Storage Technology in Healthcare

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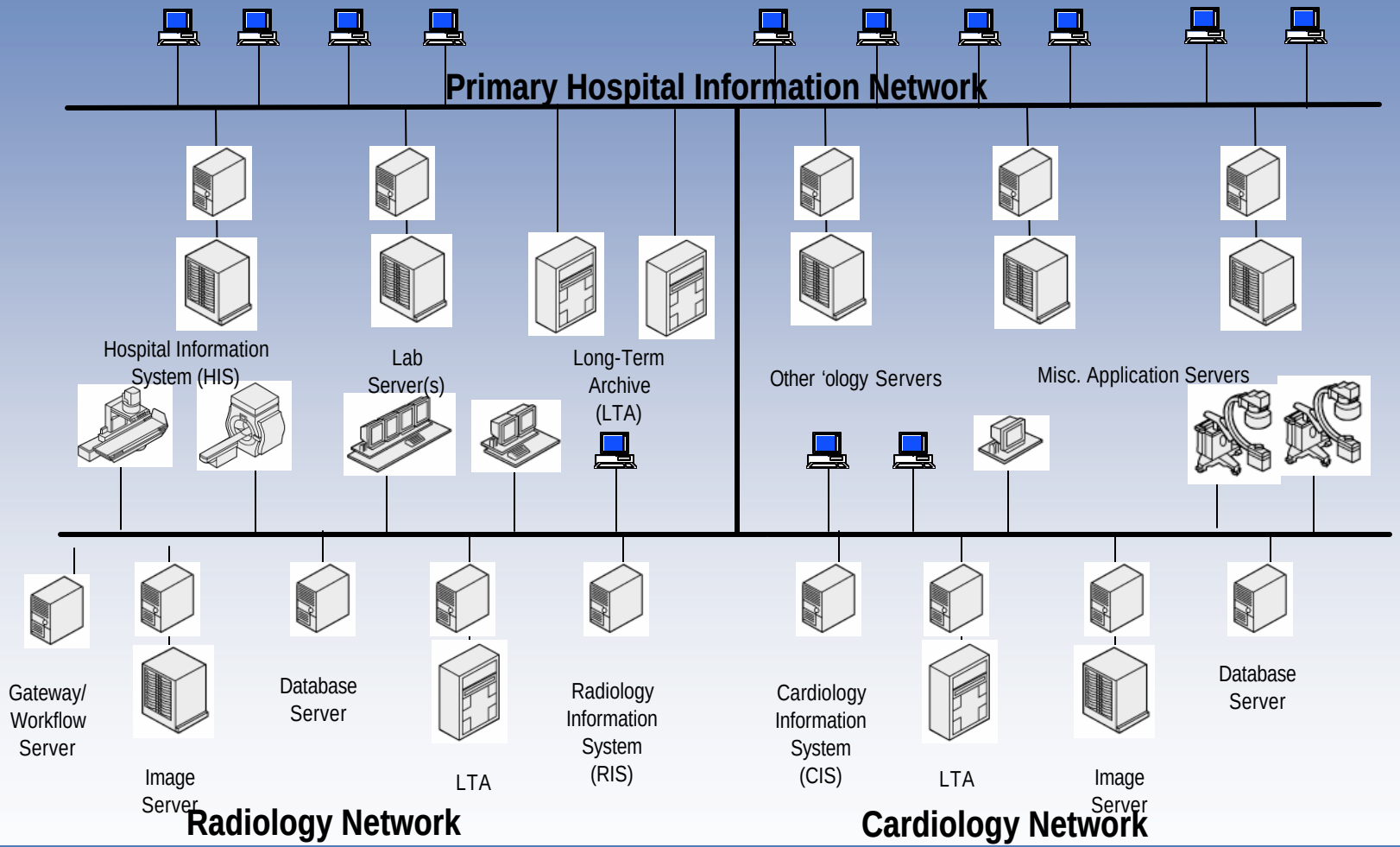
- President of KAI Consulting
- Past or current consulting relationships with:
  - Several Major Imaging & Informatics Vendors
  - Several Major IT Technology Vendors
- Other Relationships
  - Contributing Editor - Imaging Technology News
  - Board of Directors - HealthSphere Corporation

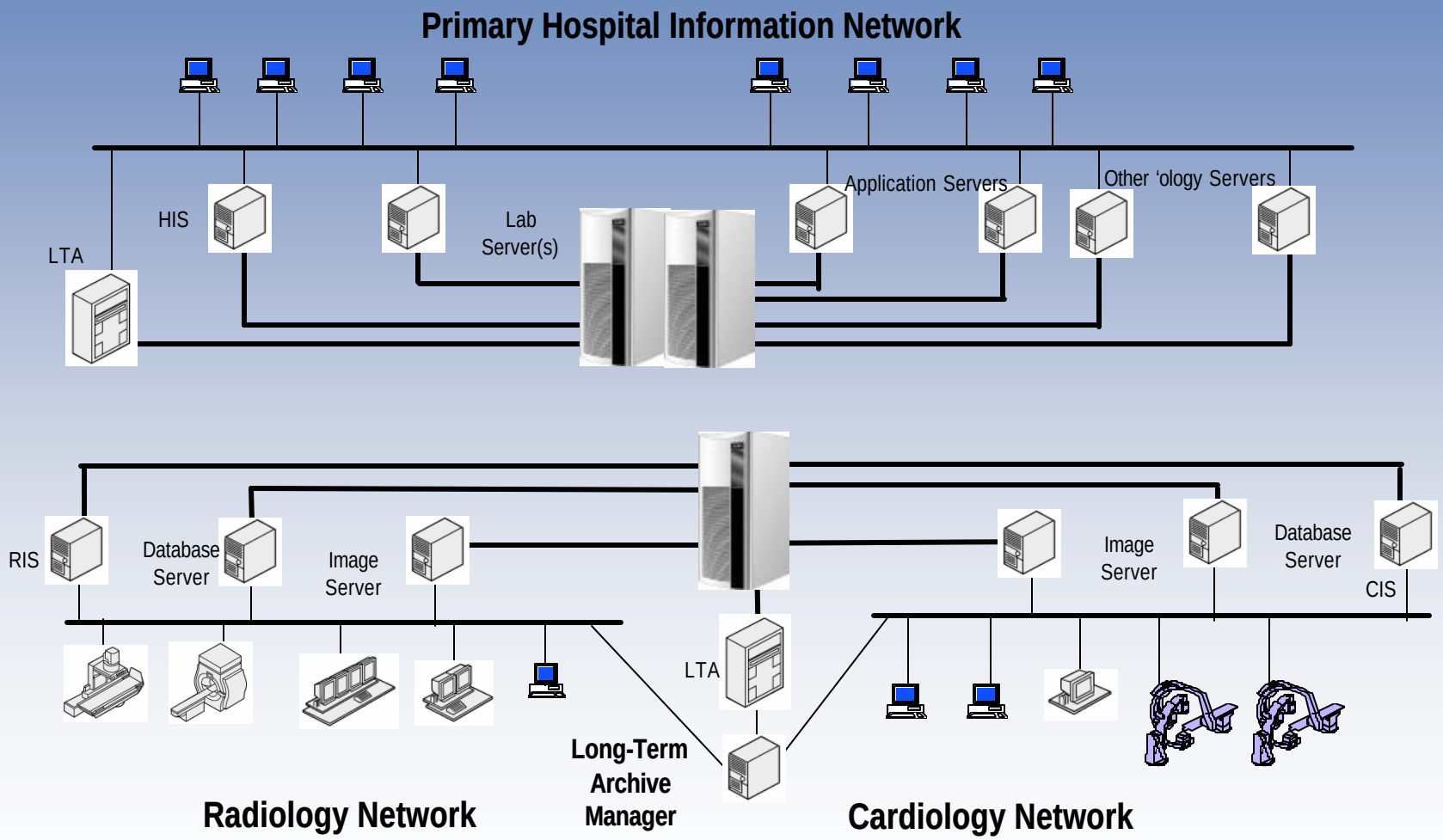
Storage Technology in Healthcare

- Brief History of Storage in Healthcare
- Storage System Challenges
- Storage Basics Review
- Storage Technologies – Hardware
- Storage Technologies – Software
- Summary

