

SkillsFuture Career Transition Program

Cloud Infrastructure Engineering

Disk, Memory & Storage

**Nanyang Technological University
Skills Union**

Course Content

- Describe and Explain what Disk, Memory and Storage are
- Describe what RAID is and its uses
- Differentiate the RAID Storage Levels

Recap & Summary

A **Program** is an **executable file** containing a set of instructions and stored passively on a disk.

A **Process** is the execution of those instructions after being loaded from the disk into memory. It is the instance of a computer program, a program in execution. One program can have multiple processes. For example, the Google Chrome browser creates an entirely separate process for every single tab or extra extension you are using.

A **Thread** is the smallest unit of execution within a process. One process can have multiple threads.

Memory



What is RAM?

Primary memory or temporary storage is called Random Access Memory (RAM).

RAMs are stored on the **motherboard**, in modules that are called Dual Inline Memory Module (DIMMs) - [Link](#)



How Does A RAM Work?

In order for data or a program to run on a computer, it first needs to be **loaded into RAM**, so the data or program is first stored on the hard drive, and is then **loaded from the hard drive into RAM**.

Once it is loaded into RAM, the **CPU can now access the data or run the program**.

How Does A RAM Work?

When the amount of available memory is too low, it might not be able to hold all the data that the CPU needs.

When this happens, some other data has to be kept on those slower hard drives, in order to compensate for the low memory.

So instead of a data going from RAM to the CPU, it has to do extra work by going back to the hard drive; when this happens, it effectively **slows down the whole computer**.

How Does A RAM Work?

How do you solve this?

Increase the amount of RAM in the computer.

By increasing the amount of memory available, more data can be loaded into the RAM.

The result: **better performance**. This serves as an explanation as to why a computer with more RAM performs better than a computer with less RAM.

More About RAMs

RAM requires **constant electrical power to store data**. If the power is turned off, the **data is erased**.

RAM also comes in different types:

DRAM – Dynamic RAM. DRAM is a kind of memory that contains capacitors, which must be constantly refreshed with electricity.

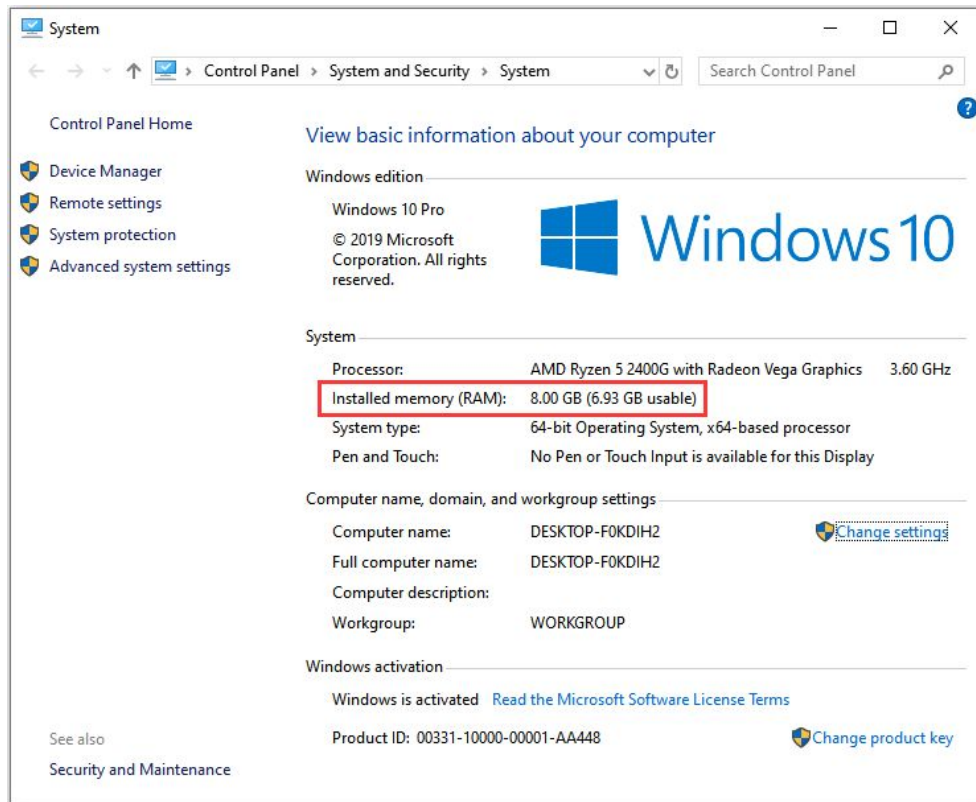
SDRAM – Synchronous DRAM. It is used today in RAM DIMMs. It operates synchronously with the system clock, and is faster than DRAM.

