



# The Future of Network Storage

**By Patrick Khoo**

(patrick@dsi.nus.edu.sg)

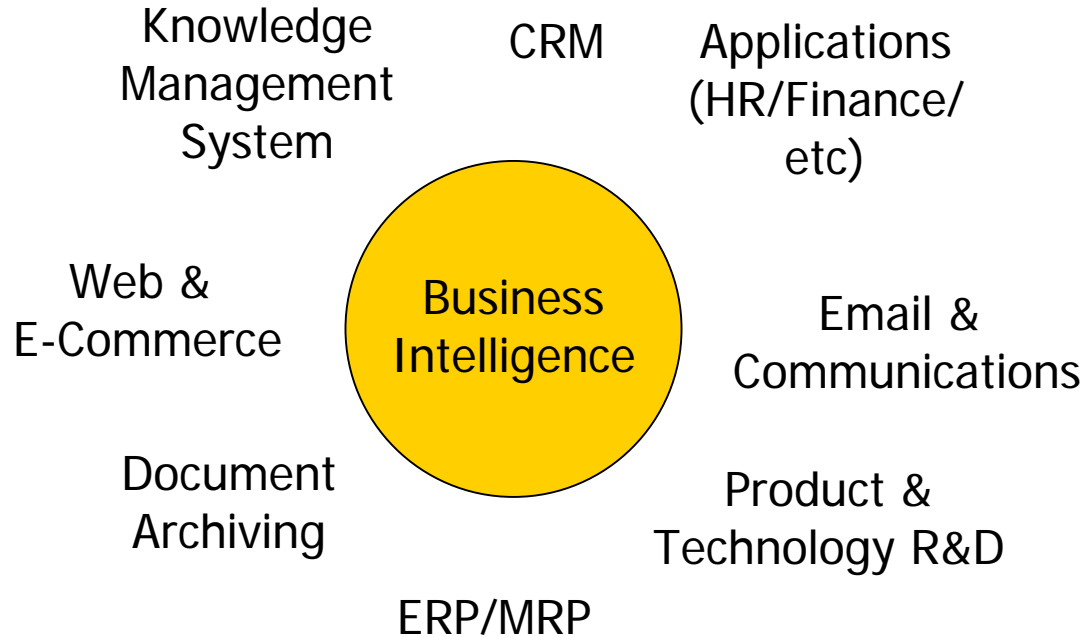
Program Manager, MCSA Group  
Data Storage Institute Singapore



# Presentation Outline

- This presentation will discuss the future of network storage technology, its challenges and some of the new efforts in this area
  - Reasons for network storage
  - Evolution of Solutions and Technology
  - Technology development and focus areas
  - Efforts at Data Storage Institute
  - Conclusions

