# Module 3

Implementing enterprise storage solutions

# Module Overview

- Overview of DAS, NAS, and SANs
- Comparing Fibre Channel, iSCSI, and Fibre Channel over Ethernet
- Understanding iSNS, DCB, and MPIO
- Configuring sharing in Windows Server 2016

# Lesson 1: Overview of DAS, NAS, and SANs

- Discussion: Which storage solutions are deployed in your environment?
- What is DAS?
- What is NAS?
- What is a SAN?
- Comparison and scenarios for usage
- Block-level storage vs. file-level storage
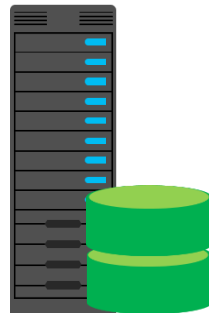
# What is DAS?

DAS is physically attached to the server

Advantages:

- Easy to configure

- Inexpensive solution

Disadvantages:

- Isolated, because the disks are attached to a single server

- Less flexible for allocation
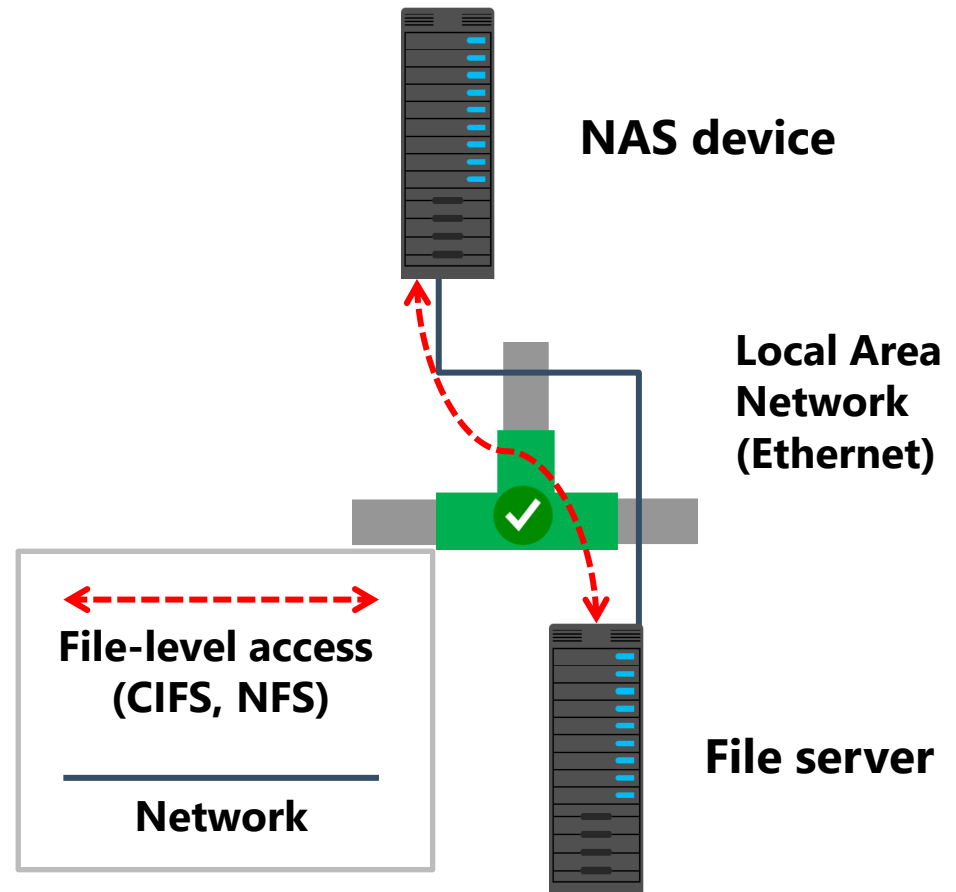
Server with attached disks

# What is NAS?

NAS is storage that is attached to a dedicated storage device and accessed through network shares

Advantages:

- Relatively inexpensive, NAS offers centralized storage at an affordable price
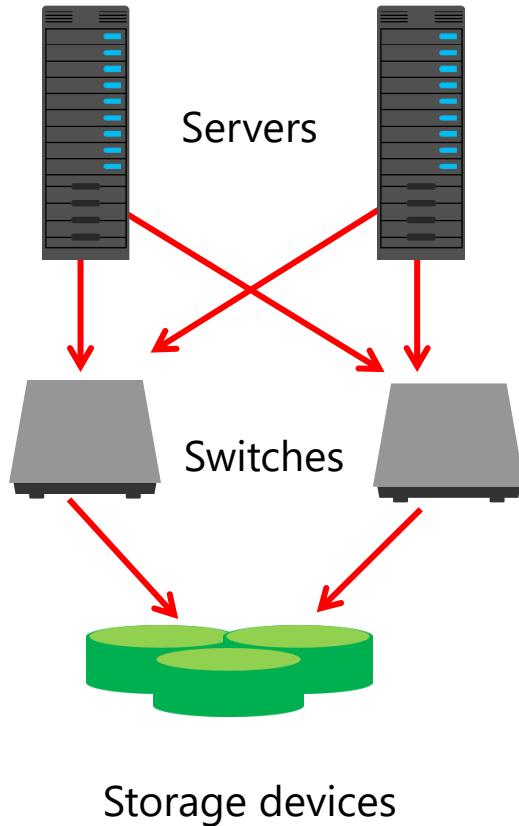
- Easy to configure

Disadvantages:

- Slower access times

- Not an enterprise solution

**NAS device**

**Local Area Network (Ethernet)**

**File-level access (CIFS, NFS)**

———

**Network**

**File server**

# What is a SAN?

SANs offers higher availability with the most flexibility



Servers

Switches

Storage devices

Advantages:

- Fastest access times
- Easily expandable
- Centralized storage
- High level of redundancy

Disadvantages:

- More expensive
- Requires specialized skills

Implement SANs by using Fibre Channel or iSCSI

# Comparison and scenarios for usage

- DAS:
  - Least complex
  - Lowest setup costs
- NAS:
  - Best solution for specific situations
  - Complementary to DAS and SAN
- SAN:
  - Highest performing
  - Has the most features

# Comparison and scenarios for usage

- Future trends:
  - Windows Server storage features are expanding <u>to improve capabilities when using DAS</u>
  - **Windows Server 2012** introduced **storage spaces** <u>to provide redundancy for DAS</u>, <u>without requiring a RAID controller</u>.
  - **Windows Server 2012 R2** introduced **storage tiering** <u>to allow the most frequently accessed disk blocks</u> to be automatically stored on SSD drives instead of spinning disks.
  - <u>High availability for</u> **shared folders** was also available by implementing **Scale-Out File Server** that stores SQL Server databases and Hyper-V virtual machines.
  - **Windows Server 2016** also adds **Storage Replica** <u>to provide block-level synchronous or asynchronous replication</u> between two servers that are using DAS

# Block-level storage vs. file-level storage

## Block-level storage:

- Is high-performing
- Is often SAN-based
- Presents LUNs to servers
- Is not the most cost-effective

## File-level storage:

- Is delivered via NAS, a storage server, or a file server
- Uses CIFS/SMB (shared folders) or NFS (exports)
- Uses block-level storage on the storage backend

# Lesson 2: Comparing Fibre Channel, iSCSI, and Fibre Channel over Ethernet

- What is Fibre Channel?
- Considerations for implementing Fibre Channel
- What is iSCSI?
- iSCSI components
- Considerations for implementing iSCSI
- Core storage components
- Demonstration: Configuring an iSCSI target

# What is Fibre Channel?

Fibre Channel components include:

- A SAN
- A computer <u>with an HBA card</u>
- <u>A Fibre Channel switch</u>

Fibre Channel over Ethernet:

- Gives you the benefits of Fibre Channel while using an inexpensive, preexisting Ethernet infrastructure

Fibre Channel layouts include:

- Arbitrated loop
- Point-to-point
- Switched fabric

# Considerations for implementing Fibre Channel

## Infrastructure considerations:

- Existing switch and cabling infrastructure
- Existing servers and HBAs
- Existing storage infrastructure

## Costs

- Fibre Channel is often more expensive than other solutions
- Large initial investment required
- Initial and ongoing training might add considerably to the cost

