Bachelor of Business Administration (BBA)

IT FOR MANAGERS

(OBBASE301T24)

Self-Learning Material
(SEM -III)

Jaipur National University
Centre for Distance and Online Education

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Course Introduction

IT For Managers is assigned 2 credits and contains 6 units. Becoming proficient in new, innovative technologies and analyzing both hardware and software systems to help meet the technology goals of an organization. Identifying, analyzing, and responding to user needs for the selection, creation, evaluation, and administration of computers and computer-based systems.

Each unit is divided into sections and sub-sections. Each unit begins with statement of objectives to indicate what we expect you to achieve through the unit.

Course Outcomes

After studying this course, a student will be able to –

1. Recall a computing problem and apply principles of computing and other relevant disciplines to identify solutions.
2. Demonstrate as a member or leader of a team engaged in activities appropriate to the program's discipline.
3. Compute, implements, and evaluate a computer-based system, process, component, or program to meet desired needs
4. Analyse decisions related to work that demonstrate understanding of the importance of being an ethical computing professional
5. Assess user needs and take them into account in the selection, creation, evaluation and administration of computer-based systems
6. Develop the skills for latest changes in business environment.

We hope you will enjoy the course.

Acknowledgement

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Unit- 1

Number Systems

Learning Outcomes:

- Students will be able to learn Number Systems in Electronics.
- Learners will learn the base or radix of number system.
- Students will learn to learn the conversion of number system.

Structure:

1.1 Introduction

Number systems are used in digital electronics to work with and depict numerical data. The three most often used number systems are hexadecimal, decimal, and binary. Binary is the most fundamental number system in digital electronics as it represents digital signals in computers and electronic devices. Decimal is the number system most commonly used in everyday life, while hexadecimal is often used in computer programming and digital

electronics. Understanding number systems is essential for converting between different formats, performing arithmetic operations, and designing digital systems. A solid foundation in number systems is crucial for anyone working in the field of digital electronics.

1.2 Number Systems in Electronics

For putting down the value of a number, most number systems follow the same pattern:
A predetermined number of values can be represented with a single numerical character, followed by a new column that counts how many times the counting system's highest value has been reached. The term "system base" refers to the whole number of numerical values that the system uses. The system of decimals, for instance, it includes ten number characters (0 to 9).

When scripting numerals bigger than 9, a second column is supplemented to the left, with 10 times the value of the column to its right.
Because the base values of the number systems typically utilised in digital electronics differ from those of the decimal system, they appear less recognisable yet function roughly the same.

Decimal, (base 10)

Decimal, also known as base 10, is a numerical system that uses ten digits to represent numbers. These digits are 0 to 9.

In a decimal number, every digit corresponds to X^{10}. As an illustration, in the number 235, the digit 5 signifies 5 units, the digit 3 denotes 3 groups of 10 units, and the digit 2 represents 2 groups of 100 units.

Binary, (base 2)

Binary, also known as base 2, is a numerical system that uses only two digits to represent numbers. These digits are 0 and 1.
In binary integer, every digit resembles to a power of 2. The leftmost digit (1 in the number 1011), for instance, denotes 8 units (2 to the power of 3), followed by digit 0 (which represents 0 units (2 to the power of 2), digit 1 (which follows) represents 2 units (2 to the power of 1), and digit 1 (which is at the rightmost position) represents 1 unit (2 to the power of 0).

Octal, (base 8)

Octal, also known as base 8, is a numerical system that uses eight digits to represent numbers. These digits are 0, 1, 2, 3, 4, 5, 6, and 7.

Every digit in an octal number denotes a X^8. For example, in the number 237, the digit 7 represents 7 units, the digit 3 represents 3 groups of 8 units, and the digit 2 represents 2 groups of 64 units.

Hexadecimal, (base 16)

Hexadecimal, also known as base 16, is a numerical system that uses 16 digits to represent numbers. These are the numbers: A, B, C, D, E, and F; 1, 2, 3, 4, 5, 6, 7, 8, 9, and so on.

In a hexadecimal number, every digit corresponds to a power of 16. Such as in the quantity 3A7, the digit 7 represents 7 units, the digit A represents 10 groups of 16 units, and the digit 3 represents 3 groups of 256 units.

For instance:

10_{10} denotes the decimal value ten. (1 ten + 0 units)

10_2 denotes the binary value two. (1 two + 0 units)

10_8 denotes the octal value eight. (1 eight + 0 units)

10_{16} denotes the hexadecimal value sixteen. (1 sixteen + 0 units)

1.3 Base Or Radix Of Number System

Base Number system

The base number system is a general concept that refers to any number system that uses a base or radix to represent numerical values. The number of distinct digits or symbols that are employed in a number system to represent numerical values is known as the base or radix of that system.

Typical examples of base number systems are the decimal system (base-10), binary system (base-2), octal system (base-8), and hexadecimal system (base-16). In the decimal system, for example, there are 10 unique digits (0-9) that are used to represent numerical values, while in the binary system, there are only 2 unique digits (0 and 1).

In general, the base number system works by assigning a value to each digit in a number, according to where it falls on the number. The value of the base raised to the power of zero is represented by the rightmost digit. while each subsequent digit to the left represents the value

of the base raised to a higher power. The value of the entire number is then calculated by summing the products of each digit and its corresponding power of the base.

The base number system is widely used in mathematics, computer science, and other fields that involve numerical calculations and representations. It allows for efficient storage and manipulation of numerical values, as well as easy conversion between different number systems.

Radix Number System

The number of possible values that may be stated using a single digit is the basis of a system, also known as the RADIX. Consequently, radix 10 is assigned to the decimal system, radix 8 to the octal system, radix 16 to hexadecimal, and radix 2 to binary.

The range of values in various number systems is displayed in the table below. Note that the hexa-decimal system uses the letters A to F to represent the numbers 10 through 15 because it can only express 16 values in a single column.

Decimal (Radix 10)	Binary (Radix 2)	Octal (Radix 8)	Hexadecimal (Radix 16)
0	0	0	0
1	1	1	1
2		2	2
3		3	3
4		4	4
5		5	5
6		6	6
7		7	7
8			8
9			9
			A
			B
			C
			D
			E
			F

1.3.1 The Radix Point

The digits used to write a number convey its value, but the number is 'scaled' by its RADIX POINT.

Although the numerals are the same, however, 555.555 is 10 times larger than 55.5555.

Instead of using the term "DECIMAL point," "RADIX point" is used when utilizing several number systems. A decimal point is used when working with decimal numbers; if another system is being used, the point should not be called a decimal point, but rather a "Binary point," "Octal point," and so forth. The easiest workaround for this is to refered as the RADIX POINT in the system (which will, naturally, have its value labeled with its radix).

1.3.2 Exponents

A decimal number, like 456.210, can be conceptualized as the sum of the values of each of its individual digits, where the value of each digit is determined by where it falls within the number (the value of the column):

Col 2	Col 1	Col 0	Col -1
4 hundreds	+ 5 tens	+ 6 units	+ 2 tenths
(4×10^{2})	$+ (5 \times 10^{1})$	$+ (6 \times 10^{0})$	$+ (2 \times 10_{-1})$
400	+ 50	+ 6	+ 0.2

$$= 456.2_{10}$$

Every digit in the integer is multiplied by the system radix raised to a power based on where it is in relation to the radix point. We refer to this as the EXPONENT. The exponent 0 is applied to the radix of the digit directly to the left of the radix point, and the exponent increases by one for each place to the left. With positive exponents to the left and negative exponents to the right, the first exponent to the right of the radix point is -1, and so on.

This way of writing numbers can be used to any number system, but it is most frequently used with decimal numbers in electronics. There is only a radix difference.

Hexadecimal exponents $98.2_{16} = (9 \times 16^{1}) + (8 \times 16^{0}) + (2 \times 16^{-1})$

Octal exponents $56.2_{8} = (5 \times 8^{1}) + (6 \times 8^{0}) + (2 \times 8^{-1})$

Binary Exponents $10.1_{2} = (1 \times 2^{1}) + (0 \times 2^{0}) + (1 \times 2\text{-}^{1})$

When using your calculator for the preceding examples, you may discover that it does not like radix points in modes other than decimal. This is how most electronic calculators work..

1.3.3 Floating Point Notation

This might be an issue if electronic calculators cannot use radix points other than in decimal. Fortunately, For every problem, there is an answer. It is also possible to eliminate the radix point without altering the value of the integer by using the radix exponent. In the sample below, see how the value stays the same as the radix points vary. All of this is accomplished simply adjusting the radix exponent.

$$102.6_{10} = 102.6 \times 10^0 = 10.26 \times 10^1 = 1.026 \times 10^2 = .1026 \times 10^3$$

By raising the exponent by one, the radix point is shifted one position to the left.

By reducing the exponent, the radix point can likewise be moved to the right. By adjusting the exponent, the radix point may be positioned anywhere it is needed - in any number system. This is known as FLOATING POINT NOTATION, and it is how calculators handle decimal points.

Normalised Form

Placing the radix point in front of the integer and keeping it there by varying the exponent will simplify electronic calculations in any radix.

Electronic storage of numbers

A number written (or saved) in this way is referred to as being in normalized form, where the most significant digit is located to the left of the radix point. For example, the normalised version of the binary number 110.112 is.110112 x 23. It is not possible to save the radix point inside a binary number since binary digits in electrical systems can only be 1 or 0. As a result, the number is saved in its normalised form, with the exponent recorded separately. When the number is shown, the exponent is then employed to return the radix point to its right location.

One nibble is equal to four bits.

One byte is equal to 8 bits.

Sometimes several bytes are referred to as "words," for example, a 32-bit word. Other examples of multiple bytes are 16 bits, 32 bits, or 64 bits. The number of bits the machine can physically process or store at once determines the length of the word.

- **Knowledge Check 1**

  Fill in the Blanks

  1. Decimal contains 10 values ranging from ____ to _____.
  1. Binary has only two possible values: ___ and ___
  2. Octal has eight values ranging from ____ to _____.
  3. _____ denotes the hexadecimal value sixteen.

- **Outcome-Based Activity 1**

  Students are advised to discuss about RADIX POINT from number system point of view by making group of 5 in class.

1.4 Type of Number System

- **Binary Number System**

The binary number system is a base-2 number system that consists of just two digits: 0 and 1. Each digit in a binary integer is referred to as a "bit," and they all represent powers of two. The bit furthest to the right denotes 2^0, or 1, the bit immediately to the left, 2^1 (or 2), the next bit to the left, 2^2 (or 4), and so on.

Binary numbers are used extensively in computer systems because they can represent the two states of an electronic switch: on (represented by 1) and off (represented by 0). This makes binary ideal for digital electronics, as it allows for the manipulation of information through simple logic gates.

An integer in decimal notation can be converted to binary using the repeated division by two method. Divide the decimal number by two to accomplish this, then note the amount that remains. The residue is again observed once the quotient is divided by two. This process is repeated until the quotient is zero, at which point the remainders are read backwards to obtain the binary equivalent.

It is possible to convert a binary number to decimal using the power-of-2 method. Multiply each binary digit by the corresponding power of two to do this, then add the results.

[For example, the binary number 1101 is equivalent to 1 x 2^3 + 1 x 2^2 + 0 x 2^1 + 1 x 2^0, which equals 13 in decimal.]

Octal Number System

The octal number system employs digits 0 through 7 and is a base-8 number system. An octal integer represents a power of 8 for each of its digits. The digit furthest to the right denotes 8^0, or 1. The digit immediately to the left denotes 8^1, or 8. The digit immediately to the left denotes 8^2, or 64. And so on.

Octal numbers are used in computer programming and networking, particularly in Unix-based systems, where file permissions are represented using octal numbers.

The repeated division-by-8 method can be used to convert a decimal value to octal. To do this, divide the decimal number by 8, then record the remaining amount. Next, the quotient is divided by 8, and the remaining amount is once more noted. The remainders are read backwards to obtain the octal equivalent, and this operation is repeated until the quotient is zero.

An octal number can be converted to decimal using the power-of-8 approach. To do this, multiply each octal digit by the corresponding power of eight, then sum the results. For instance, 6 x 8^1 + 3 x 8^0, or 51 in decimal notation, is the octal equivalent of the number 63.

Decimal Number System

The digits 0 through 9 are used in the base-10 decimal numeral system. In a decimal number, every digit corresponds to a power of 10. The digit furthest to the right denotes 10^0, or 1. The digit immediately to the left denotes 10^1, or 10. The digit immediately to the left denotes 10^2, or 100 and so on.

The decimal system is widely utilized in daily life for counting, measuring, and arithmetic operations. It is the most widely used number system globally.

Depending on the destination system, there are several ways to convert a decimal number to an octal, binary, or hexadecimal number system. For instance, the repeated division-by-2 approach can be used to convert a decimal integer to binary. You can use the repeated division-by-8 method to convert a decimal number to octal and the repeated division-by-16 method to convert a decimal number to hexadecimal.

The power-of-2, power-of-8, or power-of-16 method can be used to convert a binary, octal, or hexadecimal number to decimal, accordingly. These approaches comprise summing the results of multiplying each digit by the relevant base power.

Hexadecimal number system

Hexadecimal is a base-16 number system that represents values 10 through 15 using digits 0 through 9 and letters A through F. In a hexadecimal number, every digit corresponds to a power of 16. The digit furthest to the right denotes 16^0, or 1. The digit immediately to the left denotes 16^1, or 16. The digit immediately to the left symbolizes 16^2 (or 256), and so on.The hexadecimal system is widely used in computer programming and networking, particularly in representing memory addresses and color values.

One way to convert a decimal value to hexadecimal is to divide it by sixteen times. To do this, divide the decimal value by 16, then record the remaining amount. After dividing the quotient by 16, the leftover is once more noted. Repeat this procedure until the quotient equals zero. and the remainders are read in reverse order to get the hexadecimal equivalent.

For values greater than 9, you can use the corresponding letter in the hexadecimal system (A for 10, B for 11, and so on).

To convert a hexadecimal number to decimal, you can use the power-of-16 method. This implies summing the results of multiplying each hexadecimal number by the matching power of 16. As an illustration, the hexadecimal number 2A5. is equivalent to 2 x 16^2 + 10 x 16^1 + 5 x 16^0, which equals 677 in decimal.

- **Knowledge Check 2**
  - Describe Hexadecimal number system
  - What is Octal Number System

- **Outcome-Based Activity 2**

  Discuss and compare Decimal number system & Hexadecimal number system.

1.5 Conversion of number system.

Values written in one number system must frequently be converted to another. The simplest method is to use your calculator or a web-based converting software. That's all well and good, but this kind of number translation doesn't really assist you understand how each number system functions or how different systems are connected. In addition to teaching you how to do some simple conversions, this lesson aims to help you understand how conversions operate and how to convert between different number systems. Conversions can be handled in a number of ways without the need for a calculator; once the conversion techniques are understood, only basic math skills—multiplying, dividing, and adding—are needed.

