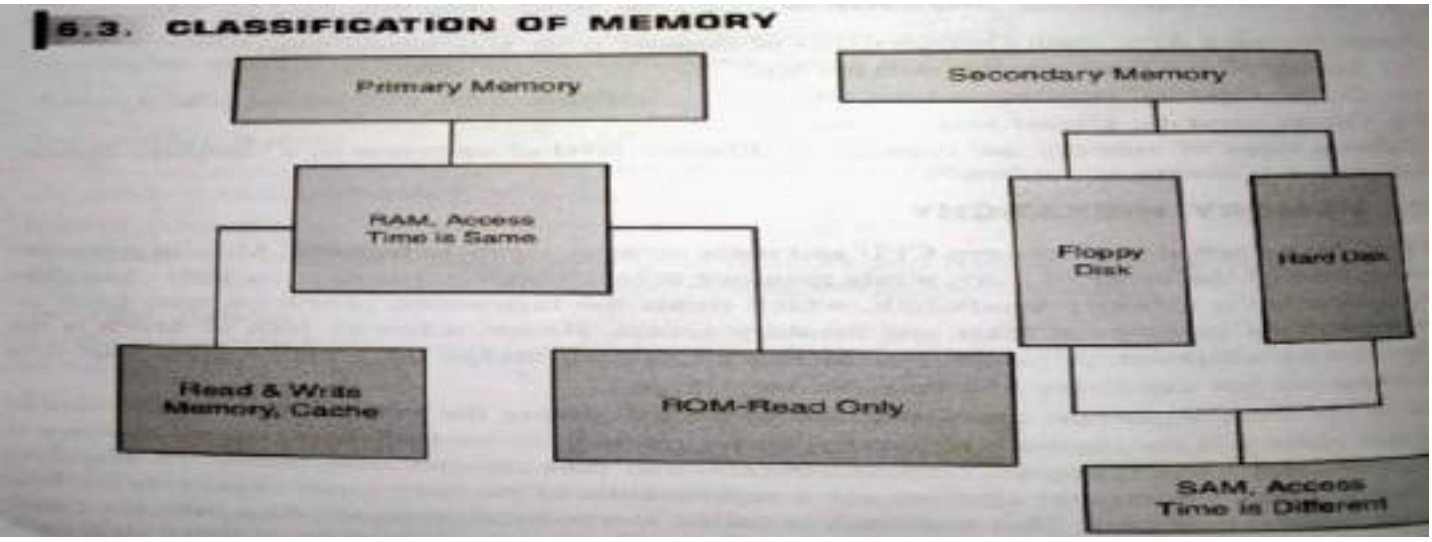
6.3. CLASSIFICATION OF MEMORY



