B.A. PART-I (SEMESTER-I) **PAPER : BAP-101**

COMPUTER SCIENCE **FUNDAMENTALS OF IT**

UNIT - 2

Lesson Nos :

2.1 : Number Systems

2.2 : Computer Codes

2.3 : Computer Codes

2.4 : Advance Trends In IT

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Department of Distance Education
Punjabi University, Patiala

B.A. PART–I **COMPUTER SCIENCE**

SEMESTER-I **PAPER – BAP-101 FUNDAMENTALS OF IT**

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

NUMBER SYSTEMS

Chapter Outline:

2.1.0 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.

2.1.1 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

2.1.1.1 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.

2.1.1.2 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.

2.1.1.3 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 10. This implies that there are 10 symbols: 0, 1, 2, 3, 4, 5, 6, 7, 8 and 9. 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.

2.1.2 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 2.1.1 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.

2.1.2.1 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 9. 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	x	10	x	10	=	1000
10^2	=	10	x	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 + 700 + 30 + 5	Is Equivalent to	9 x 1000 7 x 100 3 x 10 5 x 1	Is Equivalent to	9×10^3 7×10^2 3×10^1 5×10^0

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

2.1.2.2 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 $^{2n-1}$

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 2.1.2 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.

2.1.2.3 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 2.1.3 Octal Number System

Binary Number	Decimal Number	Octal Number
000	0	0 (0 x 8^0)
001	1	1 (1 x 8^0)
010	2	2 (2 x 8^0)

011	3	3 (3 x 8^0)
100	4	4 (4 x 8^0)
101	5	5 (5 x 8^0)
110	6	6 (6 x 8^0)
111	7	7 (7 x 8^0)
1000	8	10 (1 X 8^1 + 0 x 8^0)
1001	9	11 (1 X 8^1 + 1 x 8^0)
1010	10	12 (1 x 8^1 + 2 x 8^0)

2.1.2.4 Hexadecimal Number System

Hexadecimal is another number system that works exactly like the decimal and binary number systems except that the base is 110. Just as the decimal number represents a power of 10, 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, 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 10.4 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
13	D	1101
14	E	1110
15	F	1111

2.1.3 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.

2.1.3.1 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 $(36)_{10}$.

		Remainder
2	36	
2	18	0
2	9	0
2	4	1
2	2	0
2	1	0
	0	1

Least Significant Bit (LSB)

↑

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 $(671)_{10}$.

		Remainder
2	671	
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.

2.1.3.2 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 $(26)_{10}$.

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 $(179)_{10}$.

2.1.3.3 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	13	1	
8	1	5	
8	0	1	**Most Significant Bit (MSB)**

Taking remainders in reverse order, we get 1514213. Thus, the octal equivalent of $(432267)_{10}$ is $(1514213)_8$.

2.1.3.4 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 $(44978)_{10}$.

2.1.3.5 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.

2.1.3.6 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 $(100101011010110111)_2$.

2.1.3.7 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	511 2	**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 13F8. Thus, the hexadecimal equivalent of $(5112)_{10}$ is $(13F8)_{110.}$

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 6	**Remainder**	
16	36541	10 = A	**Least Significant Bit (LSB)**
16	2283	13 = 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 $(8EBDA)_{110.}$

2.1.3.8 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 $(9109035)_{10.}$

2.1.3.9 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	13	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.*

2.1.3.10 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 $(1000011011011011010001011100)_2$.

2.1.3.11 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.*

2.1.3.12 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 $(27361107)_8$.

2.1.4 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.

2.1.5 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

2.1.6 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. 2.2 **Author: Arun Sharma**

COMPUTER CODES

Chapter Outline:

2.2.0 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

2.2.1 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 2.2.1

Decimal	BCD Digit

Code	
0	0000
1	0001
2	0010
3	0011
4	0100
5	0101
6	0110
7	0111
8	1000
9	1001

Table 11.1 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.

2.2.2 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 0111.

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 2.2.2

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 2.2.2 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 1111.

