



## Lecture 3

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كلية التربية للعلوم الصرفة

قسم علوم الحاسبات

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# MEMORY OR STORAGE DEVICES

Memory is required in a computer to store programs and the data processed by programs.

Computer memory is made up of a large number of cells. Each cell is capable of storing one *bit* of information in the form of binary numbers.

Memory in a computer system is required for the storage and subsequent retrieval of instruction and data. A computer system uses a variety of devices for storing instructions and data required for its operations.

# MEMORY OR STORAGE DEVICES

## COMPUTER STORAGE OR MEMORY DEVICES



Hard Disk



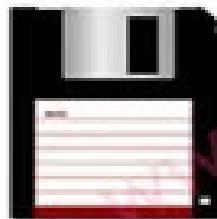
RAM



ROM



CD/DVD



Floppy



Memory Card

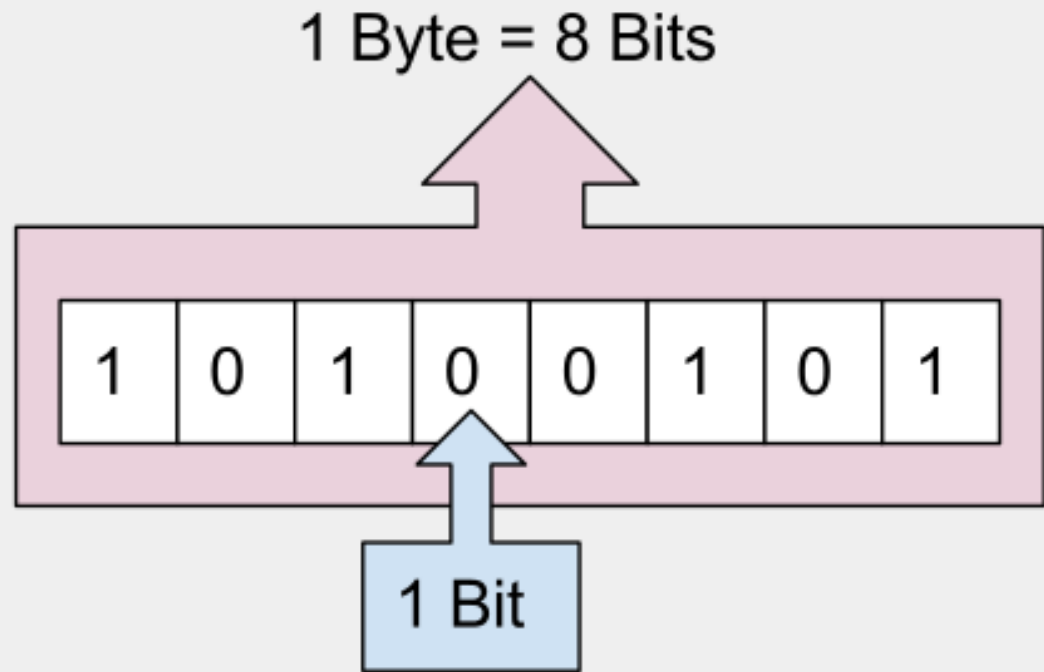


Pen Drive



Tape

# MEMORY OR STORAGE DEVICES



1 byte	= 8 bits
1 kilobyte	= 1024 bytes
1 megabyte	= 1024 kilobyte
1 gigabyte	= 1024 megabyte
1 terabyte	= 1024 gigabyte