Can You Increase RAM Online?

<https://downloadmoreram.com/> - True Or False?



Let's Check Your Memory



The screenshot shows the Windows 'System' window in the Control Panel. The left sidebar contains links to 'Control Panel Home', 'Device Manager', 'Remote settings', 'System protection', and 'Advanced system settings'. The main content area is titled 'View basic information about your computer' and displays various system details. A red rectangle highlights the 'Installed memory (RAM): 8.00 GB (6.93 GB usable)' entry. Other visible details include the Windows edition (Windows 10 Pro), processor (AMD Ryzen 5 2400G), system type (64-bit), and computer name (DESKTOP-F0KDIH2).

System

Control Panel > System and Security > System

Control Panel Home

- Device Manager
- Remote settings
- System protection
- Advanced system settings

View basic information about your computer

Windows edition

Windows 10 Pro
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System

Processor: AMD Ryzen 5 2400G with Radeon Vega Graphics 3.60 GHz

Installed memory (RAM): 8.00 GB (6.93 GB usable)

System type: 64-bit Operating System, x64-based processor

Pen and Touch: No Pen or Touch Input is available for this Display

Computer name, domain, and workgroup settings

Computer name: DESKTOP-F0KDIH2 [Change settings](#)

Full computer name: DESKTOP-F0KDIH2

Computer description:

Workgroup: WORKGROUP

Windows activation

Windows is activated [Read the Microsoft Software License Terms](#)

Product ID: 00331-10000-00001-AA448 [Change product key](#)

See also
Security and Maintenance

Let's Check Your Memory



Storage



What Is Storage?

Storage devices consists of computing hardware that used for **storing and extracting data files and objects**.

They can **hold and store information both temporarily and permanently**.

Storage devices are available in different forms, depending on the type of underlying device.

Magnetic Storage Device

One of the most popular types of storage used.

It uses **magnetization to manipulate and access data**. The device is covered with a magnetic coating and stores data in the form of tracks, spots and sectors.

Magnetic Storage Device

Floppy diskette – A normal 3 ½ inch disk can store 1.44 MB of data.

Hard drive – It is used to store portable data and backups.

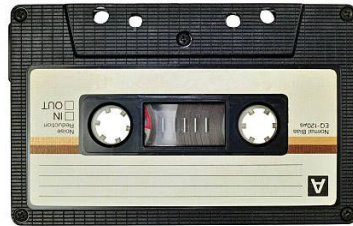
Magnetic strip – Magnetic tape drive stores video and audio using magnetic tape, like tape and video tape recorders.

Super disk – A disk drive and diskette that can hold 120 MB and 240 MB of data.

Cassette tape – A magnetic storage device used for audio recording and playback.

Zip diskette – Like a floppy diskette but more advanced.

Magnetic Storage Device



Optical Storage Device

Use of **lasers and lights** for saving and retrieving data.

Blu-ray – A digital optical storage device which was intended to replace the DVD format.

CD-ROM – An optical storage device that is read-only or cannot be modified nor deleted.

CD-R and CD-RW – CD-R is a recordable disc that can be written to once, while CD-RW is a rewritable disc that can be written to multiple times.

DVD – DVD-R and DVD+R are recordable discs that can be written to once, while DVD-RW and DVD+RW are rewritable discs that can be written to multiple times. The difference between the + and – is in the formatting and compatibility.

Optical Storage Device



Flash Memory Device

Uses non-volatile **memory chips for storage and for transferring data** and can quickly be written or erased.

Memory card – An electronic flash memory device used to store digital information and commonly used in mobile electronic devices.

Memory stick – A memory card that is removable.

SSD – Solid State Drive – A flash memory device that uses integrated circuit assemblies to save data steadily.

USB flash drive, jump drive or thumb drive – A small, portable storage device connected through the USB port.

Flash Memory Device



Online Cloud Storage

Very widespread as people can **easily access data from different devices**.

Cloud storage – Data is managed remotely and made available over a network. Basic features are free to use but upgraded version is paid monthly as a per consumption rate.

Network media – Audio, Video, Images or Text that are used on a computer network. A community of people create and use the content shared over the internet.

Online Cloud Storage



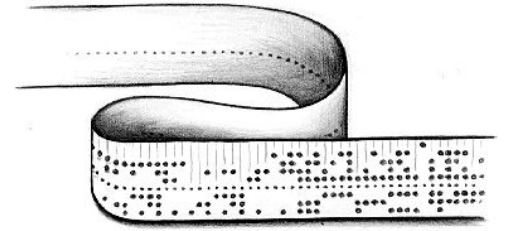
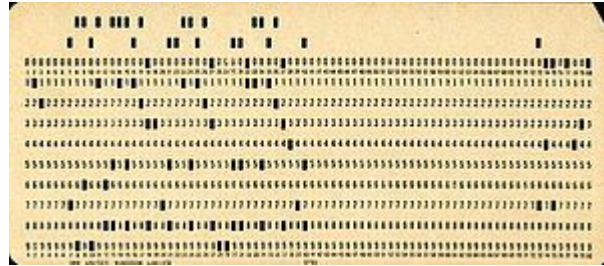
Paper Storage

Method used by early computers for saving information.

