Computer Architecture and Organization

CS 115

Lecture 8

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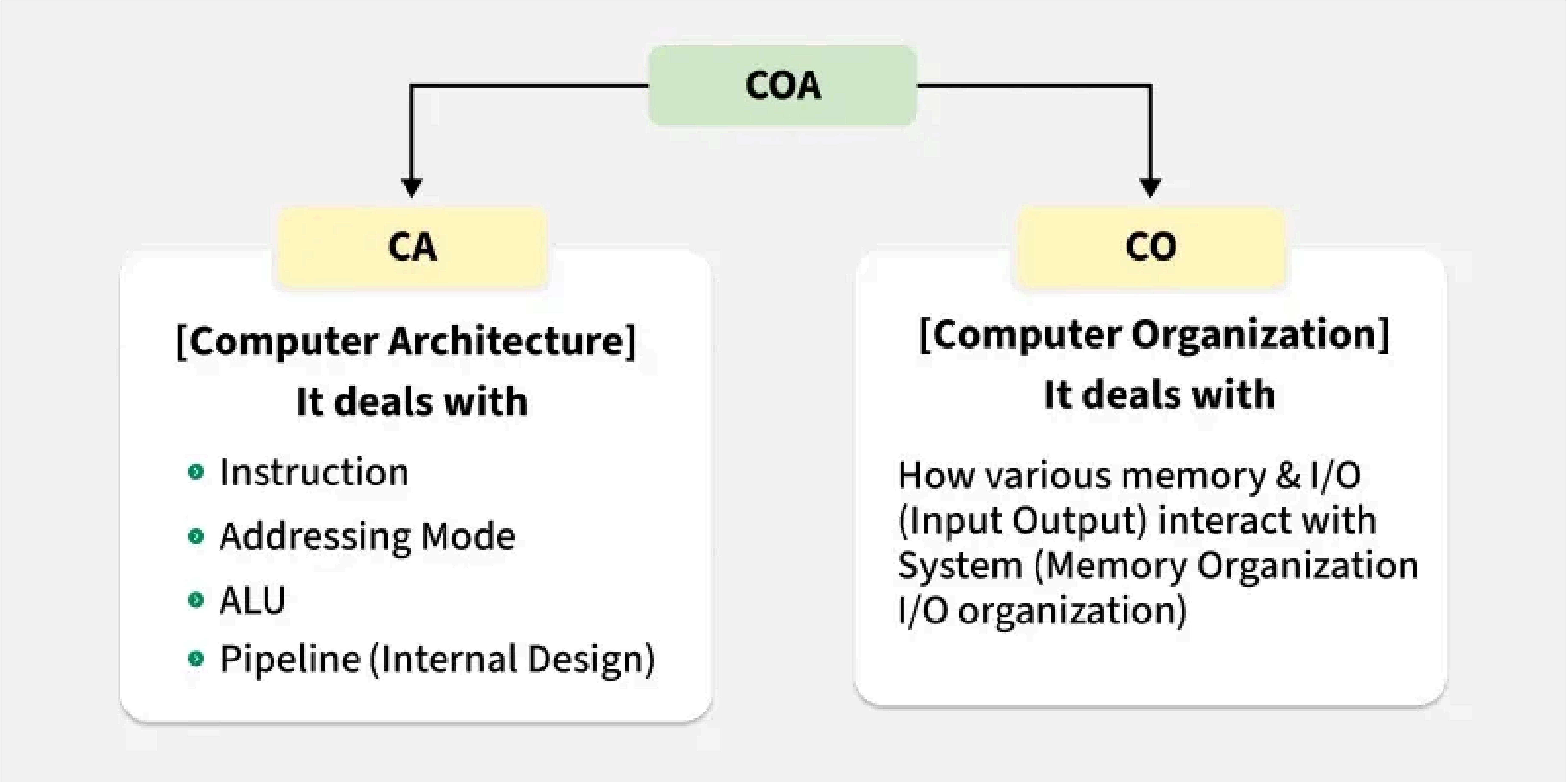
Unit V: Interfacing and Communication

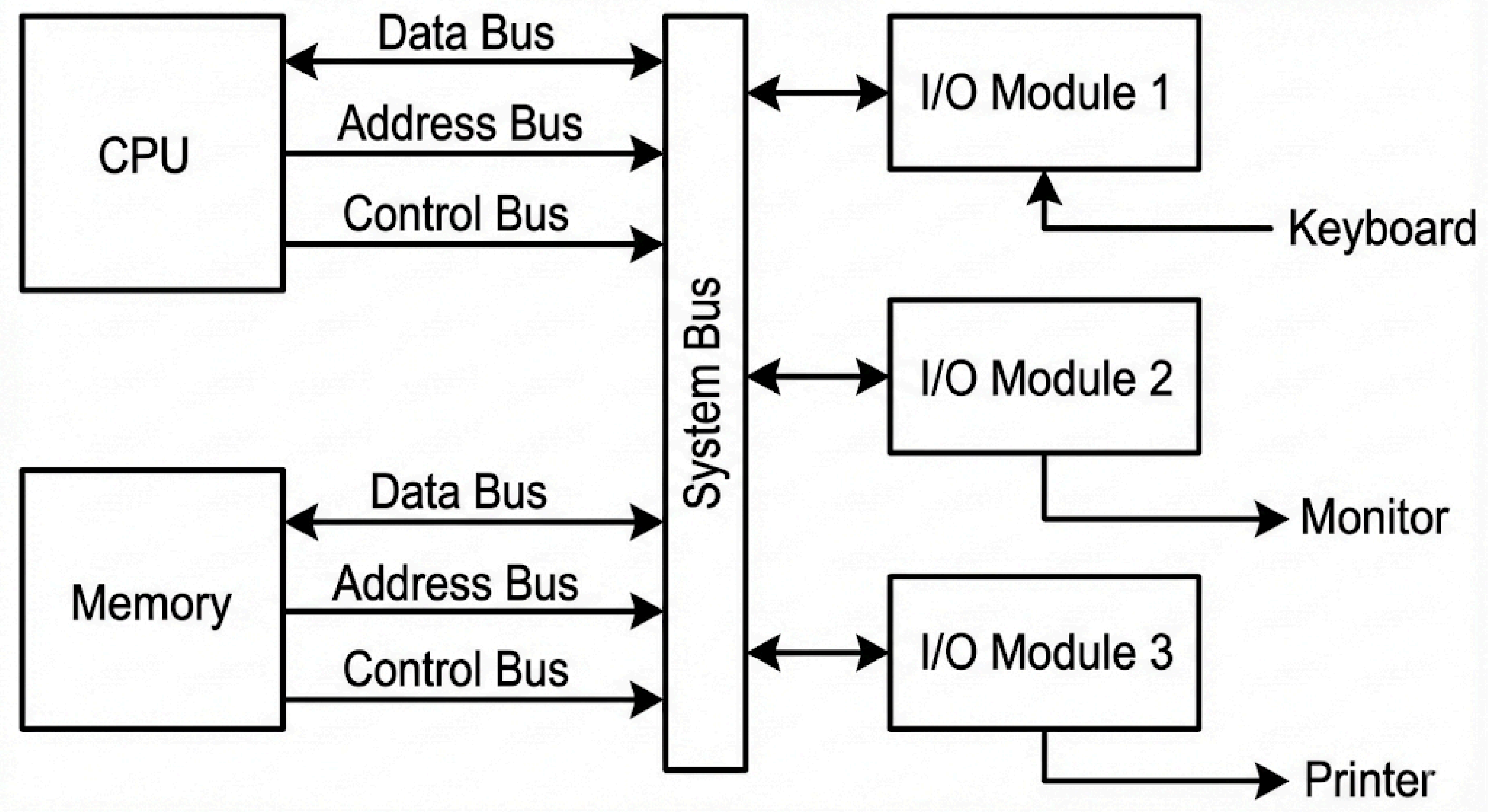
I/O Architectures


COA
CA
[Computer Architecture]
It deals with
Instruction
Addressing Mode
ALU
Pipeline (Internal Design)
CO
[Computer Organization]
It deals with
How various memory & I/O (Input Output) interact with System (Memory Organization I/O organization)

How does the brain (CPU) talk to the hands and eyes (Peripherals) without getting overwhelmed?

