Basics of Storage

DAS – NAS - SAN

& RAID

CA ANNADURAI

Data Storage

- Data storage is for future usage. If data is not stored, all computer data will vanish after power goes off.
- Contents in RAM are temporary
- Data saved in HDD are permanent.

Storage

- Dedicated Storage Architecture
  - ✓ Direct Access Storage (DAS)
    - IDE, SATA, SCSI
    - DAS is for one single computer

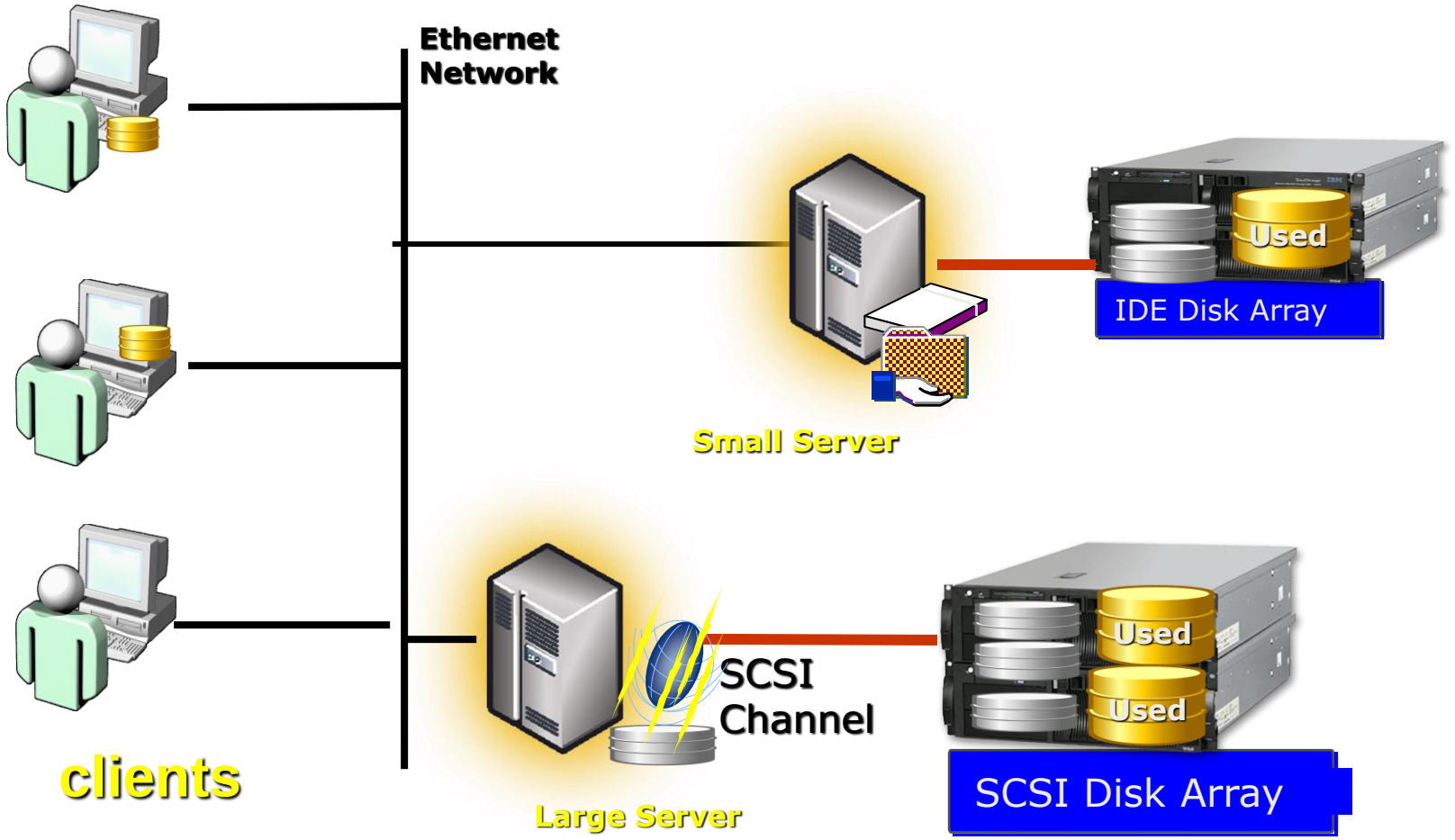
- Shared Storage Architecture
  - ✓ Network Attached Storage (NAS)
  - ✓ Storage Area Network (SAN) - Fiber Channel and Fiber Channel Switch
  - ✓ NAS & SAN storage is shared one, can be used by multiple servers

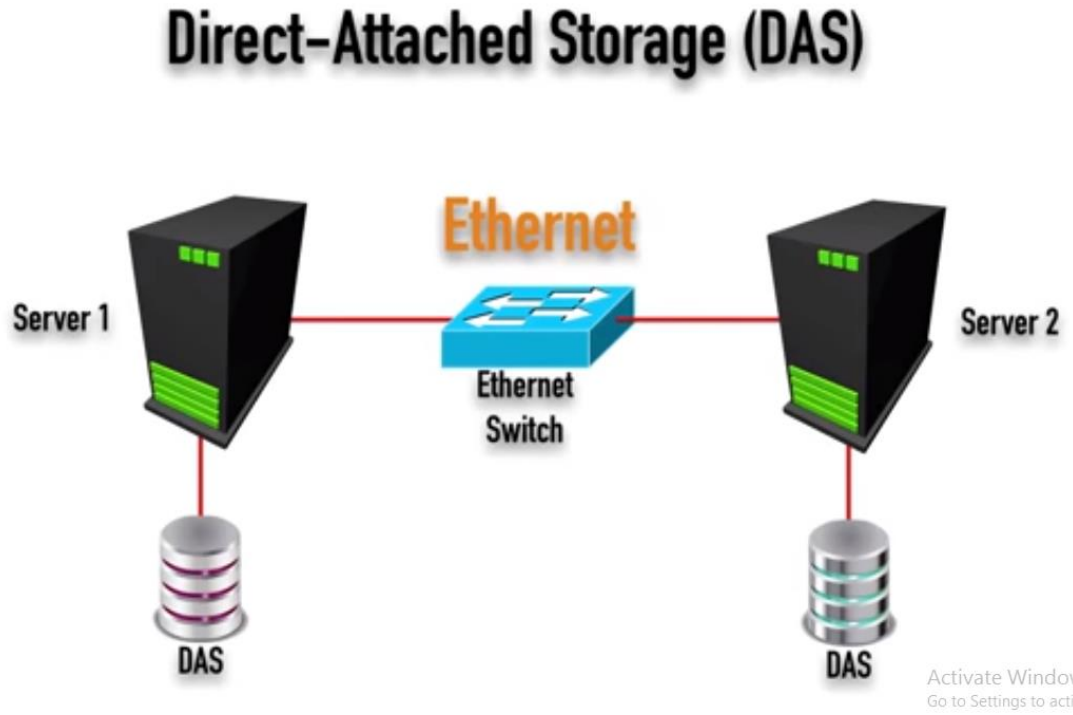
Three Basic Forms of Storage

- Direct access storage (DAS)
- Network attached storage (NAS)
- Storage area network (SAN)

- And a number of variations on each (especially the last two)

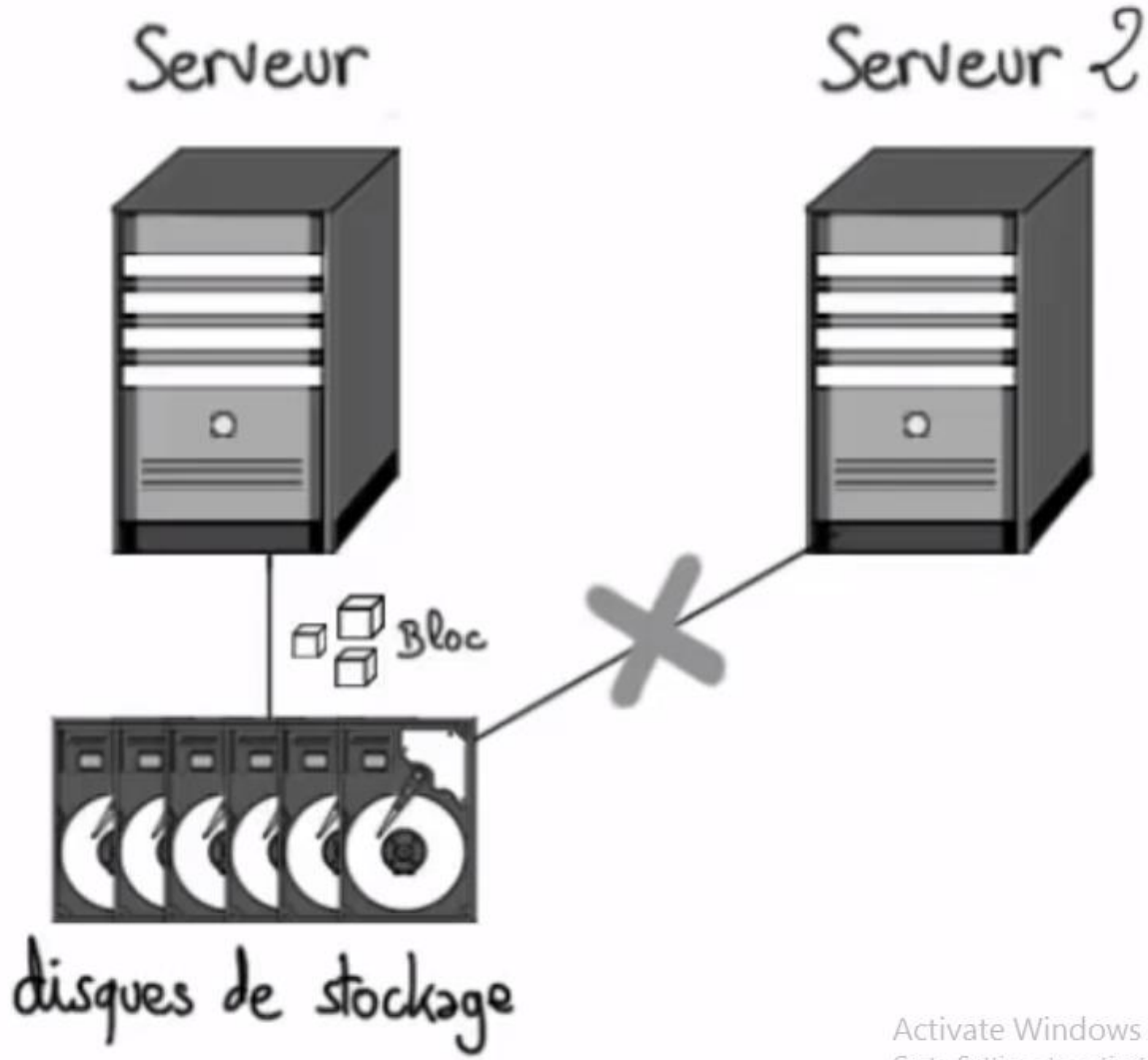
Direct Access Storage (DAS)

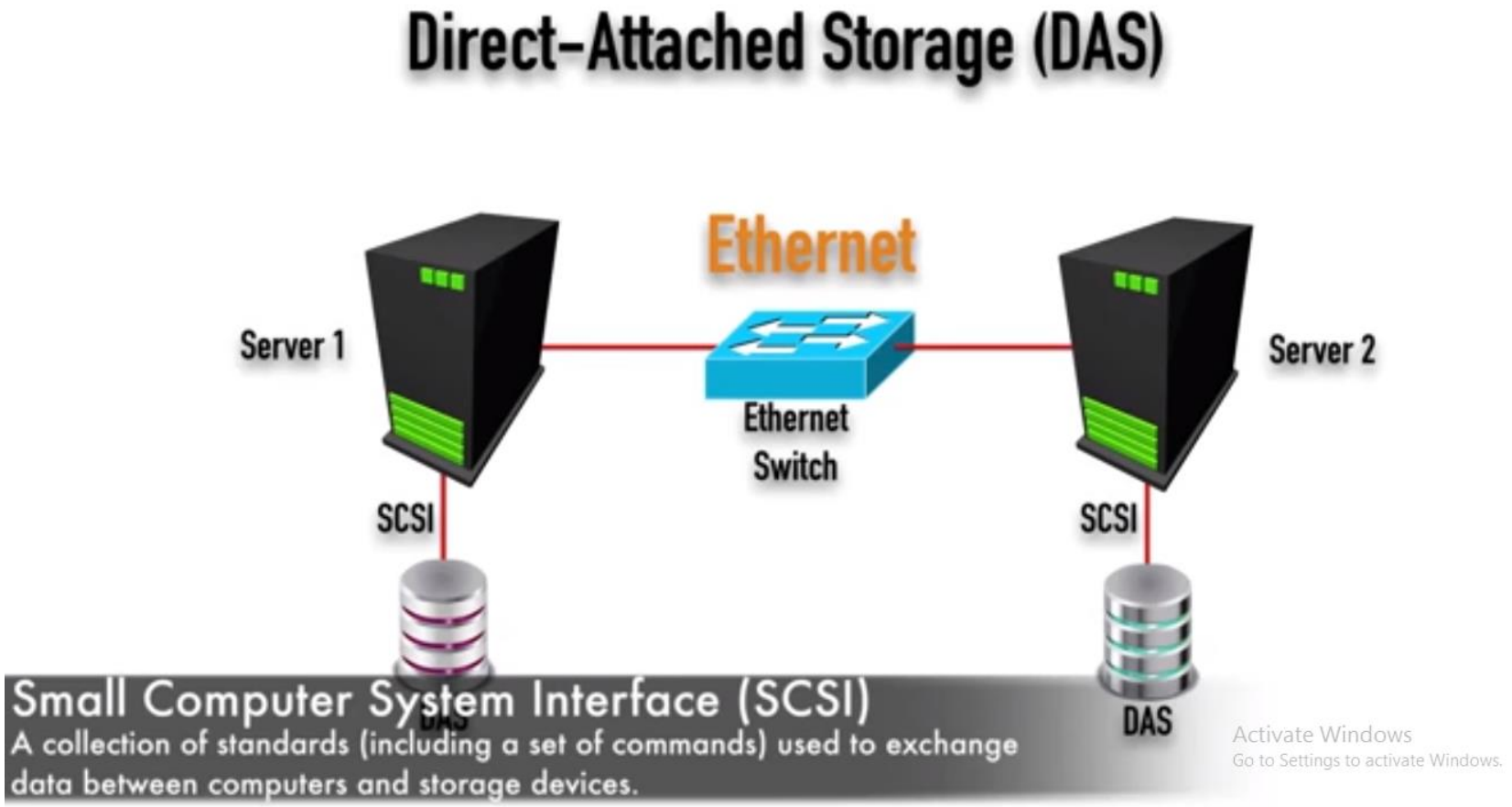




Each system has its own storage devices. Data is managed in blocks. The drawback in this model is, one system storage can not be shared for other system. Even if one system has large amount of free storage space that can not be accessed by the other system.

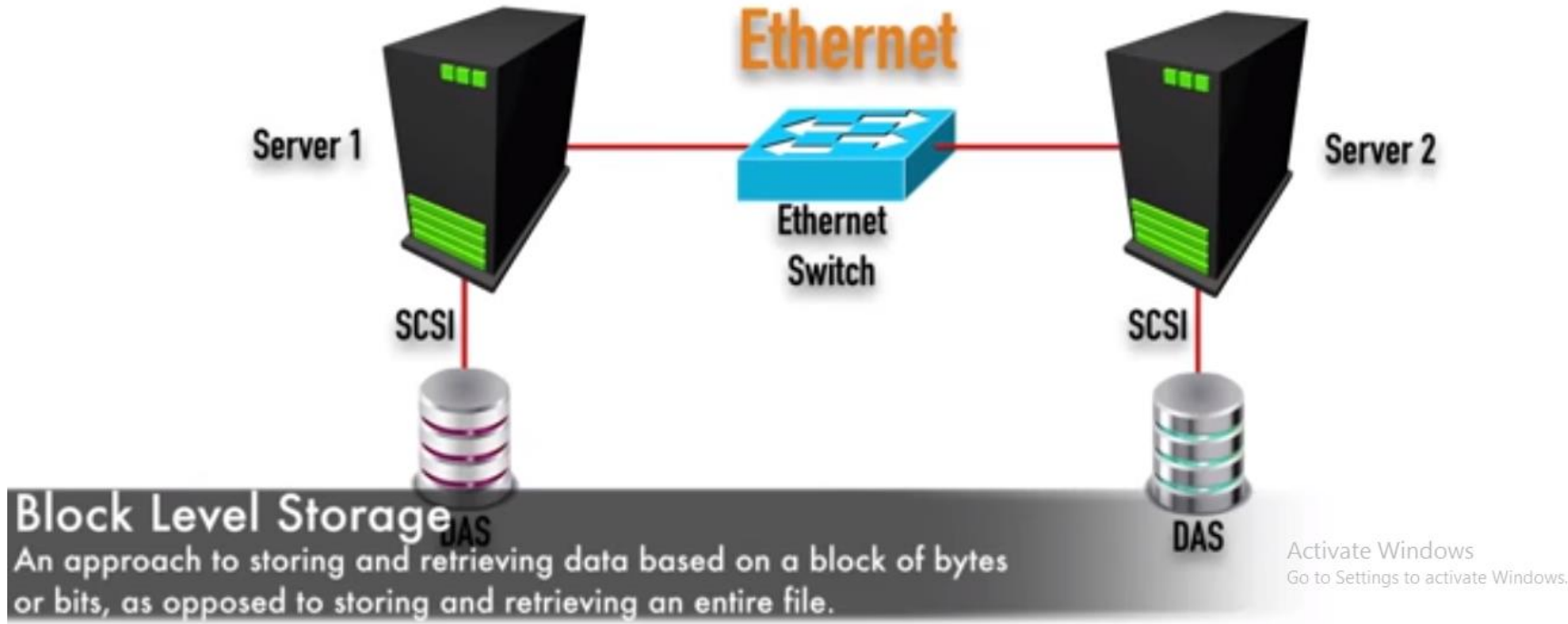
Direct Attached Storage (DAS)



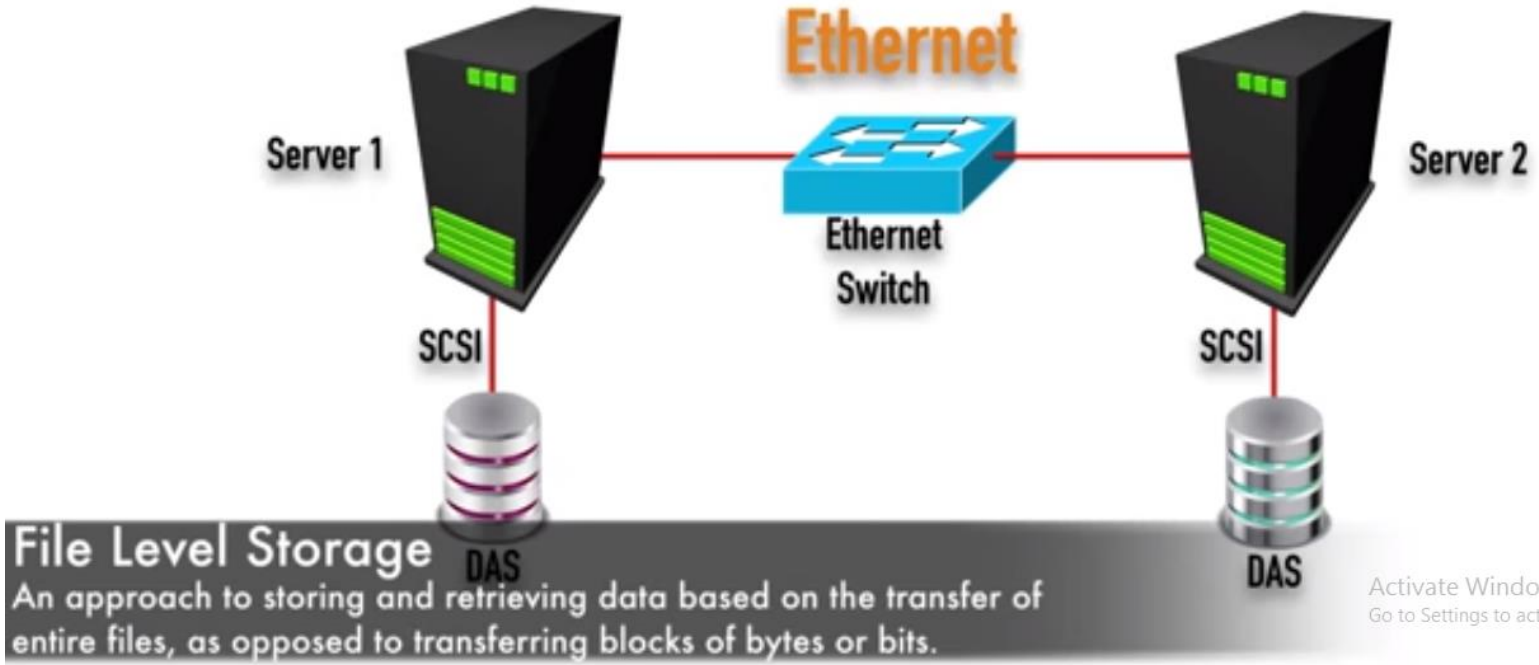


SCSI as DAS arrays provides faster access.

Direct-Attached Storage (DAS)



Direct-Attached Storage (DAS)



File Level Storage

An approach to storing and retrieving data based on the transfer of entire files, as opposed to transferring blocks of bytes or bits.

Direct Attached Storage (DAS)

DAS Use Cases & Highlights:

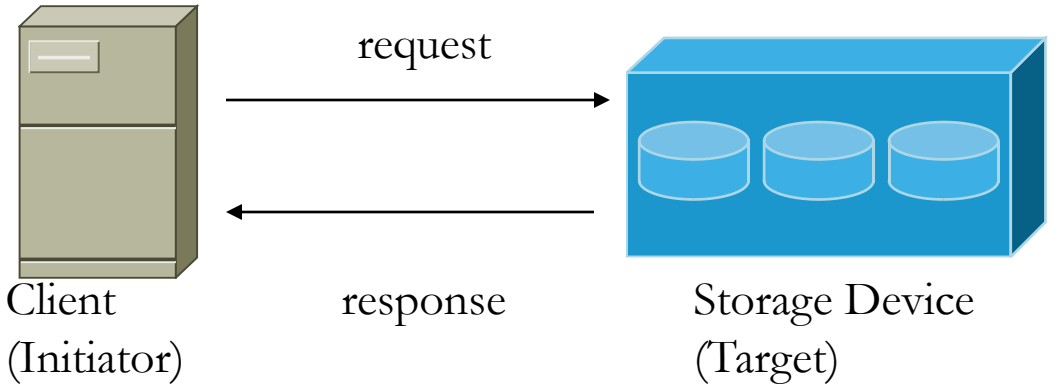
- Single Server Needs Access
- To Increase Server Capacity
  - For File Sharing
  - For Backup
  - Increases Storage Capacity ≅ 30TB
- Less Expensive Option

Small Computer System Interface (SCSI)

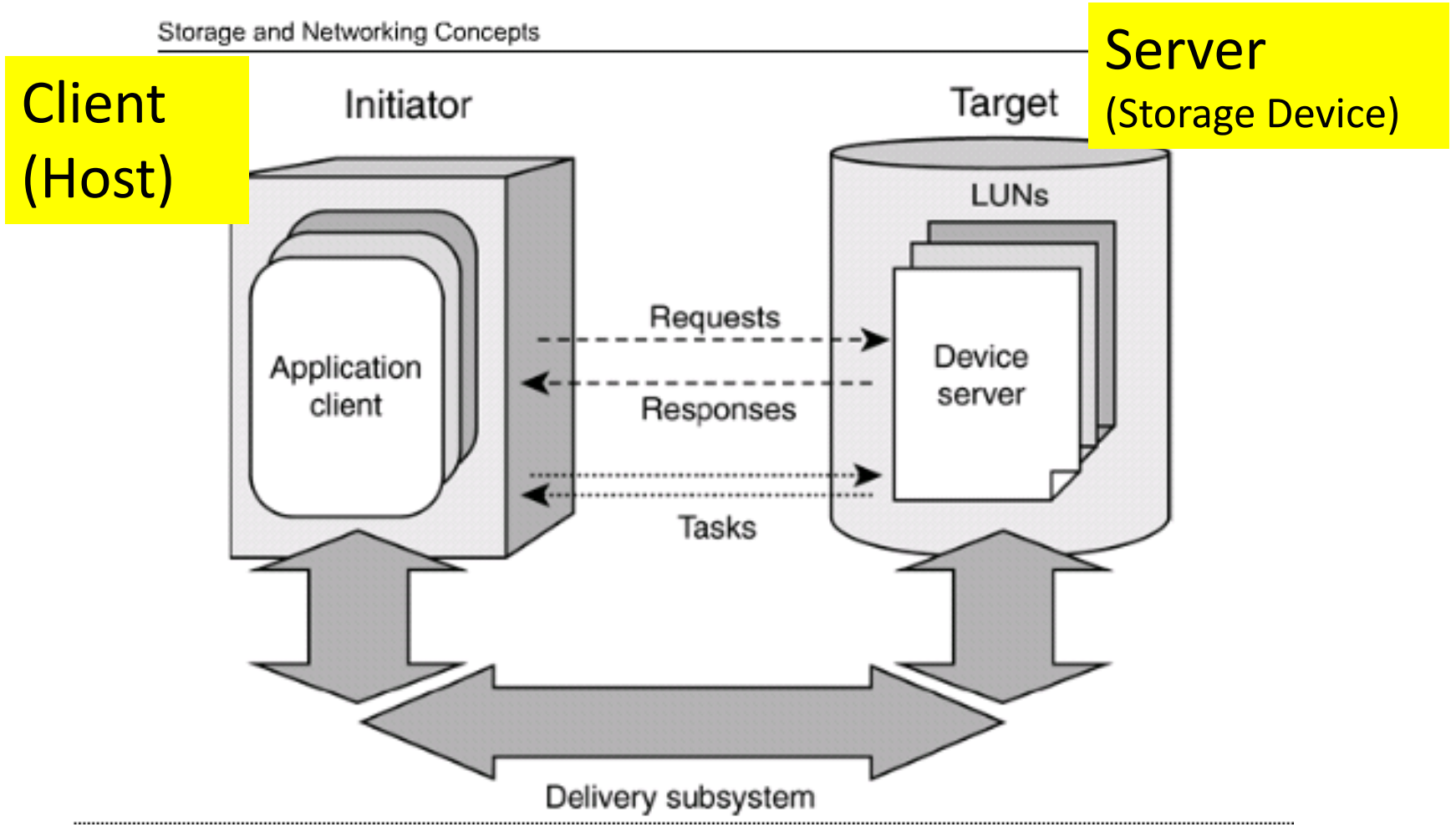
- From Shugart's 1979 SASI implementation
- An I/O bus for peripheral device, such as hard drives, tape drives, CD-ROM, scanners, etc.
  - an improvement over IDE
- A single SCSI bus connects multiple elements (max 7 or 15).
- High speed data transfer:
  - 5, 10, 20, 100, 320MB/sec, …
- Overlapping I/O capability:
  - Multiple read & write commands can be outstanding simultaneously
  - Different SCSI drives to be processing commands concurrently rather than serially. The data can then be buffered and transferred over the SCSI bus at very high speeds

SCSI Distribution Architecture

- SCSI is a client/server architecture.
- The client is called the **initiator** and issues request to the server.
- The "server" is called the **target**, which is the SCSI controller inside the storage device. It receives, process, and responds to the requests from the initiator.



