MySQL 8.4 Release Notes

Abstract

This document contains release notes for the changes in MySQL 8.4. For information about changes in a different version of MySQL, see the release notes for that version.

For additional MySQL 8.4 documentation, see the MySQL 8.4 Reference Manual, which includes an overview of features added in MySQL 8.4 (What Is New in MySQL 8.4 since MySQL 8.0), and discussion of upgrade issues that you may encounter while upgrading.

MySQL platform support evolves over time; please refer to https://www.mysql.com/support/supportedplatforms/database.html for the latest updates.

Updates to these notes occur as new product features are added, so that everybody can follow the development process. If a recent version is listed here that you cannot find on the download page (https://dev.mysql.com/downloads/), the version has not yet been released.

The documentation included in source and binary distributions may not be fully up to date with respect to release note entries because integration of the documentation occurs at release build time. For the most up-to-date release notes, please refer to the online documentation instead.

For legal information, see the Legal Notices.

For help with using MySQL, please visit the MySQL Forums, where you can discuss your issues with other MySQL users.

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Preface and Legal Notices

This document contains release notes for the changes in MySQL 8.4.

Legal Notices

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Changes in MySQL 8.4.0 (2024-04-30, LTS Release)

Audit Log Notes

- Invoking `audit_api_message_emit_udf()` with arguments of mixed types could lead to an unplanned shutdown of the server. (Bug #36301441)
- Audit log filtering by type, using error as the type, did not work correctly. (Bug #36142157)
- Following an unplanned shutdown and restart, the file that was in use by the server for writing at the time may be broken or otherwise unreadable. The Audit Log plugin log message indicating unreadability of the file was shown as an error; now instead this message is treated as a warning. (Bug #36118809)

C API Notes

- **Important Change:** The following MySQL C API functions, removed in MySQL 8.3, have been reimplemented and restored in MySQL 8.4.0:
  - `mysql_kill()`: In place of `COM_PROCESS_KILL` (removed), this function has been reimplemented such that it uses `mysql_real_query()` to execute `KILL`.

  - `mysql_list_fields()`: Restored as previously implemented, along with `COM_FIELD_LIST`.
  - `mysql_list_processes()`: Reimplemented using `mysql_real_query()` to execute `SHOW PROCESSLIST`, in place of `COM_PROCESS_INFO` (removed).
  - `mysql_refresh()`: Reimplemented using `mysql_real_query()` to execute `FLUSH` statements in place of `COM_REFRESH`, which was removed in MySQL 8.3.
  - `mysql_reload()`
  - `mysql_shutdown()`: Reimplemented using mysql_real_query() to execute a shutdown command rather than `COM_SHUTDOWN`, removed in MySQL 8.3.
  - `mysql_ssl_set()`
  - `mysql_stmt_bind_param()`

  The functions just listed are supported for the lifetime of the MySQL 8.4 series. (WL #16221)

- **Microsoft Windows:** Third party DLL files on which MySQL plugins depend are located, when installed, in the same directory as the MySQL executables. The default Windows behavior is to look for dependences in the same directory as the current executable, which is not appropriate for clients using `libmysql.dll` outside of the installation directory.

  We fix this by that changing the default behavior of MySQL clients so that the loader looks for dependencies in the directory of current module (the executable or `libmysql.dll`). In addition, since `libsasl.dll` expects to load all its required dependencies from a directory of its won, SASL plugins are now located in a dedicated subdirectory. (Bug #36006295)

Character Set Support

- When the `character_set_server` system variable was set using `SET PERSIST` or `SET GLOBAL`, it did not take effect for new client sessions or for a client establishing a connection to the server after the server was restarted. The only workaround was to set the corresponding command-line option when starting the server.

  To fix this, we now make sure that, at the time of server restart, the configuration data is read in the correct order so that the variable setting takes effect as expected. (Bug #35529604)

Compilation Notes

- The `libevent` library has been removed. (Bug #36357190)
- Added the `libcno` library. (Bug #36357181)
- Some of the files in `extra/libbacktrace` contained incorrect licensing information, copyright information, or both. (Bug #36118772)

Configuration Notes

- **Microsoft Windows:** On Windows, *MySQL Configurator* incorrectly altered the configuration settings after the **Back** and **Next** buttons were used. (Bug #36156577)
- **Microsoft Windows:** On Windows, *MySQL Configurator* no longer opens when removing a MySQL Server that was not configured. (Bug #35709927)
- **Microsoft Windows:** On Windows, *MySQL Configurator* stopped adding the `default_authentication_plugin` variable to the generated `my.ini` file, a variable removed in MySQL Server 8.4. It also removes it when upgrading an installation to MySQL 8.4. Note that the replacement variable `authentication_policy` is not set by *MySQL Configurator*. (WL #16137)

- **Microsoft Windows:** On Windows, *MySQL Configurator* no longer allows upgrading from MySQL 5.7 or earlier, when before it allowed the upgrade to execute after stating that it was not officially supported. (WL #16138)

Deprecation and Removal Notes

- **Important Change:** The deprecated `mysql_native_password` authentication plugin is now disabled by default. It can be enabled by starting MySQL with the new `--mysql-native-password=ON` server option, or by adding `mysql_native_password=ON` to the `[mysqld]` section of your MySQL configuration file.

  For more information, see Native Pluggable Authentication. (Bug #36337893)

- **Replication:** Syntax for a number of features relating to MySQL Replication that was deprecated in previous versions of MySQL has now been removed. These features include aspects of SQL statement syntax as well as several system status variables in the MySQL server. These changes are detailed following.

  SQL statements removed. The following SQL statements have been removed (replacements in brackets): `START SLAVE` (`START REPLICA`); `STOP SLAVE` (`STOP REPLICA`); `SHOW SLAVE STATUS` (`SHOW REPLICA STATUS`); `SHOW SLAVE HOSTS` (`SHOW REPLICAS`); `RESET SLAVE` (`RESET REPLICA`); `CHANGE MASTER TO` (`CHANGE REPLICATION SOURCE TO`); `RESET MASTER` (`RESET BINARY LOGS AND GTIDS`); `SHOW MASTER STATUS` (`SHOW BINARY LOG STATUS`); `PURGE MASTER LOGS` (`PURGE BINARY LOGS`); and `SHOW MASTER LOGS` (`SHOW BINARY LOGS`).

