Value SAS: A New Class of SSD and Why You Need It

What is value SAS?

Value SAS (vSAS) is a new class of SAS solid-state drives (SSDs) that is expected to replace enterprise SATA SSDs in most server applications. Compared to SATA, value SAS delivers performance, capacity, reliability, manageability and data security benefits, at a competitive price point, making them a perfect upgrade from SATA SSDs.

Why is a new type of SSD needed?

The SATA interface has peaked in performance and has no future speed improvements planned. For many applications, enterprise SATA SSDs may become a bottleneck to the server, preventing the CPU from reaching its operational or transactional potential. This may result in an underutilization of the server's compute capabilities or a negative impact in the number of clients that can be serviced simultaneously.

SSDs in Server Applications

Figure 1: The decline of SATA SSDs in servers
(source: Forward Insights SSD Insights Q4/20 Report No. FI-NFL-SSD-Q420 November 2020)

As a result of their cost-effectiveness, SATA SSDs are well-established and deployed in many servers; however, their attach rate is expected to decline over time as application and workload demands surpass their performance capabilities (Figure 1). Though SATA SSDs are a 'good' solution for application workload demands that don't require exceptionally high performance or capacities, value SAS is a better acceleration solution that supports a wider range of workloads.

Why are value SAS SSDs better than enterprise SATA SSDs?

Since value SAS is based on 12Gb/s SAS, it immediately has a leg up on 6Gb/s SATA-based SSDs as it relates to bandwidth and throughput. Measuring 'practical' performance[1], value SAS delivers 1.52x more read bandwidth than SATA, as well as 1.29x more write bandwidth, 1.88x more random read I/O Operations Per Second (IOPS) , and 3x more random mixed IOPS, as depicted in Chart 1.
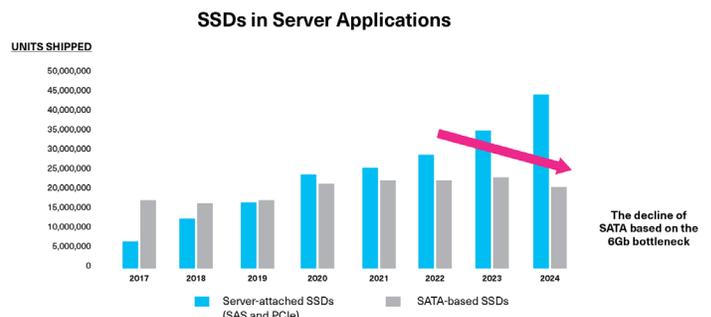
	Enterprise SATA SSDs	Value SAS SSDs	
Read / Write Operation	**Practical Performance (up to)**	**Practical Performance (up to)**	**Performance Gain (up to)**
Sequential Read	550MB/s	840MB/s	1.52x
Sequential Write	550MB/s	710MB/s	1.29x
Random Read	85K IOPS	160K IOPS	1.88x
Random Write	35K IOPS	50K IOPS	1.42x
Mixed Random (90% Read)	50K IOPS	150K IOPS	3x

Chart 1: Enterprise SATA SSD vs value SAS SSD performance comparison in an Online Transaction Processing (OLTP) example

Current value SAS SSDs will provide capacities ranging from 960 gigabytes[2] (GB) to 7,680GB compared to SATA-based SSDs which typically have a maximum capacity of 3.84 terabytes[2] (TB). They also provide multiple levels of data security with sanitize instant erase[3] (SIE) and self-encrypting drive (SED) options. The SAS interface itself provides better infrastructure and SSD management capabilities than SATA and was designed from the ground up to address robust enterprise deployments, while SATA was designed as a lower-cost interface originally targeted for consumer-grade devices. Additionally, the SAS interface provides full-duplex data transmission, while SATA is only half-duplex. This enables the SAS interface to deliver much higher transfer rates between the host and storage device. A single, full-duplex, SAS 12Gb/s port can support up to a 24Gb/s data rate (bidirectional), while a single SATA 6Gb/s port can only support 6Gb/s (unidirectional).

