Lecture three
The processor and Memory

What is a Processor?

Definition: The processor is a chip or a logical circuit that responds and processes the basic instructions to drive a particular computer. The main functions of the processor are fetching, decoding, executing, and write back the operations of an instruction. The processor is also called the brain of any system which incorporates computers, laptops, smartphones, embedded systems, etc. The ALU (Arithmetic Logic Unit) and CU (Control Unit) are the two parts of the processors. The Arithmetic Logic Unit performs all mathematical operations such as additions, multiplications, subtractions, divisions, etc and the control unit works like traffic police, it manages the command or the operation of the instructions. The processor communicates with the other components also they are input/output devices and memory/storage devices.

CPU Operations

The three primary functions of a processor are fetch, decode, execute and write back.

- Fetch- is the operation which receives instructions from program memory from a system RAM.
- Decode- is where the instruction is converted to understand which other parts of the CPU are needed to continue the operation. This is performed by the instruction decoder
- Execute- is where the operation is performed. Each part of the CPU that is needed is activated to carry out the instructions.

The logic inside the microprocessor chip can be divided into three main areas:

The register section, the control unit and the arithmetic logic unit (ALU).

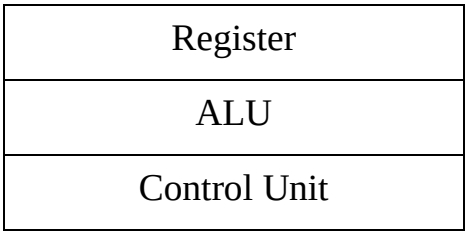


Figure () microprocessor chip with the main functional elements.

The number, size, and types of registers vary from microprocessor to another. Basic microprocessor registers there are four basic microprocessor registers:

Instruction register, program counter, memory address register and accumulator.

The main operation in ALU is ADD, Subtract which is negative addition, Multiply which is adding multiple times, divide which is negative adding

a bunch of times, Square roots, Power functions, exponentiation, logarithms, all which is addition.

Memory:-

Computer memory is a generic term for all of the different types of data storage technology that a computer may use, including RAM, ROM, and flash memory. ... Another way that computer memory can vary is that some types are non-volatile, which means they can store data on a long term basis even when there is no power.

The memory of a computer system consist of tiny electronic switches, with each switch set in one of two states: open or close. It is however more convenient to think of these states as 0 and 1.

Thus each switch can represent a binary digit or bit, as it is known, the memory unit consists of millions of such bits, bits are organized into groups of eight bits called byte.

The memory address space of a system is determined by the address bus width of the CPU used in the system. The actual memory in a system is always less than or equal to the MAS.

The 8086 has 20 address lines number is referred to as the **Memory Address Space** (MAS).

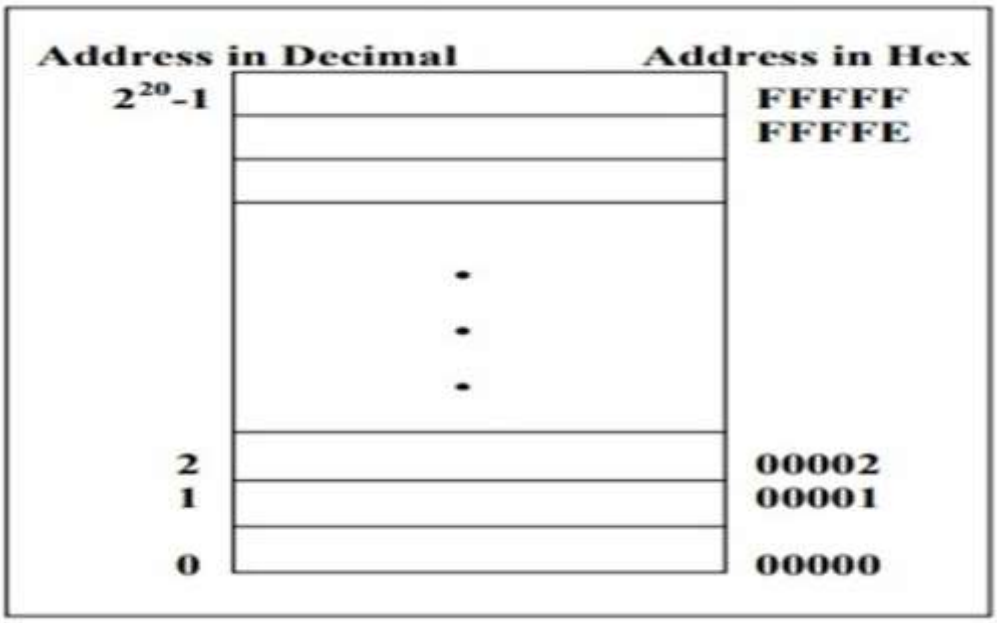
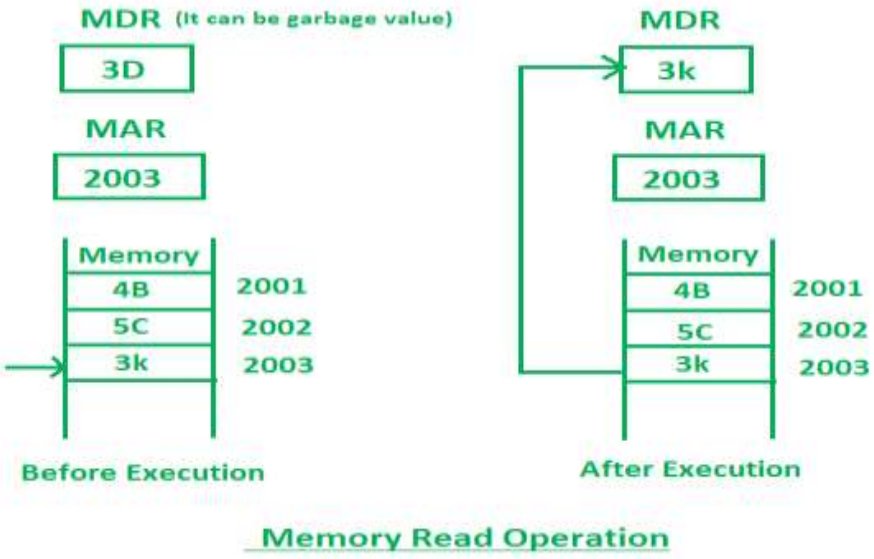


