Server Storage – Features & Futures

John Stewardson
EMEA Server Storage, Networking & Infrastructure - April 20th 2004

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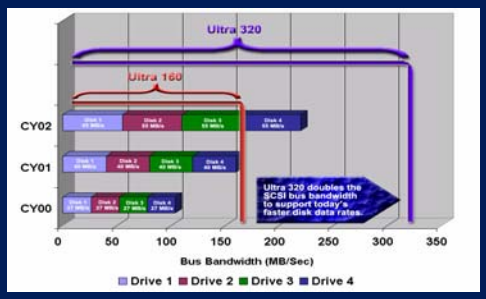
Agenda

- Technology today
  - Ultra320 is here - Finally!
  - Key Features of Smart Array 6th Generation Controllers
  - Standard Smart Array Architecture Advantages
  - Universal Storage = further consolidation
- Technology tomorrow – The next Wave!
  - Serial Futures SAS & SATA: What & Why
  - Serial Features: New Compatibility Advantages
  - Does Size Matter – Serial SCSI enables Small Form Factors
  - But It's more than the interface…

What is Ultra320

- U160 (Ultra3) had reached the limits of it's bandwidth
- U320 replaces U160 as the standard parallel SCSI interface
- U320 is backwards compatible to U2 and U3 providing a clear upgrade path & ease of integration into existing infrastructure



✓ **Improved performance**

- Double bandwidth of U160, up to 320MB/s per channel
- Quick Arbitration and Select (QAS)
- Data packetization

✓ **Improved signal and data integrity**

- Active Adaptive Filtration (AAF)
- Training pattern
- Transmitter pre-compensation
- Free running clock
- Cyclic Redundancy Check (CRC)

21/04/2004 Source: Maxtor Corporation, 2002 3

Storage is not an option:

The Smart Array Line-up

smart array 5i Plus

- low cost embedded RAID solution for ProLiant Servers
- lowest cost Battery Backed Write Cache RAID option for select ProLiant servers
- management of OS and log files

SA-641

- low cost entry level RAID solution
- option for severs without the embedded Smart Array 5i
- upgrade from previous generation RAID controllers
- upgradeable to BBWC
- management of OS and log files

SA-642

- low cost entry level RAID solution
- option for severs without the embedded Smart Array 5i
- upgrade from previous generation RAID controllers
- upgradeable to BBWC
- management of OS and log files

SA-6402

- high performance
- DAS beyond HDDs internal to the server
- ability to scale in the future (cache, channels)
- need for 2 int. or ext. channels
- maximum fault tolerance (ADG)
- database/ exchange environments

SA-6404

- the 4 channel Premium controller
- high volume storage
- more than 2 channels needed for maximum data capacity
- maximum fault tolerance (ADG)
- database/ exchange environments

Entry level RAID

Workgroup and Departmental RAID

Enterprise High Volume RAID

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HP's Entry-Level U320 controllers: Smart Array 641 & 642

- Increased Performance
  - ✓ Ultra320 SCSI
  - ✓ 64-bit, 133MHz PCI-X
  - ✓ 266MHz DDR-cache
- Flexible Configuration ("on-demand")
  - ✓ **Memory option – 64MB BBWC upgrade**
  - ✓ Channels – 1 or 2
- Investment Protection
  - ✓ Upgradeable cache
  - ✓ Seamless upgrade to performance Smart Array
  - ✓ Generational Consistency between SA family controllers

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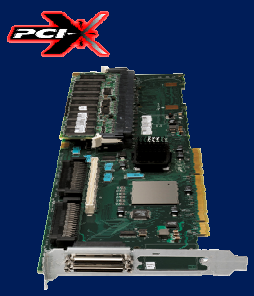
HP's Performance U320 controllers: Smart Array 6400



- High Performance
  - ✓ Ultra320 / 64-bit, 133MHz PCI-X
  - ✓ 266MHz DDR-cache (**72 Bit wide!!**)
  - ✓ **Dual RAID / Processor (SA 6404)**
- Flexible Configuration ("on-demand")
  - ✓ Cache options – 128MB, 256MB
  - ✓ Channels – 2 to 4
- Higher Availability
  - ✓ **RAID ADG (Advanced Data Guarding)**
- Investment Protection
  - ✓ 2-4 channel upgrade (Available TODAY!)
  - ✓ Upgradeable cache (256MB +)
  - ✓ Generational Consistency between SA family controllers

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HP Modular Storage Enclosures

Up to 2TB per enclosure of storage*

Mix and Match LVD HDD

- Ultra2, Ultra3, and Ultra320 devices on same Ultra320 SCSI bus
- Each device transfers data at its individual interface transfer rate (Requires Ultra320 controller)

Universal Support for:

- ProLiant, Integrity & Alpha Servers
- Smart Array Controllers Ultra2, Ultra3, Ultra320
- MSA 1000 & MA6000, MA8000, EMA12000, and EMA16000

Ultra320 single and dual I/O upgrade modules make upgrading to Ultra320 quick

* Requires use of 146GB 1" HDD

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Key Technologies:
RAID ADG (advanced data guarding)

Advanced RAID functionality for Smart Array

- Greater fault tolerance than RAID 1, 10, 5
- Lower implementation cost than RAID 1, 10

Can tolerate 2 simultaneous drive failures
No down time , No data loss

Ideal for:

- ✓ large capacity drives
- ✓ business critical data
- ✓ large RAID volumes
- ✓ remote server installations
- ✓ dense storage deployments

Available on SA-6400, MSA500, MSA1x00 Standard and SA-5302 (optional upgrade)

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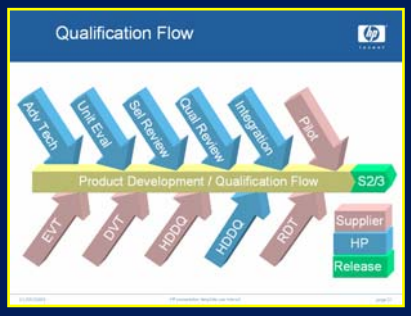
The HP advantage: Designed for the enterprise

Award Winning Design

'99 INDUSTRIAL DESIGN EXCELLENCE AWARDS
G O L D

Universal Hard Disk Drive family 10K & 15K RPM

- DAS, NAS, & SAN ready – re-deploy as your needs change
- Universal = rock solid spares strategy
- award winning ergonomic design allowing for single handed HDD removal & transportability
- designed for next enterprise cooling and vibration requirements



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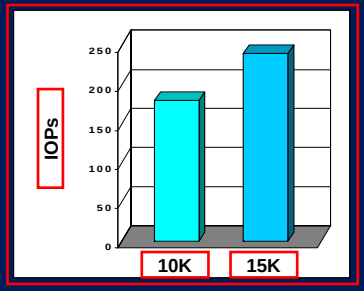
15K: The NEED For SPEED!!

- **15K is more efficient**:
  - 40% less 15K rpm HDD to achieve same performance of 10K rpm HDD
  - Fewer Drives means less overall infrastructure = Less Power Required
  - Less Power means less Heat, and cost
- **15K opens the door**
  - reducing the opportunity for SCSI bus saturation in system,
  - increased data rate allows all SCSI devices to perform at optimum levels!!
- **For more performance!**
  - HP's 15,000 rpm Hard Drives can provide up to 33-50% better performance over standard 10,000 rpm drives!!

✓ A server with multiple drives handling large numbers of transactions benefit from high IOPS performance

✓ Typically 35% IOPS improvement vs 10K



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HP – Inventing Pure Performance…

- Smart Array & ProLiant have dominated the TPC benchmark lists for years . . .
- HP Integrity Servers are now starting to lead the pack . . .
- Both ProLiant & Integrity support Smart Array & Universal Storage Enclosures for a reason…

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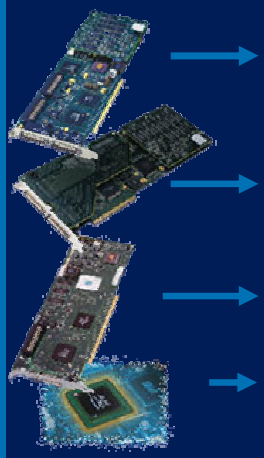
Upgrading Your Smart Array



Instant Upgrade:

1. Ensure that you are running the latest device driver and Smart Array firmware.
2. Replace the old controller and cables with the new controller and cables.
3. Reboot the server and data will be seamlessly recognized.

Smart Array 6402

- Faster performance
- Greater capacity
- Higher availability

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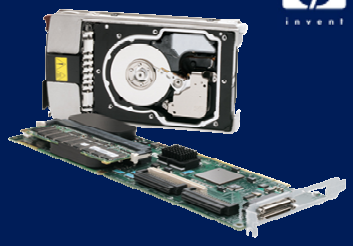
Key Competitive silver bullets SUMMARY:

Smart Array Advantage



✓ **Unmatched performance**
- TPC Benchmark leadership
- High Performance Architecture
- Ultra320 & PCI-X across the board!

✓ **Generational Consistency**
- Consistent configuration and management tools
- Proven lower cost of ownership
- Pre-failure warranty with Universal HDDs

✓ **Unparalleled Flexibility**
- Data compatibility from generation to generation
- Ease of upgrade of & between controllers
- Support for data migration & DtS Technology with Universal HDD
- Mix and Match LVD Technologies (Ultra2, Ultra3, Ultra320)

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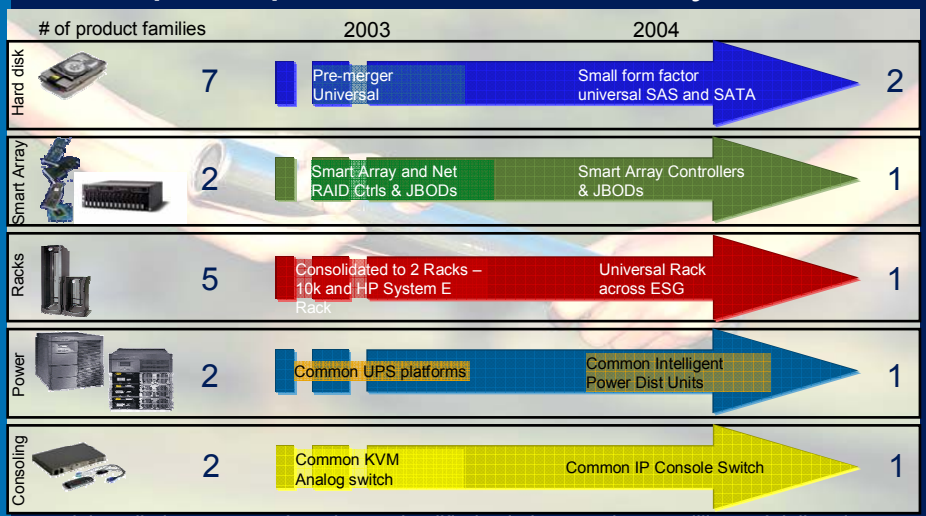
Direction: Enterprise product commonality