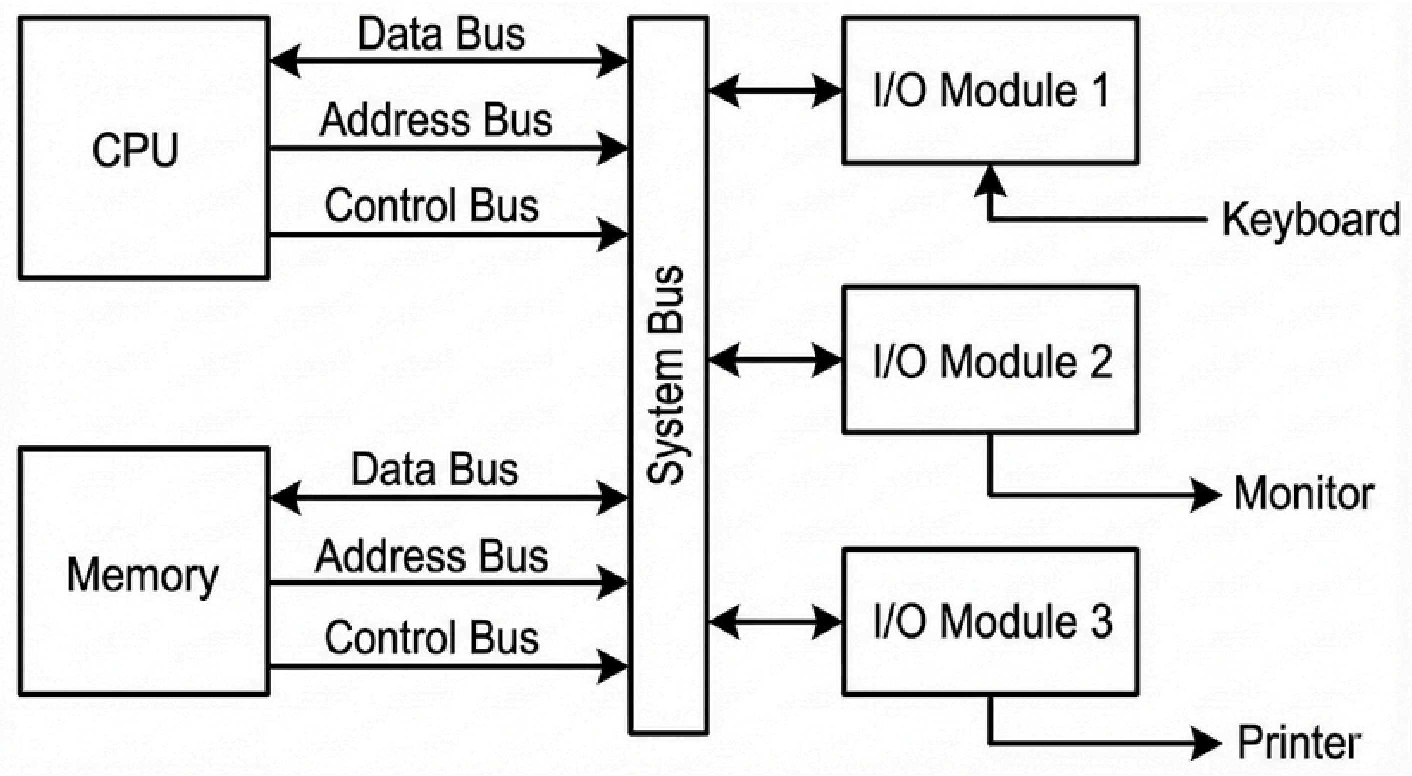
I/O Architectures

- Programmed I/O (Polling)
- Interrupt-Driven I/O
- Direct Memory Access (DMA)



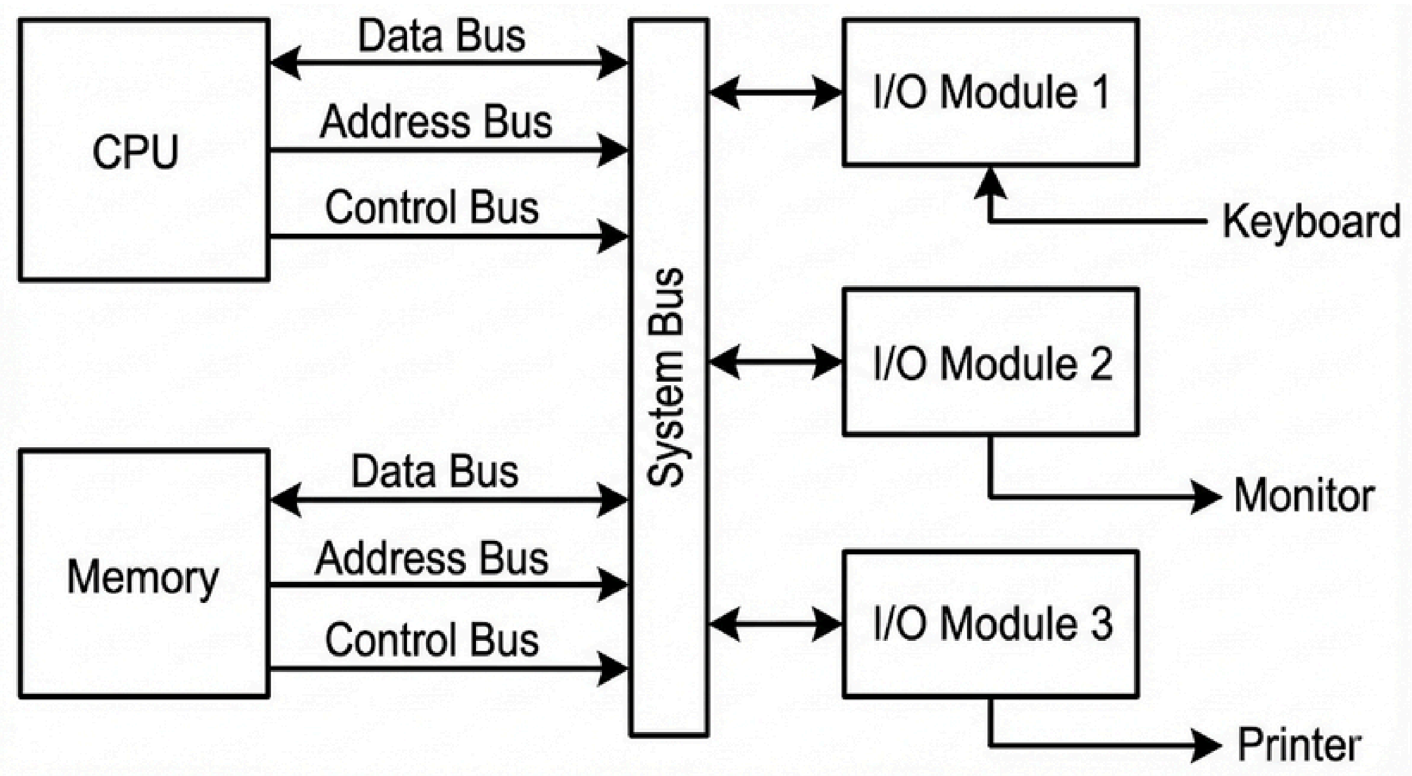
Programmed I/O (Polling)

- The CPU is responsible for checking the status of an I/O device **periodically** to see if it is ready to send or receive data.
- The CPU enters a "busy-wait" loop, **constantly asking** the device, "Are you ready? Are you ready?" until the device answers "Yes."
- This is the **simplest method to design** but the most inefficient. It wastes valuable CPU cycles that could be used for processing instructions.