Conversion from Any System to Decimal

Any value can be expressed in terms of its system radix, which is the number of values in any number system that can be expressed in a single digit.

Octal to Decimal

For instance, the system radix of octal is eight since all eight values, ranging from 0 to 7, may be written as a single digit.

Convert 111 to decimal.

Using the values of each column, (which in an octal integer are powers of 8) the octal value 111_8 can also be written as:

$(1x8^2) + (1x8^1) + (1 \times 8^0)$

As ($8^2 = 64$), ($8^1 = 8$) and ($8^0 = 1$), this gives a multiplier value for each column.

To obtain the following, multiply each column's digit by its respective column multiplier value: 1x64 = 64 , 1x8 =8 , 1x1 = 1

Then simply add these results to give the decimal value.

$64 + 8 + 1 = 73_{10}$

Therefore $111_6 = 73_{10}$.

Converting From Decimal To Any Radix

To change a decimal integer number—a decimal number that does not take into account its fractional component—to any other radix, simply divide the number by its radix and write down the remainder with each division. The remainder will be the converted result when read from bottom to top.

Decimal to Binary

To translate the decimal number 5910 to binary, for instance:

Divide 5910 by the system radix, which equals 2 in binary conversion. This results in a residual of 1 and an answer of 29.

Decimal to binary calculation steps

Divide by the base 2 to get the digits from the remainders:

Division by 2	Quotient	Remainder (Digit)	Bit #
(59)/2	29	1	0
(29)/2	14	1	1
(14)/2	7	0	2
(7)/2	3	1	3
(3)/2	1	1	4
(1)/2	0	1	5

$= (111011)_2$

Until the answer equals zero, keep dividing the answer by two and recording the remaining amount. Just write the remainders down now, beginning at the bottom, to get 1110112. Therefore $59_{10} = 111011_2$

Decimal to Octal

To convert decimal to octal, follow the same procedure, but this time use 8 as the system radix: Therefore $59_{10} = 73_8$

Decimal to octal calculation steps

Divide by the base 8 to get the digits from the remainders:

Division by 8	Quotient	Remainder (Digit)	Digit #
(59)/8	7	3	0
(7)/8	0	7	1

$= (73)_8$

Decimal to Hexadecimal

The radix is now 16 when converting decimal to hexadecimal, yet it still functions: Therefore $56_{10} = 38_{16}$

Decimal to hex calculation steps

Divide by the base 16 to get the digits from the remainders:

Division by 16	Quotient	Remainder (Digit)	Digit #
(56)/16	3	8	0
(3)/16	0	3	1

$= (38)_{16}$

Converting Binary to Decimal

Write down the binary number with the appropriate "weighting," or the values of the columns, beginning with one for the right-hand (least important column or LEAST SIGNIFICANT BIT) column in order to convert it to decimal. As you proceed left, give each column double the value of the preceding column.

Bit	2^7	2^6	2^5	2^4	2^3	2^2	2^1	2^0
Value (weighting) of each bit	128	64	32	16	8	4	2	1

Example:

To convert the binary number 0100010_2 to decimal, write down the binary number and assign a 'weighting' to each bit as in the above table

Simply sum the values of each column that has a 1 bit, disregarding any columns that contain a 0.

Applying the appropriate weighting to0100010 gives $(0 \times 2^6) + (1 \times 2^5) + (0 \times 2^4) + (0 \times 2^3) + (0 \times 2^2) + (1 \times 2^1) + (0 \times 2^0) = (34)_{10}$

Therefore: $0100010_2 = 34_{10}$

Converting Hexadecimal to Decimal

Using the table below, a similar approach may be used to quickly convert hexadecimal to decimal.

In the bottom row, the hexadecimal digits are inputted and then multiplied by the weighting value for that column.

The decimal value is obtained by adding the values from each column.

Therefore: $24CB_{16} = 9419_{10}$

Column	16^3	16^2	16^1	16^0
Value (weighting) of each column	4096	256	16	1
Hex value	2	4	C	B

$(24CB)_{16} = (2 \times 16^3) + (4 \times 16^2) + (12 \times 16^1) + (11 \times 16^0) = (9419)_{10}$

Binary and Hexadecimal

Hexadecimal is only a way to present binary in a more readable format; the conversion from binary to hexadecimal is much simpler.

Binary is frequently divided into bytes, or eight bits, which makes it simple for machines to interpret but difficult for humans to do so accurately. Each 8-bit byte in hexadecimal is divided into two 4-bit nibbles, with a value ranging from 0 to 15. As a result, one binary bit may be directly represented by each hexadecimal digit, which likewise has values between 0 and 15. This reduces the eight bits of the binary to just two hexadecimal characters.

For example:

11101001_2 is split into 2 nibbles 1110_2 and 1011_2 then each nibble is dispensed a hexadecimal value between 0 and F.

The bits in the most significant nibble (1110_2) add up to $8+4+2+0 = 14_{10} = E_{16}$

The bits in the least significant nibble (1001_2) add up to $8+0+2+1 = 11_{10} = B_{16}$

Therefore $11101011_2 = EB_{16}$

Calculation

Convert every 4 binary digits (from bit0) to hex digit (see conversion table below):
11101011
= 1110 1011
= E B
= EB

Transforming hexadecimal to binary of course simply reverses this process.

Binary	Hex.
0000	0
0001	1
0010	2
0011	3
0100	4
0101	5
0110	6
0111	7
1000	8
1001	9
1010	A
1011	B
1100	C
1101	D
1110	E
1111	F

- **Knowledge Check 3**

  Convert the following:

  1. 110100111 to decimal.
  2. 101110112 to decimal.
  3. 34E216 to decimal.
  4. BBBB16 to decimal.

- **Outcome-Based Activity 3**

  Classroom Activity - Effort these conversions to decimal WITHOUT YOUR CALCULATOR.

  111_2 77_8 ABC_{16} CC_{16}

  How do you know whether you've given the proper answer? Revert your decimal answer to its original format.

1.6 Summary

- Number systems are used to represent numerical values in various fields, including electronics.
- Different number systems use different bases or radices to represent values.
- Electronics use various number systems, including binary and hexadecimal, to represent values such as memory addresses and digital signals.
- The number of distinct digits or symbols used to represent numerical values is known as the base or radix of a number system.
- To distinguish between whole and fractional parts of a number, utilize the radix point.
- Values that are too big or little to be expressed directly are represented using exponents.
- A technique for encoding decimal numbers in a binary environment is called floating point notation.
- Common types of number systems include decimal, binary, octal, hexadecimal, and generalised (radix-n) systems.
- Conversion between number systems can be done by repeated division or multiplication, or by using conversion tables or calculators.
- Converting from binary to decimal entails multiplying each digit by the relevant power of two and combining the results, whereas converting from decimal to binary requires repeatedly dividing by two. Other number systems can be converted using comparable techniques.

1.7 Self-Assessment Questions

1. Explain Number Systems in Electronics.
2. Describe The Radix Point.
3. What are the different types of Number system?
4. Write steps to convert Binary and Hexadecimal

5. Convert 34F216 to decimal.

1.8 References

- Digital Fundamentals: Floyd, Jain R.P., Pearson Education.
- Mobile Cellular Telecommunications Analog and Digital System by Lee.
- Communication Electronics: Principles and applications by Louis E. Frenzel 3rd edition, TMH Publications.

Unit- 2

Binary Arithmetic

Learning Outcomes:

- Students will convert numbers between various number systems and perform basic arithmetic operations.
- Students will equate the binary place value to the decimal place value.
- Students will convert Base ten numbers converted from base two numbers.
- Students will learn how to measure in binary so they can develop a comprehension of the shapes that appear when binary numbers increase by 1.

Structure

2.1 Introduction

Binary arithmetic includes all common mathematical operations. The next segments contain the rules that apply to these operations when they are performed on binary numbers. The result of adding 1 + 1 + 1 (carry) is 11, which is written down as one and carried to its subsequent column.

2.2 Addition

A binary addition operation works just like the base ten decimals system, except that it's a base two system. In the binary system, there are just two digits: 1 and 0. Most of the features of the computer system rely on the binary value system. The numbers 1 and 0 are used in a binary code to activate or deactivate specific processes. The adding process in the decimal system becomes quite familiar by switching to base 2.

Before attempting to use the binary addition method, we should have a thorough understanding of how the binary numbers system functions. Due to the fact that the majority of contemporary digital computers as well as electronic circuits, carry out binary operations by expressing each bit as an electrical signal. The "OFF" state is represented by bit 0, whereas the "ON" state is represented by bit 1.

2.2.1 Rules for Binary Addition:

When you follow these recommendations or advice, adding in binary is much easier than adding in decimal. Any binary number may be added simply using these rules. There are four binary addition rules:

- $0 + 0 = 0$
- $0 + 1 = 1$
- $1 + 0 = 1$
- $1 + 1 = 10$

2.2.2 Steps for Binary Addition:

Now consider the following binary addition example: 101 + 101

Procedure for Binary Number Addition:

101 (+) 101

First, add the one's column (1+1), which, in accordance with the rules of binary addition, yields the value 10.

Then, Move the value 1 to the 10's column, leaving the 0 in the one's column.

```
          1
        101.
  (+)   101
-----------------------------------
        0
```

Step 3: Now multiply by 10 to get 1, 1+(0 + 0). Nothing goes to the hundredth place, leaving the value one in the tenth place.

```
          1
        101.
(+)     101
-----------------------------------
        10
```

Step 4: The 100th spot (1 + 1) now equals 10. In the 100s place, keep the value 0 and carry 1 to the 1000s place.

```
            1
        101.
(+)     101
-----------------------------------
        1010
```

Thus, 1010 is the outcome of the addition operation.

The value that results must be the same when you compare the binary and decimal values.

The decimal value 5 is equivalent to the binary value 101.

Thus, 5 + 5 = 10

The binary value 1010 corresponds to the decimal number 10.

2.2.3 Binary Addition using 1's complement:

The positive sign is represented by the number 0.

The negative sign is represented by the number 1.

Positive and negative numbers are added.

Case 1: Whenever a positive number is larger than a negative number.

Take the negative number's 1s complement, and then add the carry to the resulting total at the 1's location. The sum value is obtained by adding the carry to the resultant.

+ 1111 as well as -1101

+ 1 1 1 1 = 0 1 1 1 1

- 1 1 0 1 equals 1 0 0 1 0 (using the complement of 1).

———————-

0 0 0 0 1

1

———————

0 0 0 1 0

Consequently, the answer is + 0010.

Case 2: Whenever a negative number is larger than a positive number

If you take the negative number's 1s complement, there won't be any end-around transporting in this situation. Taking the 1's complement of the outcome yields the sum in the end.

+ 1111 as well as -1101

- 1 1 1 1 equals 1 0 0 0 0, when one's complement is used.

+1 1 0 1 = 0 1 1 0 1

———————-

1 1 1 0

———————

(Taking 1's complement) 1 0 0 1 0

Two Negative Numbers Added

Add the 1's complement of each negative number before continuing. A number 1 will appear in the sign bit as a result of the end around carrying. Taking the 1's complement of the outcome will yield the sum value.

Example:

-1010 as well as – 0011

1 0 1 0 equals 1 0 1 0 1 (using the complement of 1).

1 1 1 0 0 (by taking the complement of 1)

———————————

1 0 0 0 1

1

———————————

1 0 0 1 0

_____

1 1 1 0 1 (by taking 1's complement)

Consequently, the answer is - 1101.

Adding With The Complement Of Two

Find the complement of the given negative number, which is 2, first. To the sum, add the indicated positive number. The result will be determined by the bits that remain if we receive the end-around carry 1, which will result in a positive integer and the disregard of the carry bit.

2.3 Subtraction

Binary subtraction is another of the four binary procedures. It is performed by taking two binary values and applying the subtraction procedure to them. (Consisting of just the numbers 0 and 1). This procedure is similar to the basic arithmetic subtraction in mathematics that is carried out using decimal numbers.

Subtracting binary values is an arithmetic operation, much as subtracting base ten or decimal numbers. For example, in base 10 and binary number systems, 1 + 1 + 1 = 3 and 11, respectively. Because these procedures involve adding and subtracting binary integers more frequently, it is vital to use caution when borrowing.

When subtracting several binary number columns, you have to take the borrowing into consideration. One is obtained by deducting one from zero, where one is taken from the bit or digit having the next highest value.

2.3.1 Rules for Binary Subtraction:

Subtraction in binary

- 0 – 0 = 0
- 1 – 0 = 1
- 1 – 1 = 0
- 0 – 1 = 1 (Borrow 1)

2.3.2 Steps for Binary Subtraction:

1010 (-) 101

Step 1: Pay attention to the 1's column first. As per the binary subtraction requirement, which calls for borrowing 1 from the 10's location, the result of subtracting the 1's column from the 0's column (0 - 1) is 1.

Step 2: After being taken as one and borrowed from the 10's column, the number one in that column is changed to the integer 0.

1 Obtain

1 0 1 0

(-) 1 0 1

_____

1

Step 3: Subtract the worth in the tens place, which is represented by (0 - 0) = 0.

1 Obtain

1 0 1 0

(-) 1 0 1

_____

0 1

Step 4: Subtract the numbers with 100s after them. Take 1 from the 1000th position (0 - 1) to equal 1.

1 1 Obtain

1 0 1 0

(-) 1 0 1

_____

0 1 0 1

Therefore, 0101 is the outcome of the subtraction operation.

- When you compare the decimal number and the consequent value of the binary subtraction, they should match.
- The decimal value 10 is equivalent to the binary representation 1010, and the numerical value 101 is equivalent to the number 5.

- Consequently, 10 – 5 = 5.
- As a result, 0101 in binary and 5 in decimal are equal.

Knowledge Check 1

Fill in the Blanks:

1. The result of adding 1 + 1 + 1 (carry) is _____.
2. The system of _____values is used by the majority of the computer system's features.
3. The "_____" state is represented by bit 0, whereas the "ON" state is represented by bit 1.
4. _____is analogous to the basic decimal arithmetic subtraction performed in mathematics.
5. You must account for the _____ when you subtract multiple columns of binary numbers.

- **Outcome-Based Activity 1**

  Comprehending and working with binary numbers. As a result, only binary data can be used for arithmetic operations.

2.4 Multiplication

One among the four binary mathematical operations is binary multiplication. The three more fundamental operations are division, addition, and subtraction. When performing a binary function, we only work with the digits 0 and 1. The procedure used to find a binary product is comparable to the standard multiplication technique.

The binary multiplication operation actually makes use of the addition and shifting process. The multiplier process must then be completed in order to do the addition operation.

