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# NUMBER SYSTEMS

## Chapter Outline:



## 2.1A.0 Objectives

- *What is Number System?*
- *Categories of number system*
- Types of Number Systems
- *Method of conversion between number bases*

Since the early days of human civilisation, people have been using their fingers, sticks and other things for counting. It all started perhaps, with the need to figure out the assets a person had. As daily activities became more complex,

numbers became more important in trade, time, distance and in all other spheres of human life. It became apparent that we needed more than our fingers and toes to keep track of the number in our daily routine. Furthermore, ever since people discovered that it was necessary to count objects, they have been looking for easier ways to count them. Signs and symbols gained popularity for number representation. The early forms were straight lines or groups of lines.

In 3400 BC, the ancient Egyptians started using special symbols for writing the numbers. This was a major advancement because it reduced the number of symbols required. However, it was difficult to represent large or small numbers by using such a graphical approach.

### 2.1A.1 Number Systems

A number system defines a set of values used to represent *quantity.* We talk about the number of people attending a class, the number of modules taken by each student and use numbers to represent grades achieved by students in tests. Quantifying values and items in relation to each other is helpful for us to make sense of our environment.

Number systems have been around for thousands of years. We can see the remnants of several systems in our present day civilisation. The common system is the existing system based on number ten. Although, today the most common number system in use is the Arabic system, the number systems can be categorised in two broad categories:

- Non-Positional Number Systems
- Positional Number Systems

### 2.1A.1.1 Non-Positional Number Systems

In ancient times, people used to count on their fingers. When the fingers became insufficient for counting, stones, pebbles or sticks were used to indicate the values. This method of counting is called the *non-positional number system.* It was very difficult to perform arithmetic with such a number system, as it had no symbol for zero. The most common non-positional number system is the Roman Number System. In this number system, only a few characters are used to represent the numbers. The characters, which are used in this number system are I, V, X, L (for fifty), C (for hundred), etc. Moreover, since it is very difficult to perform the addition or any other arithmetic operations in this system, as a result no logical or positional techniques are used in this system.

### 2.1A.1.2 Positional Number Systems

In positional number systems, the value of each digit in a number is defined not only by the symbol but also by the symbol's position. Positional number systems have a base or radix. The first positional number system was invented by the Babylonians. They used a base 60 system. The positional number system, which is being used nowadays is called the *decimal number system.* This system is base 10 system, that is, it contains 10 digits (0, 1, 2, 3... 8, 9). Apart from the decimal number system,

there are some other positional number systems such as *binary number system, octal number system* and *hexadecimal number system* each having a radix of 2, 8 and 16, respectively. However, the principles which are applied to the decimal number system are also applicable for the other positional number systems.

### 2.1A.1.3 Base (or Radix) of System

In the number system, the base or radix tells the number of symbols used in the system. In the earlier days, different civilisations were using different radixes. The Egyptians used the radix 2, the Babylonians used the radix 60 and Mayans used 18 and 20. In contrast, modern computers use the radix 2 because they recognise only two symbols, which are represented in digital circuits as 0s and 1s.

Radix of the system is always expressed in decimal numbers. The base or radix of the decimal system is 9A. This implies that there are 10 symbols: 0, 1, 2, 3, 4, 5, 6, 7, 8 and 9A. Similarly, the system using three symbols 0, 1, 2 will be of base 3; four symbols will be of base 4 and so forth.

The base of a number system is indicated by a subscript (decimal number) and this will be followed by the value of the number.

For example:

$(7592)_{10}$ is of base 10 number system.

$(214)_8$ is of base 8 number system.

$(123)_{16}$ is of base 16 number system.

### 2.1A.2 Computer and Numbers

We apply numbers everyday, and knowing how numbers work enables us to know how a computer manipulates and stores numbers.

For a computer, everything is a number whether it may be numbers, alphabets, punctuation marks, its own instructions, etc. Let us understand with the help of an example. Consider the word 'words' which always appears on the computer screen (for us) as a series of alphabetic characters. However, for the computer, it is a combination of numbers. To the computer it appears as:

| 0111 0111 | 0110 1111 | 0111 0010 | 0110 0100 | 0111 0011 |
|---|---|---|---|---|
| (w | o | r | d | s) |

Eventually, the number systems that are generally used by the computers are:

- Decimal System
- Binary System
- Octal System
- Hexadecimal System

**Table 2.1A.1** Types of Number Systems

| Number System | Radix Value | Set of Digits. | Example |
|---|---|---|---|
| Decimal | r = 10 | (0, 1,2,3,4,5,6,7,8,9) | $(25)_{10}$ |
| Binary | r = 2 | (0, 1) | $(11001)_2$ |

| | | | |
|---|---|---|---|
| Octal | r = 8 | (0, 1,2,3,4,5,6, 7) | $(31)_8$ |
| Hexadecimal | r = 16 | (0, 1,2,3,4,5,6,7,8,9, A, B, C, D, E, F) | $(19)_{16}$ |

The important thing about the number systems is that each system is just a different method for representing the quantities. Moreover, the quantities do not change but the symbols used to represent those quantities are changed in each number system.

### 2.1A.2.1 Decimal Number System

The primary number system used is a base ten number system or *decimal number system.* The decimal system is the system which we use everyday while counting. The name is derived from the Latin word *Decem,* which means ten. This number system includes the ten digits from 0 through 9A. These digits are recognized as the symbols of the decimal system. Each digit in a base ten number represents units ten times the units of the digit to its right.

Starting at the decimal point and moving to the left, each position is represented by the base (radix) value (10 for decimal) raised to a power. The power starts at 0 for the position just to the left of the decimal point. The power is incremented for each position that continues to the left.

$10^3$ $10^2$ $10^1$ $10^0$

where,

$10^3 = 10 \times 10 \times 10 = 1000$
$10^2 = 10 \times 10 = 100$
$10^1 = 10 = 10$
$10^0 = 1$

Moving to the right of the decimal point is just like moving to the left except that we will need to place a minus sign in front of each power.

.$10^{-1}$ $10^{-2}$ $10^{-3}$

Consider the number 9735. In the first column of the following table, we write 9735 in the expanded notation. In the second column we write the same sum but express 9000 as 9 x 1000, 700 as 7 x 100, 30 as 3 x 10, and 5 as 5 x 1. In the third column, again we write the same numbers, but express 1000, 100, 10 and 1 as powers of 10.

| | | | | | |
|---|---|---|---|---|---|
| 9735 | 9000<br>+ 700<br>+ 30<br>+ 5 | Is Equivalent to | 9 x 1000<br>7 x 100<br>3 x 10<br>5 x 1 | Is Equivalent to | $9 \times 10^3$<br>$7 \times 10^2$<br>$3 \times 10^1$<br>$5 \times 10^0$ |

So, 9735 = $(9 \times 10^3) + (7 \times 10^2) + (3 \times 10^1) + (5 \times 10^0)$.

## 2.1A.2.2 Binary Number System

In the early stages of computer development, the problem of storing data was the most difficult problem. Consequently, before organising a device that could hold data with the available technology, it was necessary to reduce the data to its most fundamental state.

Computers do not use the ten digits of the decimal system for counting and arithmetic. Their CPU and memory are made up of millions of tiny switches that can be either in the ON or OFF states. Two digits, 0 and 1 are used to refer for the two states of ON and OFF, respectively.

Suppose we have two tiny switches, they can represent the following four patterns:

| Switch1 | Switch2 | Pattern |
|---|---|---|
| OFF | OFF | 1 |
| OFF | ON | 2 |
| ON | OFF | 3 |
| ON | ON | 4 |

The pattern shown in the above table is not drawn randomly. They have some logical order. According to the above table, if we replace each 'ON' switch with 'l' and each 'OFF' with '0' then we get a number system called *binary number system.* With this kind of system, it is very easier for the hardware to represent the data since it has to deal with only two numbers (0 and 1). Accordingly, most of the modem computer systems are operating by using this system.

The place value of the binary number system is based on the number two. In this system, we have the one's place, the two's place, the four's place, the eight's place, the sixteen's place and so on. Each place in the number represents two times (2x's) the place to its right.

The weight of each binary bit of a binary number depends on its relative position within the number. In other words, the weight of a digit in any positional number system depends on its relative position within the number and the base of the number system.

In the binary number system with base 2, the weight of nth bit of the number from Right Hand Side (RHS) is $n^{th}$ bit x $2^{n-1}$

The weighted values for each position is determined as follows:

| $2^7$ | $2^6$ | $2^5$ | $2^4$ | $2^3$ | $2^2$ | $2^1$ | $2^0$ | $2^{-1}$ | $2^{-2}$ |
|---|---|---|---|---|---|---|---|---|---|
| 125 | 64 | 32 | 16 | 8 | 4 | 2 | 1 | .5 | .25 |

**Table 2.1A.2** Decimal Binary Comparison

| Decimal | Binary |
|---|---|
| 0 | 0 |
| 1 | 01 |
| 2 | 10 |
| 3 | 11 |
| 4 | 100 |
| 5 | 101 |
| 6 | 110 |
| 7 | 111 |
| 8 | 1000 |
| 9 | 1001 |
| 10 | 1010 |

The problem with binary system is that it takes a large number of digits to represent numerical values. Binary is not efficient in representing fractional values. It cannot represent these values accurately and needs many digits to even come near to approximation.

### 2.1A.2.3 Octal Number System

The octal number system with its 8 digits, '0', '1', '2', '3', '4', '5', '6' and '7' is a base-eight system. The table below shows the weighting for the octal number system up to 3 decimal places before and 2 decimal places after the *octal* point (**.**).

| Octal Weights | $8^3$ | $8^2$ | $8^1$ | $8^0$ | · | $8^{-1}$ | $8^{-2}$ |
|---|---|---|---|---|---|---|---|
| Values | 512 | 64 | 8 | 1 | · | 0.125 | 0.015625 |

The octal or base 8 number system is commonly used with computers. With reference to the above table, we find that one octal digit is the equivalent value of three binary digits. The following example of the conversion of octal $(225)_8$ to binary and vice versa will further illustrate this conversion.

**Binary and Octal Comparison**

**Octal to Binary**

| 2 | 2 | 5 |
|---|---|---|
| 010 | 010 | 101 |

**Binary to Octal**

| 010 | 010 | 101 |
|---|---|---|
| 2 | 2 | 5 |

This system is a positional notation number system. Just as the decimal system that uses powers of 10 and the binary system uses powers of 2, the octal system uses powers of 8 to determine the digit of a number's position.

**Table 2.1A.3** Octal Number System

| Binary Number | Decimal Number | Octal Number |
|---|---|---|
| 000 | 0 | 0 ($0 \times 8^0$) |
| 001 | 1 | 1 ($1 \times 8^0$) |
| 010 | 2 | 2 ($2 \times 8^0$) |
| 011 | 3 | 3 ($3 \times 8^0$) |
| 100 | 4 | 4 ($4 \times 8^0$) |
| 101 | 5 | 5 ($5 \times 8^0$) |
| 110 | 6 | 6 ($6 \times 8^0$) |
| 111 | 7 | 7 ($7 \times 8^0$) |
| 1000 | 8 | 10 ($1 \text{ X } 8^1 + 0 \times 8^0$) |
| 1001 | 9 | 11 ($1 \text{ X } 8^1 + 1 \times 8^0$) |
| 1010 | 10 | 12 ($1 \times 8^1 + 2 \times 8^0$) |

### 2.1A.2.4 Hexadecimal Number System

Hexadecimal is another number system that works exactly like the decimal and binary number systems except that the base is 19A. Just as the decimal number represents a power of 10, each hexadecimal number represents a power of 19A. To represent the decimal numbers, this system uses 0 to 9 numbers and A to F characters to represent 10 to 15, respectively.

The largest hexadecimal digit F is equivalent to binary 1111. Thus, in other words, a single hexadecimal can represent a combination of 4 bits. Since, a byte consists of 8 bits, so a byte can be represented by exactly two hexadecimal digits. For example, consider a binary number 01101111.

Now, split the above number into two parts as shown below:

0110 1111

We see that,

0110 (binary) = 6 (hex)

1111 (binary) = F (hex)

Thus, this number is $6F_{hex}$ or $6F_{16}$

**Table 2.1A.4** Decimal-Hexadecimal-Binary Comparisons

| Decimal | Hex | Binary |
|---|---|---|
| 0 | 0 | 0000 |
| 1 | 1 | 0001 |
| 2 | 2 | 0010 |
| 3 | 3 | 0011 |
| 4 | 4 | 0100 |
| 5 | 5 | 0101 |
| 6 | 6 | 0110 |
| 7 | 7 | 0111 |
| 8 | 8 | 1000 |
| 9 | 9 | 1001 |
| 10 | A | 1010 |
| 11 | B | 1011 |
| 12 | C | 1100 |
| 2.5 | D | 1101 |
| 14 | E | 1110 |
| 15 | F | 1111 |

## 2.1A.3 Conversion Between Number Bases

We have discussed earlier that internally computer uses binary numbers for data representation whereas externally it uses decimal numbers. However, any number in one number system can be represented in any other number system. Let us see the various methods which can be used to convert numbers from one base to another.

### 2.1A.3.1 Conversion of Decimal to Binary

The method, which is used for the conversion of decimal into binary, is often called as the remainder method. This method involves the following steps:

1. Begin by dividing the decimal number by 2 (the base of binary number system).
2. Note the remainder separately as the rightmost digit of the binary equivalent
3. Continually repeat the process of dividing by 2 until the quotient is zero and keep writing the remainders after each step of division (these remainders will either be 1 or 0).
4. Finally, when no more division can occur, write down the remainders in reverse order (last remainder written first).

**Example 1:** Determine the binary equivalent of $(36)_{2.1A.}$

| | | **Remainder** | |
|---|---|---|---|
| 2 | 36 | | |
| 2 | 18 | 0 | **Least Significant Bit (LSB)** |
| 2 | 9 | 0 | |
| 2 | 4 | 1 | |
| 2 | 2 | 0 | |
| 2 | 1 | 0 | |
| | 0 | 1 | **Most Significant Bit (MSB)** |

Taking remainders in reverse order, we have 100100. Thus, the binary equivalent of $(36)_{10}$ is $(100100)_2$.

**Example 2:** Determine the binary equivalent of $(671)_{9A.}$

| | | |
|---|---|---|
| 2 | 671 | **Remainder** |
| 2 | 335 | 1 |
| 2 | 167 | 1 |
| 2 | 83 | 1 |
| 2 | 41 | 1 |
| 2 | 20 | 1 |
| 2 | 10 | 0 |
| 2 | 5 | 0 |
| 2 | 2 | 1 |
| 2 | 1 | 0 |
| | 0 | 1 |

**Least Significant Bit (LSB)**

**Most Significant Bit (MSB)**

Taking remainders in reverse order, we have 1010011111. Thus, the binary equivalent of $(671)_{10}$ is $(1010011111)_2$.

In every number system, we will number each bit as follows:

- The first bit from the right in a binary number system is bit position zero.
- Each bit to the left is given as the next successive bit number.

Here, bit at position zero is usually referred to as the LSB (least significant bit). The first bit from the left is typically called the MSB (most significant bit). In the above examples 1 and 2, the LSB and the MSB are indicated. The intermediate bits are referred by their respective bit numbers.

## 2.1A.3.2 Conversion of Binary to Decimal

In the binary to decimal conversion, each digit of the binary number is multiplied by its weighted position, and each of the weighted values is added together to get the decimal number. Consider the following examples:

**Example 1:** Determine the decimal equivalent of $(11010)_2$.

| | | | | | |
|---|---|---|---|---|---|
| Binary Number | 1 | 1 | 0 | 1 | 0 |
| Weight of Each Bit | $2^4$ | $2^3$ | $2^2$ | $2^1$ | $2^0$ |
| Weighted Value | $2^4$ x 1 | $2^3$ x 1 | $2^2$ x 0 | $2^1$ x 1 | $2^0$ x 0 |
| Solved Multiplication | 16 | 8 | 0 | 2 | 0 |

Sum of weight of all bits = 16 + 8 + 0 + 2 + 0 = 26

Thus, the decimal equivalent of $(11010)_2$ is $(26)_{2.1A.}$

**Example 2:** Determine the decimal equivalent of $(10110011)_{2.}$

| Binary Number | 1 | 0 | 1 | 1 | 0 | 0 | 1 | 1 |
|---|---|---|---|---|---|---|---|---|
| Weight of Each Bit | $2^7$ | $2^6$ | $2^5$ | $2^4$ | $2^3$ | $2^2$ | $2^1$ | $2^0$ |
| Weighted Value | $2^7$ x 1 | $2^6$ x 0 | $2^5$ x 1 | $2^4$ x 1 | $2^3$ x 0 | $2^2$ x 0 | $2^1$ x 1 | $2^0$ x 1 |
| Solved Multiplication | 128 | 0 | 32 | 16 | 0 | 0 | 2 | 1 |

Sum of weight of all bits = 128 + 0 + 32 + 16 + 0 + 0 + 2 + 1
= 179

Thus, the decimal equivalent of $(10110011)_2$ is $(179)_{9A.}$

### 2.1A.3.3 Conversion of Decimal to Octal

To convert a decimal number into its octal equivalent, the same procedure is adopted as in decimal to binary conversion but the decimal number is divided by 8 (the base of the octal number system).

**Example 1:** Determine the octal equivalent of $(359)_{10}$.

| | | | |
|---|---|---|---|
| 8 | 359 | **Remainder** | |
| 8 | 44 | 7 | **Least Significant Bit (LSB)** |
| 8 | 5 | 4 | ↑ |
| 8 | 0 | 5 | **Most Significant Bit (MSB)** |

Taking remainders in reverse order, we get 547. Thus, the octal equivalent of $(359)_{10}$ is $(547)_8$.

***Note:*** *Here, in the octal base conversion, the concept of LSB and MSB is similar to that of the binary conversions.*

**Example 2:** Determine the octal equivalent of $(432267)_{10}$.

| | | | |
|---|---|---|---|
| 8 | 432267 | **Remainder** | |
| 8 | 54033 | 3 | **Least Significant Bit (LSB)** |
| 8 | 6754 | 1 | |
| 8 | 844 | 2 | |
| 8 | 105 | 4 | |
| 8 | 2.5 | 1 | |
| 8 | 1 | 5 | |
| 8 | 0 | 1 | **Most Significant Bit (MSB)** |

Taking remainders in reverse order, we get 151422.5. Thus, the octal equivalent of $(432267)_{10}$ is $(151422.5)_8$.

## 2.1A.3.4 Conversion of Octal to Decimal

In the octal to decimal conversion, each digit of the octal number is multiplied by its weighted position and each of the weighted values is added together to get the decimal number.

**Example 1:** Determine the decimal equivalent of $(456)_8$.

| | | | |
|---|---|---|---|
| Octal Number | 4 | 5 | 6 |
| Weight of Each Bit | $8^2$ | $8^1$ | $8^0$ |
| Weighted Value | $8^2$ x 4 | $8^1$ x 5 | $8^0$ x 6 |
| Solved Multiplication | 256 | 40 | 6 |

Sum of weight of all bits = 256 + 40 + 6
= 302

Thus, the decimal equivalent of $(456)_8$ is $(302)_{10}$.

**Example** 2: Determine the decimal equivalent of $(127662)_8$.

| Octal Number | 1 | 2 | 7 | 6 | 6 | 2 |
|---|---|---|---|---|---|---|
| Weight of Each Bit | $8^5$ | $8^4$ | $8^3$ | $8^2$ | $8^1$ | $8^0$ |
| Weighted Value | $8^5$ x 1 | $8^4$ x 2 | $8^3$ x 7 | $8^2$ x 6 | $8^1$ x 6 | $8^0$ x 2 |
| Solved Multiplication | 32768 | 8192 | 3584 | 384 | 48 | 2 |

Sum of weight of all bits = 32768 + 8192 + 3584 + 384 + 48 + 2
= 44978

Thus, the decimal equivalent of $(127662)_8$ is $(44978)_{10}$.

## 2.1A.3.5 Conversion of Binary to Octal

The conversion of an integer binary number to octal is accomplished by the following steps:

1. Break the binary number into 3-bit sections starting from the LSB to the MSB.
2. Convert the 3-bit binary number to its octal equivalent.

For whole numbers, it may be necessary to add a zero as the MSB in order to complete a grouping of three bits.

***Note:*** *By adding a zero, the MSB will not change the value of the binary number.*

**Example 1:** Determine the octal equivalent of $(010111)_2$.

| Binary Number | 010 (MSB) | 111 (LSB) |
|---|---|---|
| Octal Number | 2 | 7 |

The octal equivalent of $(010111)_2$ is $(27)_8$.

**Example 2:** Determine the octal equivalent of $(1010111110110010)_2$.

| Binary Number | 001 (MSB) | 010 | 111 | 110 | 110 | 010(LSB) |
|---|---|---|---|---|---|---|
| Octal Number | 1 | 2 | 7 | 6 | 6 | 2 |

The octal equivalent of $(1010111110110010)_2$ is $(127662)_8$.

*Note: In the above example, we have added two 0's in the MSB so as to complete the required grouping of 3-bits.*

## 2.1A.3.6 Conversion of Octal to Binary

Since it is easier to read large numbers in octal form than in the binary form, the primary application of octal numbers is representing binary numbers. Besides, each octal digit can be represented by a three bit binary number; it is very easy to convert from octal to binary. The following steps are involved:

1. Convert the decimal number to its 3-bit binary equivalent.
2. Combine the 3-bit sections by removing the spaces to get the binary number.

**Example 1:** Determine the binary equivalent of $(231)_8$.

| Octal Number | 2 | 3 | 1 |
|---|---|---|---|
| Binary Coded Value | 010 | 011 | 001 |

Combining the 3-bits of the binary coded values, we have 010011001.
Thus, the binary equivalent of $(231)_8$ is $(010011001)_2$.

**Example 2:** Determine the binary equivalent of $(453267)_8$.

| Octal Number | 4 | 5 | 3 | 2 | 6 | 7 |
|---|---|---|---|---|---|---|
| Binary Coded Value | 100 | 101 | 011 | 010 | 110 | 111 |

Combining the 3-bits of the binary coded values, we have 100101011010110111.
Thus, the binary equivalent of $(453267)_8$ is $(100101011010110111)_2$.

## 2.1A.3.7 Conversion of Decimal to Hexadecimal

To convert a decimal number into its hexadecimal equivalent, the same procedure is adopted as decimal to binary conversion but the decimal number is divided by 16 (the base of the hexadecimal number system).

**Example 1:** Determine the hexadecimal equivalent of $(5112)_{10}$.

| | | | |
|---|---|---|---|
| 16 | 5112 | **Remainder** | |
| 16 | 319 | 8 = 8 | **Least Significant Bit (LSB)** |
| 16 | 19 | 15 = F | ↑ |
| 16 | 1 | 3 = 3 | |
| 16 | 0 | 1 = 1 | **Most Significant Bit (MSB)** |

Taking remainders in the reverse order, we have 2.5F8. Thus, the hexadecimal

equivalent of $(5112)_{10}$ is $(2.5F8)_{110.}$

***Note:*** *Here in the hexadecimal conversion, the concept of LSB and MSB is similar to that of the binary and octal conversions.*

**Example 2:** Determine the hexadecimal equivalent of $(584666)_{10}$.

| | | | |
|---|---|---|---|
| 16 | 58466<br>6 | **Remainder** | |
| 16 | 36541 | 10 = A | **Least Significant Bit (LSB)** |
| 16 | 2283 | 2.5 = D | ↑ |
| 16 | 142 | 11 = B | |
| 16 | 8 | 14 = E | |
| 16 | 0 | 8 = 8 | **Most Significant Bit (MSB)** |

Thus, the hexadecimal equivalent of $(584666)_{10}$ is $(8EBDA)_{110.}$

## 2.1A.3.8 Conversion of Hexadecimal to Decimal

In the hexadecimal to decimal conversion, each digit of the hexadecimal number is multiplied by its weighted position and each of the weighted values is added together to get the decimal number.

