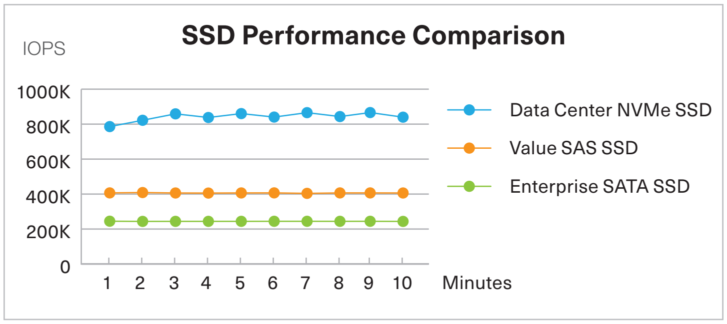
KIOXIA

Good - Better - Best: Assessing Today's SSD Interfaces in Servers

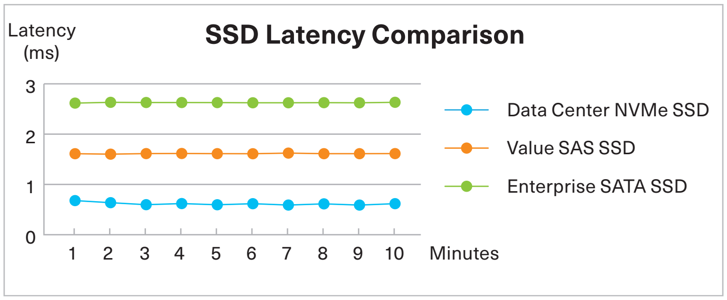
Flash-based solid state drives (SSDs) continue to replace hard drives in servers at a rapid pace requiring IT end users to decide which ones are best to meet their varying workloads and applications. There are three types of SSD interfaces that connect servers to storage media and include: SATA (Serial Advanced Technology Attachment), SAS (Serial Attached SCSI) and PCIe® (Peripheral Component Interconnect Express). The first two interfaces utilize the ATA and SCSI command sets, respectively. A newer instruction set for PCIe called NVMe™ was developed specifically for flash-based SSD media and delivers significantly higher input/output (I/O) gains using a streamlined interface command set.

One of the primary selection criteria when choosing the right SSD for your varying Hewlett Packard Enterprise (HPE®) server workloads and applications will be the SSD interface itself as many increases in I/O will be obtainable simply by using a more advanced interface protocol. As SATA SSDs are becoming ubiquitous as HDD replacements in HPE ProLiant® servers, the SATA interface cannot deliver the exceptionally high performance required by today's data-intensive applications. New SSD categories that address these limitations (e.g., Value SAS and Data Center NVMe), improve compute efficiencies and better realize the full performance potential of flash at a similar cost to SATA.

To demonstrate these performance advancements, KIOXIA America, Inc. conducted a benchmark test on an HPE DL385 Gen10 (2-socket) ProLiant server with AMD® processors that directly compares Value SAS and Data Center NVMe SSDs to SATA SSDs. The tests were based on a read-intensive (90R/10W) TPC-E™-like workload that mimics an Online Transaction Processing (OLTP) application at the disk level. The benchmarks were tested using Iometer in a Microsoft® Windows Server® 2016 environment and based on ten-minute test runs at one-minute intervals, with results measured in Input/Output Operations per Second (IOPS) – or Transactions per Second (TPS).



A server with enterprise SATA SSDs delivers over 230K IOPS, Value SAS delivers over 400K IOPS (or ~1.75x more IOPS than SATA), while Data Center NVMe delivers over 800K IOPS (or ~3.5x more IOPS than SATA).



The latency for traditional enterprise SATA SSDs is over 2.75ms, Value SAS delivers latency at over 1.5ms (or ~0.43x faster than SATA), while Data Center NVMe delivers latency at over 0.75ms (or ~0.71x faster than SATA).

IOPS Test Results

Based on four drives per benchmark, four workers per drive, a queue depth of 32, an 8K block size, and a 90/10 TPC-E workload, the IOPS results showcase how many transactions that could be supported by a server. The more IOPS that a server supports, the faster and more transactions that can be generated, as well as the number of users that can be serviced. The end result is a better online user experience.

