White Paper

The ATTO Diamond Storage Array Support for Serial ATA Features

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Introduction:

ATTO Technology's Diamond Storage Array offers three compelling reasons why it is a leading choice for today's storage needs. The ATTO Diamond Storage Array:

- Supports all of the anticipated features in Serial ATA (SATA) – Today
- Provides additional End-user performance enhancements beyond Serial ATA
- Is the only Cost-effective array solution available today with these features

The state-of-the-art Diamond Storage Array is a field tested design that supports all of the anticipated Serial ATA features, many of which still are not available today in Serial ATA products. Some of the more sophisticated features such as command Queuing, Staggered Spin Up and Hot Plug drives have been supported in the Diamond Array for several years and are a direct result of the Diamond's sophisticated Aggregated Data Transfer Technology (ADXT™) architecture.

In addition to providing the anticipated benefits of Serial ATA today, the Diamond Array offers several other important features not even planned in SATA products. These features significantly improve both performance and reliability. For example, Overlapped Command support allows commands to be simultaneously active on multiple drives at a given time. Plus, Double Edge Clocking and Multi-threaded I/O support combine to double data-transfer speeds.

The table below summarizes the advanced nature of the ATTO Diamond Storage Array compared to the current and future offerings of SATA. **The fact is, the ATTO Diamond Array has all of these benefits today and more.**

ATTO Diamond Array vs SATA Quick Comparison				
	ATTO Diamond Array	**SATA I**	**SATA II**	**SATA III**
Drive Type	**PATA**	**SATA bridged to PATA**	**Native SATA**	**Native SATA**
Availability	**Now**	**Now**	**Mid 2004**	**2005**
Feature:				
Software Compatible	Yes	Yes	Yes	Yes
Higher Data Rates	Yes	Yes	Yes	Yes
Improved Data Reliability - CRC	Yes	No	Yes	Yes
Hot Plug	Yes	Yes	Yes	Yes
Blindmate Connector	Yes	Yes	Yes	Yes
Point to Point Topology	Yes	Yes	Yes	Yes
Command Queuing	Yes	No	Yes	Yes
Stagger Spin Up	Yes	No	Yes	Yes
Enclosure Services	Yes	No	Yes	Yes
Overlapped Commands	Yes	No	No	No
Double Edge Clocking	Yes	No	No	No
Multi-threaded I/O	Yes	No	No	No

SATA versus PATA

The acronyms SATA and PATA refer to the way in which data is encoded and transported electronically. SATA or Serial ATA means literally that the data being transmitted to the ATA disk drive is done in a serial fashion, one data bit at a time. Whereas PATA or Parallel ATA means multiple data bits are transmitted to the disk at one time. As disk speeds increase in the future serializing the data will simplify the electronics and enable for higher speed disk access. Although the SATA bus bandwidth will increase, the overall throughput of a storage array will still be limited by the host interface (the 'pipe' going into the array). Reduced cabling will certainly help the manufacturers of storage arrays to simplify heat management, but will have little impact on the end user.

In addition, the SATA Specification and drives are still evolving with SATA I being the current offering and SATA II products becoming available in the second half of 2004 (a year late). The current SATA drives are of similar capacity as Parallel ATA (PATA) drives but still cost about 10% more with longer delivery and leads time. In addition, SATA is still primarily a 'bridged' solution today converting Serial ATA commands to Parallel ATA drives; however, native chip sets should start to become available in quantity in 2004 with SATA II based products sometime in the second half of 2004.

ATTO Diamond Array's Supported Features of SATA:

Compatibility with current software – Applications will not have to change and are not dependent on the disk drive technology, be it SATA or PATA.

Higher data rates – According to the current specification, future SATA drives promise to have faster individual bus speeds than today's PATA drives. However, SATA's speed advantage will be substantially diminished once incorporated into Enterprise storage arrays. Even though the proposed SATA protocol is more advanced than PATA, it still remains an "in-the-box" technology. As such, a bridging layer of technology, such as (X)ATA-to-SCSI or (X)ATA-to-Fibre Channel, must still be added to any ATA disk array in order to make it suitable for use in Enterprise storage applications. It is within this bridging layer that individual drive performance is lost as each drive's I/O processing performance is aggregated with that of the other drives in the array and then converted to the appropriate host interface protocol. As such, I/O requests are shared across multiple drives in the array and per-drive performance requirements are substantially reduced. Subsequently, even the slowest PATA drives available today many times offer more per-drive performance than can realistically be used in a storage array with 14-24 drives and two independent host interface connections.