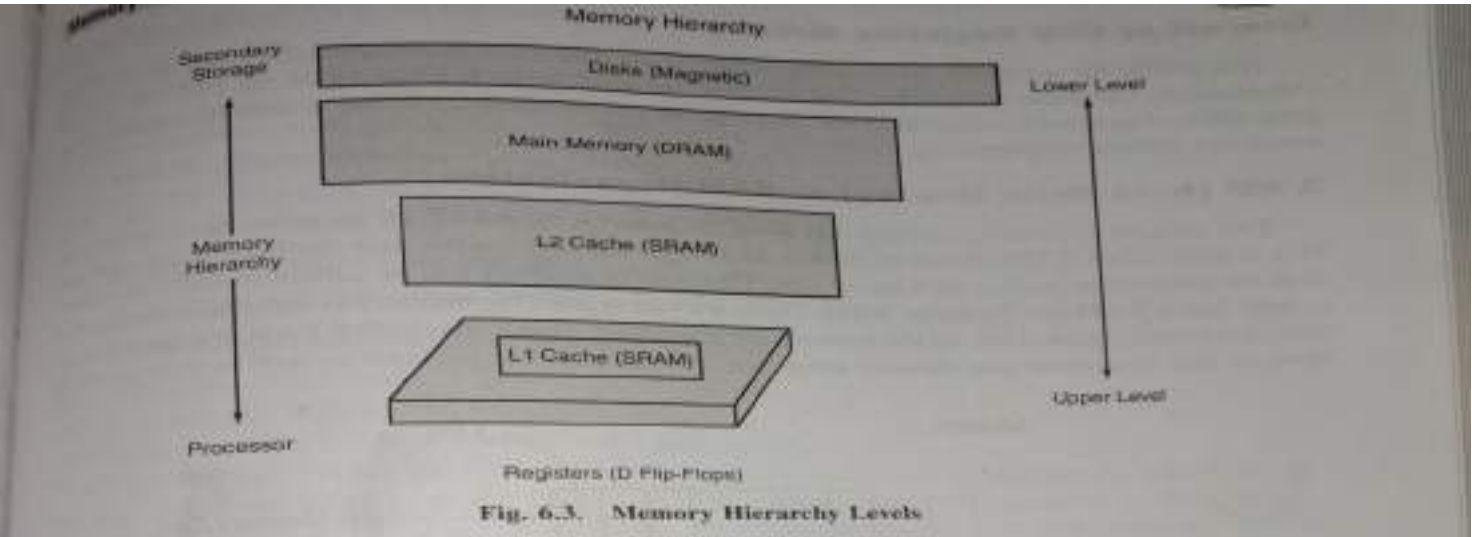
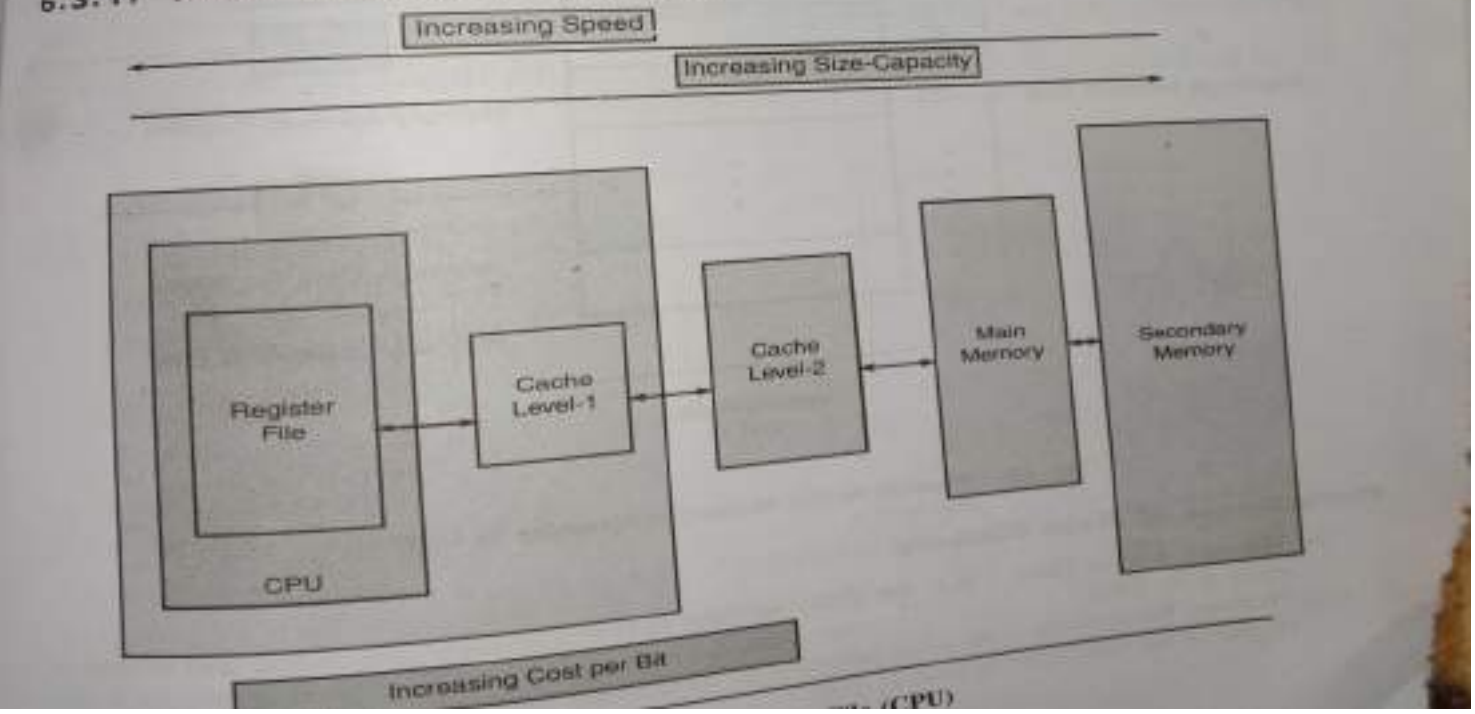


