COMPUTER MEMORY SYSTEM

No single technology is optimized in satisfying the memory requirement for a computer system. A typical computer system is equipped with a hierarchy of memory subsystem.

KEY CHARACTERISTICS OF COMPUTER MEMORY SYSTEM:

- **LOCATION:**
  - Internal: Processor Registers, Cache, Main Memory
  - External: Optical Disks, Magnetic Disks, Tapes, (Peripheral devices accessible via some I/O Controller)

- **CAPACITY:**
  - Expressed in terms of numbers of bytes or Number of words.
  - Word length can be 8, 16 or 32 bits.

- **UNIT OF TRANSFER:**
  - Number of bits read out or written into memory in a unit time.
  - For Internal Memory Unit of Transfer is number of lines connected to a component. It may be equal to word length or larger.
  - For External Memory Unit of Transfer are usually referred as Blocks.

- **ACCESS METHOD:**

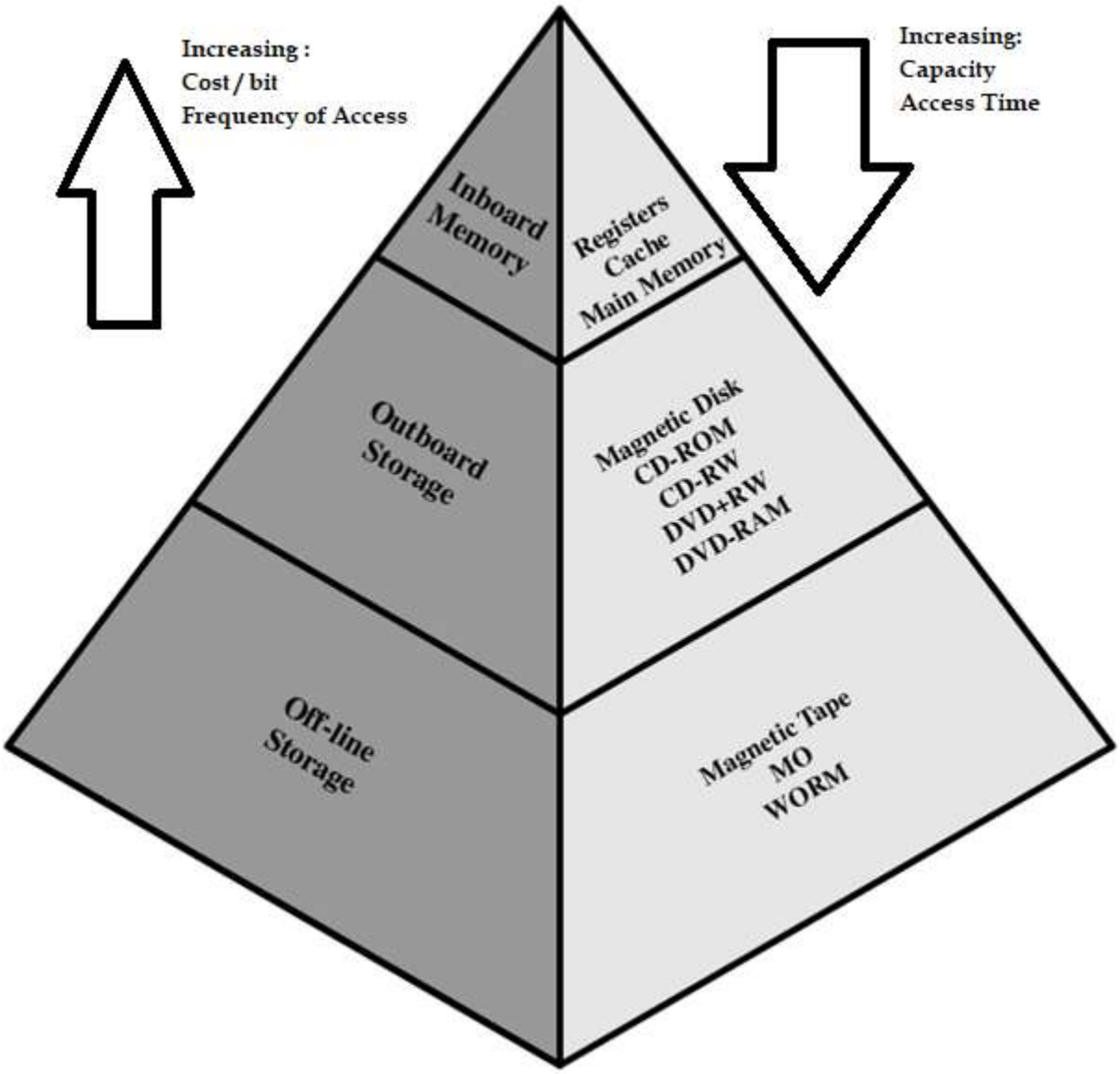
  Linear Sequential, Direct, Random or Associative Access Method.
  - **Linear Sequential Method:** Time to Access an arbitrary record is highly variable depending on W/R Head's current and desired location.
  - **Direct Access Method:** Individual blocks or record have a unique address based on Physical location. Access is direct to the desired block then sequential for the required address.
  - **Random Access Method:** Each addressable location has a unique addressing mechanism. Thus, access time is constant. Any location can be selected at Random. Main Memory and Some Cache systems have Random Access.
  - **Associative Access Method:** A storage device in which a location is identified by what is in it rather than by its position is known as Associative Access Memory.
  - Access is made based on the content or part of content of a location. This is a Random-Access type that enable a comparison of desired information with the saved information.
  - Thus, a word is searched / retrieved based on all / or a portion of its content rather than its address.
  - Each location has its own addressing mechanism & retrieval time is constant. independent of location or prior access pattern.
  - Cache / Virtual Memory storage may employ this kind of access method.

