INSTITUTE OF INNOVATION

Batch Code: 24SOTB1&B2

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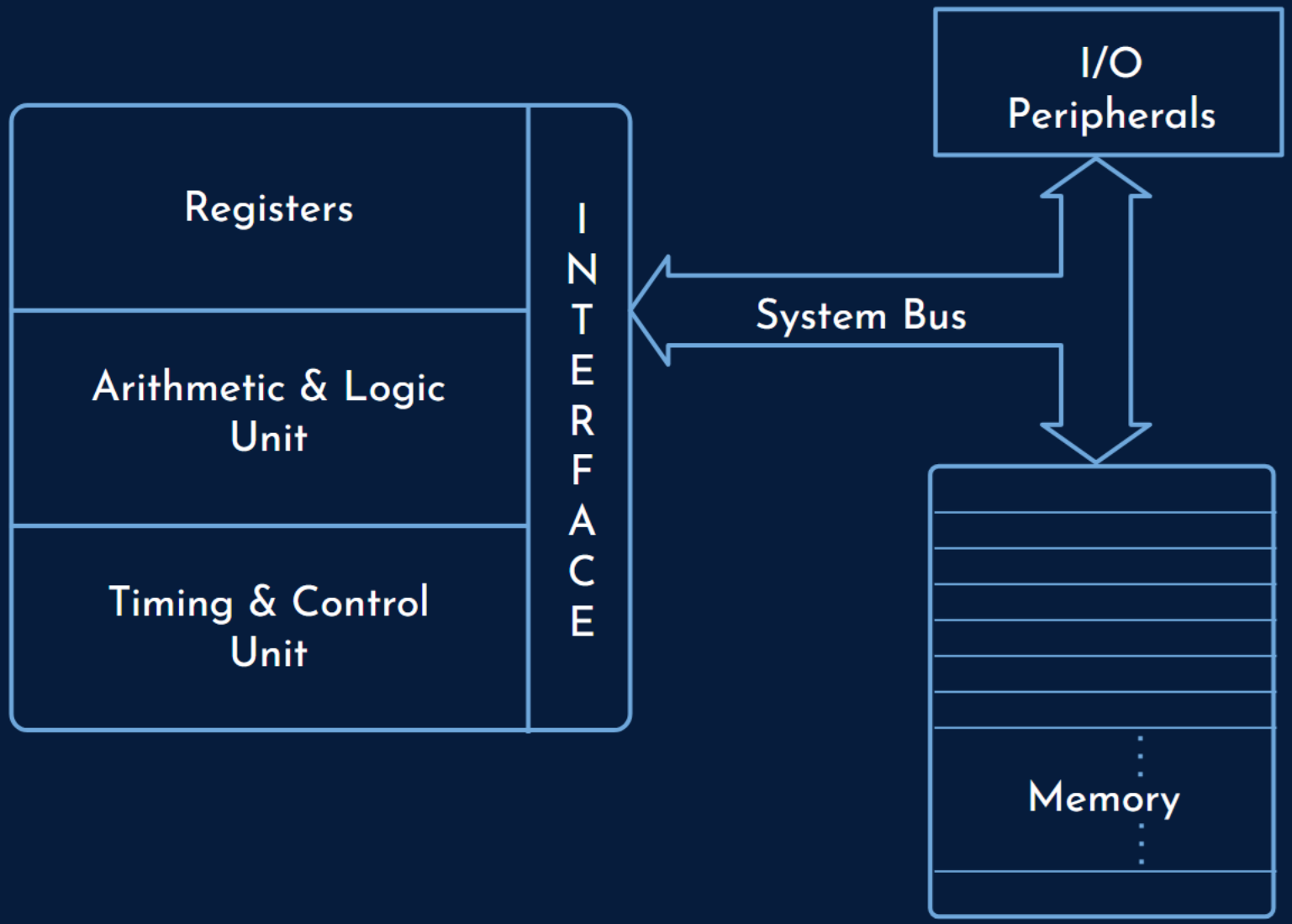
M.Sc. , UGC-NET, GATE

