# Welcome!

## Build Your Own Network Storage With DSI's HyperSCSI

9 July 2003

Data Storage Institute

A*STAR

MCSA
Modular Connected Storage Architecture

# Organised by


Data Storage Institute


Exploit Technologies

Singapore infocomm Technology Federation

# Agenda

- Intro to A*STAR and DSI
- Market Trends and Data Storage Industry
- Introduction to Network Storage
- Introduction to HyperSCSI

- Lunch Break

- Practical Session on Setting up a HS SAN
- Tea Break
- Practical Session on Setting up a HS SAN (cont)

# About A*STAR and DSI

Introduction to A*STAR and DSI

# About A*STAR


Agency for Science, Technology and Research

- Corporate Planning & Administration Division
- Science & Engineering Research Council
- BioMedical Research Council
- Exploit Technologies Pte. Ltd.

# Exploit Technologies' Role

## INTELLECTUAL PROPERTY MANAGEMENT

1. Invention Disclosure

2. Evaluation
   - Prior-art search (Novelty, Inventiveness, Industry relevance)

3. Filing
   - Recommend to file
   - Recommend to renew
   - Recommend to terminate

4. Prosecution

5. Grant/Maintenance

**Stronger Invention**

## TECHNOLOGY AND COMPETITIVE INTELLIGENCE

1. Assess patent portfolio
   - Understand own & competitors'
   - Patent strengths

2. Provide intelligence
   - Technology & industry trends
   - Research directions
   - RI competitiveness

3. Strategise IP creation
   - Develop patent strategy
   - Identify areas of invention
   - Stimulate high quality patent

**Strategic Research**

## COMMERCIALISATION ('EXPLOIT')

1. Gold mining
   - Sieve through IP assets
   - Cherry pick commercialize IP

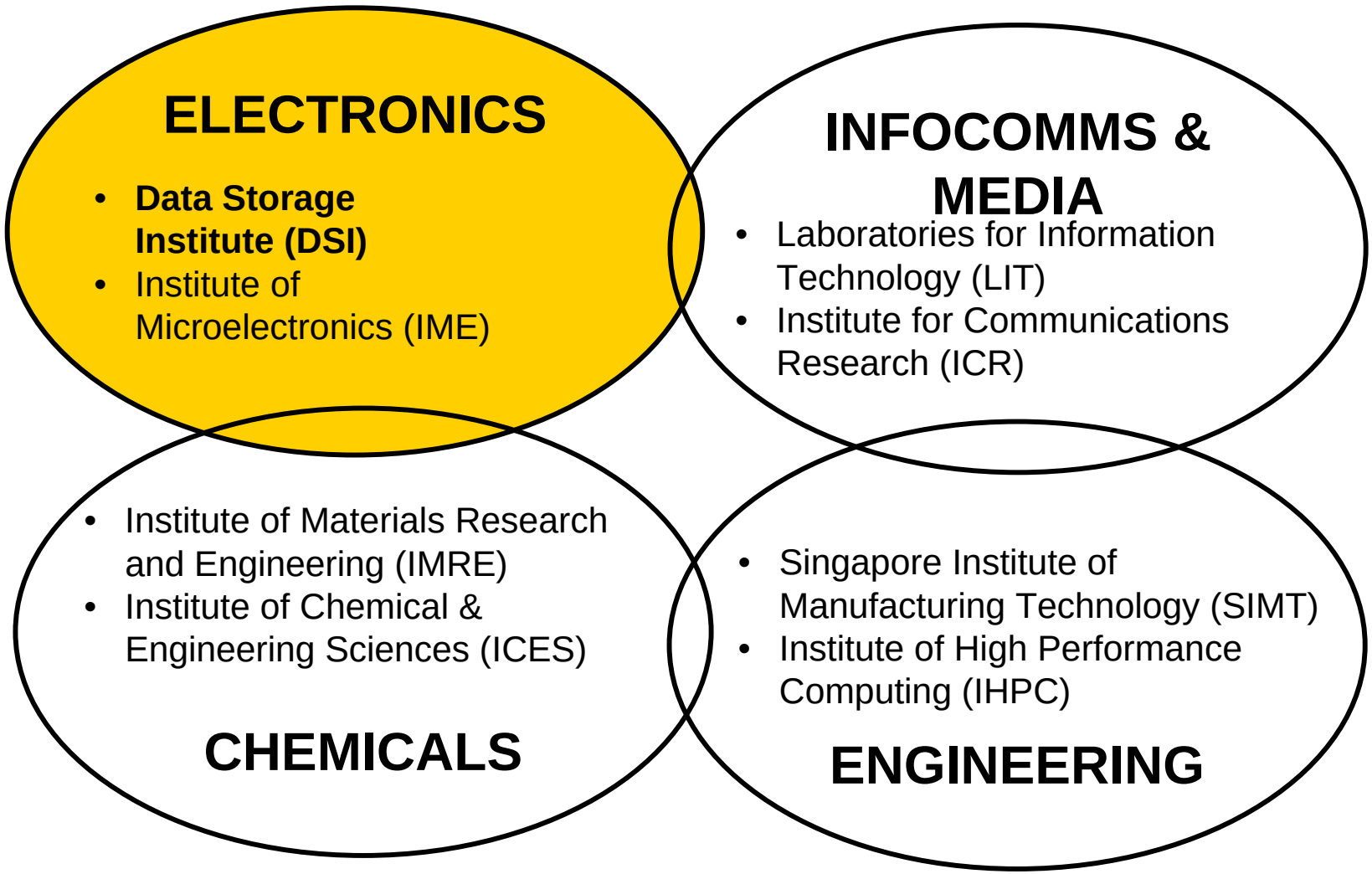
2. Consolidate IP strengths
   - Bundle IP & package

3. Identify opportunity
   - Find applications fit
   - Market needs & supply chain
   - Identify enabling industries
   - Identify potential customers

4. Funds: Technology Development vs Spin off

**Transform IP to $$$**

# Science & Engineering Research Council

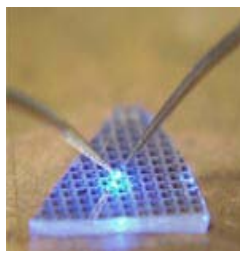


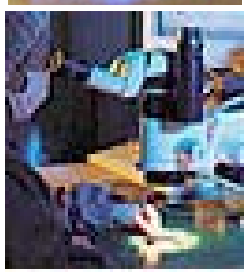

A*STAR Data Storage Institute

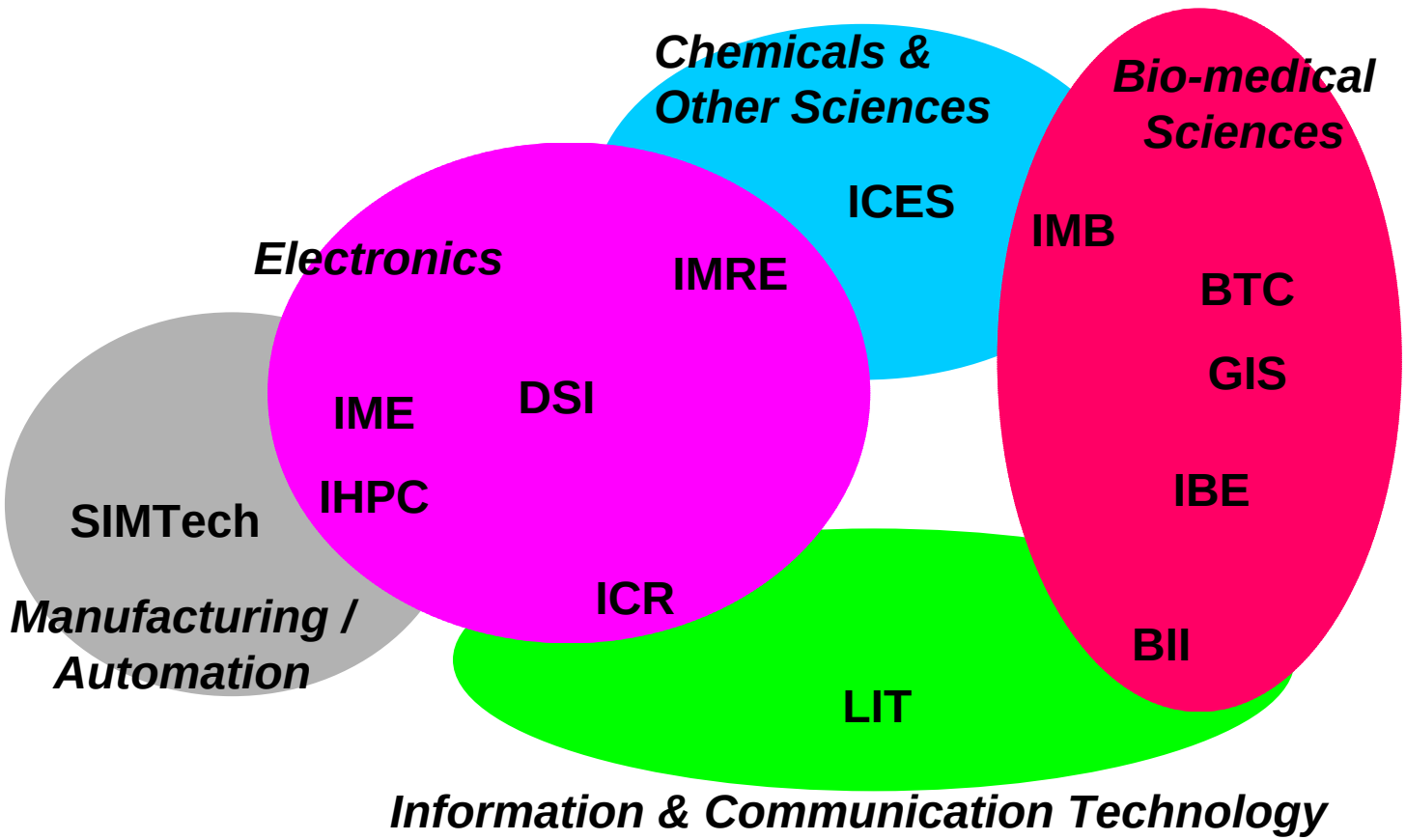
# Strong Technical Capabilities

- ★National research spending of 1.9% GDP (2001)
- ★12 renowned research institutes
- ★2 world-class technological universities
- ★More than 2,000 research scientists & engineers
- ★Target to reach 90 RSE per 10,000 workforce

NUS NTU





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# Data Storage Institute

1992 1996 1998 2000

**Magnetics Technology Centre** | **Data Storage Institute**

Servo, Coding, Magnetic CAD, Head-disk interface

Magnetic media, Optical technology

Magnetic heads, FAR

Network storage

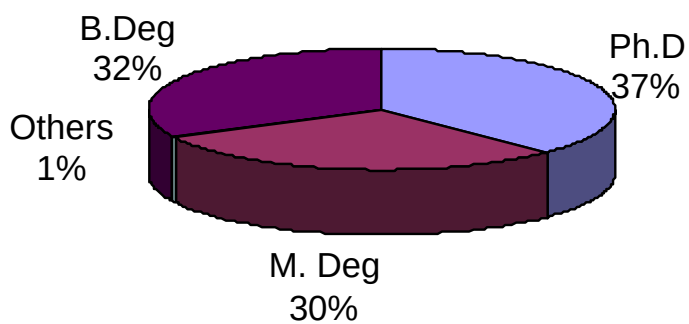
## Since establishment: (as of Jan 2002)

- M.Eng students graduated 71
- PhD students graduated 26
- Undergraduate students trained 179
- IA student trained 125
- Staff spun out to industry 74
  (in the last 3 years)
- Published journal papers 559
- Published conference papers 466
- Patent filed (granted) 73(14)

## Budget : $35 mil / year

**Current Staff (as of Jan 2002)**

| | |
|---|---|
| **Research Staff** | **181** |
| **Visiting scientists/PDF/PMF** | **13** |
| **Graduate students (RS)** | **29** |
| **Undergraduate students** | **26** |
| **Faculty Associates** | **34** |
| **DSI staff adjunct to Univ** | **11** |

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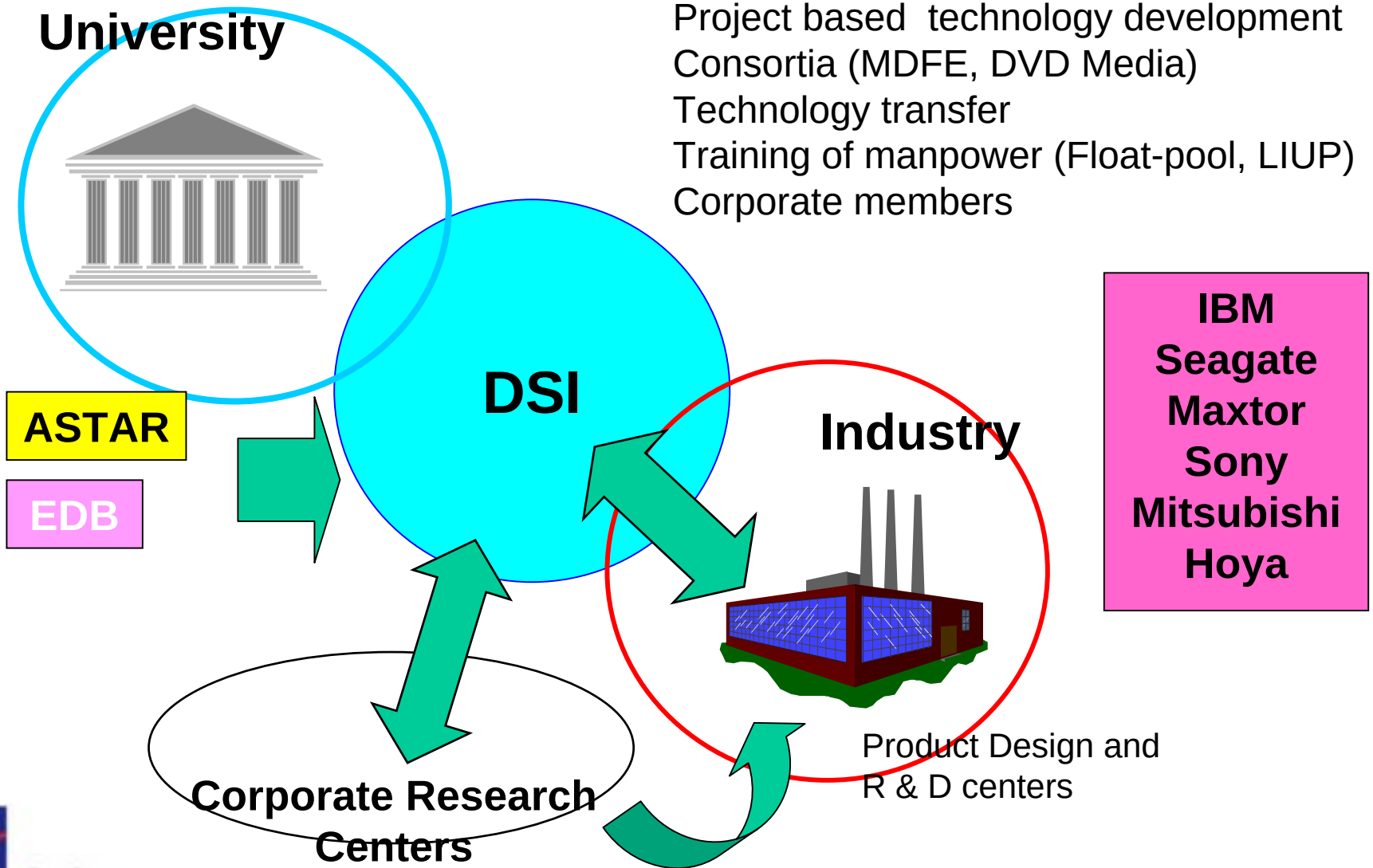
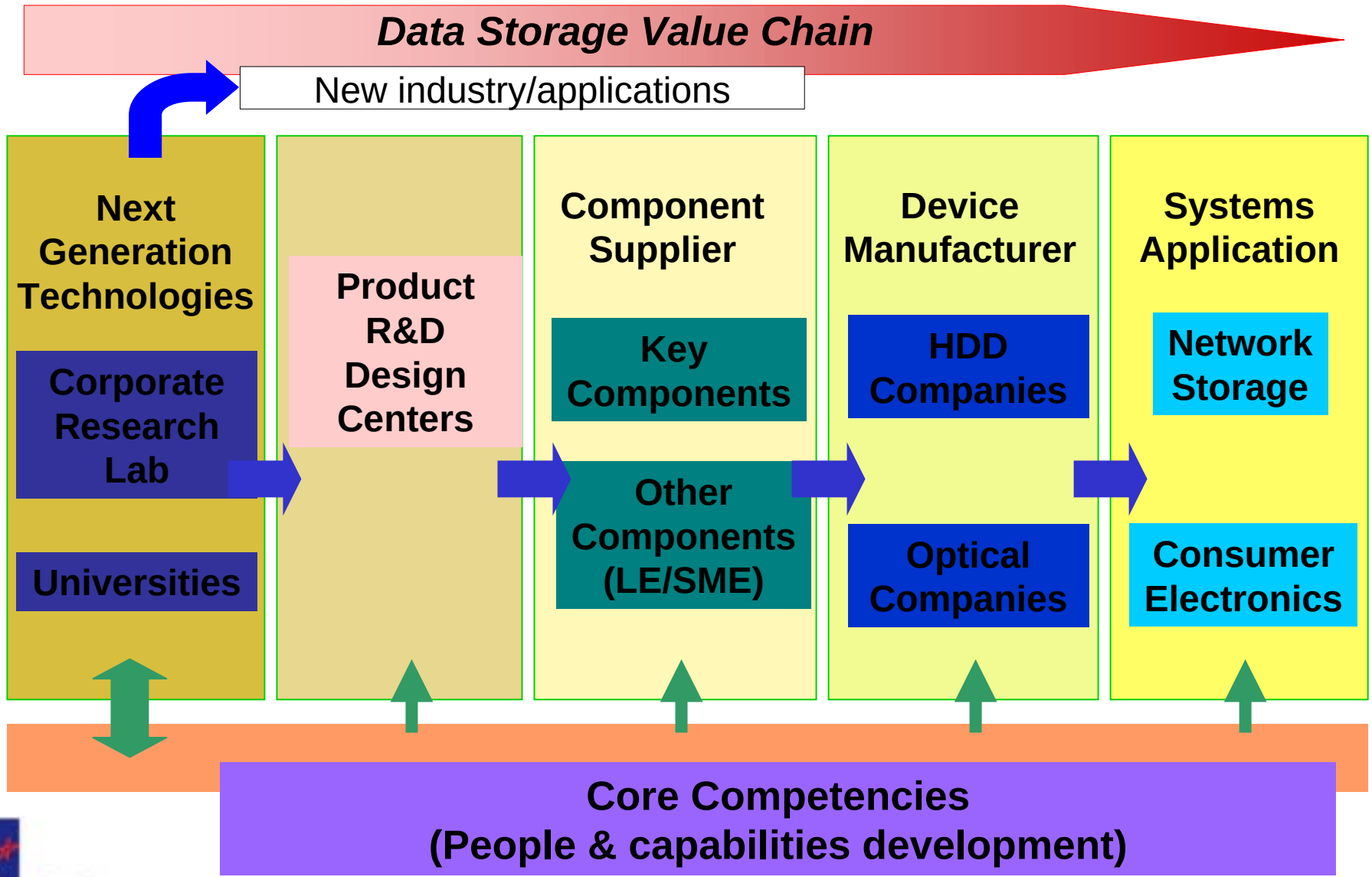
# Closing the Loop




Project based technology development
Consortia (MDFE, DVD Media)
Technology transfer
Training of manpower (Float-pool, LIUP)
Corporate members

# Data Storage Value Chain

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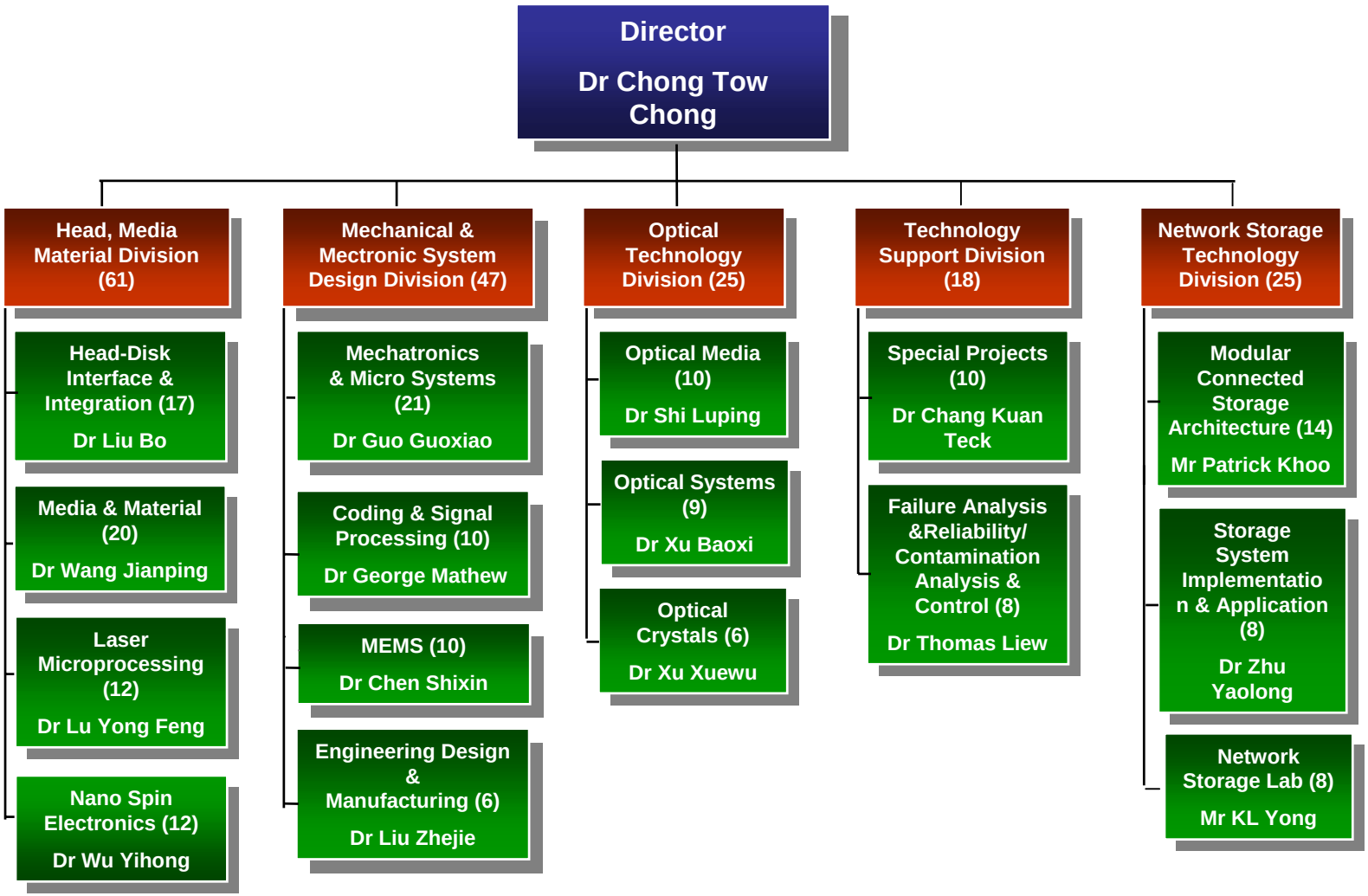
# DSI Organisational Structure



# Technology for Enterprise Capability Upgrading (T-Up)

- T-Up is an initiative to complement A*STAR's focus on the development of R&D Human Capital for Singapore
- The aim is to help strengthen capacity of local enterprises for technology innovation through secondment of A*STAR RSEs to companies
- To provide further support for local enterprises and to help them upgrade, A*STAR has joined forces with 4 other organisations

**Participating Organisations**

**Participating Research Institutes**

DSI | IHPC | I²R | IME | IMRE | SIMTech

# T-Up Benefits and Funding

- Obtain access to expertise from a pool of RSEs
- Gain exposure to leading-edge technologies
- Build in-house R&D capabilities
- Facilitate technology transfer for upgrading
- Permit human capital retention after the project to enjoy the benefits of R&D for a much longer term

- Funded on 70% of manpower cost of RSEs (Company pays 30%) for up to 2 years

# The Data Storage Industry

Some Market Trends and Industry Forecasts

# Can I do More for Less?

- University of California at Berkeley - 2001
  - 12 Exabytes in mankind's history to date
  - 12 **more** Exabytes in next two and a half years alone!