Potential to eliminate 100's of products, simplified solutions, and save millions of dollars in warehousing, logistics, P/N maintenance, and channel positioning

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Smart Array & MSA30 on Integrity

- SmartArray 6402 / 128MB cache for Windows A9890A
- SmartArray 6404 / 256MB cache for Windows A9891A
  - http://www.hp.com/products1/servers/integrity/mid_range/rx7620/supplies.html
  - http://www.hp.com/products1/servers/integrity/mid_range/rx8620/supplies.html
- Smart array 5302/128MB controller (Windows & Linux) A9825A
- Smart array 5304/256MB controller (Windows & Linux) A9826A
  - http://www.hp.com/products1/servers/integrity/entry_level/rx5670/supplies.html
  - http://www.hp.com/products1/servers/integrity/entry_level/rx2600/supplies.html

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Smart Array and AlphaServers

- SA5302A 2-channel controller with 128 MB of cache
- SA5304A 4-channel controller with 256 MB of cache
- HP StorageWorks enclosure models 4354, 4314, 4254, 4214, and 4400 (MSA30)
- Supported servers
  - AlphaServer DS10
  - AlphaServer DS20E
  - AlphaServer DS25
  - AlphaServer ES40
  - AlphaServer ES45
  - AlphaServer ES47
  - AlphaServer GS80
  - AlphaServer ES80
  - AlphaServer GS160
  - AlphaServer GS320
  - AlphaServer GS1280

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What next – coming this summer

- Completion of the 6th Generation controllers
  - Smart Array 6i
  - BBWC enabler
- Introduction of new serial bus technology to the 6th Generation: PCI-Express
- Further Qualifications of SA 6th Gen controllers
- And the beginning of the next generation…
  - Introduction of SATA JBODs into the MSA Line up

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The next chapter . . .

- Technology today
  - Ultra320 is here!
  - Key Features of Smart Array 6th Generation Controllers
  - Standard Smart Array Architecture Advantages
  - Universal Storage = further consolidation
- Serial Storage…
  - Serial Futures SAS & SATA: What & Why
  - Serial Features: New Compatibility Advantages
  - It's more than the interface…
  - Does Size matter ?

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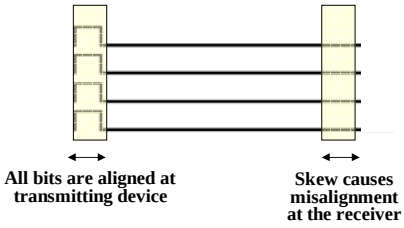
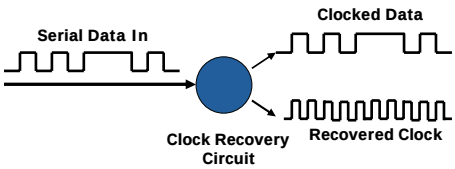
Problems with going to U640…

- With a parallel bus, all data must be arrive within in a given time period.
- Signal skew causes data to become misaligned in time at the receiver limiting the rate at which data can be transferred.
- Serial technologies uses a single data line so there is no skew.
- With serial technologies, much higher data transfer rates can be obtained per signal line.





Parallel Data Transfers **Serial Data Transfers**

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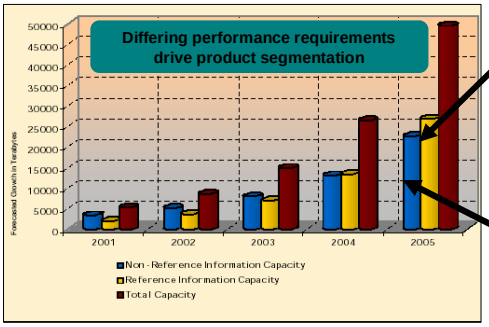
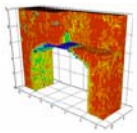
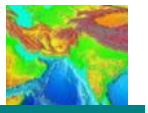
Explosive Growth of Reference Data







- **Reference data is growing at 92% CAGR compared to 60% for non-reference**
- **By 2005 reference data will exceed non-reference data**
- **<u>Characteristics:</u> data typically doesn't change with time**
- **Source: Enterprise Storage Group**