Lecture No: 3

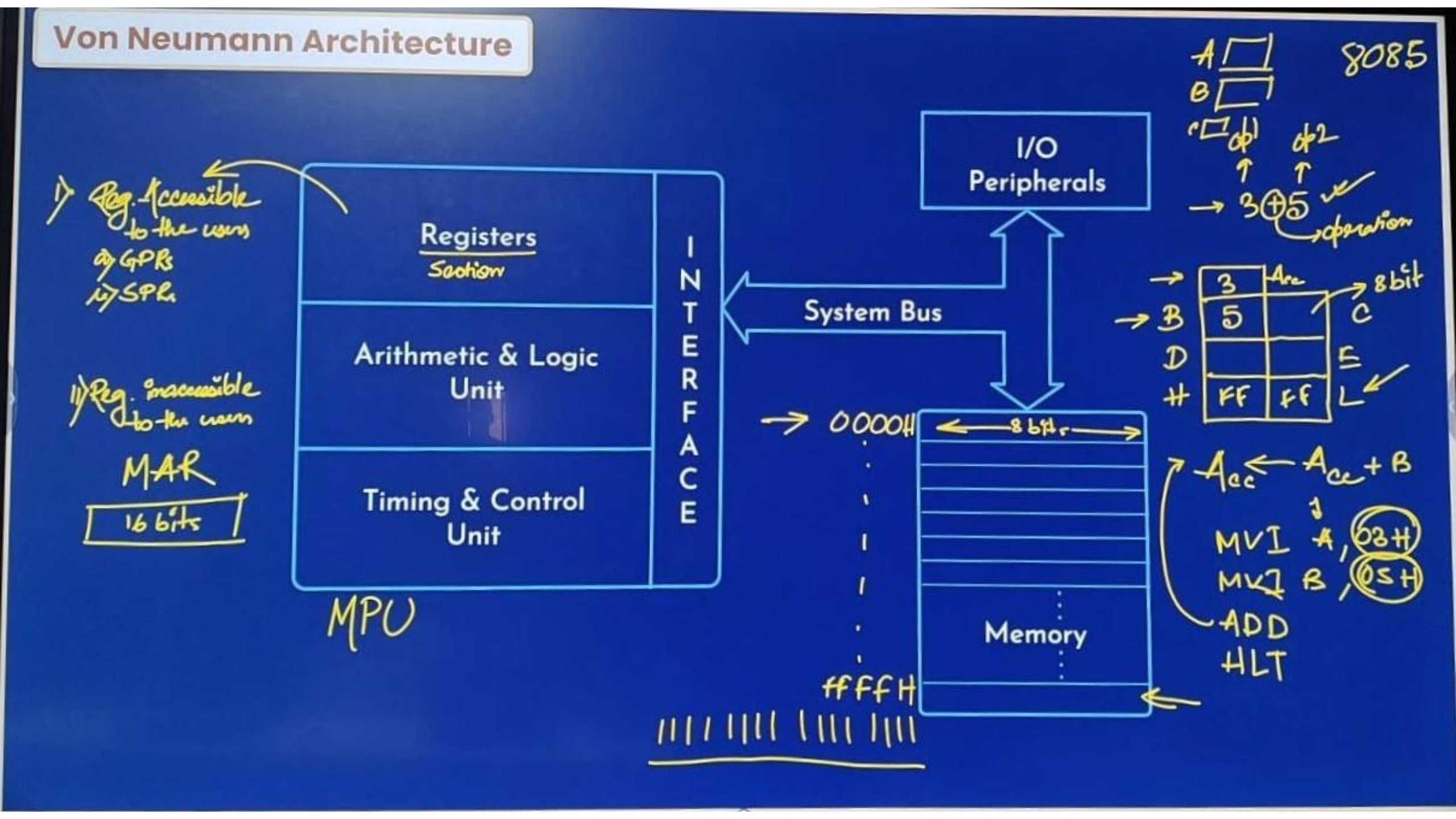
Subject: Operating Systems

Chapter: Introduction to OS

Von Neumann Architecture

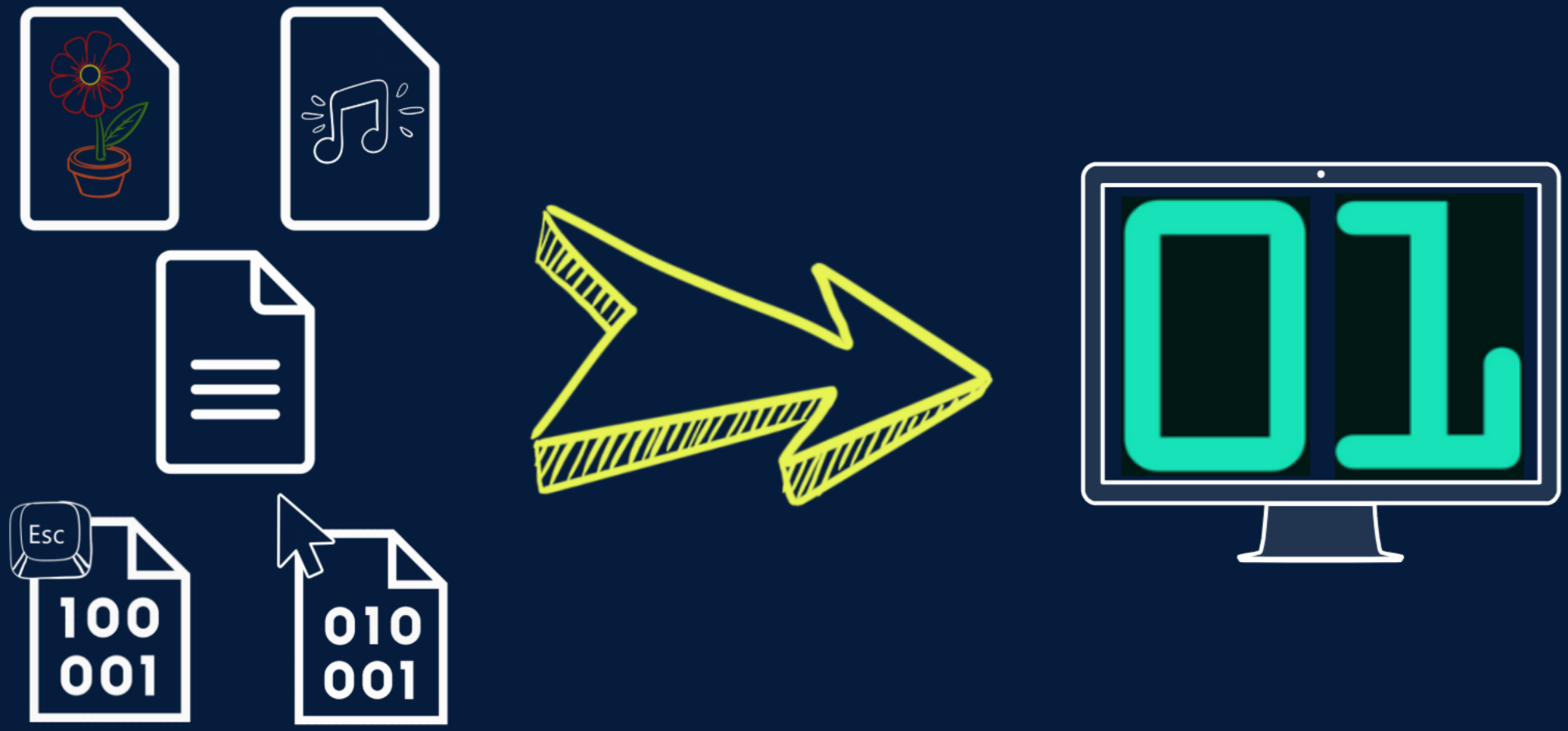