SCSI Client/Server Architecture



Network attached storage (NAS)

- Network attached storage (NAS) is a storage server, used for file storage and sharing.
- NAS is a group of hard drives attached to a network, used for storage and accessed through an assigned network IP address.
- NAS works using Ethernet with TCPIP.
- It acts as a server for file sharing. NAS is a complete storage system designed for many network systems, which may be processing millions of transactions per minute.

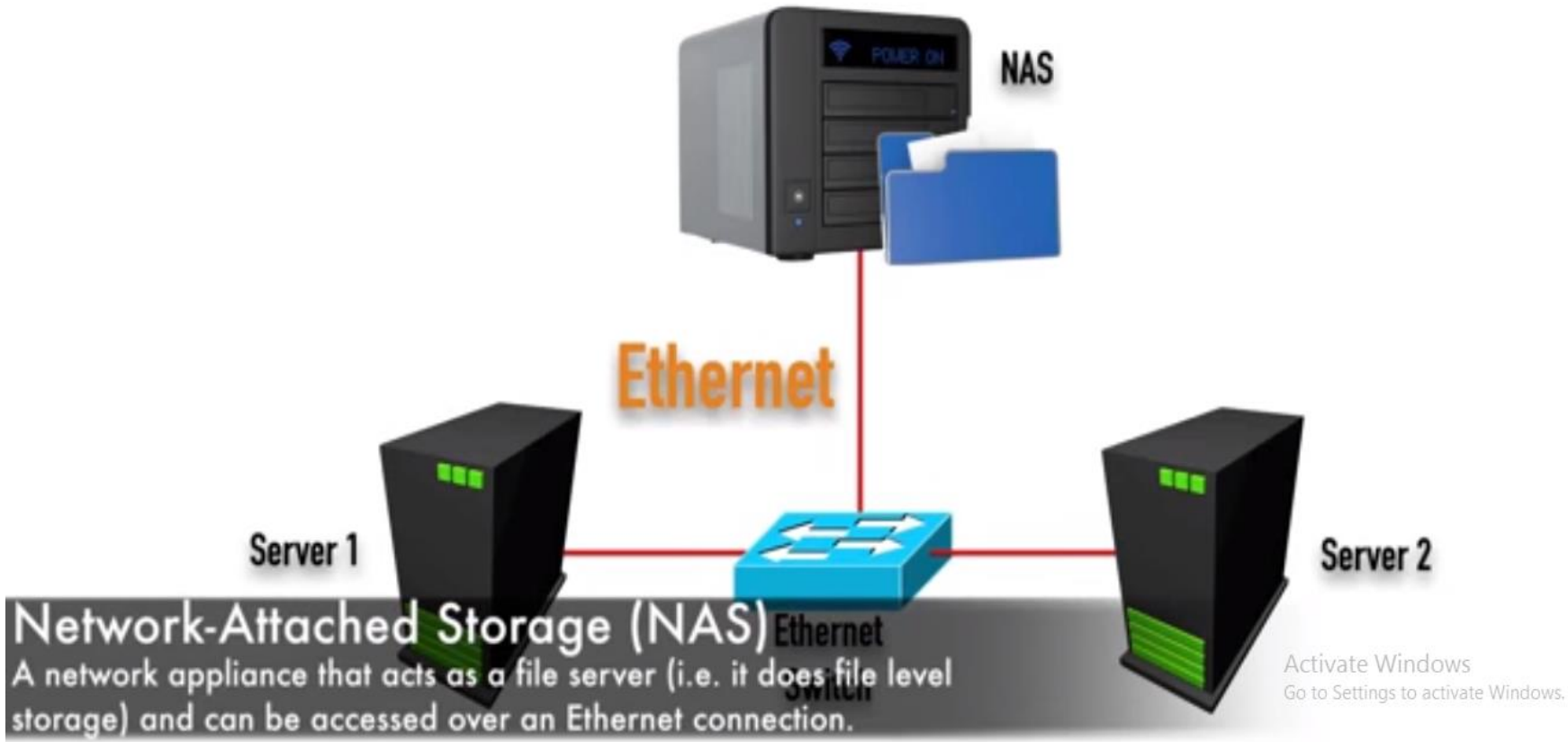

lenovo
EMC


iomega
EMC


NAS
SERVER
192.168.100.100
STATUS
USB
LAN
ENTER
SELECT
POWER
COPY


NAS
SERVER
192.168.100.100
POWER
COPY

Network-Attached Storage (NAS)



Network Attached Storage (NAS)

- **NAS is a dedicated storage device, and it operates in a client/server mode.**
- **NAS is connected to the file server via LAN.**
- **Protocol: NFS (or CIFS) over an IP Network**
  - Network File System (NFS) – UNIX/Linux
  - Common Internet File System (CIFS) – Windows Remote file system (drives) mounted on the local system (drives)
    - evolved from Microsoft NetBIOS, NetBIOS over TCP/IP (NBT), and Server Message Block (SMB)
  - SAMBA: SMB on Linux (Making Linux a Windows File Server)
- Advantage: no distance limitation
- Disadvantage: Speed and Latency
- Weakness: Security

Standalone Boxes

NAS Use Cases & Highlights:

- Used for File Sharing
- Used to Store Server Backups
- Have CPU, Memory & NIC Ports
- Can Hold 2 to 12+ Hard Drives
- “Poor Man’s SAN”
- Slower Connection & Transfer

Storage Area Network -- SAN

- SANs are commonly based on Fibre Channel (FC) technology. SAN uses fiber SAN switch and fiber cables for storing and retrieving data.
- In addition, the use of Fibre Channel over Ethernet (FCoE) makes it possible to move FC traffic across existing high speed Ethernet infrastructures and converge storage and IP protocols onto a single cable.

Storage Area Network (SAN)

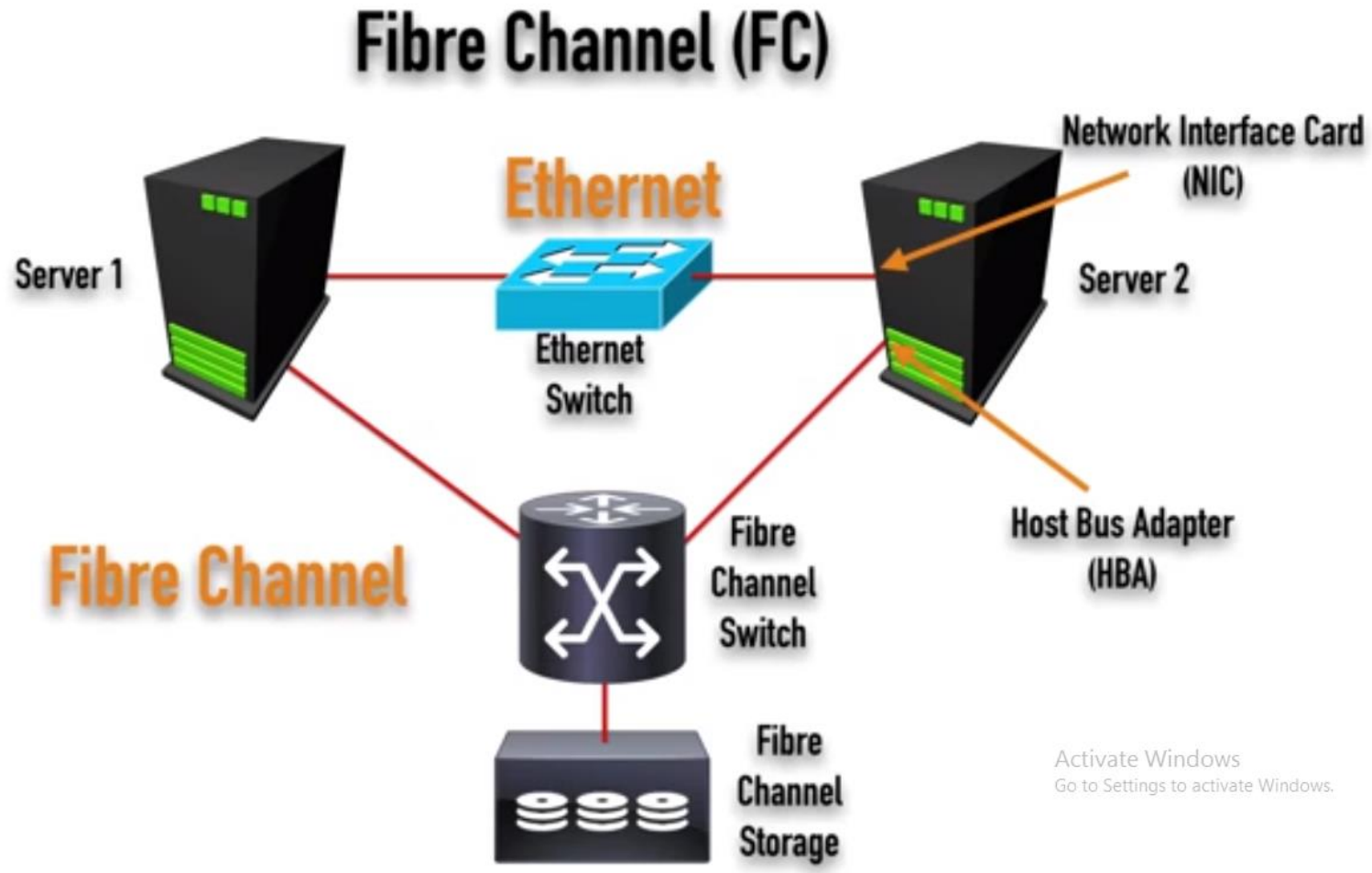
- A Storage Area Network (SAN) is a specialized, dedicated high speed network joining servers and storage, including disks, disk arrays, tapes, etc.
- High capacity, high availability, high scalability, ease of configuration, ease of reconfiguration.
- **Fiber Channel** is the de facto SAN networking architecture, although other network standards could be used.

SAN Benefits

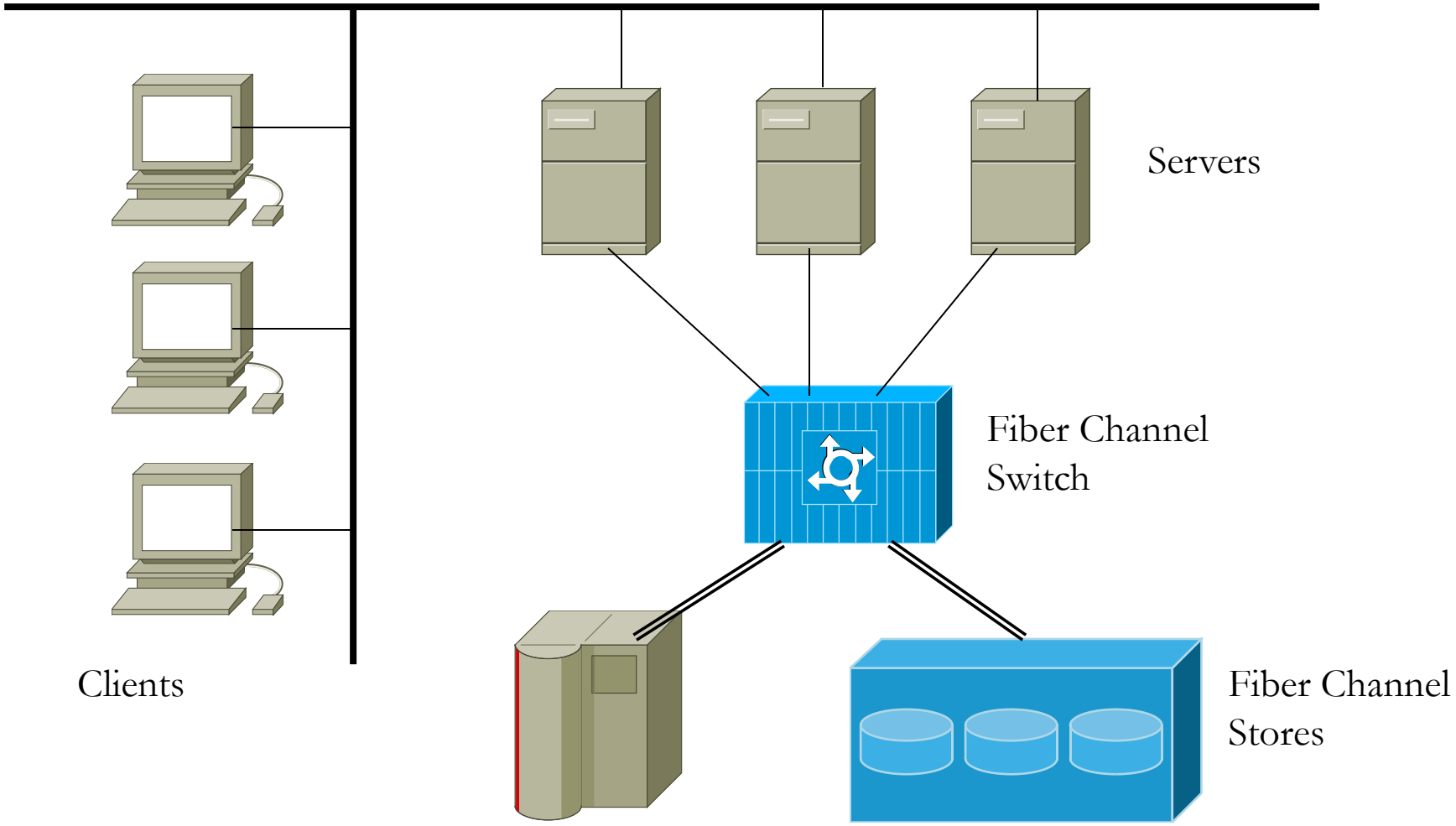
- ✓ Storage consolidation
- ✓ Data sharing
- ✓ Non-disruptive scalability for growth
- ✓ Improved backup and recovery
- ✓ Tape pooling
- ✓ High performance
- ✓ High availability server clustering
- ✓ Data integrity
- ✓ Disaster tolerance
- ✓ Ease of data migration
- ✓ Cost-effectives (total cost of ownership)

- ✓ Disk Utilisation. Most people see this as being the main benefit of SAN and NAS storage. ...
- ✓ Thin Provisioning. This is directly related to disk utilisation. ...
- ✓ Deduplication and Compression. ...
- ✓ Resiliency. ...
- ✓ Centralised Management. ...
- ✓ Centralised Backup. ...
- ✓ Snapshots. ...
- ✓ Disaster Recovery.

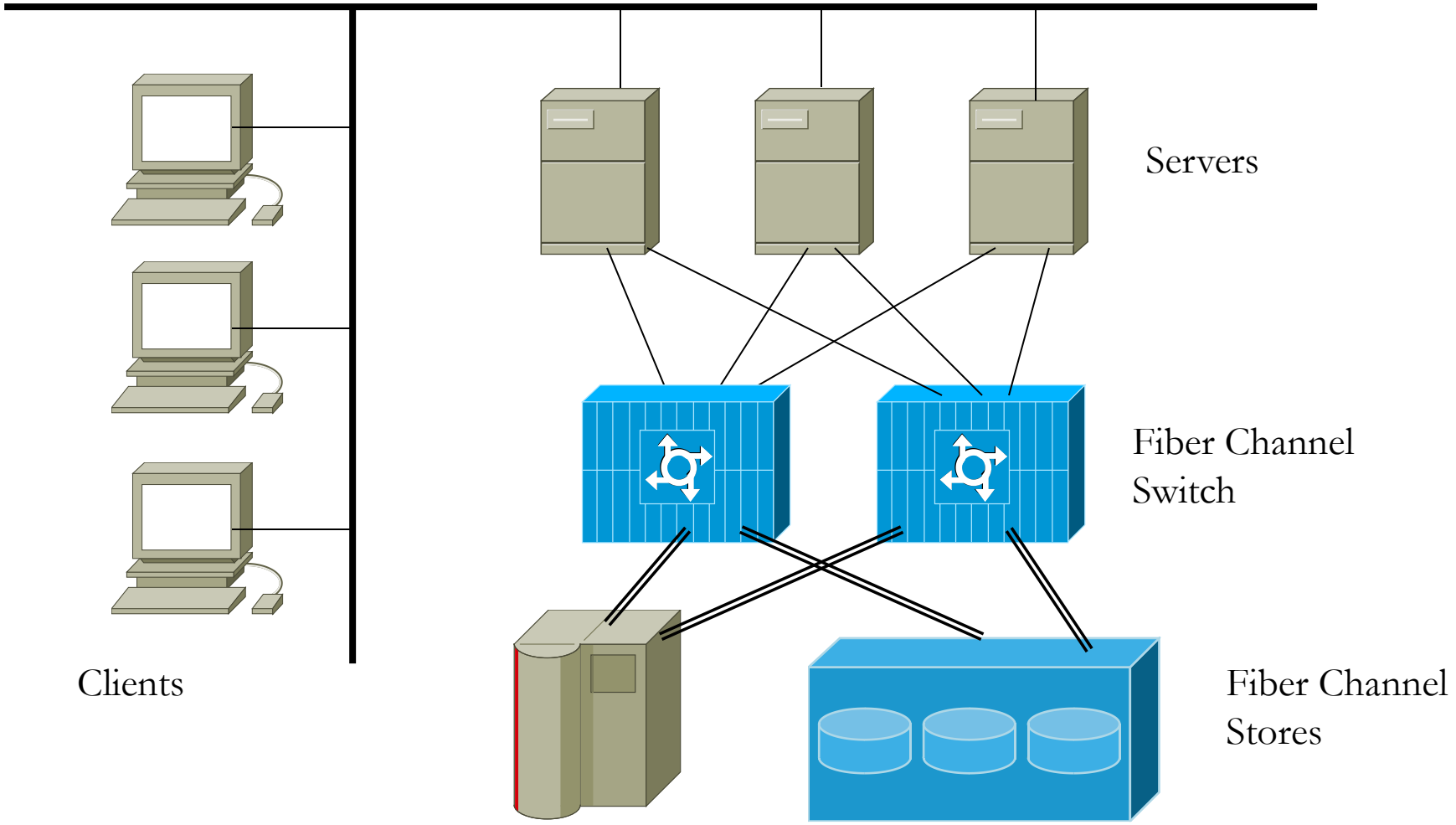
Storage Area Network -- SAN



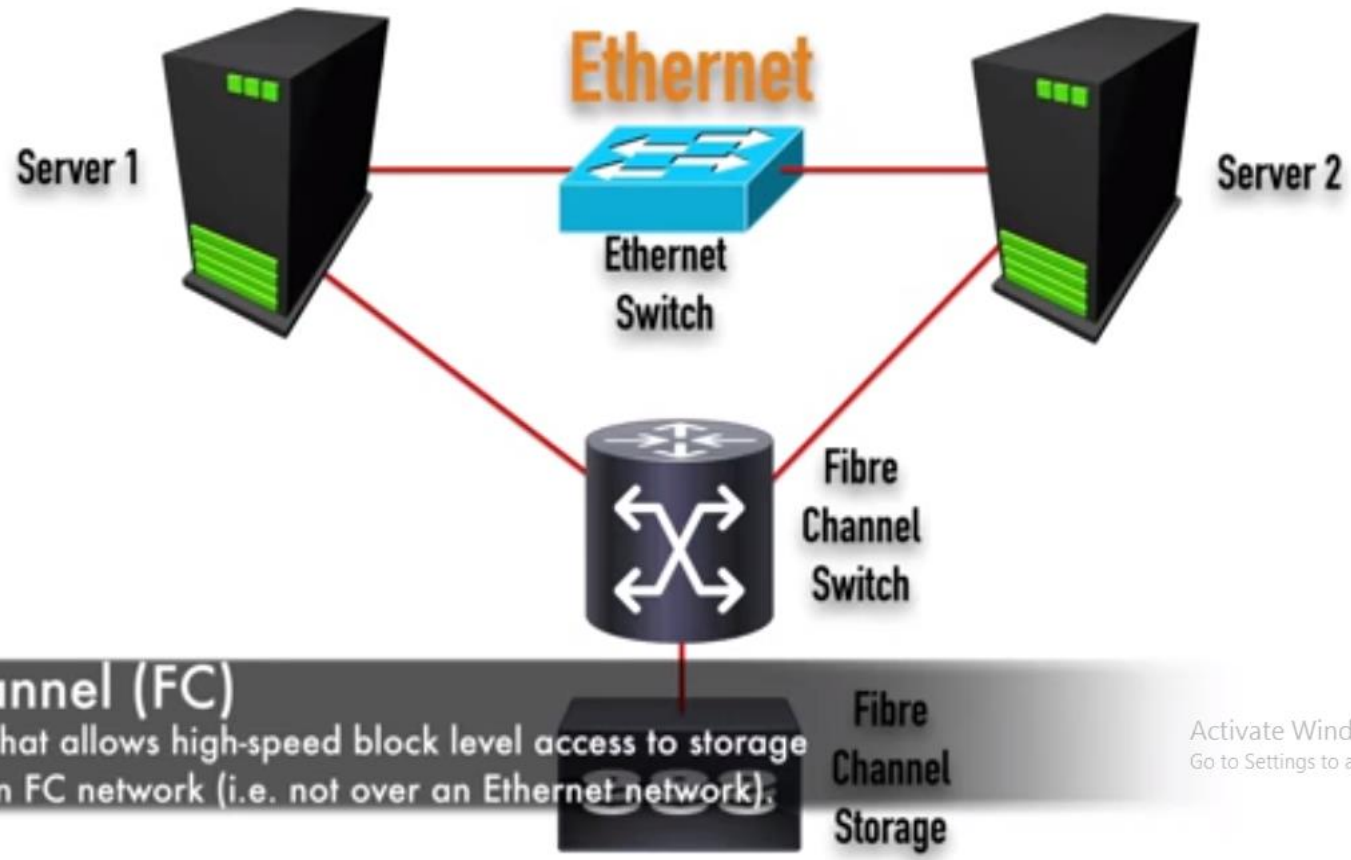
FC – Switched SAN



FC - Storage Area Network (redundant architecture)



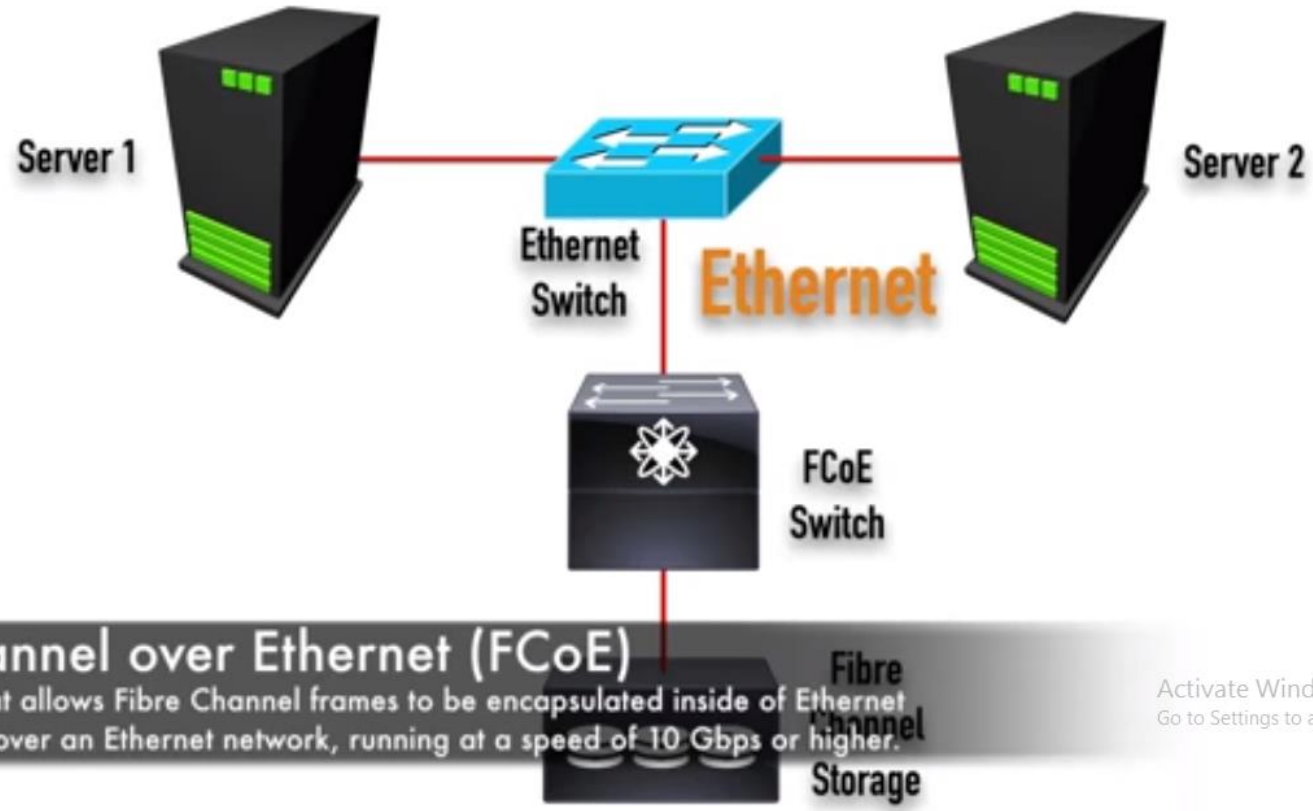
Fibre Channel (FC)



Fibre Channel (FC)

A technology that allows high-speed block level access to storage devices over an FC network (i.e. not over an Ethernet network).

Fibre Channel over Ethernet (FCoE)



Fibre Channel over Ethernet (FCoE)

A technology that allows Fibre Channel frames to be encapsulated inside of Ethernet frames and sent over an Ethernet network, running at a speed of 10 Gbps or higher.

Speed & Flexibility

SAN Use Cases & Highlights:

- Used in Backbone of Infrastructure
- Used for Virtualized Environments
- “Shared Storage Devices”
- More Expensive Option
- Better Performance & Reliability

- SAN does not has file system installed in it. So each server can have their own file systems. One can have NTFS, the other can have FAT32 file system.
- Block level storage is DAS, SAN and iSCSI
- Whereas NAS has file system installed in it directly, called NFS. File level storage. This is the major difference between NAS and SAN.

- SAN is attached through HBA (Host Bus Adaptor) – bit expensive because SAN uses fiber switch and fiber cables, plus two connectivity's adaptors - NIC and HBA for SAN switch.
- NAS uses the LAN for connectivity. So less expensive when compared to SAN.

