Documentation on Computer Architecture

Computer architecture is the fundamental design and structure of a computer system, defining how its components (CPU, memory, I/O) are organized, how they interact, and the instruction set software uses to control them, essentially bridging hardware and software to determine performance, functionality, and capabilities, explains

1. CPU (Central Processing Unit)

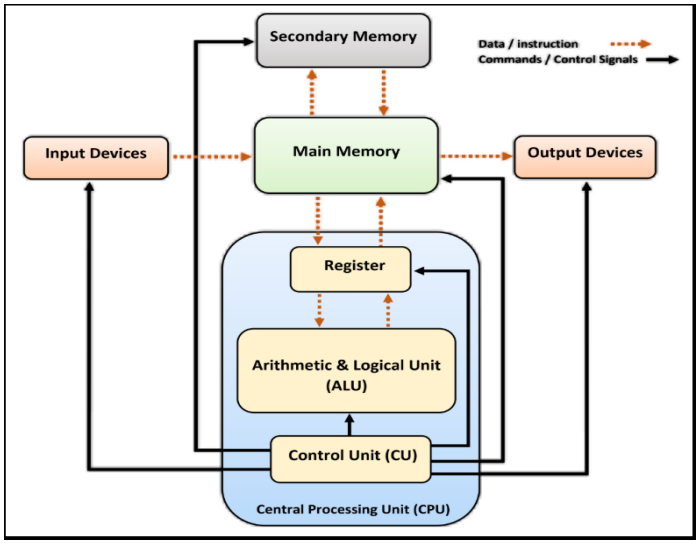
Definition - CPU is the *brain* of a computer. It executes instructions, performs calculations, and manages data flow between different components

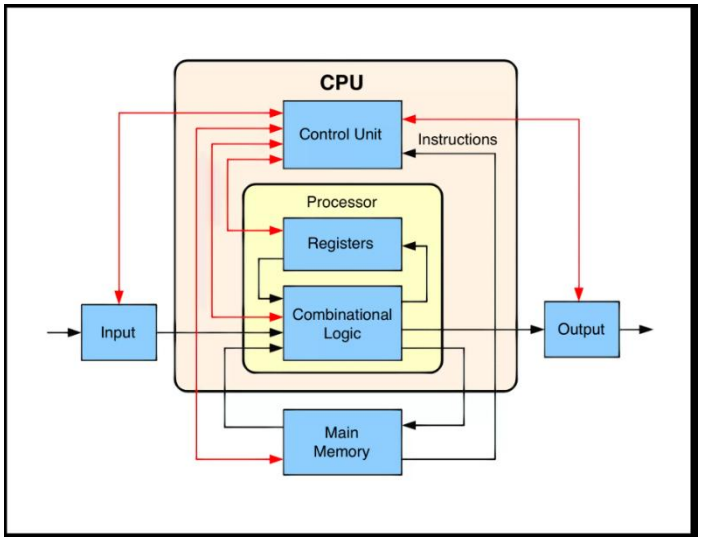
Main Components of a CPU

1. **ALU (Arithmetic Logic Unit)**
   - Performs arithmetic operations (add, subtract, multiply)
   - Performs logical operations (AND, OR, NOT, comparisons)
2. **CU (Control Unit)**
   - Controls flow of instructions
   - Directs other hardware components
3. **Registers**
   - Very small, ultra-fast memory inside the CPU
   - Stores temporary data and instructions during execution

Clock Speed

- Measured in **GHz (Gigahertz)**
- Higher GHz = faster instruction processing
- Example: 3.2 GHz ≈ 3.2 billion cycles per second

