Analyzing Binlogs to Understand Replication Lag

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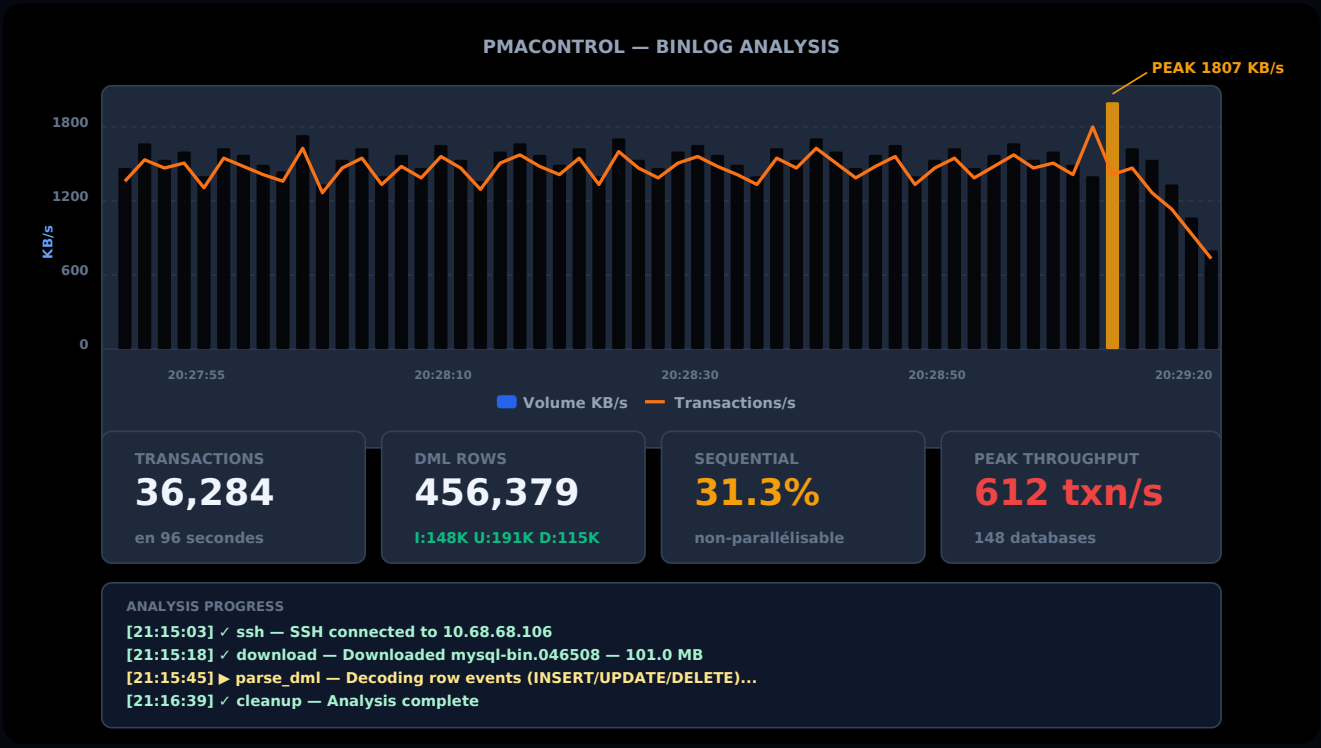
PMACONTROL BINLOG REPLICATION MYSQL MARIADB PERCONA-SERVER PERFORMANCE LAG MYSQLBINLOG



Replication Lag, the Silent Plague

Every DBA has lived through this moment: monitoring shows 300 seconds of lag on the replica, alerts are firing, and the question is always the same — **why?**

`Seconds_Behind_Master` (or `Seconds_Behind_Source` in MySQL 8) is a binary indicator: it lags or it doesn't. It says nothing about the **cause**. Is it a massive DELETE batch? A lack of parallelism? An 800 KB transaction blocking the SQL thread? To find out, you need SSH access to the master, the right `mysqlbinlog` binary, time, and a lot of grep.

PmaControl now automates all of that.

The New Feature: Binlog Analysis

How It Works

From the **slave/show** page of any replica, you can now:

1. **Select a time range** directly on the lag chart (click and drag) or via datetime fields
2. **Launch the analysis** with one click — everything runs in the background
3. **Watch real-time progress** step by step
4. **View the full report** with interactive charts and detailed metrics
5. **Receive a Telegram notification** with the summary