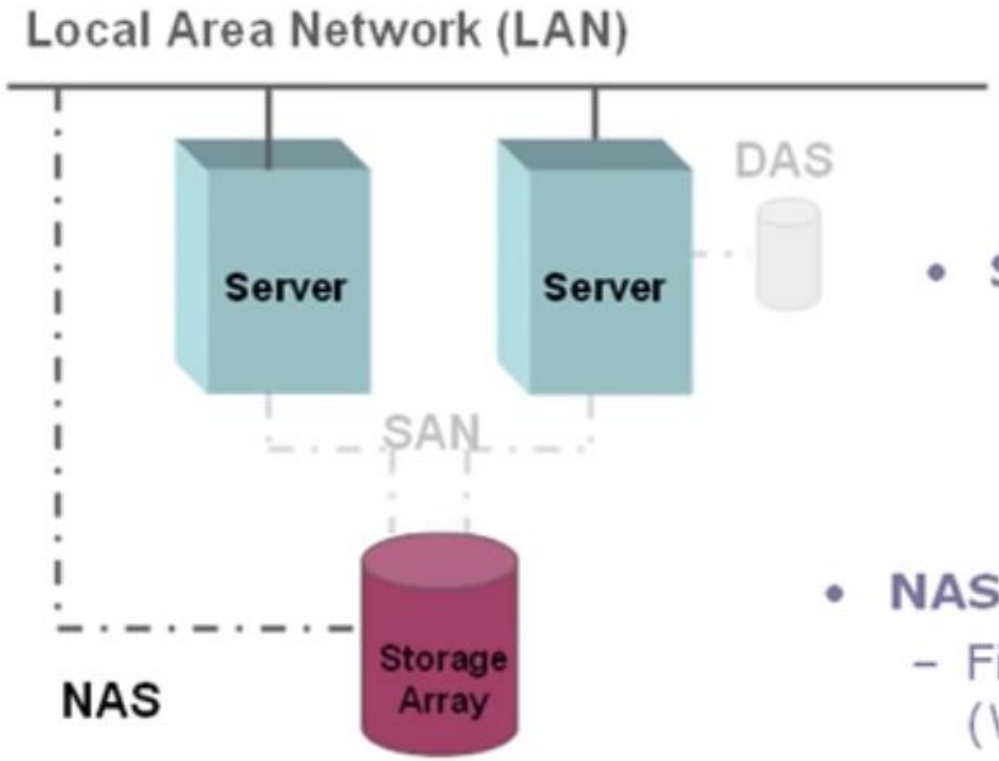
Quick Overview

	DAS	NAS	SAN
Storage Type	sectors	shared files	blocks
Data Transmission	IDE/SCSI	TCP/IP, Ethernet	Fibre Channel
Access Mode	clients or servers	clients or servers	servers
Capacity (bytes)	10^9	10^9 - 10^{12}	> 10^{12}
Complexity	Easy	Moderate	Difficult
Management Cost (per GB)	High	Moderate	Low

3 ways to connect Storage to Servers

Thin Provisioning of interest?

- **DAS** : Direct Attach Storage
  - NO sharing
  - Block Access (SAS/SATA)

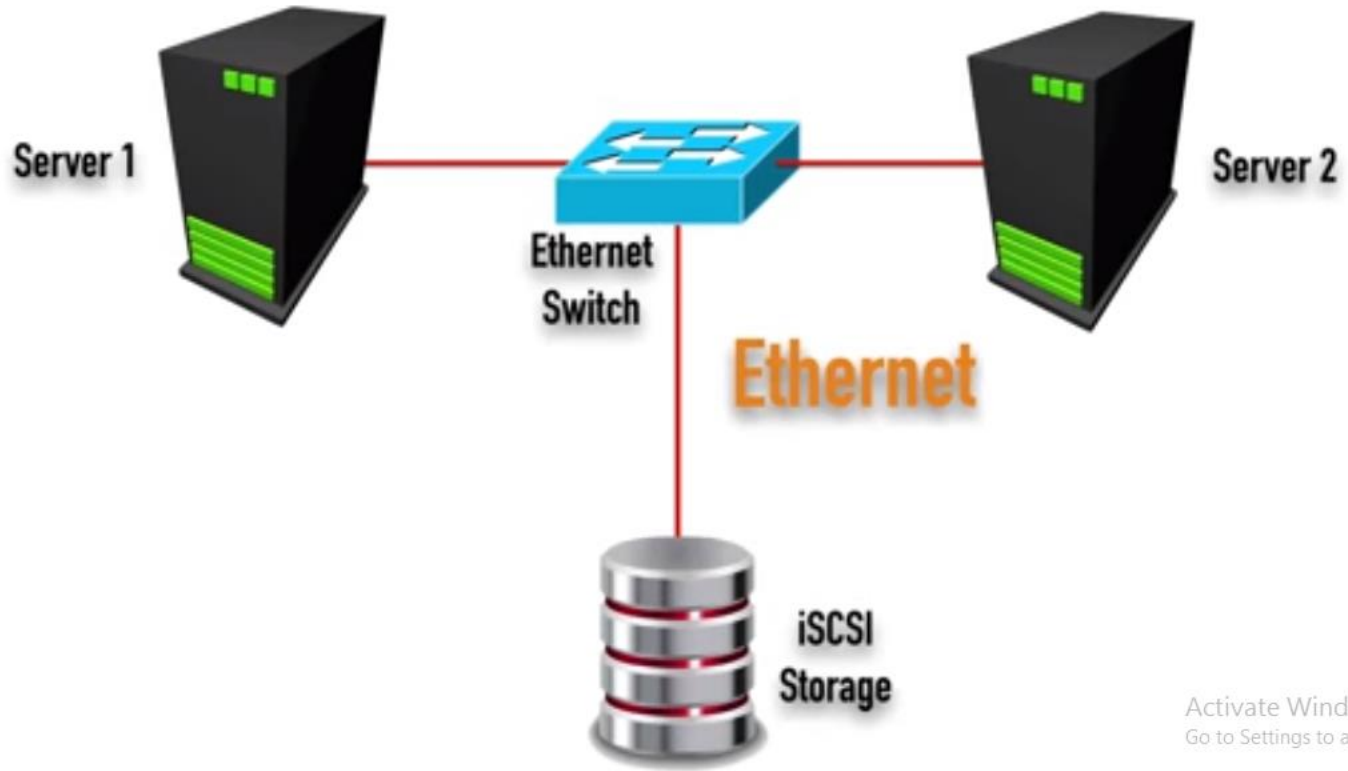


- **SAN** : Storage Area Network
  - Block Access (iSCSI/ Fibre Channel)

- **NAS** : Network Attached Storage
  - File Access (Windows CIFS/ Unix NFS)

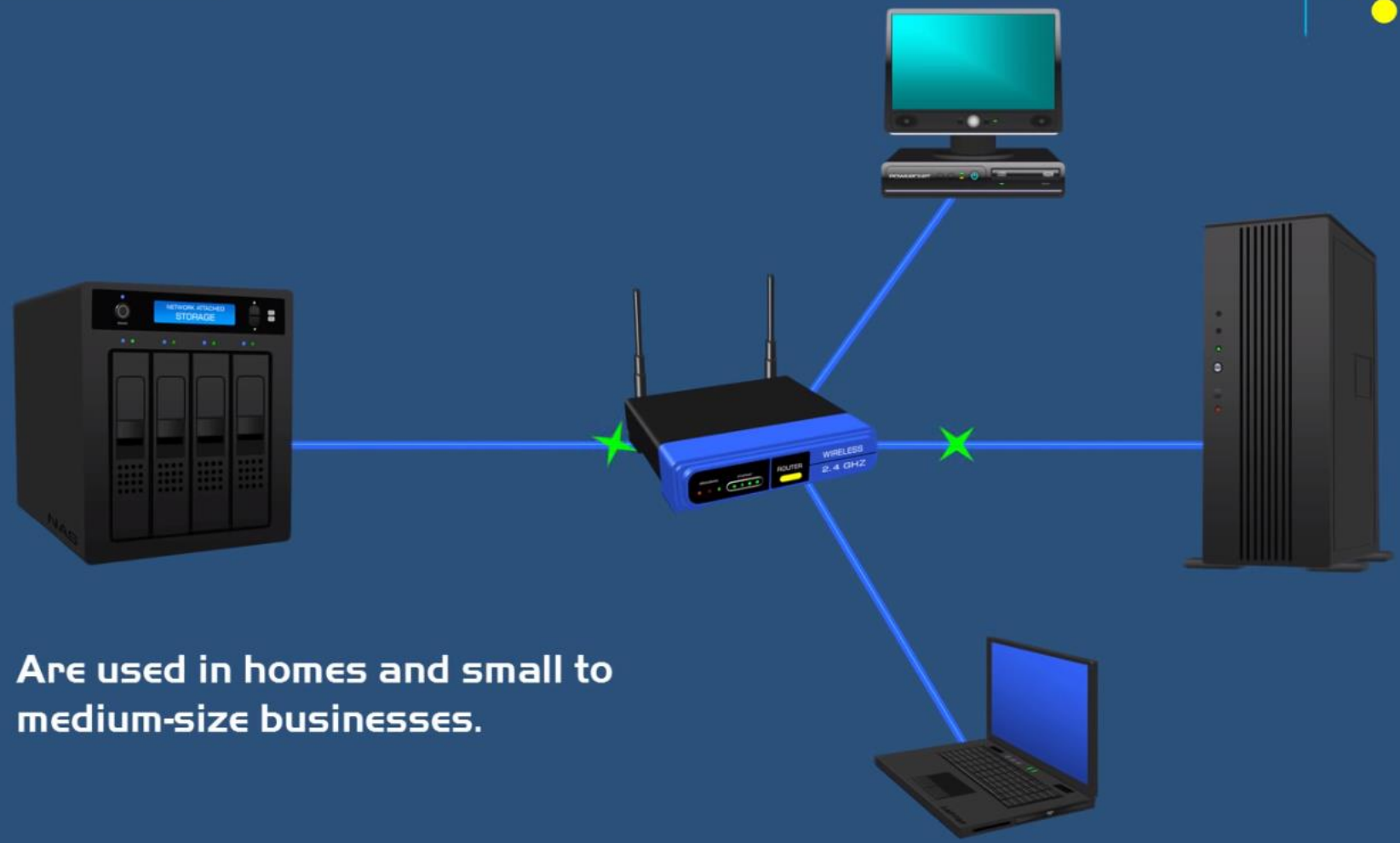
- Other technologies like Internet Small Computing System Interface (iSCSI), commonly used in small and medium sized organizations as a less expensive alternative to FC.

Internet Small Computer System Interface (iSCSI)

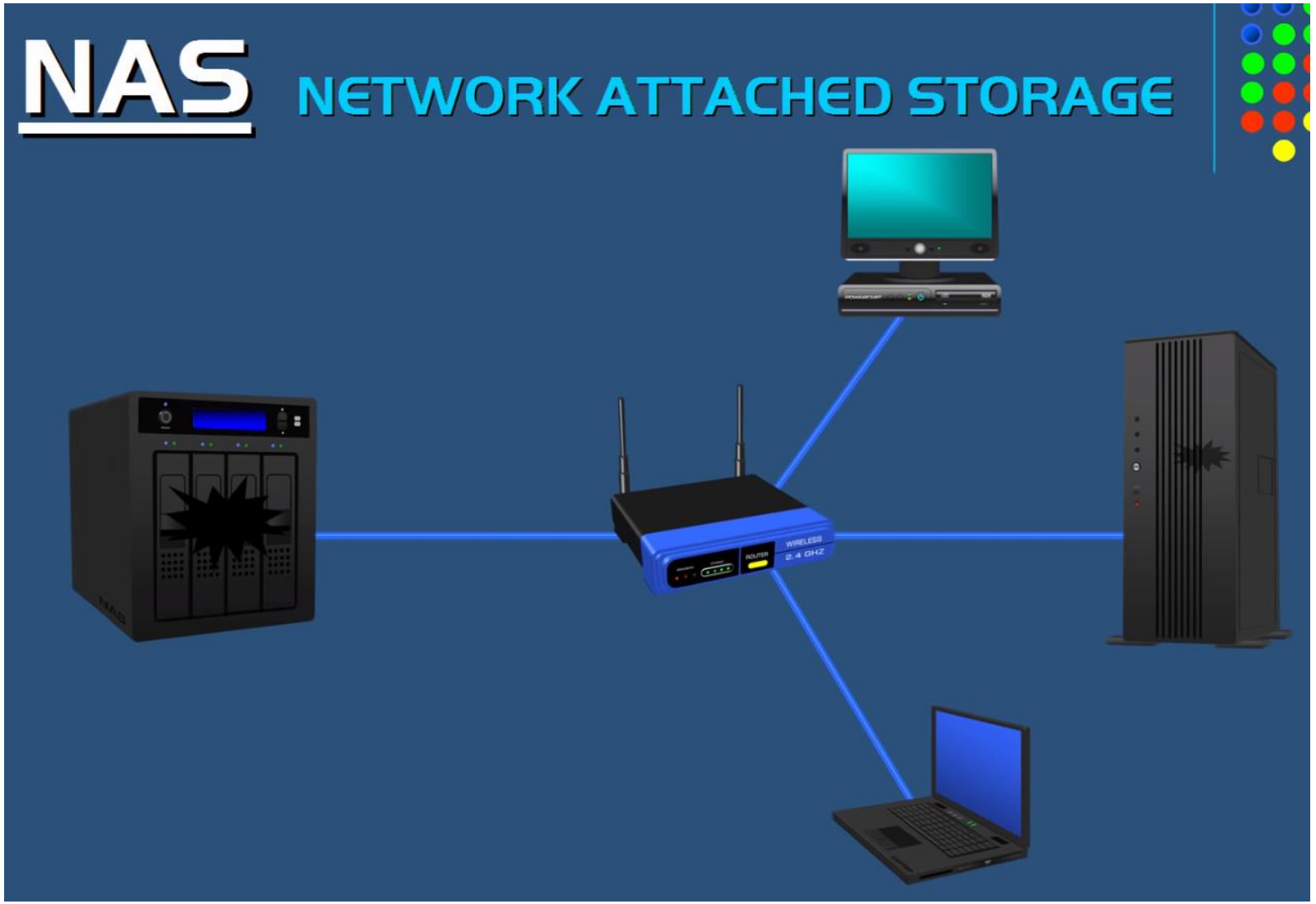


NAS

NETWORK ATTACHED STORAGE

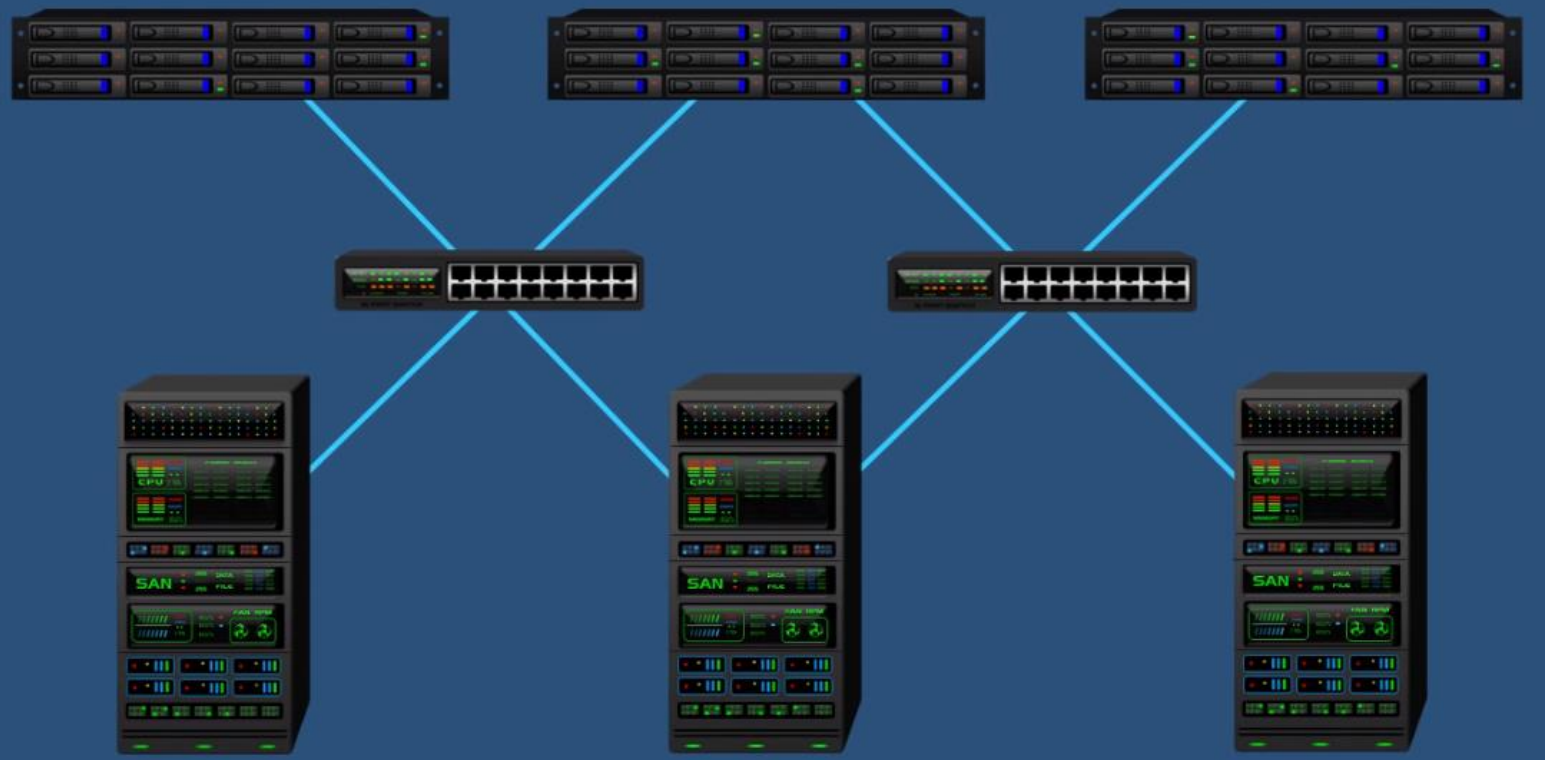


Are used in homes and small to medium-size businesses.



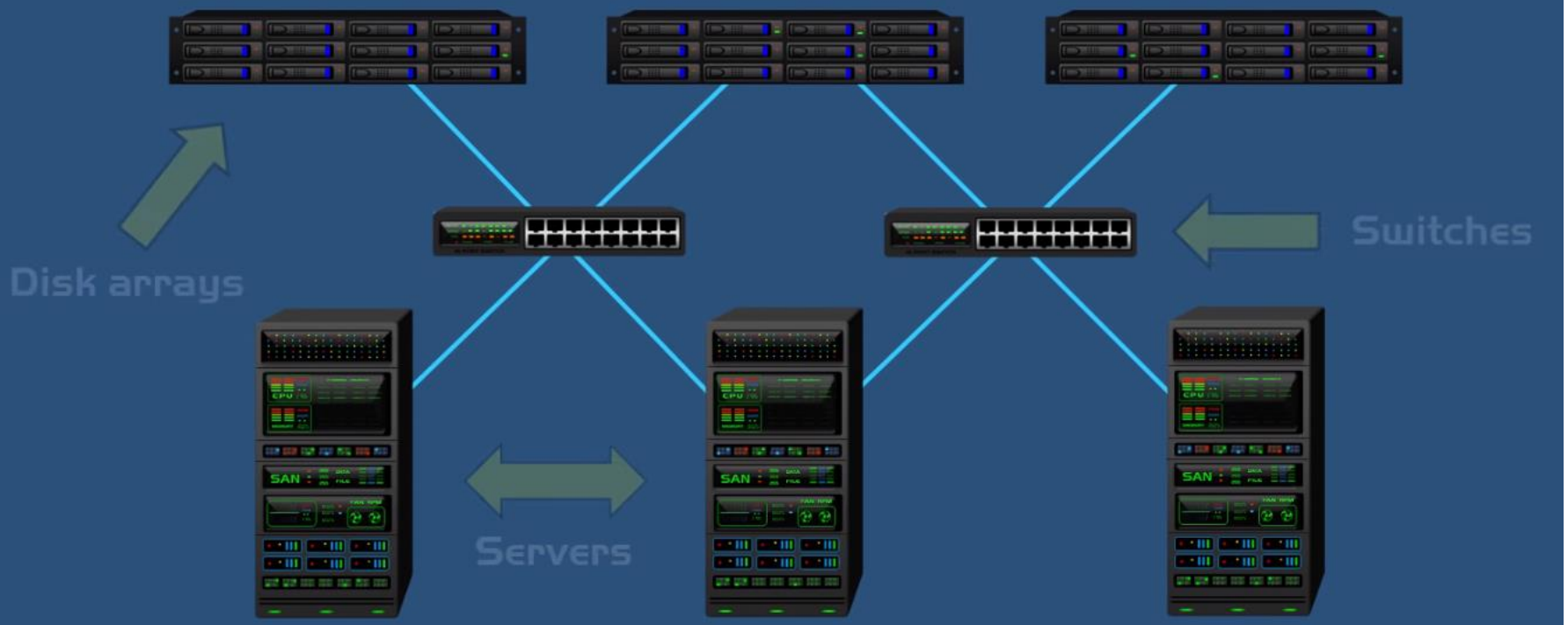
NAS is SPOF (single point of failure)

SAN STORAGE AREA NETWORK



A special, high speed network that stores and provides access to large amounts of data.

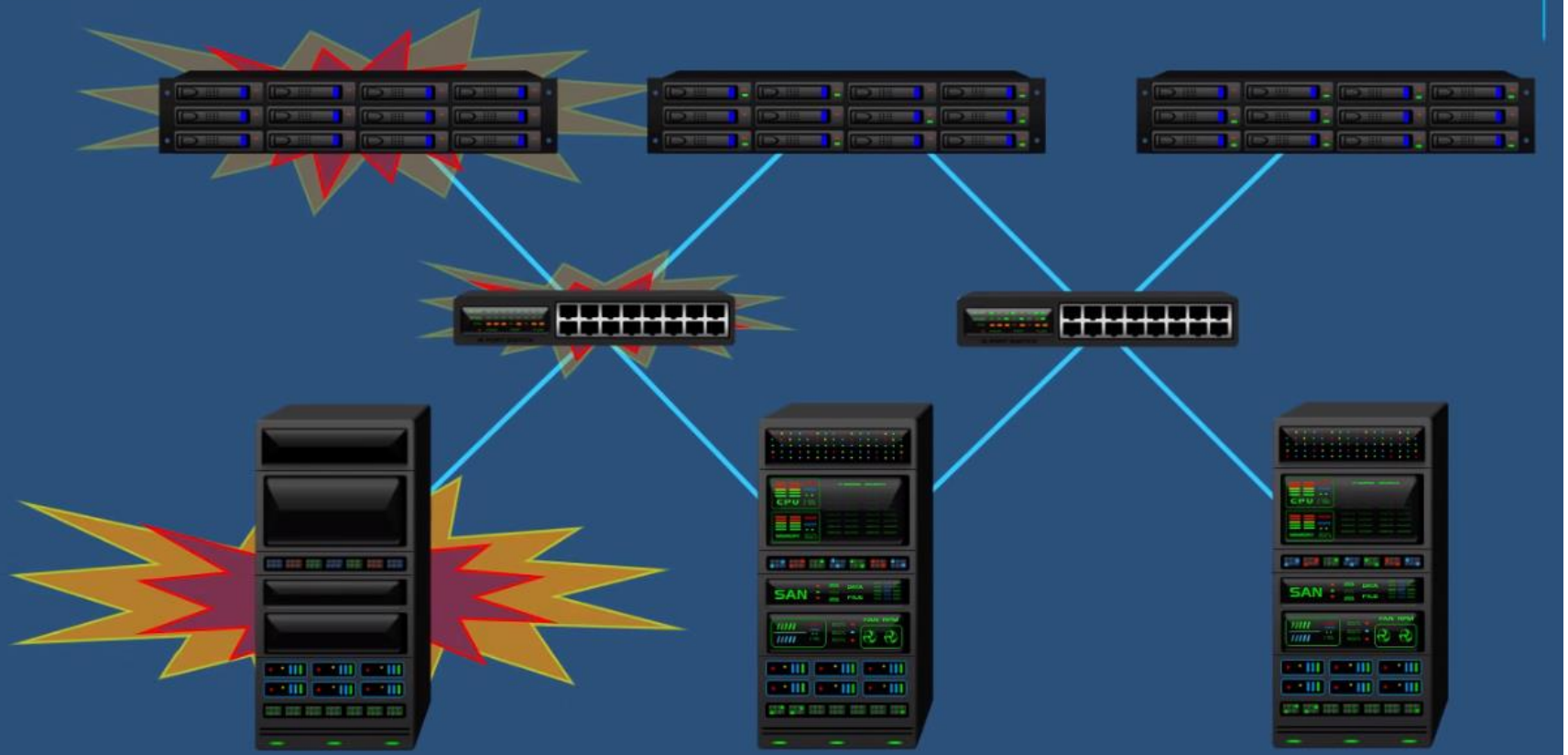
SAN STORAGE AREA NETWORK



SANs are fault tolerant.

Data is shared among several disk arrays.

SAN STORAGE AREA NETWORK



SANs are fault tolerant.