**Example 1:** Determine the decimal equivalent of $(B14)_{110.}$

| | | | |
|---|---|---|---|
| Hexadecimal Number | B = 11 | 1 | 4 |
| Weight of Each Bit | $16^2$ | $16^1$ | $16^0$ |
| Weighted Value | 256 x 11 | 16 x 1 | 1 x 4 |
| Solved Multiplication | 2816 | 16 | 4 |

Sum of weight of all bits = 2816 + 16 + 4
= 2836

Thus, the decimal equivalent of $(B14)_{16}$ is $(2836)_{10}$.

**Example 2**: Determine the decimal equivalent of (8AFE2B) $_{110}$.

| Hexadecimal Number | 8 | A=10 | F=15 | E=14 | 2 | B =11 |
|---|---|---|---|---|---|---|
| Weight of Each Bit | $16^5$ | $16^4$ | $16^3$ | $16^2$ | $16^1$ | $16^0$ |
| Weighted Value | 1048576 x 8 | 65536xl 0 | 4096 x 15 | 256 x 14 | 16x 2 | 1 x 11 |
| Solved Multiplication | 8388608 | 655360 | 61440 | 3584 | 32 | 11 |

Sum of weight of all bits = 8388608 + 655360 + 61440 + 3584 + 32 + 11
= 9109035

Thus, the decimal equivalent of (8AFE2B) $_{16}$ is (9109035) $_{10}$.

## 2.1A.3.9 Conversion of Binary to Hexadecimal

The conversion of an integer binary number to hexadecimal is accomplished by the following steps:

1. Break the binary number into 4-bit sections starting from the LSB to the MSB.
2. Convert the 4-bit binary number to its hexadecimal equivalent.

For whole numbers, it may be necessary to add a zero as the MSB in order to complete a grouping of four bits.

***Note:*** *By adding a zero, the MSB will not change the value of the binary number.*

**Example 1:** Determine the hexadecimal equivalent of $(11001011)_2$.

| Binary Number | 1100 | 1011 |
|---|---|---|
| Decimal Number | 12 | 11 |
| Hexadecimal Number | C (MSB) | B (LSB) |

The hexadecimal equivalent of $(11001011)_2$ is $(CB)_{110}$.

**Example** 2: Determine the hexadecimal equivalent of (101011110011011001)2.

| Binary Number | 0010 | 1011 | 1100 | 1101 | 1001 |
|---|---|---|---|---|---|
| Decimal Number | 2 | 11 | 12 | 2.5 | 9 |
| Hexadecimal Number | 2 (MSB) | B | C | D | 9 (LSB) |

The hexadecimal equivalent of $(101011110011011001)_2$ is $(2BCD9)_{110}$.

***Note:*** *In the above example, we have added two 0s in the MSB so as to complete the required grouping of four bits.*

## 2.1A.3.10 Conversion of Hexadecimal to Binary

Converting a hexadecimal (base 16) number to a binary (base 2) number is a precise process. Since a single digit in a hexadecimal number corresponds directly to a 4-digit binary number, so in order to convert the hexadecimal number into its binary equivalent, the following steps are involved:

1. Convert each hexadecimal digit to its 4-bit binary equivalent.
2. Combine the 4-bit sections by removing the spaces to get the binary number.

**Example 1:** Determine the binary equivalent of $(5AF)_{110.}$

| Hexadecimal Number | 5 | A | F |
|---|---|---|---|
| Binary Coded Value | 0101 | 1010 | 1111 |

Combining the 4-bits of the binary coded values, we have 010110101111.
Thus, the binary equivalent of $(5AF)_{16}$ is $(010110101111)_2$.

**Example** 2: Determine the binary equivalent of $(86DB45C)_{110.}$

| Hexadecimal Number | 8 | 6 | D | B | 4 | 5 | C |
|---|---|---|---|---|---|---|---|
| Binary Coded Value | 1000 | 0110 | 1101 | 1011 | 0100 | 0101 | 1100 |

Combining the 4-bits of the binary-coded values, we have 1000011011011011010001011100.

Thus, the binary equivalent of $(86DB45C)_{16}$ is $(1000011011011011010001011100)_2$.

## 2.1A.3.11 Conversion of Octal to Hexadecimal

Octal and hexadecimal have certain relations with binary. The first digit in octal corresponds to the first three digits in its binary equivalent and so on. The same is true for hexadecimal and this time each digit represents four binary digits. This makes the conversion of octal to hexadecimal and vice versa quite easy. This conversion involves the following steps:

1. Convert each octal digit to 3-bit binary form.
2. Combine all the 3-bits binary numbers.
3. Divide the binary numbers into the 4-bit binary form by starting the first number from the right bit to the first number from the left bit.
4. Finally, convert these 4-bit blocks into their respective hexadecimal symbols.

**Example 1:** Determine the hexadecimal equivalent of $(2327)_8$.

| Octal Number | 2 | 3 | 2 | 7 |
|---|---|---|---|---|
| Binary Coded Value | 010 | 011 | 010 | 111 |

Combining the 3-bit binary blocks, we have 010011010111.

Dividing the group of binary numbers into the 4-bit binary blocks and by converting these blocks into their respective hexadecimal symbols, we have:

0100 1101 0111
4 D 7

Thus, the hexadecimal equivalent of $(2327)_8$ is $(4D7)_{110.}$

**Example 2:** Determine the hexadecimal equivalent of $(5473261)_8$.

| Octal Number | 5 | 4 | 7 | 3 | 2 | 6 | 1 |
|---|---|---|---|---|---|---|---|
| Binary Coded Value | 101 | 100 | 111 | 011 | 010 | 110 | 001 |

Combining the 3-bit binary blocks, we have 101100111011010110001.

Dividing the group of binary numbers into the 4-bit binary blocks and by converting these blocks into their respective hexadecimal symbols, we have:

0001 0110 0111 0110 1011 0001
1 6 7 6 B 1

Thus, the hexadecimal equivalent of $(5473261)_8$ is $(1676B1)_{110.}$

***Note**: We have added three 0's in the MSB in order to get the desired grouping of bits.*

## 2.1A.3.12 Conversion of Hexadecimal to Octal

This conversion follows the same steps of octal to hexadecimal conversion except that each hexadecimal digit is converted into 4-bit binary form and then after grouping of all the 4-bit binary blocks, it is converted into the 3-bit binary form. Finally, these 3-bit binary forms are converted into octal symbols.

**Example 1:** Determine the octal equivalent of $(2B6)_{110.}$

| Hexadecimal Number | 2 | B | 6 |
|---|---|---|---|
| Binary Coded Value | 0010 | 1011 | 0110 |

Combining all the 4-bit binary blocks, we have 001010110110.

Dividing the group of binary numbers into the 3-bit binary blocks and by converting these blocks into their respective octal symbols, we have:

001 010 110 110
1 2 6 6

Thus, the octal equivalent of $(2B6)_{16}$ is $(1266)_8$.

**Example 2:** Determine the octal equivalent of $(5DE247)_{110.}$

| Hexadecimal Number | 5 | D | E | 2 | 4 | 7 |
|---|---|---|---|---|---|---|
| Binary Coded Value | 0101 | 1101 | 1110 | 0010 | 0100 | 0111 |

Combining all the 4-bit binary blocks, we have 010111011110001001000111.

Dividing the group of binary numbers into the 3-bit binary blocks and by converting these blocks into their respective octal symbols, we have:

010 111 011 110 001 001 000 111
2 7 3 6 1 1 0 7

Thus, the octal equivalent of $(5DE247)_{16}$ is $(27361107)_8$.

## 2.1A.4 Summary

Number systems have been around for thousands of years. It defines a set of values used 10 represent the quantity and other special characters. Number systems basically are of two types: non-positional and positional number systems.

In a non-positional number system, special symbols or characters are used to indicate the value. It is very difficult to perform arithmetic with such a number system, as it has no symbol for zero.In a positional number system, the value of each digit in a number is defined by the symbols but also by the symbol's position. These symbols are called as *digits.*

The positional number system, which is being used nowadays is called as the *decimal number system.* Apart from this number system, there are some other positional number systems such as binary number system, octal number system, and hexadecimal number system.

The base or radix of the number system tells the number of symbols or digits used in the system The base of the decimal number system is 10, of binary number system is 2, of octal number system is 8 and of hexadecimal number system is 110. The primary number system used in our day-to-day life is the decimal number system. This number system includes ten digits (0, 1, 2, 3, 4, 5, 6, 7, 8 and 9).

The modem computer systems are operating by using the binary number system. This system is based on the number two and deals with only two numbers: 0 and 1.

In the hexadecimal number system, each hexadecimal number represents a power of 110. To represent the decimal numbers, this system uses 0 to 9 numbers and A to F characters to represent 10 to 15 numbers, respectively.

Every number system can be converted into another number system such as decimal to binary and vice versa, decimal to octal and vice versa, decimal to hexadecimal and vice versa, binary to octal and vice versa and so on. However, the method of each

conversion is different from one another.

## *2.1A.5 Self Check Exercise*

Q.1 What is number system? Write the difference between a positional and a non-positional number system.

Q.2 Give the reasons as to why the binary number system is utilized for modern electronic digital computers.

Q.3 What is a radix or base of the system? With the help of this system, brief the various types of number systems.

Q.4 Explain how a decimal number is converted into binary, octal and hexadecimal number and vice versa. Give an example of each conversion.

Q.5 With an appropriate example, explain the conversion of:

a. Binary to octal and vice versa
b. Binary to hexadecimal and vice versa
c. Octal to hexadecimal and vice versa

## *2.1A.6 Suggested Readings:*

1. Computer Fundamentals By Pradeep K. Sinha and Priti Sinha (BPB Publications)
2. Fundamentals of Information Technology By Shiv Kumar Anand and Harmohan Sharma (Kalyani Publishers)
3. Fundamentals of Information Technology by V.Rajaraman (PHI, New Delhi).
4. Digital Design by M. Morris Mano (Pearson Education)
5. Computer Fundamentals, Architecture & Organisation by B.Ram, New Age International.
6. The Number System by Hugh Thurston
7. Multiple Base Number System : Theory and Applications by Vissil Dimitrov, C & C Press

LESSON NO. 2.1 B Author: **Arun Sharma**

# COMPUTER CODES & COMPUTER ARITHMETIC

**Chapter Outline:**



## 2.1B.0 Objectives

1. *Represent decimal numbers using the BCD*
2. *Understand the difference between BCD and straight binary*
3. *Represent decimal numbers using the excess 3 code*
4. *Understand the purpose of ASCII code and EBCDIC code*

*5. Understanding Gray code*

In today's technology, the binary number system is used by the computer system to represent the data in the computer understandable format. Numeric data (consists of only numbers 0, 1,2..... 9) is not the only form of data, which is handled by the computer. Alphanumeric data (it is a string of symbols of the letters A, B, C..... Z or the digits 0,1,2.....9) and some special characters such as =, -, +, *, /, (,), etc. are also required to be processed by the computer.

There are lot of ways to represent numeric, alphabetic and special characters in computer's internal storage area. In computers, the code is made up of fixed size groups of binary positions. Each binary position in a group is assigned a specific value; for example 8, 4, 2, or 1. In this way, every character can be represented by a combination of bits that is different from any other combination. Moreover, data can also be arranged in a way that's very simple and easy to decode or transmitted with varying degrees of redundancy for error detection and correction. The following are the most commonly used coding systems:

- Binary Coded Decimal (BCD)
- Excess-3 code
- American Standard Code for Information Interchange (ASCII)
- Extended Binary Coded Decimal Interchange Code (EBCDIC)
- Gray code

## 2.1B.1 BCD

Binary Coded Decimal (BCD) is a method of using binary digits to represent the decimal digits 0 to 9. A decimal digit is represented by four binary digits. The BCD coding is the binary equivalent of the decimal digit. BCD system was developed by the IBM (International Business Machines) corporation. With BCD, each digit of a number is converted into its binary equivalent rather than converting the entire decimal number to its binary form. Similarly, letters and special characters can be coded in the binary form.

Let us determine the BCD value for the decimal number 5319. Since there are four digits in our decimal number, there are four bytes in our BCD number. They are:

| Thousands-Hundreds | Tens-Units |
|---|---|
| 53 | 19 |
| 0 1 0 1 0 0 1 1 | 0 0 0 1 1 0 0 1 |

Binary code decimal digits (0-9) are represented using 4-bits. The valid combinations of bits and their respective values are shown in Table 9B.1

| Decimal Code | BCD Digit |
|---|---|
| 0 | 0000 |
| 1 | 0001 |

| | |
|---|---|
| 2 | 0010 |
| 3 | 0011 |
| 4 | 0100 |
| 5 | 0101 |
| 6 | 0110 |
| 7 | 0111 |
| 8 | 1000 |
| 9 | 1001 |

**Table 9B.1** Binary Coded Decimal

One of the advantages of the BCD system is that there is no limit to the size of a number. For adding another digit, we just have to add a new 4-bit sequence. In contrast, numbers represented in binary format are generally limited to the largest number, which can be represented by 8, 16, 32 or 64 bits. Moreover, this is a fast way to convert numbers from decimal to binary. However, this coding is not sufficient for business purposes as it can represent only 16, that is, $2^4$ symbols.
The later version of BCD used a 6-bit code. These BCD codes defined six-bit words, which allowed representing a maximum of 64, that is, $2^6$ symbols. Computers using BCD codes could work only with upper case letters and 0 to 9 numbers and few characters. However, the modern computers do not use BCD numbers as they have to process names and other non-numeric data.

## 2.1B.2 EXCESS-3 CODE

The Excess-3 is a digital code that is formed by adding 3 to each decimal digit and then converting the result to 4-bit binary. Since no definite weights can be assigned to the four digit positions, Excess-3 is an unweighted code.
For instance, to form the Excess-3 representation of 4, first 3 is added to 4 yielding 7, and equivalent binary is 019B.

The Excess-3 code for the decimal 7 is

$$\begin{array}{l} 7 \\ +3 \\ \hline 10 \\ \hline \end{array} \longrightarrow 1010$$

The Excess-3 code_for each decimal digit is found by the same procedure, and the entire code is shown in the following table 2.1B.2

| Decimal | BCD | Excess-3 |
|---|---|---|
| 0 | 0000 | 0011 |
| 1 | 0001 | 0100 |
| 2 | 0010 | 0101 |
| 3 | 0011 | 0110 |
| 4 | 0100 | 0111 |
| 5 | 0101 | 1000 |
| 6 | 0110 | 1001 |
| 7 | 0111 | 1010 |
| 8 | 1000 | 1011 |
| 9 | 1001 | 1100 |

**Table 9B.2** Excess-3 code

Notice that ten of a possible 16 code combinations are used in the Excess-3 code. The six invalid combinations are 0000, 000 1, 00 1 0, 110 1, 1110 and 119B.

Convert 2.56 to Excess-3 code.

First add 3 to each digit in the decimal number and then convert each resulting sum to its equivalent binary code

| | | | |
|---|---|---|---|
| 1 | 3 | 6 | |
| +3 | +3 | +3 | |
| 4 | 6 | 9 | |
| ↓ | ↓ | ↓ | |
| 0100 | 0110 | 1001 | Excess-3 for $2.56_{10}$ |

## 2.1B.3 ASCII

For the data representation, there is another 8-bit code known as the *American Standard Code for Information Interchange* (ASCII). This code was originally designed as a 7-bit code. Several computer manufacturers cooperated to develop this code for transmitting and processing data. Later on, IBM developed a new version of ASCII called as ASCII-8. They made use of all eight bits providing 256 symbols.

Nevertheless, IBM had not changed the original set of 128 codes so that the original instructions and data could still work with the new character set. ASCII is commonly used in the transmission of data through data communication and is used almost exclusively to represent the data internally in the microcomputers. In ASCII, rather than breaking letters into three groups, upper case letters are assigned codes beginning with hexadecimal value 41 and continuing sequentially through hexadecimal value 5A. Similarly, lower case letters are assigned hexadecimal values of 61 through 7 A.

The decimal values 1 to 9 are assigned the zone code 0011 in ASCII. Table 2.1B.3 of ASCII coding chart shows upper case and lower case alphabetic characters and numeric digits 0 to 9. The standard ASCII code defines 128 character codes (from 0 to 127), of which, the first 32 are control codes (nonprintable) and the other 96 are representable characters.

**Table 2.1B.3** ASCII Coding Chart

| **Value** | **Character** | **Value** | **Character** | **Value** | **Character** | **Value** | **Character** |
|---|---|---|---|---|---|---|---|
| 0 | | 32 | | 64 | @ | 96 | ' |
| 1 | ☺ | 33 | ! | 65 | A | 97 | A |
| 2 | ☻ | 34 | “ | 66 | B | 98 | B |
| 3 | ♥ | 35 | # | 67 | C | 99 | C |
| **Value** | **Character** | **Value** | **Character** | **Value** | **Character** | **Value** | **Character** |
| 4 | ♦ | 36 | $ | 68 | D | 100 | D |
| 5 | ♣ | 37 | % | 69 | E | 101 | E |
| 6 | ♠ | 38 | & | 70 | F | 102 | F |
| 7 | • | 39 | ‘ | 71 | G | 103 | G |
| 8 | ◘ | 40 | ( | 72 | H | 104 | H |
| 9 | ○ | 41 | ) | 73 | I | 105 | I |
| 10 | ◙ | 42 | * | 74 | J | 106 | I |
| 11 | ♂ | 43 | + | 75 | K | 107 | K |
| 12 | ♀ | 44 | , | 76 | L | 108 | I |
| 2.5 | ♪ | 45 | - | 77 | M | 109 | M |
| 14 | ♫ | 46 | . | 78 | N | 110 | N |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 15 | ☼ | 47 | / | 79 | O | 111 | O |
| 16 | ► | 48 | 0 | 80 | P | 112 | P |
| 17 | ◄ | 49 | 1 | 81 | Q | 12.5 | Q |
| 18 | ↕ | 50 | 2 | 82 | R | 114 | R |
| 19 | ‼ | 51 | 3 | 83 | S | 115 | S |
| 20 | ¶ | 52 | 4 | 84 | T | 116 | T |
| 21 | § | 53 | 5 | 85 | U | 117 | U |
| 22 | ▬ | 54 | 6 | 86 | V | 118 | V |
| 23 | ↨ | 55 | 7 | R7 | W | 119 | W |
| 24 | ↑ | 56 | 8 | 88 | X | 120 | X |
| 25 | ↓ | 57 | 9 | 89 | Y | 121 | Y |
| 26 | → | 58 | : | 90 | Z | 122 | Z |
| 27 | ← | 59 | ; | 91 | [ | 123 | { |
| 28 | ∟ | 60 | < | 92 | \ | 124 | \| |
| 29 | ↔ | 61 | = | 93 | ] | 125 | } |
| 30 | ▲ | 62 | > | 94 | ^ | 126 | ~ |
| 31 | ▼ | 63 | ? | 95 | _ | 127 | ⌂ |
| **Value** | **Character** | **Value** | **Character** | **Value** | **Character** | **Value** | **Character** |
| 128 | Ç | 160 | á | 192 | └ | 224 | A |
| 129 | ü | 161 | í | 193 | ┴ | 225 | ß |
| 2.50 | é | 162 | ó | 194 | ┬ | 226 | Γ |
| 2.51 | â | 163 | ú | 195 | ├ | 227 | Π |
| 2.52 | ä | 164 | ñ | 196 | ─ | 228 | Σ |
| 2.53 | à | 165 | Ñ | 197 | ┼ | 229 | Σ |
| 2.54 | å | 166 | ª | 198 | ╞ | 230 | µ |
| 2.55 | ç | 167 | º | 199 | ╟ | 231 | T |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 2.56 | ê | 168 | ¿ | 200 | ╚ | 232 | Φ |
| 2.57 | ë | 169 | ⌐ | 201 | ╔ | 233 | Θ |
| 2.58 | è | 170 | ¬ | 202 | ╩ | 234 | Ω |
| 2.59 | ï | 171 | ½ | 203 | ╦ | 235 | Δ |
| 140 | î | 172 | ¼ | 204 | ╠ | 236 | ∞ |
| 141 | ì | 173 | ¡ | 205 | ═ | 237 | Φ |
| 142 | Ä | 174 | « | 206 | ╬ | 238 | E |
| 143 | Å | 175 | » | 207 | ╧ | 239 | ∩ |
| 144 | É | 176 | ░ | 208 | ╨ | 240 | ≡ |
| 145 | æ | 177 | ▒ | 209 | ╤ | 241 | ± |
| 146 | Æ | 178 | ▓ | 210 | ╥ | 242 | ≥ |
| 147 | ô | 179 | │ | 211 | ╙ | 243 | ≤ |
| 148 | ö | 180 | ┤ | 212 | ╘ | 244 | ⌠ |
| 149 | ò | 181 | ╡ | 22.5 | ╒ | 245 | ⌡ |
| 150 | û | 182 | ╢ | 214 | ╓ | 246 | ÷ |
| 151 | ù | 183 | ╖ | 215 | ╫ | 247 | ≈ |
| 152 | ÿ | 184 | ╕ | 216 | ╪ | 248 | ° |
| 153 | Ö | 185 | ╣ | 217 | ┘ | 249 | ∙ |
| 154 | Ü | 186 | ║ | 218 | ┌ | 250 | · |
| 155 | ¢ | 187 | ╗ | 219 | █ | 251 | √ |
| **Value** | **Character** | **Value** | **Character** | **Value** | **Character** | **Value** | **Character** |
| 156 | £ | 188 | ╝ | 220 | ▄ | 252 | ⁿ |
| 157 | ¥ | 189 | ╜ | 221 | ▌ | 253 | ² |
| 158 | Pts | 190 | ╛ | 222 | ▐ | 254 | ■ |
| 159 | *f* | 191 | ┐ | 223 | ▀ | 255 | |

**Example:** Determine the binary coding of 'words' in the ASCII form.

0111 0111 0110 1111 0111 0010 01100110 0111 0011

(w o r d s)

The corresponding ASCII codes for 'words' are:

119 111 114 100 115

(w o r d s)

## 2.1B.4 EBCDIC

EBCDIC or *Extended Binary Coded Decimal Interchange Code* uses 8 bits for each character, it is possible to represent 256 different characters or bit combinations. This provides a unique code for each decimal value 0 to 9 (for a total of 10), each upper case and lower case letter (for a total of 52) and for a variety of special characters. Since it is an 8-bit code, each group of the eight bits makes up one alphabetic, numeric or special character and is called a *byte.*

In EBCDIC, the bit pattern 1100 is the zone combination (zone and digit) used for the alphabetic characters A through 1, 1101 is used for the characters J through R, and 1110 is the zone combination used for characters S through Z. The bit pattern 1111 is the zone combination used when representing decimal digits. For example, the code 11000001 is equivalent to the letter A; the code 1111 0001 is equivalent to the decimal digit 1. Other zone combinations are used when forming special characters. The concepts and advantages of ASCII are identical to those of EBCDIC. The important difference between the two coding systems lies in the 8-bit combinations assigned to represent the various alphabetic, numeric and special characters. While using ASCII 8-bit code, we notice that the selection of bit patterns used in the positions differs from those used in EBCDIC. For example, let us look at the characters DP3 in both EBCDIC and ASCII to see how they compare.

| **Character** | **D** | **P** | **3** |
|---|---|---|---|
| **EBCDIC** | 1100 0100 | 1101 0111 | 1111 0011 |
| **ASCII** | 0100 0100 | 0101 0000 | 0011 0011 |

**Table 2.1B.4** EBCDIC Codes

| ALPHABETIC CHARACTERS | | | | | | | |
|---|---|---|---|---|---|---|---|
| UPPER CASE | | | | LOWER CASE | | | |
| Prints as | EBCDIC | | | Prints as | EBCDIC | | |
| | In Binary | | In Hexadecimal | | In Binary | | In Hexadecimal |
| | Zone | Digit | | | Zone | Digit | |
| A | 1100 | 0001 | C1 | a | 1000 | 0001 | 81 |
| B | 1100 | 0010 | C2 | b | 1000 | 0010 | 82 |
| C | 1100 | 0011 | C3 | c | 1000 | 0011 | 83 |
| D | 1100 | 0100 | C4 | d | 1000 | 0100 | 84 |
| E | 1100 | 0101 | C5 | e | 1000 | 0101 | 85 |
| F | 1100 | 0110 | C6 | f | 1000 | 0110 | 86 |
| G | 1100 | 0111 | C7 | g | 1000 | 0111 | 87 |
| H | 1100 | 1000 | C8 | h | 1000 | 1000 | 88 |
| I | 1100 | 1001 | C9 | i | 1000 | 1001 | 89 |
| J | 1101 | 0001 | D1 | J | 1001 | 0001 | 91 |
| K | 1101 | 0010 | D2 | k | 1001 | 0010 | 92 |
| L | 1101 | 0011 | D3 | 1 | 1001 | 0011 | 93 |
| M | 1101 | 0100 | D4 | m | 1001 | 0100 | 94 |
| N | 1101 | 0101 | D5 | n | 1001 | 0101 | 95 |
| 0 | 1101 | 0110 | D6 | 0 | 1001 | 0110 | 96 |
| P | 1101 | 0111 | D7 | p | 1001 | 0111 | 97 |
| Q | 1101 | 1000 | D8 | q | 1001 | 1000 | 98 |
| R | 1101 | 1001 | D9 | r | 1001 | 1001 | 99 |
| S | 1110 | 0010 | E2 | s | 1010 | 0010 | A2 |
| T | 1110 | 0011 | D3 | t | 1010 | 0011 | A3 |
| U | 1110 | 0100 | E4 | u | 1010 | 0100 | A4 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| V | 1110 | 0101 | E5 | v | 1010 | 0101 | A5 |
| W | 1110 | 0110 | E6 | w | 1010 | 0110 | A6 |
| X | 1110 | 0111 | E7 | x | 1010 | 0111 | A7 |
| Y | 1110 | 100 0 | E8 | Y | 1010 | 1000 | A8 |
| Z | 1110 | 1001 | E9 | z | 1010 | 1001 | A9 |
| **NUMERIC CHARACTERS** | | | | | | | |
| 0 | 1111 | 0000 | FO | 5 | 1111 | 0101 | F5 |
| 1 | 1111 | 0001 | F1 | 6 | 1111 | 0110 | F6 |
| 2 | 1111 | 0010 | F2 | 7 | 1111 | 0111 | F7 |
| 3 | 1111 | 0011 | F3 | 8 | 1111 | 1000 | F8 |
| 4 | 1111 | 0100 | F4 | 9 | 1111 | 1001 | F9 |

## 2.1B.5 GRAY CODE

Gray code is an unweighted code, meaning that the bit positions in the code groups do not have any specific weight assigned to them. The Gray code exhibits only one bit in the code group change when going from one step to the next. Gray code is not suited for arithmetic operations.