115 Video Tapes

100Gbit/in$^2$ (2002)

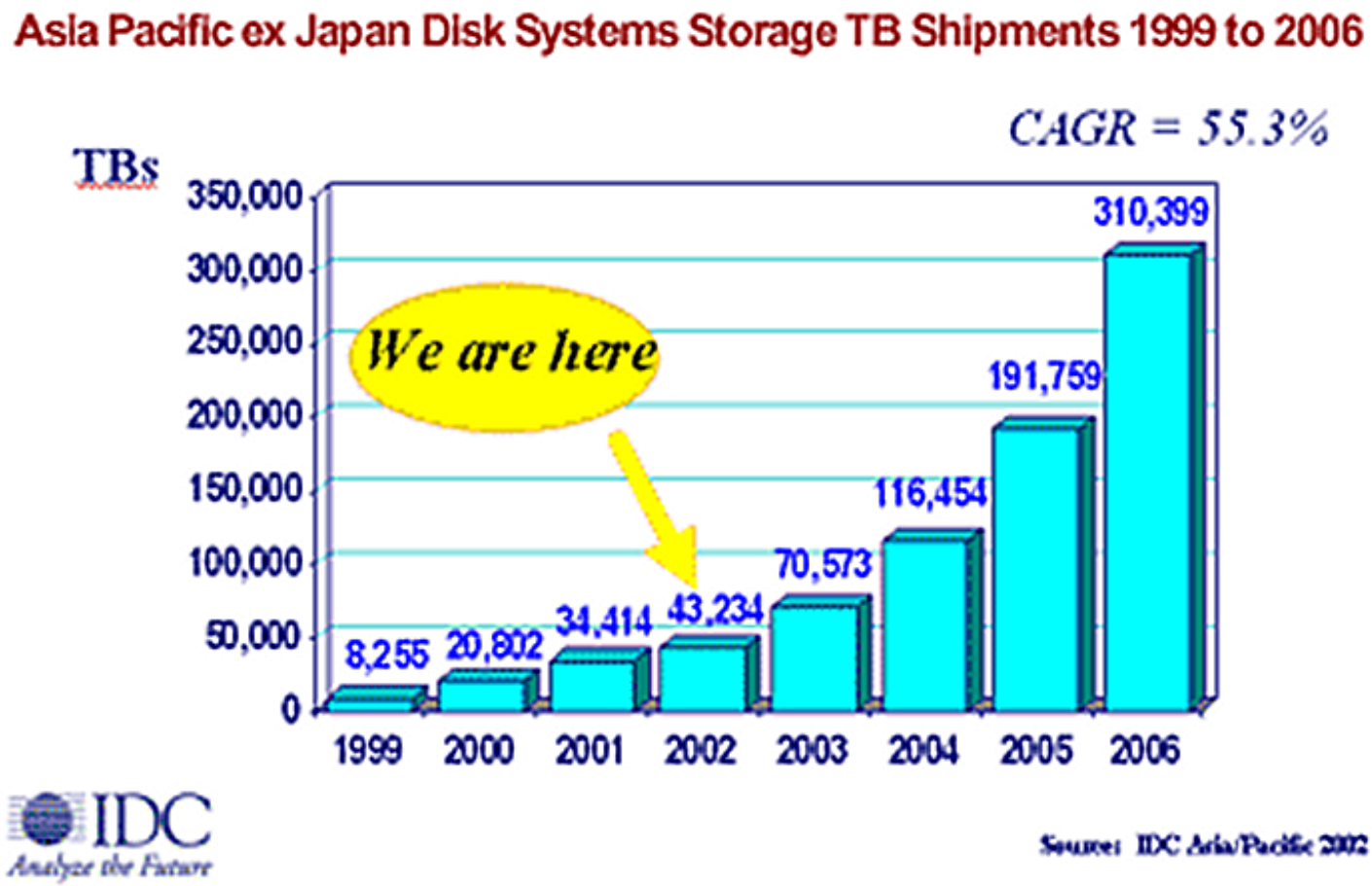
1 HDD

250 hours of video

or

80,000+ songs

# Data Growth, Storage Shipment Growth

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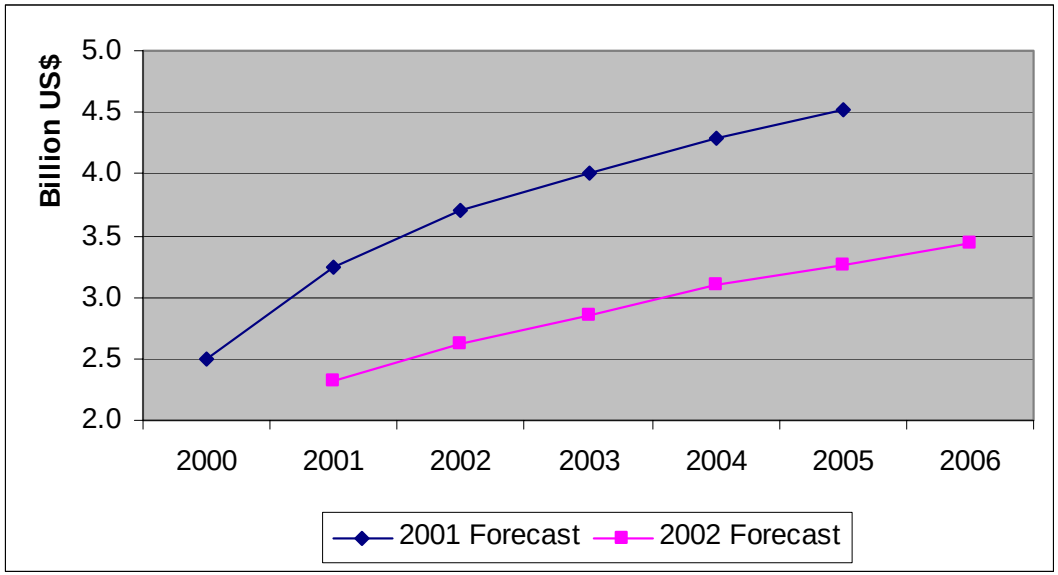
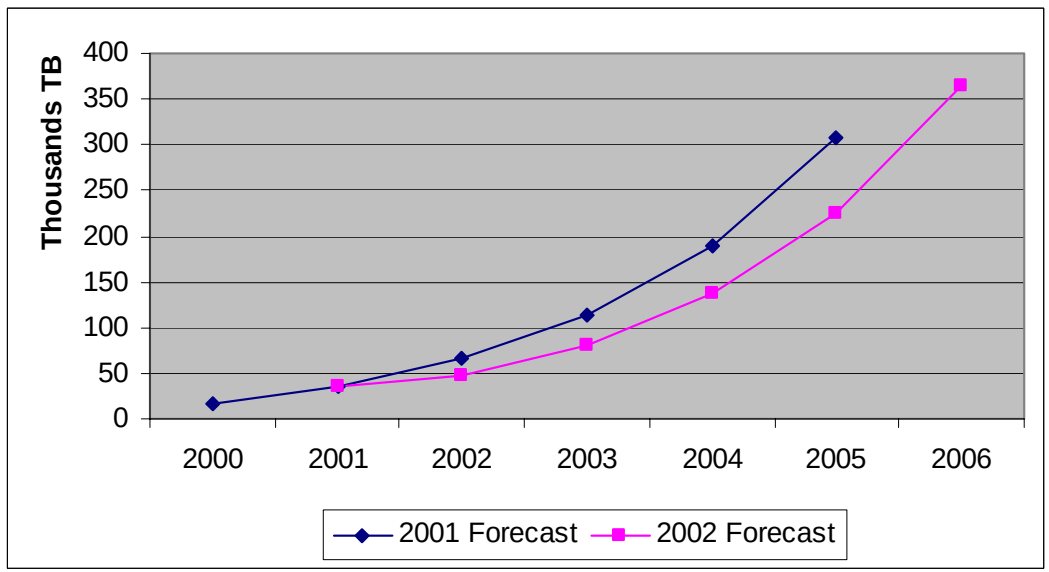
# Industry Forecasts – Comparisons




**Asia/Pacific Disk Storage Revenue, 2000-2006**

Source: IDC Asia/Pacific, 2001, 2002




**Asia/Pacific Disk Storage Terabyte Shipments, 2000-2006**

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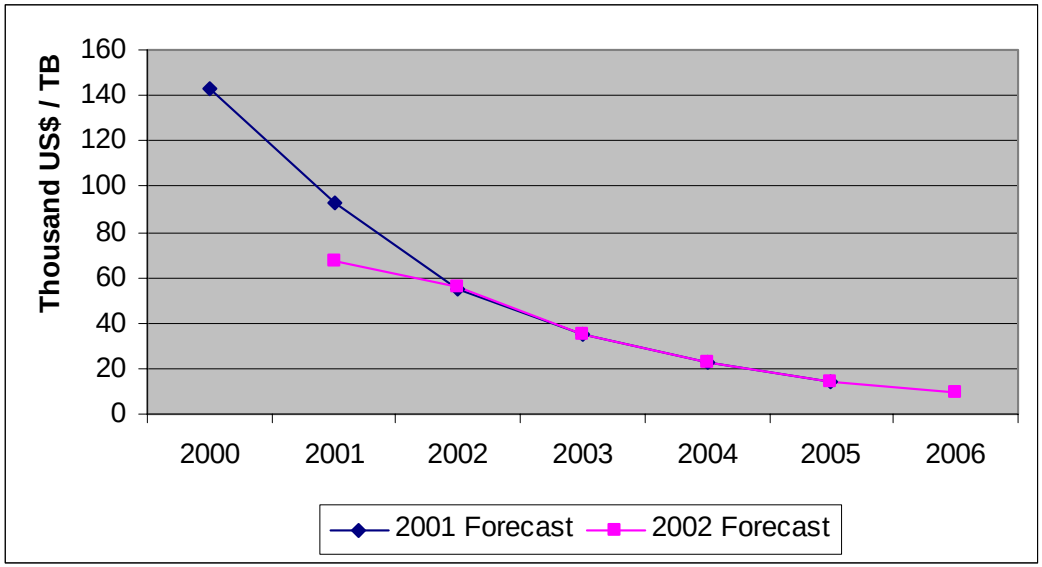
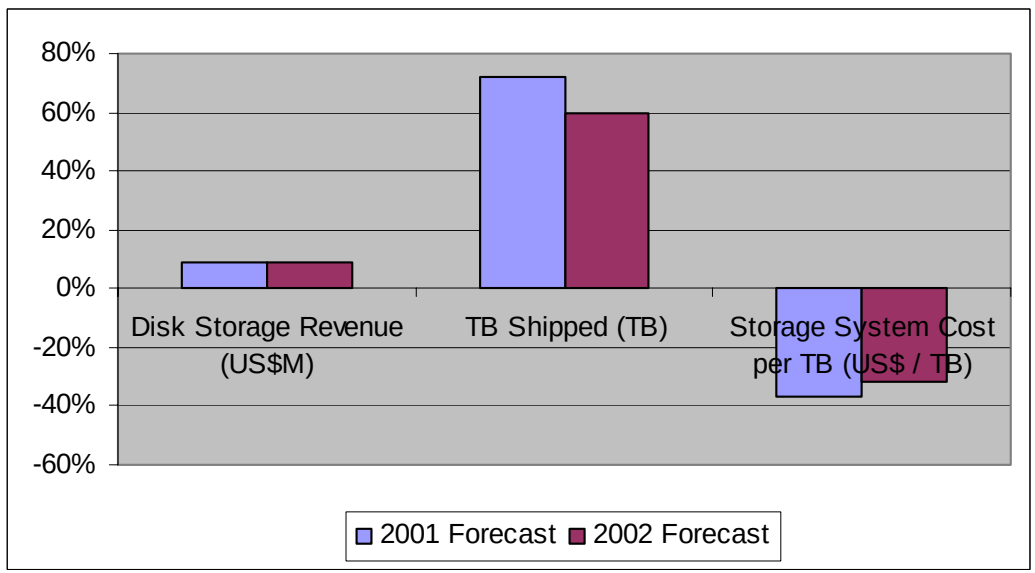
# Industry Forecasts – Comparisons




**Asia/Pacific USD/TB Storage System Costs, 2000-2006**

Source: IDC Asia/Pacific, 2001, 2002




**Asia/Pacific CAGR Forecasts, 2001-2005**

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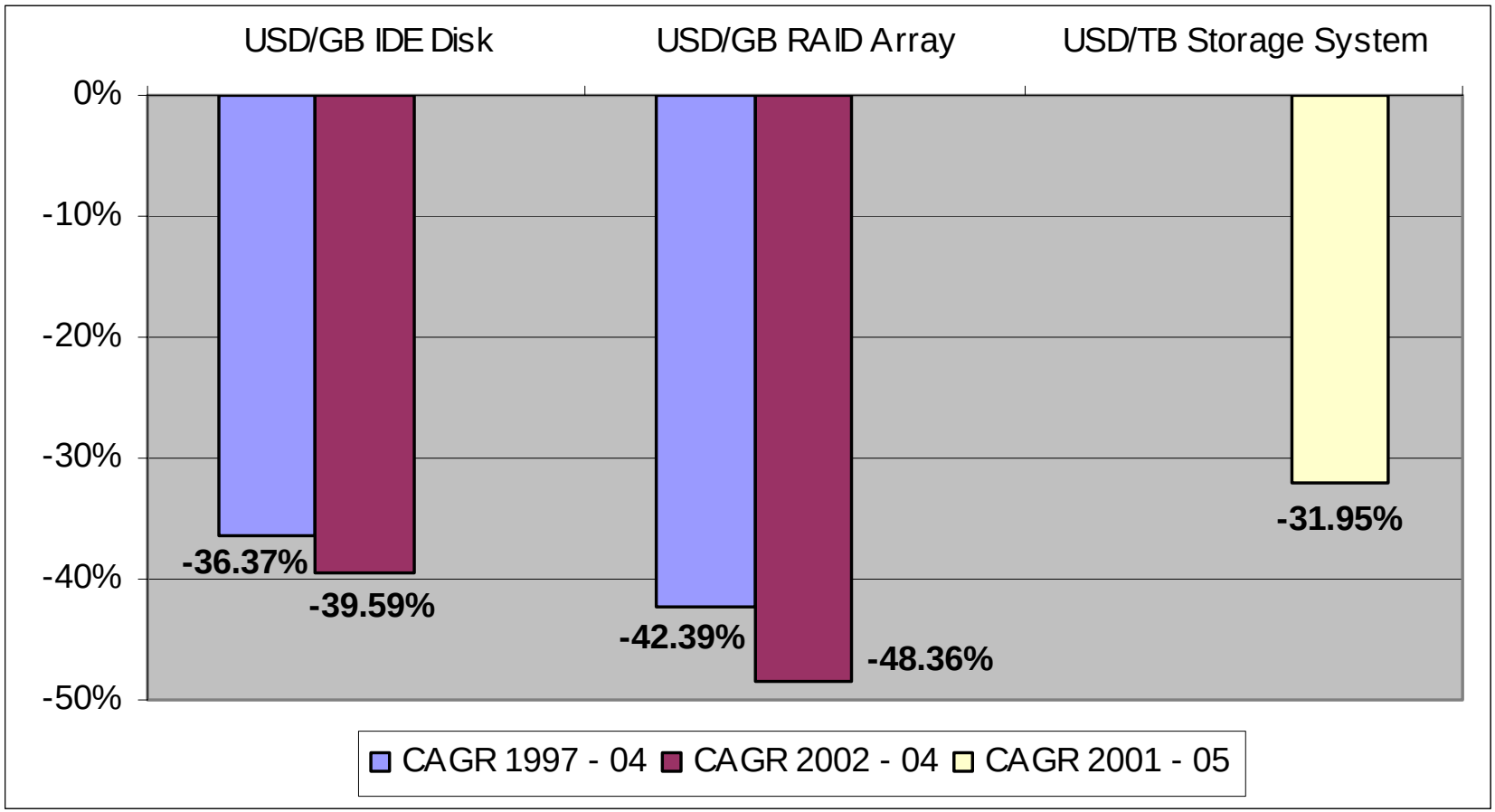
# Trends in Storage Price Erosion




Source: IDC Asia/Pacific, 2002

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# Industry Forecasts – The Difference

- What is the effect of the current economic climate on the storage business?
  - Storage growth has not been halted, merely delayed (by about one year)
  - At the same time, the cost of storage is dropping about 35% per year but will still stablise over the long term [IDC Asia Pacific 2002]

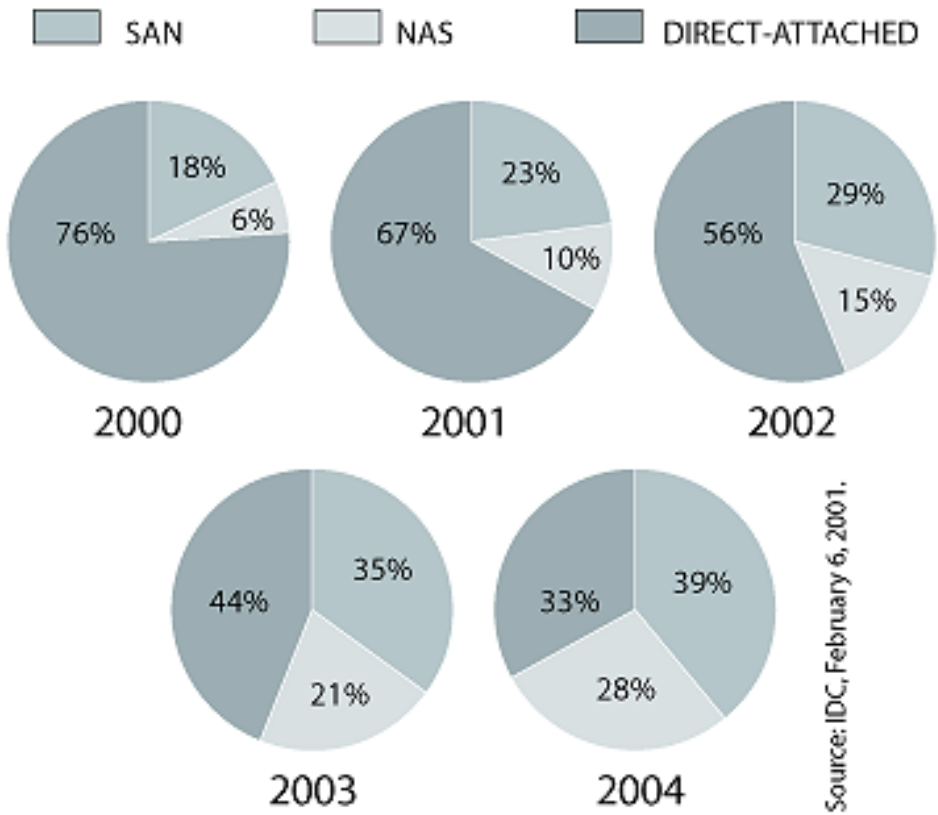
- Conclusion: The cost of storage systems has not really dropped (other than due to newer high density HDDs) – some kind of technological advancement is needed

# Storage Networking – Market Review

| | Yr 2002 | Yr 2003 | Yr 2004 | Yr 2005 | Yr 2006 | Yr 2007 | Growth |
|---|---|---|---|---|---|---|---|
| SAN | 43.43 | 41.14 | 41.21 | 45.21 | 47.30 | 49.62 | 2.7 % |
| NAS | 7.81 | 15.32 | 19.52 | 24.87 | 29.23 | 32.75 | 33.2 % |
| DAS | 36.31 | 24.57 | 20.43 | 14.55 | 10.50 | 7.31 | - 27.4 % |

Singapore Storage Market (US$ million)
Source: Business Times 23 June 2003

SAN and NAS is the Future of Storage!

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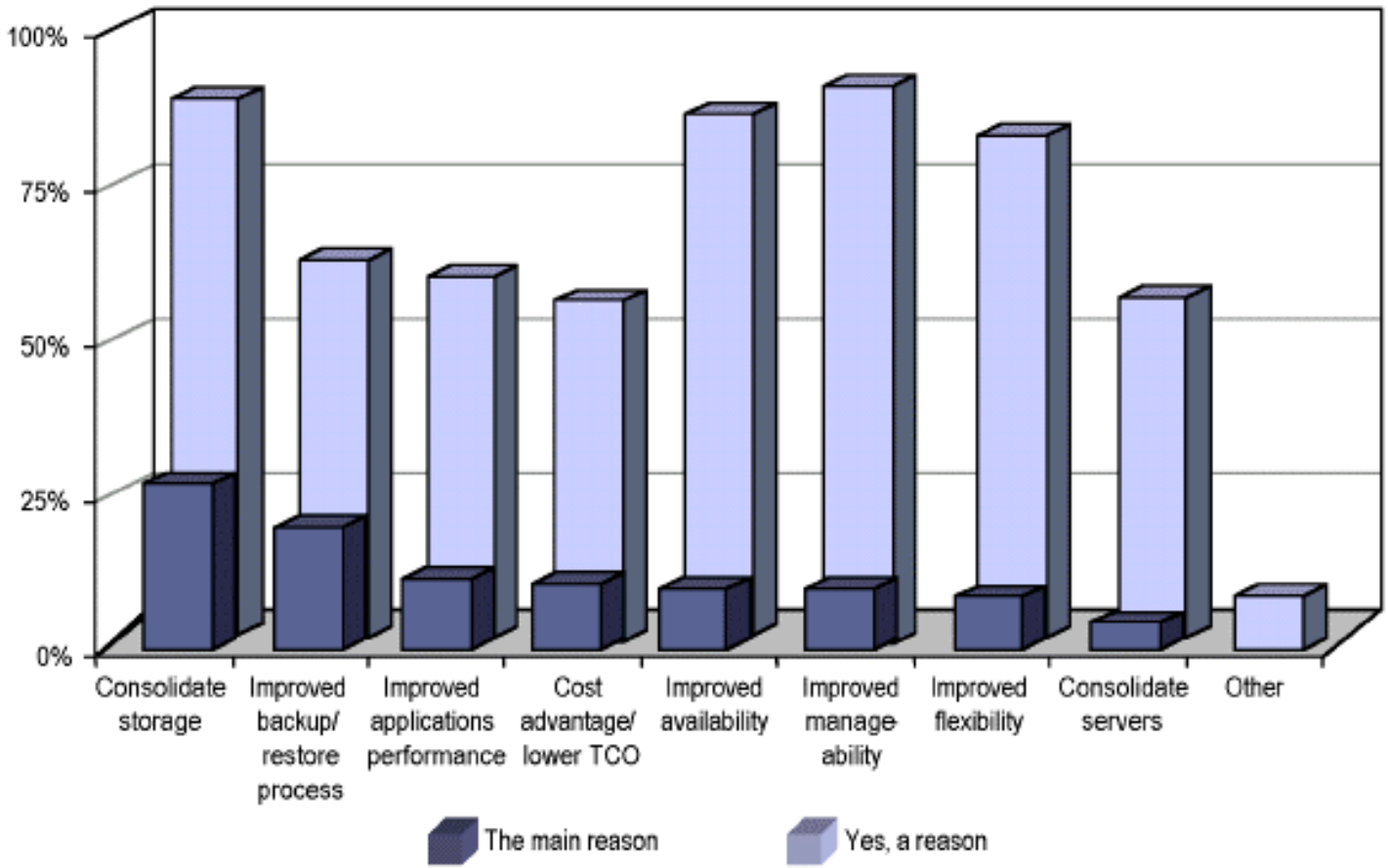
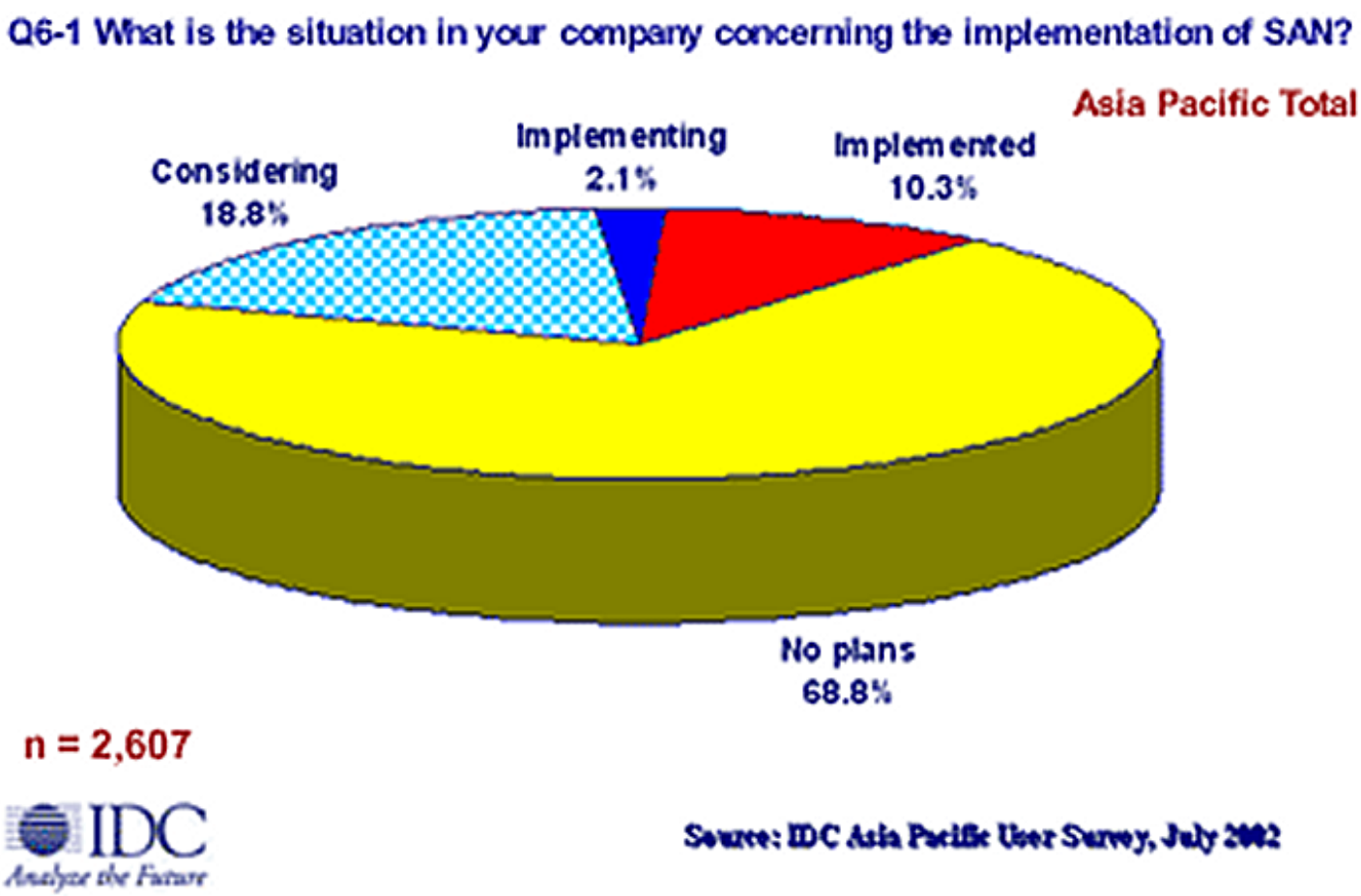
# Why SAN and NAS is cannibalising DAS




So **MANY** reasons, so **MANY** applications!

