Transitioning to 6Gb/s SAS (Serial-Attached SCSI)

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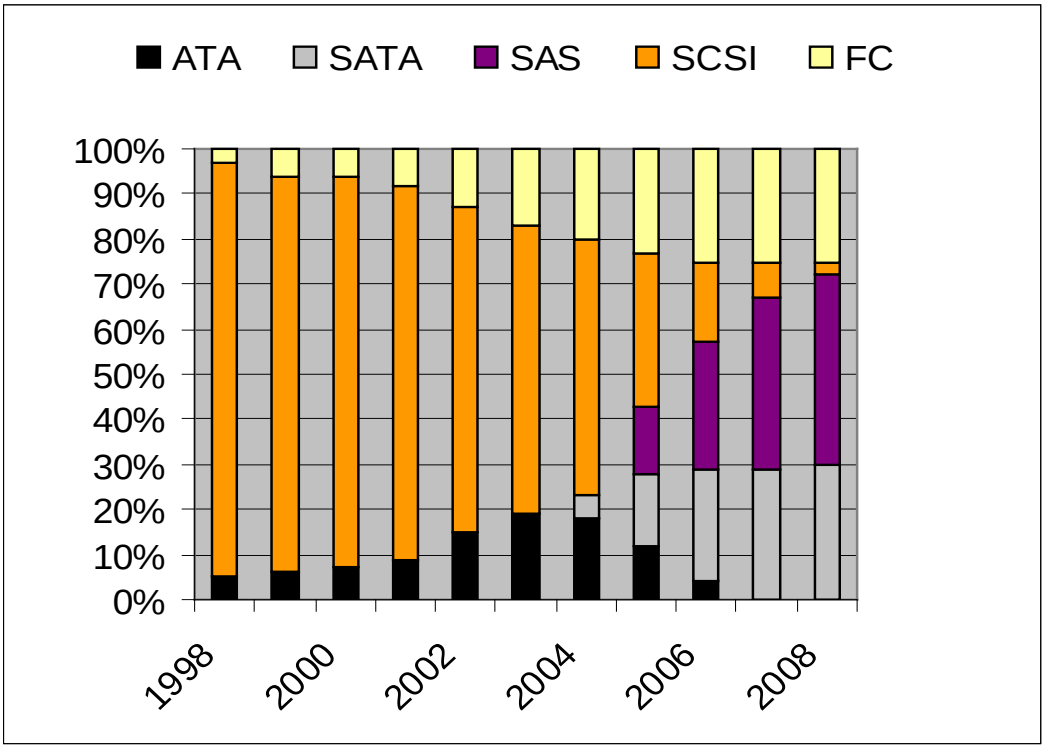
Serial Attached SCSI (SAS) Today

Today's varied server applications necessitate a variety of storage requirements. Some applications are more focused on transaction processing performance, while others are more concerned with low-cost, high availability or the ability to scale the system.

Parallel SCSI, once the dominant interface for enterprise storage, has been replaced by serial attached SCSI (SAS), which was designed to address today's server application and infrastructure complexities.

Figure 1 illustrates the historic trend of SAS emerging as the dominant drive interface for servers.

Figure 1. Historical Enterprise Server Disk Storage Trends



SAS is the prevalent Storage Interface for Direct Attach Storage (DAS). Direct attach implies attaching hard disc drive storage directly to a single server. Those drives can be either inside or outside the server chassis. While SAS leverages many of SCSI's strengths, it also brings significant performance and feature set enhancements

The ability to scale provides an organization the assurance of investment protection with their storage platform because scalability can accommodate an organization's future, inevitable, growth. SAS achieves this by breaking free of the 15-drive-barrier-per-channel limitation of

parallel SCSI technology and scales with the needs of its data center. The SAS interface dynamically increases connectivity well beyond SCSI's drive-maximum connections.

A primary feature of SAS is its ability to communicate with both SAS and SATA hard drives. SAS hard drives are typically used when performance and reliability are critical. SATA hard drives are typically used when capacity and cost are most important.