Von Neumann Architecture



"**Memory** is the faculty of the brain by which data or information is encoded, stored, and retrieved when needed."

-- Wikipedia



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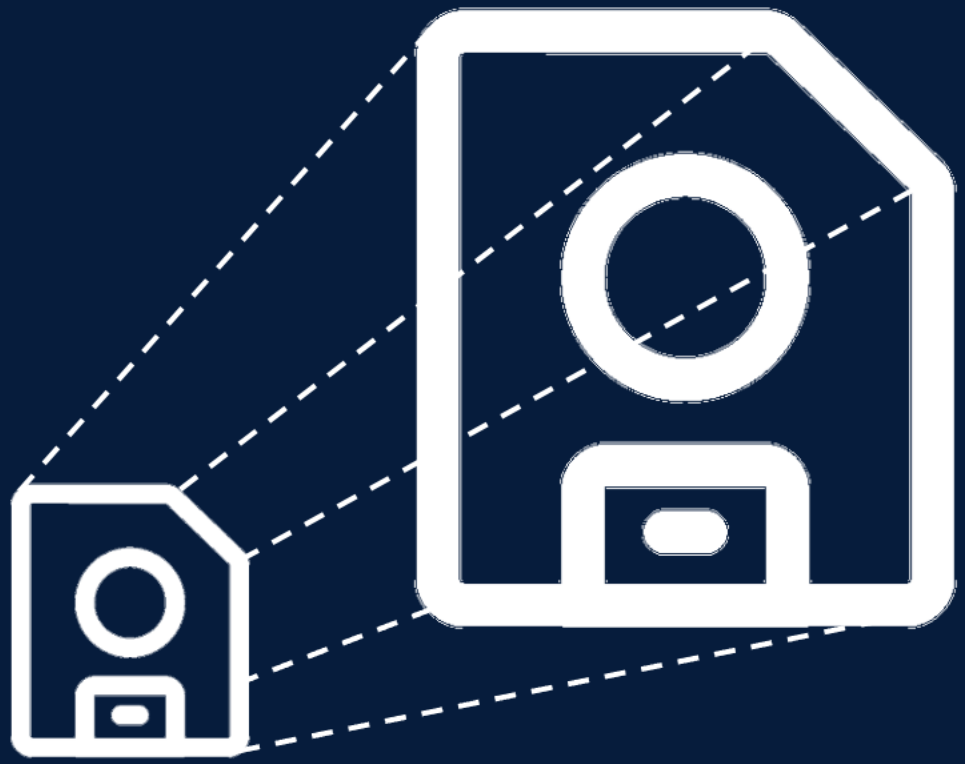
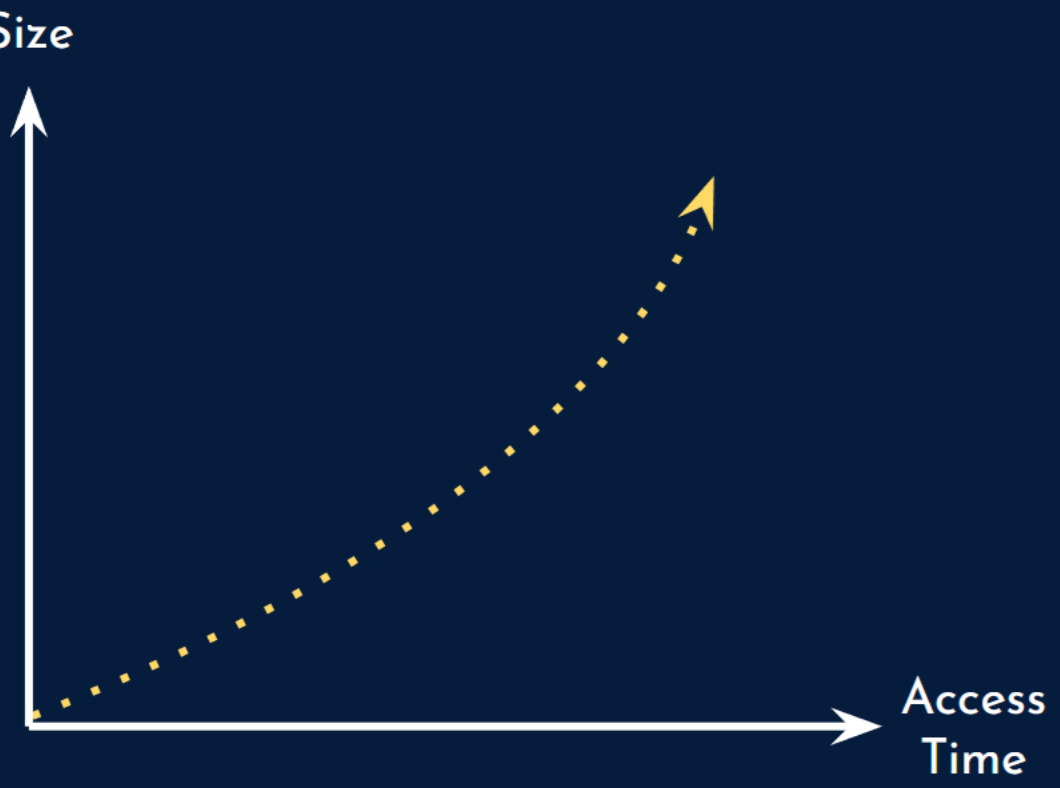
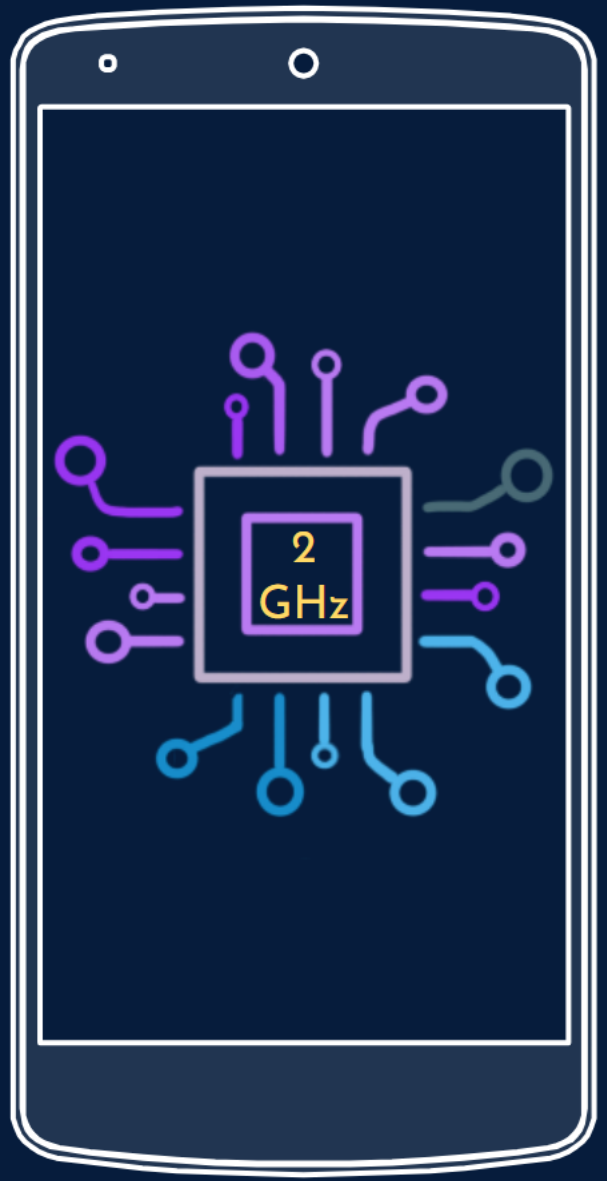




