Any Time Any Place Any Device

Knowledge is storage

Storage is caused by awareness

There is a path from awareness to storage

This path is . . .

Introduction to

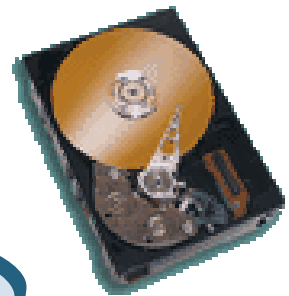
Network Storage

Modular Connected Storage Architecture Group

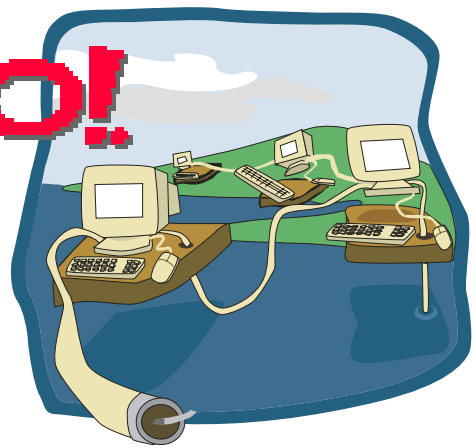
Network Storage Technology Division

Data Storage Institute

Imagine . . .



YAHOO!



Impossible World!

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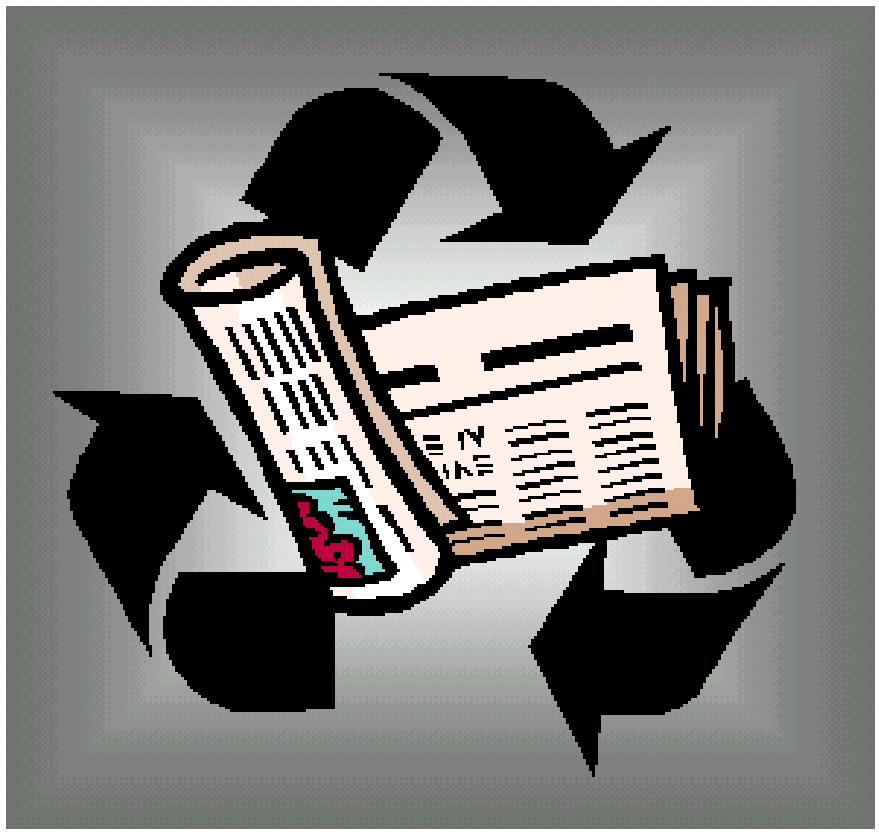
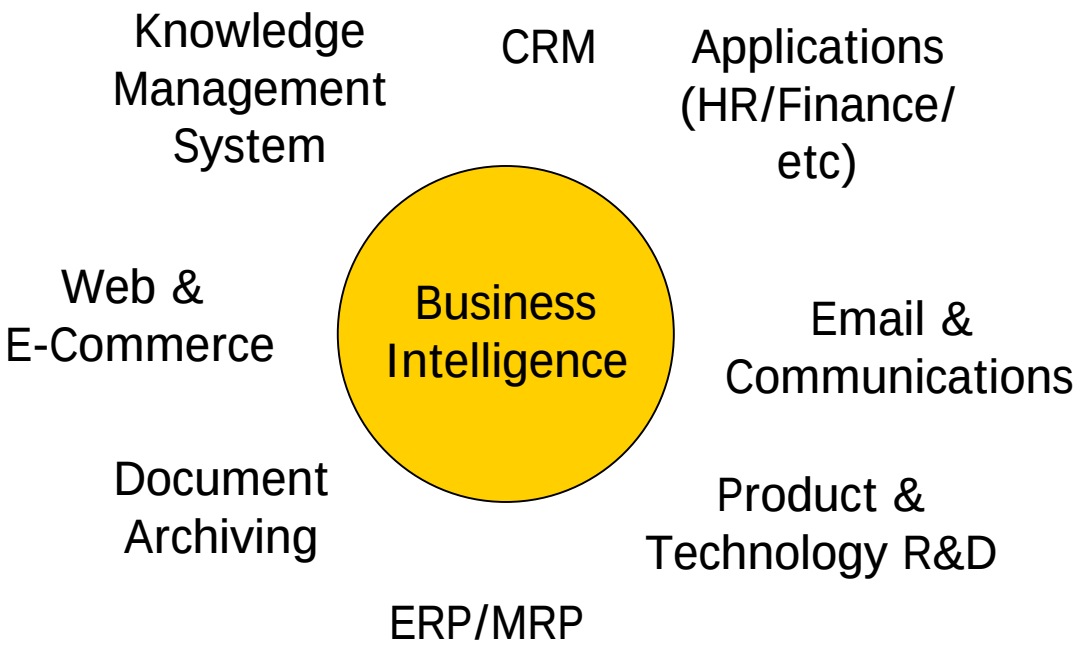
Do We Need More Storage?

- Research (AT&T Labs) has shown that a “Moore’s Law” for Data Traffic possibly exists
- Operating Systems, Files and Applications today get larger and larger

Do We Need **EVEN** More Storage?



