

Introducing the 24G SAS Interface

SAS Overview

Serial-Attached SCSI (SAS) is a point-to-point serial interface that moves data into and out of storage devices using the SCSI protocol of instruction and command sets. It remains the primary storage interface between computing and storage subsystems in data centers worldwide. The [SCSI Trade Association's](#) defined technology roadmap will enable higher performance in the future as 24G SAS is here and 48G SAS is on the horizon (Figure 1).

Of the three common SSD interfaces (SAS, SATA and PCIe®), SAS is geared toward applications that place a premium on performance, high availability and data protection. The SAS backplane also supports SATA drives, enabling SATA SSDs and HDDs to connect to SAS backplanes, host bus adapters (HBAs) or RAID controllers in servers and storage systems. Since most of today's servers are equipped with a SAS infrastructure, SAS and SATA SSDs/HDDs can be used in the same drive bay. SATA SSDs/HDDs can also be easily replaced with SAS SSDs without any changes to the SAS-enabled server or infrastructure.

24G SAS Overview with Comparisons to 12 Gb/s

At Flash Memory Summit 2018, the SCSI Trade Association promoted 24G SAS (SAS-4) as its next generation, effectively doubling the SAS-3 bandwidth from 12 gigabits per second (Gb/s) line rate. Though 24G is a speed upgrade, the SAS interface has been overhauled with new capabilities such as 128b/150b encoding, 20-bit Forward Error Correction (FEC), and backwards compatibility with SAS-3 (12 Gb/s), SAS-2 (6 Gb/s) and SATA (6 Gb/s).

2.4 GB/s Effective Single-lane Bandwidth

SSDs and hard drives based on SAS typically use two or four lanes for data to travel. With 24G SAS, each lane now supports 22.5 Gb/s, effectively doubling the bandwidth from SAS-3. When compared to the SATA interface, 24G SAS delivers about four times the bandwidth (22.5 Gb/s vs 6 Gb/s), and about eight times the bandwidth when you consider that SAS is full-duplex versus SATA at half-duplex. As data traffic increases, particularly data-intensive and computational workloads, 24G SAS performance can meet these requirements.

128b/150b Encoding

24G SAS incorporates a new encoding method that improves link efficiency to meet the requirements of the 22.5 Gb/s line rate. This new method incorporates 128b/130b encoding, plus 20-bit FEC (discussed in the next section), which allows 24G SAS to achieve the same level of data fidelity as 12 Gb/s SAS even though it is transferring data at twice the rate.

20-bit Forward Error Correction

Forward error correction is a technique used for identifying and correcting errors in digital transmissions over high frequency or noisy communications channels. It can detect and correct errors up to 20 bits long on-the-fly without requiring a retransmission. 24G SAS includes 20-bit FEC in its 128b/150b encoding scheme and is the first time that FEC has been implemented for the SAS interface. Previous SAS revisions only included error detection that retransmits an error, and in turn, reduces overall system throughput. The 20-bit FEC in 24G SAS enables many errors to be corrected in transit so that the maximum throughput can be maintained even under less than ideal operating conditions.

SAS Technology Roadmap

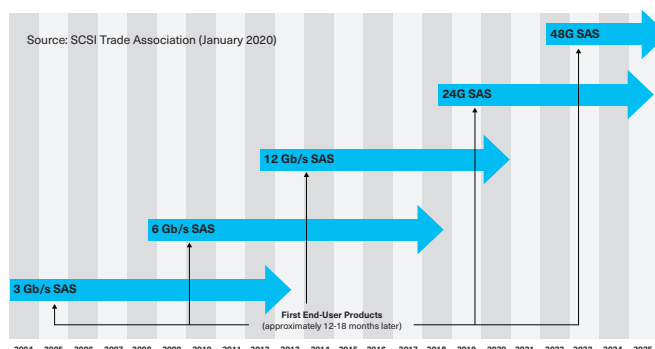


Figure 1: the SAS interface has evolved from 3 Gb/s to 24G with 48G upcoming

Adaptive PHY Training Algorithm

At the physical layer, 24G SAS features a new adaptive PHY training algorithm (APTA) that enables the SAS-4 interface to operate optimally even through extreme environments with noisy signal lines, severe temperature or operating voltage changes.

