The Benefits of SAS

SAS provides a robust, mature ecosystem for the enterprise.

Executive Summary

Serial attached SCSI, or SAS, has been an industry standard for more than ten years, and the underlying technology, SCSI, has been an industry standard for more than thirty years. SAS provides a reliable enterprise-grade interface designed specifically for computer storage. SAS technology is well established and offers a wide and robust ecosystem including host bus adapters (HBAs), RAID adapters, expanders, cables, connectors, and system backplanes. SAS storage systems can scale all the way up to large external storage systems with hundreds or thousands of storage devices.

SAS compatibility with devices and servers is nearly universal. SAS is available as an interface for hard disk drives (HDDs) and solid-state drives (SSDs), and SAS is commonly found in data center servers from nearly every manufacturer.

SAS and its Ecosystem

Most servers found in data centers include SAS backplanes that can accommodate SAS and SATA hard disk drives (HDDs) and solid-state drives (SSDs). It is relatively inexpensive to add SAS support to a server, and the modular approach allows a variety of configurations. Depending on the number of rack units the server consumes, a simple drive cage could support four SAS or SATA drives or a large set of drive bays could be included. For example, a two rack-unit (2U) data center server can easily support up to 24 2.5-inch small-form-factor (SFF) drives or up to 12 3.5-inch large-form-factor (LFF) drives. Some four rack-unit (4U) servers support as many as 60 or 90 drives.

SAS support in servers is usually provided by a SAS host bus adapter (HBA) or SAS RAID controller either mounted directly on a server motherboard in the form of a chip or on an add-in-card (AIC) installed in one of the PCIe bus slots. In either form factor, the storage processing is offloaded to the SAS processor, reducing host CPU utilization.
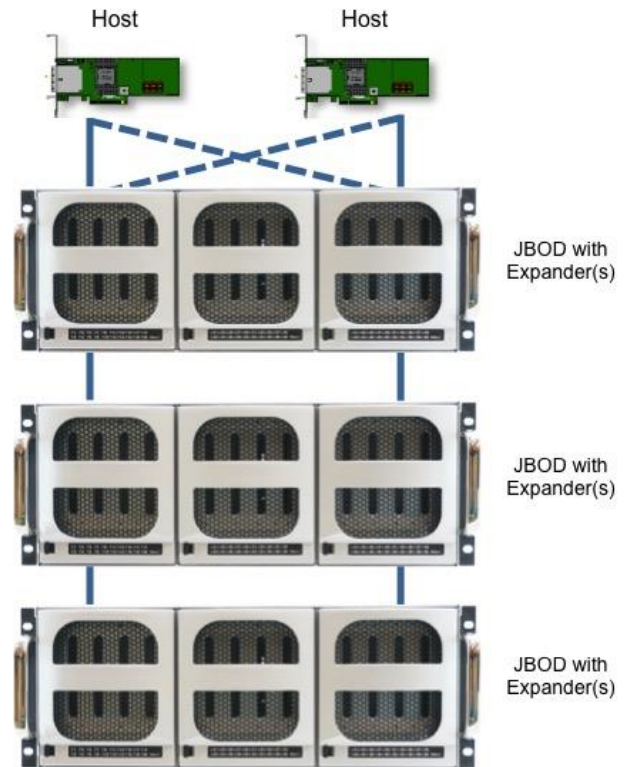
SAS support is provided "in-box" with virtually every operating system that runs in data centers, supporting a large number of SAS devices. SAS support in operating systems includes interoperability with devices from various manufacturers. Interoperability plugfests are held with each new generation of SAS and as required as these new generations mature and additional components become available.

SAS Expanders

The scaling to large numbers of devices is performed using SAS expanders. SAS expanders function in a similar way to a network switch – they allow servers, SAS controllers and storage enclosures to connect to large numbers of drives, including SSDs and HDDs. SAS supports up to 65,535 (2^{16} - 1) SAS or SATA devices in what can be considered a SAS fabric. Although server configurations typically only consist of a single initiator, the SAS protocol can support more than one initiator in a SAS domain for dual domain and multi-path configurations.
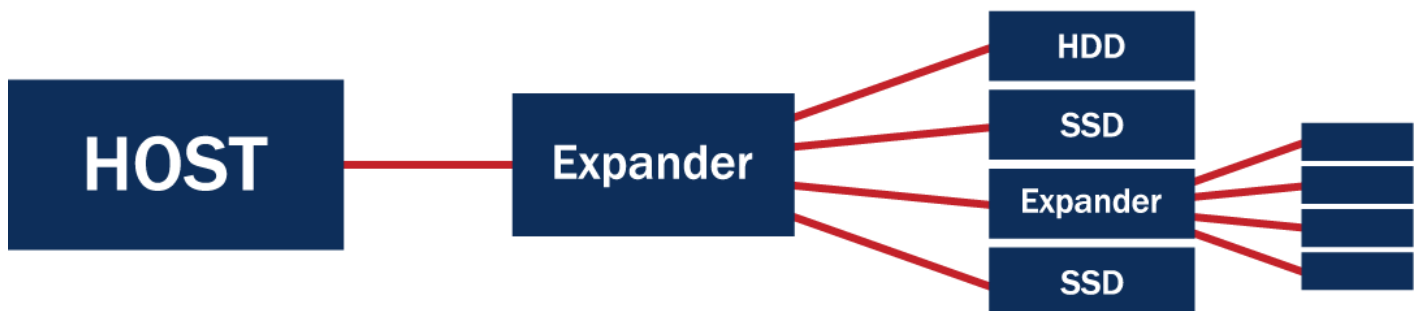
There can be more than one SAS expander in a server or storage system, with modern intelligent SAS expanders capable of discovering devices connected to them. A single SAS expander can support 24, 36, 48 or more direct-attached devices, including other SAS expanders, and these are typically deployed on server and storage system backplanes.