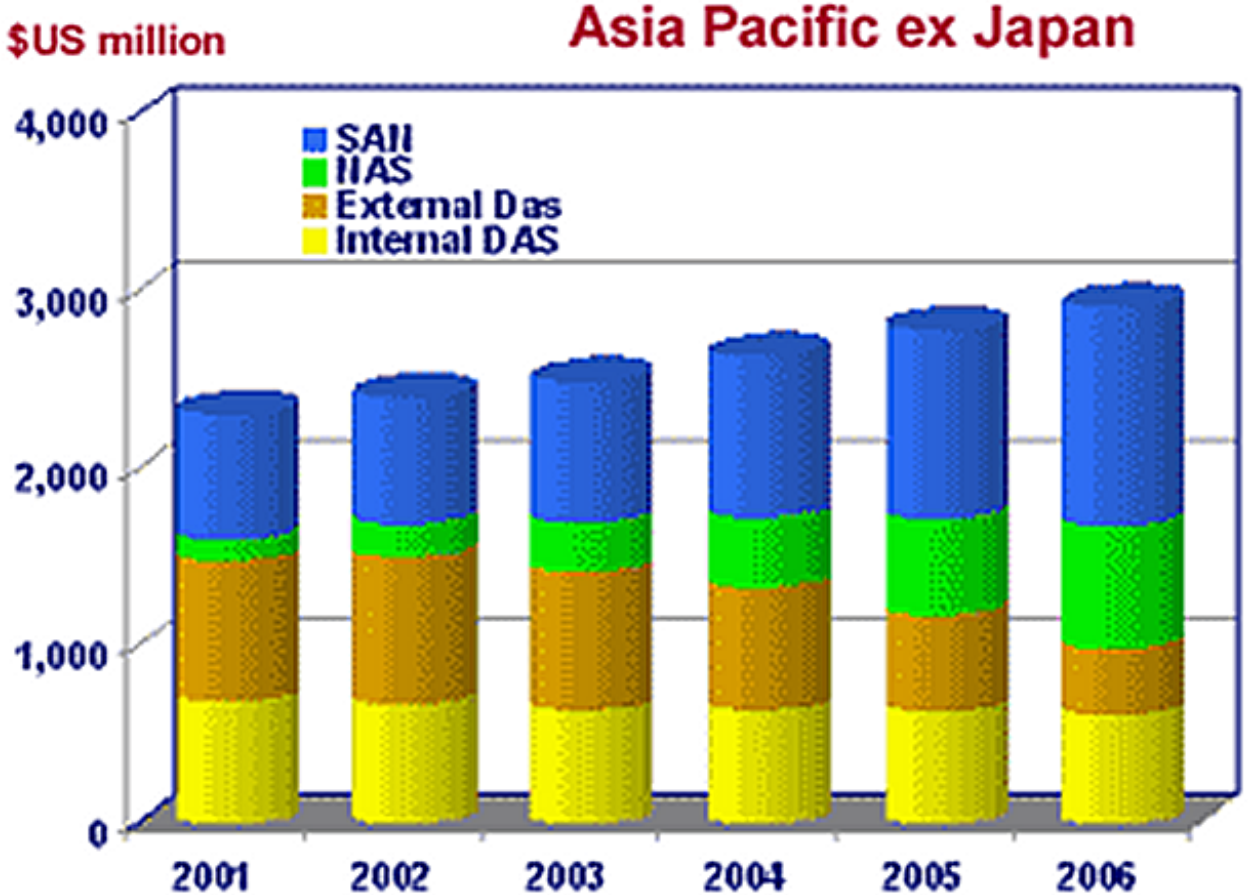
Source: Aberdeen Group, January 2002

# Half Full or Half Empty?



# Growth Opportunity in SAN/NAS

## Rapid Change in Storage Architectures




Price pressures limit revenue growth

SAN and NAS will experience rapid growth

Internal and external server-attached now in decline

IDC Analyze the Future

Data Institute

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Source: IDC Asia Pacific 2002

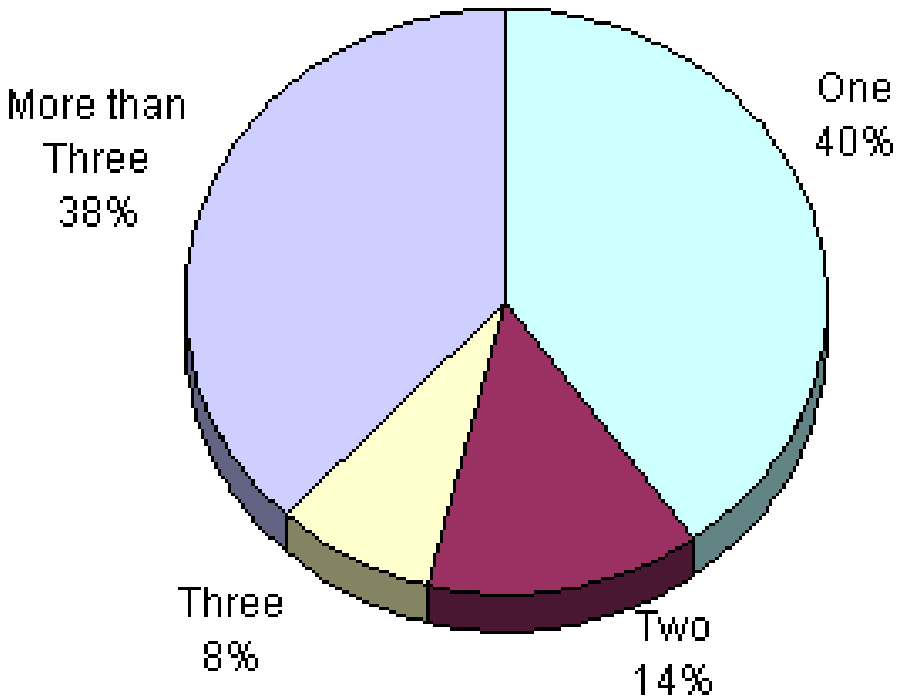
# Analyst Comments

- Network storage will become mainstream in 2003, with some users extending their initial implementations, other starting the journey. Although it has been talked about across Asia for the last couple of years and there are some big government and specific industry implementations, the number of network storage implementations - whether it is SAN or NAS - has been quite low There are a few reasons for this. For one, most organizations in Asia simply don't feel that they need it yet although this could be because of a misunderstanding of the benefits of network storage. In other cases, the organization is just too small to justify the investment. They may however need it in three to four years time. [28/11/02]

- iSCSI did not take off in 2002, and probably won't until 2004. The attraction of iSCSI is that there is a very large pool of IP experience and many networks that could be adapted for storage. However, latency is a current issue but one which is being addressed by TOEs (TCP offload engines). These will add to the cost and may not make iSCSI much cheaper than FC. [26/03/03]

- Graham Penn, Director of Storage Research for IDC Asia/Pacific

# SAN Islands are a Reality




**Number of SANs Deployed in Respondents' Organizations**

- Most organisations preparing or considering implementing SANs, should take into account adding new "independent" SANs in the future
- Most SANs are "Local" in nature
- Why do you need IP to go long distance? (for most people anyway)

Source: Aberdeen Group, January 2002

# About Network Storage

Introduction to the Basic Concepts in Network Storage

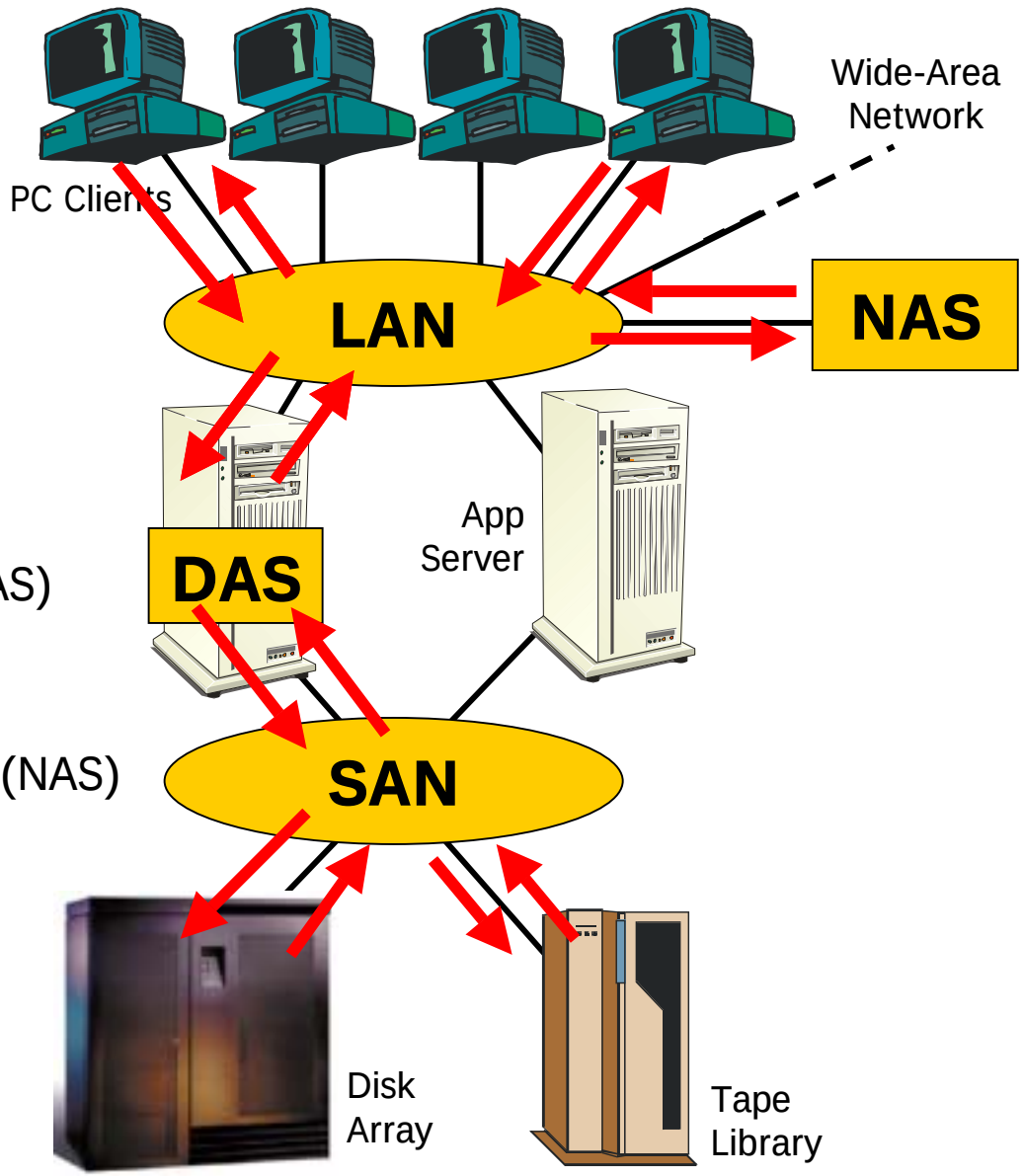
# Industry Shift From DAS to SAN / NAS

Direct Attached Storage (DAS)

Local Area Network (LAN)

Network Attached Storage (NAS)

Storage Area Network (SAN)

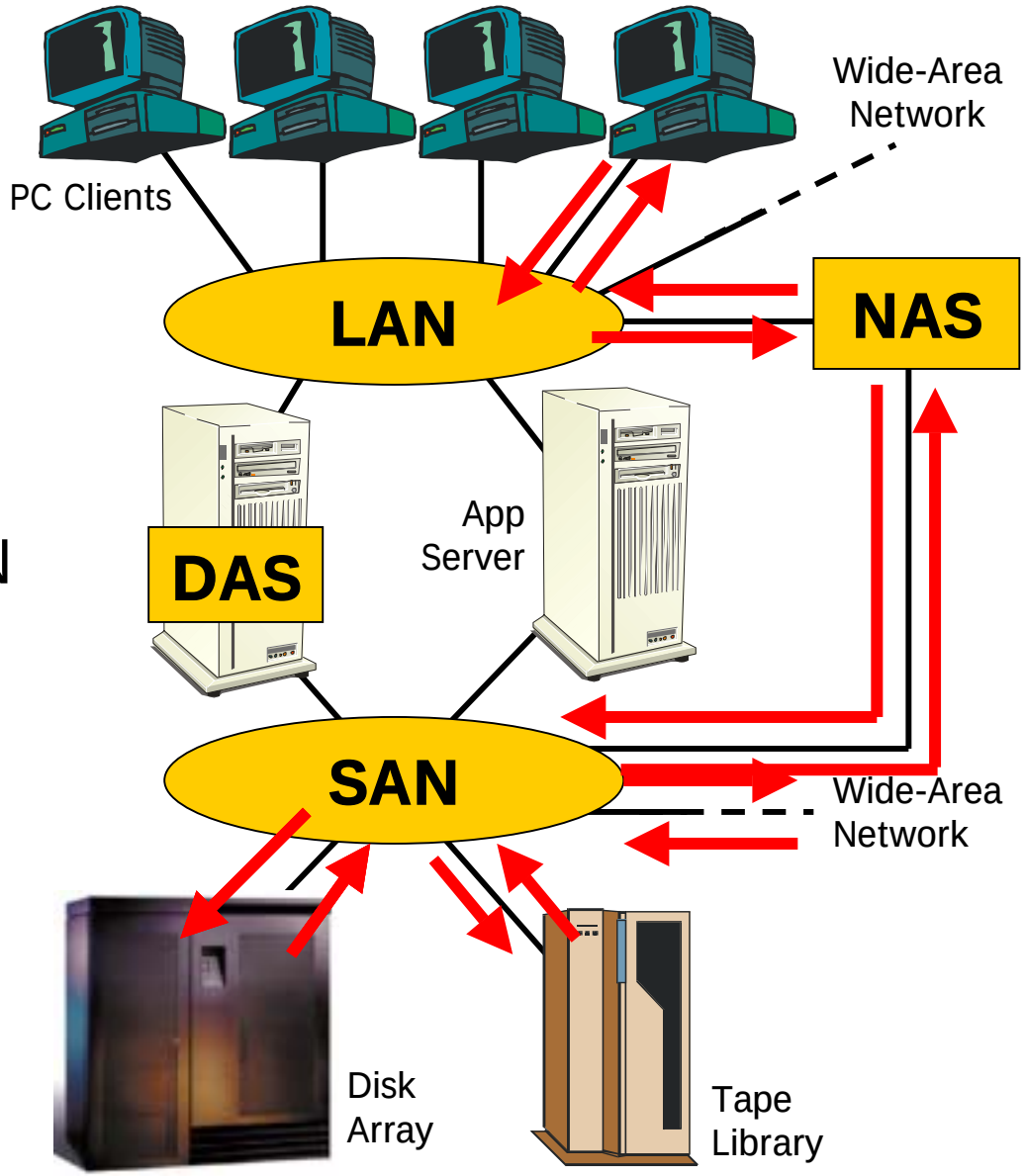


# Advanced SAN and NAS Strategies

High Speed Backup

NAS Gateway to SAN

Disaster Recovery



# Advantages of SAN / NAS

**Why SAN and NAS?**

- Lower costs
- Higher scalability
- Better reliability
- Easier management
- Secure access
- More information sharing

NAS

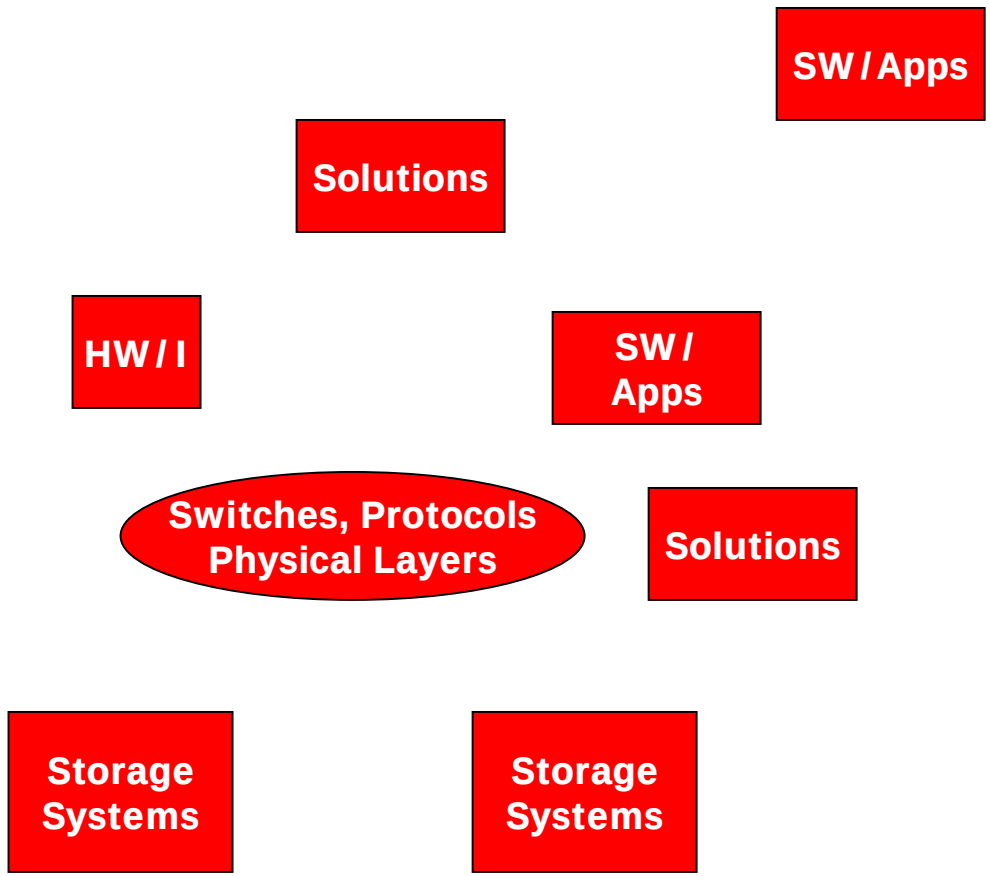
"Companies worldwide have reduced Direct Attached Storage (DAS) management costs by **$6.4 billion** by investing in Storage Area Network (SAN) and Network Attached Storage (NAS) technology"

ITCentrix, April 2003

SAN

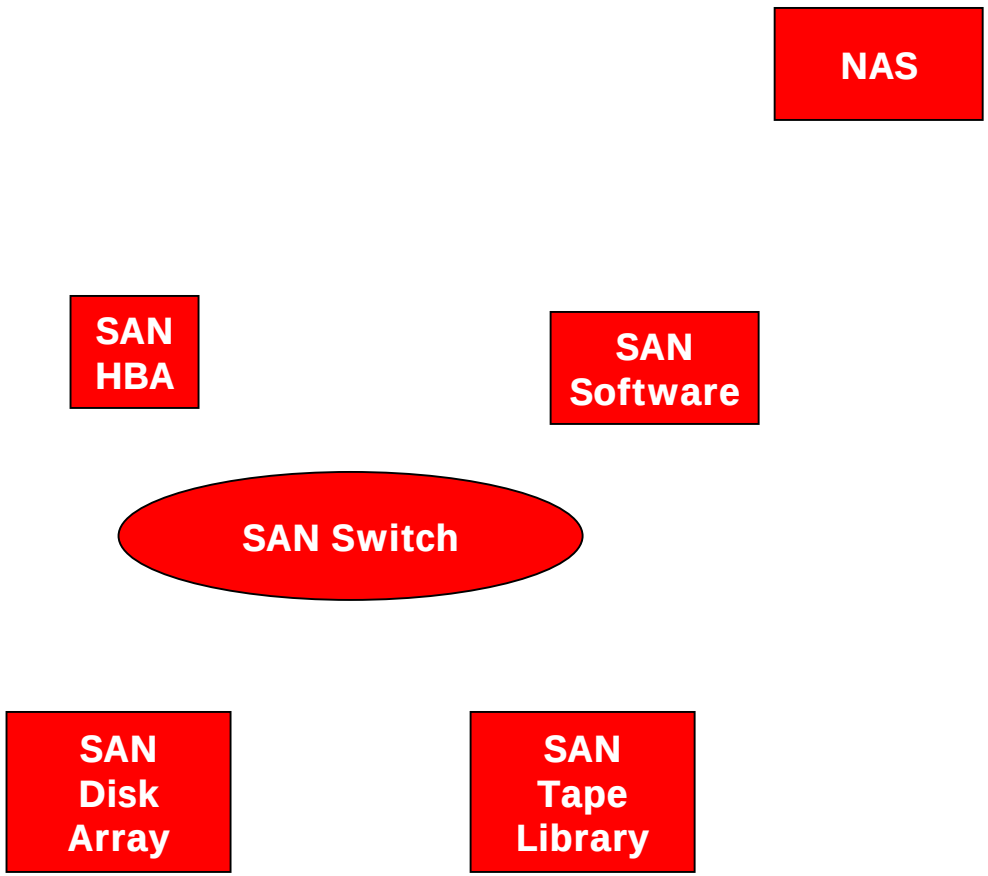
# SAN/NAS Technologies

- **Hardware / Interface:** HBA, NIC, SAS, SATA, FC
- **Software / Applications:** Device Driver, File Systems, Databases
- **Switches:** ASIC, Firmware, GBIC
- **Storage Subsystems:** RAID, Disk, Tape, ASIC, Enclosure, Cache
- **Protocols:** FC, iSCSI, FCIP
- **Physical Layers:** Ethernet, FC, Optical, Copper
- **Solutions:** Virtualisation, Disaster Recovery, Data/System Management

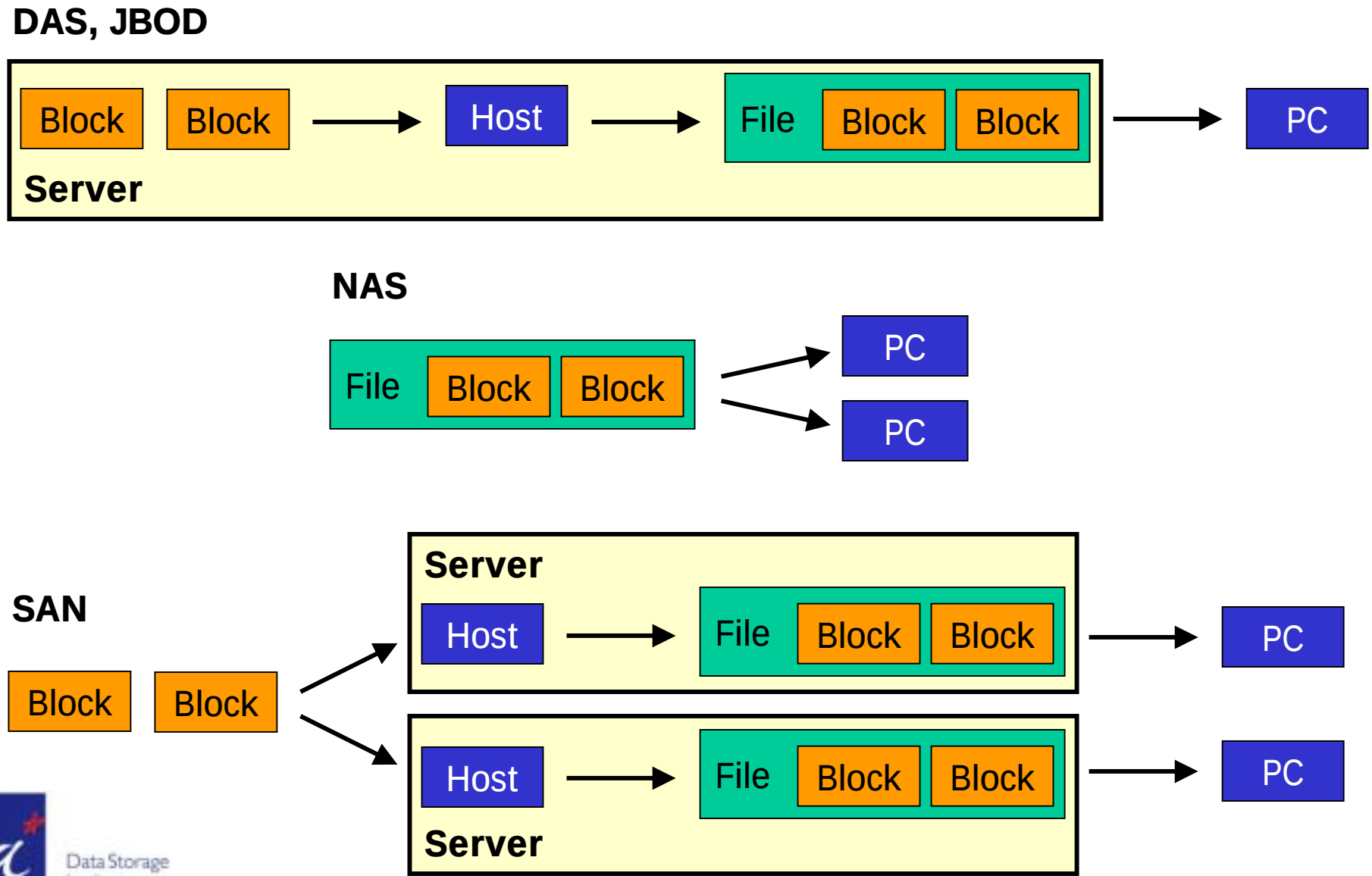


# Companies in SAN/NAS Space

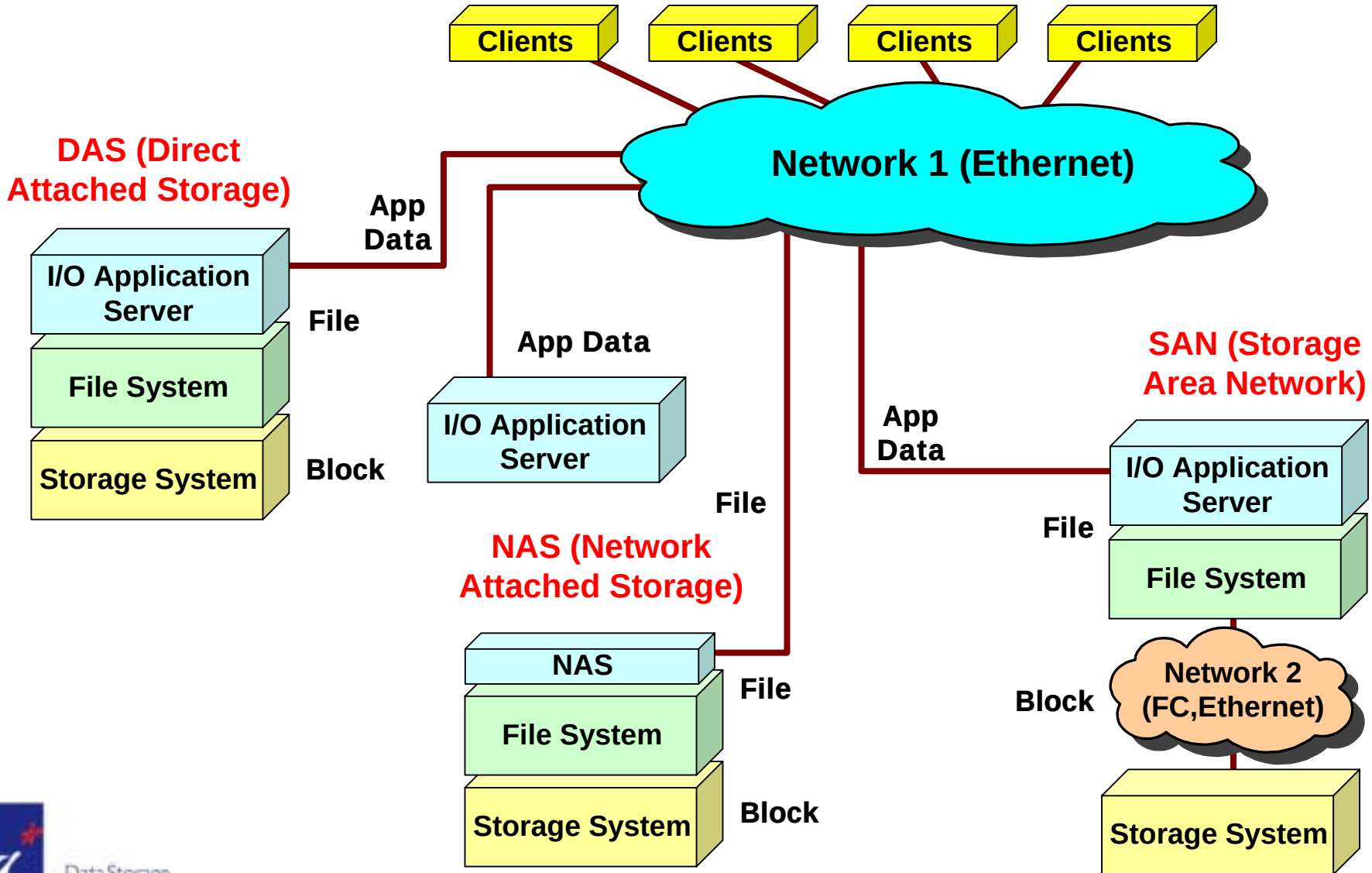
- **NAS:** Network Appliance, Iomega, Quantum Snap
- **SAN Disk Array:** EMC, HDS, IBM, HP/Compaq, Sun, XIOtech
- **SAN Tape Library:** StorageTek, ADIC, IBM, HP/Compaq, Overland
- **SAN Switch:** Brocade, McData, InRange, Nishan, Cisco
- **SAN HBAs:** Qlogic, JNI, Adaptec, Emulex, Alacritech
- **SAN Software:** Veritas, CA, IBM, FalconStor



