**Computer Memory**: Refers to the storage space within a computer where data and instructions are stored for processing.

* **CPU Access**: Computer memory allows the CPU to quickly retrieve information, which is essential for efficient processing.
* **Bit**: The smallest unit of memory is called a **bit**, which stands for **binary digit**. It can hold a value of either 0 or 1.
* **Flip-Flop**: The location where a single bit (0 or 1) is stored is called a **flip-flop**.
* **Storage Capacity**: A flip-flop can store **one bit of data**.
* **Register**: A collection of two or more flip-flops is called a **register**. Registers are used to hold data temporarily for quick access by the CPU.
* **Fastest Memory Units**: Registers and Cache Memory are the fastest types of memory.
* **Expensive Computer Memory**: The most expensive types of computer memory are **Registers**, **Cache Memory**, and **RAM**.
* **Slowest Memory**: The slowest type of computer memory is the **Disk** (such as Hard Disk Drives or HDDs and Solid-State Drives or SSDs).

**CPU Searches Data in Registers**:

* The CPU first looks for the needed data in its **registers**.

**CPU Searches Data in Cache**:

* If the data is not found in the registers, the CPU then checks the **cache memory**.

**Cache Searches Data in Main Memory**:

* If the data is not in the cache, the CPU retrieves it from **main memory (RAM)**.

**Main Memory Searches Data in Secondary Memory**:

* If the data is not found in main memory, it will then be fetched from **secondary memory** (like a hard disk or SSD).

**Registers:**

* Registers are **not part of the main memory**.
* They are the **smallest and fastest** type of memory in a computer.
* located directly on the CPU chip
* They hold small amounts of data that the CPU needs immediately.
* Registers is a **temporary storage**.
* **Registers** hold a small amount of data, usually ranging from **32 bits** to **64 bits**.

**Cache Memory**:

* **Cache Memory** are **part of the main memory**.
* They are the **smallest (1st register) and fastest (1st register)** type of memory in a computer.
* located close to the CPU
* Cache memory is typically **volatile**, meaning it loses its contents when the power is turned off.
* **Acts as a Buffer Between RAM and the CPU** => **Cache memory** acts like a waiting area between the CPU and RAM. It keeps often-used data and instructions close by so the CPU can access them quickly, making the computer run faster and work more efficiently.
* **Cache Hit**: If the required data is found in the cache, it is quickly retrieved, leading to faster processing.
* **Cache Miss**: If the required data is not found in the cache, the CPU must fetch it from the slower main memory, which takes more time.

**TYPES OF CACHE MEMORY**

* Level 1 / Register (L1)
* Level 2 / Cache Memory (L2)
* Level 3 / Main Memory (L3)
* Level 4 / Secondary Memory (L4)

**Disk vs. Disc**

* **Disk**: Refers to magnetic storage devices.
  + Examples:
    - **Hard Disk**: Used for large storage in computers.
    - **Floppy Disk**: An older, removable storage medium.
* **Disc**: Refers to optical storage devices.
  + Examples:
    - **Compact Disc (CD)**: Used for audio and data storage.
    - **Digital Versatile Disc (DVD)**: Used for video and larger data storage.

**Memory Units:**

* **1 Bit** = Binary Digit
* **4 Bits** = 1 Nibble
* **8 Bits** = 1 Byte
* **1024 Bytes** = 1 KB (Kilobyte)
* **1024 KB** = 1 MB (Megabyte)
* **1024 MB** = 1 GB (Gigabyte)
* **1024 GB** = 1 TB (Terabyte)
* **1024 TB** = 1 PB (Petabyte)
* **1024 PB** = 1 EB (Exabyte)
* **1024 EB** = 1 ZB (Zettabyte)
* **1024 ZB** = 1 YB (Yottabyte)
* **1024 YB** = 1 BB (Brontobyte)
* **1024 BB** = 1 Geop Byte

**Data** refers to the information that the computer processes and manipulates. This can include:

* **Numbers:** Integers, floating-point numbers, etc.
* **Text:** Characters, strings, and text files.
* **Images:** Bitmap or vector graphics.
* **Audio and Video:** Media files such as MP3, WAV, MP4, etc.
* **Variables:** Values that can change during program execution.

**Example:** In a database application, data could be the records of customers, including names, addresses, and phone numbers.

