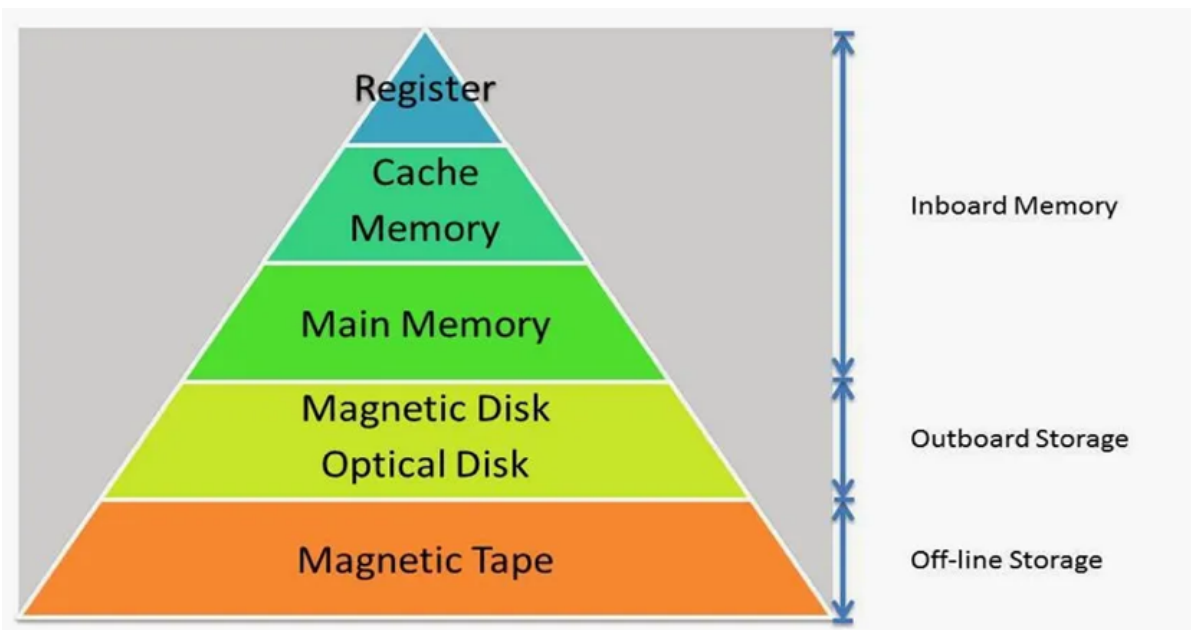
Memory organization

Memory organization is an important aspect of computer architecture, also known as the organization of computer systems (COA). It refers to the way that the computer's memory is arranged and managed. The memory of system can be thought of as a large number of addressable storage locations. Each location can store a fixed amount of data, typically measured in bits or bytes.

The way these locations are organized and accessed can have a notable impact on the overall production and functionality of the system. Memory organization involves the use of different types of memory, including RAM, ROM, cache memory, virtual memory, flash memory, and magnetic disks. Each type of memory is used for a specific purpose and has its own advantages and disadvantages.

Memory organization is also important for the efficient management of data and instructions within a computer system. It involves techniques such as memory allocation, virtual memory management, and cache management. These techniques help to optimize the use of memory and improve system performance. Overall, memory organization is a critical aspect of computer architecture that plays a important role in determining the performance, functionality, and efficiency of a computer system.



Types Of Memory Organization :

There are several types of memory organization used in computer systems, each with its own advantages and disadvantages. Here are the most common types of memory organization:

I. **Von Neumann architecture:** This type of memory organization is named after the computer scientist John von Neumann, who first proposed the concept. In this architecture, in the same memory we can store both instructions and data. This memory

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organization is simple and easy to implement, but it can lead to bottlenecks as the system tries to access both instructions and data at the same time.

II. **Harvard architecture**: In this type of memory organization, program instructions and data are stored in separate memory spaces. This allows for parallel access to instructions and data, which can lead to faster performance. However, the Harvard architecture is more complex to implement and may require more hardware resources.

III. **Cache memory organization**: Small, fast memory that stores frequently used data and instructions. Cache memory is organized into levels, with each level providing increasing storage capacity and decreasing speed. Cache memory organization is critical for improving system performance, as it reduces the time it takes to access frequently used data and instructions.