  The statements just listed have also been removed from all MySQL test programs and files, and elsewhere, where used internally.

  Statement options removed. The following options formerly supported by `CHANGE REPLICATION SOURCE TO` and `START REPLICA` have been removed and are no longer accepted by the server. They are listed here for each of these statements, with their replacements in brackets:

  - `CHANGE REPLICATION SOURCE TO` options removed:

    `MASTER_AUTO_POSITION` (`SOURCE_AUTO_POSITION`), `MASTER_HOST` (`SOURCE_HOST`), `MASTER_BIND` (`SOURCE_BIND`), `MASTER_USER` (`SOURCE_USER`), `MASTER_PASSWORD` (`SOURCE_PASSWORD`), `MASTER_PORT` (`SOURCE_PORT`), `MASTER_CONNECT_RETRY` (`SOURCE_CONNECT_RETRY`), `MASTER_RETRY_COUNT` (`SOURCE_RETRY_COUNT`), `MASTER_DELAY` (`SOURCE_DELAY`), `MASTER_SSL` (`SOURCE_SSL`), `MASTER_SSL_CA` (`SOURCE_SSL_CA`), `MASTER_SSL_CAPATH` (`SOURCE_SSL_CAPATH`), `MASTER_SSL_CIPHER` (`SOURCE_SSL_CIPHER`), `MASTER_SSL_CRL` (`SOURCE_SSL_CRL`), `MASTER_SSL_CRLPATH` (`SOURCE_SSL_CRLPATH`), `MASTER_SSL_KEY` (`SOURCE_SSL_KEY`), `MASTER_SSL_VERIFY_SERVER_CERT` (`SOURCE_SSL_VERIFY_SERVER_CERT`), `MASTER_TLS_VERSION` (`SOURCE_TLS_VERSION`), `MASTER_TLS_CIPHERSUITES` (`SOURCE_TLS_CIPHERSUITES`), `MASTER_SSL_CERT` (`SOURCE_SSL_CERT`), `MASTER_PUBLIC_KEY_PATH` (`SOURCE_PUBLIC_KEY_PATH`), `GET_MASTER_PUBLIC_KEY` (`GET_SOURCE_PUBLIC_KEY`), `MASTER_HEARTBEAT_PERIOD` (`SOURCE_HEARTBEAT_PERIOD`), `MASTER_COMPRESSION_ALGORITHMS` (`SOURCE_COMPRESSION_ALGORITHMS`), `MASTER_ZSTD_COMPRESSION_LEVEL` (`SOURCE_ZSTD_COMPRESSION_LEVEL`), `MASTER_LOG_FILE` (`SOURCE_LOG_FILE`), and `MASTER_LOG_POS` (`SOURCE_LOG_POS`).

  - `START REPLICA` options removed: `MASTER_LOG_FILE` (`SOURCE_LOG_FILE`) and `MASTER_LOG_POS` (`SOURCE_LOG_POS`).

  Status variables removed. Also as part of this work, the following system status variables have been removed from the server, and no longer appear in the output of statements such as `SHOW STATUS`. These variables are listed here, with their replacements in brackets: `Com_slave_start` (`Com_replica_start`); `Com_slave_stop` (`Com_replica_stop`); `Com_show_slave_status` (`Com_show_replica_status`); `Com_show_slave_hosts` (`Com_show_replicas`);

`Com_show_master_status` (`Com_show_binary_log_status`); and `Com_change_master` (`Com_change_replication_source`).

See also Com_xxx Variables. (WL #15831, WL #16063, WL #16069, WL #16086, WL #16087, WL #16088, WL #16089, WL #16090)

- **Group Replication:** The `group_replication_allow_local_lower_version_join` system variable is now deprecated, and setting it raises a warning (`ER_WARN_DEPRECATED_SYNTAX_NO_REPLACEMENT`).

  You should expect this variable to be removed in a future version of MySQL. Since there is no longer any reason to allow incompatible members to join a group, no replacement for this functionality is planned. (WL #16018)

- A number of server options and variables supported in previous versions of MySQL have been removed in this release. Attempting to set any of them in MySQL 8.4 raises an error. These options and variables are listed here:

  - `binlog_transaction_dependency_tracking`: Deprecated in MySQL 8.0.35 and MySQL 8.2.0.

    There are no plans to replace this variable or its functionality, which has been made internal to the server: Now, when multithreaded replicas are in use, the source `mysqld` uses always writesets to generate dependency information for the binary log; this has the same effect as setting `binlog_transaction_dependency_tracking` to `WRITESET` in previous versions of MySQL.

  - `group_replication_recovery_complete_at`: Deprecated in MySQL 8.0.34.

    Beginning with this release, the policy applied during the distributed recovery process is always to mark a new member online only after it has received, certified, and applied all transactions that took place before it joined the group; this is equivalent to setting `group_replication_recovery_complete_at` to `TRANSACTIONS_APPLIED` in previous versions of MySQL.

  - `avoid_temporal_upgrade` and `show_old_temporals`: Both deprecated in MySQL 5.6. Each of these variables no longer had any effect, and has been removed. There are no plans to replace either variable.

  - `--no-dd-upgrade`: Deprecated in MySQL 8.0.16, now removed. Use `--upgrade=NONE` instead.

  - `--old` and `--new`: Both deprecated in MySQL 8.0.35 and MySQL 8.2.0, and now removed.

  - `--language`: This option was deprecated in MySQL 5.5, and has now been removed.

  - The `--ssl` and `--admin-ssl` server options, as well as the `have_ssl` and `have_openssl` server system variables, were all deprecated in MySQL 8.0.26, and are all removed in this release. Use `--tls-version` and `--admin-tls-version` instead.

  - `default_authentication_plugin`: Deprecated in MySQL 8.0.27, and now removed. Use `authentication_policy` instead.

    You should also be aware that the syntax for setting the `authentication_policy` variable has changed; see its description in the Manual for more information.