The SAS interface also supports deeper command queuing per device (up to 65,535 queues versus 32 queues with SATA), which allows for more efficient command queueing and processing at the device level. As such, SAS is better suited for enterprise deployments with large topologies because it supports multi-level expanders, a longer cable length than SATA, as well as advanced error detection and correction mechanisms. These robust switching designs, electrical designs, and reliability designs allow for broader and more flexible topologies that support hundreds of SSDs without compromising data integrity – something that the SATA interface does not support. Lastly, the SAS interface is much more feature-rich than the SATA interface and supports more management, error recovery and error reporting features than the ATA SMART feature set utilized by SATA.

Are value SAS SSDs more effective than enterprise SATA SSDs?

Enterprise SATA SSDs utilize an instruction set originally developed for inexpensive, low-end hard drives (AHCI). When SATA SSDs are deployed within a server, the I/O commands must traverse through a software stack (Figure 2) that cannot leverage the full performance potential of flash memory. Servers with powerful, multicore processors and an abundance of DRAM, may be left waiting for data transactions to complete, resulting in an underutilization of compute resources.

In addition, SATA SSDs use the server's SAS infrastructure and hardware RAID capabilities, requiring protocol translation which adds even more latency. By contrast, value SAS uses 'native' SAS from end-to-end, eliminating the need for protocol translation, that results in improved performance. It is no secret that SAS is a more reliable and performance-oriented protocol, making it much more effective in delivering server and application performance.

Software RAID (optional)

SATA Driver

SATA Controller

Flash Controller

Flash Media

Figure 2: SATA SSD Software Stack

Why are SATA SSDs easy to replace with value SAS SSDs?

The SAS interface is designed to support the SATA protocol enabling enterprise SATA SSDs to connect to SAS backplanes, host bus adapters (HBAs) or RAID controllers in servers. Since the majority of today's servers ship with a SAS HBA or RAID card, both SAS and SATA SSDs can be used in the same drive bay. This is why SATA SSDs can be easily swapped out with SAS SSDs, requiring no changes to existing servers or infrastructure.

How is value SAS different from enterprise SAS?

The standard for high-performance, high-reliability and manageable SSDs is 12Gb/s enterprise SAS. It provides two SAS ports that can be used for redundancy/fault tolerance, or for additional performance. Value SAS is a scaled back, single-ported version of enterprise SAS, providing slightly reduced performance in exchange for being price-competitive to enterprise SATA. Since value SAS is built on enterprise SAS, there is no compromise relating to reliability.

Why not use NVMe® SSDs versus value SAS SSDs as a SATA SSD replacement?

Though NVMe SSDs offer even better drive performance than value SAS, the server infrastructure and hardware RAID options currently available are limited. Many of today's data centers, both large and small, are still utilizing SAS-based hardware RAID to provide a mature, robust level of fault tolerance and performance. Customers who buy enterprise SATA SSDs today, and use them with SAS hardware RAID, can easily choose value SAS SSDs and gain the benefits of a more mature and robust technology. Migrating directly to NVMe SSDs requires purchasing new (and usually more expensive) NVMe-enabled servers. Also, an NVMe SSD cannot connect directly to a SAS RAID controller or a SAS/SATA backplane.

Where can one find KIOXIA value SAS SSDs?

In 2018, KIOXIA America, Inc. announced its RM Series of 12Gb/s value SAS SSDs utilizing KIOXIA Corporation's BiCS FLASH™ 3D flash memory. Since then, KIOXIA RM Series SSDs have been available from select OEM customers, such as Dell EMC®.

For details, visit the 'Life After SATA' website at https://business.kioxia.com/en-us/ssd/life-after-sata.html.

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[1] The practical performance accounts for typical performance at the product level and is based on benchmark testing in a lab environment. An OLTP application was used for measurement of server-side performance. The 6Gb/s enterprise SATA SSD performance numbers are based on a sampling of leading competitive SATA SSDs as of the date of publish, while the 12Gb/s value SAS SSD performance numbers are based on KIOXIA Corporation's RM6 Series.

[2] Definition of capacity: KIOXIA Corporation defines 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} bytes = 1,073,741,824 bytes, 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, such as Microsoft Operating System and/or pre-installed software applications, or media content. Actual formatted capacity may vary.

[3] Sanitize instant Erase (SIE) is a security option in which encryption is used to make data unreadable when SSDs are taken out of commission or repurposed. It is compatible with the Sanitize device feature set which is the standard prescribed by T10 (SAS) and T13 (SATA) committees of the American National Standards Institute (ANSI).

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