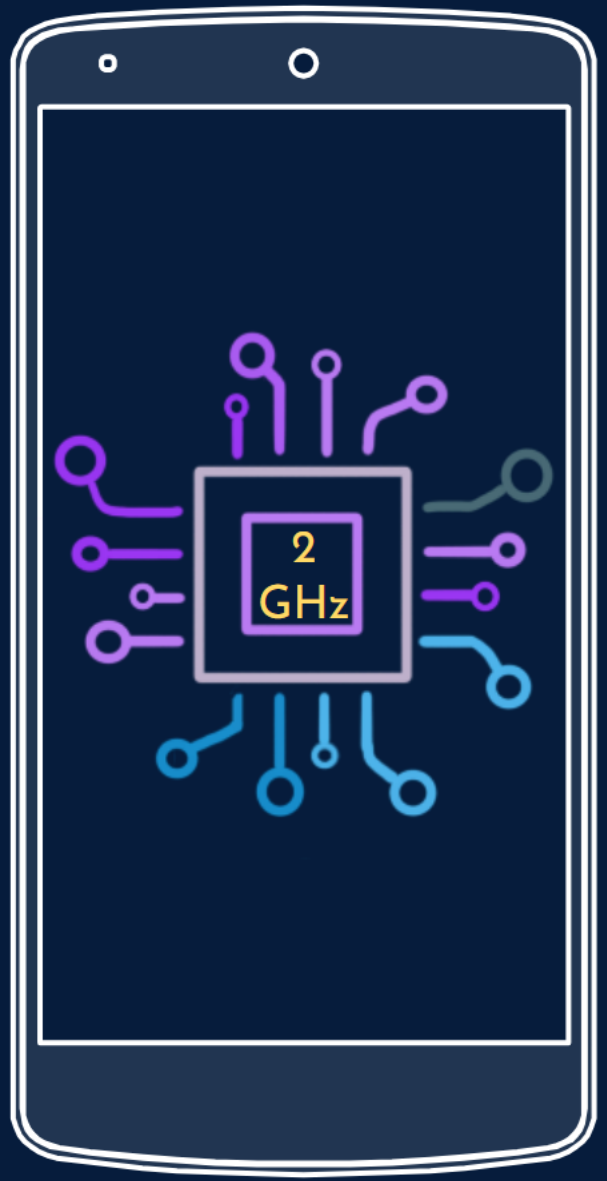


Frequency: 2 GHz

$$\text{Time: } \frac{1}{\text{Frequency}}$$

$$= \frac{1}{2 \times 10^9} \text{ Sec.}$$

1 Kilo <Unit>	= 1000 <Unit>	= 10^3 <Unit>	
1 Mega <Unit>	= 1000 Kilo <Unit>	= $10^3 \times 10^3$ <Unit>	= 10^6 <Unit>
1 Giga <Unit>	= 1000 Mega <Unit>	= $10^3 \times 10^3 \times 10^3$ <Unit>	= 10^9 <Unit>



Frequency: 2 GHz

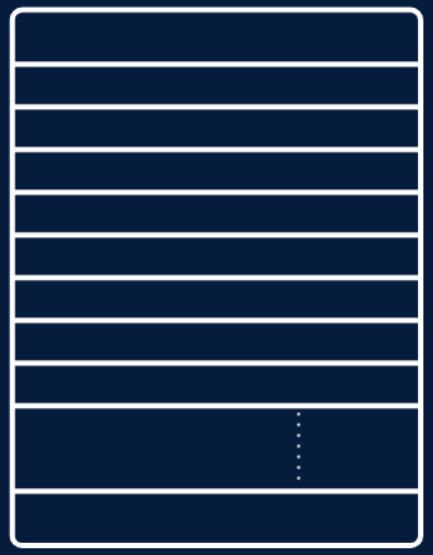
$$\text{Time: } \frac{1}{\text{Frequency}}$$