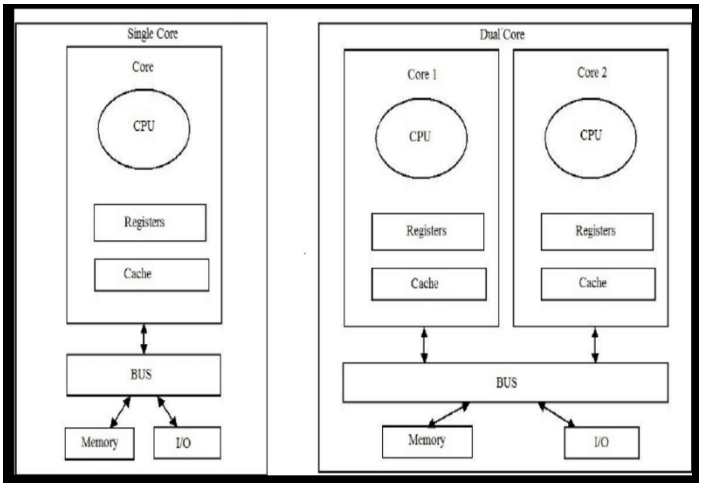




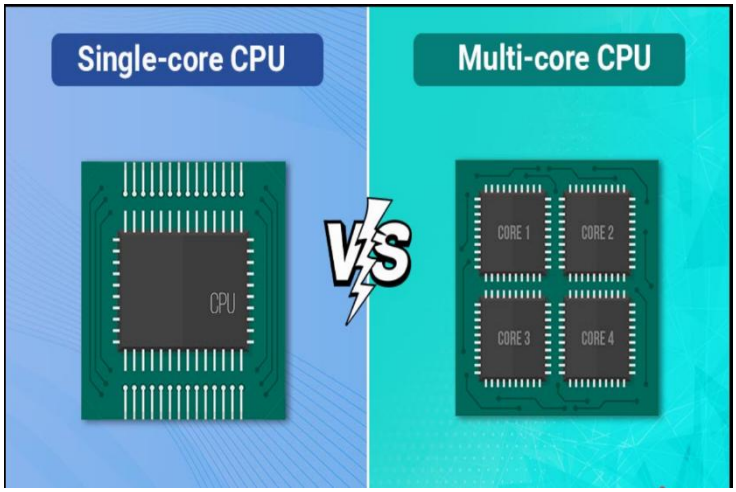
2. CPU Cores

A **Core** is an independent processing unit inside a CPU.
Earlier CPUs had one core, but modern CPUs have multiple cores.

Why Multiple Core ?
Each core can execute tasks independently
Allows multitasking and parallel processing
Example:
Quad Core – 4 Task at a time
Octa Core – 8 Task at a time



Block Diagram of Single-core and Multi-core Processor



Single Core CPU vs Multi Core CPU

3. RAM (Random Access Memory)

RAM is the computer's **temporary working memory**.
It stores data and programs *while they are being used*.

Key Properties

- **Volatile Memory:** Data disappears when power is off
- **Fast:** Much faster than hard disk/SSD
- **Direct Access:** CPU can reach any memory cell instantly

Types of RAM

1. **DRAM (Dynamic RAM)**
    - Needs constant refreshing
    - Used in normal computers
    - Cheaper, slower
2. **SRAM (Static RAM)**

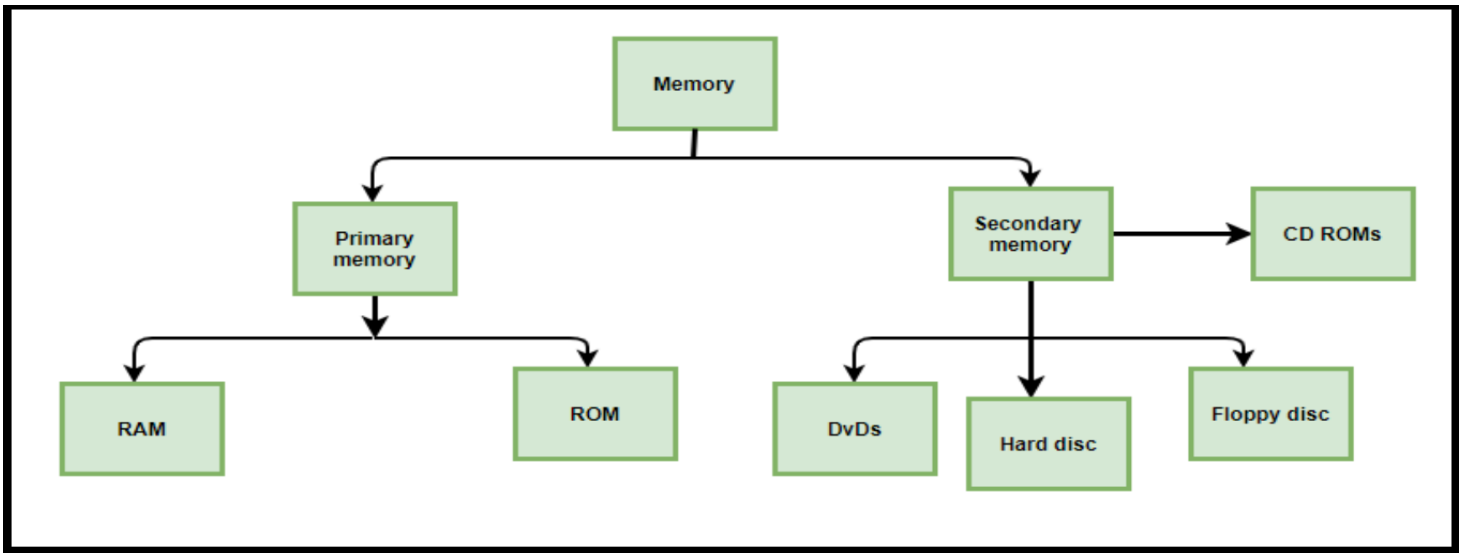
- No refresh needed
- Faster and expensive
- Used in CPU caches (L1/L2/L3)

How RAM Works

- CPU requests data
- RAM sends data to CPU
- RAM stores program instructions + variables being processed

Why RAM Matters for Performance

- More RAM = more applications open at once
- Less RAM = slow system, swapping to disk



RAM

4. CACHE

What is Cache?