  (Bug #36337893, WL #9677, WL #13965, WL #15461, WL #15839, WL #16056, WL #16058, WL #16059, WL #16095)

- In cases where an aliased table was referenced in `EXPLAIN` output, the table name was qualified with a schema name, which was not necessary and could result in confusion. These schema qualifications have been removed from the output. (Bug #36053664)

- The unused `INFORMATION_SCHEMA.TABLESPACES` table, deprecated in MySQL 8.0.22, has now been removed.

  For `InnoDB` tables, the Information Schema `INNODB_TABLESPACES` and `INNODB_DATAFILES` tables provide tablespace metadata. (WL #14065)

- `LOW_PRIORITY` used with `LOCK TABLES ... WRITE` had had no effect since MySQL 5.5, and was deprecated in MySQL 5.6. It is removed in this release; including `LOW_PRIORITY` in `LOCK TABLES` now causes a syntax error. (WL #16057)

- Support for use of the `AUTO_INCREMENT` modifier with `FLOAT` and `DOUBLE` columns was deprecated in MySQL 8.0, and is now removed. Attempting to use these together in `CREATE TABLE` and `ALTER TABLE` statements now causes an `Incorrect column specifier for column` error (`ER_WRONG_FIELD_SPEC`).

  

  Important

  Prior to upgrading to this release, you *must* alter any table having a `FLOAT ... AUTO_INCREMENT` or `DOUBLE ... AUTO_INCREMENT` column that it no longer uses either of these. Otherwise, the table cannot be upgraded.

  (WL #13103)

- The `mysql_ssl_rsa_setup` utility, which was deprecated in MySQL 8.0.34, is removed in this release. For MySQL distributions compiled using OpenSSL, the MySQL server can perform automatic generation of missing SSL and RSA files at startup. For more inforamtion, Creating SSL and RSA Certificates and Keys using MySQL. (WL #16205)

- This release removes support for the `ENGINE` clause from the following SQL statements:

  - `DROP TABLESPACE` (all variants)
  - `ALTER TABLESPACE ... DROP DATAFILE`
  - All other variants of `ALTER TABLESPACE`, with the two exceptions listed here:

    1. `ALTER TABLESPACE ... ADD DATAFILE ENGINE={NDB|NDBCLUSTER}`
    2. `ALTER UNDO TABLESPACE ... SET {ACTIVE|INACTIVE} ENGINE=INNODB`

  Other than in the exceptional cases listed previously, use of the `ENGINE` clause with `ALTER TABLESPACE` or `DROP TABLESPACE` causes the statement to be rejected with an error.

  `ENGINE` clauses for the `ALTER TABLESPACE` and `DROP TABLESPACE` statements were deprecated in MySQL 8.0. (WL #16055)

- The `SET_USER_ID` privilege, deprecated in MySQL 8.2.0, has been removed in this release, and its use in `GRANT` statements now causes a syntax error. Use the `SET_ANY_DEFINER` and `ALLOW_NONEXISTENT_DEFINER` privileges instead. (WL #15875)

- Removed the deprecated `mysql_upgrade` utility, which provided no functionality since MySQL 8.0.16. (WL #16096)

- Removed the deprecated `mysqlpump` utility along with its associated `lz4_decompress` and `zlib_decompress` helper utilities. Instead, use `mysqldump` or MySQL Shell's dump utilities. (WL #16096)

- The following plugins have been removed. They are noted in the list provided here, along with any server system variables, CMake options, and other features associated with them which have also been removed:

  - `authentication_fido`, `authentication_fido_client`: Use `authentication_webauthn` instead; see WebAuthn Pluggable Authentication.

    The `authentication_fido_rp_id` server system variable, `mysql` client `--fido-register-factor` option, and the `-DWITH_FIDO` CMake option have also been removed.

  - `keyring_file`: Use `component_keyring_file` instead; see Using the component_keyring_file File-Based Keyring Component.

    The `keyring_file_data` system variable has also been removed. In addition, the CMake options `-DINSTALL_MYSQLKEYRINGDIR` and `-DWITH_KEYRING_TEST` have been removed.

  - `keyring_encrypted_file`: Use `component_keyring_encrypted_file` instead; see Using the component_keyring_encrypted_file Encrypted File-Based Keyring Component.

    The `keyring_encrypted_file_data` and `keyring_encrypted_file_password` server system variables have also been removed.

  - `keyring_oci`: Use `component_keyring_oci` instead; see Using the Oracle Cloud Infrastructure Vault Keyring Component.

    The following server system variables have also been removed: `keyring_oci_ca_certificate`, `keyring_oci_compartment`, `keyring_oci_encryption_endpoint`, `keyring_oci_key_file`, `keyring_oci_key_fingerprint`, `keyring_oci_management_endpoint`, `keyring_oci_master_key`, `keyring_oci_secrets_endpoint`, `keyring_oci_tenancy`, `keyring_oci_user`, `keyring_oci_vaults_endpoint`, and `keyring_oci_virtual_vault`.

  - `openssl_udf`: Use the MySQL Enterprise Encryption component instead; see MySQL Enterprise Encryption.

  (WL #15937, WL #15938, WL #15939, WL #15941, WL #16140)

- Support for weak encryption ciphers has been removed. This means that, when configuring encrypted connections, MySQL no longer allows specifying any cipher that does not meet the following conditions:

  - Proper TLS version (TLS v1.2 or TLSv1.3, as appropriate)
  - Forward secrecy
  - SHA2 in cipher, certificate, or both
  - AES in GCM or any other AEAD algorithms or modes

  This has implications for setting the system variables `ssl_cipher`, `admin_ssl_cipher`, `tls_ciphersuites`, and `admin_tls_ciphersuites`. See the descriptions of these variables for their permitted values.

  You should be aware that `libmysqlclient` is not affected in this change, and continues to support ciphers that do not satisfy its conditions so that it can continue to connect to previous versions of MySQL. (WL #15801)

- The use of non-unique or partial keys as foreign keys is deprecated in MySQL. Beginning with this release, you must explicitly enable such nonstandard keys in one of the ways listed here:

  - Set `restrict_fk_on_non_standard_key` (added in this release) to `OFF`.
  - Start the server with the `--skip-restrict-fk-on-non-standard-key` option (also new in this release).

