QINGCLOUD

MaterializeMySQL:
MySQL 到 ClickHouse 的高速公路

演讲人：邰翀

About Me

- Active contributor of ClickHouse & Xenon
  - MaterializeMySQL
  - MySQL Database Engine
  - And more 40+ features

https://tceason.github.io/

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目录

- MySQL 复制历程
- ClickHouse 同步 MySQL 数据
- MaterializeMySQL Engine
- HTAP 应用场景

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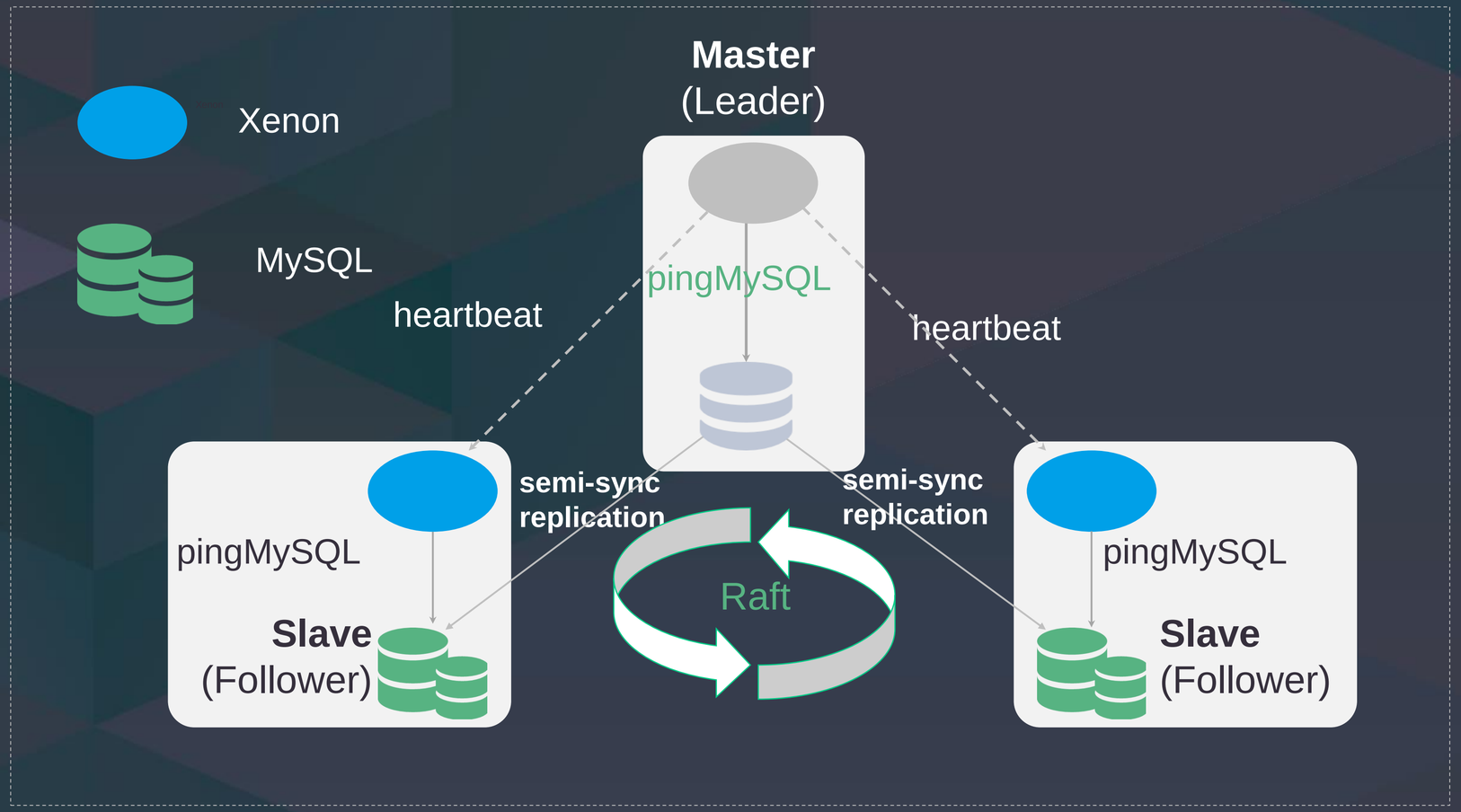
MySQL 复制历程

MySQL 复制历程


MySQL 3.23 (2001) 开始支持复制
MySQL 5.1.5 (2006-01-10) binlog支持行模式（row-based）
MySQL 5.5.0 (2009-12-07) semi-sync replication
MySQL 5.6.0 (2011) delayed replication
MySQL 5.6.3 (2011-10-03) 基于库的并行复制
MySQL 5.6.5 (2012-04-10) GTID
MySQL 5.7.2 (2013-09-21) lossless replication
MySQL 5.7.5 (2014-09-25) mutli-source replication
MySQL 5.7.x 基于组提交（事务级）的并行复制
MySQL 5.7.17(2016-10-12) group replication（MGR）
MySQL 8.0.1(2017-04-10) group replication（MGR）、基于WriteSet（记录级）的并行复制
MySQL 5.7.22(2018-04-19) 基于WriteSet（记录级）的并行复制

MySQL 复制历程



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MySQL 复制历程

MySQL Plus

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MySQL 复制历程

集群数据强一致

主从秒级切换

无中心化自动选主

跨区容灾

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但是，如何加速 OLAP 查询？？？

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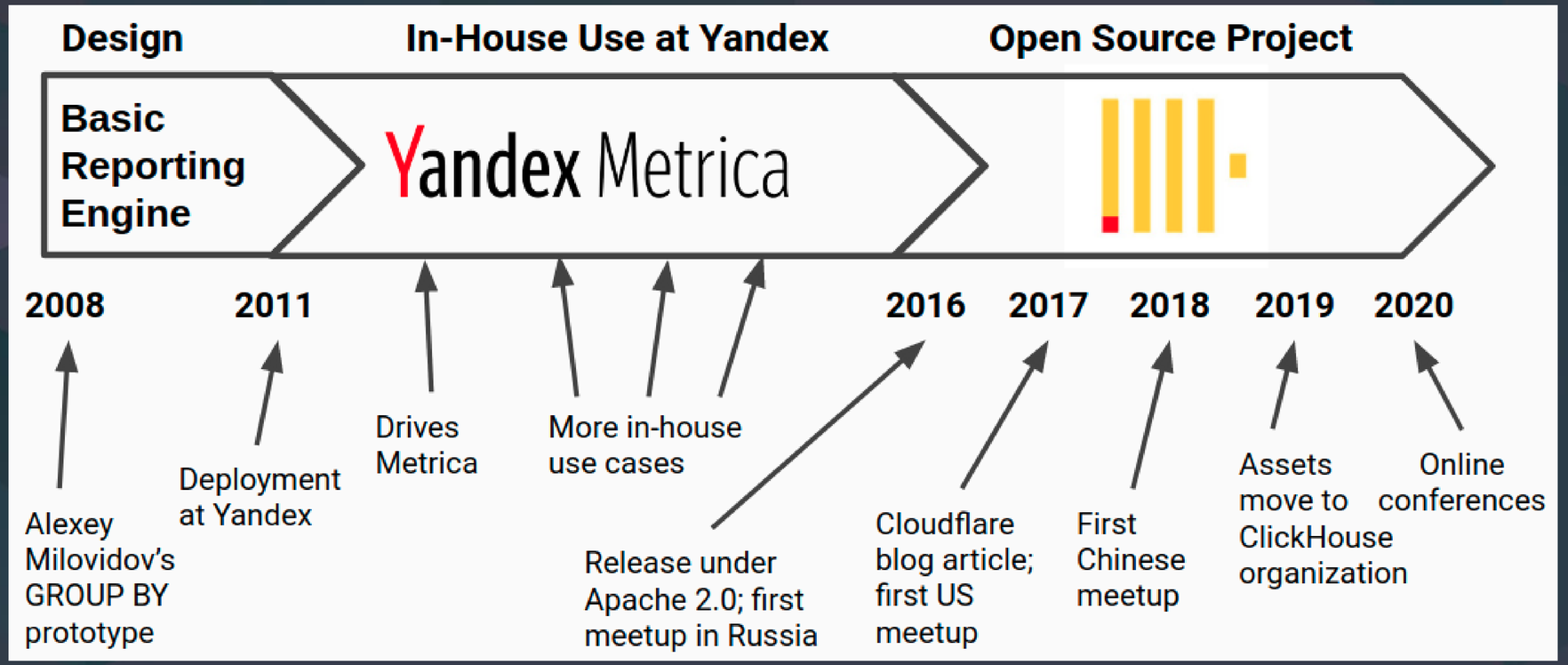
ClickHouse 同步 MySQL 数据