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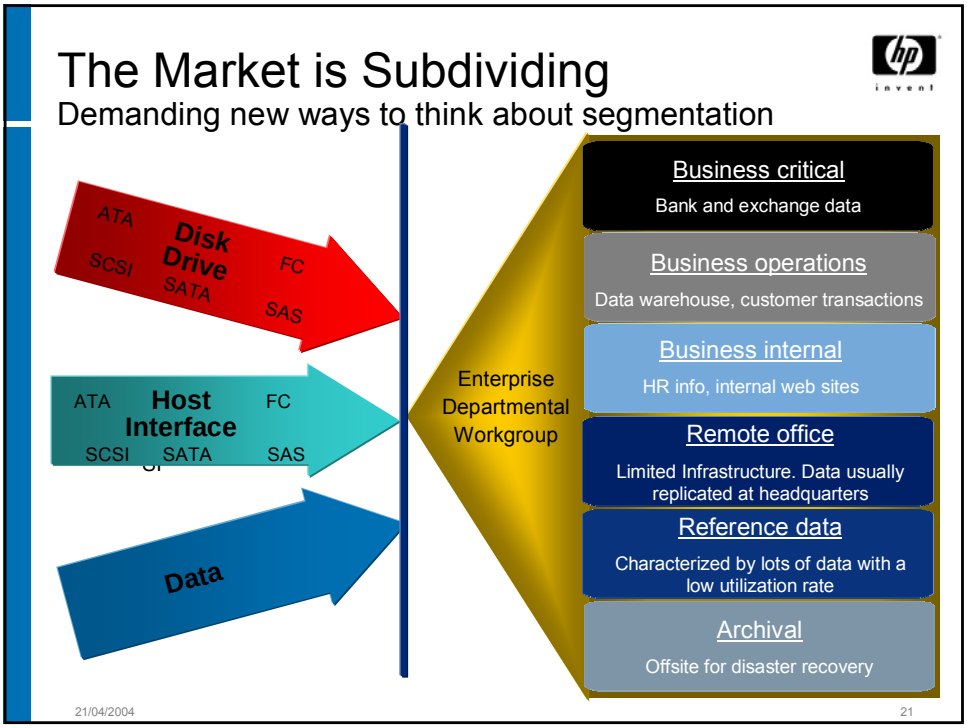
The Market is Subdividing
Demanding new ways to think about segmentation
ATA
Disk Drive
SCSI
SATA
FC
SAS
ATA
Host Interface
SCSI
SATA
FC
SAS
Data
Enterprise
Departmental
Workgroup
Business critical
Bank and exchange data
Business operations
Data warehouse, customer transactions
Business internal
HR info, internal web sites
Remote office
Limited Infrastructure. Data usually replicated at headquarters
Reference data
Characterized by lots of data with a low utilization rate
Archival
Offsite for disaster recovery
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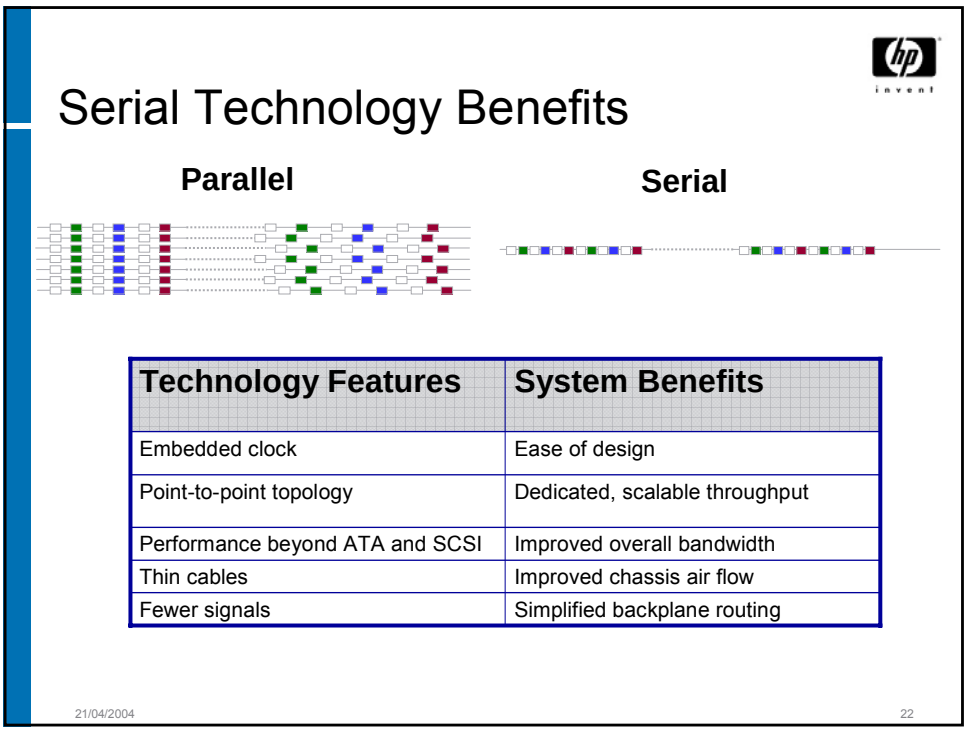
Serial Technology Benefits
Parallel
Serial
Technology Features
System Benefits
Embedded clock
Ease of design
Point-to-point topology
Dedicated, scalable throughput
Performance beyond ATA and SCSI
Improved overall bandwidth
Thin cables
Improved chassis air flow
Fewer signals
Simplified backplane routing
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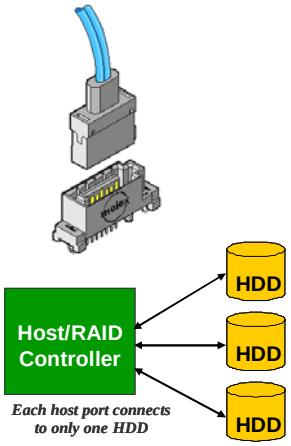
What is Serial ATA?

