KIOXIA

Application Brief

How an HPE® ProLiant® DL385 Gen 10 Plus Server with Value SAS SSDs Improves Database Performance and CPU Utilization versus SATA SSDs

The SATA interface has been at the forefront of hard drive storage for many years, so as flash-based SSDs became an alternative to HDDs, the interface was used to propel this transition. SATA-based SSDs soon became commonplace as other interface options emerged with performance improvements and lower latencies. Though they are successful alternatives to hard drives, SATA-based SSD application performance can be hindered due to its interface speed, half-duplex lane contentions and protocol limitations.

When 6 gigabit per second (6Gb/s) SATA SSDs were first introduced, the interface speed did not bottleneck NAND flash memory performance. But as flash memory performance improved with each new NAND generation (along with SAS improvements), the SATA interface performance limit of 6Gb/s became more of a bottleneck.

The SATA interface has another area of contention as data transmission is half-duplex, utilizing one lane / one direction at a time to transfer data. With faster CPUs and increasing DRAM bandwidth in today's modern-day servers, the SATA interface can be a bottleneck waiting for data transactions to complete, which in turn creates an underutilization of server capabilities and stranded compute resources. Though SATA SSDs have significant penetration in server platforms, their adoption rate is forecasted by research firms to decline as they are being replaced by higher performing SAS or NVMe® SSDs.

The half-duplex SATA interface at a 6Gb/s transfer speed can adversely affect a server's abilities to process a maximum number of new orders and deliver speedy transactions per minute (TPM) for Online Transaction Processing (OLTP) applications. It also affects efficient CPU usage. IT managers, architects and administrators want to utilize their storage resources to the fullest and maximize total cost of ownership (TCO) without purchasing additional systems to achieve required performance targets.

Introducing Value SAS SSDs

KIOXIA Corporation features a new category of SSD called value SAS SSDs that address the SATA SSD limitations. Value SAS SSDs take advantage of the SAS-3 interface and full-duplex data transmission with interface speeds up to 12Gb/s, and advancements in capacity, reliability and manageability over enterprise SATA SSDs, at cost-effective price points. The storage performance improvements provide more efficient use of a server node for utilizing its CPU and DRAM resources, while also having the ability to service I/O-intensive workloads and increase a server's load capacity so the node can support more users.

Another advantage of value SAS SSDs is they can be used in the same drive bay as SATA SSDs as most servers today are shipped with a SAS HBA or RAID card. Transitioning from SATA SSDs to value SAS SSDs is an easy process that in most cases requires no server or existing infrastructure changes.

To demonstrate the performance benefits and CPU utilization improvements of value SAS SSDs when compared to enterprise SATA SSDs, KIOXIA conducted a series of database benchmark tests comparing its RM Series value SAS SSDs to a leading vendor's currently shipping enterprise SATA SSDs.

Test Configuration

KIOXIA conducted tests in a lab environment that compared the system performance and CPU utilization of an HPE ProLiant DL385 Gen 10 Plus server platform configured with RM Series value SAS SSDs and enterprise SATA SSDs from a leading vendor. The tests utilized an operational, high-performance Microsoft® SQL Server™ database workload based on comparable TPC-C™ tests created by HammerDB software[1].

The testing provides TPM performance and CPU utilization results when running a Microsoft SQL Server database and performing queries against it. In the first test configuration, the ProLiant DL385 Gen 10 Plus server deployed four KIOXIA RM Series value SAS SSDs, while the second configuration included four enterprise SATA SSDs from a leading vendor.

Test Criteria

The hardware and software equipment used for these tests included:

- **HPE ProLiant DL385 Gen 10 Plus Server:** One (1) dual socket server with two (2) AMD EPYC™ 7702 processors featuring 64 processing cores, 2.0 GHz frequency, and 16 x 32 gigabytes[2] (GB) of DDR4 DRAM
- **Operating System:** Microsoft Windows® Server 2019 Datacenter, v1809, OS build 17763.1999
- **Application:** Microsoft SQL Server 15.0.2000.5
  Database size of 501GB
- **Test Software:** Comparable TPC-C benchmark tests generated through HammerDB v4.1 test software
- **Storage Devices (Table 1):** Four (4) KIOXIA RM Series SSDs with 3.84 terabyte[2] (TB) capacities
  Four (4) enterprise SATA SSDs (from a leading vendor) with 3.84TB capacities

Specifications / Set-up Parameters	RM6 Series	Vendor A
Interface	12Gb/s SAS	6Gb/s SATA
Capacity	3.84TB	3.84TB
Form Factor	2.5-inch[3] (15mm)	2.5-inch (15mm)
Drive Writes per Day[4] (DWPD)	1 (5 years)	0.8 (5 years)
Power	9W	3.6W
DRAM Allocation	96GB	96GB
Virtual Users	480	480

Table 1: SSD specifications and set-up parameters

Set-up & Test Procedures

Set-up: The ProLiant DL385 Gen 10 Plus server was first configured to test value SAS SSD performance and CPU utilization. Next, the server was configured for enterprise SATA SSD testing, at which time the same performance and CPU utilization tests were run and results were recorded.

Both server configurations were set-up with the Microsoft Windows Server 2019 Datacenter operating system and Microsoft SQL Server as the database application. Microsoft SQL Server was set to a maximum DRAM allocation of 96GB and the application was loaded using HammerDB test software at a database size of 501GB. For both value SAS and enterprise SATA configurations, a separate storage pool, virtual disk and full capacity volume was created for the four RM Series SSDs and the four enterprise SATA SSDs. Multiple virtual user counts were tested for each configuration and it was determined that 480 virtual users was optimal for both tested set-ups.

