Introduction To Storage

Overview of the storage subsystem
Objectives for this Unit

- Understand Storage Basics
- Introduce Direct Attached Storage
- Differentiate between types of storage
  - DAS
  - NAS
  - iSCSI
  - SAN
- Introduce Network Attached Storage
- Introduce Fibre Channel SAN
A Few Storage Basics....

- Where will data finally end up?
- How will it get there?
- What will it pass through?
Direct Attached Storage (Internal)

- CPU
- Memory
- Bus
- I/O - RAID Controller
- Disk Drives
Direct Attached Storage (Internal)

Computer System

- CPU
- Memory
- Bus
- I/O - RAID Controller
- Disk Drives

Data
Direct Attached Storage (Internal)
DAS w/ internal controller and external storage
Comparing Internal and External Storage

Internal Storage
- RAID controllers and disk drives are internal to the server.
- SCSI, ATA, or SATA protocol between controller and disks.

RAID controller is internal.
- SCSI or SATA protocol between controller and disks.
- Disk drives are external.

External Storage
- RAID controller is internal.
- SCSI Bus with external storage.
- Disk drives are external.
DAS w/ external controller and external storage

Computer System

- CPU
- Memory
- Bus
- HBA

Storage System

- Disk Enclosure
  - Disk Drives
  - Disk Drives
  - RAID Controller
DAS over Fibre Channel

HBA is internal

Fibre Channel protocol between HBAs and external RAID controller

Disk drives and RAID controller are external

External SAN Array
I/O Transfer

- **RAID Controller**
  - Contains the “smarts”
  - Determines how the data will be written (striping, mirroring, RAID 10, RAID 5, etc.)

- **Host Bus Adapter (HBA)**
  - Simply transfers the data to the RAID controller.
  - Doesn’t do any RAID or striping calculations.
  - “Dumb” for speed.
  - Required for external storage.
Storage types

- Single Disk Drive
- JBOD
- Volume
- Storage Array
- SCSI device
- DAS
- NAS
- SAN
- iSCSI
NAS: What is it?

- Network Attached Storage
- Utilizes a TCP/IP network to “share” data
- Uses file sharing protocols like Unix NFS and Windows CIFS
- Storage “Appliances” utilize a stripped-down OS that optimizes file protocol performance
Networked Attached Storage

Public or Private Ethernet network

Server has a Network Interface Card
No RAID Controller or HBA in the server

All data converted to file protocol for transmission (may slow down database transactions)

Server

NAS Server

Storage

Disk Drives

RAID Controller
iSCSI: What is it?

- An alternate form of networked storage
- Like NAS, also utilizes a TCP/IP network
- Encapsulates native SCSI commands in TCP/IP packets
- Supported in Windows 2003 Server and Linux
- TCP/IP Offload Engines (TOEs) on NICs speed up packet encapsulation
iSCSI Storage

Server has a Network Interface Card or iSCSI HBA

iSCSI HBAs use TCP/IP Offload Engine (TOE)

SCSI commands are encapsulated in TCP/IP packets

Public or Private Ethernet network

NIC or iSCSI HBA

iSCSI Storage

Disk Drives

RAID Controller
Fibre Channel: What is it?

- Fibre Channel is a network protocol implemented specifically for dedicated storage networks
- Fibre Channel utilizes specialized
  - Switches
  - Host Bus Adapters
  - RAID controllers
  - Cables
Fibre Channel Components

- **Servers**
  - Host Bus Adapters

- **Cables**
  - Fiber optic or copper

- **Fibre Channel Switches**
  - Two switches for redundancy

- **Fibre Channel Storage Array**
  - Two RAID Controllers for redundancy
  - 4–100+ disk drives per array

- **A true storage network**
  - Multiple servers
  - Multiple switches
  - Multiple Storage Arrays

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**Diagram**

- **Server A**
  - HBA
  - RAID Controller
  - Switch

- **Server B**
  - HBA
  - RAID Controller
  - Switch

- **Server C**
  - HBA
  - RAID Controller

- **FC Storage Array**
  - Disk Drives
  - RAID Controllers
SAN: What is it?

- Storage Area Network
- A network whose primary purpose is the transfer of data between storage systems and computer systems
- Fibre Channel is the primary technology utilized for SANs
- Recently, SANs have been implemented with dedicated iSCSI networks
Benefits of SAN/Consolidated Storage

- Reduce cost of external storage
- Increase performance
- Centralized and improved tape backup
- LAN-less backup
- High-speed, no single-point-of-failure clustering solutions
- Consolidation with > 70TB of storage
Fibre Channel Technology

- Provides concurrent communications between servers, storage devices, and other peripherals
- A gigabit interconnect technology
- FC1: Over 1,000,000,000 bits per second
- FC2: Over 2,000,000,000 bits per second
- A highly reliable interconnect
- Up to 127 devices (SCSI: 15)
- Up to 10 km of cabling (3-15 ft. for SCSI)
- Physical interconnect can be copper or fiber optic
Hot-pluggable - Devices can be removed or added at will with no ill effects to data communications

Provides a data link layer above the physical interconnect, analogous to Ethernet

Sophisticated error detection at the frame level

Data is checked and resent if necessary
Fibre Channel – Frame Dissection

- Up to 2048 byte payload
- 4 byte checksum for each frame
Fibre Channel

What’s with the funny name?

