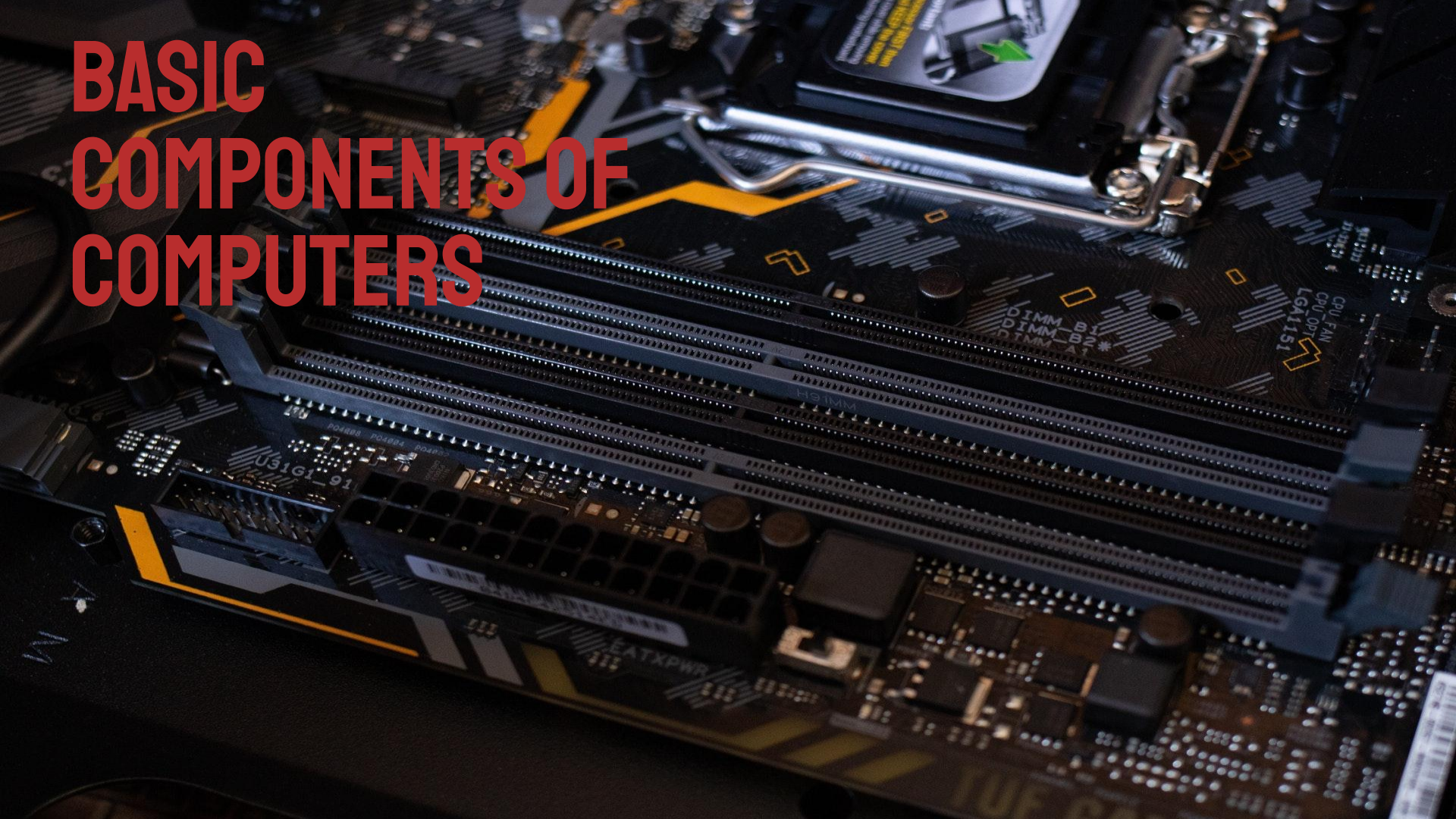# BASIC COMPONENTS OF COMPUTERS

WHAT WE WILL LEARN

HARDWARE AND SOFTWARE

CPU, MEMORY, I/O UNITS

STORAGE COMPONENTS

HARDWARE AND SOFTWARE

Hardware is the physical device on which software runs.

