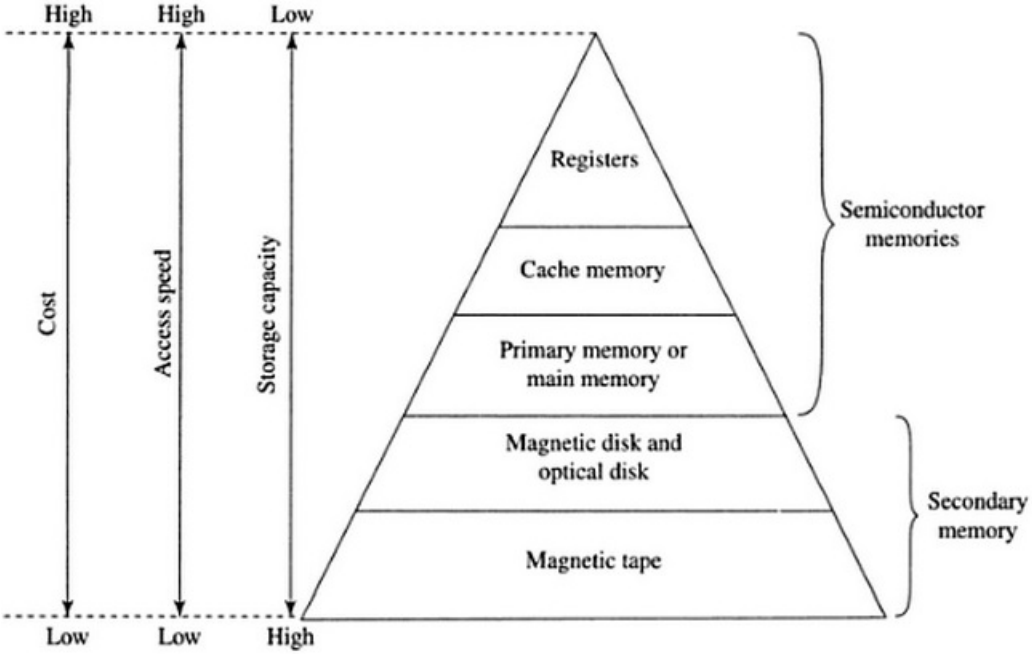
Memory Organization: Memory Hierarchy



A memory unit is an essential component in any digital computer since it is needed for storing programs and data.

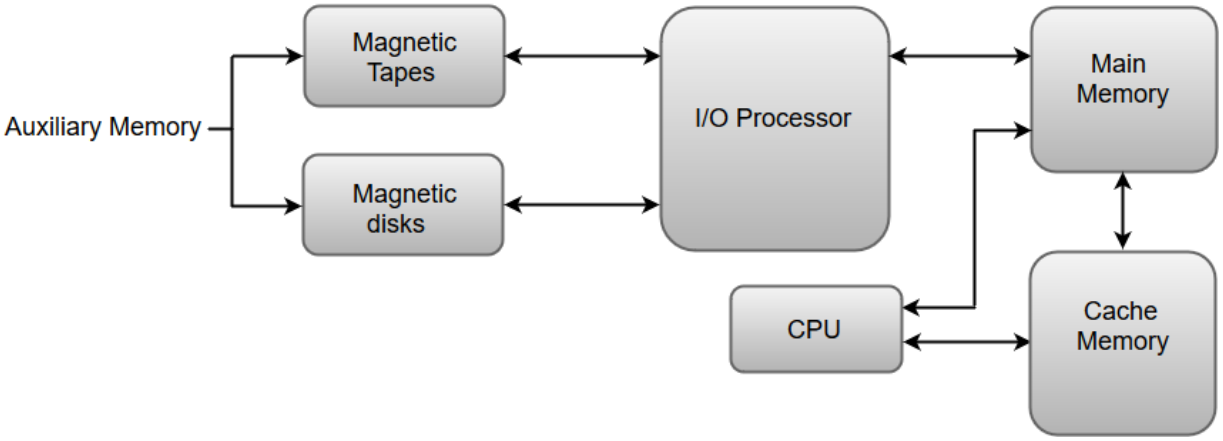
Typically, a memory unit can be classified into two categories:

1. The memory unit that establishes direct communication with the CPU is called Main Memory. The main memory is often referred to as RAM (Random Access Memory).
2. The memory units that provide backup storage are called Auxiliary Memory. For instance, magnetic disks and magnetic tapes are the most commonly used auxiliary memories.

Apart from the basic classifications of a memory unit, the memory hierarchy consists all of the storage devices available in a computer system ranging from the slow but high-capacity auxiliary memory to relatively faster main memory.

The following image illustrates the components in a typical memory hierarchy.

Memory Hierarchy in a Computer System:



Auxiliary Memory

Auxiliary memory is known as the lowest-cost, highest-capacity and slowest-access storage in a computer system. Auxiliary memory provides storage for programs and data that are kept for long-term storage or when not in immediate use. The most common examples of auxiliary memories are magnetic tapes and magnetic disks.

A magnetic disk is a digital computer memory that uses a magnetization process to write, rewrite and access data. For example, hard drives, zip disks, and floppy disks.

Magnetic tape is a storage medium that allows for data archiving, collection, and backup for different kinds of data.

