Background

Data and application workloads continue to grow at exponential rates, but processor performance still lags. Moore's Law is slowing down, and CPU performance no longer doubles every two years. Experts believe computers will reach the physical limits of Moore's Law at some point in the 2020s.

So, although SSDs are getting cheaper, denser, and faster (especially NVMe SSDs), CPU limitations due to high computational loads and high data amplification create storage I/O bottlenecks in today's data center infrastructure.

Many companies address this issue by applying more CPUs and more SSDs, leading to increased capital and operating expenses, without solving the underlying problem.

To address these fundamental issues, as well as guarantee performance, conserve network bandwidth, and optimize workloads, a possible solution is using an accelerator to address server processor and application deficiencies.
The world’s most critical applications run on SSDs. Nearly all of them use key-value storage engines, a universal software component that lays out application data on a storage device on behalf of the application.

In general, storage engines result in a combination of read, write, and space amplification. For typical database applications, this amplification ranges from 5x to 100x, consuming the bandwidth of networks, system processor cores, and profoundly impacting SSD performance and endurance.

Amplification is a result of typical storage blocks being uniform in size, no matter what they contain, resulting in space amplification and inefficient use of storage capacity. Pliops XDP increases storage performance using a new data structure made possible by hardware acceleration, without requiring changes to the users’ application software.

By eliminating the layers of the database, file, block, and storage management accumulated over time by legacy architectures, Pliops XDP allows you to take full advantage of flash storage.

Pliops Extreme Data Processor increases storage performance using a new data structure made possible by hardware acceleration, without requiring changes to user’s application software.

Deployment

With Pliops XDP, a user has several deployment options. The user can add the card in a server with direct-attached storage, a storage server, a single NVMe-oF storage system, or multiple NVMe-oF storage systems. Connecting to various JBOFs can also be valuable when addressing “blast radius” or failure domain size concerns.
How Pliops Technology Accelerates MySQL Databases

The storage interface to the host application can be block or key-value. Because Pliops XDP manages data as variable based objects, these objects are then packed and placed contiguously on the SSD (solid-state drive) physical NAND map.

Processing all of this on Pliops XDP rather than the host server is far more efficient. It frees up substantial resources resulting in significantly better economics to deploy MySQL, and many other databases, with SSDs.

Pliops partnered with Percona to test and validate Pliops Extreme Data Processor Performance Claims

Percona’s Evaluation

To fully evaluate the Pliops XDP for MySQL, Percona performed the following three tests:

- **Simple Read Access**
- **Read & Write Operation**
- **Full OLTP / TPCC**

Percona looked at the differences between mainstream MySQL and MySQL using Pliops. The focus was on identifying functional gaps that would cause MySQL-InnoDB to misbehave and to examine performance degradation and utilized space.

To do this, Percona simulated the three most common scenarios using MySQL version 8.0.17, with and without the Pliops XDP.

These scenarios were:

1. Most of the load reading data, such as a website with few editorial sections.
2. Operation of reads and writes (OLTP simple), as most of the site has dynamic content, like shop’s booking systems.
3. More OLTP/TPCC oriented traffic, with more complex structure and higher-level types of transactions.

The tests were done with and without data compression for MySQL vanilla, while the natural way for MySQL-Pliops is to compress data. Given the high volume of data stored in many systems, the ability to reduce the space utilized with efficient compression represents a significant benefit.

Percona implemented three different tests, using the same benchmark engine (sysbench) for consistency.

The tests executed were:

1. Sysbench load and then read-only traffic (200 tables 1ML rows)
2. Sysbench load and read-write traffic (200 tables 1ML rows).
3. TPCC-MySQL sysbench with scale-factor=100
The Results

The resulting sysbench dataset was over 60GB, while for TPCC with scale=100, it was over 100GB. The Buffer Pool dimension was 20GB to force InnoDB to utilize the storage layer for all operations. The database node was hosting the MySQL-Vanilla and MySQL-Pliops instances, using the same settings (almost all defaults except a few-dimensional for Buffer Pool, InnoDB log, etc.).