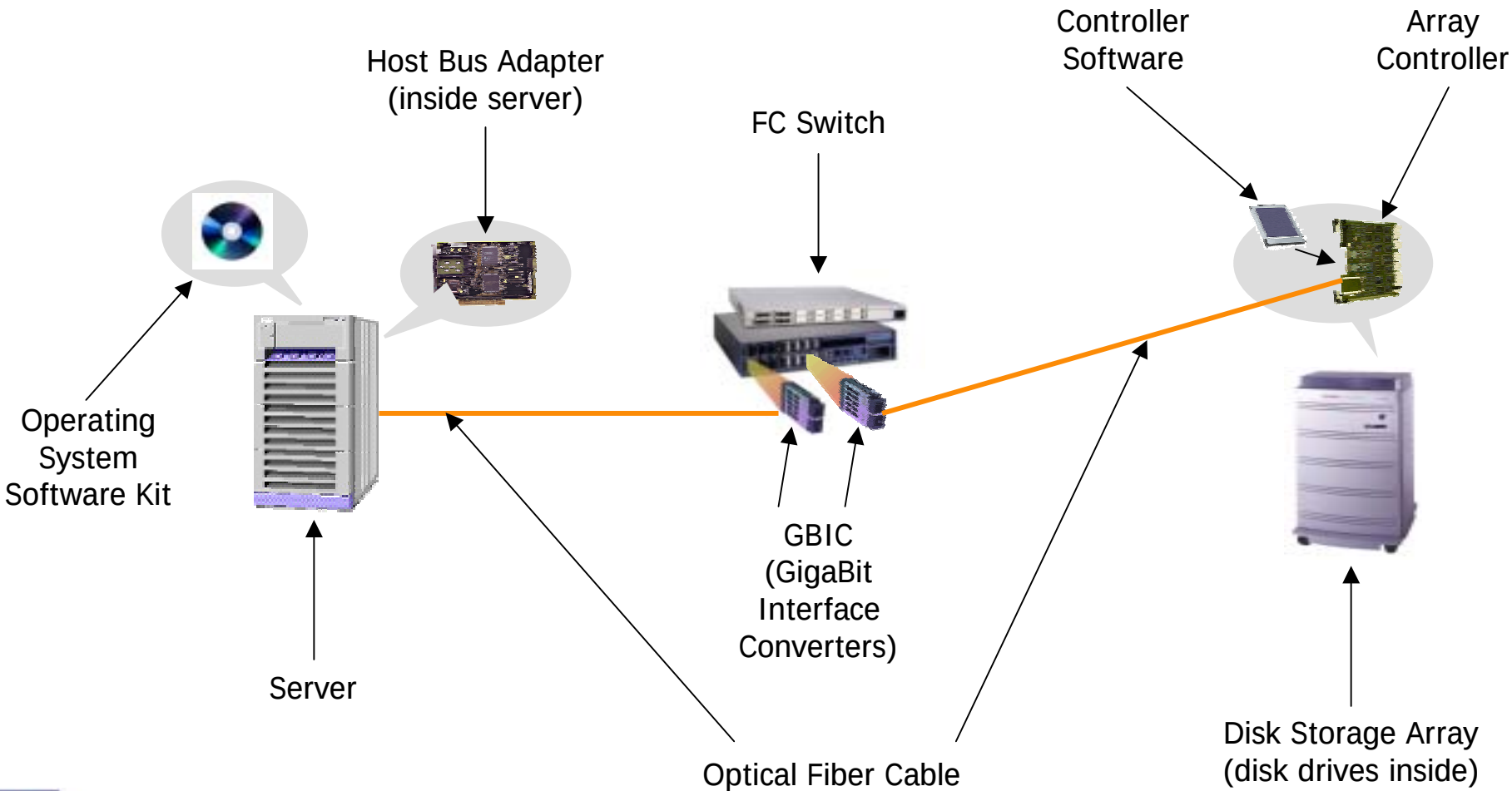
# Block vs File and DAS vs NAS vs SAN



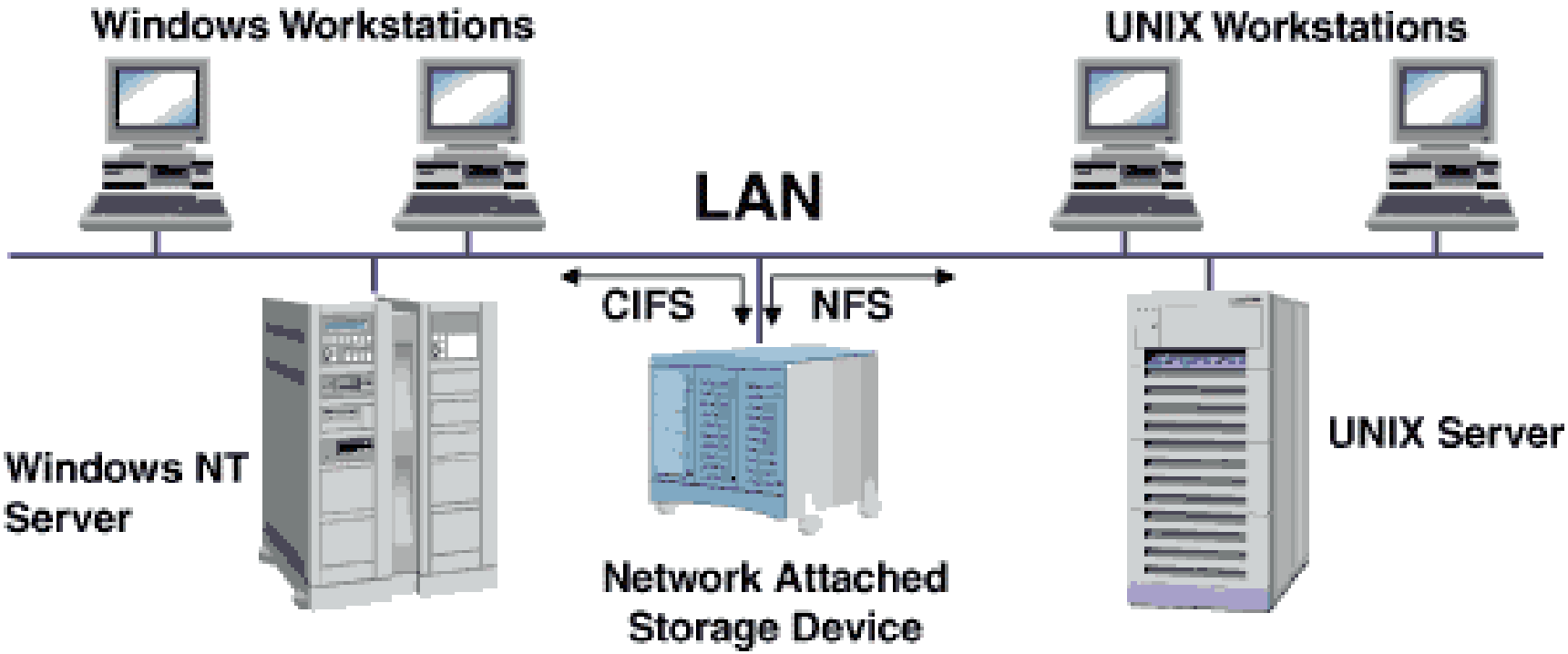
# Another View of DAS vs NAS vs SAN



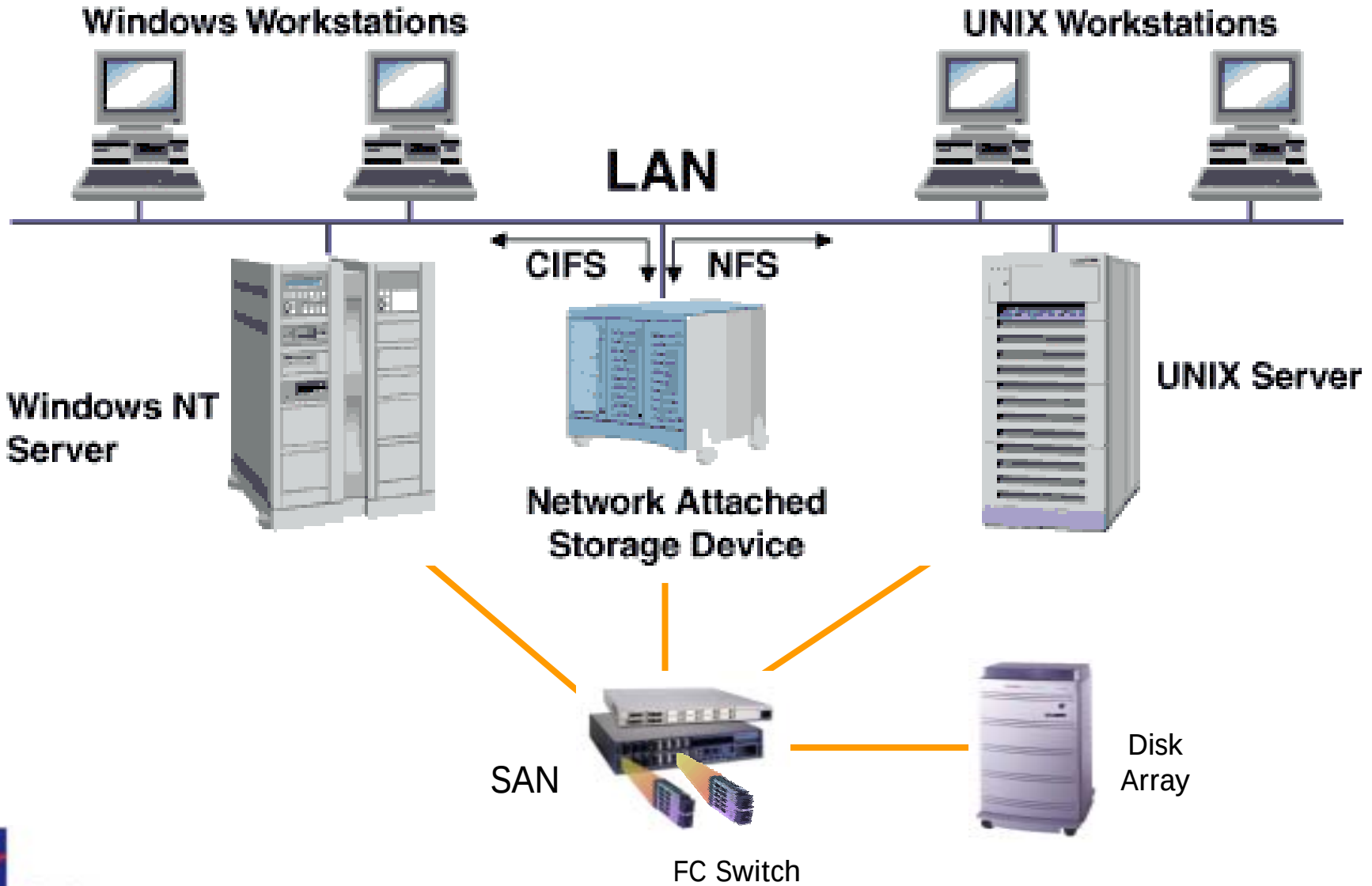
# Components of a Fibre Channel SAN



# Components of a NAS



# Components of a NAS with SAN Support

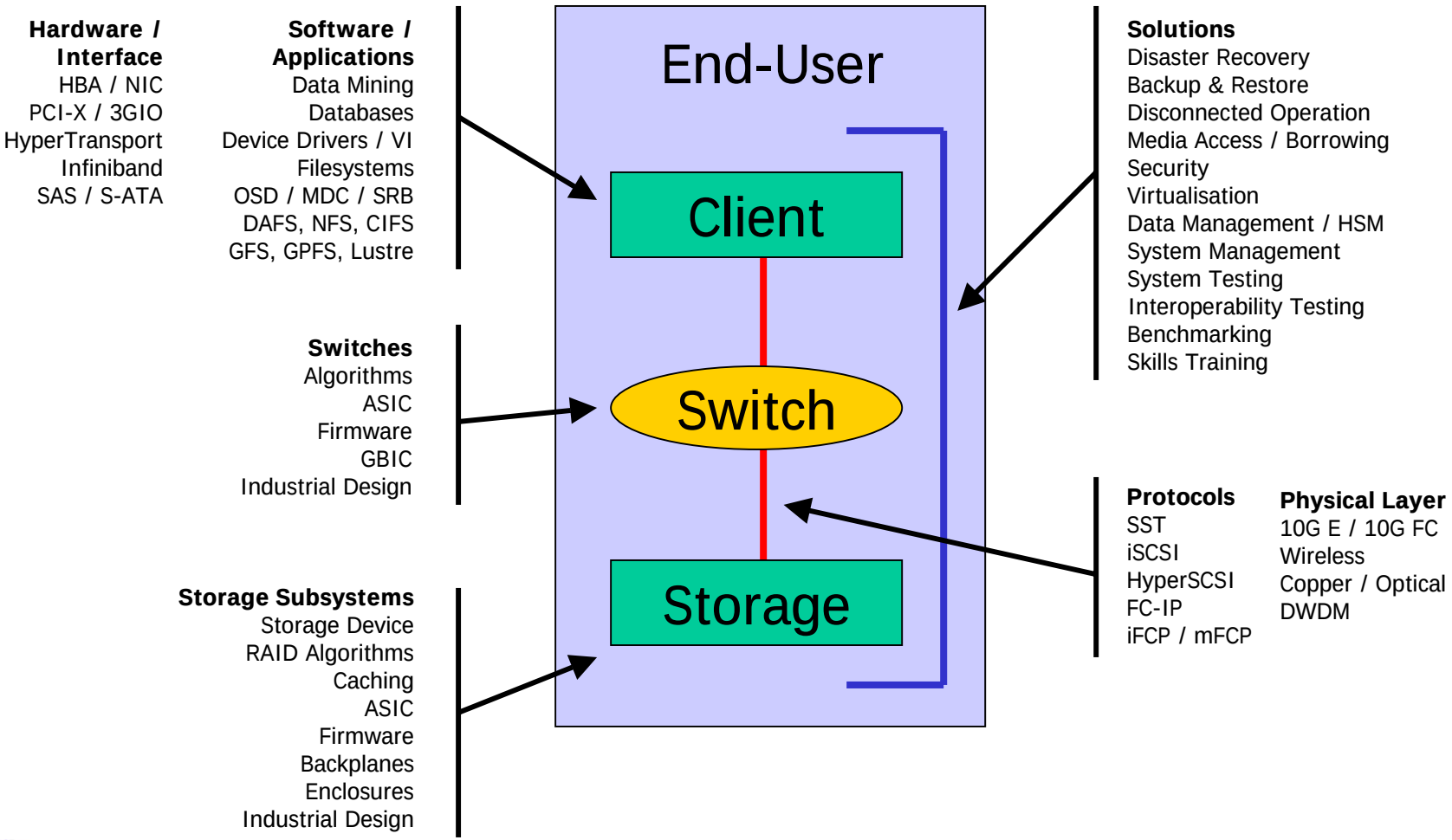


# RAID Technology

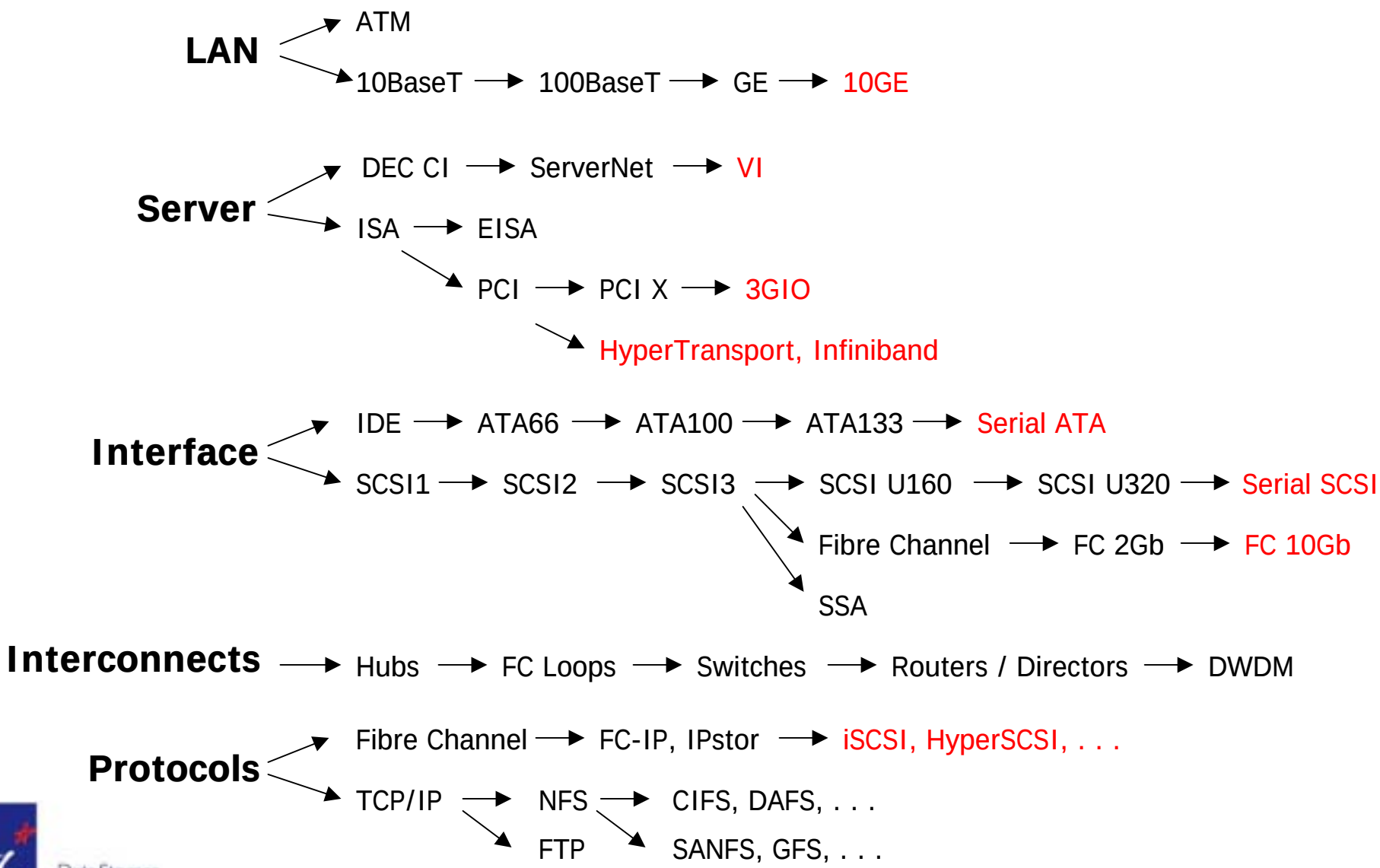
- Array of inexpensive disk drives, appears as a single logical drive for performance, capacity and reliability
  - RAID-0. Striping but no redundancy of data
  - RAID-1. Disk mirroring. Best performance & fault-tolerance in a multi-user system.
  - RAID-2. Striping across disks, with error checking and correcting (ECC)
  - RAID-3. Striping, one drive to store ECC
  - RAID-4. Large stripes, overlapped read I/O
  - RAID-5. Rotating parity array. Overlapped read/write I/O.

  - RAID-6. Second parity scheme RAID-5
  - RAID-7. Real-time embedded OS controller
  - RAID-10. Array of RAID-1 stripes
  - RAID-53. Array RAID-3  stripes

# Network Storage Ingredients



# Technology Progression

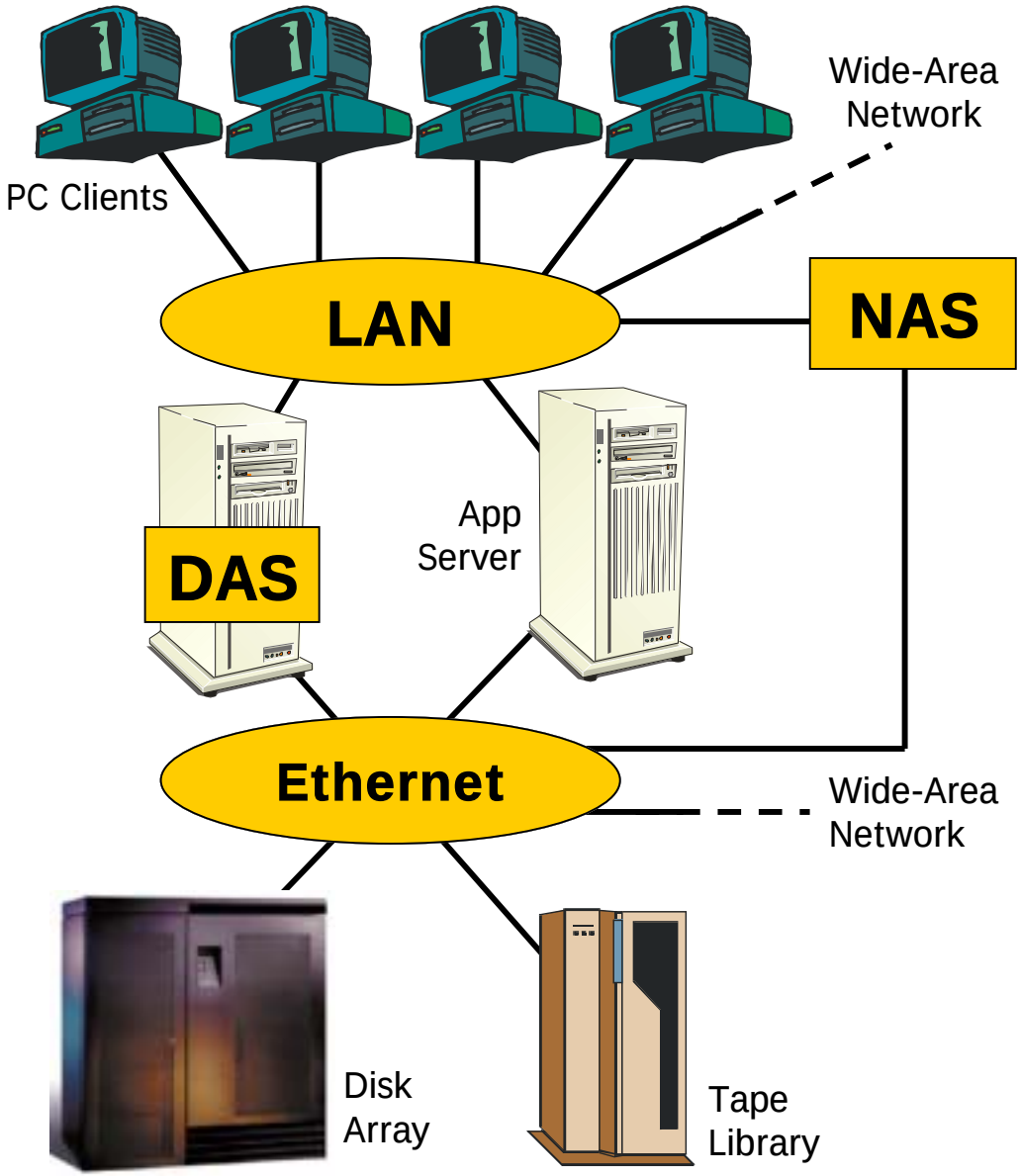


# Introduction to HyperSCSI

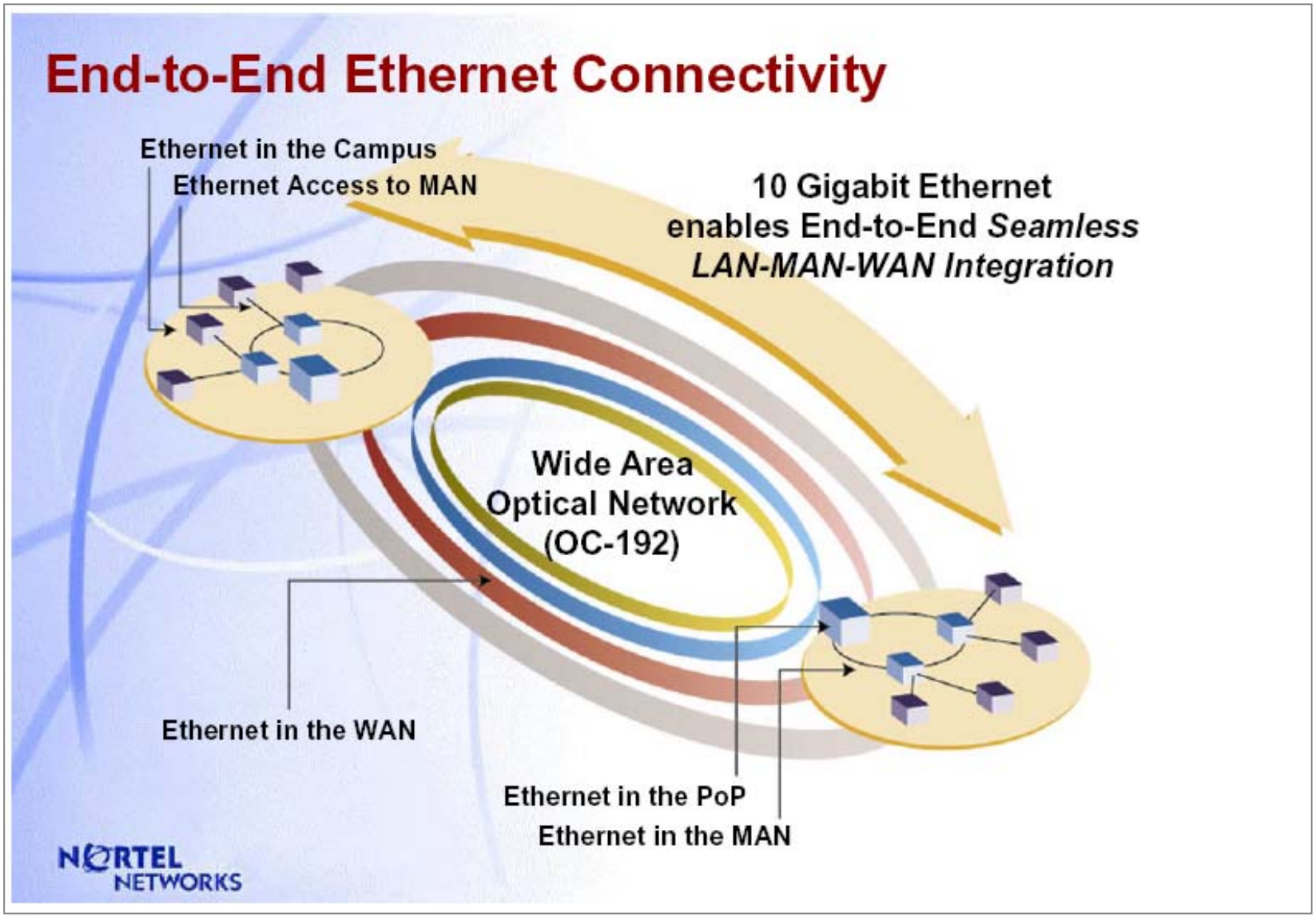
Introduction to the HyperSCSI Ethernet-based SAN Solution

# The Pain of SAN / NAS

- Normal corporate network LAN uses Ethernet, a "network" technology
- Main technology used to build SAN is Fibre Channel (FC), a "storage" technology
- FC is (currently) expensive and complex
- Can we use Ethernet instead?



