

Serial Attached SCSI

AND SERIAL ATA COMPATIBILITY

WHITE PAPER

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SCSI Trade Association



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Serial Attached SCSI and Serial ATA Compatibility

Enabling the Coexistence of Serial Attached SCSI and Serial ATA Drives in a Single Storage System

INTRODUCTION

SCSI is the dominant disk interface technology in enterprise storage today, with ATA emerging in many entry-level systems. Some enterprise solutions utilize both standards, but the inherent differences between SCSI and ATA technologies require most of them to implement two separate storage subsystems – one for SCSI and one for ATA. As disk interconnect speeds continue to rise, existing SCSI and ATA buses are reaching their practical performance limits. New interconnect technologies are needed with roadmaps that can meet performance requirements going forward. Serial Attached SCSI and Serial ATA interfaces are emerging as solutions to these problems. Serial Attached SCSI is a serial version of SCSI, while Serial ATA is a serial version of ATA. Both technologies preserve existing investments in SCSI and ATA software applications. Serial Attached SCSI is being developed to maximize compatibility with Serial ATA, enabling a single storage subsystem to accept either Serial Attached SCSI or Serial ATA hard drives. This results in unprecedented flexibility to select the drive type that is most appropriate for a particular application as well as reducing the overall solution cost. This paper presents an overview of the benefits of Serial Attached SCSI and Serial ATA compatibility in enterprise environments.

SCOPE OF THIS PAPER

This white paper is intended for IT managers and others who are interested in learning more about the compatibility between Serial Attached SCSI and Serial ATA. The author assumes that the reader has a basic familiarity with current storage architectures in addition to ATA and SCSI interface technologies.

SERIAL TECHNOLOGY BENEFITS

It has become increasingly difficult for SCSI and ATA to continue to increase performance with their existing parallel buses. The transition from parallel to serial technology is necessary if SCSI and ATA are to meet future requirements for performance and manageability. There are many benefits of transitioning SCSI and ATA to serial technology. Table 1 summarizes the features serial technology brings to SCSI and ATA, as well as the benefits of each.

INTRODUCTION TO SERIAL ATTACHED SCSI

Serial Attached SCSI is the logical evolution of the traditional SCSI interface, and it represents the continuation of more than 20 years of technology development and infrastructure investment. In Serial

Serial Technology Features	System Benefits
Point-to-point topology	Dedicated disk connections with scalable throughput
Performance starts at 1.5 Gb/s (150 MB/s) for Serial ATA in 2002 and 3.0 Gb/s (300 MB/s) for Serial Attached SCSI in 2004	Future performance and investment protection
Fewer signals than parallel buses	Easier routing for higher density
Thinner cables	Improved chassis airflow
Disk/backplane interoperability	Flexible Serial Attached SCSI and Serial ATA deployment options

Table 1 - Benefits of Serial Interface Technologies

Attached SCSI, the SCSI protocol is transported over a serial interface. Compared to the existing SCSI interface, Serial Attached SCSI enables faster device interconnect speeds, simpler cabling and improved system reliability, while preserving existing SCSI capabilities. Serial Attached SCSI also improves connectivity to larger numbers of drives via a new type of device called an Expander. An Expander is an optional portion of Serial Attached SCSI and it enables one or more Serial Attached SCSI host controller ports to connect to a large number of drives. Each Expander allows connectivity to 64 ports, which may include host connections, other Expanders, or hard drives. The Serial Attached SCSI interface standard is currently under development by the T10 Technical Committee of the InterNational Committee for Information Technology Standards (INCITS). The standard reached letter ballot status in November, 2002 and is due for release in the first half of 2003.

Serial Attached SCSI consists of three distinct protocols, each transporting different information over the serial interface:

- Serial SCSI Protocol (SSP) maps the SCSI protocol
- Serial ATA Tunneled Protocol (STP) passes through Serial ATA commands
- SCSI Management Protocol (SMP) provides management information

Figure 1 illustrates how the three Serial Attached SCSI protocols interact with existing high-level software applications. It shows a single port view of the protocol stack for simplicity but multiple ports are possible. The SCSI applications require no modification to work with Serial Attached SCSI. All three protocols share a compatible link, phy and physical interface. A system that requires compatibility between Serial Attached SCSI and Serial ATA must implement all three protocols. Serial Attached SCSI employs a common electrical and physical connection interface with Serial ATA that enables manufacturers, integrators and users to populate their systems with either Serial Attached SCSI or Serial ATA disks. This compatibility provides unprecedented choices for scalable server and storage subsystem configuration and deployment.