- Some background history required
- Originally developed to only support fiber optic cabling
- When copper cabling support was added, ISO decided not to rename the technology
- ISO changed to the French spelling to reduce association with fiber optics only medium
Fibre Channel

- How does it work?
  - Serial interface
  - Data is transferred across a single piece of medium at the fastest speed supported
  - No complex signaling required
Fibre Channel Interface Layers

- Device Driver
- SCSI Protocol
- Fibre Channel
- Fiber Optic or Copper Cabling
SCSI vs. Fibre Channel Protocol

- **SCSI**
  - SCSI protocol vs. SCSI device
  - SCSI is an established, tried and true protocol
  - Provides services analogous to TCP/IP
  - Supported in every major OS on market

- **Fibre Channel**
  - Fibre Channel runs on top of SCSI
  - No re-inventing the wheel
  - Immediate OS support
SCSI vs. FC Transmission

RAID Controller → Fibre Channel → Disk Drive

RAID Controller → SCSI → Disk Drive
<table>
<thead>
<tr>
<th>SCSI</th>
<th>Fibre Channel</th>
</tr>
</thead>
<tbody>
<tr>
<td>Interface for internal storage to</td>
<td>Used with SAN</td>
</tr>
<tr>
<td>external disks</td>
<td>Lots of built-in redundancy with</td>
</tr>
<tr>
<td></td>
<td>connections</td>
</tr>
<tr>
<td>Potential down time w/ SCSI</td>
<td>Redundant network</td>
</tr>
<tr>
<td>Single bus</td>
<td>HBA is fibre channel hardware</td>
</tr>
<tr>
<td>RAID controller is SCSI hardware</td>
<td>Standards:</td>
</tr>
<tr>
<td>Standards:</td>
<td>FC1: 100 MB/sec</td>
</tr>
<tr>
<td></td>
<td>FC2: 200 MB/sec</td>
</tr>
<tr>
<td>Media specific (copper only)</td>
<td>Provides a data link layer above the</td>
</tr>
<tr>
<td></td>
<td>physical interconnect</td>
</tr>
<tr>
<td>SCSI Limitations:</td>
<td></td>
</tr>
<tr>
<td>Cables can’t be any longer than 3</td>
<td></td>
</tr>
<tr>
<td>feet for single ended; 15 feet for</td>
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<td>LVD (low voltage differential)</td>
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<tr>
<td>No more than 15 devices on a SCSI</td>
<td></td>
</tr>
<tr>
<td>bus</td>
<td></td>
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<tr>
<td># of disk drives</td>
<td></td>
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<td></td>
<td>Fibre Channel limitations:</td>
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<tr>
<td></td>
<td>Cable length: Up to 10 kilometers (more</td>
</tr>
<tr>
<td></td>
<td>a limitation of cable than FC itself)</td>
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<tr>
<td></td>
<td>Up to 127 devices</td>
</tr>
<tr>
<td></td>
<td># of disk drives</td>
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Fibre Channel vs. iSCSI

**Fibre Channel**
- The current market leader for shared storage technologies
- Provides the highest performance levels
- Designed for mission-critical applications
- Cost of components is relatively high, particularly per server HBA costs
- Relatively difficult to implement and manage

**iSCSI**
- Relatively new, but usage is increasing rapidly
- Performance can approach Fibre Channel speeds
- A better fit for databases than NAS
- A good fit for Small to Medium Size Businesses
- Relatively inexpensive, compared to Fibre Channel
- Relatively easy to implement and manage
Microsoft Simple SAN Initiative

- Make operating system aware of SAN and SAN capabilities
- Shift integration burden from IT staff or services back to VENDORS products:
  - Microsoft
  - Storage hardware and software
  - Application developers
- Key storage technologies:
  - Volume Shadow Copy Service (VSS)
  - Virtual Disk Service (VDS)
  - Microsoft Multipath Input/Output (MPIO)
  - Microsoft iSCSI driver
    - Software Initiator (client)
    - Software Target (attached to disk subsystem)
Review

- What is the difference between a RAID Controller and an HBA?
- How many protocols may be used for DAS?
- Name two types of storage that rely on ethernet cables
- Name two benefits of SANs
- Describe the four interface layers of the Fibre Channel protocol
- Describe a scenario where an iSCSI SAN may be preferred over a Fibre Channel SAN
Summary

- How data is routed through a server to I/O
- Types of storage
  - DAS
  - NAS
  - iSCSI
  - SAN
- Benefits of SAN technology
  - Storage consolidation
  - Reduced costs
  - Centralized, LAN-free backup and restore
- The Fibre Channel protocol
  - How it works
  - Fibre Channel protocol vs. SCSI protocol
- Comparing Fibre Channel SANs and iSCSI SANs
  - Fibre Channel SANs offer mission-critical performance, with relatively high costs and high complexity
  - iSCSI SANs offer moderate to high performance at an attractive price/performance ratio and are relatively easy to administer