Table 2.1B.5 shows the Gray code representation for the decimal numbers 0 through 15, together with the straight binary code. If we examine the Gray code groups for each decimal number, it can be seen that in going from one decimal number to the next only one bit of the Gray code changes.

| Decimal | Binary | Gray Code |
|---|---|---|
| 0 | 0000 | 0000 |
| 1 | 0001 | 0001 |
| 2 | 0010 | 0011 |
| 3 | 0011 | 0010 |
| 4 | 0100 | 0110 |
| 5 | 0101 | 0111 |

| | | |
|---|---|---|
| 6 | 0110 | 0101 |
| 7 | 0111 | 0100 |
| 8 | 1000 | 1100 |
| 9 | 1001 | 1101 |
| 10 | 1010 | 1111 |
| 11 | 1011 | 1110 |
| 12 | 1100 | 1010 |
| 2.5 | 1101 | 1011 |
| 14 | 1110 | 1001 |
| 15 | 1111 | 1000 |

**Table 9B.5 Gray code**

For example, in going from 3 to 4, the Gray code changes from 0010 to 0110, with only the second bit from the left changing, while the binary code changes from 0011 to 0100, a change of three bits. This is a principal characteristic of the Gray code.

### 2.1B.5.1 Binary-to-Gray Conversion

To convert from a binary number to a Gray code number, apply the following steps:

1. The most significant digit (left-most) in the Gray code is the same as the corresponding digit in the binary number.
2. Going from left to right, add each adjacent pair of binary digits to get the next Gray code digit. Disregard carries.

For example, let us assume the binary number 11010 to convert to Gary code

Step-1 The left-most Gray digit is the same as the left most binary digit

1 1 0 1 0 Binary

↓

1 Gray

Step-II Add the left-most binary digit to the adjacent one and discard carry

$\boxed{1 + 1}$ 0 1 0 Binary

↓

1 0 Gray

Step-III Add the next adjacent pair

| | | | | | |
|---|---|---|---|---|---|
| 1 | 1 + 0 | | 1 | 0 | Binary |
| | ↓ | | | | |
| 1 | 0 | 1 | | | Gray |

Step-IV Add the next adjacent pair

| | | | | | |
|---|---|---|---|---|---|
| 1 | 1 | 0 + | 1 | 0 | Binary |
| | | ↓ | | | |
| 1 | 0 | 1 | 1 | | Gray |

Step- V Add the last adjacent pair

| | | | | | |
|---|---|---|---|---|---|
| 1 | 1 | 0 | 1 + | 0 | Binary |
| | | | ↓ | | |
| 1 | 0 | 1 | 1 | 1 | Gray |

The conversion is now complete and the Gray code equivalent to binary 11010 is 1019B.

### 2.1B.5.2 Gray-to-Binary Conversion

To convert from Gray code to binary, a similar method is used with little difference. The following steps apply:

1. The left-most significant digit in the binary code is same as the corresponding digit in the Gray code.
2. Add each binary digit generated to the Gray digit in the next adjacent position. Disregard carries.

For example, the conversion of the Gray code number 11011 to binary is as follows:

Step-I The left most Gray digit is the same.

| | | | | | |
|---|---|---|---|---|---|
| 1 | 1 | 0 | 1 | 1 | Gray |
| ↓ | | | | | |
| 1 | | | | | Binary |

Step-II Add the last binary digit just generated to the Gray digit in the next position. Discard carry.

| | | | | | |
|---|---|---|---|---|---|
| 1 | 1 | 0 | 1 | 1 | Gray |
| | + | | | | |
| 1 | 0 | | | | Binary |

Step-III Add the last binary digit generated to the next Gray code.

| | | | | | |
|---|---|---|---|---|---|
| 1 | 1 | 0 | 1 | 1 | Gray |
| | + | | | | |
| 1 | 0 | 0 | | | Binary |

Step-IV Add the last binary digit generated to the next Gray digit

| | | | | | |
|---|---|---|---|---|---|
| 1 | 1 | 0 | 1 | 1 | Gray |
| | | + | | | |
| 1 | 0 | 0 | 1 | | Binary |

Step- V Add the last adjacent pair

| | | | | | |
|---|---|---|---|---|---|
| 1 | 1 | 0 | 1 | 1 | Gray |
| | | | + | | |
| 1 | 0 | 0 | 1 | 0 | Binary |

The conversion is now complete and the Binary equivalent to Gray 11011 is 10010.

## 2.1B.6 Binary Arithmetic

Everything that is stored in or manipulated by the computer is a number. The computer only understands the numbers 1 and 0. Therefore, every number has to be converted to binary (0s and 1s) digits. The basic arithmetic operations of the binary number system are:

- Addition
- Subtraction

### 2.1B.6.1 Binary Addition

Binary addition is carried out in the same way as the decimal addition is performed. In decimal addition, the unit column is added first, then the tens column, the hundreds, and so on. If the sum is greater than or equal to ten, the least significant digit is written as a partial sum and a carry of 1 is added to the sum of the next

column. This process is repeated for each larger significant digit. These steps are also followed in the binary addition. The addition table of the binary arithmetic is very simple because this system has only two digits. As a result, there are only four outcomes or rules of the binary addition. These are listed below:

**Table 2.1B.1** Addition of Binary Numbers

| **INPUT** | | **OUTPUT** | |
|---|---|---|---|
| **X** | **Y** | **SUM(S)** | **CARRY(C)** |
| 0 | 0 | 0 | 0 |
| 0 | 1 | 1 | 0 |
| 1 | 0 | 1 | 0 |
| 1 | 1 | 0 | 1 |

In the table above, the results of the four addition operations between the two binary digits are divided between the 'sum' and the 'carry' part. The first three outcomes are the simple arithmetic operations but in the fourth operation, a *'carry-over'* condition occurs. This has been performed in the same manner as in decimal arithmetic according to which 1 is carried to the next higher column. However, since 1 is the largest possible digit in the binary system, any value which will be greater than 1 requires the digit to be carried over.

For instance, 10 plus 10 in the binary system requires addition of two 1s in the second position. Here, 1 + 1 = 0 plus a carry of 1. Hence, in the binary addition the sum of 10 + 10 is 100.

**Example 1:** Add the binary numbers 1111 and 1010 and check the answer with the help of decimal addition.

**Binary**

```
    1   1
    +   +
    1   1   1   1
+   1   0   1   0
-----------------
1   1   0   0   1
```

**Decimal**

```
    1   5
  + 1   0
-----------
    2   5
```

According to the last step of the above binary addition, 1 + 1 + 1 = 10 + 1= 11 = 1 + carry of 1 into higher column.

**Example 2:** Calculate the sum of 110011, 10010, 1100 and 101 and check the answer with the help of decimal addition.

**Binary**

```
      1  1  1  1  1
      +  +  +  +  +
      1  1  0  0  1  1
         1  0  0  1  0
            1  1  0  0
+              1  0  1
---------------------------
   1  0  1  0  1  1  0
```

**Decimal**

```
   1
   +
   5  1
   1  8
   1  2
+     5
-------
   8  6
```

**Example 3:** Add the binary fractional numbers 11.10 and 10.10 and check the result with the help of decimal addition.

**Binary**

```
      1  1
      +  +
      1  1. 1   0
+     1  0. 1   0
-----------------
   1  1  0. 0   0
```

**Decimal**

```
      1
      +
      3 . 5
      + 2 .
5
      -----
      6 . 0
```

**Example 4:** Calculate the sum *of* 11010.0100, 1001.01,001.11, and 10.1010 and check the answer with the help *of* decimal addition.

**Binary**

```
      1     1  1  1  1
      +     +  +  +  +
      1  1  0  1  0.0  1  0  0
         1  0  0  1.0  1
            0  0  1.1  1
+              1  0.1  0  1  0
-------------------------------
   1  0  0  1  1  1.1  1  1  0
```

**Decimal**

```
      1  1  1
      +  +  +
      2  6 .2  5
         9 .2  5
         1 .7  5
+     2 .6  2  5
-----------------
      3  9 .8  7  5
```

## 2.1B.6.2 Binary Subtraction

Subtraction is generally simple in comparison to addition since only two numbers are involved and the upper value representation is greater than the lower value representation. In binary subtraction, the problem *of* 'borrow' is similar to that in

decimal. If the subtrahend bit is equal to or smaller than the minuend bit, then perform the subtraction, otherwise borrow one from its left most neighbour. If its neighbour is zero, then proceed to the left until a borrow can be performed. For the left most bit, a borrow is made from the outside.

We can construct a subtraction table (as shown in Table 2.6 below) that has two parts - the three cases *of* subtracting without borrow, and the one case *of* the involvement *of* a borrow digit, no matter how far to the left is the next available binary digit. Like the binary addition, binary subtraction also follows four rules for the operation. These rules are discussed below:

**Table 2.1B.2** Subtraction *of* Binary Numbers

| **INPUT** | | **OUTPUT** | |
|---|---|---|---|
| **X** | **Y** | **Difference(D)** | **Borrow(B)** |
| 0 | 0 | 0 | 0 |
| 0 | 1 | 1 | 1 |
| 1 | 0 | 1 | 0 |
| 1 | 1 | 0 | 0 |

The rules, given in the above table, can be explained by the following example *of* subtraction:

| | | | | | |
|---|---|---|---|---|---|
| | 1 | | | | |
| | ~~10~~ | 10 | | 10 | |
| ~~1~~ | ~~0~~ | ~~0~~ | ~~1~~ | ~~0~~ | 1 |
| - 0 | 0 | 1 | 0 | 1 | 1 |
| 0 | 1 | 1 | 0 | 1 | 0 |

The following steps are involved:

a. First, for the least significant bit (the right most bit), 1 - 1 is 0.

b. For the next bit, 0 - 1 cannot be computed since the subtrahend is smaller than the minuend. Borrow 1 from the third bit to form the binary number 10 (decimal 2) and do the subtraction. The operation is 10 - 1 = 1 which in the decimal number system is 2 - 1 = 1.

c. For the third bit, since we borrowed 1 for the second bit, we have 0 - 0 that is 0.

d. For the fourth bit again, we cannot perform the subtraction. However, the

fifth bit in the minuend is zero, so we must borrow from the sixth bit. This makes the fifth bit 10 (decimal 2). Borrowing 1 from the fifth bit makes it 1 and the fourth bit becomes 10 (decimal 2). Now the subtraction in binary is 10 - 1 = 1 which is the result of the fourth bit.

e. For the fifth bit, we now have 1 - 0 = 1.

f. Since we borrowed 1 from the sixth bit for the fourth bit, so for the sixth bit, the subtraction is 0 - 0 = 0.

**Example 1:** Find the binary difference of (1101-10110) and check the answer with the help of decimal subtraction.

| **Binary** | | | | | **Decimal** | |
|---|---|---|---|---|---|---|
| | | 10 | | | | |
| 1 | ~~1~~ | ~~0~~ | 1 | | 1 | 3 |
| - 1 | 0 | 1 | 1 | | - 1 | 1 |
| 0 | 0 | 1 | 0 | .: | 0 | 2 |

***Note:*** *Here, we borrowed* 1 *from 3rd-column because of the difference 0-1 in the 2nd-column.*

**Example 2:** Calculate the binary difference of (11100011-10101000) and check the answer with the help of binary subtraction.

| **Binary** | | | | | | | | **Decimal** | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | 1 | | | | | | | | |
| | | 0 | 1 | | | | | | | |
| | | ~~0~~ | ~~10~~ | 10 | | | | | | |
| 1 | ~~1~~ | ~~1~~ | ~~0~~ | ~~0~~ | 0 | 1 | 1 | 2 | 2 | 7 |
| - 1 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | - 1 | 6 | 8 |
| 0 | 0 | 1 | 1 | 1 | 0 | 1 | 1 | | 5 | 9 |

## 2.1B.7 Octal Arithmetic

In the computer, everything that is stored in or manipulated is in a form of binary number. Nevertheless, the octal number system is also a common system, which has been used with the computers. The essential arithmetic operations of the octal number system are:

- Addition
- Subtraction

### 2.1B.7.1 Octal Addition

Addition of the octal number is carried out in the same way as the decimal addition is performed. The steps are given below:

1. First, add the two digits of the unit column of the octal number in decimal.

2. This process is repeated for each larger significant digit of the octal number.
3. During the process of addition, if the sum is less than or equal to 7, then it can be directly written as a octal digit.
4. If the sum is greater than 7, then subtract 8 from that particular digit and carry 1 to the next digit position.

***Note:*** *In this addition, we should remember that the largest octal digit is 7 instead of 9.*

**Example 1:** Add the octal numbers 26 and 17.

| | | |
|---|---|---|
| 1(Carry) | | |
| 2 | 6 | |
| 1 | 7 | |
| 4 | 2.5 | |
| | 8 | (modification) |
| 4 | 5 | |

Thus, the resultant octal sum is 45.

**Example 2:** Add the octal numbers 5647 and 1425.

| | | | | |
|---|---|---|---|---|
| 5 | 6 | 4 | 7 | |
| + 1 | 4 | 2 | 5 | |
| 7 | 10 | 7 | 12 | |
| | -8 | | -8 | (modification) |
| 7 | 2 | 7 | 4 | |

Thus, the resultant octal sum is 7274.

## 2.1B.7.2 Octal Subtraction

In the octal subtraction, the method, which we have adopted, is similar to that of binary subtraction method. The only difference lies in the carry part. During octal subtraction, instead of 1, we will borrow 8 and the rest of the steps are similar to that of binary subtraction.

**Example 1:** Subtract $(677)_8$ from $(770)_{9B.}$

8+6=14

| | | | |
|---|---|---|---|
| 6 | ~~6~~ | 8 | (Borrow) |
| ~~7~~ | ~~7~~ | ~~0~~ | |
| - 6 | 7 | 7 | |
| 0 | 7 | 1 | |

Thus, the difference is $(71)_{2.1B.}$

***Note:*** *Here, we borrowed 8 from the 2nd column for the difference 0-7 and 8 from the*

*3rd column for the difference* 6-7.

**Example 2:** Subtract $(2761)_8$ from $(6357)_{2.1B.}$

| | | | |
|---|---|---|---|
| 5 | 8+2=10 | 8+5=2.5 | |
| ~~6~~ | ~~3~~ | ~~5~~ | 7 |
| 2 | 7 | 6 | 1 |
| 3 | 3 | 7 | 6 |

Thus, the difference is $(3376)_{9B.}$

## 2.1B.8 Hexadecimal Arithmetic

The hexadecimal number system is extensively used in the memories of the computer system and in the computer instructions. The basic arithmetic operations that are to be performed are listed below:

- Addition
- Subtraction

### 2.1B.8.1 Hexadecimal Addition

The addition operation performed with the hexadecimal numbers is analogous to the decimal addition except with a few differences that are discussed in the following steps:

1. First add the unit column of the hexadecimal digits in decimal.
2. This process is repeated for each larger significant digit of the hexadecimal number.
3. During the process of addition, observe if the sum is 15 or less, then it can be directly expressed as a hexadecimal digit.
4. If the sum is greater than 15, then subtract 16 from that particular digit and carry 1 to the next digit position.

**Example 1:** Add the hexadecimal numbers $(76)_{16}$ and $(45)_{16}$.

| | | | |
|---|---|---|---|
| | 7 | 6 | |
| + | 4 | 5 | |
| | 11 | 11 | |
| | - | - | (modification) |
| | B | B | |

The hexadecimal sum is $(BB)_{16}$.

***Note:*** *In the above example, since the decimal sums are less than* 15 *so they are expressed directly in the hexadecimal form.*

**Example 2:** Add the hexadecimal numbers $(A27E9)_{16}$ and $(6FB43)_{16}$.

| | | | | | | |
|---|---|---|---|---|---|---|
| | 1 | 1 | 1 | 1 | | |
| | A | 2 | 7 | E | 9 | |
| + | 6 | F | B | 4 | 3 | |
| 1 | 17 | 18 | 19 | 18 | 12 | |
| | -16 | -16 | -16 | -16 | - | (modification) |
| 1 | 1 | 2 | 3 | 2 | 12 | |

1 1 2 3 2 C (Hex Form)

The hexadecimal sum is $(11232C)_{16}$.

### 2.1B.8.2 Hexadecimal Subtraction

The hexadecimal subtraction is based on the same principles as that of binary subtraction. In this subtraction, 16 will be used as borrow instead of 1. The rest of the steps are similar to the binary subtraction.

**Example 1:** Subtract $(75)_{16}$ from $(527)_{16}$.

| | | | | |
|---|---|---|---|---|
| | | 4 | | (Borrow) |
| | | 16+2=18 | | |
| | 5 | 2 | 7 | |
| + | | 7 | 5 | |
| | 4 | 11 | 2 | |
| | 4 | B | 2 | (Hex Form) |

The hexadecimal difference is $(4B2)_{16}$.

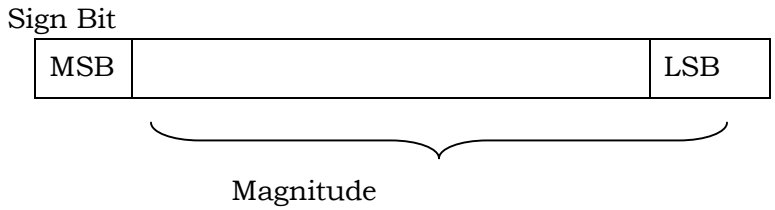
**Example 2:** Subtract $(lF65)_{16}$ from $(7E2CA)_{16}$.

| | | | | | |
|---|---|---|---|---|---|
| | | 2.5 | 16+2=18 (Borrow) | | |
| | 7 | E | 2 | C | A |
| - | | 1 | F | 6 | 5 |
| | 7 | 12 | 3 | 6 | 5 |
| | 7 | C | 3 | 6 | 5 (Hex Form) |

The hexadecimal difference is $(7C365)_{16}$.

### 2.1B.9 Signed and Unsigned Numbers

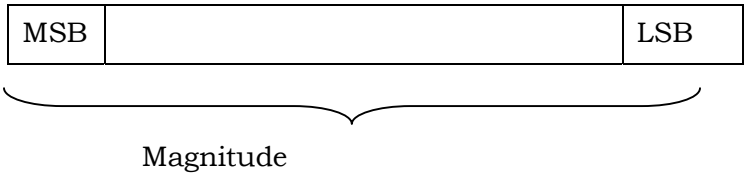
An n-bit signed binary number consists of two parts. A part denoting the sign of the number and a part denoting the magnitude of the number, The MSB is always a sign bit which denotes the sign of the number and the convention is that 0 and 1 denote '+' and '-', respectively. The remaining (n-l) bit denotes the magnitude of the number. The 8-bit sign-magnitude system ranges from -127 to +127.




In some applications, all data is either positive or negative, for example, smallest 8-bit number is 00000000 and largest is 11111111. Therefore, it ranges from 0 to 255. Here, positive and negative sign are not included with these numbers. All the bits in the binary number are used to represent magnitude of the corresponding decimal number.

There are certain restrictions in unsigned binary number. With 8-bit unsigned

arithmetic, all magnitude must be between 0 and 255. Therefore, each number being added or subtracted must be between 0 and 255 and answer must fall in the range of 0 to 255. If the magnitude is greater than 255, one should use 16-bit arithmetic.




So far, we have considered all binary numbers as unsigned numeric values. However, we can also use signed binary numbers. Whether a number is a signed number or an unsigned number depends solely on how we treat the number in our operation. We assign a bit, the MSB, as a sign bit that helps us to place a minus sign in a binary position.

The rules for signed and unsigned binary numbers are simple:

- In an unsigned number, the MSB is a weighted position bit.
- In a signed number, the MSB (the sign bit) is 0 for a positive number.
- In a signed number, the MSB (the sign bit) is 1 for a negative number.

### 2.1B.9.1 Complements

The complement of a number is the number which when added to the original will make it equal to a multiple of the base number system.

The complement of a number can be used as a representation of that number as a *negative* and as a *positive* number that represents a negative. It is a method, which can be used to make the subtraction easier for machines. Consequently, complements are used in the digital computers for simplifying the subtraction operation and for the logical operation.

For every base 'r' system, there are two types of complements: rs complement and (r-l)s complement. For decimal r = 10, we have 9s and l0s complement.

For binary r = 2, we have 1s and 2s complement.

For octal r = 8, we have 7s and 8s complement.

For hexadecimal r = 16, we have 15s and 16s complement.

### 2.1B.9.2 Negative Binary Numbers - the 1s Complement

Positive numbers are same in both sequences, but we need to define the negative numbers in the system. All the negative numbers have the binary MSB = 1, which is helpful in identifying the sign of the number. Indeed, the binary MSB is commonly known as the *sign bit.* This bit is useful in differentiating between positive and negative numbers. In addition, the sign bit allows us to divide the counting sequence evenly between positive and negative numbers.

