Unit 02

Explores the evolution of computing devices, so as to be able to describe and compare the performance of modern computers

By now you would have understood that computers assist us in converting data into information. Even though at present, there are automated computer systems, the computer too has undergone a similar evolution process as human beings and has reached the advanced stage today. The computer was born with the attempt to make an adding machine. In order to perform addition of numbers, a device called Abacus was invented around 5000 ago.

The computer evolution happened as following Era:

1. Pre-Mechanical Era (Before 1450)
2. Mechanical Era (1450 – 1840)
3. Electro-Mechanical Era (1840–1940)
4. Electronic Era (1940 – Present)

Pre-Mechanical Era (Before 1450):

The need to process data led to the invention of tools like the Abacus around 5000 years ago, enabling basic arithmetic.

Mechanical Era (1450 – 1840):

- The Pascaline was introduced by Blaise Pascal in 1642. It could add and subtract two numbers.

- The Stepped Reckoner invented by German scientist Gottfried Wilhelm Leibniz completed in 1694. This device is carried out the operations add, subtract, multiply and divide too.

- The difference engine, the first mechanical computer was developed by Charles Babbage in 1880. He presented the concept of Input, Process and Output that is used in modern computers, for the first time. Therefore, he is considered as the “Father of the computer”.

- Ada Lovelace recognized as the first programmer for writing programs for Babbage’s Analytical Engine.

Electro-Mechanical Era (1840–1940):

- 1939: Howard Aiken and IBM developed the MARK 1 (Automatic Sequence Control Calculator) at Harvard University, marking a major milestone in computing history.

- Electronic valve (vacuum tube) invented by Forest in 1906.

Electronic Era

1st Generation Computers (1940-1956)

The computers of first generation used vacuum tubes as the basic component.
Electronic valve (vacuum tube) invented by Forest in 1906

1. **ENIAC (Electronic Numerical Integrator and Calculator)** was the first electronic digital computer designed by John Mauchly and J. Presper Eckert in 1946.

2. **EDSAC (Electronic Delay Storage Automatic Calculator)** was the first full size stored program computer developed by Maurice Wilkes in 1947. EDSAC was built according to the von Neumann machine principles.

3. **EDVAC (Electronic Discrete Variable Automatic Computer)** is considered as the first digital computer that could store program was built in 1948.

4. **UNIVAC (Universal Automatic Computer)** was an electrical computer containing thousands of vacuum tubes that utilized punch cards and switches to input data and punch cards to output and store data.

2nd Generation Computers (1956 – 1963)

In this generation, **Transistors** were used as the fundamental building block.

IBM 1620, IBM 7094, CDC 1604, CDC 3600, UNIVAC 1108 were some computers developed in this generation.

3rd Generation Computers (1964 – 1975)

The computers of third generation used Integrated Circuits (ICs) in place of transistors. A single IC contains many transistors, resistors, and capacitors along with the associated circuitry.

IBM-360 series, PDP (Personal Data Processor), TDC- 316 were the computers of 3rd generation.

4th Generation (1975 – 1989)

In this generation of computers VLSI (Very Large Scale Integrated) circuits were used. VLSI circuits having more transistors and other circuit elements with their associated circuits on a single chip made it possible to have microcomputers.

Eg: DEC 10, STAR 1000, PDP 11

5th Generation Computers (1989 – present)

The ULSI (Ultra Large-Scale Integration) technology is used in this generation resulting in the production of microprocessor chips having millions of transistors and other electronic components.

Eg: Desktop, Laptop, Notebook, Ultrabook

GENERATION OF COMPUTERS AS A SUMMARY

Generation	Major Technology	Software Used	Characteristics	Systems Invented
1st Generation (1940–1956)	Vacuum tubes	Machine language	Large, slow, expensive; generated lots of heat; unreliable	ENIAC, EDSAC, EDVAC, UNIVAC
2nd Generation (1956–1963)	Transistors	Assembly language, early high-level languages (e.g., FORTRAN, COBOL)	Smaller, faster, more reliable than 1st gen; reduced heat generation	IBM 1620, IBM 7094, CDC 1604, UNIVAC 1108
3rd Generation (1964–1975)	Integrated Circuits (ICs)	Advanced high-level languages (e.g., BASIC, C)	Compact, energy-efficient, introduced multitasking and time-sharing	IBM 360 series, PDP, TDC-316
4th Generation (1975–1989)	Very Large-Scale Integration (VLSI)	Graphical user interfaces, more advanced OS (e.g., UNIX, MS-DOS)	Microcomputers became popular; portable; much faster; better energy efficiency	DEC 10, STAR 1000, PDP 11
5th Generation (1989–present)	Ultra Large-Scale Integration (ULSI)	Advanced software, AI-based systems, cloud computing	AI capabilities, high-speed processing; millions of transistors on a single chip; highly portable systems	Desktop computers, laptops, notebooks, ultrabooks, AI-driven devices

Classification of Computers

1. **Based on the Technology**

- **Analog Computer** - An analog computer is a form of computer that handles continuous values such as electrical, mechanical, or hydraulic quantities.

