

# Maximize SATA Value with SAS Controllers

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### Introduction

Remarkable cost-effectiveness has always been the hallmark of Serial ATA (SATA) disk drives, and recent improvements in performance (3Gb/s) and available capacity (up to 750GB) have only reinforced SATA's stature as the unrivalled leader in storage efficiency. Of course, SATA drives don't exist in a vacuum, and deploying them within the optimal infrastructure is key to achieving maximum SATA value.

The Adaptec Unified Serial™ Architecture storage model enables enterprises to significantly boost the scalability, performance and reliability of their SATA disk drive-based solutions. By leveraging Serial Attached SCSI's (SAS) compatibility with SATA, the comprehensive line of Adaptec SAS RAID controllers set new standards for SATA storage value.

### Background: Serial Symbiosis

SATA benefits from the more modern, enlightened strategy the storage industry applied to serial interface interoperability. By contrast, little thought was given to compatibility when the parallel SCSI and parallel ATA (PATA) standards were conceived many years ago. As a result, those two storage interfaces, while both employing parallel architectures, were completely incompatible.

Development of SAS began after the SATA 1.0 standard had started, and the authors of the SAS standard understood well the significance of SATA's growing role in the enterprise. Hence, compatibility with SATA became a key feature of SAS, enabling a variety of synergies (both fiscal and physical) by ensuring SAS and SATA drives can share the same enterprise-class storage infrastructure.

To that end, SAS cables, connectors, HBAs, and RAID controllers are fully compatible with SATA and SAS drives. Furthermore, SAS controllers seamlessly identify and communicate with SATA devices, making a SAS controller just as efficient at issuing SATA commands as a SATA controller.

SATA and SAS play distinctly different roles in the enterprise. The two technologies are complementary rather than competitive, with SATA disk drives optimized for low cost/GB and SAS drives built for transactional, high-availability applications. Together they can efficiently meet a broad spectrum of enterprise storage needs in a single infrastructure. Though this is a primary objective of the Adaptec Unified Serial Architecture, the benefits don't end there...

### SAS/SATA for Maximum SATA Value

While the ability to intermix SAS and SATA drives in the same infrastructure represents a quantum leap in storage efficiency, Unified Serial Architecture pays equally compelling dividends in storage solutions that utilize only SATA disk drives. Most SATA drive-based storage solutions can be divided into three basic configurations: direct-attached consisting of a one-to-one connection in the server; an internal backplane in the server; and an external backplane on a JBOD.

#### Less Cabling, More Drives

The simplest and most straightforward configuration, one-to-one connection, entails each SATA drive connected to a corresponding controller port on the server, i.e., one drive per one controller port. With a separate SATA cable required for each drive connection, the resulting cable clutter wastes chassis space and impedes cooling (Figure 1).

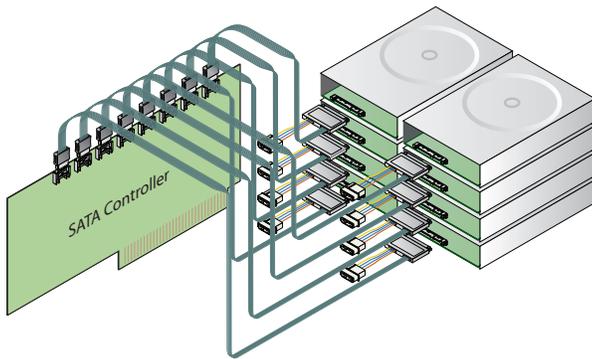


Figure 1

But, what happens when more SATA drives must be deployed to house ever-growing mountains of data? With no inherent provision for expandability, adding more drives to an eight-port SATA controller configuration is costly; either the controller must be replaced with one that offers a higher port count, or inefficient Port Multipliers (see sidebar) must be added.

SAS controllers overcome this 1:1 port/drive constraint by leveraging expander technology. Instead of being limited to a maximum of eight drives on an eight-port SATA controller, an eight-port SAS controller supports the connection of up to 128 SATA and/or SAS drives per port. By including an external port in addition to its internal ports, a SAS controller makes it literally a snap to add dozens of more drives in an external enclosure.

Internal drive connections utilize SFF-8484 connectors on the SAS controller, each of which fans out into four SFF-8482 connectors for the SATA drives. Thus connecting eight drives only requires two “multilane” SFF-8484 connectors. These space-efficient connectors enable half-size controller boards and less cabling, which improves airflow within the server and boosts system cooling (Figure 2).