When attached to SAS controllers, SAS and SATA hard drives can be mixed in a single system.

So, if compatibility is a feature, what is the benefit? Server, Workstation and External storage enclosures can be standardized around one SAS infrastructure. It is no longer a requirement to have a SATA and SCSI variant of a given component such as a server chassis.

Another compelling feature of SAS is its serial interface, which supports smaller cable connectors. This enables more storage using small, form-factor hard drives.

Other compelling SAS benefits include:

- Smaller and thinner cabling for improved routing, airflow and cooling within systems.
- Unprecedented performance and a long-range roadmap up to 12Gb/s.
- Point-to-point architecture that enables each device to connect directly to a port with dedicated bandwidth, rather than having a number of devices share a common bus.

SAS Expanders and Wide Ports

SAS wide ports are a unique feature in data storage. There is no SCSI, SATA or Fiber Channel equivalent. Wide ports enable system designers to aggregate bandwidth to increase overall performance. Essentially, the SAS connection between common endpoints acts as one bonded channel. For example a x4 (by-four) wide port aggregates four independent 3Gb/s links and provides up to 12Gb/s of bandwidth.

By providing this wide port feature that widens the data path, SAS maximizes total system performance.

SAS expanders enable the use of less controller connections to service hard drives. This reduces cost, as fewer RAID ports need to be purchased. It reduces cabling complexity and scales easily beyond 8 drives and they incur very little, if any, performance penalty verses direct connect configurations.

SAS expanders do, however, allow connection to many more drives making larger disk drive configurations much more practical.

What is 6Gb/s SAS?

IT professionals face their next business-critical technology decision as the SAS storage interface transitions from 3Gb/s standard to 6Gb/s.

The advent of 6Gb/s SAS technology represents an evolutionary advancement in storage IO to meet the growing demands on today's storage environments. With unprecedented performance levels and improved signaling and management for supporting larger disk attach, 6Gb/s SAS offers users a much more scalable and flexible direct attach storage (DAS) interface.

The 6Gbs SAS 2.0 specification doubles the current 3Gbs SAS data transfer rate. But it does more than that. 6Gb/s SAS is designed for backward compatibility with 3Gb/s SAS and 3Gb/s SATA hard drives. Regardless of the drive speed, 6Gb/s controllers will deliver significant performance improvements in both read and write applications as compared to their 3Gb/s predecessors.

Other new features of the 6Gb/s SAS controllers will offer improved signal integrity and additional safeguards to enhance data protection.

6Gb/s SAS 2.0 also brings standardized zoning, self-discovery, and self-configuration methods to expanders. This makes larger and more complex topologies easier to implement. These features, however, are designed for SAS fabrics that scale beyond the requirements for DAS-based storage subsystem requirements.

6Gb/s SAS Features

6Gb/s Serial Attached SCSI	DAS-based Server Storage	SAS Fabric
6Gb/s Throughput	★	★
3Gb/s Compatible	★	★
Standard Mini-SAS Connectors (SFF-8087 and SFF-8088)	★	★
DFE (Decision Feedback Equalization) improved signaling	★	★
SSC (Spread Spectrum Clocking) reduced radiated emissions	★	★
Enhanced Security with SED (Self-Encrypting Drive) support	★	★
Data Protection with DIF/PI	★	★
Improved Scalability	★	★
Expander Self-discovery and self configuring		★
Zoning management		★

Where Does 6Gb/s SAS Technology Really Outshine 3Gb/s SAS?

In small disk drive configurations, one to eight drives, the aggregate media rate of the disks (the speed at which the disk heads can read and write data) become the bottleneck for storage throughput. As business storage needs grow, IT centers can add more disk drives to their storage infrastructure, and the latest generation of SAS allows server performance to scale past the 3Gb SAS performance limitations: from 2.4 GB/s to 4.8 GB/s unidirectional.