- **Digital Computer** - A computer that performs calculations and logical operations with quantities represented as digits, usually in the binary number system.

2. **Based on the Purpose**

- **Special purpose computer** - Computers are designed to handle a specific problem or to perform a specific task.

- **General purpose computer** – These are designed to perform a range of tasks.

3. **Based on Size**

- **Super Computer –**

  The fastest and most powerful type of computers. Supercomputers are very expensive and are employed for specialized applications that require immense amounts of computing power.
  E.g., TIANHE-1

- **Mainframe Computer** –

  A very large and expensive computer capable of supporting hundreds, or even thousands, of users simultaneously.

- **Mini Computer –**

  Mid-size computers mainly used as small or mid-range servers operating business and scientific applications.

- **Micro Computer –**

  - **Desktop** – A personal computer sufficient to fit on a desk
  - **Laptop** – A portable computer
  - **Palmtop** – A hand size computer
  - **Notebook** - A portable computer small and thinner than Laptop.
  - **Smart phone** – This is a mobile phone used for mobile communication with an operating system and other advanced facilities.
  - **Tablet** - A tablet is a wireless, portable personal computer with a touch screen interface.

  - **Phablet** - A phablet is a small pocket-sized mobile device that is a bit larger than the size of an average smartphone and smaller than tablet. (E.g. Apple 6Plus, Galaxy Note)

The functionality of a computer in relation to the hardware and their interfaces.

Input Devices

These are used to feed data and instructions to a computer system.

Most Common Input Device:	Keyboard
Pointing Devices:	Mouse, Touchpad, Remote Control, Touch Screen
Direct Entry Input Devices:	Barcode Reader, Magnetic Stripe Reader, Smart Card Reader
Image and Video Input Device:	Video Camera, Digital Camera, Webcam, CCTV
Scanning Device:	Scanner, MICR, OMR, OCR

Output Devices

These are used to output information from a computer system.

Output can be gained in 2 ways:

Soft Copy:
A digital or electronic version of information that can be viewed on a screen but not physically touched.

Ex: Word documents, PDFs, images on a monitor, or emails.

Hard Copy:
A physical printed version of information that can be touched and handled.

Ex: Printed documents, photographs, books, or reports on paper.

Monitor

1. CRT Monitor (Cathode Ray Tube Monitor)

Working Principle:

- **Cathode Ray Tube (CRT)** monitors are the traditional bulky monitors commonly used before LCDs and LEDs became widespread.
- Inside the CRT, there's a large **vacuum tube** with a **phosphorescent screen**. This screen is coated with phosphor that emits light when struck by an electron beam.
- The **electron gun** at the back of the tube fires electrons toward the screen, which is divided into millions of tiny **pixels**. Each pixel is coated with a different color phosphor (red, green, or blue).
- The electron beam scans from top to bottom (left to right) across the screen, illuminating the phosphor-coated pixels to create an image.

Key Features:

- **Size and Weight**: CRT monitors are relatively bulky and heavy due to the large tube.
- **Resolution**: Older CRTs have lower resolutions compared to modern LCDs and LEDs.
- **Color Quality**: CRTs generally provide better color accuracy and contrast ratios than older LCDs, especially for gaming or graphical work.

Advantages:

- **Rich Colors**: Excellent color accuracy and sharpness.
- **High Refresh Rate**: CRTs support high refresh rates, reducing motion blur in fast-moving images.
- **Wide Viewing Angles**: The image quality remains consistent from most angles.

Disadvantages:

- **Size and Weight**: Bulky, heavy, and requires a large space.
- **Energy Consumption**: Consumes more power compared to modern flat-panel displays.
- **Flickering**: Some users report eye strain due to flickering at lower refresh rates.