Typical Medium to Large Healthcare Environment



Multi-department Storage Consolidation Solution



Storage System Challenges - Business

- Cost reduction verses quality patient care
- Protect confidential medical record information / HIPAA & JCAHO Compliance
- Business continuance and disaster recovery - Time to recover?
- Integrate clinical data across applications & access to shared patient information

Storage System Challenges - Technical

- Lack of qualified technical professionals
- Broader range of technologies to support
- Manage & protect increasing amounts of data – 100% availability of data required
- Security for data storage and distribution
- Distributed departmental solution vs. enterprise management
- Standards vs. proprietary solutions

Storage System Challenges - Clinical

- Information when & where it's required
- Loss or corruption of clinical and imaging databases is unacceptable
- Impact on Hospital / Patients?

FDA Storage & Archiving Opinion

- In early 2002, Kris K. Hughes, Esq. crafted a request to the FDA regarding clarification of PACS storage
- On 7/3/2003 the FDA released an opinion on storage and archiving systems
  - A general purpose storage / archive system is a class 1 device.
  - If not specifically marketed for a medical application, it does not require pre-market approval.
  - The statement “That storage is not FDA approved” is not valid.
- An educated consumer can request alternatives to the standard offering of a PACS vendor

Storage Basics Review

- Storage Evaluation Parameters
  - Capacity
  - Performance
    - Access times
    - Transfer speed
  - Interface standards
  - Reliability
- Hardware
  - Fixed Media
    - Disk
  - Removable Media
    - Tape
    - Optical
- Software
  - Storage Management
    - Device Management
    - Resource Management
  - Data Management

Storage Technologies - Hardware

- Disk Technology
  - Desktop
    - 4.2K – 7.2K RPM
    - 250GB +
  - Large Capacity
    - 250GB +
    - Usually slower <10K
  - Fast Disk
    - 10K / 15K RPM
    - Usually smaller
  - Perpendicular Recording Method
    - Higher densities
    - Future – 2 years
- Device Interface Technologies
  - Desktop
    - ATA
    - SATA
  - Enterprise
    - SCSI
    - Fiber Channel
  - Archive
    - SATA

Storage Technologies - Packaging

- Fixed
  - Enterprise
    - Very scalable
    - Multiple interface / systems
    - Very high-availability
  - Midrange
    - Usually 1 interface type
  - Low-profile & blade
    - High density
    - Multiple systems
- Removable
  - Tape Technologies
    - Fast Tape
    - Large Capacity Tape
  - Optical Technologies
    - Consumer Optical
    - Specialty Optical
  - Library Platforms
    - Desktop
    - Desk side
    - Silo

Storage Technologies -Tape & Optical

- Tape Technologies
  - Fast Tape
    - StorageTek 9840
    - Sony AIT3
  - Large Capacity
    - StorageTek 9940
    - LTO
    - Super DLT
- Optical Technologies
  - Consumer
    - CD
    - DVD Family
  - Specialty
    - MOD
    - Plasmon UDO
    - Blue-Ray DVD (future)

Technology Comparison

100MB Study

	RAID	9840 C	9940 B	LTO	Super DLT	AIT 3	MO	DVD UDO	DVD R	DVD +RW
MB / Sec Transfer rate	70	30	30	30	16	12	2	8	3	3.3
Robot	0	4	4	4	4	4	4	3	4	4
Load	0	4	18	19	12	10	5	5	4	4
Search	1	8	41	52	70	27	2	1	1	2
Transfer	4	13	13	8	16	21	125	31	83	71
Total Time	5	29	76	113	102	62	136	48	92	81
Unload Time	0	4	18	15	16	10	5	5	4	4
Total cycle time (load/xfer/unload)	5	33	94	128	118	72	141	53	96	85

