

Active Storage Networks

John A. Chandy

Department of Electrical and Computer Engineering



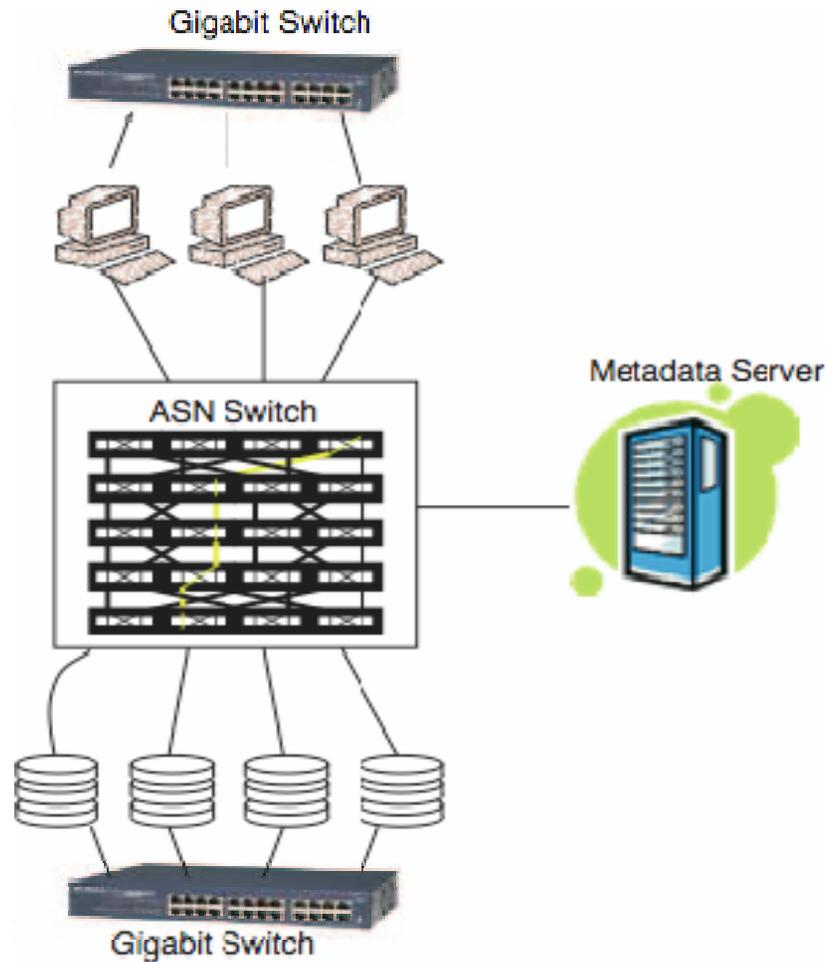
Active Storage Networks

- Can intelligence in a storage network
 - Accelerate computation?
 - Accelerate storage access?
- How do you build an active storage network?
 - Switch design
 - File system design

Motivation

- Active Disks
 - Intelligence at the disk can distribute computation to parallel disks
 - Process data in streams
 - Disks only have local view of data
- Active Storage Network
 - Network has a global view of data
 - Distributed caching of file system metadata and data
 - Redundancy optimizations

Active Storage Network



Active Storage Networks

- Application operations
 - Reduction operations
 - Database queries
 - SELECT ... ORDER BY .. LIMIT k
 - m disks n items per disk
 - $O(nm)$ for normal disks
 - $O(n + mk)$ for active disks
 - $O(n + \log mk)$ for active disks with MSN
 - Scientific applications
 - MPI_SUM, MPI_MAX, etc.



Active Storage Networks

- Application operations
 - Transformational operations
 - Sorting
 - $O(mn \log mn)$ for normal disks
 - $O(n \log n + mn \log m)$ for active disks
 - $O(n \log n + mn)$ for active disks with ASN
 - Scientific applications
 - Matrix transformations
 - stream-based
 - Video editing

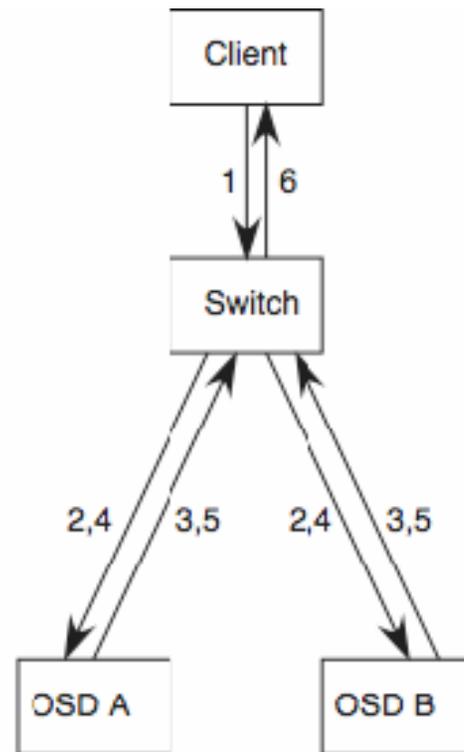
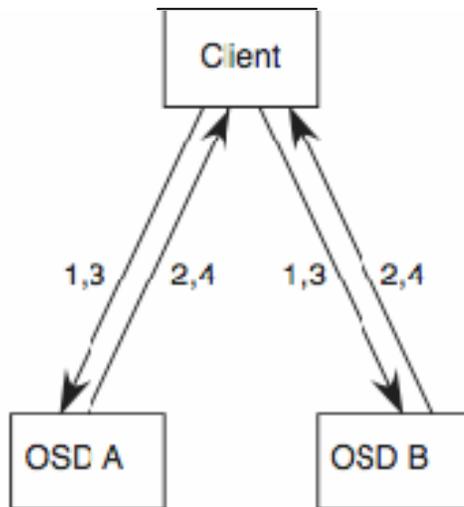
File System Caching

- Centralized cache frees up memory at the clients
- Metadata caching reduces access to metadata server
 - File layouts
 - Directory lookups
 - File access attributes



Redundancy optimizations

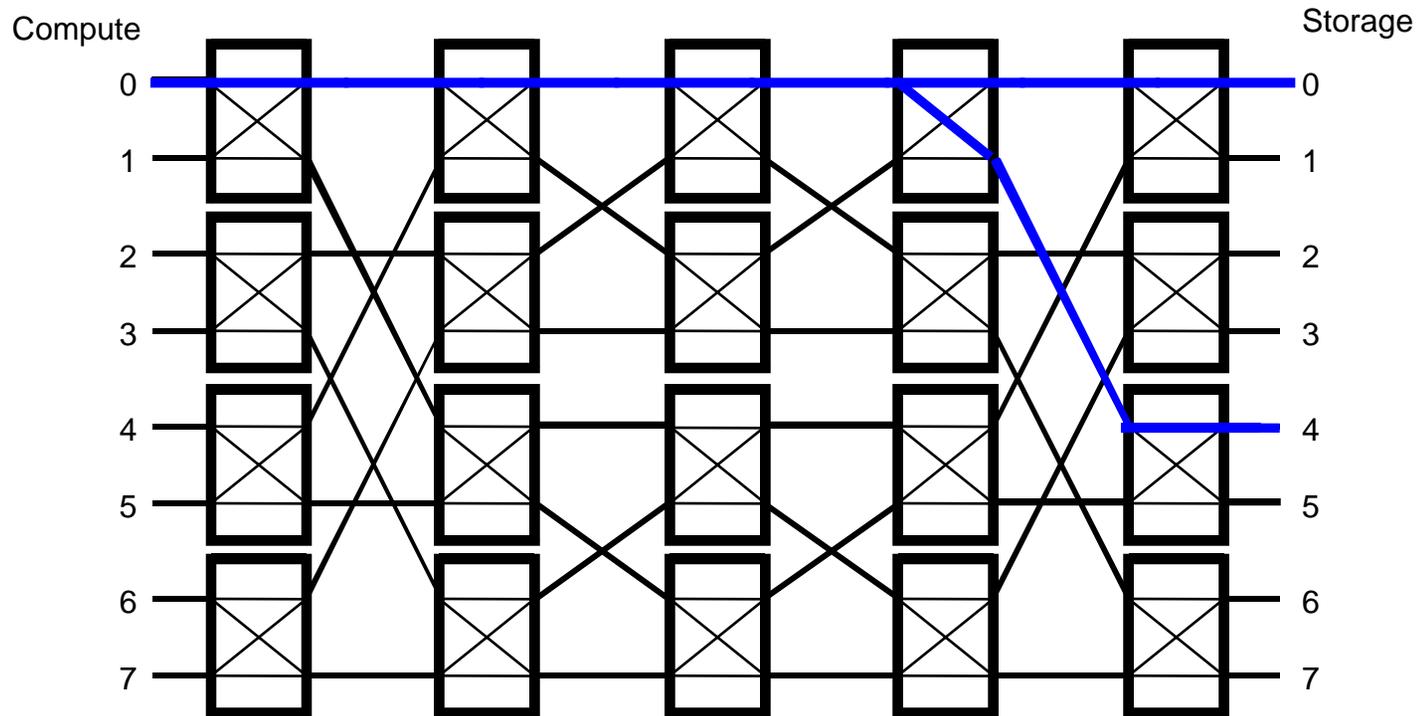
Parity calculations



Network Structure

- Topology Choices
 - Bus
 - Crossbar
 - Butterfly
 - Benes

Network Structure



ASN Switch Implementation

- Reconfigurable elements (FPGA)
 - Faster design and lower cost than ASIC
 - Fast enough to handle gigabit speeds
- Downloadable functions (netlets)
 - Software functions on embedded processors
 - Hardware functions on FPGAs

Summary of Research Goals

- Investigation of ASN topologies and architectures
- Creation of ASN switch from reconfigurable components
- HEC applications for ASNs
- Programmable functions for ASNs
- Storage system optimizations for ASNs