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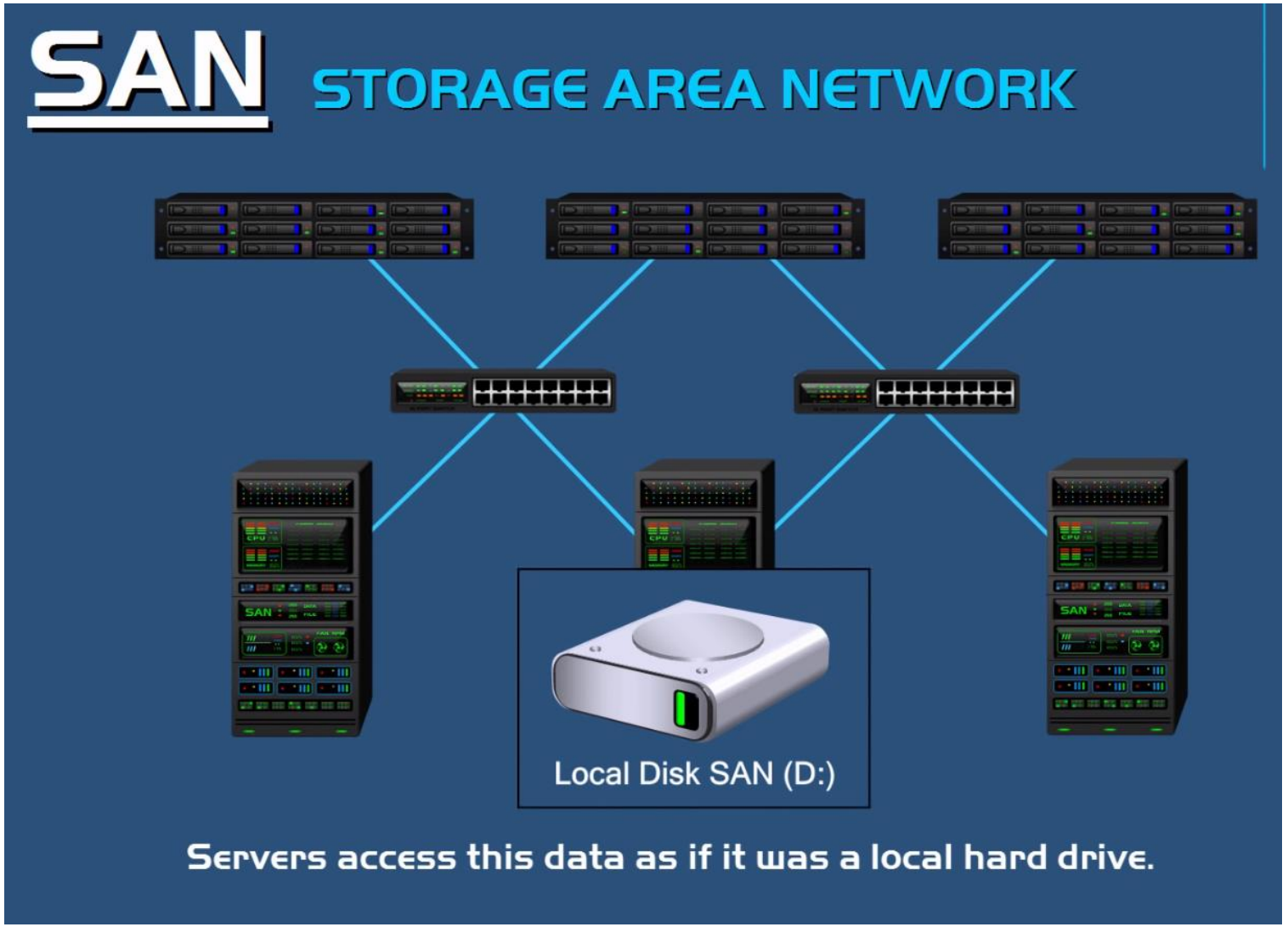
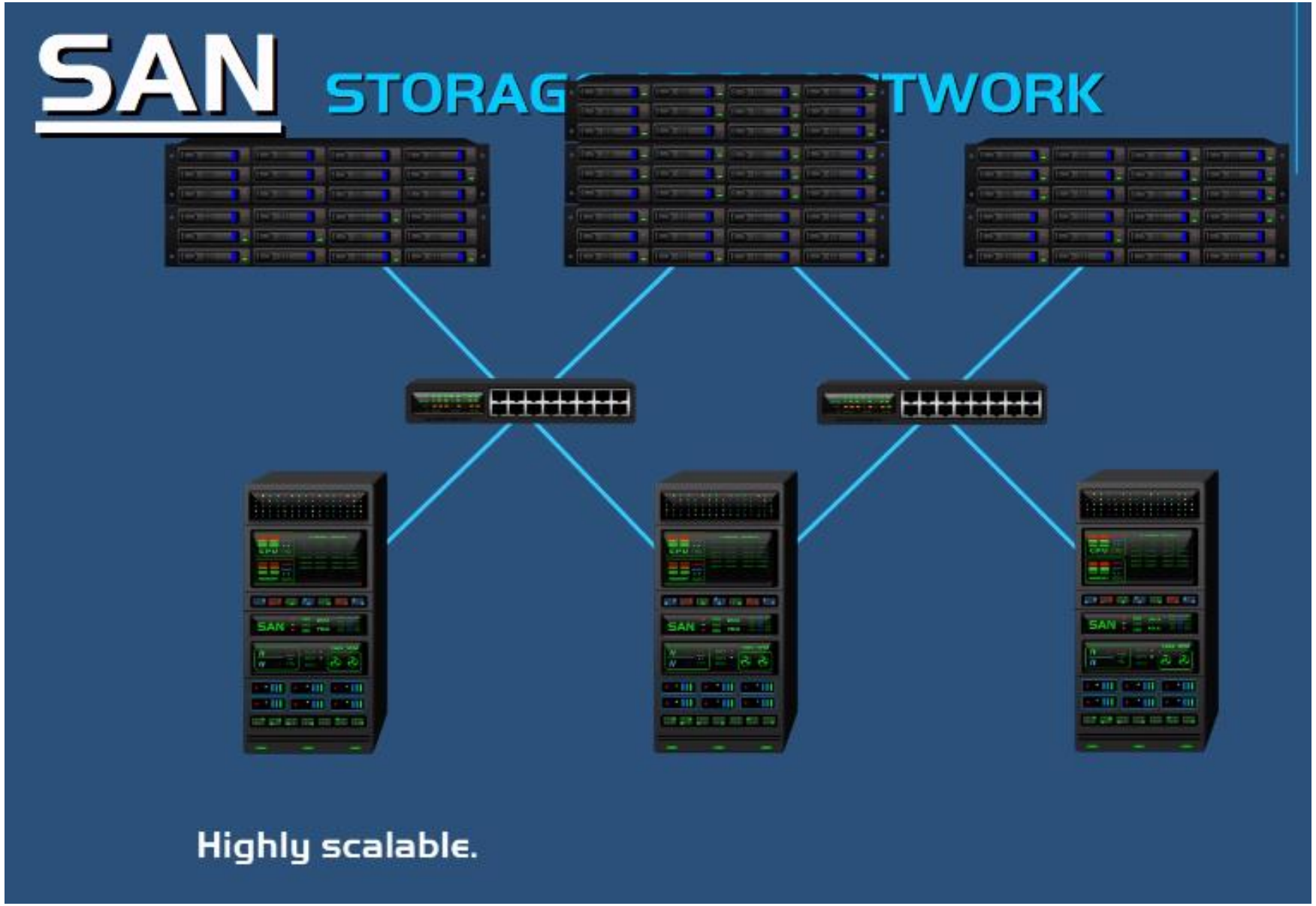
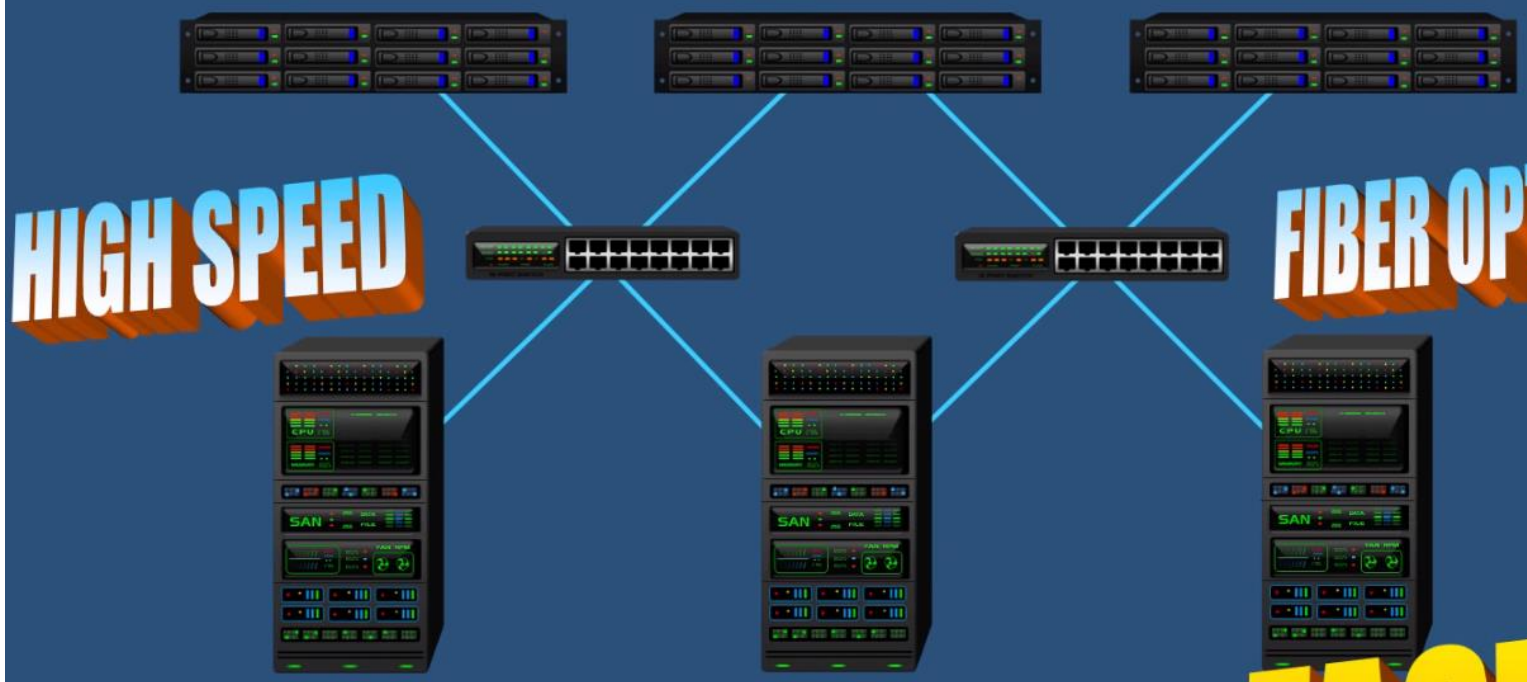


SAN, disk will display as local disk on the system. NAS is a shared storage server


SAN
STORAG TWORK
Highly scalable.

SAN

STORAGE AREA NETWORK

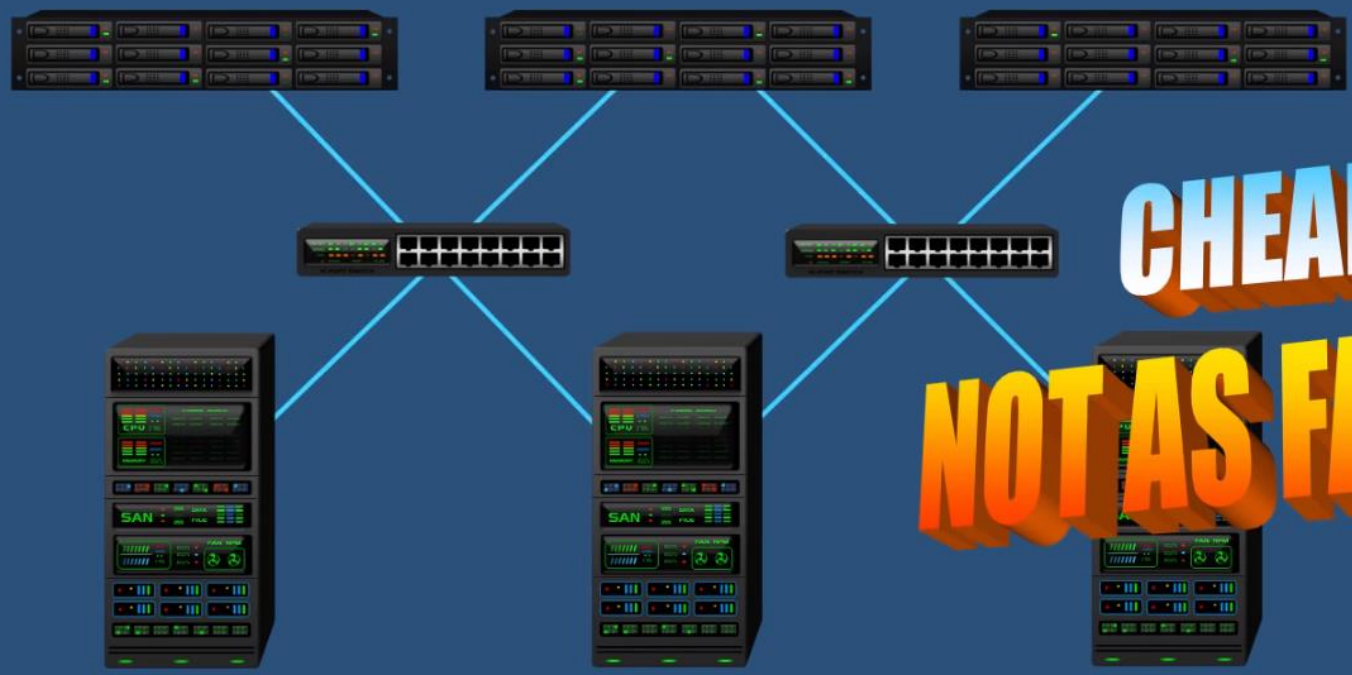


Interconnected using Fibre Channel.

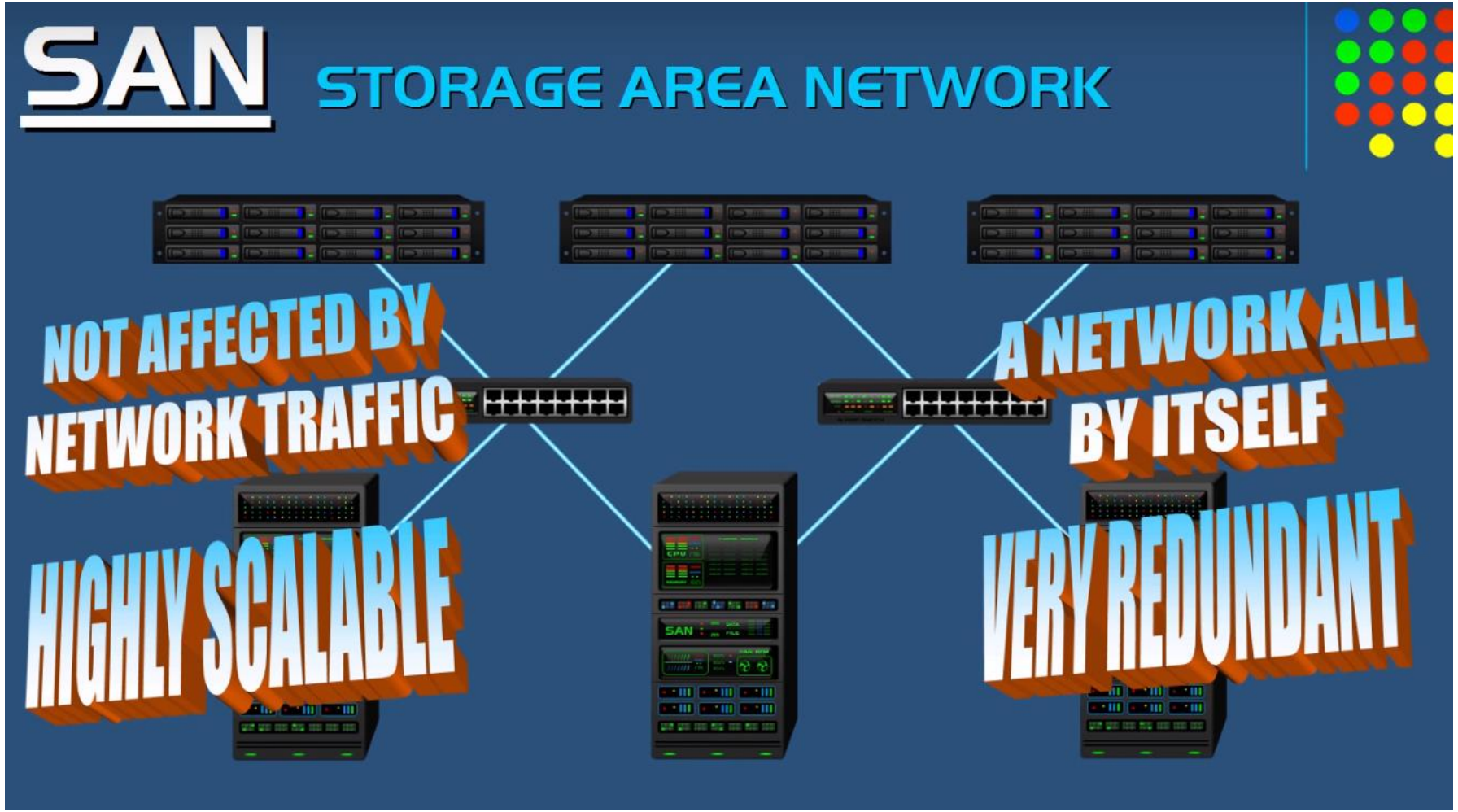
Speeds between 2 Gbit/s – 128 Gbit/s.

FAST!

SAN STORAGE AREA NETWORK



iSCSI (Internet Small Computer System Interface) – which is a cheaper alternative to using Fibre Channel.


SAN
STORAGE AREA NETWORK
NOT AFFECTED BY NETWORK TRAFFIC
HIGHLY SCALABLE
A NETWORK ALL BY ITSELF
VERY REDUNDANT
SAN

SAN

STORAGE AREA NETWORK

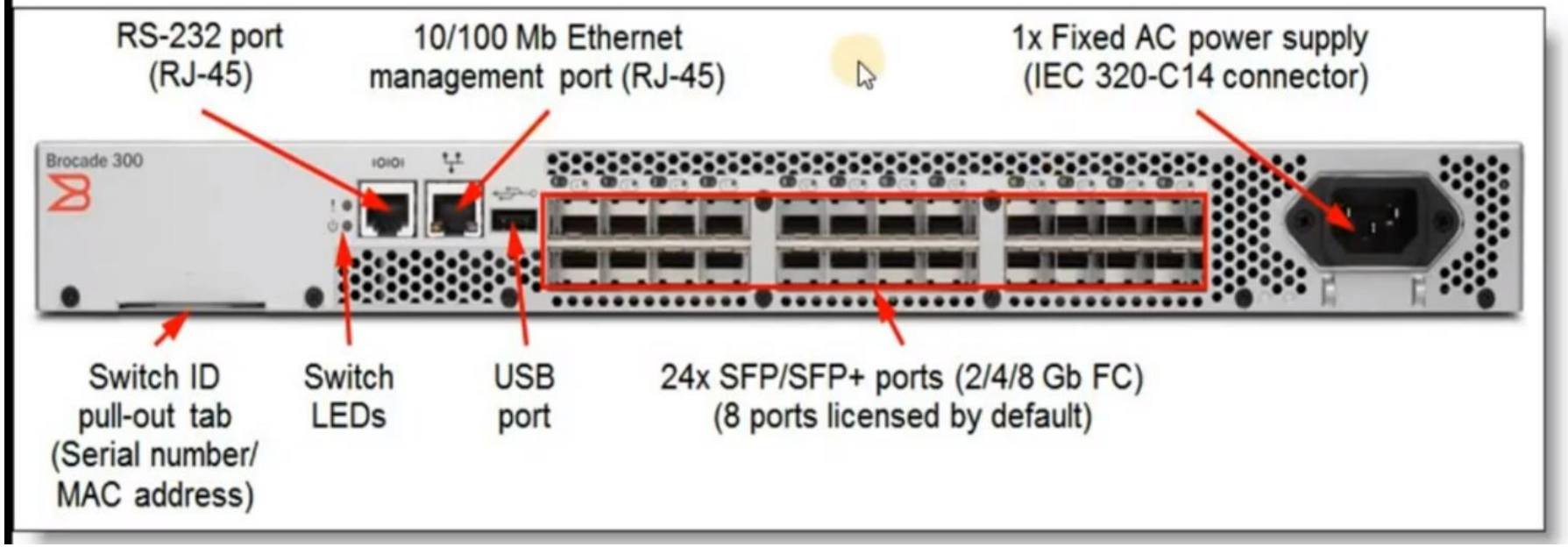
SANs are not cheap.

Mainly used by large companies.

What Is SAN Switch

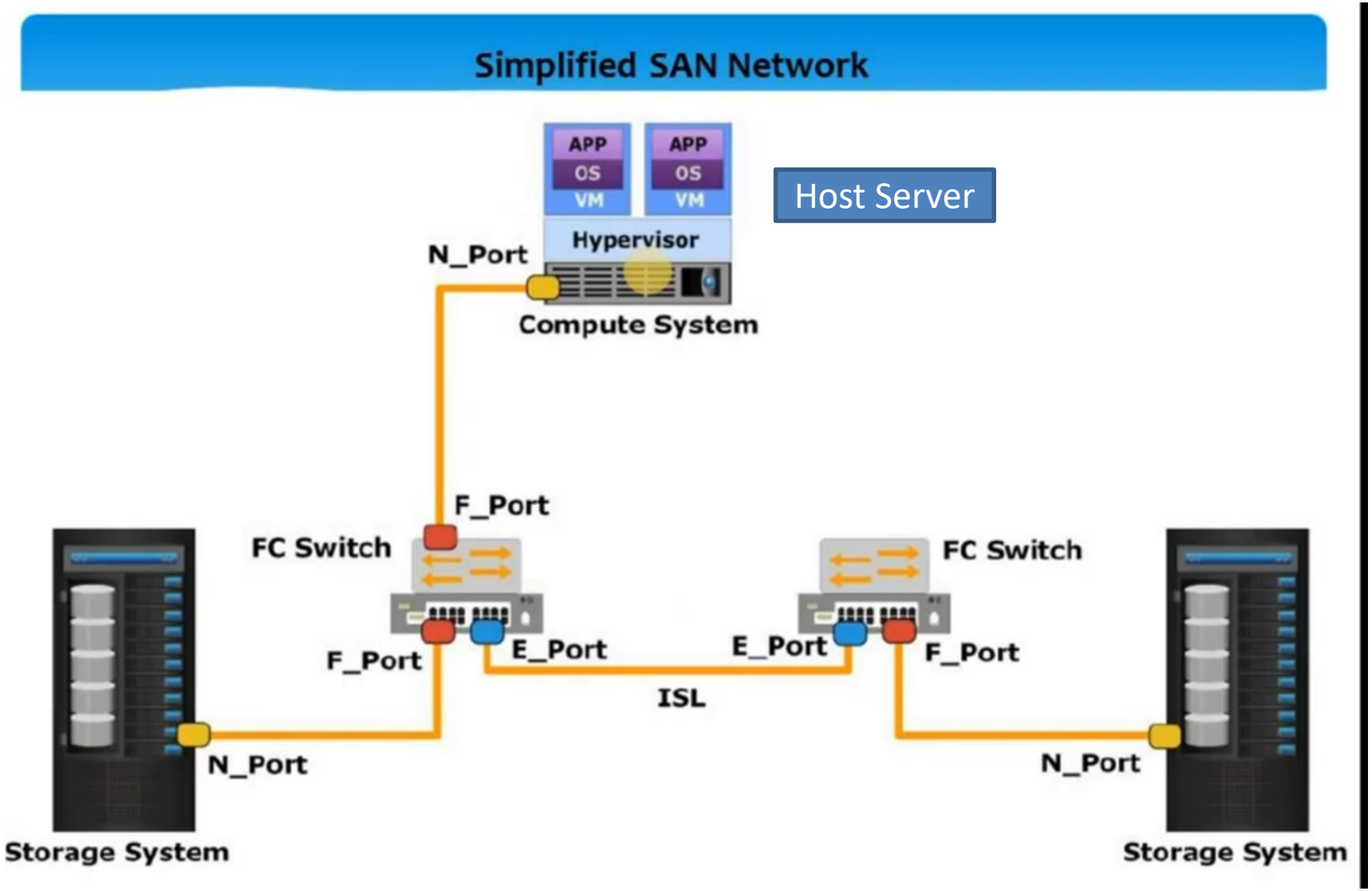
* SAN Switch is a hardware which have FC Ports
* Host and Storage device are connected to it
* It establish a communication link between host and storage device.
* Group of SAN switch is called as Fabric.
* Every SAN network has two fabric for redundancy.
* Popular Vendor Are Brocade and Cisco

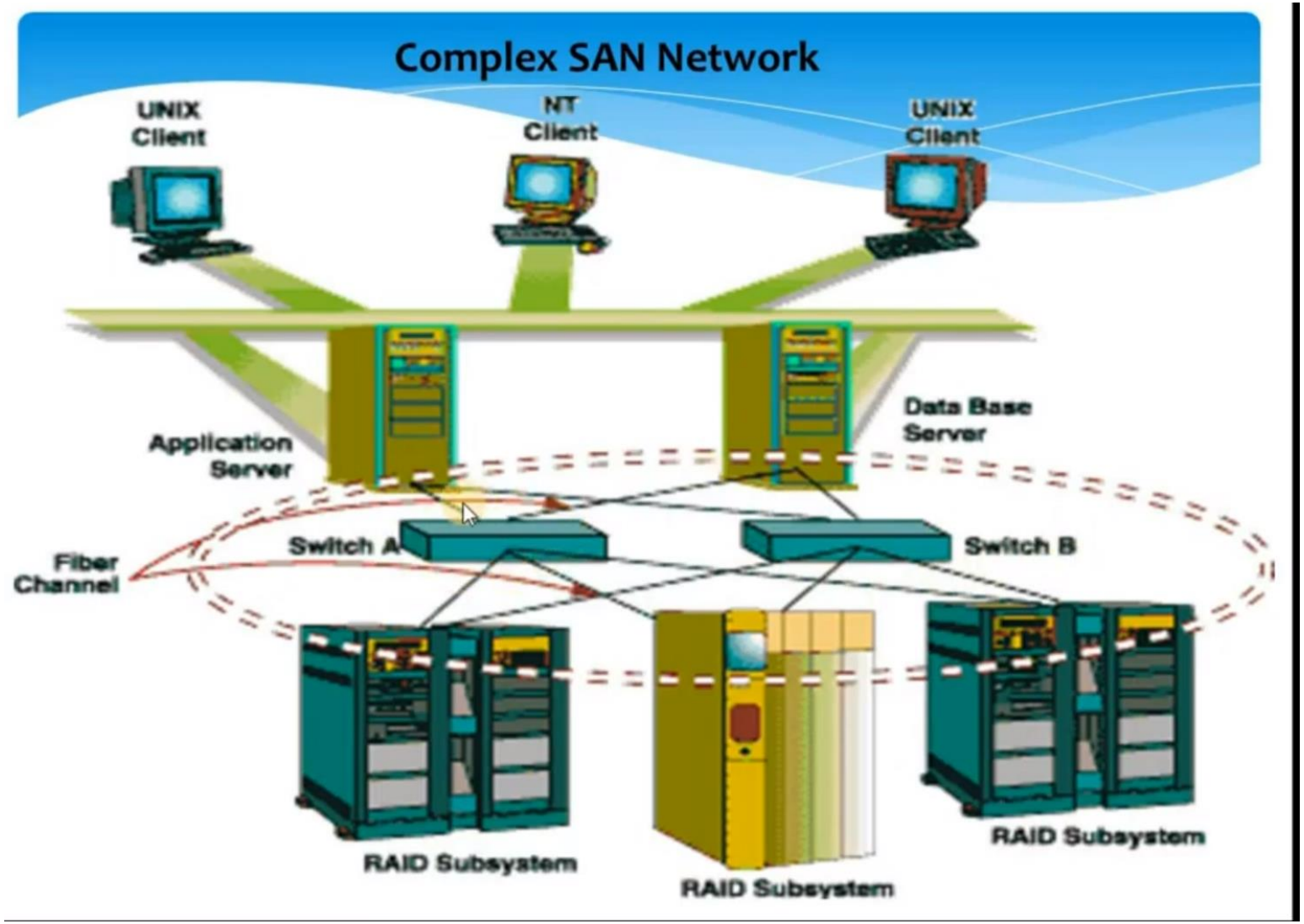
Image Of A SAN Switch



Types Of Ports In SAN Network

* **F_Port:** This is called as fabric port. This port is configured in SAN switch. This port connects to N_Port via fiber cable.
* **N_Port:** This is called as node port which represents a target or host port. N_Port are connected to F port in SAN Network.
* **E_Port:** This is called an expansion port. A port is which is designated an E_Port connects to the E_Port of another switch, to enlarge the switch fabric. This link is also called as Inter Switch Link (ISL).
* **G_Port:** This is a generic port that can operate as either an E_Port or an F_Port.


Simplified SAN Network
APP
OS
VM
APP
OS
VM
Hypervisor
Host Server
N_Port
Compute System
F_Port
FC Switch
FC Switch
F_Port
E_Port
E_Port
F_Port
ISL
N_Port
N_Port
Storage System
Storage System



Fabric means collection of group of switches interconnected together. Here switch A has multiple switches interconnected means, it is Fabic A and switch B is a separate Fabric B.

Zoning In SAN Switch

WWNN and WWPN

* WWNN – World Wide Node Name
* WWPN - World Wide Port Name
* Each device in a fiber channel Network will have a unique WWNN for each vendor.
* The FC ports in the device will have WWPN.
* fcalias, device-alias and alias are created to easy reference of WWPN.
* It is a 64bit address which is unique to each vendor.

