DATA STORAGE TECHNOLOGIES & NETWORKS
(CS C446 & IS C446)

LECTURE 33 – DAS, NAS, SAN, FIBRE CHANNEL

Small History of NAS and SAN

- In 1979, Shugart Associates defined a way to have shared disk devices. Named it as SASI
  - Shugart Associates System Interface
- Leads to SCSI (in 1982 by ANSI task group X3T9.3)
  - Small Computer System Interface
- In 1980, Sun Microsystems developed NFS
- 1984, Syntec developed NetBIOS for IBM
  - NetBIOS → SMB → CIFS
- CIFS is the predominant method of sharing files in Windows environment
- SAN is next evolution of SCSI
- NAS is next evolution of NFS and CIFS

Storage on the Network - Pragmatics

- Primary goal – sharing of data / storage
  - NAS – sharing at filesystem level
  - SAN – sharing at disk(s) level

NAS Systems

- File System Characteristics
  - Networked File systems (NFS)
    - Support for caching, retransmitted requests etc.
    - NFS, DAFS(Direct Access FS – tailored to the use of RDMA), Shared Disk FS (Example: General Parallel FS)
  - Generic vs. System-specific Interface
  - Generic vs. System-specific Implementation
  - Replication Requirements
    - Snapshots
    - Mirroring
    - Backup operations
  - Consistency Issues

Network Attached Storage

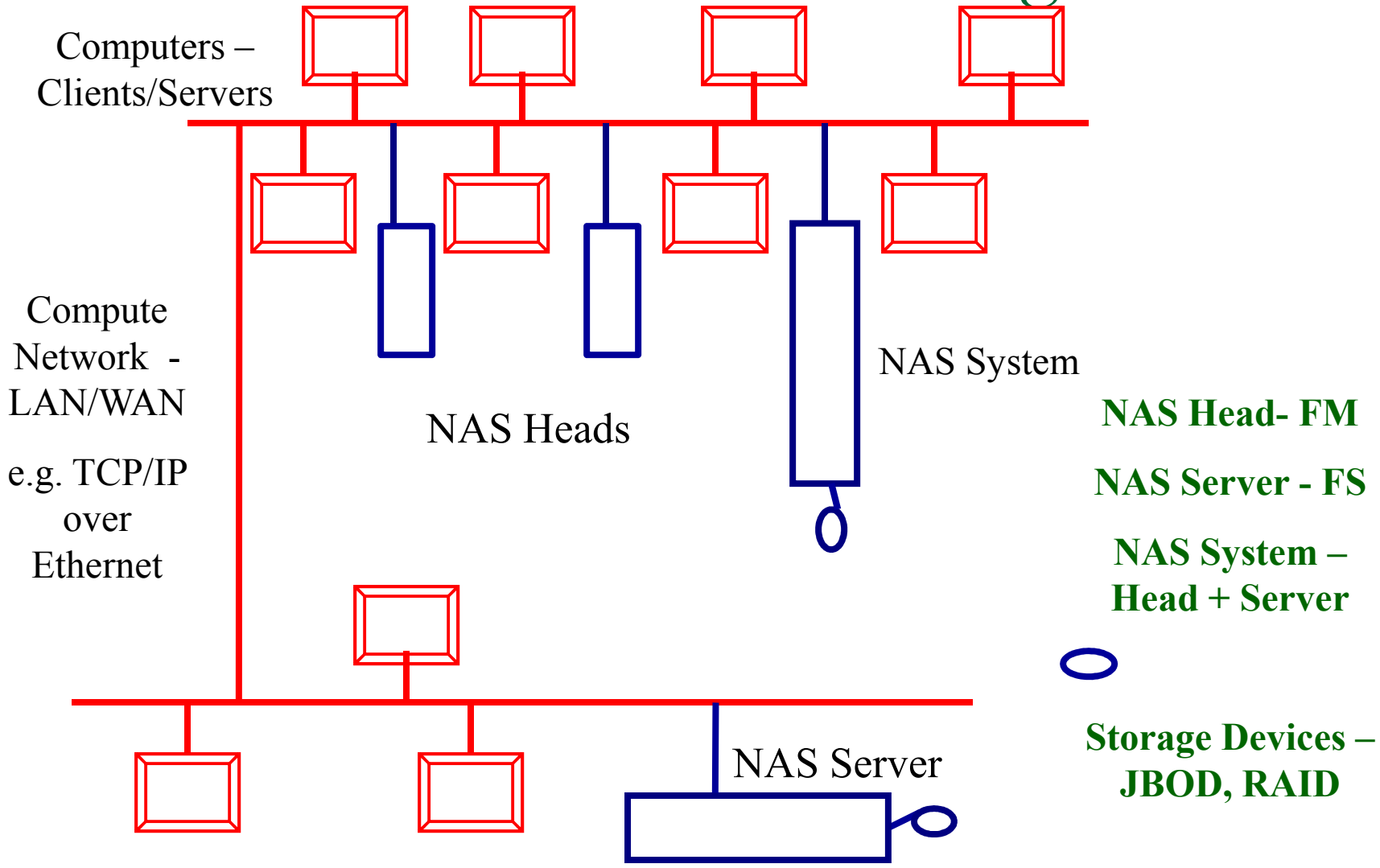
- Storage units are on the network
  - Network is the same as the compute network (LAN)
  - Data is accessed as files from file systems
    - File Systems are supported by file servers (NAS servers)
    - Novell's file servers were one of the earliest networked file servers.
  - NAS enables clients to share files quickly and directly with minimum storage management overhead
  - NAS uses network & file sharing protocols (TCP/IP for data transfer, CIFS, NFS for remote file service)
  - NAS enables windows and Linux users to share the same data seamlessly.
  - NAS uses Real-time OS optimized for file I/O, integrated hardware and software

