

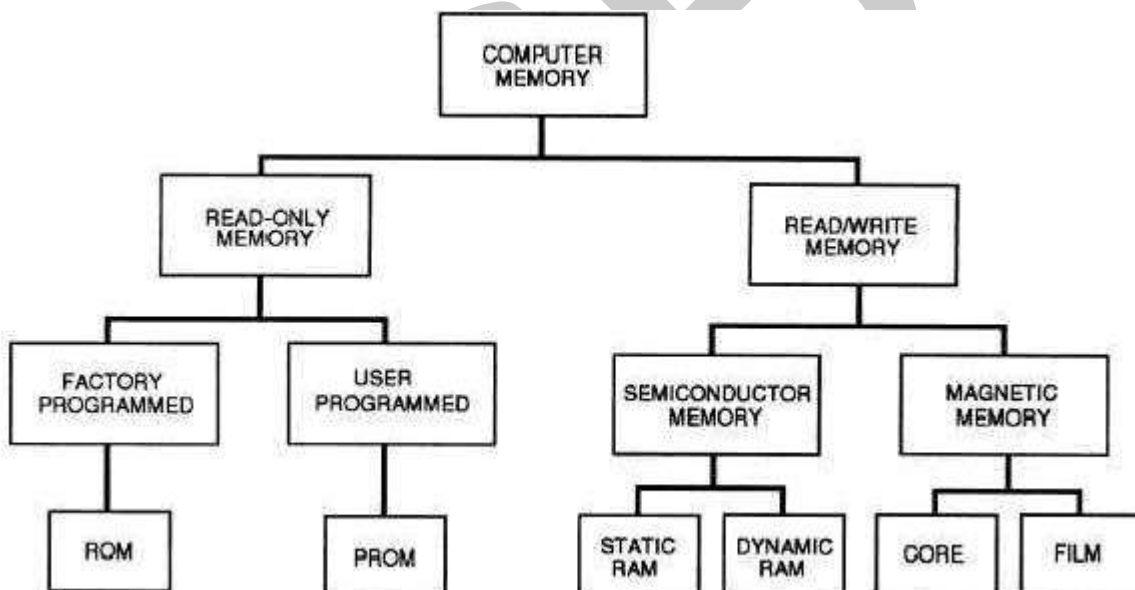
Chapter – 4 Memory

Memory Organization

Computer data storage, often called storage or memory, refers to computer components and recording media that retain digital data used for computing for some interval of time.

Computer data storage provides one of the core functions of the modern computer, that of information retention.

It is one of the fundamental components of all modern computers, and coupled with a central processing unit (CPU, a processor), implements the basic computer model.



A Primary storage or main memory of a computer system is made up of several small storage areas called location or cell.

Each of these locations can store a fixed number of bits called word length of the memory.

Each word or location has a built-in and unique number assigned to it. This number is called the address of the location and is used to identify the location.