## iSCSI transmits SCSI commands over IP networks

| Component | Description |
|-----------|-------------|
| IP network | Network that provides high performance and redundancy |
| iSCSI targets | Servers that run on the storage device and enable access to the disks |
| iSCSI initiators | Software component or host adapter on the server that provides access to iSCSI targets |
| iSCSI IQN | Globally unique identifier that iSCSI uses to address initiators and targets on an iSCSI network |

iSCSI client that runs the iSCSI initiator

TCP/IP protocol

Storage array

iSCSI Target Server
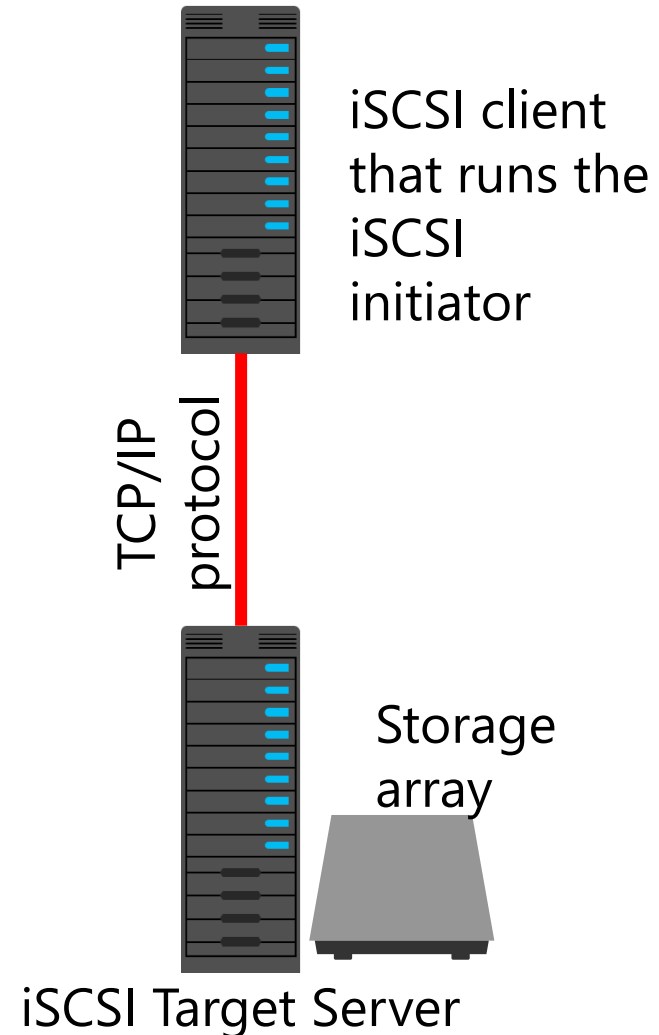
# iSCSI components

The iSCSI Target Server:

- Is available as a role service in Windows Server 2016

- Provides the following functionality:

  - Network or diskless boot
  - Server application storage
  - Heterogeneous storage
  - Lab environments

- Has the following features:

  - Authentication
  - Query initiator computer for ID
  - Virtual hard drives
  - Scalability
  - Manageability

The iSCSI initiator:

- Runs as a service in the operating system

- Is installed by default on Windows Vista and Windows Server 2008 and newer operating systems

- Requires only to be started and configured to connect the computer to the iSCSI target

# Considerations for implementing iSCSI

The primary factors to consider when planning on using iSCSI are:

- Network speeds and performance
- High availability
- Security
- Vendor information
- Infrastructure staff
- Application teams

Alternative solutions to iSCSI are Fibre Channel, Fibre Channel over Ethernet, and InfiniBand

