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paper-iv Lecture no-57

Topic: Binary Number System

The number system is a way to represent or express numbers. You have heard of various types of number systems such as the **whole numbers** and the real numbers. But in the context of computers, we define other types of number systems. They are:

- The decimal number system
- The binary number system
- The octal number system and
- The hexadecimal number system

Binary Number System (Base 2)

A computer can understand only the "on" and "off" state of a switch. These two states are represented by 1 and 0. The combination of 1 and 0 form binary numbers. These numbers represent various data. As two digits are used to represent numbers, it is called a binary or base 2 number system.

The binary number system uses positional notation. But in this case, each digit is multiplied by the appropriate power of two based on its position.

$$\begin{aligned} \text{For example, } (101101)_2 \text{ in decimal is} \\ &= 1 \times 2^5 + 0 \times 2^4 + 1 \times 2^3 + 1 \times 2^2 + 0 \times 2^1 \\ &+ 1 \times 2^0 \\ &= 1 \times 32 + 0 \times 16 + 1 \times 8 + 1 \times 4 + 0 \times 2 + \\ &1 \times 1 \\ &= 32 + 8 + 4 + 1 \\ &= (45)_{10} \end{aligned}$$

Machine language is binary. And so it is necessary to discuss how to measure the data stored in a computer. Bit and Byte are the units to measure data.

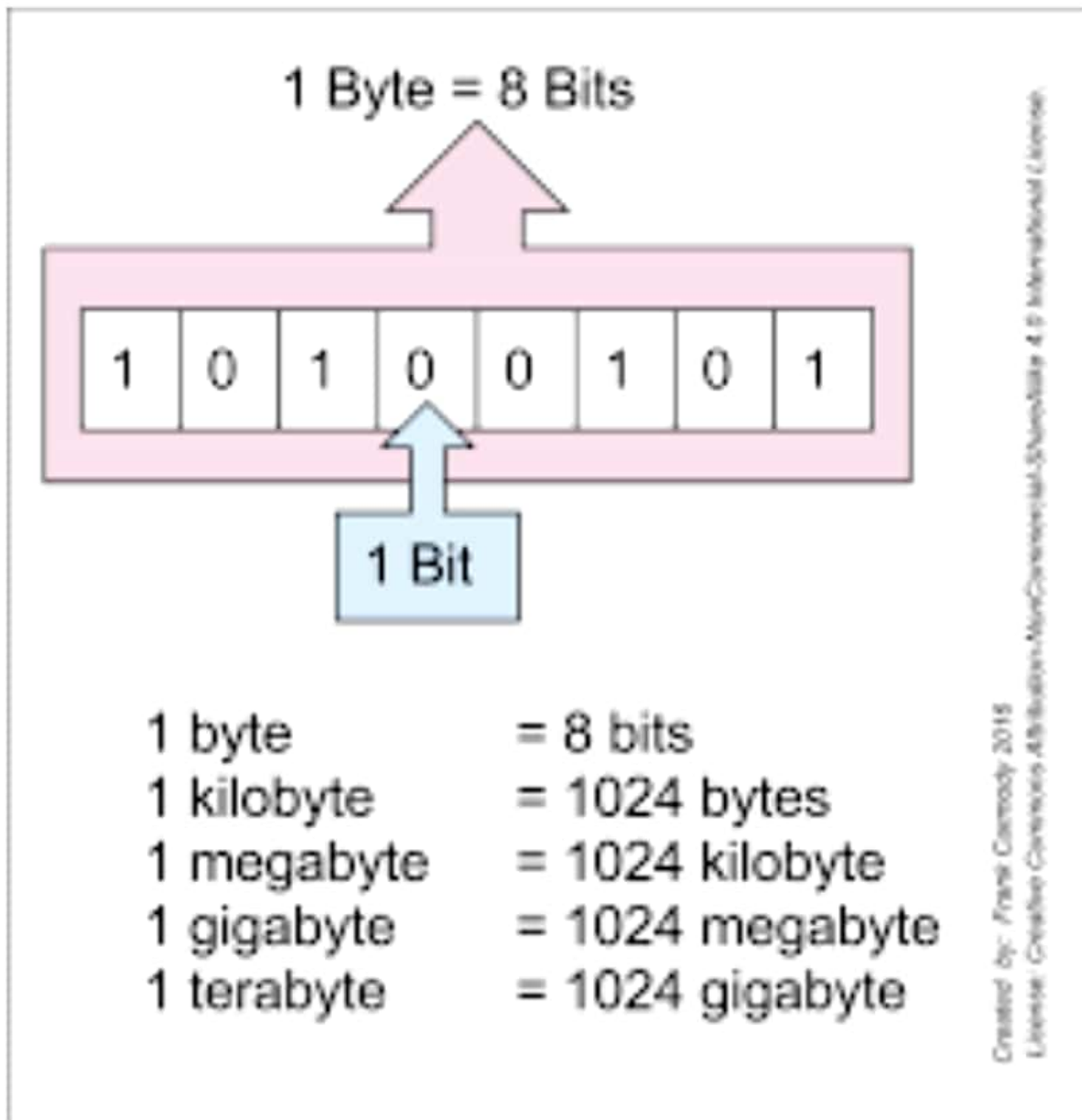
Bit

The term 'bit' is a contraction of the words 'binary' and 'digit'. It is the smallest unit of memory or instruction that can be given or stored on a computer. A bit is either a 0 or a 1. The number in the above example is a 6-bit number as it has 6 binary digits (0s and 1s).

Byte

A group of 8 bits like 01100001 is a byte. Combination of bytes comes with various names like the kilobyte. One kilobyte is a collection of 1000 bytes. A word or letter like 'A' or 'G' is worth 8 bits or one byte. One thousand bytes

make up a kilobyte (one thousand letters approximately). 1024 kilobytes form a Megabyte (Mb) and so on.



Binary Addition

It is a key for binary subtraction, multiplication, division. There are four rules of binary addition.

Case	A	+	B	Sum	Carry
1	0	+	0	0	0
2	0	+	1	1	0
3	1	+	0	1	0
4	1	+	1	0	1

In fourth case, a binary addition is creating a sum of $(1 + 1 = 10)$ i.e. 0 is written in the given column and a carry of 1 over to the next column.

Example - Addition

$$0011010 + 001100 = 00100110$$

$$\begin{array}{r} 11 \text{ carry} \\ 0011010 = 26_{10} \\ +0001100 = 12_{10} \\ \hline 0100110 = 38_{10} \end{array}$$

Binary Subtraction

Subtraction and Borrow, these two words will be used very frequently for the binary subtraction. There are four rules of binary subtraction.

Case	A	-	B	Subtract	Borrow
1	0	-	0	0	0
2	1	-	0	1	0
3	1	-	1	0	0
4	0	-	1	0	1

Example – Subtraction

$$0011010 - 001100 = 00001110$$

$$\begin{array}{r}
 11 \text{ borrow} \\
 00\cancel{1}\cancel{1}010 = 26_{10} \\
 -0001100 = 12_{10} \\
 \hline
 0001110 = 14_{10}
 \end{array}$$