To form the negative of any number, first complement all the bits of the number. This result is known as the *one's complement* of the original number. This requires us to change every logic 1 bit in a number to logic 0 and every logic 0 bit to a logic 1. For

instance, let us find the 1 s complement of 0011 0110 in binary.

| Number Format | D7 | D6 | D5 | D4 | D3 | D2 | D1 | D0 |
|---|---|---|---|---|---|---|---|---|
| Unsigned Number | 0 | 0 | 1 | 1 | 0 | 1 | 1 | 0 |
| 1s Complement | 1 | 1 | 0 | 0 | 1 | 0 | 0 | 1 |

### 2.1B.9.3 Negative Binary Numbers - the 2s Complement

We do not just place 1 in the MSB of a binary number to make it negative. We must take the 2s complement of the number. Taking the 2s complement of the number will cause the MSB to become 1.

To obtain the 2s complement of a number, there is a two-step process:

1. Take the 1 s complement of the number by changing every logic 1 bit in the number to logic 0 bit and change every logic 0 bit to logic 1 bit.
2. Add 1 to the 1's complement of the binary number. Now, we have the 2s complement of the original number. Here, we can notice that the MSB has become 1.

1s complement and 2s complement of 0011 0110 in binary is shown in the following table:

| Number Format | D7 | D6 | D5 | D4 | D3 | D2 | D1 | D0 |
|---|---|---|---|---|---|---|---|---|
| Unsigned Number | 0 | 0 | 1 | 1 | 0 | 1 | 1 | 0 |
| 1s Complement | 1 | 1 | 0 | 0 | 1 | 0 | 0 | 1 |
| 2s Compliment | 1 | 1 | 0 | 0 | 1 | 0 | 1 | 0 |

If we are using signed binary numbers and the MSB is already logic 1, it means the value is the 2s complement of the number.

### 2.1B.9.4 Representation of signed numbers using 2s complement

We have discussed *that* the signed numbers can be represented by taking out the 2s complement of the original number. However, this representation varies between positive and negative numbers.

If the number is positive, the magnitude remains in its binary form and a sign bit of 0 is placed in front of the MSB.

**Example 1:** Represent + $(12)_{10}$ in 2s complement form.

| Binary Number | | 1 | 1 | 0 | 0 |
|---|---|---|---|---|---|
| 1s Complement | | 0 | 0 | 1 | 1 |

| | | | | | |
|---|---|---|---|---|---|
| 2s Compliment | | 0 | 1 | 0 | 0 |
| With Sign Bit | **0** | 0 | 1 | 0 | 0 |

If the number is negative, the magnitude is represented in its 2s complement form and a sign bit 1 is placed in front of the MSB.

**Example 2:** Represent - $(14)_{10}$ in 2s complement form.

| | | | | | |
|---|---|---|---|---|---|
| Binary Number | | 1 | 1 | 1 | 0 |
| 1s Complement | | 0 | 0 | 0 | 1 |
| 2s Compliment | | 0 | 0 | 1 | 0 |
| With Sign Bit | **1** | 0 | 0 | 1 | 0 |

### 2.1B.9.5
### Addition-subtraction of signed numbers using 2s complement addition

The addition of signed binary numbers represented in the radix complement form is similar to the unsigned case. However, when the 2s complement of a number is added to any other binary number, it will be equivalent to its subtraction from that number. As a result, subtraction of the signed numbers by 2s complement method is performed by using the following steps:

1. Convert both the numbers into the binary equivalent form.
2. Find the 2s complement form of the number, which is subtracting, that is, subtrahend.
3. Add this 2s complement number to the minuend.
4. If there is carry of **1,** ignore it from the result to obtain the correct result.
5. If there is no carry, recomplement the result and attach the negative sign to the obtained result.

**Example 1:** Add $(27)_{10}$ and $(-11)_{10}$ using complementary representation for the negative value. Binary form of $(27)_{10} = (011011)_2$ and of $(11)_{10} = (001011)_2$

Hence, the result is $(010000)_2$ or $(16)_{10}$.

***Note:*** *Here, carry* is 1, *so ignore it and the result* is *(010000)2.*

**Example 2:** Subtract $(25)_{10}$ from $(42)_{10}$.

Binary form of $(25)_{10} = (011001)_2$ and of $(42)_{10} = (101010)_2$

Get the 2s complement of the $(011001)_2$

Here, ignore the carry 1 and the result is $(010001)_2$ or $(17)_{10}$.

## 2.1B. 10 Summary

The binary coding schemes are used to represent the internal storage area of the computers. In binary coding, every character is represented by a combination of bits. The most commonly used computer coding systems are BCD, ASCII and EBCDIC.

BCD (Binary Coded Decimal) is a method that represents the decimal digits

with the help of binary digits. It is a 6-bit code, which can represent a maximum of 64 different characters.

The Excess-3 is a digital code that is formed by adding 3 to each decimal digit. Excess-3 is an unweighted code.

ASCII is a 8-bit code and is exclusively used to represent the data internally in the microcomputers. It can represent 128 different characters.

EBCDIC or Extended Binary Coded Decimal Interchange Code uses 8 bits for each character and can represent 256 different characters. It provides a unique code for each decimal value 0 through 9 and for a variety of special characters.

Gray code is an unweighted code. Gray code is not suited for arithmetic operations.

All the computers perform the arithmetic operations in the binary mode. The basic arithmetic operations that have been performed by all the number systems are addition and subtraction.

The rules of binary addition are as follows:

0 + 0 = 0
0 + 1 = 1
1 + 0 = 1
1 + 1 = 0 plus a carry of 1 to next higher column

The rules of binary subtraction are as follows:

0 - 0 = 0
1 - 0 = 1
1 - 1 = 0
0 - 1 = 1 with a borrow from the next column

The *complement* of a number is the number which when added to the original will make it equal to a multiple of the base number system. The complement of a number can be used to represent a number as a *negative* and a *positive* number. The addition and subtraction of the signed numbers is dependent on the 2s complement of the numbers and whenever the 2s complement of a number is added to any other binary number, it will be equivalent to its subtraction from that number.

## 2.1B.11 *Self Check Exercise*

Q.1 What is the purpose of the binary coding system? Briefly explain the terms: BCD, ASCII and EBCDIC.

Q.2 What do you mean by BCD code?

Q.3 Encode these binary number in BCD

- 45
- 247
- 1029

Q.4 What is Gray code?

Q.5 Why computers have deigns to use the binary number system?

Q.6 Perform the binary addition

- 1010 + 1101
- 111011 + 101011
- 1010110 + 1011010

Q.7 Add the binary numbers 1011 and 101 in both decimal and binary forms.

Q.8 Subtract $0110111_2$ from $1101110_2$

Q.9 Subtract $011011_2$ from $110111_2$

## 2.1B.12 *Suggested Readings:*

1. Computer Fundamentals By Pradeep K. Sinha and Priti Sinha (BPB Publications)
2. Fundamentals of Information Technology By Shiv Kumar Anand and Harmohan Sharma (Kalyani Publishers)
3. Fundamentals of Information Technology by V.Rajaraman (PHI, New Delhi).
4. Digital Design by M. Morris Mano (Pearson Education)
5. Computer Fundamentals, Architecture & Organisation by B.Ram, New Age International.
6. Code : the sudden language of computer hardware and software by Charles Petzold

**LESSON NO. 2.2** **AUTHOR : DR AMARDEEP SINGH**

# DATA COMMUNICATION AND COMPUTER NETWORK



## 2.2.1 Introduction

We have entered in the era of communication technology. The dynamic world today needs fast communication channels to move data frequently from one place to another. To move data quickly from one place to another, the concept of networking has been introduced. In networking, the computers in different parts of the world are connected to each other to share data. Therefore, when a number of computers are connected with each other in such a way that they can share the information, the system is called Network. A network allows computers users to share computer equipment, programs, messages and the information

**Computer Network** :- **A computer network is a group of computer systems and**

**other computing hardware devices that are linked together through communication channels to facilitate communication and resource sharing among a wide range of users**. A network consists of following elements:

(i) **Nodes (Workstations)**: The different terminals attached to the network sharing the resources of the network are called nodes. When we attach a computer to the network it becomes the workstation of a network.

(ii) **Server**: We designate a particular node as a main or central node, which is at a well known and a fixed address to provide service to the network as a whole. The node providing the service is known as the server.

(iii) **Network Interface Unit**: The interpreter, which helps in the communication between the server and different nodes is called a Network Interface Unit. The network interface unit is a device that is attached to the server and all the workstations to maintain the connection between them. Each network interface unit has a unique node address.

### 2.2.2 Need for Networking

1. **To share computer files**: Networks enable users to share files with others. For example, a person sitting on one computer can send the file to other in sharing mode.
2. **To share computer equipment**: Printers and hard-disk drives can also be shared. Networks enable users to share such equipment by networking.
3. **Increasing speed and accuracy:** Messages can be send through networks with high speed and more accuracy
4. **Cost effectiveness:** The cost of transfer of documents using computers connected on networks is cheaper than other conventional methods like telegrams.
5. **Team Work:** Different computers on a network can be connected together and the users can work together as a group. Software packages have been developed for group working in Data Base Management systems (DBMS) and graphic applications.
6. **High reliability:** All files could be replicated (copied) on two or three machine, so if one of them is unavailable (due to hardware failure), the other backup can be used.

### 2.2.3 Types of Computer Networks

There are three types of computer networks:

1. Local Area Network (LAN)
2. Metropolitan Area Network (MAN)
3. Wide Area Network (WAN)

### 2.2.3.1 Local Area Network (LAN)

**A local area network is relatively smaller and privately owned network with the maximum span of 10 km**. to provide local connectivity within a building or small geographical area. In private offices this type of Networking is very popular and effectively used. They are widely used to connect personal computers and workstations in corporate offices and factories to share resources and exchange information. LANs often use a transmission technology consisting of a single cable to which, the entire machines are attached as shown in figure. Traditional LANs run at speeds of 10 to 100 Mbps, have low delay and make very few errors.

**Features of LAN**

i) **Limited Geographic Limits** :A LAN is designed for a small area. Generally it spans a single often, workgroup floor in a building or in a campus etc. LAN uses different protocols or rules for information transmission.

(ii) **Limited number of users :** Most LAN supports less numbers of users usually around five or ten, More users can be supported by connecting different LAN'S together, which gives better results than making one big-network of the nature of LAN.

(iii) **Reliability and Stability :**LANs tend to be very Reliable Failures on a LAN are mostly due to wrong or improper installation. Monitoring software that comes along with a LAN provides a number of useful programs like error detection, prevention of transmission loss and excellent security features.

(iv) **Flexibility :**Major development in LANs today is flexibility they offer earlier versions would support only one type of desktop computers. Today advanced LANs however can support different types of Computers. This flexibility also extends to operating systems & storage media.

(v) **Expandable :**Most LANs can be expanded easily. More nodes (Terminals) can be added. Also LANs can have more servers on same network and a user at a terminal can connect to one or many servers and work comfortably.

(vi) **Security &Administration :**A LAN administrator is one who supervises the operation of a LAN. He takes care of tasks like adding or deleting users, creating Passwords, Providing authorizations and other resources like printers and backing up data. All these tasks can be performed without much difficulty since both hardware and software are quite easy to manage today.

### 2.2.3.2 Wide Area Network

**WAN provides no limit of distance. A WAN provides long distance transmission of data, voice, image and video information over large geographical area that may comprise a country, a continent or even the whole world**. In fact in WAN, the data is transmitted via a satellite or through the telephone lines. All the big

organizations, which want to make a central data base to be used by all the branches, use WAN.

Railway, Airlines and Banking companies are examples of such network as they have a central database that is used by all the terminals. As a result you can operate your bank account from any where in India or get your reservation from any place to any other place for train journey or air flight.

**Features of WAN**

1. **Remote Data and Job Entry:** It is possible to enter data of the sales and transactions at the point-of-sale terminals using WANs. It is also possible to centralize this data in a computer for processing or reporting purposes. For example, Super markets in different cities connected through WANs can send all sales data from their remote sale centre and the central purchase and distribution centre can monitor all the sale figures on a day to daybasis.
2. **Centralizing Information:** It is often convenient for a business to centralize regional and national information. For example, auto-parts dealers can help in locating rare-auto parts using a centralized computer file of inventory items. WANs enable such dealers to query centralized databases.
3. **Facilitating Communications:** Corporations in advanced countries often use WANs to facilitate employee communications, to save on long-distance phone calls and letter writing, to cut costs on the preparation of written documents. To overcome the time lags involved in the conventional means of extracting information between different branches. Computer conferencing, in which users communicate with each other through their computer systems, is another possible function of WANs.

### 2.2.4 Elements of computer network

**1. Servers**

One of the major benefits of implementation of LAN is sharing expensive resources such as Laser printer, hard disk etc. This is achieved through providing servers on the LAN. Server may be dedicated or non-dedicated. A dedicatedserver is a computer that controls one or more resources. A non-dedicatedserver is a computer that can be used as a stand-alone pc while in the background it serves the LAN. Three major categories of servers used in LAN are

**(a)** **File Server:** It is used to share storage space for files. Besides providing storage spaces for files in a LAN environment, it is used for taking periodical backup and also to provide gateway to other servers within and between LANs.

**(b)** **Printer Server:** It is used to handle printing works of all workstation

connected in the network.

(c) **Modem Server:** In LAN environment modem is also required to get connected to other network or simply to use a telephone. A modem server is used to share this expensive resource by all connected work stations in a network ring.

**2. Work Station**

A workstation is a computer and it has its own local O.S. like DOS, Windows etc. depending on machine type. A work station's main job is to execute program files retrieved from network. In distributed processing environment, processing burden is shared by server and workstation.

**3. Network Interface Units (NIU)**

Network interface units connect each device in the LAN network to shared transmission device. NIU is also used for to implement LAN protocols (rules) and for device attachments.

**4. Hub**

There are two types of Hub

(a) **Active Hub:** An active hub is a powered distribution point with active devices which drive nodes up to 1 kilometer away. Active hubs can be cascaded to connect 8 connections to which passive hubs, file servers or another active hub can be connected. The maximum distance covered by an active hub is about approximately 2000 ft.

(b) **Passive hub:** As the name suggests it is a passive distribution point which does not use power or active devices in a network to connect up to 4 nodes within a very short distance. The maximum distance covered by a passive hub is about 300 ft.

**5. Shared Resources**

Shared Resources include storage devices attached to server, optical disk drives, printers, plotters, modems and other equipment that can be used by everyone on network. Sharing hardware not only reduces cost by making duplicate purchases redundant, but LAN can access a wide variety of equipment.

**6. Modem**

Computer generates digital data which is unsuitable for long distance communication. So for this purpose this data must be converted to analog data. It is the modulationwhich performs this conversion of data from digital to analog. The converted data in the form of analog signals can travel without any noise over long distances. This data when reaches its destination is converted back to digital data with the help of demodulation. Thusdemodulationconverts analog signals to original digital data. Modem is device which converts the analog into digital signal & vice-

versa. Modems are already used for transmission of data over telephone lines.

**7. Bridges**

Bridges are used to connect two LANs that use identical LAN protocols over a wide area. The bridge acts as an address filter which picks up packets from one LAN that are intended for a destination on another LAN and passes these packets on the network. **If** the distance between the two LANs is large, the user would require two identical bridges at either end of the communication link

**8. Routers**

Routers can be used to connect networks that many not be similar. Ro provide connectivity between two LANs or two WANs overlarge geographical distances. For large Wide Area Networks spanning thousands of kilometers the normal practice is to put network routers at suitable locations to min link costs for leased lines and provide adequate reliability from link fail Networks and other system are then connected to the nearest router

**9. Gateways**

Gateways are used to connect two dissimilar LANs. The term gateway routers are used interchangeably, though there is a slightly difference the two. A gateway is required to convert data packets from one format to another before forwarding it, as it connects two dissimilar elements

**2.2.5 Transmission Media**

Cable is the medium through which information usually moves from one network device to another. There are several types of cable which are commonly used with computer network transmission. In some cases, a network will utilize only one type of cable, other networks will use a variety of cable types. The type of cable chosen for a network is related to the network's topology, protocol and size. Understanding the characteristics of different types of cable and how they relate to other aspects of a network is necessary for the development of a successful network. The following sections discuss the types of cables used in networks and other related topics.

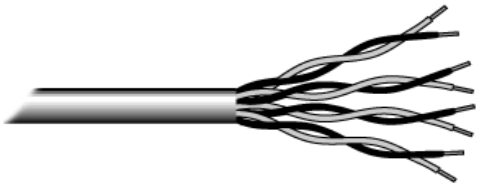
1. Twisted Pair Cable
2. Coaxial Cable
3. Fiber Optic Cable
4. Wireless transmission

**2.2.5.1 Twisted Pair Cable**

It consists of two insulated copper wires arranged in a regular spiral pattern to minimize the electromagnetic interference between adjacent pairs. It is of two types.

**a) Unshielded Twisted Pair (UTP) Cable**

Unshielded twisted pair (UTP) is the most popular and is generally the best option for telephone networks.



The quality of UTP may vary from telephone-grade wire to extremely high-speed cable. Each pair is twisted with a different number of twists per inch to help eliminate interference from adjacent pairs and other electrical devices.

- Ordinary telephone wire
- Cheapest
- Easiest to install
- Suffers from external electromagnetic interference (EM)

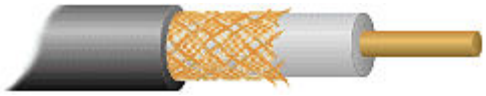
**b) Shielded Twisted Pair (STP) Cable**

A disadvantage of UTP is that it may be disturbed to radio and electrical frequency interference. Shielded twisted pair (STP) is suitable for environments with electrical interference; however,

- The pair is wrapped with metallic foil or braid to insulate the pair from electromagnetic interference.
- More expensive.
- Harder to handle (thick, heavy).

**2.2.5.2 Coaxial Cable**

Coaxial cabling has a single copper conductor at its center. A plastic layer provides insulation between the center conductor and a braided metal shield. The metal shield helps to block any outside interference from lights, external devices and other computers.



Coaxial cable

**<u>Characteristics of Coaxial Cable</u>**

- Most versatile medium
- Used in Television transmission
- Aerial to TV
- Used in Cable TV
- Long distance telephone transmission
- Can carry 10,000 voice calls simultaneously

- Short distance computer systems links
- Used in Local area networks

**Advantage and Disadvantage of Coaxial Cable**

- Supports Analog and Digital Transmission
- Amplifiers on higher bandwidth.
- Can transmit on higher frequency, Up to 600MHz.
- up to 10,800 voice conversations
- much less susceptible to interference than twisted pair
- high attenuation rate makes it expensive over long distance
- It is bulky

### 2.2.5.3 Fiber Optic Cable

Fiber optic cabling consists of a center glass core surrounded by several layers of protective materials. It transmits light rather than electronic signals eliminating the problem of electrical interference. This makes it ideal for certain environments that contain a large amount of electrical interference. It has also made it the standard for connecting networks between buildings, due to its immunity to the effects of moisture and lighting. Fiber optic cable has the ability to transmit signals over much longer distances than coaxial and twisted pair. It also has the capability to carry information at vastly greater speeds. This capacity broadens communication possibilities to include services such as video conferencing and interactive services.

But it is difficult to install and connect the fiber optics.

**Characteristics of Fiber optics**

- Greater capacity
- Data rates of hundreds of Gbps
- Smaller size & weight
- Lower attenuation
- Electromagnetic isolation
- Greater repeater spacing
- More distance in km.

**Advantages and Disadvantages of Fiber optics**

- Immunity to environmental interference
- Highly secure due to tap difficulty and lack of signal radiation
- Used in Telephone Exchange and Internet connectivity.

- Expensive over short distance
- Requires highly skilled installers
- Adding additional nodes is difficult

### 2.2.5.4 Wireless transmission

All networks are not connected with cabling, some networks are wireless. Wireless network use high frequency radio signals, infrared light beams or lasers to communicate between the computers. Each computer and file server on a wireless network has some sort of transceiver/antenna to send and receive the data. For longer distance, wireless communications can also take place through cellular telephone technology satellite, microwave transmission etc. Wireless networks are also beneficial in older buildings where it may be difficult or impossible to install cables.

The two most common types of infrared communications used in wireless transmission are line-of-sight and broadcast. Line-of-sight communication means that there must be a direct line between the computer and the transceiver. If a person walks within the line-of-sight while there is a transmission, the information would need to be sent again.

Infrared communication is a broadcast of infrared transmissions sent out in multiple directions that bounces off walls and ceilings until it eventually hits the receiver. Networking communications with laser are virtually the same as line-of-sight infrared networks. Wireless LANs have several disadvantages. They provide poor security and are susceptible to interference from lights and electronic devices. They are also slower than LANs using cabling.

### 2.2.6 Network Topologies

It is the logical arrangement of computes in a network. The various rules / methods to connect the computers in networking are known as **Topology**. The choice of topology depends upon the following factors:

1. Cost
2. Availability of physical communication line.
3. Reliability of the entire system.
4. Number of cables required.

5. Expandability of the system.
9A. Transmission delays.
7. Maximum distance.
8. Maximum number of nodes.

### 2.2.6.1 Star Topology

Star Topology is forerunner of all other topologies. Here, Server acts as heart of LAN and all PCs are connected individually to it. It is topology upon which our telephone network is built. Every communication from every user's station goes through the Central Computer before reaching it destination. Control Computer is very powerful and takes care of all networking responsibilities. This network is cheapest of all. To connect five systems we just need four cables. But failure chances are more if Central Computer Trips, whole network will go down. Sometimes Star-Shaped LAN is built with duplicate Central Computers as it allows rapid recovery from failure. But this will add to cost of Networking.

**Merits**

1. Cheaper media of Networking.
2. Less number of Cables required.
3. Transmission delays between two nodes do not increase by adding new nodes to the network.
4. If any node fails, the remaining portion of the network is unaffected.

**Demerits**

1. Central Computer must be very powerful.
2. If the host computer fails, the entire network fails.

### 2.2.6.2 Ring Topology

Ring Topology avoids dependence on Central Computer. Each node on ring can send a message to other terminalwith a unique-address. A node receives data from one of its adjacent node. The only decision a node has to take is whether the data is for its use or not. If it is addressed to it utilizes it. Otherwiseit passes it on to the next node. Every Data Unit in ring contains source & destination address.

**Merits**

1. It is a True Distributed Data processing system.
2. More reliable than STARbecause communication is not dependent on host computer.

**Demerits**

1. Addition of New Node increases the communication delays.
2. Complicated control software.

### 2.2.6.3 Bus Topology

All the PCs are connected to same cable in one stream. At one end is server

and last terminal at the other end is called Terminator**.** As with ring structure, Bus Network has also a unique address. If geographic coverage needs to be expanded, repeaters which interconnect two buses are required. In Bus topology, least length of physical Transmission medium is used. Coverage can be increased by extending the bus through use of repeaters. The Bus Topology is one of most popular topology. One reason for popularity is that, its wiring requirements are comparatively simple and growth is obtained easily & quickly.

**Merits**

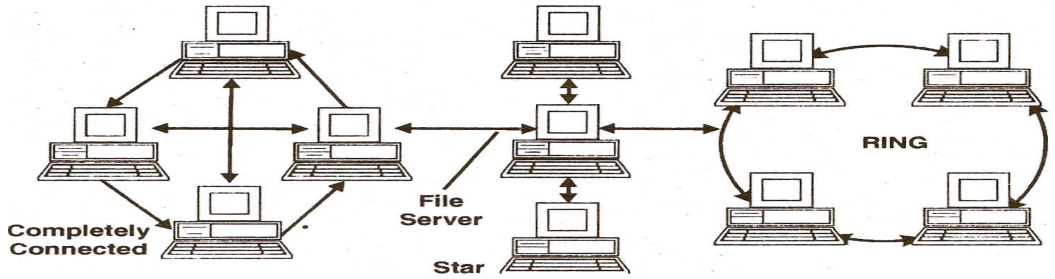
1. Less number of cables required.
2. Easy to expand.
3. Nodes can be added without distributing the rest of network.