Convert 136 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 136_{10}

2.2.3 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 2.2.3 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 2.2.3 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
13	♪	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	113	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
130	é	162	ó	194	┬	226	Γ
131	â	163	ú	195	├	227	Π
132	ä	164	ñ	196	─	228	Σ
133	à	165	Ñ	197	┼	229	Σ
134	å	166	ª	198	╞	230	µ
135	ç	167	º	199	╟	231	T
136	ê	168	¿	200	╚	232	Φ
137	ë	169	⌐	201	╔	233	Θ
138	è	170	¬	202	╩	234	Ω
139	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	╡	213	╒	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)

2.2.4 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 2.2.4 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

2.2.5 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 2.2.5 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

13	1101	1011
14	1110	1001
15	1111	1000

Table 2.2.5 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.

2.2.5.1 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 10111.

2.2.5.2 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-IIAdd 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.

2.2.6 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.

2.2.7 *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?

2.2.8 *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

B.A. PART–I **COMPUTER SCIENCE**

SEMESTER-I **PAPER – BAP-101 FUNDAMENTALS OF IT**

LESSON NO. 2.3 **Author: Arun Sharma**

COMPUTER ARITHMETIC

Chapter Outline:

2.3.0 Objectives

- Addition and subtraction of binary, octal and hexadecimal number

systems

- Know about signed and unsigned numbers
- 1's and 2's complement

Arithmetic is a branch of mathematics that involves combining numbers by addition, subtraction, multiplication and division. During school days, arithmetic was restricted only to decimal number system. However, in computer, we require arithmetic on other number systems such as binary, octal and hexadecimal. In the following few sections, we will discuss how to perform basic arithmetic on these number systems.

2.3.1 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

2.3.1.1 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 2.3.1 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	**Decimal**
1 1	
+ +	
1 1 1 1	1 5
+ 1 0 1 0	+ 1 0
1 1 0 0 1	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	**Decimal**
1 1 1 1 1	1
+ + + + +	+
1 1 0 0 1 1	5 1
1 0 0 1 0	1 8

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

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

8

2.3.1.2 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 2.3.2 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

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

Decimal

2	2	7
- 1	6	8
	5	9

2.3.2 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

2.3.2.1 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	13	
	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.

2.3.2.2 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 $(770)_{12}$.

8+6=14

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

Thus, the difference is $(71)_{12}$.

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 $(6357)_{12}$.

5	8+2=10	8+5=13	
~~6~~	~~3~~	~~5~~	7
2	7	6	1
3	3	7	6

Thus, the difference is $(3376)_{12}$.

2.3.3 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

2.3.3.1 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 $(11232C)_{16}$.

2.3.3.2 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	
16+2=18	(Borrow)

	5	2	7	
+		7	5	
	4	11	2	
	4	B	2	(Hex Form)

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

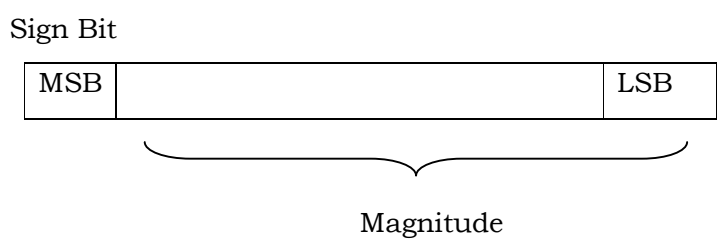
Example 2: Subtract $(lF65)_{16}$ from $(7E2CA)_{16}$.

		13	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 $(7C365)_{16}$.

2.3.4 Signed and Unsigned Numbers

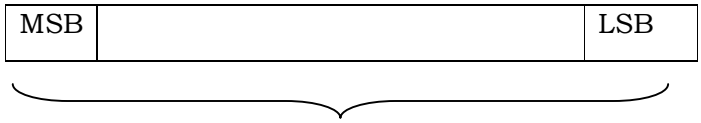
An n-bit signed binary number consists of two parts. A part denoting the sign of the number and a part denoting the magnitude of the number, The MSB is always a sign bit which denotes the sign of the number and the convention is that 0 and 1 denote '+' and '-', respectively. The remaining (n-l) bit denotes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



Magnitude

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.

2.3.4.1 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.

2.3.4.2 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

2.3.4.3 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.