Relating to IOPS, SATA is Good, Value SAS is Better, while Data Center NVMe is Best!

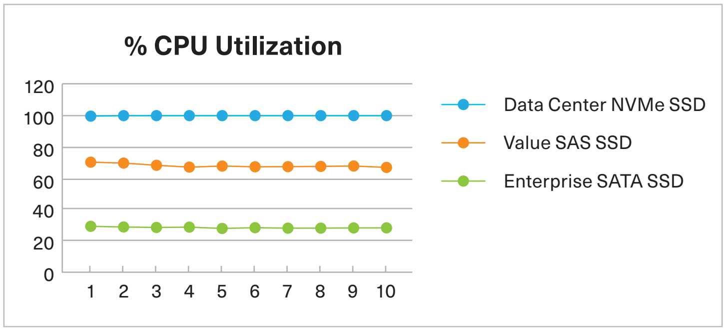
Latency Test Results

Based on the IOPS benchmark, the latency results showcase the time it takes for a data transfer to be executed. The faster that data is moved, the faster and more transactions that can be processed, as well as the number of users that can be serviced. The end result is a better online user experience.

For latency, SATA is Good, Value SAS is Better, while Data Center NVMe is Best!

CPU Utilization

The CPU utilization showcases a server's usage of its processing resources or the amount of work handled by its CPU, but in either case, determines how much compute resources are being utilized and how much more processing can be obtained. The CPU utilization for a server with enterprise SATA SSDs deployed is approximately 25%, versus Value SAS at about 67% (or ~2.68x better utilization than SATA), and Data Center NVMe at 100% utilization (or ~4x better utilization than SATA). The results demonstrate that when higher application performance is obtained, the server gets more out of its CPU. With SATA reaching its performance limits, SSDs based on this interface become a bottleneck to the server, starving the CPU from performing more transactions, thereby underutilizing compute capabilities. Value SAS and Data Center NVMe break the bottlenecks and enable better use of all server resources.



CPU Utilization Results

SATA SSD performance maxes out at 6Gb/s, limiting CPU utilization. With Value SAS and Data Center NVMe, more performance is available to obtain better use from the CPU and get more from the server itself. More CPU utilization equates to faster and more transactions that can be processed, as well as the number of users that can be serviced. The end result is a better online user experience.

Relating to CPU utilization, SATA is Good, Value SAS is Better, while Data Center NVMe is Best!

What is Value SAS?

Value SAS is a new category of SAS SSD media that is expected to replace SATA SSDs in server applications. Initial SSD offerings are expected to deliver 12Gb/s throughput in a single port configuration with advancements in capacity, reliability, manageability and data security, at a price that competes favorably with SATA SSDs.

What is Data Center NVMe?

Data Center NVMe is a new category of PCIe/NVMe SSD media designed for read intensive applications that delivers higher performance and capacities versus traditional SATA or Value SAS SSDs, but at a comparable price tag. It is expected to feature capacities up to 7.68TB with complete end-to-end data protection and emphasis on Quality of Service.

IOPS, Latency & CPU Utilization Test Criteria:

- Tests were based on a TPC-E-like benchmark
- Mimics an OLTP application at the disk level
- The total (TTL) workload was based on a read-intensive, 90/10 (R/W) split
- Read and write speed may vary depending on the host device, read and write conditions, and file size
- The IOPS results are measured in transactions per second (tps)
- All benchmarks were tested using Iometer in a Windows Server 2016 environment, an HPE DL385 ProLiant server (2-socket) with AMD processors, and a KIOXIA RM5 Value SAS SSD (in development) and CD5 Data Center NVMe SSD (in development)
- The tests were run over a 10-minute span at 1-minute intervals
- As it relates to IOPS, each 1 minute data point is based on an average over 60 seconds
- Definition of capacity: KIOXIA 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 1GB = 2^{30} = 1,073,741,824 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, such as Microsoft Operating System and/or pre-installed software applications, or media content. Actual formatted capacity may vary.