**Demerits**

1. If the communication line fails, the entire system breaks down.

### 2.2.6.4 Hybrid Topology

A hybrid topology is simply a combination of two or more then two topologies. The exact shape configuration of the network depends on the needs and the over organizational structure of the company involved. In some cases, the hybrid topology may have components of star, ring and completely connected networks topology as shown in following figure




### 2.2.6.5 Complete connected Topology

A fully connected network, complete topology or full mesh topology is a network topology in which there is a direct link between all pairs of nodes. In a fully connected network with *n* nodes, there are *n(n-1)/2* direct links. Networks designed with this topology are usually very expensive to set up, but provide a high degree of reliability due to the multiple paths for data that are provided by the large number of redundant links between nodes

### 2.2.7 Summary

A network is a collection of computers connected to each other. The network allows computers to communicate with each other and share resources and information. Computer networks may be classified according to the network topology

upon which the network is based. All networks are made up of basic hardware building blocks to interconnect network nodes, such as Network Interface Cards (NICs), Bridges, Hubs, Switches and Routers. In addition, some method of connecting these building blocks is required, usually in the form of cable which are discussed in this lesson.

### 2.2.8 Exercise

Q1 What is computer networking? What are its advantages?
Q2 Differentiate between LAN and WAN?
Q3 Write different elements of computer network?
Q4 Compare different transmission media?
Q5 Describe various Network topologies?
Q6 Differentiate between Bridges and Routers?

### 2.2.9 Suggested References

1. "Computer network protocol standards and interface", Black UD, Prentice Hall.
2. "Computer Networks", Tanenbaum, Pearson Education India.
3. "Data Communication and Networking" ,Forouzan, Tata McGraw Hill Ltd.

LESSON NO. 2.3 AUTHOR : DR AMARDEEP SINGH

# INTERNET AND ITS APPLICATIONS



## 2.3.1 Introduction

As we approach a new millennium, the Internet is revolutionizing in our society, our economy and our technological systems. No one knows for certain how far, or in what direction, the Internet will evolve. But no one should underestimate its importance. The Internet, as an integrating force, has melded the technology of communications and computing to provide instant connectivity and global information services to all its users at very low cost.

The Internet is formed by the global interconnection of hundreds of thousands of otherwise independent computers, communications entities and information systems. The Internet, sometimes called simply "the Net," is a worldwide system of computer networks i.e. a network of networks in which users is at any one computer. The Internet uses a portion of the total resources of the currently existing public telecommunication networks. The procedures by which computers communicate with each other are called "protocols." While this infrastructure is steadily evolving to include new capabilities, the protocols initially used by the Internet are called the

"TCP/IP" or (Transmission Control Protocol/Internet Protocol), named after the two protocols that formed the principal basis for Internet operation.

**The size, scope and design of the Internet allow users to:**

- connect easily through ordinary personal computers and local phone numbers.
- exchange electronic mail (E-mail) with friends and colleagues with accounts on the Internet.
- post information for others to access and update it frequently.
- access multimedia information that includes sound, photographic images and even video and
- access diverse perspectives from around the world.

The Internet is a large common space, accessible to everyone around the world. As in any public space, it should be taken appropriate precautions to protect yourself against fraudulent people and processes. Internet security analysis is broken down into a consideration of threats and corresponding defenses. For most threats there is a defense. The short course advises you to ensure you always use a firewall, virus protection and to use encryption when necessary.

### 2.3.2 The Evolution of the Internet

The internet is a global system of interconnected computer networks that uses the TCP/IP net work protocols to facilitate data transmion and exchange. The Internet was the result of some visionary thinking by people in the early 1960s that saw great potential value in allowing computers to share information on research and development in scientific and military fields. The Internet, then known as ARPANET was brought online in 1969 under a contract let by the renamed Advanced Research Projects Agency (ARPA) which initially connected four major computers at universities in the southwestern US (UCLA, Stanford Research Institute, UCSB, and the University of Utah). The early Internet was used by computer experts, engineers, scientists and librarians. There was nothing friendly about it. There were no home or office personal computers in those days, and anyone who used it, whether a computer professional or an engineer or scientist or librarian, had to learn to use a very complex system. The Internet matured in the 70's as a result of the TCP/IP architecture first proposed by Bob Kahn at BBN. As the commands for e-mail, FTP, and telnet were standardized, it became a lot easier for non-technical people to learn to use the nets. It was not easy by today's standards by any means, but it did open up use of the Internet to many more people in universities in particular. Other departments besides the libraries, computer, physics, and engineering departments found ways to make good use of the nets to communicate with colleagues around the world and to share files and resources.

While the number of sites on the Internet was small, it was fairly easy to keep track of the resources of interest that were available. But as more and more universities and organizations and their libraries connected, the Internet became harder and harder to track. There was more and more need for tools to index the resources that were available. In 1989 another significant event took place in making the nets easier to use. This protocol, which became the World Wide Web in 1991, was based on hypertext a system of embedding links in text to link to other text, which you have been using every time you selected a text link while reading these pages. Since the Internet was initially funded by the government, it was originally limited to research, education and government uses. Commercial uses were prohibited unless they directly served the goals of research and education. This policy continued until the early 90's, when independent commercial networks began to grow. It then became possible to route traffic across the country from one commercial site to another without passing through the government funded NSFNet Internet backbone. Wireless has grown rapidly in the past few years and travelers search for the wi-fi "hot spots" where they can connect while they are away from the home or office. Many airports, coffee bars, hotels and motels now routinely provide these services, some for a fee and some for free.

### 2.3.3 The Internet Architecture

The Internet's architecture is described in its name, a short from of the compound word "inter-networking". This architecture is based in the very specification of the standard TCP/IP protocol, designed to connect any two networks which may be very different in internal hardware, software, and technical design. Once two networks are interconnected, communication with TCP/IP is enabled end-to-end, so that any node on the Internet has the near magical ability to communicate with any other no matter where they are. This openness of design has enabled the Internet architecture to grow to a global scale. An individual's access to the Internet is often from home over a modem to a local Internet service provider who connects to a regional network connected to a national network. At the office, a desktop computer might be connected to a local area network with a company connection to a corporate Intranet connected to several national Internet service providers. In general, small local Internet service providers connect to medium-sized regional networks which connect to large national networks, which then connect to very large bandwidth networks on the Internet backbone. Most Internet service providers have several redundant network cross-connections to other providers in order to ensure continuous availability.

The companies running the Internet backbone operate very high bandwidth networks relied on by governments, corporations, large organizations, and other Internet

service providers. Their technical infrastructure often includes global connections through underwater cables and satellite links to enable communication between countries and continents. Each communication packet goes up the hierarchy of Internet networks as far as necessary to get to its destination network where local routing takes over to deliver it to the addressee. In the same way, each level in the hierarchy pays the next level for the bandwidth they use, and then the large backbone companies settle up with each other. Bandwidth is priced by large Internet service providers by several methods, such as at a fixed rate for constant availability of a certain number of megabits per second, or by a variety of use methods that amount to a cost per gigabyte. Due to economies of scale and efficiencies in management, bandwidth cost drops dramatically at the higher levels of the architecture.

In order to work properly, the architecture required a global addressing mechanism (or Internet address) to enable computers on any network to reference and communicate with computers on any other network in the federation. Internet addresses fill essentially the same role as telephone numbers do in telephone networks. The design of the Internet assumed first that the individual networks could not be changed to accommodate new architectural requirements; but this was largely a pragmatic assumption to facilitate progress. The networks also had varying degrees of reliability and speed. Host computers would have to be able to put disordered packets back into the correct order and discard duplicate packets that had been generated along the way.

A key architectural construct was the introduction of gateways and routers between the networks to handle the disparities such as different data rates, packet sizes, error conditions and interface specifications. The gateways would also check the destination Internet addresses of each packet to determine the gateway to which it should be forwarded. These functions would be combined with certain end-end information transmission.

### 2.3.4 The Domain Name System

The Internet evolved as an experimental system during the 1970s and early 1980s. It then flourished after the TCP/IP protocols were made mandatory on the ARPANET and other networks in January 1983; these protocols thus became the standard for many other networks as well. Indeed, the Internet grew so rapidly that the existing mechanisms for associating the names of host computers to Internet addresses (known as IP addresses) were about to be stretched beyond acceptable engineering limits. Most of the applications in the Internet referred to the target computers by name. These names had to be translated into Internet addresses before the lower

level protocols could be activated to support the application. The designers of the DNS also developed seven generic "top level" domains, as follows:

- Education- EDU
- Government – GOV
- Military – MIL
- International – INT
- Network – NET
- (non-profit) Organization – ORG
- Commercial – COM
- Information – info
- Mobile devices - .mobi
- business - .biz
- museums - .museum
- individuals - .name
- Cooperatives - .coop
- Asia-pacific region - .asia
- travel and tourism industry - .travel

The Domain Name System (DNS) was and continues to be a major element of the Internet architecture, which contributes to its scalability. It also contributes to controversy over trademarks and general rules for the creation and use of domain names, creation of new top-level domains and the like.

The growth of Web servers and users of the Web has been remarkable, but some people are confused about the relationship between the World Wide Web and the Internet. The Internet is the global information system that includes communication capabilities and many high level applications. The Web is one such application. The existing connectivity of the Internet made it possible for users and servers all over the world to participate in this activity. Electronic mail is another important application. As of today, over 90 million computers take part in the Internet and about 8.6 million web sites were estimated to be accessible on the net. Virtually every user of the net has access to electronic mail and web browsing capability. Email remains a critically important application for most users of the Internet, and these two functions largely dominate the use of the Internet for most users.

### 2.3.5 The Internet Standards Process

Each distinct version of an Internet standards-related specification is published as part of the "Request for Comments" (RFC) document series. This archival series is the official publication channel for Internet standards documents and other publications of the IESG, IAB and Internet community. RFCs can be obtained from a number of

Internet hosts using anonymous FTP, gopher, World Wide Web, and other Internet document-retrieval systems. The RFC series of documents on networking began in 1969 as part of the original ARPA wide-area networking (ARPANET) project. RFCs cover a wide range of topics in addition to Internet Standards, from early discussion of new research concepts to status memos about the Internet. RFC publication is the direct responsibility of the RFC Editor, under the general direction of the IAB.

At present, the standards efforts for Internet are carried out primarily under the auspices of the Internet Society (ISOC). The Internet Engineering Task Force (IETF) operates under the leadership of its Internet Engineering Steering Group (IESG), which is populated by appointees approved by the Internet Architecture Board (IAB) which is now part of the Internet Society.

There are other bodies with considerable interest in Internet standards or in standards that must inter work with the Internet. Examples include the International Telecommunications Union Telecommunications standards group (ITU-T), the International Institute of Electrical and Electronic Engineers (IEEE) local area network standards group (IEEE 801), the Organization for International Standardization (ISO), the American National Standards Institute (ANSI), the World Wide Web Consortium (W3C), and many others.

The goals of the Internet Standards Process are:

- technical excellence.
- prior implementation and testing.
- clear, concise and easily understood documentation.
- openness and fairness and
- timeliness.

As Internet access and services are provided by existing media such as telephone, cable and broadcast, interactions with standards bodies and legal structures formed to deal with these media will become an increasingly complex matter. The intertwining of interests is simultaneously fascinating and complicated, and has increased the need for thoughtful cooperation among many interested parties.

The Internet can now be accessed virtually anywhere by numerous means. Mobile phones, data cards, handheld gameconsoles and cellular routers allow users to connect to the Internet from anywhere there is a cellular network supporting that device's technology. Within the limitations imposed by the small screen and other limited facilities of such a pocket-sized device, all the services of the Internet, including email and web browsing, may be available in this way. Service providers may restrict the range of these services and charges for data access may be significant, compared to home usage.

### 2.3.6 The Internet security

Use of a good password is your first security defence. You should always use a password on any computer that others can access, so that no one can access your private information, use your account and impersonate you on the Internet, delete your files by mistake, etc. The most common type of password on the Internet are passwords you know, mainly alphanumeric keywords. For a reasonably secure home computer, password selection might be a less critical issue, but on networks open to the Internet there are many very real threats to administrator, network and application passwords. Many ingenious programs have been written to crack passwords at high volume, some by hackers and some as legitimate security testing tools, and are of course loose on the Internet. Many of these programs use a variety of dictionary based attacks to combine common words and word variations to try thousands of passwords as fast as the targeted system will permit. Some start by guessing a whole bunch of common passwords. Lots of people use their birthday or spouse's birthday, the name of someone from their family or friends, the name of a favorite pet, or some other high profile subject for their password. Avoid all the obvious choices, since professional hackers try these first.

If you give a site personal data like an email address, home address, phone number, birth date, or credit card number, be aware that the information can be easily cross referenced by a range of large service companies to assemble a detailed database of your buying habits, surfing patterns and interests. And it usually is. If you do give site personal information, it is a good idea to first read their Internet privacy policy to see how confidential they promise to keep it.

### 2.3.7 Application of Internet

**1. To find general information about a subject**

The Web is like a huge encyclopedia of information. The volume of information you'll find on the Web is amazing. For every topic that you've ever wondered about, there's bound to be someone who's written a Web page about it. The Web offers many different perspectives on a single topic. For example, for a selection of pages about Internet will show thousand of pages. In fact you can even find online encyclopedias. Many of these are now offering a subscription service which lets you search through the complete text of the encyclopedia. There are also many free encyclopedias that may give you a cut-down version of what you would find in a complete encyclopedia.

**2. To access information not easily available elsewhere**

One of the great things about the Web is that it puts information into your hands that you might otherwise have to pay for or find out by less convenient means. Online shopping, information of product, company profile, document download,

journals, books etc. can be easily accessed. It's faster and easier than writing mail and cheaper than using the telephone.

**3. Communication and Social networking**

The Web is generally a very friendly place. People communicate by email from strangers, and friendships are quick to form from casual correspondence. The impersonal aspect of email and chatting tends to encourage people to reveal surprisingly personal things about themselves. When you know you will never have to meet someone face-to-face, you may find it easier to tell them your darkest secrets. Cyber-friendships have often developed into real life ones too. In industries the concept of chatting is used to share the information in term of video conferencing.

**4. To discuss their interests with like-minded people**

Did you think you were alone in your obsession with a singer, TV programmer, author and hobby? Chances are there's and Internet group for people like you. You can share your technical, communicational, personality development skills with other people. The scientists, researchers, innovators can share their views with each other on websites and other persons can take benefit of it.

**5. VoIP (Voice over Internet Protocol)**

It has started from an optional two-way voice chat provided by some of the instant messaging systems that started around the year 2000. The benefit of VoIP is that it can be free or cost much less than a normal telephone call, because the Internet carries that voice traffic. VoIP is surely a cheap solution for long distance call.

**7. To learn**

Internet has huge knowledge of material of all the topics and subjects. You can get the on line information of any topic. Journals, Magazines, newscast letters, papers, assignments, tutorials, quizzes etc. is available on Internet. Online distance education courses can give you an opportunity to gain a qualification over the Internet.

**8. To read the news**

If you are in hurry to attend classes or for office work just open the internet to get the latest news on any news bulletin or news paper.

**9A. To find software**

The Internet contains a wealth of useful downloadable shareware. Some pieces of shareware are limited versions of the full piece of software, other are time limited trials. Some shareware are free for educational institutes or for non-commercial purposes.

**10. To buy things**

You can do on-line shopping dealing with a reputable company for purchase of any product. Now days these type of shopping are giving good discount. The transaction

of money is done mostly by credit cards. Though, transaction using such Web Sites is risky.

**11. To advertise a product**

Most company Web sites start up as a big advertisement for their products and services. It may be hard to see why anyone would willingly visit a 10 page advertisement but these advertisements are very useful to anyone genuinely interested in finding out about their products. Companies may also give away some information for free as an incentive for people to visit their pages.

**12.To make money**

A popular way to make money out of the Web is from advertising revenue. Popular sites have banners at the top of the page enticing people to click them and be taken to the advertiser's Web site. These banners are generally animated and very appealing, with mysterious messages to make users wonder where they will be taken. For each person that clicks the ad, the host site gets commission. Making money this way is only successful if the site gets lots of visitors (thousands a day); so the sites must be very useful and offer something of real value to their visitors.

**2.5. Educational Websites**

The rise of the internet has sparked new innovation into making teaching and learning much more convenient and one of the main features it presents to the college curriculum is the class website. Many classes have websites that are made specifically for the class but that's only for those who have professors who can create one ahead of time. Although, nowadays there are universal websites in which professors can just list the class under websites such as Blackboard and Web camera in which students can access it with the accounts they make under those websites. Nowadays, professors require students to create accounts in those websites because most of the time the information they put up on the website is important such as grades and homework. Overall, the convenience that class websites have put upon the class curriculum has demonstrated its effectiveness by making it easier for both professor and student.

**14.Mailing System**

The email is most likely one of the greatest innovations since the internet. It was become widely universal and has literally been built into the everyday lives of millions of people. The aspect of it that makes it so great is the fact that it allows instantaneous travel of information in either short distance or long distance. That convenience of it alone makes it so attractive to everyone. In the case of the college classes, not only its use is important but more towards it being required. Nowadays, most college classes require students to have email accounts and they even further

enforce this during the registry process of students in the colleges as they have everyone being registered to the college create an email account under the college.

**15.Webcasts**

More and more technological innovations have taken place in the world of the internet and one of the most interesting ones is webcast. Webcast allows many things like speeches, lectures and even demonstrations to be recorded and posted up online so that everyone can watch it. This brings convenience to a whole new level. In terms of its use in college classrooms, it is becoming more widely accepted and also used. Many classes, more specifically, large lectures are webcasted and students can view the lectures online. This makes it so that if they miss the lecture, they can view it anytime from anywhere there's a computer and online connection. This also makes it easier for students to enforce the material as they can re watch certain parts of the lecture over and over so they can truly learn the material. This is probably one of the most useful innovations for the college class curriculum as often times students don't go to class and this makes them make up for it.

**16.File sharing**

A computer file can be e-mailed to customers, colleagues and friends as an attachment. It can be uploaded to a website or FTP server for easy download by others. It can be put into a "shared location" or onto a file server for instant use by colleagues. In any of these cases, access to the file may be controlled by user authentication the transit of the file over the Internet may be obscured by encryption, and money may change hands before or after access to the file is given. The price can be paid by the remote charging of funds from, for example, a credit card whose details are also passed hopefully fully encrypted across the Internet. These simple features of the Internet, over a worldwide basis are changing the basis for the production, sale and distribution of anything that can be reduced to a computer file for transmission. This includes all manner of print publications, software products, news, music, film, video, photography, graphics and the other arts. This in turn has caused seismic shifts in each of the existing industries that previously controlled the production and distribution of these products. Internet collaboration technology enables business and project teams to share documents, calendars and other information. Such collaboration occurs in a wide variety of areas including scientific research, software development, conference planning, political activism and creative writing.

**1.8 Summary**

Internet is necessary tool to access the data, transactions, on line information, communicating the ideas, research analysis etc. The Internet provides teachers, researchers and students with countless opportunities to research and exchange information. The Internet has made it easy for government departments and agencies

to communicate with other organizations and with the citizens they serve. The Internet facilitates exchanges between employees within the same company and between the company and its customers and suppliers. The Internet Protocol (IP) is the method or protocol by which data is sent from one computer to another on the Internet. The functionality of Internet is controlled by Internet architecture board which is having different standards named as protocols for different applications. Proper use of firewalls, Anti Virus and auto protected system should be there to make smooth Internet connectivity.

### 2.3.9 Exercise

Q1 Define Internet?
Q2 Write a short note on history of Internet?
Q3 What is internet architecture board?
Q4 Who is controlling the Internet facilities?
Q5 What is DNS? How the Internet standards are governed?
Q6 How internet connectivity can be made secure?
Q7 Write the applications of Internet in detail?

### 2.3.10 Suggested References

1. "Internet: The complete Reference", Young, 2002, Tata Mcgraw Hill Publishing Company Limited.
2. "Internet:The Complete Reference" 2nd Edition, 1997 by Hahan H, Tata Mcgraw Hill Publishing Company Limited.
3. "Internet Security Dictionary" by Phoha, VirV, Springer.

# INTERNET COMPONENTS



## 2.4.1 Internet Components

The Internet, sometimes called simply "the Net," is a worldwide system of computer networks i.e. a network of networks in which users at any one computer. The main components of internet are E-mail, TELNET, WWW, Chatting, Bulletin board, Web browsers, Virus, Worms etc. Which are discussed in the following section.

### 2.4.1.1 WWW

World Wide Web is a type of service provided by the internet, with the help of which we can access various websites. The most widely used part of the Internet is the World Wide Web (often abbreviated "WWW" or called "the Web"). Its outstanding feature is hypertext, a method of instant cross-referencing. In most Web sites, certain words or phrases appear in text of a different color than the rest often this text is also underlined. When you select one of these words or phrases, you will be transferred to the site or page that is relevant to this word or phrase. Sometimes there are buttons, images, or portions of images that are "clickable." If you move the pointer over a spot on a Web site and the pointer changes into a hand, this indicates that you can click and be transferred to another site.

The World Wide Web is a system of interlinked hypertext documents accessed via the Internet. With a Web browser, one can view Web pages that may

contain text, images, videos and other multimedia, navigate between them using hyperlinks. Such a collection of useful, related resources, interconnected via hypertext links is named as "web" of information. The World Wide Web was created in 1989 by British scientist Tim Berners-Lee, working at the European Organization for Nuclear Research (CERN) in Geneva.

Viewing a Web page on the World Wide Web normally begins either by typing the URL of the page into a Web browser or by following a hyperlink to that page or resource. The Web browser then initiates a series of communication messages, behind the scenes, in order to fetch and display it. First, the server-name portion of the URL is resolved into an IP address using the global, distributed Internet database known as the domain name system or DNS. This IP address is necessary to contact and send data packets to the Web server.

The browser then requests the resource by sending an HTTP request to the Web server at that particular address. In the case of a typical Web page, the HTML text of the page is requested first and parsed immediately by the Web browser, which will then make additional requests for images and any other files that form a part of the page.

The five basic surfing techniques are described below:

- Surfing. You don't have to wait for a page to load to click a link, press the back button, or select a new link from your bookmarks. You can take action whenever you are ready. Jumping ahead of the browser is recommended if the link you want is already loaded but the rest of the page is lagging behind. When you click on a link as soon as it is available, you speed up and accentuate the feeling of surfing from wave to wave.
- Chains. After you click on several links and proceed through several pages, you create a chain of web sites accessible with the down-arrow beside your browser's Back button. You can click on the browser Back button to return to a previous page and read it again, and then repeatedly click forward to return to the last page without the trouble of finding the links you used last time. If you click a new link from any page, you start a new chain from that point on.
- Reloading. You can stop and then reload a page at any time if it is having problems loading or to ensure you have the latest copy of a page that updates regularly.
- Stopping. You can stop the load of any page at any time by clicking Stop on the toolbar or pressing <Esc>. The browser will display as much of the page as it loaded and all of the displayed links will be operational.
- Restarting. If a page seems to be taking a long time to load, don't hesitate to stop the connection and then select the link again. As long as the messages in the bottom border show that some parts of the page are loading then you

should let it continue, but if nothing happens for more than a minute then something is likely stalled and you should stop and reload the page again.

### 2.4.1.2 Electronic mail (e-mail)

For many Internet users, electronic mail (e-mail) has practically replaced the Postal Service for short written transactions. Electronic mail is the most widely used application on the Net. You can also carry on live "conversations" with other computer users, using Internet Relay Chat (IRC). More recently, Internet telephony hardware and software allows real-time voice conversations. It is Short for electronic mail, which is used for the transmission of messages over communications networks. The messages can be notes entered from the keyboard or electronic files stored on disk. Most mainframes, minicomputers, and computer networks have an e-mail system. Some electronic-mail systems are confined to a single computer system or network, but others have gateways to other computer systems, enabling users to send electronic mail anywhere in the world. Companies that are fully computerized make extensive use of e-mail because it is fast, flexible and reliable.

Most e-mail systems include a text editor for composing messages, but many allow you to edit your messages using any editor you want. You then send the message to the recipient by specifying the recipient's address. You can also send the same message to several users at once. This is called broadcasting. You should copy and paste addresses into the To field instead of typing them for both ease of use and accuracy. If it is an address you will use again, then you should always enter it in your address book. If you want to send an email to more than one person at once, you can enter multiple email addresses separated with commas in any of the address fields, including the bcc field.