What Is Zoning

* Zoning involves 3 to 4 steps which is performed in SAN Switch.
* Zoning is binding or grouping of initiator port and target ports.
* Zoning ensures flow of traffic between a particular initiator and target.
* There are two types of Zoning
  * Hard Zoning
  * Soft Zoning

Difference Hard and Soft Zoning

Hard Zoning

* This is done using Domain ID and Port number of Switch.
* This is highly secure.
* If any physical changes SAN network rezoning needs to be done.

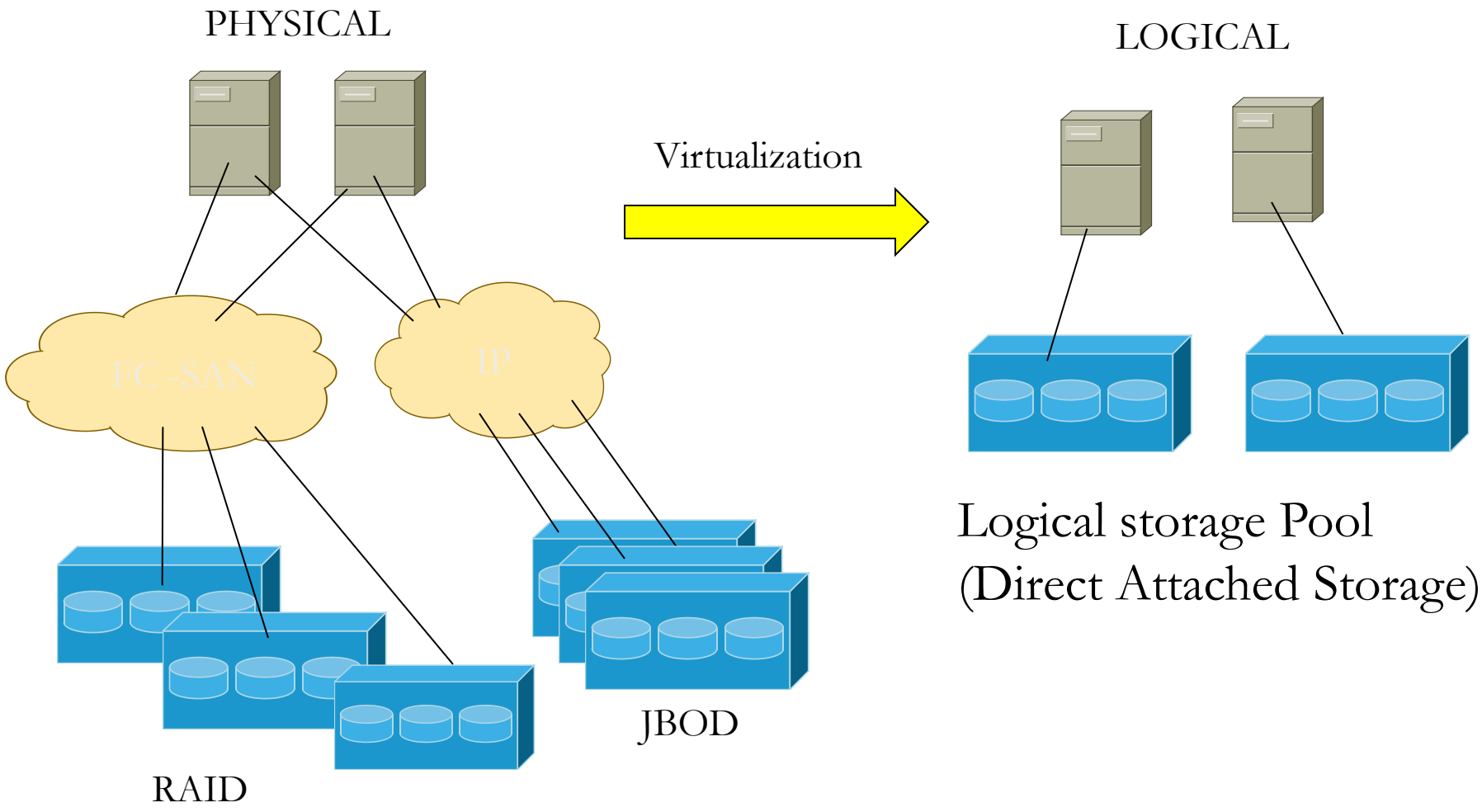
Soft Zoning

* This zoning is done using WWPN of the Port or using fcalies.
* This is less secure.
* Any physical changes in SAN network no effect on zoning.

Storage Virtualization

- Definition: storage virtualization hides the physical storage from applications,
- Virtualization allows the application to reference the storage resource by its *common name* where the actual storage could be on a complex, multilayered, multipath storage networks.
- RAID is an early example of storage virtualization.

Storage Virtualization



RAID

Redundant array of
independent disks

Speed
Fault Tolerance
Redundancy

- RAID, short for redundant array of independent (originally inexpensive) disks is a disk subsystem that stores your data across multiple disks to either increase the performance or provide fault tolerance to your system (some levels provide both).
- There are two ways of implementing the system. Software raid and hardware raid.

- Hardware raid is directly managed by a dedicated hardware controller to which the disks are connected.
- The raid calculations are managed by an on-board processor which offloads the strain on the host processor CPU.
- However, the performance of today's CPUs has increased so much, that this advantage has become more or less obsolete.
- HW controllers do provide an extra failsafe element with its BBU (Battery Backup Unit) that protects your data in case of an unexpected power loss to the server.

- Software RAID is part of the OS and is the easiest and most cost effective implementation.

- It does not require the use of an additional (often costly) piece of hardware and the proprietary firmware.

- RAID is a way of storing the same data on multiple hard disks to protect data in the case of a hardware failure.
- RAID is not backup
- When a file is corrupted or deleted, RAID will not protect that.
- RAID only protects data from hardware failures

Redundant Array of Independent Disks (RAID)

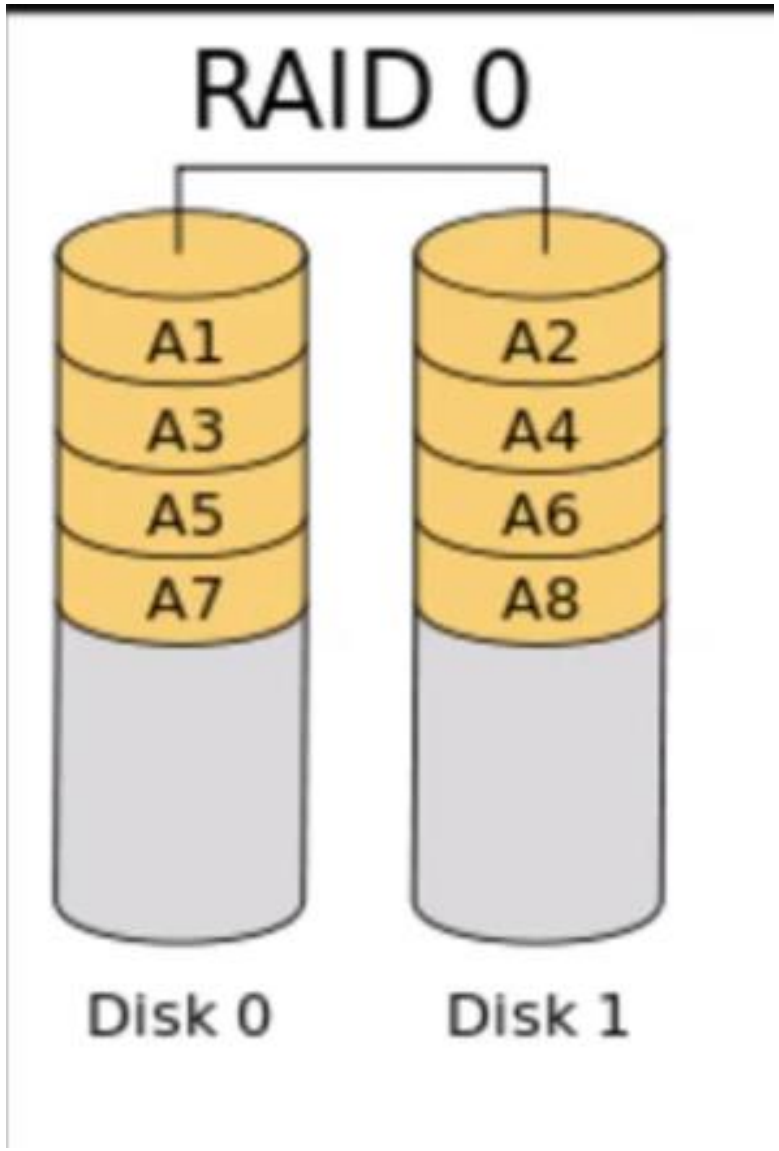
- A group of hard disks is called a disk array
- RAID combines a disk array into a single virtual device
  - called RAID drive
- Provide fault tolerance for shared data and applications
- Different implementations: Level 0-5
- Characteristics:
  - Storage Capacity
  - Speed: Fast Read and/or Fast Write
  - Resilience in the face of device failure

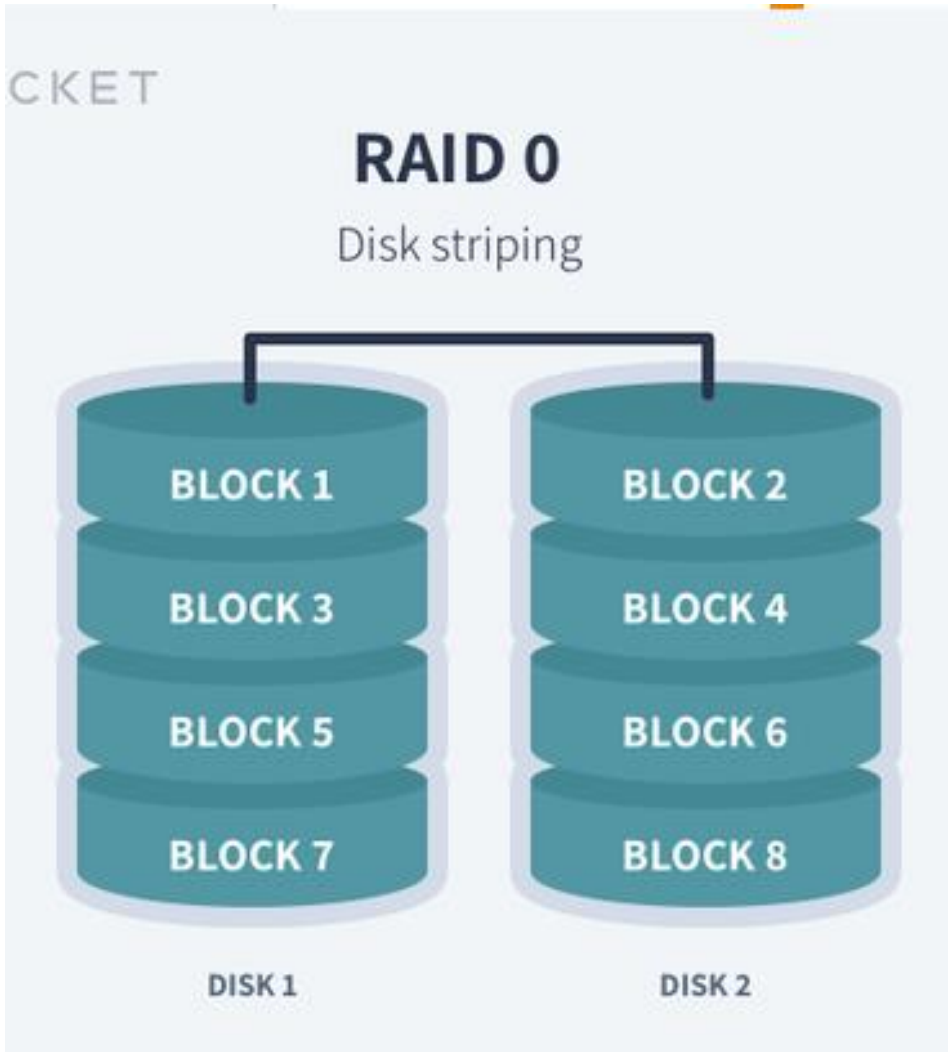
RAID Functions

- **Spanned**
  - **Interconnected with multiple disks to create a single large volume storage**
- **Striping**
  - Write consecutive logical byte/blocks on consecutive physical disks
- **Mirroring**
  - Write the same block on two or more physical disks
- **Striping with Parity**

-Write consecutive logical byte/blocks on consecutive physical disks, with parity to retrieve the data in case of failure. (Parity is a mathematical calculation to retrieve the data)

RAID 0


RAID 0
A1
A3
A5
A7
A2
A4
A6
A8
Disk 0
Disk 1


CKET
RAID 0
Disk striping
BLOCK 1
BLOCK 3
BLOCK 5
BLOCK 7
BLOCK 2
BLOCK 4
BLOCK 6
BLOCK 8
DISK 1
DISK 2

- RAID 0 is striping
- To implement minimum two disks to maximum 32 disks are used
- Data is broken into blocks and written to all available disks
- Highest read, write performance
- Since multiple disks are involved, all disks read, write controllers are involving in reading and writing, by which RAID 0 offers highest read, write performance.
- No fault tolerance
- Any one disks fails, entire data is lost

Advantages

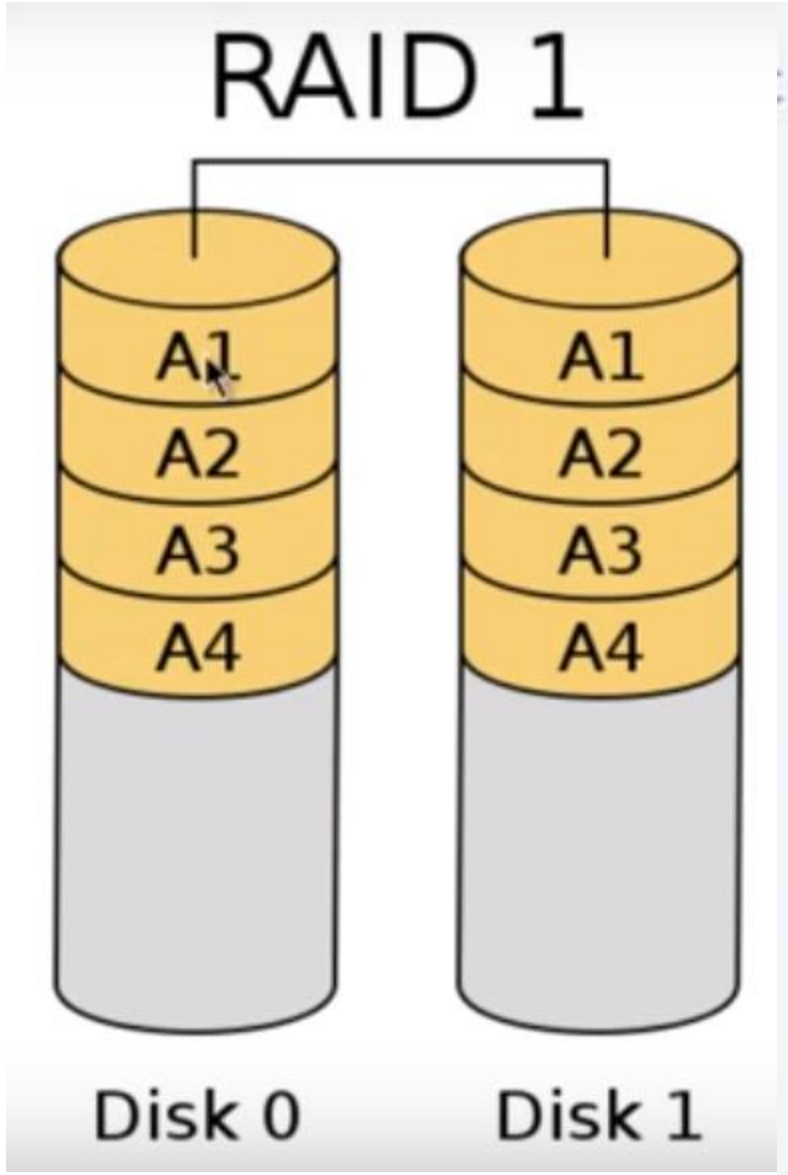
1. I/O performance is greatly improved by spreading the I/O load across many channels and drives
2. No parity calculation overhead is involved
3. Very simple design
4. Easy to implement

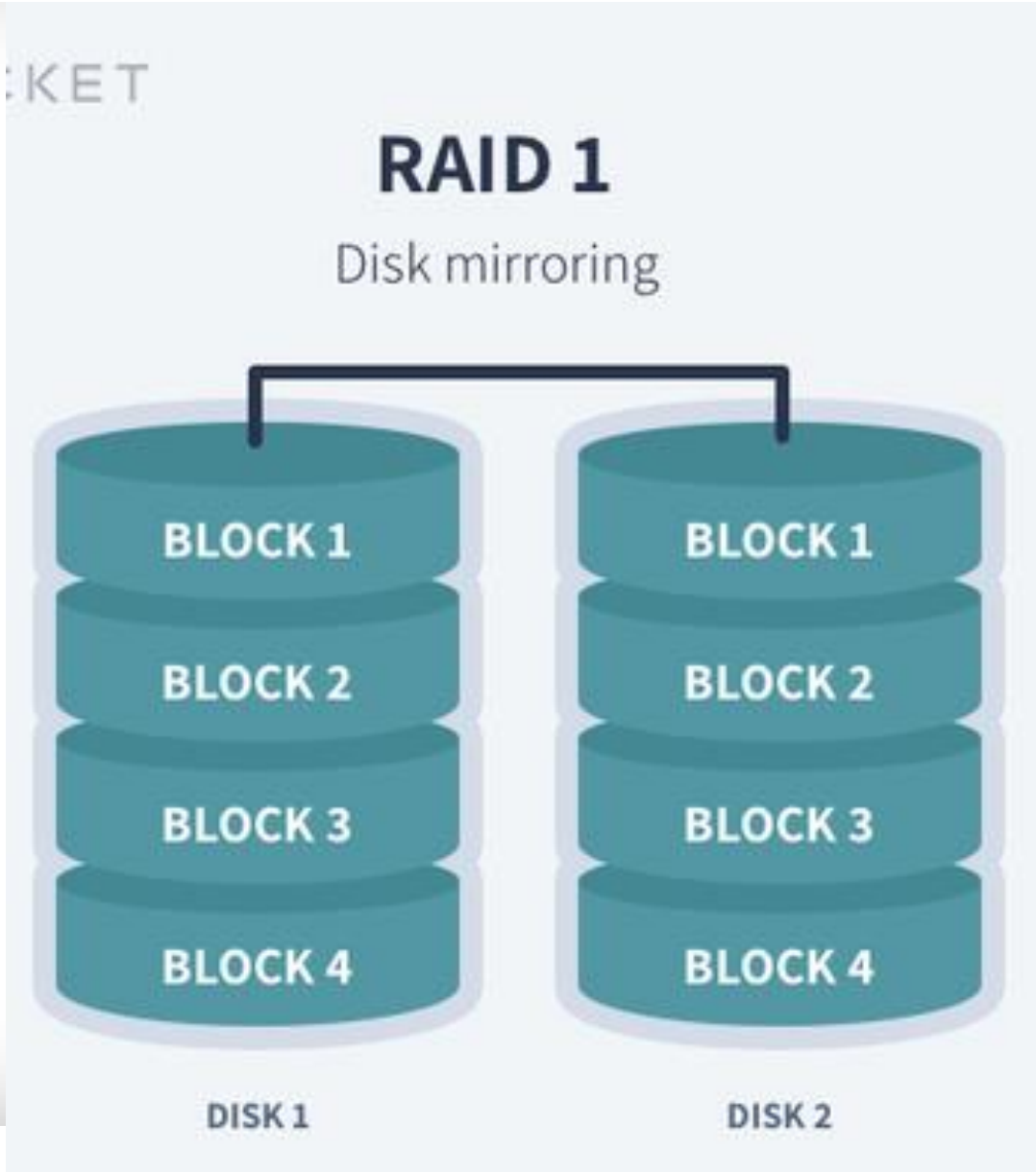
Disadvantages

The failure of just one drive will result in all data in an array being lost

Applications

- Video production and editing
- Image Editing
- Any application requiring high bandwidth


RAID 1
A1
A2
A3
A4
A1
A2
A3
A4
Disk 0
Disk 1


RAID 1
Disk mirroring
BLOCK 1
BLOCK 2
BLOCK 3
BLOCK 4
BLOCK 1
BLOCK 2
BLOCK 3
BLOCK 4
DISK 1
DISK 2

- RAID 1 is Mirroring
- Implemented generally between two identical disks.
- Data available on one disk will be replicated to the other disk, that’s why it is called mirroring.(complete replica)
- Moderate read, write performance
- Only 50% of the total storage space is utilized
- High cost per MB
- Supports fault tolerance
- If a disk fails in a pair, then other disk continue to offer the same data

RAID Level 1

Advantages

1. 100% redundancy of data means no rebuild is necessary in case of a disk failure, just a copy to the replacement disk.
2. Under certain circumstances, RAID 1 can sustain multiple simultaneous drive failures.
3. Simplest RAID storage subsystem design

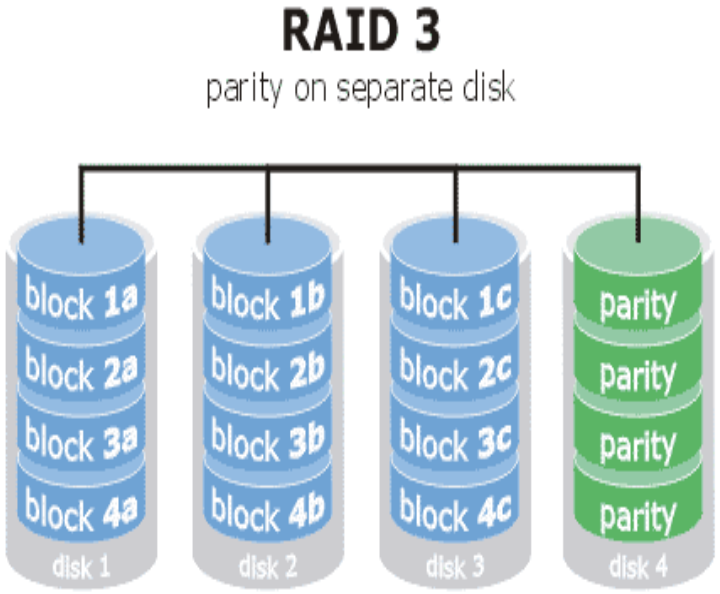
Disadvantages

1. Highest disk overhead of all RAID types.
2. The cost, it requires twice the space of logical disk that it supports.

Applications

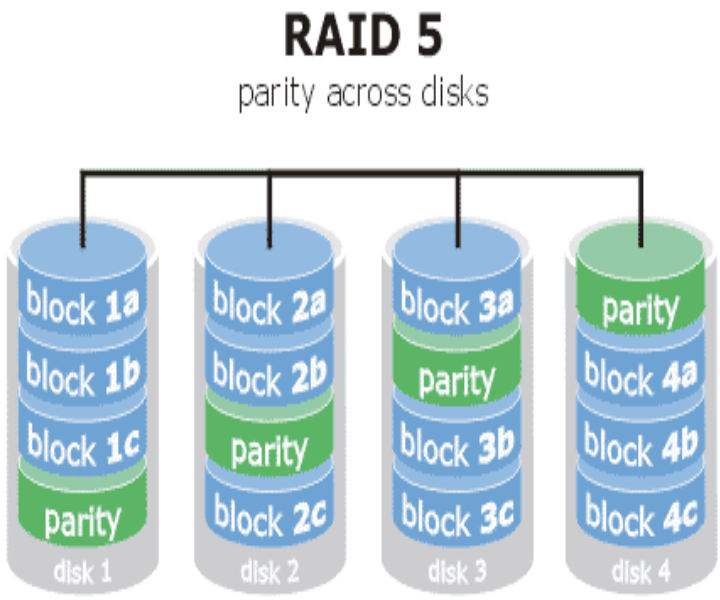
- Accounting Payroll
- Financial
- Any application requiring very high availability

