Technical Research Report

PROWESS

A Big Step Up from SATA: Testing KIOXIA RM6 Series Value SAS SSDs

Prowess Consulting testing showed that KIOXIA RM6 Series Value Serial-Attached SCSI (vSAS) solid-state drives (SSDs) can deliver improved database performance on transaction processing and query-based workloads compared to 6 gigabits per second (Gb/s) Serial ATA (SATA) SSDs, at a similar cost.

Executive Summary

The Serial ATA (SATA) interface for storage drives was introduced in 2000, and its last major revision in 2008 brought support for 6 gigabits per second (Gb/s) speeds.[1] SATA drives have limitations, such as the half-duplex inability to read and write at the same time, that make them no longer suitable for the increasing performance demands of the modern data center.

As data centers look to modernize away from SATA drives, there are two main alternatives to consider: Serial-Attached SCSI (SAS) and NVM Express™ (NVMe™). SAS is now a common storage interface in data centers, and NVMe is a newer, costlier, and higher-performing interface.[2] Companies still reliant on SATA drives can benefit from benchmark testing to help them decide at what pace and for what workloads to upgrade to SAS drives.

Prowess Consulting conducted testing to evaluate the performance differences between KIOXIA value SAS (vSAS) drives and Samsung® SATA drives on typical database workloads in a modern data center. The testing used Microsoft® SQL Server® running on Windows Server® 2022, and it ran HammerDB benchmarks to evaluate both online transaction processing (OLTP) workloads (with the TPROC-C benchmark) and analytic workloads (with the TPROC-H benchmark). According to HammerDB, these two benchmarks "complement each other in investigating the capabilities of a particular database."[3]

Today's Storage Landscape and Options

The data center storage market continues to grow dramatically. Global installed capacity is expected to double between 2020 and 2024, reaching 13.2 ZB.[4] While there has been a major shift in recent years from spinning hard-disk drives (HDDs) to solid-state drives (SSDs), there has not been an equally significant shift yet away from the SATA interface. In 2022, the majority of companies (55 percent) used local SATA-based SSDs in their servers, whereas 40 percent used SAS SSDs and 37 percent used NVMe.[5] It would seem companies have been quick to recognize the performance advantages of SSDs, but slow to recognize the limitations of the SATA interface. Either that or the price advantage of SATA SSDs has, at least until recently, been a deciding factor.

Companies have good reasons to modernize their data center storage and leave SATA drives behind, but they need to balance the requirement for performance and capacity against the need for cost-effective solutions. Cloud applications require high availability, and increasingly complex workloads need warm-tier data access that SATA drives can struggle to deliver. But moving to the newest and fastest technology, NVMe, might not warrant the higher costs if the intermediate option, vSAS, can provide the needed performance at a more affordable price.

Prowess Consulting wanted to answer two questions that would help companies decide whether and when to move from SATA drives to vSAS drives:

1. What practical performance advantage could be gained by moving to vSAS?
2. What is the difference in price performance between vSAS and SATA drives?

To answer the performance question, we conducted benchmark testing as described in the following section. After that, the paper addresses the questions of price and total cost of ownership (TCO).

Putting vSAS and SATA to the Test

Prowess Consulting conducted benchmark testing on a Dell™ PowerEdge™ R650 server running Windows Server 2022 with SQL Server 2022. We tested the server with two different RAID 10 configurations, one using four 3.84 TB KIOXIA RM6 Series vSAS SSDs, and the other using four 3.84 TB Samsung SATA SSDs. Table 1 provides configuration details for the systems used in our testing.

Table 1 | Server configurations are identical except for the storage disks

Configuration	KIOXIA vSAS RAID 10	Samsung® SATA RAID 10
Model name	Dell™ PowerEdge™ R650	Dell™ PowerEdge™ R650
CPU	Intel® Xeon® Silver 4314 processor	Intel® Xeon® Silver 4314 processor
Number of CPUs	2	2
Cores/threads per CPU	16/32	16/32
Storage technology	SAS	SATA
Disk	3.84 TB KIOXIA RM6 Series KRM6VRUG3T84	3.84 TB Samsung® PM883 MZ7LH3T8MLT0D3
Number of disks	4	4
Installed memory	256 GB error correction code (ECC) DDR4	256 GB error correction code (ECC) DDR4
Memory DIMM	8 x 32 GB Hynix® HMAA4GR7CJR8N-XN	8 x 32 GB Hynix® HMAA4GR7CJR8N-XN
Operating system (OS)	Windows Server® 2022	Windows Server® 2022
Microsoft® SQL Server® version	Microsoft® SQL Server® 2022 Developer edition build 20348	Microsoft® SQL Server® 2022 Developer edition build 20348
HammerDB	4.5	4.5