Interrupt-Driven I/O

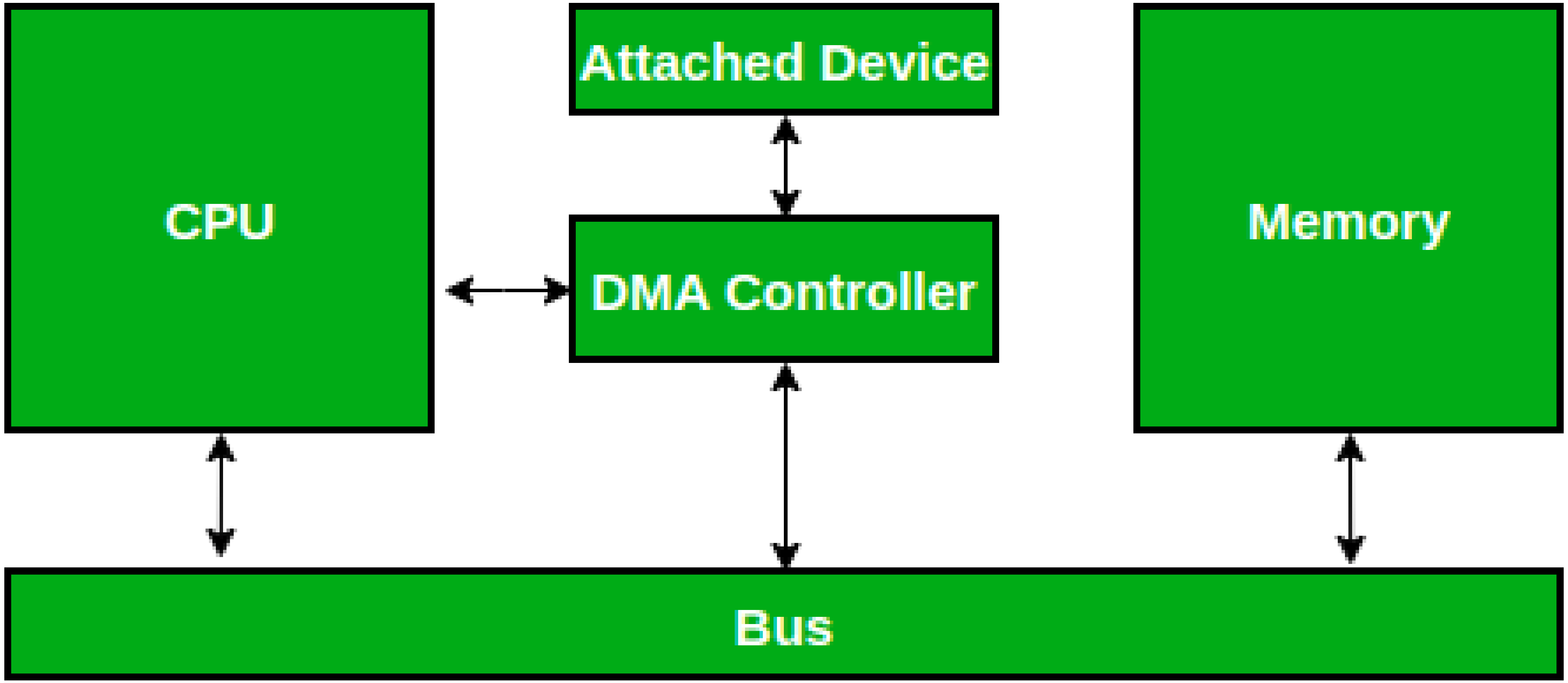
- The CPU issues an I/O command and then continues executing other instructions. When the I/O device is ready, it sends a **hardware signal** (**an Interrupt**) to the CPU.
- Upon receiving the interrupt, the CPU pauses its current task, saves its state (Context Switch), executes an **Interrupt Service Routine (ISR)** to handle the data, and then resumes the original task.
- Vastly more efficient than polling. It allows the OS to be multitasking.



Direct Memory Access (DMA)

- A specialized hardware module (**DMA Controller**) takes over the task of transferring data between memory and I/O devices, bypassing the CPU entirely for the transfer duration.
- The CPU tells the DMA controller: "Move 1GB of data from Disk to RAM." The CPU then goes back to work. The DMA controller handles the heavy lifting and interrupts the CPU only when the entire 1GB transfer is complete.
- This is critical for modern performance. It allows you to transfer massive files from a USB drive or play high-definition video without freezing your mouse cursor or crashing the system.

Direct Memory Access (DMA)