$$= \frac{1}{2 \times 10^{9}} \text{ Sec.}$$

$$= \frac{1}{2} \times 10^{-9} \text{ Sec.}$$

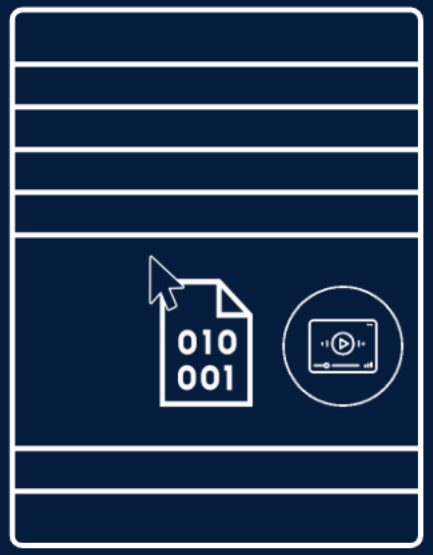
$$= \frac{1}{2} \text{ nsec.}$$

Primary Memory



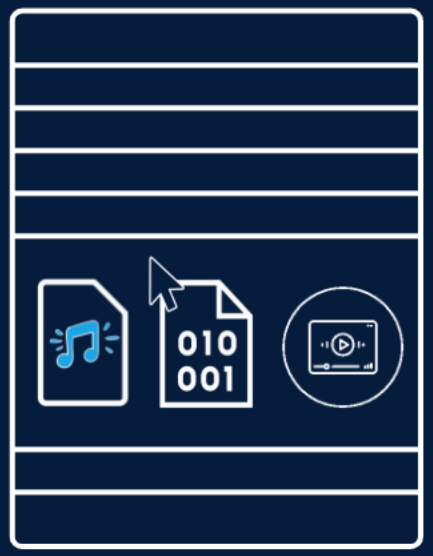
Secondary Memory

Primary Memory



Secondary Memory

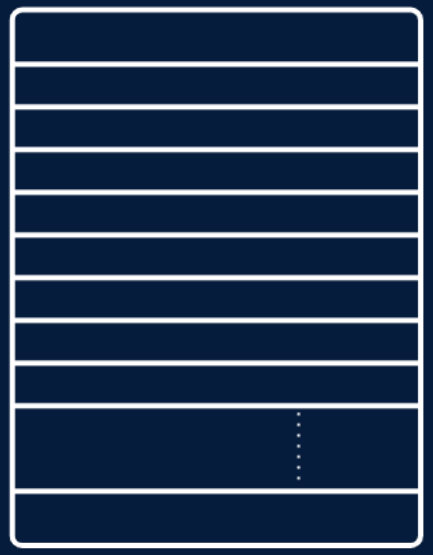
Primary Memory



Secondary Memory

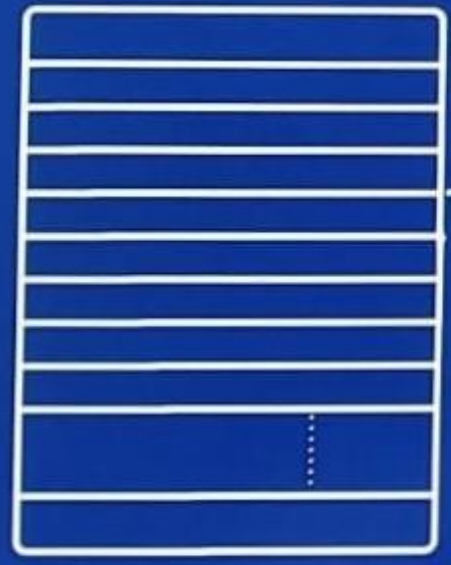
Primary Memory

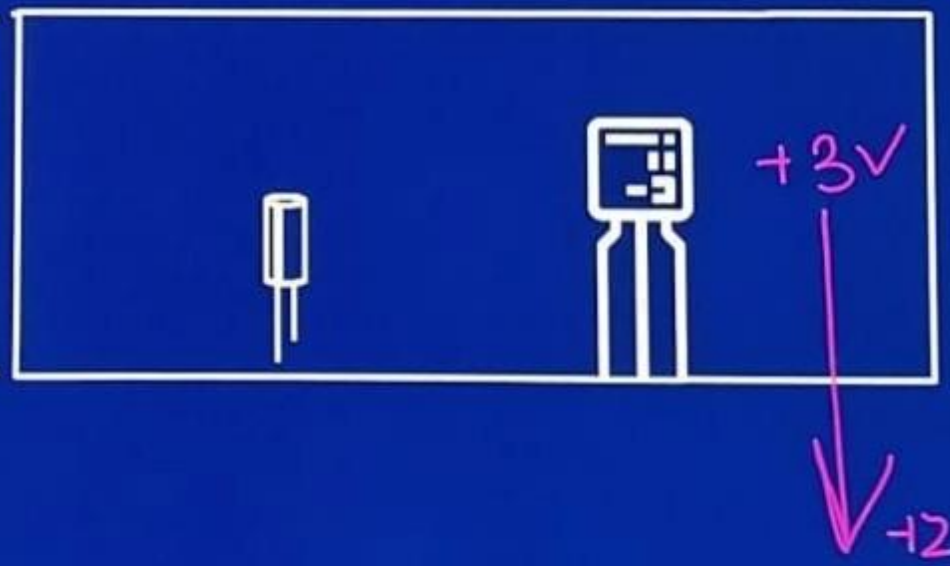
Random Access Memory
R.A.M.

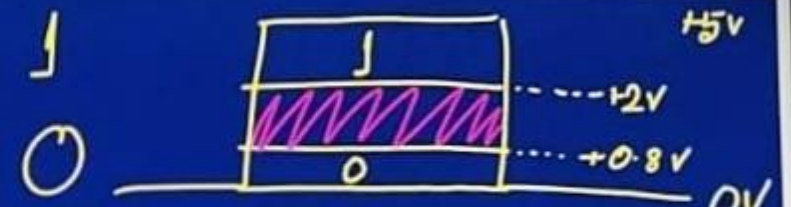


Primary Memory

Dynamic Random Access Memory
D.R.A.M.







Primary Memory

Dynamic Random Access Memory

D.R.A.M.

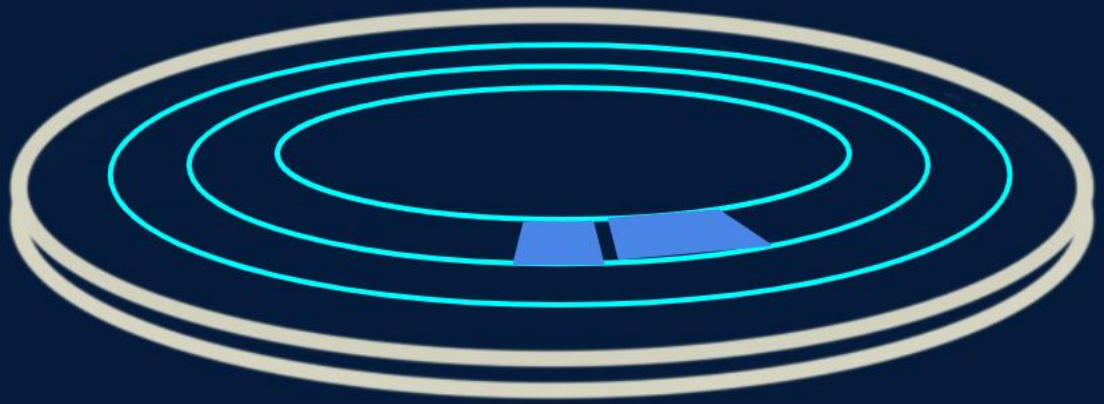
Primary Memory

Dynamic Random Access Memory
D.R.A.M.