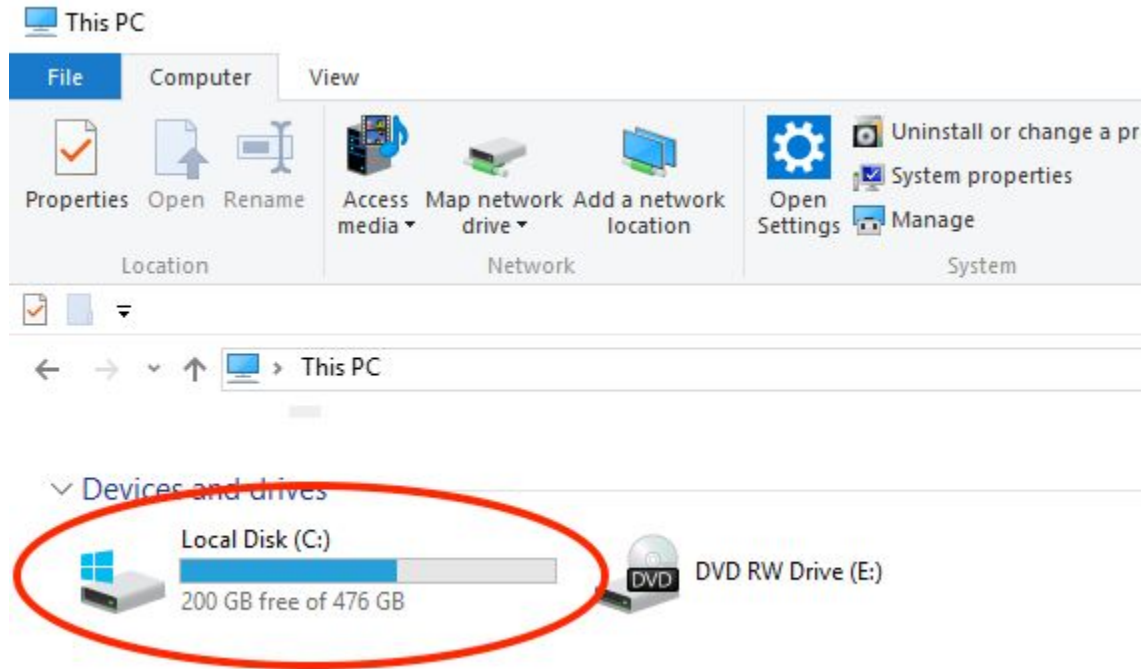
OMR – Optical Mark Recognition – A process of capturing marked data of human from forms like surveys and tests. It is used to read questionnaires with multiple choices that are shaded.

Punch card – A piece of hard paper used to contain digital information coming from the perforated holes. The presence or absence of holes in predetermined positions define the data.

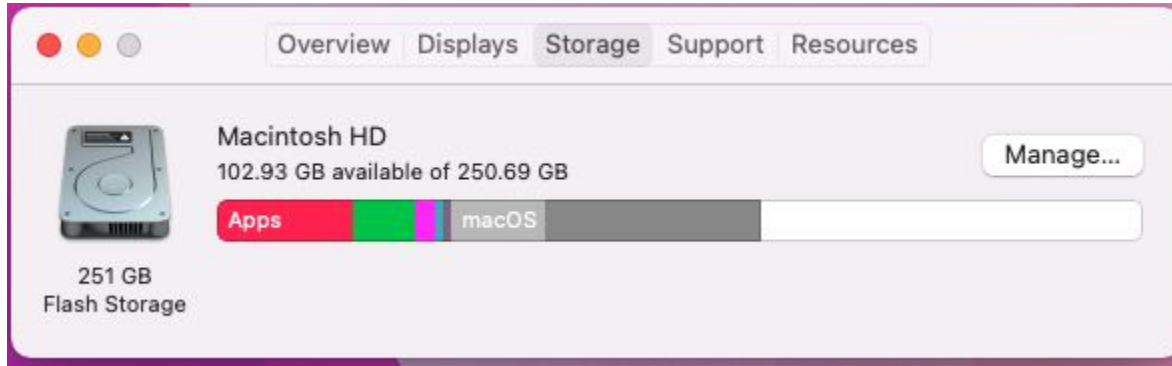
Paper Storage



Let's Check Your Storage



Let's Check Your Storage



AWS Storage To Know

Object, file, and block storage



Amazon Simple Storage Service (S3)

Object storage with industry-leading scalability, availability, and security for you to store and retrieve any amount of data from anywhere.