Test Procedures: HammerDB software was used to run the comparable TPC-C workload utilizing the four RM6 Series value SAS SSDs and recorded the TPM and CPU utilization results. The same test process for the enterprise SATA SSDs configuration was repeated, with results recorded as well. *See Test Results section.*

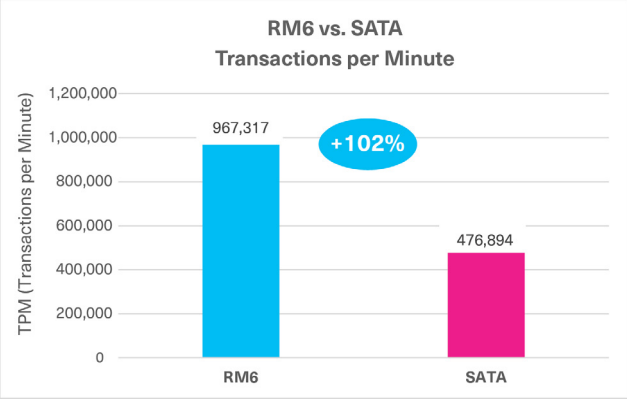
Test Results

TPM and CPU utilization tests were run with the respective result of each recorded. For both TPM and CPU utilization, the higher the value, the better the result.

Transactions Per Minute

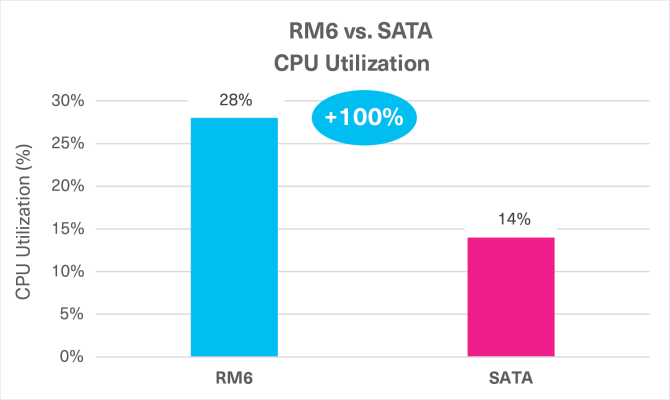
In an OLTP database environment, TPM is a measure of how many transactions in the TPC-C transaction profile that are being executed per minute. The HammerDB software, executing the TPC-C transaction profile, randomly performs new order transactions and randomly executes additional transaction types such as payment, order status, delivery and stock levels. One transaction does not necessarily equate to one new order as a new order can have multiple transactions. The TPM tests conducted simulate an OLTP environment where there are a large number of users that generate simple, yet short transactions that require sub-second response times and return relatively few records.

TPM Test Results:



CPU Utilization
CPU utilization represents a percentage of the total amount of available CPU cycles being used for a given workload and was measured to ensure that the AMD EPYC 7702 CPUs were not incurring any extra processing for OLTP applications such as database workloads. Low utilization means that the CPUs are not being used efficiently and could result in an underutilization of server capabilities and stranded compute resources.

CPU Utilization Test Results:



Test Analysis

KIOXIA value SAS SSDs enabled the HPE ProLiant DL385 Gen 10 Plus server to deliver 102% more transactions per minute than enterprise SATA SSDs from a leading vendor. Additionally, the value SAS configuration utilized the AMD EPYC 7702 processors 100% more when compared to enterprise SATA. Value SAS SSD performance enables a better utilization of server resources versus enterprise SATA SSD that could result in increased user capacity for an existing infrastructure or TCO savings as a result of not having to purchase more servers to achieve required performance targets.

RM6 Series SSD Overview

The RM6 Series is KIOXIA's 2nd generation value SAS SSD product line that delivers improved performance over previous RM Series generations. The series is based on the 12Gb/s SAS interface and features 7.68TB maximum capacities, single-port interfaces, 1 DWPD for read-intensive applications (RM6-R Series) and 3 DWPD for mixed use applications (RM6-V Series), up to a 9-watt power envelope, and a host of supported security capabilities – all of which support a wide variety of workloads. The RM6 Series delivers up to 2x the performance versus enterprise SATA SSDs while being priced to compete against them.

RM6 Series SSDs
12Gb/s SAS

High-Performance[5]
SeqRead = up to 840MB/s
RanRead = up to 160K IOPS
SeqWrite = up to 710MB/s
RanWrite = up to 50K IOPS

Configurable Flexibility
1 and 3 DWPD options
960GB – 7,680GB capacities

Summary

Though sufficient replacements for traditional spinning disk drives, enterprise SATA SSDs encounter performance challenges for some modern workloads. These challenges are a direct result of the 6Gb/s SATA III performance limitation, the use of traditional hard drive processes, and a single half-duplex transmission path.

When compared to enterprise SATA SSDs, value SAS SSDs are a better option as they deliver faster application performance and improved CPU utilization at very competitive price points. Value SAS SSDs also provide an easy replacement path for enterprise SATA SSD since both types of SSDs can reside in the same drive and easily swapped without any server or infrastructure changes.

For IT managers, architects, database administrators and storage engineers, the increased transactional database performance delivered by value SAS SSDs is a welcomed addition to achieve required performance targets without adding acquisition costs to the server or system infrastructure. In conjunction, end customers and users enjoy a better and faster experience.

Bottom line: Value SAS SSDs delivered 102% more transactions per minute and 100% better CPU utilization when compared to leading enterprise SATA SSDs.

NOTES:

[1] 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.

[2] Definition of capacity - KIOXIA Corporation defines a kilobyte (KB) as 1,000 bytes, 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] 2.5-inch indicates the form factor of the SSD and not the drive's physical size.

[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] Read and write speed may vary depending on the host device, read and write conditions, and the file size.

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