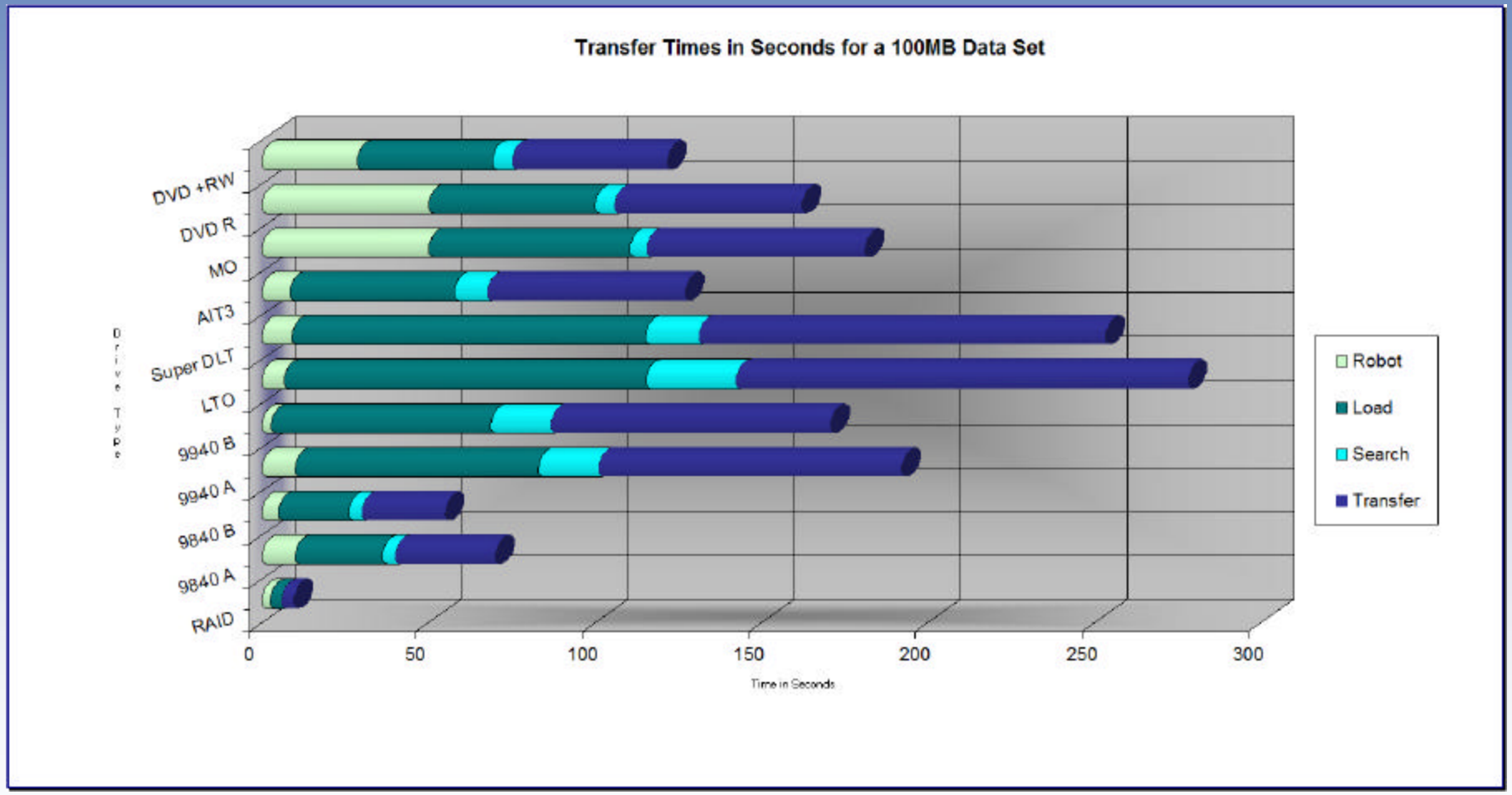
250MB Study

	RAID	9840 C	9940 B	LTO	Super DLT	AIT3	MO	DVD UDO	DVD R	DVD +RW
MB / Sec Transfer rate	70	30	30	30	16	12	2	8	3	3.3
Robot	0	4	4	4	4	4	4	3	4	4
Load	0	4	18	19	12	10	5	5	4	4
Search	1	8	41	52	70	27	2	1	2	2
Transfer	1	5	3	3	6	8	50	13	50	29
Total Time	2	21	66	78	108	49	61	30	33	39
Unload Time	0	4	18	15	16	10	5	5	4	4
Total cycle time (load/xfer/unload)	2	25	84	93	124	59	66	35	37	43

Charts provided courtesy of StorageTek

Technology Comparison

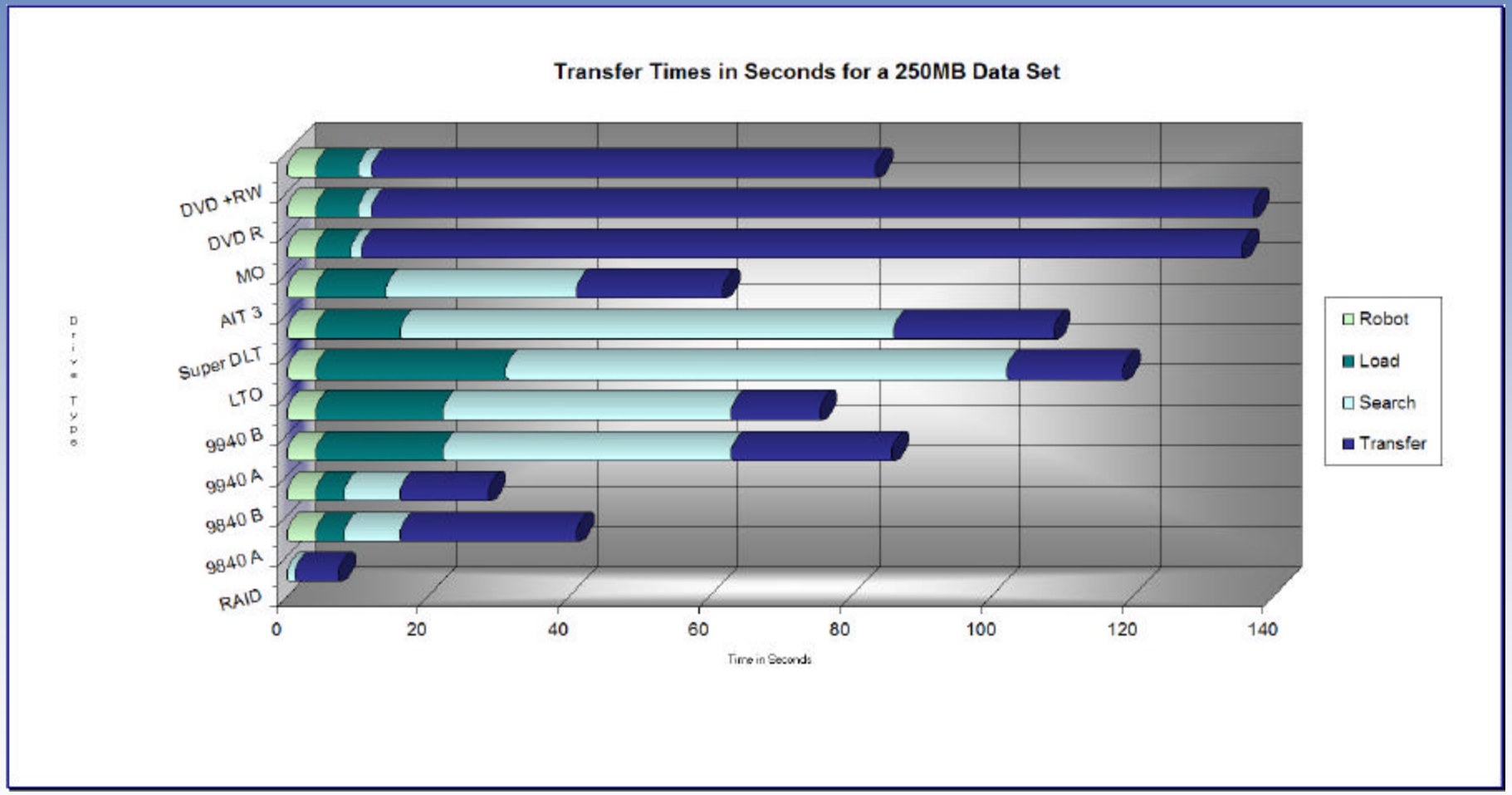
100MB X-Ray Study



Charts provided courtesy of StorageTek

Technology Comparison

250MB Cardiac Study



Charts provided courtesy of StorageTek

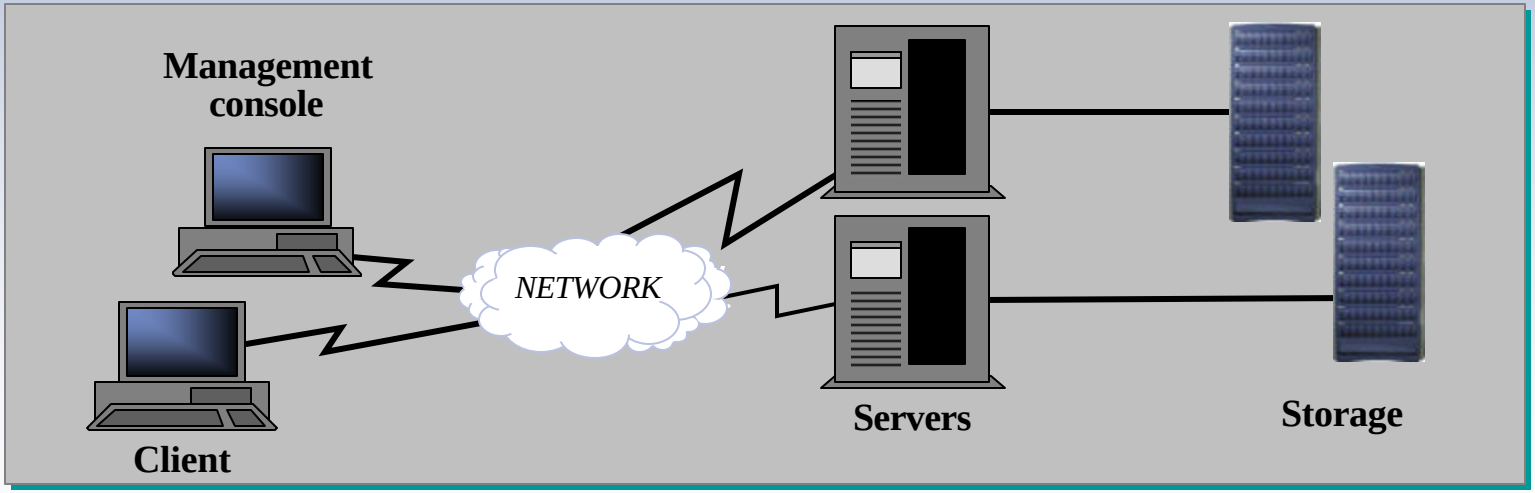
Storage Technologies - Hardware

- Storage Topologies
  - **DAS** - Direct Attached Storage
  - **NAS** – Network Attached Storage
  - **SAN** - Storage Area Network
  - **Hybrid**
  - **iSCSI**