  The `restrict_fk_on_non_standard_key` server system variable is `ON` by default. This means that any attempt to use a nonstandard key as a foreign key in a `CREATE TABLE` or `ALTER TABLE` statement is rejected with the error `ER_FK_NO_INDEX_PARENT`; setting it to `ON` allows such statements to run, but they raise `ER_WARN_DEPRECATED_NON_STANDARD_KEY` as a warning.

  Upgrades to MySQL 8.4 releases from MySQL 8.0 are supported even if the old database contains one or more foreign keys referring to non-unique or partial keys. As part of the upgrade process, the server prints a list of warning messages with the names of those foreign keys referring to nonstandard keys.

  See the description of `restrict_fk_on_non_standard_key` for more information. (WL #15699)

  References: See also: Bug #30615520, Bug #97836.

Firewall Notes

- Following an upgrade, some MySQL Firewall stored procedures were not updated as expected. (Bug #36084930)
- Several enhancements have been made in the stored procedures provided by MySQL Enterprise Firewall. These improvements are listed here:

  - Stored procedures provided by MySQL Enterprise Firewall are now transactional. When an error occurs during execution of a firewall stored procedure, an error is reported, and all changes made by the stored procedure up to that point in time are rolled back.
  - Firewall stored procedures now avoid performing unnecessary combinations of `DELETE` plus `INSERT` statements, as well as those of `INSERT IGNORE` plus `UPDATE` operations, making them faster and more efficient.
  - User-based stored procedures and UDFs, previously deprecated, now raise a deprecation warning, such that calling either of `sp_set_firewall_mode()` or `sp_reload_firewall_rules()` now generates such a warning. See Firewall Account Profile Stored Procedures, as well as Migrating Account Profiles to Group Profiles, for more information.

  (WL #15790)

INFORMATION_SCHEMA Notes

- Fixed a potential race condition in the `PROCESSLIST` table. (Bug #35509371)

Keyring Notes

- Migration from a keyring component to a keyring plugin is now supported. To perform such a migration, use the `--keyring-migration-from-component` server option introduced in this release, setting `--keyring-migration-source` to the name of the source component, and `--keyring-migration-destination` the name of the target plugin.

  See Key Migration Using a Migration Server, for more information. (WL #16017)

Optimizer Notes

- This release adds support for automatic updates of histograms. When this feature is enabled for a given histogram, the histogram is updated whenever `ANALYZE TABLE` is run on the parent table. Automatic recalculation of persistent statistics by `InnoDB` also updates the histogram when automatic updates are enabled.

  Automatic histogram updates use the same number of buckets as the histogram was originally specified with, if any.

  To enable automatic histogram updates, include the `AUTO UPDATE` option (added in this release) for the `ANALYZE TABLE` statement. To disable it, include `MANUAL UPDATE` instead. `MANUAL UPDATE` (no automatic updates) is the default if neither option is specified. When upgrading to this release, existing histograms are treated as though they had been created using `MANUAL UPDATE`.

  For more information, see Histogram Statistics Analysis. See also Configuring Persistent Optimizer Statistics Parameters. (Bug #36053241, WL #15786)

- The multi-range read (MRR) optimization did not perform as well as in previous releases. (Bug #113711, Bug #36220640)

Performance Schema Notes

- User variables assigned decimal values were rounded up in the `user_variables_by_thread` table. (Bug #35781732)

Server Administration

- **Important Change:** This release adds a privilege which is specific to the use of the `FLUSH PRIVILEGES` statements. Unlike the existing `RELOAD` privilege, the new `FLUSH_PRIVILEGES` privilege applies only to `FLUSH PRIVILEGES` statements. This privilege is global in scope, and is applicable to users and roles.

  The `RELOAD` privilege continues to be supported in this capacity to provide backwards compatibility; users having this privilege can still execute `FLUSH PRIVILEGES` statements following an upgrade. As part of upgrading to a MySQL 8.4 release, a check is performed to see whether there are any users having the `FLUSH_PRIVILEGES` privilege; if there are none, users having the `RELOAD` privilege are automatically assigned the new privilege as well. (WL #16044)

- **Important Change:** This release adds a new `OPTIMIZE_LOCAL_TABLE` privilege. Users must have this privilege to execute `OPTIMIZE LOCAL TABLE` and `OPTIMIZE NO_WRITE_TO_BINLOG TABLE` statements.

  When upgrading from a previous releases, users already having the `SYSTEM_USER` privilege are automatically granted the `OPTIMIZE_LOCAL_TABLE` privilege. (WL #15819)

Thread Pool Notes

- The Performance Schema `tp_connections` thread pool plugin table contained no entries for connections that were in the `admin` group. (Bug #36296830)

Functionality Added or Changed

- **Important Change; Group Replication:** MySQL 8.0 performs special handling for group members whose version is 8.0.17 or earlier. This special handling is removed in the current release.

  Users of MySQL 8.0 are encouraged to upgrade all instances to the latest 8.0 release prior to upgrading to MySQL 8.4. (Bug #36314222)

- **Important Change; Group Replication:** The default values of two server system variables relating to Group Replication have changed:

  - The default value of the `group_replication_consistency` system variable is now `BEFORE_ON_PRIMARY_FAILOVER`; previously, this was `EVENTUAL`.
  - The default value of the `group_replication_exit_state_action` system variable is now `OFFLINE_MODE`; previously, this was `READ_ONLY`.

  For more information, see the descriptions of the variables listed, as well as Configuring Transaction Consistency Guarantees, and Responses to Failure Detection and Network Partitioning. (WL #15712, WL #15713)