# “Ethernet the World!”



# Network and Storage Differences

*You can't compare an Ethernet cable with a SCSI cable, SCSI cables transmit data in parallel!*

Overheard from a computer science professor

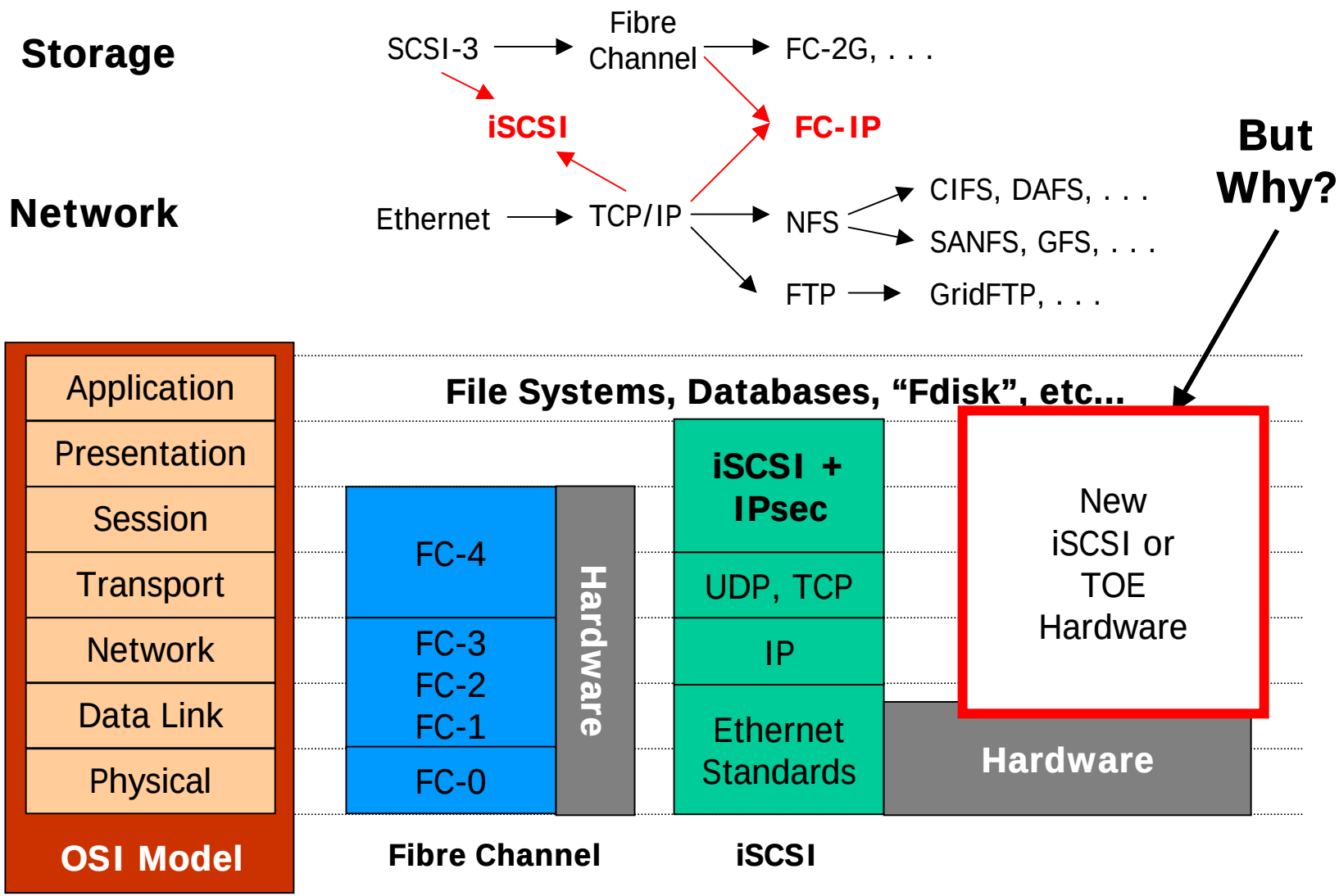
**Conclusion:**

Storage systems are very different from Network systems

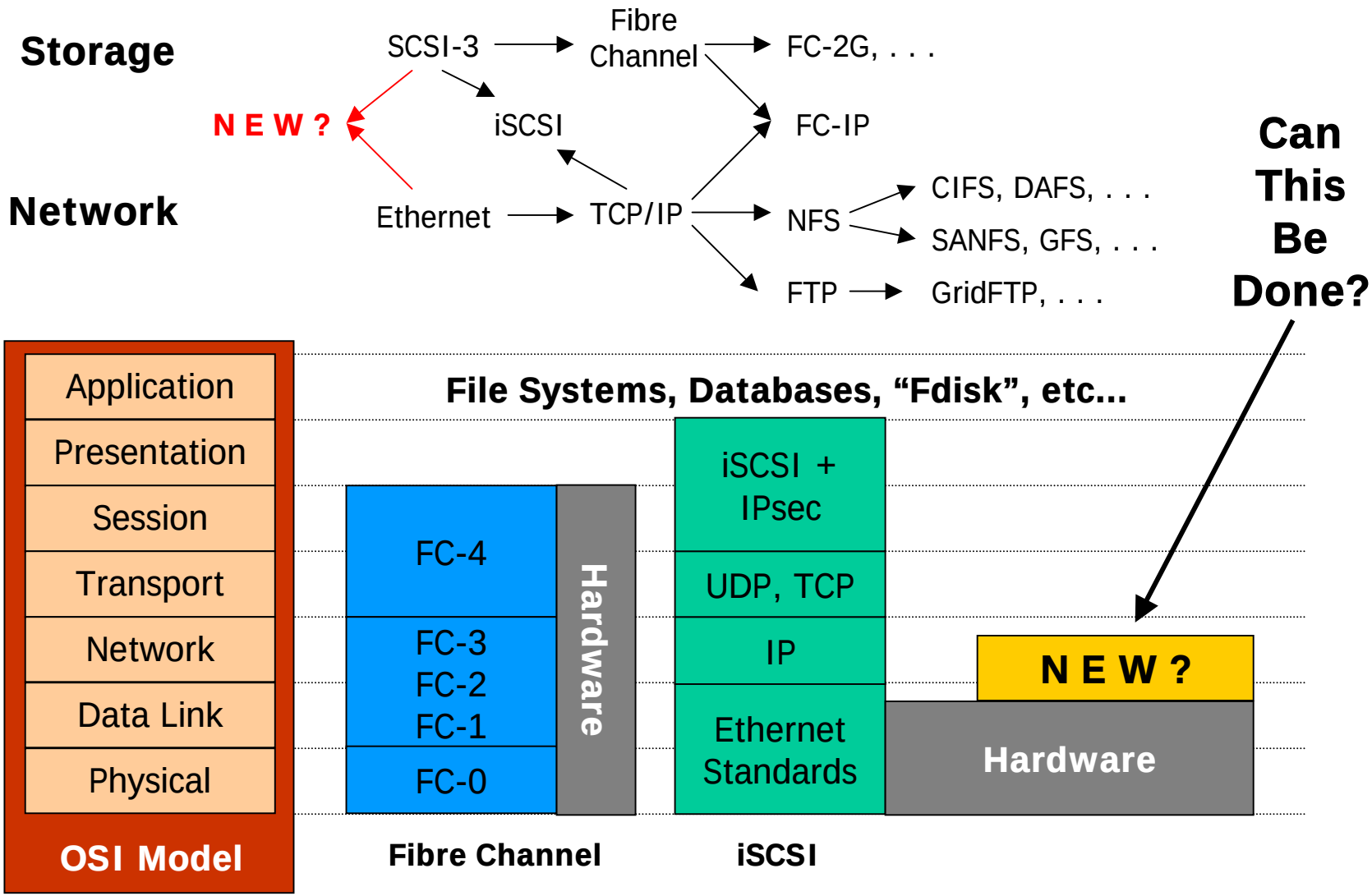
**Corollary:**

Network systems providing Storage must therefore be designed differently from *normal* Network systems

# Combine Two Worlds . . .



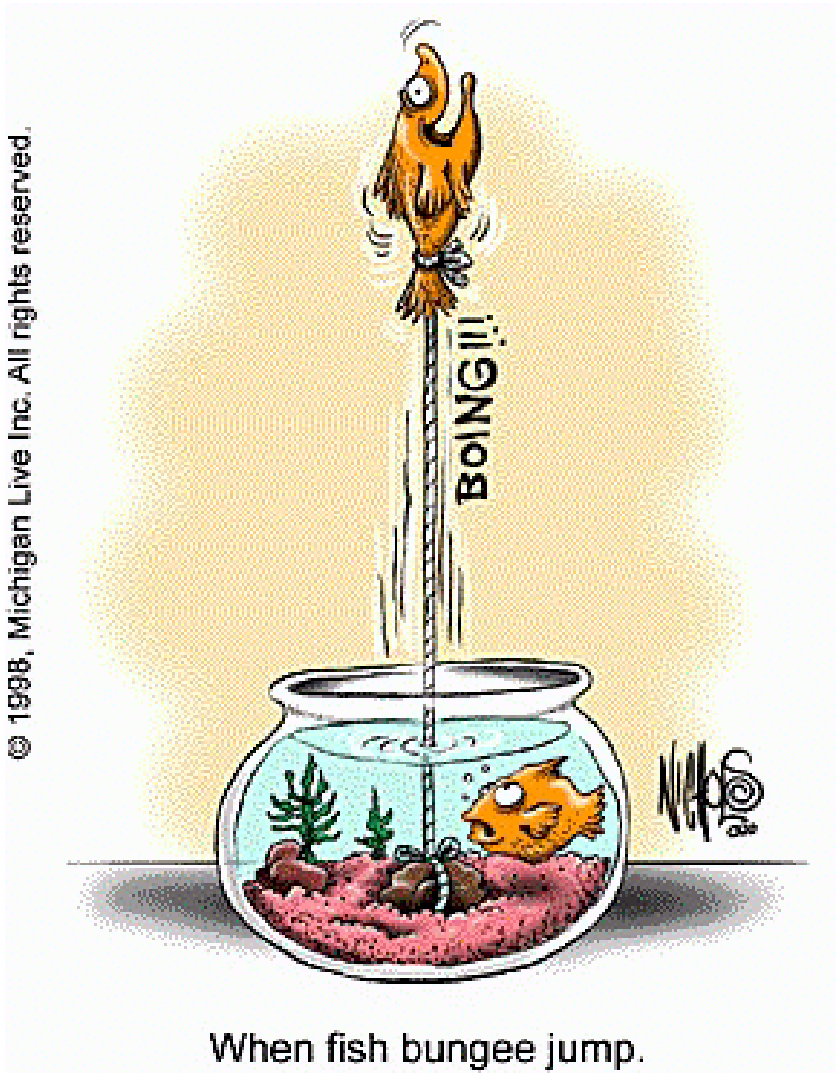
# . . . And Think Out of the Box



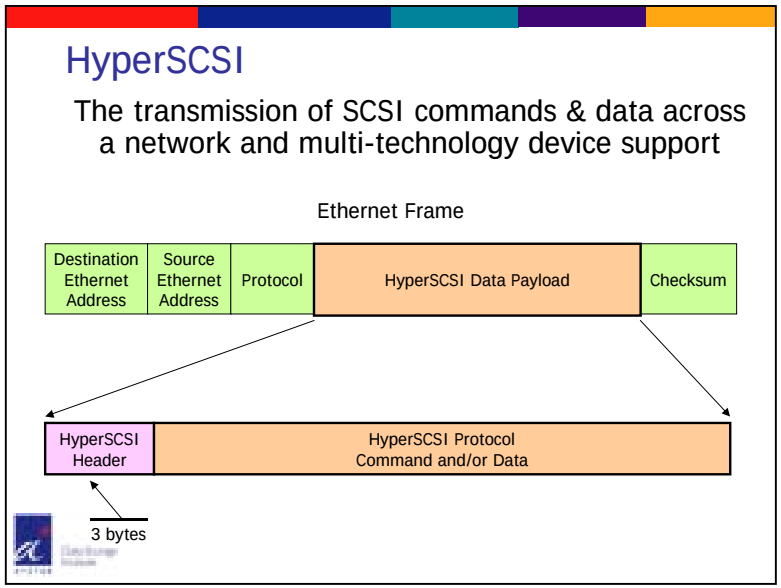
# Can This Be Done?

**Innovate!**

. . . and think of new ways to do old things.

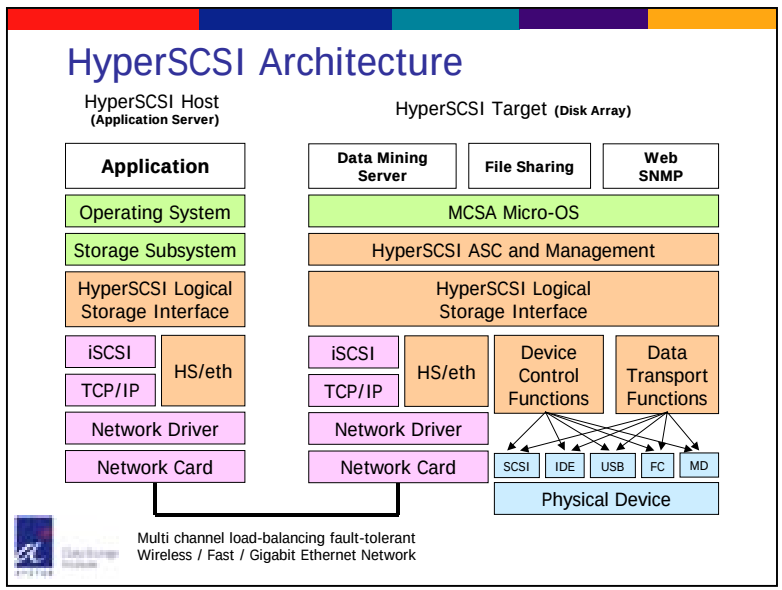


# Yes, It Can Be Done!




- **HyperSCSI** is a new open source Network Storage Protocol
- Transmit SCSI commands and data over a network
- High performance, secure, simple, low cost solution
- Runs directly on Ethernet (No TCP/IP!)

Access storage over a network

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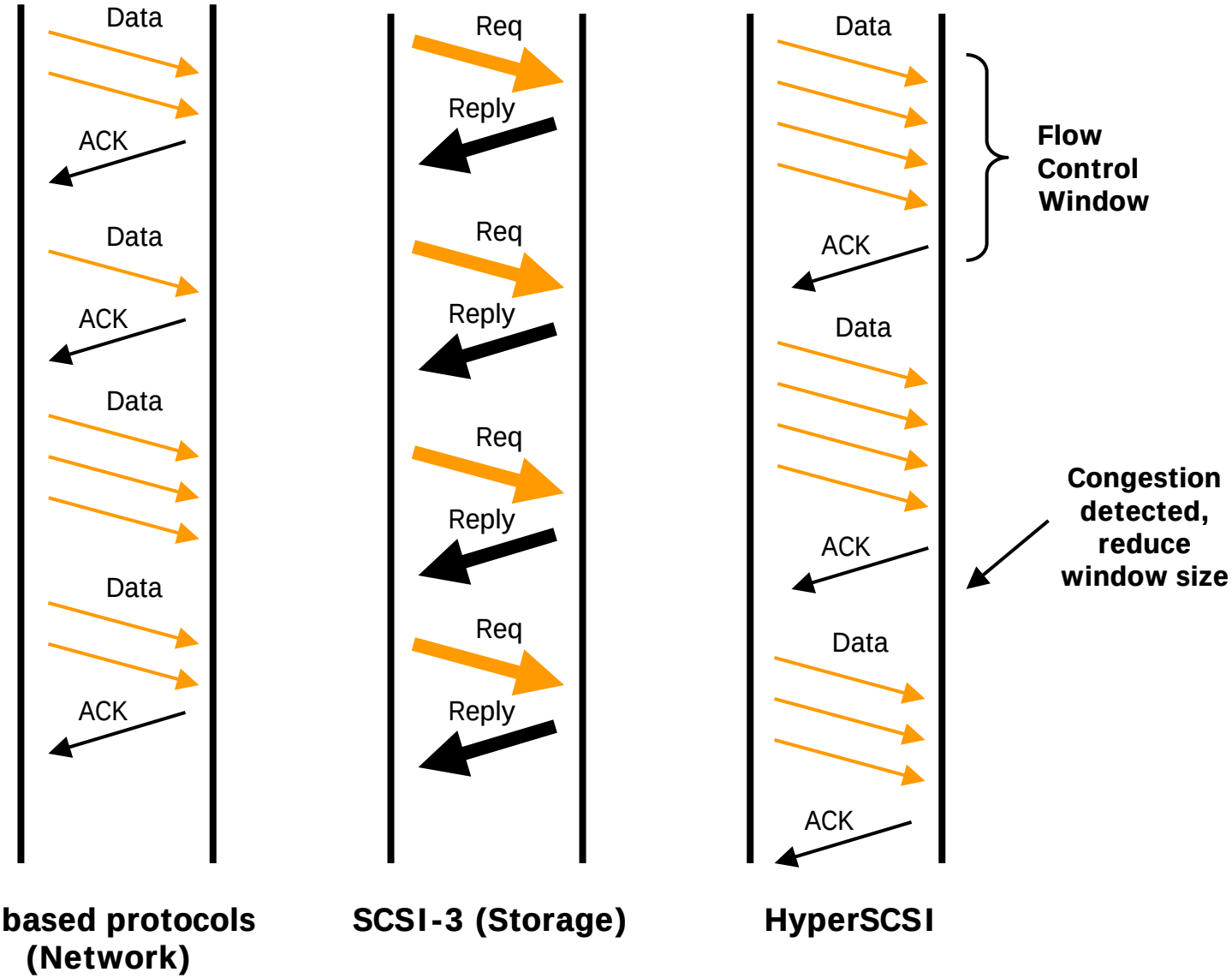
# “Stealing” Components

| | Network | Storage | HyperSCSI |
|---|---|---|---|
| Flow Control | Sliding window | “Buffer Credit”-based * | Dynamically sized fixed window |
| Transmission | Stream-based | Block-based | Block-based |
| Data Delivery | Guaranteed | Guaranteed | Guaranteed |
| Channels | Single-channel (vendor specific trunking) | Parallel transmission | Vendor independent multi-channel |
| Addressing | “Unlimited” | Limited | Almost “Unlimited” ** |
| Device Discovery | Lookup-based | Broadcast-based (Bus Scan) | Broadcast-based (Local-area) |
| Authentication | Multi-user challenge & response | Physical security or Zone/LUN Masking | Single-user challenge & response |
| Tx Security | (Add-on) Encryption | Physical security | (Built-in) Encryption |
| Scalability | “Unlimited” | Limited | Almost “Unlimited” ** |
| Access | Wide-area | Local-area | Local-area |



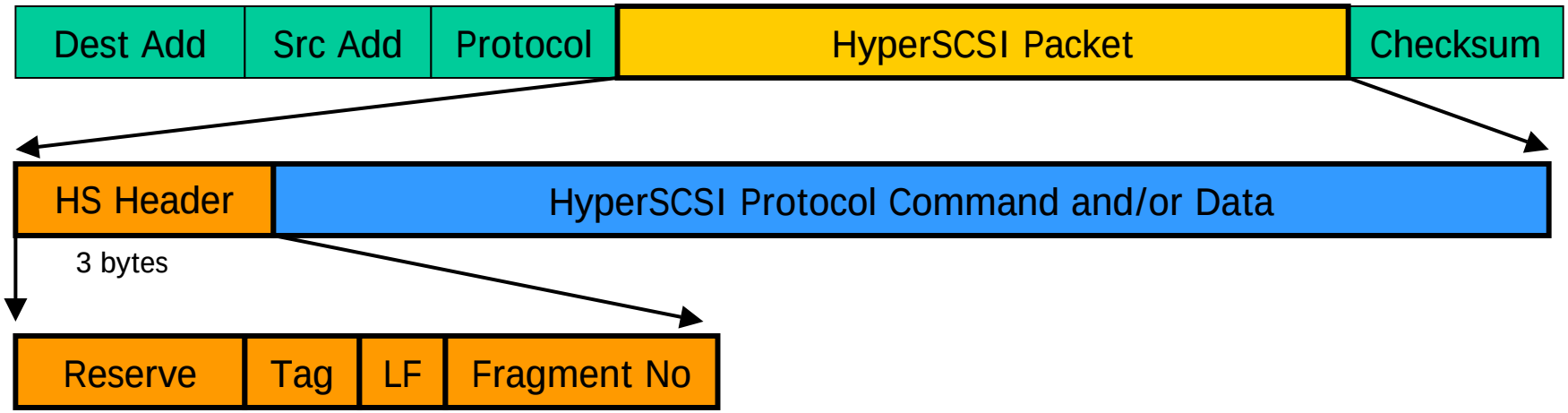
This is not meant to be a complete or accurate depiction of the components or mappings, but merely as an illustration of the differences between systems and components

# Flow Control



# The HyperSCSI Protocol

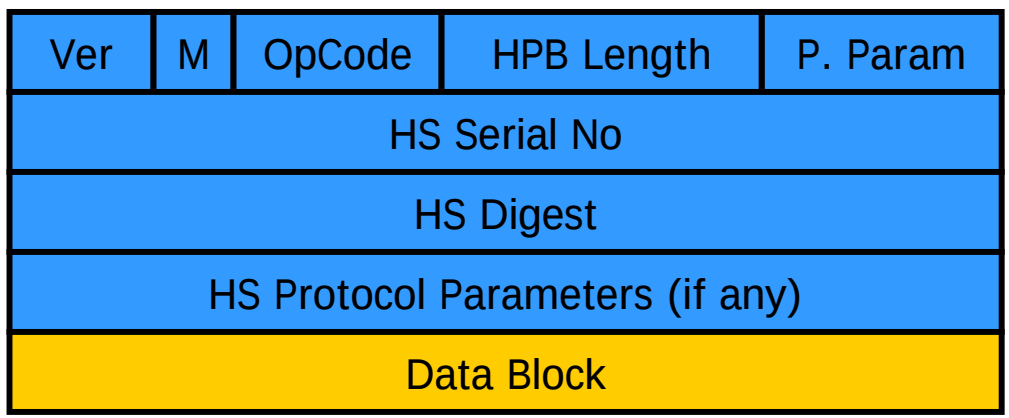
**HyperSCSI Packet Framing / Encapsulation on Ethernet**




No TCP/IP!

Routeable?
Secure?
Reliable?

**HyperSCSI Command and Data Block**

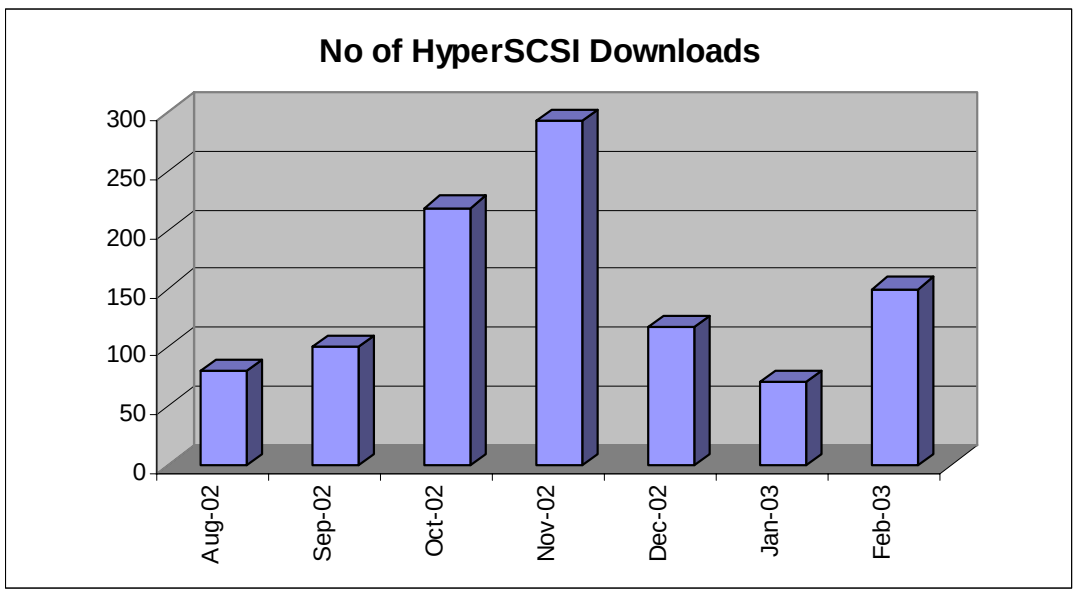


# HyperSCSI – Key Features

- Basic HyperSCSI Client and Server – Open Source since 28 August 2002
- Runs on raw Ethernet – does not need or use TCP/IP
- High performance – more than 60% faster than similar existing TCP/IP and UDP/IP based network storage protocols (101MByte/s sustained throughput on Gigabit Ethernet Jumbo Frames with only one 1.2GHz CPU)
- Independent of hardware or vendor products including support for:
  - Various storage types – disk, optical, tape, removable
  - Various storage interfaces – SCSI, Fibre Channel, IDE/ATA, USB
  - Various network interfaces – Wireless LAN 802.11b, Fast Ethernet, Gigabit Ethernet, GE+Jumbo Frames, Ethernet LANE over ATM
  - Various platforms – Linux, Windows 2000/XP, Embedded Linux, Xscale, x86 Family or Processors
  - Various protocol compatibilities – HyperSCSI is recognised by IEEE and IANA, therefore it can be deployed in a multi-protocol network environment safely
- Includes built-in 128-bit Encryption, active device discovery for plug and play ad-hoc network storage, extensible device options for customisation, etc
- Designed for easy deployment, and above all, to provide users with the freedom of choice, to implement network storage the way they want to, with the options they need

# HyperSCSI Downloads


- More than 1000 downloads in six months since 28 August 2002, average of 5.6 downloads a day
- 1000th download of HyperSCSI was for version 2003-02-18 on 23 February from Sweden



# What Others Have to Say

"This work is quite impressive. **I would categorise this as a disruptive technology**."