SAS Generation	PCI-Express Interface	Number of SAS drives required saturate bandwidth (RAID 0)
1.0 (3Gb)	1.0	10
2.0 (6Gb)	2.0	20

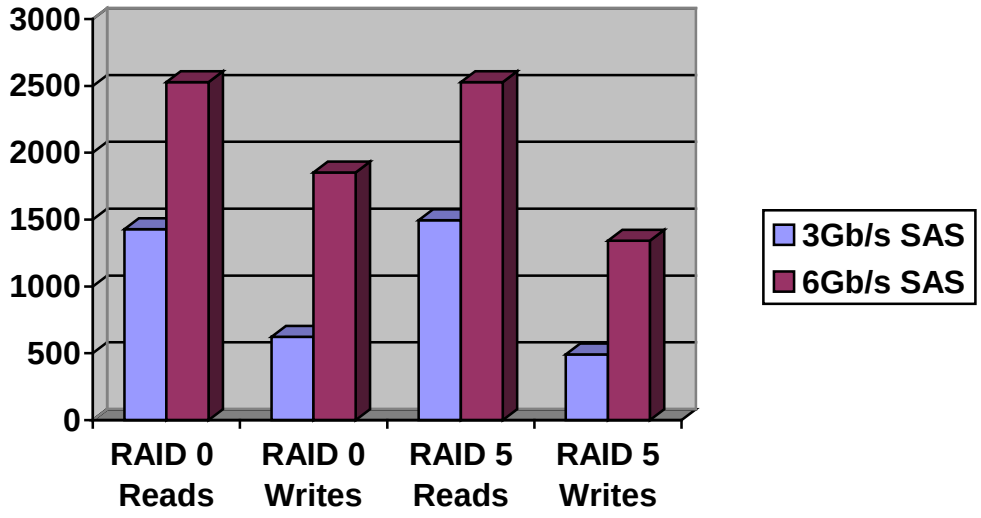
In addition to the improvements in the SAS bandwidth, PCI Express 2.0 provides double the system-to-storage controller interconnect speed. The x8 PCI Express 1.0 interface linking the controller to the host platform limited throughput even further to a theoretical 2GB/s maximum, that limitation has been raised to 4GB/s (unidirectional).

What to Expect

RAID controllers employing 6Gb/s SAS technology will excel in both high IOP and high bandwidth applications. Applications and environments that will benefit most range from traditional data center applications, such as random IOps intensive email, web and database servers, to streaming and archival applications that will benefit from improved sequential read and write throughput. What does this mean? More users, more video streams, more email accounts, and faster backups are now possible.

Figure 2 illustrates anticipated bandwidth (MB/s) improvements between 3Gb/s SAS and 6Gb/s SAS RAID controllers. In a 24-drive configuration, up to 70% in sequential read and 190% in sequential write improvements can be anticipated.

Figure 2. IOMeter 100% seq. Reads/Writes MB/s: 24 disk, 15k rpm, RAID 0/5, 256k stripe size, 1 MB transfer size



In random read and write applications (measured in IOs per second or IOPs), other variables begin to have a more significant role in measuring data path performance. The RAID controller processing cores, memory bandwidth and capacity, and the behavior of the RAID stack itself have much more significant impacts on performance verses raw throughput in sequential data profiles.

These application environments will benefit most significantly from 15Krpm Hard Disk Drives (HDDs) or Solid State Drives (SSDs). A separate white paper focusing on application benchmarks measured in IOPs—such as e-mail, web, file and database servers— will look at storage performance using disk drives as well as solid state drives.

Indeed, 6Gb/s SAS technology does deliver performance enhancements that overcome data path bottlenecks in the previous SAS generation. However, only by leveraging a true end-to-end 6Gb/s SAS ecosystem—incorporating PCIe 2.0-based 6Gb/s SAS controllers, 6Gb/s SAS expanders and 6Gb/s SAS physical drives—can you exploit this technology evolution to its fullest potential.