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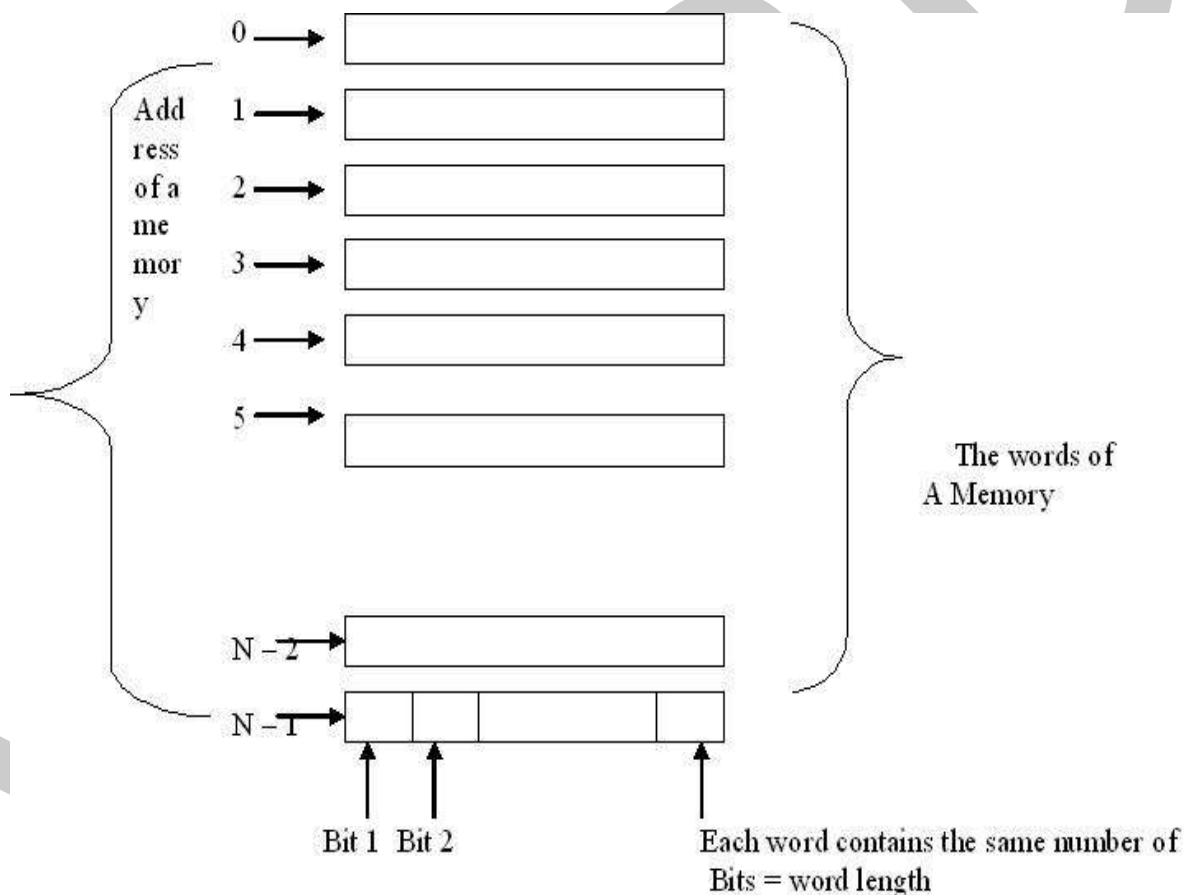
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Each location can hold either a data item or an instruction and its address remains the same, regardless of its contents. The first address normally starts at 0 and the highest address equals the number of words that can be stored in the memory minus 1.

- For example, if a memory has 1024 locations, the address range between 0 and 1023.
- Hence, at address 0 we find a word, at address 1 a second word, at address 2 a third word, and so on, up to the final word at the last address (1023).



Storage Evaluation criteria

Any storage unit of a computer system is characterized and evaluated based on following properties:

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- 1. Storage capacity.** It is the amount of data that can be stored in the storage unit. A large capacity is desired. As compared to secondary storage units, primary storage units have less storage capacity.
- 2. Access time.** It is the time required to locate and retrieve stored data from the storage unit in response to a program instruction. A fast access time is preferred. As compared to secondary storage units, primary storage units have faster access time.
- 3. Cost per bit of storage.** It refers to the cost of a storage unit for a given storage capacity. Obviously, lower cost is desired. As compared to secondary storage units, primary storage units have higher cost per bit of storage.
- 4. Volatile.** If the storage unit can retain the data stored in it even when power is turned off or interrupted, it is called non-volatile storage. On the other hand, if the data stored are lost when power is turned off or interrupted, it is called volatile storage. Obviously, a non-volatile storage is desirable.
- 5. Random access.** If the time taken to access a piece of data from a storage unit is independent of the location of the data in the storage unit, it is called **random access storage** or **random access memory(RAM)**. In almost all computer system primary storage units have random access property and secondary units have either pseudo-random access location but not exactly same or sequential access property.

More Bytes

- You might have about 8-bits computers, 16-bits computers, 32-bits computers, etc.
- The refers to the word length of memory of a computer in terms of its total number of bits per memory lengths of 64 bits or more.

- The obvious question that arises is –“What is the advantage of having more number of bits per word, instead of having more words of smaller size (length)?”

Fixed & Variable Word-length Memory

- Main memory of some computers is designed to a fixed number of characters in each numbered address location. Such computers are said to be word-addressable and they employ a fixed-word-length memory approach.
- Storage space is always allocated in multiples of word-length.
- Therefore, if a word-addressable computer has a fixed word-length of 4 byte (4 characters), it will require one word (4 bytes) to store the word “CAT” and two words (8 bytes) to store the word “BOMBAY”.
- In many computers, main memory is designed to store a single character (A, B, 1, 2, +, -, etc.) at each numbered address.
- Computers designed in this manner said to be character-addressable and they employ a variable-word-length memory approach.
- Hence, in these machines only 3 bytes will be required to store the word of “CAT” and 6 bytes to store the word “BOMBAY”.
- In table difference between summarized between fixed-word-length and variable-word-length memory approaches.

Main Memory Capacity

- Main memory capacity of large system is normally more than that of smaller systems. This capacity is defined in terms of the number of bytes a computer system can store.
- Memory capacity of a computer system is normally stated in terms of kilobytes (KB), which is equal to $1024 (2^{10})$ bytes of storage, or megabytes (MB), which is equal to $1,048,576 (2^{20})$ bytes of storage, or gigabytes (GB) which is equal to $1,073,741,824 (2^{30})$ bytes storage.