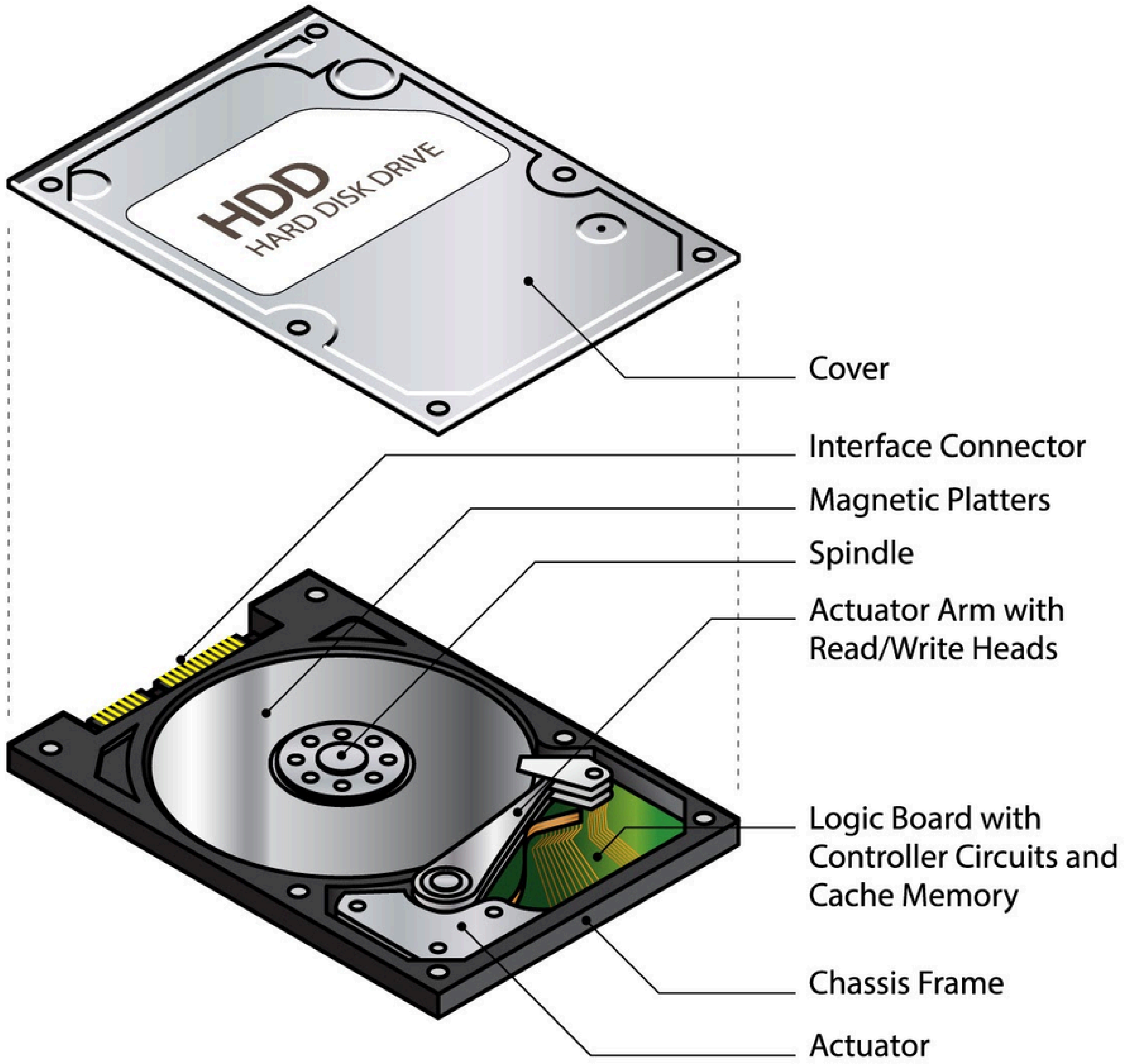


Storage Technologies

Where do we put the data when the power goes out?

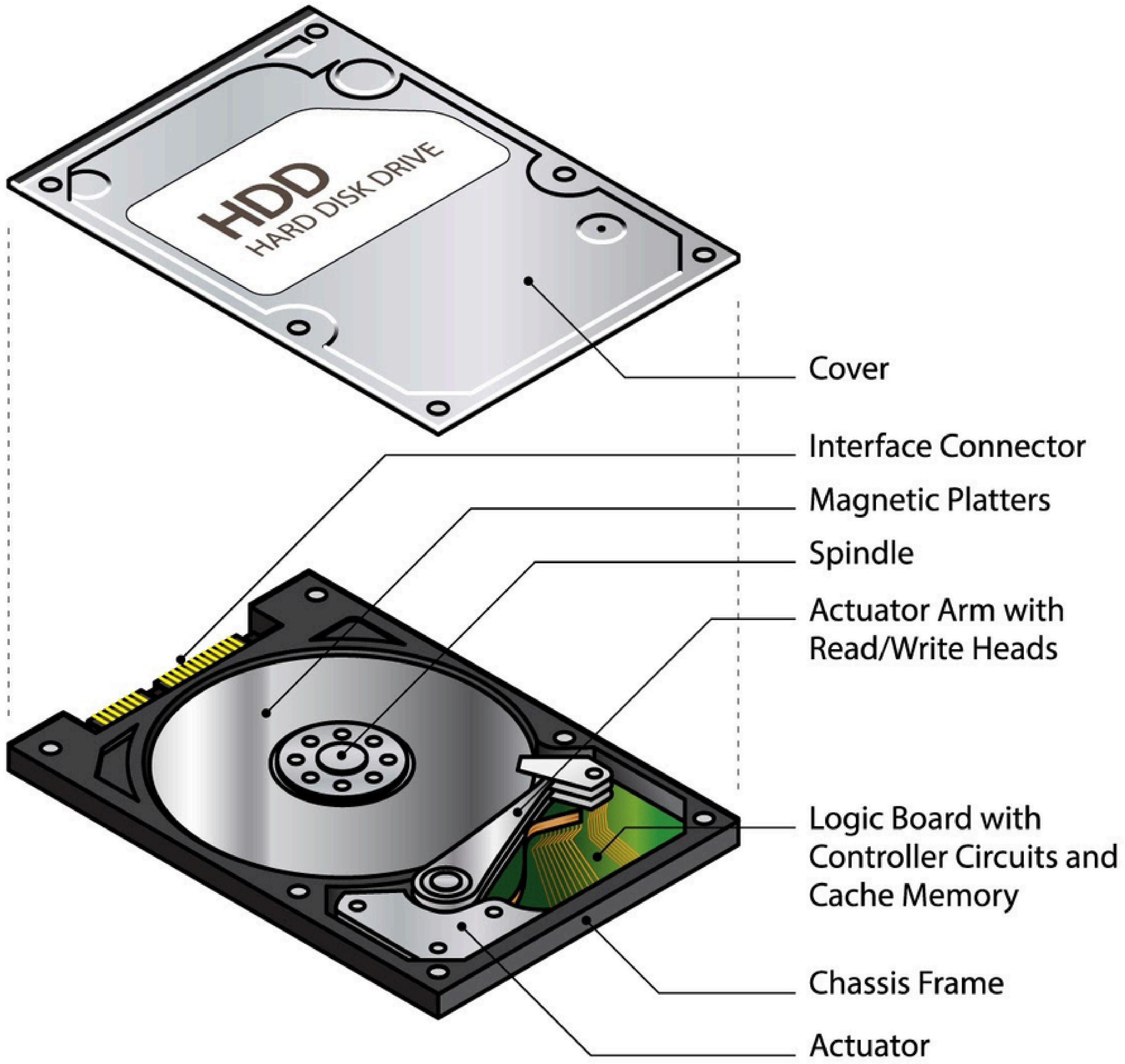
Magnetic Disk Technology (HDD)

- **Platter:** The circular disk coated in magnetic material.
- **Spindle:** Rotates the platters (typically 5400 or 7200 RPM).
- **Read/Write Head:** Floats on a cushion of air nanometers above the platter to read magnetic polarity (0 or 1).
- **Actuator Arm:** Moves the head across the disk.



Magnetic Disk Technology (HDD)

- While SSDs are faster, Magnetic HDDs are still the king of Capacity per Dollar. They are used in almost all cloud data centers (AWS, Google Drive) to store the petabytes of data we generate.