SSD Optimizations through SAS Storage Intelligence

24G SAS supports storage intelligence that enables applications to manage write streams to reduce garbage collection interruptions and write amplification, while providing better control over background housekeeping tasks. Through better management of write operations, SSD performance and life expectancy can be improved.

24G SAS SSDs – KIOXIA PM6 Series

KIOXIA (formerly Toshiba Memory) is the first storage vendor¹ to introduce SSDs based on the 24G SAS interface with their recent PM6 Series introduction. These 24G SAS SSDs leverage industry-leading BiCS FLASH™ 3D flash memory technology while delivering the largest 2.5-inch SAS SSD capacity¹ at 30.72 TB². The series features a full line-up of supported capacities, endurances and security options to meet the most demanding application and workload requirements of tier 1 server and storage OEMs. The PM6 Series is KIOXIA's 6th SAS SSD generation that builds on the company's successes as a leading SAS SSD vendor.

When compared to the previous generation PM5 Series of 12 Gb/s SAS SSDs³, the new PM6 24G SAS Series effectively doubles the bandwidth and delivers significant performance gains⁴. In a narrow dual, read-intensive environment, using a supported capacity of 7,680 GB² (at 1 DDPD⁵ endurances), the PM6 Series:

- *Doubled sequential read performance (narrow dual)*
- *Up to 70% improved sequential write performance*
- *Up to 50% better random read performance*
- *Up to 120% greater random write performance*



The SAS interface uses additional SCSI commands geared toward error recovery, error reporting and block reclamation that has made an extremely reliable interface even more reliable. They follow a history of proven reliability and are the clear choice for 24G SAS SSDs. In a world with data breaches, the PM6 Series delivers increased data security with SSD options that include Sanitize Instant Erase⁶ (SIE) and Self-Encrypting Drive (SED) with TCG-Enterprise encryption⁷ security options⁸ and SED FIPS 140-2 (Level 2) support⁹.

24G SAS SSD Market Availability

SSDs based on 24G SAS will soon be available in servers from market leading OEMs. Market availability for KIOXIA's PM6 24G SAS SSD Series is expected in Q4 2020.

NOTES:

¹ Based on publicly available specifications from competitive 24G SAS SSD products as of this publication – November 2020, Rev. 2.0WW.

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 = 2³⁰ bits = 1,073,741,824 bits, 1 GB = 2³⁰ bytes = 1,073,741,824 bytes and 1 TB = 2⁴⁰ 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 PM6 Series SSD performance is preliminary and subject to change without notice.

⁴ An Online Transaction Processing (OLTP) application was used for measurement of server-side performance to provide the data locality benefits of direct-attached storage (high-performance / low-latency). The results showcase SSD interface bandwidth and performance and how many operations/transactions that a server's CPU can process. The performance measurements were derived from KIOXIA PM6 Series 24G SAS SSD products, tested at 1 DDPD (Drive Write per Day), and configured with all supported capacities.

⁵ 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.

⁶ The Sanitize Instant Erase (SIE), Self-Encrypting Drive (SED), FIPS (Federal Information Processing Standards) optional models are available. SIE option supports Crypto Erase, which is a standardized feature defined by the technical committee (T10) of INCITS (the InterNational Committee for Information Technology Standards).

⁷ SED supports TCG-Enterprise SSCs. For more details, please make inquiries through "Contact us" in each region's website, <https://business.kioxia.com/>

⁸ Optional security feature compliant drives are not available in all countries due to export and local regulations.

⁹ FIPS drives are designed to comply with FIPS 140-2 Level 2, which define security requirements for cryptographic module by NIST (National Institute of Standards and Technology). For the latest validation status of each model, please contact us in each region's website, <https://business.kioxia.com/>

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