

Chapter 4

Primary Memory

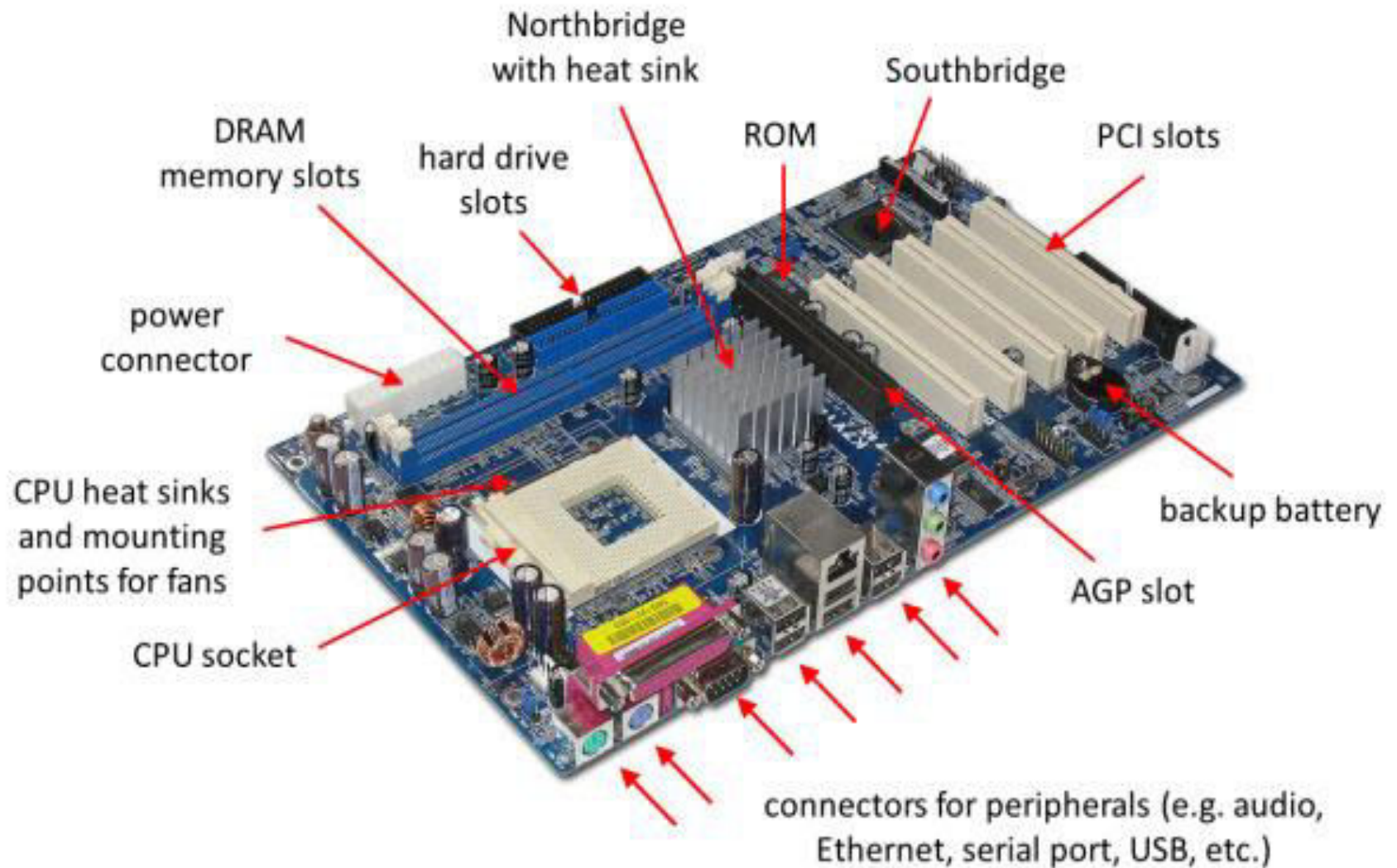


Introduction

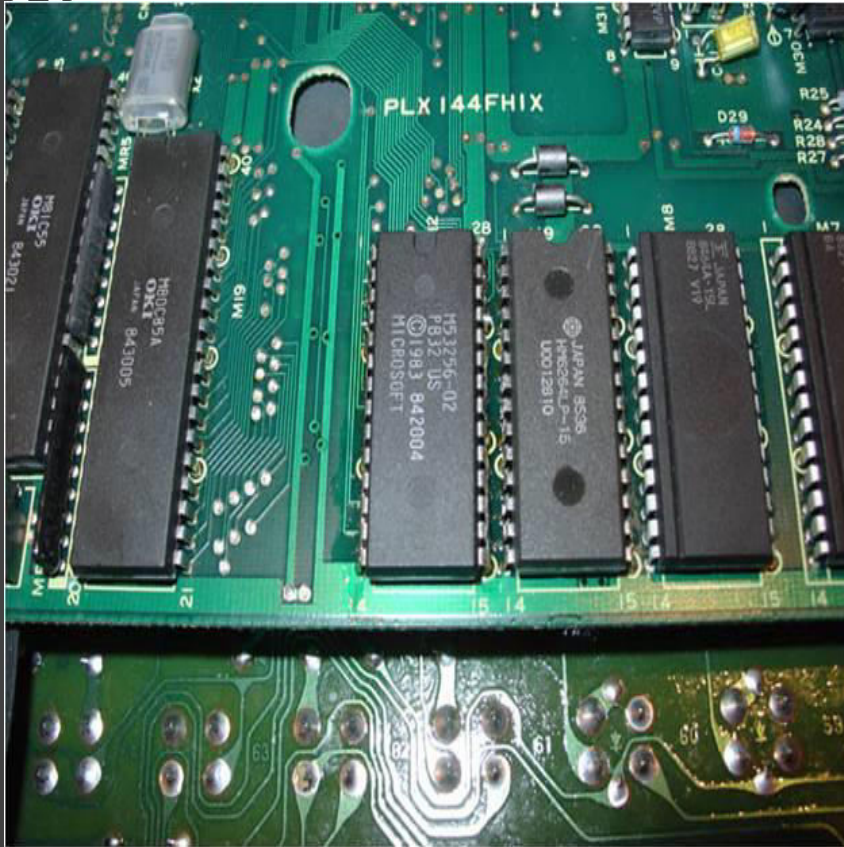
- Computer Memory Refers to electronics holding place for instruction and data where the processor can reach quickly.
- Memory can be classified into two broad categories:
 - (1) **Primary** Memory (to handle the data).
 - (2) **Secondary** Memory (to store the output).



Motherboard



ROM, RAM



Memory Representation

- The basic unit of memory is bit. Memory can be represented in the bit and bytes..
 - 1 Bit = Binary Digit
 - 8 Bits = 1 Byte
 - $2^{10} = 1024$ Bytes = 1 KB (**Kilo Byte**)
 - $2^{20} = 1024$ KB = 1 MB (**Mega Byte**)
 - $2^{30} = 1024$ MB = 1 GB (**Giga Byte**)
 - $2^{40} = 1024$ GB = 1 TB(**Terra Byte**)