Fig. 6.3. Memory Hierarchy Levels

6.3.1. Main or Primary Memory



Internal or CPU Registers Memory

Every CPU has a register file or array which is used by CPU as internal temporary memory for computation, therefore, sometimes this is called **internal scratch memory** of the CPU. A system programmer has access to this memory. Any register can be accessed by the system programmer for usage like system programming.

R/WM (Read Write Memory) or RAM Organisation

This memory is volatile, meaning that when the power is turned off, all the contents are destroyed. This is also called RAM (Random Access Memory) and also called user memory since user can store his program as well as data inside this. This type of memory can be subdivided into two main groups: Static RAM and Dynamic RAM. There are two types.This memory is volatile, meaning that when the power is turned off, all the contents are destroyed. This is also called RAM-Random Access Memory and also called user memory since user can store his/her program as well as data inside it.

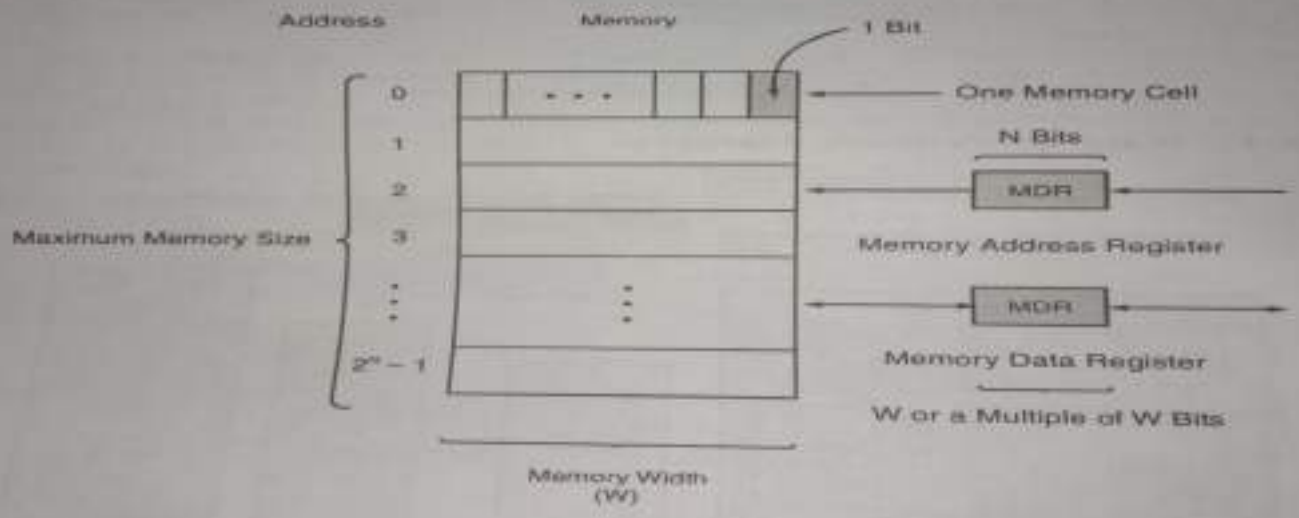


Fig. 6.5. Random Access Memory Addressing by CPU

Performance of Main Memory

(i) **Memory Access Time :** It is the delay or time between request generation and arrival of word in the CPU.

(ii) **Memory Bandwidth :** At what rate data is transferred between CPU and main memory. Higher is the rate better is your system.

Address is Represented in Hexadecimal or Octal

The term comes from the way data is accessed in this memory, and symbolizes the possibility to access any part of the memory at any given time. The contrary would be sequential memory, which mostly has a meaning in tape backup situations. Early computers also used drum memory, which was sequential (kind of) in nature.

(i) **SRAM – Static Random Access Memory**

(ii) **DRAM – Dynamic Random Access Memory**

- FP – Fast Page RAM
- EDO – Extended Data Output
- SDRAM – Synchronous DRAM

Static RAM Organization and Main Features

(i) It is made of flip-flops.

(ii) Low density, high power, expensive, fast.

(iii) Static: content will last "forever"(until lose power)

The term comes from the way data is accessed in this memory, and symbolizes the possibility to access any part of the memory at any given time. The contrary would be sequential memory, which mostly has a meaning in tape backup situations. Early computers also used drum memory, which was sequential (kind of). All computer memory modules used in computers today are of the RAM type. A RAM is organized typically as bytes to store data and its address is represented in HEX-Format. Any memory configuration can be fabricated using basic SRAM Cell and address decoder circuit.

Write : (i) Drive Bit Lines (Bit = 1, Bit = 0) (ii) Select Row; Read : (i) Precharge Bit and Bit to V_{dd} or $V_{dd}/2 \rightarrow$ Make Sure Equal! (ii) Select Row (iii) Cell Pulls One Line Low (iv) Sense Amp on Coloumn

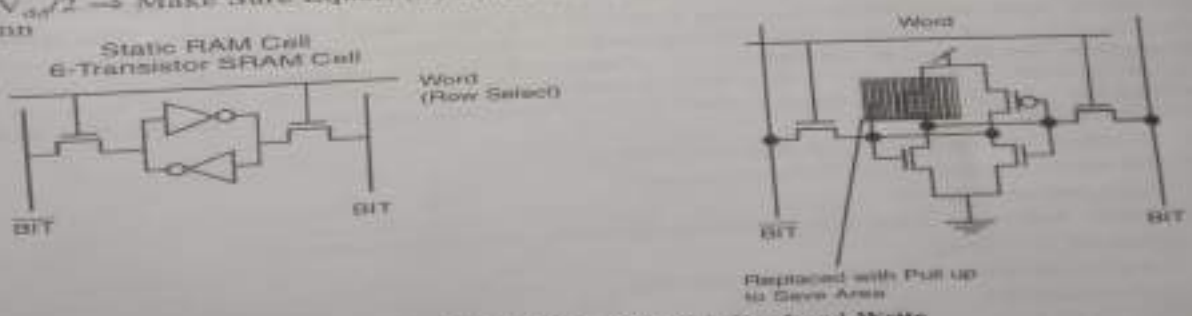


Fig. 6.6. Static RAM Cell With Read and Write

(i) Based on flip-flops and requires several transistors.

(ii) Fast access time and bits stored as on/off switches.

(iii) No charges to leak and No refreshing needed when powered.

(iv) Used in Cache memory design.

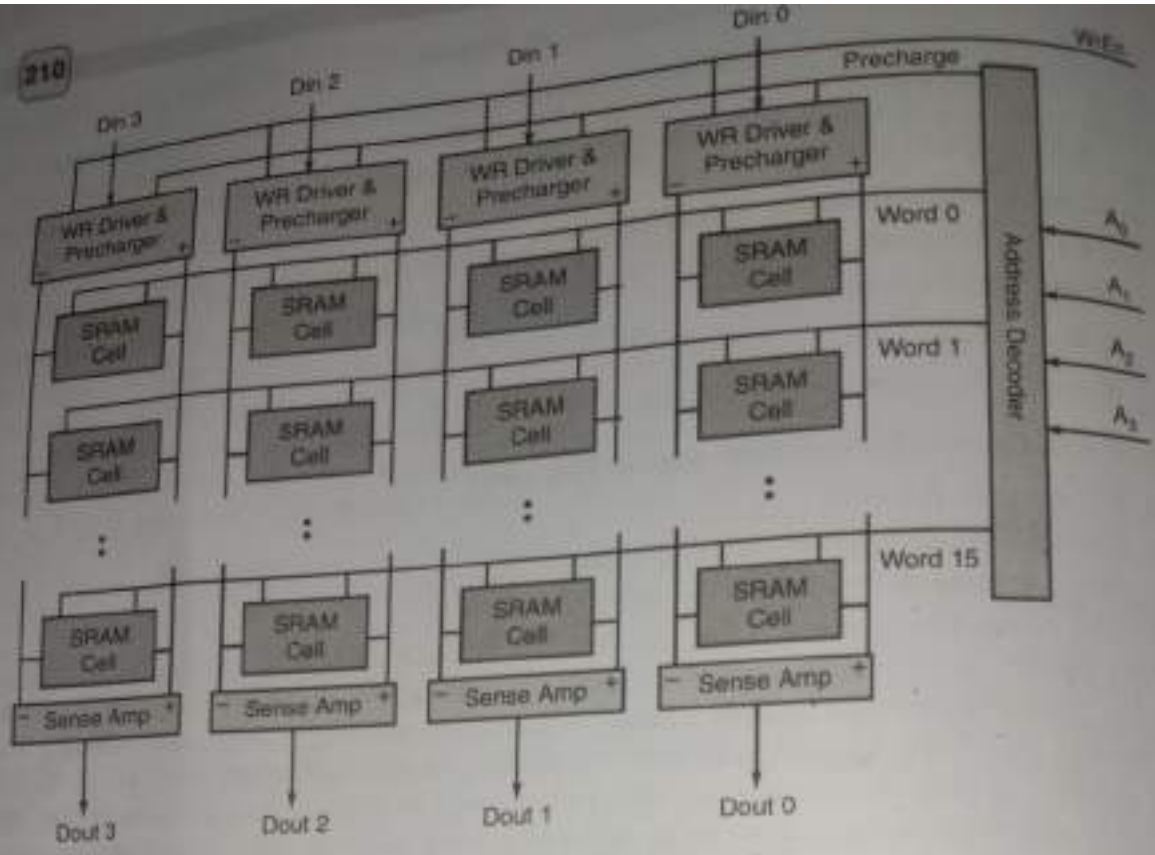


Fig. 6.7. SRAM Organisation 16-Works × 4 Bit

DRAM Organization

DRAM is made up of MOS Transistor Gates. It is a refreshing type memory. The difference between the two is that as long as power is maintained on the memory modules the DRAM will hold its information. The content of DRAM memory disappears from the memory within milliseconds, so in order to maintain its data it has to be refreshed periodically. This makes the DRAM memory much slower than the SRAM. The computer memories you usually see are a form of DRAM, like SDRAM and DDR-SDRAM.

(*i*) Requires one capacitor and one transistor.
(*ii*) But needs refresh every few milliseconds.
(*iii*) Need refresh circuits.
(*iv*) Slower access time and bits stored as charge in capacitors.
(*v*) Charges may leak.
(*vi*) Simpler construction and smaller per bit.
(*vii*) Less expensive.

Dynamic RAM is constructed of tiny capacitors that leak electricity. DRAM requires a recharge every few milliseconds to maintain its data. Static RAM technology, in contrast, holds its contents as long as power is available. SRAM consists of circuits similar to the D flip-flops. SRAM is faster and much more expensive than DRAM; however, designers use DRAM because it is much denser (can store many bits per chip), uses less power, and generates less heat than SRAM. The different types of SRAM include asynchronous **SRAM**, synchronous **SRAM**, and **pipeline burst SRAM.**

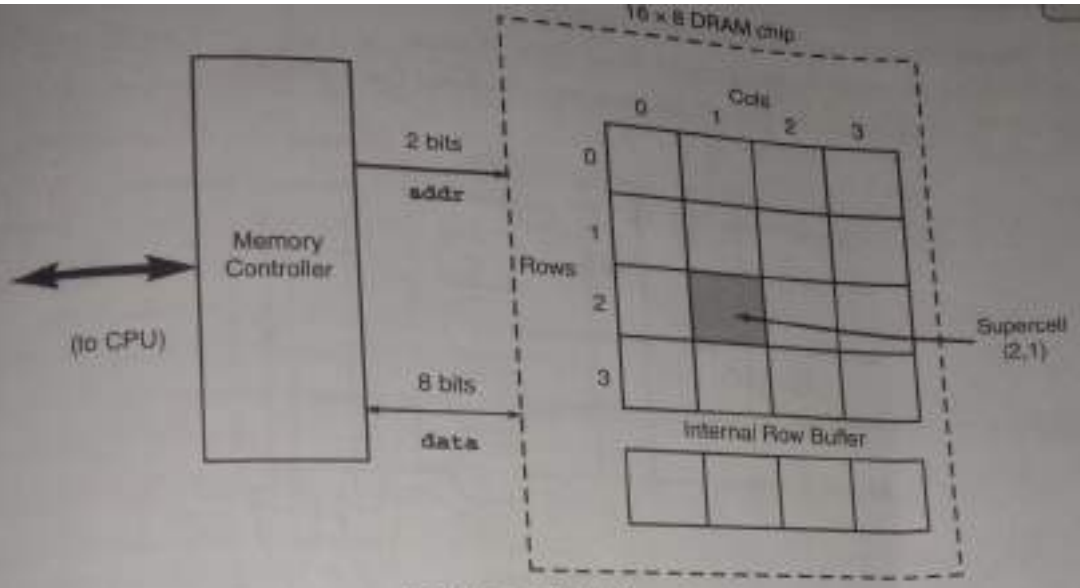


Fig. 6.8. DRAM Organisation

For these reasons, both technologies are often used in combination: DRAM for main memory and SRAM for cache. The basic operation of all DRAM memories is the same, but there are many flavors, including Multibank DRAM (MDRAM), Fast-Page Mode (FPM) DRAM, Extended Data Out (EDO) DRAM, Burst EDO DRAM (BEDO DRAM), Synchronous Dynamic Random Access Memory (SDRAM), Synchronous-Link (SL) DRAM, Double Data Rate (DDR) SDRAM, and Direct RAMBUS DRAM.

Circuit Structure and Actual DRAM Chips (DRAM)

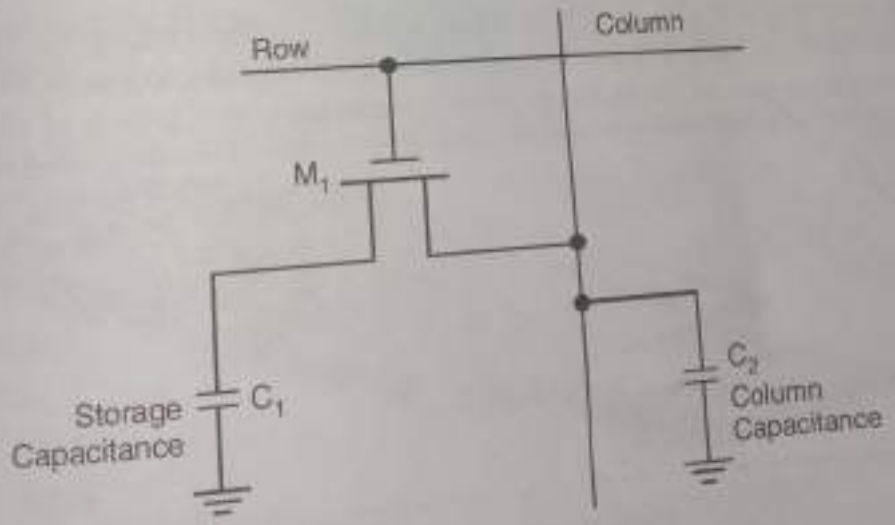


Fig. 6.9. DRAM Circuit