What Happens Behind the Scenes

When you launch an analysis, PmaControl executes a 15-phase pipeline:

```
[21:15:02] ✓ init — Analysis #42 — slave=85 master=106 range=[20:27:51 → 20:29:27]
[21:15:02] ✓ master_info — Master: prod-db-01 — 10.68.68.106:3306
[21:15:02] ✓ version — Version: 8.0.44
[21:15:02] ✓ binary — Using: mysqlbinlog-8.0 — Ver 8.0.42
[21:15:03] ✓ credentials — MySQL user: pmacontrol@10.68.68.106:3306
[21:15:04] ✓ find_binlogs — Found 1 binlog file(s): mysql-bin.046508
[21:15:18] ✓ fetch — Fetched mysql-bin.046508 — 101.0 MB (via --read-from-remote-server,
cached)
[21:15:19] ✓ file_ranges — 1 file(s) probed
[21:15:45] ✓ parse_gtid — Parsed 36284 transactions, total 97.2 MB, 123 >100KB, 3 >500KB
[21:16:12] ✓ parse_dml — I:148,659 U:191,867 D:115,853 = 456,379 rows across 148 databases
[21:16:38] ✓ parse_volume — 97 seconds of data, peak 612 txn/s, peak 1807 KB/s
[21:16:39] ✓ parse_ddl — No DDL — 100% DML row-based
[21:16:39] ✓ metadata — 1 metadata file(s) written
[21:16:39] ✓ store — Report stored successfully
[21:16:39] ✓ cleanup — Cleanup done — analysis complete
```

Each step is visible in real-time in the UI, with full detail of what's happening. No more guessing whether the transfer is in progress or the parsing is stuck. Note: fetching uses the MySQL protocol (`--read-from-remote-server`), not SSH — no key to deploy on the master.

The Right Binary for the Right Version

A classic pitfall: using a MariaDB `mysqlbinlog` to read a MySQL 8 binlog, or vice-versa. Events are marked "Ignorable" and row-based data becomes unreadable.

PmaControl ships **8 static mysqlbinlog binaries** (x86_64 and aarch64):

Binary	Versions Covered
`mysqlbinlog-5.6`	MySQL 5.5, 5.6, Percona 5.6
`mysqlbinlog-5.7`	MySQL 5.7, Percona 5.7
`mysqlbinlog-8.0`	MySQL 8.0
`mysqlbinlog-8.4`	MySQL 8.4 LTS
`mysqlbinlog-9.7`	MySQL 9.7 LTS
`mysqlbinlog-mariadb`	MariaDB 10.x, 11.x, 12.x (generic fallback)

The selection is automatic: PmaControl reads the `version` variable from the master's metrics and picks the closest compatible binary (see `MysqlbinlogBinaryResolver`). For MySQL Oracle, the strategy is to pick the **lowest version ≥ the master's** (forward compatibility is more reliable than backward). For MariaDB, the resolver also supports more specific binaries named `mysqlbinlog-mariadb-10.11`, `mysqlbinlog-mariadb-11.8`, etc. — deployed on demand when a host exposes a binlog format specific to its minor.

The Analysis Report

Volume Per Second Chart

The main chart shows two overlaid series:

- **Blue bars**: volume in KB/s (sum of `transaction_length` per second)
- **Orange line**: transactions per second

This is the DBA's first reflex: is the lag from a one-off spike or sustained throughput? The chart answers immediately.

MTS Parallelism Metrics

This is where the analysis becomes truly valuable. PmaControl parses the `last_committed` and `sequence_number` fields from each GTID event to compute:

- **% of sequential transactions** — those where `sequence_number = last_committed + 1`, which cannot be parallelized by the Multi-Threaded Slave
- **Maximum parallelism group size** — how many transactions can actually run concurrently
- **Group distribution** — how many groups of 1, 2, 3... transactions

Concrete example: if 31% of transactions are sequential and the max parallelism is 7, then even with 16 `replica_parallel_workers`, most will sit idle. The recommendation is clear: enable `binlog_transaction_dependency_tracking = WRITESET` on the master.

Large Transaction Detection

Large transactions are the #1 replication killer. A single 834 KB transaction touching 6,171 rows blocks the SQL applier thread for its entire duration — all other transactions queue up behind it.

PmaControl counts:

- Transactions > 100 KB
- Transactions > 500 KB
- The largest transaction (with its content: which tables, how many rows)

Top Tables

The report lists the 30 most modified tables with INSERT/UPDATE/DELETE breakdown. This is often where you find the toxic pattern: batches that `DELETE FROM table WHERE ...; INSERT INTO table ...` to "refresh" data instead of using `INSERT ... ON DUPLICATE KEY UPDATE` or smaller transactions.

Automatic Recommendations

Based on the metrics, PmaControl generates concrete recommendations:

- "Sequential transaction ratio is 31.3%. Consider `binlog_transaction_dependency_tracking = WRITESET`."
- "3 transaction(s) > 500 KB. Large transactions block the SQL applier thread."
- "148 databases modified. Multi-tenant pattern may cause replication hot-spots."

These aren't generic advice — they're computed from the actual data in your binlogs.

Telegram Notification

When the analysis completes, a summary is automatically sent via Telegram:

```
Binlog Analysis Complete
Slave: replica-prod-01
Master: master-prod-01 (8.0.44)
Range: 2026-04-13 20:27:51 → 2026-04-13 20:29:27
━━━━━━━━━━━━━━━━━━━━
Size: 101.0 MB | Txn: 36,284 | Duration: 96s
DML: I:148,659 U:191,867 D:115,853 = 456,379 rows
Peak: 612 txn/s | Avg: 378.0 txn/s
Sequential: 31.3% | Max parallel: 7
Large txn: 123 >100K, 3 >500K (max 815 KB)
Databases: 148
━━━━━━━━━━━━━━━━━━━━
• High write throughput (peak 612 txn/s). Ensure replica_parallel_workers >= 8.
• Sequential transaction ratio is 31.3%. Consider WRITESET.
• 3 transaction(s) > 500 KB block the SQL applier thread.
```

The on-call DBA has everything they need to act, right in their pocket.