**Instructions** are commands that tell the computer what operations to perform on the data. They are part of a program. The instructions **guide** the CPU on what tasks to perform. The CPU **follows** these instructions step by step to complete the program. This can include:

* **Arithmetic Operations:** Add, subtract, multiply, divide.
* **Control Flow:** Conditional statements (if-else), loops (for, while).
* **Input/Output Operations:** Reading data from or writing data to devices.
* **Data Manipulation:** Sorting, searching, or modifying data.

**Example:** In a simple program, an instruction might be to calculate the sum of two numbers and store the result in a variable.

A diagram of a computer memory

Description automatically generated

A diagram of a computer memory

Description automatically generated

**Primary memory**, also known as **"main memory"** or **"internal memory,".**

**Characteristics of Primary Memory:**

* **Location:** It is located on the **motherboard** of the computer.
* **Connection:** It is **directly connected to the CPU,** which allows for fast data access and processing.
* **Purpose:** It temporarily **stores data and instructions** that the CPU is currently using or will need shortly.
* **Volatility:** It is often volatile, meaning the data is lost when the computer is turned off (in the case of RAM).

A screenshot of a computer program

Description automatically generated

A screenshot of a computer

Description automatically generated

A screenshot of a computer

Description automatically generated

**ROM TYPES**

* **PROM (Programmable Read-Only Memory)**
* EPROM (Erasable Programmable Read-Only Memory)
* EEPROM (Electrically Erasable Programmable Read-Only Memory)

**PROM (Programmable Read-Only Memory)**

* **Characteristics**: A type of ROM that can be programmed once after it's made.
* **When to use it**: Ideal for applications where the data won’t need to change, like certain firmware in devices.
* **How it works**: Data is written by burning out tiny connections in the chip, which means it can’t be changed later.

**2. EPROM (Erasable Programmable Read-Only Memory)**

* **Characteristics**: A type of ROM that can be erased and reprogrammed multiple times.
* **When to use it**: Useful when you might want to update the data, such as in firmware updates.
* **How it works**: You can erase the data by exposing the chip to ultraviolet (UV) light, and then reprogram it.

**3. EEPROM (Electrically Erasable Programmable Read-Only Memory)**

* **Characteristics**: A more flexible version of EPROM that can be erased and rewritten electrically.
* **When to use it**: Common in devices like computers for things that need to be updated often, like BIOS settings.
* **How it works**: You can erase and rewrite the data electronically, and it can be done one byte at a time.

**Storage Devices (Secondary Memory)**

**A screenshot of a video

Description automatically generated**

Secondary memory, also known as secondary storage or auxiliary memory, refers to a computer's long-term storage for programs and data. Unlike primary memory (like RAM), which is volatile and loses its contents when the power is off, secondary memory retains data even when the computer is turned off.

**Characteristics of Secondary Memory**

 **Persistent Storage**:

* This means that the data stays saved even when the computer is turned off. You don’t lose your files unless you decide to delete them or overwrite them with new information.

 **Capacity**:

* Secondary memory usually has a much larger storage capacity than primary memory (like RAM). This allows you to store a lot more data, such as documents, photos, videos, and applications.

 **Speed**:

* Accessing data from secondary memory is generally slower than accessing data from primary memory. However, advancements in technology, like Solid State Drives (SSDs), are making secondary memory faster than it used to be.

 **Cost**:

* Secondary memory is usually more affordable for storing large amounts of data compared to primary memory. This makes it a cost-effective option for users who need to store a lot of information.

Some examples of secondary memory devices include:

* Hard disk drives (HDD)
* Solid-state disks (SSD)
* Flash memory
* Magnetic tapes
* Floppy disks
* Optical disks such as CDs and CDROMs

**Methods for Data Accessing in Secondary Memory**

When it comes to accessing data stored in secondary memory, there are primarily two methods:

* **Sequential Access** and **Random Access**.

**Sequential Access**

Definition: Sequential access is a method of accessing data in a linear sequence.

**How It Works**: When you want to find something, the system starts at the beginning of the data and goes through it line by line or record by record. It keeps checking each piece of data until it finds what you’re looking for.

**Example**: Imagine you have a long list of names. If you want to find a specific name, you would start at the top of the list and read each name until you reach the one you want.

**Examples:**

* **Tape Drives:** Tapes store data sequentially, requiring physical movement to access different parts of the tape.
* **Text Files:** Reading a text file line by line involves sequential access.
* **Audio and Video Files:** Playing audio or video files sequentially requires accessing the data in a linear order.