ClickHouse 同步 MySQL 数据



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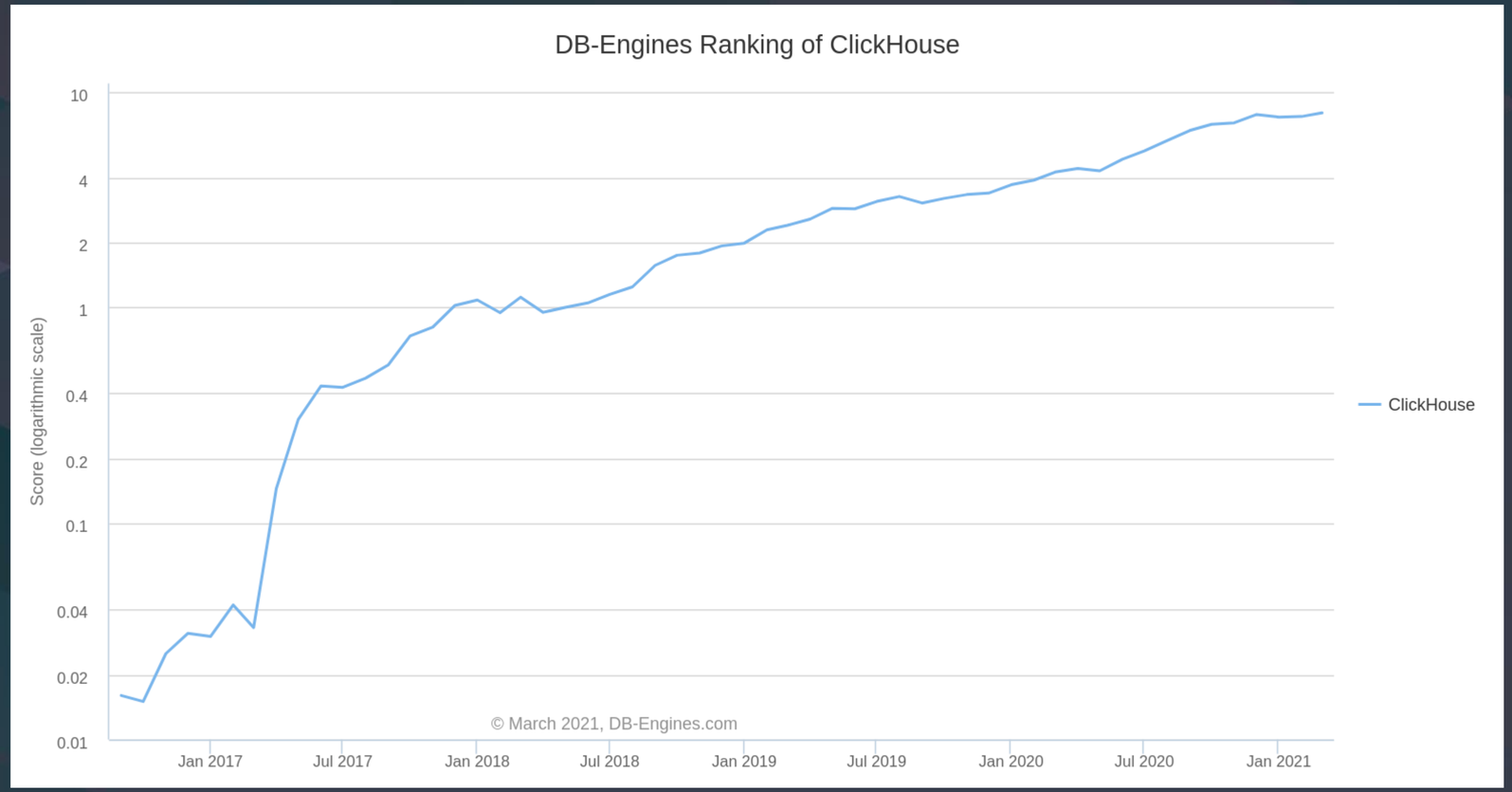
ClickHouse 同步 MySQL 数据



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ClickHouse 同步 MySQL 数据

- MySQL Table Engine
  - Mapping to MySQL table
  - Fetch table struct from MySQL
  - Fetch data from MySQL when execute query

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ClickHouse 同步 MySQL 数据

- MySQL Database Engine
  - Mapping to MySQL Database
  - Fetch table list from MySQL
  - Fetch table struct from MySQL
  - Fetch data from MySQL when execute query