- **Four-wire replacement for the physical layer of parallel ATA**
  - 100% SW compatible “drop in” replacement for ATA
  - Low voltage (600 mV max) differential signaling w/ 8b10b encoding
- **“Star” topology (point-to-point, no hubs)**
  - Each device gets full bandwidth
  - No bus arbitration/collision overhead
  - ATA RAID becomes simpler to implement
- **Serial ATA has attributes and features that extend its capabilities**
  - Provides additional capabilities such as hot plug and 1st party DMA



SATA connector drawing courtesy of Molex

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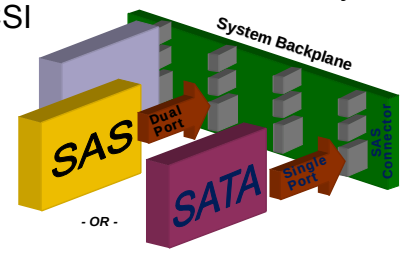
What is Serial Attached SCSI?

- Four-wire replacement for the physical layer of parallel SCSI
  - SW compatible “drop in” replacement for parallel SCSI
  - Low voltage (1600 mV max) differential signaling w/ 8b10b encoding
- “Star” topology (point-to-point, no hubs)
  - Each device gets full bandwidth
  - Minimum arbitration overhead
- SAS has attributes and features that can extend it beyond the capabilities of parallel SCSI
  - Provides many additional superset features (such as dual-port and 16K devices per domain)
  - Mix / Match with SATA
  - Configurable Bandwidth!



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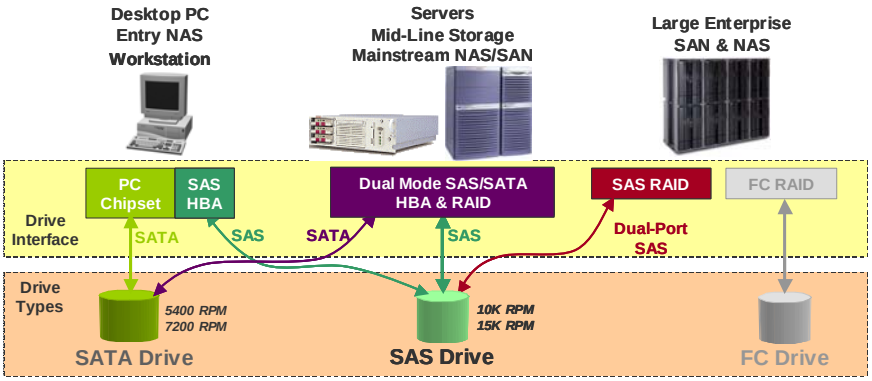
Why Serial Attached SCSI?



SAS supports SATA devices
- Enables systems to be configured with SATA or SAS drives
- Provides More flexibility to channel partners and end users

SAS was developed as a serial replacement to SCSI
- Difficult to go beyond U320 – clock skew issues
- Need for smaller & simpler connections
- Preservation of SCSI protocol and cost structure for primary markets

SAS includes enterprise features with parallel SCSI cost structure
- Dual port devices
- High connectivity
- More scalable performance
- Better system interoperability
- Enhanced fault isolation

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Technology Comparison of Interface

	SATA	SAS	Fibre Channel FCAL
Performance	Half-duplex	Full-duplex with Link Aggregation	Full Duplex
	1.5 Gb/s Introduction 3.0 Gb/s in 2004	3.0 Gb/s Introduction 6.0 Gb/s in 2006	2.0 Gb/s 4 Gb/s in 2004
Connectivity	1.5 m internal cable > 8 m external cable	> 8 m internal and external cables	15 m external cable
	One device (fan-out devices demonstrated)	>128 devices (16,384 max)	127 devices
	No peer-to-peer	Peer-to-peer	Peer-to-peer
Availability	Single-port HDDs	Dual-port HDDs	Dual-port HDDs
	Single-host	Multi-initiator	Multi-initiator
Driver Model	Software transparent with Parallel ATA	Software transparent with Parallel SCSI	Software transparent with Parallel SCSI

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SAS Expander Devices

- SAS edge expander sets
  - Contain one or more edge expander devices (provides for increased connectivity at lower cost)
  - Connect to SAS initiators, SAS targets, SATA devices, and/or one SAS expander device via narrow or wide ports
  - May only have ports in one domain

- SAS fan-out expander devices
  - Connect to SAS initiators, SAS targets, SATA devices, and/or SAS edge expander sets via narrow or wide ports
  - May only have ports in one domain
  - Only 1 fan-out expander per SAS domain

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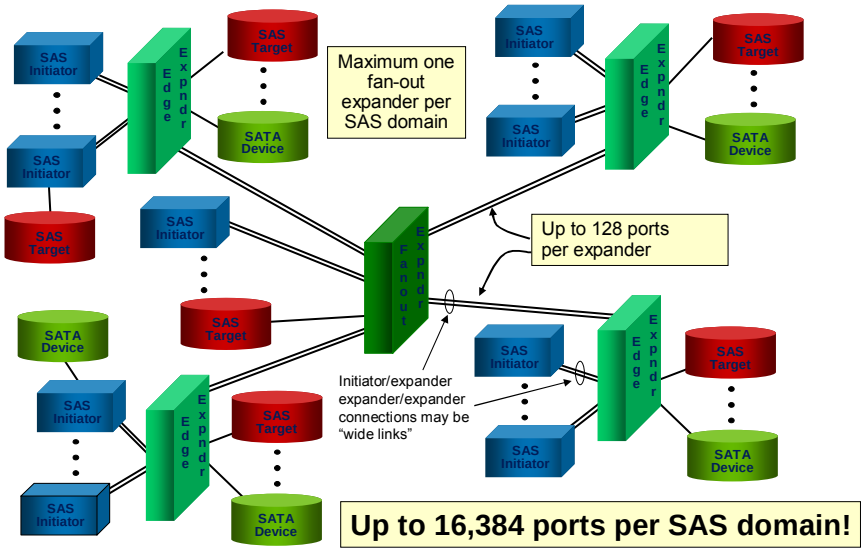
Maximum SAS Domain Topology



Up to 16,384 ports per SAS domain!