Hubert M. Yoshida, VP and CTO, Hitachi Data Systems, SAB DSI 2002/03

"I was deeply impressed by the high standard level of R&D activities at DSI, which **I believe will innovate a breakthrough technology** as the demand for storage capacity increases in the coming broadband era."

Kunitake Ando, President and COO, Sony Corporation, Review 2001

". . . 3 years ago, I discussed the possibility for a protocol like HyperSCSI that put storage directly on Ethernet - as opposed to over IP. I still believe this is the best way to go. So, **I am extremely excited to find out about this important work**."

Marc Farley, Author of "Building Storage Networks", 2002

"That is a very good news that you managed to get HyperSCSI running over Wireless LAN. Sustaining ~100MB/s throughput is very impressive. **I am very impressed by your work.** We are rebuilding our cluster nodes to use 2.4.16 kernel and will install the HyperSCSI software soon. I cannot wait to see HyperSCSI working in our test bed."

Dr Rei Lee, Research Scientist, Lawrence Berkeley National Labs, 2002

# What Others Have to Say

"That is a very good news that you managed to get HyperSCSI running over Wireless LAN. Sustaining ~100MB/s throughput is very impressive. **I am very impressed by your work.** We are rebuilding our cluster nodes to use 2.4.16 kernel and will install the HyperSCSI software soon. I cannot wait to see HyperSCSI working in our test bed."

Dr Rei Lee, Research Scientist, Lawrence Berkeley National Labs, 2002

"Wow, update on this one. To simulate a failure I was just pulling the network cable from the HS server. I now understand that this is just one type of failure, and there is another type, where the disk itself fails but the HS Server is still able to communicate with the HS client. **In this type of failure HyperSCSI works absolutely great!** I faked a disk failure on the server, and the client barely blinked, just continued on in degraded mode."

Jesse Keating, Engineer, PogoLinux, 2003

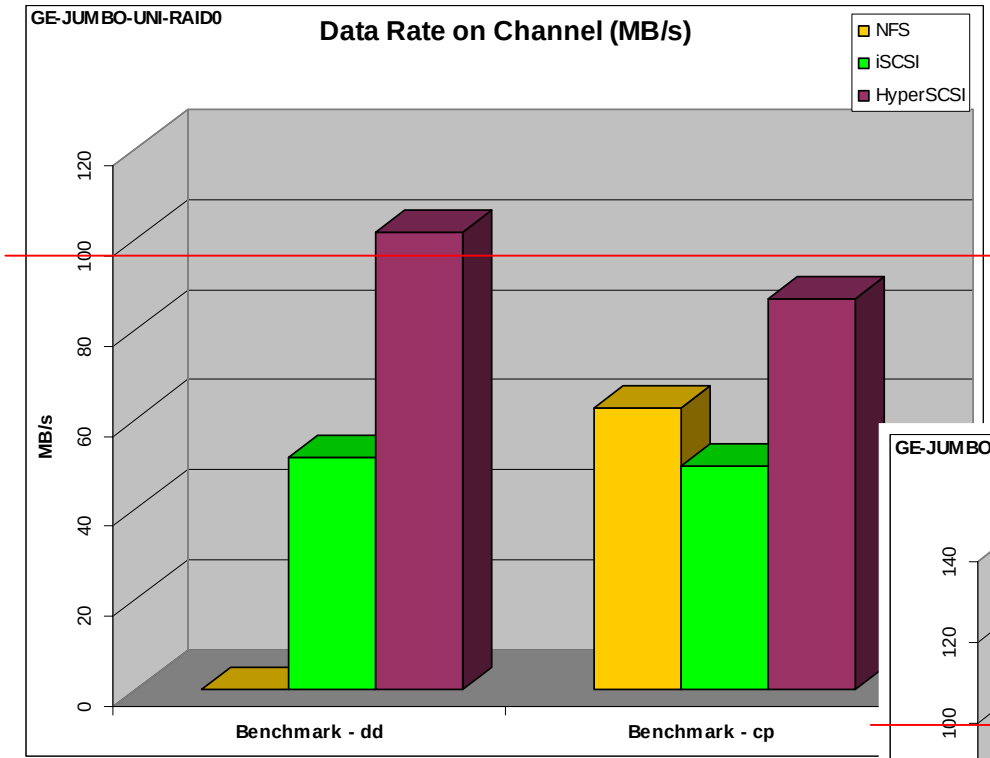
"I had been researching a solution for about a month before I stumbled across HyperSCSI. I started out looking at FiberChannel but the protocol is cryptic, the Linux support is poor, and I object to the cost being 6-20x that of Gig-Ethernet when its basically the same technology. I looked at iSCSI but again the protocols are over engineered, the Linux support is poor, the cost of equipment is robbery, and there are a lot of research papers that suggest block protocols over TCP/IP are a poor choice. The Linux network block driver is a hack and not a very good one. I looked into doing sharing with a SCSI bus, but the lack of target mode support in Linux killed that idea quickly. So I started researching how to do raw Ethernet access in Linux with the intent of writing a Ethernet based protocol to allow machines concurrent access to raw disk. **And then I found HyperSCSI. Its simple. Its elegant. You can implement it using commodity hardware. It works today. End of search.**"

Christopher Shaulis, Internet User, Dallas Texas, 2002

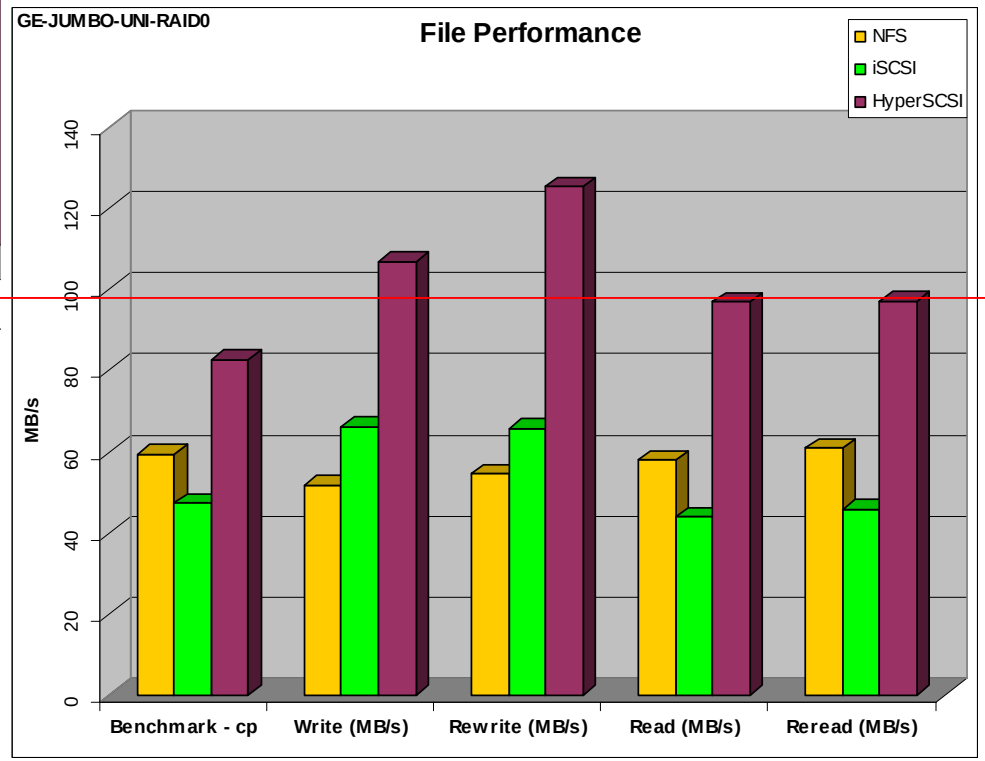
# Recent HyperSCSI Milestones

- October 15: Multi-channel implementation of HyperSCSI achieves near linear increase in performance when using up to 4 FE channels
- December 7: Ethereal Protocol Analyser software includes a HyperSCSI dissector in its latest version (0.9.8)
- December 26: Windows 2000 HyperSCSI client achieves 10MB/s over Fast Ethernet
- January 12: World's first "Live" production implementation of a HyperSCSI Gigabit Ethernet SAN is activated in DSI
- February 18: Release of HyperSCSI version 20030218 with key support for LVM, SMP and various bug fixes
- May 5: Release of HyperSCSI version 20030506 with various bug fixes. Also includes the first ever HyperSCSI Client for the Windows 2000 Professional platform for evaluation purposes
- June 10: HyperSCSI is now a registered trademark of the Data Storage Institute of Singapore

# High Performance – Physical Disk




100MB/s sustained data transfer speeds for both block and file, more than 60% faster than NFS and iSCSI protocols in comparative benchmark tests




Tests conducted on a clean Gigabit Ethernet network with Jumbo frames, single initiator and target, 8 hard disks configured in RAID0 and using only common off-the-shelf hardware and software without special tweaks or optimisations.

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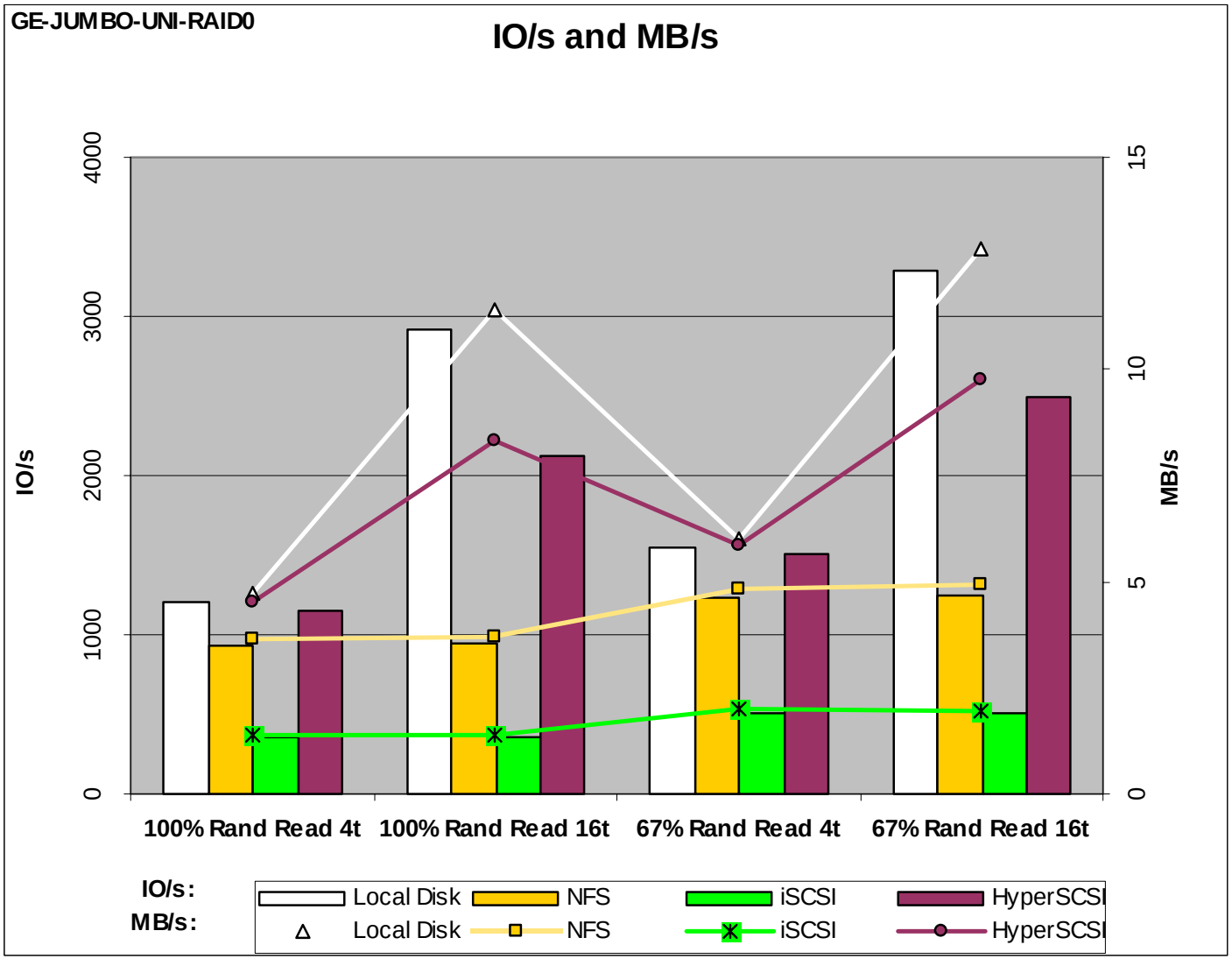
# High Performance – Physical Disk

Tests conducted on a clean Gigabit Ethernet network with Jumbo frames, single initiator and target, 8 hard disks configured in RAID0 and using only common off-the-shelf hardware and software without special tweaks or optimisations.

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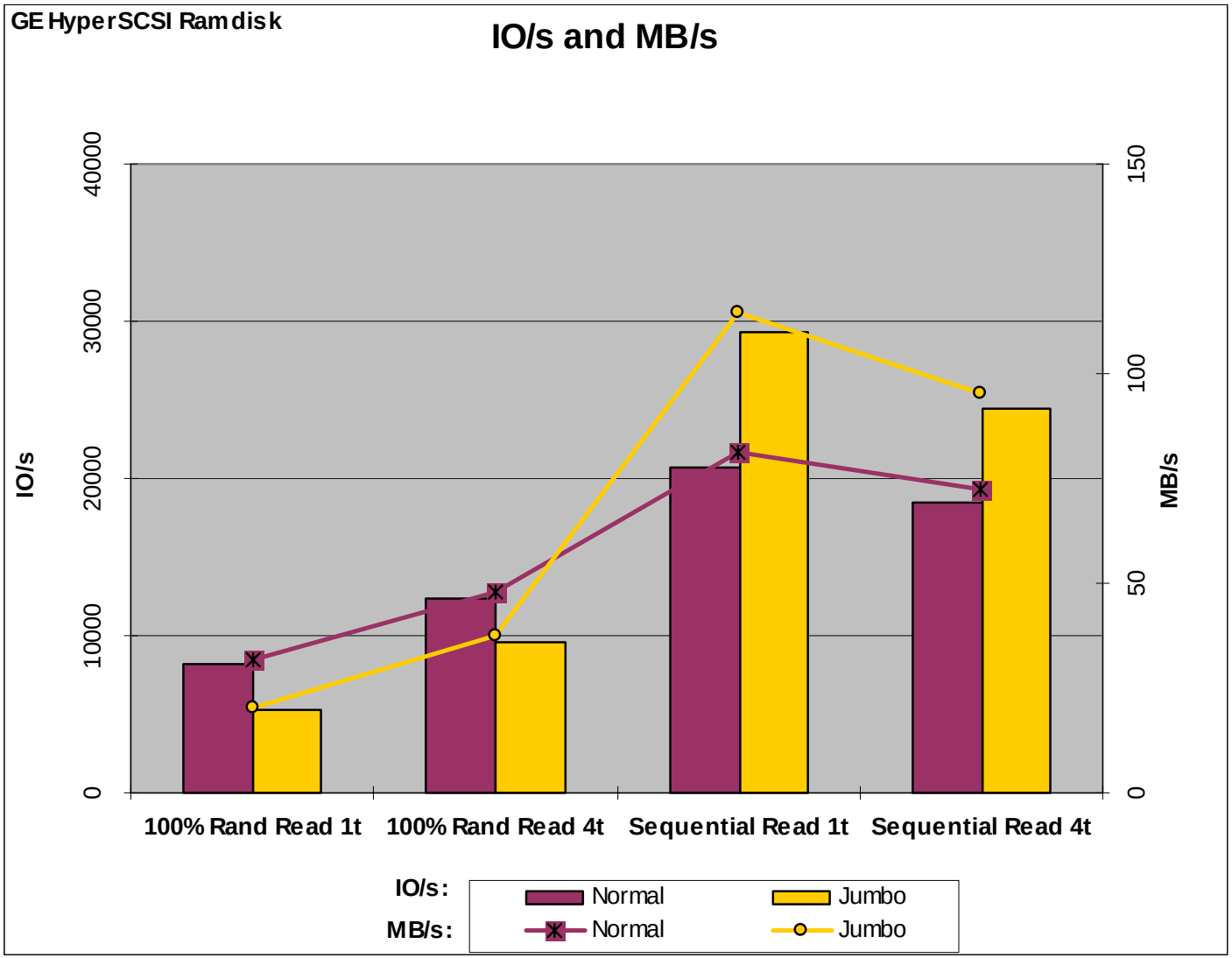
# High Performance – RAM Disk




Conducted on a 512MB PC133 Ramdisk

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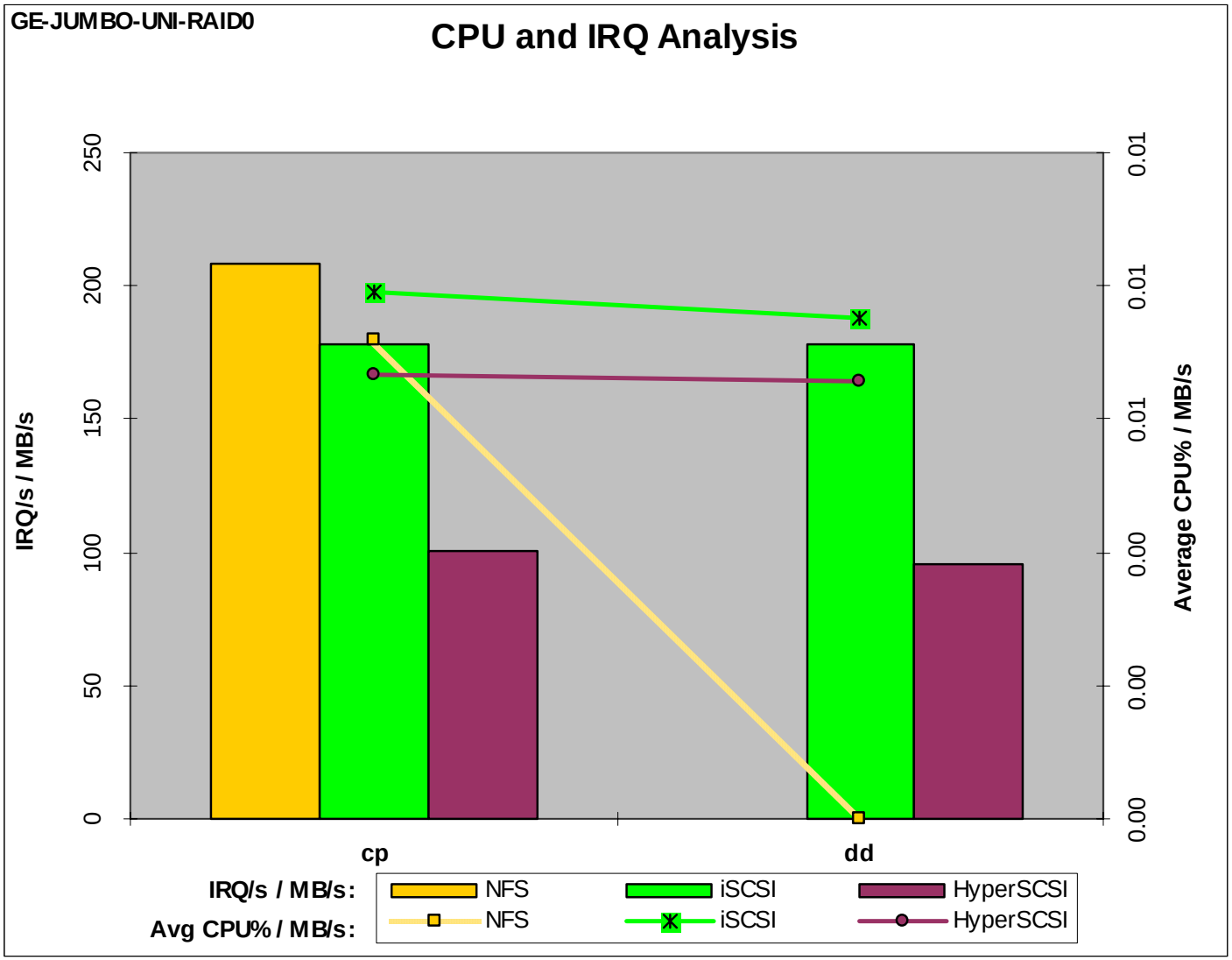
# Low CPU Utilisation – Physical Disk

Tests conducted on a clean Gigabit Ethernet network with Jumbo frames, single initiator and target, 8 hard disks configured in RAID0 and using only common off-the-shelf hardware and software without special tweaks or optimisations.

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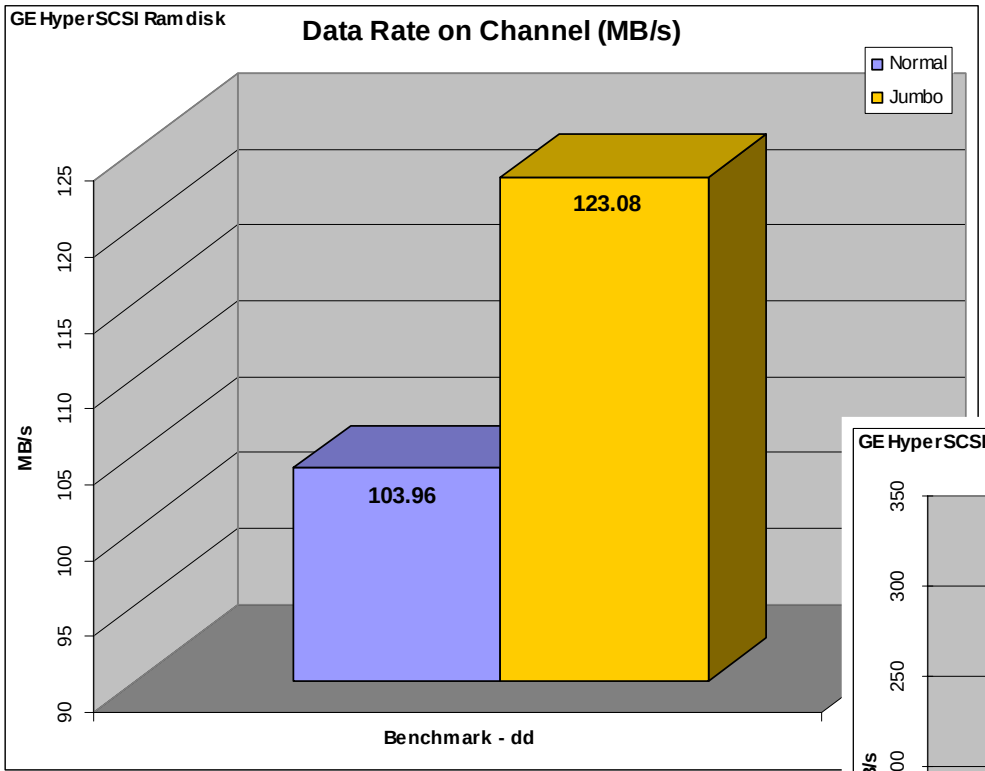
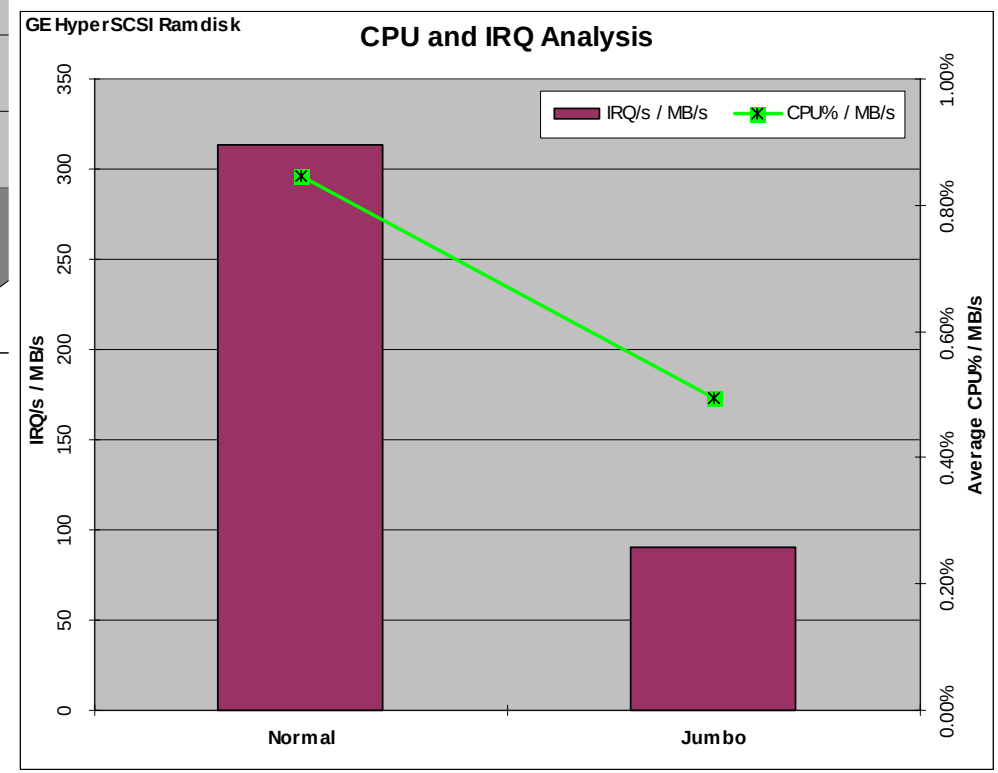
# Low CPU Utilisation – RAM Disk




Conducted on a 512MB PC133 Ramdisk

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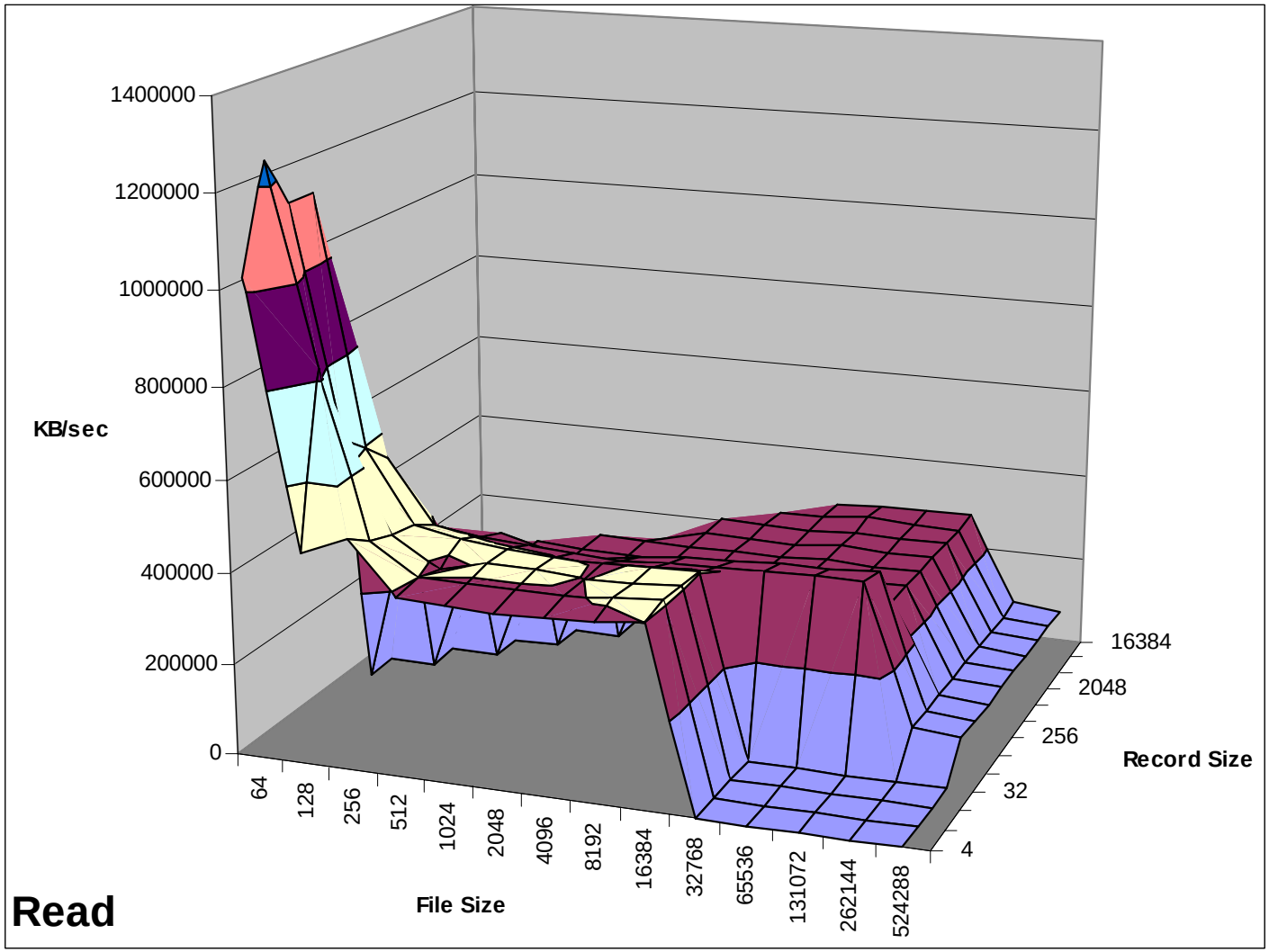
# Predictable and Stable Performance

Tests conducted on a clean Gigabit Ethernet network with Jumbo frames, single initiator and target, 8 hard disks configured in RAID0 and using only common off-the-shelf hardware and software without special tweaks or optimisations.