Software is code in various forms, for example operating systems, applications such as games and editors, utility programs such as anti-virus software.

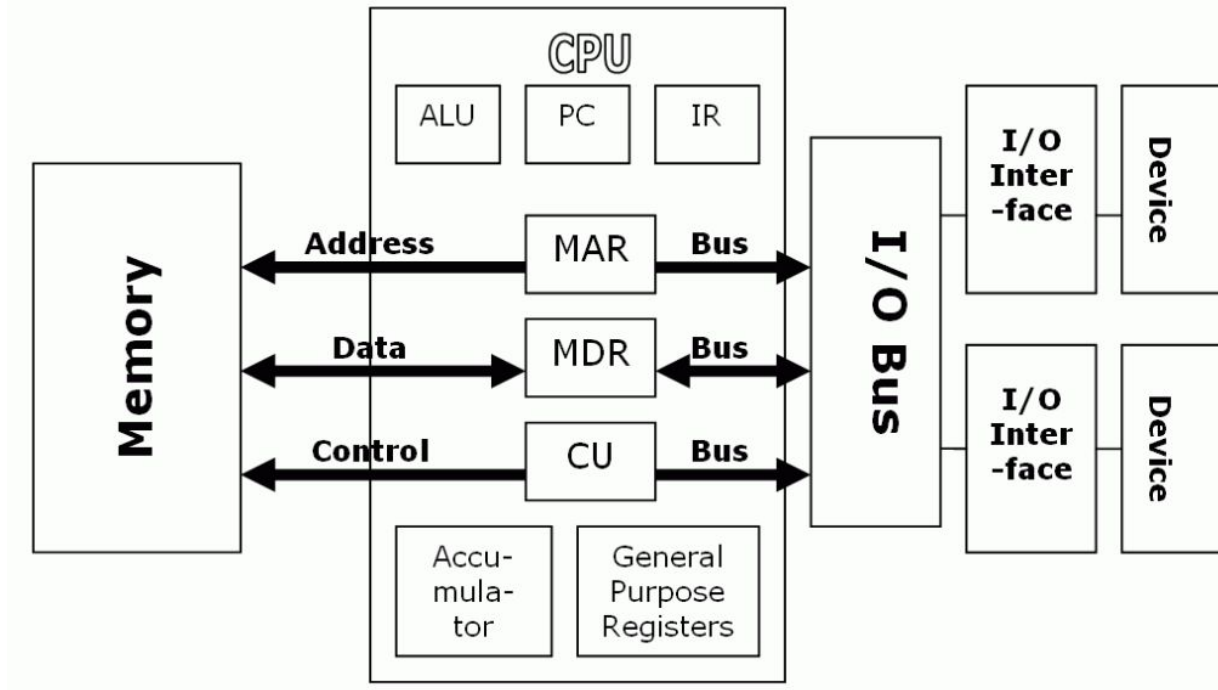**Hardware and software complement each other**:
Hardware cannot do complex tasks without software.
Software needs hardware to turn code into actions in the real world.