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- Therefore, a computer having 32MB of memory is capable of storing $32 * 1048576 = 33,554,432$ bytes or characters.

Volatile memories — Volatile memories are memories that lose their contents when the power is turned off. A semiconductor memory is an example.

Nonvolatile memories — Nonvolatile memories are memories that do not lose their contents when power is removed. Core memory is an example

Access time

- Access time is a measure of the time required to read from or write the data to a
- Particular address in the memory. It is the interval from the instant at which a request for data is initiated until the data is available for use. It can range from a few nanoseconds (ns) to microseconds

Address

Address is Identification, represented in the form of a name, label, or number, for designating a location in storage area.

8085MP uses following Address modes.

- Direct Addressing
- Register Addressing
- Indirect Addressing
- Immediate Addressing
- Implicit Addressing

Direct Addressing

Direct Addressing mode in this mode of addressing the address of operand is given in the instruction. Store the content of accumulator in the memory location 6000H.

Register Addressing

A high-speed circuit that holds the addresses of data to be processed or of the next instruction to be executed.

Indirect Addressing

An address mode that points to another pointer rather than the actual data. This mode is prohibited in RISC architecture.

Immediate Addressing

In immediate addressing, the instruction itself contains the value to be used. This is like using a constant like 7 or 39 in an expression in a higher level language.

Implicit Addressing

An implicit address structure and technique are disclosed for rapidly accessing storage registers by eliminating the need for generating a separate address before referencing the register.

A structure is provided for generating an address composed of parameters which are incorporated into the contents of the storage register.

Types of Memory

1. RAM
2. ROM
3. FLASH
4. PROM
5. EPROM
6. EEPROM

RAM: Random Access Memory

- The word Random Access Memory means the computer can access any memory cell without accessing all cells. Sequentially that is the memory is said to be RANDOM ACCESS MEMORY.
- It has random access property any part of the this memory can be access directly for reading or writing data in the same time
- Contains of this memory remain in it as long as electrical current is available if power fails all the contains in the memory will be lost. It is also called read – write memory.
- Information can be read from can written in to it during the operation.
- The users enters program and data into RAM it retains stored as long as power supplying is on and the contain will lost when power supply which off.
- So, it is known as are two kinds of RAM Static RAM and Dynamic RAM.

ROM: Read Only Memory

- Non-volatile memory chip in which data are stored permanently, and cannot be altered by programmers
- The ROM is Read Only Memory
- It is semiconductor memory and used for permanent storage
- This memory cannot be return into when power is switch off the contain of row remain unchanged it has also called random access property.
- It contains assembler, compiler, monitor, programs or any other permanent program ROM's widely use for function table (sine, cosine, logarithm, square roots) multiplication, division, sub rooting etc.

- Contain of RAM are stored at the time of manufacturing.
- So, they can't be change after manufacture.

PROM: Programmable Read Only Memory

- Similar to read only memory with the exception that these chips can be reprogrammed by using special external equipment
- ROM can be programmed once special circuit is used for programming it.
- Once program it becomes Read Only Memory

EPROM: Erasable PROM

- It is an Erasable PROM.
- The contains are Erase by exposing it to high intensity Ultra violet light source 10 to 20 minute.
- Ultra violet source it wave length 2537 Å is used for this purpose
- The user can't Erase the contain of single memory location word entire contain are Erase.