INTRODUCTION TO SERIAL ATA

Serial ATA is the logical evolution of parallel ATA, the prevalent disk interface technology in desktop PCs, entry-level servers and entry-level networked storage systems. The Serial ATA 1.0 specification was released in August 2001 by the Serial ATA Working Group and focuses on features required for internal storage. Serial ATA extends the ATA technology roadmap, beginning at disk interconnect speeds of 1.5 Gb/s (150 MB/s). In addition, Serial ATA enables

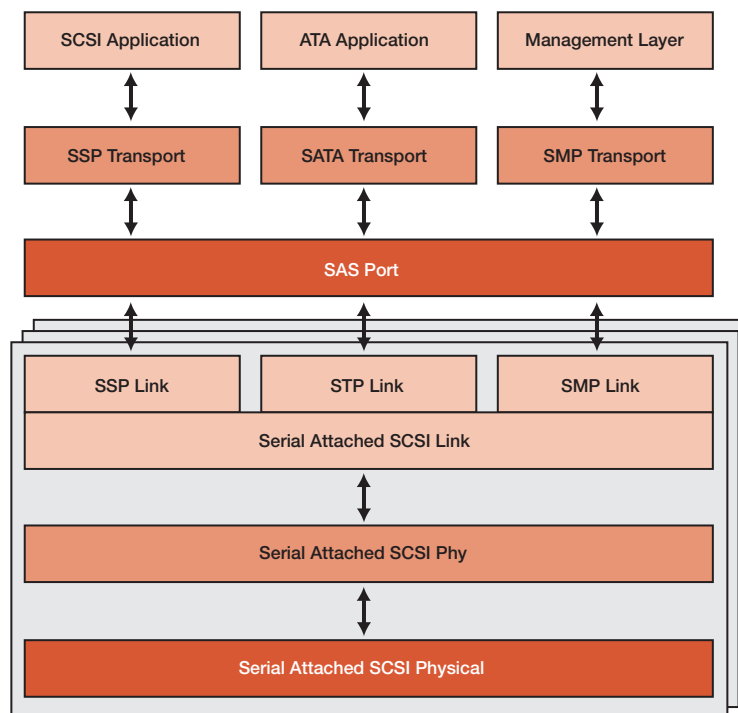


Figure 1 – Serial Attached SCSI Protocols

hot-pluggable devices for easier device replacement, thinner cables for improved in the box cooling, longer cables for simpler cable routing and cyclical redundancy checking (CRC) for enhanced data reliability. The point-to-point cabling of Serial ATA also eliminates the confusing master/slave configuration of parallel ATA.

The Serial ATA II Working Group is delivering industry standards to enable ongoing enhancements to Serial ATA. One of the central goals of the Working Group is to ensure backward-compatibility with Serial ATA 1.0 compliant devices while preserving the cost structures required by the desktop market segment. The specification entitled “Extensions to Serial ATA 1.0” is the first to be released under Serial ATA II. Enhancements include the definition of system level device-activity LED behavior, extended differential voltage ranges and Serial ATA command queuing.

SERIAL ATA/SERIAL ATTACHED SCSI COMPATIBILITY OVERVIEW

Within the context of this paper, compatibility is defined as the ability of a Serial Attached SCSI system to use either Serial Attached SCSI disks or Serial ATA disks.

Figure 2 illustrates how mainstream servers take advantage of this compatibility. A Serial Attached SCSI drive plugs into a Serial Attached SCSI-enabled server that supports all three Serial Attached SCSI protocols. The same Serial Attached SCSI server can also accept a Serial ATA drive through the use of an Expander.

SERIAL ATA/SERIAL ATTACHED SCSI COMPATIBILITY AT THE PHYSICAL LAYER

The physical and electrical interfaces defined in the Serial Attached SCSI and Serial ATA 1.0 specifications are very similar, as shown in Table 2.