Prowess Consulting conducted two HammerDB benchmark tests:

1. HammerDB TPROC-C to test transaction processing performance using 640 warehouses and an increasing number of up to 112 virtual users to stress the system with 10,000,000 total transactions per user.[6]
2. HammerDB TPROC-H to test analytic performance by using scale factors (database sizes) of 30, 300, and 1,000 GB, each scale size tested with 5 and 10 virtual users.

For detailed testing methodology and configurations used in this study, see Methodology.

Results and Analysis

The following charts detail the results of our benchmark testing.

TPROC-C Benchmark Results

Figure 1 shows that the system with vSAS drives outperformed the system with SATA drives in new orders per minute (NOPM) across every number of virtual users.

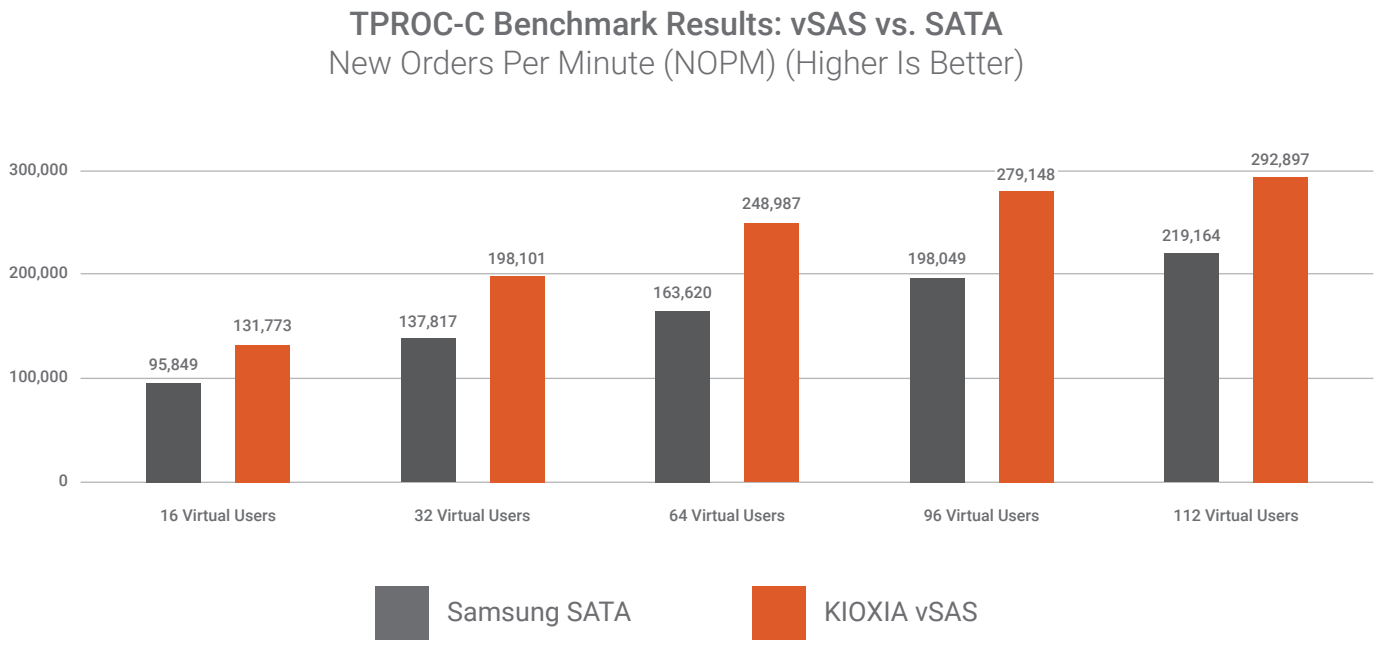

Figure 1 | The system with vSAS drives outperformed the system with SATA drives in NOPM

The performance advantage delivered by the KIOXIA vSAS drives ranged from 1.33x to 1.52x. It's interesting to note that the greatest advantage (1.52x) was seen with 64 virtual users. Our theory is that 64 virtual users represents an optimal performance scenario because the servers under test have 64 threads; therefore, each user is efficiently allotted exactly one thread.

