Computer Hardware

1. Components of a Computer

The four classic components of a computer are briefly described below. Moreover, each component will be discussed in more detail in its own section. The operation of the processor is best understood in terms of these components.

1. Input.
2. Central Processing Unit (CPU).
3. Memory.
4. Output.

1. Input device

Input devices allow the user to enter his data into the processor, or control its operation. Most personal computers have a mouse and keyboard, but laptop systems typically use a touchpad instead of a mouse. Other input devices include webcams, microphones, joysticks, and image scanners.

2. CPU

The computer industry used the term "central processing unit" as early as 1955. A central processing unit (CPU), also called a central processor, main processor, microprocessor, or just processor, is the electronic circuitry within a computer that executes instructions that make up a computer program.

The CPU performs basic arithmetic, logic, controlling, and input/output (I/O) operations specified by the instructions in the program.

The work that a CPU does generates heat, which is why your computer has a fan inside. A more powerful CPU is necessary for intense computer work like editing high-definition video or programming complex software.

The CPU is the heart and brain of a computer. It receives data input, executes instructions, and produces information. Which performs most of the processing inside a computer.

A processor register is a quickly accessible location available to a computer's processor. Registers usually consist of a small amount of fast storage, some registers have specific hardware functions, and may be read-only or write-only. Processor registers are normally at the top of the memory hierarchy, and provide the fastest way to access data.

❖ CPU clock speed

CPU clock speed, or clock rate, is measured in **Hertz**, generally in gigahertz or **GHz**. A CPU's clock speed rate is a measure of how many clock cycles a CPU can perform per second. For example, a CPU with a clock rate of 1.8 GHz can perform 1,800,000,000 clock cycles per second.

This seems simple on its face. The more clock cycles a CPU can perform, the more things it can get done, right?

Well, yes and no. On the one hand, clock speeds are useful when comparing similar CPUs in the same family. For example, let's say you're comparing two Intel Haswell Core i5 CPUs, which only differ in their clock rate. One runs at 3.4 GHz, and one runs at 2.6 GHz. In this case, the 3.4 GHz processor will perform 30% faster when they're both running at their top speed.

This is true because the processors are otherwise the same. But you can't compare the Haswell Core i5's CPU clock rate against another type of CPU, such as an AMD CPU, ARM CPU, or even an older Intel CPU.

❖ **Principal components of a CPU include :**

ALU, CU, Registers, and Cache Memory.

a. Arithmetic logic unit (ALU)

It performs arithmetic and logic operations, processor registers that supply operands to the ALU and store the results of ALU operations. Operand? (It is the quantity on which an operation is to be done.), (such as a quantity, data, address, or part of the instruction). Ex. in 7 + y, 7 and y are the operands.

b. Control unit (CU)

It is a component of a computer's central processing unit (CPU) that directs the operation of the processor. It tells the computer's memory, arithmetic and logic unit and input and output devices how to respond to the instructions that have been sent to the processor. It directs the operation of the other units by providing timing and control signals. Most computer resources are managed by the CU. It directs the flow of data between the CPU and the other devices. The Control unit generates control signals that direct the operation of memory and the datapath. The control signals do the following:

1. Tell memory to send or receive data, (fetching).
2. Tell the ALU what operation to perform.
3. Route data between different parts of the datapath. (ALU, register and I\O).

c. Cache Memory a CPU cache is a hardware cache used by the central processing unit (CPU) of a computer to reduce the average cost (time or energy) to access data from the main memory. A cache is a smaller, faster memory, located closer to a processor core, which stores copies of the data from frequently used main memory locations.

Most CPUs have a hierarchy of multiple cache levels (L1, L2, often L3, and rarely even L4), with separate instruction-specific and data-specific caches at level 1.

d. Registers A processor often contains several kinds of registers, which can be classified according to their content or instructions that operate on them:

1. **Data registers:** It can hold (keeps) numeric data values such as integer, floating point values, as well as characters, small bit arrays, and other data. In some older and low-end CPUs, a special data register, known as the accumulator, is used implicitly for many operations.
2. **Address registers:** can hold addresses and are used by instructions that indirectly access primary memory.
3. **General-purpose registers (GPRs):** can store both data & addresses, i.e., they are combined data/address registers.
4. **Special-purpose registers (SPRs):** can hold program state; they usually include the program counter, also called the instruction pointer.
5. **Status registers:** can hold truth values often used to determine whether some instruction should or should not be executed.
6. **Constant registers:** can hold read-only values such as zero, one, or pi.
7. **Vector registers:** can hold data for vector processing done by SIMD instructions (Single Instruction, Multiple Data).
8. **Internal registers:** registers not accessible by instructions, used internally for processor operations.
9. **Instruction register:** It holding the instruction currently being executed.
10. Registers related to **fetching information** from RAM:
    - ❖ Memory buffer register (MBR), also known as Memory data register (MDR).
    - ❖ Memory address register (MAR).