2. LCD Monitor (Liquid Crystal Display Monitor)

Working Principle:

- **LCD (Liquid Crystal Display)** monitors use a liquid crystal substance that doesn't emit its own light. Instead, the light is provided by a **backlight** (commonly fluorescent or LED-based).
- The screen consists of a grid of liquid crystals that can change their alignment when an electric current is passed through them. This controls the amount of light passing through each pixel.
- **Thin Film Transistor (TFT)** technology is commonly used in LCDs. TFT refers to the use of a thin film transistor for each pixel. The TFT helps control the individual pixels more precisely, improving image clarity and responsiveness.
- The light is typically polarized, and as the liquid crystals shift their orientation, they allow varying amounts of light to pass through, creating the image.

Key Features:

- **Thin and Lightweight**: LCDs are much thinner and lighter than CRT monitors, making them ideal for portable devices like laptops.
- **Energy-Efficient**: LCDs consume less power than CRT monitors.
- **Resolution**: Higher resolutions are possible, providing sharper images and text compared to CRTs.

Advantages:

- **Compact Size**: Thin design, saving space and weight.
- **Low Power Consumption**: More energy-efficient than CRTs.
- **High Resolution**: Supports high-definition resolutions with crisp image quality.
- **Better for Eyes**: Less flicker and eye strain than CRT monitors.

Disadvantages:

- **Color Accuracy**: Color accuracy and contrast ratios are generally not as good as CRTs, especially in older models.
- **Viewing Angles**: Viewing angles can be narrow, with some color distortion if viewed from extreme angles.

3. LED Monitor (Light Emitting Diode Monitor)

Working Principle:

- **LED Monitors** are technically a type of **LCD** monitor, but with a key difference in how the backlighting is provided.
- **LEDs (Light Emitting Diodes)** are used as the backlight source in LED monitors, replacing the fluorescent backlight used in traditional LCDs.
- The main advantage of LED technology is that the LEDs can be arranged in a variety of ways, including **edge-lit** (where LEDs are placed along the edges of the screen) and **full-array** (where LEDs are spread across the back of the screen).
- In **OLED (Organic LED)** screens, each pixel is a self-emitting diode, meaning it doesn't require a backlight.

Key Features:

- **Superior Brightness**: LED displays provide higher brightness levels compared to traditional LCDs.
- **Thinness**: LED displays are ultra-thin, making them ideal for slim and lightweight designs.
- **Energy-Efficient**: More power-efficient than regular LCDs, especially in edge-lit designs.

Advantages:

- **Better Contrast and Color**: High contrast ratios and vibrant colors, especially in high-end models like OLED.
- **Slim Profile**: Much thinner and lighter than traditional LCD or CRT monitors.
- **Energy Efficiency**: LED monitors consume less power compared to older LCD monitors with fluorescent backlighting.
- **Faster Response Time**: Some LED models (especially OLED) have faster response times, reducing motion blur in fast-moving images.

Disadvantages:

- **Cost**: LED monitors, especially OLEDs, tend to be more expensive than regular LCDs.
- **Burn-in Issues (for OLED)**: OLED displays may suffer from "burn-in," where static images become permanently imprinted on the screen if displayed too long.

Comparison of CRT, LCD, and LED Monitors:

Feature	CRT Monitor	LCD Monitor	LED Monitor
Technology	Electron gun + phosphorescent screen	Liquid crystal + backlight	LCD with LED backlight
Size	Bulky and large	Thin and compact	Ultra-thin and lightweight
Weight	Heavy	Light	Very light
Power Consumption	High	Moderate	Low
Resolution	Low	High	High
Color Accuracy	Excellent (in some cases)	Good	Excellent (with better contrast)
Price	Inexpensive (outdated now)	Affordable	Expensive (especially OLED)
Viewing Angle	Good	Moderate	Excellent (depending on model)

Printer

Printer is used to produce a hard copy output.

1. Impact Printers

Impact printers use a mechanical process where the print head physically strikes an ink ribbon to transfer ink onto paper, similar to how a typewriter works.

Features of Impact Printers:

- Loud in operation due to mechanical striking.
- Suitable for printing carbon copies or multipart forms.
- Typically used for industrial or business purposes.

Types of Impact Printers:

1. **Dot Matrix Printer**:
    - **Working**: Uses a matrix of tiny pins (e.g., 9-pin or 24-pin) that strike an ink-soaked ribbon to create dots on paper.
    - **Advantages**: Low running cost, reliable for printing forms and invoices.
    - **Disadvantages**: Low-quality output and noisy.

