Random Access Memory (RAM) and Read Only Memory (ROM)

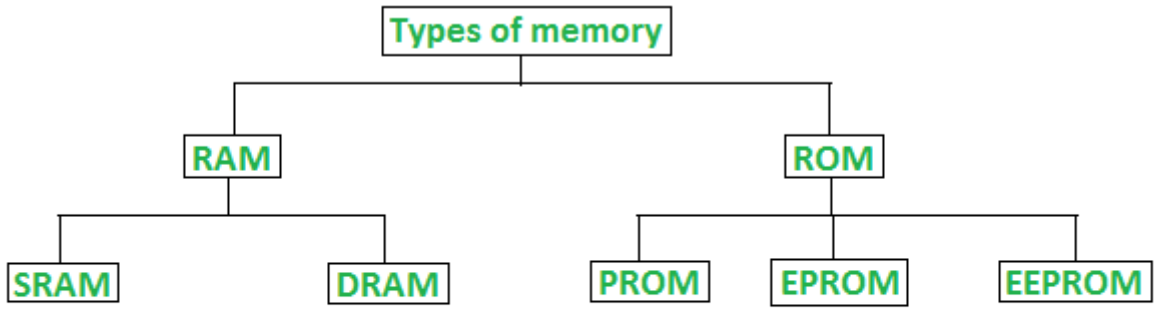
- Memory is a fundamental component of computing systems, essential for performing various tasks efficiently. It plays a crucial role in how computers operate, influencing speed, performance, and data management. In the realm of computer memory, two primary types stand out: Random Access Memory (RAM) and Read-Only Memory (ROM). Understanding the difference between RAM and ROM is vital for appreciating their respective roles in a computer's operation. While RAM enables efficient processing and multitasking, ROM provides the necessary stability and reliability for system functions. Together, these memory types ensure that computers can operate smoothly and effectively in a digital landscape.

Types of Memory

Memory is the most essential element of a computing system because without it computer can't perform simple tasks. Both types of memory (RAM and ROM) are important for the computer, but they serve different purposes. RAM is used to store data that the computer is currently using, while ROM is used to store data that the computer needs to boot and operate. RAM is faster than ROM, as the data stored in it can be accessed and modified in any order, while data stored in ROM can only be read.

Computer memory is of two basic types:

1. Primary memory (RAM and ROM)
2. Secondary memory (Hard Drive, CD, etc).



Classification of computer memory

Classification of Primary Memory

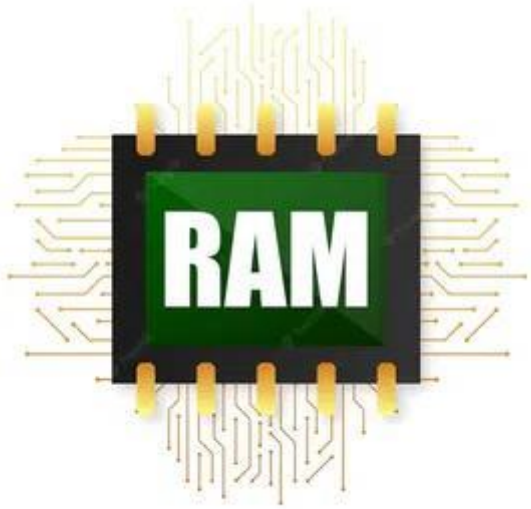
RAM and ROM serve different purposes in computer systems.

Random Access Memory (RAM)

Random Access Memory (RAM) is a type of computer memory that is used to temporarily store data that the computer is currently using or processing. RAM is volatile memory, which means that the data stored in it is lost when the power is turned off. RAM is typically used to store the operating system, application programs, and data that the computer is currently using.

- It is also called read-write *memory* or the *main memory* or the *primary memory* .
- The programs and data that the CPU requires during the execution of a program are stored in this memory.

- It is a volatile memory as the data is lost when the power is turned off.



Random Access Memory

Read-Only Memory (ROM)

Read Only Memory (ROM) is a type of computer memory that is used to permanently store data that does not need to be modified. ROM is non-volatile memory, which means that the data stored in it is retained even when the power is turned off. ROM is typically used to store the computer's BIOS (basic input/output system), which contains the instructions for booting the computer, as well as firmware for other hardware devices.

- Stores crucial information essential to operate the system, like the program essential to boot the computer.
- It is non-volatile.
- Always retains its data.
- Used in embedded systems or where the programming needs no change.
- Used in calculators and peripheral devices.
- ROM is further classified into four types- M *ROM* , *PROM* , *EPROM* , and *EEPROM* .

Read-Only Memory (ROM)

Difference Between RAM and ROM

Parameter	RAM	ROM
Storage Type	Temporary Storage.	Permanent Storage.
Storage Capacity	Store data in MBs.	Store data in GBs.
Data Volatility	Volatile.	Non-volatile.
Usage	Used in normal operations.	Used for startup process of computer.
Data Writing Speed	Writing data is faster.	Writing data is slower.