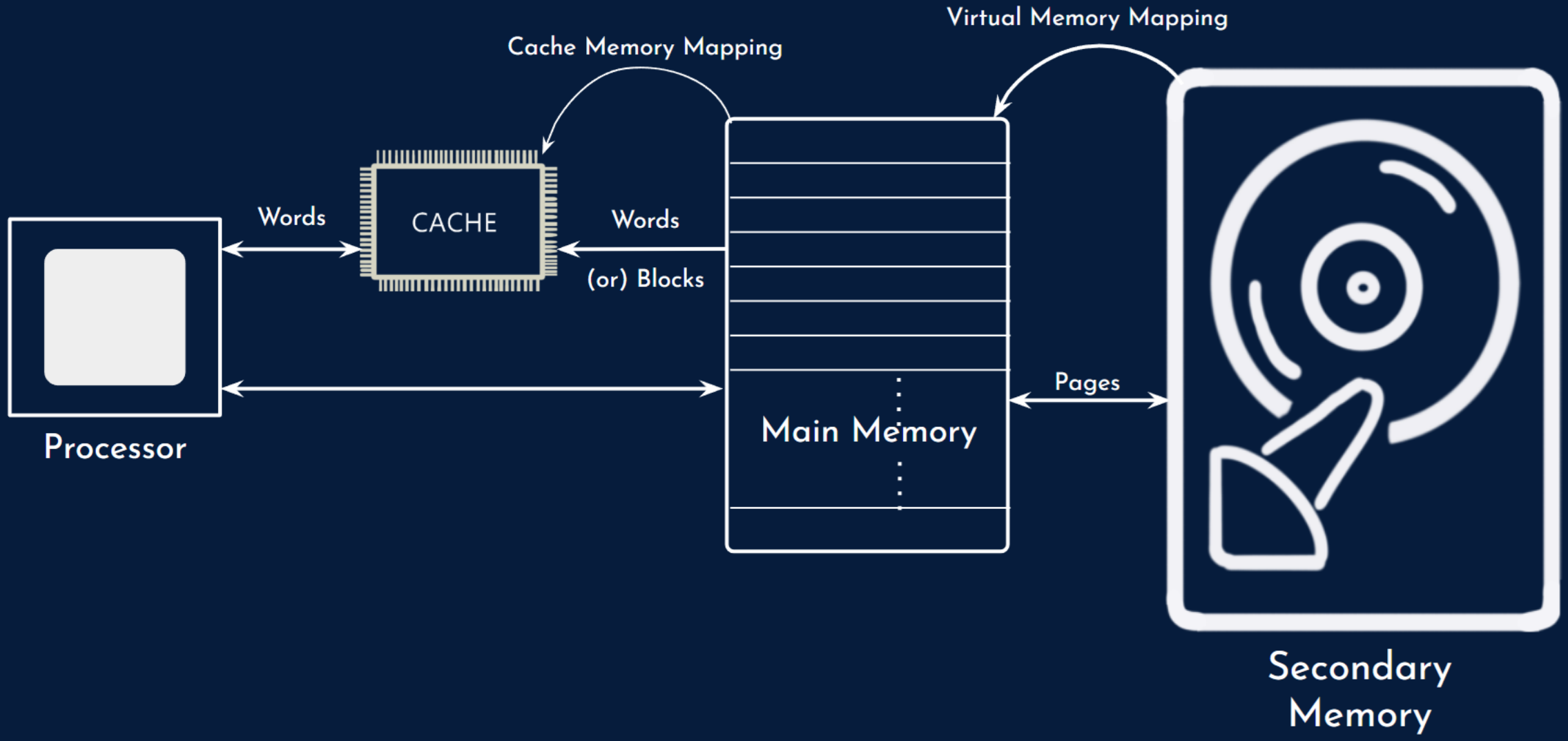
Static Random Access Memory
S.R.A.M.

Secondary Memory :

- Slower than Primary Memory.
- Retains Data Permanently.
- Bigger in size.
- Cost-effective.
- Semi-Random accessibility.