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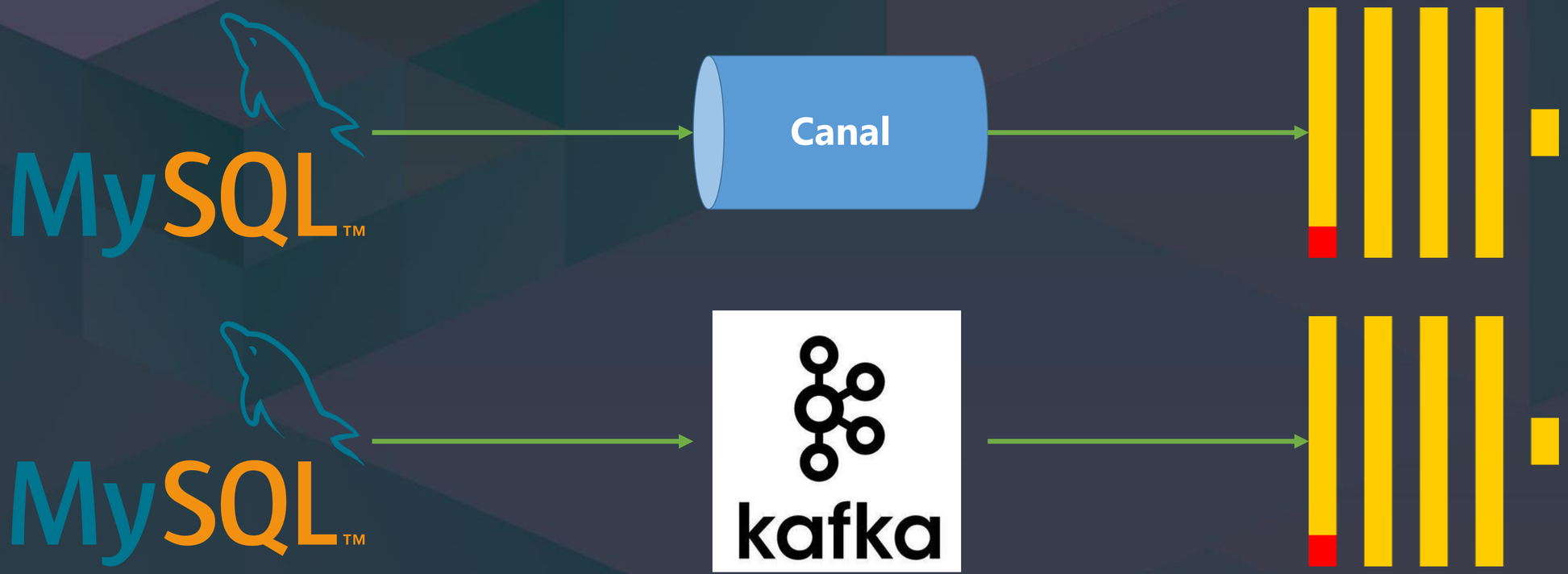
ClickHouse 同步 MySQL 数据

- Some others



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ClickHouse

能否主动同步并订阅

MySQL ？？？

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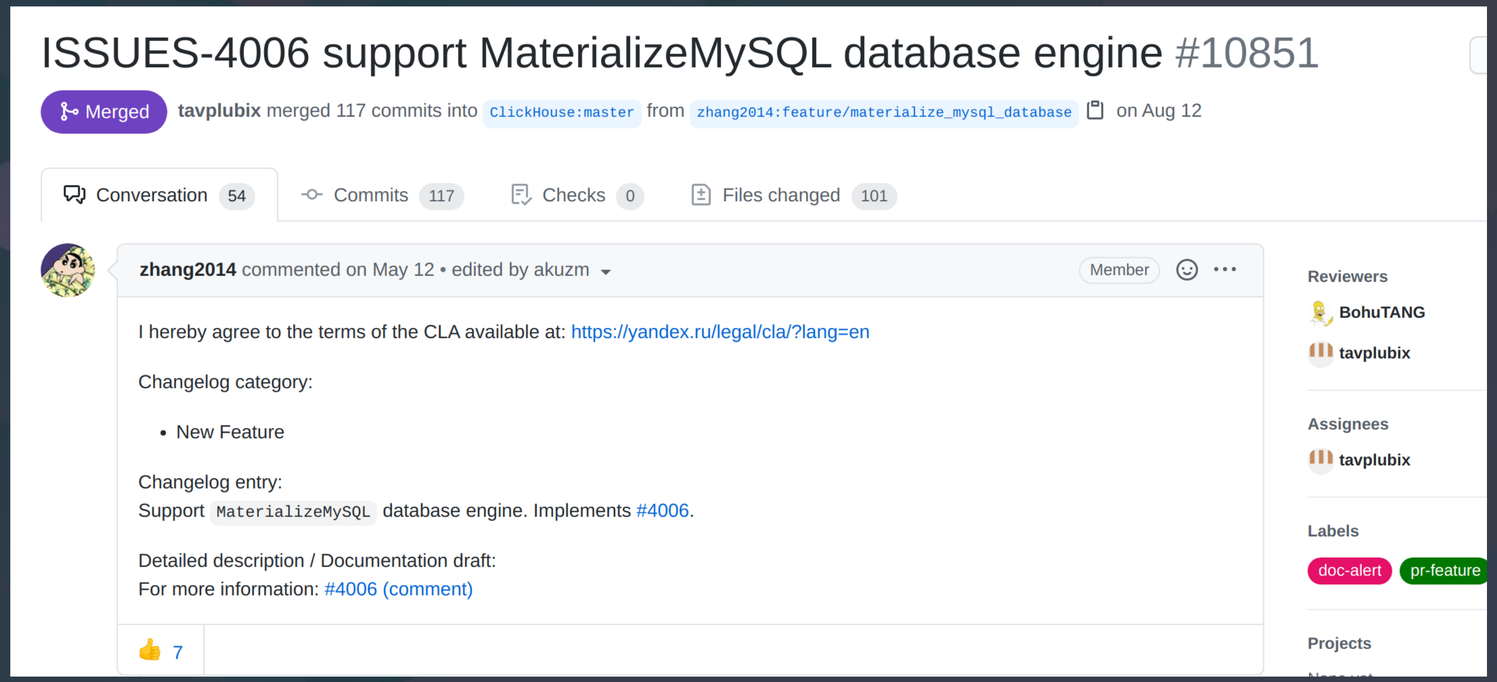
MaterializeMySQL Engine

MaterializeMySQL Engine



ISSUES-4006 support MaterializeMySQL database engine #10851

Merged **tavplubix** merged 117 commits into `ClickHouse:master` from `zhang2014:feature/materialize_mysql_database` on Aug 12

Conversation 54 | Commits 117 | Checks 0 | Files changed 101

zhang2014 commented on May 12 • edited by akuzm — Member

I hereby agree to the terms of the CLA available at: https://yandex.ru/legal/cla/?lang=en

Changelog category:

- New Feature

Changelog entry:
Support `MaterializeMySQL` database engine. Implements #4006.

Detailed description / Documentation draft:
For more information: #4006 (comment)

👍 7

Reviewers
BohuTANG
tavplubix

Assignees
tavplubix

Labels
doc-alert pr-feature

Projects

由青云ClickHouse 团队贡献

https://github.com/ClickHouse/ClickHouse/pull/10851

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MaterializeMySQL Engine

- • Mapping to MySQL database
- • Consume MySQL BINLOG and store to MergeTree
- • Experimental feature (20.8, recommend latest stable version)

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MaterializeMySQL Engine

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MaterializeMySQL Engine


```
CREATE DATABASE test
ENGINE =
MaterializeMySQL('172.17.0.3:3306',
'demo', 'root', '123')
```