Amazon Elastic File System (EFS)

A simple, serverless, elastic, set-and-forget file system for you to share file data without managing storage.

FSx

Amazon FSx

Fully managed, cost-effective file storage offering the capabilities and performance of popular commercial and open-source file systems.



Amazon Elastic Block Store (EBS)

Easy to use, high-performance block storage service for both throughput and transaction-intensive workloads at any scale.

AWS Storage To Know

Data migration



AWS DataSync

Online data transfer service that optimizes network bandwidth and accelerates data movement between on-premises storage and AWS storage.



AWS Snow Family

Offline data transfer devices with built-in security and logistics features for simplified data migration.

AWS Storage To Know

Hybrid cloud storage and edge computing



AWS Storage Gateway

Hybrid cloud storage service that gives you on-premises access to virtually unlimited cloud storage.



AWS Snow Family

Edge compute, data collection, and data transfer services with security and end-to-end logistics for mobile and rugged deployments.

Break Time



RAID



What is RAID?

RAID is an acronym for **Redundant Array of Independent Disks**.

It is a **data storage virtualization technology** that **combines multiple physical disk drive** components **into one or more logical units** for the purposes of:

- Data redundancy,

- Performance improvement,

- Or both.

What is RAID?

With RAID enabled on a storage system, you can **connect two or more drives** in the system so they **act as one large volume fast drive** or set them up as one system drive used to automatically and instantaneously duplicate (or mirror) your data for real-time backup.



Key Terminologies

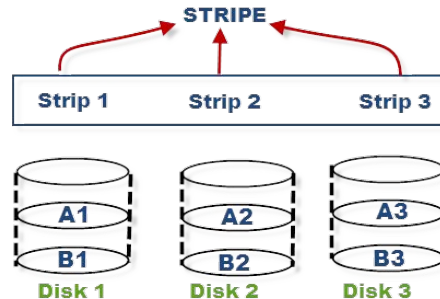
Block

Block in RAID refers to a chunk of data

Key Terminologies

Striped Volume

Striping **spreads the data for a single volume over two or more drives**, with each drive containing only part of the volume being distributed. When reading or writing a large file, the request gets sent to all of the drives at the same time.



Key Terminologies

Mirrored Volume

Mirroring uses **two or more drives to create a volume protected from drive failure.**

Unlike Striped Volumes, **each drive contains a copy of the entire drive.** As long as one of the Mirrored Volume's drives is still working and attached to your computer, it is safe and will function normally.

Key Terminologies

Parity

By definition, parity is the “**state of being equal.**” Parity computations are used in RAID drive arrays **for fault tolerance by calculating the data in two drives and storing the results on a third.** If a drive fails and is replaced, the RAID controller rebuilds the lost data from the other two volumes.

Dedicated Parity is when the parity information is all stored on a single drive. Distributed Parity spreads the data across all the drives in the array.

Key Terminologies

Parity

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Different RAID Levels

There are **6 different levels** (or volume types) of RAID: 0, 1, 4, 5, 6, and 1+0 (10). They each have their pros and cons regarding the balance of speed and security.

