Sub: Computer Science

Topic: Computer Memory   **Date: 18ᵗʰ June 2020**

MEMORY UNIT

To process data, both the data to process and the instructions to process them are needed to be stored in the computer. All types of computer data and instructions can be stored in special locations of the computer called the computer memory. Depending upon the type of storage there can be two basic types of memories, namely primary memory and secondary memory.

I.   **PRIMARY MEMORY :-**
     The primary memory is the main memory of the computer and a computer cannot run without it. There are basically two classification of primary memory namely- RANDOM ACCESS MEMORY (RAM) and READ ONLY MEMORY (ROM), where RAM is a volatile memory that is used to temporarily store instructions and data that are needed during a program execution, ROM is a non-volatile memory that stores instructions that are required by the computer during startup or booting. The RAM acts as the working memory for the CPU for storing temporary data but the contents are erased if the power is switched off. In contrast, the computer reads the instructions permanently stored in the ROM every time the power is turned on.

II. **SECONDARY MEMORY :-**
     However to store large volumes of data permanently we need a secondary storage device. The secondary memory is a permanent memory, where the results of data processing are stored from the RAM for future use. Unlike a RAM, one can store both programs and data permanently in a secondary storage. In case permanent storage of data is not required, secondary memory becomes optional. Therefore, a computer may run without permanent storage, but it cannot work without primary memory. Magnetic storage media like hard disks, floppy disks; optical media like CD's, DVD's and semiconductor flash memories are examples of secondary storage memory.

DIFFERENCE BETWEEN PRIMARY AND SECONDARY MEMORY

PRIMARY MEMORY	SECONDARY MEMORY
1) Usually volatile memory.	1) Is a non-volatile memory.
2) Data is lost in case power is switched off.	2) Data is permanently stored even if power is switched off.
3) It is the working memory of the computer.	3) It is used for storage of data in the computer.
4) A computer cannot run without primary memory.	4) A computer may run without secondary memory.
5) Examples of primary memory are RAM & ROM.	5) Examples of secondary memory are hard disk, CD-ROM, DVD, etc.

TYPES OF ROM:-

There are various types of ROM's available. A common feature for all these is their ability to retain data and program forever, even during a power failure. As described below, different types of ROMs are distinguished by the methods used to write new data to them and the number of times they can be rewritten.

I. **ROM :-**
   These are the first semi-conductor ROMs that contained a pre-programmed set of data or instructions. The contents of the ROM had to be specified before manufacturing the chip, so that the actual data could be used to arrange the transistors inside it.

II. **PROM (PROGRAMMABLE ROM) :-**
   It is purchased in an un-programmed state. Special equipment called a device programmer is then used to write the data into PROM. The data is written one word at a time by applying an electrical charge to the input pins of the chip. Once a PROM has been programmed in this way, its contents are permanent. As a result, PROMs are also known as **one-time programmable memories**.

III. **EPROM (ERASABLE AND PROGRAMMABLE ROM) :-**
It is programmed in exactly the same manner as PROM. However unlike a PROM, EPROMs can be erased and reprogrammed repeatedly. To erase an EPROM it is exposed to a strong source of ultraviolet light. By doing this the entire chip is reset to its initial un-programmed state. (It is also sometimes called an **UVEPROM**).

IV. **EEPROM (ELECTRICALLY ERASABLE AND PROGRAMMABLE ROM) :-**
Internally, they are similar to EPROMs, but instead of using UV light, the erase operation is done electrically. Any byte within an EEPROM can be erased and rewritten without the need to reprogram the whole chip, as in an EPROM. (It is pronounced as E^2PROM).

COMPARISON CHART FOR ROMs

TYPE	WRITABLE	COST PER BYTE	SPEED
ROM	NO	INEXPENSIVE	FAST
PROM	ONLY ONCE WITH A DEVICE	MODERATE	FAST
EPROM	MANY TIMES WITH A DEVICE PROGRAMMER	MODERATE	FAST
EEPROM	MANY TIMES	EXPENSIVE	FAST TO READ, SLOW TO ERASE/WRITE

RANDOM ACCESS MEMORY (RAM) :-

Programs are loaded into the main memory and run from there. Data is also loaded into the memory for faster access. This type of memory in which all these operations are done is known as the **Random Access Memory** or **RAM**. It is so called because the amount of time required to access data stored in the RAM is the same, independent of the location of data in the RAM. That is, the data can be randomly accessed with the same access time. Whereas a write operation on a RAM is destructive, a read operation is non-destructive. However, a RAM is volatile in nature and requires a regular supply of power to refresh its contents. In the absence of any refreshing supply or when the computer is switched off, the content of the RAM is lost.

Depending upon its retentive power, a RAM can be broadly classified into a **STATIC RAM** and **DYNAMIC RAM** as described below.