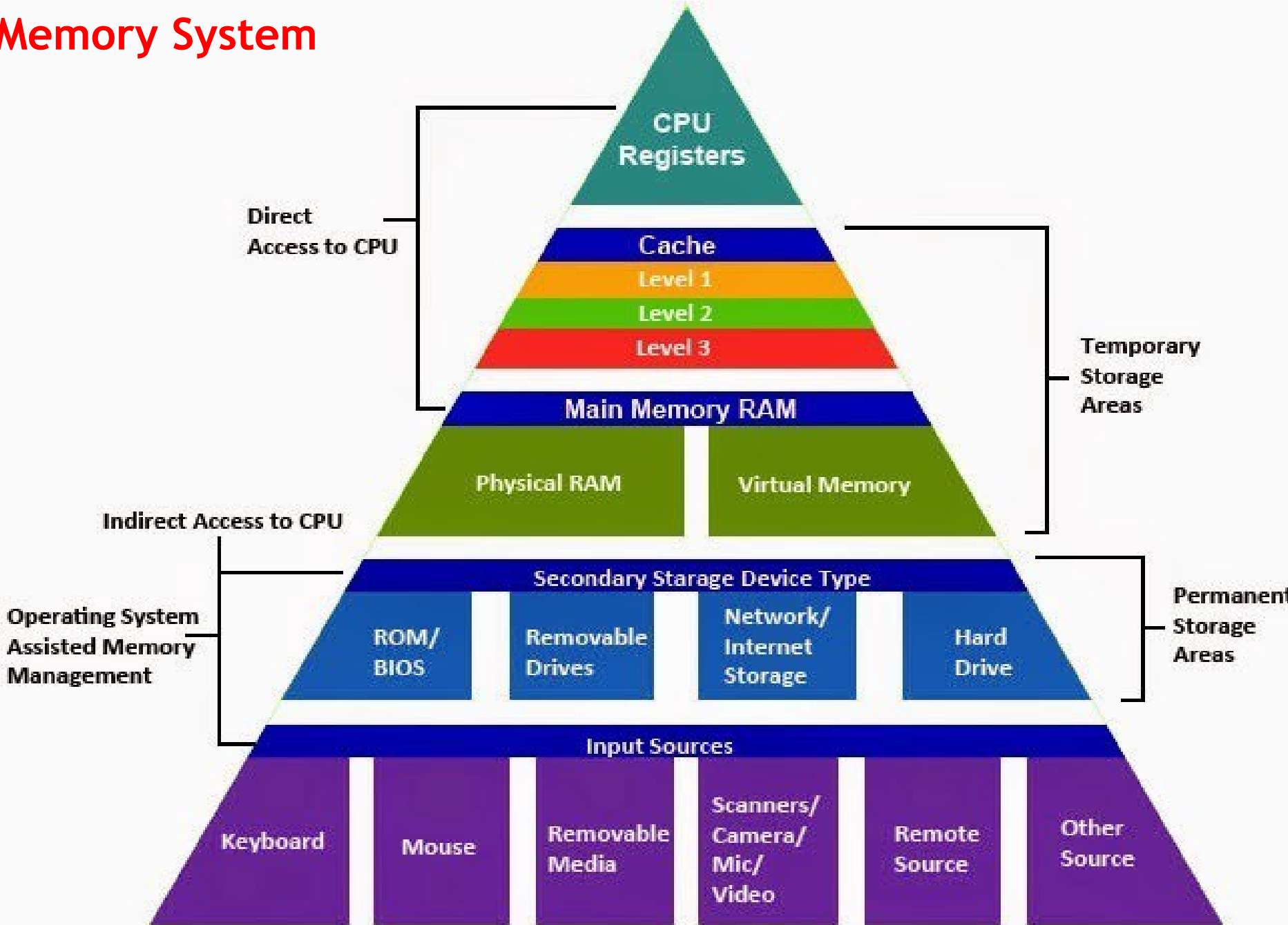
# Memory System

Normally, the information to be stored on a computer is classified in two basic categories - data and instructions. Although a memory system is a very simple system, it exhibits a wide range of technology. But unfortunately, faster memory is more costly.