What about Businesses?



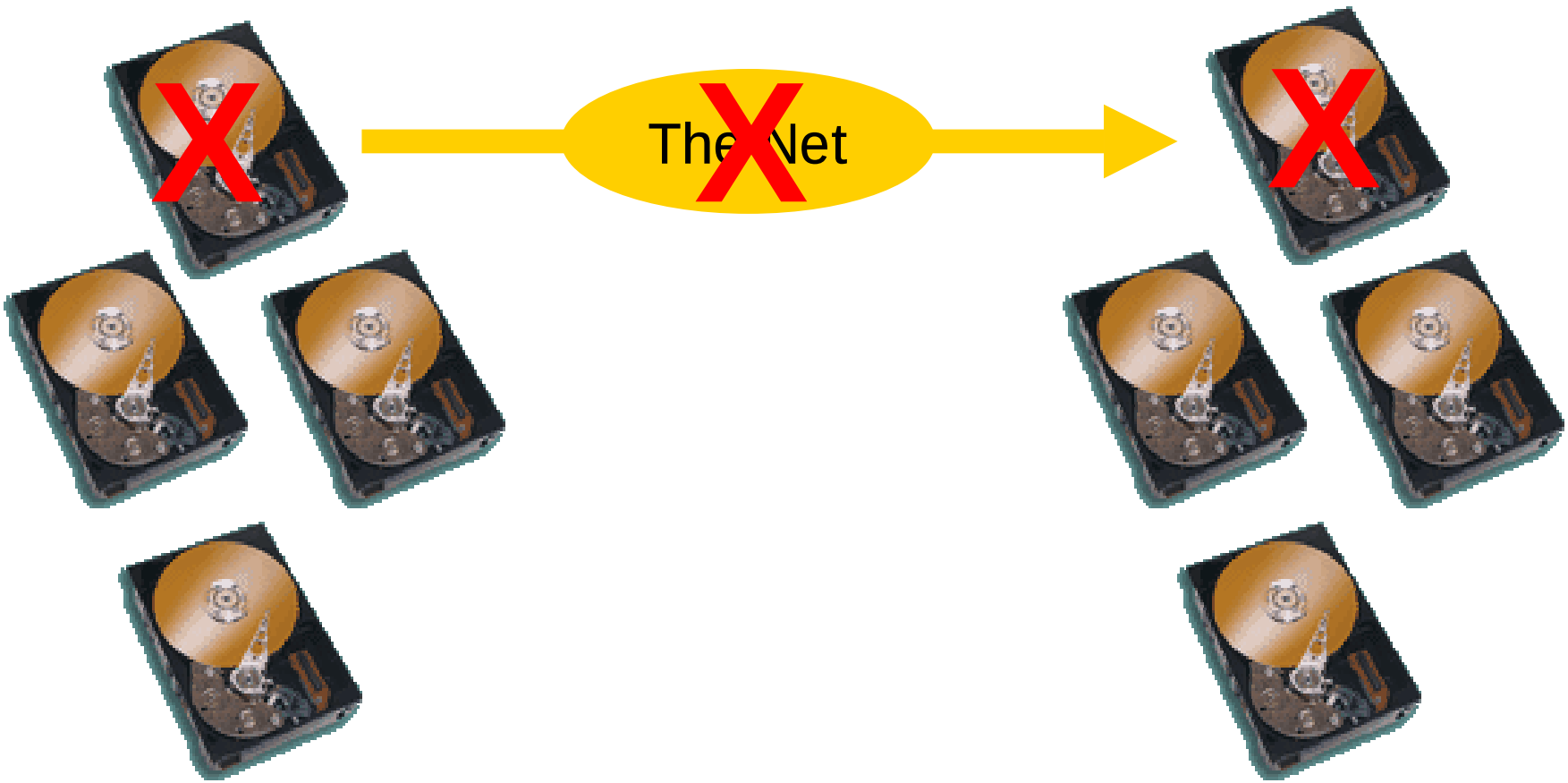
The **FUTURE** Growth of Storage

- 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

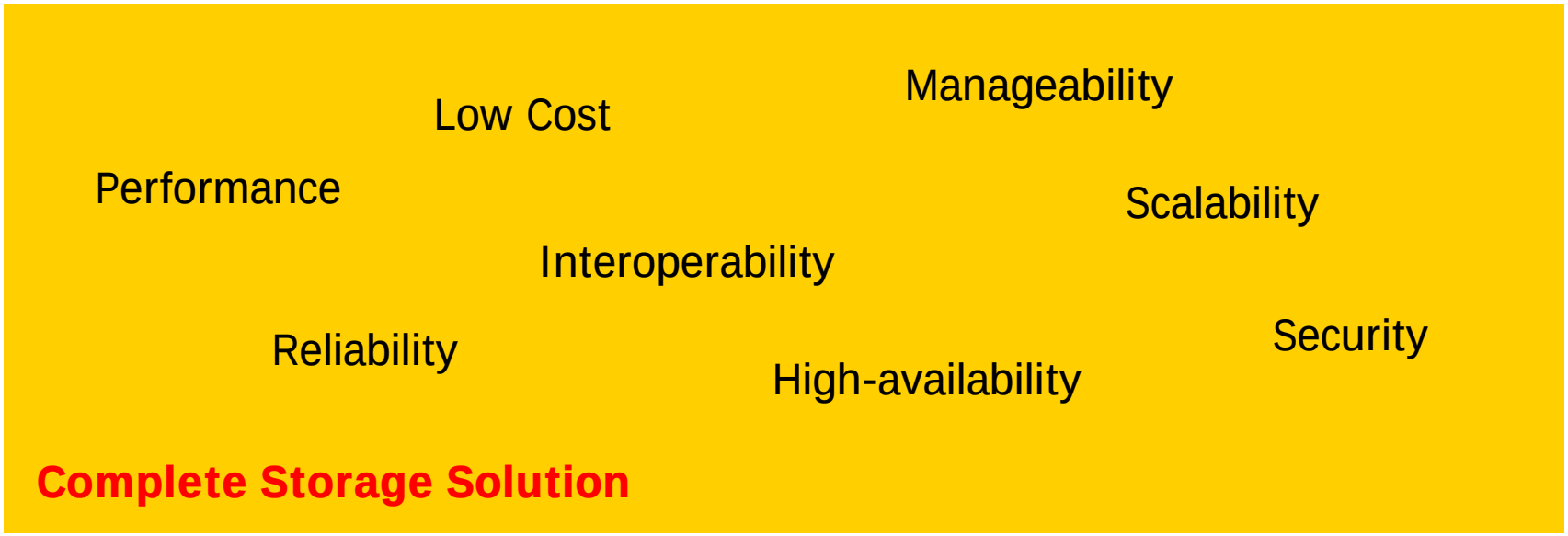
*** 1000GB = 1TB, 1000TB = 1PB, 1000PT = 1EB, 1EB = 1,000,000 TB or approx 25 million 40GB HDDs**

Scalability and High Availability



Performance and Security

What are the Requirements?