Multiplying binary numbers involves multiplying the multiplicand by the multiplier, which is similar to the decimal system. Note that multiplication by zero converts every bit to a zero, hence this operation might be skipped in the intermediate steps. Once multiplied by 1, the multiplicand value does not change in any way.

2.4.1 Rules of Binary Multiplication:

When you understand the following multiplication rules, binary multiplication is significantly simpler than decimal multiplication, as are other binary operations. Binomial multiplication follows the following rules:

- $0 \times 0 = 0$
- $0 \times 1 = 0$
- $1 \times 0 = 0$
- $1 \times 1 = 1$

According to these laws, it is obvious that a binary multiplication that includes 0 will produce zero. Hence,

The binary result of both 0 and 0 equals 0.

The binary sum of 1 and 0 is 0.

The binary result of 1, as well as 0, is 0.

But 1 is the binary data combination of 1 and 1.

Method to Example 1: 1010 101

Solution:

1010 × 101

1010

(×) 101

_____

1010

0000

_____

First Intermediate Sum, 01010

1010

_____

110010

Comparing values to decimal values

10102 = 1010

10102 = 510

10 x 5 = 5010

(110010)2 = 5010

2.5 Division

The binary division procedures are similar to the base 10 decimal system, with the exception of base 2. The division is undoubtedly one of the most difficult basic mathematical operations. Division problems can be approached in a number of ways using binary operations. Long division is the most basic and efficient of them all.

2.5.1 Rules of Binary Division:

Binary division is much easier than decimal division if you remember the following division rules. The following are some basic rules for binary division:

- 1÷1 = 1
- 1÷0 = No meaning
- 0÷1=0
- 0÷0 = Meaningless

The four-step technique used in the division of binary numbers is similar to that used in the decimal number system.

- Divide
- Multiply
- Subtract
- knock down

In relation to a decimal value,

(01111100)*2* = (1111100)*2* = 124*10*

(0010)*2* = (10)*2* = 2*10*

Whenever you divided 124 by 2, you will obtain the value 62 as the outcome.

Consequently, 62's binary equivalent is (111110)*2*

(111110)2 = 62*10*

The outcome is the same whether the system is binary or decimal.

Solve the 01111100 0010 equation.

Solution:

Given, 01111100 ÷ 0010

Here, the divisor is 0010, and the dividend is 01111100.

The integer's value stays the same if the zeros are removed from the Most Important Bit in the dividend and the divisor.

As a result, the divisor changes to 10, and the dividend becomes 1111100.

Use long division from this point forward.

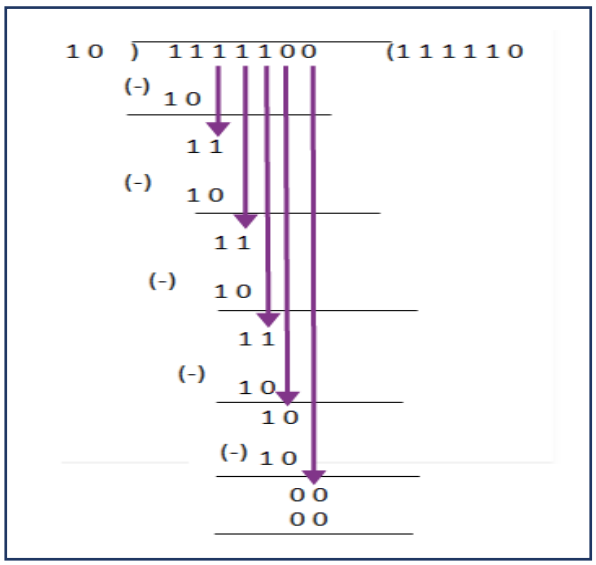

Fig. 2.5 Binary Division

Step 1: Examine the dividend's first two digits and contrast them with the divisor. In the quotient position, increase by 1. The remaining is 1 after the value has been subtracted.

Step 2: Next, take the next number out of the dividend component, and then repeat the steps from Step 1

Step 3: Continue the procedure through contrasting the dividend with the divisor values until the residual equals zero.

Step 4: In this instance, since you have zero remaining in the dividend part after setting the remainder value to 0, add that zeroes to the quotient component.

As a result, the quotient value, which equals 111110, is the result.

Therefore, 01111100 ÷ 0010 = 111110

2.6 Subtraction

For subtracting two binary values using the complement of 1, follow these steps:

- Find the complement of 1 of the subtrahend in the first step.
- Next, combine the minuend with the complement number.

- If you have a carry, add it to the LSB. Otherwise, take the result's negative 1's complement.

1) For instance, 10101 - 00111

When we subtract 00111 by its complement 1, we get the number 11000. Now add them up. So,

10101 + 11000 =101101.

When we add the carry bit 1 from the aforementioned result to the LSB of a result, we get 01101+1=01110, which represents the solution.

2) 0101 through 0111

01000 is the outcome of taking the subtrahend 10111's 1's complement. Now add the two numbers. Thus,

10101+01000 =11101.

We did not receive the carry bit in the above result. Decide on the counterpart of 1 of the result, which equals 00010, the final solution and a negative integer.

Subtraction using 2's complement:

For subtracting two binary values using the complement of 2, follow these steps:

- Determine the 2's complement for what you subtrahend in the first step.
- The complement number and the minuend are added.
- If the two numbers add up to a carry, we discard the carry therefore, the result is positive; otherwise, we take the result's 2's complement, which is a negative number.

For instance,

1)10101 - 00111

Taken as 11001, the 2's complement of the subtraction 00111.

Now add them up. So,

10101+11001 =101110.

We find that carry bit 1 in the aforementioned outcome. Therefore, we eliminate this carry bit, leaving the final outcome and a positive integer.

2) 10101 - 10111

When we take the 2's complement of the subtraction 10111, the result is 01001. We now combine the two figures. So,

10101+01001 =11110.

We did not receive the carry bit in the above result. Calculate the result's 2's complement, or 00010, then. The ultimate solution is the negative number.

- **Knowledge Check 2**

  Fill in the Blanks:

  1. When performing a binary function, we only work with the digits 0 and _____.
  2. The procedure used to find a binary product is comparable to the standard _____ technique.
  3. Note that multiplication by zero causes all of the bits to become _____.
  4. With the exception of base 2, the binary _____ operations resemble the base ten decimal system.
  5. Binary operations can be used to _____ division problems in a variety of ways.

- **Outcome-Based Activity 2**

  A binary converter is an electrical device that multiplies two binary integers in digital technology, such as computers. A digital multiplier can be implemented using a variety of computerised mathematics methods.

2.7 Summary

- The following sections include the rules that control these processes when they are applied to binary integers. One plus one plus one (carry) equals eleven, which is expressed as one and carried to the column behind it.
  - • With the exception of being a base 2 system, a binary addition operation functions similarly to the base 10 decimal system. There are only two digits in the binary system: 1 and 0. The binary value system is used by the majority of the computer system's functions.
  - Binary subtraction is another of the four binary procedures. It is performed by taking two binary values and applying the subtraction procedure to them. (Consisting of just the numbers 0 and 1). This procedure is similar to the basic arithmetic subtraction in mathematics that is carried out using decimal numbers.
  - When performing a binary function, we only work with the digits 0 and 1. The procedure used to find a binary product is comparable to the standard multiplication technique.

- With the exception of base 2, the binary division operations resemble the base 10 decimal system. Of the fundamental arithmetic operations, the division is perhaps one of the trickiest.

2.8 Self-Assessment Questions

1. What is the rules for Addition of Binary arithmetic?
2. Explain the concept of Multiplication binary arithmetic.
3. Solve 10111 – 10110 using 1’s complement.
4. Explain the concept of subtraction using 2’s complement.
5. Solve 1010 * 1011.

2.9 References

- Data Encoding and Representation, Bitwise as well as Arithmetic Operations, and Advanced Binary Basic Programming and Computer Science (Kindle Edition),2018, Sunil Tanna.
- computerscience.chemeketa.edu, "3.3. Binary as well as Its Advantages – CS160 Reader." obtained on May 22, 2022.

Unit- 3

Computing Environment and Data Storage

Learning Outcomes:

- Students would be able to comprehend the parts of computers and memory.
- Students would be able to learn about the history of computing.
- Students would be able to learn about the Role of Operating Systems.
- Students would be able to know about the Various Primary and Secondary memories.

Structure

3.1 History of computing

The first known calculator is probably the abacus. It is still in use today, particularly in Asia, having been there since at least 1100 BCE. Usually, it consists of a rectangular frame with thin, beaded parallel rods stretched across it. The abacus gave each rod a distinct weight or

unit long before systematic positional notation for writing numbers was developed. This typically directed a wide range of numbers to be represented by a small number of beads and may have served as the model for the creation of the Indian zero and the Hindu-Arabic numeral system. In any event, basic arithmetic operations like addition, multiplication, subtraction, and division can be performed with ease using abacus beads.which are helpful in business transactions and recordkeeping.

Since the abacus is a digital instrument, values are subtly reflected in it. A bead clearly represents zero or one when it is in one of two locations.

When Scottish mathematician John Napier published his logarithms discovery in 1614, computing devices took a different turn. As anyone can affirm, It is far simpler to add two 10-digit integers than to multiply them together, and logarithms allow you to convert a multiplication problem into an addition problem. The logarithmic property, which states that the logarithm of the product of two numbers is equal to the sum of the logarithms of the numbers, allows for this generalization. By 1624, logarithms of numbers up to 20,000 were available in 14-digit significant digit tables, and astronomers seized upon this labor-saving solution for labor-intensive astronomical computations.

The transformation of multiplication into addition was particularly important for the development of computing since it made mechanization much more straightforward. Soon after, analog computing systems that represent digital values with comparable physical lengths using Napier's logarithms first appeared. The Gunter scale, or Gunter as navigators called it, was a tool developed in 1620 by English mathematician Edmund Gunter, who also coined the terms cotangent and cosine.

Around 1632, mathematician William Oughtred and an English clergyman developed the first slide rule based on Napier's theories. Although the first slide rule was round, Oughtred also made the first rectangular one in 1633. Gunter and Oughtred's analog devices had a number of advantages over electronic devices such as the abacus, in addition to certain disadvantages.

3.2 Early Computers

Ballistics calculations and other statistical processes were in high demand between 1935 and 1945 to support military operations; these tasks were labor-intensive and were completed by personnel using antiquated calculators. At this time, there was a rush to create specialized

digital computers that could compute shooting tables, ballistics problems, and code-breaking calculations more quickly. Many such machines were developed by industrial firms, government agencies and office machine manufacturers in Great Britain, United States and Germany.

Differential Analyser

In the 1920s, a wide range of commercial calculators were available, but they lacked the power to solve scientific computing problems. It was made up of shafts, gears and wires. It was faster compared to the traditional calculators, but it was still cumbersome and slow, requiring two or three days of configuration time before it could resolve an issue.

In 1935, a more accurate and faster differential analyser was constructed, but it, too, needed modifications with hammers and screwdrivers before it could be used.

Harvard Mark I

Commencing in 1939, it possessed the same huge size as other PCs of that era. The Mark I was 15.2 meters (50 feet) long and 2.4 meters (8 feet) tall. Its 800,000 pieces were mostly sourced from IBM punched-card machinery. It was 5.5 metric tonnes (10,000 pounds) in weight, had 805 kilometers (500 miles) of wire, and used a lot of electricity. To keep the equipment cool, tons of ice were required daily.

ENIAC (Electronic Numerical Integrator and Computer)

American meteorologist John Mauchly (1907–1980), who worked on meteorological computations, started building a cheap digital computer. 18,000 vacuum tubes, 10,000 capacitors, 70,000 resistors, 1,500 relays, and 6,000 switches were all part of the ENIAC's hardware. It weighed 33 metric tonnes (60,000 pounds) and 162 square metres (1,800 square feet) in size. It was 30.5 metres (100 feet) long, 0.9 metres (3 feet) deep and 3.1 metres (10 feet) high, requiring 160 kilowatts of power. It took two powerful 20-horsepower blowers to cool it down.

EDVAC (Electronic Discrete Variable Automatic Computer)

Rather than vacuum tubes, EDVAC was given delay-line storage. The binary number system was used for the delay lines. They had a capacity of 1,024 bits, which could be used for keeping 32 32-bit words. The EDVAC was predicted to need from 2,000 to 8,000 words of storage, requiring 64 to 256 delay lines.

3.3 Vacuum tubes

A vacuum tube is a gadget that was invented in 1904 by the English physicist John Ambrose Fleming; that includes electrodes for regulating the flow of electrons. In general, it's used for constraining the flow using a vacuum in a sealed container. It was also used as an amplifier or a switch in early computers, and it is also recognised as an electron tube or a valve.

As a cathode, the vacuum tube generates electrons and an anode, and the anode gathers the electrons for forming a diode. There were, however, other types of vacuum tubes obtainable, that were classified according to the electrodes numbers. The electrodes are then typically bound by the glass in a casing; when sufficiently recharged, it can behave as a conductor with all of the air removed. As lightning moves through the atmosphere, a path for electrons is created. Because of the vacuum shape, it is usually referred to as a vacuum tube.

Vacuum Tube's Different Types

The vacuum tube is an intriguing cleaning component which is employed for a variety of purposes. These vacuum tubes primarily consist of an anode and a cathode.

1. **Diode Vacuum Tubes:** The diode is the most basic type of vacuum tube, with two terminals: a cathode and an anode. The thermionic effect causes electrons to transmit from the cathode's surface when it is sufficiently heated. When a high electrostatic potential cathode is implemented to a lower electric potential anode, the cathode transmits negatively charged electrons which are captivated to the anode. The electric currents then flow in the direction of positive charges due to convection.

2. As a result, electron flow is always regarded from the cathode to the anode. The principal motivation for this is that the current of the negative charges travelling in the same direction is roughly comparable to positive charges currently travelling in the opposite direction.

3. **Triode Vacuum Tubes:** It is a different kind of vacuum tube in which electric currents circulate from the high potential V+. However, a valve to control this flow is still required. A grid is required between the anode and the cathode in a triode, which functions as a third terminal.

4. **Tetrode Vacuum Tubes:** The primary goal of developing the triode was to facilitate the tetrode vacuum tubes introduction. The tetrode has a fourth electrode named the screen

between the grid and the anode. This advanced component's main goal is to shorten the capacitance generated by the grid and the anode.

5. **Pentode Vacuum Tubes:** The main concept behind the pentode was to improve on the tetrodes vacuum tubes. In this type of vacuum tube, there is a greater possibility that electrons from the cathode will reach the anode with sufficient energy to boost secondary electron emission from the anode itself.

3.4 Various Computer Generations

Computer system evolution is typically discussed in terms of several generations. The succession of several generations brought about the growth of computer technology. Now let's examine how computer technology has changed throughout the years.