# Where is Information Today?

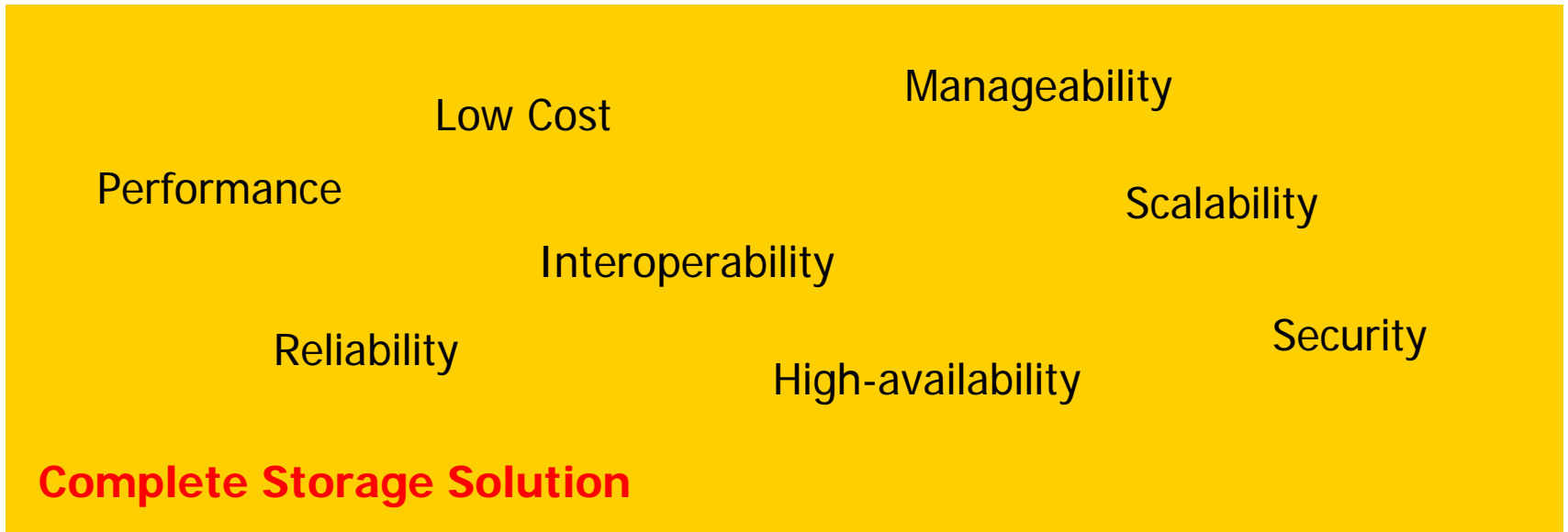


# The **FUTURE** Growth of Storage

- 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!
- Bear Stearns Store/Forward Report - May 2001
  - Median global 2000 company had 40TB of online storage space in 1998
  - This is expected to increase to 300TB at end 2001
  - And projected to rise to 1 Petabyte in 2003
  - This represents a CAGR of 76% for total installed network storage capacity globally over the next 3 years

\* 1000GB = 1TB, 1000TB = 1PB, 1000PT = 1EB, 1EB = 1,000,000 TB or approx 25 million 40GB HDDs

# What are the Requirements?



- So, what do users **REALLY** want?
  - Can I get it to do what I need?
  - Can I afford it?
  - Can I depend on it?
  - Can I get it fixed quickly if it breaks?



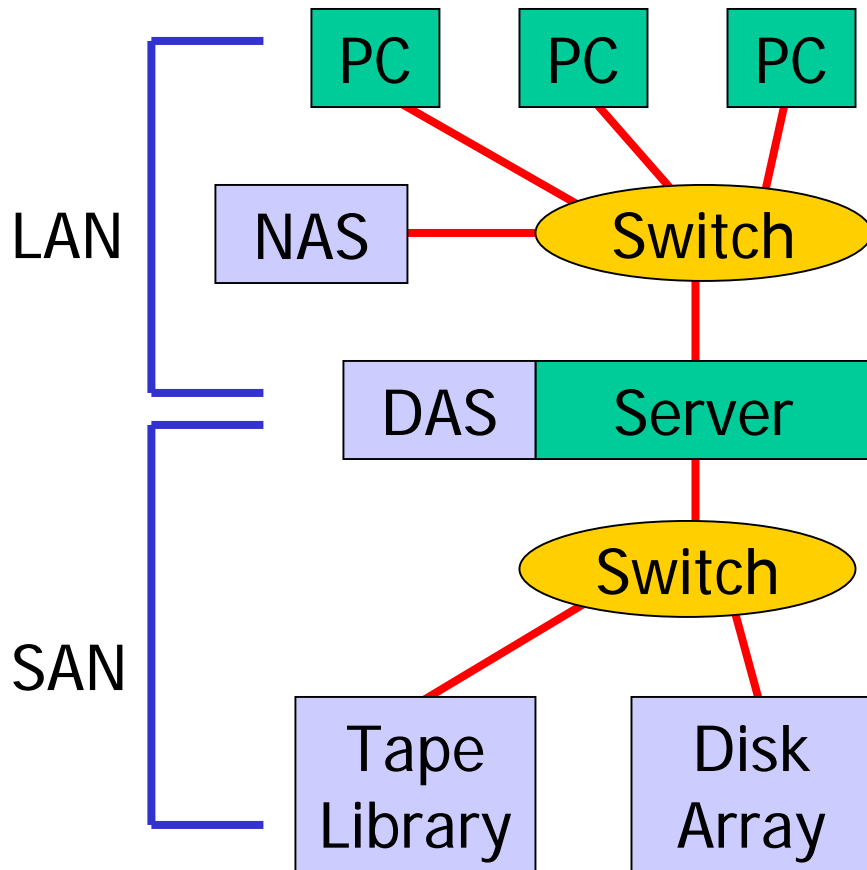
# Why **NETWORK** Storage?