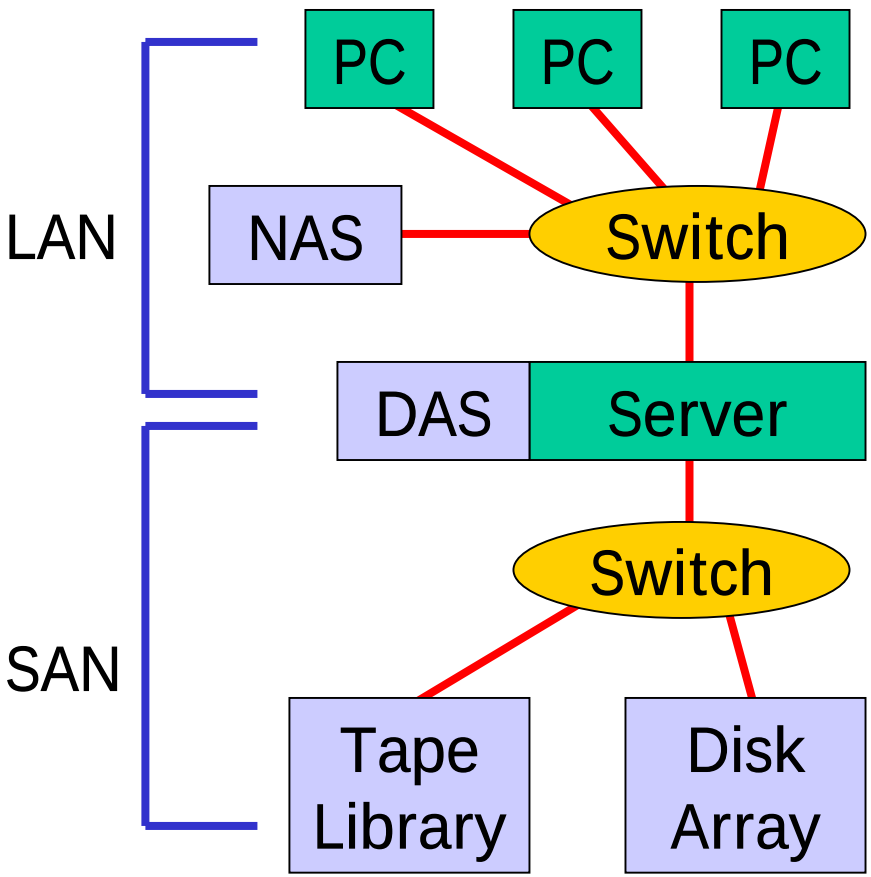
- So, what do users **REALLY** want?
  - Can I get it to do what I need?
  - Can I afford it?
  - Can I depend on it?
  - Can I get it fixed quickly if it breaks?

Why Network Storage?

- **Relieve** your **Server**
- **Free** your **Network**
- **Scale** your **Storage**
- **Ease** your **Management**
- **Share** your **Data**
- **Protect** your **Investment**

Why network storage? Duh . . . !

What is Network Storage?