First Generation

The period from 1940 to 1956 is known as the First Generation of Computers. Vacuum tubes or thermionic valve machines were used in the construction of the first PC generation. Printouts showed the results of this system, which took paper tape and punched cards as input and output. Computers of the first generation were binary-coded, using a language of 0 to 1. EDVAC and ENIAC are a few examples.

Second Generation

Most people agree that the Second Generation of computers came along between 1956 and 1963. The second generation of computers was made using transistor technology. Compared to the first generation, the second generation was smaller. The second generation of PCs required less computing time than the first generation.

Third Generation

The third generation of computers was developed between 1963 and 1971. The third generation of computers was made possible by the development of integrated circuit (IC) technology. The third generation of Personal Computers were smaller than the second generation. Third-generation PCs required less processing time than computers from the second generation. Both power consumption and heat output were reduced by the third-generation computer. The maintenance costs of the third-generation computers were likewise minimal. The third generation of computers was more suited for business use.

Fourth Generation

Computers were regarded as belonging to the fourth generation from 1972 until 2010. The fourth generation of computers was made possible by microprocessor technology. By the

time of the fourth generation, computers had become more portable and smaller. The machine of the fourth generation started to generate very little heat. Both the speed and the accuracy have increased significantly. Relative to the preceding generation, the production cost was extremely low. Additionally, it was available to a larger audience.

Fifth Generation: The period from 2010 to the present as well as afterwards, is regarded to be computer technology's fifth generation. At the time, computer generations were classified just by virtue of hardware, but fifth-generation technology also consists of software. Computers from the fifth generation were powerful and had a lot of storage. This generation of computers allowed for rapid work and simultaneous completion of subtasks. Popular fifth-generation advanced technologies include quantum computation, artificial intelligence, nanotechnology, and parallel processing.

3.5 Parts of Computer and memory including CPU, bus and peripherals:

Various parts of computer and memory are discussed below:

Motherboard

The main board, or motherboard, is the part that screws straight into the computer chassis.
The motherboard is immediately plugged in to everything else, including cards. The power supply, RAM, CPU, disks, and other parts are all connected to it. Enabling all the physical parts to work together and communicate with one another is its responsibility. There are several connectivity possibilities available on a good motherboard. Moreover, it has the fewest bottlenecks that can exist. Everything works as it should, allowing each component to perform at its best and fulfil its purpose.

CPU: Computer systems' central processing unit, or CPU, is their brain. It processes all the data at the computational level. It reads every process from RAM and trains it to perform the tasks that the computer system requires.. For securing the central processing unit onto the motherboard, the CPU is usually accommodated in a socket that uses a latch or lever with a hinged plate with a cut-out in the middle. There are numerous copper pads beneath it for the socket contacts to make electrical contact with.

- **Zero Insertion Force:** Although these sockets are more attractive, they are mostly discovered on older computer motherboards. A lever-operated pathway for clamping the processor's pins.
- **Pin Grid Array:** This socket is similar to the ZIF socket despite having a different pin count and pin pitch.

- **Land Grid Array or LGA:** Today, it is more commonly found on motherboards. The processor is held in place by a levered hinged plate with a focal cut-out.
- **Ball Grid Array or BGA:** The CPU is directly soldered to the motherboard. As a result, it is not user-swappable. It is vulnerable to poor interconnection.

Random Access Memory (RAM):

RAM is a kind of main memory that enables fast access to both reading and writing. RAM is volatile memory, which means that all of the data is lost when the power is switched off. Data is stored in RAM so the CPU can process it. RAM speed is a significant contributor to a computer system's overall speed. It inserts directly into a long slot with contacts on both sides. Similar to a processor, it operates at a clock speed.

Hard Disk Drive: This type of storage is non-volatile. It stores files for your desktop in addition to acting as a boot drive, which lets you run the operating system (OS) from it. You can install a variety of operating systems, depending on what you need. A software application, like Microsoft Windows, that is placed on a machine to enable it for use is called an operating system (OS). A mechanical drive's physical fragility is its most vulnerable feature. One or more platters on a mechanical hard drive spin continuously at 5200 to 10,000 revolutions per minute (RPM). The distance between the read and write heads and the platter is just 0.002 (51 micro M) inches.**SSD:** An SSD is a kind of hard drive that does not contain any moving parts. It is made up of a flash memory bank that can store a satisfactory data amount. While SSDs are becoming increasingly large, they are not cost-effective for putting away large amounts. The SSD is a high-performance drive. It's quick and won't be broken as easily by a few bumps.

Visual Display Unit (VDU) or Monitor: An output device called a monitor shows the graphical data produced by the system's GPU. The most popular method of monitor used with a modern PC is an LED (Light Emitting Diode) backlit LCD (Liquid Crystal Display). There are also different computer screen aspect ratios and sizes. The aspect ratio refers to the proportion of height to width.

Keyboard: A keyboard is a type of input gadget that is used to interact with a computer. When you press a key on the keyboard, you have sent a tiny amount of data to the computer that informs it which key you press. When the device obtains keyboard input, it's able to

utilise the keystrokes in digital form to carry out a particular operation in any software that is in use.

Mouse: A mouse is an input device that allows a user to communicate with computer systems by continuously moving a pointer on the monitor. Nowadays, mice contain more buttons compared to the standard three or much more operations. The user can use the three main buttons for grabbing, selecting, accessing and scrolling additional menus and options. A computer mouse, which can be wireless or wired, is a useful pointing device.

- **Knowledge Check 1**

  Fill in the Blanks:

  1. A mouse is an input gadget which permits the customer to move a _____displayed on the monitor.
  2. _____ can make use of the keystrokes in digital form for performing a particular task.
  3. A monitor is an output device used to _____.
  4. LED stands for _____.
  5. LCD stands for _____.

- **Outcome-Based Activity 1**

  Show some screenshots of the peripheral devices of the computer.

3.6 Basics of digital data storage:

Digital data storage is mostly used for fail-safe data storage and backup. Cloud storage has become a component of digital data over the past few years. It is a server which stores all uploaded data, such as media files. It is typically used by businesses which contain huge amounts of data that must be shielded and backed up.

Storing of digital data

Data is technically stored as numbers or code for a desktop for reading and controlling. It is then guided by computer input rules and saved in various places. Data contained within files could be kept offline in various drive types, on a physical site, such as online in the cloud or a hard drive.

Various ways for the data storage

There are various kinds of data storage, and it is essential to comprehend how they differ from one another. RAM, or memory, is temporary data storage that lets the machine obtain it rapidly. The information kept here is not permanent. In contrast to slower storage options, it lets a machine read data quickly.

In contrast to RAM storage, the other storage kind is a gadget, such as a hard drive, which holds permanent data. Because the drive can be internal or external, this storage is possibly portable. Personal data contained within various files, such as media, is typically saved on external drives or hard drives for prospective usages. It also aids the uploader in retrieving information faster in the long term.

Alternatives to traditional storage

Digital data storage started as a computer audio storage technology. It was then converted to have included various digital files. Businesses are increasingly abandoning traditional on-site sites in favour of cloud-based systems that improve collaboration. When businesses have to share data with third parties, they set up a digital data centre. These systems conserve space, time and funds. They are also essential as they offer immediate backup security.

Companies safeguard sensitive data by providing round-the-clock and adequate service. As a result, they are going to trust their data to systems and companies whose main objective is digital data storage. These systems avoid overloading of data and storing data within infrastructures which enable businesses to access their information faster.

Digital data storage systems

Data storage systems are servers that store company data in spots other than the company office. Although digital asset management software keeps data in a similar manner, there are a few slight variations. DAM is appropriate for documents and media files because it improves retrieval, collaborative effort and sharing.

DAM technically holds data, but it's oriented more towards businesses that want to keep and share digital files with external parties. It also efficiently arranges files. Take into account a DAM system when you require to store a variety of file types, like other documents and media.

The digital storage future

Businesses require more methods and space for keeping records as it expands and changes. Nobody, without a doubt, can forecast what is to come. However, given the information we have so far, we can certainly make estimations. If we continue on our current path, data should continue to grow at an exponential rate. Moreover, for legal purposes, businesses will be obligated to maintain detailed records.

The most vital point you are able to perform is focus on what you particularly require to successfully keep your data. Digital data storage ought to assist in reducing storage space, but also provide your business with the capacity to rapidly fetch files. To make the most of your data, make use of the correct storage system.

3.7 Various Primary and Secondary Memories:

In general, a computer system has two memory kinds.

Primary Memory or Volatile Memory

It's referred to as internal memory in computers. It is sometimes called transitory memory or main memory. It keeps track of the data and instructions that the CPU or system is currently processing. Primary memory is referred to as volatile memory, as it starts to lose all data when the power is turned off. There are two kinds of main memory.

- ROM
- RAM

RAM stands for Random Access Memory; it is an acronym for the same. One kind of read/write memory is RAM. It is the primary memory of the computer system. This memory is merely short-term. The data stored in RAM is lost when the computer's power source is switched off.

Types

Static RAM: Static RAM is what it's called. As long as the power source is turned on, data is kept in this RAM. SRAMs are more expensive and power-hungry. When compared to dynamic RAM, they are speedier.

Dynamic RAM: It retains data even when the power source is turned on in a matter of milliseconds, on average. In terms of cost, speed, and power consumption, dynamic RAM is less expensive.

Read Only Memory −Read Only Memory is a term that can be shortened. One kind of permanent memory is ROM. The ROM data is retained even after the power supply is switched off. At the point of production, the computer manufacturer incorporates and permanently stores the ROM content. ROM cannot be overwritten by the computer. Another name for it is non-volatile memory. The following are the names of the three kinds of ROM memory:

Programmable Read Only Memory, also known as PROM — It is used to write data once and read it several times. Once a chip has been programmed, its stored data cannot be altered. Non-volatile memory is the kind that it is.

Erasable Programmable Read Only Memory (EPROM) chips -Programmed by wiping out the data that was previously stored in them. Because of the information stored in EEPROM, the chip is exposed to UV light.

Electrically Erasable Programmable Read Only Memory- In a matter of milliseconds,it erase every byte of data on the device or just a portion of it.

Non-Volatile Memory or Secondary Memory

It is the external memory of a computer. It is also known as auxiliary memory or persistent memory. It is employed to permanently store different programs and data. The data is stored permanently in this non-volatile memory, even in the event of a power outage.

The following are the secondary storage devices:

Floppy Disks: A floppy disc, also known as a floppy diskette, floppy disc or floppy, is a kind of storage media which reads data storage information. It is used for keeping electronic data, such as a PC file. Being one of the first hardware storage types created by IBM in 1967 that could read and write a handheld device made it extremely expensive.

Magnetic (Hard) Disk: A magnetic disc is a type of data storage device that employs magnetisation to write, access, and rewrite data. It is magnetically coated and keeps data in the form of spots, tracks and sectors. Magnetic discs include hard discs, floppy disks and zip discs.

Magnetic Tapes: Magnetic tape is a physical storage medium for various data types. It is seen as an analog solution as opposed to more modern forms of storage media, such as solid

state disc (SSD) drives. Magnetic tape served as a primary means of storing binary data and audio for several decades, and certain systems continue to employ it today.

Pen Drive: A USB drive, also known as a memory stick or flash drive, is a portable and small gadget that can be plugged into your computer's USB port. USB drives are frequently employed for information storage, backup, and file transfer between gadgets.

Optical Disk (CD, DVD): An optical disc drive, as used in computers, is a disc drive that uses electromagnetic waves or laser light that is close to, inside, or part of the visible light spectrum to read or write data to optical discs.

Knowledge Check 2

State True or False

1. Primary memory is a computer's external memory.
2. RAM is used to permanently hold various information and programmes.
3. EPROM chips can be programmed by deleting the information previously kept in them.
4. ROM is a type of permanent memory.
5. Dynamic RAM is less expensive, has a slower speed, and uses less power.

- **Outcome-Based Activity 2**
  Show pictures of various primary and secondary memory with screenshots.

3.8 Role of Operating Systems

An operating system is a software that runs programs and serves as a conduit for human and computer hardware communication. Allocating resources and services, such as devices, processors, memory, and information, is the primary duty of an operating system. The operating system has a traffic controller, a memory management module, a scheduler, I/O programs, and a file system to handle these resources.

Functions of Operating Systems: Various functions of the operating system are discussed below:

Security

Password protection and other related measures are employed by the operating system to secure user data. Moreover, it stops unauthorized access to user information and applications.

Control over the performance of system

The operating system keeps an eye on the overall health of the machine to maximize performance. To get a complete view of the security of the system, monitor the time elapsed between service requests and system responses. It can increase productivity by providing relevant information for troubleshooting.

Job Accounting

The operating system records the amount of time and resources used by particular activities and users; this information can be used to compute the amount of resources used by a particular user or by a group of users.

Error Detecting Aids

The operating system continuously monitors the system to find flaws and prevent a computer system from being careless.

Coordination among Other Software and Users

Operating systems also begin to arrange and assign users to compilers, interpreters, assemblers, and other software.

Managing Memory

Principal memory, sometimes known as main memory, is managed by the operating system. It is composed of an enormous number of words, or bytes, each having a unique address. Fast storage that the CPU can completely utilize is main memory. A program needs to be loaded into the primary memory before it can be run. The following are the methods the operating system uses to manage memory:

- In multiprogramming, the operating system keeps track of which processes have memory access for how long. This means that user programmes can use specific bytes of memory, memory locations that have recently been allotted, and memory locations that have not yet been utilized.
- It provides memory to the process when it requests it and releases memory when the process departs or accomplishes an I/O operation.

Process Management

The operating system (OS) detects which processes are directly in contact with the processor in a multiprogramming environment, as well as how much processing time each process appears to have. We refer to this feature of the operating system as process scheduling. The operating system handles the following tasks related to processor management:

• It tracks the advancement of procedures.

This function is carried out by a program called a traffic controller.

• A process is assigned to a CPU that is processor-based. The CPU is put out of service when a process is no longer needed.

Device Management

Directories provide for easier navigation and use of a file system. Additional files and directories might be present in these directories. An operating system's file management tasks include, among other things, trying to maintain track of where data is stored, each file's state, user access settings. All of these characteristics are referred to as the file system.

3.9 Various Generations and Types of Computer Software

Programming languages are categorised into many generations. This categorisation was historically used to indicate the immense influence of programming styles.

Second generation (2GL): Assembly languages are classified as second-generation programming languages (2GL).

For instance: Assembly languages

Fourth generation (4GL): Fourth-generation languages are typically focused on very particular programming domains. Assistance for database management, mathematical optimisation, report generation, web development or GUI development may be included in 4GLs.

Examples: Unix Shell, ABAP, PL/SQL, SQL, R, Oracle Reports.