Advantages of Random Access Memory (RAM)

- **Speed:** RAM is much faster than other types of storage, such as a hard drive or solid-state drive, which means that the computer can access the data stored in RAM more quickly.
- **Flexibility:** RAM is volatile memory, which means that the data stored in it can be easily modified or deleted. This makes it ideal for storing data that the computer is currently using or processing.
- **Capacity:** The capacity of RAM can be easily upgraded, which allows the computer to store more data in memory and thus improve performance.
- **Power Management:** RAM consumes less power compared to hard drives, and solid-state drives, which makes it an ideal memory for portable devices.

Disadvantages of Random Access Memory (RAM)

- **Volatility:** RAM is volatile memory, which means that the data stored in it is lost when the power is turned off. This can be a problem for important data that needs to be preserved, such as unsaved work or files that have not been backed up.
- **Capacity:** The capacity of RAM is limited, and although it can be upgraded, it may still not be sufficient for certain applications or tasks that require a lot of memory.
- **Cost:** RAM can be relatively expensive compared to other types of memory, such as hard drives or solid-state drives, which can make upgrading the memory of a computer or device more costly.

Advantages of Read Only Memory (ROM)

- **Non-volatility:** ROM is non-volatile memory, which means that the data stored in it is retained even when the power is turned off. This makes it ideal for storing data that does not need to be modified, such as the BIOS or firmware for other hardware devices.

- **Reliability:** Because the data stored in ROM is not easily modified, it is less prone to corruption or errors than other types of memory.
- **Power Management:** ROM consumes less power compared to other types of memory, which makes it an ideal memory for portable devices.

Disadvantages of Read Only Memory (ROM)

- **Limited Flexibility:** ROM is read-only memory, which means that the data stored in it cannot be modified. This can be a problem for applications or firmware that need to be updated or modified.
- **Limited Capacity:** The capacity of ROM is typically limited, and upgrading it can be difficult or expensive.
- **Cost:** ROM can be relatively expensive compared to other types of memory, such as hard drives or solid-state drives, which can make upgrading the memory of a computer or device more costly.

Types of Random Access Memory (RAM)

- Static RAM (SRAM)
- Dynamic RAM (DRAM)

1. Static RAM: SRAM stands for Static Random Access Memory. It is a type of semiconductor which is widely used in computing devices and microprocessors.

2. Dynamic RAM: DRAM stands for Dynamic Random Access Memory. It is made of Capacitors and has smaller data life span than Static RAM.

Difference Between DRAM and SRAM

Parameter	DRAM	SRAM
Construction	Constructed of tiny capacitors that leak electricity.	Constructed of circuits similar to D flip-flops.
Data Retention	Requires a recharge every few milliseconds to maintain its data.	Holds its contents as long as power is available.
Speed	Slower than SRAM.	Faster than DRAM.
Storage Capacity	Can store many bits per chip.	Can not store many bits per chip.
Power Consumption	Uses less power.	Uses more power.
Heat Generation	Generates less heat.	Generates more heat.
Typical Usage	Used for main memory.	Used for cache.

Types of Read-Only Memory (ROM)

1. PROM (Programmable Read-Only Memory)
2. EPROM (Erasable Programmable Read Only Memory)
3. EEPROM (Electrically Erasable Programmable Read Only Memory)
4. MROM (Mask Read Only Memory)

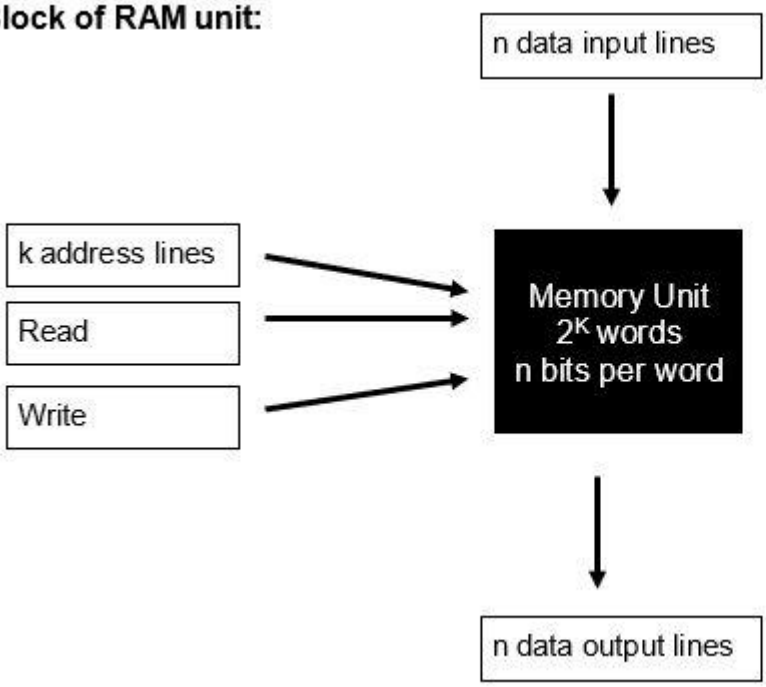
1. PROM (Programmable read-only memory): It can be programmed by the user. Once programmed, the data and instructions in it cannot be changed.
2. EPROM (Erasable Programmable read-only memory): It can be reprogrammed. To erase data from it, expose it to ultraviolet light. To reprogram it, erase all the previous data.
3. EEPROM (Electrically erasable programmable read-only memory): The data can be erased by applying an electric field, with no need for ultraviolet light. We can erase only portions of the chip.
4. MROM(Mask ROM): Mask ROM is a kind of read-only memory, that is masked off at the time of production. Like other types of ROM, mask ROM cannot enable the user to change the data stored in it. If it can, the process would be difficult or slow.