- Through network storage,
  - costs are lowered
  - scalability is ensured
  - reliability is increased
  - management is made easier
  - access is secured
  - information sharing becomes commonplace

Requirements that conventional direct attached storage is unable to meet

- Why network storage? Duh . . . !

# Evolving NST Strategies



## Definitions

LAN - Local Area Network

DAS - Direct Attached Storage

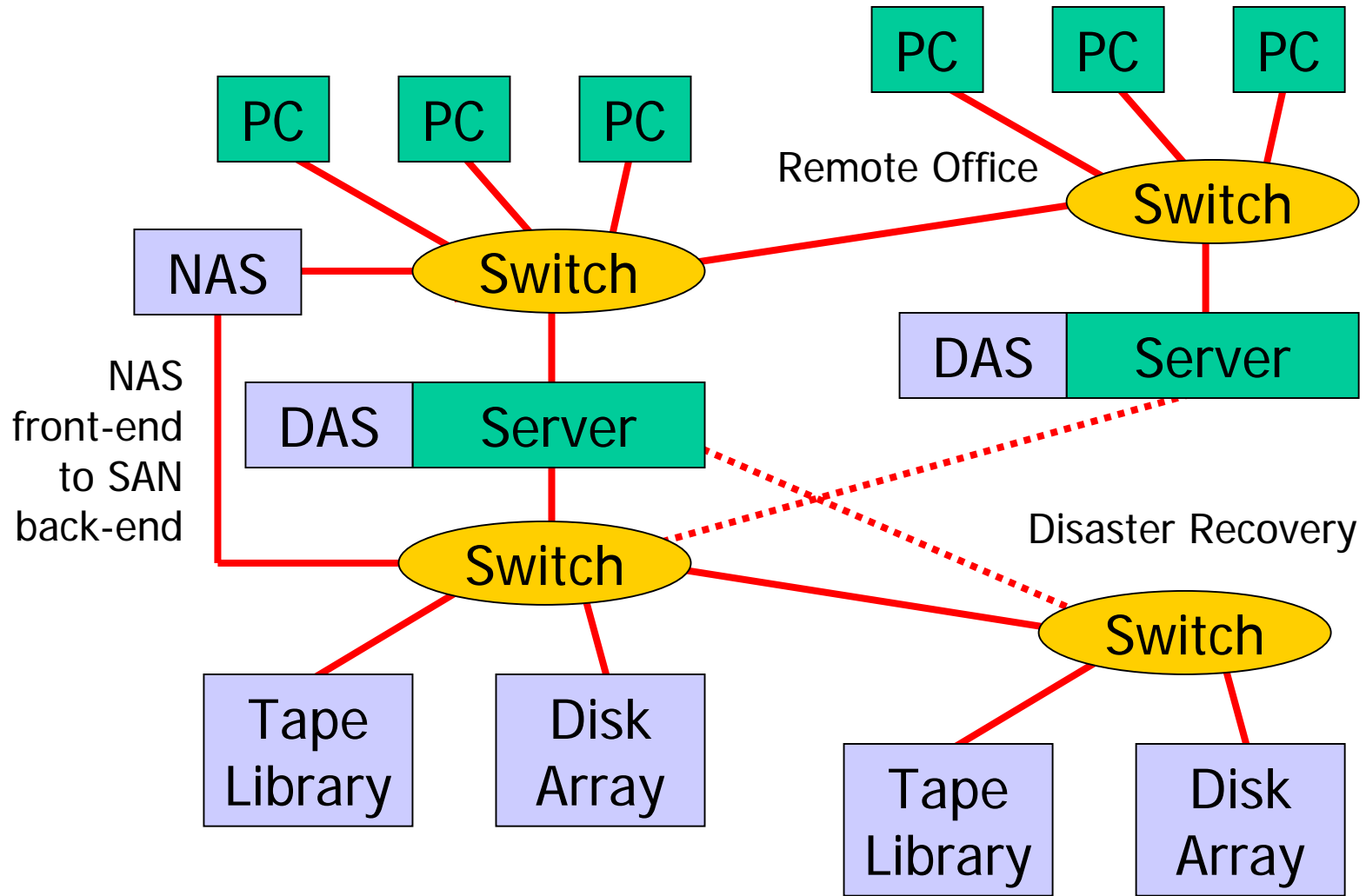