# Core storage components

- **Network adapters** are usually used on Ethernet networks
- **HBAs** are usually used on storage networks such as SAN
- Converged network adapters(called **CNA**) can be used on Ethernet networks or SANs
  - FCoE(Fibre Channel over Ethernet)는 충분한 대역폭(10G)을 가진 Ethernet에 Storage 트래픽을 함께 태워서 별도의 HBA 카드 및 SAN Switch의 연결없이 사용할 수 있도록 해주는 기술입니다. 이를 위해서 CNA 카드가 필요하다
  - CNA 카드는 Ethernet과 SAN 트래픽(HBA)을 FCoE로 변환시켜주는 역할을 한다. 이를 통해 SAN 이든 Ethernet 트래픽이든 한개의 10G 이더넷 포트를 타고 상단의 스위치와 연결된다
  - FCoE를 사용하기 위해서 CNA 카드는 서로 다른 특성을 가지는 트래픽인 Ethernet과 FC(Fibre Channel)를 합쳤다가 공통의 물리적 포트를 통해 전달한 다음, 궁극적으로는 다시 분리하는 방법이 필요하다. Ethernet은 Switch를 이용하고, FC 트래픽은 SAN을 거쳐 Storage로 간다
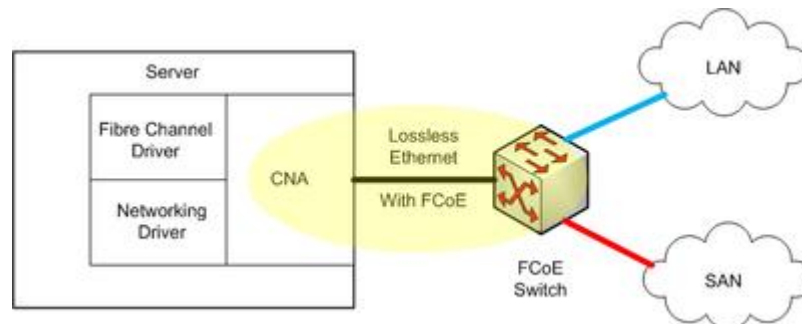
# Core storage components

- **InfiniBand host channel adapters** are used on InfiniBand networks
  - InfiniBand는 Ethernet이나 Fibre Channel 인터페이스와 달리 channel adapter(인피니밴드 카드)인 HCA(Host Channel Adapter)와 TCA(Target Channel Adapter) 형태로 분류한다.
  - HCA는 서버나 PC처럼 운영체제를 탑재한 컴퓨터에 설치된 어댑터
  - TCA는 별도의 스토리지 시스템 등과 같은 장치에 설치된 어댑터
  - HCA와 TCA가 두 개의 채널로 연결되어 있다고 가정하면 평상시에는 두 개의 채널이 낼 수 있는 속도로 데이터를 전송하다가 한쪽 채널에 장애가 발생할 경우에도 정상적인 채널에서 서비스를 계속할 수 있다.
  - InfiniBand의 특징
    - 하나의 스토리지 장치를 여러 대의 서버가 공유할 수 있음. 이것은 하나의 채널을 여러 개의 장치들이 동시에 쓸 수 있음을 나타낸 것이다
    - 두 개 이상의 스토리지 장치 간에 데이터를 복사할 경우, HCA가 설치된 호스트 컴퓨터가 복사 작업을 시작시키는 명령을 내리면, 복사 작업이 완료될 때까지 호스트 컴퓨터가 작업에 관여하지 않음. 이것은 스토리지를 쓰거나 관리하는 데에서 호스트 컴퓨터의 CPU 자원을 소비하지 않기 때문에 호스트 컴퓨터가 병목으로 작용하는 현상을 방지할 수 있으므로 스토리지 성능이 향상됨을 보여준다
- **Disk controllers (RAID Controller)**facilitate communication between disk drives and a CPU

# Demonstration: Configuring an iSCSI target

In this demonstration, you will see how to:
- Add the iSCSI Target Server role service
- Create two iSCSI virtual disks and an iSCSI target
- Connect to the iSCSI target
- Verify the presence of the iSCSI drive

- What is iSNS?
- What is DCB?
- What is MPIO?
- Demonstration: Configuring MPIO

# What is iSNS?

The iSNS Server service is a Windows feature that:

- Has three primary components: the iSNS server, iSNS client, and iSNS database

- Has several advantages, including that it:

  - Reduces administrative overhead by automating the configuration of iSCSI clients