2. **Daisy Wheel Printer**:
    - **Working**: Uses a wheel with characters embossed on it. Each character strikes the ribbon to print.
    - **Advantages**: Better quality than dot matrix.
    - **Disadvantages**: Very slow, limited to pre-defined fonts.

3. **Line Printer**:
    - **Working**: Prints an entire line at a time (e.g., chain or drum printers).
    - **Advantages**: Extremely fast.
    - **Disadvantages**: Bulky and limited formatting options.

2. Non-Impact Printers

Non-impact printers do not involve any mechanical striking. They use technologies like lasers, inkjets, or thermal processes to transfer images or text to paper.

Features of Non-Impact Printers:

- Silent and faster than impact printers.
- High-quality output.
- Unable to print multipart forms (no carbon copies).

Types of Non-Impact Printers:

1. **Laser Printer**:
    - **Working**: Uses a laser beam to create an electrostatic image on a drum, which attracts toner particles and transfers them to paper. Heat is applied to fix the toner.
    - **Advantages**: High speed, sharp text/graphics, cost-effective for bulk printing.
    - **Disadvantages**: Expensive initial setup, larger size.

2. **Inkjet Printer**:
    - **Working**: Sprays tiny droplets of liquid ink directly onto the paper.
    - **Advantages**: High-quality color printing, affordable initial cost.
    - **Disadvantages**: Slow for bulk printing, high cost of ink.

3. **Thermal Printer**:
    - **Working**: Uses heat to transfer dye or pigment onto paper (commonly used in receipts and labels).
    - **Advantages**: Fast, reliable for specific tasks.
    - **Disadvantages**: Expensive paper, limited usage to thermal materials.

Comparison of Impact vs Non-Impact Printers:

Feature	Impact Printers	Non-Impact Printers
Mechanism	Mechanical striking	No mechanical striking
Noise	Noisy	Quiet
Speed	Moderate	Fast
Print Quality	Low	High
Carbon Copies	Yes	No
Examples	Dot Matrix, Daisy Wheel	Laser, Inkjet, Thermal

CPU and its compatibility with motherboard

1. Socket Support

- The **socket** is the physical interface on the motherboard where the CPU is installed.
- Different CPUs require specific socket types. For example:
  - **Intel**: LGA 1700, LGA 1200, etc.
  - **AMD**: AM4, AM5, etc.
- **Compatibility**: The motherboard's socket must match the CPU's socket type for installation.

2. Chipset Support

- The **chipset** is a collection of circuits on the motherboard that manage communication between the CPU, memory, and peripherals.
- Each chipset is designed to work with specific CPU families. For example:
  - **Intel**: Z790, B760 (compatible with certain generations of Intel Core processors).
  - **AMD**: B550, X670 (compatible with certain generations of Ryzen processors).
- **Manufacturer Examples**: AMD, Intel, and Nvidia (for GPUs and certain specialized chipsets).

3. Thermal Design Power (TDP) and Motherboard Wattage Support

- **TDP**: Refers to the amount of heat the CPU generates under workload, measured in watts.
- **Motherboard Wattage Support**:
  - The motherboard must provide adequate power and cooling for the CPU's TDP.
  - If the CPU's TDP exceeds the motherboard's power capacity, it could lead to system instability or damage.
- Example: A CPU with a TDP of **125W** requires a motherboard capable of supporting at least **125W**.

4. BIOS Support

- **BIOS (Basic Input/Output System)**:
  - Controls the hardware initialization and provides runtime services.
  - Sometimes, motherboards require a BIOS update to recognize newer CPUs.
- **Process**:
  - Check the motherboard manufacturer's website for BIOS updates.
  - Update the BIOS (if necessary) before installing the new CPU.

Steps to Ensure Compatibility:

1. Identify the CPU model and socket type.
2. Verify the motherboard's socket type matches the CPU.
3. Confirm the chipset supports the CPU family and features (e.g., overclocking, PCIe versions).
4. Check if the motherboard supports the CPU's TDP.
5. Ensure the BIOS version is compatible with the CPU (update if needed).

<u>Storage Devices</u>

1. **Fixed internal magnetic hard disk -**

   A data storage device that uses magnetic storage to store and retrieve digital information using one or more rigid rapidly rotating disks (platters) coated with some magnetic material.

2. **External hard disk an external hard drive -**

   A portable storage device that can be attached to a computer through a USB Port.

