Serial Attached SCSI

- Better Performance, Scalability, and Reliability for better Storage Solutions

Presenting at Intel Booth #812
4/6/06
New Storage Challenges

- Companies are facing new storage challenges driven by rapid data growth, new applications that require high throughput and high availability, and new regulations that require long-term accessible data storage
- Shrinking budgets are making IT departments more cost-conscious than ever
- The SCSI interface can no longer keep up with these increased demands
- Fibre Channel and SATA interfaces force customers to choose between performance and budget
The Emergence of Serial Attached SCSI (SAS)

- Newest Storage Interface for Direct Attach Storage (DAS)
- SAS Improves & Builds on Parallel SCSI Foundation
  - Supported by ANSI T10 Standards Committee (Same as SCSI)
  - Successor to Ultra320 SCSI on Industry Roadmap
- Significant Performance & Feature Set Enhancements
Why Serial?

Parallel does not mean faster….

Parallel clock rate is limited by bit skew

Serial is self-clocking

Data signals on the SCSI cable
SAS Delivers Increased Performance

- 3 Gb/s (300 MB/s) Initial Transfer Rate Increasing to 12 Gb/s (1.2 GB/s) in Successive Generations
- Point to Point Connection with Dedicated Bandwidth
- Full Duplex Data Transfer Allowing Simultaneous Upstream & Downstream Data Flow Effectively Doubling Line Rate Performance
- Ability to Combine up to Four Ports to Aggregate Bandwidth (Wide Ports)
SAS Performs better than SCSI

SCSI vs. SAS

PCI-x Limitation

Measuring almost 280K I/O per second (4K Sequential Read) with 16 drives.
Fewer Signal Lines

✓ As server form factors shrink,
  ▪ Cabling becomes more difficult,
  ▪ Backplanes become harder to route,
  ▪ Small Form Factor HDDs are used to improve IOPs while reducing power and space requirements.

✓ Serial technologies require less signal lines
  ▪ Creating thinner cables to ease cable routing,
  ▪ Reducing backplane routing complexity,
  ▪ Enabling the use of smaller connectors with SFF HDDs
Serial Technology Enables Choice

- One backplane accommodates SAS and SATA HDDs
- Dual-port is available for redundancy & high reliability server operations

- High-performance & highly-reliable SAS disk drives can be used for mission critical and performance-oriented applications
- High-capacity SATA drives can be used for disk enhanced backup or reference data
SAS is Exceptionally Scalable

- SAS Supports up to 16,256 Devices in a Single Domain, greatly Improving on the 16 device limit of a Parallel SCSI Bus
- Each Device is Assigned a Unique World Wide Name (WWN) Making SCSI Bus IDs No Longer Necessary
- SAS Offers Cabling Distances of up to 8m
- Smaller Connector Size Enables Small Form Factor HDDs for increasing Drive Density and Spindle Count
- SAS Expanders Act as High Speed Switches Allowing Tremendous Flexibility in Application Configuration
## Benefits of Serial Attached SCSI

**SAS vs. SCSI**

<table>
<thead>
<tr>
<th>Serial Attached SCSI Features</th>
<th>System Benefits</th>
</tr>
</thead>
<tbody>
<tr>
<td>Point-to-point topology vs. sharing bus</td>
<td>Dedicated disk connections with scalable throughput</td>
</tr>
<tr>
<td>Performance starts at 3.0Gb/s (300MB/s) per link, Full duplex data transfer 6.0Gb/s version will available in 2007</td>
<td>Better performance and future investment protection</td>
</tr>
<tr>
<td>Work with expander for cascading devices</td>
<td>Allowing much higher capacity and scalability of storage system</td>
</tr>
<tr>
<td>Fewer signals than parallel buses</td>
<td>Easier routing for higher density (e.g. backplane design)</td>
</tr>
<tr>
<td>Thinner cables / small connectors</td>
<td>Improved chassis airflow / Enabling Small Form Factor HDD increasing Drive Density and Spindle Count</td>
</tr>
<tr>
<td>Disk/backplane interoperability</td>
<td>Flexible SATA or SAS HDD deployment</td>
</tr>
<tr>
<td>Dual port available</td>
<td>Providing high availability I/O (higher system reliability similar advantage to Fibre Channel Dual loop)</td>
</tr>
</tbody>
</table>
SAS Board Overview