Architecture of RAM

Due to RAM architecture, the memory cells can be accessed for information from anywhere on the computer system.

This communication between different peripherals and RAM is achieved by **data input and output lines, control lines which specify the direction of transfer, and address selection lines**.

Block of RAM unit:



The input data lines provide information which will be stored in the memory.

The data output lines is the information coming out of the specific word, which is chosen from the 2^k available in the memory.

Both of these input will specify the direction of transfer which is required.

(A "word" is a unit that a machine uses when working with memory, i.e. 32bit machine, means the word is 32bits long)
(A "bit" is the basic unit of information in computing)

Read and Write Operations

RAM can perform two operations, they are **read** and **write.**
Read: A signal transferring out
Write: A signal transferring in
Once the RAM accepts one of these control units, the internal circuits, which are situated inside the memory, provide the function, which is expected, from the user.

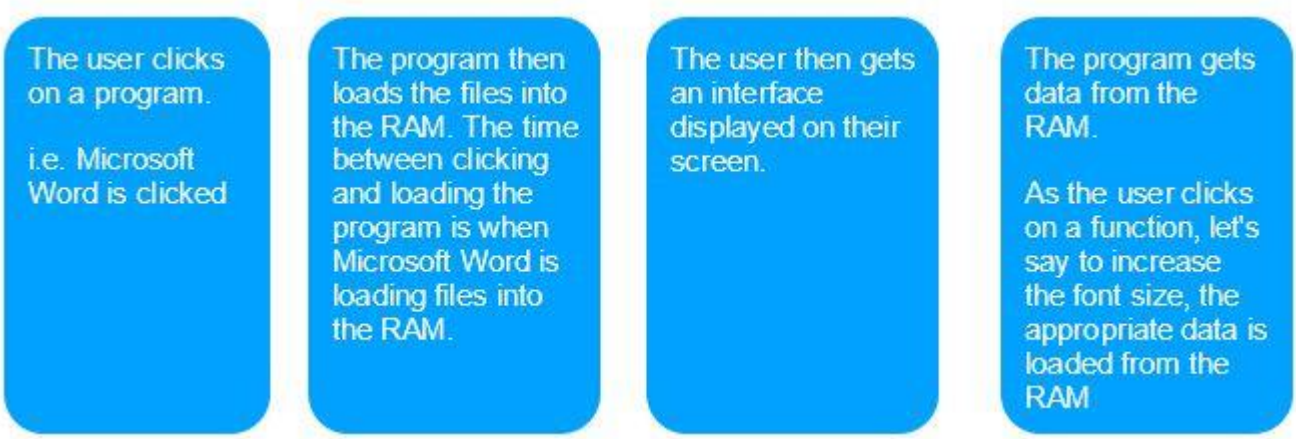
The process is:

1. The binary address of the required word is applied into the address lines
2. Apply the "data bits" that will be stored in memory into the data input lines
3. The write input will be activated
4. Once the steps above are complete, the memory unit will take the bits in the input data lines and will store them, specified by the address lines.

To transfer a stored word out of the memory unit the following occurs:

1. The binary address of the required word is applied into the address lines
2. Activate the read input (content of the word does not change after reading)

Lastly, the memory unit will take the "bits" from the "word" which was selected by the address, and apply them into the output data lines.



Architecture of ROM:

Information in the form of binary is stored permanently inside ROM by the manufacture; the information is injected in the form of bits. ROM consists of logic gates only, arranged in a way that they store specified bits.

Block structure:

- The unit consists of k input lines and n out lines.
- The k input lines take the input address from where we want to access the content of the ROM.
- Since the input lines are either 0 or 1 (binary form). The input lines can be referred to as 2^k total addresses and each of these addresses contains n bit of information, which will be given out as the output of the ROM. This is specified as 2^k x n ROM

Internal structure:

The internal structure consists of two components: the decoder and OR (logic) gates.

- The decoder is a combinational circuit. It is used to decode any encoded form like binary to understandable forms like decimal form. Within the ROM structure, the input into a decoder will be binary and the output will be represented in decimal form.
- All the OR logic gates will have outputs of the decoder as their input.