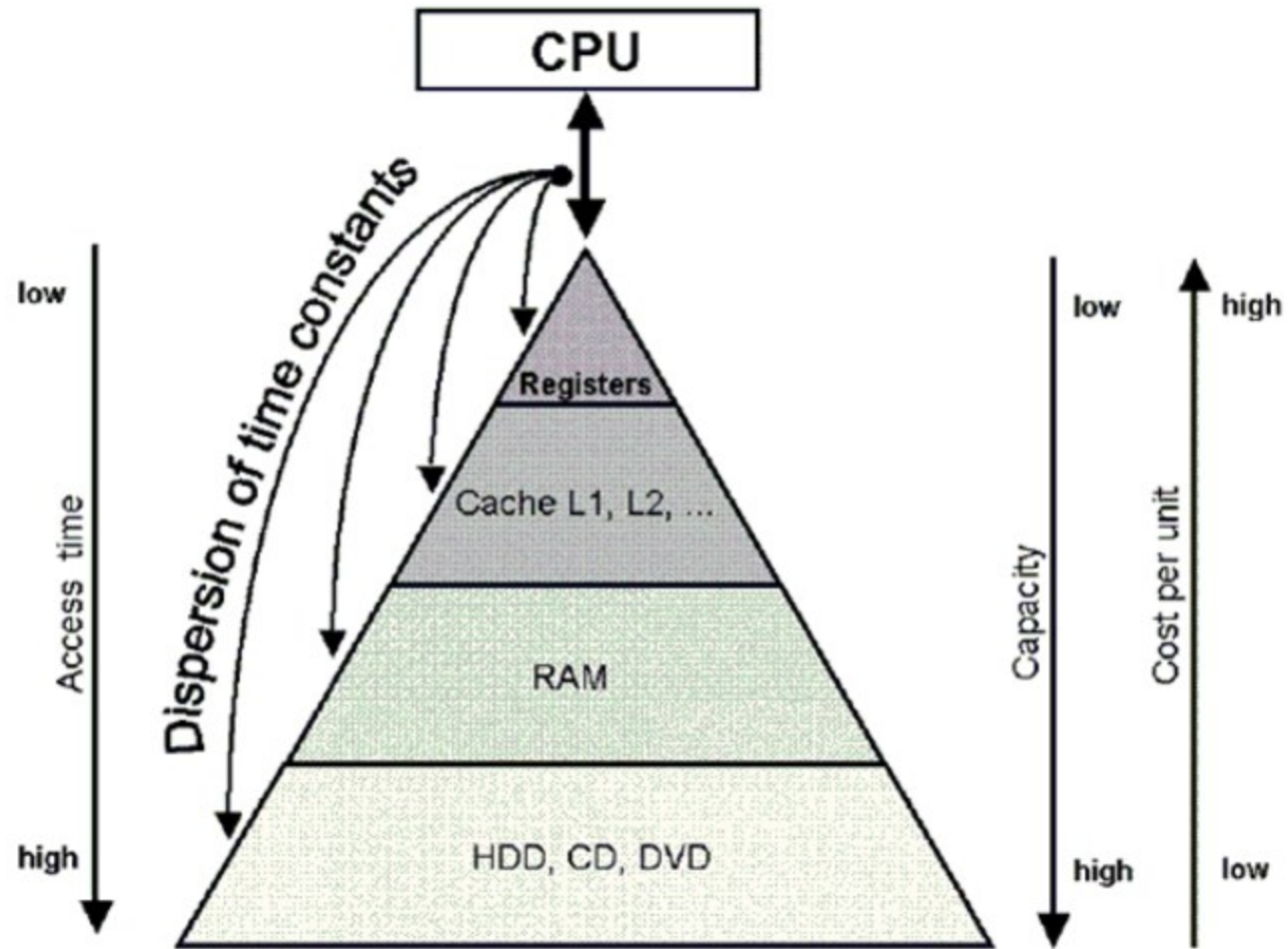
On the other hand, memories with smaller cost have very high access time. This is the time taken by the CPU to access a location in memory. This results in slower operation of the CPU.

Thus, the cost versus access time has led to a hierarchy of memory where we supplement fast memories with larger, cheaper and slower memories. Therefore, memory system may have different types, costs, organisations, technologies and performances.