- X6DH3-G2 (Nocona/Irwindale) 8 ports / RAID 0, 1
- X6DHR-3G2 (Nocona/Irwindale) 8 ports / RAID 0, 1
- X6DHP-3G2 (Nocona/Irwindale) 8 ports (4 in, 4 out) / RAID 0, 1
- X6DA3-G2 (Nocona/Irwindale) 8 ports / RAID 0, 1
- PDSM3 (8 ports / RAID 0, 1) – Pentium D
- X7DA3/i dual Xeon (Dempsey/Woodcrest), Greencreek Chipset,
- X7DB(G)3+/i+ dual Xeon (Dempsey/Woodcrest), Blackford (Greencreek) Chipset
- X7DB(G)R-3/i, dual Xeon (Dempsey/Woodcrest), Blackford (Greencreek) Chipset
- X7DB(G)P-3/E, dual Xeon (Dempsey/Woodcrest), Blackford (Greencreek) Chipset
- X7DB(G)A-3/i dual Xeon (Dempsey/Woodcrest), Blackford Chipset
- All-In-One SAS ZCR card (additional RAID 5, 10 and performance)
# Supermicro SAS Motherboards

<table>
<thead>
<tr>
<th>MODEL</th>
<th>X6DH3-G2 / X6DHi-G2</th>
<th>X6DHR-3G2 / X6DHR-EG2</th>
<th>X6DA3-G2 / X6DAi-G2</th>
<th>X6DHP-3G2</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Processor</strong></td>
<td>Dual 64-bit Xeon up to 3.80GHz (Pavilion support)</td>
<td>Dual 64-bit Xeon up to 3.80GHz (Pavilion support)</td>
<td>Dual 64-bit Xeon up to 3.80GHz (Pavilion support)</td>
<td>Dual 64-bit Xeon up to 3.80GHz (Pavilion support)</td>
</tr>
<tr>
<td><strong>Chipset/System Bus</strong></td>
<td>Intel E7520 800MHz</td>
<td>Intel E7520 800MHz</td>
<td>Intel E7525 800MHz</td>
<td>Intel E7520 800MHz</td>
</tr>
<tr>
<td><strong>Form Factor</strong></td>
<td>Ext. ATX 12&quot; x 13.05&quot;</td>
<td>Ext. ATX 12&quot; x 13.05&quot;</td>
<td>Ext. ATX 12&quot; x 13.05&quot;</td>
<td>Proprietary 11.24&quot; x 16.2&quot;</td>
</tr>
</tbody>
</table>

**Optimized Chassis**

| X6DH3-G2 | X6DHR-3G2 | X6DA3-G2 | X6DHP-3G2 |
| X6DH3-G2 | 1U: SC816A-700 (oem only) | SC816A-R700 (oem only) |
| 2U: SC823T-R5000C, SC823T-R500LP |

**Memory Capacity & Slots**

| 16 GB ECC Reg. DDR3 400 SDRAM in 8 DIMMs | 16 GB ECC Reg. DDR3 400 SDRAM in 8 DIMMs | 16 GB ECC Reg. DDR3 400 SDRAM in 8 DIMMs | 16 GB ECC Reg. DDR3 400 SDRAM in 8 DIMMs |

**Expansion Slots**

| 2 PCI Express x8 | 1 Universal PCI-x 133MHz or 1 PCI Express x8 | 1 PCI Express x16 | 1 Universal PCI-x 100MHz |
| 2 PCI-x 100MHz | 1 Universal PCI-x 100MHz or 1 PCI Express x8 | 1 PCI Express x4 (using x16 slot) | 1 PCI Express x100MHz |
| 1 PCI Express x8 | |

**Onboard SAS/SATA**

- Adaptec 9410 controller for 8 SAS/SATA; RAID 0, 1, 0x0 (SAS only)
- Intel 8230ESB controller for 2 SASA; RAID 0, 1

**Zero Channel RAID (ZCR) Card Support**

- ACC-LPZCR1 (X6DH3-G2 only)
- AOC-S0ZCR1 (X6DHR-3G2 only)
- AOC-LPZCR1 (X6DA3-G2 only)
- AOC-LP2CR1
SAS Chassis with SES2