IV. **Virtual memory organization**: It is a technique that allows a computer to use more memory than it physically has. Virtual memory creates a virtual address space that is mapped to the physical memory. This memory organization is critical for running large applications that require more memory than is available on the system.

V. **Flash memory organization:** It is a non-volatile memory that is used in portable devices, such as USB drives and memory cards. Flash memory organization involves dividing the memory into blocks and pages, with data stored in individual pages. This allows for efficient read and write operations and makes flash memory ideal for storing data in portable devices.

Ways To Organize Memory in a computer system :

RAM (Random Access Memory): RAM is a type of computer memory that allows data to be read or written in any order. It is a volatile memory that can be accessed randomly and is used to store data and programs temporarily while they are being used.

ROM (Read-Only Memory):ROM, or Read-Only Memory, is a type of computer memory that is non-volatile, meaning that it retains its contents even when the power is turned off. As the name suggests, ROM is read-only, meaning that data can be read from it, but it cannot be written to.

Cache memory: Memory organization is used to implement cache memory, which is a small and fast memory used to temporarily store frequently used data and instructions. It acts as a buffer between the CPU and the main memory, and is much faster than the main memory. Cache memory is located closer to the CPU, which reduces the time it takes for the CPU to access the data and instructions.

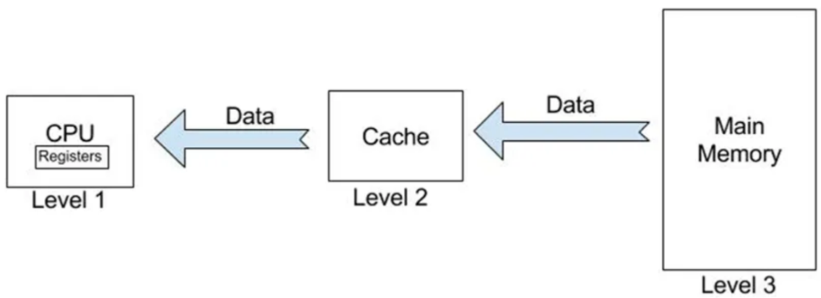
Virtual Memory: It is a technique that allows a computer to use more memory than it physically has. It creates a virtual address space that is mapped to the physical memory.

Flash memory: It is a type of non-volatile memory that is used in portable devices, such as USB drives and memory cards. It is also used in solid-state drives (SSDs).

Magnetic Disk: Magnetic disks are used for mass storage in computer systems. They are non-volatile and can store large amounts of data.

Cache Memory:

To temporarily store frequently accessed data and instructions, systems use cache memory, a compact, high-speed memory. It is situated between the CPU and the main memory of the computer and is a part of the hierarchy of memory. The cache memory is always checked by the CPU before it can access any data or instructions. The system performs better and saves time if the data or instruction is discovered in the cache. When information is not located in the cache, it must be accessed from the main memory, which takes additional time. The concept of locality of reference governs how cache memory functions. Consequently, frequently accessed information and instructions are likely to be used once more soon.



Interface is the path for communication between two components. Interfacing is of two types, memory interfacing and I/O interfacing.

Memory Interface

When we are executing any instruction, we need the microprocessor to access the memory for reading instruction codes and the data stored in the memory. For this, both the memory and the microprocessor require some signals to read from and write to registers.

The interfacing process includes some key factors to match with the memory requirements and microprocessor signals. The interfacing circuit therefore should be designed in such a way that it matches the memory signal requirements with the signals of the microprocessor.

IO Interfacing

There are various communication devices like the keyboard, mouse, printer, etc. So, we need to interface the keyboard and other devices with the microprocessor by using latches and buffers. This type of interfacing is known as I/O interfacing.