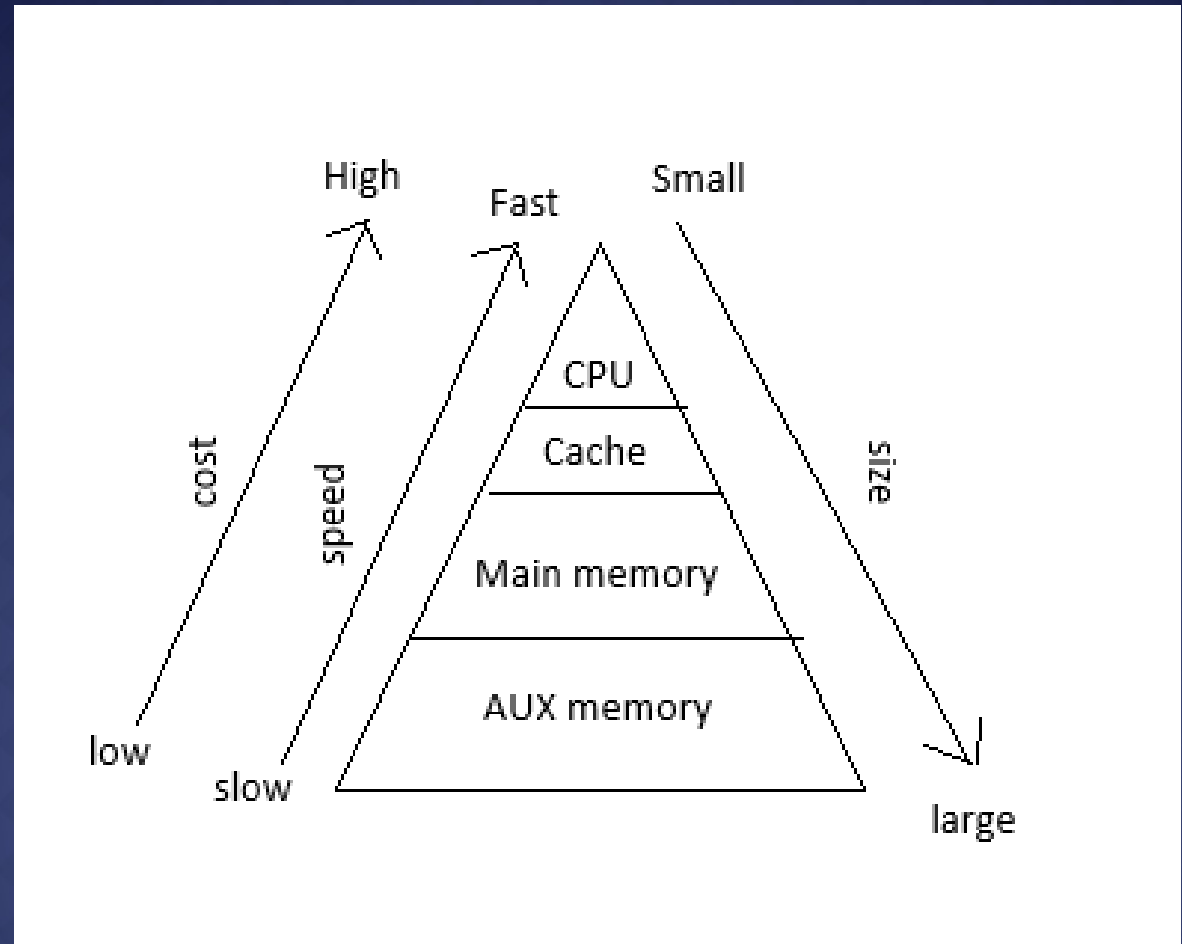
# Memory System



# Memory System

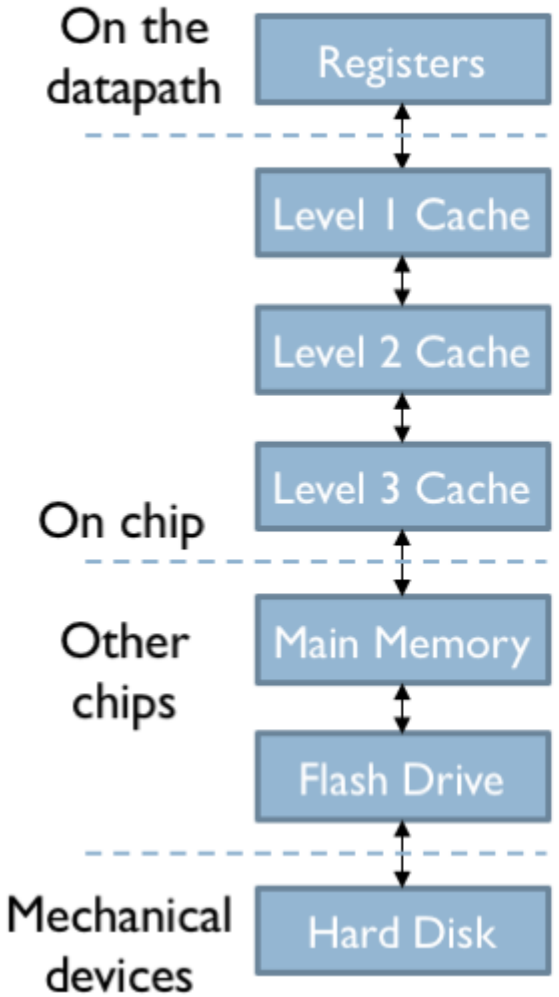


# Memory System





# Memory System



Access time	Capacity	Managed By
1 cycle	1 KB	Software/Compiler
2-4 cycles	32 KB	Hardware
10 cycles	256 KB	Hardware
40 cycles	10 MB	Hardware
200 cycles	10 GB	Software/OS
10-100us	100 GB	Software/OS
10ms	1 TB	Software/OS