**SES2 (SCSI Enclosure Service 2) feature:**
- Provide Drive Activity, Drive Failure, and Drive Presence Indication for each individual drive slot
- Include Drive Failure Alarm and an Overheat / Drive Fail / Drive Rebuild LED Indicator
- Temperature Monitoring
**SUPERmicro® SC823T/SC823TQ*-R500 (RC/LP)**

Form Factor: 2U Chassis supports up to 12” x 13” E-ATX Motherboard
CPU Support: Dual 64-bit Xeon, Pentium D & Pentium 4 Processors
PCI I/O: 7 low-profile full-length expansion slots
Hard Drive Bay: 6 SAS (w/SES2*) or SATA drive bays
Peripheral Drives: 1 slim CD and 1 floppy drive
Cooling System: 4 x 6300rpm fans
Power Supply: 500W redundant w/2C(+5V: 30 amp, +12V: 32 amp)
Dimensions & Weight: 16.9” (426mm) x 3.5” (89mm) x 25.6” (650mm) / 50 lbs.

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**SUPERmicro® SC733T/SC733TQ*-645**

Form Factor: Mid-tower Chassis supports up to 12” x 13” E-ATX Motherboard
CPU Support: Dual 64-bit Xeon, Pentium D & Pentium 4 Processors
PCI I/O: 7 expansion slots
Hard Drive Bay: 4 SAS (w/SES2*) or SATA drive bays
Peripheral Drives: 1 floppy drive & 2 USB
Cooling System: 1 x 12cm & 1 x 9cm Pulse Width Modulated fans
Power Supply: 645W w/low-noise fan control (+5V: 30 amp, +12V: 46 amp)
Dimensions & Weight: 16.8” (427mm) x 7” (178mm) x 20.9” (531mm) / 40 lbs.

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**SUPERmicro® SC743T/SC743TQ*-R760**

Form Factor: Tower/4U Rackmount Chassis supports up to 12” x 13”
E-ATX Motherboard
CPU Support: Dual 64-bit Xeon, Pentium D & Pentium 4 Processors
PCI I/O: 7 front-end expansion slots
Hard Drive Bay: 6 SAS (w/SES2*) or SATA drive bays
90° Rotatable Module: 2 Front side USB 2.0, 2 x 5.25” drive bays, 1 floppy
100% Cooling Redundancy: 4 cooling fans, 2 exhaust fans and air shroud
Power Supply: 760W triple-redundant w/2C(+5V: 36 amp, +12V: 50 amp)
Dimensions & Weight: 17.8” (452mm) x 7” (178mm) x 26.5” (670mm) / 72 lbs.
Super Server With SAS

- 1U Rack mount server
- 2U Rack mount server
- Tower or 4U Rack mount server
- 1U Rack mount redundant power server
SAS Mobile Rack and JBOD

SUPER™ M28E1/M28E2

**Front View**
- 8 x 2.5" hot-swap SAS HDD
- Fan fail detection LED & Alarm
- Overhead LED indication alarm
- HDD fail alarm & indication
- Two 5.25" drive bay enclosure (2U height)

**Rear View**
- CSE-M28E1
  - 8cm fan cooling subsystem
  - CSE-M28E1: 1 expander supports SAS HDD
- CSE-M28E2
  - 8cm fan cooling subsystem
  - CSE-M28E2: 2 expanders support dual-ports SAS HDD

M14 Mobile Rack
- Enclosure (single 5.25" drive bay) (x1)
- 2.5" hot swappable HDD trays (x4)
- 40mm x 28mm cooling fan (x1)
- Backplane (x1)
- Dimension (W) 146mm x (H) 42.5mm x (D) 204mm (W/O fan)
- (W) 146mm x (H) 42.5mm x (D) 171mm (W/O fan)

3U JBOD (3.5" SAS)
- SC836 – 16 Drives
- SC933 – 15 Drives
- Single or Dual Expanders
Supermicro All-in-One ZCR Cards

- All-in-One Zero-Channel RAID Cards second generation:
  - AOC-LPZCR2
- Take advantage of onboard SAS/SATA/SCSI onboard controllers to achieve hardware RAID.
- All-In-One: Support SAS/SATA/SCSI modes by jumper settings. Save cost without buying separate ZCR cards.
- Replace the old Adaptec SCSI DAC-0008(2010S), DAC-0009(2015S), SATA AOC-2020SA and AOC-2025SA.
- Better performance, cost-effective and complete solution.
- Support SAS mode SES-II enclosure management functionalities.
- Available now.
SCSI SAF-TE Enclosure Management and SES2: SCSI Enclosure Service 2