NAS - Network Attached Storage

SAN - Storage Area Network

## Components

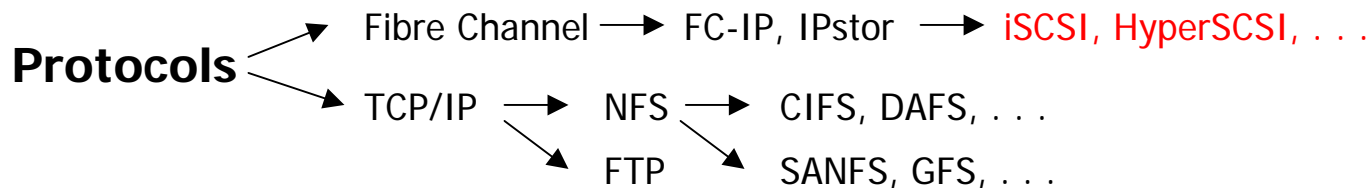
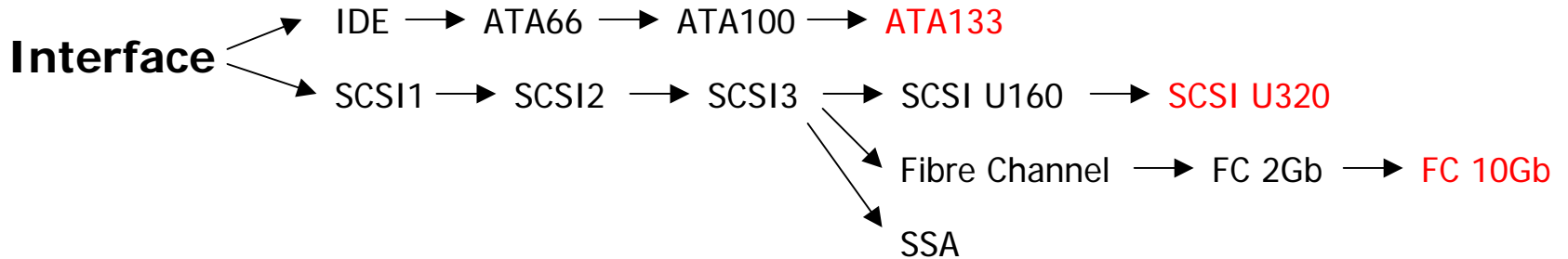
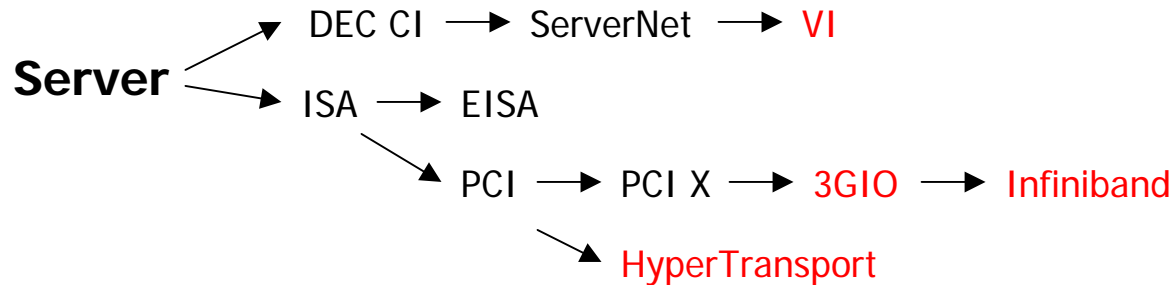
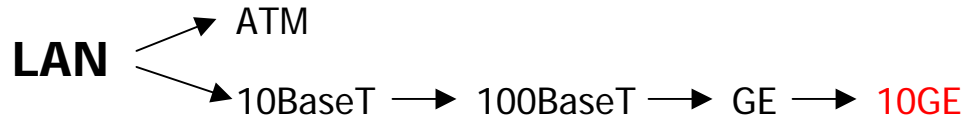
- Servers
- Storage systems (eg. disk arrays, tape libraries, etc)
- Interconnect technologies (eg. fibre optic cables, switches etc)
- Host-bus Adapters (HBA), Network Interface Cards (NIC)
- System and Data Management Software