2.3.4.4 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

2.3.4.5 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 $(17)_{10}$.

2.3.4 Summary

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.

2.3.5 *Self Check Exercise:*

Q.1 Why computers have deigns to use the binary number system?

Q.2 Perform the binary addition

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

Q.3 Add the binary numbers 1011 and 101 in both decimal and binary forms.

Q.4 Subtract 0110111_2 from 1101110_2

Q.5 Subtract 011011_2 from 110111_2

2.3.6 *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.

LESSON NO. 2.4 **(Reference Material)**

ADVANCE TRENDS IN IT

2.4.1 Objective

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.

2.4.2 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.

2.4.2.1 Characteristics 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.

2.4.2.2 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.

2.4.2.3 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.

2.4.3 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.

2.4.3.1 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

2.4.4 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.

2.4.5 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.

LT E 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.

2.4.5 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 ofϖ 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 LANϖ transceiver or "base station" that can connect one or many wireless devices simultaneously to the Internet.
- Wi-Fi cards - They accept the wireless signal andϖ 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

2.4.6 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.

2.4.7 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.

2.4.8 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

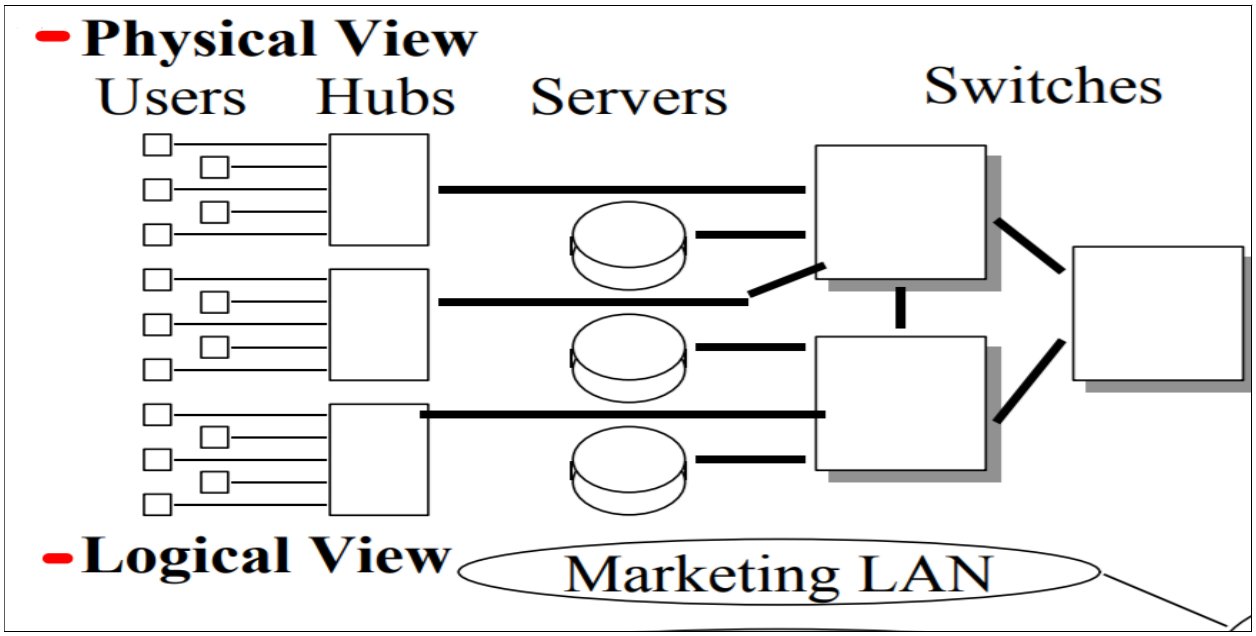


Figure-1 A reference VLAN

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

2.4.9 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.

2.4.10 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.

