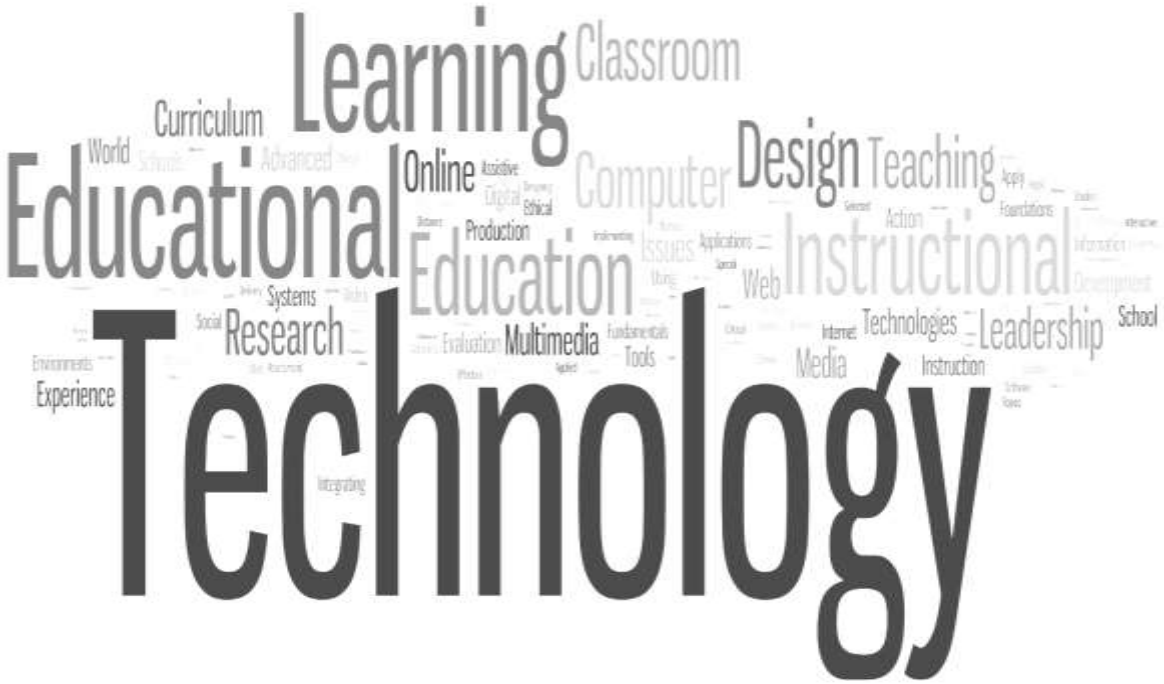
UNIT I Computer Organization and Instructions

Memory

TECHNOLOGY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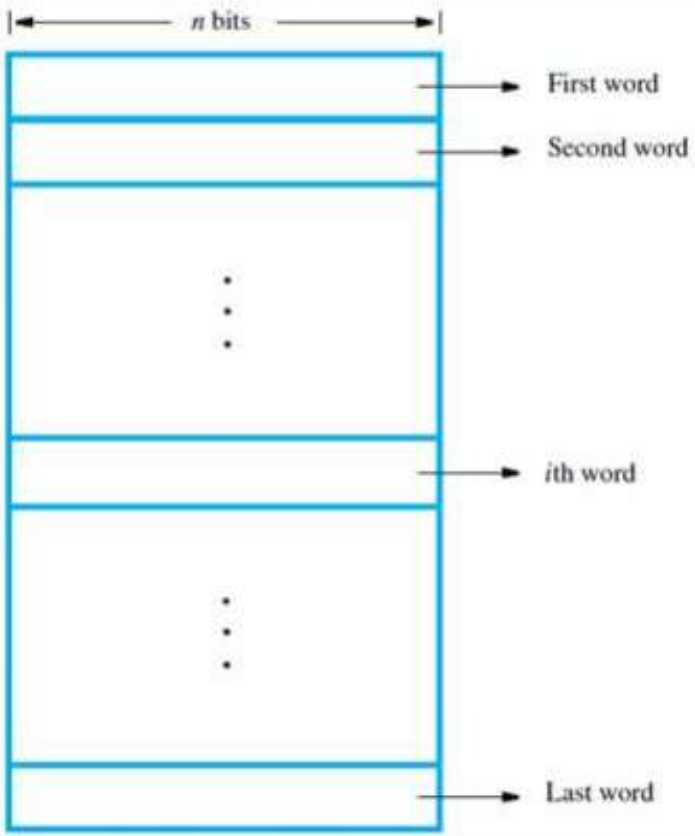
What is a Memory

Memory consists of many millions of storage cells (flip-flops).