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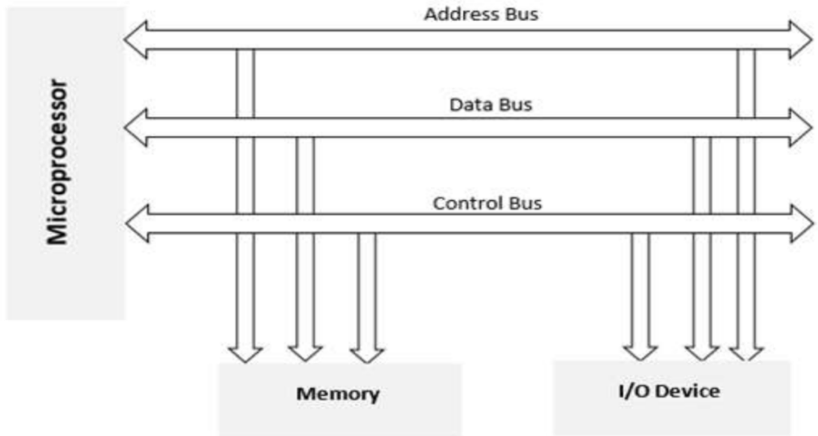
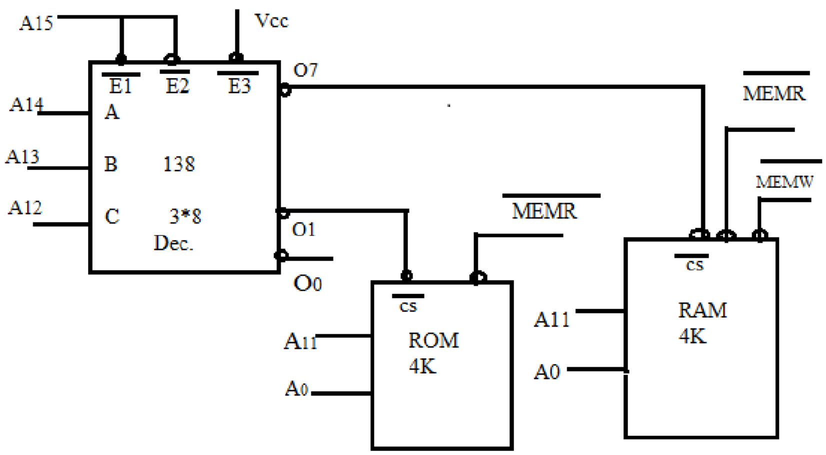


Memory Map

A memory map refers to the way memory is structured and allocated in a system, typically in computing and embedded systems. It defines how different regions of memory are assigned to various functions, such as code execution, data storage, and hardware interaction.

Types of Memory Maps

1. **Physical Memory Map**
   - Represents the actual hardware memory layout, including RAM, ROM, I/O registers, and memory-mapped peripherals.
   - Common in embedded systems and microcontrollers.
2. **Virtual Memory Map**
   - Used in modern operating systems to abstract physical memory for each process.
   - Maps virtual addresses to physical addresses using paging or segmentation.
3. **Memory-Mapped I/O (MMIO)**
   - A technique where hardware registers (like for a GPU or network card) are mapped into memory space, allowing access via normal memory instructions.
4. **File Memory Mapping**
   - A method that maps a file directly into a process's address space.
   - Useful for large files or inter-process communication.



EX1/ Find the range of addresses for each memory chip & draw the memory map?

4k → $2^2 * 2^{10} = 2^{12}$

A11 ⟵ A0

ROM

A15	A14	A13	A12	A11	A10	A9	A8	A7	A6	A5	A4	A3	A2	A1	A0
0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1

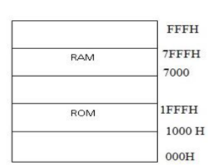
Range of addresses 1000H ⟵ 1FFFH

RAM

A15	A14	A13	A12	A11	A10	A9	A8	A7	A6	A5	A4	A3	A2	A1	A0
0	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0
0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1

Range of addresses 7000H ⟵ 7FFFH

Memory map



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EX2/ Repeat EX 1 if we exchange 4K byte of ROM by 1 K byte of EPROM?

RAM doesn't change (Range of addresses 7000H ⟵ 7FFFH)

ROM

A15	A14	A13	A12	A11	A10	A9	A8	A7	A6	A5	A4	A3	A2	A1	A0
0	0	0	1	X	X	0	0	0	0	0	0	0	0	0	0
0	0	0	1	X	X	1	1	1	1	1	1	1	1	1	1

A11	A10	Range of addresses
0	0	1000 ⟶ 13FF
0	1	1400 ⟶ 17FF
1	0	1800 ⟶ 1BFF
1	1	1C00 ⟶ 1FFF

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