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MaterializeMySQL Engine

History data

New data

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MaterializeMySQL Engine

Check MySQL Vars

Select history data

Consume new data

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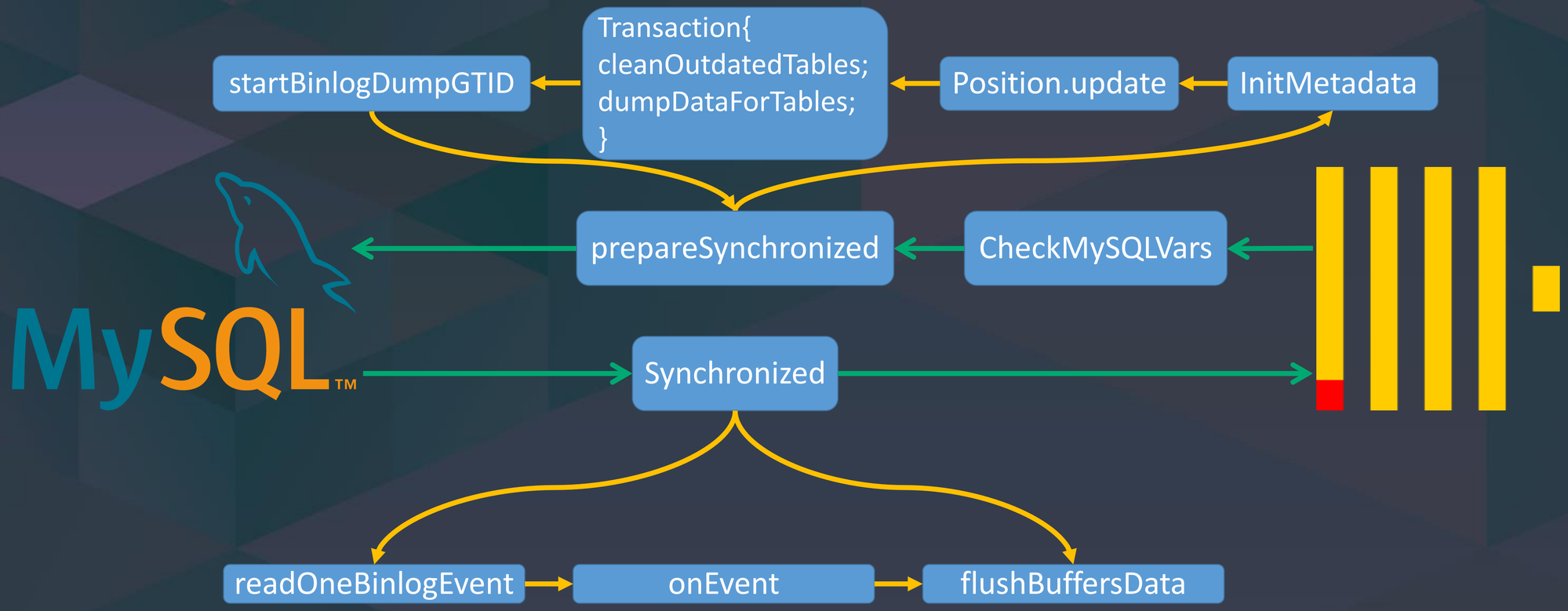
MaterializeMySQL Engine



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MaterializeMySQL Engine

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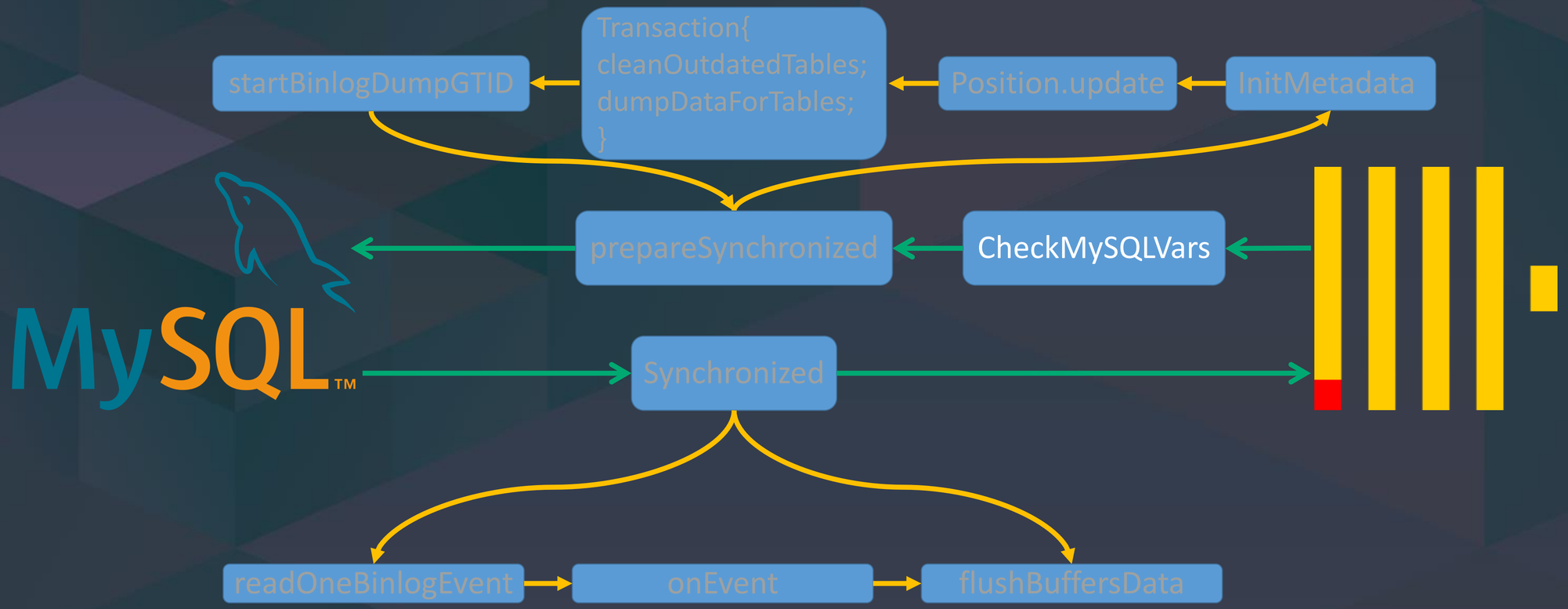
MaterializeMySQL Engine



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MaterializeMySQL Engine

Check MySQL Vars

```
SHOW VARIABLES WHERE (Variable_name = 'log_bin'
        AND upper(Value) = 'ON')
OR (Variable_name = 'binlog_format'
        AND upper(Value) = 'ROW')
OR (Variable_name = 'binlog_row_image'
        AND upper(Value) = 'FULL')
OR (Variable_name = 'default_authentication_plugin'
        AND upper(Value) = 'MYSQL_NATIVE_PASSWORD')
OR (Variable_name = 'log_bin_use_v1_row_events'
        AND upper(Value) = 'OFF');
```