Definitions

LAN - Local Area Network

DAS - Direct Attached Storage

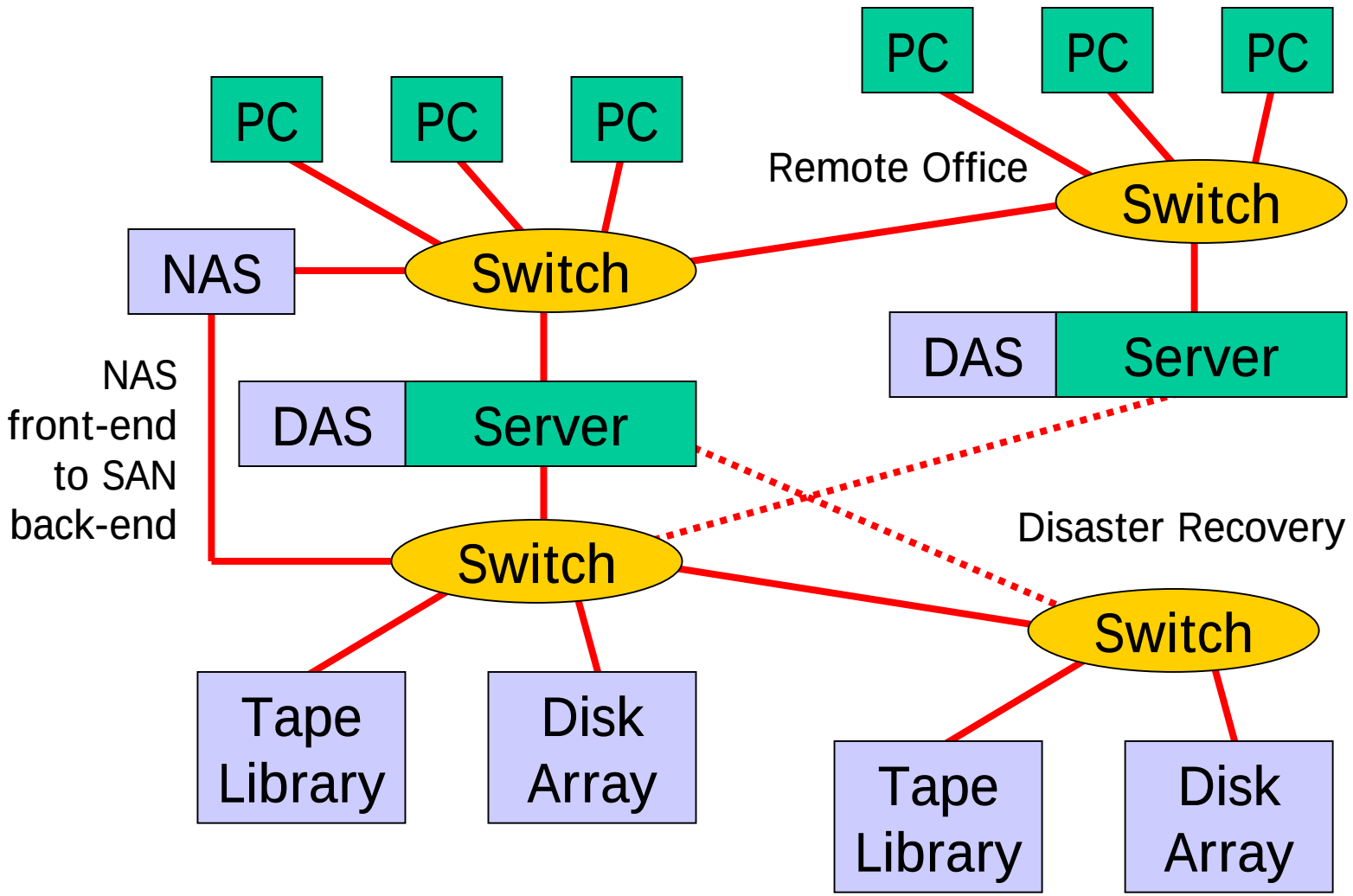
NAS - Network Attached Storage

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

Even More Complex Network Storage



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Network Storage Technology

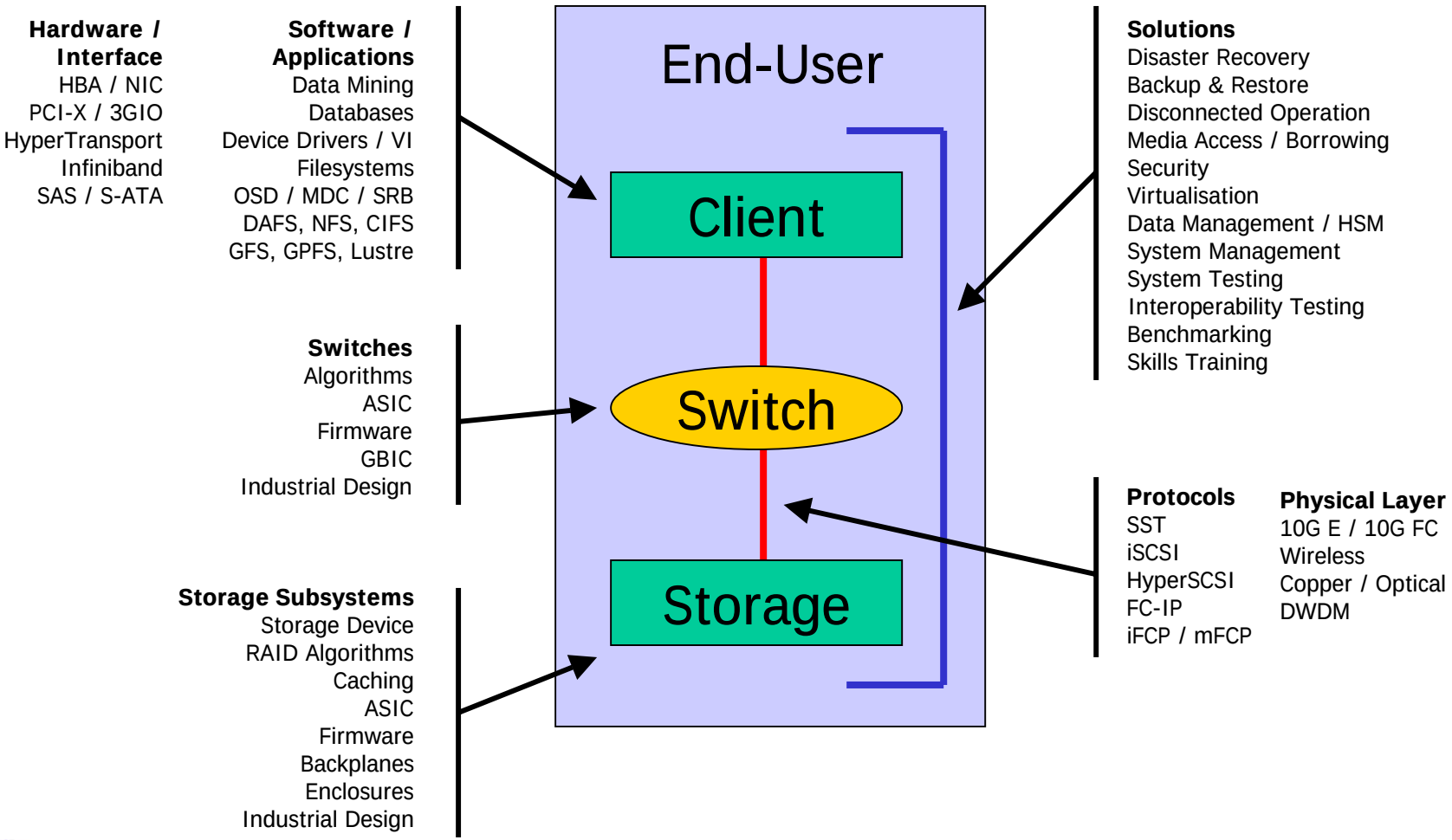
Software — **Hardware**

Application User Space	OS/Kernel Device Driver	Embedded OS Firmware	PCB Design	IC/ASIC Design