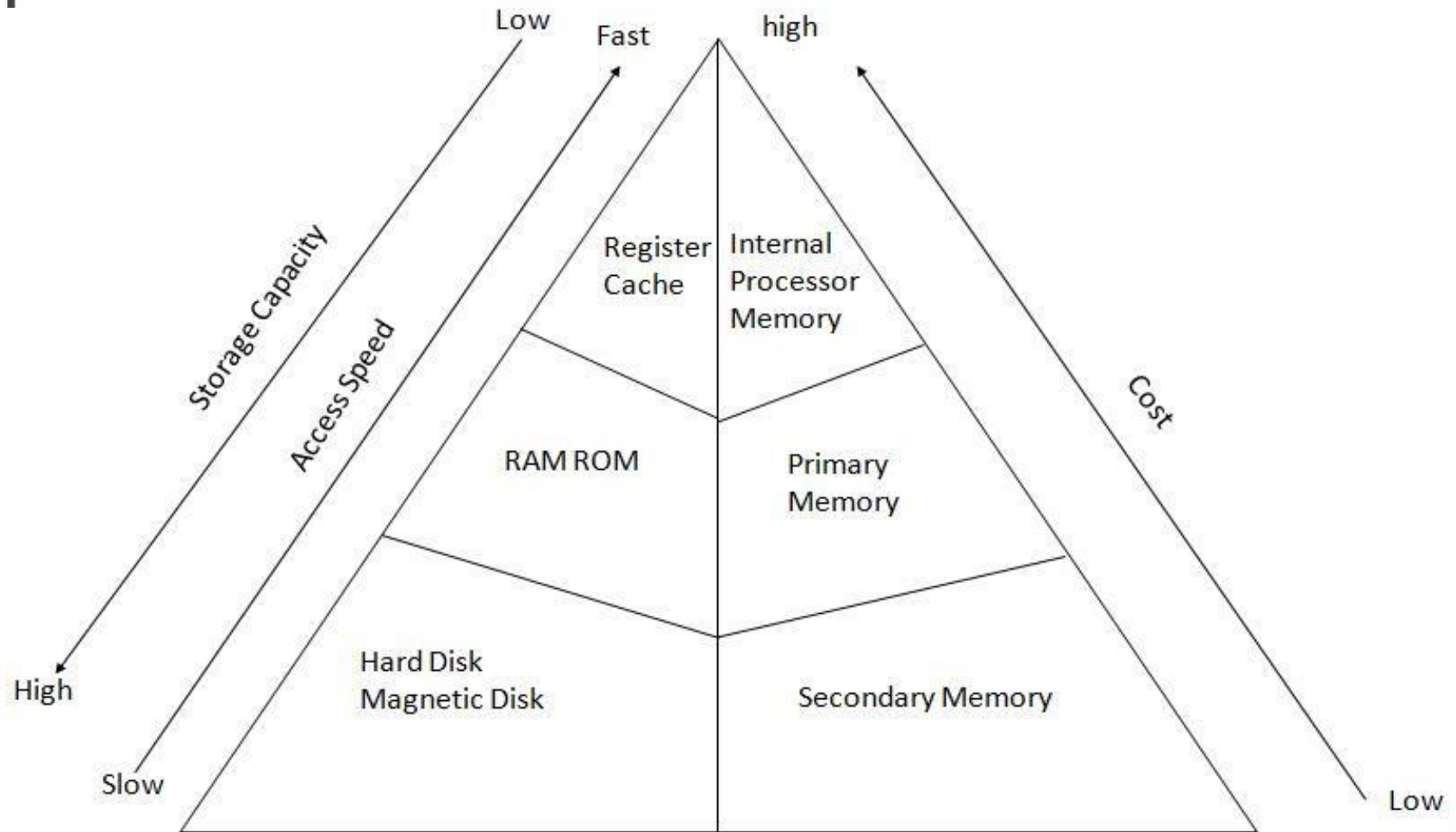


Memory Hierarchy

- The memory is characterized on the basis of two key factors— capacity and access time.
- Three fundamental types of memory:
 - Internal processor Memory
 - This memory is placed in CPU and it includes cache memory and special registers, both of which can be directly accessed by processor.
 - Primary Memory
 - RAM and ROM fall in the category of primary memory, also known as main memory.
 - Secondary Memory
 - Also known as auxiliary memory, secondary memory provides backup storage for instructions and data.
 - Most commonly used secondary memory devices are hard disk, magnetic disk, and magnetic tapes.



Memory Hierarchy



Storage Evaluation Criteria

- Storage Capacity
 - It refers to size of memory.
- Cost
 - Estimated by the cost per bit of storage.
- Access Time
 - Time required between the request made for read/write operation and time it takes for completion of the request.
- Physical Characteristics
 - Four parts namely, electronic, magnetic, mechanical and optical
- Permanence of Storage
- Access Mode
 - Sequential
 - Random
 - Direct



READ ONLY MEMORY (ROM)

- ROM stands for Read Only Memory.
 - we can only read but cannot write on it.
 - It 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 in the computer, other electronic items like washing machine and microwave oven.
- **BIOS(Basic Input Output System)** is the responsible for the startup of computer so it can be considered as a Read only memory.
- ROM for each and Every computer may be different that's what the compatibility issue of platform generating while we use a different platform.
- Also can said **OTP(One time programmed)** means if it is programmed once it cannot be reprogrammed.