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MaterializeMySQL Engine

Check MySQL Vars

Select history data

Consume new data

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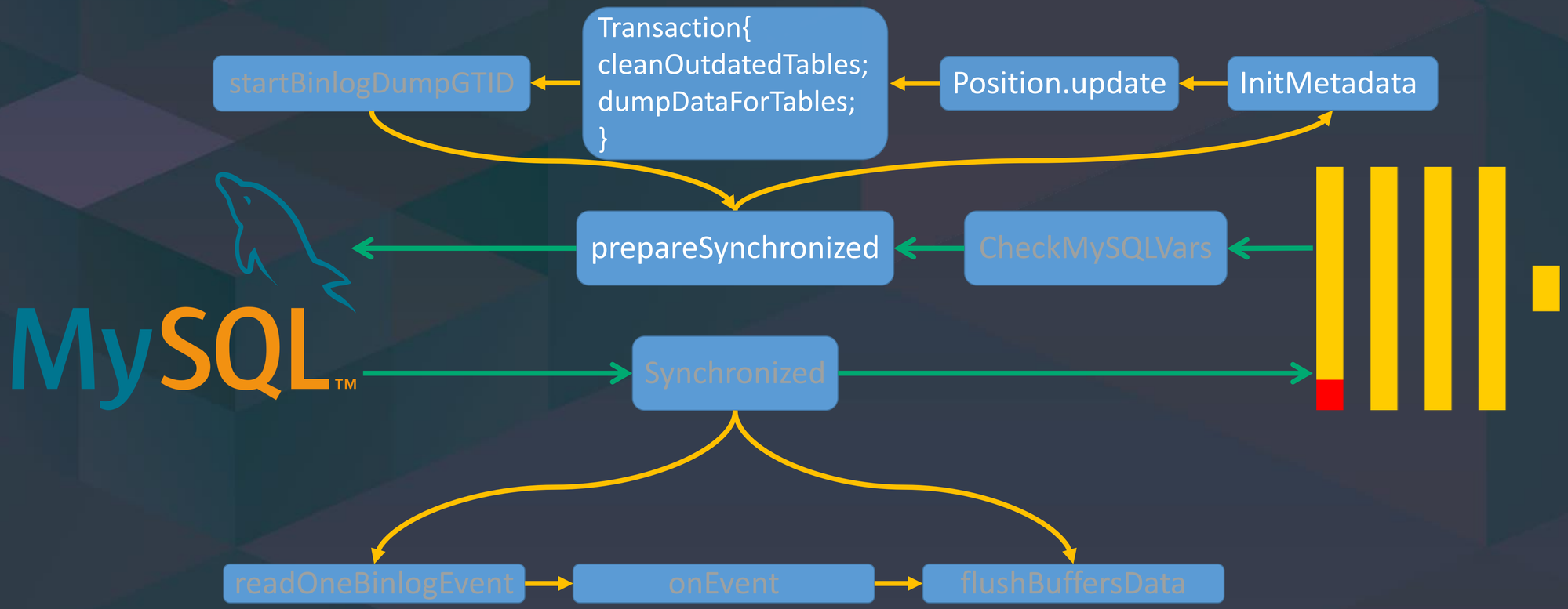
MaterializeMySQL Engine



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MaterializeMySQL Engine

Select history data

```
std::optional<MaterializeMetadata> MaterializeMySQLSyncThread::prepareSynchronized()
{
    connection = pool.get();

    MaterializeMetadata metadata(
        connection, DatabaseCatalog::instance().getDatabase(database_name)->getMetadataPath() + "/.metadata",
mysql_database_name, opened_transaction);
    if (!metadata.need_dumping_tables.empty())
    {
        Position position;
        position.update(metadata.binlog_position, metadata.binlog_file, metadata.executed_gtid_set);

        metadata.transaction(position, [&]()
        {
            cleanOutdatedTables(database_name, global_context);
            dumpDataForTables(connection, metadata, query_prefix, database_name, mysql_database_name, global_context, [this] {
return isCancelled(); });
        });
    }
    connection->query("COMMIT").execute();
}
```

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MaterializeMySQL Engine

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return isCancelled(); });
        });
    }
    connection->query("COMMIT").execute();
}
```

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MaterializeMySQL Engine

Select history data

```
connection->query("FLUSH TABLES;").execute();
connection->query("FLUSH TABLES WITH READ LOCK;").execute();

fetchMasterStatus(connection);
fetchMasterVariablesValue(connection);
connection->query("SET SESSION TRANSACTION ISOLATION LEVEL REPEATABLE READ;").execute();
connection->query("START TRANSACTION /*!40100 WITH CONSISTENT SNAPSHOT */;").execute();

opened_transaction = true;
need_dumping_tables = fetchTablesCreateQuery(connection, database, fetchTablesInDB(connection, database));
connection->query("UNLOCK TABLES;").execute();
```

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MaterializeMySQL Engine

Select history data

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        Position position;
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        metadata.transaction(position, [&]()
        {
            cleanOutdatedTables(database_name, global_context);
            dumpDataForTables(connection, metadata, query_prefix, database_name, mysql_database_name, global_context, [this] {
return isCancelled(); });
        });
    }
    connection->query("COMMIT").execute();
}
```

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MaterializeMySQL Engine

Select history data

```
void MaterializeMetadata::transaction(const MySQLReplication::Position & position, const std::function<void()> & fun)
{

    String persistent_tmp_path = persistent_path + ".tmp";

    {
        WriteBufferFromFile out(persistent_tmp_path, DBMS_DEFAULT_BUFFER_SIZE, O_WRONLY | O_TRUNC | O_CREAT);

        /// TSV format metadata file.
        writeString("Version:\t" + toString(meta_version), out);
        writeString("\nBinlog File:\t" + binlog_file, out);
        writeString("\nExecuted GTID:\t" + executed_gtid_set, out);
        writeString("\nBinlog Position:\t" + toString(binlog_position), out);
        writeString("\nData Version:\t" + toString(data_version), out);

        out.next();
        out.sync();
        out.close();
    }
    commitMetadata(std::move(fun), persistent_tmp_path, persistent_path);
}
```

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MaterializeMySQL Engine

Select history data

```
std::optional<MaterializeMetadata> MaterializeMySQLSyncThread::prepareSynchronized()
{
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    if (!metadata.need_dumping_tables.empty())
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        metadata.transaction(position, [&]()
        {
            cleanOutdatedTables(database_name, global_context);
            dumpDataForTables(connection, metadata, query_prefix, database_name, mysql_database_name, global_context, [this] {
return isCancelled(); });
        });
    }
    connection->query("COMMIT").execute();
}
```

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MaterializeMySQL Engine

Select history data

```
auto iterator = master_info.need_dumping_tables.begin();

for (; iterator != master_info.need_dumping_tables.end() && !is_cancelled(); ++iterator)
{
    const auto & table_name = iterator->first;
    Context query_context = createQueryContext(context);
    String comment = "Materialize MySQL step 1: execute MySQL DDL for dump data";
    tryToExecuteQuery(query_prefix + " " + iterator->second, query_context, database_name, comment); /// create table.

    auto out = std::make_shared<CountingBlockOutputStream>(getTableOutput(database_name, table_name, query_context));
    MySQLBlockInputStream input(
        connection, "SELECT * FROM " + backQuoteIfNeed(mysql_database_name) + "." + backQuoteIfNeed(table_name),
        out->getHeader(), DEFAULT_BLOCK_SIZE);

    Stopwatch watch;
    copyData(input, *out, is_cancelled);
}
```

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MaterializeMySQL Engine

Select history data

```
auto iterator = master_info.need_dumping_tables.begin();

for (; iterator != master_info.need_dumping_tables.end() && !is_cancelled(); ++iterator)
{
    const auto & table_name = iterator->first;
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    tryToExecuteQuery(query_prefix + " " + iterator->second, query_context, database_name, comment); /// create table.

    auto out = std::make_shared<CountingBlockOutputStream>(getTableOutput(database_name, table_name, query_context));
    MySQLBlockInputStream input(
        connection, "SELECT * FROM " + backQuoteIfNeed(mysql_database_name) + "." + backQuoteIfNeed(table_name),
        out->getHeader(), DEFAULT_BLOCK_SIZE);

    Stopwatch watch;
    copyData(input, *out, is_cancelled);
}
```