Modern SAS expanders support multiple data rates and per the SAS specification, are required to be backward-compatible two generations. Bandwidth aggregation can be used to allow slower end devices to fully utilize the bandwidth of faster host connections.

SAS provides native scalability to 1,000s of storage devices

SAS JBODs

SAS JBOD (Just a Bunch Of Disks) units have been commonplace for years, providing a simple way to extend and scale up the number of storage devices available to a server or storage system. SAS JBODs support a range of drives – up to several dozen in a single chassis – depending on the manufacturer's design and the drive type. Unlike some of the newer protocols, these SAS JBODs include well-established, standardized in-band enclosure and chassis management mechanisms.

Many SAS JBODs support the concept of adding drive shelves through a fairly simple mechanism of "daisy-chaining" shelves together. This is a common way of scaling up the amount of storage and is used with SAS JBODs and often with other types of external storage systems.

SAS Dual-Ported Drives

SAS supports the concept of dual-ported drives. This allows either two hosts to directly connect to the same drive simultaneously or one host to access the drive via two channels. The latter method provides a redundant path to the drive in the event of a controller failure or for "dual-active" configurations for increased performance.

SAS MPIO

Enterprise environments require high availability, which means that in the event of component failures in the data path, access to data is not lost. Multi-path I/O (MPIO) is a common technique to overcome failures in the I/O path, providing for continuous access to data. SAS has well-developed support for MPIO, allowing multiple access paths to a device or set of devices. The SAS MPIO functions are integrated with operating system MPIO functions to provide a complete multi-pathing storage solution.

In the example on the right, a path between the server and the first JBOD or between any of the JBODs could fail, but the host server would still have access to the data in all of the JBODs.

MPIO
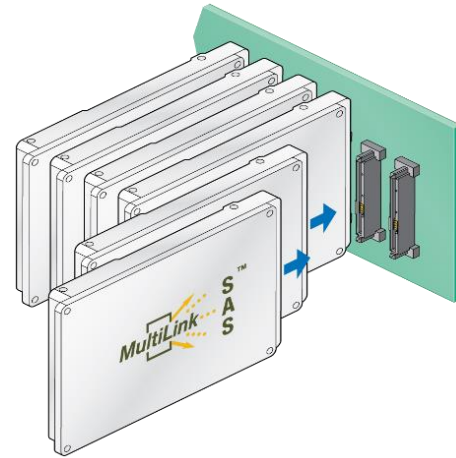
HOST

RAID   RAID

JBOD

JBOD

JBOD

SAS Hot Swap

"Hot swap" or "surprise add/removal" has been supported by SAS for many years. This includes inserting and removing drives from server drive bays and external storage drive bays, and works for both HDDs and SSDs.
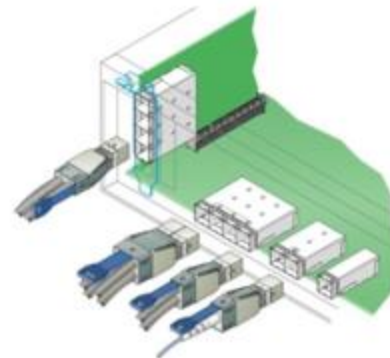
SAS Power Consumption

SAS HDDs and SSDs generally consume up to approximately 12 watts of power when active, depending on the type and capacity of the device, and less power during idle states. NVMe drives, by contrast, typically consume 25 watts when active.

SAS Cabling and Connectors

For any ecosystem of computer storage components and devices, there needs to be a way to connect these devices together. SAS has a fully developed cabling and connector ecosystem that covers external, internal, and mid-plane SAS connections for multiple operating speeds and for one, two, and four-port count connections.

SAS flexibility allows hot addition and reconfiguration of storage pools

SAS offers multiple connectivity solutions

Summary and Conclusion

Regardless of the configuration of internal or external adapters, drives and drive enclosures, configuring a SAS system is relatively easy to perform, using common, well-known steps. SAS provides the flexibility and reliability to support storage solutions ranging from high performance to capacity-optimized and provides native scalability to 1,000s of storage devices.

SAS is also a proven and sustainable storage platform that supports future storage needs. By leveraging its strong storage legacy, SAS continues to innovate with a roadmap that extends to 24Gb/s SAS and beyond.