- SCSI Accessed Fault Tolerant Enclosures Industry standard to interface with enclosed components
- Indicate disk drives failure with alarm and LED.
- Indicate disk drives rebuild through LED.
- Avoid human error, such as pulling out wrong disk drives.
- Temperature monitoring.
- SAF-TE chips:
  - SCSI controlled by GEM318 firmware and I2C interface
  - SAS controlled by AMI MG9071/9072 firmware and I2C interface. Downward compatible to support SATA disk drives.
Enterprise Class HDD Interfaces

Source: IDC
# SCSI vs. SAS vs. FC

<table>
<thead>
<tr>
<th></th>
<th>SCSI</th>
<th>SAS</th>
<th>FC-AL</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Performance</strong></td>
<td>Parallel Bus</td>
<td>Full duplex</td>
<td>Full duplex</td>
</tr>
<tr>
<td></td>
<td>320MB/s</td>
<td>3.0Gbps/300MB/s</td>
<td>2.0Gbps/200MB/s</td>
</tr>
<tr>
<td></td>
<td>Extensive Command Queuing</td>
<td>Extensive command queuing</td>
<td>Extensive Command queuing</td>
</tr>
<tr>
<td><strong>Connectivity</strong></td>
<td>12m</td>
<td>8m</td>
<td>15m</td>
</tr>
<tr>
<td></td>
<td>15 device</td>
<td>&gt;128 devices</td>
<td>127 devices</td>
</tr>
<tr>
<td></td>
<td>Arbitrated bus</td>
<td>Point to Point Connection</td>
<td>Arbitrated loop</td>
</tr>
<tr>
<td></td>
<td>Interconnect not compatible with SAS</td>
<td>Interconnect compatible with SATA</td>
<td>Not compatible with SAS or SATA</td>
</tr>
<tr>
<td><strong>Availability</strong></td>
<td>Single port</td>
<td>Dual port</td>
<td>Dual port</td>
</tr>
<tr>
<td></td>
<td>Multi initiator</td>
<td>Multi initiator</td>
<td>Multi initiator</td>
</tr>
<tr>
<td></td>
<td>Hot swappable (80 pin)</td>
<td>Hot swappable</td>
<td>Hot swappable</td>
</tr>
<tr>
<td><strong>Driver Model</strong></td>
<td>Software not transparent with SAS</td>
<td>Software transparent with Parallel SCSI</td>
<td>Software transparent with Parallel SCSI</td>
</tr>
</tbody>
</table>
Serial technology is prevalent today, stable, and mature.

Increase the storage systems utilization, reduce the TCO significantly.

SAS Technology Has Room to Grow

- **SAS 3Gb/s**
- **SAS 6Gb/s**
- **SAS 12Gb/s**

IOPS/U

Performance

Density / Scalability

IOPS /U
The next evolution of SCSI, Serial Attached SCSI, SAS is the answer!
Where SCSI Fits

SCSI currently addresses the need for high-performance, reliable storage – such as direct attached primary storage.

<table>
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<th>High Performance</th>
<th>Reliability</th>
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<td>Scalability</td>
<td>Low Cost</td>
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Where SATA Fits

SATA currently addresses the need for low-cost storage – such as near line storage and disk-to-disk backup.

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</table>
Where Fibre Channel Fits

Fibre Channel currently addresses the need for high-performance, highly reliable, scalable storage – such as transaction-intensive and networked storage.
Serial Attached SCSI Fits Everywhere – One Solution for Many Needs

Serial Attached SCSI will address all of these needs, with high-performance, highly reliable, scalable storage that can be mixed-and-matched with SATA drives, allowing you more control over your storage budgets.

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</tr>
</thead>
<tbody>
<tr>
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<td>Low Cost</td>
</tr>
</tbody>
</table>
Key Points

- Serial Attached SCSI is an evolutionary technology, based on the most trusted architecture in the data center – SCSI
- SAS provides many benefits including greater flexibility, scalability, and performance
- Enables mixing-and-matching of both SAS and SATA drives in the same enclosure
- SCSI and Fibre Channel ideal for scenarios that require high-performance and reliability; SATA is ideal for low-cost, large capacity storage – and SAS is suited for use across the entire storage spectrum!
- Supermicro is an industry leading provider of complete and mature SAS server solution.