Sairam INSTITUTIONS

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YEAR	SEM
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CS8392

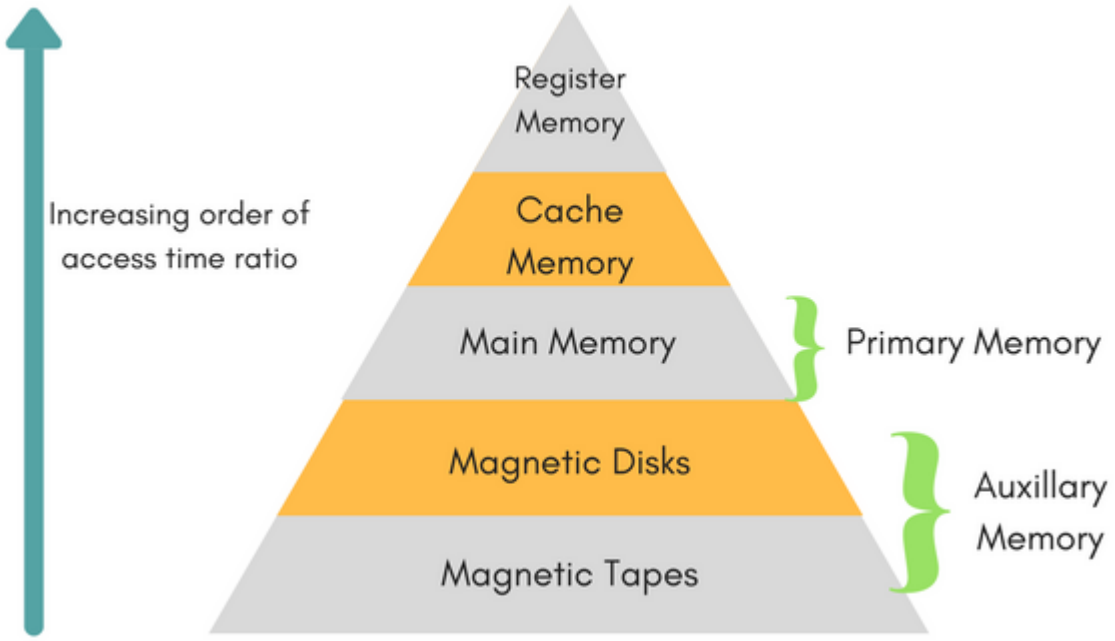
OPERATING SYSTEMS
(Common to CSE, IT)

UNIT No. 1

1.3 Memory Hierarchy, Cache Memory, Direct Memory Access

Version: 1.XX

Memory Hierarchy



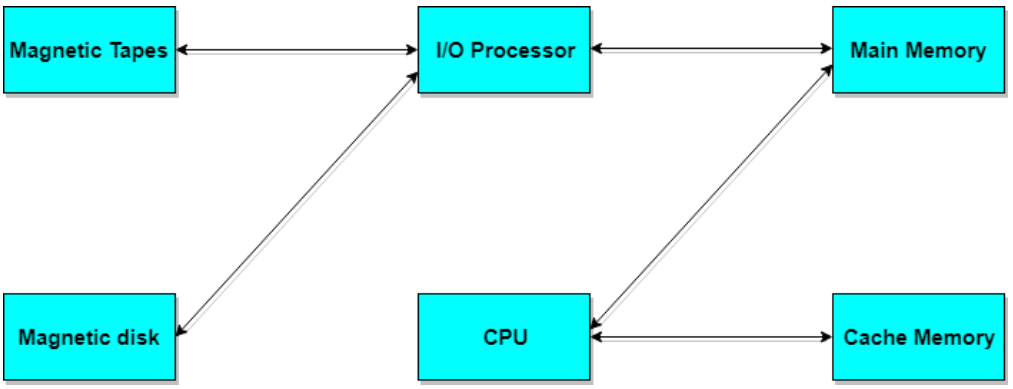
The total memory capacity of a computer can be visualized by hierarchy of components. The memory hierarchy system consists of all storage devices contained in a computer system from the slow Auxiliary Memory to fast Main Memory and to smaller Cache memory.

Auxillary memory access time is generally **1000 times** that of the main memory, hence it is at the bottom of the hierarchy.

The **main memory** occupies the central position because it is equipped to communicate directly with the CPU and with auxiliary memory devices through Input/output processor (I/O).

When the program not residing in main memory is needed by the CPU, they are brought in from auxiliary memory. Programs not currently needed in main memory are transferred into auxiliary memory to provide space in main memory for other programs that are currently in use.

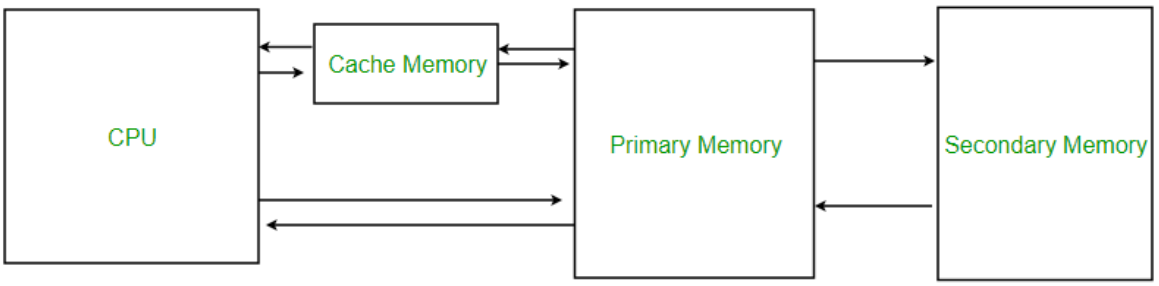
The **cache memory** is used to store program data which is currently being executed in the CPU. Approximate access time ratio between cache memory and main memory is about **1 to 7~10**



Cache Memory in Computer Organization

Cache Memory is a special very high-speed memory. It is used to speed up and synchronizing with high-speed CPU. Cache memory is costlier than main memory or disk memory but economical than CPU registers. Cache memory is an extremely fast memory type that acts as a buffer between RAM and the CPU. It holds frequently requested data and instructions so that they are immediately available to the CPU when needed.