Fifth generation (5GL): It is any programming language that solves problems utilising restrictions provided to the programme instead of an algorithm crafted by the programmer. It includes most logic programming and constraint-based languages, as well as some other declarative languages. It resolves on its own using technology known as Artificial Intelligence.

Fifth-generation programming languages are meant to be used on desktops to solve specific problems without the need for human intervention, whereas fourth-generation languages are meant to be used to create original programs. In this way, the user doesn't have to worry

about how to implement an algorithm or routine for fixing problems; instead, they can focus on what problems to solve and what conditions to meet. These are mostly employed in research on artificial intelligence. Fifth-generation languages include the Lisp-based ICAD, as well as Mercury and OPS5. A frame language is an example of a concept, like KL-ONE.**For instance:** OPS5, Prolog, Mercury

Sixth generation (6GL): It refers to any programming language that is centred on visual development. These are referred to collectively as "Visual Development." or "NoCode".

For instance: Bubble.io

3.10 Summary

• The first known calculator is probably the abacus. It is still in use today, particularly in Asia, having been there since at least 1100 BCE. Usually composed of thin parallel rods laced with beads, it has a rectangular frame.

- Primary memory, sometimes known as main memory, is maintained by the operating system. There are tons of words, or bytes, in the primary memory, each having an address.

  •The operating system determines the general health of the system in order to maximize performance. To get a full picture of the health of the system, monitor the time elapsed between service requests and system responses. Because it provides crucial information for troubleshooting, this can increase efficiency.

- Data storage systems are servers that store corporate data in places other than the company office. Although digital asset management software keeps data in a similar manner, there are a few subtle differences. DAM is appropriate for media documents and files because it improves retrieval, collaboration and sharing.
- As a cathode, the vacuum tube generates electrons and an anode, and the anode collects the electrons to form a diode. There were; however, other types of vacuum tubes obtainable, which were classified based on the electrodes count.

• Computers were regarded as belonging to the fourth generation from 1972 to 2010. The fourth generation of computers was made possible by microprocessor technology. Computers had become so compact that they could be carried about by the fourth generation.

3.11 Self-Assessment Questions

1. Discuss about the main role of the operating system.
2. Explain about the various generations and types of Computer software.
3. Write a note on the vacuum tubes and the history of computing.
4. What do you mean by various primary and secondary memories?
5. Discuss about the basics of digital data storage.
6. Write a note on various parts of the computer and memory.

3.12 References / Reference Readings

- Huebner, E., &Henskens, F. (2018). The role of operating systems in computer forensics. *ACM SIGOPS Operating Systems Review*, *42*(3), 1-3.
- Mollah, M. B., Islam, K. R., & Islam, S. S. (2016, April). Next generation of computing through cloud computing technology. In *2012 25th IEEE Canadian conference on electrical and computer engineering (CCECE)* (pp. 1-6). IEEE.
- Unsworth, N., & Engle, R. W. (2017). The nature of individual differences in working memory capacity: active maintenance in primary memory and controlled search from secondary memory. *Psychological review*, *114*(1), 104.
- Tsunoda, Y., Horigome, S., & Tsutsumi, Z. (2021, January). Optical digital data storage technologies with semiconductor laser head. In *Optical Data Storage* (p. MB1). Optica Publishing Group.
- Shao, F., Sun, R., Diao, K., & Wang, X. (2018, October). A new secure architecture of network computers based on single CPU and Dual Bus. In *2008 Fifth IEEE International Symposium on Embedded Computing* (pp. 309-314). IEEE.
- Misra, G., Kumar, V., Agarwal, A., & Agarwal, K. (2016). Internet of things (iot)–a technological analysis and survey on vision, concepts, challenges, innovation directions, technologies, and applications (an upcoming or future generation computer communication system technology). *American Journal of Electrical and Electronic Engineering*, *4*(1), 23-32.

Unit- 4

Data Transmission

Learning Outcomes:

- Students would be able to learn about the Basic of Digital transmission.
- Students would be able to know about the LAN and WAN system.
- Students would be able to understand the Networking technologies.
- Students would be able to know about the devices and topologies of Network.

Structure

4.1 Basic of Digital Transmission

Data communication is the transmission of ciphertext from one location to another via an electronic transmission system. It can also be characterised as the transfer of data between two gadgets via a wireless or wired transmission medium. It is the transmission of digital information (typically in binary form) among two or more terminals or points. Data are in digital form at both the destination and source; however, all through transmitting, they can be in either analogue or digital form. Signals, which are physical parameters that fluctuate over time, carry information. A voltage corresponding to the voice amplitude, as in a basic

telephone, a series of light pulses in a radio-electric wave or an optical fibre can all be used as the signal.

The primary goal of data communication is to share data, which is accomplished by adhering to certain regulations and rules known as protocols and standards. The causes justify the interaction among devices:

i. Lessens the amount of effort and time needed to complete a business task.
ii. Intercepts company data at the point of origin
iii. Streamlines control over company data
iv. Hastens information dissemination.
v. Diminishes both present and potential company costs.
vi. Allows for the growth of company capacity at a sensible additional expense as the organisation grows.
vii. Contributes to the organisation's goal of centralising computer systems.
viii. Promotes enhanced organisational management control.

The efficiency of a data communication system is determined by three key factors:

Delivery

The system has to get the data to the right place. The intended user or device should be the only one with access to data.

Precision

Accurate data must be provided by the system. Unfixed data that has been altered during transmission is worthless.

Promptness

The system needs to provide data in a timely manner. Data that is canceled or postponed has no value at all. When it comes to speech, video, and audio data, timely delivery is attempting to provide information as soon as it is created, in the order that it is created, and without significant delay. The term "real-time transmission" describes this.

Data Communication Component

The transmitter sends the message, and the recipient receives it. The protocol is a set of guidelines that controls how data is transformed from an encoded form to a decoded form. The medium is the channel by which the message is sent. The message is, of course, vital to

each and every component. The message is a representation of the data being communicated. The essential components of a communication system are as follows:

Transmitter

The transmitter is the device that sends out the information. It might be a phone, computer, video camera, workstation, or other gadget.

Receiver

The receiver is the device that receives the communication. It might be a television, workstation, phone, computer, or other gadget.

Medium

The transmission medium is the actual path a message travels on its way from the sender to the recipient. You can employ radio waves, lasers, coaxial cables, fiber-optic cables, and twisted pair wire.

Message

The data transmission to be delivered is the message. It could consist of text, numbers, pictures, audio, video, or any combination of these.

Protocol

A protocol is a collection of regulations governing the transmission of data. It is a contract between the communicating devices. Two devices may be linked but not interacting without a protocol, just as an individual speaking German could be comprehended by an individual speaking only Japanese.

4.2 Networking Technologies and physical transmission media

Information is transferred between large and little volumes of data using technology. Both corporations and educational institutions can use this technology. Network technicians can transmit digital data, including audio, video, and data files, since they are knowledgeable about the setup, maintenance, and troubleshooting of network technology. When required by the organization, users can use networking to send and receive files and messages via email or other streams.

Assessing a business's informational and organizational requirements as well as estimating the cost of account management, hardware, installation, security, and training are all part of

the process of growing a network. After a network is put into place, technicians are in charge of keeping it operating by helping employees who run into issues.

Types of Network Technology Network technology can be categorized based on transmission and scalability. This technology enables the exchange and transfer of data. There are two ways to implement transmission-based network technology: point-to-point and multi-point.
From Point to Point In a point-to-point network, data can be sent via an unguided medium for wireless networks and a guided medium for wired networks when the sender and receiver (nodes) are directly connected.

Multiple points In multi-point, many nodes are directly connected to one another in a linear form through the use of a generally recognized medium. Similar to time-sharing, multi-point network technology mostly utilizes one of these two connections. Each node in the first connection has a specific time window for communication, but in the second scenario, nodes' interactions might occur simultaneously.

Network Technology Is Scale Dependent LAN, WAN, MAN, VPN, and PAN are examples of ideas found in scalable network technology.

Network in the Local Area Another term for a local area network (LAN) is an IEEE 802 network, which makes use of devices like laptops, desktop computers, and mobile phones that are connected within a 100- to 10-kilometer radius. The main determinants of this network's characteristics are its error rate, speed, range, and users.

Network for the Metropolitan Area A bridge is a network that creates a metropolitan area network (MAN) by joining several local area networks (LANs) via a networking device.

Wide Area Network

A route is a network that creates a WAN by joining many WANs with a networking device. Private and public WANs are the two different types of WANs.

- Public WAN: Government agencies oversee this kind of WAN.
- Private WAN: Known as ARPANET, the US Military's Defense Wing is expanding this kind of WAN.

Individualized Personal Network It's a computer network that makes it possible for machines around an individual to communicate with one another. These networks can be wireless, like ZigBee, IR, and ultra-wideband, or wired, like USB or FireWire. The typical range of this network is a few meters. Among the most important parts of this are wireless keyboards, printers, game consoles, wireless mouse, wireless headsets for cell phones, and barcode scanners.

Virtual Private Network

It is launched virtually on the public network for interaction and information transmission from the sender to the recipient. This network establishes an encrypted and secure connection above a less secure network, such as the public internet. Tunnelling protocols are used at both the sending and receiving ends of this network to encode and decode data.

Advantages

The following are some of the benefits of network technology.

- It is highly adaptable.
- It enhances interaction and knowledge accessibility.
- It enables the simple sharing of resources.
- Files are simple to share.
- It is less expensive.
- The storage capacity would be increased.

Disadvantages

The following are some of the drawbacks of network technology.

- It loses autonomy and is durable.
- It makes security more difficult.
- It is open to malware and viruses.
- It requires a skilled operator.
- It necessitates a one-of-a-kind setup.

- **Knowledge Check 1**

  Fill in the Blanks:

  1. _____ is launched virtually on the public network for communication and data transmission from the sender to the receiver.
  2. A PAN (personal area network) is a computer network, and it facilitates interaction between _____.
  3. _____ type of WAN is handled by government divisions.
  4. A network where numerous LANs are united jointly by a networking gadget is referred to as _____.
  5. A different name for LAN is _____.

- **Outcome-Based Activity 1**

  Make a VPN network on your computer and show outcomes.

4.3 LAN

A collection of devices connected in a single physical location, such as a building, house, or office, is called a local area network, or LAN. A local area network (LAN) can be big or small, ranging from a single user network at home to an enterprise setting in an office or school with lots of devices and users.
No matter how big or small, the ability to connect devices in a single, constrained area is what makes a LAN unique. On the other hand, a wide area network (WAN) or metropolitan area network (MAN) covers a large geographic area. MANs and WANs connect a large number of LANs to one another.

What is a Local Area Network (LAN)?

Connectors, switches, access points, routers, and other components make up a local area network (LAN), which enables devices to

The advantages of a LAN

A local area network (LAN) offers the same advantages as any other networked collection of devices. With just one Internet connection, the devices may be made available to each other, exchange files and printers, and even be watched over.

In order to connect PCs to other PCs, LANs were developed in the 1960s for use by colleges, universities, and research organizations (like NASA). Before Ethernet technology was developed (1973, at Xerox PARC), commercialized (1980), and standardized (1983), LANs were not often utilized.

Although the benefits of having devices connected to a network have long been understood, LANs were uncommon in almost all types of settings until Wi-Fi technology was widely used.

4.4 WAN and Internet network topologies and devices

WAN: TA wide-area network (WAN) is the technology that connects your offices, data centers, cloud storage, and cloud applications. The term "wide-area network" refers to a network that reaches beyond a single building or large campus to encompass multiple locations spread throughout a given area, or perhaps the entire world. A wide area network (WAN) is used, for instance, by businesses with multiple foreign branch offices to communicate office networks. The largest wide area network (WAN) in the country is the internet, which is made up of numerous interconnected international networks. Wide-area networks, or WANs, are the enterprise's backbone nowadays. Companies use wide area networks (WANs) to complete the following while digitizing resources:

Use video and voice to interact.

- Customers and staff should share resources.
- Access data stockpiling and backup data remotely.
- Attach to applications that are hosted in the cloud.
- Internal applications may be executed and hosted.

The Open Systems Interconnection (OSI) model, which abstractly described and streamlined all telecommunication, serves as the foundation for wide-area network (WAN) architectures. The OSI model depicts any computer network as having seven layers. Various network technologies perform on each of these layers, resulting in a functional WAN.

Internet network topologies and devices

Network topology is the conceptual and physical configuration of a network's links and nodes. Common parts of nodes include routers, switches, and software with router and switch

functions. Network topologies can often be expressed using graphs. Network topologies define how networks are configured and where traffic flows are located in space. Network topology diagrams can be used by administrators to determine the appropriate traffic flow channel and node locations. A well-designed and specified network topology makes it easier for a company to find and fix problems, which improves the efficiency of data transport.

Network geometry is the definition of a network's logical and physical topologies. Devices are shown as network nodes in network topology, with the links connecting them as lines. The nature of

Topologies are divided into multiple categories. Physical topologies, for instance, have included the foregoing:

Bus network: A single wire connects each node in the bus network topology in series with one another. Nowadays, cable broadband distribution networks are the main places where this setup is found.

Star network: In a star network topology, a central hub connects a central device to every other node. The majority of switched local area networks based on Ethernet switches, as well as wired networks in homes and offices, have a physical star topology.

Ring network: A closed-loop design links the nodes in a ring network structure. While some rings can only send information in one way, others have bidirectional data transmission capabilities. Bidirectional ring networks are more flexible than bus networks since traffic can arrive at a node from either direction.

Mesh network: The topology of a mesh network links nodes to provide many available paths between at least some network sites. If every node in a network has a direct connection to every other node and only a few nodes have strong connections to other nodes, the network is said to be fully mesh. Combining several routes increases cost while improving adaptability. Dedicated links, however, demand more room.

Tree network: This topology consists of a single root node to which all other nodes are connected in a hierarchical manner. The topology is connected in the form of a star. Many larger Ethernet switch networks, including data center networks, are configured using trees.

Hybrid network: A hybrid network topology is any combination of two or more topologies.

Network devices types

Hub -A hub is one of the most fundamental pieces of network hardware that connects multiple computers or other network devices (network devices hub). A hub is a piece of hardware that can only communicate with a desktop through various connections or devices.

Switch

A switch is a piece of physical circuitry used in networking that controls the flow of signals (network devices switch). A switch can be used to open or close a connection. When the switch is disengaged, a signal or electricity can flow via the connection. When the switch is switched off, the flow is halted and the circuit connection is broken.

Router

A router is a networking hardware piece that receives, assesses, and forwards incoming packets to another network.

Bridge

Bridges' primary purpose in network architecture is to forward and store frames between the many segments that they connect. To send frames, they make use of hardware Media Access Control (MAC) addresses. Bridges can either forward or block data flowing by attempting to analyze MAC addresses.