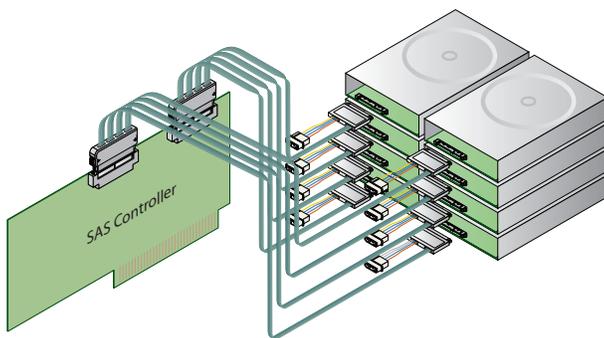


Figure 2

## PROBLEMATIC PORT MULTIPLIERS

The SATA II specification includes Port Multipliers (PMs), hub-like devices that enable each PM-equipped port on the SATA host controller to connect up to 15 drives. Unfortunately, there are significant drawbacks to PMs:

**Compatibility** — Port Multipliers require SATA II host controllers that are Port Multiplier-aware; legacy SATA 1.0 controllers must be replaced.

**Scalability** — Port Multipliers can’t be daisy-chained together, severely limiting their flexibility and expandability. PMs costs can quickly become prohibitive as drive quantities escalate. For example, connecting 100 drives via an eight-port SATA controller would require seven Port Multipliers (and consume seven controller ports).

**Performance** — Port Multipliers only support one active host connection at a time, significantly degrading effective throughput. Each time communication is initiated with a drive time-consuming drive reset must occur.

**Data Integrity** — PMs must close the connection to one drive to open a new one to another. When a connection is closed drive history (e.g., data source, destination drive, data & command context) is lost; with each opened connection the chance of misidentification and sending data to the wrong drive is increased.

## Cost-Per-Drive is Key

An eight-port SAS controller (approximately \$600) can support a large number of drives. With only internal connectors, an eight-port controller can connect up to eight drives directly, or more if expanders are used. Using external connectors, an eight-port controller can connect up to 128 drives by scaling with JBODs. For the purposes of this discussion, if the controller has both internal and external connectors and is configured with only eight drives internally and twelve drives externally, the cost-per-drive is still \$30 (or less), 40 percent less than the SATA controller.

Because SATA uses point-to-point connectivity, the scaling available with SAS controllers is not possible with SATA controllers. SATA drives must be connected on a one-to-one basis with the SATA connectors on the controller – i.e, a four-port SATA controller can connect up to four drives, an eight-port SATA controller can connect up to eight drives, etc. This means that the number of drives needed must be known prior to purchasing a SATA controller, or additional hardware costs will be incurred.

In the real world, drive counts are constantly growing to accommodate the flood of data that swamps the enterprise. SATA controllers lack the ability to efficiently and cost-effectively

connect a multitude of additional drives, and that makes them a poor bargain. Cost-per-drive, not initial purchase price, is the ultimate measure of disk drive controller value.

Cost-Per-Drive: SAS vs. SATA controllers			
	Approximate Cost	Number of Drive Connections	Cost-per-Drive
SAS controller (8 ports)	\$600	8 internal; 12 external (typical figure), (up to 128 maximum)	\$30 (or less)
SATA controller (8 ports)	\$400	8 internal; 0 external, (port multiplier required)	\$50

And the benefits of SAS controllers extend beyond cost-effectiveness:

- Performance**  
 SAS expanders are true enterprise-class, high-speed switches that enable simultaneous communication between multiple initiators and targets, a key factor in maintaining high net throughput as drive counts continue to climb.
- Reliability**  
 SATA drives are single port and have no automatic failover capability; should the drive's host controller fail, communication with the drive is lost. SAS drives are built to function in rigorous 24/7 enterprise storage environments, and are fundamentally more robust than SATA drives, a critical consideration when no backup controller is available.
- Data Integrity**  
 SAS expander route tables contain addresses for all attached SATA and SAS drives, ensuring they can be readily located and sent data regardless of their location in the SAS domain. This greatly reduces the risk of losing data by sending it to the wrong drive.

### The Backplane Advantage

More sophisticated than one-to-one connection configurations, internal SAS/SATA backplanes mirror the efficiency of SAS controllers by reducing the number of connectors and cables needed to connect a multitude of SATA drives. For example, one SFF-8484 connector on the controller and another on the backplane seamlessly handle four internal drives (Figure 3).