- **Important Change; Group Replication:** When issued with `group_replication_consistency` set to `BEFORE_ON_PRIMARY_FAILOVER`, the MySQL `KILL` statement now ignores any consistency guarantees, with any interrupted transactions now being rolled back.
- **Important Change:** For platforms on which OpenSSL libraries are bundled, the linked OpenSSL library for MySQL Server has been updated to version 3.0.13. Issues fixed in OpenSSL version 3.0.13 are described at https://www.openssl.org/news/cl30.txt. (Bug #36261675)
- **Important Change:** Upgrading from MySQL 5.7 to MySQL 8.4 is not supported; the code and behavior was updated to reflect this. Upgrade MySQL 5.7 to 8.0 before proceeding to 8.4. (WL #15924)
- **InnoDB:** Progress messages are now logged periodically during long-running rollbacks as informational note level error messages, initially as `ER_IB_LONG_ROLLBACK_FULL` (which appends transaction information) followed by successive `ER_IB_LONG_ROLLBACK`. (WL #15822)
- **InnoDB:** Changed the default values for the following `InnoDB` configuration options: `innodb_adaptive_hash_index`, `innodb_buffer_pool_in_core_file`, `innodb_buffer_pool_instances`, `innodb_change_buffering`, `innodb_doublewrite_files`, `innodb_doublewrite_pages`, `innodb_flush_method`, `innodb_io_capacity`, `innodb_io_capacity_max`, `innodb_log_buffer_size`, `innodb_numa_interleave`, `innodb_page_cleaners`, `innodb_parallel_read_threads`, `innodb_purge_threads`, `innodb_read_io_threads`, `innodb_use_fdatasync`, `temptable_max_ram`, `temptable_max_mmap`, and `temptable_use_mmap`. The settings affected by `innodb_dedicated_server` also changed.

  For a list of new default values in comparison to MySQL 8.0, see What Is New in MySQL 8.4. (WL #16179)

- **Packaging:** Added support for Fedora 40 and Ubuntu 24.04.
- **Group Replication:** When a member rejoining a group has transactions to apply on the `group_replication_applier` channel from previous participation in the group, those transactions are applied when the member rejoins before connections to a donor during distributed recovery.

  This backlog of transactions to apply can be monitored using the `performance_schema.replication_applier_status_by_worker` table, but there was no information about it in the error log, which could lead to the mistaken impression that the server was stalled.

  Now in such cases, one of the messages `Distributed recovery will wait until the transactions ... contained on the group_replication_applier channel are applied` or `Distributed recovery finished applying the transactions ... contained on the group_replication_applier channel` is also written to the error log, as appropriate. (Bug #36229998)

- **Group Replication:** MySQL Group Replication now supports preemptive certification information garbage collection when running in single-primary mode. This feature can be enabled using the `group_replication_preemptive_garbage_collection` system

variable added in this release; when enabled, only the write sets for those transactions that have not yet been committed are kept, which can save time and memory consumption. `group_replication_preemptive_garbage_collection_rows_threshold` (also introduced in in this release) sets a lower bound on the number of certification rows needed to trigger preemptive garbage collection when the feature is enabled; the default value is 100000.

The value of `group_replication_preemptive_garbage_collection` can be changed only when Group Replication is not running, and has no effect on a group running in multi-primary mode. To change from multi-primary mode and single-primary mode, use the `group_replication_switch_to_single_primary_mode()` function; see Changing the Group Mode, for more information about this. For help with obtaining information about memory consumed by the garbage collection process, see Monitoring Group Replication Memory Usage with Performance Schema Memory Instrumentation. (WL #15923)

- The clone plugin version requirements were relaxed to allow cloning between different point releases in the same series. In other words, only the major and minor version numbers must match when previously the point release number also had to match.

  For example, clone functionality now permits cloning 8.4.0 to 8.4.14 and 8.0.51 to 8.0.37. For 8.0, previous restrictions still apply to versions older than 8.0.37, so cloning the likes of 8.0.36 to 8.0.42 or vice-versa is not permitted. (Bug #36293529, WL #15989)

- When using the iterator-based format for `EXPLAIN FORMAT=JSON` (that is, when `explain_json_format_version` is `2`), the output now contains a `query_type` field identifying the type of statement (select, insert, delete, and so on). (Bug #36134568)

Bugs Fixed

- **Important Change; Replication:** The `TRANSACTION_GTID_TAG` privilege is now required to set the `gtid_executed` server system variable. (Bug #36201133)

- **Important Change:** The Robin Hood hashing library has been replaced with `unordered_dense`. (Bug #36158022)

- **InnoDB; Microsoft Windows:** Improved redo log performance on Windows by opening redo log files in overlapped mode. (Bug #36154818)

  References: This issue is a regression of: Bug #12527.

- **InnoDB:** The log writer calls functions that temporarily releases log.writer_mutex, which in case of `innodb_log_writer_threads=OFF` potentially led to other threads writing to redo log in-between. (Bug #36425219)

- **InnoDB:** Some FTS operations on tables with FTS indexes could have caused inconsistent results. For example, if the server terminated while synchronizing the FTS cache or when synchronization occurred concurrently with another FTS operation.

  Our thanks to Yin Peng and the Tencent team for the contribution. (Bug #36343647)

- **InnoDB:** When creating an index on a table containing data, valgrind occasionally reported reads of uninitialized memory from ddl::Builder::bulk_add_row. (Bug #36342792)

- **InnoDB:** On Windows, keeping a file open without a shared write lock and attempting to acquire the `fil_shard` mutex caused a deadlock with another thread that had acquired the `fil_shard` mutex and was attempting to access the same file. (Bug #36159317)

  References: See also: Bug #32808809.

- **InnoDB:** Fixed a potential redo log rotation issue that could emit a "Found existing redo log files, but at least one is missing" error during recovery. (Bug #36124625)

- **InnoDB:** Found and fixed an assertion failure related to full-text indexes. (Bug #35836581)

- **InnoDB:** Added a log buffer check to the fil_tablespace_redo_* functions for them to better handle corrupt redo logs. (Bug #35676721)
- **InnoDB:** Improved buffer handling during the tablespace deletion process, a situation that could have potentially caused an assertion failure. (Bug #35676106, Bug #36343647)
- **InnoDB:** The redo log would potentially not log a column order change with instant DDL, which could cause an incorrect log replay during recovery. (Bug #35183686)
- **InnoDB:** With `innodb_parallel_read_threads` set to a value greater than 1, `InnoDB` unnecessarily disabled read-ahead heuristics which resulted in stalls when pages were not already in the buffer pool. (Bug #113482, Bug #36142806)
- **InnoDB:** Importing a tablespace had a hard limit of 128 characters for the imported column names, which did not properly account for variable-length encodings. It's now set to 64 * the maximum length of a multi-byte characters.

  Our thanks to Lee Adria for the contribution. (Bug #113208, Bug #36047803)
- **InnoDB:** Running a query that used a unique hash index with the TempTable storage engine could take significantly more time compared to running the query with the MEMORY engine.