The results for transactions per minute (TPM) were quite similar, as shown in Figure 2.

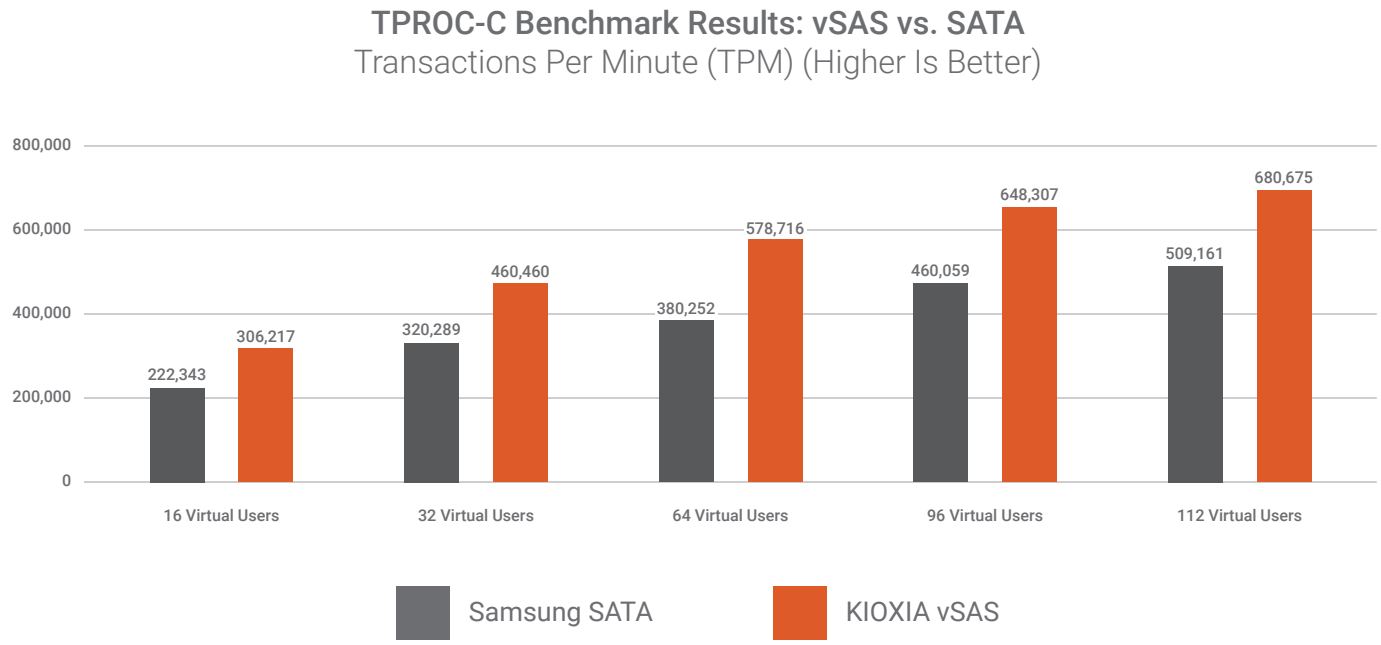

Figure 2 | The system with vSAS drives outperformed the system with SATA drives in TPM

Once again, the system with KIOXIA vSAS drives showed superior performance across all numbers of virtual users tested. Here also, the performance advantage ranged from 1.33x to 1.52x, with the greatest advantage found with 64 virtual users.

TPROC-H Benchmark Results

We conducted TPROC-H testing for 5 and 10 virtual users at database scales of 30, 300, and 1,000 GB. For both numbers of virtual users, we found that the KIOXIA vSAS drives delivered better performance relative to the SATA drives as the size of the workload/ database increases.