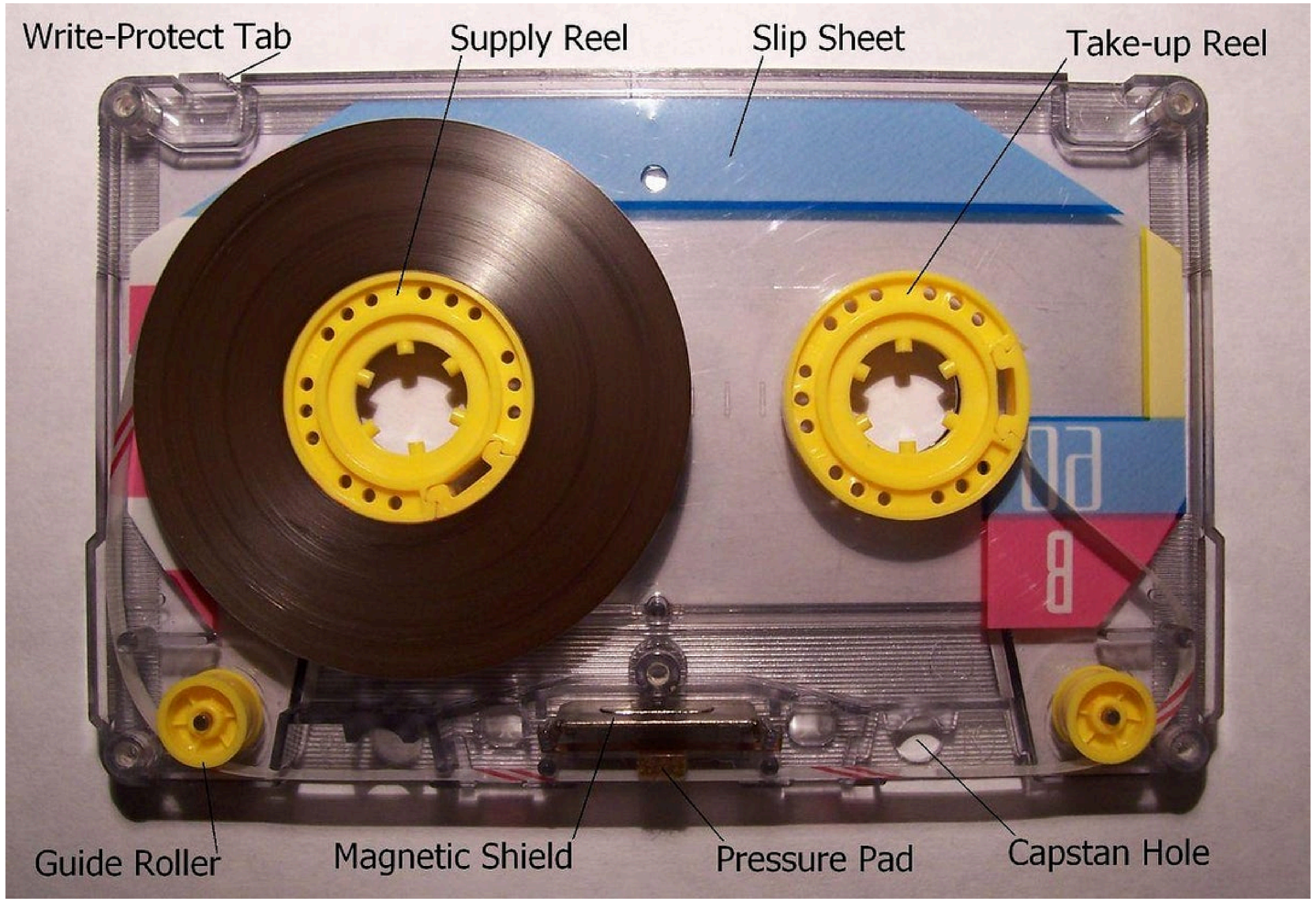


Optical Disks

- **CD/DVD/Blu-ray:** Data is stamped or burned into a spiral track as Pits (indentations) and Lands (flat surface).
- **Reading:** A laser beam reflects differently off a pit versus a land. A sensor reads these reflection changes as binary data.
- Optical media is "**Write Once, Read Many**" (**WORM**) ideal for distribution (movies, games) and archival. It is immune to magnetic interference (a magnet won't erase a DVD).

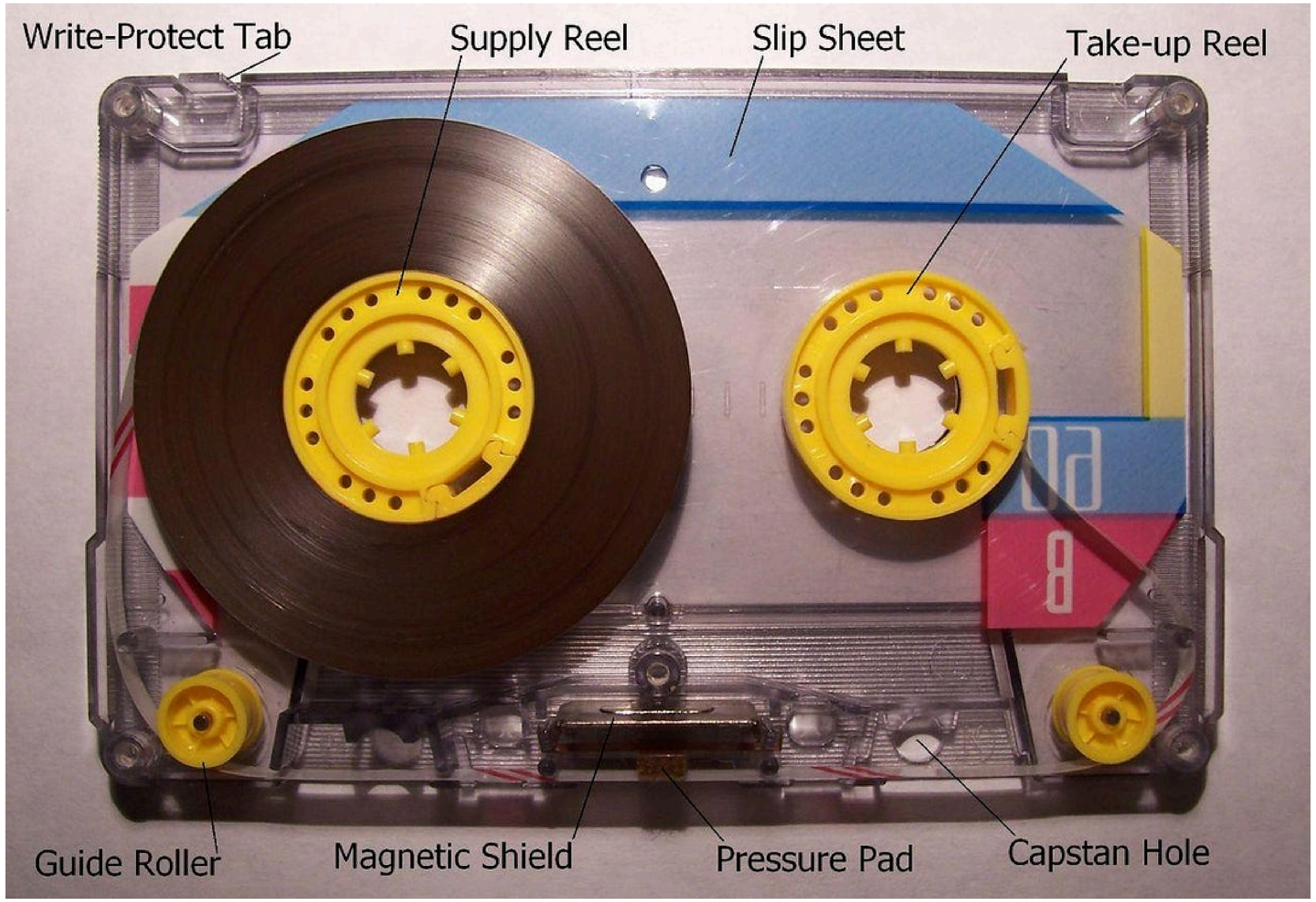
Magnetic Tape

- A sequential access storage medium consisting of a long strip of plastic film with a magnetic coating.
- **Sequential Access.** To read data at the end of the tape, you must fast-forward through everything before it. (Unlike a Disk, which has Random Access).



Magnetic Tape

- It is the **cheapest** and most reliable method for Cold Storage (Archival). Banks, hospitals, and governments use LTO (Linear Tape-Open) tape cartridges to back up systems because tapes can last 30+ years and consume zero electricity when sitting on a shelf.