Types of ROM

1. Masked ROM:

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

2. Programmable ROM (PROM):

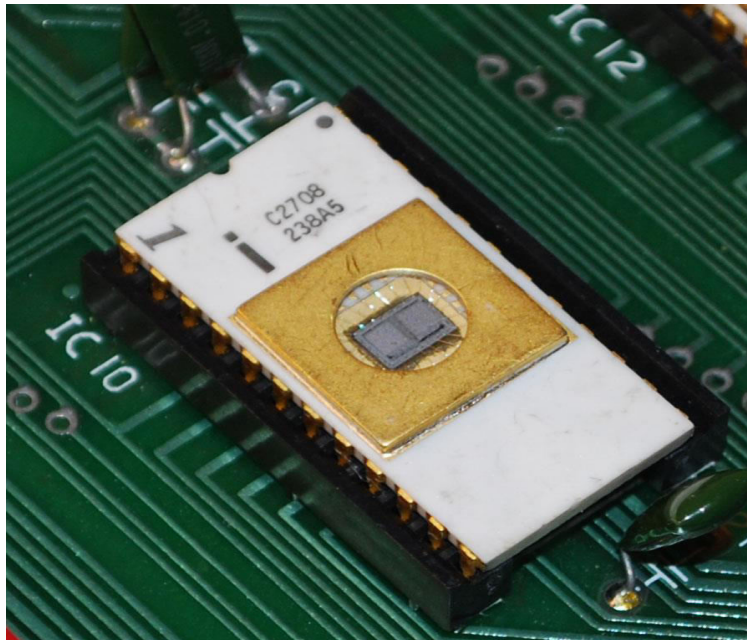
- The user buys a blank PROM and enters the desired contents using a PROM program, also known as one-time programmable (OTP) device
- Inside the PROM chip there are small fuses which are burnt out during programming.
- It can be programmed only once and is not erasable.



Types of ROM (cont..)

3. Erasable Programmable ROM (EPROM):

- EPROM can be erased by exposing it to **ultra-violet light** for a duration of up to 40 minutes.
- This process will erase the entire EPROM and then it reprogrammed.
- EPROMs are more expensive than PROMs.



Types of ROM (cont..)

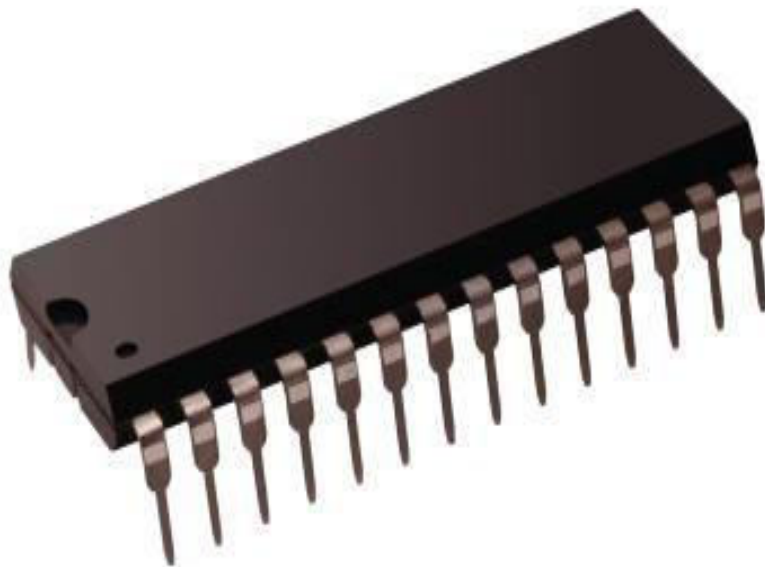
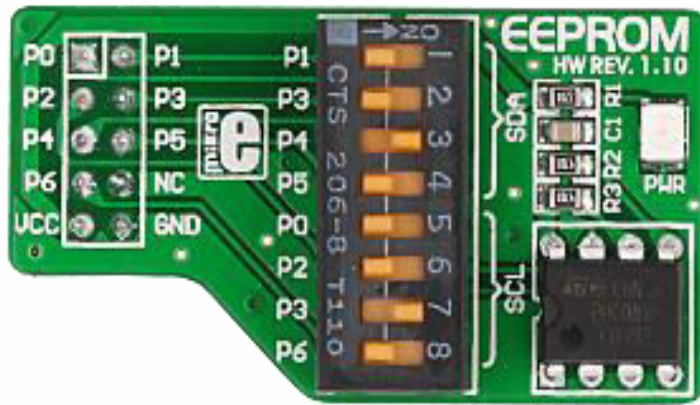
4. Electrically Erasable and Programmable Read Only Memory (EEPROM):