# Evolving NST Strategies





# Technology Progression





# Some Ongoing “Religious” Wars

- SAN versus NAS versus NAS+SAN
- Fibre Channel versus Gigabit Ethernet
- iSCSI versus FC-IP
- SCSI U160 versus ATA100
- Block versus file access
- Metadata controllers versus storage virtualisation
- HSM versus online archiving
- Tape versus optical versus magnetic backup
- 3GIO versus Infiniband versus HyperTransport
- Distributed versus centralised



# Future Network Storage Users

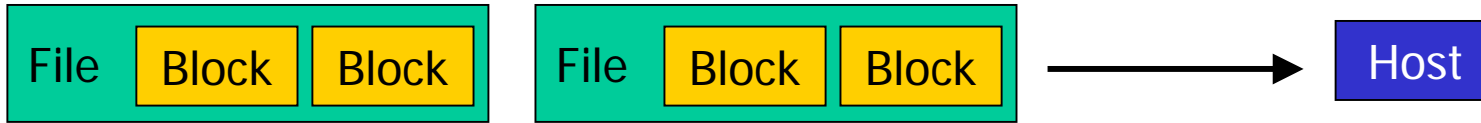
- Wide-Area High Performance users
  - Disaster Recovery, Caching, Mirroring, Global CRM
- SME / SMI users
  - SMEs can scale to support their larger enterprise customers (esp suppliers to MNC manufacturers)
- Mobile / Wireless users
  - M-commerce, WAP, GPRS, PDA