Benefits

- Supports comprehensive access to information
  - Supports many to one & one to many configurations
- Improved efficiency
  - Specialized OS for file server operations
- Improved flexibility – compatible for UNIX & Windows
- Centralized storage – minimizes data duplication
- Simplified management – centralized console
- Scalability
- High availability
  - Offers efficient replication and recovery options. High data availability [uses cluster for failover]
- Security

- NAS uses file level access for all of its I/O operations [does not specify its logical block address]
- NAS OS issues a block I/O request to fulfill the file read and write request that it receives
  - The retrieved data is again converted to file level I/O for applications and clients
  - NAS systems come in different configurations:
    - Preconfigured file servers [consisting of 1 or more internal servers, preconfigured disk capacity & special OS]
    - Server including FM and FS and direct attached storage
    - NAS head (only the FM) separate from the FS.

Network Attached Storage



Components of NAS

- NAS head (CPU and Memory)
- One or more Network Interface Card (NIC)
- Optimized OS for managing NAS functionality
- NFS and CIFS protocols for file sharing
- Storage protocols to connect and manage physical disk resources (ATA, SCSI, FC)

NAS I/O Operations

- Process of NAS I/O
  - Requester packages an I/O request into TCP/IP and forwards through the network stack
  - NAS device receives the request
  - NAS device converts the I/O request into an appropriate physical storage request [block level I/O] and performs the operation with physical storage
  - NAS device processes and repackages the data [received from physical storage] into an appropriate file protocol response.
    - NAS device packages this response into TCP/IP again and forwards it into the client

Hosting and Accessing Files on NAS

- Create storage array volumes
  - Create volumes on storage array & assign LUN to the volumes. Present newly created volumes to NAS device
- Create NAS volumes
  - Perform a discovery operation on the NAS device to recognize the new array volumes and create NAS volumes
- Create NAS file systems on the NAS volumes
- Mount the created NAS file systems on NAS device
- Access the file systems
  - Publish the mounted file system on the network using NFS and CIFS for client access

Factors affecting NAS performance and availability

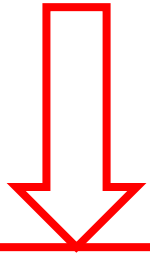
- Number of hops
- Authentication with a directory service such as LDAP, Active directory or NIS
- Retransmission
- Over utilized routers and switches
- File / directory lookup and metadata requests
- Over utilized NAS devices
- Over utilized clients

Storage on the Network - Pragmatics

- NAS Advantages
  - Logical File sharing and File system organization (replication/back-up, snapshots etc.)
  - Plug-n-play file systems
    - Low instillation and maintenance cost
  - High scalability
  - Optimized file system operations

NAS Systems

- File Servers
  - Networked Filesystems
    - E.g. NFS on Unix, CIFS on Windows
  - Provide a rich file system interface for remote files
  - Custom Operating systems
    - Performance tuned for specific tasks (i.e. *cooked I/O*) in Unix
  - May include custom hardware
    - High Performance Bus, RDMA and caching



Raw I/O - record level access – typically required for database transactions

Cooked I/O – access via files – typically sequential

NAS Systems

- File Servers
  - Operating System Implementation
    - Customized Operating Systems
      - Typically thinned versions of Linux or Windows
    - Most tasks are I/O bound (particularly file I/O)
      - Simpler scheduling and task management
      - No user management or user interaction required
    - Restricted Memory allocation model (Mostly for buffering)
      - No heap needed
      - Limited stack size
    - Tasks are (soft) real-time
      - At the server level, I/O requests must have time-bounds to provide performance guarantees