  Our thanks to xiaoyang chen for the contribution. (Bug #113178, Bug #36037224, Bug #36224958)
- **InnoDB:** The redo log consumer could not advance if capacity was full and another thread was executing USER-related operations such as `CREATE USER`. This also blocked new connections, which potentially prevented the workaround solution of increasing `innodb_redo_log_capacity` size. (Bug #112608, Bug #36004840)
- **InnoDB:** In debug builds, there was an assertion failure in InnoDB's background when a transaction it wanted to acquire an MDL lock on was no longer active.

  This fix is based on a patch from Genze Wu with Alibaba, thank you for the contribution. (Bug #112424, Bug #35835864)

  References: This issue is a regression of: Bug #33700835.
- **InnoDB:** The MySQL truncate undo operation (purge thread) did not remove the `undo_{space_number}_trunc.log` file when attempting to truncate the undo tablespace. (Bug #112262, Bug #35784192)
- **InnoDB:** With `innodb_parallel_read_threads` set to a value greater than 1, InnoDB would unnecessarily request asynchronous reads which required more synchronization during I/O completion and created a bottleneck due to the limited number of available threads (`innodb_read_io_threads`) for handling I/O operations. Now this performs synchronous instead of asynchronous reads. (Bug #112137, Bug #35740866)
- **InnoDB:** A trx would unexpectedly halt after encountering an incorrect trx->in_innodb value.

  Our thanks to Shaohua Wang for the contribution. (Bug #110652, Bug #35277407)
- **InnoDB:** Fixed performance issues related to querying the `data_lock` and `data_lock_waits` tables when thousands of read-only transactions were present. (Bug #109539, Bug #34951273)
- **InnoDB:** MySQL no longer ignores the optimizer hint to use a secondary index scan, which instead forced a clustered (parallel) index scan. In addition, added the ability to provide an index hint that forces use of a clustered index. (Bug #100597, Bug #112767, Bug #31791868, Bug #35952353)

  References: This issue is a regression of: Bug #12978.
- **Replication:** `diagnostics.sql` prevented upgrades to MySQL 8.4.0 from earlier versions of MySQL when restoring from data containing old replication terminology such as `SHOW SLAVE STATUS`. (Bug #36323066)

- **Replication:** `Gtid_tagged_log_event` encoded the correct value only when the original commit timestamp was equal to the immediate commit timestamp, instead of only when they were different. (Bug #36312880)

- **Replication:** In certain cases, the `gtid_next` server system variable accepted an invalid value, displayed an invalid value after setting it (even to a legal value), or both. (Bug #36308318)

- **Replication:** The replication receiver thread did not report errors when a replication channel was configured with an unknown network namespace. The receiver thread stopped when such an error occurred but no reason for the halt was shown or logged. (Bug #36054355)

- **Replication:** With `binlog_format=ROW` and `gtid_mode=OFF`, deadlocks were sometimes reported among workers contending for the auto-increment lock when applier concurrency was high on the replica. (Bug #35851009)

- **Replication:** In certain cases, the SQL thread terminated with error `MY-001755` (`ER_MTA_CANT_PARALLEL`) when executed with the parallel applier. (Bug #35431274)

- **Replication:** Failure of `XA COMMIT` of a prepared transaction could result in transaction rollback. (Bug #33650776)

- **Replication:** The replication receiver thread stopped with an error if the replication source server sent a heartbeat event containing a binary log file position that was above the 4GB offset, due to the large size of the binary log file. A new heartbeat event (Heartbeat_log_event_v2, log event type 41) that handles the larger value correctly has been added for use in this situation. (Bug #29913991)

- **Replication:** When the server printed an `ER_REPLICA_HEARTBEAT_FAILURE` error message, it did not respect the length of the master log file name, leading to it print unrelated data. (Bug #29913928)

- **Group Replication:** Problems arose when members `M1` and `M2` were in a group, with `M1` using `u1` as its recovery user and `M2` using `u2` as its own recovery user, and both users `u1` and `u2` existing on `M1` and `M2` with all necessary privileges, and when a new member `M3` joined the group using `u2` as its recovery user. `M3` knew only of user `u2`, but did not know of user `u1`, leading `START GROUP REPLICATION` on `M2` to be rejected since `M1` was unable to connect to `M2`. This also generated a new `view_id` listing the group members as `M1` and `M2`, but `M1` nevertheless continued trying to connect to `M3`, with `M1` logging `Error in establishing mysql connection` and M3 logging `Access denied` errors for the connection attempts from `M1`.

  By design, XCom stores the last three known configurations, including references to physical connections shared among all past and present configurations. This is done to facilitate quick reconnections by nodes rejoining the group, explicitly or implicitly, and that were already present in any of those configurations.

  A side effect of this was that we might keep attempting to connect to a node that was currently not in the group. To solve this problem, we inhibit error logging if the node is not in the current configuration, in order to avoid false negatives which might lead a DBA or an operator to think mistakenly that there is a problem in the system. (Bug #36210988)

  References: See also: Bug #32592027.

- **Group Replication:** Improved handling of GTID sets. (Bug #36093405)

- **Group Replication:** Two cases were found in which a member exited the group and moved to the `ERROR` state, but did not honor the action specified by `group_replication_exit_state_action`; these are listed here:

  - When an error occurred while enabling `super_read_only`
  - When member join recovery was not possible, due to missing binary logs and clone groups on group members

  Example: When the value of `group_replication_exit_state_action` was `OFFLINE_MODE` and one of these events took place, offline mode was not enabled as expected. (Bug #36076308)

- **Group Replication:** After successfully setting a new primary, `group_replication_set_as_primary()` in some cases waited indefinitely for the operation to complete. (Bug #36059098)

- **Group Replication:** For errors affecting transactions with `AFTER` (`ER_GRP_RPL_TRX_WAIT_FOR_GROUP_PREPARE_FAILED`), the message that was written to the error log referenced a session ID instead of the UUID. (Bug #35953196)

- **Group Replication:** A group running group replication with a primary `i1` and two secondaries `i2` and `i3` started to have intermittent issues because of high memory usage on the primary. The secondaries began reporting the primary as unreachable then reachable again, and the primary began reporting the secondaries as intermittently reachable then reachable as well. Following a period of such instability, the secondaries expelled the original primary (`i1`) and elected a new one (`i2`).