The differences between the two interfaces are due to the fact that there are different primary usage models for each technology. For instance, Serial ATA is a technology developed for the desktop and must use spread spectrum clocking to pass FCC “Open Box” emission requirements. Serial Attached SCSI is primarily designed for servers and enclosures, which are considered “Closed Box” systems and thus are not required to meet the more stringent consumer-level FCC emission requirements. Another difference is the transmit (Tx) and receive (Rx) differential voltage ranges. Serial Attached SCSI voltage ranges are higher than Serial ATA ranges to drive signals over backplanes and cables up to 10 meters in length. The Serial ATA voltage ranges enable driving signals over a one meter cable. Obviously, it takes stronger signals to drive 10 meters of cable than one meter. In addition, it takes stronger signals to drive over backplanes than it does to drive the signals over a one meter cable. During initialization, a Serial Attached SCSI system that implements all three Serial Attached SCSI protocols recognizes the type of drive connected to each port and adjusts the differential voltage levels to match the drive.

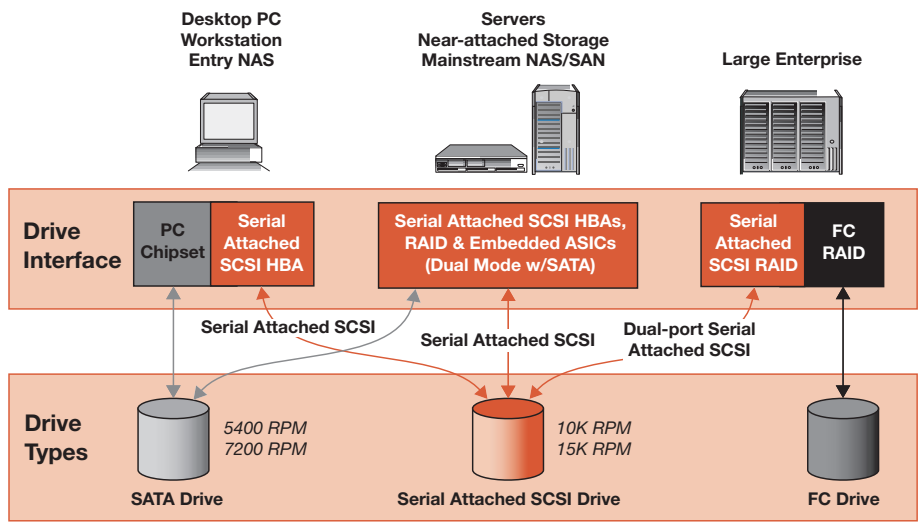


Figure 2 – Serial Attached SCSI/Serial ATA Compatibility

	Serial ATA 1.0	Serial Attached SCSI
Spread spectrum clocking	Yes	Not required for native Serial Attached SCSI peripherals; supported for SATA compatibility
Signal rate	1.5 Gbps	1.5 Gbps & 3.0 Gbps
Tx voltage	400-600 mV	800-1600 mV
Rx voltage	325-600 mV	275-1600 mV
Nominal differential impedance	100	100
Bit Error Rate on the bus	10 ⁻¹²	10 ⁻¹²
Dual Porting	No	Yes

Table 2 – Comparison of Serial Attached SCSI and Serial ATA 1.0 Physical Interfaces

COMPATIBILITY AT THE CONNECTOR

The Serial Attached SCSI connector is compatible with Serial ATA drives. For reference, “S” pins are signal pins, while “P” pins are power pins. Pins S1-7 and P1-15 of the Serial Attached SCSI connector are the same as the Serial ATA connector pin-out, with the exception of P11. Serial ATA 1.0 defines P11 as “reserved,” while Serial Attached SCSI defines this pin as the READY LED signal, enabling Serial Attached SCSI drives to provide device activity indication similar to traditional SCSI drives. Serial Attached SCSI also defines signal pins S8-14 to enable dual-ported drives.

The left side of Figure 3 shows the two drive connectors and illustrates how connector-level compatibility is enabled. The power pins are located in the same place for both Serial ATA and Serial Attached SCSI connectors. The Serial Attached SCSI Port 1 pins are located in the same place as on the Serial ATA connector. The Serial Attached SCSI Port 2 pins are located on the underside of the Port 1 pins. A Serial ATA drive plugged into a Serial Attached SCSI connector is not able to drive signals over the Port 2 pins.

Serial Attached SCSI connectors have filled in the notch on the connector to ensure that Serial Attached SCSI drives can only be plugged into Serial Attached SCSI systems. This is required because Serial ATA host controllers do not understand SCSI protocols and will not recognize a Serial Attached SCSI drive. Notching the Serial Attached SCSI drive connector prevents a Serial Attached SCSI drive from being plugged into a Serial ATA host controller, which would result in a non-functioning drive.