- Each cell can store a bit of information i.e. 0 or 1 (Figure).
- Each group of n bits is referred to as a word of information, and n is called the word length.
- The word length can vary from 8 to 64 bits.
- A unit of 8 bits is called a byte.
- Accessing the memory to store or retrieve a single item of information (word/byte) requires distinct addresses for each item location. (It is customary to use numbers from 0 through 2ˆk-1 as the addresses of successive-locations in the memory).
- If 2ˆk = no. of addressable locations;

then 2ˆk addresses constitute the address-space of the computer. For example, a 24-bit address generates an address-space of 2ˆ24 locations (16 MB).

Memory Locations and Addresses

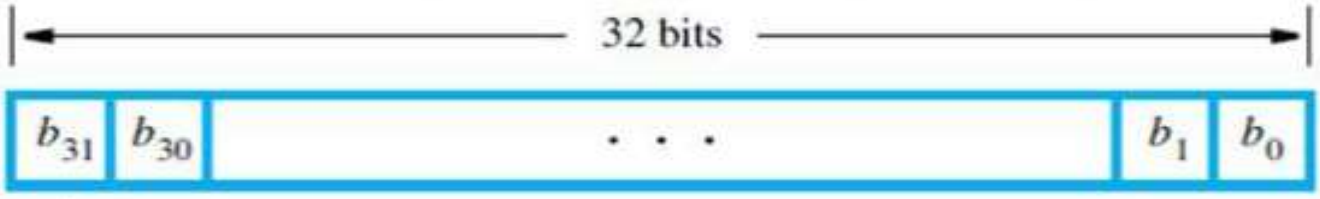


Modern computers have word lengths that typically range from 16 to 64 bits.

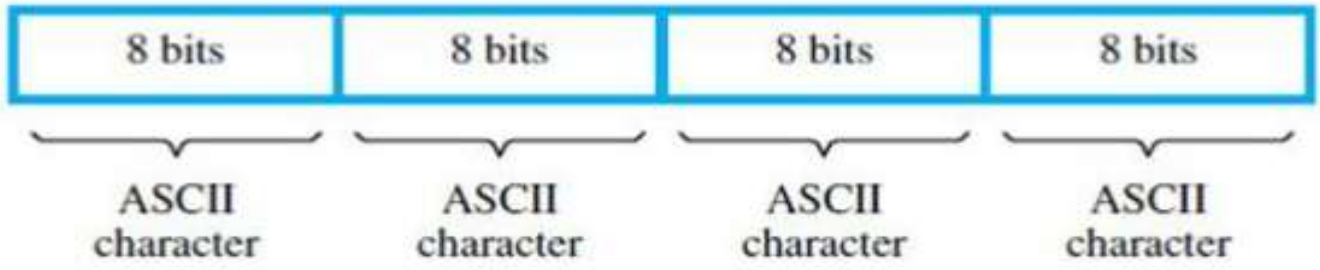
If the word length of a computer is 32 bits, a single word can store a 32-bit signed number or four ASCII-encoded characters, each occupying 8 bits.

A unit of 8 bits is called a ***byte***.

Memory Locations and Addresses cont..



(a) A signed integer



(b) Four characters

Memory Locations and Addresses cont..

Machine instructions may require one or more words for their representation.

Accessing the memory to store or retrieve a single item of information, either a word or a byte, requires distinct names or addresses for each location. It is customary to use numbers from **0** to $2^k - 1$, for some suitable value of **k**, as the addresses of successive locations in the memory. Thus, the memory can have up to 2^k addressable locations. The 2^k addresses constitute the address space of the computer.

Memory Locations and Addresses cont..

For example, a 24-bit address generates an address space of 2^{24} (16,777,216) locations. This number is usually written as

16M

(16 mega), where **1M** is the number 2^{20} (1,048,576). A 32-bit address creates an address space of 2^{32} or

4G

(4 giga) locations, where **1G** is 2^{30}.

Byte Addressability

Now we have 3 basic information

Bit, Byte and Word

A byte is always 8 bits, but the word length typically ranges from 16 to 64 bits.