Gateway

When we talk about networking, a gateway is a networked device that serves as an entrance point into another network. For example, a wireless router is frequently used as the default gateway in residential networks. A gateway is essentially a messenger agent that receives data from one network, analyzes it, and then sends it to another network. Protocol converters, another name for gateways, are devices that operate at any OSI model layer.

Modern

When used in networking, a modem is a hardware device that enables a computer to send and receive data over phone lines (network devices modem). In essence, a modem is a piece of hardware that connects a computer or router to a broadband network.
The device sends a signal via a phone line after converting digital data into an analog audio stream. In response, the modem changes an analog signal back to a digital signal when it comes in. There are various types of modems, such as removable, internal, external, and onboard models. A modem operates at either the physical layer (Layer 1) or the data connection layer (Layer 2) of the OSI model, depending on its kind.

Knowledge Check 2

State True or False.

1. The physical layer is in charge of raw data transfer in the shape of optical signals and digital bits.
2. The data link layer is in charge of defining rules and conventions for protocols for physical layer processes.
3. A hybrid network topology is any three or more topologies combined.
4. The tree network topology consisted of one root node linked to all other nodes in a hierarchy.
5. An access point (AP) is a wireless network device that serves as a gateway for devices to link to a local area network.

- **Outcome-Based Activity 2**

  Show pictures of some network topologies.

4.5 Summary

- A client/server LAN is made up of many gadgets (the customers) that are linked to a central server. File storage, device access, application access and network traffic are all managed by the server. Any connected device that keeps running or connects to applications or the Web is considered a client. Clients can connect to the server via wirelessly or by cables.
- Data communication is the transmission of encoded data from one location to another via an electronic transmission system. This could also be characterised as the transfer of data between two gadgets via a wireless or wired transmission medium.
- The message is sent by the transmitter and received by the receiver. The medium is the channel through which the message is transmitted, and the protocol is a set of rules that governs how information moves from encrypting to decrypting. Of course, the message is core to all of the components. The data being conveyed is represented by the message.
- A VPN (virtual private network) is launched virtually on the public network to allow communication and data transmission from communicator to the recipient. This network

establishes an encrypted or secured connection above a less secure network, such as the public internet.

- A PAN (personal area network) is a computer network which enables computers to interact in close proximity to an individual. These networks can be wired, such as FireWire or USB, or wireless, such as ultra-wideband, IR and ZigBee.
- The session layer is responsible for managing sessions or connections between remote and local applications. It has the ability to close, open or discontinue the connection among two devices. For example, suppose your booking system is on a web server in the central office, and you work from home. After authentication, the session layer establishes a connection between the web server and your computer. This is a logical connection rather than a physical connection.
- Any mix of two or more topologies represents a hybrid network topology. Because they can accommodate a variety of configurations, hybrid topologies generally offer exceptional flexibility.

4.6 Self-Assessment Questions

1. What do you mean by the basics of Digital transmission?
2. Discuss about Networking technologies.
3. Explain about the Physical transmission media.
4. Write a short note on LAN.
5. Define WAN.
6. Explain about various internet network topologies and devices.

4.7 References / Reference Readings

- Benedetto, S., &Biglieri, E. (2019). *Principles of digital transmission: with wireless applications*. Springer Science & Business Media.
- Alves, M., & Tovar, E. (2016). Engineering PROFIBUS networks with heterogeneous transmission media. *Computer communications*, *30*(1), 17-32.
- Nuzman, C., Saniee, I., Sweldens, W., & Weiss, A. (2020). A compound model for TCP connection arrivals for LAN and WAN applications. *Computer Networks*, *40*(3), 319-337.

- Held, G. (2021). *Data communications networking devices: operation, utilisation and LAN and WAN internetworking*. John Wiley & Sons, Inc.
- Clyne, L. (2018). LAN/WAN interworking. *Computer Networks and ISDN Systems*, *16*(1-2), 34-39.
- Haddadi, H., Rio, M., Iannaccone, G., Moore, A., & Mortier, R. (2018). Network topologies: inference, modelling, and generation. *IEEE Communications Surveys & Tutorials*, *10*(2), 48-69.

Unit- 5

Business Uses of IT

Learning Outcomes:

- Students would be able to learn about the Types of IT systems.
- Students would be able to understand the SCM and CRM systems.
- Students would be able to learn about ERP systems.
- Students would be able to know about the DSS systems.

Structure

5.1 Types of IT Systems: TPS, MIS and DSS, and Key Features of Each

5.1.1 TPS

All transaction data is gathered, modified, and accessed by a transaction process system (TPS), a business transaction information processing system. Reliability, performance, and consistency are attributes of a TPS.

A batch processing and batch process system, which processes multiple requests at once, is commonly used to compare with transaction processing and transaction process systems. While batch processing does not require user involvement, the former requires. In batch processing, the results of every transaction are not easily available. Additionally, there is a delay since several requests must be handled, stored, and then fulfilled. Transaction processing is instantaneous, and each transaction's results are instantly available. During the batch processing delay time, mistakes may occur. Transaction processing errors can occur, however they are

To accomplish performance, consistency and reliability, data in a data warehouse must be easily available, backup methods should be in place, and a recovery strategy should be in place for dealing with human failure, system failure, software applications, computer viruses or natural disasters. The four components of a TPS are as follows. To comprehend how the system works, one needs to first comprehend them.

- **Inputs:** Inputs are actual requests for products or funds submitted to a company's TPS by third parties. Inputs are typically coupons, bills, invoices, and custom orders.
- **Output:** Outputs are the papers that a TPS produces after processing all inputs, such as receipts that businesses keep in their records. Such documents aid in the validation of transactions and provide critical reference information for tax and other official reasons.
- **Storage:** The storage component of a TPS is where businesses save their input and output data. Some companies keep the records in a database. This component guarantees that all papers are secure, available, and organised for future reference.
- **Processing System:** The processing system examines each input and generates a useful output, such as a receipt. It aids in the organisation of the incoming data and specifies what the results must be. It is important to realise that the processing time differs based on the kind of TPS used by a company.

Features

A TPS must have the following characteristics :

- Managed Access: TPSs are useful organizational instruments for managing access. Because of this, it is only in the custody of authorized individuals. Stated differently, it limits the authority and handling of transactions to designated personnel.
- Link with the outside world: By providing information to suppliers and customers, TPS creates a link with the outside world.
- Fast Response: This feature is essential for a TPS because companies can't keep their customers waiting for extended periods of time before completing a transaction.
- Inflexibility: Regardless of the client, user, or time of day, a TPS processes every transaction consistently to maximize efficiency.
- Reliability: Since customers do not tolerate mistakes, a TPS needs to be trustworthy and have the right safety and security measures in place.
- Specification Distribution

5.1.2 MIS

An enterprise department called management information systems (MIS) is in charge of monitoring the hardware and software tools that a firm uses to make crucial business decisions. The term "MIS" can be used to describe a department within a firm as well as a class of computer software that is used to organize, store, and analyse data. Nowadays, "MIS" is a general word used in a variety of applications.

MIS software Types

The four major kinds of MIS software are as follows :

The enterprise department in charge of managing an organization's software and hardware technologies used to make crucial business decisions is called management information systems (MIS). Apart from designating a specific division inside an organization, "MIS" can also refer to a class of computer programmes used for data archiving, organisation, and analysis. These days, the word "MIS" is used broadly in a variety of applications.

Features: The qualities of MIS ought to constantly be centred on individuals who will use it. A good MIS should have these characteristics:

Flexible: Depending on the needs of the organization, a MIS should allow you to evaluate data from numerous sources in different ways.

- User-friendly: To get what they need, managers shouldn't need a thorough understanding of information systems. The management shouldn't be overburdened with information by the reports generated by the MIS, nor should using it require an excessive amount of time.
- Versatile: A MIS should be able to accommodate a range of expertise and abilities.
- Collaborative: A MIS should enhance communication between management and staff members across the board in an organization.

5.1.3 DSS

It is a piece of software used to support decisions, actions, and judgments made by businesses or organizations. Massive amounts of data are sorted through and assessed by a DSS, which generates comprehensive information that may be used to resolve problems and make choices.

Information from different time periods' revenue or historical data, objective or anticipated sales statistics, and other operations- or inventory-related data can all be used in a DSS.

A decision support system (DSS) is a computerised system that collects and evaluates data

- A decision support system (DSS) is an automated system that gathers, assesses, and synthesizes data into comprehensive information reports.
- A standard operations scheme, which collects data merely, is not the same as a decision support system.
- With the aid of decision support systems, one may handle problem-solving tasks, event management, and planning more quickly, more accurately, and more efficiently.

Understanding a Decision Support System (DSS)

A decision support system gathers information, assesses it, and compiles it into comprehensive reports. A DSS differs from a conventional operations application, which collects data alone, in that it is an informational application.

The DSS can be operated totally by humans or fully automatically. In certain situations, it could include both. The best systems evaluate information and decide for the user. If nothing else, they help customers make better decisions more quickly.

Using a DSS

The DSS can be used by a company's operations management and other planning departments to compile data and information and turn it into actionable insight. In actuality, the main users of these technologies are middle-to upper-level managers.

For example, a DSS may be used to project a company's earnings based on projections of sales of new products for the following six months. With so many variables involved, the predicted revenue figures are not a straightforward computation that can be done by hand. On the other hand, a DSS may combine all of the different components and offer a result as well as alternative results based on the company's prior product, sales data, and current variables.

DSS Characteristics

Communicating with the client in a comprehensible way is the main objective of using a DSS. The benefit of a DSS system is that it may be configured to generate multiple reports based on the specifications provided by the client. For example, the DSS may generate and present data graphically in the form of a textual report or a bar chart showing expected revenue.

As technology develops, data analysis is no longer restricted to large, cumbersome mainframe systems. A DSS may be installed on the majority of computer systems, including desktops and laptops, as it is merely a program. Portable devices can also be used to access some DSS programs.

The flexibility of the DSS is especially helpful for clients who travel frequently. It makes it possible for them to always be informed.

DSS Features :

- It's a way to arrange data so that you can utilize it to make decisions. It includes using a database in a particular decision-making process. A decision support system improves the decision maker's approach to problem-solving rather than just providing an output in the form of a report or automating data transformation.
- A DSS enables the decision-maker to interact in a natural way because of the careful design of the user interface.
- Semi-structured, complex problem-expressing decisions are the target audience for decision assistance systems. These problems still provide an obstacle to full

computerization.

Although a DSS can be designed to promote isolated, one-time decisions, the opportunity or issue that a DSS is most useful for addressing is

- **Knowledge Check 1**
  Fill in the Blanks

  1. A decision support system is normally developed for either a _____ and _____.
  2. The fundamental objective of employing a DSS is _____.
  3. The DSS might either be entire _____ or _____.
  4. MIS stands for_____.

- **Outcome-Based Activity 1**
  Show an example of an MIS system along with screenshots.

5.2 Overview of Enterprises System such as ERP, CRM and SCM

5.2.1 ERP

The acronym for enterprise resource planning is ERP. The easiest approach to explain ERP is to think of all the essential business operations—human resources, finance, supply chain, manufacturing, procurement, services, and so forth—that are necessary for an organization to run. ERP essentially helps to handle all of these procedures effectively under a single system. It is commonly known as the record system of the organization.
But contemporary ERP systems are far from straightforward and have little in common with ERP from the past. These days, they are provided via the cloud and make use of cutting edge technologies like artificial intelligence (AI) and machine learning to enable intelligent automation, higher efficiency, and real-time insight throughout the business's activities. Modern cloud-based ERP applications

Significance of ERP

Often referred to as "the enterprise central nervous system," an ERP software system provides the intelligence, automation, and integration needed to effectively carry out all daily

business operations. To provide a single source of truth across the organization, the ERP system should hold most or all of an organisation's data.

Finance need an ERP in order to close the books quickly. Sales need ERP to manage every client's orders. ERP software that functions properly is essential for logistics to provide the right services and goods to customers on schedule. Accounts Payable needs ERP in order to properly and on time refund vendors. Management needs immediate access to the business's operations in order to make prompt decisions. Because they require accurate financial records, banks and investors rely on the reliable data provided by the ERP system.

Six prime ERP benefits :

Numerous advantages of a well-designed ERP system differ depending on how the system is put into practice. For example, cloud ERP has different benefits than on-premise ERP. Having said that, all contemporary ERP solutions have the following six main benefits: Increased output: Simplify and automate your core business operations so that employees can accomplish more with less resources.

Extra information Eliminate information silos, create a single source of truth, and get quick solutions for business issues that are vital to the goal. Quicker reporting Streamline business and financial reporting and facilitate outcome discussion. Real-time response to insights can improve performance. Cut down on risk: Boost regulatory compliance, increase business control and visibility, and anticipate and minimize risk.

5.2.2 CRM

Using a system called customer relationship management (CRM), you can keep track of all the interactions and connections your company has with both present and potential customers. To improve commercial ties is the obvious goal. Businesses can improve profitability, streamline operations, and maintain client relationships with the help of a CRM system.

CRM is a commonly used term for a CRM platform or system, which is a tool that helps with productivity, sales management, contact management, and other areas.CRM software frees you up to focus on managing your business relationships with specific people, like clients, customers, suppliers, or coworkers, throughout the interaction lifecycle, including finding

potential clients, earning their business, and offering additional services and support. CRM software enables your sales and marketing

Who is CRM software for?

CA Managing external relationships and contacts is a key component of success in any business area, including customer service, sales, hiring, business growth, and marketing. A CRM system helps everyone in this regard.CRM software enables you to manage advertising campaigns, track service issues, find sales opportunities, track client contact information, and keep track of customer interactions all in one location. It also makes client encounter data accessible to any employee in your company who might need it.

When data is readily visible and accessible, collaboration and productivity are easier to achieve. Every employee in your company has access to a wealth of information about customers, including how they were dealt with, what they bought, when they last bought, how much they paid, and much more.

The CRM importance for your business

As the industry with the fastest and greatest growth rate for corporate application software, CRM software is becoming more and more important. By 2027, it is projected that global CRM spending will surpass $114.4 billion USD. Your business needs a future strategy that is focused on your customers and backed by the right technology if you want to survive. You have targets for sales, profitability, and business goals. Nevertheless, getting reliable, current information on your progress can be challenging. How can the deluge of data from marketing, sales, social media monitoring, and customer service be transformed into useful business intelligence?

A CRM system can give you a thorough understanding of your clientele. A straightforward, customizable dashboard that shows a client's previous interactions with you,

CRM system functions

It can additionally automatically bring in other information, such as recent headlines about the business's operations, and it may keep private data, like a customer's communication preferences. The CRM tool combines this data to provide you with an exhaustive list of businesses and individuals overall, allowing you to comprehend your connection over time.

A CRM platform can also be linked to other company tools that aid in the development of client connections. CRM solutions are becoming more open and may link with your favourite business tools, like document signing, surveys, accounting and billing, allowing information to flow in both directions and providing you with a genuine 360-degree perspective of your client.