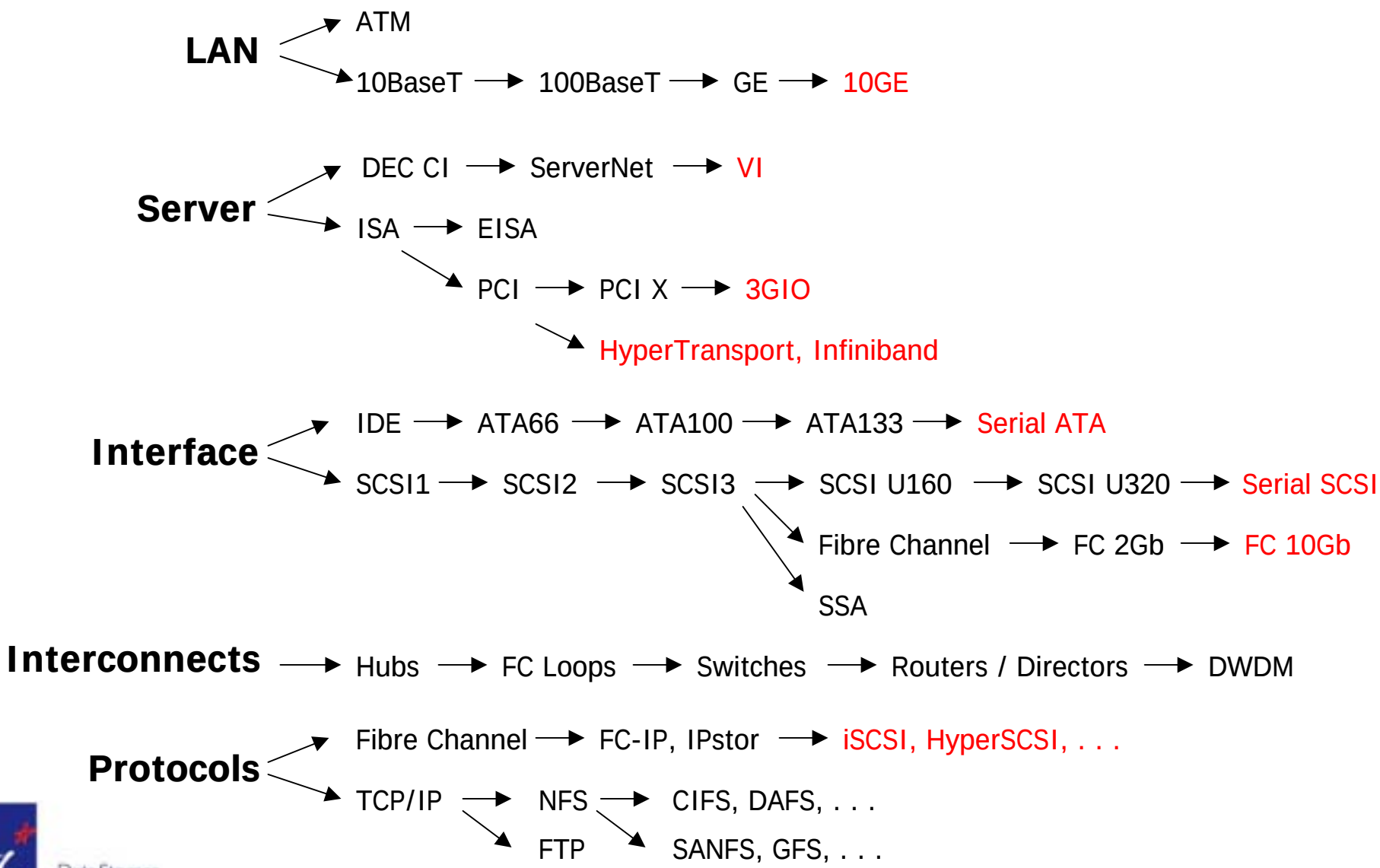
Storage Device	Interface Technology	RAID / Disk Array	Network Communications	Virtualisation / Management

Component — **System**

Network Storage Ingredients



Technology Progression



Network Storage at DSI

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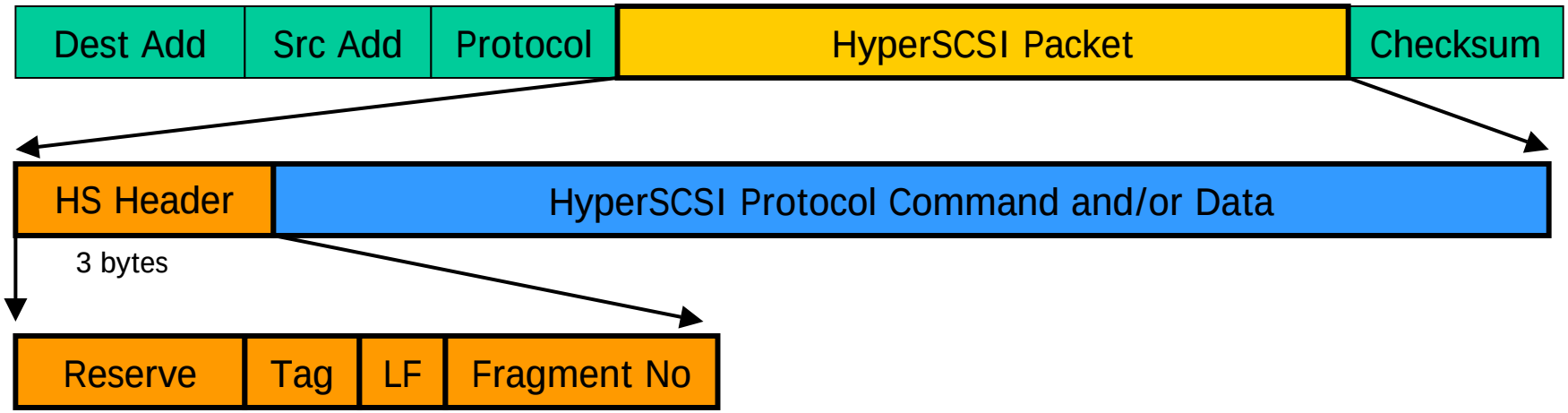
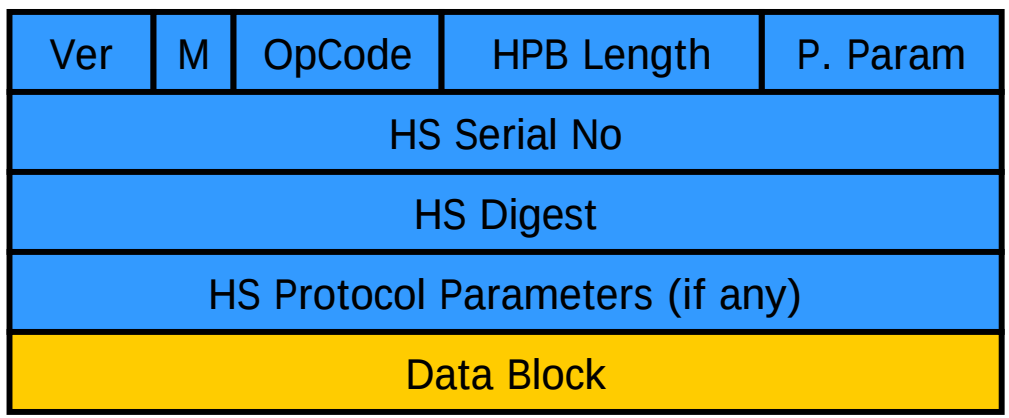
MCSA
Modular Connected Storage Architecture