3. **Magnetic tape –**

   Is one of the oldest technologies for electronic data storage on a magnetic surface. Tape has largely been displaced as a primary and backup storage medium, but it remains well-suited for archiving because of its high capacity, low cost and long durability. It is a sequential recording system that is not good for random-access. With tape archiving, there is no online copy for quick retrieval, as everything is vaulted for the long term.

4. **Optical discs –**

   An optical disc is an electronic data storage medium that can be written to and read using a low-powered laser beam.

5. **DVD-RAM -**

   Is like ordinary Random-Access Memory (RAM), it can be repeatedly read, written to, and erased. DVD-RAM discs can be rewritten 100 times more than a DVD-RW.

6. **Flash drives and memory cards -**

   Uses Electrically Erasable Programmable Read Only Memory (EEPROM) technology to store data on one or more semiconductor chips.

Parallel Computing

Parallel computing involves performing multiple computations or processes simultaneously by dividing a large task into smaller sub-tasks, each executed on separate processors or computers.

How It Works:

- The large task is divided into smaller tasks.
- These tasks are distributed across multiple processors or systems to execute concurrently.

Advantages:

- Faster execution for divisible tasks.
- Efficient use of multiple processors.
- Scalability in solving large, complex problems.

Challenges:

- Some tasks cannot be broken into smaller parts.
- Uneven distribution of tasks may lead to inefficiency.
- Coordination, communication, and synchronization among processors add overhead.

Grid Computing

A distributed computing model where a network of loosely connected computers works together to solve complex problems, often over the Internet or local networks.
Unlike parallel computing, grid computing doesn't rely on a single central processor but on a network of independent systems sharing resources.

Architecture:

- A **main computer** distributes tasks to multiple networked systems.
- These systems collectively utilize shared resources for computation.

Examples of Applications:

1. **Application Partitioning**: Breaking problems into manageable parts.
2. **Task Scheduling**: Assigning tasks and workflows to systems in the grid.
3. **Data Communication**: Ensuring data is available where and when needed.
4. **Code Provisioning**: Distributing application code to specific nodes.
5. **Results Management**: Analyzing and collating outcomes from nodes.
6. **Autonomic Features**: Self-configuration, self-optimization, and fault recovery.

Use Cases:

- Scientific research (e.g., protein folding, weather forecasting).
- Complex simulations (e.g., astrophysics, climate modeling).

Key Differences between Parallel and Grid Computing:

Aspect	Parallel Computing	Grid Computing
Architecture	Multiple processors or cores in a single system.	Distributed, loosely connected systems.
Task Division	Tasks divided into smaller parts for simultaneous execution.	Tasks distributed across networked computers.
Communication	Requires high-speed communication (e.g., shared memory).	Relies on standard networks, such as the Internet.
Examples	Multi-core CPUs, supercomputers.	SETI@home, climate simulations.

Schedulers

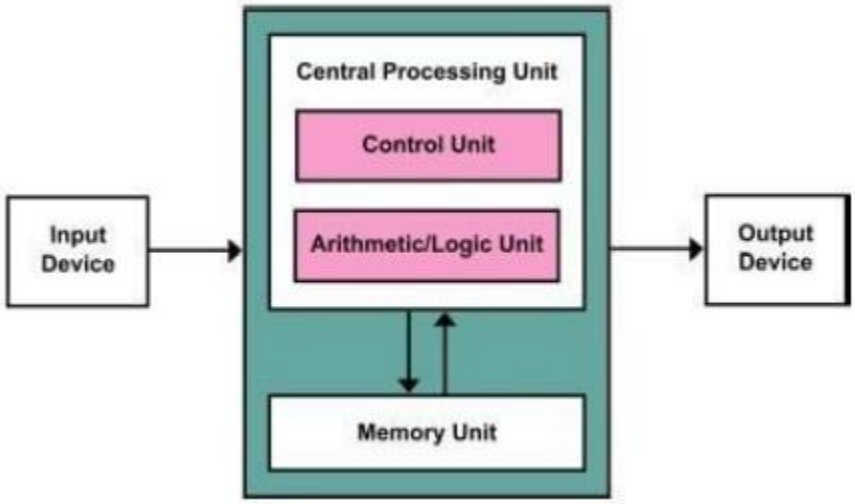
Applications or systems responsible for managing and optimizing the execution of tasks in computing environments, particularly in parallel or grid computing.

Functions:

1. **Resource Allocation:** Assigns required resources to jobs.
2. **Task Partitioning:** Divides jobs for parallel execution.
3. **Data Management:** Handles data distribution and retrieval.
4. **Event Correlation:** Monitors and links events for execution coordination.