I. **DYNAMIC RAM (DRAM) :-**

A Dynamic RAM cell is a volatile memory that usually consists of a transistor and a capacitor and requires periodic electrical refreshing to retain its data. It needs to be recharged at frequent intervals of time (every two milliseconds) to retain its information. This extra activity makes it comparatively slower than SRAM. To retain the data for a longer time, the DRAM chip is refreshed at regular intervals of time before the data is lost. As the capacitor needs to be recharged at regular intervals of time, such a RAM is called a Dynamic RAM.

II. **STATIC RAM (SRAM) :-**

Unlike a DRAM, SRAM is a type of RAM which can retain its contents as long as electrical power is applied to the chip. However, if the power is switched off, its contents will be lost forever. Instead of a transistor and a capacitor, the memory cell of SRAM consists of a memory laten (made using flip-flop circuits). Once a laten is turned ON, it can retain its value as long as the power is ON without any refreshing, since this RAM do not require periodic refreshing of the existing data, these are called Static RAM and are much faster than Dynamic RAM.

COMPARISON BETWEEN DRAM AND SRAM :-

DRAM	SRAM
1) It is a volatile memory.	1) It is also a volatile memory.
2) Basic memory cell consists of a transistor and a capacitor.	2) Basic memory cell consists of several transistors only.
3) Needs to be refreshed at regular intervals of time to retain its data.	3) No need to refresh at regular intervals of time to retain its data.
4) Packing density is high.	4) Packing density is low.
5) Cost per bit is low.	5) Cost per bit is high.

6) Speed is of the order of 80 nanoseconds.	6) Speed is of the orders of 20 nanoseconds.
7) Used to manufacture main working memory of a computer.	7) Used to manufacture cache memory of a computer.
8) It has high storage capacity.	8) It has low storage capacity.
9) It requires less power.	9) It consumes more power.

DIFFERENCE BETWEEN RAM AND ROM :-

RAM	ROM
1) Full form is Random Access Memory.	1) Full form is Read Only Memory.
2) It is a form of temporary or volatile memory where the memory content is lost if the power is switched off.	2) It is a form of permanent or non-volatile memory where the contents are stored permanently.
3) It is usually used to form the working memory of the computer.	3) It is usually used to form the BIOS chip of the computer.
4) One can both read and write data to a RAM.	4) One can only read data from a ROM.

- **SD-RAM (SYNCHRONOUS DRAM) :-**
  Ram used in computers is generally SDRAM. It works with synchronous speed, i.e. at clock speed of the entire system.

- **DDR SDRAM (DOUBLE DATA RATE SD RAM) :-**
  DDR shuffles data over the bus for every rise and fall of the clock cycle.

- **EDO RAM (EXTENDED DATA OUT RAM)**

- **RDRAM (ROMBUS DRAM)**

- **VRAM (VIDEO RAM)**

CACHE MEMORY:-

Cache memory is also a type of volatile memory like RAM but is much faster than RAM. It is basically made using static RAM technology and hence the access time of cache memory is much faster than that of RAM. It is thus used to temporarily store active data and instructions during processing and functions in between the CPU and the main memory, i.e. the RAM.

As most programs contain a number of iterative loops (such as while and for), if an instruction is executed there is a likelihood of the same instruction being executed again soon. Similarly while working with tables, records or arrays of data, the processor works with the same set of data over a short period of time. This type of instruction and data that is needed frequently is stored in the cache memory of a computer for faster access. A computer system can contain more than one cache memory.

TYPES OF CACHE:-

   I.   **ASYNCHRONOUS SRAM.**
   II. **SYNCHRONOUS BURST SRAM.**
   III. **PIPELINE BURST SRAM.**

MEMORY REGISTER :-

Apart from the cache memory, the processor contains several special high speed memory registers located inside the control unit and the ALU. These are used to store the current instruction and data, address of the next instruction to execute and the immediate result of any registers to access data and instructions. Examples of some of these registers are :-

   a) **MEMORY ADDRESS REGISTER (MAR):-**
      Used to hold the address of the current memory location.

   b) **INSTRUCTION REGISTER (IR):-**
      Holds the current instruction that is being executed.

   c) **PROGRAM COUNTER (PC):-**
      Holds the address of the next instruction to be executed.

   d) **INPUT/OUTPUT RESISTERS:-**
      These are used to communicate with the input/output devices.

   e) **ACCUMULATOR (AC):-**
      It is used to store the result of any arithmetic operation in ALU.

FLASH MEMORY:-

Flash memory is a solid storage device, which means that there are no mechanical moving parts and everything is done electronically. It works similar to an EEPROM and use a special CMOS transistor. With an additional second gate called a floating gate. The presence of this floating gate makes the flash memory non-volatile in nature, which means that the data is not lost even if the power is switched off. These can be electrically programmed to store, modify, or erase data.

Flash memory is nowadays used in various applications like in the Computer's BIOS Chip, Smart Media, Compact Flash (which are usually found in digital cameras),pen drives (used as a removable storage device for general data backup and storage).