The HyperSCSI Protocol

HyperSCSI Packet Framing / Encapsulation on Ethernet

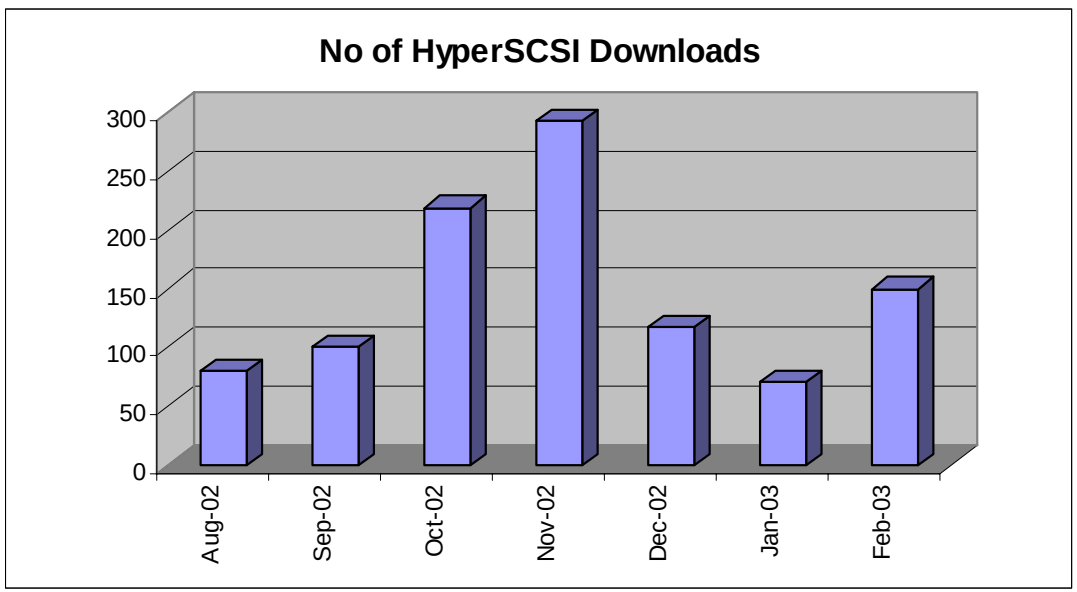


HyperSCSI Command and Data Block



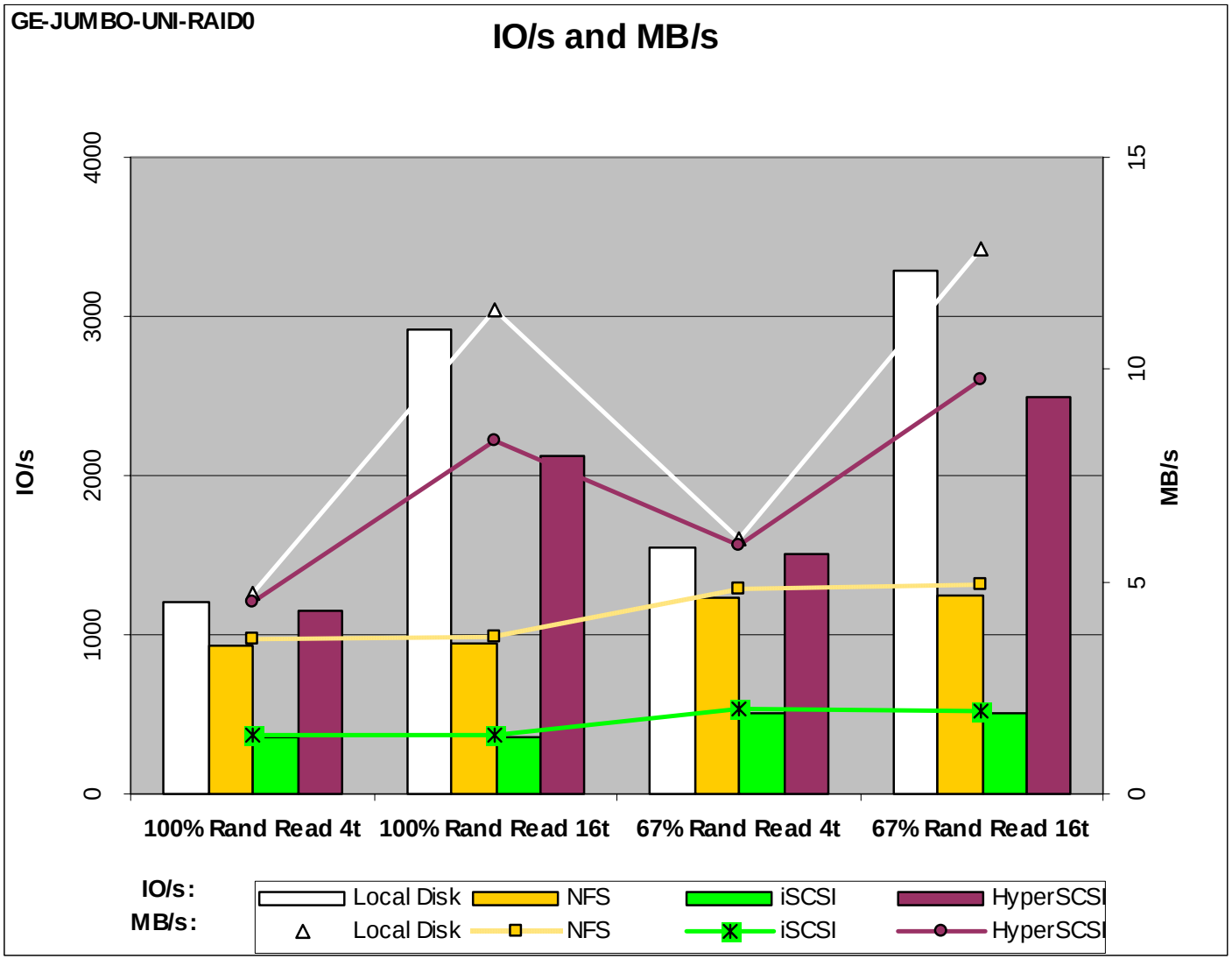
HyperSCSI Downloads

- 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



Performance Benchmarking

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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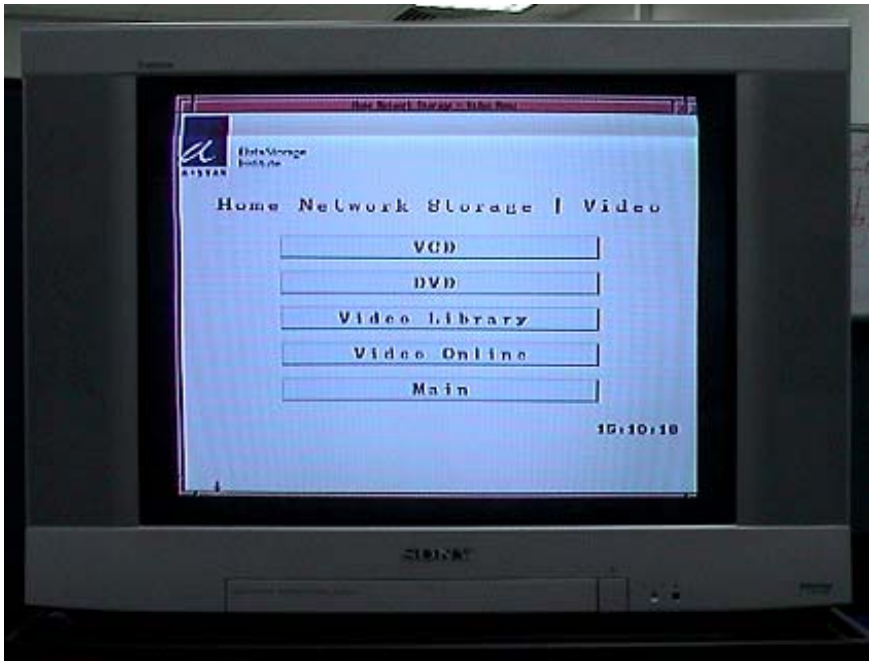