- Consumer / SOHO users
  - Home storage networks, remote workers

# Block / Protocol Efforts



- Current technologies:
  - SCSI, ATA, Fibre Channel
  - iSCSI, FCIP, SoIP, IPstor, HyperSCSI
- Upcoming technologies:
  - New block protocols, physical layer independent
  - Simultaneous block access / block level locking
  - Multi-channel communications
  - Low cost transport mechanisms

# File System / Director Efforts



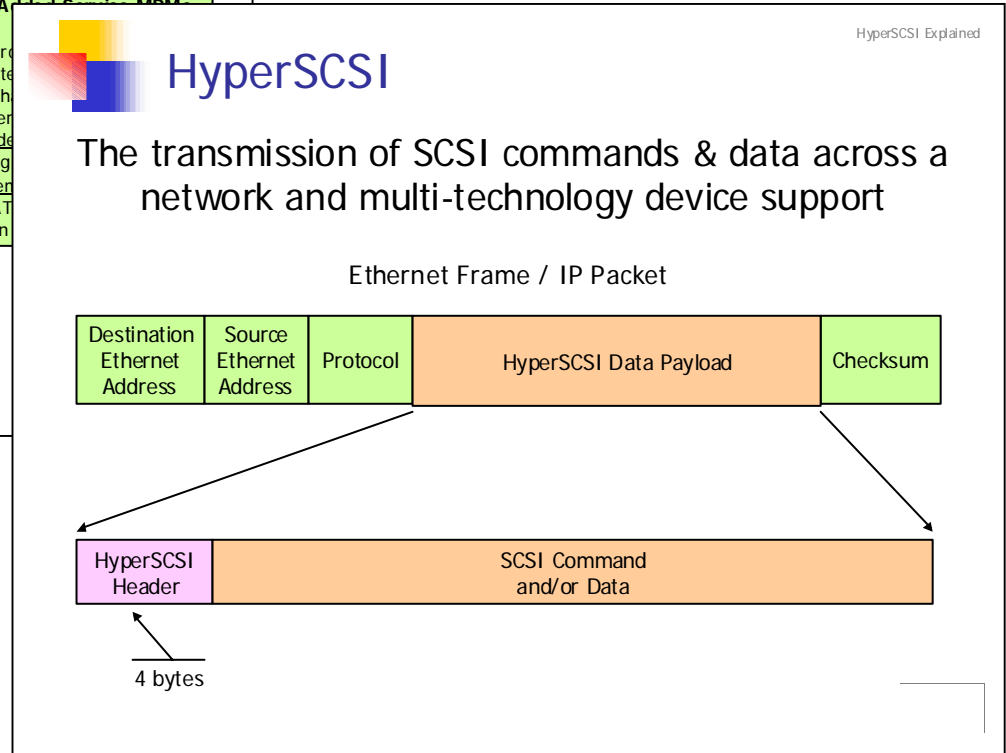
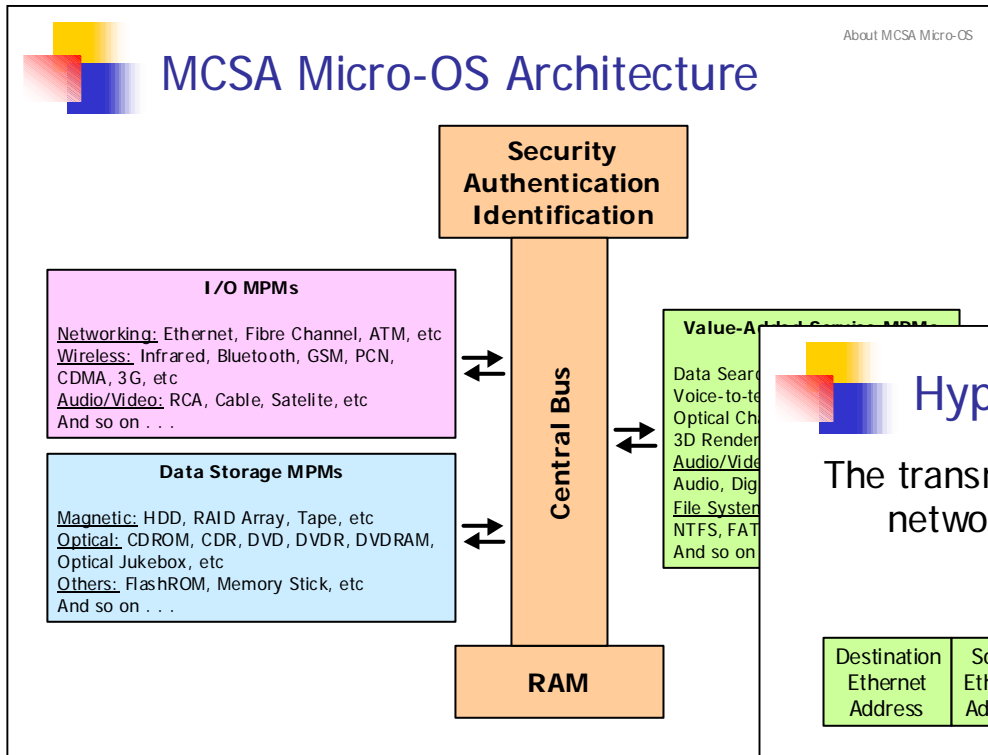
- Current technologies:
  - File System Protocols (NFS, CIFS, GFS, etc)
  - Database systems (Oracle, MS SQL, Sybase etc)
  - Metadata controllers, Directors
- Upcoming technologies:
  - Object-oriented storage
  - Integrated storage and information management tools
  - Storage virtualisation