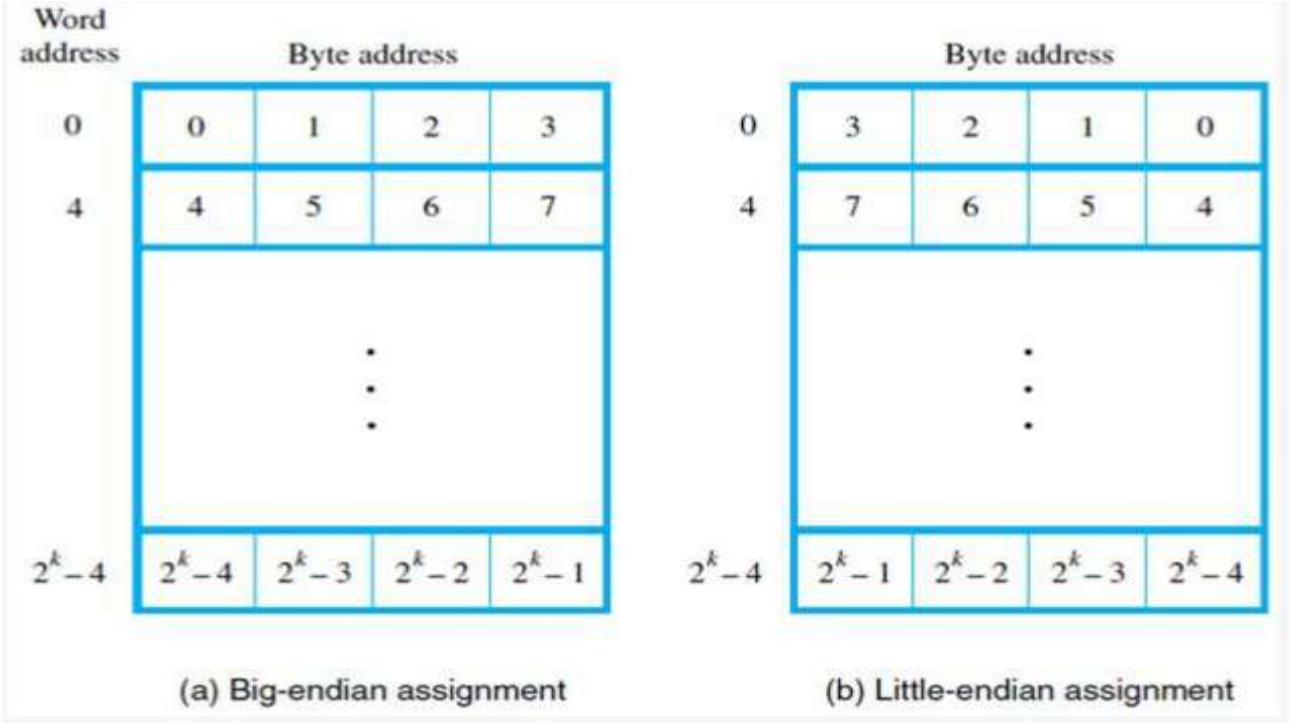
It is not possible to allocate memory address to every bit locations in memory

- In byte-addressable memory, successive addresses refer to successive byte locations in the memory.
- Byte locations have addresses 0, 1, 2. . . . .
- If the word-length is 32 bits, successive words are located at addresses 0, 4, 8. . with each word having 4 bytes.

Big Endian and Little Endian

There are two ways that byte addresses can be assigned across words

- Big- Endian - Big-endian is an order in which the "big end" (most significant value in the sequence) is stored first, at the lowest storage addres
- Little – Endian - Little-endian is an order in which the "little end" (least significant value in the sequence) is stored first.



Memory Operations

Both program instructions and data operands are stored in the memory. To execute an instruction, the processor control circuits must cause the word (or words) containing the instruction to be transferred from the memory to the processor.

Operands and results must also be moved between the memory and the processor.

Thus, two basic operations involving the memory are needed, namely, `Read` and `Write`.

Memory Operations- Read

The `Read` operation transfers a copy of the contents of a specific memory location to the processor. The memory contents remain unchanged.

To start a Read operation, the processor sends the address of the desired location to the memory and requests that its contents be read.

The memory reads the data stored at that address and sends them to the processor.

Memory Operations- Write

The `Write` operation transfers an item of information from the processor to a specific memory location, **overwriting the former contents** of that location.

To initiate a Write operation, the processor sends the address of the desired location to the memory, together with the data to be written into that location.

The memory then uses the address and data to perform the write.

Thank you