Technical Architecture

Binlog Retrieval: Like an IO Thread

PmaControl doesn't use SSH to fetch binlogs. It uses `mysqlbinlog --read-from-remote-server` which connects to the master via MySQL protocol, exactly like a replica's IO thread. PmaControl's existing MySQL credentials are enough — no SSH key required on the master.

```
mysqlbinlog --read-from-remote-server \
  --host=10.105.1.11 --port=3306 \
  --user=pmacontrol --password=*** \
  --raw --result-file=/tmp/analysis/ \
  mysql-bin.1054495
```

If PmaControl can connect to the master's MySQL (which it already does for monitoring), it can fetch the binlogs. No additional setup required.

Smart Binlog File Discovery

A production master can have **thousands** of binlog files (we encountered 2,712 files during development). Scanning each file to find the time range would be prohibitively slow.

The 2-step strategy:

1. **Anchor from the slave's position** — read `Master_Log_File` from `SHOW SLAVE STATUS` to know the current binlog. Also query `SHOW MASTER STATUS` on the master to account for replication lag. This gives a narrow window instead of scanning all 2,712 files.
2. **Binary search** — within this window, probe each file's first timestamp via `mysqlbinlog --stop-position=8192` (reads only the FORMAT_DESCRIPTION header + first event). With binary search, finding the right file among 100 candidates takes only 7 probes instead of 100.

Result: binlog discovery on a master with 2,712 files takes **2 seconds** instead of minutes.

Persistent cache + JSON sidecar for AI

Downloaded binlogs are stored under `data/binlog_analysis/<master_id>/` with a **30-day TTL**. Direct consequence: re-analyzing the same time range (or an adjacent range that hits the same files) is free network- and time-wise — you immediately get `Cache hit: mysql-bin.046508`.

For each cached binlog, PmaControl also writes a `mysql-bin.046508.meta.json` sidecar containing a structured summary: total transactions, MTS parallelism, top DML tables, DDL, peak txn/s. This JSON is designed to be consumed by an LLM agent (see the site's AI Agents page) that needs to reason about an incident without re-parsing the binlogs itself.

The 8 Static Binaries, and Why

PmaControl ships pre-compiled `mysqlbinlog` binaries for each major version. This comes from a technical lesson: **an incompatible `mysqlbinlog` doesn't produce an error — it produces silently wrong results**.

Real example: a MariaDB `mysqlbinlog` reading a MySQL 8.0 binlog marks row-based events as "Ignorable" and skips them. The transaction count drops from 36,284 to 0. No error is displayed.

mysqlbinlog 5.6/5.7 Bug: `--raw` Ignores `--stop-datetime`

A trap discovered during development: in `--raw --read-from-remote-server` mode, mysqlbinlog versions 5.6 and 5.7 **silently ignore** the `--start-datetime` and `--stop-datetime` options. Instead of stopping at the requested date, the process acts like an IO thread and **waits forever** for new

events.

The solution in PmaControl: use `--raw` without time filters (downloads the complete file, then exits), and apply time-range filtering only during local parsing. A 120-second timeout per file is added as a safety net.

Asynchronous Pipeline with Real-Time Progress

The analysis runs in the background via Glial CLI (`php App/Webroot/index.php slave runBinlogAnalysisCli <id>`). The frontend polls status every 2 seconds, showing progress in a terminal-style display. The `progress` JSON field stores each of the 15 phases with timestamps.

Result Storage

Everything is persisted in the `binlog_analysis` table:

- Volume per second (JSON)
- Top tables (JSON)
- Parallelism distribution (JSON)
- Recommendations (JSON)

Results are accessible at any time from the analysis history.

Concrete Use Cases

"The replica lag at 3 AM"

Monitoring shows a lag spike at 3 AM. Next morning, the DBA selects the 02:55-03:10 range on the chart and launches the analysis. Result: a `port_flux` refresh batch that DELETEs + INSERTs 15,000 rows in a single transaction across 148 databases. Solution: split into 500-row transactions.

"Why won't the replica catch up?"

Lag keeps growing despite 8 parallel workers. The analysis shows 35% sequential transactions and a max parallelism of 5. Solution: enable WRITESET on the master and increase to 16 workers.

"What's the replication impact of this batch?"

Before running a migration batch in production, analyze a similar binlog from a staging environment to estimate replication impact.

How to Use It

1. Open PmaControl → Slave → Show on your replica
2. Click and drag on the lag chart to select a time range
3. Click "Analyze Binlogs"
4. Watch the steps unfold in real-time
5. Review the report, check the recommendations
6. Receive the summary on Telegram

That's it. No manual SSH, no `mysqlbinlog | grep | awk | sort`, no script to maintain. Replication lag diagnosis in one click.