Cache is the ultra-fast memory inside the CPU which stores frequently used instruction and RAM.

Cache Levels

1. L1 Cache (Level 1)
   - Fastest + Smallest
   - Located inside each core
   - Size: 32–128 KB

2. L2 Cache (Level 2)
   - Larger than L1
   - Slower than L1
   - Size: 256 KB – 1 MB per core

3. L3 Cache (Level 3)
   - Shared across all cores
   - Larger but slower
   - Size: 4–64 MB

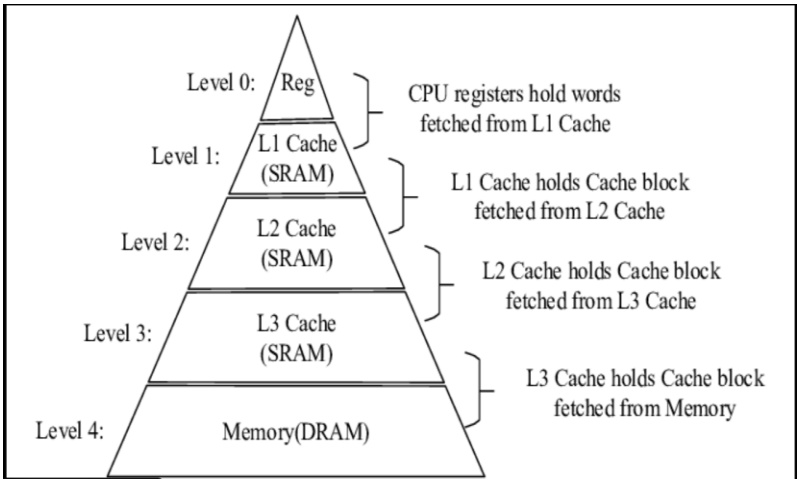


Fig 4.1 Cache Level hierarchy

How Cache Improves Performance

- Stores copies of frequently used data
- Reduces time spent accessing RAM
- Increases CPU efficiency dramatically

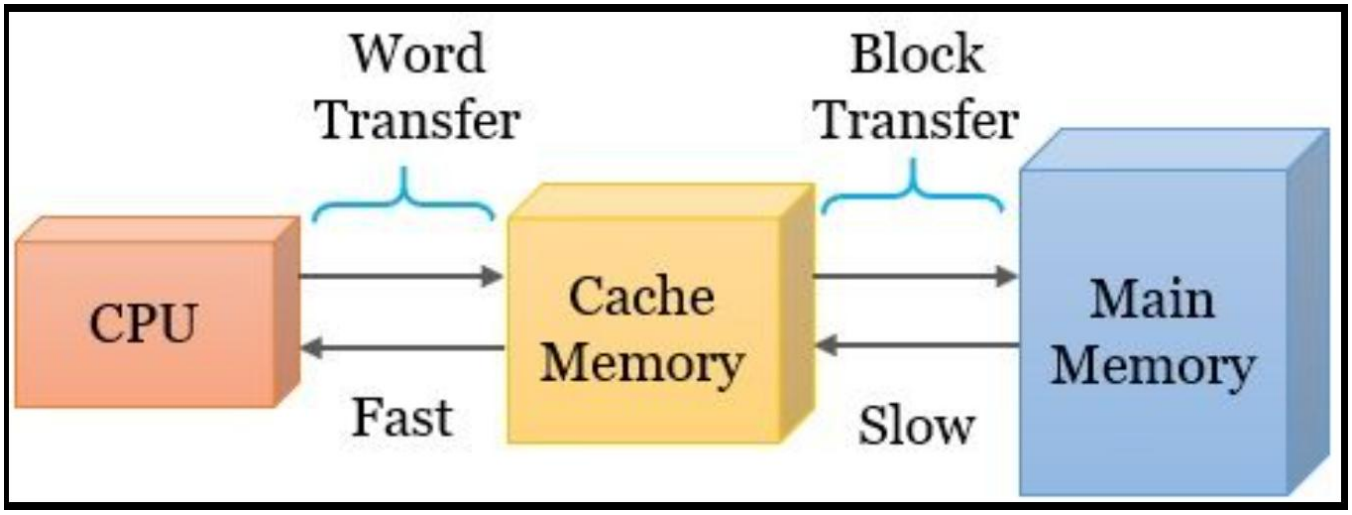


Fig 4.2 Difference between Cache and Main Memory