KIOXIA

Performance Brief

New 24G SAS PM6 Series SSDs Deliver Superior Performance in MySQL® Database Environments

Executive Summary

KIOXIA (formerly Toshiba Memory) is the first[1] storage vendor to introduce SSDs based on the 24G SAS (SAS-4) interface with its PM6 Series. These new enterprise SAS SSDs deliver the fastest[1] SAS SSD performance as each 24G SAS lane supports a line rate of 22.5 gigabits per second (Gb/s), effectively doubling the bandwidth from the previous SAS-3 (12Gb/s) generation. PM6 Series SSDs leverage industry-leading BiCS FLASH™ 3D flash memory technology and feature a full line-up of supported capacities (up to 30.72 terabytes[2] (TB)), endurances and security options to meet the demanding application and workload requirements of server and storage OEMs. The PM6 Series is KIOXIA's sixth SAS SSD generation that builds on the company's successes as a leading SAS SSD vendor.

The PM6 Series delivers up to 81% higher transactions per minute (TPM) when compared to available competitive 12Gb/s SAS offerings, as well as significantly reducing transactional write latency of a mainstream server platform running a relational database management system (RDBMS). These results are validated by internal testing conducted by KIOXIA that compared its new PM6 Series 24G SAS SSDs to the latest and currently shipping 12Gb/s SAS SSDs from two leading vendors. A description of the test benchmarks (criteria, set-up and test procedures) and the test results (visual representations and analyses) are presented in this brief.

The test results provide a real-world expectation of results that can be achieved when running a MySQL database application using comparable equipment and performing queries against the database.

Description of Benchmarks

Benchmark tests were conducted by KIOXIA in a lab environment that compared TPM performance and transactional write latency of a mainstream server platform. The storage configuration included PM6 Series SAS SSDs and the latest and currently shipping 12Gb/s SAS SSDs from two leading vendors (Vendor A and Vendor B). The tests utilized an operational high-performance online transaction processing (OLTP) MySQL database workload based on comparable TPC-C™ benchmarks created by HammerDB[3] software.

Test Criteria

The hardware and software equipment used for these benchmark tests included the following:

- **Server:** Two (2) AMD EPYC™ 7702P dual socket servers featuring 128 processing cores, 2.0 GHz frequency, 128 GB of DDR4, and a 24G SAS host bus adapter (under development from another vendor)
- **Operating System:** Centos™ v8.2
- **Application:** MySQL v8.0
- **Benchmark Software:** Comparable TPC-C benchmark tests generated through HammerDB test software
- **Storage Devices (Table 1):**

Four (4) KIOXIA PM6 Series 24G SAS SSDs:	3.84 TB capacities
Four (4) Vendor A 12Gb/s SAS SSDs:	3.84 TB capacities
Four (4) Vendor B 12Gb/s SAS SSDs:	3.84 TB capacities

Specifications	PM6 Series	Vendor A	Vendor B
Interface	24G SAS	12Gb/s SAS	12Gb/s SAS
Capacity	3.84 TB	3.84 TB	3.84 TB
Form Factor	2.5-inch (15 mm)	2.5-inch (15 mm)	2.5-inch (15 mm)
NAND Flash Type	3D TLC (96-layer)	3D TLC (96-layer)	3D TLC (96-layer)
Drive Writes per Day[4] (DWPD)	1	1	1
Port Configuration	Single (1x4)	Single (1x4)	Single (1x4)
Power (run at the maximum setting)	18W	14W	14W
Data Warehouses[5]	1,000	1,000	1,000
Virtual User Count	64	64	64
Buffer Pool Size	32 gigabytes[2] (GB)	32 GB	32 GB

Table 1: SSD specifications and set-up parameters

Set-up & Test Procedures

The test system was configured using the hardware and software equipment outlined above. Separate AMD EPYC 7702P servers were used to host the MySQL database and the HammerDB v3.3 application to avoid contention from either application. Without the two-server testbed to conduct separate testing, the applications could have interfered with memory and/or CPU cycles, and potentially compromised the test results.

The HammerDB load testing software was configured with a test schema based on the TPC-C benchmark (to emulate a MySQL OLTP database environment). The MySQL app was then loaded with 1,000 data warehouses that comprised about 100 GB of the server's storage capacity and the memory allocation to the MySQL buffer was set to 32 GB. This represents a typical real-world database configuration that creates a fairly normal database size, and that no more than one-third of the 100 GB database could be cached at one time.

Additionally, the test tool was configured for 64 virtual users to simultaneously send query threads in order to obtain responses. The query response time was also set to one millisecond (ms), demonstrating the ability to achieve very fast responses.

Both the TPM and write latency tests were run once for each SSD series with the highest test score recorded. The write latency results were gathered while the TPM test was ongoing. The objective of the benchmark tests was to showcase how 24G SAS SSDs provide significantly higher performance and lower latencies for common database applications when compared to 12Gb/s SAS SSDs.

Test Results

The TPM and write latency benchmarks were conducted with the highest (best) value recorded. For TPM, the higher the value, the better the result was. For write latency, the lower the value, the better the result.

Transactions Per Minute

In an OLTP database environment, TPM is typically the measure of how many new orders a system can support while it is executing additional transaction types such as payment, order status, delivery and stock levels. These applications normally have a large number of users that conduct simple, yet short transactions that require sub-second response times and return relatively few records.