Cache memory is used to reduce the average time to access data from the Main memory. The cache is a smaller and faster memory which stores copies of the data from frequently used main memory locations. There are various different independent caches in a CPU, which store instructions and data.



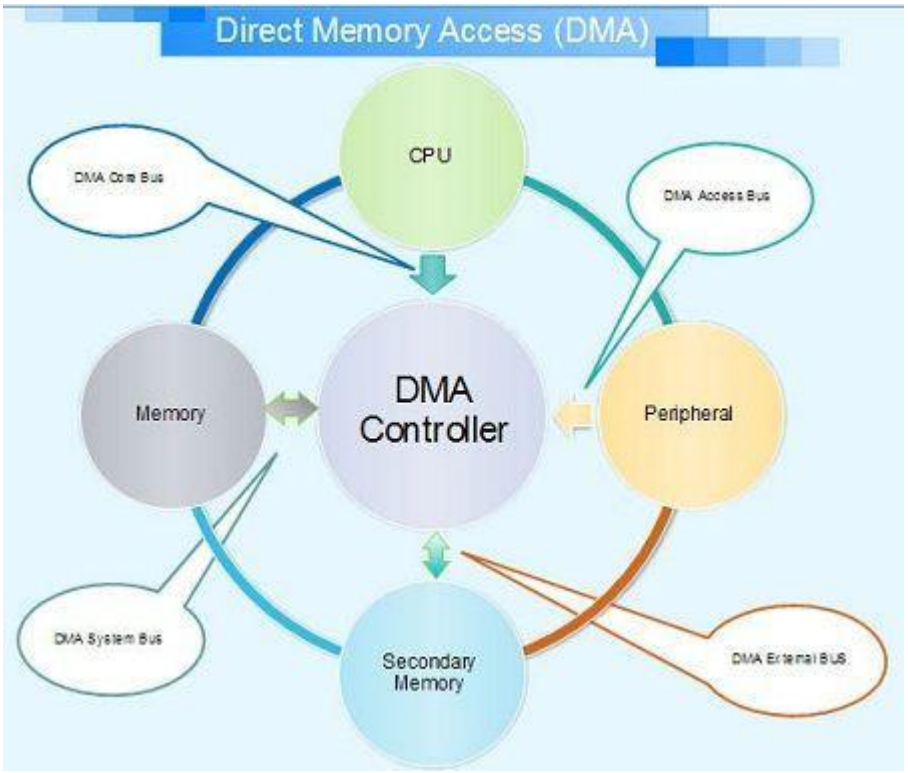
Levels of memory:

- **Level 1 or Register –**
  It is a type of memory in which data is stored and accepted that are immediately stored in CPU. Most commonly used register is accumulator, Program counter, address register etc.
- **Level 2 or Cache memory –**
  It is the fastest memory which has faster access time where data is temporarily stored for faster access.
- **Level 3 or Main Memory –**
  It is memory on which computer works currently. It is small in size and once power is off data no longer stays in this memory.
- **Level 4 or Secondary Memory –**
  It is external memory which is not as fast as main memory but data stays permanently in this memory.

Direct memory access (DMA)

DMA stands for "Direct Memory Access" and is a method of transferring data from the computer's RAM to another part of the computer without processing it using the CPU. While most data that is input or output from your computer is processed by the CPU, some data does not require processing, or can be processed by another device.

In these situations, DMA can save processing time and is a more efficient way to move data from the computer's memory to other devices. In order for devices to use direct memory access, they must be assigned to a DMA channel. Each type of port on a computer has a set of DMA channels that can be assigned to each connected device. For example, a PCI controller and a hard drive controller each have their own set of DMA channels.



For example, a sound card may need to access data stored in the computer's RAM, but since it can process the data itself, it may use DMA to bypass the CPU. Video cards that support DMA can also access the system memory and process graphics without needing the CPU. Ultra DMA hard drives use DMA to transfer data faster than previous hard drives that required the data to first be run through the CPU.

An alternative to DMA is the Programmed Input/Output (PIO) interface in which all data transmitted between devices goes through the processor. A newer protocol for the ATAIIDE interface is Ultra DMA, which provides a burst data transfer rate up to 33 mbps. Hard drives that come with Ultra DMAl33 also support PIO modes 1, 3, and 4, and multiword DMA mode 2 at 16.6 mbps.

DMA Transfer Types

Memory To Memory Transfer

In this mode block of data from one memory address is moved to another memory address. In this mode current address register of channel 0 is used to point the source address and the current address register of channel is used to point the destination address in the first transfer cycle, data byte from the source address is loaded in the temporary register of the DMA controller and in the next transfer cycle the data from the temporary register is stored in the memory pointed by destination address. After each data transfer current address registers are decremented or incremented according to current settings. The channel 1 current word count register is also decremented by 1 after each data transfer. When the word count of channel 1 goes to FFFFH, a TC is generated which activates EOP output terminating the DMA service.