Storage Topologies
Direct Access Storage (DAS)

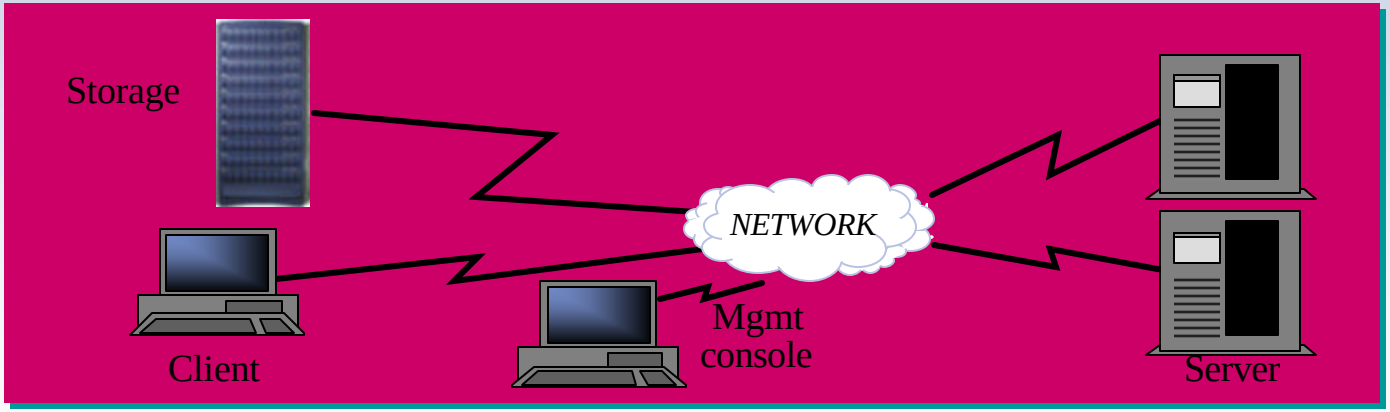
- Utilizes block transfer
- Direct connection using SCSI, Fibre Channel or ESCON

- File system on and managed by servers
- Typical connection used for most legacy PACS systems



Storage Topologies
Network Attached Storage (NAS)

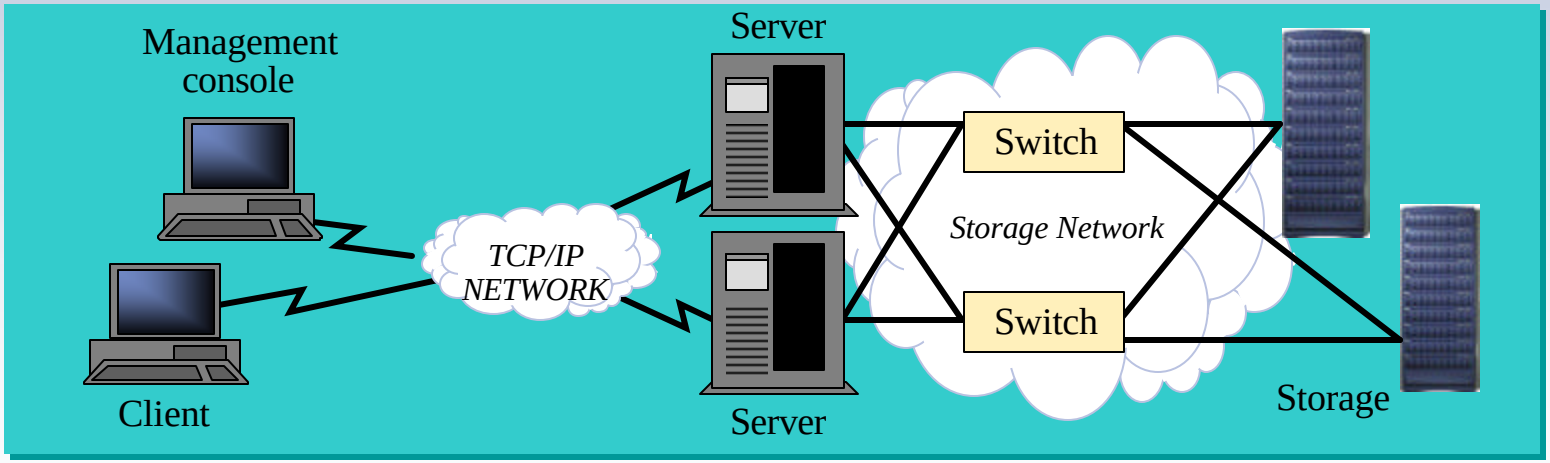
- File-oriented using byte transfer
- Connection via standard network protocols
  - TCP/IP, NFS, CIFS
- Higher network overhead
- File system on storage device
- Lower acquisition costs
- Lower single system availability



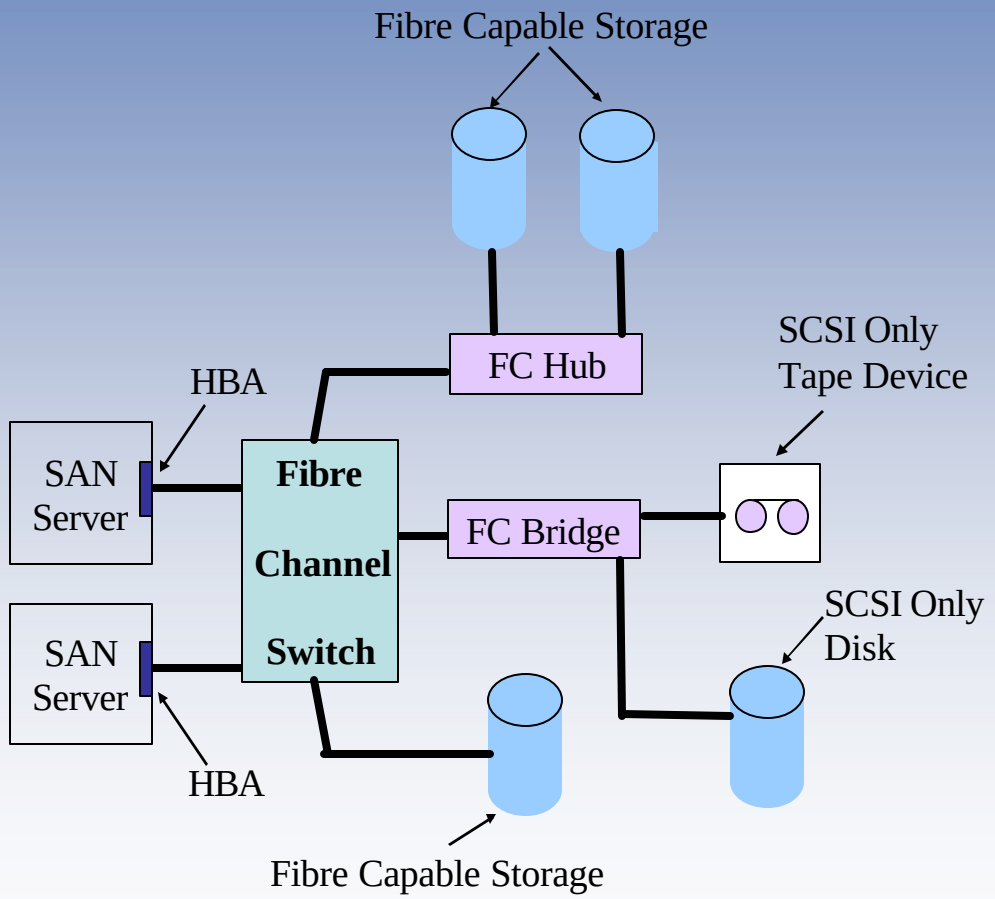
Storage Topologies
Storage Area Network (SAN)