  - Is compatible with iSCSI and Fibre Channel

  - Can make an IP network function like a SAN

  - Can integrate IP and Fibre Channel networks seamlessly
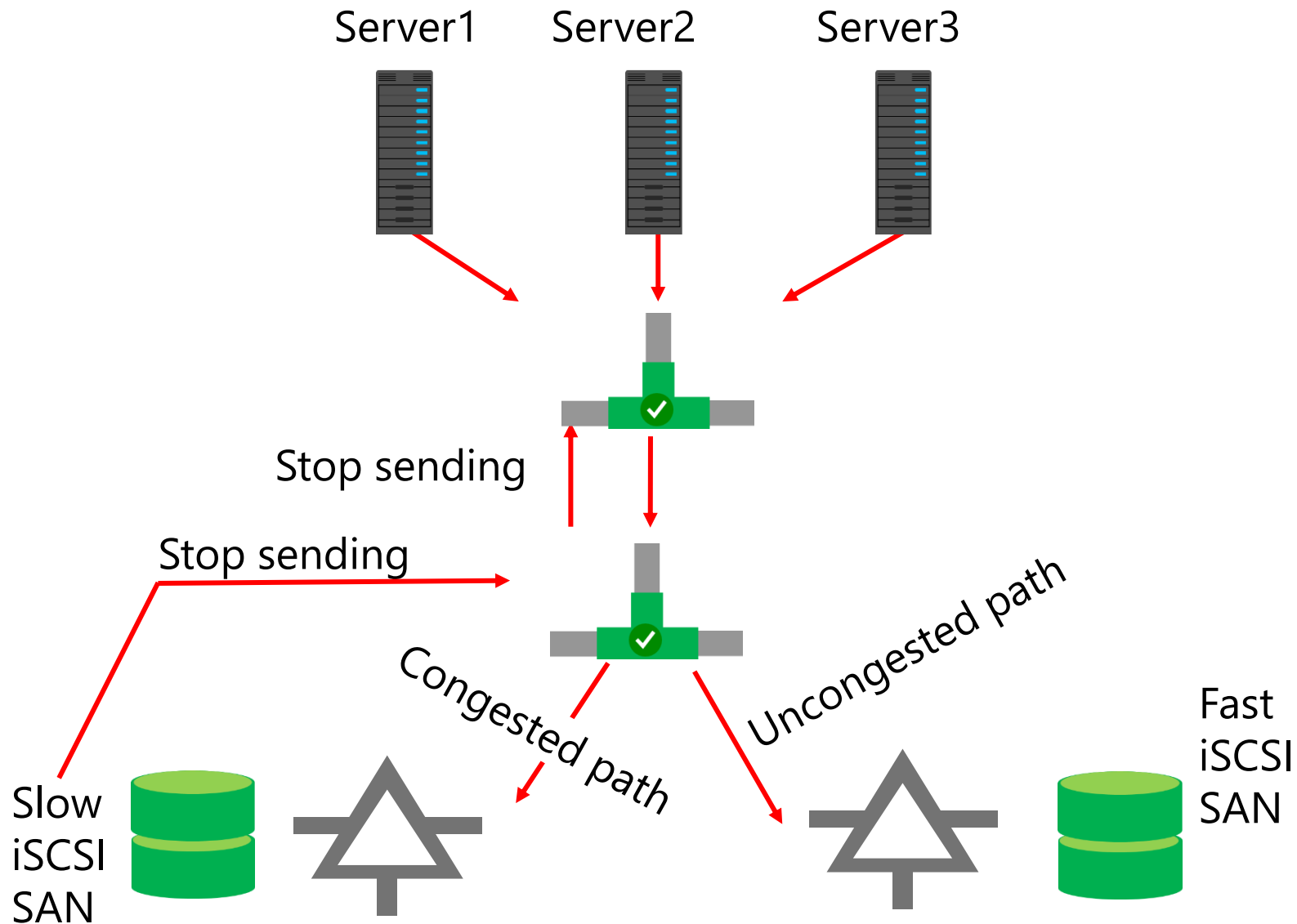
- Is not yet in widespread use

# What is DCB(Data-Center-Bridging)?

- Most existing datacenters typically have several physical networks
  - System administrators and users might use an **Ethernet network**
  - Data storage might use a separate physical **Fibre Channel network**
  - High-performance computers might use an **InfiniBand network**
  - However, having separate networks increases costs and management overhead when you are building and maintaining the networks.
- **DCB** provides a standard by which you can combine these networks into a single physical infrastructure that supports all of the above protocols and iSCSI.
  - Typically, when you use a converged network adapter or a dedicated iSCSI HBA, the adapter vendor's software includes the ability to configure hardware-based QoS and other features of DCB.
  - Additionally, the network switches to which hosts connect must support DCB.