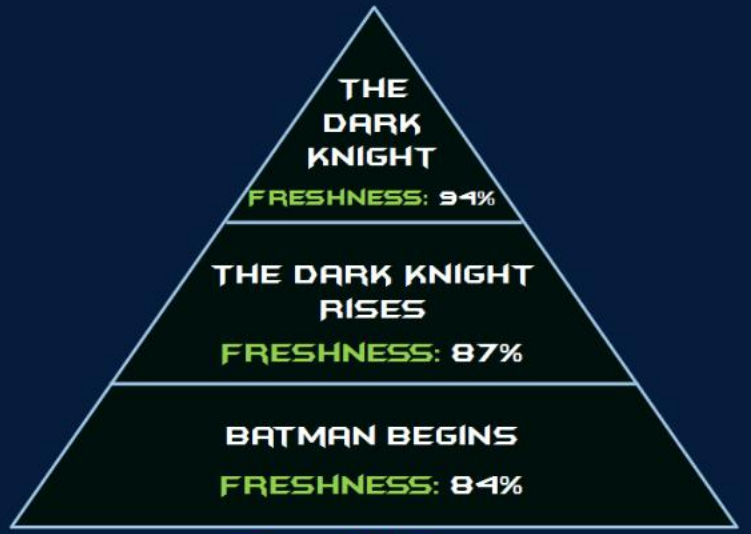


The Big Picture



HIERARCHY  RANKING

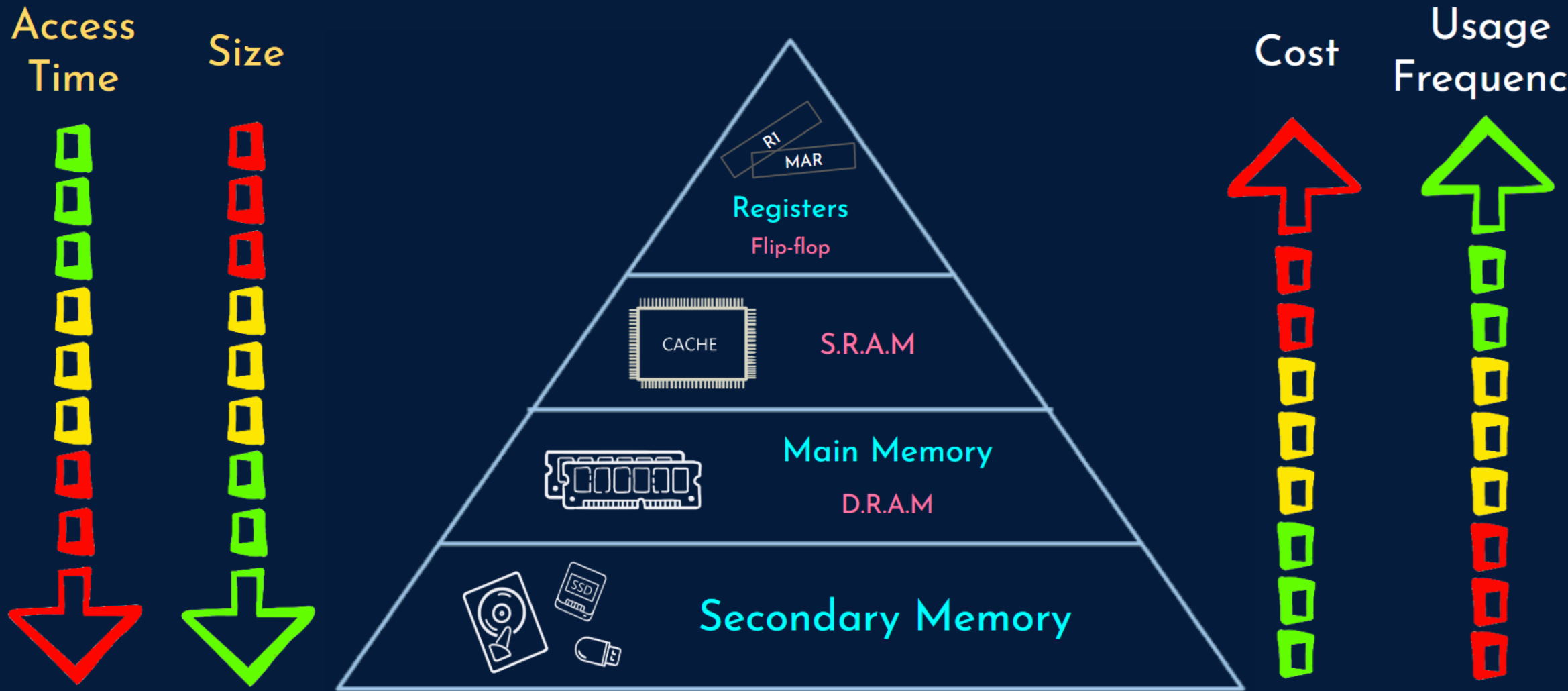
Release Year



Rotten Tomatoes

metacritic

Memory Hierarchy



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Thank You

Class 3:

Topics:

Memory Hiererchy

Primary Memory (RAM)

Cache Memory

SSD and Secondary Memory

Memory – Definition & Function

- Memory in computers works like a brain: **encodes, stores, and retrieves** data.
- Earlier called **"store"**.
- Everything—images, audio, text, even a mouse click—is kept as **bits (0/1)**.
- Processor (the computer's "brain") processes millions of these bits.

Speed vs Size Challenge

- **One big memory unit?** Not practical—**larger size ⇒ slower access**.
- **Processor speed:** extremely fast. Example:
    - 2 GHz ⇒ Time for 1 operation = 1 / (2×10^9) s = **0.5 ns** (half a nanosecond).
- If memory is slower, CPU **waits idle**, wasting efficiency.
- Designers must balance **speed, size, and cost**.

Primary Memory

- **Role:** Holds instructions/data for immediate execution.
- **RAM (Random Access Memory):** Any cell can be accessed directly.
    - Usually **Dynamic RAM (DRAM)** – needs **periodic refresh** (capacitor charge).
- **Volatile:** Data lost when power is off.

Cache Memory

- Faster than DRAM; sits **between CPU & main memory**.
- Built with **Static RAM (SRAM)** – no capacitor, **very fast** but **costly**.
- Also **volatile**.

- Stores frequently used data → like **keeping your phone in a pocket** instead of a backpack.

Secondary Memory

- **Permanent storage** – large, cheap, **non-volatile**.
- Slower because access is **semi-random**.
    - Ex: **Hard Disk Drive (HDD)** – head moves to track, then block.

Memory Organization – Big Picture

- **Registers:** Inside CPU, hold tiny amounts (just an instruction or two).
- **Cache ↔ Main Memory:** Communicate using **blocks/words** via **cache mapping**.
- **Main ↔ Secondary:** Managed by **Operating System** through **virtual memory & paging/demand paging**.
- **Fun fact:** CPU knows registers, cache, main memory—but **has no idea secondary memory exists**; OS handles it all.

Key Takeaway:
Efficient computing = **hierarchy of memories** (Registers → Cache → RAM → Secondary) **not** one giant memory.

Memory Hierarchy – Ranking & Purpose

- **Hierarchy = Ranking** of memory units based on different parameters.

1️⃣ Ranking by Access Time & Size

(Fastest/Smallest ➔ Slowest/Largest)

1. **Registers** – Flip-flops inside CPU, **least access time**.
2. **SRAM Cache** – Very fast, small.
3. **DRAM Main Memory** – Slower, bigger.
4. **Secondary Storage** – Hard disks/SSDs, **slowest**, largest.

2️⃣ Ranking by Cost & Usage Frequency

(Cheapest/Least Used ➔ Costliest/Most Used)

- Order **reverses**: Secondary < DRAM < SRAM < Registers.
- Higher in the hierarchy ⇒ **higher cost** & **more frequent use**.

🎯 **Purpose of the Hierarchy**

- **Bridge the speed gap** between ultra-fast CPU and slower memories.
- Achieve **high performance at reasonable cost** by combining different types of memory.

How computer memory works

SSD vs. HDD