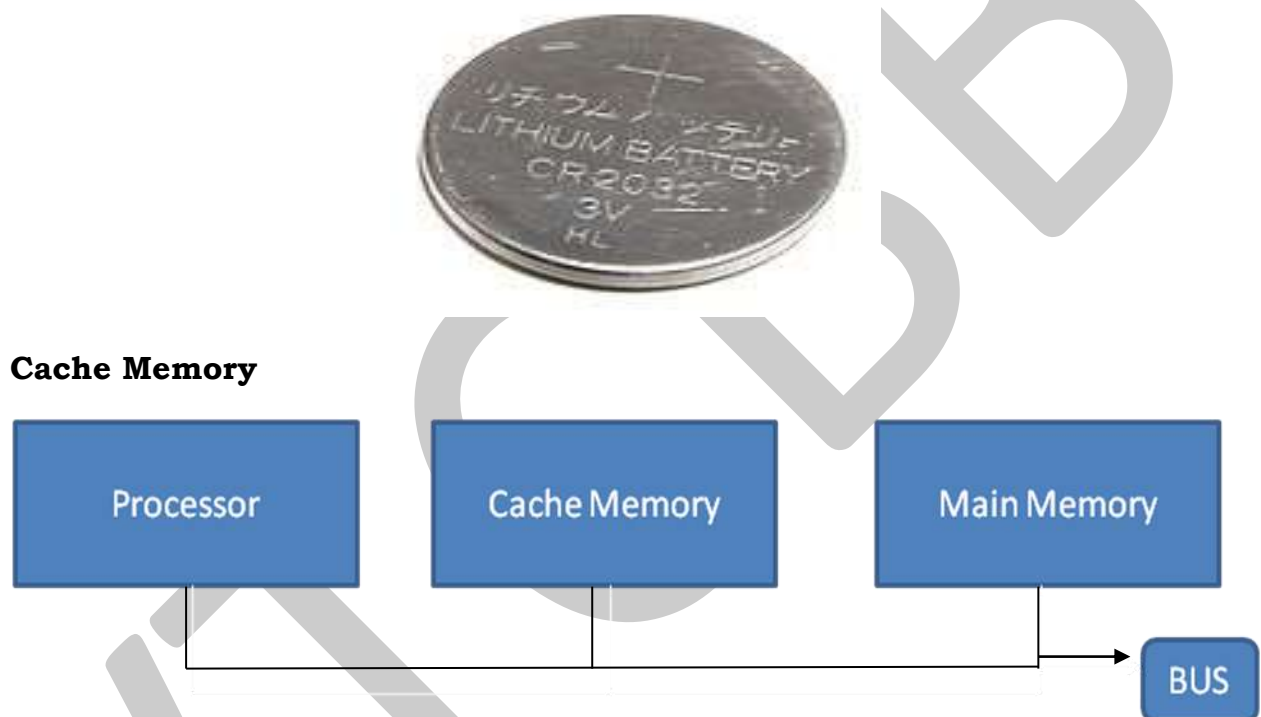
EEPROM: Electrically Erasable PROM

- EPROM chip in which stored information is erased by using high voltage electric pulse (not beat). Also known as FLASH Memory
- This ROM doesn't need to remove it from micro computer for erasing
- This memory can be Erase Electrically in few milli second of kind (10 milli second) about 10 milli second is required to write. Each of data input device.
- If required single bit than also bit Erase and programming of this memory is much Erase as computer to EEPROM

CMOS: Complementary metal-oxide-semiconductor

- CMOS mismatch CMOS mismatch errors typically occur if

- The computer's power-on self-test program:
- Finds a device that is not recorded in the CMOS.
- Does not find a device that is recorded in the CMOS.
- Finds a device that has different settings than those recorded for it in CMOS.
- Detects a CMOS checksum error.



“A small high speed memory that is used to increase speed processing by making current programs and data available to CPU at a rapid(fast) rate.”

- It is Place in between CPU and Main Memory
- The most heavily use memory words are kept in cache
- When the CPU needs a word it first look in the cache only if the word is not there it goes to main memory
- It is fabricated using high speed semiconductor devices

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- The effective cycle time of cache would be about a tenth of main memory cycle time it cost about ten times the cost/byte of main memory
- Its access time is 15 to 20 nanosecond
- While that of the main memory is 18 nanosecond.
- It stores instructions which are going to be executed immediately many computers are designed with two cache memory. One is called an instruction cache and other data cache.
- They are normally of equal size,
- The series of instructions are copied in the cache from the main memory data to be processed by these instructions are copied into the data cache.
- The processor fetches these instructions and data from the cache memories. Thus, fetch time is reduced when instructions or data are copied into them from the main memory which is done automatically.
- It is at any time the required instruction isn't in the cache.
- The processor fetches the instruction from the main memory

Virtual Memory

"Simulating more random access memory (RAM) than actually exists, allowing the computer to run larger programs and manipulate programs concurrently."

- The term virtual means something which appears to be present but actually it is not.
- The virtual memory is a technique that permits the user to use more memory when a computer actually has the main memory available in computer is called real or physical memory
- The secondary memory is provided in a computer for bulk storage.
- The CPU doesn't address secondary memory directly.
- CPU executes programs which are in the main memory programs and data are transferred from the secondary memory to the main memory and they are transferred for processing when required the results and modified information are again stored in the secondary memory

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- The programmer repairs a program which uses more space then the capacity of main memory.
- Such programs are executed by virtual memory technique
- The memory management unit transfer a port of program from the secondary memory to the min memory this path of the program is executed
- After executing this path of the program it is send back to the secondary memory there after CPU takes another part of program for execution.
- Thus primary (Main memory) its only currently needed portion of the program that is no longer needed send back to the secondary memory.
- This is too & for movement of instruction and data between main & swapping.