- Utilizes block transfer
- Switched connections via Fibre Channel
- Lower impact on network vs. NAS

- File system on and managed by servers
- Generally higher implementation costs
- More complex than NAS

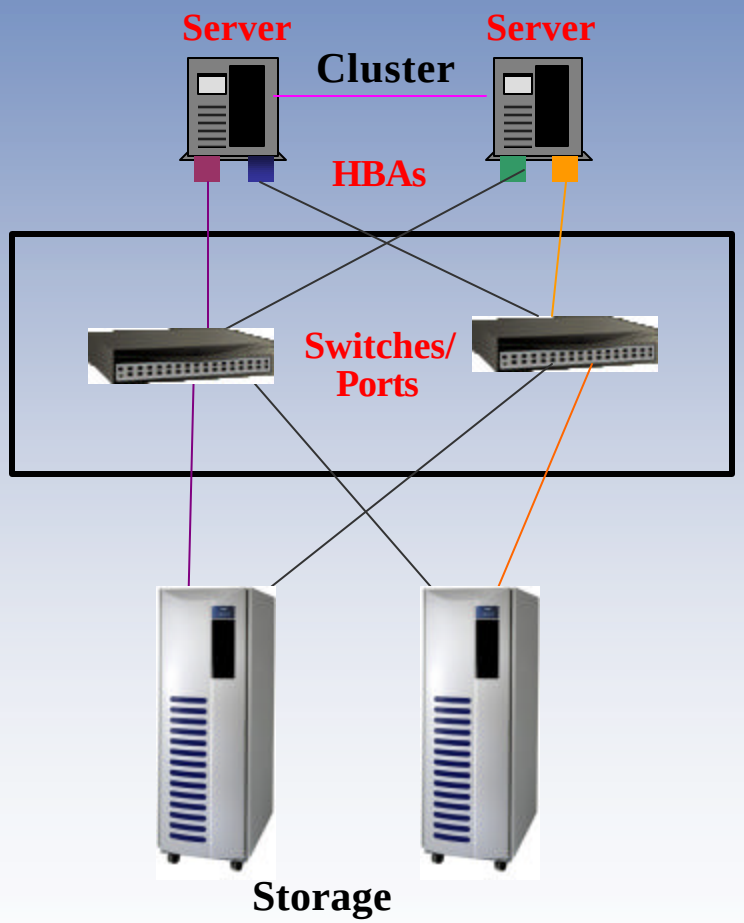


Storage Topologies
SAN Components - The Basics



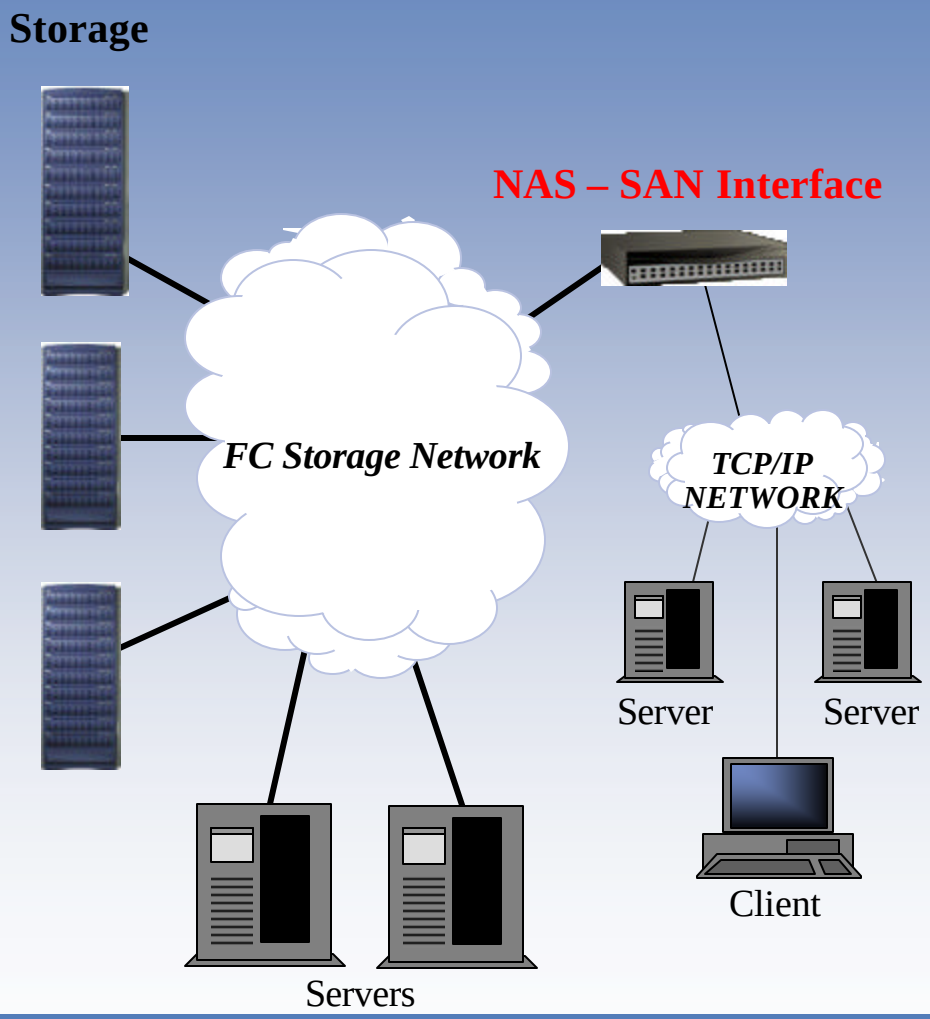
- **Host Bus Adapter - HBA**
  - Connection point from a server to Fibre Channel
- **Hub**
  - Logically creates a loop
- **Switch**
  - Device which allows simultaneous any-to-any connectivity
  - 99.9% Availability
  - Self-Engineered (like s/w RAID)
- **Director**
  - Highly available switch
  - 99.999% Availability
  - Factory Engineered (like h/w RAID)
- **Bridge**
  - Conversion between SCSI and Fibre Channel