In the meantime, the Diamond Storage Array utilizes a high-performance, sophisticated RAID controller technology to aggregate the performance of all 24 drives in the array to sustain benchmark performance data-transfer rates of over 240 MB/sec.

The Diamond Array's internal RAID architecture uses the latest advances in ATA drive technology, including Command Overlap, Command Queuing and Double Clocking of data transfers to provide performance equal to or better than most native Fibre Channel or SCSI arrays.

Using ATTO's patent-pending hardware-assisted ATA Interface Engine (AIE), the Diamond Array performs very fast data transfers from drive to controller via Ultra DMA protocol that operate at 100 MB/sec. Because this is a hardware solution, rather than the traditional software polling method of the ATA interface, the Diamond Array substantially improves the response time to the individual ATA drives. This method further allows the Diamond Array to achieve comparable I/O

access times versus native Fibre Channel and SCSI arrays, due, in part, to the sheer number of drive spindles contained in the Diamond Storage Array.

Improved Data Reliability (CRC) - Serial ATA adds 32 bit CRC error correction for all data, commands and status information transmitted.

The Diamond Storage Array uses ATTO patent-pending technology, which provides enhanced reliability and data integrity today with Parallel ATA and in advance of future versions of SATA. For example, data, commands and status information sent to each device are all protected by Cyclic Redundancy Check (CRC) and not just the data. This same technology also supports the use of native command queuing if supported by the drives.

Improved Drive Reliability – Current SATA drive manufacturers are hinting that future SATA drives will have better reliability statistics than today's PATA drives. However, to date there are not sufficient quantities of native SATA drives available to accurately project Mean Time Between Failure (MTBF) and other reliability statistics. What are available today are either limited production prototype SATA drives or native PATA disk drives with PATA-to-SATA adapters included on the drive interface. Additionally, initial reports from several drive manufacturers are that a majority of the components (the primary difference being the electrical interface components) in SATA drives will be identical to current PATA disk drives to take advantage of the economies of scale and reduce drive cost. Therefore, it is reasonable to assume that tomorrow's SATA drives should have similar reliability characteristics to today's PATA drives.

While individual drive reliability is a major component to overall system reliability and availability, the fact remains that any disk drive will fail at some point in its service life. Therefore, it is important that a level of redundancy be incorporated into the system to guard against data loss due to drive malfunction. Using RAID techniques are the most common and cost-effective methods to protect your data. Through highly sophisticated and advanced RAID technology, the ATTO Diamond Storage Array is able to offer better data reliability and availability per cost than many much-more expensive native SCSI/Fibre Channel disk arrays.

Hot Plug Support/Presence Detect – SATA II feature. The ability to remove and re-insert a drive without damage. A defective drive can be removed from operation and replaced by a new drive, thus eliminating the need to power down an array or take an array off-line. According to the current industry specification, future SATA disk drives will be capable of on-the-fly replacement or "hot-swapping." This advanced feature allows for quick replacement of failed drives without the need to power down the entire assembly.

Having recognized the need for this feature early on, ATTO Technology developed proprietary drive-sled technology that allows for hot-swap functionality of the standard PATA disk drives in its Diamond Storage Array product. These integrated electronics allow drive sleds to be removed/reinserted on-the-fly without powering the unit down. And, if configured accordingly, the Diamond Array can also automatically initiate the rebuild of the lost data from the redundant sources in the array.

Design of the drive sleds and array housing eliminates Electrostatic Discharge (ESD) during insertion and removal.

Blindmate Connector - Necessary for hot plugging.

The connectors on the Diamond Array's drive sleds are specially designed such that ground is established prior to power being applied to the sled, thus preventing damage to any of the components on the sled or the midplane. The Diamond Array's firmware also plays a role by ensuring that power is not applied to the drives until the midplane has established the fact that a

sled has been properly installed. Conversely, when a sled is pulled from the array, power is safely removed from the sled.

Point to Point Topology – Each source is connected to one destination. There is a one-to-one correlation between the bus interface and each drive on a bus, unlike Parallel ATA, which has a Master/Slave configuration.

The ATTO Diamond Storage Array utilizes 12 individual ATA busses. This configuration allows for maximum I/O and data-transfer rates as the Diamond Array utilizes the Command Overlap functionality of today's most advanced ATA drives. Command Overlap is a performance feature long inherent in more expensive SCSI and Fibre Channel drives and reduces drive latency, thereby increasing the Diamond Storage Array's performance compared to other ATA storage arrays.

Staggered Drive Spin up – SATA II feature. Method of staggering the spin up of drives to reduce the initial power load when the array/drives are first turned on.