Example: Controlling a robot arm. Software makes complex calculations about how the arm should move; hardware makes the moves.
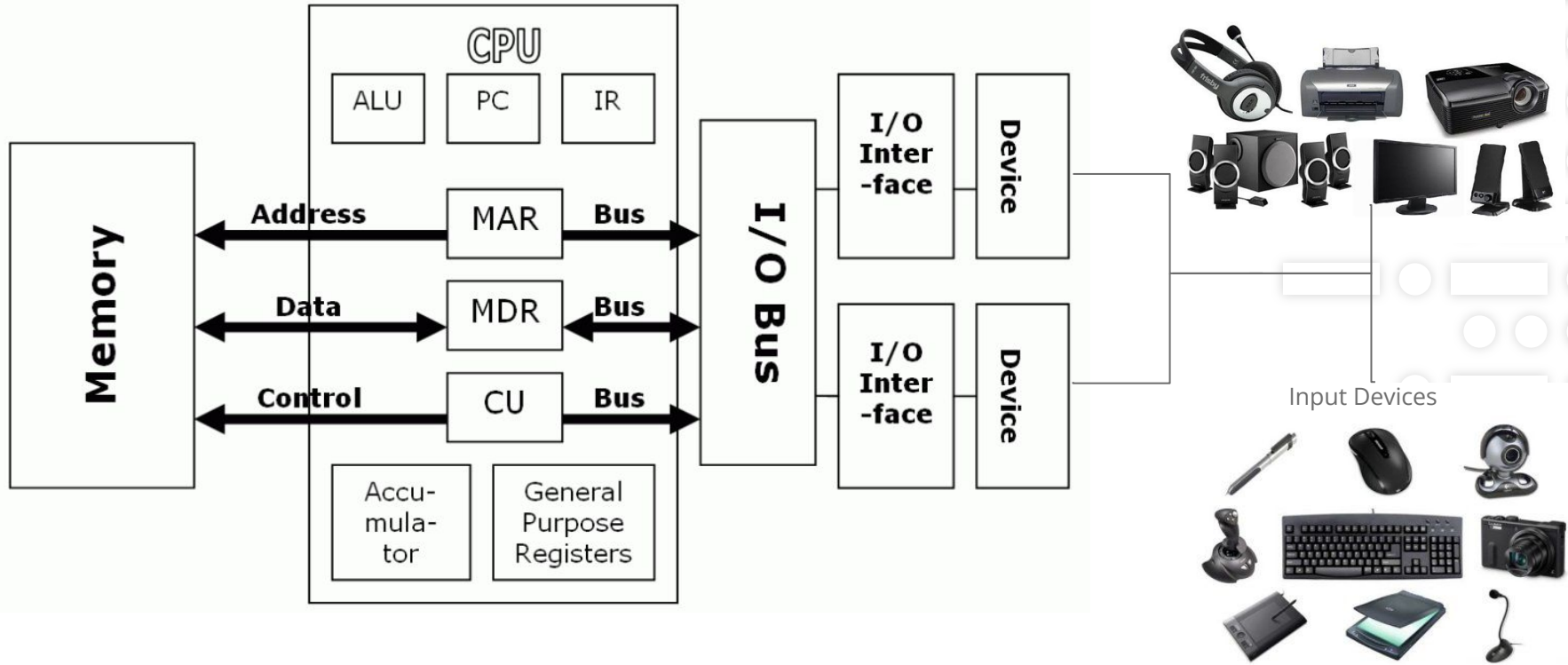
BASIC COMPONENTS OF COMPUTERS

Exercise: Check each acronym by searching its meaning on the web!

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INPUT-OUTPUT UNITS

Output Devices

Input Devices

CPU

| ALU | PC | IR |

Memory

Address ↔ MAR ↔ Bus

Data ↔ MDR ↔ Bus

Control ↔ CU ↔ Bus

| Accu-mula-tor | General Purpose Registers |

I/O Bus

I/O Inter-face

Device

I/O Inter-face

Device

CENTRAL PROCESSING UNIT (CPU)

A single CPU will have one or more core processing units that run instructions sent to it via software such as applications and the Operating System.

A core processing unit contains a control unit, arithmetic/Logic unit, registers and a memory cache. Some modern CPUs contain up to 10 or more cores which allow separate processes to run simultaneously.
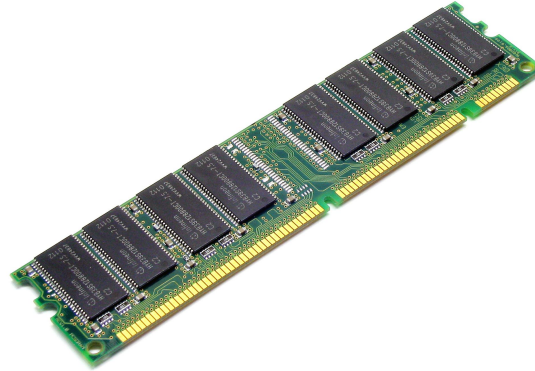