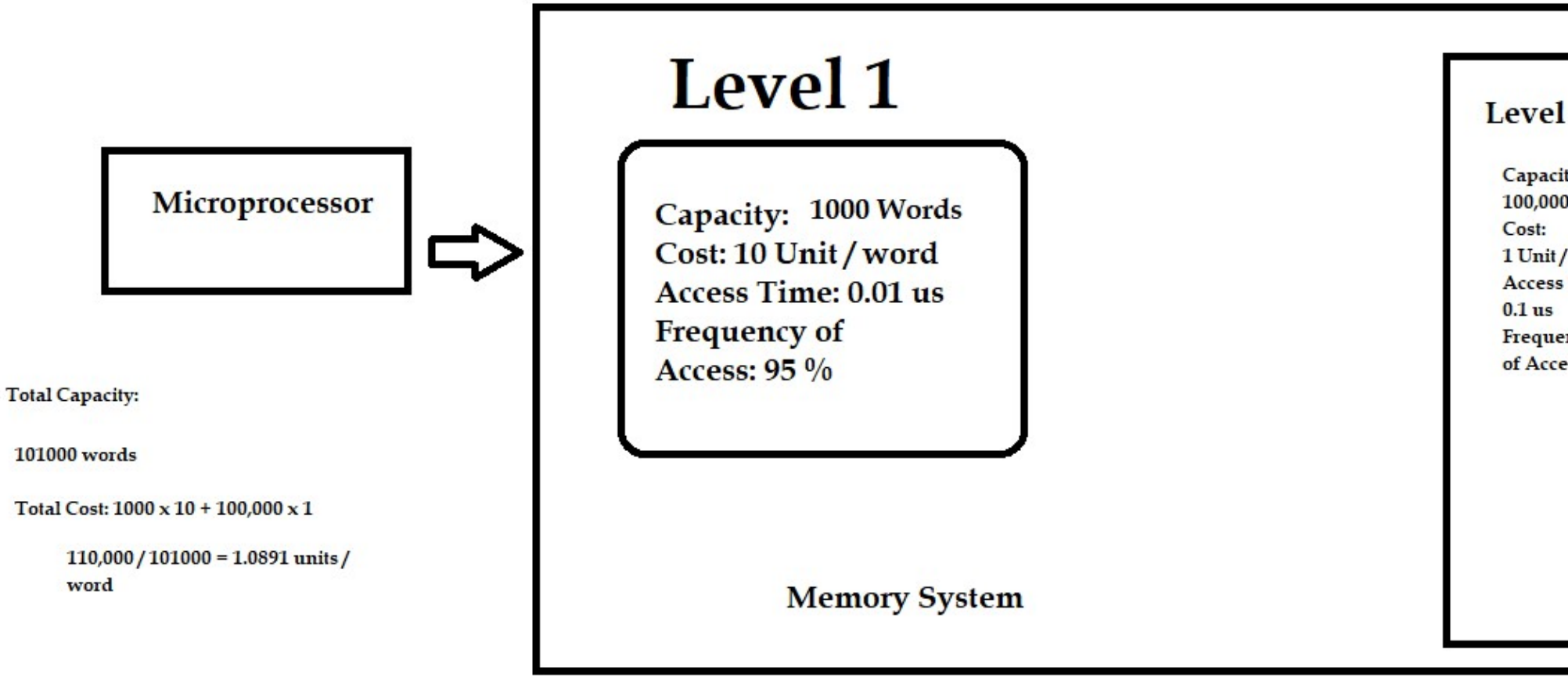
- **PERFORMANCE:**

  Performance of memory system are measured based on three parameters.
    - Access Time, Cycle Time and Data Transfer Rate.
  - **Access Time:** It has different definition for RAM (RAM & Associative Access Memories) and Non-RAM (Direct and Sequential Access Memories)

- For RAM Access Time is defined as time required from the instant a request appears in an Address Register until the time the desired information appears in the output buffer or the target register.
- For Non-RAM access time is time it takes to position Read-Write Mechanism at the desired location.
- Time Required from the instant an instruction is decoded until the time the desired information is Found but NOT Read.
- Time required to Read the record will depend upon the length of the record, thus not included in Access Time.
- In RAMs, Access Time is made constant by properly organizing the addressing scheme and the storage media.
- In Non-RAMs Access Time depend on the following factors:
    - Location of the information required.
    - Current position of the storage system relative to the desired information.
- **Cycle: Time:** It is defined only for RAMs, how frequently we can make memory references. Cycle Time = Ta + Ts
  Where Ta = Access Time
  Ts = Transient Time
- **Transfer Rate:** It is defined as the Rate at which data can be transferred into or out of a memory unit.
- For RAM Transfer Rate = 1 / Cycle Time
- For Non-RAMs the Following relationship is valid:
    - Tn = Ta + N/R
    - R = N / (Tn – Ta)
    - Tn = Average Access Time to read or write N bits
    - Ta = Average Access Time
    - N = Number of bits
    - R = Transfer Rate in bits / sec (bps)

- **PHYSICAL TYPE:** Semiconductor, Optical, Magnetic, Magneto Optical
- **PHYSICAL CHARACTERISTICS:** Volatile / Non Volatile, Erasable / Non-Erasable.
- **ORGANISATION:** Memory Modules


Increasing :
Cost / bit
Frequency of Access
Increasing:
Capacity
Access Time
Inboard Memory
Registers
Cache
Main Memory
Outboard Storage
Magnetic Disk
CD-ROM
CD-RW
DVD+RW
DVD-RAM
Off-line Storage
Magnetic Tape
MO
WORM



Total Capacity:

101000 words

Total Cost: 1000 x 10 + 100,000 x 1

110,000 / 101000 = 1.0891 units / word