# Memory System

## Types of Memory

A memory system can be considered to consist of three types of memories. These are as follows:

1. Internal processor memories
2. Primary memory or main memory
3. Secondary or auxiliary memory

Any storage unit of a computer may have the following characteristics:

Storage capacity is the amount of information/data a storage unit can hold. Accessing the data to/from these memories may be fast or slow.

The speed and availability of inexpensive memory has an enormous impact on computer technology. The high speed memory devices are more expensive and occupy less space in comparison to the slow speed memory devices.

# Memory System

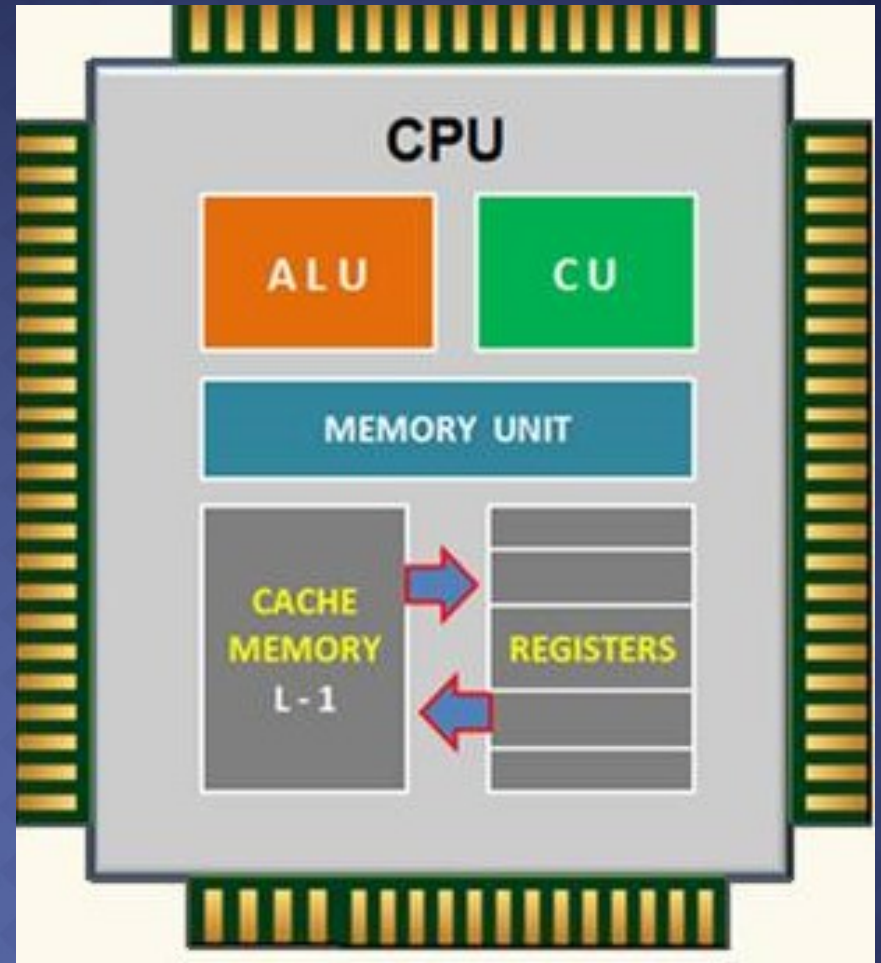
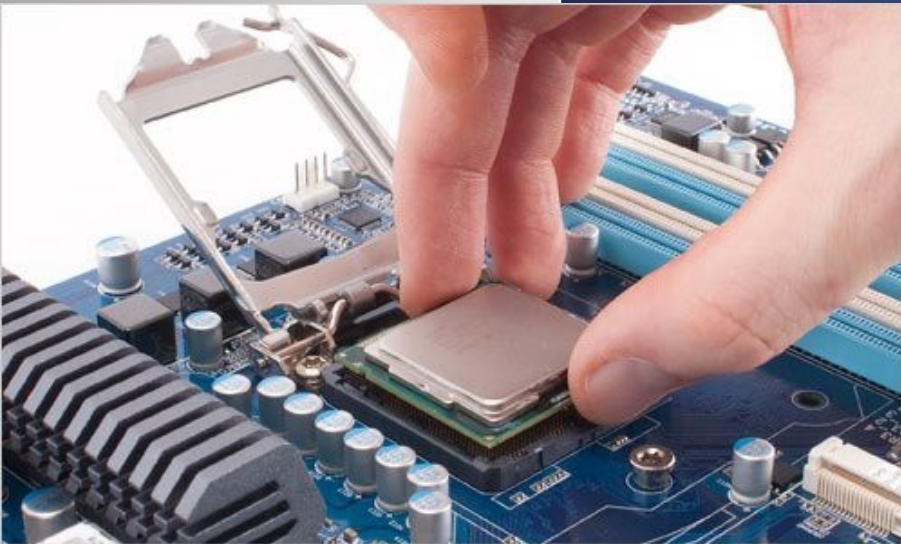
## Internal Processor Memories