  Under these conditions, queries against the `performance_schema.replication_group_members` table on the former primary (`i1`) reported `i1` as `ONLINE` and `PRIMARY`, `i2` as `ONLINE` and `SECONDARY`, and `i3` as `ONLINE` and `SECONDARY` for an extended period of time (12 hours or more) until the `mysqld` process was restarted on `i1`.

  The problems observed were found to have begun on the original primary (`i1`) when one of the secondaries was overloaded and began intermittently leaving and joining the group, its connections being dropped and recreated repeatedly on the primary server. During the reconnection process, the primary hung when trying to create the connection, thus blocking the single XCom thread. This was traced to the invocation of `SSL_connect()` on the XCom communication stack, which changed in MySQL 8.0.27 from asynchronous to synchronous form. When a node was overloaded, it might not respond to the `SSL_connect()` call, leaving the connecting end blocked indefinitely.

  To fix this, we now connect in a way that is non-blocking, and that returns in case of a timeout, leaving the retry attempts to the caller—in this specific case, the XCom thread when trying to reconnect to another node. (Bug #34348094)

- **JSON:** `JOIN` and `GROUP BY` handled some `JSON` column values differently. (Bug #101048, Bug #31969607)

- **MySQL NDB ClusterJ:** The `setLimits()` method can now be chained to `deletePersistentAll()` to limit the number of items to delete. See the description of `deletePersistentAll()` for details. (Bug #36049906)

- Events created within other stored programs were not always handled correctly. (Bug #36402968)

  References: This issue is a regression of: Bug #17809, Bug #11745618.

- The `strings` and `strings_shared` library files declared but did not supply the function `mysql::collation::find_by_id()`. (Bug #36353447)

- Raised the minimum required version of CMake to build MySQL from 3.5.1 to 3.14.6. (Bug #36338366)

References: See also: Bug #35553331.

- Configuration of the backtrace library was performed too early in the build process, and the library itself was built with an incomplete set of compiler flags, differing in both these respects from the rest of the server. (Bug #36292247)
- `SET GLOBAL offline_mode=ON` did not always perform correctly when issued under high loads. (Bug #36275182)

  References: See also: Bug #36405894.
- Upgraded `curl` to version 8.6.0. (Bug #36267545)
- Added a new error message for the case when a timeout is detected in `net_read_raw_loop()` rather than in the thread pool code. This includes information about the conditions triggering the timeout. This is an error-level message if the timeout occurs earlier than indicated by `wait_timeout`. (Bug #36250895)

  References: See also: Bug #34857147.
- `mysqldump` did not always interpret the server version correctly. (Bug #36248967)

  References: See also: Bug #36405879.
- Condition pushdown to a view was rejected with a collation mismatch if the view was created with a different character set than the character set used when querying the view. (Bug #36246859)
- Improved the SQL grammar in `sql/sql_yacc.yy` by removing four shift-reduce conflicts which were not needed. (Bug #36221823)
- Use of the deprecated `exec_program()` command has been replaced by `execute_process()` to provide compatibility with CMake 3.28.1 and later. (Bug #36220656)
- The MLE component was added to the minimal RPM build. (Bug #36210740)
- Some queries using `NULLIF()` and `EXCEPT` raised an assertion in `set_typelib()`. (Bug #36151537)

  References: See also: Bug #33045412.
- Certain queries raised an assertion in `EstimateDeleteRowsCost()`. (Bug #36130806)

  References: This issue is a regression of: Bug #35590128.
- A query of the form `SELECT 1 FROM t WHERE CAST(a AS UNSIGNED INTEGER) = 1 AND a = (SELECT 1 FROM t)` led to an assertion in `item_func.cc`. (Bug #36128964)
- When selecting two empty strings that were combined with `UNION` as in `SELECT '' AS a UNION SELECT '' AS b`, the type of the resulting data was `CHAR(0)` instead of `VARCHAR(0)`.

  We fix this by removing an exception that was made for strings of length 0. (Bug #36112585)
- Upgraded the `protobuf` library to version 25.1. (Bug #36108397)
- For building Enterprise Linux RPMs, the build scripts now point to a newer `strip` command (under `/opt/rh/gcc-toolset-12`), and they now check that the corresponding `dwz` tool is available. Previously this was only implemented for EL8. (Bug #36090069)
- We now look for `gcc-ar` and `gcc-ranlib` when building on Oracle Linux with link-time optimization. (Bug #36089900)
- Use `sa_sigaction` rather than `sh_handler` for catching fatal signals, which allows the signal handler to output more information when handling `SIGSEGV` or `SIGFPE` signals. (Bug #36082110)

- The MySQL client was unable to authenticate with mysql_native_password to old MySQL Server versions that don't support pluggable authentication, such as MySQL 5.0.15. (Bug #36066161)
- Improved the messages written to the log during a server downgrade. (Bug #36053108)
- Keyring component error logging now supplies more information than previously when the component is unable to initialize. (Bug #36037172)
- Set `_ITERATOR_DEBUG_LEVEL` to `0` when compiling debug builds on Windows using Clang. (Bug #36032501)
- When performing a rollup on an `ENUM` or `SET` column, an assertion was raised in `sql/item_sum.cc` during resolution when type information for neither of these types could be found. (Bug #36028294)

  References: See also: Bug #33045412.
- When a Common Table Expression (CTE) contained an `INTERSECT` or `EXCEPT` set operation, the second use of the same CTE in a subsequent join returned a wrong result. (Bug #36002215)
- Killing a query, while it was evaluating an uncorrelated subquery containing a hash join during optimization, led to an assert in `sql/sql_select.cc`. (Bug #35991384)
- The server sometimes terminated unexpectedly in response to a specific query. (Bug #35957627)
- A rollup query with a window function such as `COUNT()` in the select list, which was also partof an `ORDER BY`, led to an unexpected shutdown of the server. (Bug #35947358)

  References: This issue is a regression of: Bug #33069747.
- Improved view and trigger definer handling by view and table DDL. (Bug #35942937)
- The server did not always return metadata to the client correctly for certain queries. (Bug #35904044)
- Found and fixed an assertion failure at `handler::ha_index_end()` in `handler.cc`. (Bug #35877600)
- For a query such as `SELECT DISTINCT t1.x, t2.x FROM t AS t1, t AS t2 WHERE t1.pk = t2.x`, where `t1.pk = t2.x` and `pk` is the primary key, there is a functional dependency `t2.x->t1.x`. This means that some candidate plans grouped on `{t2.x, t1.x}` and others on `{t1.x}`, which were both valid but yielded different row estimates for two sets of fields, since this did not take functional dependencies into account.