Figure 3 shows time needed to complete the analytic workload on a database at the scale of 30 GB.

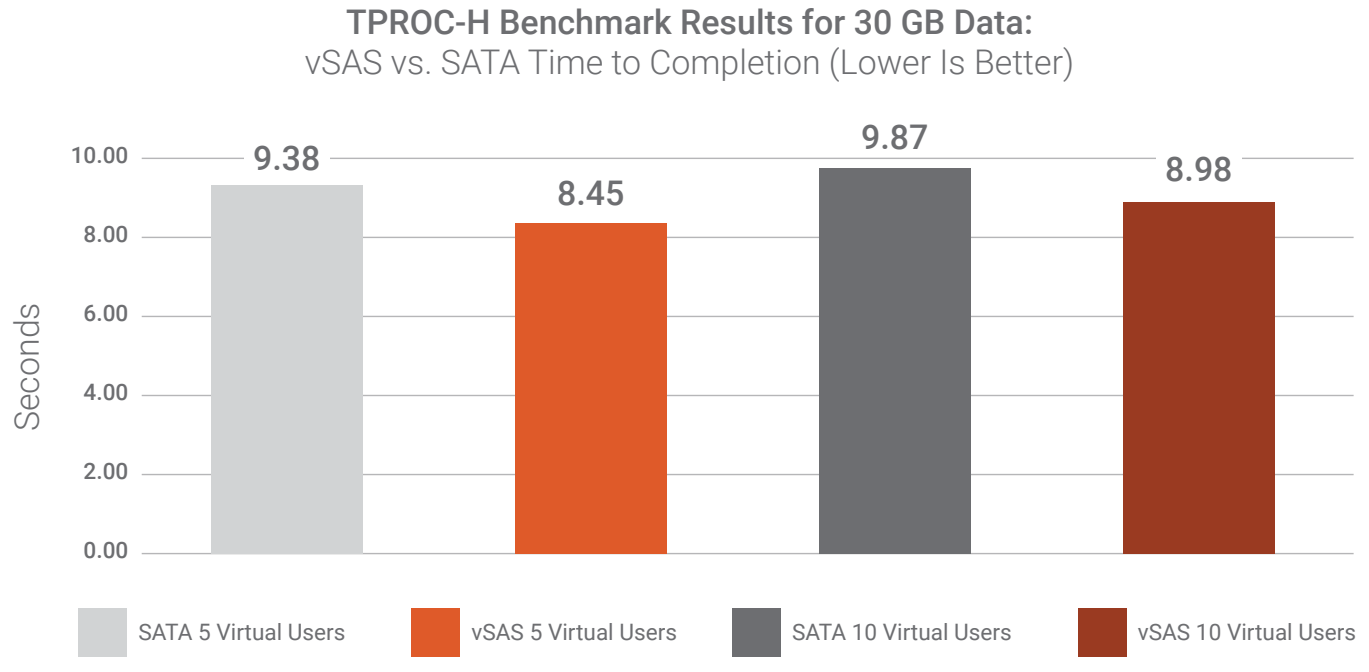

Figure 3 | vSAS drives complete analytic tasks on 30 GB data in less time than SATA drives

For both 5 and 10 virtual users, the tasks were completed by the system with vSAS drives in approximately 10 percent less time (9.9 and 11 percent, respectively).

When the scale of the database is increased to 300 GB, the performance advantage for the vSAS drives becomes more significant, as shown in Figure 4.