Figure (): Logical view of the system memory

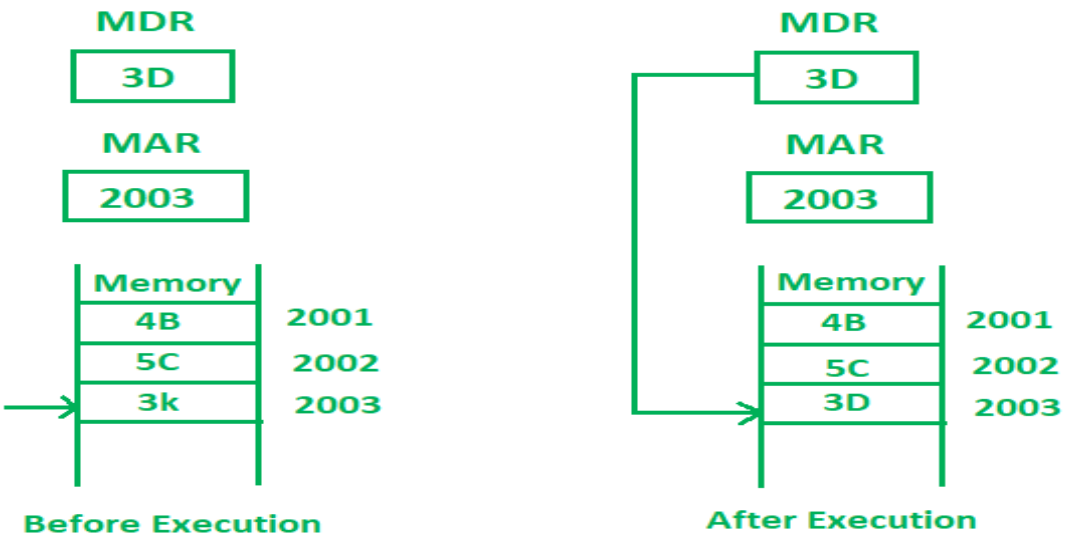
Memory Operations

There are two key operations on memory:

1. **Read or fetch (address)** returns value without changing the value stored at that address.
    a. Put address into MAR
    b. Tell memory unit to "load"
    c. Memory copies data into MDR



2. **Write or store (address, new-value)** writes new value into the cell at the given address.
    a. Put address into MAR
    b. Put new-value into MDR
    c. Tell memory unit to "store"
    d. Memory stores data from MDR into memory cell.



Memory Write Operation

Some Basic Concepts:-

Memory Access Times:- It is a useful measure of the speed of the memory unit. It is the time that elapses between the initiation of an operation and the completion of that operation (for example, the time between READ and MFC).

Memory Cycle Time:- It is an important measure of the memory system. It is the minimum time delay required between the initiations of two successive memory operations (for example, the time between two successive READ operations). The cycle time is usually slightly longer than the access time.

Addresses

Group of bits which are arranged sequentially in memory, to enable direct access, a number called address is associated with each group. Addresses start at 0 and increase for successive groups. The term location refers to a

group of bits with a unique address. Table 1 represents Bit, Byte, and Larger units.

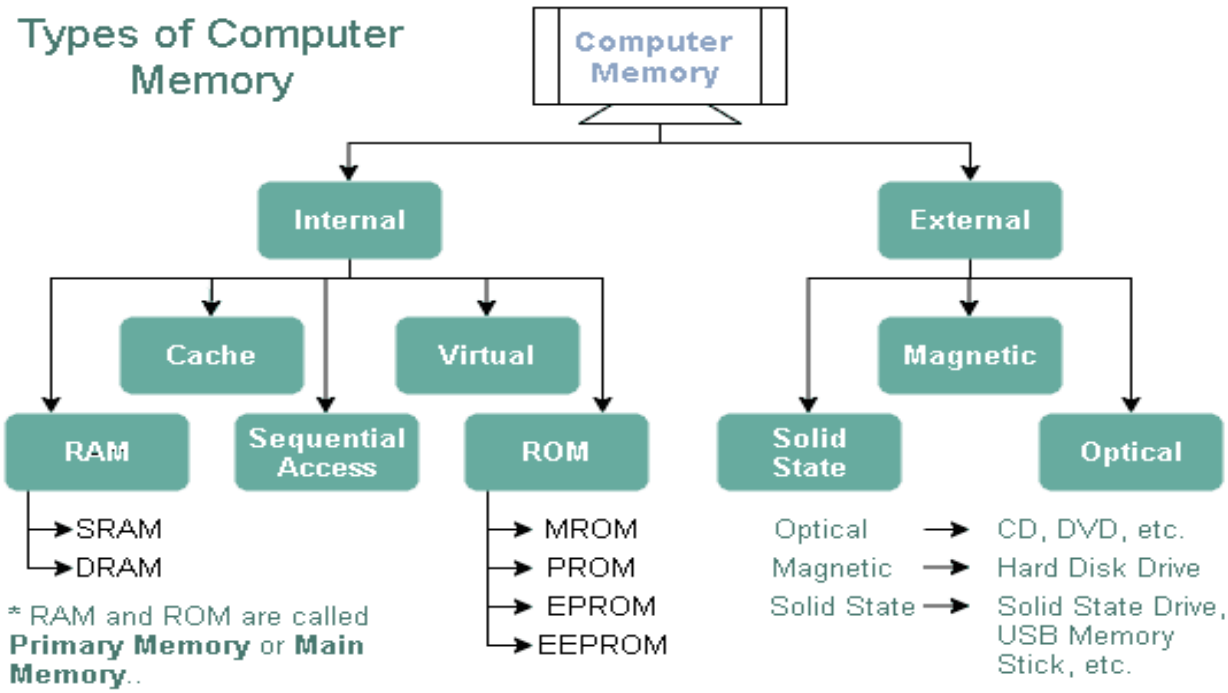
Table1: Bit, Byte, and Larger units.

Name	Number of Byte
Bit	0 or 1
Byte	is a group of bits used to represent a character, typically 8-bit.
Word	2-bytes (16-bit) data item
Double Word	4-byte (32-bits)
Quadword	8-Bytes (64-bit)
Paragraph	16-bytes (128-bit)
KiloByte (KB)	the number 2^{10} = 1024 = 1K for KiloByte, (thus 640K = 640 * 1024 = 655360 bytes)

Type of computer memory:-

There are basically two types of computer memory

- Internal memory
- External memory



Internal memory:-
Internal memory usually refers to the chip or modules that are directly connected to the motherboard.

The following are the available internal memories used in the computer system.

1. Random Access Memory (RAM) –

- It is also called as *read write memory* or the *main memory* or the *primary memory*.
- The programs and data that the CPU requires during execution of a program are stored in this memory.
- It is a volatile memory as the data loses when the power is turned off.
- RAM is further classified into two types- *SRAM (Static Random Access Memory)* and *DRAM (Dynamic Random Access Memory)*.

2.Read Only Memory (ROM) –

- Stores crucial information essential to operate the system, like the program essential to boot the computer.
- It is not volatile.
- Always retains its data.
- Used in embedded systems or where the programming needs no change.
- Used in calculators and peripheral devices.
- ROM is further classified into 4 types- *ROM*, *PROM*, *EPROM*, and *EEPROM*.

Types of Read Only Memory (ROM) –

1. **PROM (Programmable read-only memory)** – It can be programmed by user. Once programmed, the data and instructions in it cannot be changed.
2. **EPROM (Erasable Programmable read only memory)** – It can be reprogrammed. To erase data from it, expose it to ultra violet light. To reprogram it, erase all the previous data.
3. **EEPROM (Electrically erasable programmable read only memory)** – The data can be erased by applying electric field, no need of ultra violet light. We can erase only portions of the chip.

RAM	ROM
1. Temporary Storage.	1. Permanent storage.
2. Store data in MBs.	2. Store data in GBs.
3. Volatile.	3. Non-volatile.
4.Used in normal operations.	4. Used for startup process of computer.
5. Writing data is faster.	5. Writing data is slower.

Difference between RAM and ROM

Secondary Memory

This type of memory is also known as external memory or non-volatile. It is slower than the main memory. These are used for storing data/information permanently. CPU directly does not access these memories, instead they are accessed via input-output routines. The contents of secondary memories are first transferred to the main memory, and then the CPU can access it. For example, disk, CD-ROM, DVD, etc.

Characteristics of Secondary Memory

- These are magnetic and optical memories.
- It is known as the backup memory.
- It is a non-volatile memory.
- Data is permanently stored even if power is switched off.
- It is used for storage of data in a computer.
- Computer may run without the secondary memory.
- Slower than primary memories.