

Fundamentals of Computers and Computing

CSE 1101

(Computer Memory)

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Computer Memory

- Computer **memory** is any physical device capable of storing information temporarily like **RAM** (random access memory), or permanently, like **ROM** (read-only memory).
- The memory is divided into large number of small parts called cells.
- Each location or cell has a unique address which varies from zero to memory size minus one.
- For example if computer has 64k words, then this memory unit has $64 * 1024 = 65536$ memory locations. The address of these locations varies from 0 to 65535.

Memory Units

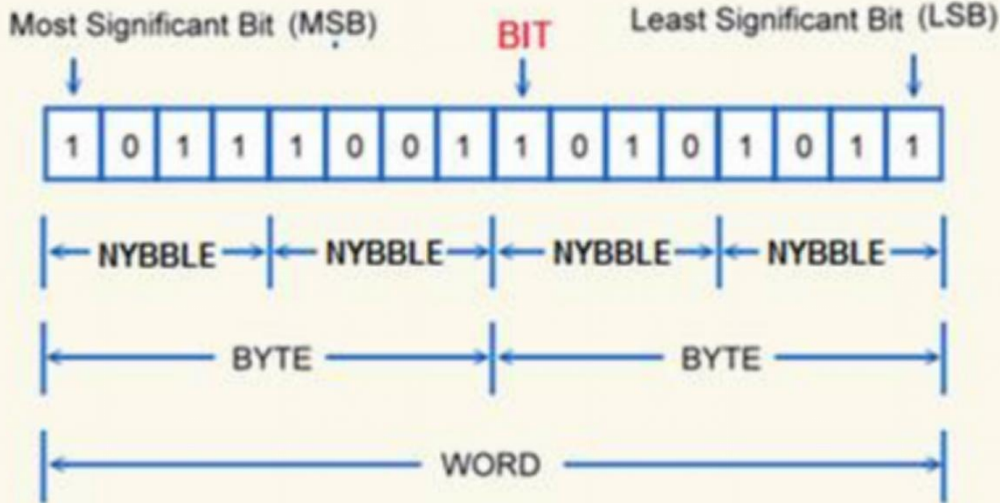
- A **bit** (short for **b**inary **dig**it) is the smallest unit of data in a computer. A **bit** has a single binary value, either 0 or **1**. **Bits** are generally designed to store data and execute instructions in **bit** multiples called bytes.
- **Nibble**: A group of 4 bits is called nibble.
- The **byte** is a unit of digital information that most commonly consists of **eight bits**. Historically, the **byte** was the number of **bits** used to encode a single character of text in a computer and for this reason it is the smallest addressable unit of memory in many computer architectures.

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- Word: A computer **word**, like a byte, is a group of fixed number of bits processed as a unit which varies from computer to computer but is fixed for each computer. A word is basically the number of bits a particular computer's CPU can deal with in one go. It varies depending on the computer architecture.
- The length of a computer word is called **word-size** or **word length** and it may be as small as **8 bits** or **may be as long as 96 bits**. A computer stores the information in the form of computer words.