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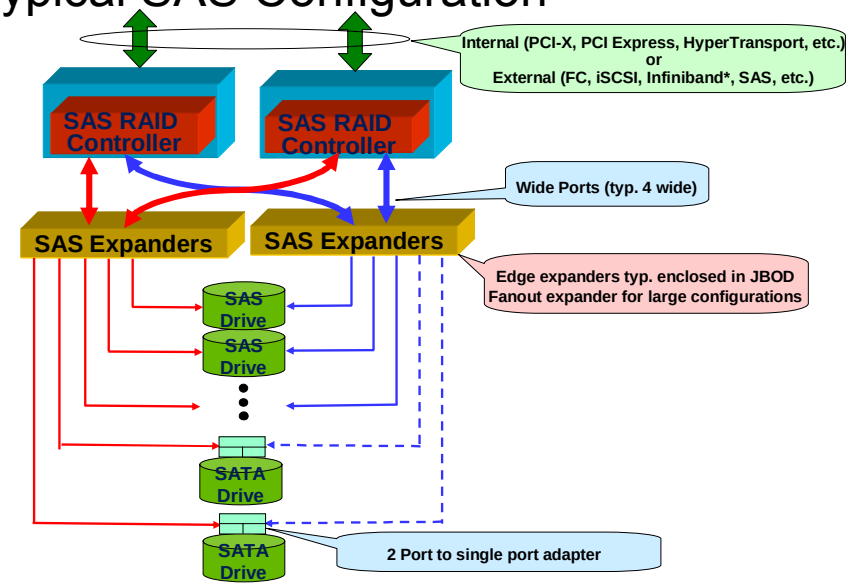
Typical SAS Configuration



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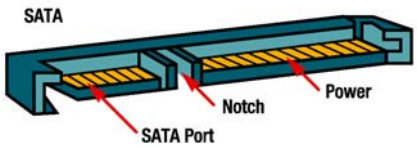
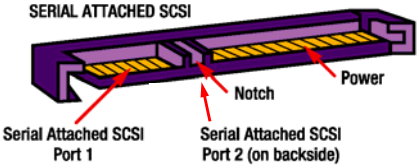
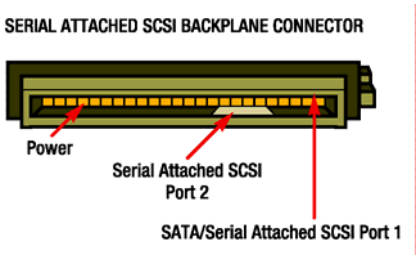
Device & Backplane Connectors

SAS and SATA device connectors







- SAS backplane connectors accept both SAS target and SATA device connectors
- SATA backplane connectors will not accept SAS target connectors)

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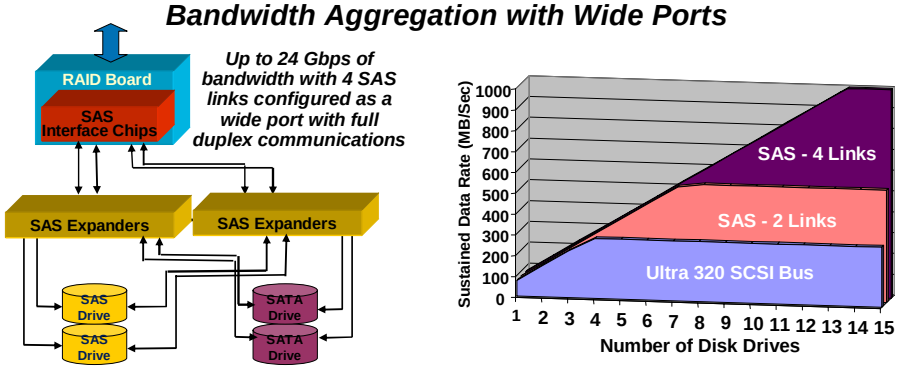
SAS Delivers Scalable Performance



- Four link, SAS controller provides scalable back-end bandwidth for up to 24Gbps data transfers with full duplex communications.
- Point-To-Point connections eliminate the shared bus bottleneck.
  - Bandwidth aggregated over multiple, low-cost Serial Attached SCSI links
  - Rate matching supports 1.5Gbs SATA and 3.0Gbs SAS drives for optimal performance

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External Cable and Connector

- Four, full-duplex physical links per connector
- 4 × 2 × 3.0 Gb/s = 24 Gb/s = 2,400 MB/s max