Sent messages are stored in electronic mailboxes until the recipient fetches them. To see if you have any mail, you may have to check your electronic mailbox periodically, although many systems alert you when mail is received. After reading your mail, you can store it in a text file, forward it to other users or delete it. Copies of mail can be printed out on a printer if you want a paper copy.

Usually, it takes only a few seconds or minutes for mail to arrive at its destination. This is a particularly effective way to communicate with a group because you can broadcast a message or document to everyone in the group at once. Although different e-mail systems use different formats, there are some emerging standards that are making it possible for users on all systems to exchange messages. Some of the examples of Email provider are Yahoo, Google, Rediff, sify etc.

### 2.4.1.3 Telnet

**Telnet is a user command and an underlying TCP/IP protocol for accessing remote computers**. Through Telnet, an administrator or another user can access someone else's computer remotely. On the Web, HTTP and FTP protocols allow you to request specific files from remote computers, but not to actually be logged on as a user of that computer. With Telnet, you log on as a regular user with whatever privileges you may have been granted to the specific application and data on that computer. Telnet is most likely to be used by program developers and anyone who has a need to use specific applications or data located at a particular host computer.

The Telnet program runs on your computer and connects your PC to a server on the network. You can then enter commands through the Telnet program and they will be executed as if you were entering them directly on the server. This enables you to control the server and communicate with other servers on the network. To start a Telnet session, you must log in to a server by entering a valid username and password. Telnet is a common way to remotely control Web servers.

The telnet commands allow you to communicate with a remote computer that is using the Telnet protocol. You can run telnet without parameters in order to enter the telnet context, indicated by the Telnet prompt (telnet>).

### 2.4.1.4 Chatting

On the Internet, chatting is talking to other people who are using the Internet at the same time you are. Usually, this "talking" is the exchange of typed-in messages requiring one site as the repository for the messages (or "chat site") and a group of users who take part from anywhere on the Internet. In some cases, a private chat can be arranged between two parties who meet initially in a group chat. Chats can be ongoing or scheduled for a particular time and duration. Most chats are focused on a particular topic of interest and some involve guest experts or famous people who "talk" to anyone joining the chat.

Chats are conducted on online services by bulletin board services, and by Web sites. Several Web sites, notably America Online, Yahoo, Google Talk, Orkut etc. exist solely for the purpose of conducting chats. Chatting can also be used for simulated or virtual reality environment which helps in video conferencing for companies, education program, research etc. Videoconferencing provides students with the opportunity to learn by participating in a 2-way communication platform. Furthermore, teachers and lecturers from all over the world can be brought to classes in remote or otherwise isolated places. Students from diverse communities and backgrounds can come together to learn about one another. Students are able to explore, communicate, analyze and share information and ideas with one another. Through videoconferencing students can visit another part of the world to speak with others, visit a company, a museum and so on, to learn.

Internet Relay Chat (IRC) is a system for chatting that involves a set of rules and conventions and client/server software. On the Web, certain sites such as Talk City or IRC networks such as the Undernet provide servers and help you download an IRC client to your PC. You can start a chat group (called a channel) or join an existing one. There is a protocol for discovering existing chat groups and their members. Depending on the type of network, nicknames can be reserved (registered) or just used during the session. Some channels encourage you to register a nickname that you always use and even offer space for a personal profile, picture, and personal home page link.

#### 2.4.1.5 Bulletin board

Bulletin board system (BBS) is a computer or an application dedicated to the sharing or exchange of messages or other files on a network. A BBS may be accessible from a dial-up modem, Telnet or the Internet. BBS interface is a text-based. Although recent Web-based versions have a graphical, interactive user interface, the text-only interface preferred by BBS purists can often be accessed by Telnet. Most BBS are devoted to a particular subject, although some are more general in nature. Among special interests represented on BBS are dentistry, law, guns and multi-player games.

The BBS is often free, although some charge a membership or use fee. Many BBS have Web sites, and many Internet access providers have bulletin board systems from which new Internet users can download the necessary software to get connected. Despite the vastly greater reach of the Internet, the BBS is still fairly common in parts of the world where the Internet is less established and is still valued by many with Internet access for its ability to promote a sense of community.

#### 2.4.1.6 Web Browsers

Web browser is a piece of software which provides the interface between the user and Internet. Using the Web, you have access to millions of pages of information. Web browsing is done with a Web browser. A web browser is a software application which enables a user to display and interact with text, images, videos, music, games and other information typically located on a Web page at a website on the World Wide Web or a local area network. Text and images on a Web page can contain hyperlinks to other Web pages at the same or different website. Web browsers allow a user to quickly and easily access information provided on many Web pages at many websites by traversing these links. Web browsers format HTML information for display, so the appearance of a Web page may differ between browsers.

Some of the Web browsers currently available for personal computers include Internet Explorer, Mozilla Firefox, Netscape, Google Chrome and AOL Explorer etc. Web browsers are the most commonly used type of HTTP.

Although browsers are typically used to access the World Wide Web, they can also be used to access information provided by Web servers in private networks or content in file systems.

Web browsers communicate with Web servers primarily using HTTP (hypertext transfer protocol) to fetch web pages. HTTP allows Web browsers to submit information to Web servers as well as fetch Web pages from them. Pages are located by means of a URL (uniform resource locator), which is treated as an address, beginning with http: for HTTP access. Many browsers also support a variety of other URL types and their corresponding protocols, such as gopher: for Gopher (a hierarchical hyperlinking protocol), ftp: for FTP (file transfer protocol) etc. The combination of HTTP content type and URL protocol specification allows Web page designers to embed images, animations, video, sound and streaming media into a Web page, or to make them accessible through the Web page.

Early Web browsers supported only a very simple version of HTML. The rapid development of proprietary Web browsers led to the development of non-standard dialects of HTML, leading to problems with Web interoperability. Modern Web browsers support a combination of standards and dynamic HTML and XHTML, which should display in the same way across all browsers. Currently many sites are designed using HTML generation programs such as Adobe, Dreamweaver or Microsoft FrontPage. The appearance of a particular Web site may vary slightly depending on the browser you use. Also, later versions of a particular browser are able to render more "bells and whistles" such as animation, virtual reality, sound, and music files than earlier versions.

**2.4.7 Virus**

It is a program or piece of code that is loaded onto your computer without your knowledge and runs against your wishes. Viruses can also replicate themselves. All computer viruses are manmade. A simple virus that can make a copy of itself over and over again is relatively easy to produce. Even such a simple virus is dangerous because it will quickly use all available memory and bring the system to a halt. An even more dangerous type of virus is one capable of transmitting itself across networks and bypassing security systems.

Since 1987, when a virus infected ARPANET, a large network used by the Defense Department and many universities, many antivirus programs have become available. These programs periodically check your computer system for the best-known types of viruses.

A computer virus is a small program written to alter the way a computer operates, without the permission or knowledge of the user. A virus must meet two criteria:

1. It must execute itself. It often places its own code in the path of execution of another program.

2. It must replicate itself. For example, it may replace other executable files with a copy of the virus infected file. Viruses can infect desktop computers and network servers alike.

Some viruses are programmed to damage the computer by damaging programs, deleting files, or reformatting the hard disk. Others are not designed to do any damage, but simply to replicate themselves and make their presence known by presenting text, video and audio messages. Even these viruses can create problems for the computer user. They typically take up computer memory used by legitimate programs. As a result, they often cause erratic behavior and can result in system crashes. In addition, many viruses are bug-ridden and these bugs may lead to system crashes and data loss. Computer viruses of one kind or another have infected the Internet since its very first years of existence. Virus protection is now required technology for everyone that uses the Internet.

Signs that your computer might have a virus could include spontaneous startup of programs like email programs, unexplained attempts by programs on your computer to access the Internet, changes in file date stamps, unusually slow program load or run times, lots of unexplained disk activity or failure of a program or your computer to start. However, if you have an anti-virus protection running, then problems like a slow computer or lots of disk activity are most likely caused by an inefficient system configuration, not enough memory, a fragmented disk, or other benign causes, since most viruses won't give any visible signs.

Some viruses are only annoying, displaying a message, using extra memory or disk, or changing file names. However, some are destructive and will change files and erase data, and some will erase your entire hard drive. Some run silently in the background and give outside agent's complete control of your computer without your knowledge whenever you are connected to the Internet.

#### 2.4.7.1 Types of viruses

1. <u>File infector viruses</u>
2. File infector viruses infect program files. These viruses normally infect executable code, such as .com and .exe files. The can infect other files when an infected program is run from floppy, hard drive or from the network. Many of these viruses are memory resident. After memory becomes infected, any non infected executable that runs becomes infected. Examples of known file infector viruses include Jerusalem and Cascade.
3. <u>Boot sector viruses</u>
4. Boot sector viruses infect the system area of a disk; that is, the boot record on floppy disks and hard disks. All floppy disks and hard disks (including disks containing only data) contain a small program in the boot record that is run when the computer starts up. Boot sector viruses attach themselves to this part of the

disk and activate when the user attempts to start up from the infected disk. These viruses are always memory resident in nature. Most were written for DOS, but, all PCs, regardless of the operating system, are potential targets of this type of virus. All that is required to become infected is to attempt to start up your computer with an infected floppy disk thereafter, while the virus remains in memory, all floppy disks that are not write protected will become infected when the floppy disk is accessed. Examples of boot sector viruses are Form, Disk Killer, Michelangelo, and Stoned.

5. Master boot record viruses

   Master boot record viruses are memory-resident viruses that infect disks in the same manner as boot sector viruses. The difference between these two virus types is where the viral code is located. Master boot record infectors normally save a legitimate copy of the master boot record in a different location. Windows NT computers that become infected by either boot sector viruses or master boot sector viruses will not boot. This is due to the difference in how the operating system accesses its boot information, as compared to Windows 98/ME. Examples of master boot record infectors are NYB, AntiExe and Unashamed.

6. Multipartite viruses

   Multipartite viruses infect both boot records and program files. These are particularly difficult to repair. If the boot area is cleaned, but the files are not, the boot area will be re infected. The same holds true for cleaning infected files. If the virus is not removed from the boot area, any files that you have cleaned will be re infected. Examples of multipartite viruses include One_Half, Emperor, Anthrax and Tequilla.

7. Macro viruses

   These types of viruses infect data files. They are the most common and have cost corporations the most money and time trying to repair. Macro viruses infect Microsoft Office Word, Excel, PowerPoint and Access files. Newer strains are now turning up in other programs as well. All of these viruses use another program's internal programming language, which was created to allow users to automate certain tasks within that program. Because of the ease with which these viruses can be created, there are now thousands of them in circulation. Examples of macro viruses include W97M.Melissa, WM.NiceDay and W97M.Groov.

### 2.4.3 Worms

A worm is similar to a virus by design and is considered to be a sub-class of a virus. Worms spread from computer to computer, but unlike a virus, it has the capability to travel without any human action. A worm takes advantage of file or information transport features on your system, which is what allows it to travel unaided. The biggest danger with a worm is its capability to replicate itself on your system, so

rather than your computer sending out a single worm, it could send out hundreds or thousands of copies of itself, creating a huge devastating effect. One example would be for a worm to send a copy of itself to everyone listed in your e-mail address book. Then, the worm replicates and sends itself out to everyone listed in each of the receiver's address book, and the manifest continues on down the line. Due to the copying nature of a worm and its capability to travel across networks the end result in most cases is that the worm consumes too much system memory (or network bandwidth), causing Web servers, network servers and individual computers to stop responding. In recent worm attacks such as the much-talked-about Blaster Worm, the worm has been designed to tunnel into your system and allow malicious users to control your computer remotely.

Some people distinguish between general viruses and worms. A worm is a special type of virus that can replicate it and use memory, but cannot attach it to other programs. Worms are programs that replicate themselves from system to system without the use of a host file. This is in contrast to viruses, which requires the spreading of an infected host file. Although worms generally exist inside of other files, often Word or Excel documents, there is a difference between how worms and viruses use the host file. Usually the worm will release a document that already has the "worm" macro inside the document. The entire document will travel from computer to computer, so the entire document should be considered the worm.

Worms spread by exploiting vulnerabilities in operating systems. All vendors supply regular security updates. Users need to be wary of opening unexpected email, and should not run attached files or programs, or visit web sites that are linked to such emails. Anti-virus and anti-spyware software are helpful, but must be kept up-to-date with new pattern files at least every few days. The use of a firewall is also recommended.

### 2.4.4 General precautions

1. Be suspicious of email attachments from unknown sources.
2. Verify that attachments have been sent by the author of the email. Newer viruses can send email messages that appear to be from people you know.
3. Do not set your email program to "auto-run" attachments.
4. Obtain all Microsoft security updates.
5. Back up your data frequently. Keep the write-protected media in a safe place preferably in a different location than your computer.
6. Specific to AntiVirus.
7. Make sure that you have the most recent virus definitions. It is recommended that you run LiveUpdate at least once per week. Symantec Security Response updates virus definitions in response to new virus threats.

8. Scan all new software before you install it. Because boot sector viruses spread by floppy disks and bootable CDs, every floppy disk and CD should be scanned for viruses. Shrink-wrapped software, demo disks from suppliers, and trial software are not exempt from this rule. Viruses have been found even on retail software.

Use caution when opening email attachments. Email attachments are a major source of virus infections. Microsoft Office attachments for Word, Excel and Access can be infected by Macro viruses. Other attachments can contain file infector. Software programs such as antivirus software are the most useful in protecting your computer from harmful viruses. These programs are used to detect and eliminate viruses. Anti-virus software can be purchased from any software vendor or downloaded off the internet. Care should be taken in the selection of anti-virus software, as some programs are not very affective in finding and eliminating viruses. Also, when downloading anti-virus software from the Internet, one should be cautioned that some websites say they are providing protection from viruses with their software, but they are really trying to install Anti Virus on your computer by disguising it as something else.

### 2.4.5 Summary

To know about the world wide information Internet is used. Today it is the necessary tool for daily usages. Its components and services like WWW, chatting, Email, Web Browsing are used for communicating and receiving the required information. The World Wide Web is a way of accessing information over the medium of the Internet. It is an information-sharing model that is built on top of the Internet. The Web uses the HTTP protocol, only one of the languages spoken over the Internet, to transmit data. Web services, which use HTTP to allow applications to communicate in order to exchange business logic, use the Web to share information. The Web also utilizes web browsers. Since the computers are explored to outer world through internet, there is possibility of Viruses and worm. The types of Viruses and how to protect your desktop from malicious programs are also discussed in this chapter.

### 2.4.6 Exercise

Q1 What is WWW?

Q2 Write the functioning of E-mail?

Q3 What are the benefits of Videoconferencing?

Q4 Why we are using the Telnet Protocol?

Q5 What is BBS?

Q6 Why there is need for Web Browsers? Explain?

Q7 List various Web browsers and there advantages?

Q8 What is Virus? Explain different types of Viruses?

Q9 How Worm is different then virus?

Q10 Write the precautions for making your Personal computer risk free?

### 2.4.7 Suggested References

1. "Internet: The complete Reference", Young, 2002, Tata Mcgraw Hill Publishing Company Limited.
2. "Computers Today", Sanders, D., Tata McGraw-Hill.
3. "PC Software for Windows Made Simple", R.K.Taxali, TMH.

**LESSON NO. 2.5** **Reference Material**

## ADVANCE TRENDS IN IT



### 2.5.1Objective

In this Chapter an overview about all the new concepts and terms would be provided which are linked with the modern day technologies used in mobile world in relation to Internet, technologies and its applications.

### 2.5.2 Mobile Internet

Mobile internet can be referred as accessing the Internet from a Smartphone or tablet which has a cellular connection. or The mobile Internet, defined as wireless access to the digitized contents of the Internet via mobile devices, has advanced significantly, both in terms of its user population and its technology. With the advancing technological innovations we are reaping its benefits greatly. Imagine a day when you don't have access to the mobile gadgets or network access on these devices. the mere thought itself makes many of us uncomfortable.

As we all know that among many gadgets we have today, Mobile phone is one very useful piece of technology and internet is a revolutionary gift. When the two are merged we get the convenience of mobile internet. It makes our work much easier. Accessing Internet on your mobile is much easier and simpler now.Various statistics show that The number of **mobile internet users in India** is skyrocketing from from 371 million in June 2016 to aprox. 450 million in June 2017, the total number of mobile internet subscribers in India increased 21.3%. A report points out that 77% of urban users and 92% of rural users consider mobile as the

primary device for accessing the Internet, largely driven by availability and affordability of Smartphone's.

Interestingly, during the same period, the number of high-speed mobile Internet users in India, using 3G or 4G connectivity, went up by 91.5%. In June 2016, only 142 million mobile internet users were accessing the internet through high-speed data connectivity, also known as mobile broadband. The figure has swollen to 272 million in June 2017, nearly doubling the number of high-speed mobile internet users in India in just one year.

### 2.5.2.1Characteristics of the Mobile Internet

The characteristics of the mobile Internet can be understood from three different perspectives: user, environment, and system. First, from the user's perspective, mobile Internet devices are usually more personal and individual than stationary Internet devices. It is not uncommon for people to share their desktop computers, whereas it is very rare for them to share mobile Internet phones. Therefore, the mobile device always carries its user identity. Second, from the environmental perspective, mobile Internet systems usually provide instant connection to the Internet, which enables users to access the Internet anywhere and anytime. A mobile Internet system is portable and always available. By contrast, stationary Internet systems are not usually movable and require long preprocesses, such as booting up, which usually take more than a few minutes. Third, from the system's perspective, most mobile Internet systems, especially cellular phones, have a lower level of available resources compared to those provided by the stationary Internet. While mobile Internet devices are very portable and handy, they have smaller screens, less convenient input/output facilities, and lower multimedia processing capabilities than do desktop computers, for example.

**Advantage** and disadvantages of mobile internet

However, like a coin has two sides Mobile internet has pros and cons too. Here are a few advantages and disadvantages of mobile internet.

**Advantages**

- Convenience is one main advantage of mobile internet. Now we do not need a desktop or laptop with internet. All we need is just a mobile that supports Internet connection. So, now accessing internet is hassle free without wired, modems etc.
- Files and documents can be easily downloaded on your phone. Songs can be downloaded online, games can be played on your mobile with internet. Email can be read and sent anytime and anywhere.
- There is no need for installing any software repeatedly. All that is needed is internet recharge cards, buy them and access the internet. You can also subscribe for internet data plan on 3G or 4G.

- Perhaps the biggest advantage of mobile internet is always having access to the latest facts, figures and information as it happens. This information might range from breaking news delivered by news sites, to stock and shares prices or other business information, to travel updates and the latest weather forecasts in your area. Having up-to-date info allows you to make decisions with all the correct facts at hand.
- Another practical use of mobile internet is to find information regarding the area around you. For example, you might want to find the nearest restaurant, gig or bar and your mobile internet could tell you with a quick look on a search engine. You could then get recommendations and find a map. Many phones also come set up to utilize GPS (Global Positioning System), which uses satellites to locate the phone's user and provide information based on their location. This means the info you obtain using mobile internet can be personalized for you and is thus more helpful, especially if, for example, you are lost on the road and need directions home.
- With many people now using social networking sites, such as Facebook, Twitter and LinkedIn mobile internet can only make engaging with contacts on these sites easier. In particular, having the net on your cell phone allows you to update your status or check what your friends are up to at the touch of a button---handy for organizing your social life.

**Disadvantages**

- The internet connection on mobile phones is not too fast and sometimes problem arises in certain areas.
- Sometimes while downloading files problems arise because of the poor connection and it takes a lot of time to download the file and if the connection is too weak the file may not be downloaded at all.
- One big disadvantage is you need to pay extra bucks for the mobile internet apart from the talk time. Mobile internet costs you a lot and so you need to shell out extra money for the data you use.
- There are privacy issues to consider, too. With more and more people accessing the internet through mobiles, it's easy to forget that five of the major search engines archive the search histories of their users on a regular basis, according to a report from the Center for Democracy & Technology. So individuals may be giving away more information than they realize through their increased net usage.

### 2.5.3 GPS ( Global Positioning System)

The GPS is a Global Navigation Satellite System (GNSS) developed by the United States Department of Defence. It is the only fully functional GNSS in the world. It uses a constellation of between 24 and 32 earth orbit satellites that transmit precise radio signals, which allow GPS receivers to determine their current location, the time, and their velocity. These satellites are

high orbit, circulating at 14,000km/hr and 20,000km above the earth's surface. The signal being sent to the earth at the speed of light is what is picked up by any GPS receiver that are now commonplace worldwide. The first satellite navigation system, used by the United States Navy, was first successfully tested in 1960. Using a constellation of five satellites. A GPS receiver calculates its position by precisely timing the signals sent by the GPS satellites high above the Earth. Each satellite continually transmits messages containing the time the message was sent, precise orbital information (the ephemeris – orbit path and speed of each satellite), and the general system health, current date and time of all GPS satellites (the almanac). The receiver measures the transit time of each message and computes the distance to each satellite. A form of triangulation is used to combine these distances with the location of the satellites to determine the receiver's location. The position is displayed, perhaps with a moving map display or latitude and longitude; elevation information may be included. Many GPS units also show information such as direction and speed, calculated from position changes.

**Basic Concept of GPS**

It might seem three satellites are enough to solve for position using triangulation maths, however a very small timing error multiplied by the very large speed of light (the speed at which satellite signals travel) —results in a large positional error. The receiver uses a fourth satellite to solve for x, y, z, and t which is used to correct the receiver's timer.

Although four satellites are required for normal operation, fewer apply in special cases. If one variable is already known (for example, a ship or plane may have known elevation), a receiver can determine its position using only three satellites. Some GPS receivers may use additional clues or assumptions (such as reusing the last known altitude or including information from a vehicle computer) to give a degraded position when fewer than four satellites are visible.

**GPS Strengths and Weaknesses?**

GPS has several strengths but just as many weaknesses. Understanding this ensures that the most is gained from the technology without expecting more than is possible from this current system.

**Strengths**

- The system is self calibrating – Just turn on and use.
- Can be used in the field – doesn't require a laboratory or artificial environment.
- The technology is relatively small (typical GPS system is now no larger than a small mobile phone).
- Supplies the user with Location Based information that can be used for mapping (cars), location (geocaching), performance analysis (sport), GIS (Geographic Information

Services – Google Earth as an example – pick a street and the technology can link to a database showing what retail outlets are in that vicinity). Works anywhere on earth

- Can give bearings, directions.
- There is currently no charge to use the signal (US Department of Defence bears the cost of system maintenance and upgrade).
- Several new GPS systems are being installed globally over the next 5 years giving greater accuracy and usability.
-

**Weaknesses**

- The technology is very power hungry, most systems will only last 8-12 hours before needing a battery replacement or recharge.
- The GPS signal is unable to pass through solid structures so is unable to work indoors, underground, under the water, or under a dense canopy of trees.
- Can be affected by large buildings and is typically unreliable in CBD areas.
- GPS accuracy is related to the quality of signal reception, the larger the antenna the better the signal – so absolute miniaturisation is not possible whilst maintaining good positioning accuracy

### 2.5.4 Overview of 3G, 4G

The demand of mobile and internet is increasing day by day, they are becoming the preferred means of personal and professional communication, giving a new dimension to the telecom industry. To meet up the users demand more and more advancement is being done in the field of communication. This section gives an overview of the evolution of wireless network technologies from 1G to 4G. First things first: "G" stands for "generation," so when you hear someone refer to a "4G network," that means they're talking about a wireless network based on fourth-generation technology. A wireless carrier might support 4G or 3G while some phones are built for just one of those. Your location might only let your phone get 2G speeds, or you might see the term 5G thrown around when talking about Smartphone's.

Since 1G was introduced in the early '80s, a new wireless mobile telecommunications technology has been released around every 10 years. All of them refer to the technology used by the mobile carrier and device itself; they have different speeds and features that improve on the generation prior to it.