A new CRM generation takes one step more seriously: integrated intelligence streamlines administrative duties such as data entry and service case routing or lead, allowing you to focus on more important responsibilities. Automatically produced analytics allow you to comprehend your consumers, even forecasting how they will react and behave so you can plan the appropriate approach.

5.2.3 SCM

The administration of the movement of services and goods is known as supply chain management, and it encompasses all processes that convert raw materials into finished products. It comprises actively presenting a company's supply-side processes in order to optimise client value and obtain an edge in the marketplace.

Working of Supply Chain Management

SCM refers to providers' efforts to design and operate supply chains which are as inexpensive and efficient as possible. Supply chains include everything from manufacturing to the development of products to the information systems required to manage these endeavours.

Typically, SCM aims to centrally manage or connect a product's manufacturing, distribution and shipment. Companies may save expenses while getting items to customers quicker by optimising the supply chain. It is accomplished by maintaining tighter control over internal inventories, distribution, internal manufacturing, sales, and supplier stocks.

SCM is founded on the notion that practically every product that enters the market is the result of the work of several companies that comprise a supply chain. Although supply chains have been around for centuries, most businesses have only recently recognised them as a value-add to what they do.

5 Parts of SCM

The supply chain management strives to maintain costs low and disruptions to a minimum. The work involves more than just inventory and logistics purchases. Supply chain managers manage and oversee the entire logistics and supply chain to optimise efficiency and reduce the expenditures of the company's supply chain."

Efficiency and Productivity gains can have a direct impact on a firm's bottom line. Good supply chain management keeps businesses out of the news and away from costly lawsuits and recalls. The supply chain manager in SCM coordinates the logistics of all the supply chain aspects, which include the five components listed below :

Planning

SCM frequently starts with planning to align supply with manufacturing and clients' demands in order to achieve the best possible outcomes. Companies must forecast their potential demands and react appropriately. This applies to the raw materials required at each manufacturing stage , the constraints and capacity of equipment, and the manpower requirements throughout the SCM process. Large organisations frequently depend on ERP system components to combine data and generate strategies.

Sourcing

Efficient SCM operations rely primarily on solid partnerships with suppliers. Working with vendors to deliver raw materials required during the manufacturing process is what sourcing implies. A corporation might be capable of planning ahead of time and collaborating with a supplier to get goods.Distinct industries, however, are going to have distinct sourcing needs. SCM sourcing in general includes ensuring:

- The raw materials satisfy the manufacturing standards required for product production.
- The costs that were paid for the goods are reasonable in comparison to market assumptions.
- Due to unanticipated situations, the provider has the ability to deliver emergency products.
- The vendor has a track record of delivering high-quality goods on schedule.

Supply chain management is extremely important when working with perishable items. When sourcing items, businesses should consider lead time and how successfully a supplier can meet those requirements.

Manufacturing

At the core of the supply chain management procedure, the corporation turns raw materials into something new by utilising personnel, machinery or other external forces. Although it is not the final stage of supply chain management, this end product is the final objective of the production procedure.

Assembly,inspection,testing and packaging are examples of sub-tasks in the manufacturing process. A company must be conscious of waste and other controllable issues that may cause variations from initial intentions during the process of production. For instance, if an organisation uses more raw materials compared to the planned and sourced for due to an absence of staff training, the organisation must either correct the problem or go back to the previous SCM stage.

Delivering

A corporation must get its products into the hands of its customers once they have been manufactured and sales have been completed. Because the consumer is still not acquainted with the goods, the distribution process is frequently viewed as a contributor to brand image. A corporation with effective SCM procedures has solid delivery channels and logistic capabilities to assure safe, timely and low-cost product delivery.

It involves having a diverse or backup distribution mechanism in case one mode of transportation becomes temporarily unavailable. For instance, how can record snowfall in distribution centre areas affect the business's delivery procedure?

Returning

The supply chain management process is completed with client returns and product support . It's bad enough if a consumer must exchange a product, but it's even worse when it's owing to a business error. This return procedure is known as reverse logistics, and the business must guarantee that it is capable of receiving products that are returned and appropriately assigning refunds for returns accepted. Whether a corporation is conducting a product recall or a consumer is merely dissatisfied with the goods, the customer interaction must be resolved.

A lot of individuals think of consumer returns as a two-way street between the consumer and the corporation. However, intercompany communication for recognising expired, defective or non-conforming goods is a critical component of consumer returns. The supply chain management process will fail if the underlying cause of a consumer's return is not addressed, and further returns are likely.

Knowledge Check2

State True or False

1. An ERP system is made up of business applications or integrated modules that communicate with one another and collaborate on a database.
2. Finance needs an ERP to close the books swiftly.
3. Customer relationship management (CRM) is a technology that manages all of your business's interactions and connections with clients and potential clients.
4. A CRM platform can also be linked to other company tools that aid in the development of client connections.
5. Supply chain management (SCM) refers to providers' efforts to design and carry out supply chains that are as cost-effective and efficient as possible.

- **Outcome-Based Activity 2**

  Show an example of an ERP system along with screenshots.

5.3 Summary

- A transaction process system (TPS) is a business transaction information processing system that collects, alters, and retrieves all transaction data. A TPS's characteristics comprise performance, consistency and dependability.
- Management information systems (MIS) is an enterprise department in charge of overseeing the software and hardware technologies that the company utilises for making business-critical decisions. In addition to referring to a company's department, the expression "MIS" can also apply to an assortment of computer software utilised to organise, store and analyse data.
- A decision support system (DSS) is a software programme that helps a business or organisation make decisions, make decisions, and plan courses of action. A DSS sifts through and evaluates vast data volumes , producing detailed information that can be utilised to address issues and make decisions.
- The fundamental goal of employing a DSS is to convey information to the client in an understandable manner. A DSS system is advantageous because it can be programmed for producing a variety of reports according to customer parameters. The DSS, for instance,

may produce and display information graphically, such as in a bar chart representing predicted revenue or as a written report.

- ERP is an abbreviation for enterprise resource planning.The easiest way to define ERP is to consider all of the essential business operations required for the operation of an organisation: human resources, finance, manufacturing, services, supply chain, buying, and so on.
- Customer relationship management (CRM) is a system that allows you to manage all of your company's interactions and relationships with current and prospective clients. The purpose is straightforward: to strengthen commercial connections. A CRM system assists businesses in staying in touch with clients, streamlining procedures, and increasing profitability.
- The administration of the movement of services and goods is known as supply chain management, and it encompasses all processes that transform raw materials into finished products. It comprises actively simplifying a company's supply-side processes in order to optimise client value and obtain an edge in the marketplace.

5.4 Self-Assessment Questions

1. Write a short note on the TPS.
2. What do you mean by MIS?
3. Discuss about DSS along with all its features.
4. Write in detail about the CRM Enterprise system.
5. Explain about the ERP system in detail.

5.5 References /Reference Readings

- Rohlf, F. J. (2015). The tps series of software. *Hystrix*, *26*(1), 9-12.
- Alavi, M., & Carlson, P. (2020).A review of MIS research and disciplinary development. *Journal of management information systems*, *8*(4), 45-62.
- Power, D. J. (2017). What is a DSS? *The On-line executive journal for data-intensive decision support*, *1*(3), 223-232.
- Klaus, H., Rosemann, M., & Gable, G. G. (2020). What is ERP?. *Information systems frontiers*, *2*, 141-162.

- Hillman Willis, T., & Hillary Willis-Brown, A. (2022). Extending the value of ERP. *Industrial management & data systems*, *102*(1), 35-38.
- Rigby, D. K., Reichheld, F. F., & Schefter, P. (2022). Avoid the four perils of CRM. *Harvard business review*, *80*(2), 101-6.
- Larson, P. D., & Halldorsson, A. (2018). What is SCM? And, where is it?. *Journal of Supply Chain Management*, *38*(3), 36-44.

Unit- 6

New and Emerging Technologies

Learning Outcomes:

• Knowledge regarding Wireless Transmission Technologies would be available to the students.

• The overview of cloud computing would be clear to students.

• Knowledge of the many types of cloud services would be available to students.

• The fundamentals of the Internet of Things would be clear to students.

Structure

6.1 Basics of Internet of Things

The Internet of Things (IoT) links real and virtual items. Intelligent machinery and devices are linked to one another and to the internet digitally. They use technology to collect, interpret, and link pertinent information regarding their local surroundings. The gadgets carry out certain actions based on this data. For example, when a sensor detects the outside

temperature, the smart gadget in which it is installed increases the heating. All of this occurs automatically, with no active user participation. If desired, the user may manage the IoT devices online, such as using a smartphone app.

This is made feasible through the collaboration of connected components like sensors, microcontrollers and actuators, which turn electrical impulses into movement, pressure, temperature, or other mechanical variables. Individual devices, gateways and databases that integrate many networks comprise IoT systems. They connect to the internet via a primarily wireless interface and receive or give commands. While transmission, sensitive data is secured and protected in the background by security technologies.

Working of IoT

The devices themselves—smartwatches, cell phones, and electrical appliances like TVs and washing machines—are the first step in the Internet of Things process.

Four fundamental IoT system components :

1) Sensors/Devices: Devices or Sensors are essential components that allow you to gather real-time data from the environment around you. All of this data may be of varying complexity. Either a video stream or a simple temperature monitoring sensor might be used. Numerous sensors on a device may be used for purposes other than sensing. For instance, a mobile phone has several sensors, such a camera and GPS, but it is unable to detect some objects.

2) Connectivity: The gathered data is moved to a cloud computing architecture. There should be several communication lines connecting the sensors to the cloud. These include WAN, Bluetooth, WI-FI, satellite or mobile networks, and other communication techniques.

3) Data Processing: The software handles the data after it has been recorded and moved to the cloud. Simply keeping an eye on the temperature or readout on appliances like air conditioners and heaters can serve as this strategy. However, it can also be extremely complex, for example, employing computer vision to detect objects in video.

4) User Interface: The end user needs to be able to access the information in a certain way. This can be done by allowing them to set alarms on their phones or by sending them emails or texts with notifications. An interface that periodically actively analyzes the user's IoT

system might be necessary. For example, the user might have installed a camera in their home. He plans to use a web server to request access to all feeds and video recordings.

Benefits:

Following are the primary advantages of IoT technology :

Technical Optimisation: IoT technology contributes significantly to the advancement of technologies. For example, with IoT, a manufacturer may gather data from multiple automotive sensors. The maker examines them in order to enhance their layout and render them more effective.

Enhanced Data Collection: Traditional data collecting has limits, as well as being designed for passive use. IoT enables fast data action.

Reduced Waste: IoT provides real-time information, allowing for more effective decision-making and resource management. For instance, if a manufacturer discovers a defect in numerous vehicle engines, he may monitor the manufacturing plans of those engines and use the manufacturing belt to resolve the problem.

Enhanced Client Engagement: IoT enables you to enhance the client experience by recognising and correcting problems.

6.2 Wireless Transmission Technologies and Architecture

Wireless communication is nothing more than a medium. The tools required for transmitting information from a single gadget to another are referred to as wireless communication tools. As a user of such technology, one must discover the most effective form of wireless services that meet his requirements.

Wireless Application Protocol, or WAP to those who oppose the Wireless World, is a survey document in and of itself. WAP, on the other hand, is going to be addressed not just since there is an obligation to examine WAP but also because it would be unfair not to consider WAP while addressing Wireless Technology.

WAP is one of the most current and fully established protocols available. WAP quickly became the foundation and paradigm for other protocols, like Ericsson's Bluetooth, which is a relatively new technology on the market nowadays.

Despite the fact that these protocols have various purposes, they cover comparable ground and have very similar goals and principles, which will be described further ahead. WAP provides for things like web browsing on cell phones, which other protocols do not.

Wireless Communication Components

Although each protocol has its own set of criteria and specifications, there are some common traits and aims that all protocols strive for. The following are some general parameters that these procedures attempt to follow:

- **Unlimited range and roaming:** The user's location with the portable device is unimportant. Data can be delivered and accepted regardless of how close or far a user is to the base provider.
- **Delivery Guarantee:** Irrespective of a user's status or location, all data and messages are certain to be sent. Even if the portable gadget is switched off, the user will see a new message when she or he turns it back on.
- **Delivery Dependability:** All messages are ensured to be complete and correct.
- **Notification:** Informs the user that some data has arrived and needs to be checked
- **Connectivity Options:** Sending and receiving messages provide a wide range of possibilities, not only in hardware for the portable gadget but also in getting communications.
- **Millions of Users:** Capable of engaging millions of users.
- **Priority Alerts:** Capable of distinguishing between data and messages that are of greater significance compared to others andcapable of swiftly and effectively managing high-priority data flow.
- **Communication:** The capacity for communication between users using portable devices when those devices are equipped with software that is both dependable and easy to use.
- **Host Reconfiguration:** The capacity to reform when in a different setting. Person A, for instance, is holding a Bluetooth-enabled Palm Pilot. Person A visits the office, where a full Bluetooth network has been established, and Person A's Palm Pilot is configured to the business network settings. Person A begins driving home at the end of the day. Person A arrives home and goes inside, where Person A's residence has a completely distinct Bluetooth network setup.

Person A pulls out the Palm Pilot, and the Palm Pilot instantly reconfigures itself to the Bluetooth network settings in Person A's house. As a result, the Palm Pilot functions in one setting and can recognise when it goes from one place to another and can set itself up wherever it is.

Host Mobility: One host's network settings include its Subnet Mask, IP address, Gateway Address, and so on. Now, if this one host chooses to relocate, it needs to modify its settings all over again, but it must notify others that it has done so. The host's flexible mobility permits it to go and come as it pleases without even notifying others of its departure. Even though the host has migrated, interaction with it is still feasible.

Dynamic Encapsulation: Registering a mobile host with its base agent is necessary; this can be done by sending requests for login and logout as well as deactivation and activation alerts. It is going to avoid fraudulent logins and re-routing one's prior date somewhere it should not be.

6.3 Opportunities and Challenges in Implementation

Having access to the correct gig workers might help you hire a professional engineer to do a thorough WLAN site survey. Don't be concerned if you don't know how to do a site survey. A well-qualified gig worker has all of the expertise and resources required to conduct your site survey to discover difficulties prior to collaborating with you to fix them.

The site study will assess the Radio Frequency behaviour on-site and the appropriate placements for Access Points. Engineers will create a wireless site survey checklist that would highlight potential deployment, design and management problems offered by your facility.

This checklist would consist of the following:

The network's intended use: A shared office will require quite different requirements than an events venue or a warehouse. It has serious consequences for you.

Capacity needs and Coverage: Which areas will require availability, as well as what will require the most capacity for reliable data transfer? Where might activities with possibly high bandwidth requirements happen?