Computer Memory Organization

UNDERSTANDING BITS , NYBBLE , BYTE , WORD



Memory

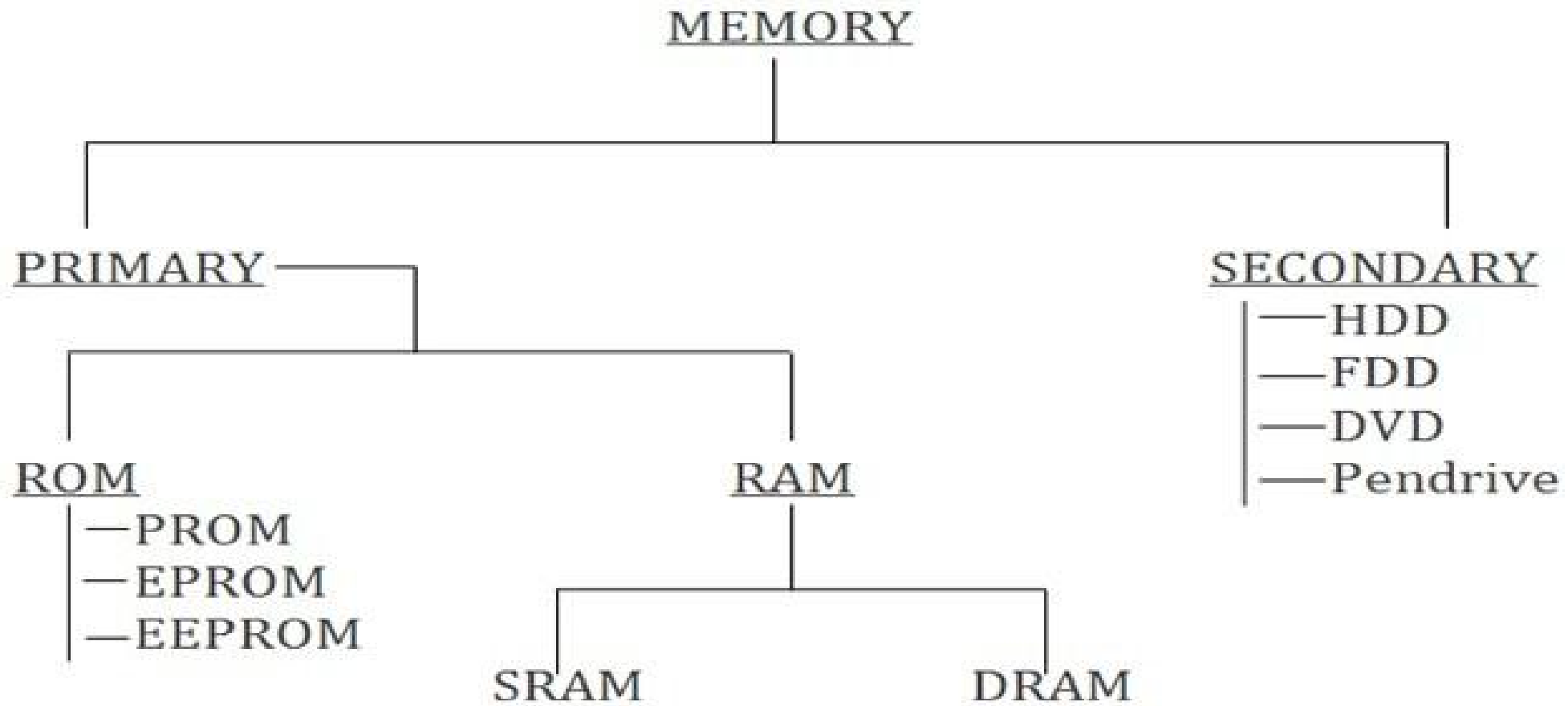
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Sr.No.	Unit	Description
1	Kilobyte (KB)	1 KB = 1024 Bytes
2	Megabyte (MB)	1 MB = 1024 KB
3	GigaByte (GB)	1 GB = 1024 MB
4	TeraByte (TB)	1 TB = 1024 GB
5	PetaByte (PB)	1 PB = 1024 TB

Types of Computer Memory

1. Primary Memory/Main Memory
2. Secondary Memory
3. Cache Memory

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Primary Memory (Main Memory)

- Primary memory holds only those data and instructions on which computer is currently working. It has limited capacity and data is lost when power is switched off. It is generally made up of semiconductor device. The data and instruction required to be processed reside in main memory. It is divided into two subcategories: RAM and ROM.

Characteristics of Main Memory

- These are semiconductor memories
- It is known as main memory.
- Usually volatile memory.
- Data is lost in case power is switched off.
- It is working memory of the computer.
- Faster than secondary memories.
- A computer cannot run without primary memory.

Random Access Memory

- RAM(Random Access Memory) is the internal memory of the CPU for storing data, program and program result. It is read/write memory which stores data until the machine is working. As soon as the machine is switched off, data is erased.
- Access time in RAM is independent of the address that is, each storage location inside the memory is as easy to reach as other locations and takes the same amount of time. Data in the RAM can be accessed randomly but it is very expensive.

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- RAM is volatile, i.e. data stored in it is lost when we switch off the computer or if there is a power failure. Hence a backup **uninterruptible power system(UPS)** is often used with computers. RAM is small, both in terms of its physical size and in the amount of data it can hold.
- RAM is of two types
 - I. Static RAM (SRAM)
 - II. Dynamic RAM (DRAM)