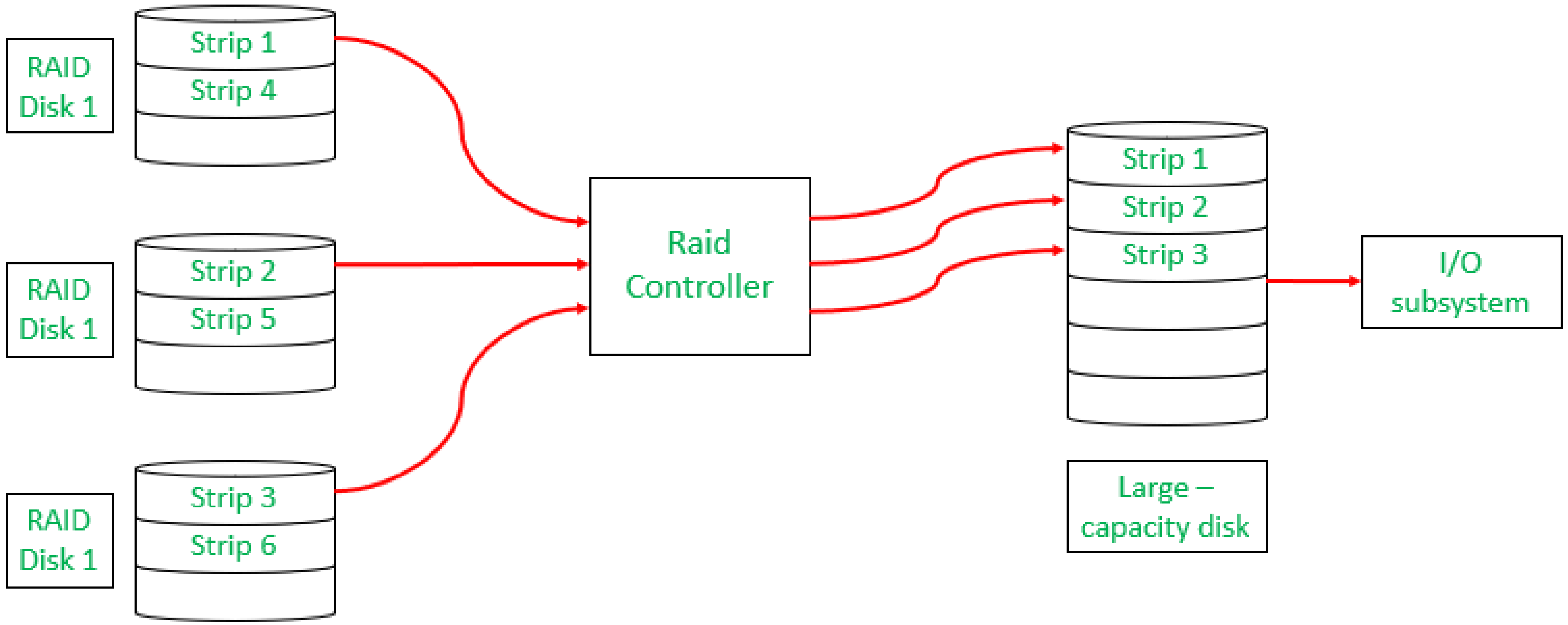
Advanced Architectures

How do we stop a broken hard drive from deleting our data?

RAID Architectures

RAID (Redundant Array of Independent Disks) combines multiple physical disk drives into a single logical unit.

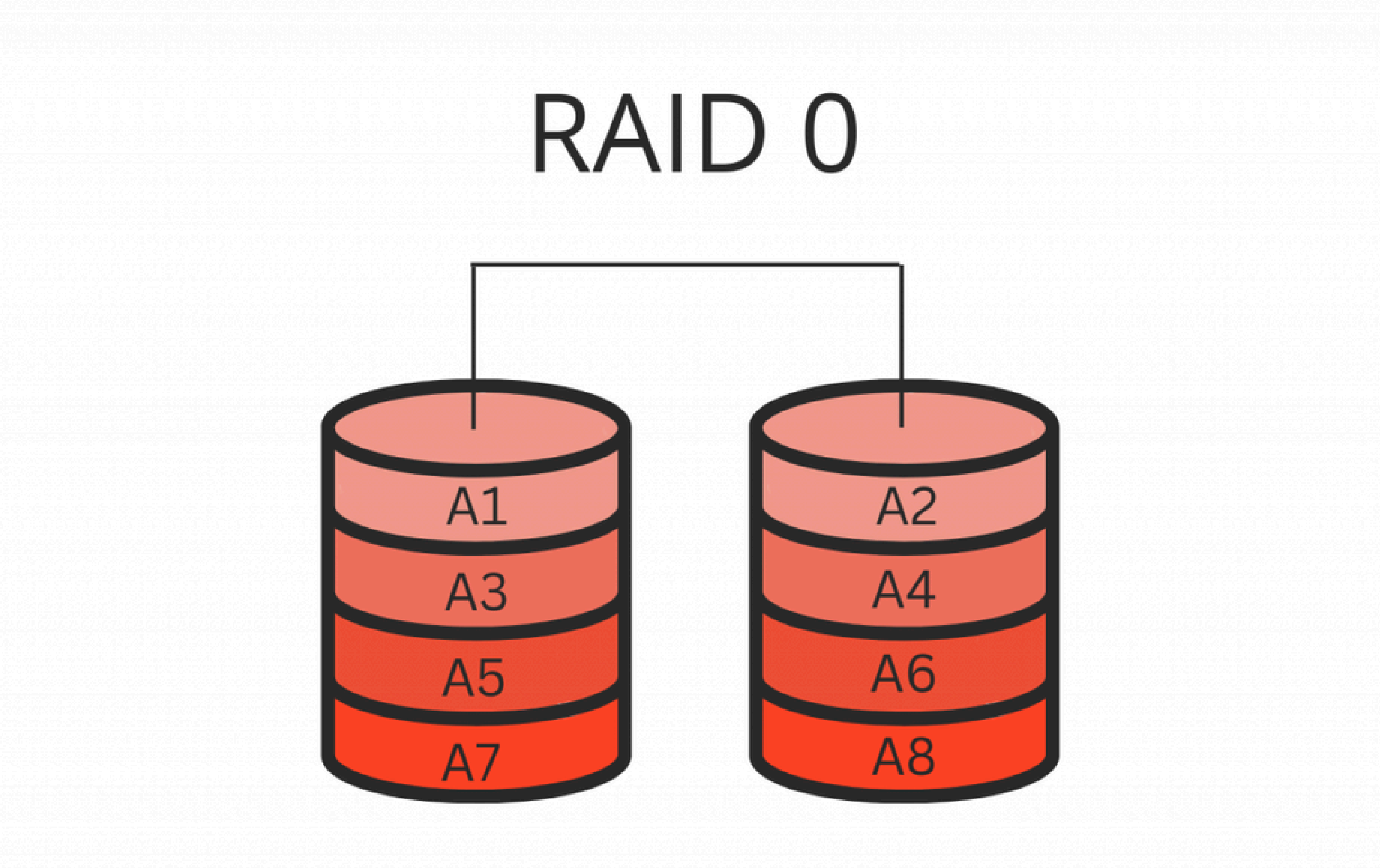
- **RAID 0 (Striping)**
- **RAID 1 (Mirroring)**
- **RAID 5 (Striping with Parity)**
- **RAID 6**



RAID Architectures

RAID 0 (Striping)