While an acronym is sometimes techno babble the layperson needn’t master, others are important for everyday understanding. You might want to know how these technologies differ and how it applies to you when you're buying a phone, getting coverage details, or subscribing to a mobile carrier.

### Initial Generations

1G is an analog technology and the phones generally had poor battery life and voice quality was large without much security, and would sometimes experience dropped calls. Cell phones received their first major upgrade when they went from 1G to 2G. This leap took place in 1991 on GSM networks first, in Finland, and effectively took cell phones from analog to digital.

The 2G telephone technology introduced call and text encryption, plus data services like SMS, picture messages, and MMS.

Although 2G has replaced 1G and is superseded by the technologies described below, it's still used around the world. The max speed of 2G with General Packet Radio Service (GPRS) is 50 Kbps or 1 Mbps with Enhanced Data Rates for GSM Evolution (EDGE)

Before making the major leap from 2G to 3G wireless networks, the lesser-known 2.5G and 2.75G was an interim standard that bridged the gap 2.5G introducing a new packet switching technique that was more efficient than what we previously being used.

This led to 2.75G which provides a theoretical threefold capacity increase. 2.75G with EDGE began in the US with GSM networks (AT&T being the first)

### Overview 3G

The 3G brought great transformation in mobile communication world. The 3G fulfils the specifications of International Mobile Telecommunications-2000 (IMT- 2000), the official International Telecommunication Union which intended to provide wireless access to global telecommunication system. To meet the IMT-2000 standards, a system is required to provide peak data rates of at least 200 kbit/s. The most important IMT-2000 proposals are the Universal Mobile Telecommunications System (UMTS) as the successor to GSM. The UMTS uses the W-CDMA, TD-CDMA, or TD-SCDMA air interfaces in which WCDMA is the most popular air-interface technology for the UMTS. The main components includes BS (Base Station) or nod B, RNC (Radio Network Controller), apart from WMSC (Wideband CDMA Mobile Switching Centre) and SGSN/GGSN.

The W-CDMA gives additional advantages of high transfer rate, and increased system capacity and communication quality by statistical multiplexing. The WCDMA utilizes efficiently the radio spectrum, because the CDMA technique enables all base stations to use the same frequency. In the WCDMA system, the data is split into separate packets, which are then transmitted using packet switching technology, and the packets are reassembled in the correct sequence at the receiver end by using the code that is sent with each packet. The UMTS systems are designed to provide a range of data rates, depending on the user's circumstances, providing up to 144 kbps for moving vehicles, up to 384 kbps for pedestrians and up to 2 Mbps for indoor or stationary users. The3G basically focused on multimedia applications such as video calling, videoconferencing for mobile phones, improved capacity, world roaming, low cost, better compatibility, high speed data.

**Key features and facilities of 3G**

- Faster data rates.
- Supports multimedia applications such as video and photography
- Value added services like mobile television, GPS• (global positioning system), video call and video conferencing.
- High speed mobile internet access.
- Increased capacity.

**Basic disadvantages of 3G**

- Requires 3G compatible handsets.
- The cost of upgrading to 3G devices is expensive.
- Power consumption is high.
- 3G requires closer base stations which is expensive.

### 2.5.4 **Overview of 4 G**

The 4G is an emerging technology in the field of communication. As the data requirements increased, efforts were made to improve the downlink and uplink throughput rates by employing higher modulation techniques. Third Generation Partnership Project (3GPP) launched the Long Term Evolution (LTE) project in November 2004 in order to ensure the continued competitiveness of the UMTS in the future. As LTE is considered as the evolution of universal mobile telephone system (UMTS), hence LTE's equivalent components are thus named evolved UMTS terrestrial radio access (EUTRA) and evolved UMTS terrestrial radio access network (EUTRAN). The basic architecture of LTE contains a separate IP connectivity layer for all the IP based services and Evolved Packet System (EPS) which handles the overall communication procedure.

LTE is completely an all IP based system. Since there are provisions in LTE for inter-operation with existing systems, there are various paths available to connect to LTE. An operator with a GPRS/EDGE network or aNon- 3GPP systems can connect to a LTE network. Due to this increased flexibility, LTE is the choice of majority of operators worldwide. By using Orthogonal Frequency Division Multiple Access (OFDMA), LTE will be able to provide download rates of about 100 Mbps for multiantenna (2x2), multiple-input multiple output (MIMO) for the highest category terminals. For these terminals upload rate is about 50 Mbps. Moreover, it provides better mobility, efficient radio usage, high level of security, flexible spectrum utilization, reduced delay/latency, cost efficient deployment and various other advantages which makes LTE more reliable and user friendly.

**Key features and facilities of 4G**

- High spectral efficiency.
- High voice quality.

- Easily access internet, streaming media, video calling etc.
- Very low latency.
- Simple protocol architecture.
- Efficient multicast/broadcast.

**Basic disadvantages of 4G**

- Higher data prices for consumers
- It is very expensive and hard to implement
- Complex hardware.
- Power usage is more

**Overview of 5 G**

5G is a proposed, but the not-yet-implemented wireless technology that's intended to improve on 4G. Some of the plans for 5G include device-to-device communication, better battery consumption, and improved overall wireless coverage.The max speed of 5G is aimed at being as fast as 35.46 Gbps, which is over 35 times faster than 4G. However, data rates of tens of Mbps might be expected for thousands of users, and around 100 Mbps for metropolitan areas.

### 2.5.5 Introduction of WiFi

WIFI is stand for Wireless Fidelity is generic term that refers to IEEE 802.11 standard for Wireless Local Networks or WLANs. WIFI is an alternative network to wired network which is commonly used for connecting devices in wireless mode. It helps to connects computers to each other, to the internet and to the wired network. WIFI uses radio technology to transmit and receive data at high speed. Wi-Fi is a simple and cost effective way to connect to internet without the need of wires. It is growing in popularity because of decreasing costs and the freedom it gives to users.

Securing communication and services in wireless networks is a complex problem. There are several areas of concern. A wireless device needs to have some way to reliably prove its identity and to reliably confirm the identity of the device on the other end of the connection. Without cables and Ethernet jacks, this is not as straightforward as it once was. The fact that no obvious physical connection is required to send and receive packets brings up questions regarding the ability of others to not only read legitimate packets but also to be able to interject their own. These activities may or may not be malicious, but in all cases they should be handled by the security components of the network.

**Elements of WIFI network**

- Access Point (AP) - The AP is a wireless LAN transceiver or “base station” that can connect one or many wireless devices simultaneously to the Internet.

- Wi-Fi cards - They accept the wireless signal and relay information. They can be internal and external.
- Safeguards - Firewalls and anti-virus software protect networks from uninvited users and keep information secure

**Advantages**

- Wireless Ethernet. Wi-Fi is an Ethernet replacement. Wi-Fi and Ethernet, both IEEE 802 networks, share some core elements.
- Extended Access. The absence of wires and cables extends access to places where wires and cables cannot go or where it is too expensive for them to go.
- Cost Reduction. As mentioned above, the absence of wires and cables brings down cost. This is accomplished by a combination of factors, the relatively low cost of wireless routers, no need for trenching, drilling and other methods that may be necessary to make physical connections.
- Mobility. Wires tie you down to one location. Going wireless means you have the freedom to change your location without losing your connection.
- Flexibility. Extended access, cost reductions, and mobility create opportunities for new applications as well as the possibility of creative new solutions for legacy applications.

**Disadvantages**

- Interference
- Degradation in performance
- High power consumption
- Limited range

### 2.5.6 Introduction to Bluetooth

Bluetooth is one of the most efficient short distance wireless communication devices in our daily lives. With its stability and convenience in communication, this has allowed Bluetooth technology to become a valuable asset for both computers and electronic communication. It was first developed by a group called Bluetooth Special Interest Group (SIG) which formed by elite companies such as Ericsson, Nokia, Intel, IBM and Toshiba in May 1998. Bluetooth technology was officially approved in the summer of 1999. Since then the creation of Bluetooth wireless communication is widely used in various electronics and has been expanding every day. Starting from communication between mobile phones and computers, Bluetooth has expanded to enable communication between such forms as headsets, printers and automobiles. Bluetooth is a combination of hardware and software technology, running on a hardware radio chip and utilizing software to provide the main control and security protocols. By using this newer hardware and smarter software algorithms to direct network data we can achieve more efficient, flexible and secure wireless communications. The future is geared towards wireless communication as the cables seen on desktops are slowly becoming

obsolete. The movement towards Bluetooth is rapidly rising and the low cost and efficiency is a clear indication of the unlimited possibilities of Bluetooth.

**How does Bluetooth Work**

Bluetooth establish connection using Radio waves signal, it broadcasts its signal at Radio frequency of 2.45 Gigahertz. The picture to the immediate right is the Bluetooth radio chip that provides the communication between devices. Once the hardware radio chip is installed on two electronic devices, wireless communication can be established hopping channels up to 1600 times per second. Because Bluetooth is using Radio waves to achieve communication, the main chip operates with frequency hopping and thus does not need a clear path between two devices.

The control of communication aspect is more complicated and software plays an important role to control communication. Every main Bluetooth chip has an identity coding and different types of links. Both of these characteristics of the chip allow two different devices to communicate. Two devices must have the same type of linkage in order to establish communication.

The concept behind a Bluetooth communication is the use of masters and slaves. The master works as the moderator between communication between itself and the slave as well as between the slaves themselves. The Bluetooth network can link up to eight devices with this use of masters and slaves. This type of network is referred to as a piconet. As a connection needs to be made between two slaves, then one slave will “act” as a master and communicate to the other slave while still maintaining connection to the original master.

**Advantages of Bluetooth**

- It is an open specification that is publicly available and royalty free.
- Its short-range wireless capability allows peripheral devices to communicate over a single air-interface, replacing cables that use connectors with a multitude of shapes, sizes and numbers of pins.
- Bluetooth supports both voice and data, making it an ideal technology to enable many types of devices to communicate.
- Bluetooth uses an unregulated frequency band available anywhere in the world.

**Disadvantages of Bluetooth**

- It can be hacked into, security is a major concern.
- If installed on a cellphone it is prone to receiving cell phone viruses
- It only allows short range communication between devices
- It can only connect two devices at once
- It can lose connection in certain conditions

**Comparision of Wifi& Bluetooth technologies**

The Table-1 below provides an comparitive overview of the WiFi& Bluetooth based technologies.

### 2.5.7 Introduction to Cloud Computing

Cloud computing is a computing paradigm, where a large pool of systems are connected in private or public networks, to provide dynamically scalable infrastructure for application, data and file storage. With the advent of this technology, the cost of computation, application hosting, content storage and delivery is reduced significantly. Cloud computing is a practical approach to experience direct cost benefits and it has the potential to transform a data center from a capital-intensive set up to a variable priced environment.

The idea of cloud computing is based on a very fundamental principal of „reusability of IT capabilities'. The difference that cloud computing brings compared to traditional concepts of "grid computing", "distributed computing", "utility computing", or "autonomic computing" is to broaden horizons across organizational boundaries. Forrester defines cloud computing as: "A pool of abstracted, highly scalable, and managed compute infrastructure capable of hosting end customer applications and billed by consumption."

| | Bluetooth | Wi-I |
|---|---|---|
| **Frequency** | 2.4 GHz | 2.4, 3.6, 5 |
| **Cost** | Low | High |
| **Bandwidth** | Low ( 800 Kbps ) | High (11 M |
| **Specifications authority** | Bluetooth SIG | IEEE, W |
| **Security** | It is less secure | Security issues are alre |
| **Year of development** | 1994 | 1991 |
| **Primary Devices** | Mobile phones, mouse, keyboards, office and industrial automation devices. Activity trackers | Notebook computers, desktop co mobile |
| **Hardware requirement** | Bluetooth adaptor on all the devices connecting with each other | Wireless adaptors on all the devic router and/or wireles |
| **Range** | 5-30 meters | With 802.11b/g the typical range meters (300 ft) outdoors. 802.11n I Fi communication has greater ran also increas |
| **Power Consumption** | Low | High |

**Table-1** : Comparison of Bluetooth &WiFi

#### Cloud Computing Models

Cloud Providers offer services that can be grouped into three categories.

- Software as a Service (SaaS): In this model, a complete application is offered to the customer, as a service on demand. A single instance of the service runs on the cloud & multiple end users are serviced. On the customers side, there is no need for upfront investment in servers or software licenses, while for the provider, the costs are lowered, since only a single application needs to be hosted & maintained. Today SaaS is offered by companies such as Google, Salesforce, Microsoft, Zoho, etc.
- Platform as a Service (Paas): Here, a layer of software, or development environment is encapsulated & offered as a service, upon which other higher levels of service can be built. The customer has the freedom to build his own applications, which run on the provider s infrastructure. To meet manageability and scalability requirements of the applications, PaaS providers offer a predefined combination of OS and application servers, such as LAMP platform (Linux, Apache, MySql and PHP), restricted J2EE, Ruby etc. Google s App Engine, Force.com, etc are some of the popular PaaS examples.
- Infrastructure as a Service (Iaas): IaaS provides basic storage and computing capabilities as standardized services over the network. Servers, storage systems, networking equipment, data centre space etc. are pooled and made available to handle workloads. The customer would typically deploy his own software on the infrastructure. Some common examples are Amazon, GoGrid, 3 Tera, etc

**Understanding Public and Private Clouds**

Enterprises can choose to deploy applications on Public, Private or Hybrid clouds. Cloud Integrators can play a vital part in determining the right cloud path for each organization.

**Public Cloud**

Public clouds are owned and operated by third parties; they deliver superior economies of scale to customers, as the infrastructure costs are spread among a mix of users, giving each individual client an attractive low-cost, “Pay-as-you-go” model. All customers share the same infrastructure pool with limited configuration, security protections, and availability variances. These are managed and supported by the cloud provider. One of the advantages of a Public cloud is that they may be larger than an enterprises cloud, thus providing the ability to scale seamlessly, on demand.

**Private Cloud**

Private clouds are built exclusively for a single enterprise. They aim to address concerns on data security and offer greater control, which is typically lacking in a public cloud. There are two variations to a private cloud:

- On-premise Private Cloud: On-premise private clouds, also known as internal clouds are hosted within one s own data center. This model provides a more

standardized process and protection, but is limited in aspects of size and scalability. IT departments would also need to incur the capital and operational costs for the physical resources. This is best suited for applications which require complete control and configurability of the infrastructure and security.

- Externally hosted Private Cloud: This type of private cloud is hosted externally with a cloud provider, where the provider facilitates an exclusive cloud environment with full guarantee of privacy. This is best suited for enterprises that don't prefer a public cloud due to sharing of physical resources.

**Hybrid Cloud**

Hybrid Clouds combine both public and private cloud models. With a Hybrid Cloud, service providers can utilize 3rd party Cloud Providers in a full or partial manner thus increasing the flexibility of computing. The Hybrid cloud environment is capable of providing on-demand, externally provisioned scale. The ability to augment a private cloud with the resources of a public cloud can be used to manage any unexpected surges in workload.

**Cloud Computing Benefits**

Enterprises would need to align their applications, so as to exploit the architecture models that Cloud Computing offers. Some of the typical benefits are listed below:

- Reduced Cost: There are a number of reasons to attribute Cloud technology with lower costs. The billing model is pay as per usage; the infrastructure is not purchased thus lowering maintenance. Initial expense and recurring expenses are much lower than traditional computing.
- Increased Storage: With the massive Infrastructure that is offered by Cloud providers today, storage & maintenance of large volumes of data is a reality. Sudden workload spikes are also managed effectively & efficiently, since the cloud can scale dynamically.
- Flexibility: This is an extremely important characteristic. With enterprises having to adapt, even more rapidly, to changing business conditions, speed to deliver is critical. Cloud computing stresses on getting applications to market very quickly, by using the most appropriate building blocks necessary for deployment.

**Cloud Computing Challenges**

Despite its growing influence, concerns regarding cloud computing still remain. In our opinion, the benefits outweigh the drawbacks and the model is worth exploring. Some common challenges are:

- Data Protection: Data Security is a crucial element that warrants scrutiny. Enterprises are reluctant to buy an assurance of business data security from vendors. They fear losing data to competition and the data confidentiality of consumers. In many instances, the actual storage location is not disclosed, adding onto the security concerns of enterprises. In the existing models, firewalls across data centers (owned by enterprises) protect this sensitive information. In the cloud model, Service providers are responsible for maintaining data security and enterprises would have to rely on them.
- Data Recovery and Availability: All business applications have Service level agreements that are stringently followed. Operational teams play a key role in management of service level agreements and runtime governance of applications. In production environments, operational teams support
    - Appropriate clustering and Fail over
    - Data Replication
    - System monitoring (Transactions monitoring, logs monitoring and others)
    - Maintenance (Runtime Governance)
    - Disaster recovery
    - Capacity and performance management

  If, any of the above mentioned services is under-served by a cloud provider, the damage & impact could be severe.
- Management Capabilities: Despite there being multiple cloud providers, the management of platform and infrastructure is still in its infancy. Features like „Auto-scaling for example, are a crucial requirement for many enterprises. There is huge potential to improve on the scalability and load balancing features provided today.
- Regulatory and Compliance Restrictions: In some of the European countries, Government regulations do not allow customer's personal information and other sensitive information to be physically located outside the state or country. In order to meet such requirements, cloud providers need to setup a data center or a storage site exclusively within the country to comply with regulations. Having such an infrastructure may not always be feasible and is a big challenge for cloud providers.

### 2.5.8 Introduction to VLAN technology

In a traditional LAN, workstations are connected to each other by means of a hub or a repeater. These devices propagate any incoming data throughout the network. However, if two people attempt to send information at the same time, a collision will occur and all the transmitted data will be lost. Once the collision has occurred, it will continue to be propagated

throughout the network by hubs and repeaters. The original information will therefore need to be resent after waiting for the collision to be resolved, thereby incurring a significant wastage of time and resources. To prevent collisions from traveling through all the workstations in the network, a bridge or a switch can be used. These devices will not forward collisions, but will allow broadcasts (to every user in the network) and multicasts (to a pre-specified group of users) to pass through. A router may be used to prevent broadcasts and multicasts from traveling through the network. The workstations, hubs, and repeaters together form a LAN segment. A LAN segment is also known as a collision domain since collisions remain within the segment. The area within which broadcasts and multicasts are confined is called a broadcast domain or LAN. Thus a LAN can consist of one or more LAN segments. Defining broadcast and collision domains in a LAN depends on how the workstations, hubs, switches, and routers are physically connected together. The Figure-1 depicts a reference VLAN. VLAN's allow a network manager to logically segment a LAN into different broadcast domains (see Figure 1). Since this is a logical segmentation and not a physical one, workstations do not have to be physically located together. Users on different floors of the same building, or even in different buildings can now belong to the same LAN

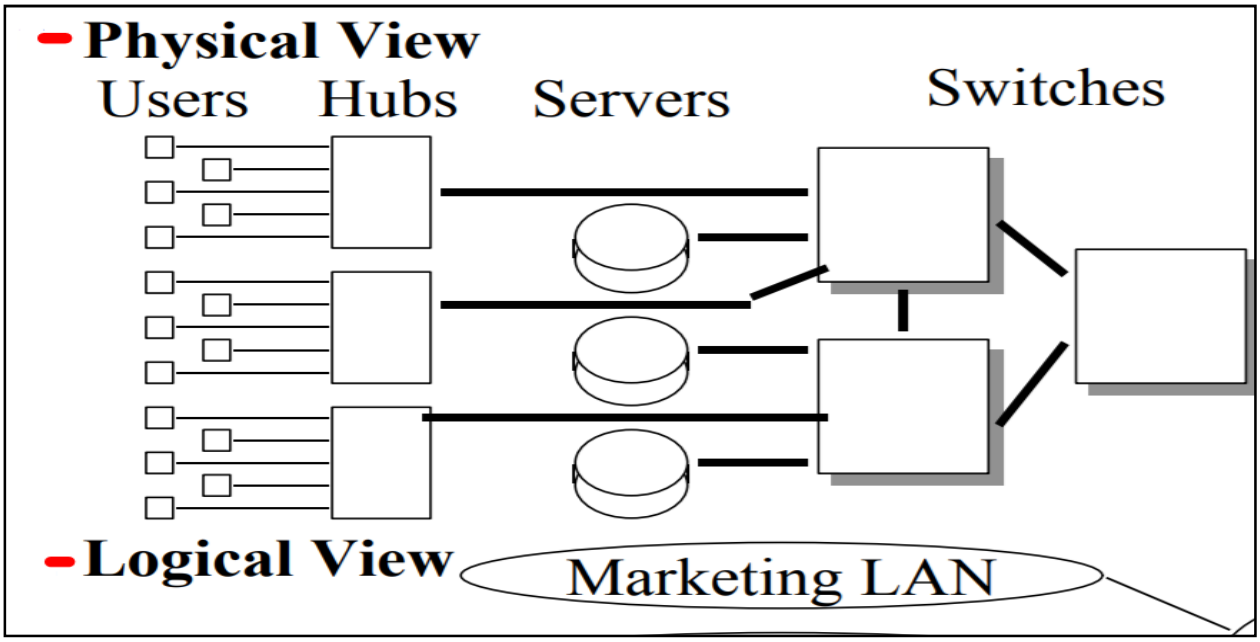



**Figure-1** A reference VLAN

**Why use VLAN's**

VLAN's offer a number of advantages over traditional LAN's. They are:

- Performance: In networks where traffic consists of a high percentage of broadcasts and multicasts, VLAN's can reduce the need to send such traffic to

unnecessary destinations. For example, in a broadcast domain consisting of 10 users, if the broadcast traffic is intended only for 5 of the users, then placing those 5 users on a separate VLAN can reduce traffic. Compared to switches, routers require more processing of incoming traffic. As the volume of traffic passing through the routers increases, so does the latency in the routers, which results in reduced performance. The use of VLAN's reduces the number of routers needed, since VLAN's create broadcast domains using switches instead of routers.

- Formation of Virtual Workgroups: Nowadays, it is common to find cross-functional product development teams with members from different departments such as marketing, sales, accounting, and research. These workgroups are usually formed for a short period of time. During this period, communication between members of the workgroup will be high. To contain broadcasts and multicasts within the workgroup, a VLAN can be set up for them. With VLAN's it is easier to place members of a workgroup together. Without VLAN's, the only way this would be possible is to physically move all the members of the workgroup closer together
- Simplified Administration: Seventy percent of network costs are a result of adds, moves, and changes of users in the network .Every time a user is moved in a LAN, re-cabling, new station addressing, and reconfiguration of hubs and routers becomes necessary. Some of these tasks can be simplified with the use of VLAN's. If a user is moved within a VLAN, reconfiguration of routers is unnecessary. In addition, depending on the type of VLAN, other administrative work can be reduced or eliminated [Cisco white paper]. However the full power of VLAN's will only really be felt when good management tools are created which can allow network managers to drag and drop users into different VLAN's or to set up aliases. Despite this saving, VLAN's add a layer of administrative complexity, since it now becomes necessary to manage virtual workgroups.
- Reduced Cost: VLAN's can be used to create broadcast domains which eliminate the need for expensive routers.
- Security: Periodically, sensitive data may be broadcast on a network. In such cases, placing only those users who can have access to that data on a VLAN can reduce the chances of an outsider gaining access to the data. VLAN's can also be used to control broadcast domains, set up firewalls, restrict access, and inform the network manager of an intrusion

### 2.5.9 Introduction to Firewals

Firewalls can be an effective means of protecting a local system or network of systems from network-based security threats while at the same time affording access to the outside world via wide area networks and the Internet.

