

Network Attached Secure Disks (NASD)

A proposal to NSIC for collaborative storage interface research

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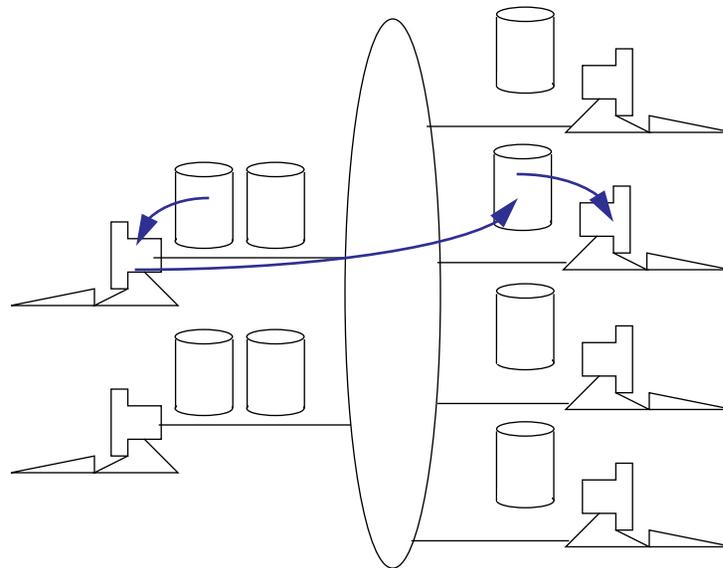
- **Storage Architecture Trends**
 - **Excessive Copying in Network Storage Architecture**
 - **Disk and Network Bandwidth Converging**
 - **Increasing Storage-embedded Function**
- **Network-Attached Storage Alternatives**



Trends: Data bytes travel over LANs

Workstation a poor and costly server

- designed around caching for processor-local work
- open physical system bus standard slows advances
- network bandwidth limited to approx single disk bandwidth
- induces extra copying



Trends: Migration to serial drive interface

Drive data rate rising rapidly

- **linear bit density up 20% per year**
- **spindle RPM doubled in 4 years**
- **new partial response, maximum likelihood encodings**

SCSI physical interconnect under stress

- **electrically noisy; large connectors; limited addressability**

Switching to serial interconnects

- **Firewire - desktop system bus**
 - **SSA - 20 MB/s SCSI packet ring**
 - **Fibrechannel - 120MB/s, multi-protocol, packet ring/switch**
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- **Are storage interconnects good LANs?**



Trends: Growth in drive-embedded functionality

Fast-moving, profit-tight marketplace

VLSI gives more cycles & bytes at constant price

- controllers in 2000 expected to have 200 MHz processors
- compete with value-added intelligence for performance

Disk scheduling

- use SCSI queue tags, only place for geometry-sensitive detail

Readahead/writebehind

- plenty of systems have OSs with poor caching



RAID support

- **offload parity update computation**

Cost of managing storage per year 7X storage cost

- **dynamic adaptation to workload**
- **selection and migration through redundancy schemes**
- **support for backup**

Dynamic mapping for transparent optimizations

- **log-structured for write (and read) bandwidth**
 - **log-structured for large write optimization**
 - **floating parity or parity logging**
 - **cache and media compression**
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- **SCSI storage abstraction too low level ?**

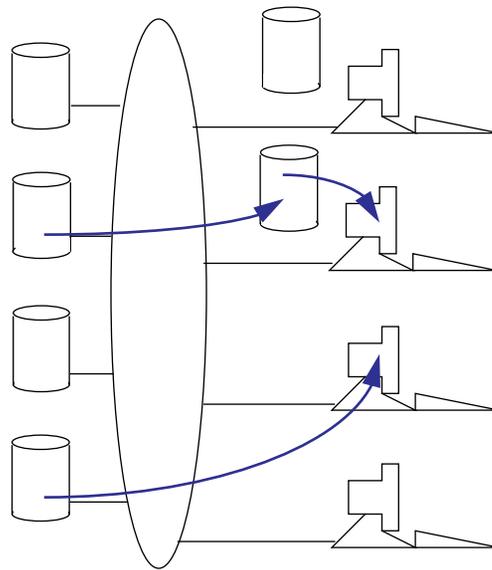


Alternative: Network attached storage

Attach storage directly to network

- fewer copies and appropriate bandwidth
- addressability for drive-to-drive transfer

Streamline LAN to storage performance standard



Alternative: Raise storage functional interface

< object, offset, length >

- **better readahead/writebehind and caching**
- **at-storage allocation management (dynamic mapping)**
- **object specific handling (compression, availability)**

Richer functional interface

- **hint for access patterns, allocation**
- **priority levels for interspersing small & large accesses**
- **admission-controlled isochronous transfers**



Alternative: Repartition file system model

Out-source device specific control from file system

- **retain namespace, access list interpretation, coherence model**
- **similar to client/server network file system partition**

Extensible, client library to parallelize storage

- **network RAID, parallel program support**
- **dynamic availability, load balancing**
- **client filesystem code and client machine untrusted**



Alternative: Integrate drive into LAN security protocol

Arbitrary packets must not be seen as commands

- **private key cryptography based on drive serial number**
- **tamper-resistant encryption for authentication check**
- **authentication server enables access to drive by passing drive a UID and session key**

May improve system security model

- **no logins at drive (SNMP style interface for administration)**
- **user configurable encryption over net or on media**
- **encryption over net requirements pay for authentication**



CMU PDL/DSSC Plans

Focus on drive embodiment

- far enough out for academic research

Cooperation

- NSIC interface pre-standards working group

Starting model of repartitioned file system

- Scotch Parallel File System

Controlling cost

- thin protocol stack on-drive; off-drive protocol emulation

Drive architecture

- drive system bus for caching, streaming, encrypt, parity, ...



Summary

Network-attached Secure Disks (NASD)

- “first class network citizens”
- direct data transfer to client
- eliminate workstation file server
- raise drive interface to file system
- integrate with authentication-based security
- repartition file system between client and drive
- support multiple client filesystem personalities
- optimized protocol processing, emulation for interoperability
- cost-constrained, transfer-oriented drive architecture