Main Memory

The main memory in a computer system is often referred to as **Random Access Memory (RAM)**. This memory unit communicates directly with the CPU and with auxiliary memory devices through an I/O processor.

The programs that are not currently required in the main memory are transferred into auxiliary memory to provide space for currently used programs and data.

I/O Processor

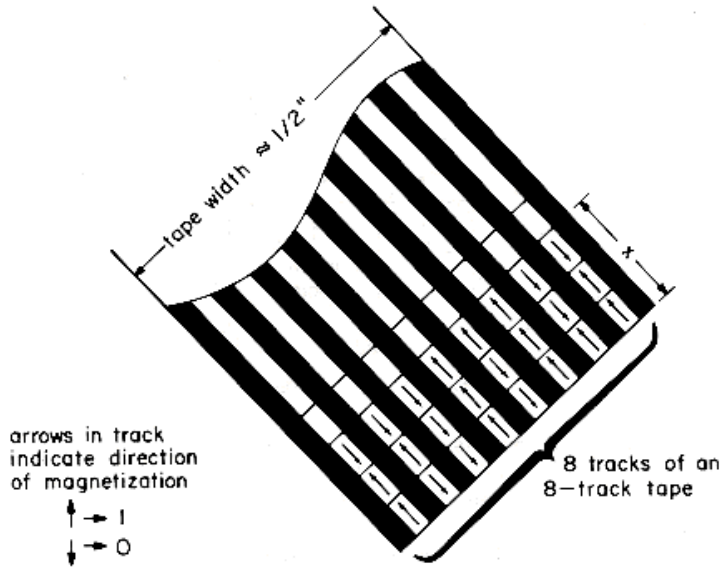
The primary function of an I/O Processor is to manage the data transfers between auxiliary memories and the main memory.

Cache Memory

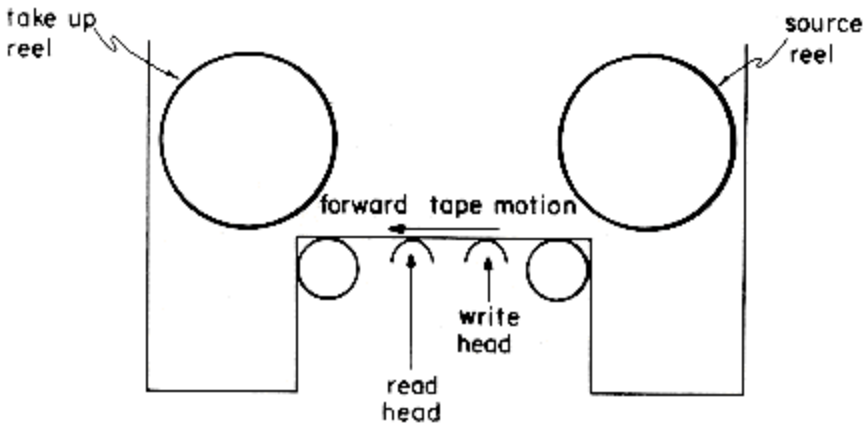
The data or contents of the main memory that are used frequently by CPU are stored in the cache memory so that the processor can easily access that data in a shorter time. Whenever the CPU requires accessing memory, it first checks the required data into the cache memory. If the data is found in the cache memory, it is read from the fast memory. Otherwise, the CPU moves onto the main memory for the required data.

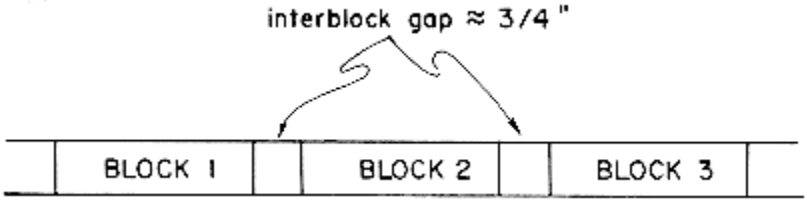
Secondary Memory: Magnetic Tape

Magnetic tape devices for computer input/output are similar in principle to audio tape recorders. The data is recorded on magnetic tape approximately 1/2\" wide. The tape is wound around a spool. A new reel of tape is normally 2400 ft. long (with use, the length of tape in a reel tends to decrease because of frequent cutting off of lengths of the tape). Tracks run across the length of the tape, with a tape having typically 7 to 9 tracks across its width. Depending on the direction of magnetization, a spot on the track can represent either a 0 or a 1 (i.e., a bit of information). At any point along the length of the tape, the combination of bits on the tracks represents a character (e.g., *A*-*Z*, 0-9, +, :, ;, etc.). The number of bits that can be written per inch of track is referred to as the tape density. Examples of standard track densities are 800 and 1600 bpi (bits per inch). Since there are enough tracks across the width of the tape to represent a character, this density also gives the number of characters per inch of tape.



A tape drive consists of two spindles. On one of the spindles is mounted the source reel and on the other the take up reel. During forward reading or forward writing, the tape is pulled from the source reel across the read/write heads and onto the take up reel. Some tape drives also permit backward reading and writing of tapes; i.e., reading and writing can take place when tape is being moved from the take up to the source reel.


take up
reel
source
reel
forward tape motion
write
head
read
head


interblock gap ≈ 3/4"
BLOCK 1
BLOCK 2
BLOCK 3