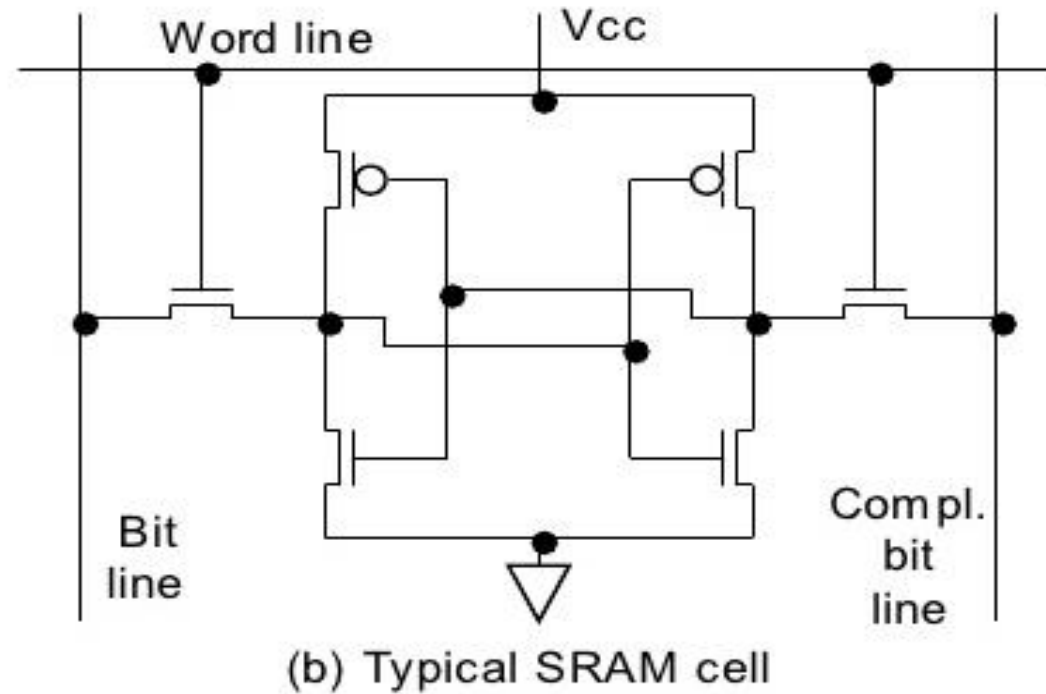
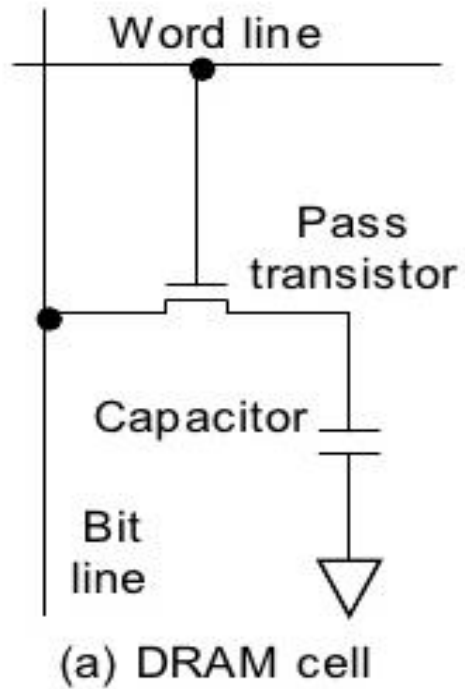
I. Static RAM (SRAM)

- The word **static** indicates that the memory retains its contents as long as power is being supplied. However, data is lost when the power gets down due to volatile nature. SRAM chips use a matrix of **6-transistors** and no **capacitors**. Transistors do not require power to prevent leakage, so SRAM need not have to be refreshed on a regular basis.
- Because of the extra space in the matrix, SRAM uses more chips than DRAM for the same amount of storage space, thus making the manufacturing costs higher. So SRAM is used as cache memory and has very fast access.

II. Dynamic RAM (DRAM)

- DRAM, unlike SRAM, must be continually **refreshed** in order to maintain the data. This is done by placing the memory on a refresh circuit that rewrites the data several hundred times per second. DRAM is used for most system memory because it is cheap and small. All DRAMs are made up of memory cells which are composed of one **capacitor** and one **transistor**.

Random Access Memory



Read Only Memory (ROM)

- ROM stands for Read Only Memory. The memory from which we can only read but cannot write on it. This type of memory is non-volatile. The information is stored permanently in such memories during manufacture. A ROM, stores such instructions that are required to start a computer. This operation is referred to as **bootstrap**. ROM chips are not only used in the computer but also in other electronic items like washing machine and microwave oven.

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- There are several kinds of ROM
 1. MROM (Masked ROM)
 2. PROM (Programmable ROM)
 3. EPROM (Erasable and Programmable ROM)
 4. EEPROM (Electrically Erasable and Programmable ROM)

MROM (Masked ROM)

- The very first ROMs were hard-wired devices that contained a pre-programmed set of data or instructions. These kind of ROMs are known as masked ROMs which are inexpensive.

PROM (Programmable Read only Memory)

- PROM is read-only memory that can be modified only once by a user. The user buys a blank PROM and enters the desired contents using a PROM program. Inside the PROM chip there are small **fuses** which are burnt open during programming. It can be **programmed** only once and is not **erasable**.

EPR0M(Erasable and Programmable Read Only Memory)

- The EPR0M can be erased by exposing it to ultra-violet light for a duration of up to 40 minutes. Usually, an EPR0M eraser achieves this function. During programming, an electrical charge is trapped in an insulated gate region. The charge is retained for more than ten years because the charge has no leakage path. For erasing this charge, ultra-violet light is passed through a quartz crystal window(lid). This exposure to ultra-violet light dissipates the charge. During normal use the quartz lid is sealed with a sticker.

EEPROM(Electrically Erasable and Programmable Read Only Memory)

- The EEPROM is programmed and erased electrically. It can be erased and reprogrammed about ten thousand times. Both erasing and programming take about 4 to 10 ms (millisecond). In EEPROM, any location can be selectively erased and programmed. EEPROMs can be erased one byte at a time, rather than erasing the entire chip. Hence, the process of re-programming is flexible but slow.

Secondary Memory

- Whenever there is a need to store huge amount of information, it is stored in the secondary memory. These are used for storing data/Information permanently. This type of memory is also known as external memory or non-volatile. This type of memory is characterized with the help of virtues of large capacity for storage and low cost per bit of storage. But it is slower than main memory. The control unit is not capable to directly access secondary storage. Contents of secondary memories are first transferred to main memory, and then CPU can access it. Hard disk, floppy disk, and flash drive are good examples of secondary memory.

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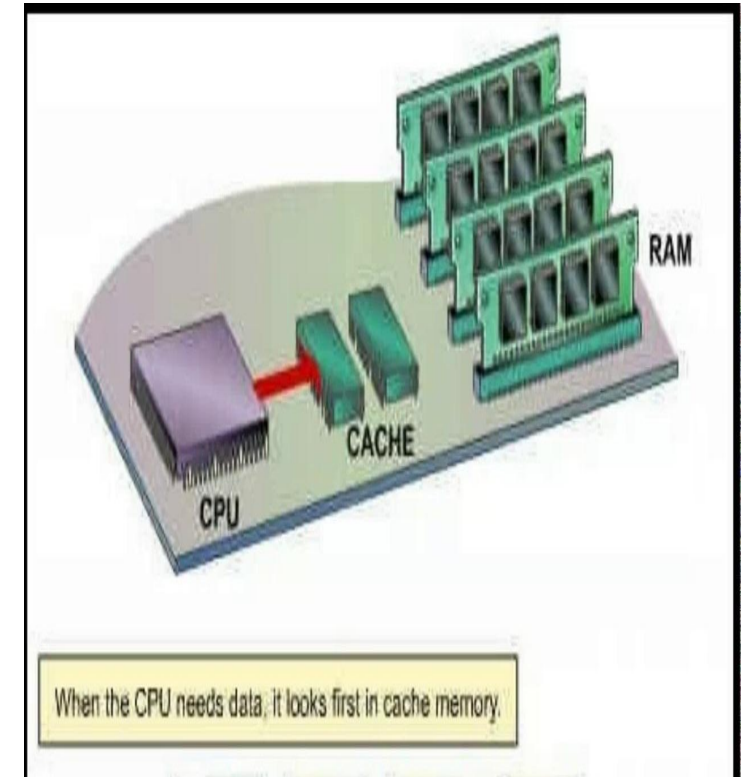
Fig.: Secondary memory

Cache Memory

- The *Cache Memory* is the volatile computer memory which is very nearest to the CPU so also called **CPU memory**, all the Recent Instructions are Stored into the Cache Memory. It is the fastest memory that provides high-speed data access to a computer microprocessor. But the Capacity of the Cache Memory is too low in compare to Memory (random access memory (RAM)) and Hard Disk.

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- Cache memory is a very high speed **semiconductor memory** which can speed up CPU.
- It acts as a buffer between the **CPU and main memory.**
- It is used to hold those parts of data and program which are most frequently used by CPU.
- The parts of data and programs are transferred from **disk** to cache memory by operating system, from where CPU can access them.



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❑ **Advantages**

- Cache memory is faster than main memory.
- It consumes less access time as compared to main memory.
- It stores the program that can be executed within a short period of time.
- It stores data for temporary use.

❑ **Disadvantages**

- Cache memory has limited capacity.
- It is very expensive.