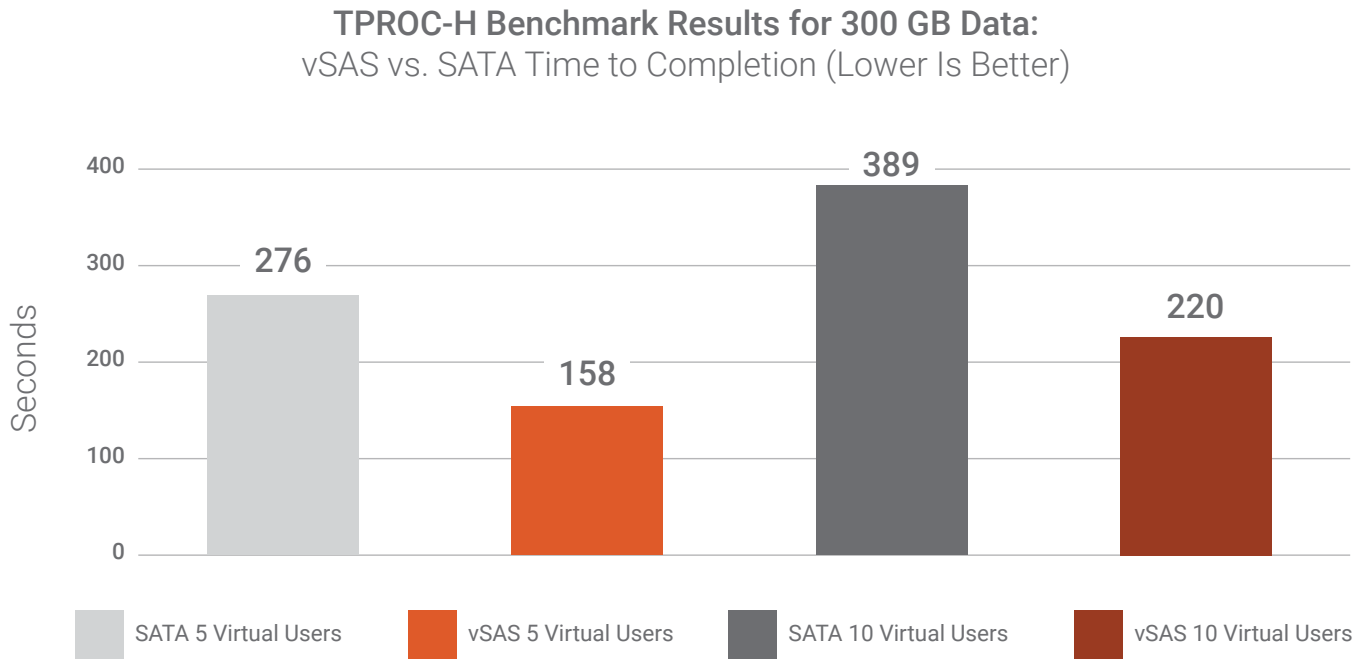

Figure 4 | vSAS drives complete analytics tasks on 300 GB data in less time than SATA drives

At a scale of 300 GB, the system with vSAS drives completed the workload in three quarters the time of the SATA drives (74.6 percent for 5 users and 76.8 percent for 10 users).

Finally, at the largest scale tested, 1,000 GB, Figure 5 shows the system with vSAS drives completed the tasks in less than a third the time of the system with SATA drives.