Identifying installation and cabling path requirements- Once they have a strong understanding of your requirements, gig workers would move around your site to determine

where APs ought to be located for the best capacity and coverage. It will additionally plan the mechanics of connecting the necessary APs.

Outside interferences- There could be outside interference affecting the operation of your network. These involve misconfigured APs in adjacent areas.

User flow- The needs for commercial WLANs have changed, yet access points were once centralized. Access points should now be positioned in places where they will be most used. A site assessment will also assess user flow in order to determine the best places for APs.

Security- APs are set to keep your network safe and prohibit unauthorised persons from entering it.

Overcoming the Challenges

As you can see, there are numerous possible issues that might hinder your WLAN setup and maintenance. You can develop and apply preemptive solutions to tackle difficulties prior to them occurring if you have access to the correct independent contractors.

The more thorough the site survey, the more equipped you are going to be to promptly solve difficulties, decreasing downtime and increasing security and productivity.Finding the ideal gig workers for such a delicate and crucial job, on the other hand, might be tough. This is where we step in.

Future wireless technologies will come in two flavours: some will be whole new approaches to enabling connectivity, while others will be improvements on existing ones. Among the upcoming wireless technologies are:

5G: There will be two separate frequencies used by 5G. Wider channel sizes and more flexible encoding will help low-frequency 5G reach its speed, which it will do by using Wi-Fi and currently available cellular bands. Additional 5G versions will function at frequencies between 28 and 39 gigahertz (GHz), which are not often used.

Verizon Wireless launched the first 5G home service in October 2018 in a number of cities, even though the networks did not meet the global mobile criteria for 5G defined at the end of 2017. AT&T plans to roll out a 5G network that complies with the standard completely. In order to meet the requirements, Verizon plans to replace its devices in 2019.5G is seen as critical to emerging technologies such as virtual reality or VR and IoT, requiring large

quantities of bandwidth and speed, in addition to giving quicker bandwidth and other consumer benefits.

The 6G network: With exceptionally low latency and speeds of up to 100 Gbps, the 6G network would function at frequencies between 100 GHz and 1 terahertz (THz). According to researchers, hundreds or even thousands of simultaneous connections should be supported by 6G. All things considered, the system should be able to deliver higher capacity with lower power consumption.Of course, there are still obstacles that must be resolved in determining how 6G would function. Obstructions, for example, are more of a problem at high frequencies. It may be vital that we resolve these challenges and begin preparing the 6G network as soon as possible. Some industry experts believe that the fast-expanding IoT network will soon exceed 5G.

Massive MIMO Antennas: It will play a crucial role in making 5G and eventually 6G networks possible. A Massive MIMO system consists of many more antennas at each link terminating than just a few. It greatly expands the capacity of the system by allowing many transmissions to go over the same radio channel simultaneously.

Massive MIMO allows you to hypothetically build the system as large as you would like it to be. It was previously considered that wireless data had limitations on capacity; however, researchers discovered that there are no limits when employing Massive MIMO. Simply add more antennas to increase capacity.

The LTE Future: LTE is a high-speed wireless communication protocol that specifies routes to full 4G speeds. LTE, along with LTE-A Pro and LTE Advanced, is now a component of the 4G LTE system. These advances aid in fulfilling capability demands and accelerating swiftness. Along with serving as a conduit for 5G, they will also increase throughput to levels that will be comparable to those of the next fifth generation of wireless networking technology. As 5G networks are deployed, LTE technologies are going to fill in the gaps where coverage is currently lacking. 4G will serve a similar purpose.

Some more sophisticated LTE technologies are going to function in combination with 5G. LTE-A, Gigabit LTE and LTE-A Pro, and maybe other future LTE varieties, will contribute to 5G support. LTE-A is already accessible and can give faster speeds compared to 4G. LTE-A Pro has the potential to attain speeds of up to 3 Gbps, while actual speeds will most likely be lower.

Li-Fi: Li-Fi is an intriguing new wireless technology that works similarly to Wi-Fi but transmits data via visible light rays as opposed to radio waves. Researchers at Edinburgh University created the technique, which was tested at a facility in Estonia.

Li-Fi use might be advantageous for several reasons. It offers increased speed and security. In lab tests, it has reached speeds of 224 Gbps. It achieved 1 Gigabyte per second (GBps) in an Estonian field test.

6.4 Cloud Computing Overview: The practice of remotely configuring, altering, and accessing hardware and software resources is known as cloud computing. It offers online infrastructure, apps, and data storage.

Fundamental Ideas

Behind the scenes, some services and models are in place to make cloud computing feasible and accessible to end users. The operational models for cloud computing are listed below:

Models of Deployment

The type of cloud access, or the location of the cloud, is specified by deployment models. There are four possible types of cloud access: Community, Private, Public, and Hybrid.

Public Cloud

The general public can access systems and services through the public cloud. The open nature of public clouds may make them less safe.

Individual Cloud

Within a business, systems and services are made available via the private cloud. It is more secure because of its private nature.

Community Cloud

The community cloud provides technologies and services to a group of businesses.

Hybrid Cloud

A combination of private and public clouds, the hybrid cloud allows for the execution of non-essential tasks in the public cloud and vital operations in the private cloud.

Benefits

- Numerous advantages of cloud computing are listed below:
- Applications can be accessed as utilities on the internet. The programs can be changed and modified online at any moment.

- The program does not need to be installed in order to use or manipulate cloud applications.
- Cloud computing offers online development, deployment tools, and a runtime environment for programming through the PaaS architecture.
- Cloud resources are made available across the network so that users of any kind, regardless of platform, can access and utilize them.
- Cloud computing makes self-service available whenever needed. It is possible to access the resources without the need for cloud service providers.
- Because cloud computing is so efficient and uses resources well, it is quite affordable.
- Cloud computing provides load balancing, which increases reliability.

Risks associated to Cloud Computing

Although cloud computing is a promising breakthrough with many advantages in the computing industry, it is not without dangers. Some of these are covered further below:

Privacy and Security

It is the most significant issue with cloud computing. Entrusting sensitive information to cloud service providers is always problematic since infrastructure management and data management in the cloud are provided by other companies.

Even while cloud computing providers offer extremely secure password-protected accounts, any proof of a security breach may result in the loss of customers and businesses.

Lock In

It is difficult for customers to switch Cloud Service Providers (CSPs). It results in service dependence on a single CSP.

Failure of Isolation

The failure of an isolation mechanism that separates memory, storage, and routing amongst tenants is linked to this risk.

Compromise in Management Interface

The customer administration interfaces of a public cloud provider are available via the internet.

Data Deletion that Is Incomplete or Insecure

It's possible that the requested information won't be deleted. One of the following causes it to happen:

- Extra copies of the data are stored but become inaccessible when the original data is erased.
- A disc containing data from numerous tenants is damaged.

Cloud Computing Characteristics

Cloud computing has four distinct properties. They are revealed below:

Self-Service On Demand

Customers can access resources and web services whenever they need them thanks to cloud computing. One can utilize and access a website whenever they like.

Access to a Wide Range of Networks

Because cloud computing is entirely web-based, it may be accessible from any location and at any moment.

Resource Sharing

Numerous tenants can share a resource pool due to cloud computing. Hardware, operating systems, and database instances can all be shared on a single physical instance.

Quick Elasticity

The resources can be scaled vertically or horizontally at any time. Resource scaling is the process of adjusting resources to meet changing demand, either rising or falling. An automatic analysis is performed on the resources that clients are utilizing at any given time.

Measured Service

The cloud provider supervises and tracks all parts of the cloud service in this service. It is essential for resource optimisation, capacity planning and billing, among other things.

- **Knowledge Check 1**

  State True or False

  1. The hybrid cloud combines private and public clouds.
  2. A variety of services and models operate in the background to make cloud computing accessible and feasible for end users.
  3. The community cloud provides systems and services to a group of businesses.
  4. The general public can access services and systems through the public cloud. Public clouds can appear less secure since they are more accessible.
  5. Systems and services are made available within an organization through the private cloud. It is more secure because of its private nature.

- **Outcome-Based Activity 1**

  Make use of cloud storage platforms and screenshot the outcomes.

6.5 Types of Cloud Services such as IaaS, PaaS and SaaS

- **IaaS**

Cloud computing that uses the internet to supply virtualized computer resources is known as infrastructure as a service (IaaS). IaaS is one of the three main categories of cloud computing services, along with platform as a service (PaaS) and software as a service (SaaS).
Under the IaaS model, the cloud provider manages IT infrastructures, which comprise servers, storage, and network hardware, and makes them available to subscriber organizations via virtual machines that can be accessed over the internet. Businesses can gain a lot fromIaaS, including the potential for workloads that are quicker, easier, more flexible, and less expensive.

Working of IaaS

IaaS customers use a WAN, such as the internet, to connect to services and resources. They can also use the cloud provider's services to configure the remaining components of an application stack. For example, the user can create virtual machines (VMs) and access the IaaS platform. Install OS systems on each virtual machine, set up databases and other middleware, build storage containers for workloads and backups, and install the corporate workload.
Clients can then utilise the provider's services to manage disaster recovery, monitor expenses, analyse achievement, solve application difficulties, balance network traffic and track expenditures.

Any cloud computing model necessitates the involvement of a provider. The provider is frequently a third-party company that focuses on providing IaaS. Amazon Web Services (AWS) and Google Cloud Platform (GCP) are examples of independent IaaS providers. Another option for a business is to create its own infrastructure services provider and build its own private cloud.

PaaS

Platform as a Service, or PaaS, is a runtime environment. It simplifies the design, testing, implementation, and administration of web applications for programmers. These programs are available online and can be purchased from a cloud service provider on a pay-per-use

basis. With PaaS, the cloud service provider maintains back-end scalability, so end users don't have to worry about infrastructure administration.

Infrastructure (servers, networking, and storage) and platform (middleware, database management systems, development tools, business intelligence, and more) are included in PaaS to support the web application life cycle.

Example: Google App Engine, Joyent,Force.com, Azure.

Includes: 1. Programming languages

PaaS companies offer a variety of programming languages for developers to use when creating applications. Java, Ruby, PHP, Go, and Perl are among the common programming languages offered by PaaS companies.

2. Application frameworks

PaaS companies offer application frameworks to help in application development. Node.js, Joomla, Drupal, Spring, WordPress, Rack, Play and Zend are some prominent application frameworks offered by PaaS providers.

3. Databases

To connect with the apps, PaaS providers provide databases such as ClearDB, MongoDB, PostgreSQL and Redis.

4. Other tools

Other tools needed to create, deploy and test applications are provided by PaaS providers.

- **SaaS**

A technique for offering software as a service over the Internet is called software as a service, or SaaS. Other names for SaaS applications include hosted software, on-demand software, and web-based software.

It is a software delivery strategy which enables SaaS applications to function on the servers of SaaS providers rather than deploying and upholding software on-premises. The SaaS provider controls application access, covering security, performance and availability.

Features of SaaS

SaaS's Multi-Tenant Architecture

An architecture known as multi-tenancy allows all SaaS apps and vendor clients to share a single infrastructure and code that is managed centrally. Manufacturers may generate new

ideas faster thanks to it, saving them the time it would take to support out-of-date code during development.

SaaS Makes Customization Easy

Programs can be readily customized by users to meet their own business needs without interfering with the shared infrastructure. Through recurring updates, a SaaS strategy maintains and supports the unique customization changes made by each user and business. As a result, SaaS providers can enhance their offerings more often, lowering client risk and acquisition costs.

Increased Network Device Access

Your business may access data from any networked device with a SaaS solution, which makes it easier to track data usage, manage credentials, and guarantee that numerous users see the same data at once.

SaaS Uses the Internet for Consumers

Anyone familiar with My Yahoo! or Amazon.com will be able to identify the Web interface of common SaaS products. The SaaS model offers a point-and-click interface for making changes, which makes the weeks or months it takes to replace traditional corporate software seem utterly archaic.

- **Knowledge Check 2**

  Fill in the Blanks

  1. One kind of cloud computing is _____, which provides virtualized computer resources over the internet.
  2. The acronym for IaaS is ____.
  3. PaaS, or platform as a service, provides a _____.
  4. PaaS companies offer application frameworks that make it simple to grasp the _____.
  5. SaaS stands for _____.

- **Outcome-Based Activity 2**

  Make use of SaaS cloud storage platforms and screenshot the outcomes.

6.6 Summary

- In order to collect data from the environment in real time, sensors or devices are necessary. There could be a range of intricacy in this data. It could be a video stream or a simple temperature monitoring sensor.
- IoT technology contributes significantly to the advancement of technologies. For example, with IoT, a manufacturer may gather data from multiple automotive sensors. The maker examines them in order to enhance their layout and render them more effective.
- Wireless communication is nothing more than a medium. The tools needed for transmitting information from a single gadget to a different one are referred to as wireless communication tools. As a user of such technology, one must discover the best form of wireless services that meet the requirements.
- One host's network settings include its IP address, Gateway Address, Subnet Mask and so on. Now, if this one host opts to relocate, it needs to modify its settings all over again, but it must notify others that it has done so.
- The hybrid cloud combines elements of the public and private clouds; non-essential tasks are completed in the public cloud and crucial operations are completed in the private cloud.
- A form of cloud computing known as infrastructure as a service distributes virtualized computer resources over the internet. IaaS is one of the three main categories of cloud computing services, along with platform as a service (PaaS) and software as a service (SaaS).

6.7 Self-Assessment Questions

1. What do you mean by the basics of the Internet of things?
2. Write a note on Wireless Transmission Technology.
3. What are the Opportunities and Challenges in Implementation of IoT?
4. Write an overview of Cloud Computing.
5. What are the various types of Cloud Services?
6. Write a short note on IaaS.

6.8 References / Reference Readings

- Morgan, J. (2019). A simple explanation of the internet of things. *Retrieved November 20*, 2015.
- Lueth, K. L. (2018). IoT basics: Getting started with the Internet of Things. *White paper*, 1-9.
- McSpadden, J. O., & Mankins, J. C. (2020). Space solar power programs and microwave wireless power transmission technology. *IEEE microwave magazine*, *3*(4), 46-57.
- Kapil, D., Tyagi, P., Kumar, S., &Tamta, V. P. (2017, August). Cloud computing: Overview and research issues. In *2017 International Conference on Green Informatics (ICGI)* (pp. 71-76). IEEE.
- Manvi, S. S., & Shyam, G. K. (2018). Resource management for Infrastructure as a Service (IaaS) in cloud computing: A survey. *Journal of Network and computer applications*, *41*, 424-440.
- Rani, D., & Ranjan, R. K. (2019). A comparative study of SaaS, PaaS and IaaS in cloud computing. *International Journal of Advanced Research in Computer Science and Software Engineering*, *4*(6).