RAID 3

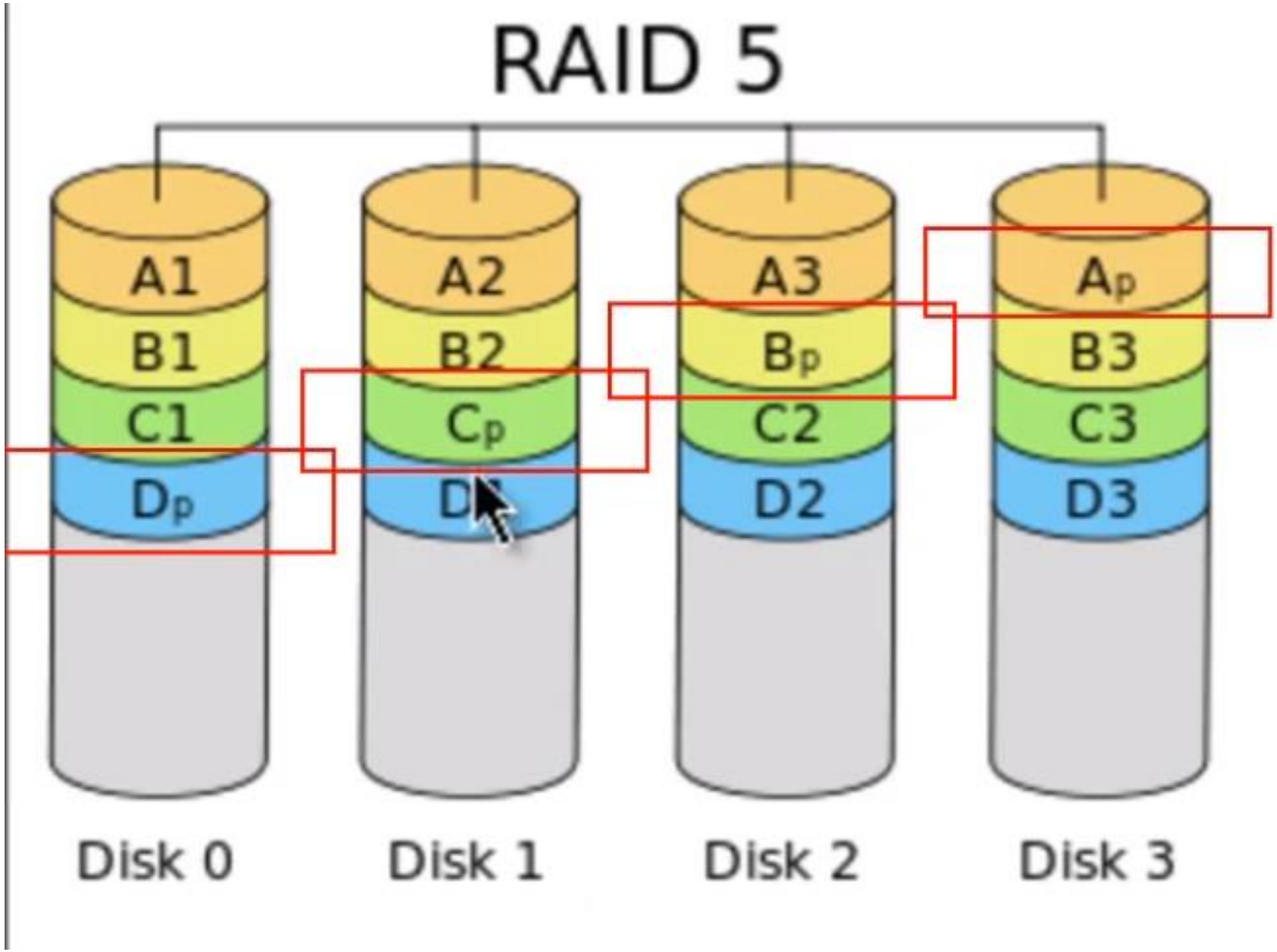


Disk striping with Dedicated Parity Drive

RAID 5



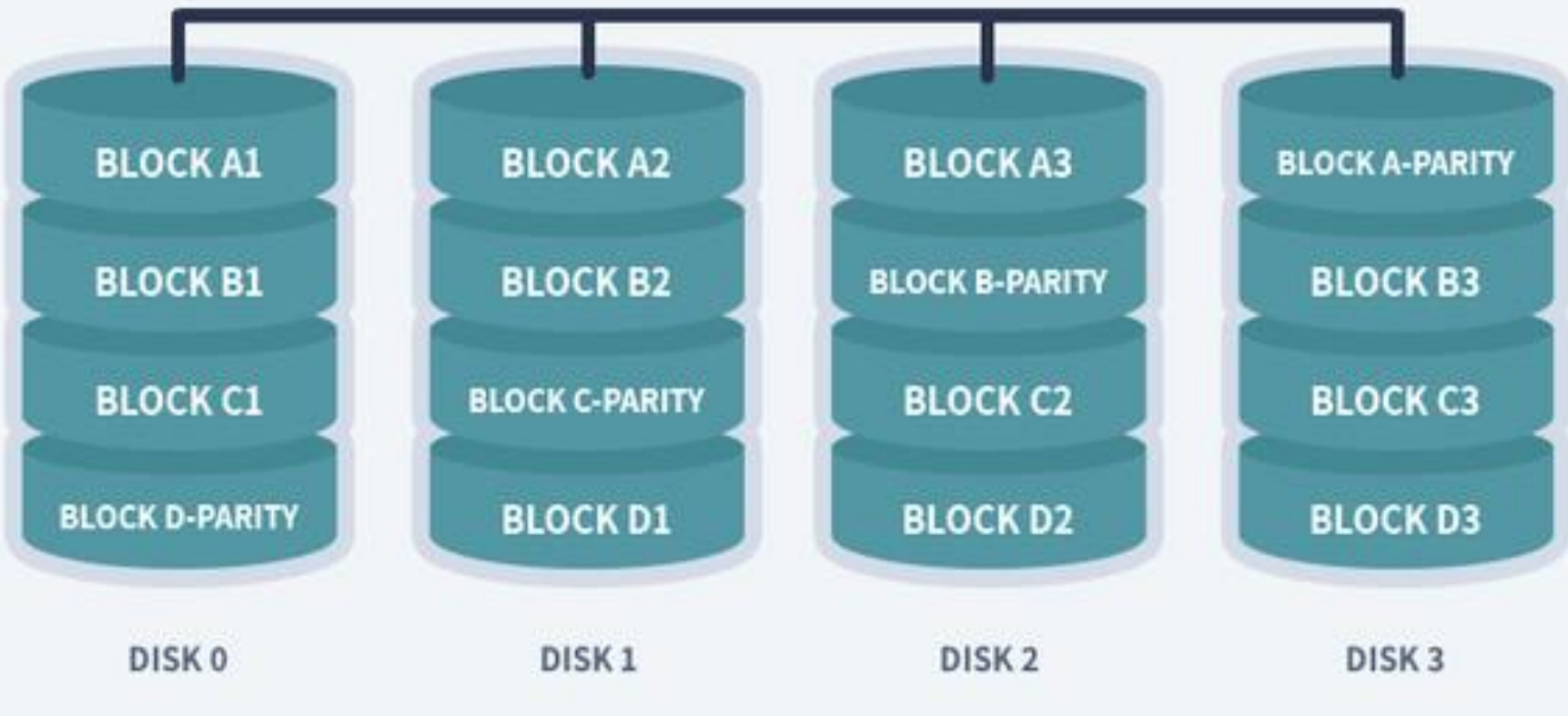
Disk striping with Distributed Parity Data


RAID 5
A1
B1
C1
Dp
A2
B2
Cp
D3
A3
Bp
C2
D2
Ap
B3
C3
D3
Disk 0
Disk 1
Disk 2
Disk 3

DATAPACKET

RAID 5

Disk striping with parity



- RAID 5 is striping with parity
- To implement minimum 3 to maximum 32 disks are used
- Good read, write performance
- Data is broken into blocks and written to all available disks
- Better read performance compared to write performance.
- During writing RAID5 writes data + parity, so additional over head.
- Supports fault tolerance with one disk failure only

- Excellent Performance
- Reading will be extremely very good in speed.
- Writing will be Average, slow if we won't use a Hardware RAID Controller.
- Rebuild from Parity information from all drives.
- Full Fault Tolerance.
- 1 Disk Space will be under Parity.
- Can be used in file servers, web servers, very important backups.

RAID Level 5

Advantages

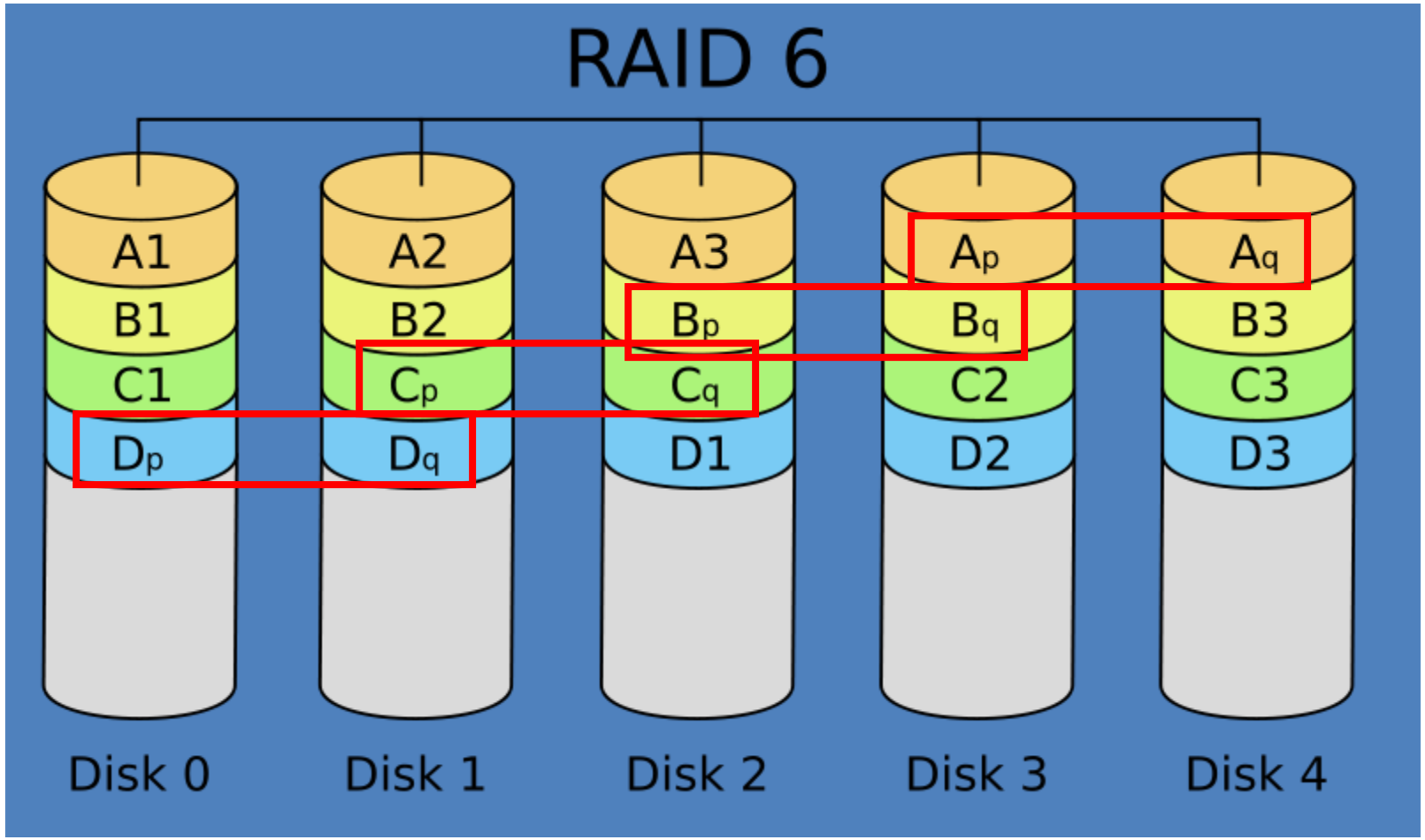
1. Highest Read data transaction rate.
2. Low ratio of ECC (parity) disks to data disks means high efficiency Good aggregate transfer rate

Disadvantages

1. Most complex controller design Difficult to rebuild in the event of a disk failure (as compared to RAID level 1)

Applications

- File and application servers.
- Database serversWeb, e-mail, and news servers.
- Intranet servers.
- Most versatile RAID level

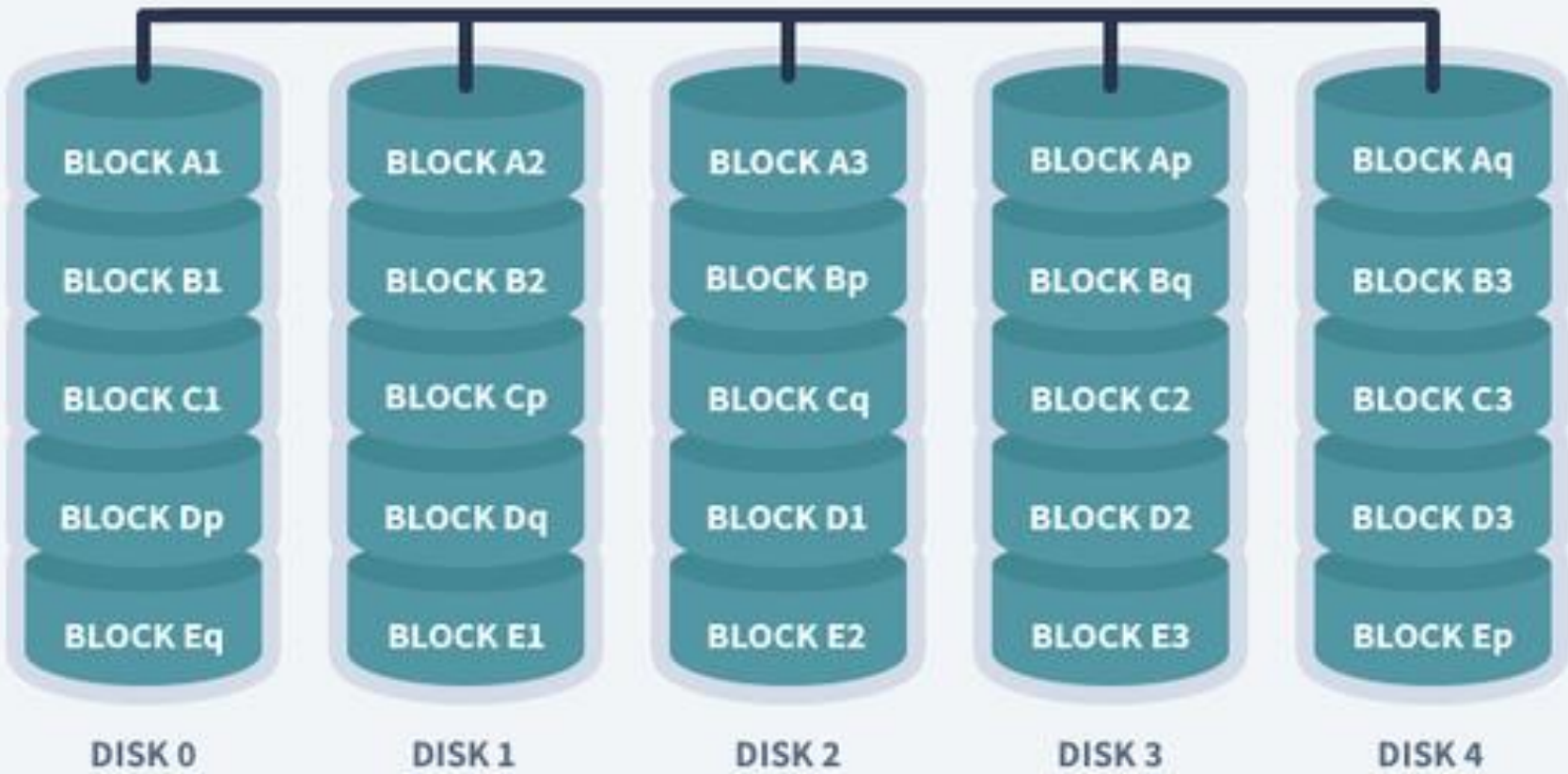


Striping with dual parity

DATAPACKET

RAID 6

Disk striping with double parity



- RAID 6 is enhanced from RAID5.
- RAID 6 is striping with dual parity
- To implement minimum 4 to maximum 32 disks are used
- Good read, write performance
- Data is broken into blocks and written to all available disks
- Better read performance compared to write performance. During writing RAID6 writes data + dual parity, so additional over head.
- Supports fault tolerance with two disk failure.

RAID Level 6

Advantages

1. Provides for an extremely high data fault tolerance.
2. Can sustain multiple simultaneous drive failures

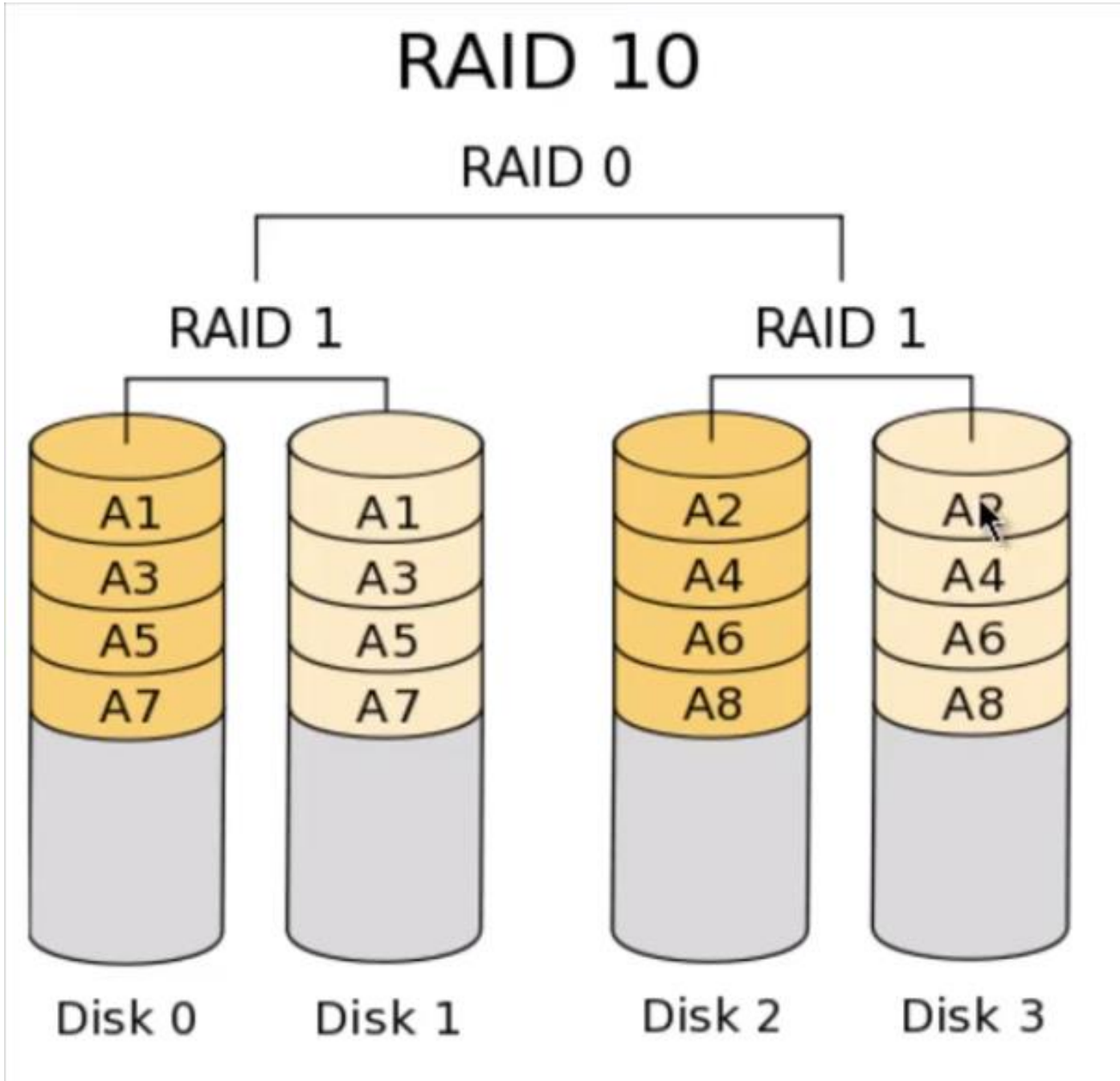
Disadvantages

1. More complex controller design Controller.
2. Overhead to compute parity addresses is extremely high

Applications

- Perfect solution for mission critical applications or Hard Real Time systems.

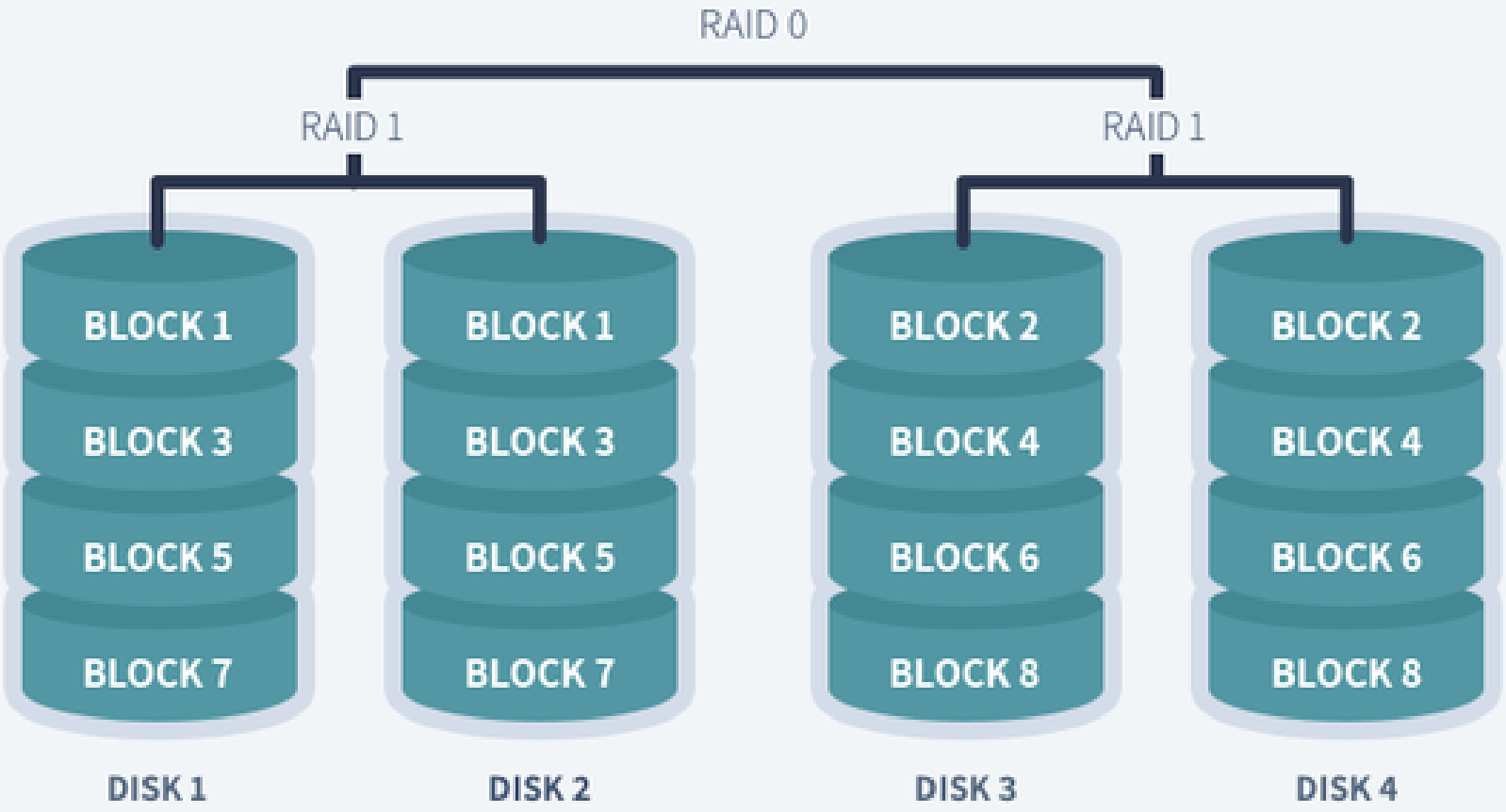
- Read Performance will be good.
- Write Performance will be Poor if we not using a Hardware RAID Controller.
- Rebuild from 2 Parity Drives.
- Full Fault tolerance.
- 2 Disks space will be under Parity.
- Can be Used in Large Arrays.
- Can be use in backup purpose, video streaming, used in large scale.


RAID 10
RAID 0
RAID 1
RAID 1
A1
A3
A5
A7
A1
A3
A5
A7
A2
A4
A6
A8
A4
A6
A8
Disk 0
Disk 1
Disk 2
Disk 3