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MaterializeMySQL Engine

Select history data

```
const auto & create_defines = create_query.columns_list->as<MySQLParser::ASTCreateDefines>();
NamesAndTypesList columns_name_and_type = getColumnsList(create_defines->columns);
const auto & [primary_keys, unique_keys, keys, increment_columns] = getKeys(create_defines->columns, create_defines->indices, context,
columns_name_and_type);


auto columns = std::make_shared<ASTColumns>();
columns->set(columns->columns, InterpreterCreateQuery::formatColumns(columns_name_and_type));
columns->columns->children.emplace_back(create_materialized_column_declaration(sign_column_name, "Int8", UInt64(1)));
columns->columns->children.emplace_back(create_materialized_column_declaration(version_column_name, "UInt64", UInt64(1)));

auto storage = std::make_shared<ASTStorage>();

if (ASTPtr partition_expression = getPartitionPolicy(primary_keys))
    storage->set(storage->partition_by, partition_expression);

if (ASTPtr order_by_expression = getOrderByPolicy(primary_keys, unique_keys, keys, increment_columns))
    storage->set(storage->order_by, order_by_expression);

storage->set(storage->engine, makeASTFunction("ReplacingMergeTree", std::make_shared<ASTIdentifier>(version_column_name)));
```

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MaterializeMySQL Engine

Select history data

```
CREATE TABLE `demo`.`t` (
  `id` int(11) NOT NULL,
  `col_1` varchar(20) DEFAULT NULL,
  PRIMARY KEY (`id`)
) ENGINE=InnoDB;
```

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MaterializeMySQL Engine

Select history data

```
CREATE TABLE test.t
(
    `id` Int32,
    `col_1` Nullable(String),
    `_sign` Int8 MATERIALIZED 1,
    `_version` UInt64 MATERIALIZED 1
)
ENGINE = ReplacingMergeTree(_version)
PARTITION BY intDiv(id, 4294967)
ORDER BY tuple(id)
```

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MaterializeMySQL Engine

Check MySQL Vars

Select history data

Consume new data

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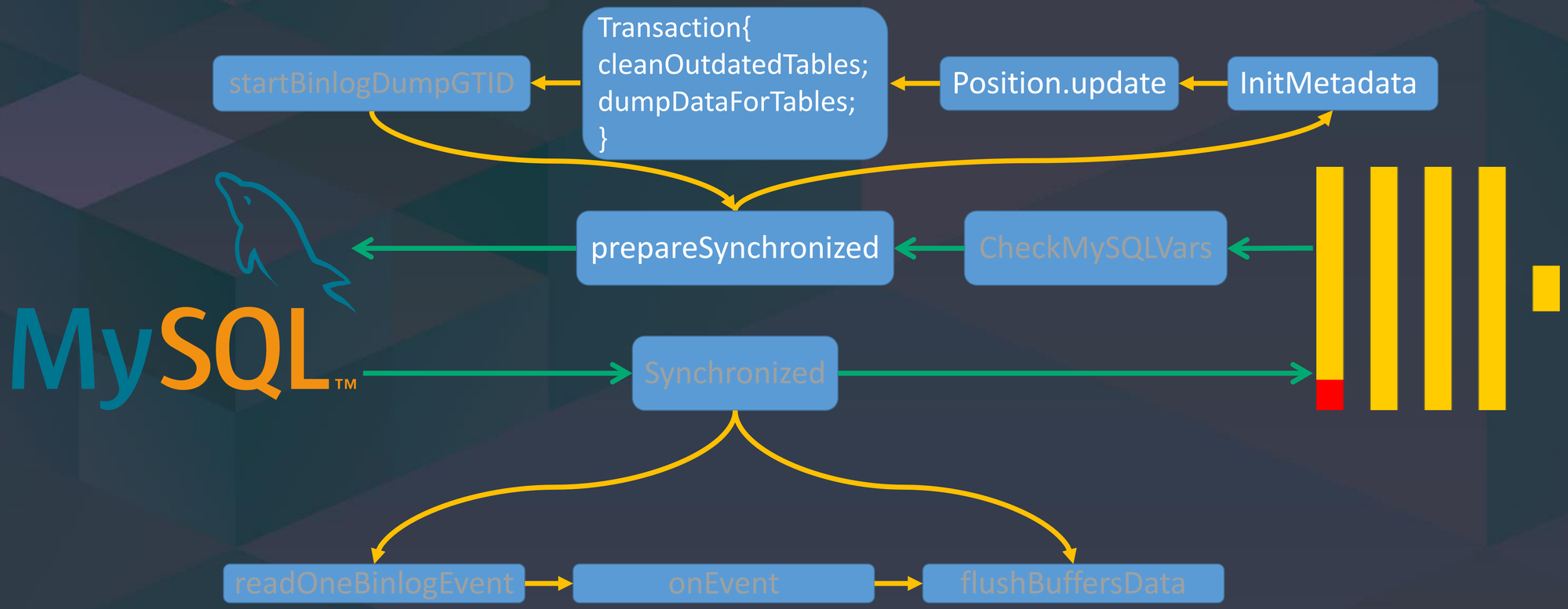
MaterializeMySQL Engine



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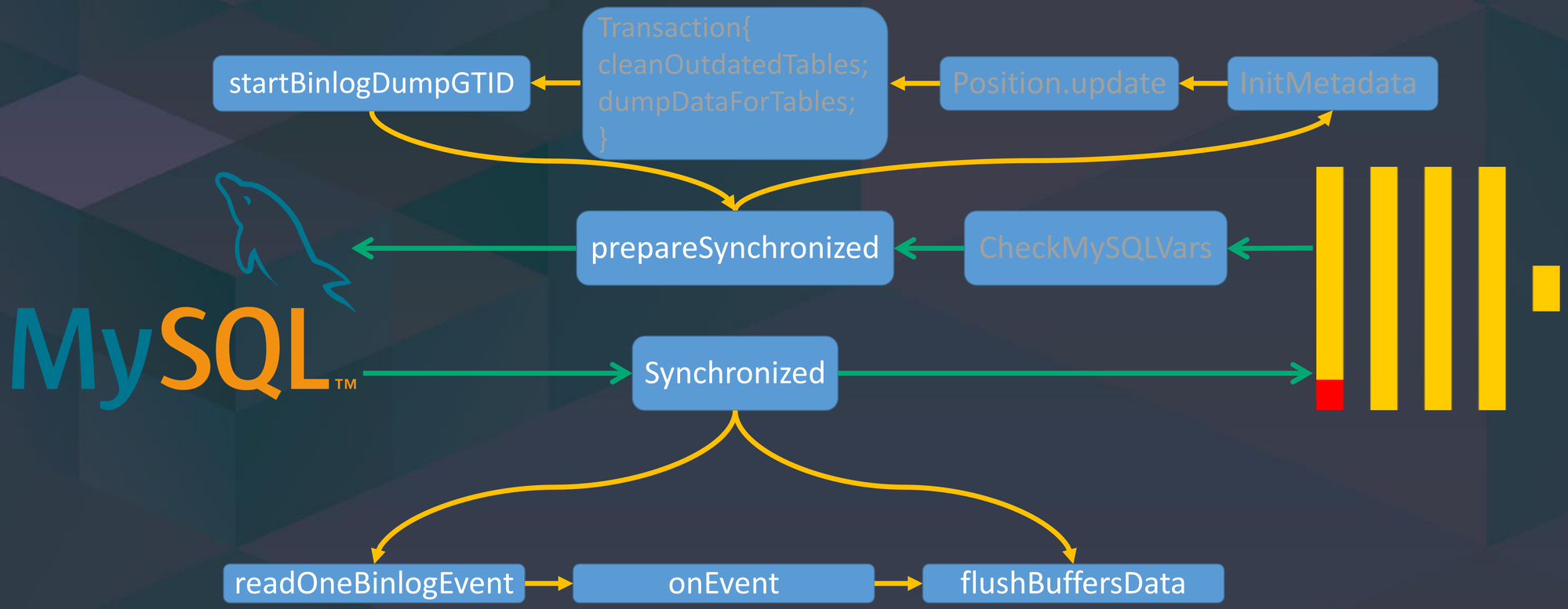
MaterializeMySQL Engine