- EEPROM can be erased by an electrical charge and then written to by slightly higher-than-normal voltage.
- 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.

5. Flash ROM:

- Flash ROM, also called **flash BIOS** or flash memory, is a type of constantly powered non-volatile memory that can be erased and re-programmed in blocks.
- It is a variation of EEPROM.





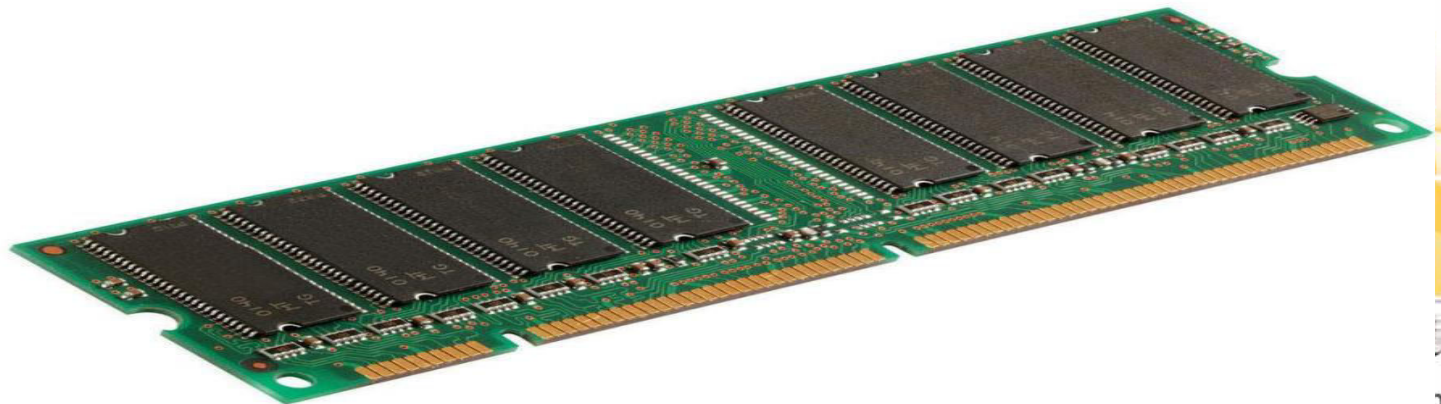
Advantages of ROM

- ❖ The advantages of ROM are as follows:
 - Non-volatile in nature
 - These cannot be accidentally changed
 - Cheaper than RAMs
 - Easy to test
 - More reliable than RAMs
 - These are static and do not require refreshing
 - Its contents are always known and can be verified