3. Memory

Memory holds instructions and most of the data for currently executing programs. The rest of the data is held in programmable registers, which can only hold a limited amount of data. Computer memory is divided into:

- ❖ Main (or primary) memory.
- ❖ Auxiliary (or secondary) memory.

Main memory holds instructions and data when a program is executing, while auxiliary memory holds data and programs not currently in use and provides long-term storage.

In computing, memory refers to a device that is used to store information for immediate use in a computer or related computer hardware device. It typically refers to semi-conductor memory, specifically Metal-Oxide-Semiconductor (MOS) memory, where data is stored within MOS memory cells on a silicon integrated circuit chip.

The term "memory", meaning "primary storage" or "main memory", is often associated with addressable semi-conductor memory, (silicon-based MOS transistors). There are two main kinds of semiconductor memory, volatile and non-volatile.

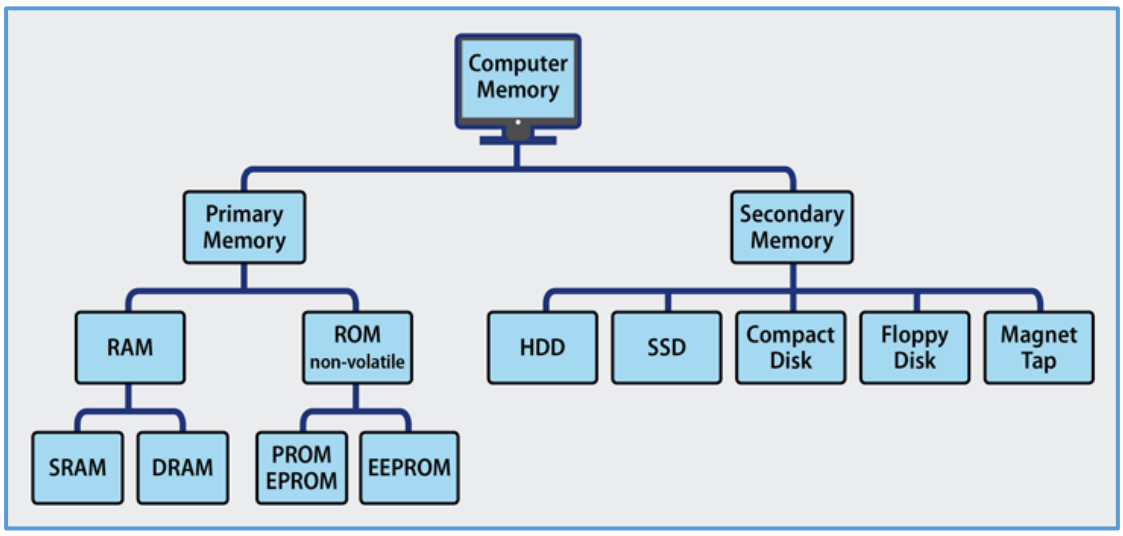
Volatile = Data is lost when power is removed. **Non-volatile** = keeps its data without power. Examples of non-volatile memory are:

- ROM.
- PROM (programmable ROM).
- EPROM (erasable programmable ROM).
- EEPROM (electrically erasable programmable ROM) (used for storing firmware such as BIOS).

Examples of volatile memory are primary storage, which is typically

- RAM.
- DRAM (dynamic RAM; DRAM chip requires only 1capacitor & 1 transistor).

- SRAM (static RAM; much faster than DRAM but energy-consuming. Its high price and used as CPU cache & for processor registers & in networking devices. SRAM chip needs a cell of 6 transistors.



Types of Computer Memory

4. Output device

Output is data going from the processor to external output devices. Output devices are designed around the senses of human beings. For example, monitors display text that can be read, speakers produce sound that can be heard, such devices also could include printers, disks, networks, and other output devices.