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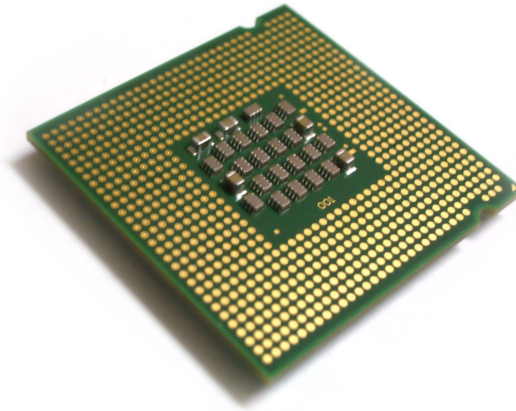
MEMORY UNIT

Memory comes in several forms:

RAM - Random Access Memory
- Stores any data that OS and Applications use.
- In the critical path of every computation.

ROM - Read Only Memory
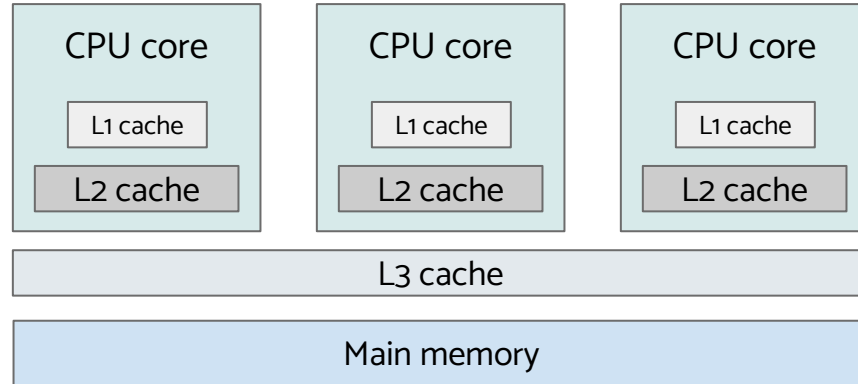- For permanent storage, eg. BIOS for bootups.

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HIGH-SPEED MEMORY: CACHE

Cache: Smaller and fast memory between CPU and main memory.

L1-cache: Built into the CPU. 8-64 KB size

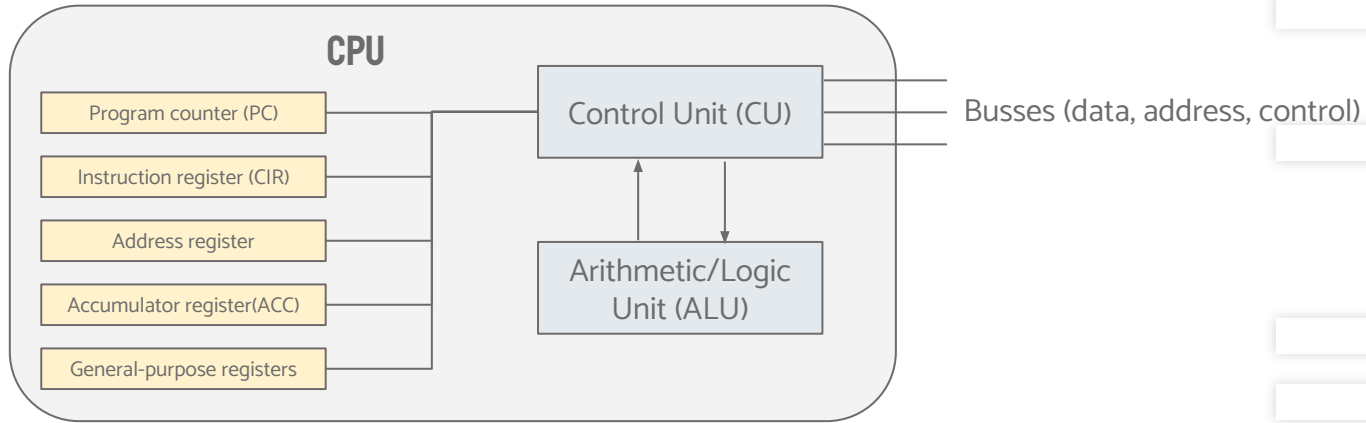L2/L3-cache: Built into the CPU or motherboard. 1-8 MB size.