The Von- Neumann Architecture

Von Neumann Architecture consists of a CPU, memory and input output devices. The program is stored in the memory. The CPU fetches an instruction from the memory at a time and executes it.



Major components of this architecture:

1. Central processing unit
    (i) Control unit (CU)
    (ii) Arithmetic and logic unit (ALU)
    (iii) Memory register
2. Memory
    (i) Primary memory
    (ii) Secondary memory
3. Input device
4. Output device

Data bus

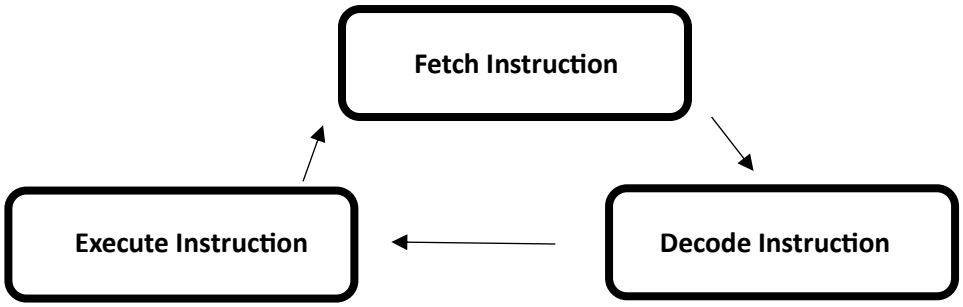
A data bus is a system within a computer or device, consisting of a connector or set of wires, that provides transportation for data.

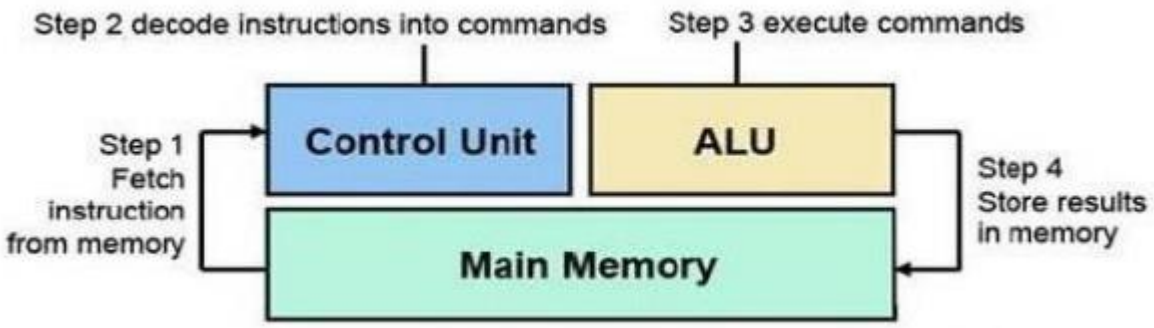
Control bus

Control bus is used to transmit a variety of control signals to components and devices.

Fetch – Decode – Execute Cycle

The Fetch-Decode-Execute Cycle (also known as the **Instruction Cycle**) is the sequence of steps a CPU follows to execute instructions from a program. This cycle repeats continuously while the computer is running.





Fetch Phase

Retrieve the next instruction from memory.

- **Steps**:
    1. The **Program Counter (PC)** holds the address of the next instruction to be executed.
    2. The address in the PC is sent to the **Memory Address Register (MAR)**.
    3. The instruction is fetched from memory and loaded into the **Memory Data Register (MDR)**.
    4. The instruction is then moved to the **Instruction Register (IR)** for decoding.
    5. The PC is incremented to point to the next instruction in sequence.

Decode Phase
Interpret the fetched instruction.

- **Steps**:
    1. The CPU decodes the instruction stored in the IR.
    2. The **Control Unit (CU)** identifies the operation (e.g., arithmetic, logic, data movement) and the operands.
    3. Signals are sent to the appropriate CPU components to prepare for execution.

Execute Phase
Perform the operation specified by the instruction.

- **Steps**:
    1. The decoded instruction is executed by the **Arithmetic Logic Unit (ALU)**, registers, or other CPU components.
    2. Operations may involve:
        - Arithmetic or logical calculations.
        - Data transfer between memory and registers.
        - Interaction with input/output devices.
    3. Results are stored in the **Accumulator**, a register, or memory.