The ATTO Diamond Array currently supports the staggered spin up of drives. This feature is also utilized by the 'remote power up/down down of the array' via in-band command.

Command Queuing – SATA II feature. A simple and streamlined command queuing model. Command Queuing is a feature that allows a disk drive to "stack up" several I/O requests in to a "Command Queue." Sophisticated algorithms then allow the drive to process those commands in such a way as to maximize the drive's overall performance. Preliminary industry specifications for SATA drives indicate that native support for Command Queuing similar to more expensive SCSI and Fibre Channel drives may be available within a few generations of drive technology.

Several high-performance PATA drives currently support Command Queuing as well, but in a slightly different methodology. With PATA Command Queuing, the I/O stacking takes place between the Master and Slave drives on the same ATA bus. Although PATA bus technology only allows for one drive to be active on a bus at any given time, the Command Queuing functionality allows for Master and Slave drives to coordinate IO requests. This means that while one of the two drives may be performing the specific IO request, the other can actively prepare for its IO request once the bus is free.

As the only ATA storage array to currently have a dual disk drive sled design, the ATTO Diamond Storage Array is the only ATA storage array available today that is capable of supporting Command Queuing. The unique design of the Diamond Array's dual-disk drive sled allows the array to take advantage of this feature, which results in markedly improved per-drive performance of the ATTO Diamond Array over any other currently available ATA disk array.

Enclosure Services/Management – SATA II feature. Provide support for SCSI Enclosure Services (SES) and SCSI Accessed Fault Tolerant Enclosures (SAF-TE).

The Diamond Storage Array offers password protected telnet access. ATTO supplies SCSI and Fibre Channel In-band access to all CLI commands and for SES. ATTO supports remote power-down or power-up of disk drive modules. The Diamond Storage Array can deliver systems administrators a quick and concise synopsis of the system's status via the Serial/Ethernet management ports or In-band via the SCSI or Fibre Channel interface connections.

The Diamond Storage Array custom SNMP MIB ties directly into a centralized SNMP console, providing up-to-the minute status of all major components. Several methods of notification ranging from audible to visible to SES are also available to inform the user of component failures. We offer SES support to report on, and sometimes affect the status of, power supplies, blowers,

temperature sensors, drive sleds, disk drives, etc.. Below is a summary of capabilities:

- System management designed into the Diamond Array's firmware enables the status of the array to be presented via RS-232, Ethernet or In-band via the SCSI or Fibre Channel host connections.
- Environmental monitoring of temperature at three key areas within the array enclosure.
- Configuration and monitoring of subsystem using simple text commands.
- Component health monitoring of host interfaces, power supplies, cooling assemblies and disk drives with status/error reporting via SNMP, SES, and CLI in addition to audible and visual methods.
- Event log continually displayed via SNMP, SES and CLI.
- Supports automatic IP address assignment via DHCP.
- Manual confirmation required for all activities which may result in destructive operations.
- System management console is password-protected.
- ATTO QuickRAID™ configuration tools streamlines and simplifies array configuration. Automatically determines volume sizes and associated group members and assigns Logical Unit Numbers to individual RAID volumes.
- Detailed help is available on all configuration and management commands.
- System management can control host interface speed, duplexing, and or loop-type (FIBRE CHANNEL-AL, FIBRE CHANNEL-SW, P2P).

Conclusion:

Once again, the Diamond Storage Array is a field tested design that supports all of the anticipated Serial ATA features, many of which still are not available today in Serial ATA products. This leading-edge technology is built on ATTO's proven core competencies in the SCSI and Fibre Channel storage technologies. At the center of ATTO's Diamond Storage Array is its intelligent midplane containing a combination of custom application-specific integrated circuits (ASICs), microprocessors, and proprietary software. Developed by ATTO, this technology comprises patent-pending elements that work together to minimize system overhead and maximize data throughput. ATTO's exclusive Aggregated Data Transfer Technology (ADXT™) aggregates the performance of individual ATA drives to achieve the high data-transfer rates needed for today's Enterprise-level applications. This exclusive combination of features offers the performance of Fibre Channel or SCSI storage arrays with the cost advantages of ATA disk technology.

Understandably, the introduction of SATA disk drives has created a lot of confusion among users who wonder whether they should stick with PATA or go with SATA. The short answer is that if the drives are sold inside of a cabinet and the cabinet is doing its job at the right price, it doesn't matter what interface the drives use. As long as your data reliably gets transferred, your job is done. Again, most of the SATA enhancements are inside and will not be seen by the end user.

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