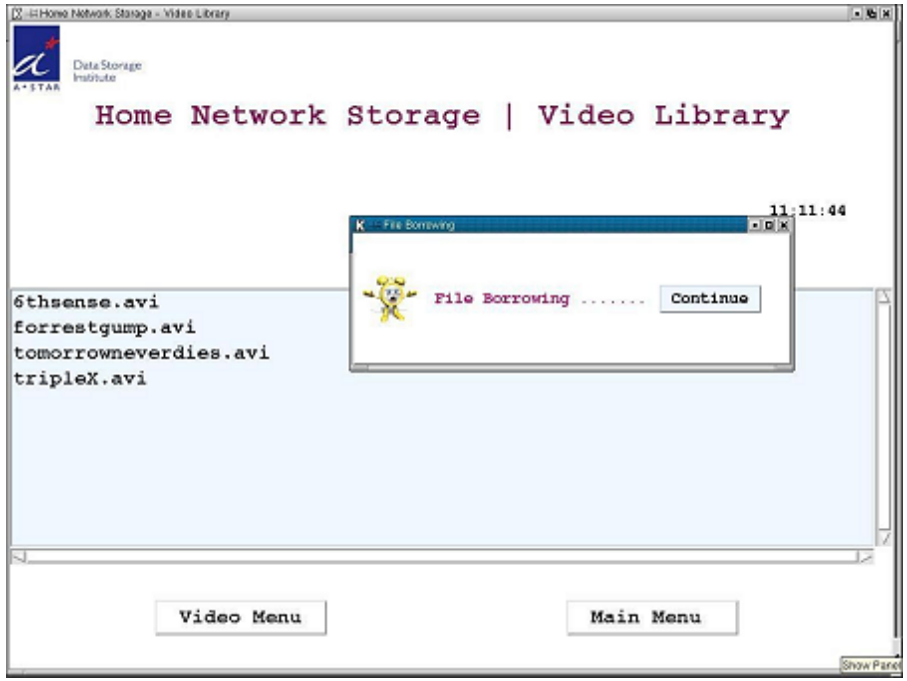
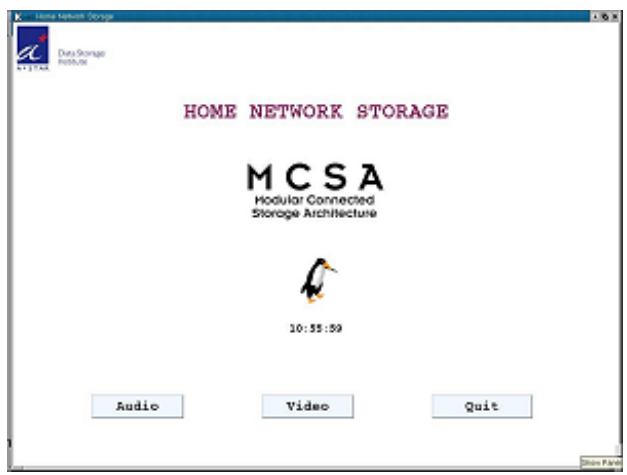
Consumer User-Interface





- Graphical user-interface
- Infrared and keypad control with LCD display
- On-screen display for feedback



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Data and Information Management

```
localhost/root/MODIRS: ./Iindex -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 138885 words ...
Database files saved to disk.
```