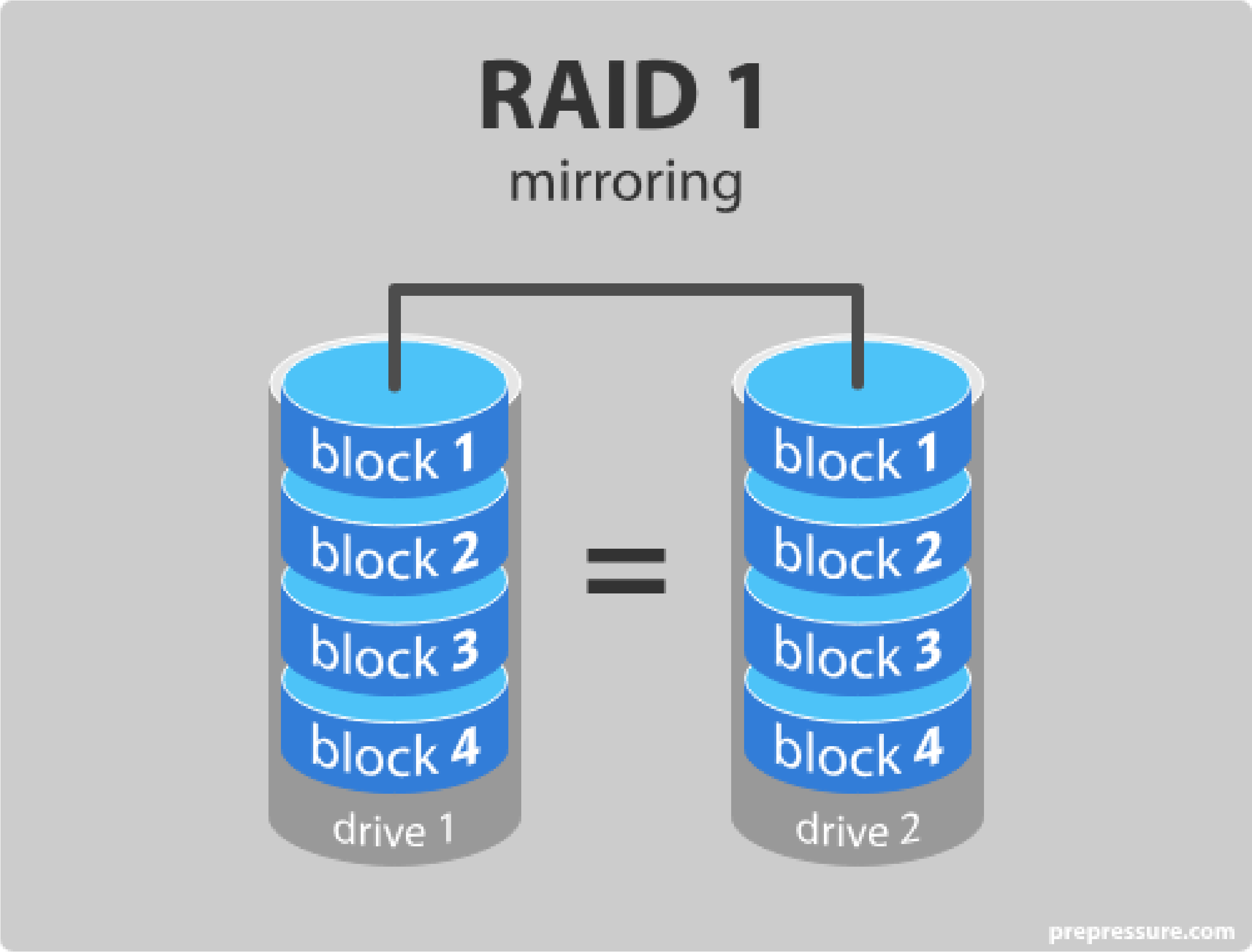
- Splits data evenly across two or more disks.
- Pros: Extreme speed (Read/Write happens on all drives at once).
- Cons: Zero Redundancy. If one drive fails, all data is lost.
- Use Case: Video editing cache (where speed matters more than safety).



RAID Architectures

RAID 1 (Mirroring)

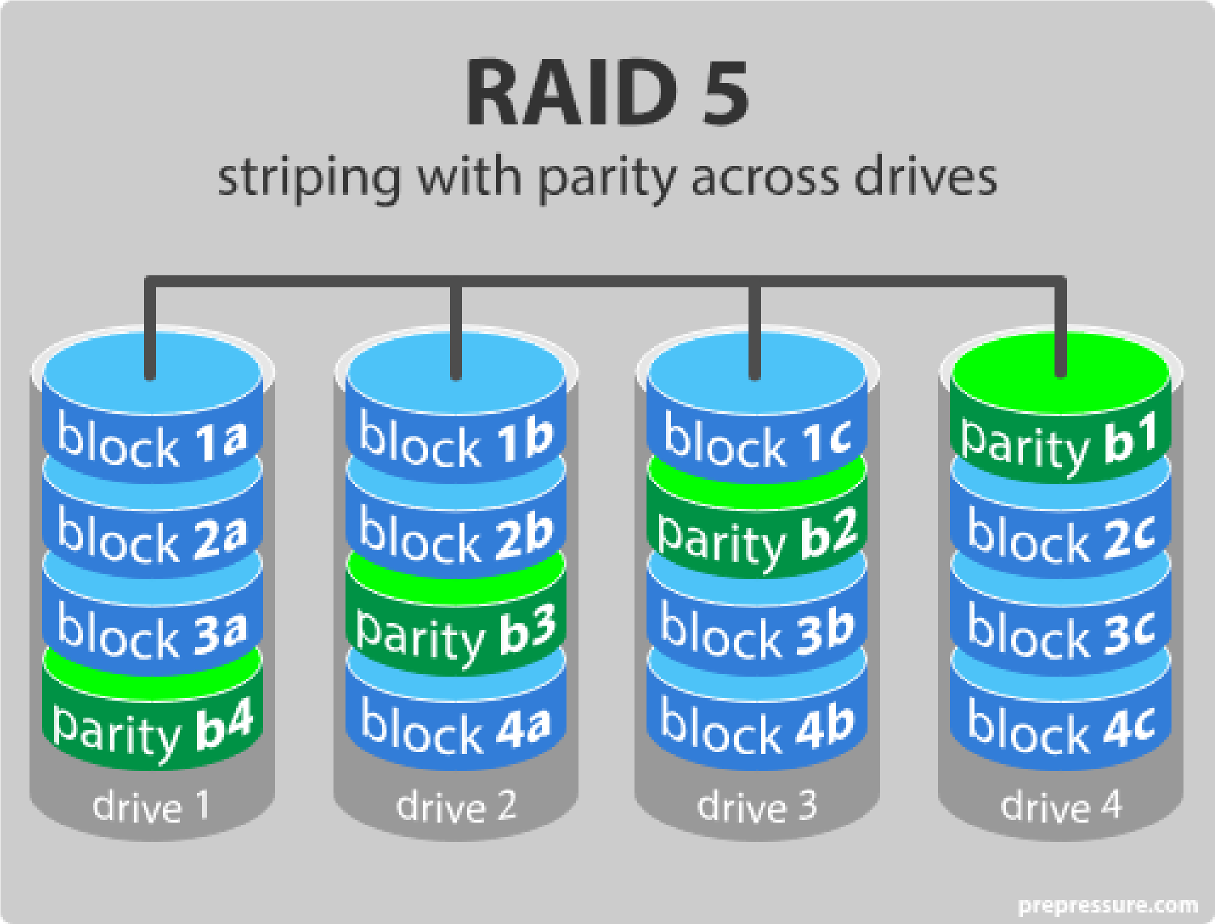
- Concept: Exact copy of data on two or more disks.
- Pros: 100% Redundancy. If one drive fails, the system keeps running.
- Cons: Expensive (You buy 2TB of drive space to get 1TB of storage).
- Use Case: Operating System drives, Critical financial data.