CPU core	CPU core	CPU core
L1 cache	L1 cache	L1 cache
L2 cache	L2 cache	L2 cache

L3 cache

Main memory

# HIGH-SPEED MEMORY: REGISTERS

Registers: Smallest unit of storage, built inside the processor.

BUSES:

Think of a data bus as you would a normal bus, but instead of people it carries data. Data buses are how data travels around your computer and from storage units to Applications and the Operating System. There are basically three types of bus:

1. An address bus: Is a computer bus that is used to specify a physical address. When a processor or DMA-enabled device needs to read or write to a memory location, it specifies that memory location on the address bus. The width of the address bus determines the amount of memory a system can address. Source Wikipedia

2. A data bus: In computer architecture, a bus is a communication system that transfers data between components inside a computer, or between computers. This expression covers all related hardware components and software, including communication protocols. Source Wikipedia

3. A control bus: In computer architecture, a control bus is part of the system bus, used by CPUs for communicating with other devices within the computer. While the address bus carries the information about the device with which the CPU is communicating and the data bus carries the actual data being processed, the control bus carries commands from the CPU and returns status signals from the devices. For example, if the data is being read or written to the device the appropriate line will be active. Source Wikipedia
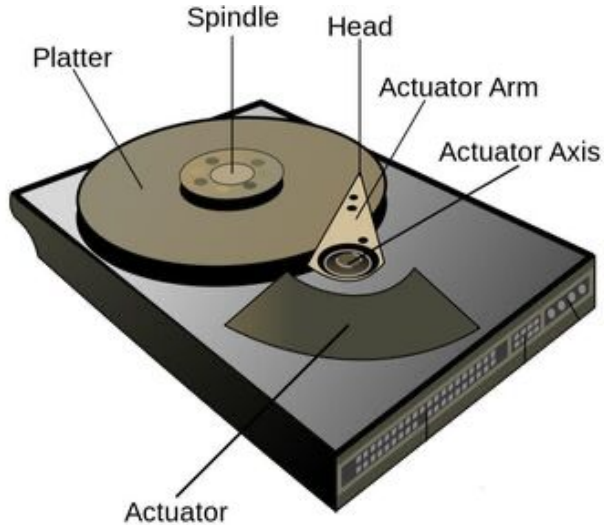
CPU Memory I/O device

Address bus

Data bus

Control bus
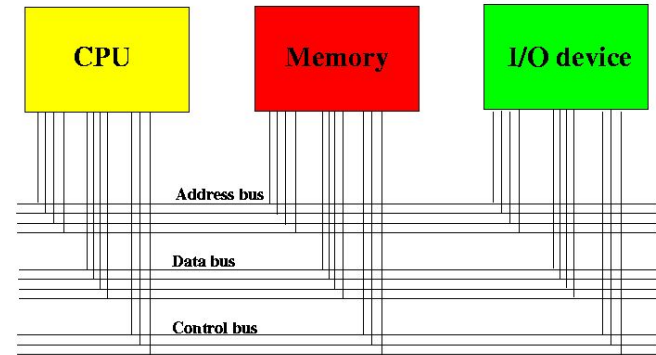
STORAGE UNIT: HARD DISK

Hard drives have two essential components:

- Mechanical component
- Electronic component

STORAGE UNIT: HOW HARD-DISK WORKS

Platter
Spindle
Head
Actuator Arm
Actuator Axis
Actuator

Hard drive read/write head

Read head
Electromagnetic write head

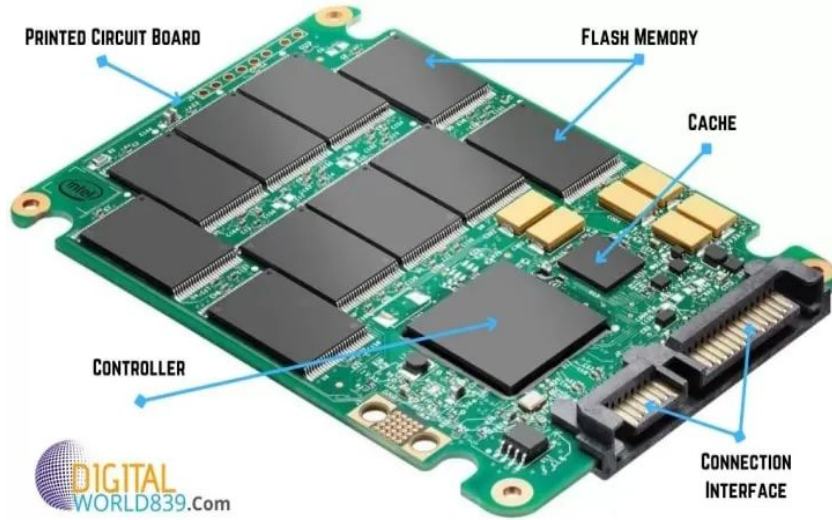| N	S	N	S	S	N	S	N
S	N	S	N	N	S	N	S

1 0 1 0 0 1 0 1
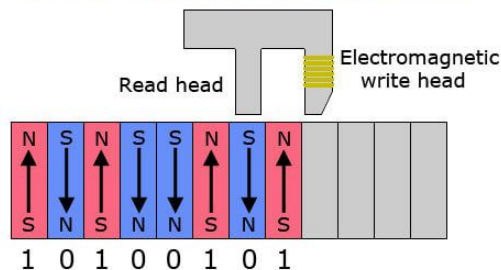
ComputerHope.com

How does it work when I click save?

1. The spindle spins the platter.
2. The actuator arm moves across the platter.
3. Your saved information moves down the actuator arm to the read/write head.
4. The head changes the polarity in a particular sector (an area on the platter - see below) on the platter to either a number of north poles or south poles.
5. Having e.g. North pole, South pole, North, North, South etc is much like ones and zeros of binary (as per diagram on left).
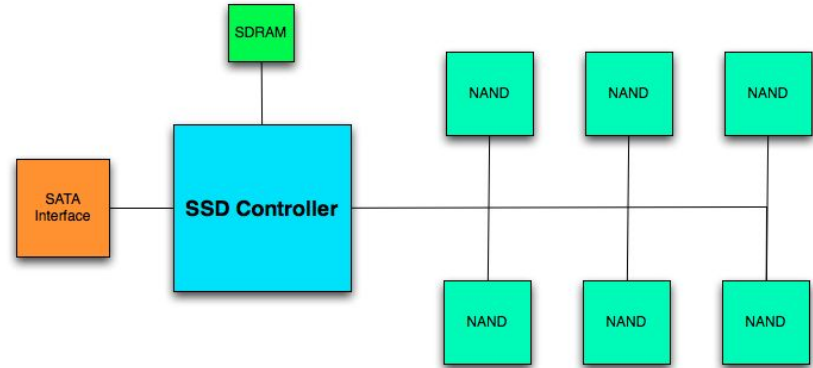

Track
Platter
Read Head
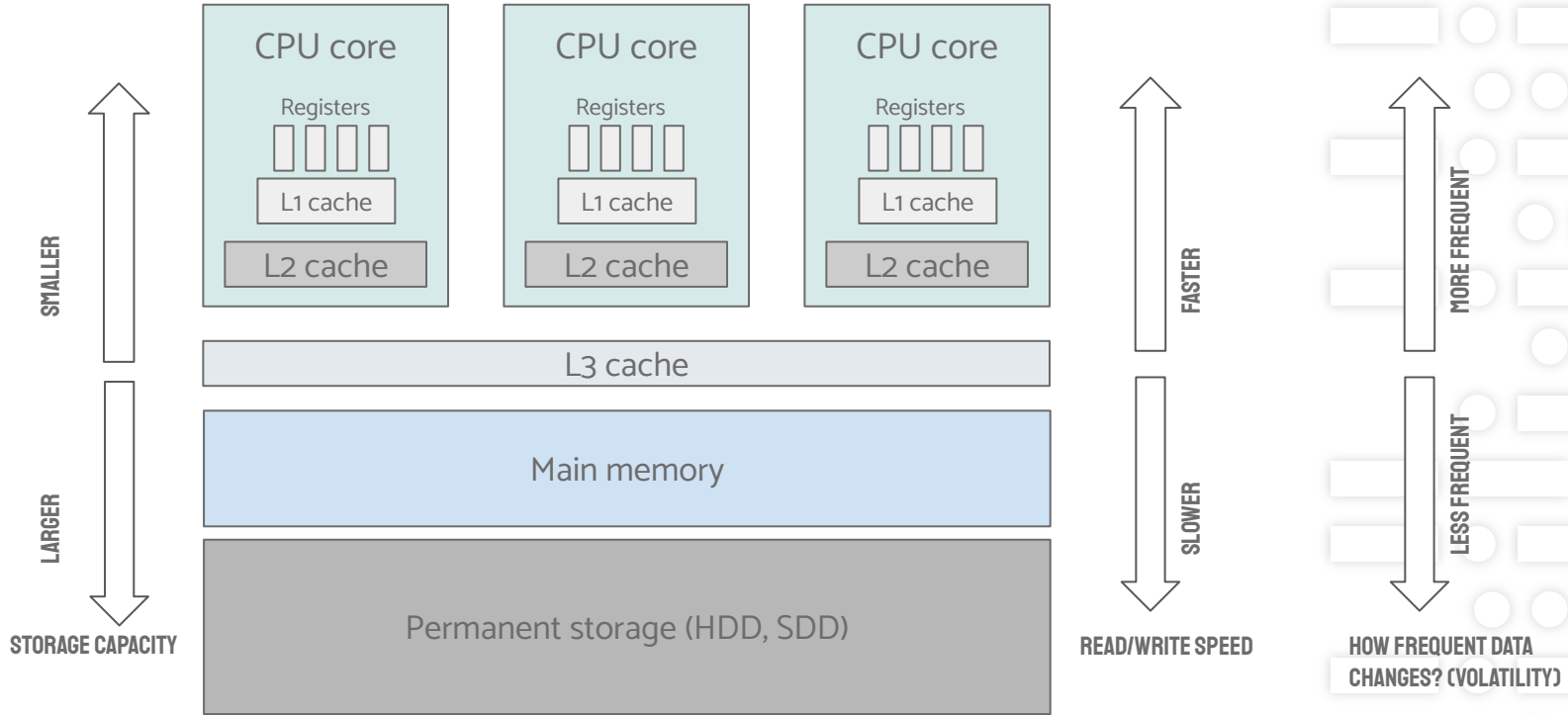Sector

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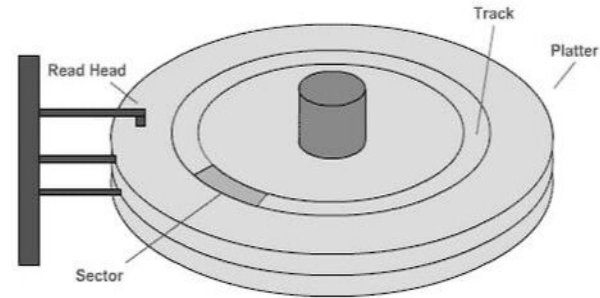
SSD: SOLID-STATE DISK DRIVES:

Uses Flash Memory (Nand (Not And) memory chips) instead of mechanical parts making them faster than mechanical HDD

Basic SSD Block Diagram

HIERARCHY OF STORAGE UNITS

CPU core — Registers — L1 cache — L2 cache

CPU core — Registers — L1 cache — L2 cache

CPU core — Registers — L1 cache — L2 cache

L3 cache

Main memory

Permanent storage (HDD, SDD)

SMALLER
LARGER
STORAGE CAPACITY

FASTER
SLOWER
READ/WRITE SPEED

MORE FREQUENT
LESS FREQUENT
HOW FREQUENT DATA CHANGES? (VOLATILITY)

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STORAGE SYSTEMS COMPARISON

| Level	1	2	3	4	5
Name	registers	cache	main memory	solid-state disk	magnetic disk
Typical size	< 1 KB	< 16MB	< 64GB	< 1 TB	< 10 TB
Implementation technology	custom memory with multiple ports CMOS	on-chip or off-chip CMOS SRAM	CMOS SRAM	flash memory	magnetic disk
Access time (ns)	0.25-0.5	0.5-25	80-250	25,000-50,000	5,000,000
Bandwidth (MB/sec)	20,000-100,000	5,000-10,000	1,000-5,000	500	20-150
Managed by	compiler	hardware	operating system	operating system	operating system
Backed by	cache	main memory	disk	disk	disk or tape