  Now we ensure that we perform a single calculation of the number of distinct rows, and use that number for all plan candidates. (Bug #35855573)
- When running queries against a table with a multi-value index, the server sometimes exited unexpectedly, often while executing a complex `SELECT` query which used this index. (Bug #35789759)
- Improved code in `sql/item_subselect.cc`. (Bug #35733778, Bug #35738531, Bug #35779012)
- Some aggregations of window functions were not handled correctly. (Bug #35560806)
- `CREATE USER IF EXISTS` was not always logged correctly. (Bug #35530823)
- The server did not disallow subqueries in partition expressions properly. These are invalid, and should cause a syntax error. (Bug #35476172)
- Upgraded the minimum Boost version used to 1.84.0. (Bug #35259498)
- Some `RANK() ... OVER()` queries raised an assertion in `sql/sql_executor.cc`. (Bug #35228083)

- When successive `ALTER TABLE ... ALGORITHM=COPY` statements were issued within 10 seconds of one another, the `n_rows` value became 0. (Bug #35127747)

- Running two concurrent `OPTIMIZE TABLE` statements on the same table with fulltext indexes and `innodb_optimize_fulltext_only` enabled sometimes caused the server to exit. (Bug #34929814)

- Removed a memory leak observed while running `authentication_kerberos` under Valgrind. (Bug #34482788)

- A query using `MAX(column)` gave different results before and after an index was added to the column. (Bug #34057432)

- Some queries that used the `LEAD()` or `LAG()` window functions on a column of type `SET` or `ENUM` hit an assertion during resolution. The same assertion was hit in some queries using the `LEAST()` or `GREATEST()` function on a `SET` or `ENUM` column. (Bug #33045412)

- When adding a `HAVING` condition to a temporary table, it is expected that all the fields in the `HAVING` condition are already replaced with the temporary table fields, but for a query which had an expression involving the internal `Item_row` type in the `HAVING` clause, constant expressions were not getting cached, so that the `HAVING` clause still held references to the fields from the underlying tables. (Bug #30112096)

- In queries that materialized rows in a temporary table before performing hash join or streaming aggregation, data was sometimes copied twice from the temporary table to the join buffer or aggregation buffer. While this did not cause any wrong results, it led to inefficient use of buffer space with a possible negative impact on performance.

  This was due to the internal `WalkTablesUnderAccessPath()` function visiting tables in `MATERIALIZE` access paths twice: first when it saw the `MATERIALIZE` access path itself, and then again when it visited the `table_path` member of the MATERIALIZE access path.

  We fix this by not visiting the table when seeing the `MATERIALIZE` path, and doing so only when seeing the `table_path` below `MATERIALIZE`. (Bug #113647, Bug #36190386)

- Updated the URL used for downloading the Boost C++ libraries. (Bug #113576, Bug #36164514)

- In the debug server, an intersection comparing columns of different types sometimes triggered an assert in `sql/item.cc`. (Bug #113385, Bug #36094867)

- A transform could be semantically invalid when the selected item in the subquery tested for `NULL`; the left outer join with a grouped derived table might in such cases produce `NULL` while the original subquery might not. To prevent this from happening, we now bar such subqueries from being transformed. (Bug #113318, Bug #36070542)

- The fix for a previous issue, first addressed in MySQL 8.0.30, was incomplete.

  Our thanks to Hao Lu for the contribution. (Bug #113174, Bug #36035044)

  References: This issue is a regression of: Bug #110801, Bug #35328028.

- On s390x, we now compile the FMA test with `-O2` to avoid overoptimization.

  Our thanks to Jonathan Albrecht for the contribution. (Bug #113096, Bug #36016140)

- Although s390x is a big-endian platform, the little-endian ICU data directory was used for compiling.

  Our thanks to Jonathan Albrecht for the contribution. (Bug #113095, Bug #36016141)

- `SET SESSION optimizer_switch = 'hash_set_operations=off'` after preparing a statement led to an assertion in `sql/sql_select.cc` when trying to execute the same prepared statement. (Bug #112919, Bug #35970620)

- The server now uses `ER_NO_REFERENCED_ROW_2` or `ER_ROW_IS_REFERENCED_2` for foreign key errors whether error details are displayed, or not. In addition, we now display parent and child table details in error messages when the user has the proper grants. (Bug #112589, Bug #35868410)

- Incorrect results were sometimes obtained from a query that used a group by loose index scan. (Bug #112541, Bug #35854362)

- An assertion in `sql/sql_derived.cc` that checked whether a referenced item in an `Item_ref` object had consistent outer reference information failed when the reference was of type `OUTER_REF`. For objects of type `Item_outer_ref`, dependency information was set for the `Item_outer_ref` object and the original expression that this reference points to, but an intermediate reference object between the `Item_outer_ref` and the original expression did not contain this information. (Bug #112478, Bug #35846847)

- An assertion failed in debug builds when inserting data with a zero-length column, such as `CHAR(0)` or `BINARY(0)`, into a table. Now, a less strict assertion more accurately fails only if it detects that a non-zero number of bytes copied from a source is identical to the target. (Bug #111450, Bug #35507763)

- MySQL did not build correctly using the `musl` version of `libc`.

  Our thanks to Sam James for the contribution. (Bug #110808, Bug #35330950)

- Using a default string histogram on a `TEXT` column raised an assertion due to a collation mismatch when comparing histograms bucket values with the string returned by `REVERSE(1)`. (Bug #110527, Bug #35227319)

- A `VALUES` statement in a correlated lateral or (other) dependent subquery yielded an incorrect result. (Bug #109252, Bug #110076, Bug #34852090, Bug #35087820)