COMPATIBILITY IN THE BACKPLANE

The similar physical and electrical interfaces between Serial Attached SCSI and Serial ATA enable the development of a new type of backplane using Serial Attached SCSI connectors. This design enables either a Serial Attached SCSI drive or a Serial ATA drive to be plugged into the backplane. The right side of Figure 3 illustrates a Serial Attached SCSI backplane connector and how it can accept either a Serial Attached SCSI or Serial ATA hard drive.

Within a Serial Attached SCSI domain, a Serial Attached SCSI initiator port can also function as a Serial ATA Tunneled Protocol (STP) initiator port, capable of accepting Serial ATA drives, as long as the Serial Attached SCSI port supports all three Serial Attached SCSI protocols. Such a Serial Attached SCSI port opens a STP connection on behalf of the Serial ATA drive so that Serial ATA frames can pass through the connection to the drive.

A system that can use either Serial Attached SCSI or Serial ATA drives follows a few simple steps to identify which type of drive is attached. Because Serial Attached SCSI and Serial ATA use dissimilar differential voltages, it is important not to drive a Serial ATA device at Serial Attached SCSI voltage levels, to avoid damaging the drive. The Serial Attached SCSI standard defines the method the system uses during device discovery to determine the type of drive attached to any given port and to drive the differential voltage signals at the appropriate levels.

High-availability systems are designed to prevent any single component failure from crashing the system. Multi-initiator capabilities enable a drive to be connected to more than one host controller so that if one host controller fails, the drive can still be accessed via the second controller. Multi-initiator capabilities present a significant challenge to compatibility. The SCSI protocol enables SCSI drives to be controlled and accessed by more than one initiator

device on the bus. Serial Attached SCSI continues this tradition, but since it is a serial point-to-point interface, two sets of Serial Attached SCSI signals must be delivered to each drive. By comparison, the ATA protocol is not capable of multi-initiator access, and Serial ATA drives are capable of receiving only one set of signals. To enable a backplane to utilize either Serial Attached SCSI or Serial ATA drives, the STP protocol enhances Serial ATA by enabling a limited form of multi-initiator access.

BENEFITS OF SERIAL ATTACHED SCSI/SERIAL ATA COMPATIBILITY

The compatibility between Serial Attached SCSI and Serial ATA has widespread benefits for the industry and for enterprise users. The different groups that benefit are described in the following sections.

BACKPLANE MANUFACTURERS

Today, many backplane manufacturers develop a backplane for SCSI drives and a separate backplane for ATA drives. Parallel SCSI and ATA create a large number of signals that must be routed, requiring many layers in the backplane. The emergence of Serial Attached SCSI technology means that manufacturers need to develop only one backplane design with fewer layers and fewer signal traces. Vendors can use the same Stock Keeping Unit (SKU) to support both Serial Attached SCSI and Serial ATA drives. The use of serial technologies also reduces the number of layers in the backplane, resulting in a less expensive board.

SYSTEM OEMS

Compatibility means that system OEMs can now sell an upgrade package simply by selling new drives. This is accomplished by utilizing a backplane that supports both Serial Attached SCSI and Serial ATA drives. The use of one Serial Attached SCSI backplane simplifies inventory management and results in lower costs and validation efforts. OEMs can reduce costs while maintaining margins and profitability.

VARs AND SYSTEM INTEGRATORS

Serial Attached SCSI and Serial ATA compatibility enables VARs and integrators to easily configure a custom system for an individual customer, simply by installing the preferred disks. VARs no longer need to worry about installing the proper backplane, the proper cables and the proper drives. Instead, they can simply populate the backplane with the desired drive type. Overall benefits include reduced inventory costs, easier product differentiation and simplified training.

END USERS

End users benefit from the cost reductions that Serial ATA/Serial Attached SCSI compatibility provides to backplane manufacturers, system OEMs and VARs. The ability to change from Serial ATA to Serial Attached SCSI drives without purchasing new systems simplifies the upgrade process and helps future-proof end-user investments.