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MaterializeMySQL Engine

Consume new data

```
client.connect();
client.startBinlogDumpGTID(randomNumber(), mysql_database_name, metadata.executed_gtid_set,
metadata.binlog_checksum);

Buffers buffers(database_name);
while (!isCancelled())
{
        BinlogEventPtr binlog_event = client.readOneBinlogEvent(std::max(UInt64(1), max_flush_time -
watch.elapsedMilliseconds()));
        if (binlog_event)
                onEvent(buffers, binlog_event, *metadata);
        if (!buffers.data.empty())
                flushBuffersData(buffers, *metadata);
}
```

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MaterializeMySQL Engine

Consume new data

```
client.connect();
client.startBinlogDumpGTID(randomNumber(), mysql_database_name,
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max_flush_time - watch.elapsedMilliseconds()));
    if (binlog_event)
        onEvent(buffers, binlog_event, *metadata);
    if (!buffers.data.empty())
        flushBuffersData(buffers, *metadata);
}
```

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MaterializeMySQL Engine

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client.connect();
client.startBinlogDumpGTID(randomNumber(), mysql_database_name, metadata.executed_gtid_set,
metadata.binlog_checksum);

Buffers buffers(database_name);
while (!isCancelled())
{
    BinlogEventPtr binlog_event = client.readOneBinlogEvent(std::max(UInt64(1), max_flush_time -
watch.elapsedMilliseconds()));
    if (binlog_event)
        onEvent(buffers, binlog_event, *metadata);
    if (!buffers.data.empty())
        flushBuffersData(buffers, *metadata);
}
```

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MaterializeMySQL Engine

Consume new data

```
void MaterializeMySQLSyncThread::onEvent(Buffers & buffers, const BinlogEventPtr & receive_event,
MaterializeMetadata & metadata)
{
    if (receive_event->type() == MYSQL_WRITE_ROWS_EVENT)
    { ... }
    else if (receive_event->type() == MYSQL_UPDATE_ROWS_EVENT)
    { ... }
    else if (receive_event->type() == MYSQL_DELETE_ROWS_EVENT)
    { ... }
    else if (receive_event->type() == MYSQL_QUERY_EVENT)
    { ... }
}
```

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MaterializeMySQL Engine

Consume new data

```
void MaterializeMySQLSyncThread::onEvent(Buffers & buffers, const BinlogEventPtr & receive_event,
MaterializeMetadata & metadata)
{
    if (receive_event->type() == MYSQL_WRITE_ROWS_EVENT)
    {
        WriteRowsEvent & write_rows_event = static_cast<WriteRowsEvent &>(*receive_event);
        Buffers::BufferAndSortingColumnsPtr buffer = buffers.getTableDataBuffer(write_rows_event.table,
global_context);
        size_t bytes = onWriteOrDeleteData<1>(write_rows_event.rows, buffer->first,
++metadata.data_version);
        buffers.add(buffer->first.rows(), buffer->first.bytes(), write_rows_event.rows.size(), bytes);
    }
}
```

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MaterializeMySQL Engine

Consume new data

```
void MaterializeMySQLSyncThread::onEvent(Buffers & buffers, const BinlogEventPtr & receive_event,
MaterializeMetadata & metadata)
{
    if (receive_event->type() == MYSQL_WRITE_ROWS_EVENT)
    { ... }
    else if (receive_event->type() == MYSQL_UPDATE_ROWS_EVENT)
    { ... }
    else if (receive_event->type() == MYSQL_DELETE_ROWS_EVENT)
    {
        DeleteRowsEvent & delete_rows_event = static_cast<DeleteRowsEvent &>(*receive_event);
        Buffers::BufferAndSortingColumnsPtr buffer = buffers.getTableDataBuffer(delete_rows_event.table,
global_context);
        size_t bytes = onWriteOrDeleteData<-1>(delete_rows_event.rows, buffer->first,
++metadata.data_version);
        buffers.add(buffer->first.rows(), buffer->first.bytes(), delete_rows_event.rows.size(), bytes);
    }
}
```

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MaterializeMySQL Engine

Consume new data

```
void MaterializeMySQLSyncThread::onEvent(Buffers & buffers, const BinlogEventPtr & receive_event,
MaterializeMetadata & metadata)
{
    else if (receive_event->type() == MYSQL_UPDATE_ROWS_EVENT) {
        for (size_t index = 0; index < rows_data.size(); index += 2) {
            if (likely(!writeable_rows_mask[index])) {
                sign_column_data.emplace_back(1);
                version_column_data.emplace_back(version); }
            else {
                /// If the sorting keys is modified, we should cancel the old data, but this should not happen frequently
                sign_column_data.emplace_back(-1);
                sign_column_data.emplace_back(1);
                version_column_data.emplace_back(version);
                version_column_data.emplace_back(version);}}}}
```

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MaterializeMySQL Engine

Consume new data

```
void MaterializeMySQLSyncThread::onEvent(Buffers & buffers, const BinlogEventPtr & receive_event,
MaterializeMetadata & metadata)
{   else if (receive_event->type() == MYSQL_QUERY_EVENT)
    {
        QueryEvent & query_event = static_cast<QueryEvent &>(*receive_event);
        position_before_ddl.update(metadata.binlog_position, metadata.binlog_file,
metadata.executed_gtid_set);
        metadata.transaction(position_before_ddl, [&]() { buffers.commit(global_context); });
        if (query->as<ASTDropQuery>())
            ...
        else if (query->as<ASTRenameQuery>())
            ...
        else if (query->as<MySQLParser::ASTAlterQuery>())
            ...
        else if (query->as<MySQLParser::ASTCreateQuery>())
            ...
    }
}
```

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MaterializeMySQL Engine

Consume new data

```
client.connect();
client.startBinlogDumpGTID(randomNumber(), mysql_database_name, metadata.executed_gtid_set,
metadata.binlog_checksum);

Buffers buffers(database_name);
while (!isCancelled())
{
    BinlogEventPtr binlog_event = client.readOneBinlogEvent(std::max(UInt64(1), max_flush_time -
watch.elapsedMilliseconds()));
    if (binlog_event)
        onEvent(buffers, binlog_event, *metadata);
    if (!buffers.data.empty())
        flushBuffersData(buffers, *metadata);
}
```

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MaterializeMySQL Engine

Consume new data