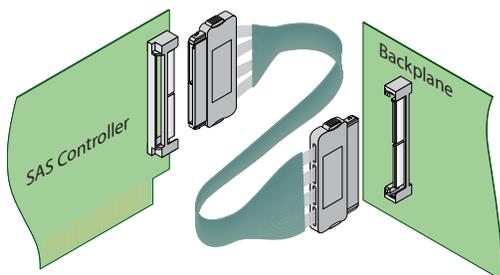


Figure 3

For even more space-constrained environments, SAS controllers and backplanes can utilize the SFF-8087 Mini connector (Figure 4).

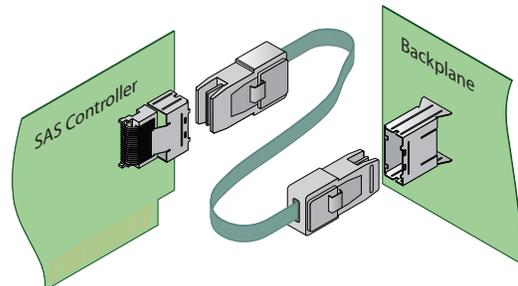


Figure 4

Regardless of the SAS connector employed, SAS/SATA backplanes add additional value by incorporating multifunction SEP chips that can supply drive information, manage temperatures and LED indicators, and even incorporate simple logic for hot plugging drives.

But perhaps the most important feature of SAS/SATA backplanes is the ease with which they can be daisy-chained together to offer effortless drive expansion. Xtore quickly recognized the value proposition of SAS/SATA backplanes, and has developed storage server supporting both SAS and SATA environments. When more drives are needed, another backplane can simply be cascaded off one already in place.

These backplanes are an elegant solution for high drive-count server environments, eliminating a morass of internal cabling. More importantly, they deliver remarkable scalability while connected to a single SAS controller. As a result the SAS controller's cost-per-drive is reduced to a fraction of any SATA controller.

### JBODs for Massive Scalability

When the sheer quantity of data to be stored demands high drive counts, JBODs are an efficient and cost-effective solution. A SAS controller simplifies connection to a JBOD, with an additional port specifically designed for external storage. Thus, a tower-style server equipped with an eight-port SAS controller can hold multiple internal drives and supplement them with dozens of external drives housed in one or more JBODs (Figure 5).

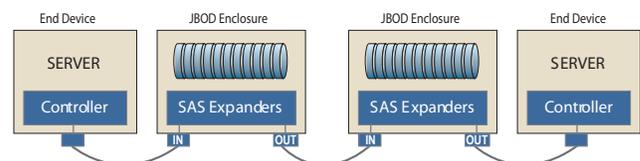


Figure 5

Leading enclosure vendors like Xtore ([www.xtore.com](http://www.xtore.com)) have embraced the advantages of SAS/SATA infrastructure, and developed backplanes optimized for that environment. This will pay huge dividends for storage managers — with a theoretical limit of over 16,000 devices in a single SAS domain, the scalability potential of SAS/SATA JBODs is virtually limitless.

### SAS-Ready SATA Drives

As the SAS infrastructure has evolved to meet the needs of servers and JBOD storage, so too has SATA drive technology. While any SATA II drive can be used with a SAS controller, Seagate's Barracuda ES is an example of a new class of SATA drives designed for optimal use in these SAS/SATA environments. With up to 1TB, Barracuda ES complements SAS drive performance with breakthrough capacity. Barracuda ES has higher reliability than conventional desktop-class SATA drives to support 24/7 operation. Enhanced error recovery, coupled with a high tolerance to rotational vibration — common in multi-drive SAS/SATA solutions — sustains system performance levels despite having dozens of drives packed into a single system.

### Conclusion

SATA disk drives have taken the enterprise by storm because they offer an unbeatable combination of low cost, high capacity and performance. So, it makes sense to maximize the extraordinary value of SATA drives by deploying them with Unified Serial Controllers, rather than with SATA controllers.

SAS was specifically architected to deliver seamless compatibility with SATA drives, enabling SAS controllers to bring greater scalability and lower cost-per-drive to SATA deployments. Combined with SAS-ready innovations in SATA drive technology, SAS/SATA systems are more ready than ever for real-world applications. Simply put, investing in SATA drives just got smarter now that they can be partnered with SAS controllers in Unified Serial solutions.



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