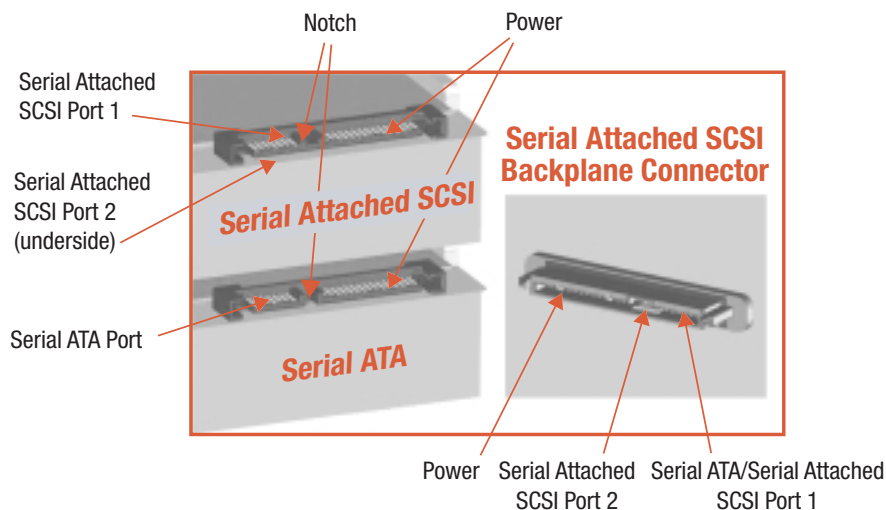


Figure 3 – Serial Attached SCSI and Serial ATA Connector Compatibility

TECHNOLOGY STATUS AND PRODUCT AVAILABILITY

Cooperation between companies representing different portions of the storage ecosystem has enabled the development of Serial Attached SCSI technology to proceed at a rapid rate. All of the original Serial Attached SCSI technology definition milestones established in 2001 have been reached on schedule, which indicates the strength of industry support for this technology.

The Serial ATA specification reached revision 1.0 in 2001, and Serial ATA products are available today from a wide variety of manufacturers.

Serial Attached SCSI specification revision 1.0 is targeted for release as an ANSI standard in the first half of 2003. Products will be under development throughout 2003 and 2004, with first samples of products expected in the first half of 2004. Fully validated Serial Attached SCSI systems are expected to ship in volume in 2005. Because Serial ATA products are available now, compatibility between Serial Attached SCSI and Serial ATA will be implemented with the initial release of Serial Attached SCSI systems.

CHOOSING BETWEEN SERIAL ATA AND SERIAL ATTACHED SCSI DISKS

A natural question arises from Serial Attached SCSI/Serial ATA compatibility: when should a user specify Serial ATA disks, and when should one use Serial Attached SCSI disks? The answer is based on the inherent differences between SCSI disk drives and ATA disk drives today.

SCSI disks are designed and manufactured to meet the enterprise requirements of high reliability and high mean-time-between-failure (MTBF). The MTBF in SCSI drives is measured over continuous usage 24/7 and 52 weeks per year. The high rotational speeds of SCSI drives (10K and 15K rpm) combined with low seek times result in the highest-performing drives available. SCSI drives are tailored to support mission-critical data in applications where reliability and availability are key requirements. Serial Attached SCSI disks will continue this trend and also move towards smaller form factor drives as enterprise requirements change. In addition, SCSI's 20-year history of software and middleware are preserved in Serial Attached SCSI drives.

ATA disks are widely used in desktop and mobile PCs where cost is a dominant consideration. ATA drives have lower MTBF than SCSI drives and are generally tested in less-stringent environments over shorter periods of time. The common ATA drive rotational speed is approximately 7200 rpm, with the norm typically one to two generations behind the rotational speed of common SCSI drives. Slower rotational speeds enable higher capacity so ATA drives tend to have a higher capacity than SCSI drives. The lower MTBF and slower speeds enable ATA drives to be priced significantly lower than SCSI drives with comparable capacity. There are situations where cost and capacity are the key concerns. In this scenario, Serial ATA will be the preferred interface choice.

CONCLUSION

Disk interconnects are making the transition to serial technologies in order to overcome the performance limitations of today's parallel buses and to enable future growth. Serial Attached SCSI is the serialized version of SCSI, while Serial ATA is the serialized version of ATA. Serial Attached SCSI will change the landscape of disk interconnects, because its inherent compatibility with Serial ATA drives will enable unprecedented levels of flexibility with lower overall system costs. The SCSI Trade Association (STA) is working closely with the Serial ATA II Working Group to ensure compatibility between the two interconnect specifications going forward.

The STA promotes the understanding and use of SCSI technology and influences the evolution of SCSI standards to meet future industry needs. For more information, please visit the STA web site at <http://www.scsita.org>, send an email to info@scsita.org, call the STA office at (415) 561-6273 or send a fax to (415) 561-6120.

For more information on Serial ATA, contact the Serial ATA II Working Group at <http://www.serialata.org>.