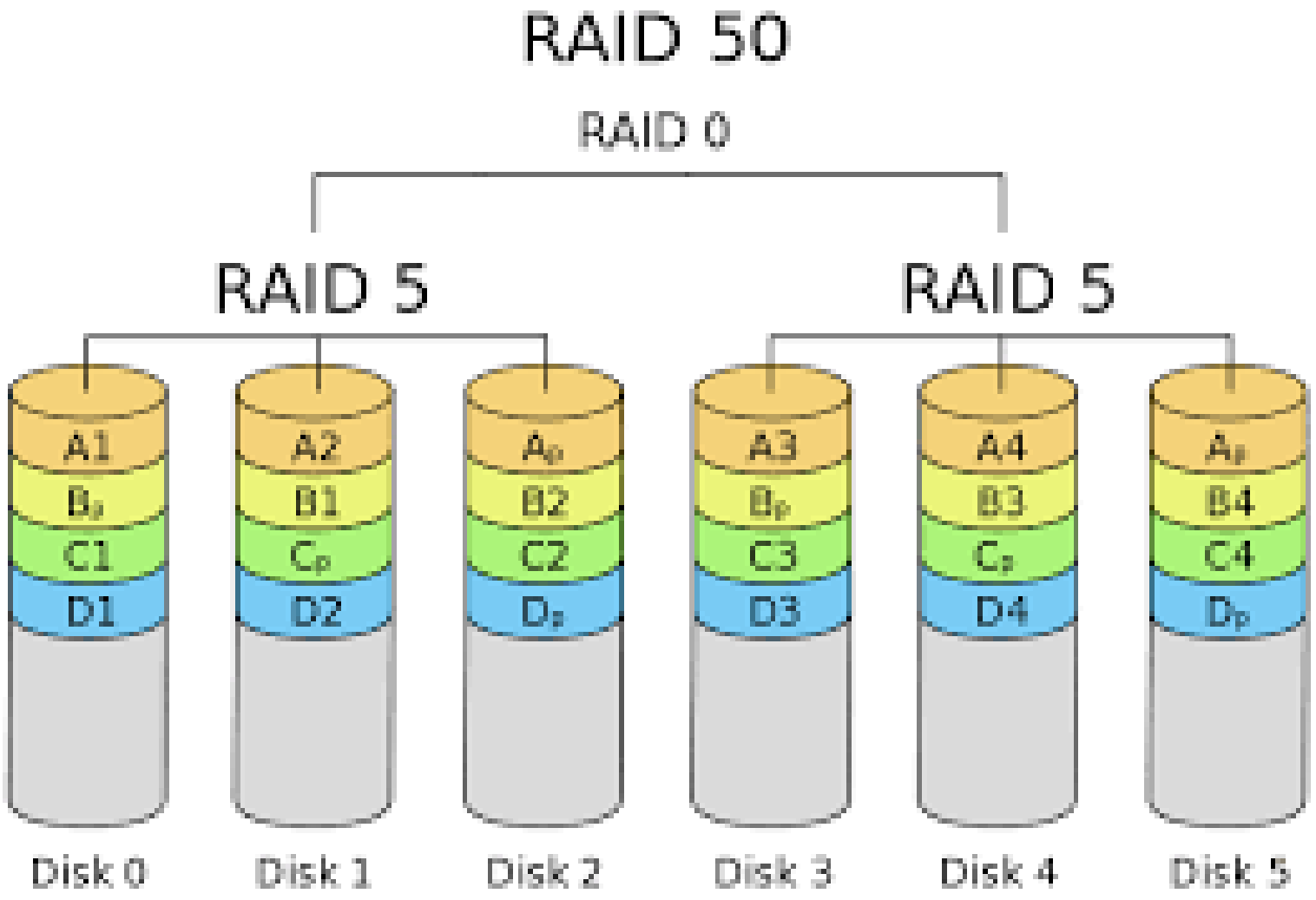
DATAPACKET

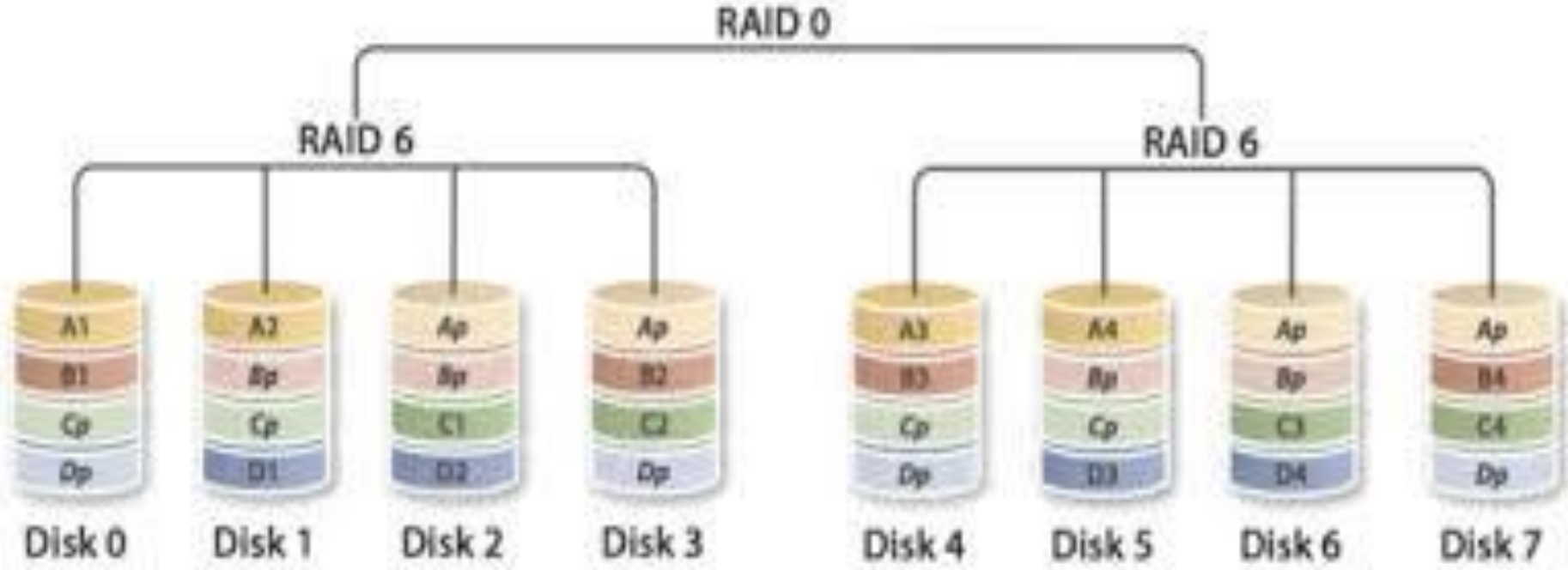
RAID 10

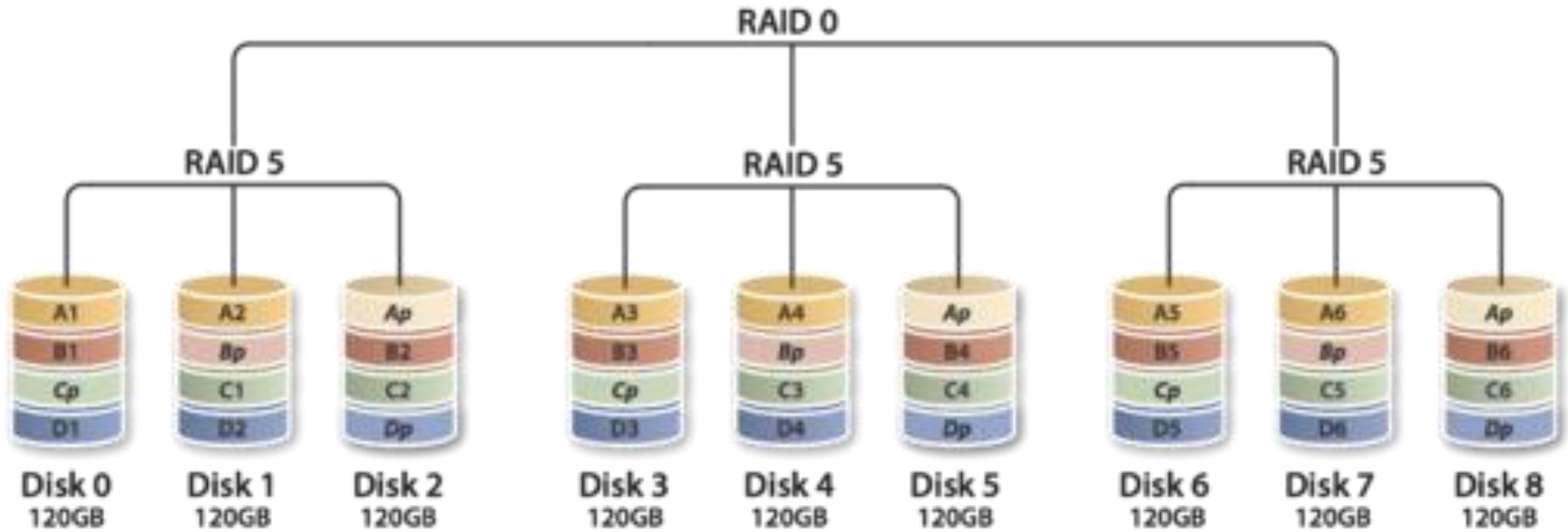
Disk striping & mirroring

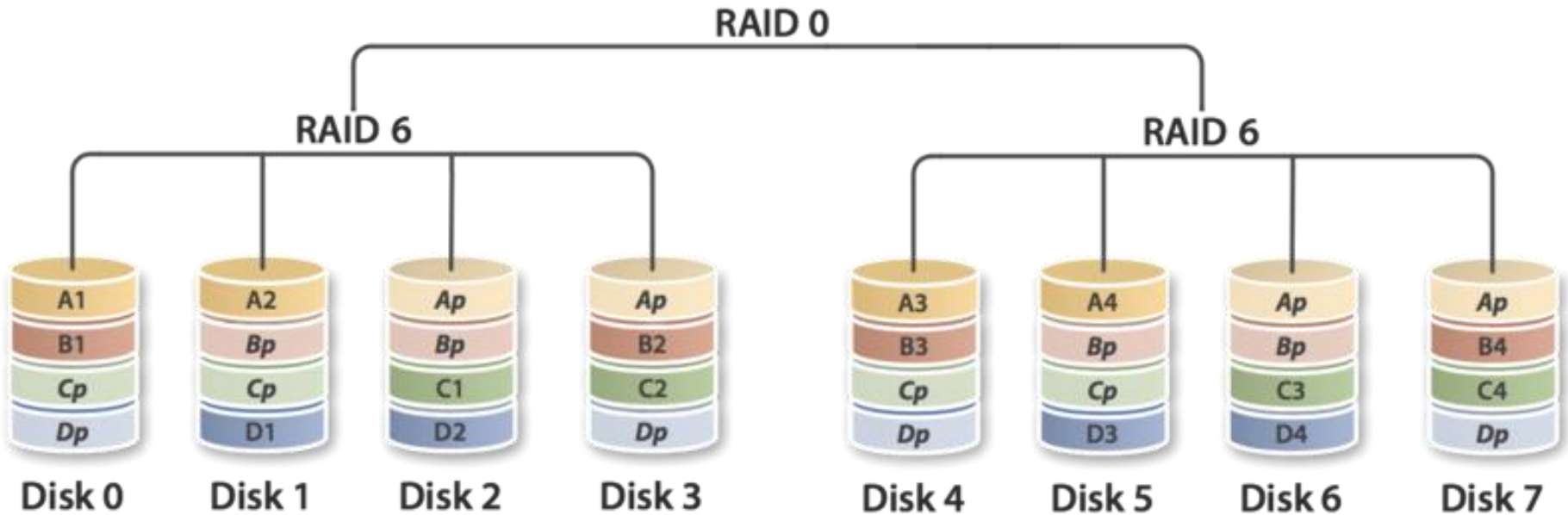


- RAID 10 is combination of RAID 1 + RAID 0
- RAID 10 provides performance and data protection
- More expensive method
- Only 50% of total storage will be utilized
- In the above implementation, out of 4 disks only 2 disk space is utilized
- Same way RAID 50 and RAID 60 also provides faster I/O performance and fault tolerance


RAID 50
RAID 0
RAID 5
RAID 5
A1
B1
C1
D1
A2
B1
Cp
D2
Ap
B2
C2
D2
A3
Bp
C3
D3
A4
B3
C3
D4
Ap
B4
C4
Dp
Disk 0
Disk 1
Disk 2
Disk 3
Disk 4
Disk 5


RAID 0
RAID 6
RAID 6
A1
B1
Cp
Dp
A2
Bp
Cp
D1
Ap
Bp
C1
D2
Ap
B2
C2
Dp
A3
B3
Cp
Dp
A4
Bp
Cp
D3
Ap
Bp
C3
D4
Ap
B4
C4
Dp
Disk 0
Disk 1
Disk 2
Disk 3
Disk 4
Disk 5
Disk 6
Disk 7


RAID 0
RAID 5
RAID 5
RAID 5
A1
B1
Cp
D1
A2
Bp
C1
D2
Ap
B2
C2
Dp
A3
B3
Cp
D3
A4
Bp
C3
D4
Ap
B4
C4
Dp
A5
B5
Cp
D5
A6
Bp
C5
D6
Ap
B6
C6
Dp
Disk 0
120GB
Disk 1
120GB
Disk 2
120GB
Disk 3
120GB
Disk 4
120GB
Disk 5
120GB
Disk 6
120GB
Disk 7
120GB
Disk 8
120GB


RAID 0
RAID 6
RAID 6
A1
B1
Cp
Dp
A2
Bp
Cp
D1
Ap
Bp
C1
D2
Ap
B2
C2
Dp
A3
B3
Cp
Dp
A4
Bp
Cp
D3
Ap
Bp
C3
D4
Ap
B4
C4
Dp
Disk 0
Disk 1
Disk 2
Disk 3
Disk 4
Disk 5
Disk 6
Disk 7

Level	Description	Minimum number of drives[b]
RAID 0	Block-level striping without parity or mirroring	2
RAID 1	Mirroring without parity or striping	2
RAID 2	Bit-level striping with Hamming code for error correction	3
RAID 3	Byte-level striping with dedicated parity	3
RAID 4	Block-level striping with dedicated parity	3
RAID 5	Block-level striping with distributed parity	3
RAID 6	Block-level striping with double distributed parity	4

Featured Concepts of RAID

- **Parity** method in raid regenerate the lost content from parity saved information's. RAID 5, RAID 6 Based on Parity.
- **Stripe** is sharing data randomly to multiple disk. This won't have full data in a single disk. If we use 3 disks half of our data will be in each disks.
- **Mirroring** is used in RAID 1 and RAID 10. Mirroring is making a copy of same data. In RAID 1 it will save the same content to the other disk too.
- **Hot spare** is just a spare drive in our server which can automatically replace the failed drives. If any one of the drive failed in our array this hot spare drive will be used and rebuild automatically.

RAID's are in various Levels. Here we will see only the RAID Levels which is used mostly in real environment.

- **RAID0** = Striping
- **RAID1** = Mirroring
- **RAID5** = Single Disk Distributed Parity
- **RAID6** = Double Disk Distributed Parity
- **RAID10** = Combine of Mirror & Stripe. (Nested RAID)

Data Backup

- Backup is mainly to protect data from data loss.
- Backups have two distinct purposes. The primary purpose is to recover data after its loss, be it by data deletion or corruption.
- The secondary purpose of backups is to recover data from an earlier time, according to a user-defined data retention policy.

- Data loss can occur due to:
  - ✓ Hardware or System Malfunctions. According to a survey of **data loss's causes**, more than two-fifth of users **lose data** because of hardware or system malfunctions. ...
  - ✓ Human Errors. Believe or not, human error is also one of the most common **causes of data loss**. ...
  - ✓ Software Corruption. ...
  - ✓ Computer Viruses and Malware. ...
  - ✓ Natural Disasters. Fire, Flood, Earthquake, Cyclone,

Backups are like an insurance policy protects data against loss of data due to:

- Hardware failures
- Human error
- Application failures
- Security breaches, such as hackers or viruses

✓ High-availability storage arrays(RAID) have reduced the need to recover data because of hardware failures.

✓ RAID can protect data from loss due to hardware failures; however, these availability features cannot protect against the other factors that can result in loss of data.

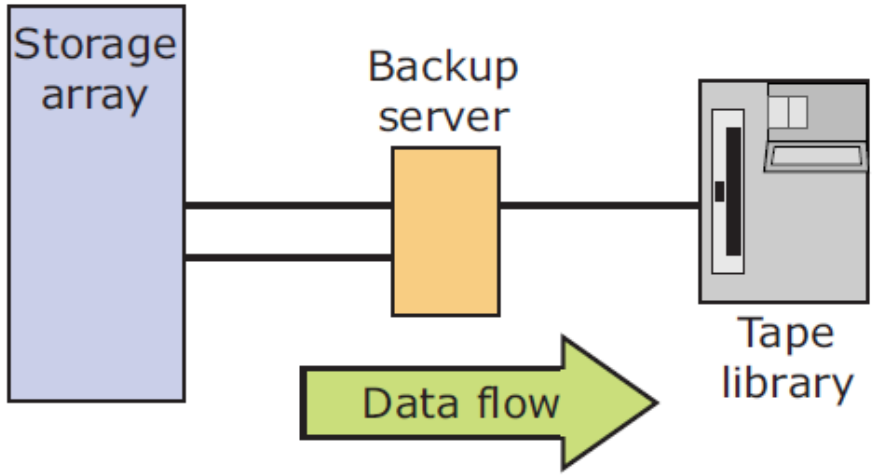
Backups are sometimes used as an archive; for instance, government regulations require that certain financial data must be kept for a specific number of years. In this context, a backup also becomes an archive.

Direct-attached backups

- Many organizations started with a simple backup infrastructure called direct-attached.

- This topology is also sometimes referred to as host-based or server-based backup.

- Each backup system has dedicated tape devices. Backups are performed directly from a backup system's disk to a backup system's tape devices.



Data flow for direct-attached backups

The key advantage of direct-attached backups is speed. The tape devices can operate at the speed of the channels.

Direct-attached backups optimize backup and restore speed, since the tape devices are close to the data source and dedicated to the host.

Disadvantages

- Direct-attached backups impact the host and the application, since backups consume host I/O bandwidth, memory, and CPU resources.
- Direct-attached backups are generally better suited for smaller environments.
- Large Organizations needs large numbers of tape devices, A wide variety of backup media might be in use.

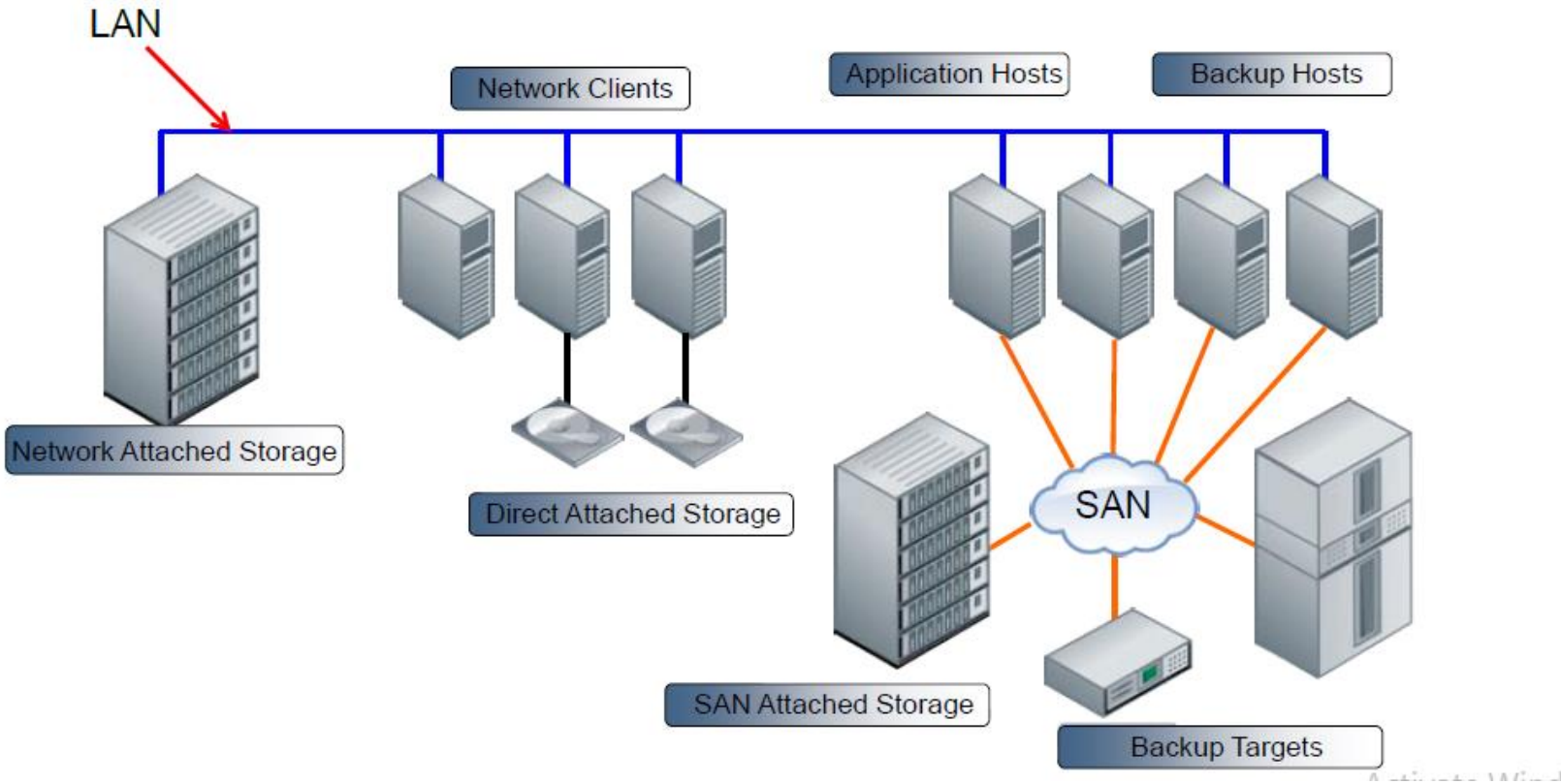
- ✓ Operators could find it difficult to manage tape.
- ✓ It might be difficult to determine if everything is being backed up properly.
- ✓ Dispersed backups, multiple media types, diverse tools, and operational complexity can challenge the task of business continuance recovery.

Network backup

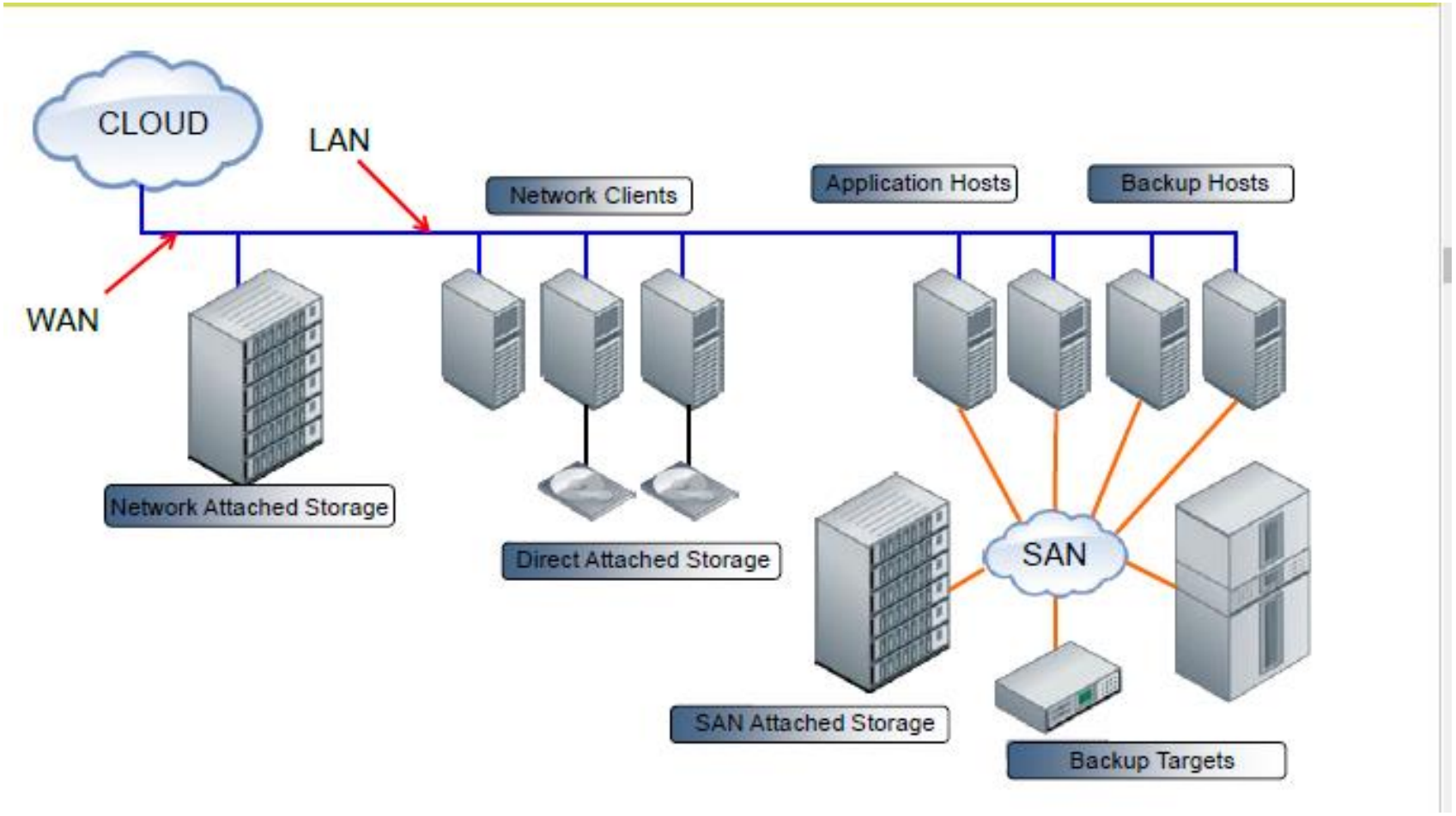
- Network backup is a system where the elected data from your backups clients (a single computer, or a network of computers), is transmitted through a network (aka internet) and sent to your backup server.
- This server can be privately owned and managed, or publicly hosted with a cloud backup provider.
- Other network backup systems are using NAS or SAN storage devices for shared data.

One of the best things about network storage is that you can send all of your data to a local server or an off-site server via the Internet without the mess, risks and complications of physical storage devices. (on-site)

Backup on Networking - LAN



Backup on Internet or Cloud - WAN



Backup Medias

- Magnetic tape
- Magnetic tape has long been the most commonly used medium for bulk data storage, backup, archiving, and interchange.
- Tape has typically better capacity-to-price ratio when compared to hard disk. (cost ratio is narrowing, now)
- Tape is a sequential access medium, so even though access times may be poor(slow), the rate of continuously writing or reading data can actually be very fast.

- Hard disk
- The main advantages of hard disk storage are low access times(faster), availability, capacity and ease of use.
- External disks can be connected via local interfaces like SCSI, USB, FireWire, or eSATA, or via longer distance technologies like Ethernet, iSCSI, or Fibre Channel.

- Optical storage
- Recordable CDs, DVDs, and Blu-ray Discs are commonly used with personal computers.
- However, the capacities and speeds of these and other optical discs have traditionally been lower than that of hard disks or tapes (though advances in optical media are slowly shrinking that gap).

- SSD/Solid-state drive
- Also known as flash memory, thumb drives, USB flash drives, CompactFlash, SmartMedia, Memory Stick, Secure Digital cards, etc.,
- A solid-state drive does not contain any movable parts unlike its magnetic drive counterpart, making it less susceptible to physical damage, and can have huge throughput in the order of 500Mbit/s to 6Gbit/s.
- As of now they are very costly

- On-line
- On-line backup storage is typically the most accessible type of data storage, which can begin a restore in milliseconds.
- An internal hard disk or a disk array (maybe connected to SAN) is one example of an on-line backup. This type of storage is convenient and speedy.

- Remote backup service (cloud backup)
- Backing up via the Internet to a remote location can protect against events such as fires, floods, or earthquakes which could destroy locally stored backups.
- Off-line storage requires some direct action to provide access to the storage media: for example inserting a tape into a tape drive or plugging in a cable.

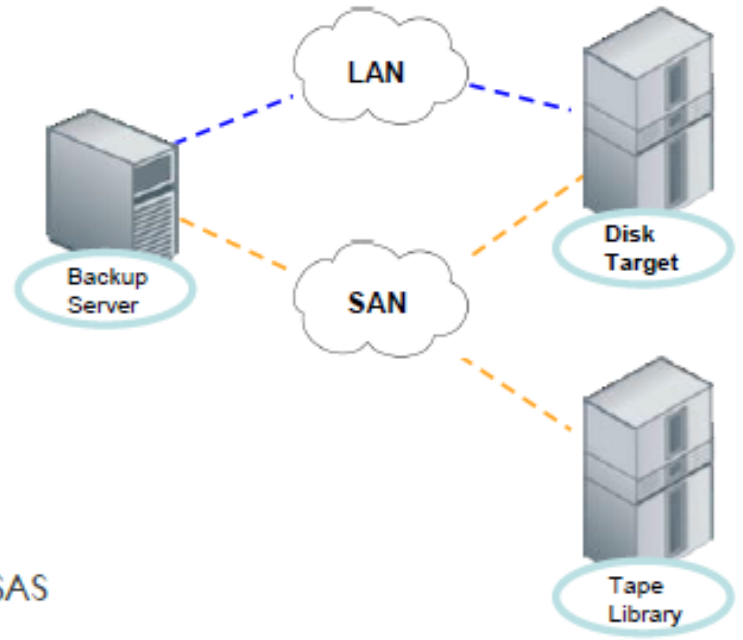
- On-site / Off-site data protection
- One copy of backup media will be stored on site for data recovery from server failures.
- Another copy of the backup media may be sent to an off-site vault to protect against a site failures due to natural calamities disaster or other site-specific problem.
- The vault can be as simple as a system administrator's home office or as sophisticated as a disaster-hardened, temperature-controlled, high-security bunker with facilities for backup media storage.