# What is DCB?

- Features of DCB include:
  - Congestion notification
    - This can help the devices sending data to regulate the traffic that they are generating in order to avoid congestion
  - Priority-based flow control
    - This is a link-layer flow control mechanism that you can control based on the type of data being transmitted on the network
  - Enhanced transmission selection
    - This enables the system to reserve bandwidth for iSCSI and other network protocols

- DCB is a Windows Server 2016 feature that you can install from Windows PowerShell or by using Server Manager
  - Install-WindowsFeature "Data-Center-Bridging"
- You use Windows PowerShell to manage the QoS functionality in DCB
  - Get-Help *Qos*
  - Get-Command -Module DcbQos, NetAdapter, NetQos

# What is DCB?



Server1    Server2    Server3

Stop sending

Stop sending

Congested path

Uncongested path

Slow iSCSI SAN

Fast iSCSI SAN

# What is MPIO?

- MPIO is a storage network enhancement that <u>provides multiple physical paths from a computer to a block storage provider</u>, regardless of whether the storage attaches directly to the storage provider or is available over a network.

- MPIO has been built into Windows Server since Windows Server 2008.

- In addition to this support built into Windows Server operating systems, <u>many storage vendors offer their own MPIO software</u> that can be installed on computers running Windows Server that connect to the backend storage.