The TPM test results are presented (Table 2) and visually represented (Figure 1):

Benchmark Test	PM6 Series (24G SAS)	Vendor A (12 Gb/s SAS)	Vendor B (12 Gb/s SAS)
Transactions per Minute	348,726	198,238	192,563
PM6 24G SAS SSD Advantage		+75.9%	+81.0%

Table 2: TPM comparison of enterprise SAS SSDs (higher is better)

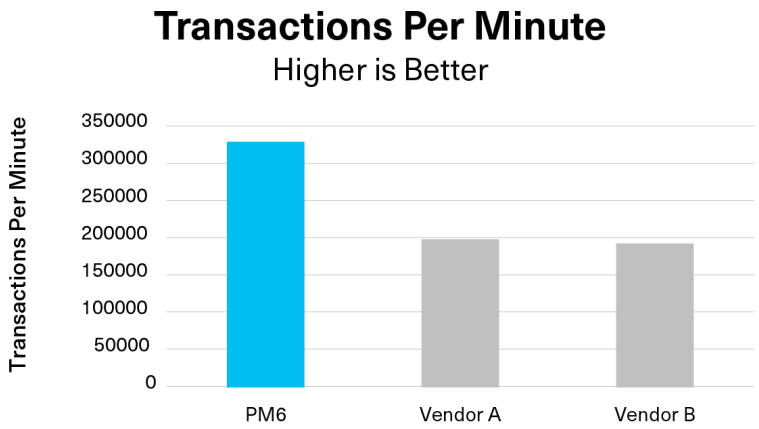

Figure 1: visual representation of the TPM comparison (higher is better)

Write Latency

Latency is the measure of the time that is required for a sub-system or one of its components to process a single storage transaction or data request. The time it takes for the data to begin moving from one system to another can greatly affect application performance and the user experience. Write latency is the delay in time before a storage device completes writing the data following an instruction from the host for that transfer.

The write latency test results are presented (Table 3) and visually represented (Figure 2):

Benchmark Test	PM6 Series (24G SAS)	Vendor A (12 Gb/s SAS)	Vendor B (12 Gb/s SAS)
Write Latency	3.05 ms	5.23 ms	4.78 ms
PM6 24G SAS SSD Advantage		-41.6%	-36.1%

Table 3: Write latency comparison of enterprise SAS SSDs (lower is better)

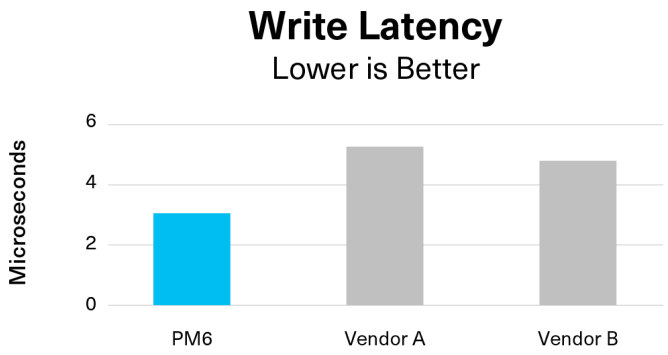

Figure 2: visual representation of the write latency comparison (lower is better)

Test Analysis

From the results of the benchmarks, 24G SAS SSDs (KIOXIA PM6 Series) enabled the server to deliver up to 81% higher transactions per minute when compared to the latest and currently shipping 12Gb/s SAS SSDs from two leading vendors. The PM6 Series' TPM performance enables a mainstream server platform to support significantly more transactions, all while servicing transactions with up to 41% better write latency.

Summary

If a server can deliver more storage bandwidth and input/output operations per second (IOPS) performance, it can complete more database transactions per minute. The domino effect is that more users can be serviced by the server simultaneously, a higher Quality of Service (QoS) can be delivered, IT costs can be reduced, and users can enjoy a better database experience. The PM6 Series 24G SAS SSDs deliver meaningful database performance increases without a price premium when compared to PM5 Series 12Gb/s SAS SSDs.

Additional PM6 Series 24G SAS SSD information is available here.

NOTES:

[1] Based on publicly available specifications from competitive 24G SAS SSD products as of this publication, November 2020, Rev. 1.0.

[2] Definition of capacity - KIOXIA Corporation defines a megabyte (MB) as 1,000,000 bytes, a gigabyte (GB) as 1,000,000,000 bytes and a terabyte (TB) as 1,000,000,000,000 bytes. A computer operating system, however, reports storage capacity using powers of 2 for the definition of 1Gbit = 2^{30} bits = 1,073,741,824 bits, 1GB = 2^{30} bytes = 1,073,741,824 bytes and 1TB = 2^{40} bytes = 1,099,511,627,776 bytes and therefore shows less storage capacity. Available storage capacity (including examples of various media files) will vary based on file size, formatting, settings, software and operating system, and/or pre-installed software applications, or media content. Actual formatted capacity may vary.

[3] HammerDB is benchmarking and load testing software that is used to test popular databases. It simulates the stored workloads of multiple virtual users against specific databases to identify transactional scenarios and derive meaningful information about the data environment, such as performance comparisons. TPC Benchmark C is a supported OLTP benchmark that includes a mix of five concurrent transactions of different types, and nine types of tables with a wide range of record and population sizes and where results are measured in transactions per minute.

[4] Drive Write(s) per Day: One full drive write per day means the drive can be written and re-written to full capacity once a day, every day, for the specified lifetime. Actual results may vary due to system configuration, usage, and other factors.

[5] The 1,000 data warehouses, in combination with the 32G buffer pool size, represents a typical real-world database configuration that creates a fairly normal database size.