MOTHERBOARD

Printed circuit board and foundation, providing power and communication across various hardware components.
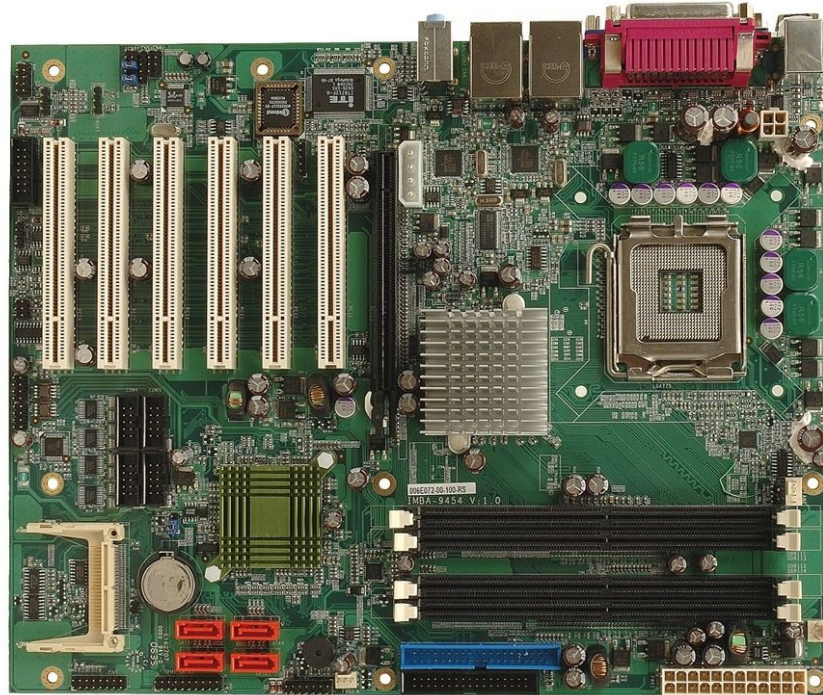
GRAPHICAL PROCESSING UNIT (GPU)

Specialized for parallel processing and operations suitable for graphics and video rendering. Commonly used to process AI/ML (Artificial Intelligence/Machine Learning) algorithms as well as memory intensive graphics work, including video rendering, 3D Modelling and of course rendering Game graphics

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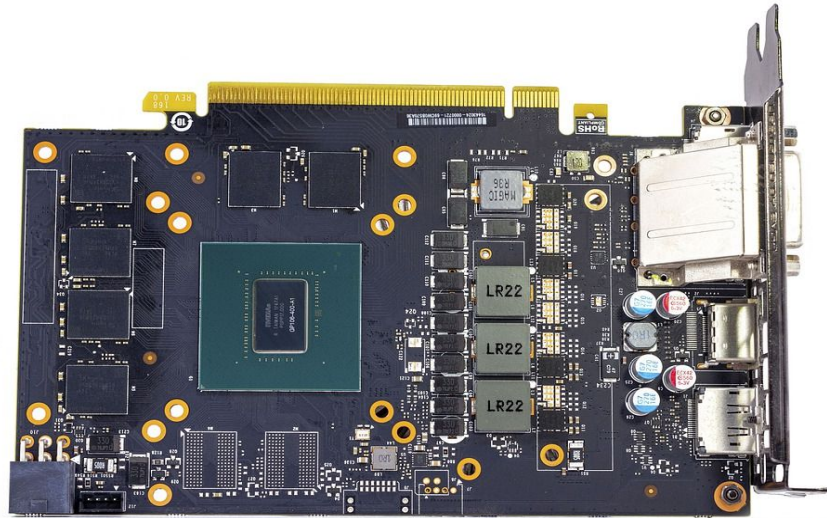
PHYSICAL PORTS

Connect computer system to external devices for input and output.