```
void MaterializeMySQLSyncThread::flushBuffersData(Buffers & buffers, MaterializeMetadata &
metadata)
{
    metadata.transaction(client.getPosition(), [&]() { buffers.commit(global_context); });

    const auto & position_message = [&]()
    {
        WriteBufferFromOwnString buf;
        client.getPosition().dump(buf);
        return buf.str();
    };
    LOG_INFO(log, "MySQL executed position: \n {}", position_message());
}
```

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HTAP 应用场景

MySQL Plus + ClickHouse

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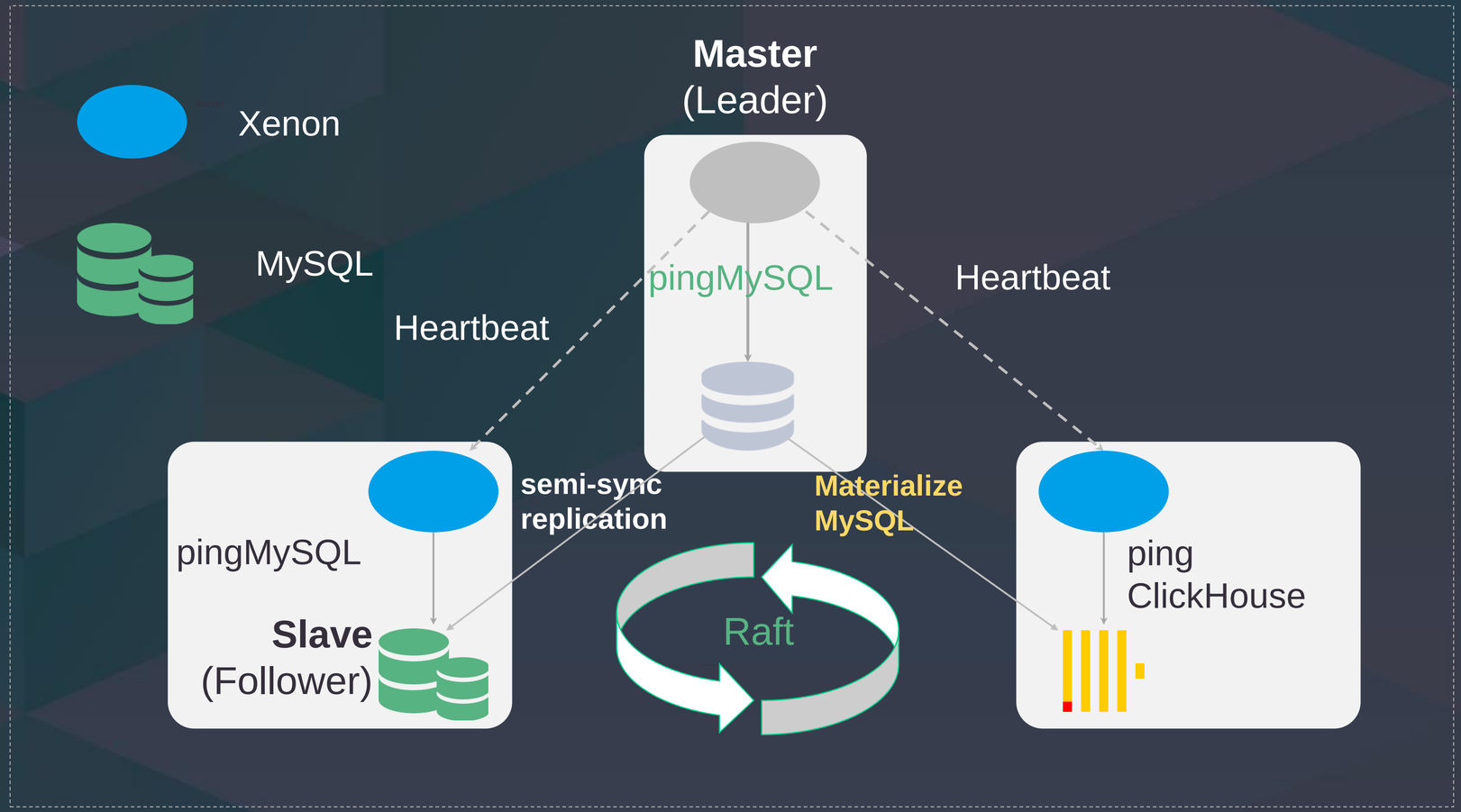
HTAP 应用场景



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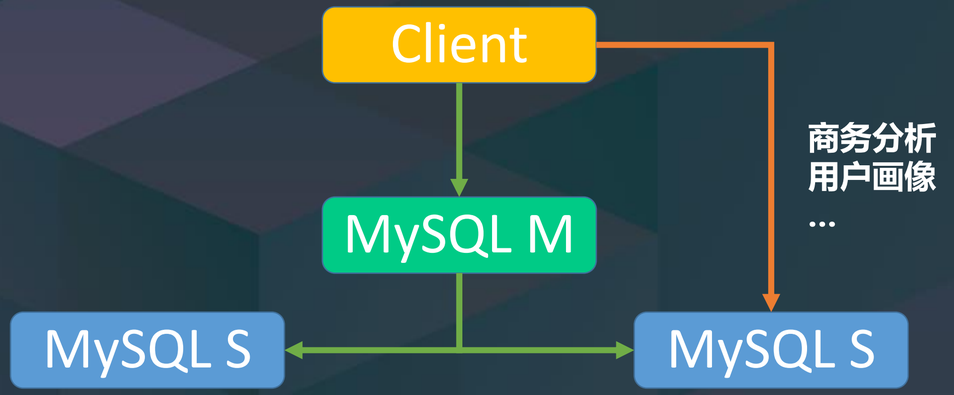
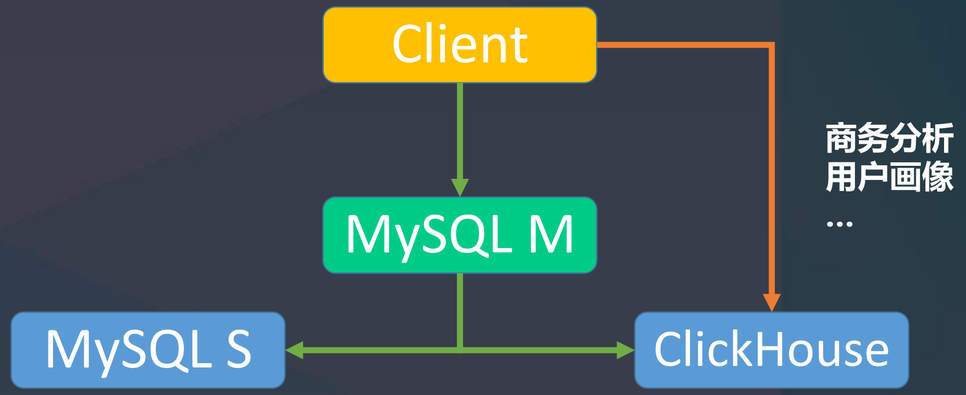
HTAP 应用场景





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MySQL Plus
关系型数据库
RadonDB
分布式数据库
PostgreSQL
关系型数据库
数据库
DATABASE
ClickHouse
分析型数据库
PolonDB
分布式关系型数据库
ChronusDB
时序数据库
MongoDB
非关系型数据库
Redis
非关系型数据库
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THANKS FOR WATCHING

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