Storage Topologies
Enterprise Class SAN - No SPOF



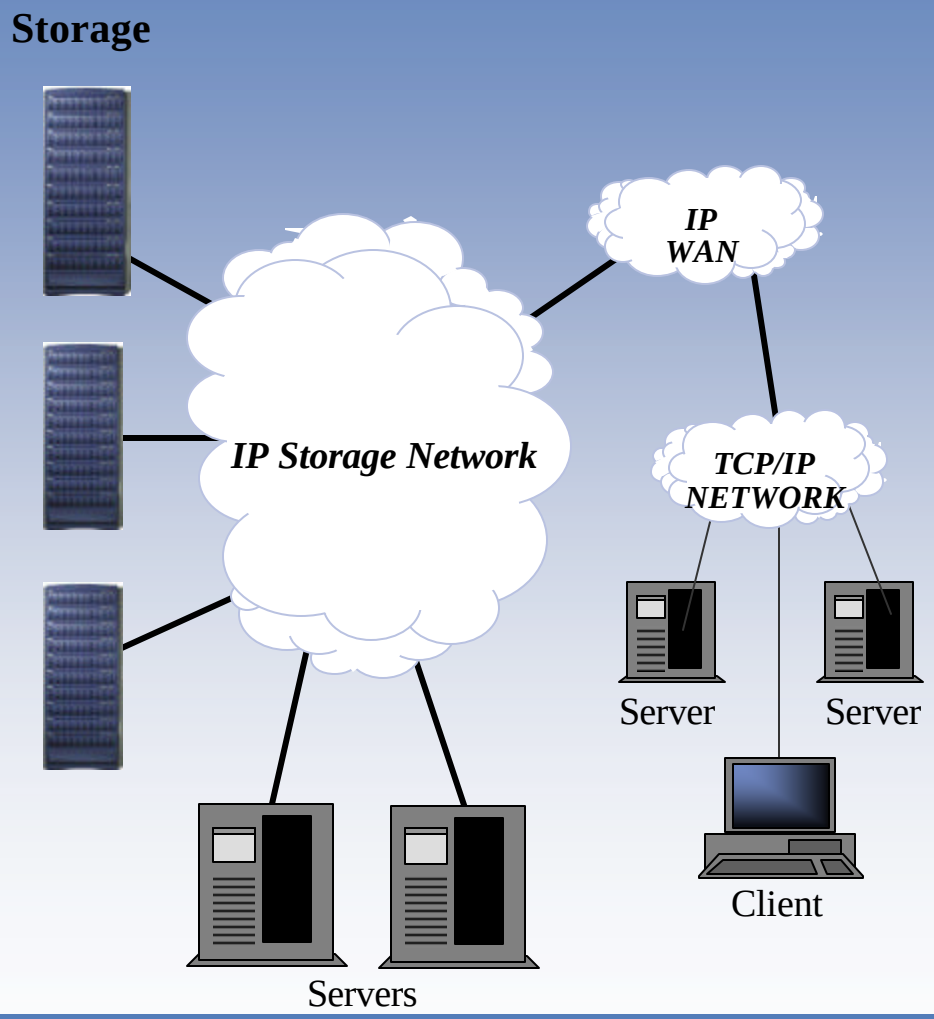
- Cluster Software for Server Availability
- Dual HBAs per Server
- Redundant Switches
- Redundant Cabling & Data Paths
- RAID disks served across separate disk controllers
- Multiple FC & Disk Controllers
- Proactive Diagnostics
- Mgmt software monitoring logical and physical storage & switches
- Alert Escalation via SNMP, Email, page

Storage Topologies - Hybrid



- NAS – SAN Gateway
  - Adds file interface to a block SAN
  - Leverages a common storage infrastructure
  - Supports NAS standards

Storage Topologies - ISCSI



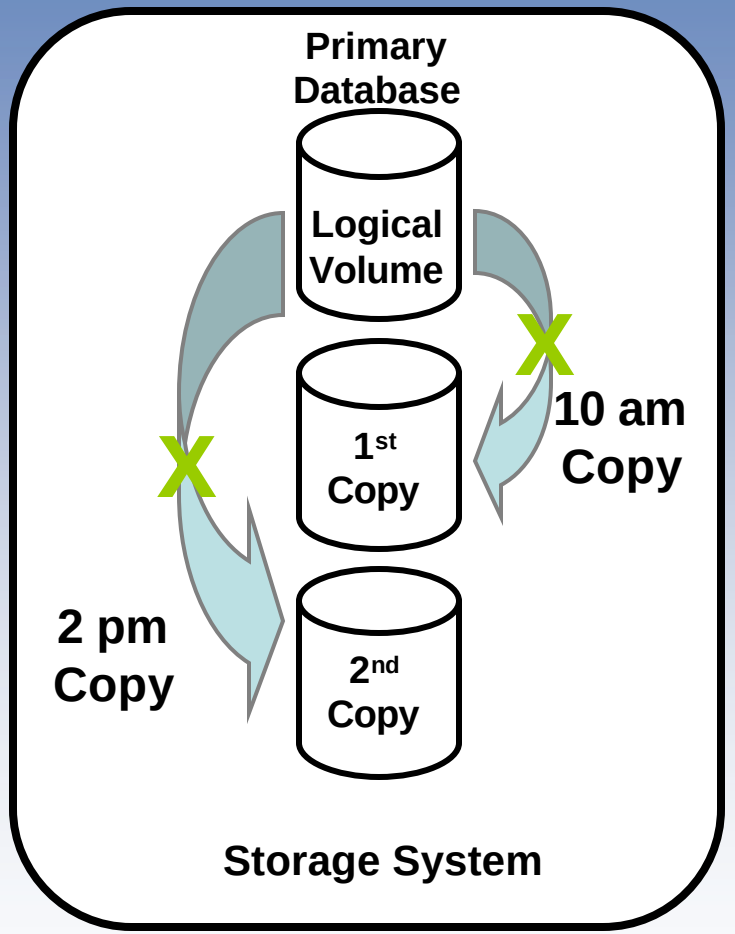
- Uses IP network
- More overhead than Fiber Channel
- 1Gb/s
- Typically lower cost
- Can use standard IP WANs
- High performance requires TCP/IP off-load engine (TOE) cards

Storage Technologies - Software

- **File Replication Tools**
  - General purpose
  - Application dependant
- **Backup Applications**
  - Image-based
  - File-base
- **Storage Management Applications**
  - Local mirroring & instant Point-in-Time (PIT) copy
  - Remote mirroring
- **Hierarchical Storage Management (HSM)**
- **Content Addressable Storage (CAS)**
  - NAS based
  - Grid based

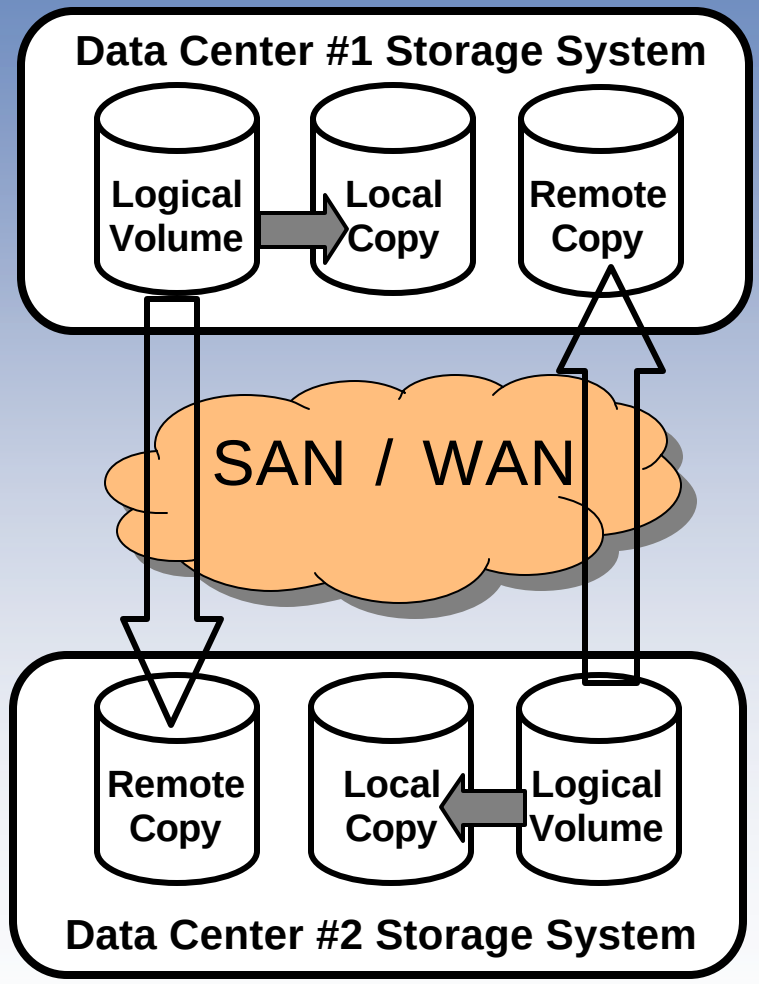
Storage Management
Local Mirror & PIT Copies