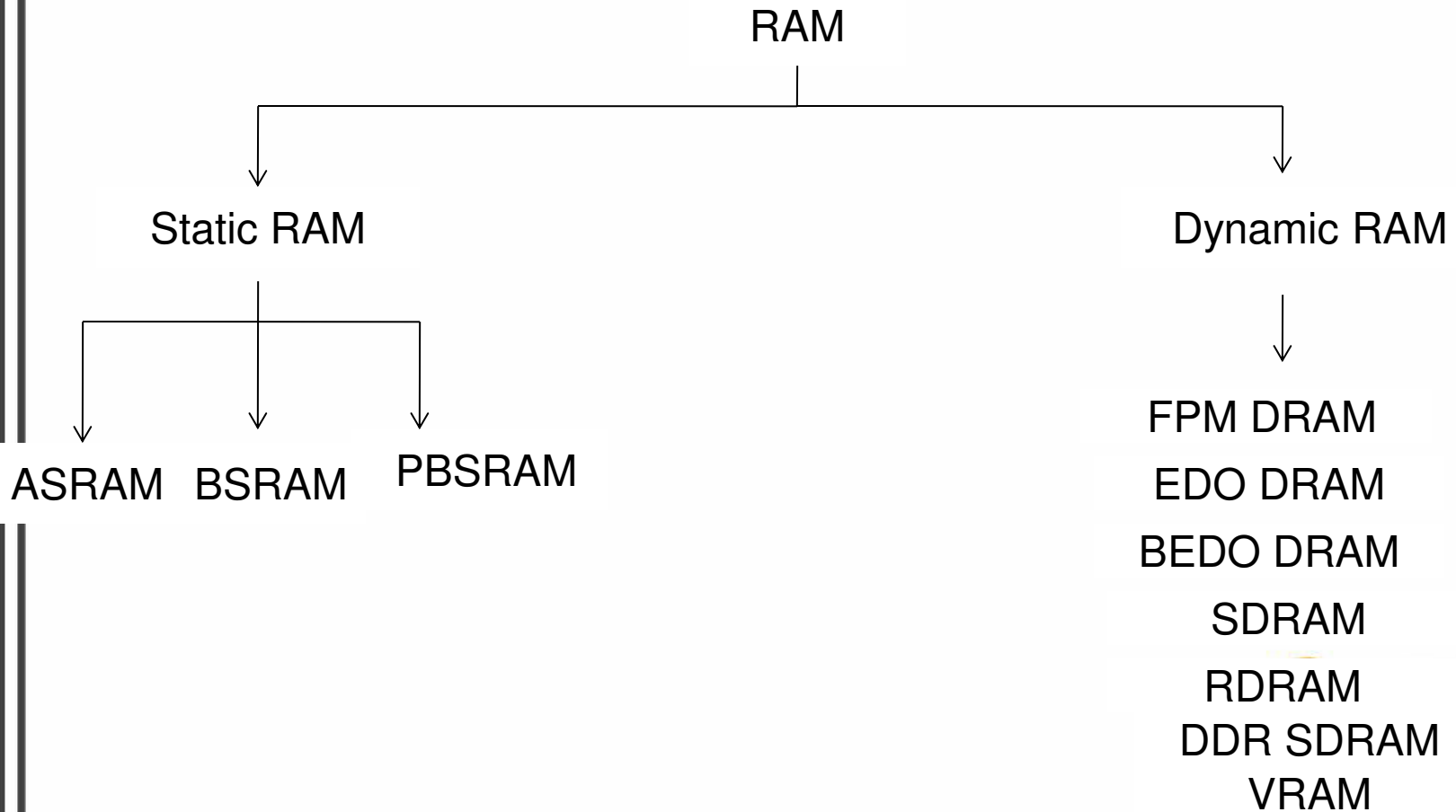


Random Access Memory (RAM)

- RAM(Random Access Memory) is the primary 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.
- RAM is **volatile**, i.e. data stored in it is lost when we switch off the computer or if there is a power failure.
- RAM is small, both in terms of its physical size and in the amount of data it can hold.
- Data in the RAM can be accessed randomly but it is very expensive.



Types Of RAM



Types of RAM



Static RAM

- 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.
- It does not need to be **refreshed** periodically.
- SRAM chips use a matrix of 6-transistors and no capacitors.
- SRAM is very fast but more expensive than DRAM.
- SRAM uses more chips than DRAM for the same amount of storage space, thus making the manufacturing costs higher.
- It is often used as cache memory due to its high speed.



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.



SRAM versus DRAM

- Primary difference => lifetime of the data they store.
 - SRAM retains its contents as long as power is applied on the chip.
 - DRAM has an extremely short data lifetime.
- Total number of cells in the SRAM chip is less than DRAM
- SRAM is fast, has **low latency** (time gap between request and the action being performed), and does not need to be refreshed.
- SRAM is large and expensive. It require more power to operate so it produces a lot of heat.



SRAM versus DRAM

- DRAM is simple, small and **space efficient**. It is slower and have longer latency than SRAM.
- SRAM has lower access time as compared to DRAM.