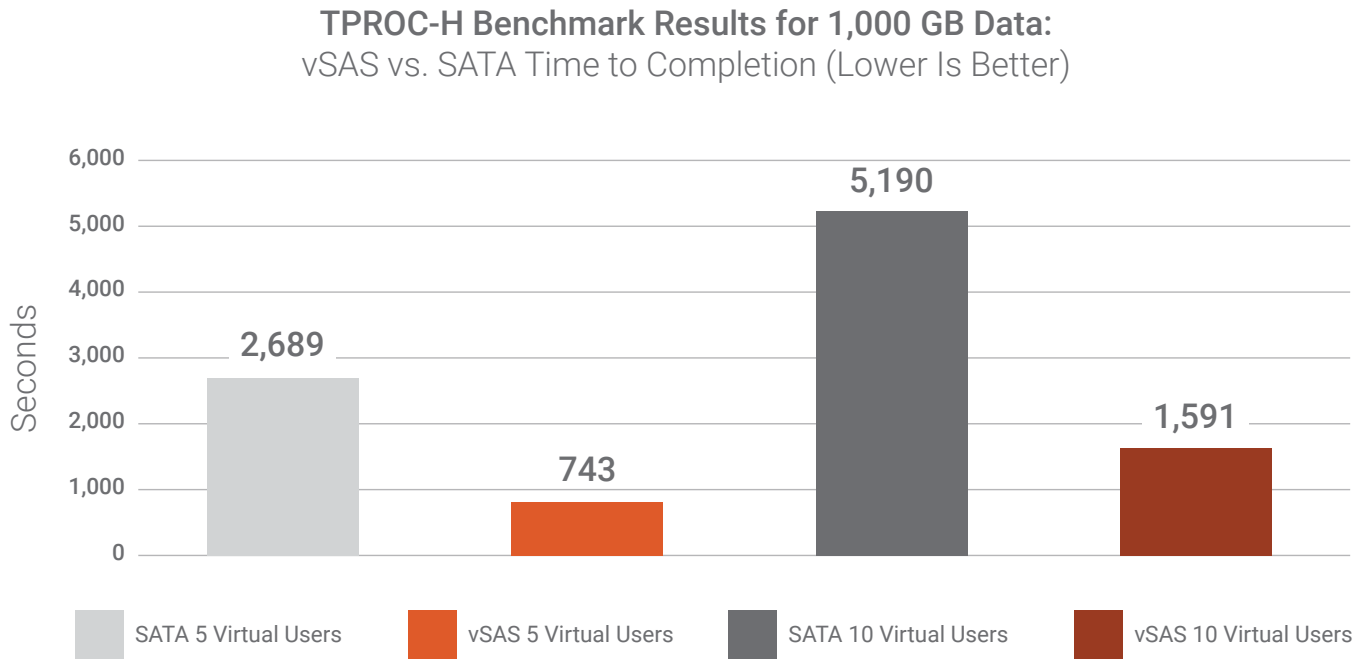

Figure 5 | The vSAS drives complete analytic tasks on 1,000 GB data in less time than the SATA drives

The system with SATA drives took 3.62x as long to complete the tasks with 5 users, and 3.26x as long with 10 users, compared to the system with vSAS drives.

Price Performance

While raw performance information is valuable, top of mind for many decision makers is price performance. When considering a technology upgrade such as moving from SATA drives to SAS drives, what is the bang for the buck? In order to assist with answering that question, we used the raw performance results presented above, adjusted them to account for pricing differences between the two kinds of drives we tested, and normalized the results.[7]

Figure 6 shows that the system with vSAS drives delivers between 1.25x and 1.43x better price performance than SATA drives.