RAID Architectures

RAID 5 (Striping with Parity)

- Concept: Data is striped across disks, but a "Parity" block is calculated and stored.
- Pros: Good balance. Faster than RAID 1, Safer than RAID 0. Can survive 1 drive failure.
- Use Case: General file servers.



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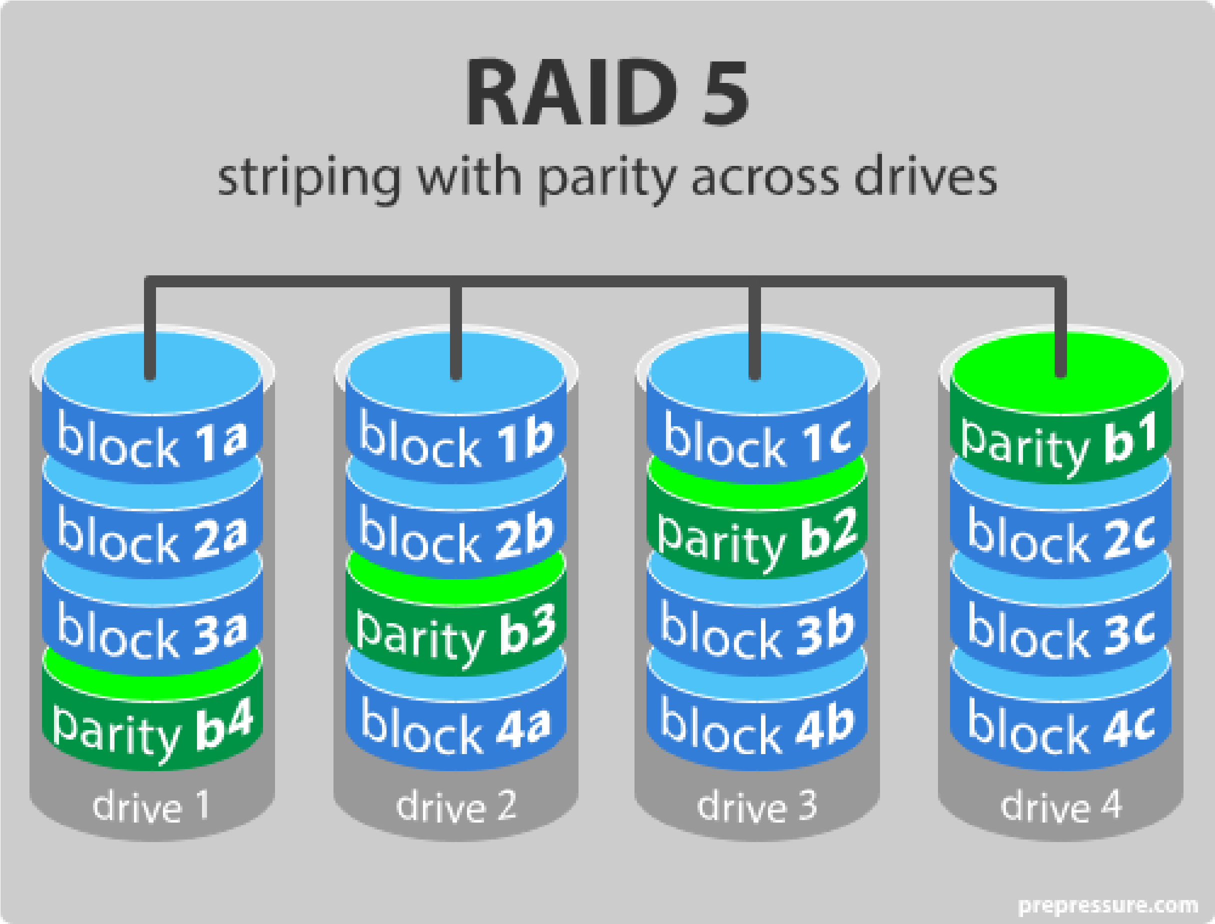

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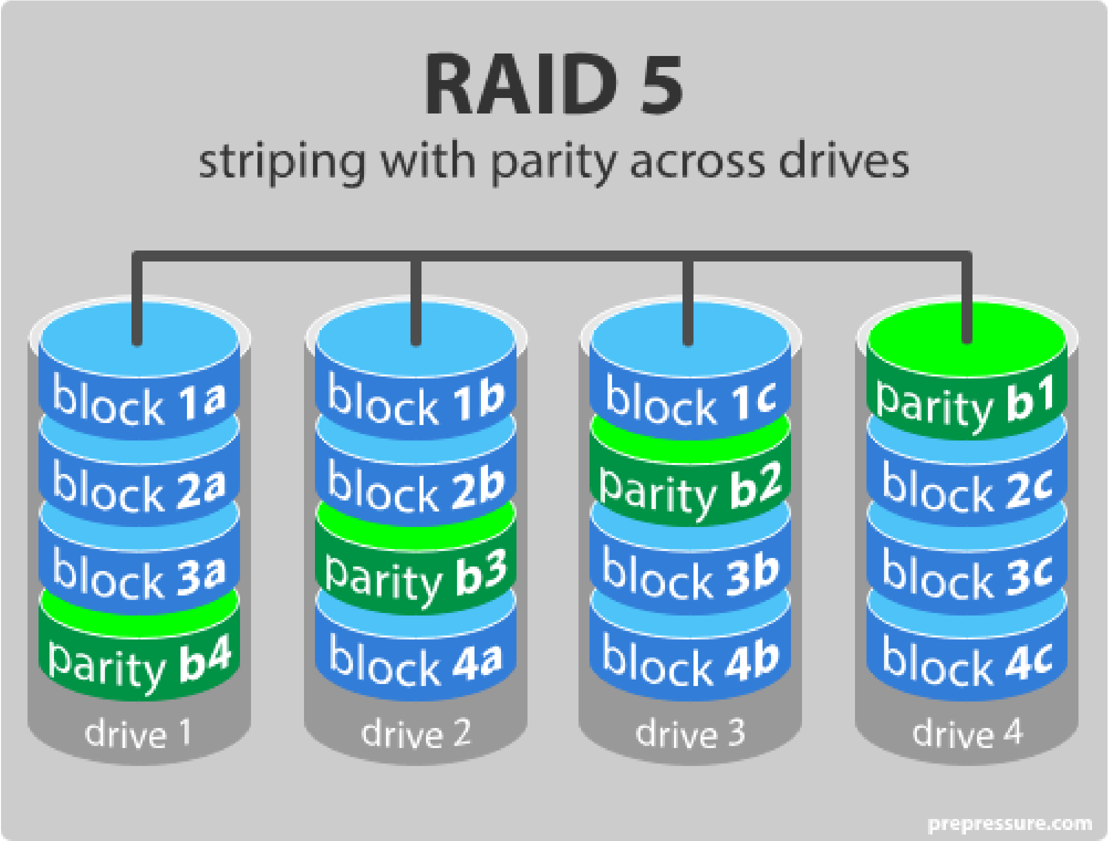

RAID 6

- Similar to RAID 5 but writes two parity blocks, allowing the system to survive two simultaneous drive failures.

End of Presentation

Questions...?

sana po sir madali lang
exam hihi