These consist of the small set of high-speed registers and high speed buffer memory (cache) which are internal to a processor and are used as temporary locations where actual processing is done.

Register is a small amount of storage available on the CPU whose contents can be accessed more quickly than storage available elsewhere.

Processor registers are at the top of the memory hierarchy and provide the fastest way for a CPU to access data.

# Memory System



# Memory System

*The important registers, within the CPU are:*

*Program Counter (PC). A program counter keeps track of the next instruction to be executed.*

*Instruction Register (IR) is a register which holds instruction to be decoded by the control unit.*

*Memory Address Register (MAR), is a register which points to the memory location which the CPU plans to access, either for reading or for writing.*

*MBR (memory buffer register) which is also referred to as memory data register.*

*(MDR) Memory Data Register is used for storage data either coming to the CPU or data being transferred by the CPU.*

*Accumulator (ACC) is a general purpose register used for storing variables, temporary results and results produced by arithmetic logic unit of the CPU.*

# Memory System

## Cache Memory

Cache memory is a small high speed buffer memory used to hold instructions temporarily during processing.

The CPU of a computer system commonly uses cache memory where it holds or buffers the contents of the main memory because the CPU runs much faster than the main memory.

Thus to reduce the waiting time of the CPU the cache is used. Cache memory reduces traditional system bottlenecks because system RAM is much slower than CPU.

This prevents the processor from having to wait for a program and data from slower main memory.

A cache typically operates by retaining copies of blocks of storage, each containing recently used information. This memory (or caches) is usually transparent or invisible to the processor.