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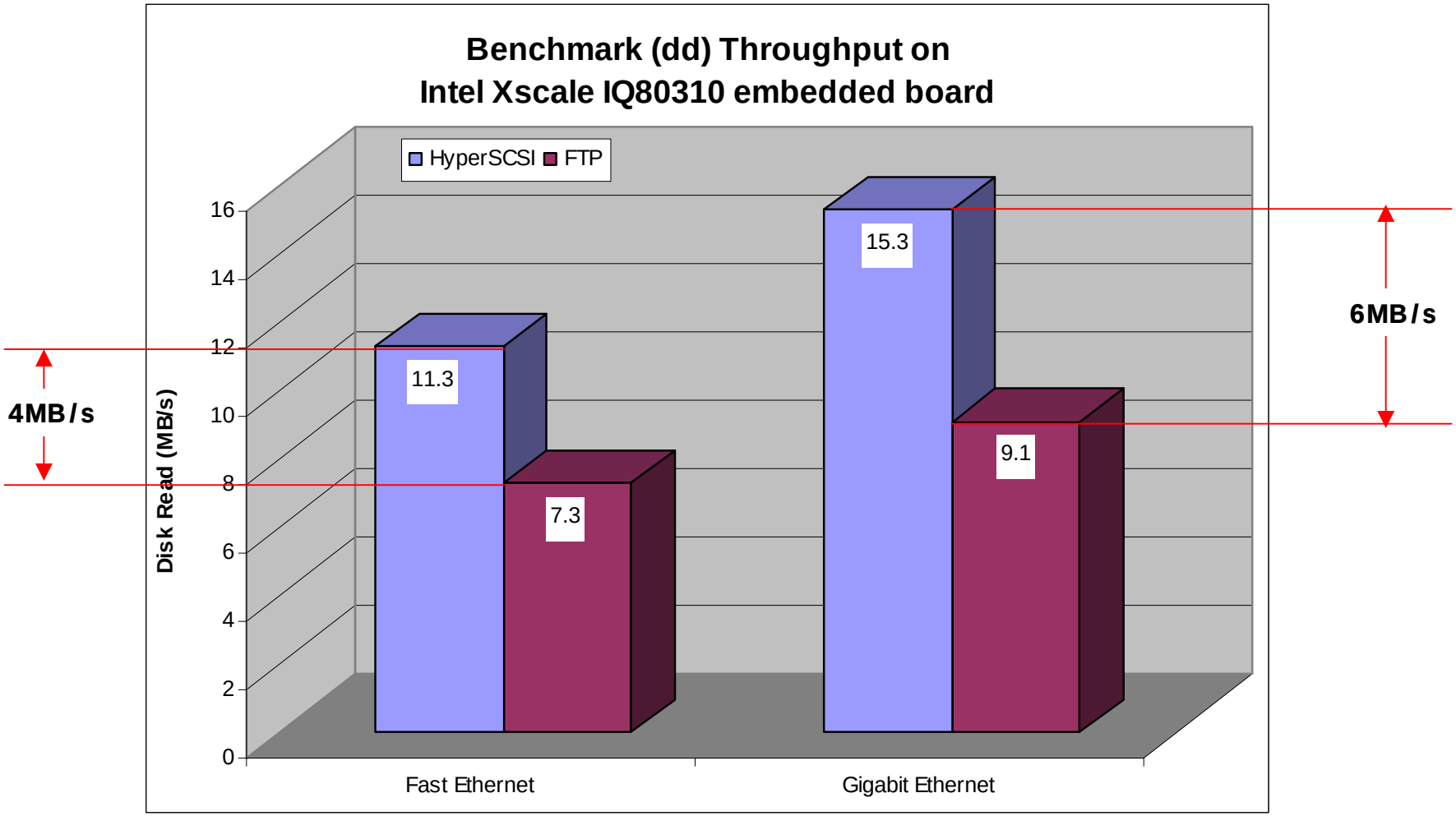
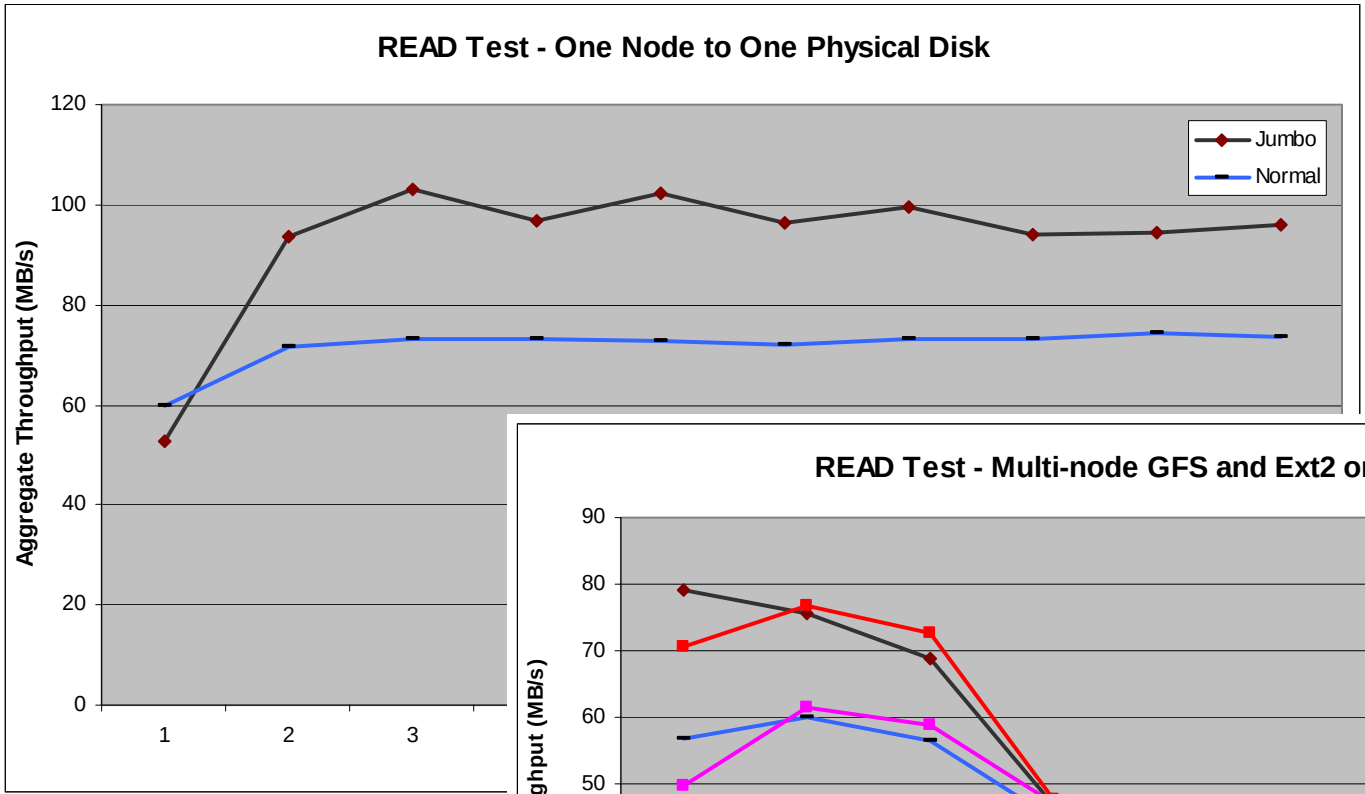
# Lower Embedded Overheads

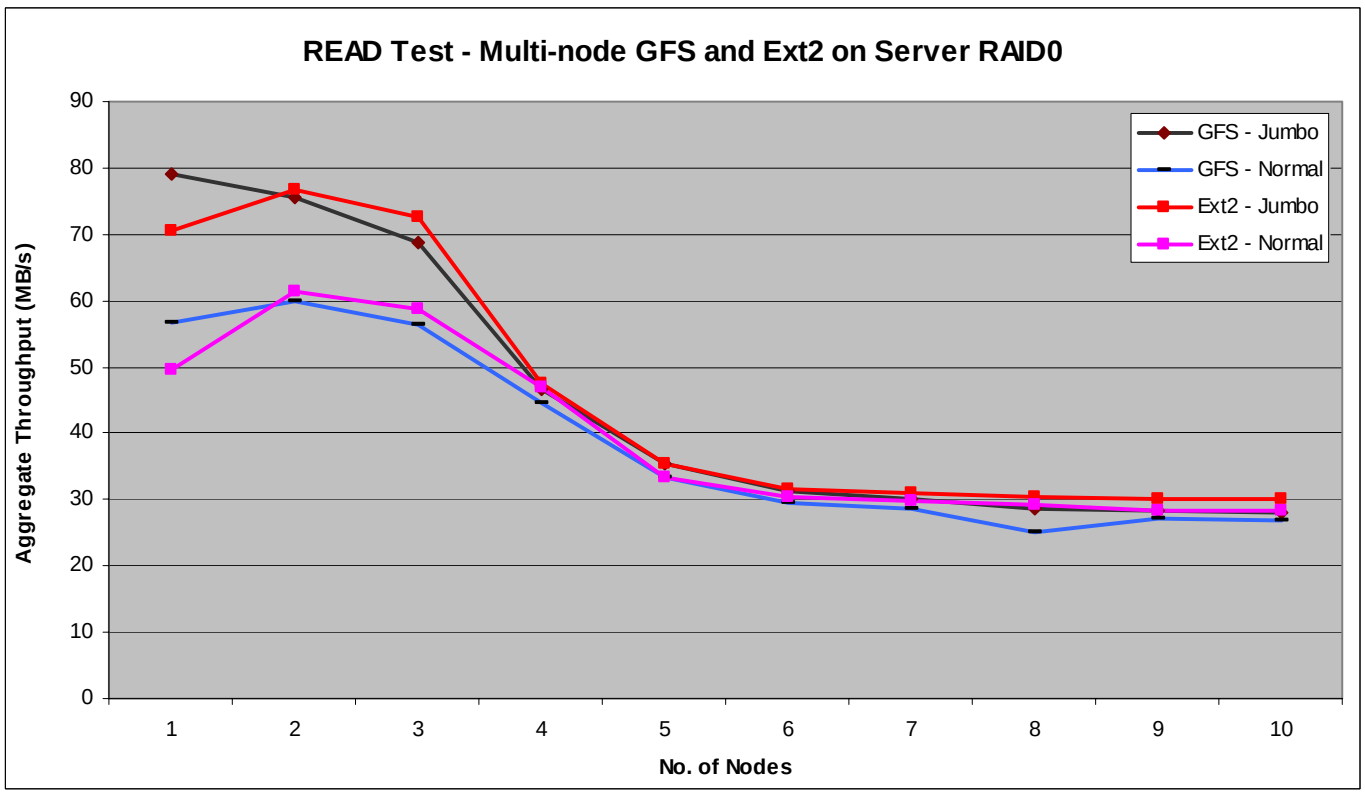



Single drive on Embedded Board running Embedded Linux
Slow GE Performance is noted due to poor memory speed on IQ80310 EVB (well documented HW bug)

# File Systems and Multiple Clients




Each node read different file on same RAID0 volume on one server, Sistina GFS and Ext2 File Systems used




Each node read different file on different physical disk with Ext2 simultaneously, one node to one physical disk on one server

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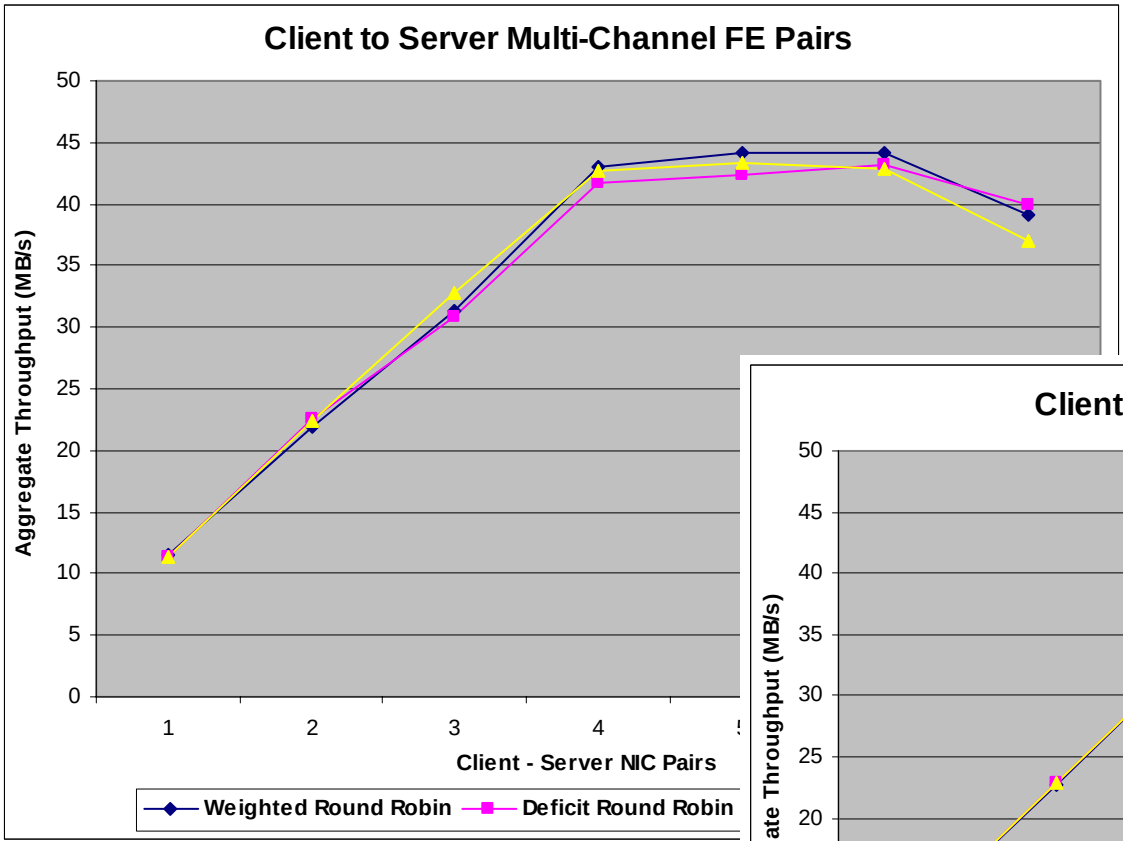
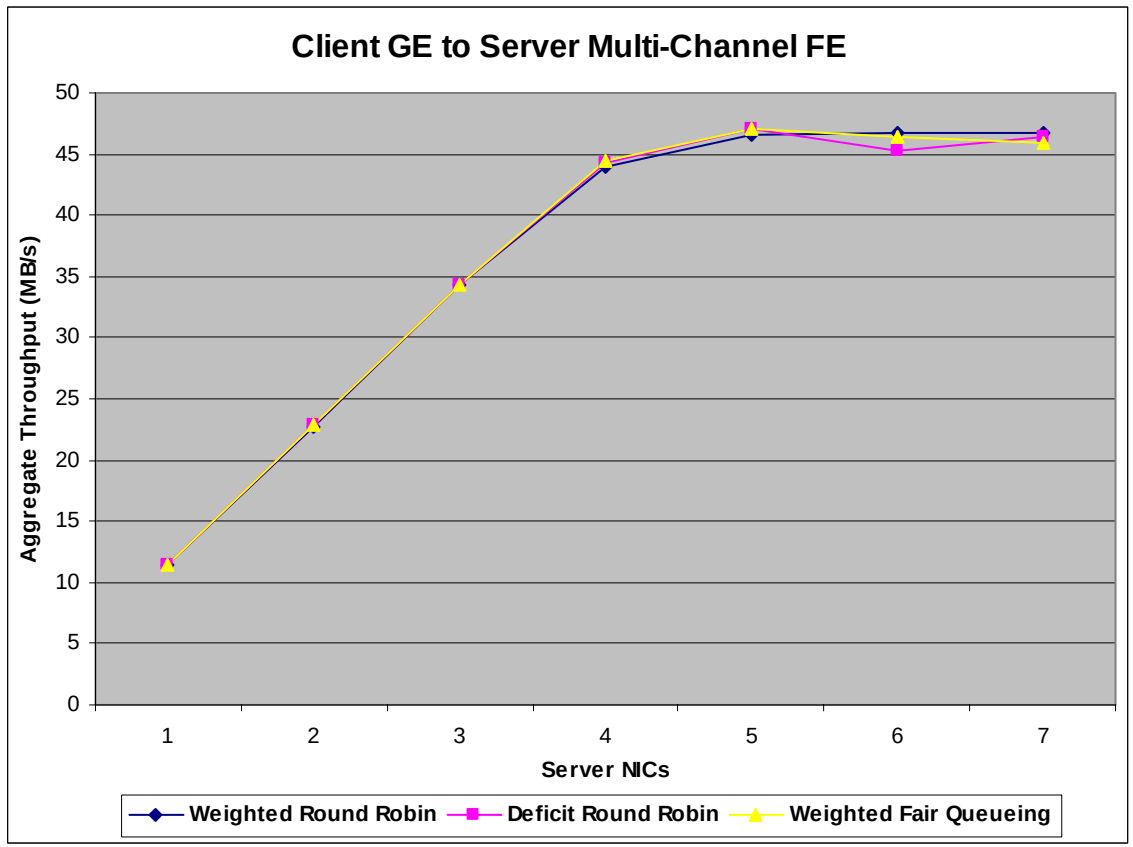
# Multi-Channel Technology

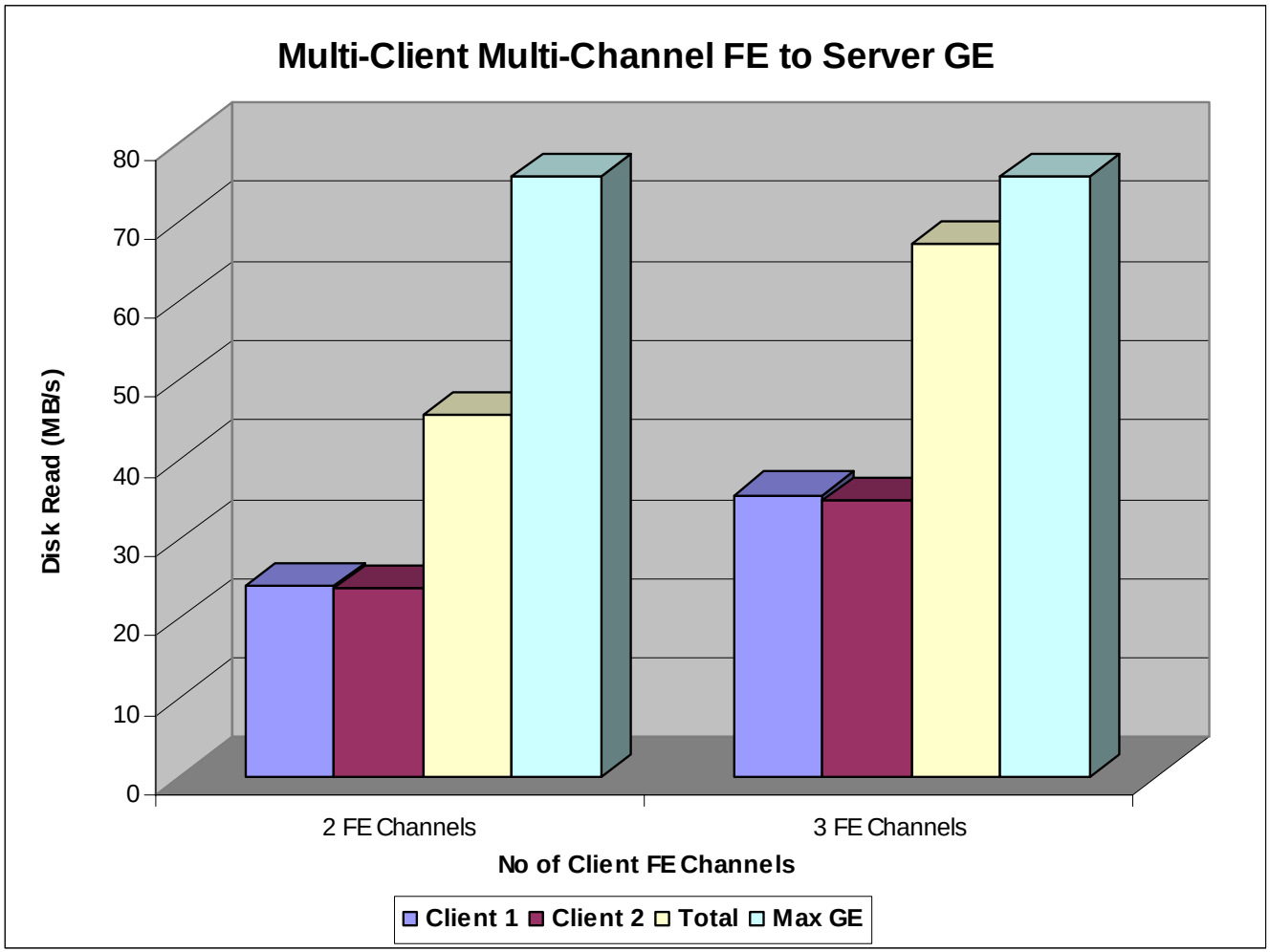



RAID0 on Client, Two HDDs on Server, One FE channel added on both client and server in pairs

RAID0 on Client, Two HDDs on Server, One GE channel on client, add one FE channel on server in succession



# Multi-Channel Multi-Client




RAID0 on Client, Two HDDs on Server, One GE channel on server, add one FE channel on each client in pairs
* Weighted Fair Queuing algorithm used
* Max GE Performance is measured from one GE channel between client and server

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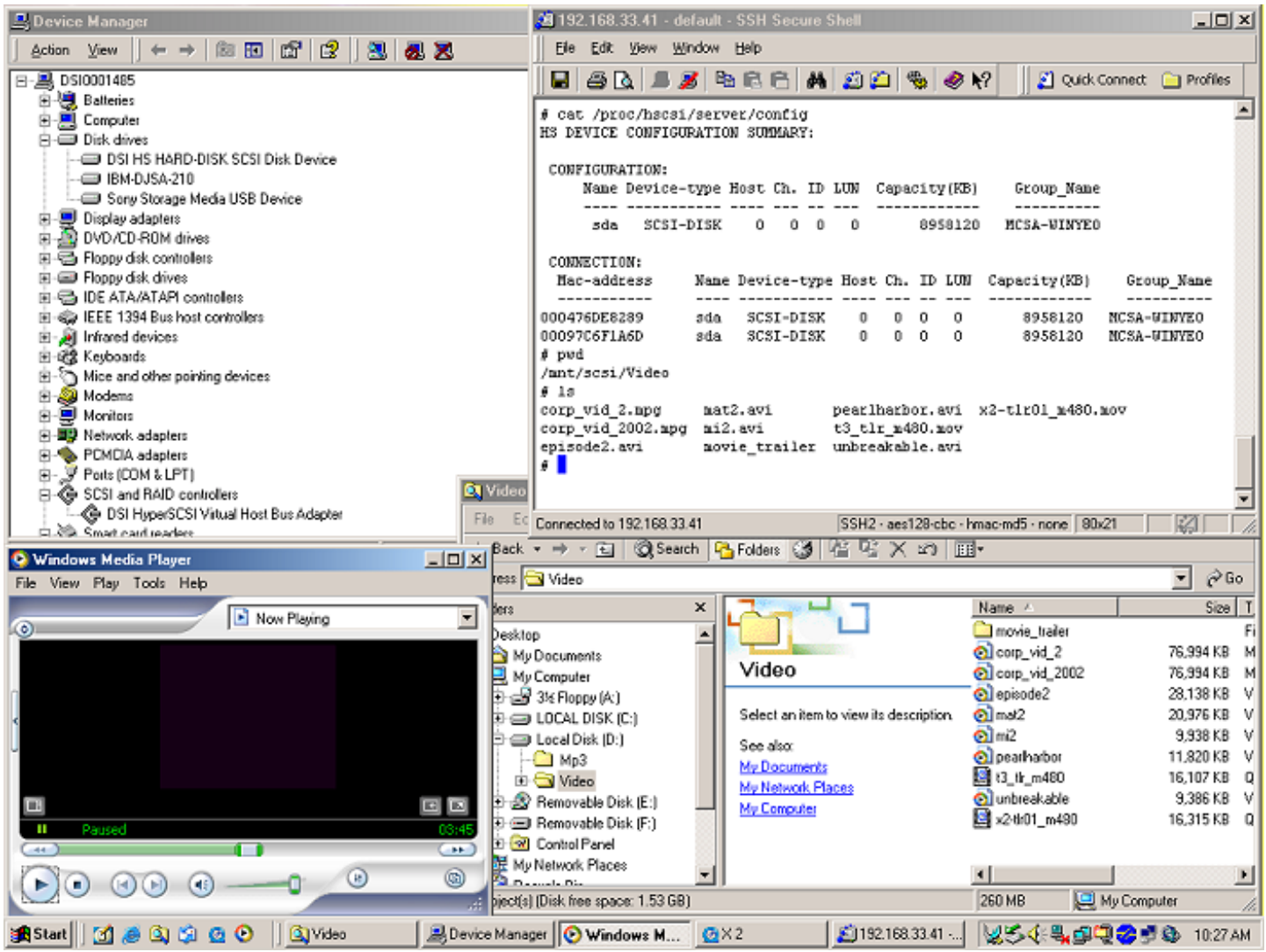
# Porting to Windows 2000 / XP



# Is This for Real? **Yes** for Consumers!



- Wireless Network Storage
- Personal and Home Networks
- Consumer Electronics
- Entertainment and Content Distribution

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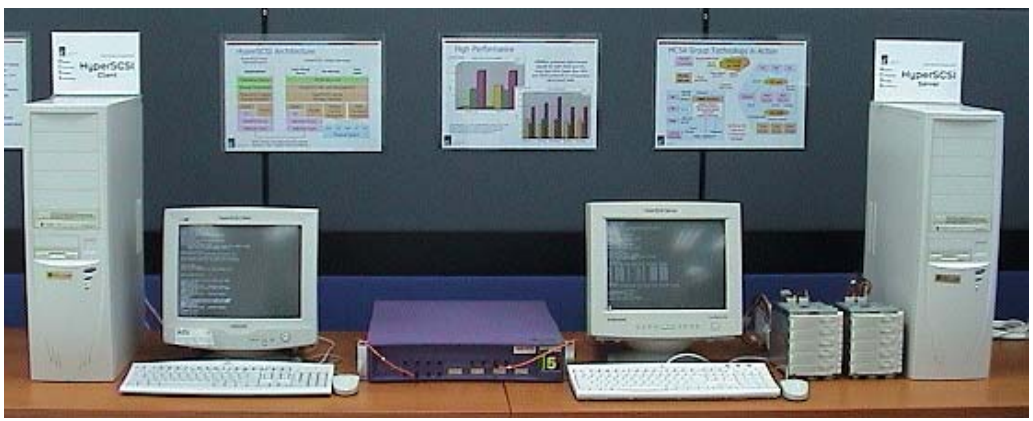
# Is This for Real? **Yes** for Corporates!

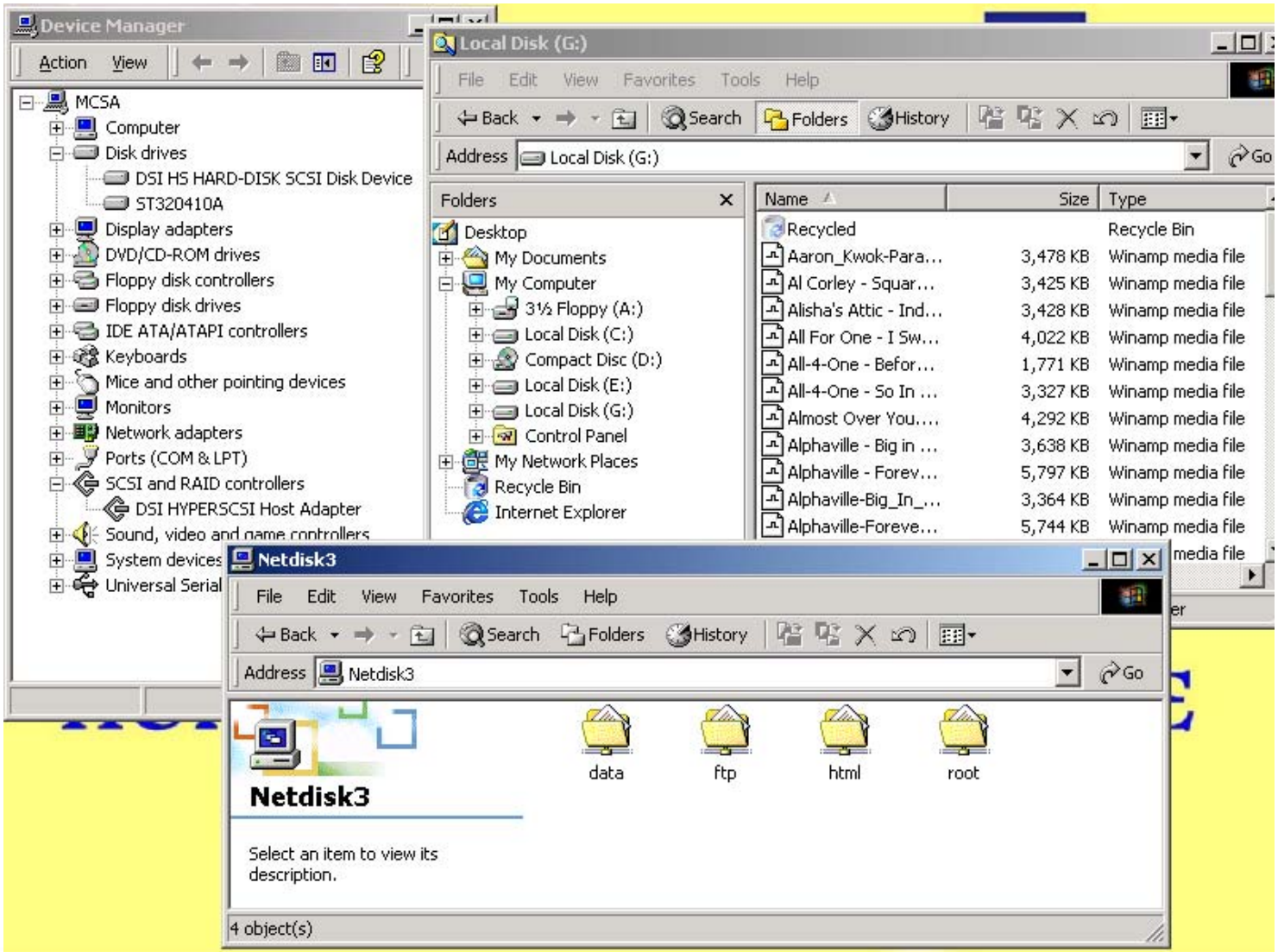
- Storage Area Networks (SAN) and Network Attached Storage (NAS)
- Information Continuance, Performance, Security and Reliability

# Is This for Real? **Yes** for Clusters!

- Storage for HPC / Grid
- Remote Boot, Concurrent Access, Cluster File Systems



# Is This for Real? **Yes** for Convergence!

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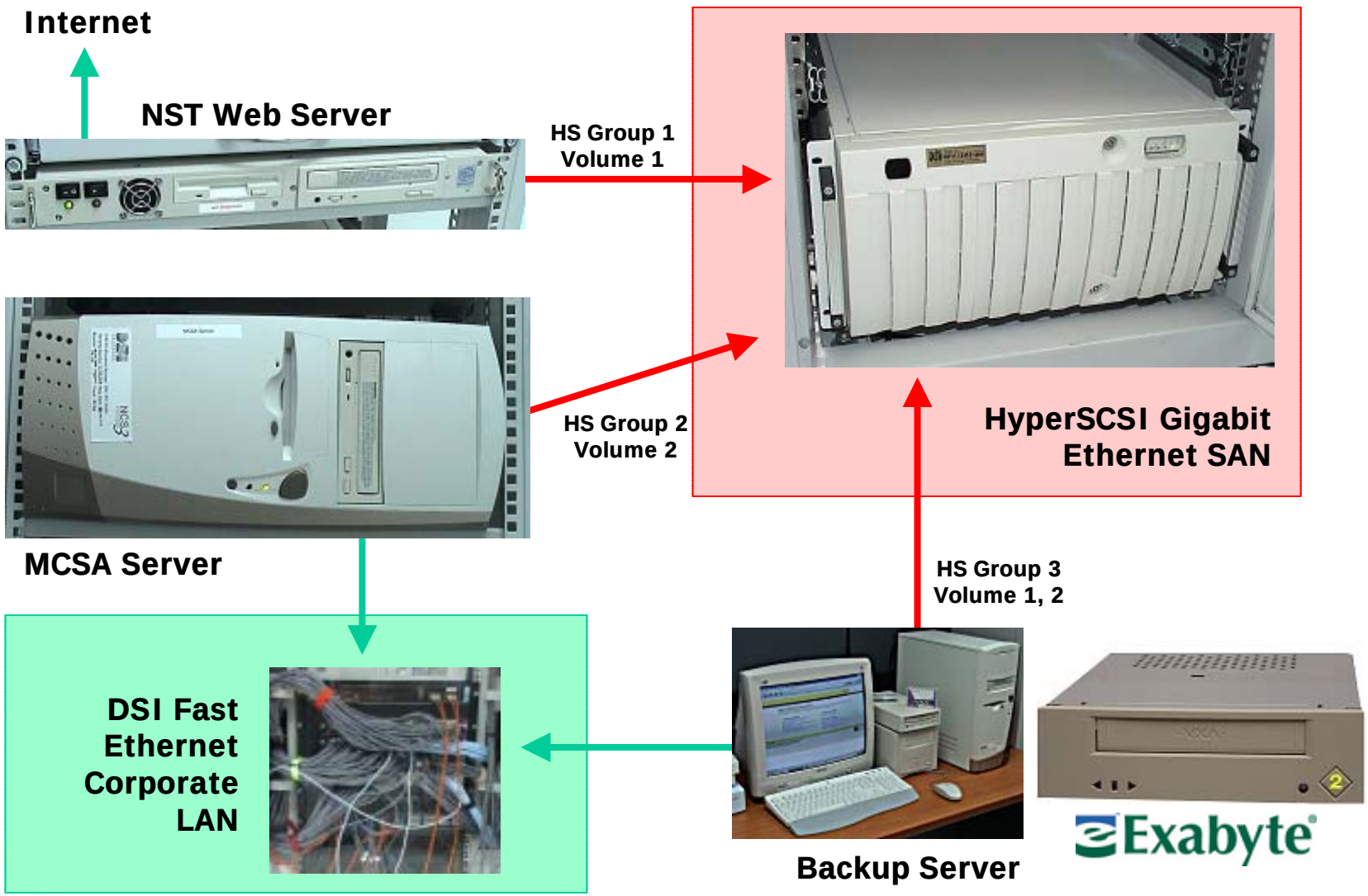
# Is This for Real? **Yes** for Production!



# HyperSCSI Practical Session

Take a hands-on test-drive of HyperSCSI

# HyperSCSI Packages

- Linux HyperSCSI server/client
  - Supports Kernel 2.4, RedHat 7.3 – 9.0
- Windows HyperSCSI client
  - Supports Win2k

# Installing HyperSCSI

- Linux
  - Compile from source code
  - RPM package
- Windows
  - Zip file, inf driver installation

# HyperSCSI Configuration File

## Client

```
[HYPERSCSI-CLIENT-CONFIG-VERSION-20030218]
 [ADD]

 [MODULE_DEF]
 SG_TABLE_SIZE: 16
 MULTI_RCV_THREAD: 3
 MULTI_XMIT_THREAD: 2
 REXMIT_COUNT: 2
 DIRECT_MC: 0

[NETWORK_DEF]
 LAN_1: ETH0

[GROUP_DEF]
 GROUP_NAME: HS-Group1
 PASSWORD: 0123456789
 NET: LAN_1
 TARGET_IP: 192.168.1.1
 VOL_ID: 0
 VOL_OPT: 0

[END]
```

## Server

```
 [HYPERSCSI-SERVER-CONFIG-VERSION-20030218]
[ADD]

[MODULE_DEF]
 PKT_WINDOW_SIZE: 16
 MULTI_RCV_THREAD: 2
 MULTI_XMIT_THREAD: 3
 REXMIT_COUNT: 2
 DIRECT_MC: 0

 [VOL_DEF]
 VOL_1: SDA SCSI-DISK 0 0 8 0
 VOL_2: SDB SCSI-DISK 0 0 9 0

 [NETWORK_DEF]
 LAN_1: ETH0

 [GROUP_DEF]
 GROUP_NAME: HS-Group1
 PASSWORD: 0123456789
 NET: LAN_1
 IP_ON: 0
 VOL_NAME: VOL_1
 VOL_OPT: 0:0
 VOL_NAME: VOL_2
 VOL_OPT: 0:0

 [END]
```

# HyperSCSI Configuration File – Details

- There are four different Definitions. They are:
  - [MODULE_DEF]

    Defines module parameters
  - [VOL_DEF]

    Defines volumes to be exported (for server only)
  - [NETWORK_DEF]

    Defines networks to be used
  - [GROUP_DEF]

    Defines HyperSCSI Groups

# [MODULE_DEF]

- **PKT_WINDOW_SIZE: n**
  - It defines the number of packets that will be sent before requiring an acknowledgement from the receiver. This parameter is only available for server module.
- **SG_TABLE_SIZE: n**
  - This parameter allows the HyperSCSI client to set the SCSI scatter-gathering table size. This parameter is only available for the client module.
- **MULTI_RCV_THREAD: n**
  - This parameter tells the module to start n number of threads for processing packets received.
- **MULTI_XMIT_THREAD: n**
  - This parameter tells the module to start n number of threads for transmitting packets.
- **REXMIT_COUNT: n**
  - This parameter sets the number of times the module should re-transmit if a packet is lost before reporting an error.
- **DIRECT_MC: 0**
  - This parameter is defined for multi-channel communications.
  - (Not available in released version)

# [VOL_DEF]

- Defines the volumes and physical devices that a HyperSCSI server can assign and export to any HyperSCSI Group.

```
[VOL_DEF]
VOL_1:  SDA   SCSI-DISK   0 0 8 0
VOL_2:  SDB   SCSI-DISK   0 0 9 0
VOL_n:  <dev-name> <dev-type> <host> <channel> <scsi_id> <lun>
```

- HyperSCSI currently supports SCSI, IDE, USB and Fibre Channel interfaces for hard disks, removable disks, optical disks (CD, CDR, CDRW, DVD), tape and SCSI generic devices

# Server Volume Definition Examples

The last four numbers are often known as HCIL for “Host-Channel-ID-LUN”, the identifiers used to identify a specific SCSI device in a system.

- SCSI Hard Disk

VOL_1: SDA SCSI-DISK h c i l

- SCSI Optical Disk

VOL_1: SCD0 SCSI-CDROM h c i l

- SCSI Tape Drive

VOL_1: ST0 SCSI-TAPE h c i l

- IDE Hard Disk

VOL_1: HDB IDE-DISK 0 0 0 0

- IDE Optical Disk

VOL_1: SCD0 IDE-CDROM h c i l

- Software RAID Volume

VOL_1: MD0 RAID 0 0 0 0

- Logical Volume Manager Group

VOL_1: vol_name LVM 0 0 0 0

# [NET_DEF]

- Defines the network interfaces that the HyperSCSI modules can use for communication. Each entry in this section must start with “LAN_” and have a number attached to it.

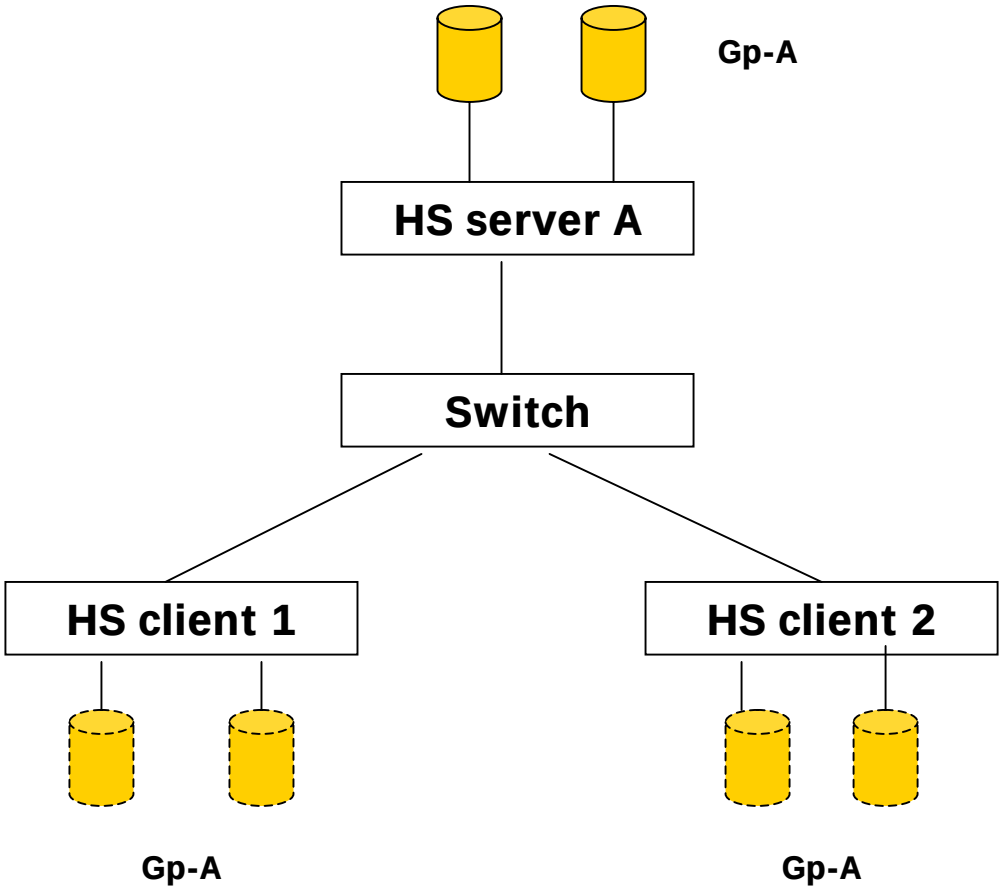
```
[NETWORK_DEF]
LAN_1: ETH0
LAN_2: ETH1
LAN_3: ETH2 ETH3
```

# [GROUP_DEF]

- **GROUP_NAME: <group-name>**
  - More than one client or server can be in a single Group, but a client or a server cannot have more than one Group with the same name in its configuration.
- **PASSWORD: <password>**
  - The password must be between 5 and 20 characters long, is case-sensitive and can be alphanumeric. Spaces and special characters are not allowed.
- **NET: LAN_n**
  - This specifies that this Group must use the specific network interface defined in the [NETWORK_DEF] section.
- **VOL_NAME: VOL_n**
  - This specifies that the server can export this volume or physical device defined in [VOL_DEFsection to this group.
- **VOL_ID: n**
  - This parameter allows a HyperSCSI client to expect a specific device exported by the server. The order of VOL_ID definitions corresponds with the VOL_NAME defined in the HyperSCSI server.
- **VOL_OPT: <device-option-string>**
  - This line must be preceded by a VOL_NAME (in the case of a server) or a VOL_ID (in the case of a client). This parameter allows a HyperSCSI server and client to set device specific options.

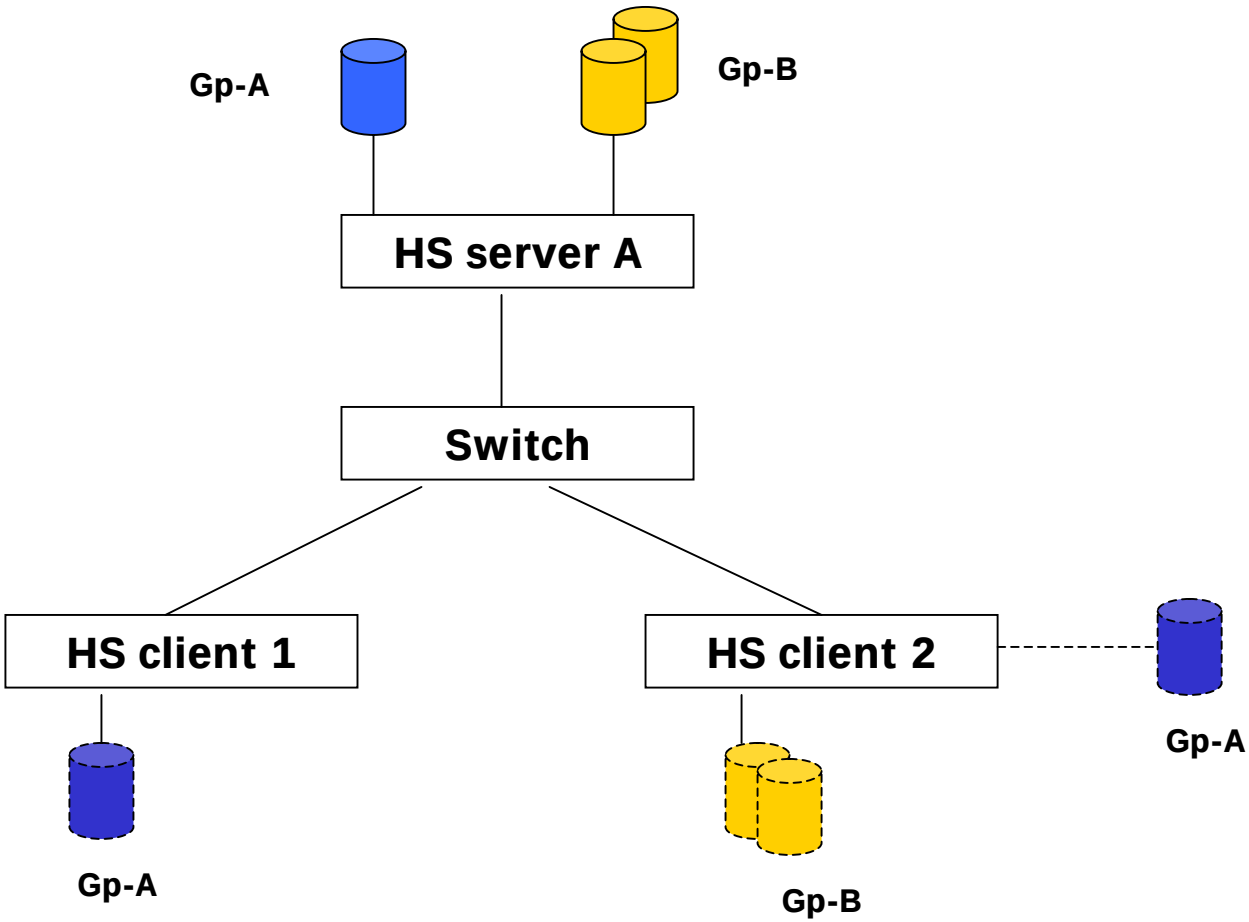
# HyperSCSI Group Name Examples

**Single server and multiple clients: Single HS-Group**



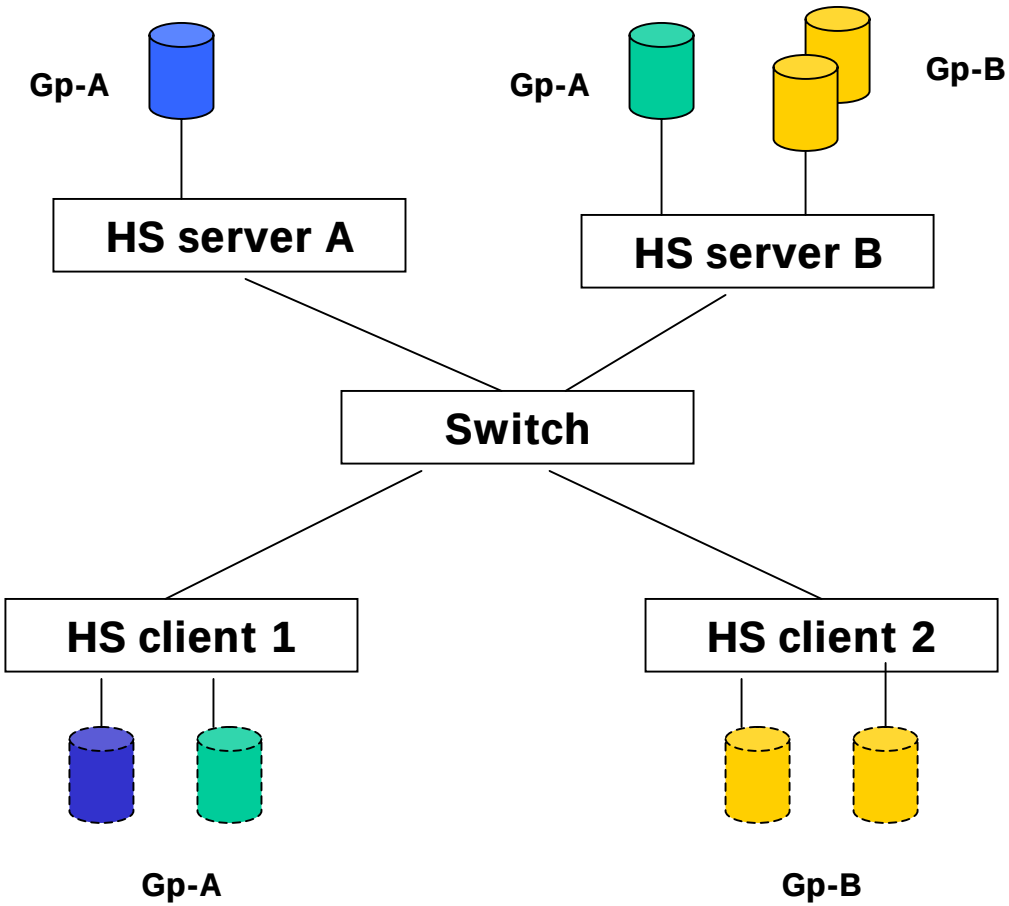
# HyperSCSI Group Name Examples

**Single server and multiple clients: Multiple HS-Groups**



# HyperSCSI Group Name Examples

**Multiple server and multiple clients: Multiple HS-Groups**



# Thank You

**http://nst.dsi.a-star.edu.sg/mcsa/**