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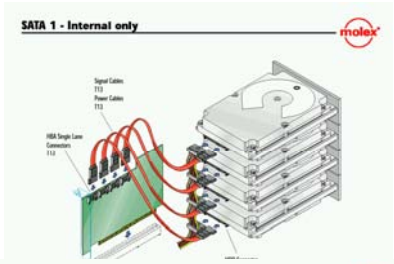
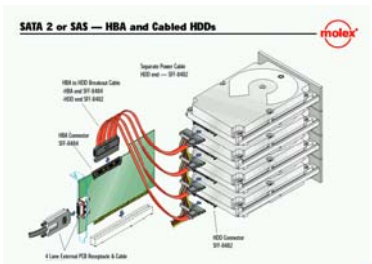
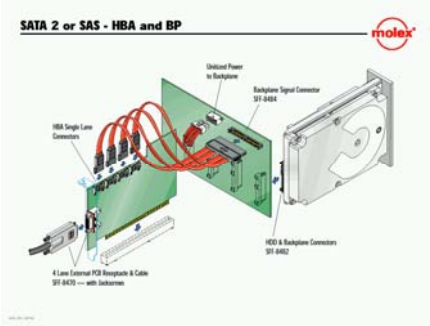
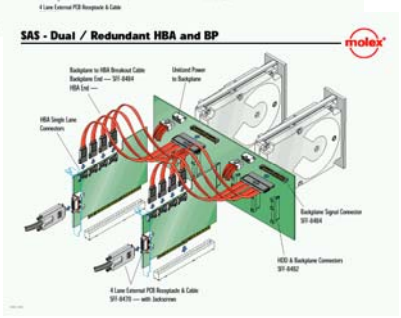
Cable Configurations









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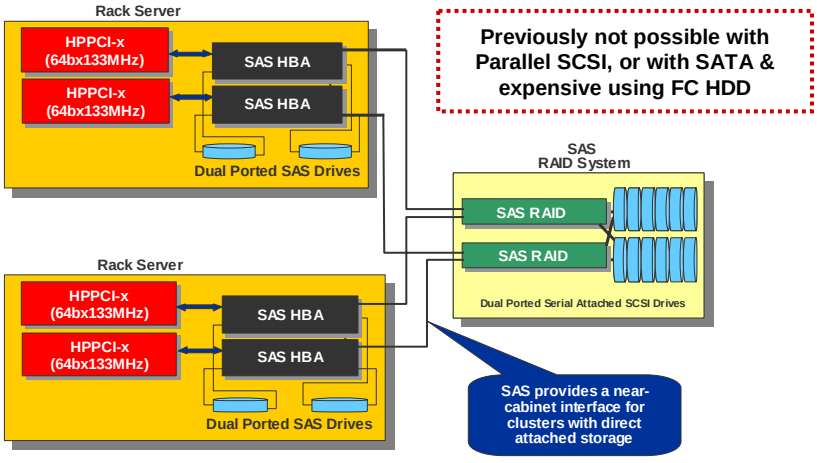
Low-cost Direct Attached Clusters



Serial Attached SCSI Supports Cost Efficient Clusters

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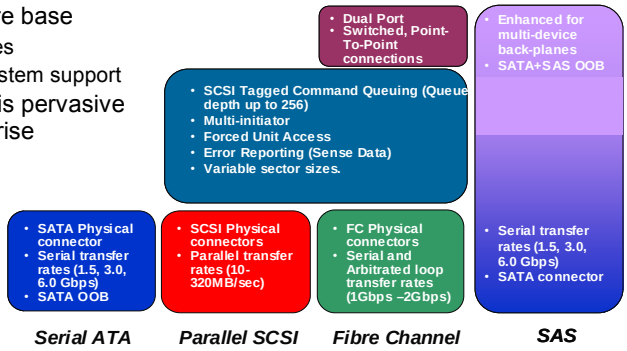
Enterprise Software Support

- SAS employs the SCSI command set to maintain compatibility with installed base of enterprise applications.
  - SCSI command set is robust and stable
    - 20 years of investment and enhancements
    - Extensive IT management experience
  - Entrenched software base
    - Management utilities
    - Broad operating system support
  - The SCSI protocol is pervasive in servers & enterprise storage
    - FC, iSCSI, IB…

Extending Technology Investments



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SAS for Mixed Online/Midline Apps

Dual port SAS drives for main stream, enterprise storage applications

SATA drives integrate disk to disk backup within the RAID array or server to shorten backup and restore times

Dual Port SAS drives for networked file storage

Serial Attached SCSI will support mixed classes of disk drives within a single JBOD or RAID enclosure

SAS drives **SATA drives**

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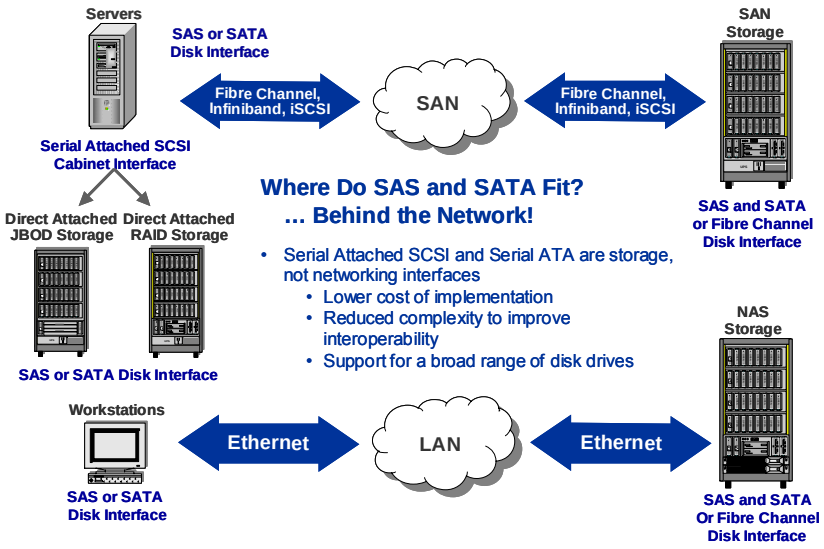
Where Does Serial Storage Fit?



