

Seven reasons SAS will be the new enterprise storage standard

Overview

The most pervasive storage networking technology has come to a crossroads. For the past 20 years, parallel SCSI has been the predominant datacentre interface and the standard means for hard drives to interconnect and communicate in server and storage environments. However, its use of a parallel bus nature prohibits future growth and development and must be overhauled in order to address next-generation demands for signal integrity, performance, reliability, and even such fundamentals as cable lengths.

Serial Attached SCSI (SAS) is emerging as the succeeding standard for enterprise server and storage environments. SAS uses serial technology to leverage proven SCSI functionality and offers new levels of performance, availability, and customer choice by supporting both enterprise-class SAS disk drives as well as cost-effective SATA disk drives in the same environment. With the flexibility to configure storage subsystems with either or both types of drives, storage managers can mix high performance and low cost storage in the same subsystem to maximise their return on investment and ensure scalability for future growth.

SAS features

1. Point-to-Point Architecture

SAS uses a point-to-point architecture so that each device connects directly to a SCSI port rather than having a number of devices sharing a common bus. Without a shared bus, SAS arbitration is a straightforward switching process with its dedicated bus. As a result, performance is enhanced because latency is minimised and there is less overhead compared to a parallel SCSI bus. Also, the SAS interface can carry a substantially higher throughput for greater performance; its connectivity features improve data transaction reliability and enhance the ability to locate and repair failures.

2. Compatibility

SAS maintains the core strengths of parallel SCSI by incorporating existing SCSI commands that interface with a broad range of storage management and enterprise-class application software. This compatibility protects users' current investments in SCSI software, middleware, and drivers, allowing them to continue to tap into this wellspring of SCSI knowledge while driving innovative and effective SAS deployments throughout the enterprise.

3. Higher performance and efficiency

SAS can currently deliver a data transfer rate of 3Gbps, with speeds reaching 6Gbps planned for the next phase of development. Full-duplex operation doubles the effective throughput by enabling simultaneous signal transfers in both directions. The duplex feature reduces a major cause of latency and allows aggregation of several ports as "wide" links so data can travel at a higher transfer rate. The improved signal arbitration also means that all devices have equal access to the host with higher efficiency.

4. Connectivity and enhanced scalability

With SAS expanders, a single SAS domain can contain up to 16,384 devices with no performance degradation. Topologies built on SAS expanders have significantly more build-out capabilities than current IT installations as more than one SAS port can be combined into a wide port for higher bandwidth. For example, a host computer can connect from a Host Bus Adapter (HBA) to a disk array through 4X, multi-lane, wide links and a disk array can connect to JBOD (Just a Bunch Of Disks) expansion boxes over 2X wide links.

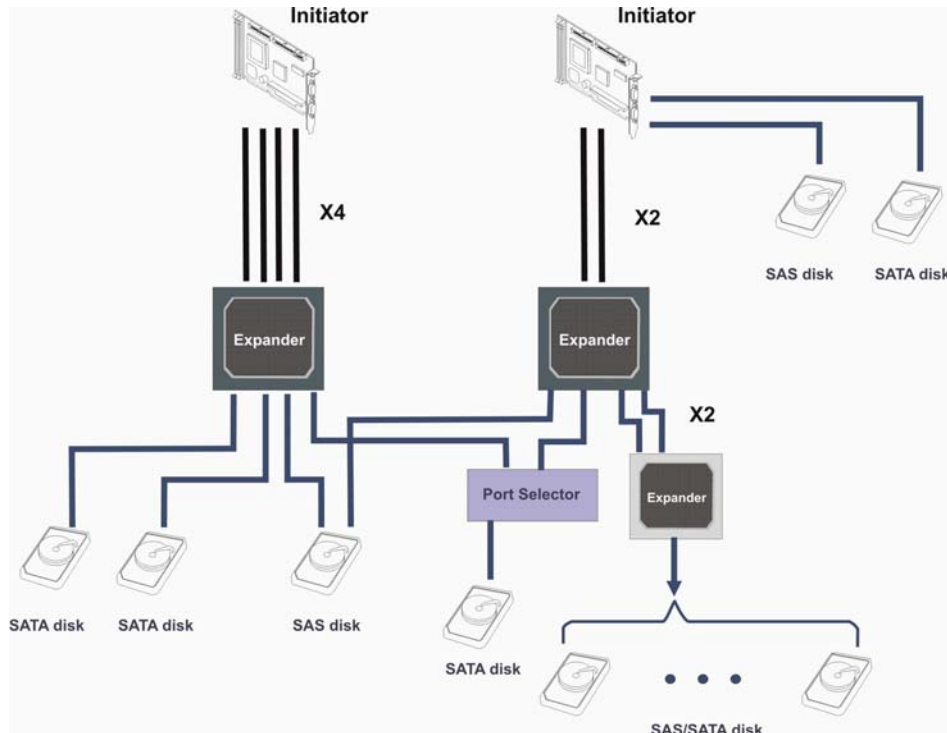


Figure 1: Using SAS Expanders for Connectivity and Scalability

5. Flexibility

Serial ATA (SATA) disk drives are fully compatible with SAS cables, connectors, backplanes, expanders, and host bus adapters. Investments in current disk drives can thus be protected both in terms of matching drive performance and of cost to business requirements. SAS-SATA compatibility significantly reduces the cost and complexity of building a datacentre by minimising the number of individual components that must be qualified, inventoried, and maintained.