# What is MPIO?
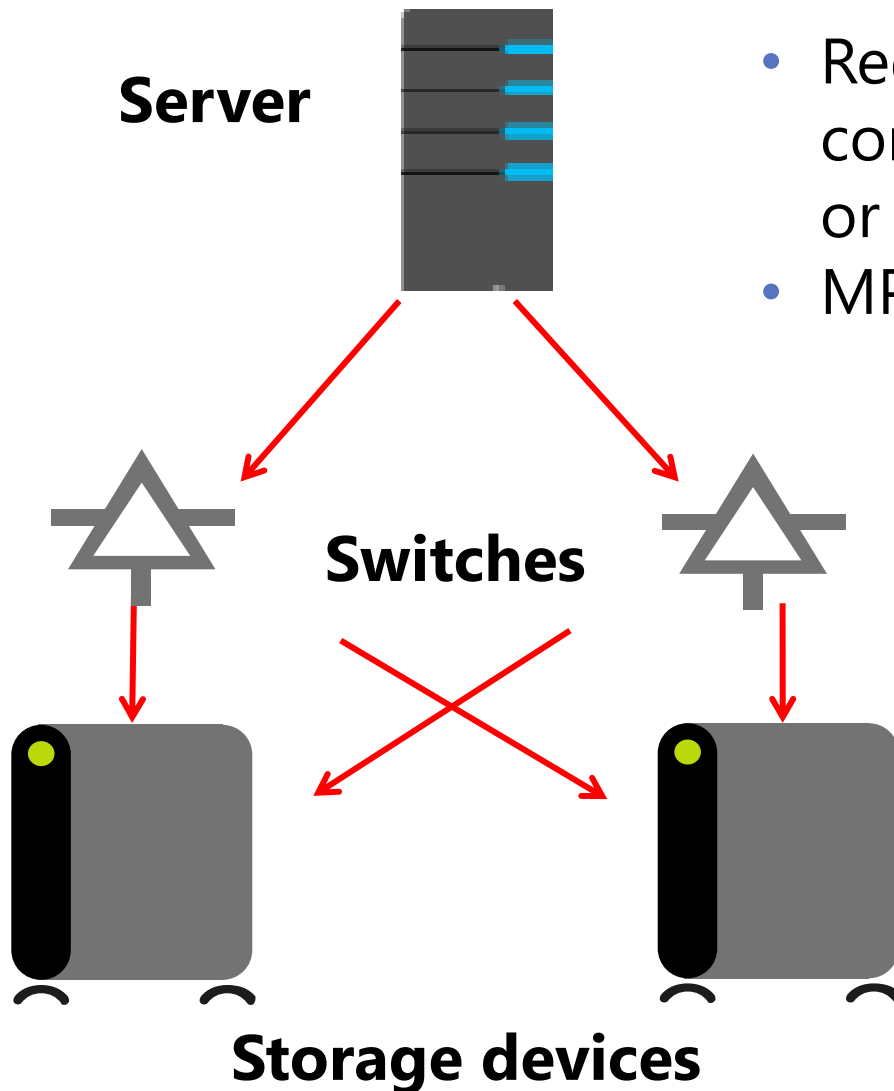
**Server**

- Redundant network adapters, converged network adapters, or HBAs in server
- MPIO enabled on server

**Switches**

- Dual switches
- Switches have redundant connections to storage devices
- Redundant storage devices

**Storage devices**

# Demonstration: Configuring MPIO

In this demonstration, you will see how to configure MPIO

# Lesson 4: Configuring sharing in Windows Server 2016

- What is SMB?
- Configuring SMB shares
- Demonstration: Configuring SMB shares by using Server Manager and Windows PowerShell
- What is NFS?
- Configuring NFS shares
- Demonstration: Configuring an NFS share by using Server Manager

# What is SMB?

- SMB is the file-sharing protocol that Windows client and server operating systems use
    - Each new version has additional features
    - SMB 3.0 introduced large performance benefits
    - SMB 3.0.2 added:
        - Scale-Out File Server
        - Removable SMB 1.x
- SMB 3.1.1 added:
    - Pre-authentication integrity
        - <u>Protects from man-in-the-middle attacks</u> by using a SHA-512 hash to verify packet contents during session setup
    - SMB encryption improvements
        - SMB encryption now defaults to use the AES-128-GCM encryption algorithm.
    - Cluster dialect fencing
        - To support rolling upgrades of Scale-Out File Server clusters, file shares in mixed mode use SMB 3.0.2. After all nodes in the cluster are upgraded, then file shares begin using SMB 3.1.1.

# Configuring SMB shares

- There are three SMB share profiles:
  - Quick
  - Advanced
  - Applications
- Windows PowerShell cmdlets for SMB share management:
  - **New-SmbShare**
  - **Set-SmbShare**
  - **Remove-SmbShare**
  - **Get-SmbShare**
  - **Get-SmbSession**
  - **Get-SmbOpenFile**
  - **Set-SmbBandwidthLimit**

In this demonstration, you will see how to:

- Create an SMB share by using Server Manager
- Create an SMB share by using Windows PowerShell
- View SMB session information

# What is NFS?

- NFS is a file system based on open standards
- Current version is 4.1
- Windows NFS components include:
  - Client for NFS
  - Server for NFS
- Support for Kerberos v5 authentication
- The primary uses for NFS are:
  - Storage for VMware virtual machines
  - Sharing data across multiple operating systems
  - Sharing data across different IT infrastructures after a company merger

# Configuring NFS shares

- Install the Server for NFS server role
- Two options for NFS share profile:
  - NFS Share – Quick
  - NFS Share – Advanced
- Authentication options:
  - Kerberos v5 authentication
  - No server authentication
- Share permissions define allowed and denied hosts
- Follow best practices

# Demonstration: Configuring an NFS share by using Server Manager

In this demonstration, you will see how to configure an NFS share by using Server Manager

# Lab: Planning and configuring storage technologies and components

- Exercise 1: Planning storage requirements
- Exercise 2: Configuring iSCSI storage
- Exercise 3: Configuring and managing the share infrastructure

Logon Information

Virtual machines: **20740C-LON-DC1**
                  **20740C-LON-SVR1**
User name:        **Adatum\Administrator**
Password:         **Pa55w.rd**

Estimated Time: 60 minutes

# Lab Scenario

You are a Storage Administrator in Adatum Corporation, and part of your job is to ensure that your data storage systems meet both short-term and long-term business needs that evolve regularly.

# Lab Review

- Implementing MPIO for iSCSI is not as simple as installing MPIO. In this lab, what other steps did you perform to enable MPIO?
- When you use Get-SmbOpenFile, do all open files display?