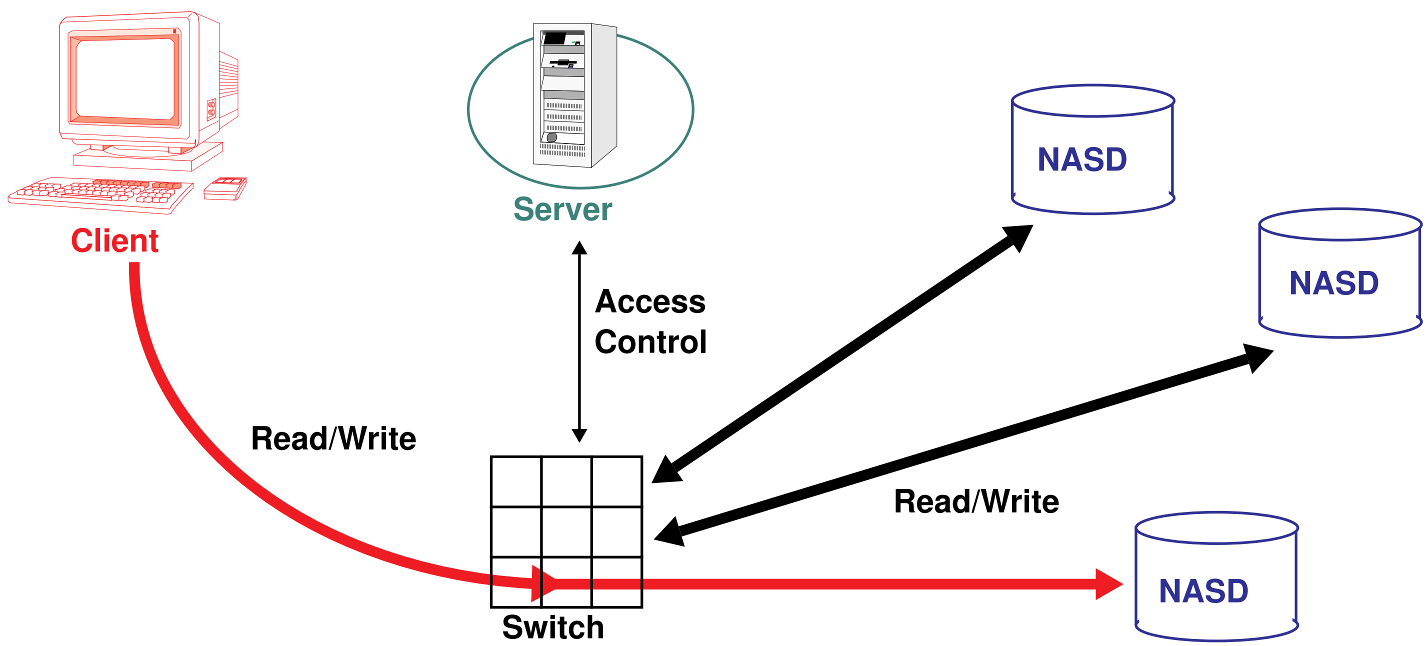
Network-Attached Secure Disks (NASD)

Garth A. Gibson, CMU, http://www.pdl.cs.cmu.edu/NASD

Latency....Bandwidth.....Latency....Bandwidth

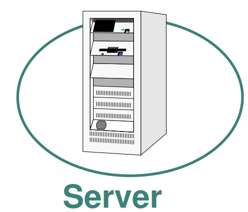
Disk Scheduling	RAID	Deep Prefetching	NASD
Client caches	LFS	Coop. caches	Zebra

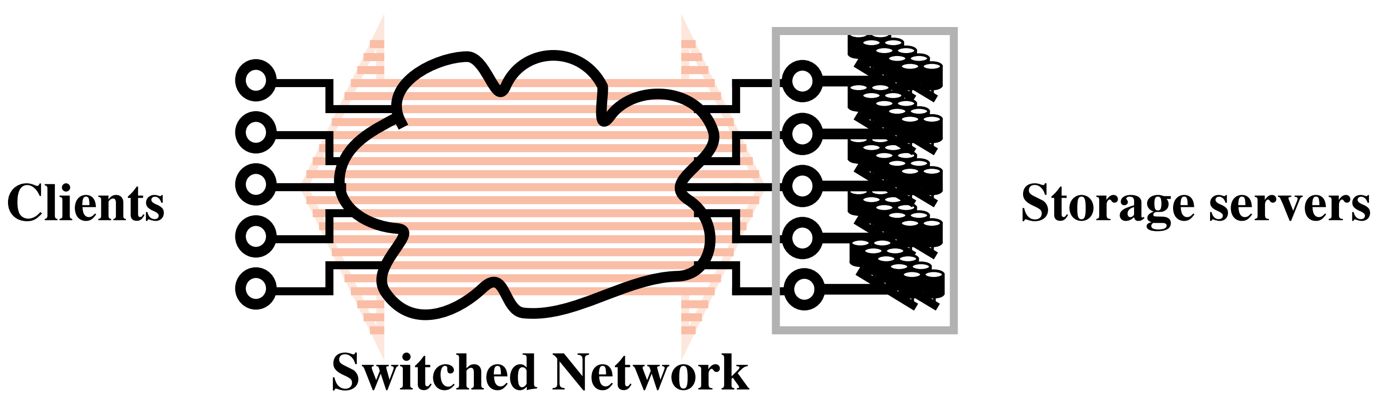


Storage Striped over Scalable Networks

Partitions distributed file server

- high-level striped file manager
  - naming, access control, consistency, atomicity
- low-level networked storage server
  - direct read/write, high bandwidth transfer





Low-level network storage architecture

Disk bandwidth: now 10+ MB/s; soon 30+ MB/s

Disk-embedded, high-speed, packetized SCSI

- **100+ MB/s Fibrechannel peripheral interconnect**

How many drives per low-level storage server?

Many == super-servers to amortize cost

Few == must minimize server cost

- **fold into client (xFS)**
- **fold into disk (NASD) !**

A Taxonomy for Network-Attached Storage

Server-Attached Disk (SAD)

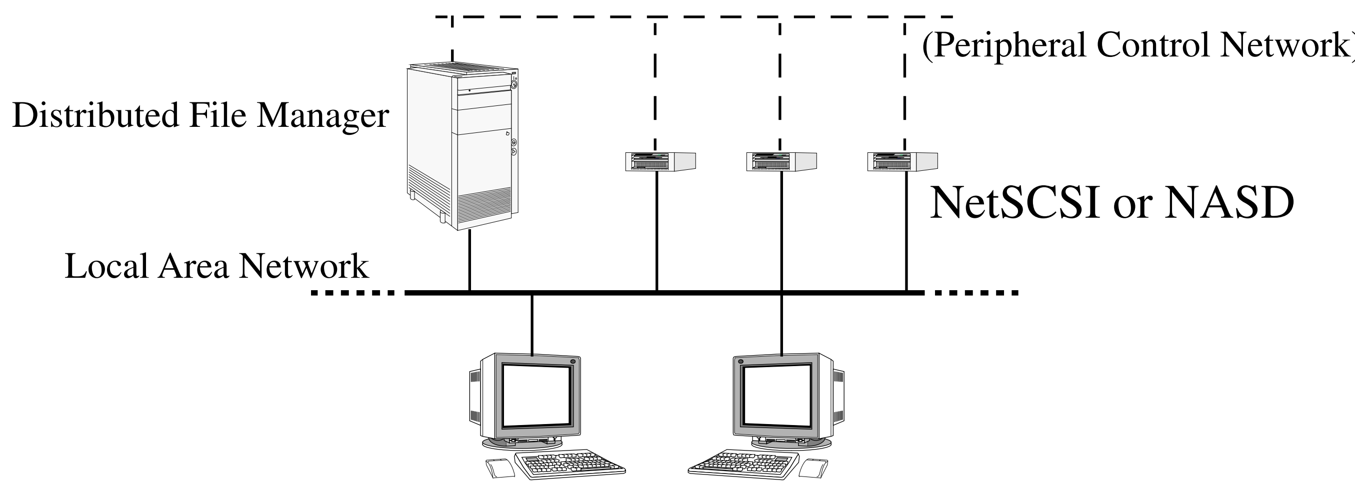
- **workstation running file server code**

Networked SCSI (NetSCSI)

- **minimal differences from today's SCSI disks**

Network-Attached Secure Disk (NASD)

- **significant, enabling interface difference from SCSI**



Commodity NASD: Might it help NFS?

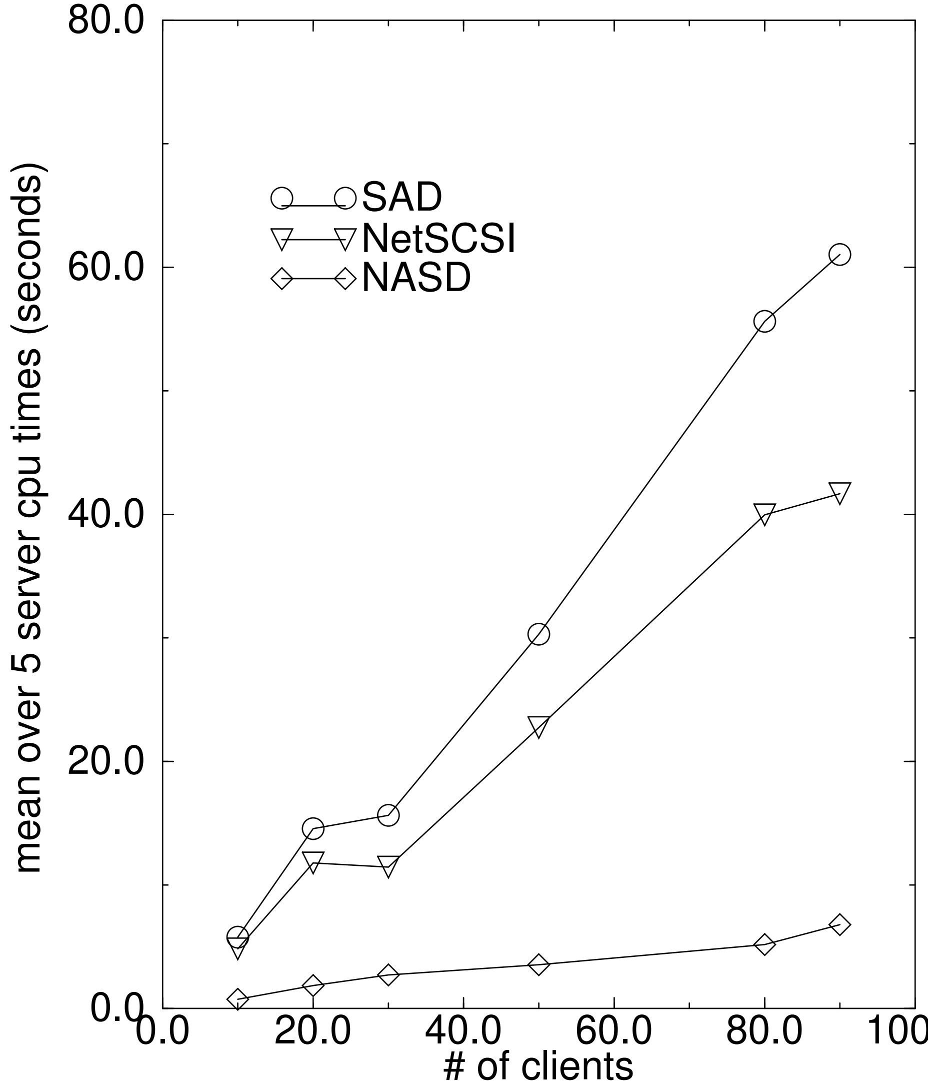
Can we offset drive cost increase?

Trace-replay

- replay transformed RPCs at NFS server

Manager savings

- NASD saves ~10X
- NetSCSI saves ~33%



Conclusion

- Network-attached exploits switching for BW scaling
- Multiple categories of network-attached make sense
  - SAD - workstation fileserver
  - NetSCSI - server-mgd SCSI transfers to client
  - NASD - server-independent client access to drive
- Higher level interfaces enable storage innovation
- NASD may lower traditional manager work by 10x

http://www.pdl.cs.cmu.edu/NASD

Q&A: Related Work

Network-attached (secure) storage

- Baracuda, Seagate; DVD, van Meter; Auspex/NetApp, Hitz

Third-party transfer

- RAID-II, Drapeau; PIO, Berdahl; MSSRM, P1244; SCSI

Richer storage interfaces

- Logical Disk, deJonge; Petal, Lee; Attribute Mgd, Wilkes;

Server striping

- Zebra, Hartman; xFS, Dahlin

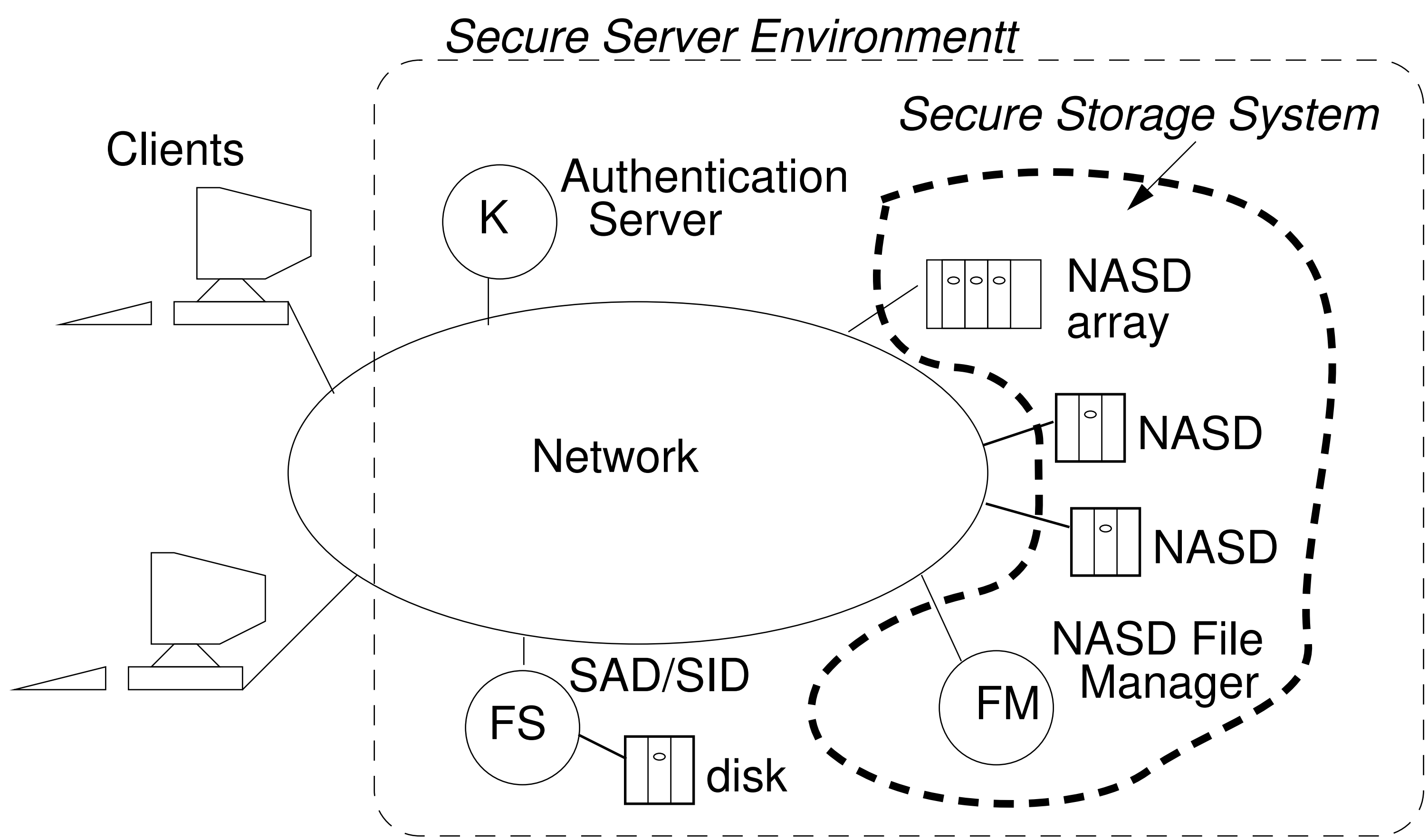
Application-assisted storage

- Mapped cache, Maeda; Fbufs, Druschel; LRU-SPU, Cao; compiler hints, Mowry; Cooperative caching, Dahlin

Q&A: Network-Attached Security Issues

Arbitrary packets must not be seen as commands

- **physical security and/or cryptography (digests)**



Q&A: Caching in Striped Storage

Can't cache in manager for free !?

1) Client cache effectiveness is primary

- cooperative caching

2) Partition server cache over storage servers

- striping minimizes hotspots

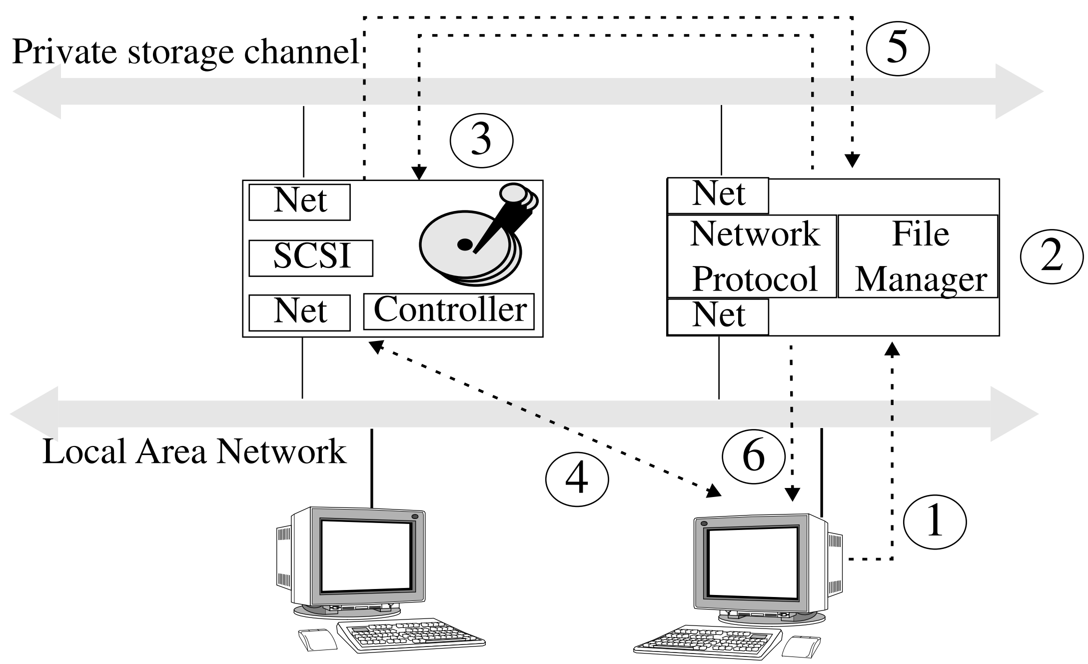
3) Informed prefetching hides disk, net latency

Q&A: Networked SCSI (NetSCSI)

Minimize change in drive HW, SW, IF: RAID-II

- server translates (2) and forwards (3) request (1)
- drive delivers data directly to client (4)
- drive status to server (5), server status to client (6)

Scalable aggregate bandwidth through striping



Q&A: Network-Attached Secure Disk (NASD)

Avoid file manager unless policy decision needed

- access control once for all accesses to drive object
- spread access computation over all drives under manager

Off-load manager work, reduce indirection delays