- RAID 0
- RAID 1
- RAID 4
- RAID 5
- RAID 6
- RAID 10

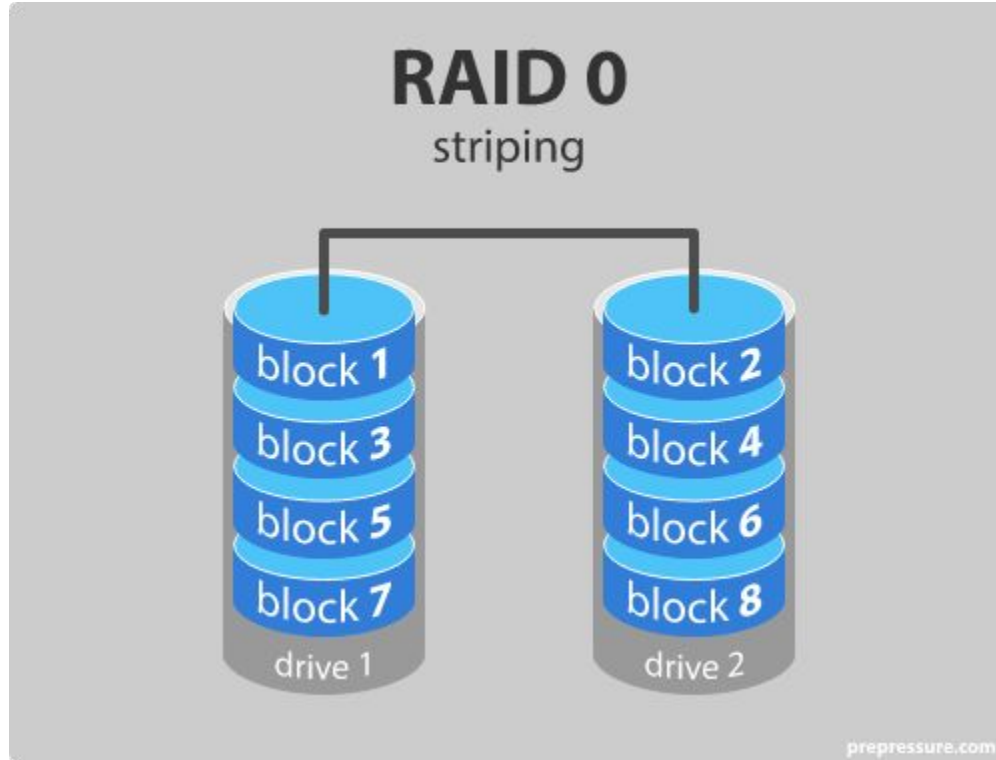
RAID 0 - Performance

RAID 0 mode provides disk striping across all drives in the RAID drive group.

RAID 0 **does not provide data redundancy** but does provide the **best performance** of any RAID levels.

RAID 0 **breaks up data into smaller segments** and stripes the data segments across each drive in the drive group.

RAID 0 - Performance



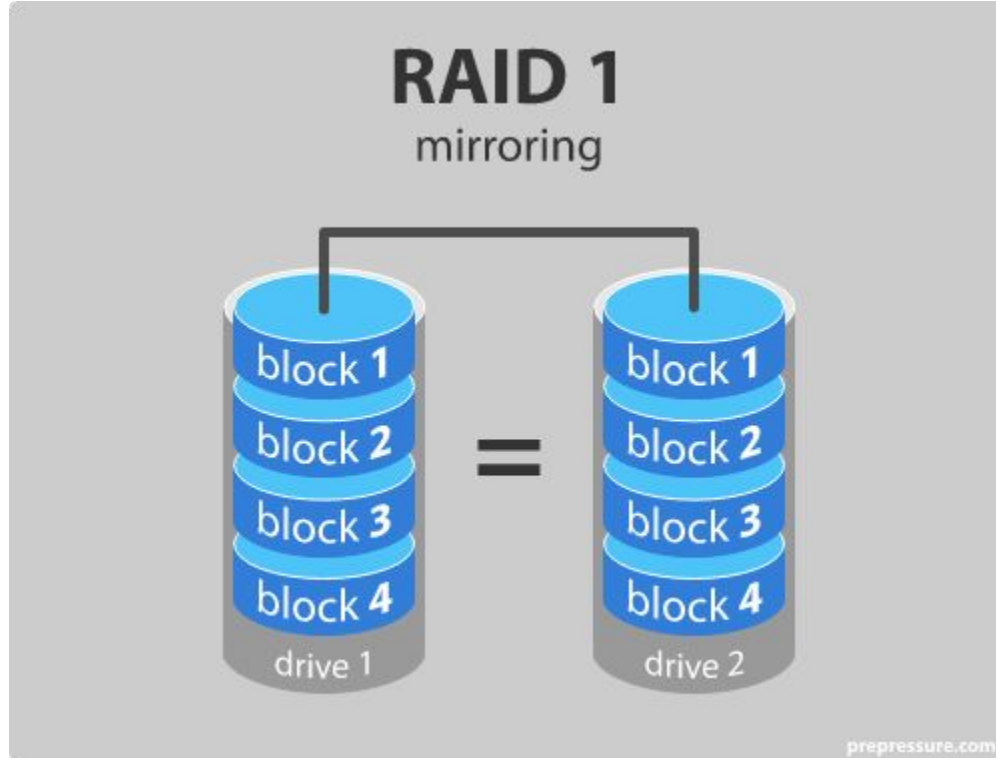
RAID 1 - Data Protection

RAID 1 sets the system to data protection mode (also known as mirrored mode or RAID 1) and the capacity is divided in half.

Half of the capacity is used to store your data and half is used for a duplicate copy.

If one drive goes down your data is protected because it's duplicated.

RAID 1 - Data Protection

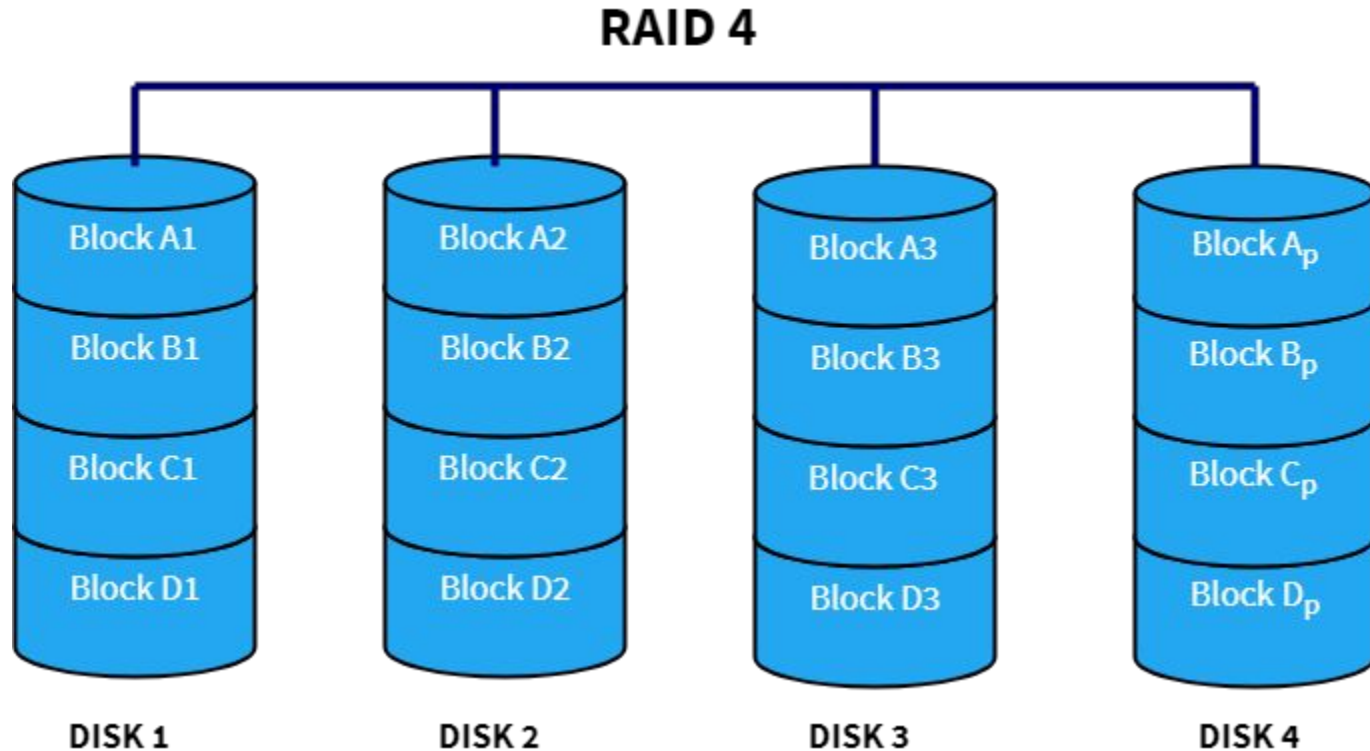


RAID 4 - Fault Tolerance

RAID 4 is a RAID configuration that uses block-level striping across two or more independent disks with a **dedicated parity disk**.

This storage technology is similar to RAID 5 in that both use block-level striping with parity, as a result, RAID 4 is rarely used in favour of RAID 5.

RAID 4 - Fault Tolerance

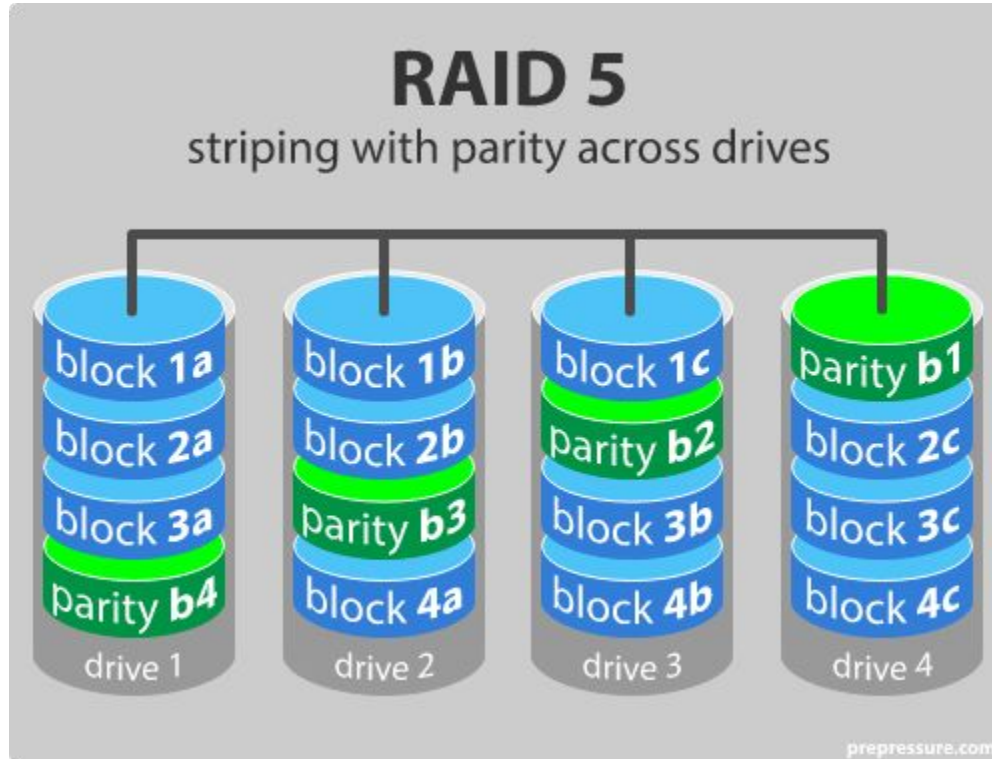


RAID 5 - Data Protection & Speed

In systems with **three or more drives** we recommend that you set the system to RAID 5.

This gives you the best of both worlds: **fast performance** by striping data across all drives; **data protection** by dedicating a quarter of each drive in a four-drive system to fault tolerance leaving three quarters of the system capacity available for data storage.

RAID 5 - Data Protection & Speed



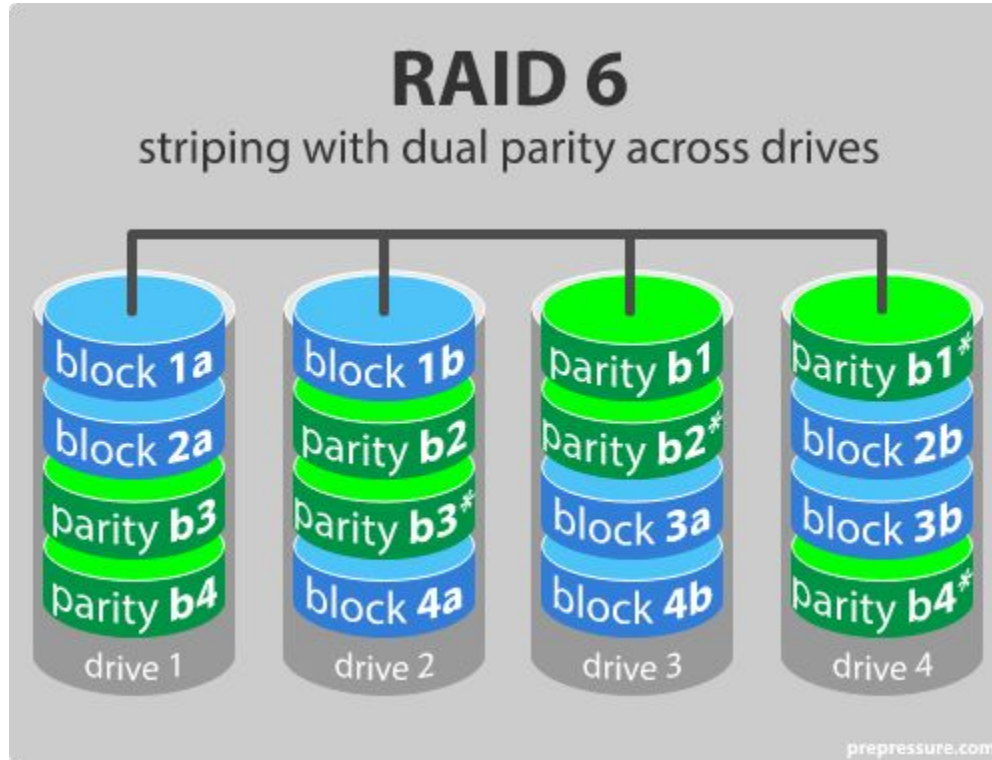
RAID 6 - Improved Data Protection

RAID 6 systems implement the “striping” approach in a classic manner.

RAID 6 systems **distribute all user data and parity information evenly** across the integrated hard disks.

This means that each disk saves the data blocks (here: A1, A2, etc.), sometimes the parity blocks (here: Ap1, Ap2, etc.) of a data stripe.