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What Makes an Industry Standard?

Storage Providers and Drive Manufacturers

Component/Infrastructure

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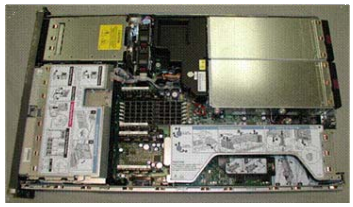
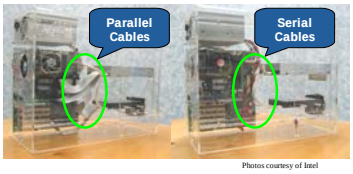
Why Small Form Factors?

- Product Challenges
  - dense architectures
  - thermal envelopes overloading
  - power draws overloading
  - airflow designs must improve
  - new processors run hotter
  - natural technology evolution
- Customer Requirements
  - Need for increased performance vs. capacity requirements in data center.
  - Want more spindles, not more capacity.
  - Data protection is a must
  - RAID rebuild times need to speed up (but increase with disk drive capacity)





Photos courtesy of Intel

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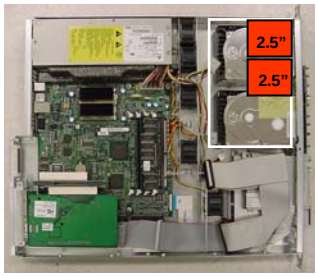
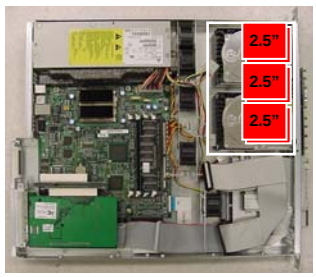
The Benefits of 2.5” Disk Drives

Lower power & Improved Airflow



More Drives per Server



- 2.5” drives will consume 70% less space and 30% less power than 3.5” drives enterprise drives
- Enables either reduced power consumption and improved airflow and/or more drives per server.

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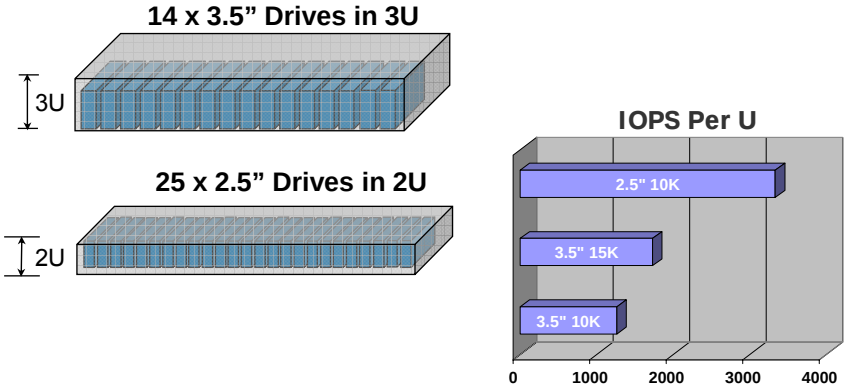
SFF = Better Performance Footprint

- SAS enables design of smaller form factor drives to deliver higher performance in space constrained environments



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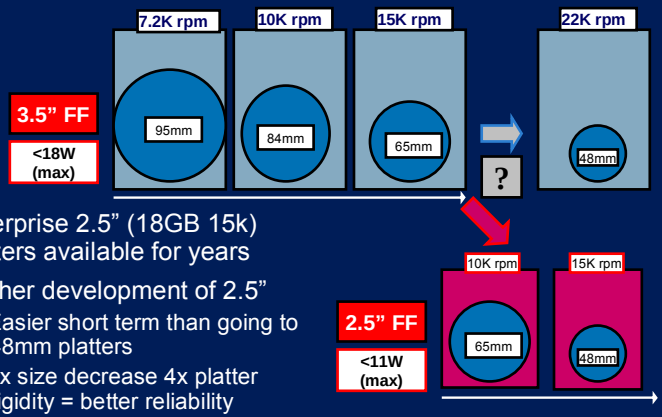
Small Form Factor rational for suppliers: Size for performance?

➔ More performance means reduction of seek times (head positioning time)



- Enterprise 2.5” (18GB 15k) platters available for years
- Further development of 2.5”
  - →Easier short term than going to 48mm platters
  - →2x size decrease 4x platter rigidity = better reliability

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Summary of Server Storage

Current Technology

- Ultra320 is here and brings loads of performances
- The summer will see the final turn of Ultra320
- The Server Bus begins to go Serial with PCI - Express

The Next Generation

- Serial Storage is starting to roll out with SATA products
- SAS will begin about 6 Months later and allows native interoperability between SCSI & ATA HDD
- SAS brings more flexibility, better performance, and enterprise reliability to the Serial Storage revolution
- SAS also allows Small Form Factor Drives to begin rolling out.

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