Two basic memory operations:-

The memory unit supports two fundamental operations: Read and Write. The read operation read a previously stored data and the write operation stores a value in memory .See Figure 4

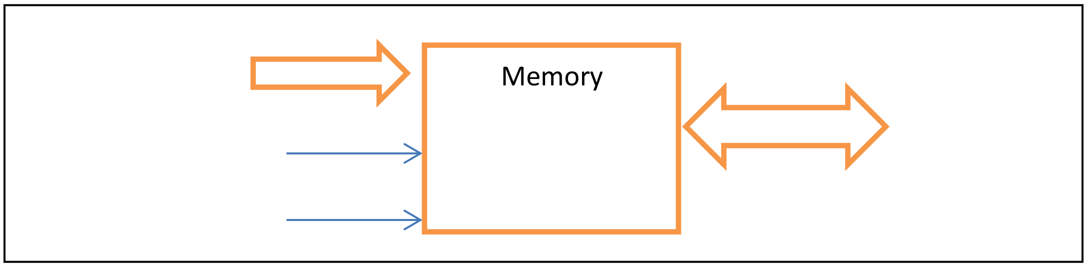

Figure 4: Block diagram of system memory

Steps in a typical read cycle:

1- Place the address of the location to be read on the address bus.

2- Activate the memory read control signal on the control bus.

3- Wait for the memory to retrieve the data from the address memory location.

4- Read the data from the data bus.

5- Drop the memory read control signal to terminate the read cycle.

Steps in a typical write cycle:

1- Place the address of the location to be written on the address bus.

2- Place the data to be written on the data bus.

3- Activate the memory write control signal on the control bus.

4- Wait for the memory to store the data at the address location.

5- Drop the memory write control signal to terminate the write cycle.

Addresses: group of bits which are arranged sequentially in memory, to enable direct access, a number called address is associated with each group.

Addresses start at 0 and increase for successive groups. The term location refers to a group of bits with a unique address. Table 1 represents Bit, Byte, and Larger units.

Table1: Bit, Byte, and Larger units.

Name	Number of Byte
Bit	0 or 1
Byte	is a group of bits used to represent a character, typically 8-bit.
Word	2-byte (16-bit)
Double Word	4-byte (32-bits)
Quadword	8-byte (64-byte)
Paragraph	16-byte (128-bit)
Kilo Byte (KB)	The number 2^{10}=1024=1 KB thus 640K=640*1024=655360 bytes)
Megabyte (MB)	(1024*1024) byte or 1,048,576 byte) approximately 1,000,000 bytes
Gigabyte (GB)	(1024*1024*10240byte) or (1,073,741,824 byte), approximately 1,000,000,000 bytes.
Terabyte (TB)	Approximately 1,000,000,000,000 bytes.

Memory chips:

Memory chips have two main properties that determine their application, storage capacity or size and access time or speed. A memory chip contains a number of locations, each of which stores one or more bits of data known as its bit width. The storage capacity of a memory chip is the product of the number of locations and the bit width. For example, a chip with 512 locations and a 2-bit data width has a memory size of 512×2=1024 bits.

Since the standard unit of data is a byte (8 bits), the above storage capacity is normally given as 1024/8 =128 bytes.

The number of locations may be obtained from the address width of the chip. For example, a chip with 10 address lines has 2^{10}= 1024 or 1 k locations. Given

an 8-bit data width, a 10- bit address chip has a memory size of $2^{10} \times 8$ = 1024×8 = 1k ×1 byte = 1 KB.
The computer's word size can be expressed in bytes as well as in bits.
For example, a word size of 8-bit is also a word size of one byte; a word size of 16- bit is a word size of two byte. Computers are often described in terms of their word size, such as an 8-bit computer, a 16-bit computer and so on.
For example, a 16-bit computer is one in which the instruction data are stored in memory as 16-bit units, and processed by the CPU in 16-bit units. The word size also indicates the size of the data. Bus which carries data between the CPU and memory and between the CPU and I/O devices. To access the memory, to store or retrieve a single word of information, it is necessary to have a unique address. The word address is the number that identifies the location of a word in a memory.
Each word stored in a memory device has a unique address. Addresses are always expressed as binary number, although hexadecimal and decimal numbers are often used for convenience.
The second properties of memory chips is access time, access time is the speed with which a location within the memory chip may be made a variable to the data bus. It is defend as the time interval between the instant that an address is sent to the memory chip and the instant that the data stored in to the location appears on the data bus. Access time is given in nanosecond (ns) and varies from 25 ns to the relatively slow 200 ns.