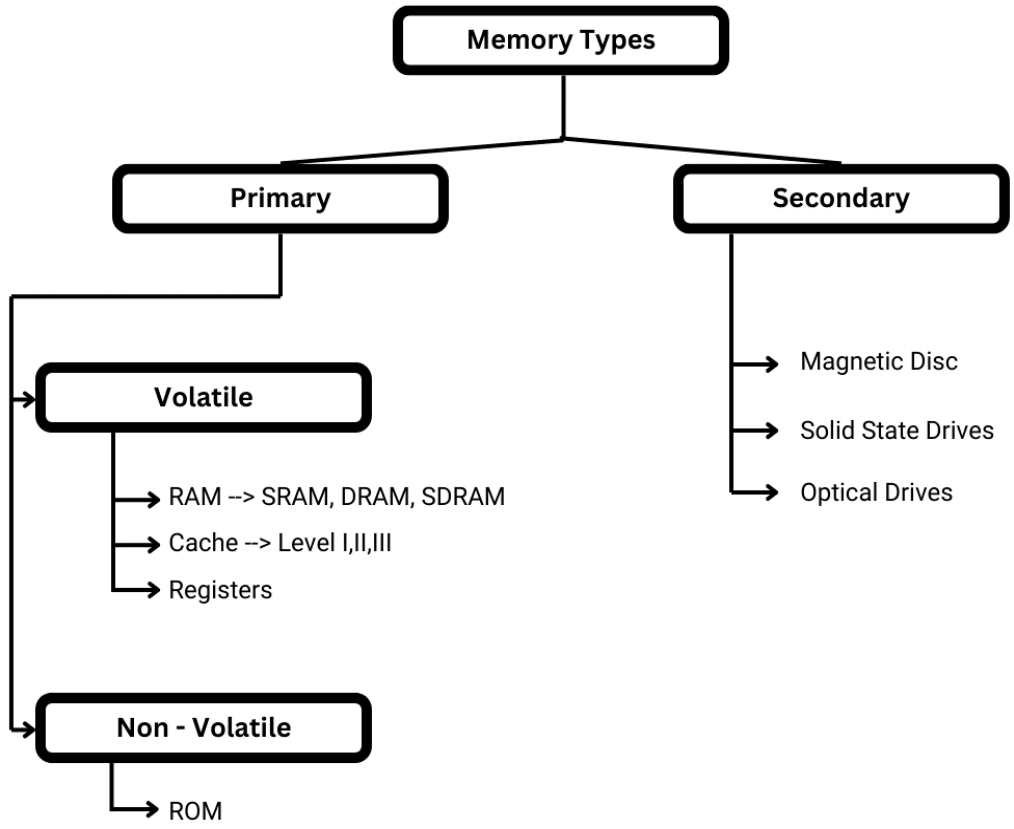
Multi-core processors

A multi-core processor is a single computing component with two or more independent actual processing units(cores), which are units that read and execute program instructions. Therefore, the single processor can run multiple instructions on separate cores at the same time.

Need of multi-core processor

1. Can be run a program by dividing some parts. So, it gets executed fast.
2. It enables parallel programming.
3. To get the high performance from a single machine.

PC memory system to identify different types of memory and their main characteristics



Note: All Secondary Storages are Non-Volatile Memories

Volatile memory

Volatile memory is a computer storage that only holds the data while the device is powered.

Cache memory

The cache memory is used to store program instructions that are frequently accessed by software during operation.

Types of cache memories

1. **Level 1 (L1)** cache is extremely fast but relatively small, and is usually embedded in the processor chip (CPU).
2. **Level 2 (L2)** cache is often more capacity than L1. It may be located on the CPU or on a separate.
3. **Level 3 (L3)** cache is typically specialized memory that works to improve the performance of L1 and L2. It can be significantly slower than L1 or L2, but is usually double the speed of RAM.

RAM (Random Access Memory)

RAM is the main memory of the computer that holds data for running applications and required data for computer.

Types of RAM

SRAM (Static Random-Access Memory)

- **Definition**: A type of memory that retains data as long as power is supplied.
- **Characteristics**:
  - Faster and more expensive than DRAM.
  - Consumes more power.
  - Used for cache memory in CPUs.
  - Does not require periodic refreshing.
- **Technology**: Built using flip-flops, which hold data statically.

DRAM (Dynamic Random-Access Memory)

- **Definition**: A type of memory that stores data in capacitors.
- **Characteristics**:
  - Slower and cheaper than SRAM.
  - Requires periodic refreshing (every few milliseconds) to retain data.
  - Used as main memory in computers (e.g., RAM sticks).
  - Higher density than SRAM.
- **Technology**: Uses a single transistor and capacitor per memory cell.