# Grid Storage / Shared Computing



- Upcoming technologies:
  - Massive Data and Computing Grids
  - GridFTP
  - Globus Toolkit
  - Distributed data synchronisation
  - Single sign-on access

# DSI Efforts in Network Storage



# DSI Efforts in Network Storage

The image displays a Netscape browser window showing a web interface for 'HNS - Home Network Storage'. The interface includes a navigation menu with options like 'USER MANAGEMENT', 'SYSTEM MANAGEMENT', and 'SOFTWARE RAID CONFIGURATION'. A 'Logout' link is visible at the bottom left, along with the time '22:08:29' and date 'Wednesday August 29 2001'. The browser title bar reads 'MAIN MENU - Netscape'.

Overlaid on the right is a window titled 'HNS - Home Network Storage' with a logo for 'MCSA Modular Connected Storage Architecture' and a penguin icon. Below the penguin is a timestamp '21:55:52' and four buttons labeled 'Audio', 'Video', 'Fax', and 'Telephone'.

At the bottom right, a photograph shows several electronic devices: a black Philips remote, a silver remote, a black remote, and a green hard drive.



# DSI Efforts in Network Storage

## Audio/Video Playback Functions

- Playback of various media formats and technologies
  - Video formats: MPEG I, MPEG II, DivX
  - Audio formats: MP3, Wav, Raw
  - Optical discs: VideoCD, Digital Versatile Disc, Audio CD
- Media Borrowing Technology
  - Supports above video and audio formats
  - Arbitrary borrowing period
  - Supports HyperSCSI for remote data access Server

Mosi-Oa-Tunya Progress

## Data and Information Management

Mosi-Oa-Tunya Progress

```
localhost/root/MODIRS: ./Index -r ../
```

```
MODIRS Intelli-Index v1.1
Building document list ...
Building database ISEARCH:
Parsing files ...
Parsing /root/.kde/share/config/emaildefaults, key=10
Parsing /root/.kde/share/config/kdeglobals, key=2265
Parsing /root/.kde/share/config/konquerorrc, key=31062
Parsing /root/.kde/share/config/kdesktoprc, key=43549
Parsing /root/Mail/drafts, key=11776782142
Parsing /root/Mail/inbox.fn, key=11786782142
Parsing /root/Mail/outbox.fn, key=11796782158
Parsing /root/Mail/sent-mail.fn, key=11806782175
Parsing /root/Mail/trash.fn, key=11816782195
Parsing /root/Mail/drafts.fn, key=11826782211
Parsing /root/addressbook.fn, key=11846794374
Indexing 13885 words ...
Database files saved to disk.
```

```
localhost/root/MODIRS: ./Isearch happy
```

```
MODIRS Intelli-Search v1.1
Searching database ISEARCH:
Query String = happy
Got 2 hits
```

```
2 document(s) matched your query, 2 document(s) displayed.
```

**MODIRS**  
Modular Document Indexing  
and Retrieval System

Score	File
1. 100	/root/MODIRS/src/infix2rpn.cxx
2. 100	/root/MODIRS/typescript

```
Select file #:
```

# DSI Efforts in Network Storage

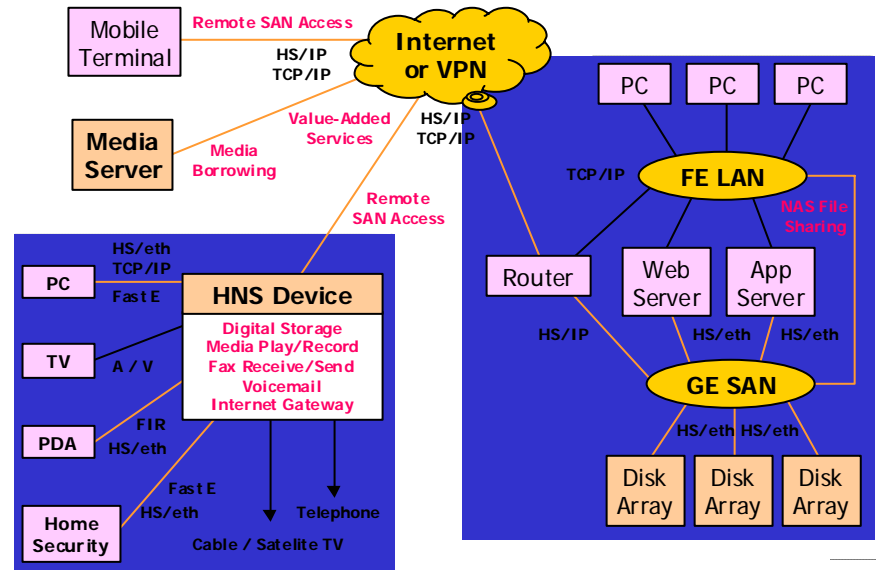
## MCSA Group Prototypes

MCSA Group Results



## The MCSA Group Vision with XDS

The Future





# DSI Interoperability Lab

## **Demonstration Facilities**

- Technical (non-Marketing) Demonstration / Seminar Facilities
- New Technology Testing / Pilot Demonstrations / Benchmarking

## **Solutions Testing**

- Proof-of-Concepts of Storage Solutions
- Solutions and Interoperability Certification
- Benchmarking, Performance and Load Simulations Analysis and Reports