- Provides multiple mirror copies
- Operates in Block Mode
- Supports PIT copies
- Allows rapid database restore
- Technologies
  - Full Copy
  - Table Image



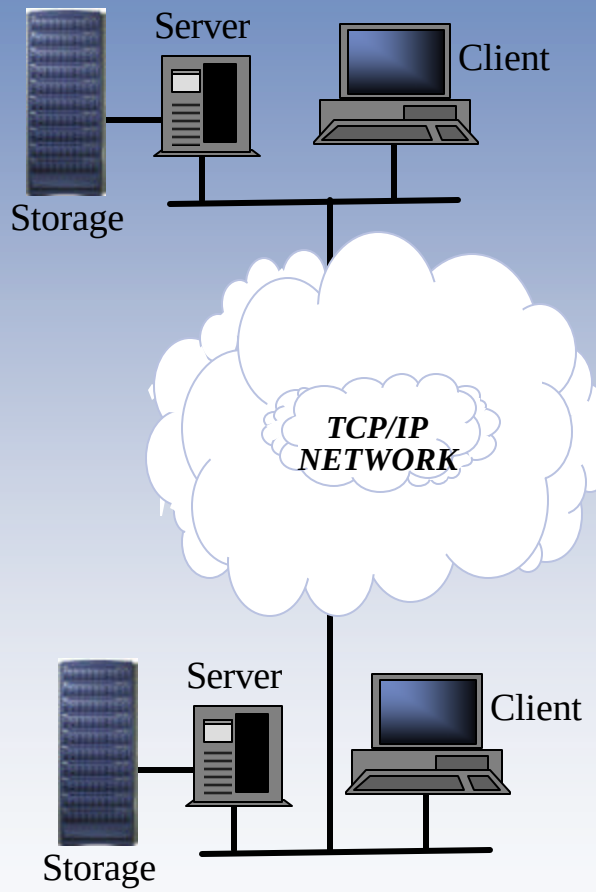
Storage Management
Remote Mirroring

- Provides multiple copies in different physical locations
- Allows recovery for catastrophic failures
- Communication infrastructure dependant
- Technologies
  - Synchronous
  - Asynchronous



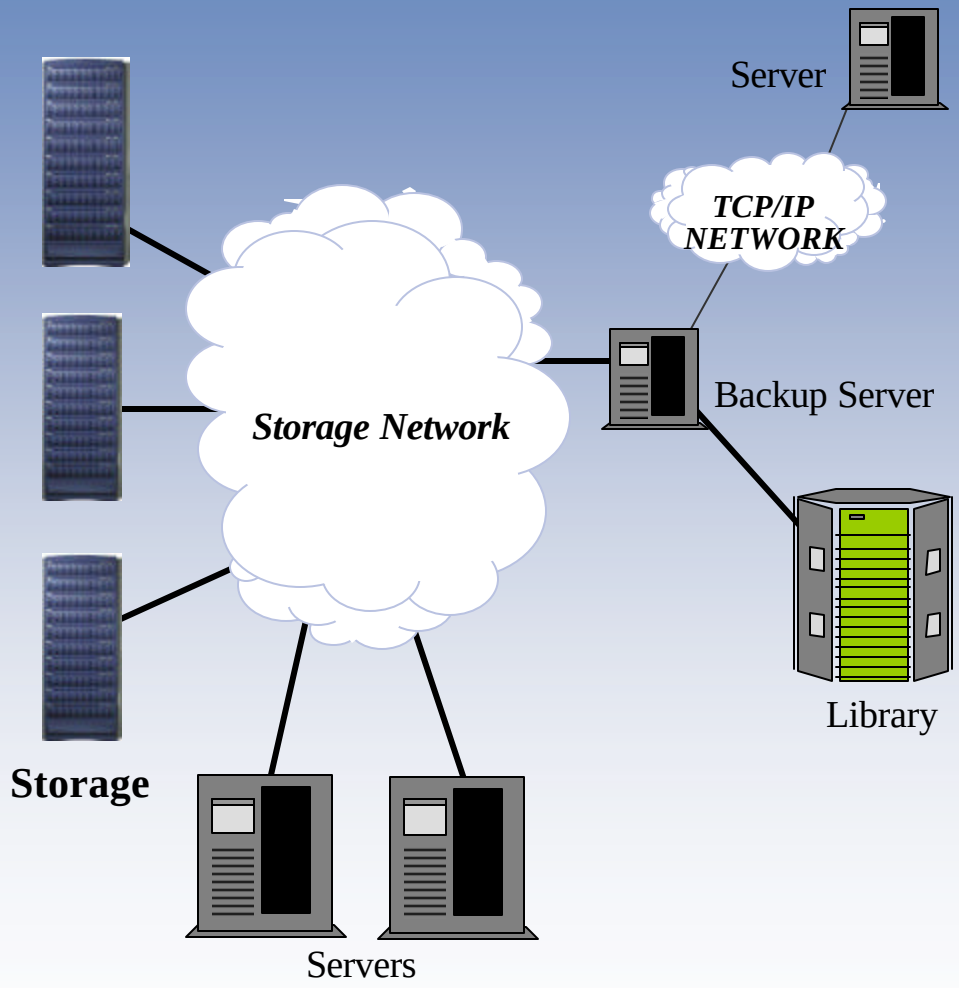
Storage Management - Replication

- Provides ability for copies in multiple systems
- Operates at the server & file level
- Policy-based
- Copies are usually read-only data
- Used to bring data closer to users
- Can be complex to implement
- Usually application dependant