Traditional Backup Types

- Full Backup
  - Everything copied to backup (cold or hot backup)
    - Full view of the volume at that point in time
  - Restoration straight-forward as all data is available in one backup image
  - Huge resource consumption (server, network, tapes)
- Incremental Backup
  - Only the data that changed since last full or incremental
    - Change in the archive bit
  - Usually requires multiple increments and previous full backup to do full restore
  - Much less data is transferred
- Differential backup
  - All of the data that changed from the last full backup
  - Usually less data is transferred than a full
  - Usually less time to restore full dataset than incremental

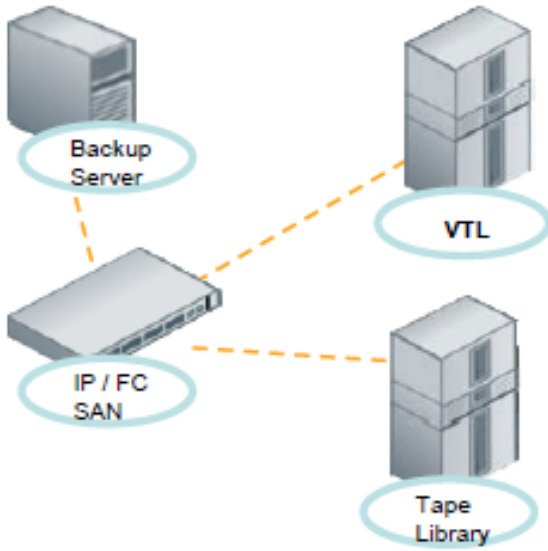
B2D / D2D

- What?
  - Backup to Disk / Disk to Disk Backup
  - Disk as a primary backup target
- Why?
  - Performance and reliability
    - Reduced backup window
    - Greatly improved restores
    - RAID protection
    - Eliminate mechanical interfaces
  - Eliminate (tape) multiplexing
  - More effective sharing of backup targets
- Considerations
  - Fibre Channel Disks versus SATA versus SAS
    - I/O random access vs. MB/s sequential
  - SAN, NAS or DAS
  - B2D or VTL
  - Consider a mix of Disk and Tape (D2D2T)



VTL

- What:
  - Virtual Tape Libraries emulate traditional tape
  - Fits within existing backup environment
  - Easy to deploy and integrate
  - Reduce / eliminate tape handling

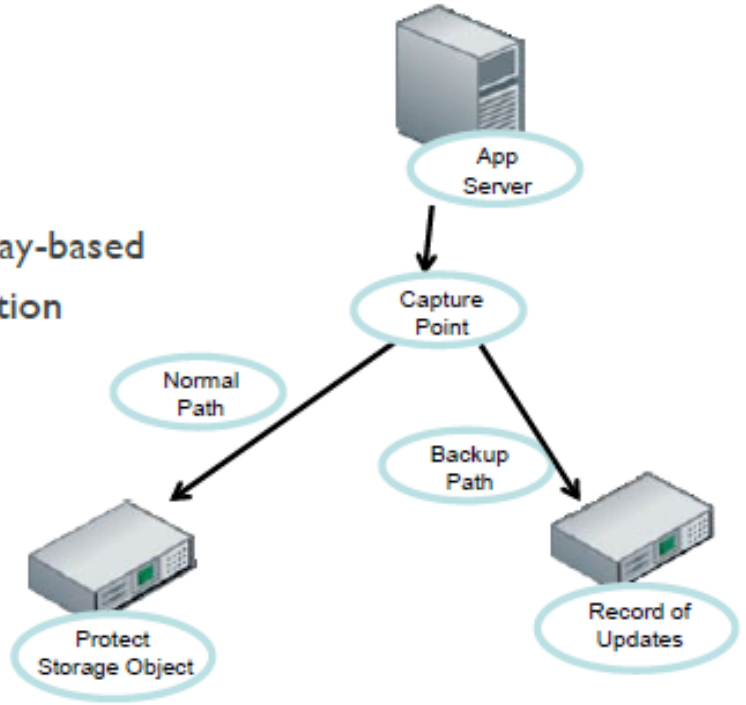


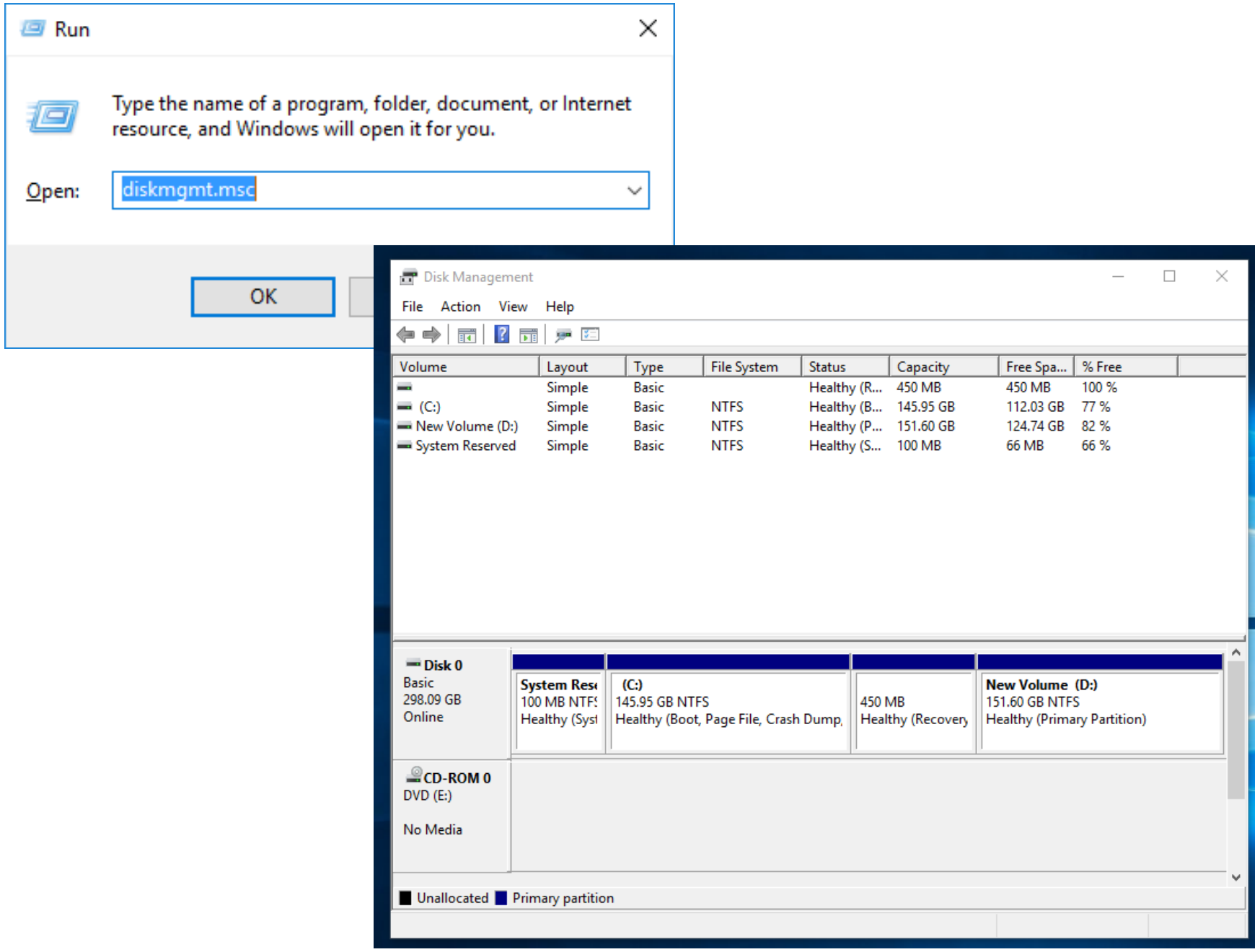
- Why:
  - Improved performance and reliability (see B2D)
  - Reduced complexity versus straight B2D or tape
  - Unlimited tape drives reduce device sharing, improve backup times
  - Enables technologies such as remote replication, deduplication

- Considerations:
  - Easy to manage in traditional backup software environment:
  - Can extend the life of current physical tape investment

CDP

- What:
  - Continuous Data Protection
  - Capture every change as it occurs
  - May be host-based, SAN-based, array-based
  - Protected copy in a secondary location
  - Recover to any point in time
- How:
  - Block-based
  - File-based
  - Application-based
- Why:
  - Implementations of true CDP today are delivering zero data loss, zero backup window and simple recovery. CDP customers can protect all data at all times and recover directly to any point in time.
  - Near CDP (Snapshots, checkpoints) may also help but will not catch every change




Run
Type the name of a program, folder, document, or Internet resource, and Windows will open it for you.
Open:
diskmgmt.msc
OK
Disk Management
File Action View Help
Volume Layout Type File System Status Capacity Free Spa... % Free
Simple Basic Healthy (R... 450 MB 450 MB 100 %
(C:) Simple Basic NTFS Healthy (B... 145.95 GB 112.03 GB 77 %
New Volume (D:) Simple Basic NTFS Healthy (P... 151.60 GB 124.74 GB 82 %
System Reserved Simple Basic NTFS Healthy (S... 100 MB 66 MB 66 %
Disk 0
Basic
298.09 GB
Online
System Res
100 MB NTFS
Healthy (Syst
(C:)
145.95 GB NTFS
Healthy (Boot, Page File, Crash Dump,
450 MB
Healthy (Recovery
New Volume (D:)
151.60 GB NTFS
Healthy (Primary Partition)
CD-ROM 0
DVD (E:)
No Media
Unallocated
Primary partition

```
C:\Users\Admin>diskpart
```

```
Microsoft DiskPart version 10.0.14393.0

Copyright (C) 1999-2013 Microsoft Corporation.
On computer: DESKTOP-9LSNM4E

DISKPART>
```

```
DISKPART> list disk

  Disk ###  Status         Size     Free     Dyn  Gpt
  --------  -------------  -------  -------  ---  ---
  Disk 0    Online          298 GB      0 B

DISKPART>
```

```
DISKPART> detail disk

Hitachi HTS543232A7A384
Disk ID: 301E8F3A
Type   : SATA
Status : Online
Path   : 0
Target : 0
LUN ID : 0
Location Path : PCIROOT(0)#PCI(1F02)#ATA(C00T00L00)
Current Read-only State : No
Read-only  : No
Boot Disk  : Yes
Pagefile Disk  : Yes
Hibernation File Disk  : No
Crashdump Disk  : Yes
Clustered Disk  : No
```

```
  Volume ###  Ltr  Label        Fs     Type        Size     Status     Info
  ----------  ---  -----------  -----  ----------  -------  ---------  --------
  Volume 1         System Rese  NTFS   Partition    100 MB  Healthy    System
  Volume 2     C                NTFS   Partition    145 GB  Healthy    Boot
  Volume 3     D   New Volume   NTFS   Partition    151 GB  Healthy
  Volume 4                      NTFS   Partition    450 MB  Healthy    Hidden

DISKPART> _
```

```
DISKPART> list disk

  Disk ###  Status         Size     Free     Dyn  Gpt
  --------  -------------  -------  -------  ---  ---
  Disk 0    Online          298 GB      0 B

DISKPART> select disk 0

Disk 0 is now the selected disk.

DISKPART>
```

```
DISKPART> select disk 1

Disk 1 is now the selected disk.

DISKPART> create partition primary size=2000

DiskPart succeeded in creating the specified partition.
```

```
DISKPART> list partition

  Partition ###  Type              Size     Offset
  -------------  ----------------  -------  -------
  Partition 1    Primary            100 MB  1024 KB
  Partition 2    Primary            145 GB   101 MB
  Partition 3    Recovery           450 MB   146 GB
  Partition 4    Primary            151 GB   146 GB

DISKPART>
```

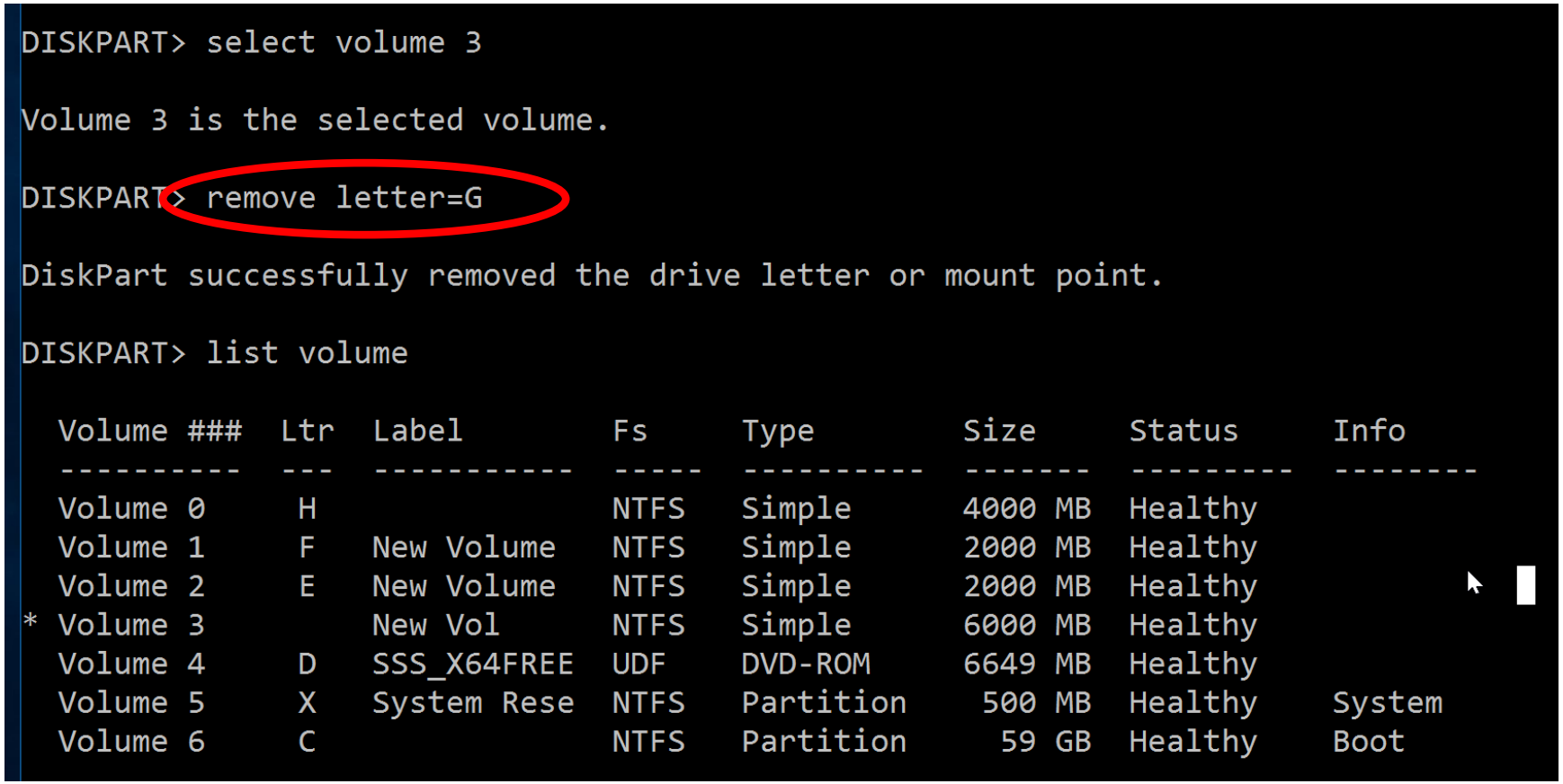
```
DISKPART> select partition 2

Partition 2 is now the selected partition.

DISKPART> detail partition

Partition 2
Type  : 07
Hidden: No
Active: No
Offset in Bytes: 105906176

  Volume ###  Ltr  Label        Fs     Type        Size     Status     Info
  ----------  ---  -----------  -----  ----------  -------  ---------  --------
* Volume 2     C                NTFS   Partition    145 GB  Healthy    Boot

DISKPART>
```

```
DISKPART> list volume

  Volume ###  Ltr  Label        Fs     Type        Size     Status     Info
  ----------  ---  -----------  -----  ----------  -------  ---------  --------
  Volume 0     E                       DVD-ROM         0 B  No Media
  Volume 1         System Rese  NTFS   Partition    100 MB  Healthy    System
* Volume 2     C                NTFS   Partition    145 GB  Healthy    Boot
  Volume 3     D   New Volume   NTFS   Partition    151 GB  Healthy
  Volume 4                      NTFS   Partition    450 MB  Healthy    Hidden
```

```
DISKPART> select volume 3

Volume 3 is the selected volume.

DISKPART> detail volume

  Disk ###  Status         Size     Free     Dyn  Gpt
  --------  -------------  -------  -------  ---  ---
* Disk 0    Online          298 GB      0 B

Read-only              : No
Hidden                 : No
No Default Drive Letter: No
Shadow Copy            : No
Offline                : No
BitLocker Encrypted    : No
Installable            : Yes

Volume Capacity        :  151 GB
Volume Free Space      :  124 GB
```

Assigning Drive Letter

```
DISKPART> select volume 5

Volume 5 is the selected volume.

DISKPART> assign letter=x

DiskPart successfully assigned the drive letter or mount point.

DISKPART> list volume

  Volume ###  Ltr  Label        Fs     Type        Size     Status     Info
  ----------  ---  -----------  -----  ----------  -------  ---------  --------
  Volume 0     H                NTFS   Simple      4000 MB  Healthy
  Volume 1     F   New Volume   NTFS   Simple      2000 MB  Healthy
  Volume 2     E   New Volume   NTFS   Simple      2000 MB  Healthy
  Volume 3     G   New Vol      NTFS   Simple      6000 MB  Healthy
  Volume 4     D   SSS_X64FREE  UDF    DVD-ROM     6649 MB  Healthy
* Volume 5     X   System Rese  NTFS   Partition    500 MB  Healthy    System
  Volume 6     C                NTFS   Partition     59 GB  Healthy    Boot
```


DISKPART> select volume 3
Volume 3 is the selected volume.
DISKPART> remove letter=G
DiskPart successfully removed the drive letter or mount point.
DISKPART> list volume
Volume ### Ltr Label Fs Type Size Status Info
Volume 0 H NTFS Simple 4000 MB Healthy
Volume 1 F New Volume NTFS Simple 2000 MB Healthy
Volume 2 E New Volume NTFS Simple 2000 MB Healthy
* Volume 3 New Vol NTFS Simple 6000 MB Healthy
Volume 4 D SSS_X64FREE UDF DVD-ROM 6649 MB Healthy
Volume 5 X System Rese NTFS Partition 500 MB Healthy System
Volume 6 C NTFS Partition 59 GB Healthy Boot

- **Delete partition:**
- To delete the currently active partition, **delete partition** command can be used.

- **Delete volume:**
- A volume can be deleted the same way as a disk or a partition. So, to delete the selected volume, you can utilize the benefits of the cool command called **delete volume**.

Syntax: create volume simple [size] [disk #]

- **format:**
- One of the most important commands used inside DiskPart is **format**. You should first select the volume you want to format using **select volume** command before using format.
- ***Syntax:*** format FS=NTFS label=”My Drive” Quick Compress
- **FS:** FS represents the **file system**.
- **Label:** label is the name of your drive. You can write anything.
- **Quick Compress:** It compresses the drive accordingly.
- This is for Dynamic Volume
- Diskpart>create volume simple size=1024
- Diskpart>select volume 4
- Diskpart>delete volume

- **create partition:**
- There are various commands dependant on the type of partition you need to create. You can create a primary partition by using the **create partition primary** command along with some option parameters including the **size (MBs)** and **offset**. You can also create **extended partitions** and **logical partitions** using **create partition extended**and **create partition logical** commands respectively.
- ***Syntax:*** create partition primary, logical, extended [size] [offset]
- Diskpart>create partition primary size=1000
- Diskpart>format FS=NTFS label=”My Drive”
- Diskpart>select partition 5
- Diskpart>delete partition

diskpart /delete D:

In the above example, the D: partition would be deleted.

diskpart /add \Device\HardDisk0 20

In the above example, a 20 MB partition would be created on the HardDisk0 device.

```
diskpart
diskpart>list disk
diskpart>select disk 1
diskpart>list partition
diskpart>create partition primary size=2000
diskpart>list partition
diskpart>select partition 2
diskpart>format FS=ntfs label="myvol1"
diskpart>list volume
diskpart>select volume 6
diskpart>assign letter=G
diskpart>list disk
diskpart>select disk 1
diskpart>list partition
diskpart>select partition 2
diskpart>delete partition
```

END

```
# pvdisplay
  --- Physical volume ---
  PV Name               /dev/sdc1
  VG Name               new_vg
  PV Size               17.14 GB / not usable 3.40 MB
  Allocatable           yes
  PE Size (KByte)       4096
  Total PE              4388
  Free PE               4375
  Allocated PE          13
  PV UUID               Joqlch-yWSj-kuEn-IdwM-01S9-XO8M-mcpsVe
```

The **pvscan** command scans all supported LVM block devices in the system for physical volumes.

The following command shows all physical devices found:

```
# pvscan
 PV /dev/sdb2   VG vg0   lvm2 [964.00 MB / 0   free]
 PV /dev/sdc1   VG vg0   lvm2 [964.00 MB / 428.00 MB free]
 PV /dev/sdc2            lvm2 [964.84 MB]
 Total: 3 [2.83 GB] / in use: 2 [1.88 GB] / in no VG: 1 [964.84 MB]
```

```
# lvdisplay -v /dev/vg_linux/var
    --- Logical volume ---
  LV Name                /dev/vg_linux/var
  VG Name                vg_linux
  LV UUID                2MvMBz-BQcq-e1cn-dnp2-osra-A5d4-1cb980
  LV Write Access        read/write
  LV Status              available
  # open                 1
  LV Size                1.49 GB
  Current LE             381
  Segments               2
  Allocation             inherit
  Read ahead sectors     0
  Block device           254:4

  Using logical volume(s) on command line
# lvdisplay --version
  LVM version:     2.01.14 (2005-08-04)
  Library version: 1.01.05 (2005-09-26)
  Driver version:  4.4.0
#
```

BROCADE FOS CLI COMMANDS

alicreate "Name", "domain,port#"	Used to create an alias
alicreate "Name","portname1; portname2"	To create multiple ports under a single alias
alidelete "Name"	To delete an alias
aliadd "Name", "domain,port#"	To add additional ports to an alias
aliremove "Name", "domain,port#"	To remove a port from the alias
alishow "AliName"	To show the alias configuration on the switch
zoneObjectRename {old_name} {new_name}	Rename a zone. Do a cfgsave followed by an cfgenable {configname} after.
zonecreate "Zone Name", "alias1; alias2"	To create zones based on alias
zonedelete "ZoneName"	To delete a zone
zoneadd "ZoneName", "alias name"	To add additional alias into the zone
zoneremove "ZoneName",	To remove an alias from the zone

“alias name”	
zoneshow “zoneName”	To show the zone configuration information
cfgcreate “Configname”, “Zone1; Zone2″	To create configurations by adding in zones
cfgdelete “ConfigName”	To delete a configuration
cfgadd “ConfigName”, “Zone3″	To add additional zones in the configuration
cfgremove “ConfigName”, “Zone3″	To remove a zone from the configuration
cfgshow “ConfigName”	To show the details of that configuration
cfgenable “ConfigName”	To enable a configuration on the switch
cfgsave	To have the effective configuration to be written into the flash memory

Show Commands

psshow	Displays the status of the power supply
fansshow	Displays the status of the fans
tempshow	Displays the status of the temperature readings
sensorshow	Displays the status of the sensor readings
nsshow	Displays information in the name server
nsshow -t	Displays information in the name server
nsshow -r	Displays the information in the name server along with the state change registration details
nscamshow	Displays detailed information of all the devices connected to all the switches in the fabric (Remote Name Servers)
nsallshow	Displays the 24 bit address of all devices that are in the fabric
licenseshow	Displays all the licenses that have been added in the switch
date	Displays the current date set on the switch
bannershow	Displays the banner that will appear when logging in using the CLI or web

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CISCO

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HITACHI

Hitachi Command Suite

Command name	Description
DeletePool	Deletes a DP pool.
DeletePPortFromPRPU	Deletes a port that belongs to a physical resource group from a specific physical resource group.
DeleteQuorumDiskID	Deletes a quorum disk ID being used on global-active device from a storage system.
DeleteSpareDrive	Deletes or releases a spare drive.
DeleteStorageArray	Deletes a storage system as a management target of the Device Manager server.
DeleteVirtualVolume	Deletes DP volumes.
DeleteVLDEVFromVRPU	Deletes a virtual LDEV from a virtual resource group and deletes the virtual information (virtual emulation, virtual SSID number, virtual LUSE, and virtual CVS) for the virtual LDEV.
DeleteVResourcePartitionUnit	Deletes a virtual resource group.
FormatLU	Formats an LU.
GetArrayReservation	Obtains information about a locked storage system.

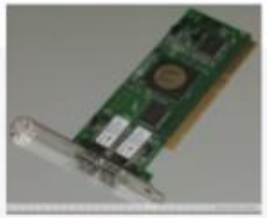
GetArrayReservation	Obtains information about a locked storage system.
GetPoolShrinkStatus	Obtains the execution status of a DP-pool shrink operation.
GetStorageArray#	Obtains information about a storage system.
GetTieredPoolStatus	Obtains the execution status of manually-executed performance monitoring and hardware tier relocation for an HDT pool.
GetVStorageArray	Obtains information about a virtual storage machine.
GetZeroPageReclaimStatus	Obtains the execution status of a zero-page reclaim operation.
ModifyArrayReservation	Extends the maximum period for which a specified storage system is locked.

`RefreshPerformanceData`	Obtains storage system performance information collected by Hitachi Tuning Manager, and refreshes the Device Manager server database with the most recent information.
`RefreshResourceLabels`	Refreshes labels by obtaining the labels set in a storage system and then applying them to the Device Manager server database.
`RefreshStorageArrays`	Refreshes the configuration information for all of the storage systems that are managed by the Device Manager server with the most recent information.
`ReserveVLDEV`	Reserves a virtual LDEV belonging to a virtual resource group, for a global-active device S-VOL.
`RunZeroPageReclaim`	Releases unused capacity in DP volumes.
`ShrinkPool`	Shrinks a DP pool.

Command name
AddArrayGroup
AddArrayReservation
AddExternalArrayGroup
AddHostStorageDomain
AddLabel
AddLogicalUnit
AddLUSE
AddPArrayGroupToPRPU
AddPHSDToPRPU
AddPLDEVToPRPU
AddPool

What components make up a SAN?

Host - HP-UX, Windows, Sun Solaris, Linux



st Bus Adapter

Fiber Cables

Fiber Channel Switch

Storage Array

What components make up a SAN?

Host - HP-UX, Windows, Sun Solaris, Linux

ost Bus Adapter

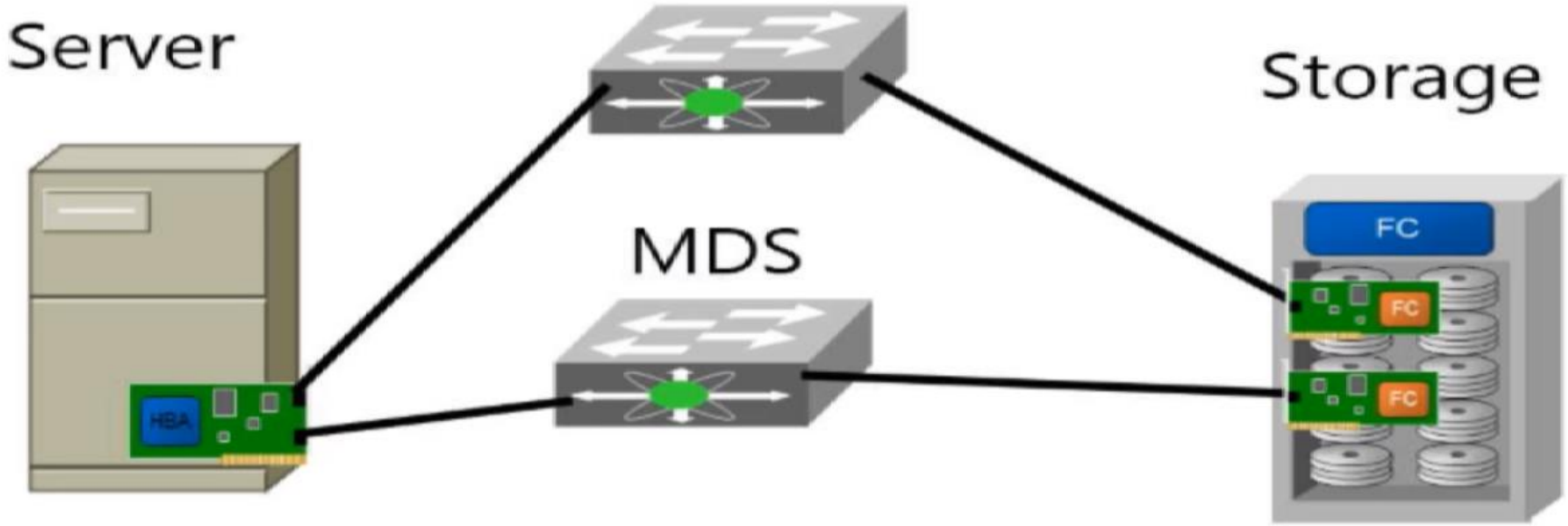
Fiber Cables

Multi-pathing software

Fiber Channel Switch

Unlike the DAS, Servers attached to a SAN have redundant connections to Storage Disk i.e. data via redundant fiber channel switches, eliminating single point of failure.

Storage Array



HBA - Host Bus Adapter

WWN
World Wide Names

WWNN - adapt.
WWPN - port

World Wide Node Name – WWNN / World Wide Port Name - WWPN

Virtualization Intelligence

- **Host-Based**: storage virtualization could be implemented on the host through Logical Volume Management (LVM) which provides the logical view of the storage to the host operating system.
- **Switch-based**: intelligence of storage virtualization could be implemented on the SAN switches. Each server is assigned a Logical Unit Number (LUN) to access the storage resources.
  - Switch-based virtualization could be in dual configuration for high availability.
  - Pros: ease of configuration and management ; redundancy/high availability
  - Cons: potential bottleneck on the switch; higher cost

Storage Virtualization