**THE NEED FOR FIREWALLS**

Information systems in corporations, government agencies, and other organizations have undergone a steady evolution. The following are notable developments:

• Centralized data processing system, with a central mainframe supporting a number of directly connected terminals

• Local area networks (LANs) interconnecting PCs and terminals to each other and the mainframe

• Premises network, consisting of a number of LANs, interconnecting PCs, servers, and perhaps a mainframe or two

• Enterprise-wide network, consisting of multiple, geographically distributed premises networks interconnected by a private wide area network (WAN)

• Internet connectivity, in which the various premises networks all hook into the Internet and may or may not also be connected by a private WAN

Internet connectivity is no longer optional for organizations. The information and services available are essential to the organization. Moreover, individual users within the organization want and need Internet access, and if this is not provided via their LAN, they will use dial-up capability from their PC to an Internet service provider (ISP). However, while Internet access provides benefits to the organization it enables the outside world to reach and interact with local network assets. This creates a threat to the organization. While it is possible to equip each workstation and server on the premises network with strong security features, such as intrusion protection, this may not be sufficient and in some cases is not cost-effective. Consider a network with hundreds or even thousands of systems, running various operating systems, such as different versions of UNIX and Windows. When a security flaw is discovered, each potentially affected system must be upgraded to fix that flaw. This requires scaleable configuration management and aggressive patching to function effectively. While difficult, this is possible and is necessary if only host-based security is used. A widely accepted alternative or at least complement to host-based security services is the firewall.

The firewall is inserted between the premises network and the Internet to establish a controlled link and to erect an outer security wall or perimeter.The aim of this perimeter is to protect the premises network from Internet-based attacks and to provide a single choke point where security and auditing can be imposed. The firewall may be a single computer system or a set of two or more systems that cooperate to perform the firewall function. The firewall, then, provides an additional layer of defense, insulating the internal systems from external networks.

This follows the classic military doctrine of “defense in depth,” which is just as applicable to IT security.

## FIREWALL CHARACTERISTICS

Some of the following design goals for a firewall:

1. All traffic from inside to outside, and vice versa, must pass through the firewall. This is achieved by physically blocking all access to the local network except via the firewall. Various configurations are possible, as explained later in this chapter.
2. Only authorized traffic, as defined by the local security policy, will be allowed to pass. Various types of firewalls are used, which implement various types of security policies, as explained later in this chapter.
3. The firewall itself is immune to penetration.This implies the use of a hardened system with a secured operating system.Trusted computer systems are suitable for hosting a firewall and often required in government applications.

[SMIT97] lists four general techniques that firewalls use to control access and enforce the site’s security policy. Originally, firewalls focused primarily on service control, but they have since evolved to provide all four:

• Service control: Determines the types of Internet services that can be accessed, inbound or outbound. The firewall may filter traffic on the basis of IP address, protocol, or port number; may provide proxy software that receives and interprets each service request before passing it on; or may host the server software itself, such as a Web or mail service.

• Direction control: Determines the direction in which particular service requests may be initiated and allowed to flow through the firewall.

• User control: Controls access to a service according to which user is attempting to access it. This feature is typically applied to users inside the firewall perimeter (local users). It may also be applied to incoming traffic from external users; the latter requires some form of secure authentication technology, such as is provided in IPsec

• Behavior control: Controls how particular services are used. For example, the firewall may filter e-mail to eliminate spam, or it may enable external access to only a portion of the information on a local Web server.

Before proceeding to the details of firewall types and configurations, it is best to summarize what one can expect from a firewall. The following capabilities are within the scope of a firewall:

1. A firewall defines a single choke point that keeps unauthorized users out of the protected network, prohibits potentially vulnerable services from entering or leaving the network, and provides protection from various kinds of IP spoofing and routing attacks.The use of a single choke point simplifies security management because security capabilities are consolidated on a single system or set of systems.

2. A firewall provides a location for monitoring security-related events. Audits and alarms can be implemented on the firewall system.
3. A firewall is a convenient platform for several Internet functions that are not security related. These include a network address translator, which maps local addresses to Internet addresses, and a network management function that audits or logs Internet usage.

Firewalls have their limitations, including the following:
1. The firewall cannot protect against attacks that bypass the firewall. Internal systems may have dial-out capability to connect to an ISP. An internal LAN may support a modem pool that provides dial-in capability for traveling employees and telecommuters. 2. The firewall may not protect fully against internal threats, such as a disgruntled employee or an employee who unwittingly cooperates with an external attacker.
3. An improperly secured wireless LAN may be accessed from outside the organization. An internal firewall that separates portions of an enterprise network cannot guard against wireless communications between local systems on different sides of the internal firewall.
4. A laptop, PDA, or portable storage device may be used and infected outside the corporate network, and then attached and used internally.

### 2.5.10 Introduction to E-Commerece

E-Commerce or Electronics Commerce is a methodology of modern business, which addresses the need of business organizations, vendors and customers to reduce cost and improve the quality of goods and services while increasing the speed of delivery. Ecommerce refers to the paperless exchange of business information using the following ways −

- Electronic Data Exchange (EDI)
- Electronic Mail (e-mail)
- Electronic Bulletin Boards
- Electronic Fund Transfer (EFT)
- Other Network-based technologies

**E-Commerce provides the following features −**

- **Non-Cash Payment** − E-Commerce enables the use of credit cards, debit cards, smart cards, electronic fund transfer via bank's website, and other modes of electronics payment.
- **24x7 Service availability** − E-commerce automates the business of enterprises and the way they provide services to their customers. It is available anytime, anywhere.
- **Advertising / Marketing** − E-commerce increases the reach of advertising of products and services of businesses. It helps in better marketing management of products/services

- **Improved Sales** − Using e-commerce, orders for the products can be generated anytime, anywhere without any human intervention. It gives a big boost to existing sales volumes.
- **Support** − E-commerce provides various ways to provide pre-sales and post-sales assistance to provide better services to customers.
- **Inventory Management** − E-commerce automates inventory management. Reports get generated instantly when required. Product inventory management becomes very efficient and easy to maintain.
- **Communication improvement** − E-commerce provides ways for faster, efficient, reliable communication with customers and partners.

**Traditional Commerce v/s E-Commerce**

| Sr. No. | Traditional Commerce | E-Commerce |
|---|---|---|
| 1 | Heavy dependency on information exchange from person to person. | Information sharing is made easy via electronic communication channels making little dependency on person to person information exchange. |
| 2 | Communication/ transaction are done in synchronous way. Manual intervention is required for each communication or transaction. | Communication or transaction can be done in asynchronous way. Electronics system automatically handles when to pass communication to required person or do the transactions. |
| 3 | It is difficult to establish and maintain standard practices in traditional commerce. | A uniform strategy can be easily established and maintain in e-commerce. |
| 4 | Communications of business depends upon individual skills. | In e-Commerce or Electronic Market, there is no human intervention. |
| 5 | Unavailability of a uniform platform as traditional commerce depends heavily on personal communication. | E-Commerce website provides user a platform where al l information is available at one place. |
| 6 | No uniform platform for information sharing as it depends heavily on personal communication. | E-Commerce provides a universal platform to support commercial / business activities across the globe. |

## Advantages of E-Commerce

E-Commerce advantages can be broadly classified in three major categories −

- Advantages to Organizations
- Advantages to Consumers
- Advantages to Society

### Advantages to Organizations

- Using e-commerce, organizations can expand their market to national and international markets with minimum capital investment. An organization can easily locate more customers, best suppliers, and suitable business partners across the globe.
- E-commerce helps organizations to reduce the cost to create process, distribute, retrieve and manage the paper based information by digitizing the information.
- E-commerce improves the brand image of the company.
- E-commerce helps organization to provide better customer services.
- E-commerce helps to simplify the business processes and makes them faster and efficient.
- E-commerce reduces the paper work.
- E-commerce increases the productivity of organizations. It supports "pull" type supply management. In "pull" type supply management, a business process starts when a request comes from a customer and it uses just-in-time manufacturing way.

### Advantages to Customers

- It provides 24x7 support. Customers can enquire about a product or service and place orders anytime, anywhere from any location.
- E-commerce application provides users with more options and quicker delivery of products.
- E-commerce application provides users with more options to compare and select the cheaper and better options.
- A customer can put review comments about a product and can see what others are buying, or see the review comments of other customers before making a final purchase.
- E-commerce provides options of virtual auctions.
- It provides readily available information. A customer can see the relevant detailed information within seconds, rather than waiting for days or weeks.
- E-Commerce increases the competition among organizations and as a result, organizations provides substantial discounts to customers.

Advantages to Society

- Customers need not travel to shop a product, thus less traffic on road and low air pollution.
- E-commerce helps in reducing the cost of products, so less affluent people can also afford the products.
- E-commerce has enabled rural areas to access services and products, which are otherwise not available to them.
- E-commerce helps the government to deliver public services such as healthcare, education, social services at a reduced cost and in an improved manner.

**Dis-advantages of E-Commerece**

The disadvantages of e-commerce can be broadly classified into two major categories

- Technical disadvantages
- Non-Technical disadvantages

Technical Disadvantages

- There can be lack of system security, reliability or standards owing to poor implementation of e-commerce.
- The software development industry is still evolving and keeps changing rapidly.
- In many countries, network bandwidth might cause an issue.
- Special types of web servers or other software might be required by the vendor, setting the e-commerce environment apart from network servers.
- Sometimes, it becomes difficult to integrate an e-commerce software or website with existing applications or databases.
- There could be software/hardware compatibility issues, as some e-commerce software may be incompatible with some operating system or any other component.

Non-Technical Disadvantages

- **Initial cost** − The cost of creating/building an e-commerce application in-house may be very high. There could be delays in launching an e-Commerce application due to mistakes, and lack of experience.
- **User resistance** − Users may not trust the site being an unknown faceless seller. Such mistrust makes it difficult to convince traditional users to switch from physical stores to online/virtual stores.
- **Security/ Privacy** − It is difficult to ensure the security or privacy on online transactions.
- Lack of touch or feel of products during online shopping is a drawback.
- E-commerce applications are still evolving and changing rapidly.

- Internet access is still not cheaper and is inconvenient to use for many potential customers, for example, those living in remote villages.

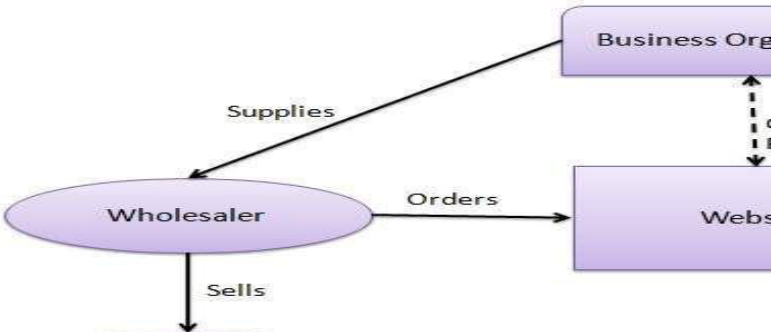
**E-Commerce Models**

E-commerce business models can generally be categorized into the following categories.

- Business - to - Business (B2B)
- Business - to - Consumer (B2C)
- Consumer - to - Consumer (C2C)
- Consumer - to - Business (C2B)
- Business - to - Government (B2G)
- Government - to - Business (G2B)
- Government - to - Citizen (G2C)

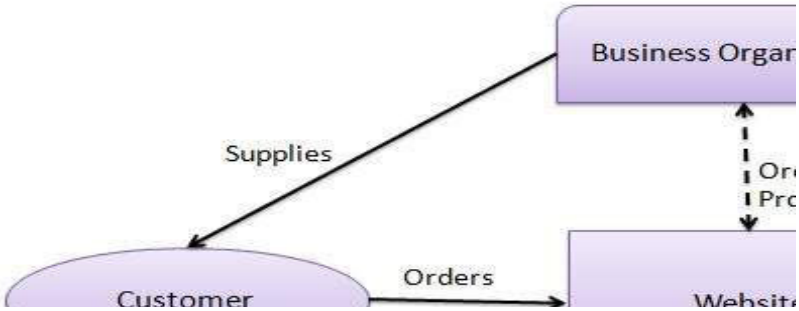
Business - to - Business

A website following the B2B business model sells its products to an intermediate buyer who then sells the product to the final customer. As an example, a wholesaler places an order from a company's website and after receiving the consignment, sells the endproduct to the final customer who comes to buy the product at one of its retail outlets.



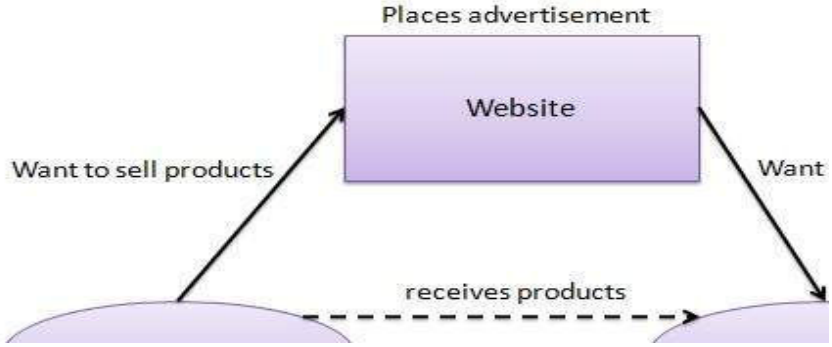

Business - to - Consumer

A website following the B2C business model sells its products directly to a customer. A customer can view the products shown on the website. The customer can choose a product and order the same. The website will then send a notification to the business organization via email and the organization will dispatch the product/goods to the customer.



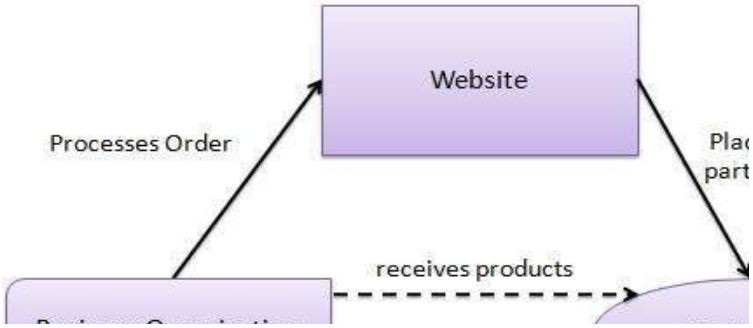

Consumer - to - Consumer

A website following the C2C business model helps consumers to sell their assets like residential property, cars, motorcycles, etc., or rent a room by publishing their information on the website. Website may or may not charge the consumer for its services. Another consumer may opt to buy the product of the first customer by viewing the post/advertisement on the website.



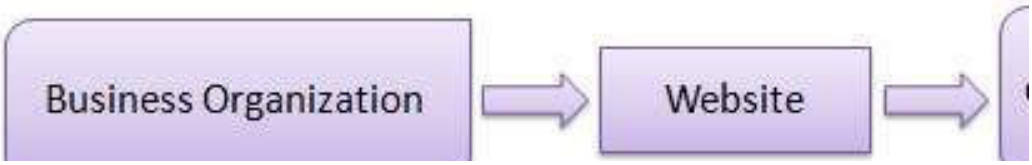

Consumer - to - Business

In this model, a consumer approaches a website showing multiple business organizations for a particular service. The consumer places an estimate of amount he/she wants to spend for a particular service. For example, the comparison of interest rates of personal loan/car loan provided by various banks via websites. A business organization who fulfills the consumer's requirement within the specified budget, approaches the customer and provides its services.




Business - to - Government

B2G model is a variant of B2B model. Such websites are used by governments to trade and exchange information with various business organizations. Such websites are accredited by the government and provide a medium to businesses to submit application forms to the government.

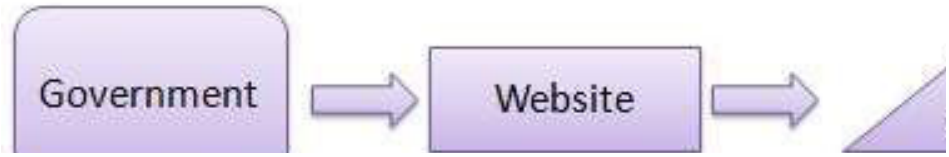



Government - to - Business

Governments use B2G model websites to approach business organizations. Such websites support auctions, tenders, and application submission functionalities.


Government - to - Citizen

Governments use G2C model websites to approach citizen in general. Such websites support auctions of vehicles, machinery, or any other material. Such website also provides services like registration for birth, marriage or death certificates. The main objective of G2C websites is to reduce the average time for fulfilling citizen's requests for various government services.




### 2.5.11 Introduction to Nanotechnology

Nano: Greek prefix which means dwarf

Nanotechnology can be defined as :

1. Research and technology development at the atomic, molecular or macromolecular levels, in the length scale of approximately 1 -100 nanometer
2. Creating and using structures, devices and systems that have novel properties and functions because of their small and/or intermediate size
3. Ability to control or manipulate on the atomic scale

Nanotechnology ("nanotech") is manipulation of matter on an atomic, molecular, and supramolecular scale. The earliest, widespread description of nanotechnology referred to the particular technological goal of precisely manipulating atoms and molecules for fabrication of macroscale products, also now referred to as molecular nanotechnology. A more generalized description of nanotechnology was subsequently established by the National Nanotechnology Initiative, which defines nanotechnology as the manipulation of matter with at least one dimension sized from 1 to 100 nanometers. This definition reflects the fact that quantum mechanical effects are important at this quantum-realm scale, and so the definition shifted from a particular technological goal to a research category inclusive of all types of research and technologies that deal with the special properties of matter which occur below the given size threshold. It is therefore common to see the plural form "nanotechnologies" as well as "nanoscale technologies" to refer to the broad range of research and applications whose common trait is size. Because of the variety of potential applications (including industrial and military), governments have invested billions of dollars in nanotechnology research. Until 2012, through its National Nanotechnology Initiative, the USA has invested $3.7 billion, the European Union has invested $1.2 billion and Japan has $750 million.

Nanotechnology as defined by size is naturally very broad, including fields of science as diverse as surface science, organic chemistry, molecular biology, semiconductor physics, energy storage, microfabrication, molecular engineering, etc. The associated research and applications are equally diverse, ranging from extensions of conventional device physics to completely new approaches based upon molecular self-assembly, from developing new materials with dimensions on the nanoscale to direct control of matter on the atomic scale.

Scientists currently debate the future implications of nanotechnology. Nanotechnology may be able to create many new materials and devices with a vast range of applications, such as in nanomedicine, nanoelectronics, biomaterials energy production, and consumer products. On the other hand, nanotechnology raises many of the same issues as any new technology, including concerns about the toxicity and environmental impact of nanomaterials, and their potential effects on global economics, as well as speculation about various doomsday scenarios. These concerns have led to a debate among advocacy groups and governments on whether special regulation of nanotechnology is warranted.

### 2.5.12 Introduction to Social Media

**"Social media"** is a way for people to communicate and interact online. While it has been around since the dawn of the World Wide Web, in the last 10 years or so we've seen a surge in both the number and popularity of social media sites. It's called social media because users engage with (and around) it in a social context, which can include conversations, commentary, and other user-generated annotations and engagement interactions.

Publishing content has become exponentially simpler over the last several years, which has helped skyrocket the use of social media. Non-technical web users are now able to easily create content on a rapidly growing number of platforms, including those that are owned (hosted communities, blogs, etc.), rented (social networks or third-party communities), and occupied (commenting, contributing, etc.). Today's web has shifted from a "one-to-many" to a "many-to-many" method of engagement, and we're loving it.

#### Facebook

When Facebook started in 2004, it was a bare-bones social network focused on connecting college students. Nine years and more than 1 billion active users later, Facebook has become the most widely-used social network to date and has shaped online interaction as we know it. From connecting distant friends and family members, to bridging the gap between brands and their communities, Facebook has taken the way we interact online to a whole new level.

Since its inception, Facebook has become an integral component of people's online social presence. For many, Facebook is the only online social network in which they participate, though the level of engagement varies across the user spectrum. From those that check the network periodically throughout the week to those who are almost compulsively active, the core driving force to participation is connection: connecting with colleagues, friends old and new, alumni networks, and for an increasing percentage of users, even professional connections.

The network itself has transformed into one with highly customizable privacy and visibility settings. Users can dial down their visibility to the point where they are nearly invisible on the platform. They can choose which posts or updates are visible and to whom. Conversely, those

users who have chosen a more all-in approach can leave everything completely public, from the images they're tagged in to their active stream on Spotify.

**Twitter**

Founded in 2006, Twitter's 140-character bite-size updates have transformed the world's access to real-time information. Its simple interface allows for sharing anything from breaking news to sports, to great content, to worldwide politics. In a time when we're oversaturated with media, Twitter also allows us to access what we need to know. Much of the reporting from the Arab Spring uprisings was done directly through Twitter. Through all of this, brands are joining the network not only to promote their messages, but also to quickly and succinctly address the needs of their customers.

Twitter has become a tool for everything from facilitating the collapse of governments to showing off your newborn. Through Twitter, athletes have added sideline commentary and Hollywood has dialed up the drama. Consumers use the service to share and find content. For many, Twitter has replaced their RSS subscriptions and traditional news media.

Due to its mostly public nature, Twitter's most powerful use is connecting people. The platform allows complete strangers to come together over common interests and ideas and to participate in conversations that range from the relatively mundane to the incredibly important. Some users may choose to essentially live-tweet their day, while others limit their contributions primarily to content sharing. Your goal is to identify what types of users you'll be looking for and engaging with and gain an understanding of how and why they're using the tool. By understanding their motivations behind using the site, you'll be better able to target your efforts and content in meaningful ways.

**Google+**

If you're like most of the Internet, you've probably delayed your investment in Google+ in hopes of a sign that it's time to make a move. Consider this your sign. Google's social endeavor, Google+, became the new kid on the playground in 2011. It initially adopted many features from Facebook and Twitter, mixing in its own unique functionality like Circles and Hangouts. The platform is a little different from other social networks, in that it acts as a social layer across many of Google's own properties—including the display ad network—thus connecting millions of sites. With nearly 67% of US search engine volume, Google is still the biggest player in the search engine game. And, with Google+ posts passing link equity to other pages, building a presence here is a better idea than ever.

So how many people actually use Google+? The latest numbers from Google, posted in October of 202.5, show that there are about 300 million active monthly users who upload 1.5 billion photos every week.

While exact numbers aren't available, reports commonly estimate the site's users as about 70% male and 30% female. CircleCount reports the US as the biggest audience, followed by

India and Brazil. Perhaps most interestingly, by a large majority, those reporting a job role are students. The large majority of the remaining top are in either technology (developers, engineers, designers) or photography. The secret here is really about determining if your audience is there, and at this point, it's a safe bet it is.

**LinkedIn**

The world's largest professional social network connects colleagues with each other and businesses with current and potential employees, all while enabling community development and content sharing. LinkedIn's potential lies in its power to build authority, establish thought leadership, and cultivate a robust network. Join us for a peek behind the curtain to see if LinkedIn is a match for your business.

If you took your water cooler, networking event, business card holder, and Rolodex, smooshed them together, and put that concoction up on a domain, you would approximate LinkedIn. People build out their profiles to showcase their professional background and resumes. They are able to connect with individuals they know or have worked with, leave each other recommendations, and find new connections. LinkedIn can also be a great place to look for and find a job, as it takes the utility of job boards and adds in the human connections that are so invaluable in finding the right position.

For companies, especially recruiters, that is just the beginning. Business professionals have created their profiles and gotten recommendations from co-workers, making it a solid fit for brands looking to recruit new talent. LinkedIn allows hiring managers to search and filter candidates based on multiple factors, and users can join groups based on professional interests.

**YouTube**

After its humble beginnings in 2005, YouTube has become more than just a place to watch cat videos. Eight years later, YouTube has morphed into the world's second-largest search engine, a driver of online culture, and a springboard for Internet fame. There’s still plenty of cat videos to go around, but YouTube has its sights on bigger, better ideas. a word, sharing. Content is being uploaded and shared through YouTube at record rates. Users can follow channels (which have gotten more sophisticated in their design and functionality over the years), upload their own content, comment on and discuss videos, and follow other users' content. With the ability to link directly to or embed videos, YouTube has become a primary source of video entertainment for users all over the web. Its ability to monetize through ads—both for itself and its users—adds a layer of financial sustainability.