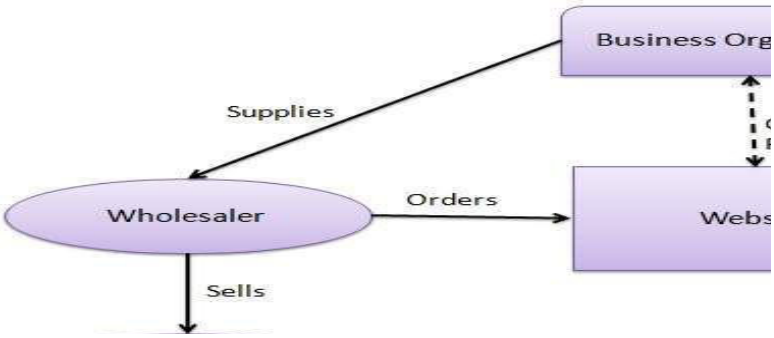
E-Commerce Models

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)

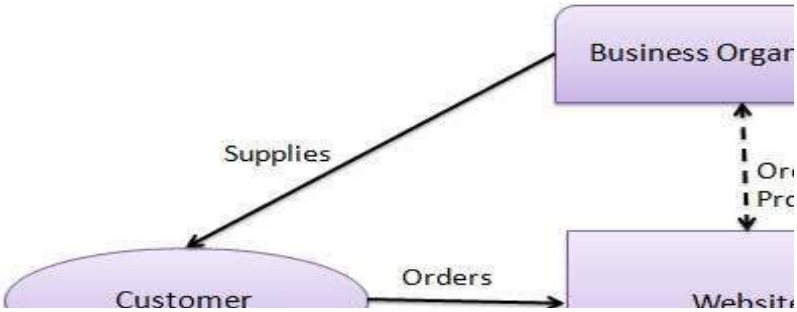
Business - to - Business

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.



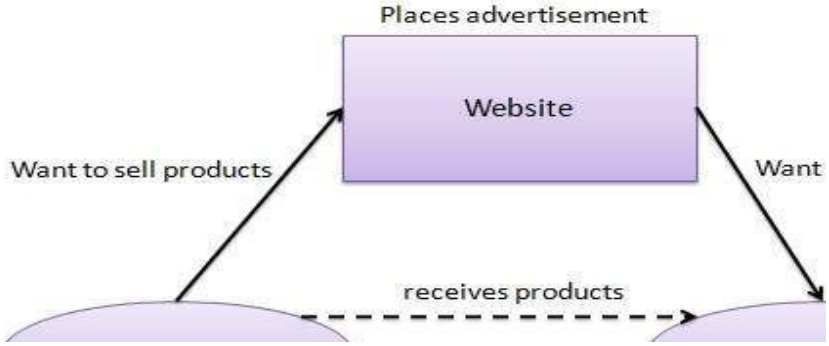
Business - to - Consumer

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.



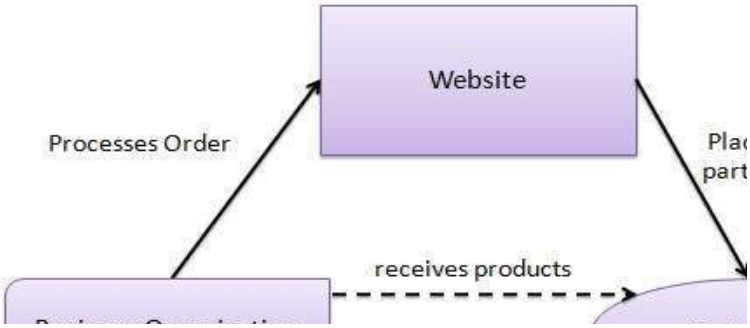
Consumer - to - Consumer

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.



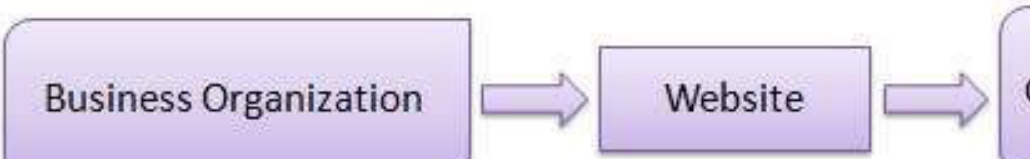
Consumer - to - Business

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.

2.4.11 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.

2.4.12 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 2013, 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.

Type Setting :

Department of Distance Education, Punjabi University, Patiala.