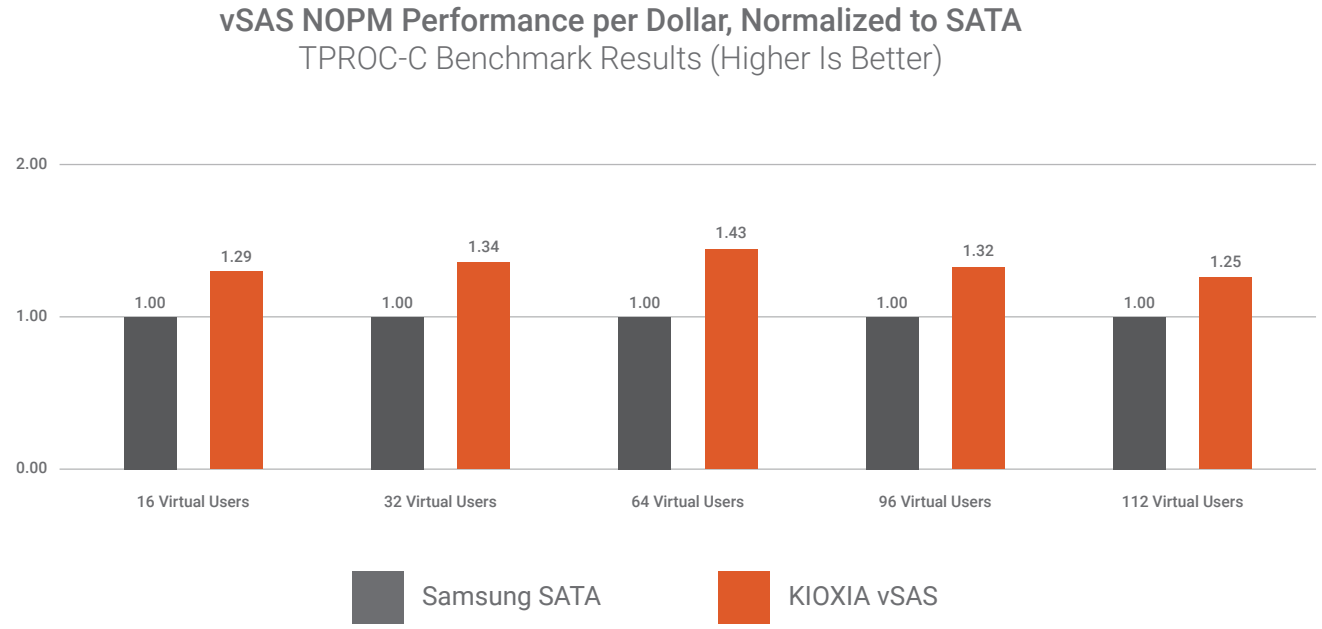

Figure 6 | vSAS drives deliver more NOPM performance per dollar than SATA drives

Finally, a note on power consumption, which is related to price performance but also to sustainability. Prowess Consulting tested the power consumed midway through the TPROC-C benchmark testing for each number of virtual users. The average power draw was 284.8 W for the Samsung SATA drives and 281.4 W for the KIOXIA vSAS drives. While this difference of barely 1 percent is not as significant on its own as other price-performance advantages we've presented here, it's worth noting that in large operations with tens of thousands of SSDs, this small power savings can add up.

Conclusion

Prowess Consulting testing demonstrates the performance benefits of deploying KIOXIA RM6 Series vSAS SSDs in the data center, compared to traditional SATA 6 Gb/s SSDs. These performance advantages translate directly into price-performance advantages as well, given that the KIOXIA vSAS SSDs are similar to the SATA drives in price, power consumption, and expected life span.

The TPROC-C benchmark results show the system with KIOXIA vSAS SSDs consistently delivered higher throughput (NOPM and TPM) across a wide range of virtual user numbers. This simulates a real-world usage model in which a database receives both requests for data and changes to this data from a number of users over time.

The TPROC-H benchmark results demonstrate faster processing of analytic workloads by the system with KIOXIA vSAS SSDs, with particularly impressive results when the scale of the database is larger. This benchmark measures the kind of workloads typical of decision support, business intelligence, and data warehouse applications.

KIOXIA vSAS drives represent a significant step up in performance over SATA drives, with only a minimal step up in cost. Companies seeking higher performance at similar prices should consider upgrading from aging SATA drives to today's vSAS option.

Learn More

Learn more about KIOXIA vSAS SSDs at LifeAfterSATA.com.

Find out how KIOXIA vSAS SSDs stack up in terms of security and performance:
Encryption versus Performance with KIOXIA Value SAS SSDs

See more research reports by Prowess Consulting.

[1] Wikipedia. "SATA." Accessed February 2023. https://en.wikipedia.org/wiki/SATA.

[2] For a testing evaluation of NVMe™ versus SATA, see www.prowesscorp.com/project/is-it-time-to-switch-to-nvme-ssd-get-better-performance-per-dollar-for-modern-workloads.

[3] HammerDB. "Chapter 11. Introduction to Analytic Testing (TPROC-H derived from TPC-H) and Cloud Queries." Accessed February 2023. www.hammerdb.com/docs/ch11.html.

[4] IDC. "Enterprises Rely on Public Cloud Object Storage to Manage Data Growth, Ensure Resilience, and Generate Value. February 2021. www.ibm.com/downloads/cas/ZW9Z057J.

[5] Spiceworks Ziff Davis (SWZD). "Hardware Trends in 2022 and Beyond." Accessed February 2023. https://swzd.com/resources/hardware-trends-in-2022-and-beyond/.

[6] The servers have 64 threads, and normally one thread/virtual user can control up to five warehouses. In the case of this testing, we increased that number to 10 warehouses per thread—640 warehouses in total—to increase the load on the servers.

[7] Pricing is based on alternate configurations of a Dell™ PowerEdge™ R750 rack server at www.dell.com/en-us/shop/servers-storage-and-networking/poweredge-r750-rack-server/spd/poweredge-r750, as of March 20, 2023. Price for a 3.84 GB MU drive was $6,675.86 for a vSAS drive and $6,271.02 for a SATA drive. Pricing varies by product and vendor and fluctuates over time. This pricing is offered as a representative example.

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