NOTS:

- The large computer (mainframes) have word-sizes that are usually in the 32-to-64 –bits range.

- Mini computers have a word sizes from 8-to-32-bits range.

- Microcomputers have a word sizes from 4-to-32-bits range.

In general a computer with a larger word size can execute programs of instruction at a fast rate because more data and more instruction are stuffed into one word. The larger word sizes, however, mean more lines making up the data bus, and therefore more interconnections between the CPU and memory and I/O devices.
The word size is 4-bit therefore there are 4-data I/P lines and 4data O/P lines.
This memory has 32 different words, and therefore has 32 different addresses (storage location) from (00000) to(11111). Thus, we need a 5 address I/P lines.

Memory capacity = number of memory storage
Location ×size of each word
= (number of word) × (number of bits per word)
= m (word)*n (bits)
= m*n bits

The capacity of memory depends on two parameters, the number of words (m) and the number of bits per word (n).

Every bit added to the length of address will double the number of words in the memory.

The increase in the number of bits per bits requires that an increase the length of data I/P and data O/P lines.

EX:-

A certain memory chip is specified as 2K×8:

1. How many words can be stored on this chip?
2. What is the words size?
3. How many total bits can this chip store?

SOL:-

1. 2K =2 × 1024 = 2048 words
2. The word size is 8-bits (1 byte).
3. Capacity = 2048 × 8 = 16 KB. Memory chip

EX:- A certain memory chip is specified as 2K × 16

1. How many words can be stored on this chip?
2. What is the words size?
3. How many total bits can this chip store?

SOL:-

1. 2K = 2 × 1024 = 2048 words
2. The word size is 16-bits(2 byte).
3. Capacity = 2048 * 16 = 32KB.

EX:- Which memory stores the most number of bits:
2MG × 8 memory or 2MG × 16 memory?

SOL:-

1. Capacity =(2 × 1024 ×1024) × 8 = 16,777,216 bits.

2. Capacity =(2 × 1024 ×1024) ×16= 33,554,432 bits.

EX:- Which memory stores the most number of bits:
4MG × 8 memory or 2MG × 16 ?

SOL:-
1. Capacity = (4 × 1024 ×1024) × 8 =33,554,432 bits.
2. Capacity = (2 × 1024 × 1024) ×16= 33,554,432 bits.

EX:- A certain memory has a capacity of 4K × 8
1. How many data I/P & data O/P lines?
2. How many word address line?
3. What is its capacity in byte?

SOL:-
1. 8each line:- data I/P lines = data O/P lines =8
2. 4 × 1024 = 4096 words

Thus, there are 4096 memory add nesses
2^8 =4096 2^8 =2^{12}
So X=12 it required a 12 bit address line
3. The capacity = (4 ×1024) × 8= 32,768 bit = 32,769/8 =4096 byte
(Since 1byte = 8 bit).

EX: - the a certain memory has a capacity of 4K×16
1. How many data I/P & data O/P lines?
2. How many word address lines?
3. What is its capacity in byte?

SOL:-
1. 16 each one.
Data I/P lines = data O/P lines =16
2. 4 × 1024 = 20496 words
Thus, there are 4096 memory addresses.
4096 = 2^{12}
It is require a 12-bit address line.
3. Capacity = (4 × 1024) × 16 = 65,536 bit
= 65,536 / 8 = 8.192 byte

Types of memory

The memory unit can be implemented using a variety of memory chips- different speeds, different manufacturing technology, and different sizes.

1- Read Only Memories (ROM):

ROMs allow only read operation to be performed. This memory is non-volatile. Most ROMs are programmed and cannot be altered.

This type of ROM is cheaper to manufacture than other types of ROM. The program that controls the standard I/O functions (called BIOS) is kept in ROM, configuration software.

Other types of ROM include:

A- Programmable ROM (PROM).

B- Erasable PROM (EPROM) is read only memory that can be Re-programmed using special equipment.

C- EAPROM, Electrically Alterable Programmable ROM is a Read Only Memory that is electrically reprogrammable.

2- Read/Write Memory (RAM):-

Read/Write memory is commonly referred to as Random Access Memory (RAM); it is divided into static and dynamic.

A-Static RAM (SRAM): used for implementing CPU registers and used for special high speed memory called cache memory this greatly improves system performance. **Static RAM** keeps its value without having to be refreshed.

B-Dynamic RAM (DRAM), the bulk of main memory in a typical computer system consists of dynamic ram. DRAM is where programmed, data are kept when a program is running. It must be refreshed with in less than a millisecond or losses its contents.