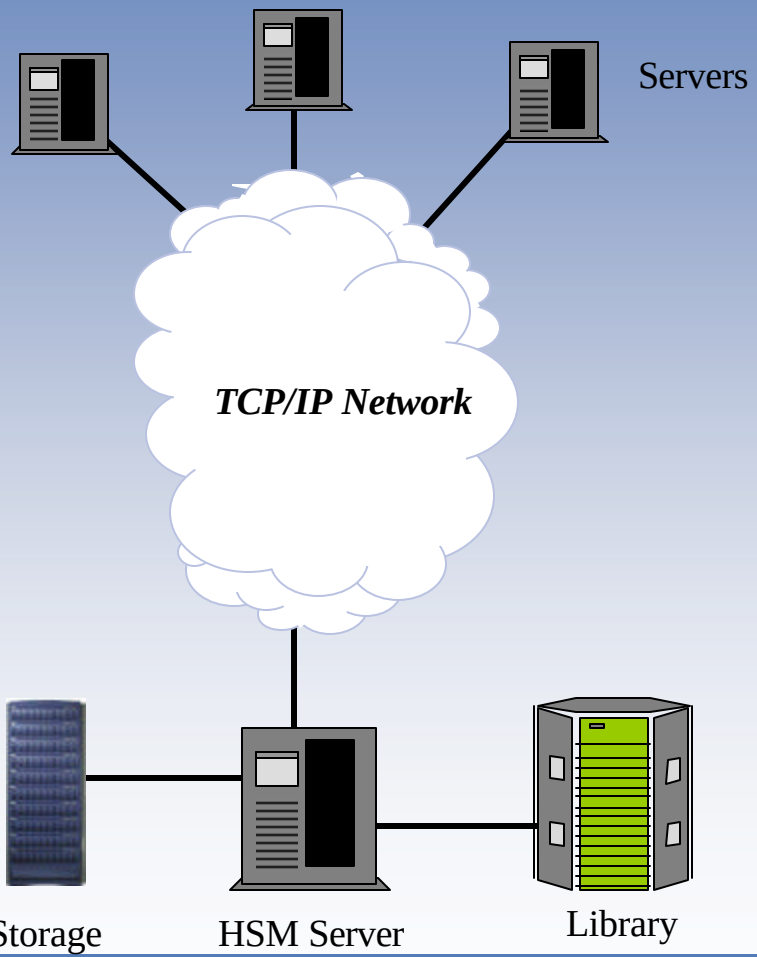
Storage Management - Backup

- Two models
  - Image
  - File
- Most require database be varied off-line
- Slow restoration from removable media
- SAN usually requires backup server



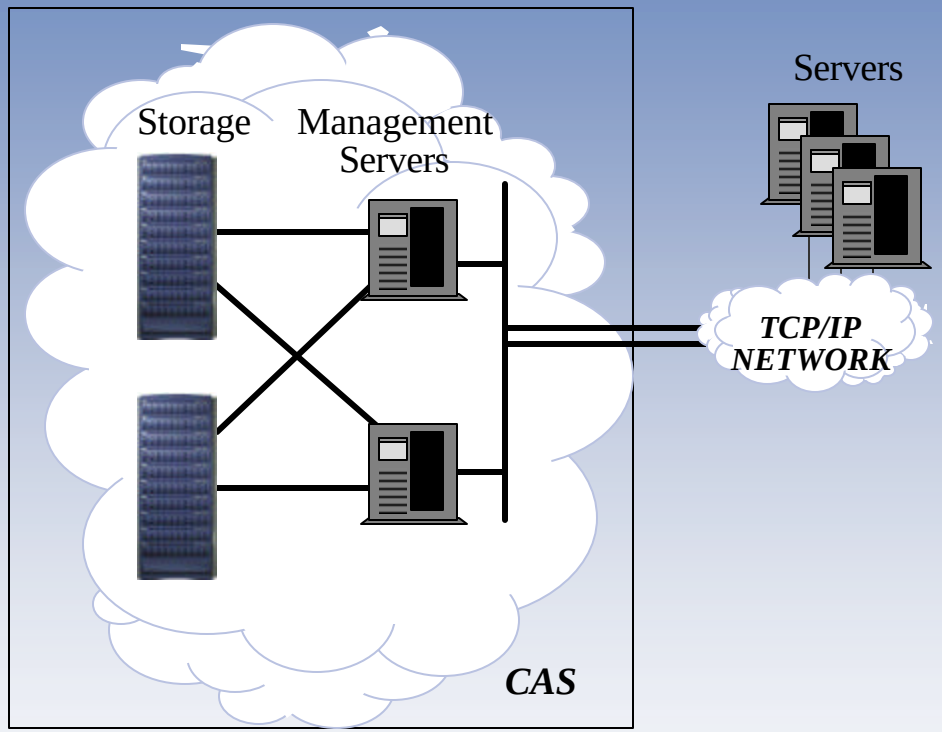
Data Management
Hierarchical Storage Management

- Tiered storage management
- Limited data movement policies
  - File Age (time/ date stamp)
  - File Size
  - Inactivity
- Uses management server file system
- Usually slower
- Industry standard interfaces
  - FTP or NFS

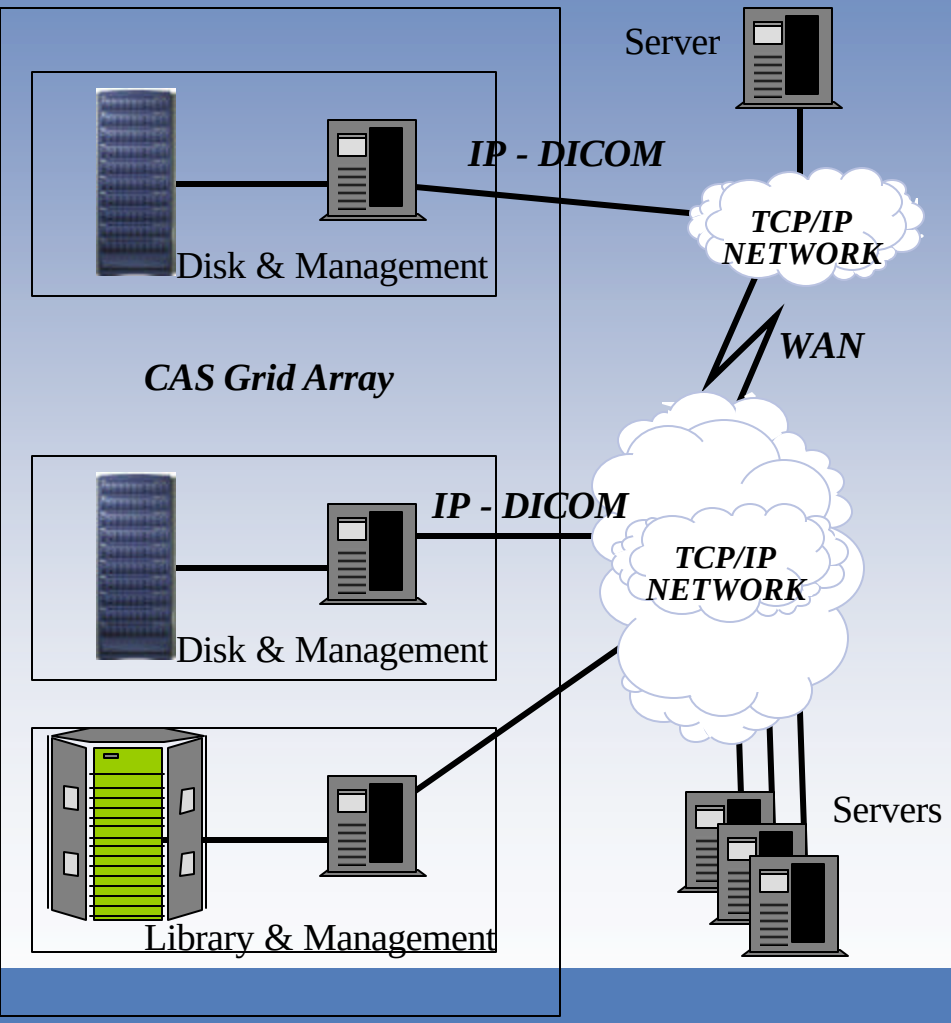


Data Management
Content Addressable Storage - CAS

- Object based storage
- Policy based data management
- Value of Metadata
- Proprietary CAS
  - Proprietary APIs
  - Limited metadata searching
- Open systems CAS
  - Standards based interfaces & protocols



Data Management
Content Addressable Storage - Grid



- Standards-based CAS
  - Industry standard interfaces
    - TCP/IP
    - DICOM
  - Uses DICOM header to create metadata
  - Policy based data management & protection
  - Used to address limited bandwidth within geographically distributed enterprises

Summary

- To meet the financial, information access, data protection and security requirements of the future, the departmental silos of storage should yield to enterprise data asset management.

- Before you commit to any PACS or informatics vendor, verify they can operate within your current and/or planned storage environment .

Contact Information

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Questions?