

Chapter 6

Data Storage and Storage Networks

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CMP 110: Data Communications & the Internet
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Direct Attached Storage

- Used where data sharing is limited to specific departments
- Used where centralized management is not an issue
- Consists of data storage devices physically attached to a single server
 - Same enclosure, or connected by cabling in a separate enclosure

Direct Attached Storage

- Ideal for expanding the capacity of individual servers
 - Easily installed and configured
 - More drives can be added as capacity requirements grow

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Direct Attached Storage

- Limitations
 - Capacity is limited by the physical structure of the server and external enclosures
 - Best used by small or departmental networks, in which a fixed number of users require shared access
 - Data is inaccessible if the server crashes

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Direct Attached Storage

- Limitations
 - Unused storage space is unavailable to other departments
 - Each server requires its own backup solution
 - Network data traffic can slow down the rest of the network
 - Does not scale well

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Direct Attached Storage

- **RAID**
 - Stands for redundant array of independent disks
 - One practical implementation of DAS

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Direct Attached Storage

- **RAID 0**

- Stripes data across two or more disks for improved Read/Write performance
- No data redundancy - single drive failure results in loss of data from whole set

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Direct Attached Storage

- **RAID 1**

- Replicates and maintains identical copies of data on two sets of drives
- Redundant and fault-tolerant
- Commonly called **data mirroring**

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Direct Attached Storage

- **RAID 5**

- Stripes data across three or more drives
- Also stripes **parity** information (for error correction)
- Fault-tolerant, but not redundant

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Direct Attached Storage

- **RAID 6**

- RAID 5 plus an additional drive just for parity
- Can recover from the failure of two drives
- Not redundant

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Direct Attached Storage

- **RAID 1 + 0**
 - Mirrors two striped arrays
 - Redundant and fault-tolerant

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Network Attached Storage

- A server computer that is optimized to provide fast and efficient shared data-storage services to network clients
- No network services other than file sharing
- Specialized operating system designed for optimum file-sharing performance

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Network Attached Storage

- **Common Internet File System (CIFS)**

- Originally known as Server Message Block (SMB)
- Developed by IBM in the early 1980s
- Functions within the upper three layers of the OSI model
- Common on Windows operating systems
- Linux systems can connect to CIFS shares using Samba

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Network Attached Storage

- **Network File System (NFS)**

- Developed by Sun Microsystems; released in 1984
- Standard file-sharing system in all UNIX/Linux systems

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Network Attached Storage

- **Network File System (NFS)**

- Originally designed for encapsulation in UDP packets
- Switched to TCP packets in version 3 for improved performance and more efficient use of bandwidth

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Network Attached Storage

- **Other NAS Protocols**

- HTTP
- FTP
- WebNFS
- NetWare Core Protocol (NCP)
- AppleTalk Filing Protocol (AFP)

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Network Attached Storage

- Why use NAS?
 - Why not just set up a Windows server that supports CIFS, or a Unix or Linux server that supports NFS?

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Network Attached Storage

- Why use NAS?
 - Different solutions require different sets of expertise
 - General-purpose operating systems provide sub-optimal file-sharing support
 - Other servers perform better once they no longer have to share files

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Network Attached Storage

- NAS Terminology
 - **NAS Appliance**
 - NAS device in which file-storage devices are self-contained in one computer that can be connected to the network
 - **NAS Head**
 - NAS device to which users connect
 - Connects to storage devices through network storage fabric

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Network Attached Storage

- NAS Terminology
 - **Network Storage Fabric**
 - Specialized network that connects NAS head with storage devices
 - **NAS Gateway**
 - Allows network users to connect to a SAN

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Network Attached Storage

- NAS Configuration Options
 - NAS devices are generally configured through a web interface, or through SSH

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Network Attached Storage

- NAS Configuration Options
 - **High-Availability NAS Clustering**
 - Provides continuous access to data even if a NAS server crashes
 - Two or more NAS heads are linked in a cluster, which is connected to a shared set of storage disks

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Network Attached Storage

- NAS Configuration Options
 - **High-Availability NAS Clustering**
 - Any head can process any request -- allows for active/active failover
 - Data is not fault-tolerant without mirroring
 - **Network Data Management Protocol (NDMP)**
 - Automatically backs up NAS data

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Network Attached Storage

- Advanced NAS Technologies
 - **Non-Volatile RAM (NVRAM)**
 - Cache that retains its contents even during crash, reboot, or power loss
 - **Direct Access File System**
 - RAM in the NAS device performs as an extension of client's RAM

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Network Attached Storage

- Advanced NAS Technologies
 - **iSCSI**
 - Maps the SCSI protocol on top of TCP; allows transfers to avoid translation to CIFS/NFS first

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Storage Area Networks

- A **Storage Area Network (SAN)** is a network that uses Serial SCSI to store and retrieve vast amounts of data

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Storage Area Networks

- Historical Reasons for SAN Usage
 - Originally, to separate backup traffic from LAN traffic and to provide shared access to centralized data storage
 - As data storage and backup needs grew, with the advent of large databases, backups had to be preformed continuously
 - SANs moved data storage and backups off the LAN while still providing shared access to data

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Storage Area Networks

- Contemporary Reasons for SAN Usage
 - High availability
 - Disaster recovery
 - Business continuation

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Storage Area Networks

- **SCSI** (Small Computer System Interface)
 - Provides parallel data transport mechanism for data delivery
 - An alternative to IDE, SATA, etc.

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Storage Area Networks

- **SCSI** (Small Computer System Interface)
 - Limitations:
 - Insufficient when connecting many computers to a single set of shared storage devices
 - Only 16 storage devices may be connected to the same cable
 - Limitations on cable length

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Storage Area Networks

- **SCSI** (Small Computer System Interface)
 - Limitations are overcome by **Serial SCSI**
 - Theoretical limits: 16 million hosts can connect to 16 million storage devices located miles away

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Storage Area Networks

- **Data Block Transfer Service**
 - Transfers data between devices without the assistance of a file system
 - Therefore, it can move large amounts of data as quickly as possible
 - Data blocks are processed by a file system such as NFS or CIFS for presentation to the user

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Storage Area Networks

- **Fibre Channel**

- A commonly-used Serial SCSI protocol that provides Data Block Transfer Service

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Storage Area Networks

- **Fibre Channel**

- Architectures:
 - Point-to-point: one server and one storage device
 - Fibre Channel Arbitrated Loop: connects up to 126 servers and storage devices with a hub
 - Fibre Channel Fabric Topology: connects up to 16 million devices with a FC switch

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Storage Area Networks

- **Fibre Channel**

- Fibre Channel makes IP Storage Networks possible using FCIP, iFCP, or iSCSI