6. Simpler, suppler, longer cabling and compact connectors

SAS connectors and cables are considerably smaller than those used for parallel SCSI. Thinner cables simplify cable routing, save space, improve airflow/cooling, and are easier to manage. Smaller SAS connectors easily fit into small form factor (SFF) devices.

The eight-meter cable length is sufficient for connecting both direct-attached storage (DAS) and storage arrays deployed near the server. Within a tiered and intertwined expander architecture, every two devices are linked with a dedicated connection that can be expanded using SAS expanders. Thousands of feet of cabling can exist in a SAS domain.

7. Improved reliability and availability

The serial point-to-point architecture of SAS technology eliminates crosstalk and signal skews. The dual-ported interface ensures that if one SAS host controller fails, the other data port can maintain uninterrupted communication with a second controller. As a result, a SAS interface is more reliable,

offers improved signal integrity and hence a higher level of data availability. Hot-plug capability further ensures uninterrupted data availability by permitting drive swapping without having to shut the system down.

Serial and parallel technologies comparison

Traditional ATA and SCSI disk interfaces transmit data in parallel signals and share a drive bus when multiple drives are installed. Serial interfaces, including SAS and SATA, provide a physical point-to-point connection without sharing a bus. Parallel ATA and SCSI transfer rates have doubled many times over the years, but no further growth is expected. In addition, it is important to remember that because SCSI devices share a bus architecture, the use of multiple disk drives can quickly consume the total bus bandwidth. Point-to-point architectures such as point-to-point connectivity and serial data links can eliminate this bottleneck thus making interface speed less relevant.

Table 1: SCSI, SAS, SATA and Fibre Channel comparison

Feature	SCSI	SAS	SATA	Fibre Channel
Topology	Parallel bus	Point-to-point	Point-to-point	Point-to-point arbitrated loop switch
		Full duplex with link aggregation and wide ports	Half duplex	Full duplex
Performance	3.2Gbps	3Gbps 6Gbps (ready soon)	1.5Gbps 3Gbps	2Gbps 4Gbps
Disk drive	10,000-15,000 rpm MTBF 1.2 million hours	10,000-15,000 rpm MTBF 1.2 million hours	7,200-10,000 rpm MTBF 500,000 hours	10,000-15,000 rpm MTBF 1.2 million hours
Connectivity	1 to 12 meters (LVD)	> 8 metres external cable	1 metre internal cable	10km w/ external optic fibre cable
	14 devices	128 devices by 1 expander; 16K physical max w/ fan-out expanders	One device Fan-out devices (multiplier)	127 devices Loop or loop switch
	SCSI only	SAS & SATA	SATA only	Fibre Channel only
Availability	Single-port	Dual-port	Single-port	Dual-port
	Multi-initiator shared bus	Multi-initiator point-to-point	Single host point-to-point	Multi-initiator, shared media or point-to-point
Driver and model		Software transparent with parallel SCSI	Software transparent with parallel ATA	Software transparent with parallel SCSI

More significantly, SAS and SATA interfaces hold a promise for next-generation disk drives because their point-to-point bandwidth far surpasses the hardware performance of current disk drives. Furthermore, smaller cables and wider links make physical implementation easier and less likely to fail.

Available SAS-related devices

Internal SAS connection, HBAs and disk drives

A SAS connection can accommodate SAS or SATA disk drives. High-availability storage is easily achieved using SAS HBA/RAID cards and disk drives in a server enclosure providing basic protection for primary storage. For higher reliability, there is a trend to embed SAS connectivity within a server enclosure so that storage capacity can be easily expanded using a RAID enclosure or expansion arrays (JBODs) that come with SAS connectivity.

Expanders/switches

While parallel SCSI can only be applied in direct-attached storage which can later become an isolated storage island, SAS can be applied using a fabric-like methodology where multiple SAS initiators can connect and concurrently access multiple SAS storage devices. Storage resources are therefore shared over SAS interconnects and the number of linked devices is far beyond the scale of any parallel SCSI application.

External storage enclosures

SAS can be implemented as both the host-side and drive-side interfaces in an external disk array. External storage arrays currently support SCSI, SATA, and Fibre Channel disk drives. By adding a SAS interface, a storage administrator may choose to distribute less important, infrequently accessed data to SATA drives and use high-reliability SAS drives for primary storage. SATA and SAS drives can co-exist within an enclosure or later be interchanged depending on the intended application. SAS drives are designed for high-performance and high-reliability applications, while SATA drives aim to fit into cost-effective and high-density solutions. With SAS switches and fan-out expanders, SAS applications can be highly flexible.

Conclusion

With its new levels of performance, availability, and customer choice, SAS is poised to replace parallel SCSI as the predominant data centre interface by supporting both enterprise-class and cost-sensitive applications. SAS storage subsystems combine powerful and flexible expansion capabilities with new connectivity options to maximise customers' ROI and allow for future growth. Storage administrators can easily install new storage devices in a direct attached topology or build a small scale SAS SAN without adding expensive switching equipment.