RAID 6 - Improved Data Protection



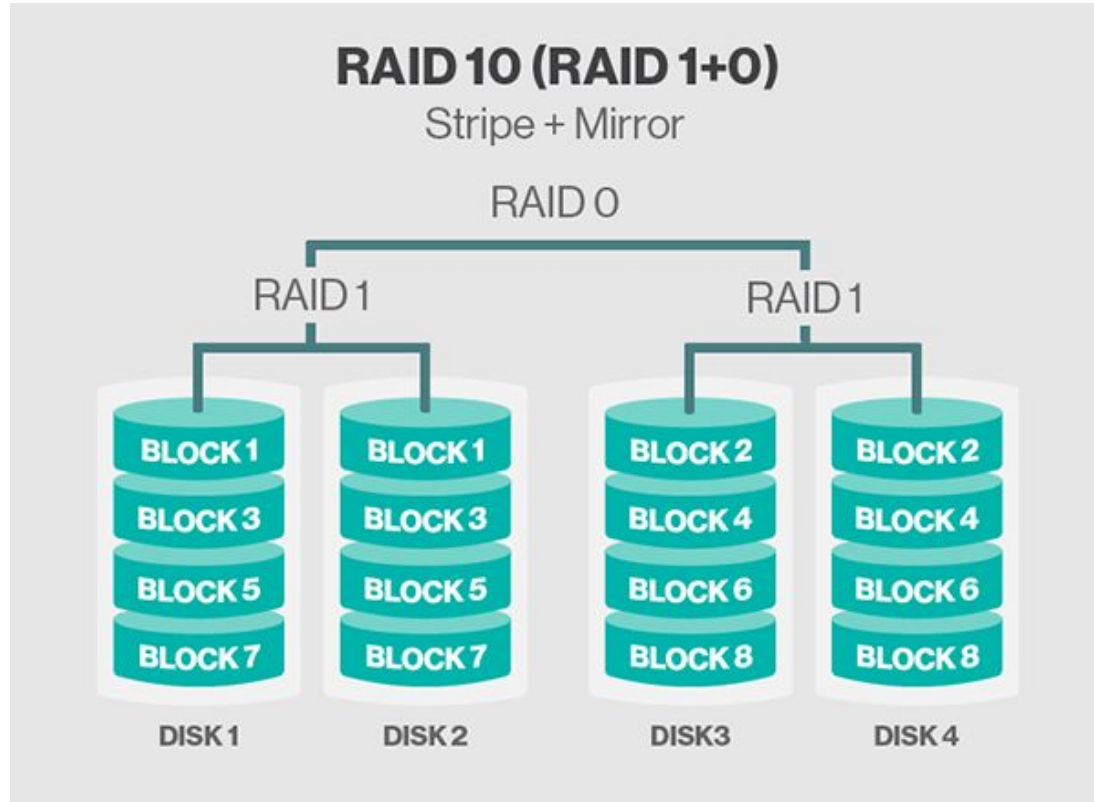
RAID 10 - High Reliability & Performance

RAID 10 or RAID 1+0 delivers very high I/O rates by striping RAID 1 (mirrored) segments.

This RAID mode is good for **business critical database management solutions** that require **maximum performance and high fault tolerance**.

A system set to RAID 10 yields half the total capacity of all the drives in the array.



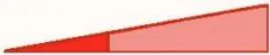
RAID 10 - High Reliability & Performance






RAID Summary



RAID Summary

RAID 0	RAID 1	RAID 4
Blocks Striped. No Mirror. No Parity.	Blocks Mirrored. No Stripe. No Parity.	Blocks Striped and Dedicated Parity.
Capacity 	Capacity 	Capacity 
<ul style="list-style-type: none">• Fastest RAID• No protection from disk failure• Best for scratch storage when editing digital video/photos/media• Requires 2 or more disks	<ul style="list-style-type: none">• Safest RAID• Most disk failure protection• Best for critically important data where access speed is not an issue• Requires 2 or more disks	<ul style="list-style-type: none">• Fast and safe• Best for general use on SSDs• Super-fast read/write of large files used for video, animation, photography, and graphics• Requires 3 or more disks

RAID Summary

RAID 5	RAID 6	RAID 1+0 (10)
Blocks Striped. Distributed Parity.	Blocks Striped. Two Distributed Parity.	Blocks Mirrored and Striped.
Capacity 	Capacity 	Capacity 
<ul style="list-style-type: none">• Fast and safe• Best for general use on HDDs• Super-fast read/write of large files used for video, animation, photography, and graphics• Requires 3 or more disks	<ul style="list-style-type: none">• Similar to RAID 5 with an additional parity block of recovery information• Allows for the failure of 2 disks• Slightly slower than RAID 5 on writes, no added delays on reads• Requires 4 or more disks	<ul style="list-style-type: none">• Fastest and safest RAID option• Best for businesses or those needing high performance with increased reliability• Requires 4 or more disks

Useful Links

<https://www.enterprisestorageforum.com/hardware/dimm/>

What's next?