For MySQL-Vanilla, Percona loaded the data twice, once without compression, the second with table compression and 8K key-block-size. For MySQL-Pliops, the compression feature is currently hardcoded and active by default. Both MySQL implementations used the same NVMe drive to store the data. The difference was in using the Pliops Extreme Data Processor and KV approach for the MySQL-Pliops.

Percona ran tests in the application node, connected to the database server with a 10G network link. Each experiment ran with 1-32-64-96-128-256 thread(s), with 60 minutes for each thread set. Each iteration had at least two runs. Results were calculated based on each test (12 hours per iteration, per MySQL version). Each full iteration was repeated in different moments of the week and on different days for four full tests. Percona calculated the final dataset, normalizing the information from all tests and organized as uncompressed/compressed data.

Based on the documentation provided by Pliops, and shared knowledge of the use of SSD with FTL/KV implementation, Percona expected that Pliops XDP would show functional and performance improvements.

Concerning FTL/KV, some specific operations such as Update and Delete are less effective compared to Inserts. Percona expected to see less improvement in OLTP traffic with a heavy load, compared with a Read/Write load with more straightforward and smaller transactions. Percona expected a significant difference between MySQL-Vanilla and MySQL-Pliops when comparing performance per second and total volume of data and expected Pliops XDP to excel here.

Significant Usage of Percona Monitoring Tool (PMM)

Throughout this evaluation, Percona utilized their PMM tool continuously.
Key Results

In general MySQL-Pliops performed significantly better than MySQL-Vanilla. This was due to MySQL-Pliops’ more efficient data structures, which facilitate/reduce the overheads that compression causes in MySQL-Vanilla. MySQL-Pliops handled Read-Only traffic significantly better. This was a result of the data being decompressed by Pliops XDP when accessing it from disk.

When data is compressed, MySQL-Pliops performs much better than MySQL-Vanilla.

MySQL-Vanilla is significantly affected, reaching a maximum of 157ms latency, while the maximum value for MySQL-Pliops was 29ms. This indicates a higher level of stability and predictability in operation execution and 5x lower latency than MySQL-Vanilla.

Data Compression

The design and implementation of Pliops’ compression solution are very different from that of MySQL. The Pliops solution is based on externalizing all the compression and decompression from InnoDB, plus KV operations. This makes it happen closer to the storage level, with obvious benefits. This approach results in far better performance than the existing MySQL method.

In terms of data compression and observability, another element may seem minor but still represents an additional benefit.

When managing a production database, it is vital to know the amount of data you have on disk, either uncompressed or compressed. When using compression, MySQL-Vanilla reports only the dimension of the compressed data, while MySQL-Pliops reports the real data dimension.

This information makes it easier for your DBA to manage, forecast, and provision the need for space on disk and memory in case of scaling requirements or standard operation. This is because MySQL-InnoDB utilizes decompressed data when loading it into Buffer Pool.
How Pliops Can Benefit Your Business

Pliops XDP is not a specialized MySQL version, like a column-store solution, or a time series. Its key value approach optimizes the storage layer but does not affect or limit the functionalities and flexibilities of MySQL- InnoDB or other database solutions. This makes Pliops XDP for MySQL a versatile solution that can fit many scenarios and databases.

A significant strength of the Pliops Extreme Data Processor is the data reduction benefit. If the ratio results obtained during the PoC are maintained, 10TB of data in MySQL-Vanilla would fit into just 2.9TB when using Pliops XDP for MySQL. This represents enormous space-savings, without performance degradation, and in fact, with a significant performance increase.

90% Lower Query Latency
72% Reduced SSD Space
3x Higher Queries per Second

Test results show that Pliops Extreme Data Processor accelerates your database applications by up to 3x and reduces compressed data by up to 72%

About Pliops

Pliops multiplies the effectiveness of organizations’ infrastructure investments by exponentially increasing datacenter performance, reliability, capacity, and efficiency. Founded in 2017 and named as one of the 10 hottest semiconductor startups by CRN in 2020 and 2021. Pliops global investors include NVIDIA, Intel Capital, SoftBank, Western Digital, KDT, and Xilinx. Learn more at www.pliops.com.