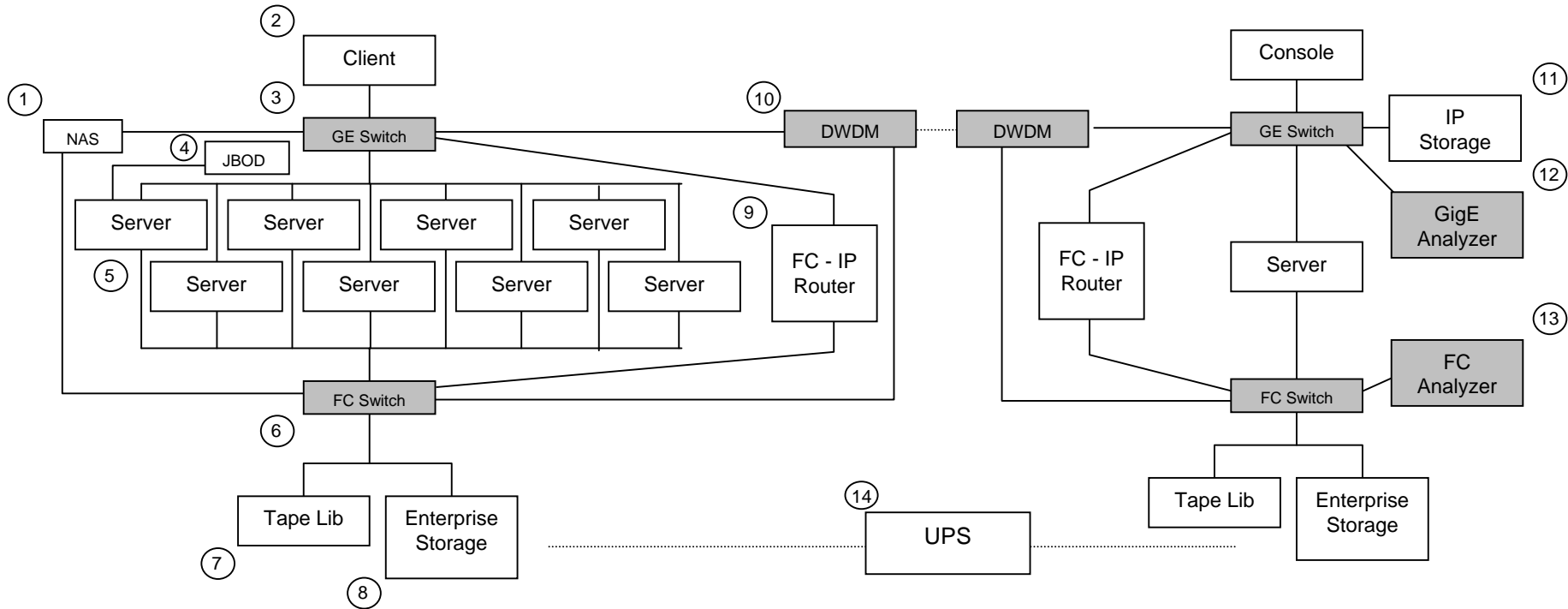
## **Corporate Solutions Development Center**

- Secure, short term project based co-development hosting
- Development tools, systems and environment
- Corporate Development Center Facilities with access to SINGAREN (INTERNET II)

## **Training Laboratory**

- Laboratory-based training facilities and hands-on sessions
- Training and Seminar functions and facilities

# Proposed Lab Logical Diagram



## 1. NAS (2 units)

- (Netapp F800)
- Maxattach

## 2. Client Pc and console (2 units)

- Pentium Class PC

## 3. GigE Switch (2 units)

- Cisco 24 port
- 3Com 24 port

## 4. JBOD (1 unit)

- Ciprico

## 5. Servers (9 units)

- Linux (x2)
- Win 2000/ NT (x2)
- SUN Solaris
- IBM AIX
- HP UX
- Novell Netware
- Compaq TRU64

## 6. Fibre Channel Switch (2 units)

- Gadzoox AL 8 port
- Brocade Silkworm 24 port

## 7. Tape Library (2 units)

- Adic
- IBM Magestar
- StorageTek

## 8. Enterprise Storage System (2 units)

- HDS Lightning
- EMC Symmetrix
- IBM Shark
- Compaq Storaeworks

## 9. FC-IP Router (4 units)

- NishanSystem FC/IP Router
- Cisco Storage Router
- Lucent Optistar

## 10. WAN (2 units)

- ATM / Optical Switch
- Cisco Metro 1500 (DWDM)

## 11. IP Storage (1 unit)

- IBM iSCSI 200i & 300i

## 12. Gig E Analyzer (2 units)

- Finisar

## 13. FC Analyzer (2 units)

- Finisar
- Fluke

## 14. UPS (1 unit)



# What is the Strategy for the Future?

We must remember the fundamentals:

**Who are the users?**

**What are their needs?**

**What technologies or solutions can  
meet those needs?**



# Conclusion

What is the future of  
Network Storage Technologies?

The best way to predict  
the future is to

**INVENT** it!



# Thank You

<http://nst.dsi.nus.edu.sg/mcsa/>