SDRAM (Synchronous Dynamic Random-Access Memory)

- **Definition**: A type of DRAM that operates in synchronization with the CPU clock.
- **Characteristics**:
  - Faster than traditional DRAM due to synchronization.
  - Commonly used in modern computer systems.
  - Allows for pipelining, which improves efficiency.
  - Available in versions like DDR (Double Data Rate) SDRAM (e.g., DDR4, DDR5).

These types of memory differ in speed, cost, and application. SRAM is for speed-critical tasks (e.g., CPU cache), DRAM is for general-purpose memory, and SDRAM provides enhanced performance for high-speed applications.

Registers

Registers are small, high-speed storage locations within a CPU used to temporarily hold data and instructions during processing.

ROM – Read Only Memory

ROM retains its contents even when the computer is turned off. ROM stores essential programs such as the program that boots the computer.

Types of ROM

1. **PROM (Programmable ROM):**
   It is a memory chip on which data can be written only once. Once a program has been written onto a PROM, it remains there forever.

2. **EPROM (Erasable PROM):**
   EPROM is a special type of memory that retains its contents until it is exposed to ultraviolet light. The ultraviolet light clears its contents, making it possible to reprogram the memory.

3. **EEPROM (Electrically Erasable PROM):**
   It can be erased by exposing it to an electrical charge.

Secondary Storage

1. Magnetic Storage Devices

- **Definition**: Uses magnetic fields on a medium for storing data.
- **Characteristics**:
  - Involves spinning disks or tapes and read/write heads.
  - Commonly used for large-scale, cost-effective storage.
- **Examples**:
  - Hard Disk Drive (HDD)
  - Floppy Disk
  - Magnetic Tape

2. Optical Storage Devices

- **Definition**: Uses lasers to read/write data onto optical media.
- **Characteristics**:
  - Durable and less affected by environmental conditions.
  - Slower and lower capacity compared to hard drives.
- **Examples**:
  - CD (Compact Disc)
  - DVD (Digital Versatile Disc)
  - Blu-ray Disc

3. Solid-State Storage Devices

- **Definition**: Stores data electronically using silicon microchips.
- **Characteristics**:
  - No mechanical parts, leading to higher speed and durability.
  - Produces less heat and has a predictable lifespan.
- **Examples**:
  - SSD (Solid-State Drive), Flash Drive, Memory Card

Memory Access method

Sequential access

Start at the beginning and read through in order.

Eg: Tape

Random access

Individual addressesidentify directly and access the data immediately,
Eg: RAM

Memory Hierarchy

1. Data Access Speed (Fast → Slow)

1. Register
2. Cache
3. RAM (Random-Access Memory)
4. ROM (Read-Only Memory)
5. Flash Memory
6. Hard Disk
7. Optical Disc
8. Magnetic Tape

2. Storage Capacity (Large → Small)

1. Magnetic Tape
2. Hard Disk
3. Optical Disc
4. Flash Memory
5. RAM
6. ROM
7. Cache
8. Register

Key Takeaways

- **Registers and Cache**: Extremely fast but have minimal capacity; used directly by the CPU.
- **Magnetic Tape and Hard Disks**: Slow but provide massive storage for backups and archival purposes.
- **Flash Memory**: A balance of speed and capacity, widely used in modern devices.

Founders List

ENIAC -	John Presper Eckert and John Mauchly
EDVAC -	John Presper Eckert, and John Mauchly
EDSAC -	Maurice Wilkes, Von Neuman (Architecture)
UNIVAC -	John Presper Eckert and John Mauchly
Vacuum Tubes -	John Ambrose Fleming (diode), Lee De Forest (triode)
Transistors -	John Bardeen, Walter Brattain, and William Shockley
Integrated Circuits-	Jack Kilby
Microprocessors -	Federico Faggin, Marcian Hoff, Masatoshi Shima, and Stan Mazor
AI -	John McCarthy, Marvin Minsky, Allen Newell, and Herbert A. Simon
Apple -	Steve Jobs, Steve Wozniak, and Ronald Wayne
Facebook -	Mark Zuckerberg, Eduardo Saverin, Andrew McCollum, Dustin Moskovitz
Windows -	Bill Gates and Paul Allen
Microsoft -	Bill Gates and Paul Allen
Laptops -	William Moggridge
PC -	Don Estridge and the IBM team
Mobile Phone -	Martin Cooper and the Motorola team