MODIRS
Modular Document Indexing and Retrieval System

```
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.

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

Select file #:
```

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Applying Technology – Wireless / CE

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

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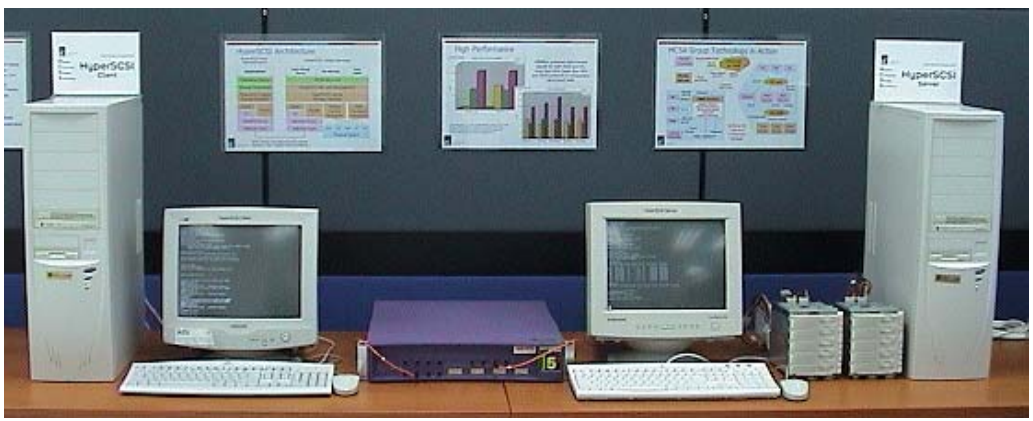
Applying Technology – Corporate

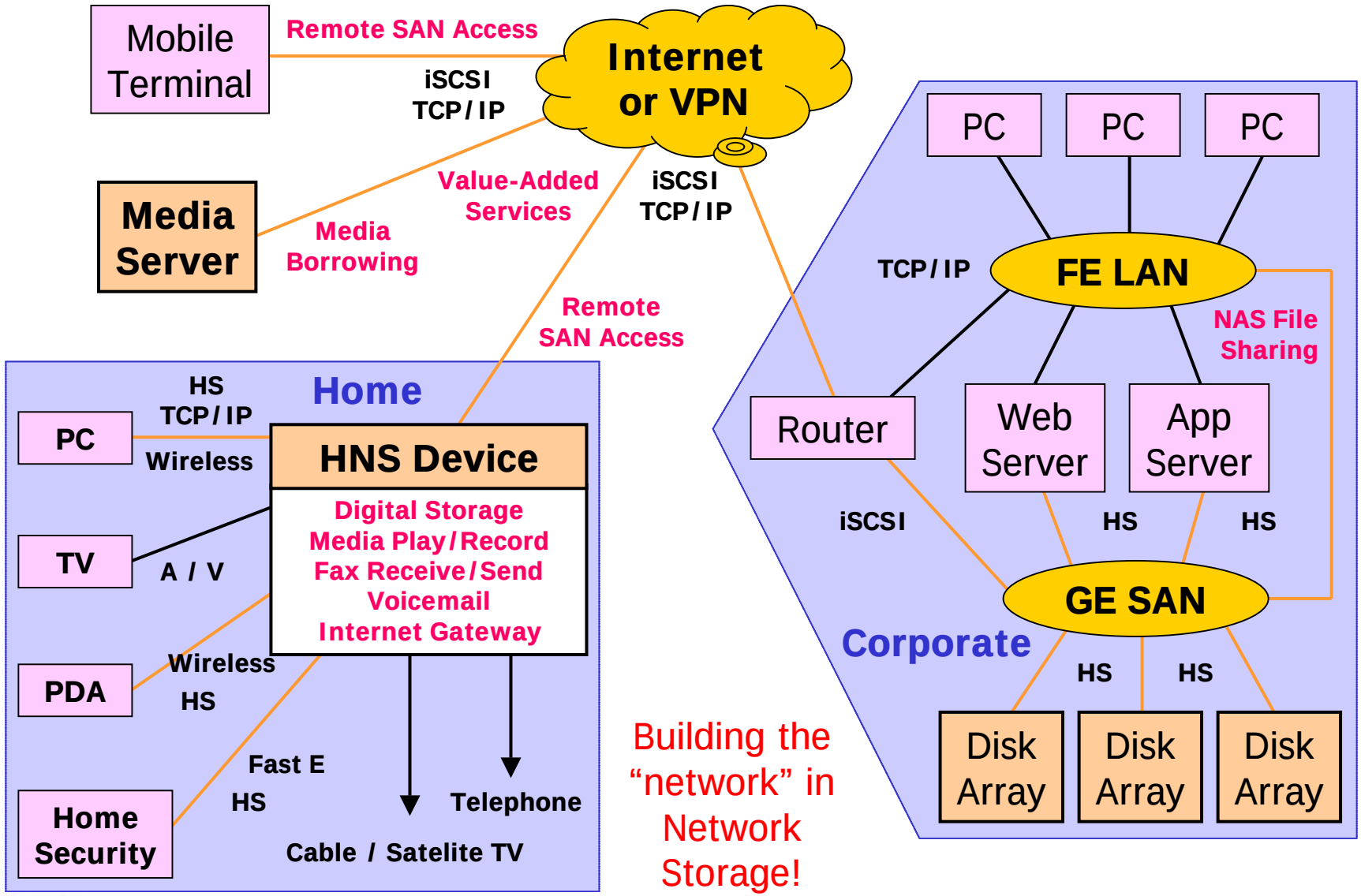
- Storage Area Networks (SAN) and Network Attached Storage (NAS)
- Information Continuance, Performance, Security and Reliability

Applying Technology – Clusters

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



The Network Storage Vision



Building the "network" in Network Storage!

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Conclusion

- Data is Growing and it needs to be Stored!
- Network Storage is the key to solving this and related real-world problems in the Enterprise and Consumer spaces
- The solutions are complex, and the technologies involved are diverse
- There's lots of cutting-edge and interesting work in Network Storage being done right here in Singapore!

So, 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?

What is the future of
Network Storage Technologies?

The best way to predict
the future is to

INVENT it!

Thank You

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