# Memory System

## LEVELS OF CACHE MEMORY:

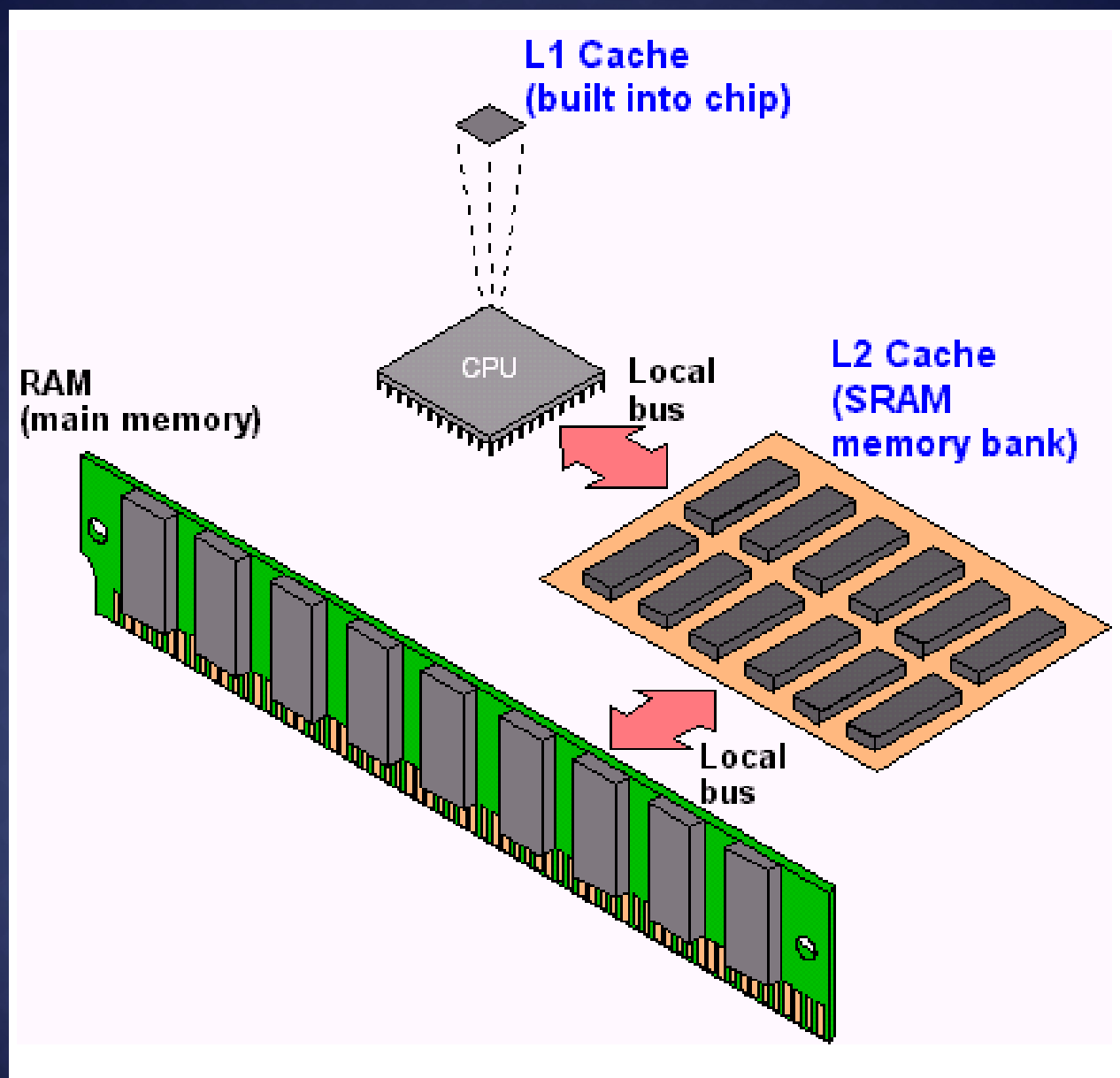
There are levels of cache memory, defined by a chip's proximity to CPU.

I. **Level 1:** cache is memory built onto CPU chip for storage of data or commands just been used.

II. **Level 2:** cache is located on CPU chip but slightly farther away from CPU or on separate chip next to CPU. Therefore takes longer to access. Contains more storage area than Level 1.

III. **Level 3:** slower for CPU to reach but larger in size, similar to Level 2.

# Memory System





# Memory System

*Cache is a collection of data duplicating original values stored elsewhere or computed earlier, where the original data is expensive to fetch (owing to longer access time) or to compute, compared to the cost of reading the cache.*

*In other words, a cache is a temporary storage area where frequently accessed data can be stored for rapid access. Once the data is stored in the cache, future use can be made by accessing the cached copy rather than refetching or recomputing the original data, so that the average access time is reduced.*

# Memory System

## Primary Memory

It is a large memory which is fast but not as fast as an internal processor register. The processor directly accesses this memory. The primary memory or the main memory is part of the main computer system.

The processor or the CPU directly stores and retrieves information from it. This memory is accessed by the CPU, in a random fashion. That means any location of this memory can be accessed by the CPU to either read information from it, or store information in it.

The primary memory itself is implemented by two types of memory technologies. The first is called *Random Access Memory (RAM)* and the other is *Read Only Memory (ROM)*.

# Memory System

A more appropriate name for RAM is RWM (read write memory), the CPU can write and read information from any primary memory location implemented using RAM.

The other part of primary memory is implemented using ROM which stands for Read Only Memory.

There are two types of built-in memory, permanent and temporary, known as ROM and RAM, respectively, details of each given below: