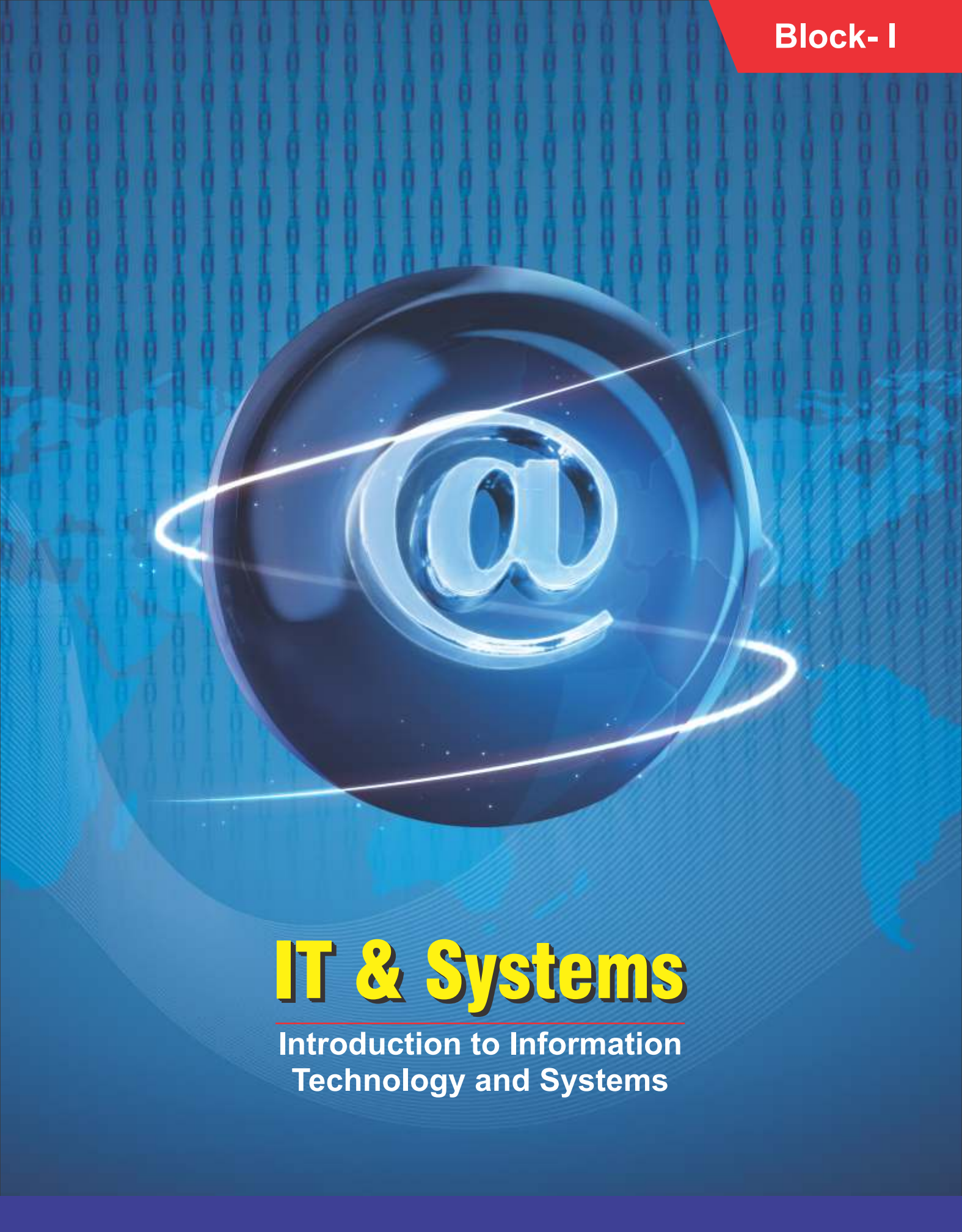
Block- I



IT & Systems

Introduction to Information Technology and Systems

Block

1

INTRODUCTION TO INFORMATION TECHNOLOGY AND SYSTEMS

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COURSE INTRODUCTION

Information technology and systems (IT & Systems) refers to the collection of tools, technologies, and systems that make it easy for individuals, businesses and other organizations to use, create, manage and exchange information. New developments in information technology have fundamentally transformed the way in which business is carried out. The increasing power and falling costs of computers have made information storage, analysis and distribution faster, easier and less expensive than any time before in human history.

The Internet has removed geographical barriers, making it possible fro companies to source material from one country, process it in another country, package it in yet another country and sell the final product globally. Consumers have information on products and services at their fingertips; they can compare different products, services or manufacturers to choose the best entertainment, communication, and commerce for many people. Consequently, electronic commerce is fast becoming an important component of the world economy.

The IT technologies used in 21st Century are changing the way product is being designed and developed. Cloud, mobile, and social technologies are used in current day products and services. Management is taking decisions based on analysis of big data and business intelligence. IT is used extensively in reducing business processes, business process reengineering and business process design. There are many improvements in methodologies, processes, tools and techniques used for software product design and architecture.

Given the importance of information technology and systems for businesses, managers need to understand the concepts and upgrade their knowledge in the field.

IT & Systems examines key issues in information technology and information systems, and their relevance for organizations to remain competitive in this era of globalization.

BLOCK 1: INTRODUCTION TO INFORMATION TECHNOLOGY AND SYSTEMS

The first block to the course on IT & Systems deals with the fundamental concepts relevant to information technology and information systems. The block contains three Units. Unit 1 and Unit 2 deal with information technology, while Unit 3 deals with information systems.

The first Unit, *Computer Systems: An Overview*, introduces you to the world of computer systems. As you know, computers have become an integral part of our personal as well as professional lives. We now use computers to perform most of our daily work. For example, the ATM machines that we use to perform some of our banking transactions are based on computer systems; a computer is used to generate a bill for the products purchased from a retail outlet; etc. As computers are being used widely in the areas of communication, work, education, and research, it is very important for us to understand the basics of computer systems.

The second Unit, *Operating Systems*, deals with the operating systems that play a key role in the functioning of computer systems. The operating system manages the hardware and software resources in a computer, and controls the interaction between the user and the computer. It is, therefore, important to have a clear understanding about the functions of an operating system, and the various types of operating systems.

The third Unit, *Fundamentals of Information Systems*, provides the basic concepts relating to information and information systems. In every organization, information is used for a specific purpose and it affects the process of decision making at various levels within the organization. An information system helps in converting the available raw data into useful information products, which in turn helps in facilitating the process of managerial decision making in the organization. The relationship between MIS, information and knowledge is highlighted. Human factors in information systems are also important considerations in current days.

Unit 1

Computer Systems – An Overview

Structure

1.1 Introduction

In this unit, we introduce you to computer systems. Computers are electronic devices that perform the basic operations of input, processing, storage, and output under the direction and control of a program. Computers take the user supplied data as input, process this data into information by carrying out the arithmetic and/or logical operations on the represented data, store the results for future use, and display the results as per the specified format.

This unit will give you an overview of the evolution of computer systems and the five generations of computers. We shall then move on to understand the organization of computer systems, the various categories of computers, and the different peripheral devices used in computer systems. Finally, we would be discussing about the interaction between the hardware and the software components of a computer system.

1.2 Objectives

By the end of this unit, you should be able to:

- Explain how the computers have evolved.
- Recall the five generations of computers.
- Illustrate how the computer system is organized.
- Classify the various types of computers.
- Identify the different peripheral devices used in computers.
- Differentiate the roles of hardware and software in a computer.

1.3 Evolution of Computer Systems

The 'abacus' was considered as one of the earliest computing devices. It enabled the users to represent numbers by the position of beads on a rack. In 1694, Blaise Pascal invented the first digital calculating machine that had the ability to add up numbers that were entered by turning dials. In 1842, Charles Babbage invented a completely automatic analytical engine that was powered by steam. In 1880, keyboards were first used in the US. During this time, Herman Hollerith developed the concept of punched cards which could be used as input media.

In 1944, Howard A. Aiken of Harvard University collaborated with IBM to develop the Mark I computer, also known as the IBM Automatic Sequence Controlled Calculator (ASCC). It was the first automatic calculating machine that was based on the techniques already developed for the punched card machinery. The machine was extremely reliable but very complex in design and huge in size.

The Electronic Numerical Integrator and Calculator (ENIAC) was the first electronic computer; it was developed for military requirements at the Moore School of Engineering, University of Pennsylvania, in 1946. It was faster than the earlier computers. However, it could store and manipulate only limited amount of information, and it had a complex architecture. This made it difficult to detect errors and change the programs. The Electronic Discrete Variable Automatic Computer (EDVAC) was designed on the stored program concept. It was the first computer to have the ability to store a program in its memory. It was a multipurpose computer and used binary digits (0 and 1 where, 0 = off and 1 = on). The Universal Automatic Computer (UNIVAC) was the first digital computer and the first computer to be commercially available in the market.

1.4 Generations of Computers

The history of computer development can be understood in terms of five generations of computers. Several technological developments have taken place during these generations with smaller, cheaper, more powerful, more efficient, and more reliable computers and related peripherals emerging in the marketplace.

1.4.1 First Generation Computers (1940-56)

The first generation computers like ENIAC and UNIVAC used vacuum tubes. These vacuum tubes were huge, expensive to operate, required a huge amount of electricity, generated a lot of heat, and were also not reliable. The first generation computers used machine language to carry out operations and were able to solve only one problem at a time. Punched cards and paper tape were used as input devices while the output was generated through printouts.

1.4.2 Second Generation Computers (1956-63)

The second generation computers used transistors which were smaller and more reliable than the vacuum tubes. These computers were smaller, faster, cheaper, more efficient, and more reliable than the first generation computers. Punched cards were used as input devices while the output was produced through printouts. Assembly languages were used by these computers which enabled the users to give instructions in the form of words. However, these computers required frequent maintenance and manual assembling of the individual components.

1.4.3 Third Generation Computers (1963-71)

The third generation computers used integrated circuits which enhanced the processing capabilities of the system. Keyboards were used to feed in the input and monitors were used for displaying the output. These computers allowed the users to perform multiple applications at one time. They were smaller, faster, and cheaper than the previous generation of computers. Computing concepts such as time sharing and batch processing were developed during this period.

1.4.4 Fourth Generation Computers (1971-91)

The fourth generation computers used Very Large Scale Integration (VLSI) of the circuits in which more than one million components were integrated on a single chip. These computers were smaller, more powerful, and had the ability to form networks. These features led to the development of the Internet and the World Wide Web. The mouse, handheld devices, and Graphical User Interfaces were also developed during this generation.

1.4.5 Fifth Generation Computers (1991 and Beyond)

The fifth generation computers are based on artificial intelligence and have voice recognition capabilities. These computers use parallel processing of semi -conductors for advanced computing. They have the ability to respond to natural languages and are capable of learning and self-organization.

While the size and price of computers have continuously decreased from the first generation to the fifth generation, the reliability, efficiency, and power of computers have continuously increased. The memory capacity of computers has also significantly increased from the first generation to the fifth generation.

Check Your Progress-1

1. Which of the following statements is **false**?
   a. Computers have the ability to accept, store, and execute programmed instructions.
   b. Computers have the ability to display results as per the specified format.
   c. Computers have the ability to accept user-supplied data.
   d. Computers have the ability to perform only mathematical operations.

2. _____ was the first electronic computer.

3. Match the following:

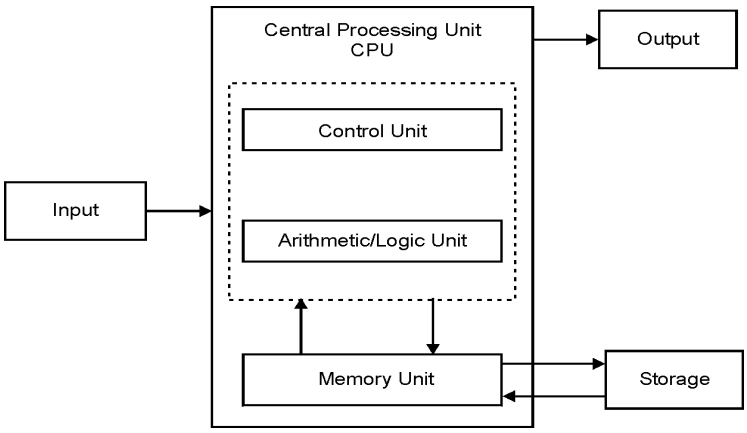
i. First generation computers	p. Parallel processing
ii. Second generation computers	q. Transistors
iii. Third generation computers	r. Vacuum tubes
iv. Fourth generation computers	s. Integrated circuits
v. Fifth generation computers	t. Very large-scale integrated circuits

4. The Internet and the World Wide Web were developed during the _____ generation of computers.
   a. First
   b. Second
   c. Third
   d. Fourth
5. What are the characteristics of fifth generation computers?

1.5 Organization of Computer Systems

Computers perform the four basic operations of Input, Processing, Output, and Storage (IPOS) which together constitute the IPOS cycle. The basic organization of a computer remains the same though the internal design or structure might differ from one system to another. Figure 1.1 provides a block diagram of a computer. The lines in the figure indicate the flow of instructions and data, while the Control Unit and the Arithmetic/Logic Unit together direct the flow of control in the Central Processing Unit (CPU).

Figure 1.1: Basic Organization of a Computer System



Source: https://texon0209.blogspot.com/2019/02/basic-computer-organization.html

1.5.1 Input Unit

Data and instructions are entered into the computer through the input unit. Keyboard, mouse, microphone, etc., are some of the examples of input devices. The data is entered in various forms depending on the type of input devices. For instance, a keyboard can be used to input characters, numbers, and certain symbols. Regardless of the ways in which the input devices receive the inputs, the input interfaces convert them into binary codes, i.e., 0s and 1s, as the primary memory of the computer is designed to accept data only in this format.

1.5.2 Central Processing Unit

The actual processing of the data takes place in the CPU, which is referred to as the brain of the computer. The CPU stores the data and instructions in the primary memory of the computer, called the Random Access Memory (RAM) and processes them from this location. The Arithmetic Logic Unit (ALU) and the Control Unit (CU) are the two subcomponents of the CPU. The CPU also consists of circuitry devices called cache and registers.

1.5.2.1 Arithmetic Logic Unit

Data and instructions stored in the RAM are transferred to the ALU for processing. The ALU carries out the logical and the arithmetic operations on the data and the results are temporarily stored in the RAM. After processing, the final results are stored in the secondary memory, i.e., the storage unit, and are released through an output device.

1.5.2.2 Control Unit

The CU retrieves the information from the storage unit, interprets the instructions, and issues signals that result in their execution. It helps in maintaining order and directs the operations of the entire system. It selects, interprets, and ensures the proper execution of the program instructions.

1.5.2.3 Processors

Certain computers use multiple processors for processing in order to reduce the load on a single processor. Following are the various types of processor designs.

1.5.2.4 Support Processor Design

In a support processor design, specialized processors carry out tasks like input/output, memory management, arithmetic operations, multimedia processing, and telecommunication. Support microprocessors, called as channels, control the movement of data between the CPU and the Input / Output devices. In advanced microprocessors, several processing functions are combined in a single processor.

1.5.2.5 Control Processor Design

In a control processor design, multiple microprocessors execute more than one instruction at a time. These processors have built-in capabilities that provide backup facilities during a power failure.

1.5.2.6 Parallel Processor Design

In a parallel processor design, a group of processors is used to execute program instructions. In parallel processing, several processors are organized into clusters or networks to process program instructions. This model is called as neural network. Neural networks are used for pattern recognition and other tasks that are very difficult to program using conventional techniques. Programs that use neural networks are capable of self-learning and of adapting to changes. Parallel processing capabilities enable the programmers to incorporate advanced computing capabilities.

1.5.2.7 CISC

The Complex Instruction Set Computer (CISC) is a microprocessor architecture in which the CPU supports about two hundred instructions. The processing circuitry consists of many special-purpose circuits which carry out these instructions at high speed. The CISC chips are complex and expensive to produce.

1.5.2.8 RISC

As CPUs were becoming increasingly complex and had large sets of instructions, some computer manufacturers began to build CPUs that executed a limited set of instructions. The Reduced Instruction Set Computer (RISC) is a type of microprocessor architecture that accepts only a limited set of instructions. It enhances the processor's efficiency and uses a less complex set of instructions when compared to the CISC architecture. RISC processors can execute the instructions very fast, and are cheaper to design and produce compared to CISC microprocessors.

1.5.3 Output Unit

The output unit sends out the final results of processing to the users through output devices like the monitor, printer, etc. A monitor displays the final results on the screen while a printer is used for obtaining the output as a printout. These devices link the computer with the users. The output interfaces convert the binary code produced by the computer into the human-readable form.

1.5.4 Storage Unit

The storage unit of a computer system is designed to store the data generated at various stages of processing. The data and instructions entered into the computer system for processing and the final results generated by

the computer after processing are stored in the storage unit. Storage media like hard disks, floppy disks, etc., aid in storing the data in various forms. The hard disk is an integral part of the computer system. Also called as hard drive, disk drive, or hard disk drive, the hard disk provides a large amount of storage space for the programs and data. These days, hard disks are available with several gigabytes of storage capacity. The floppy disk drives, CD-ROM/CD-RW drives, DVD drives, and USB (Universal Serial Bus) ports enable storage and exchange of data with others using storage media like floppy disks, compact discs, digital video discs (DVDs), and pen drives.

Check Your Progress-2

6. Input interfaces are used to:
7. Which of the following components of a computer system is responsible for the actual processing of data?
   a. Input Unit
   b. Storage Unit
   c. Central Processing Unit
   d. Output Unit
8. The _____ of a computer system maintains order and directs the operations of the entire system by selecting, interpreting, and ensuring the execution of program instructions.
9. What are channels?

1.6 Categories of Computers

Computers are broadly classified on the basis of their utility, technology, size, and capacity.

1.6.1 Classification Based on Purpose

Different organizations use computers in different ways. Based on their usage, computers are classified into general purpose computers and special purpose computers.

1.6.1.1 General Purpose Computers

General purpose computers are the most common type of computers used for educational and commercial purposes. Desktop and network computers are used as general purpose computers. Desktop computers are personal computers that are designed for individuals to carry out their work easily. In network computers, the software is accessed from a network and no disk

drives are required to store the software, thus resulting in low operational cost. Web TVs are network computers that enable users to connect to the Internet using their TV sets.

1.6.1.2 Special Purpose Computers

Special purpose computers are developed to serve a specific purpose and are used for weather forecasting, medical diagnostics, space application, etc. These computers carry out complex operations which require high amount of accuracy and speed. Engineers, architects, circuit designers, financial analysts, and other professionals, who need exceptionally powerful processing and output capabilities, use these computers. Professional workstations are examples of special purpose computers.

1.6.2 Classification Based on Technology Used

Based on the technology used, computers are classified into analog computers, digital computers, and hybrid computers.

1.6.2.1 Analog Computers

Analog computers operate on physical properties like temperature, speed, pressure, etc., and solve problems by making constant use of the modified data. Analog computers are developed to serve special purposes like conducting scientific and engineering tasks. For example, speedometers make use of analog computers.

1.6.2.2 Digital Computers

In digital computers, data is stored and represented as discrete quantities or numbers. Data is inputted in the text form but it is converted into the binary format (0s and 1s) for processing and storage purposes. Digital computers are developed to serve general purposes like reservation systems, data processing, scientific investigation, games, desktop publishing, etc.

1.6.2.3 Hybrid Computers

Hybrid computers are a blend of analog and digital computers. These computers store analog signals as numbers. Analog-to-digital and digital-to-analog converters are used to convert analog signals to numbers and vice-versa, respectively. These computers are used in artificial intelligence and computer-aided manufacturing.

1.6.3 Classification Based on Size and Capacity

Computers can be classified based on their size, operation speed, memory size, storage capacity, and number of simultaneous users.

1.6.3.1 Supercomputers

Supercomputers are designed to process huge amounts of scientific data. These computers have very high processing speeds as they have several

CPUs running simultaneously. Supercomputers have huge primary memories and the most advanced processing capabilities. These computers are also very expensive, costing millions of dollars. Supercomputers are usually used for forecasting weather, economic forecasting, carrying out complex calculations, nuclear energy research, energy management, and engineering design and testing purposes. These computers are designed with modern computer architecture, including engine cooling systems to dissipate internal heat buildup. Blue Gene/L, CRAY3, CRAYXMP, PARAM 9000, and PARAM 10000 are some examples of supercomputers.

To keep pace with the need to solve increasingly complex problems and applications, computers are evolving at a faster pace with the passing of each decade. Starting from relatively clumsy, giant machines that required large space and were instructed using punched cards, the supercomputers today have reached speeds and capacity where their processing performance is measured in terms of petaflops (10^{15} floating point operations per second). Exhibit 1.1 discusses world's fastest computer in 2021.

Exhibit 1.1: Japan's Fugaku Keeps Position as World's Fastest Supercomputer

The term supercomputers represent very powerful machines demonstrating the highest level of performance. These supercomputers find use in highly advanced applications where the amount of data is extremely complex and large making it difficult to analyze using other computers. Such applications include environmental or space research, testing of complex mathematical models, healthcare research or military research besides others. Quite naturally, big data processing is an area of interest as regards processing by supercomputers. Some frequently observed characteristics of supercomputers are use of multiple CPUs, immense storage capacity, very fast input/output capability, specialized cooling systems, and vector arithmetic to operate on a pair of lists of numbers enabling faster processing of data.

With the passing of decades, different models of super computers have emerged starting from Cray supercomputers and extending to Japan's Fagaku supercomputer of 2021. The Fagaku supercomputer has been developed by Fujitsu and Japan's national research institute Riken. It achieved a score of 442 petaflops, or quadrillions of floating-point operations per second as compared to 148 petaflops by IBM's Summit supercomputer that stood at the second place. Some of the other names in

Contd. .....

this impressive list of fast supercomputers are Sierra from IBM at 125 petaflops with highly efficient power consumption, Sunway TaihuLight from China and HPC5 which is the most powerful industrial supercomputer in the world at 70 petaflops.

Besides Japan, US and China have invested heavily in research to develop supercomputers with an objective of developing machines capable of exascale computing (one exaflop equals a thousand petaflops). These supercomputers are expected to be twice as fast as or more than the Japanese Fagaku supercomputers and expected to begin operations before end of 2021.

Source: https://asia.nikkei.com/Business/Technology/ Japan-s-Fugaku-keeps-position-as-world-s-fastest-supercomputer June 29, 2021

1.6.3.2 Mainframes

Mainframes are huge multi-user systems that allow multiple users to carry out complex mathematical calculations. These computers have huge primary memories, large processing and data communication capabilities, and enable simultaneous handling of huge databases. Mainframes are required to be stored in special rooms that have a controlled climate and are mainly used for railway ticket reservation, airline ticket booking, and banking. IBM 3090, IBM 4381, IBM 4300, and IBM ES-9000 are some examples of mainframes.

1.6.3.3 Minicomputers

Minicomputers are multi-user systems that can handle the computing needs of a smaller organization and can support around 50-100 users simultaneously. These computers are cheaper than mainframes and hence are used to replace them where there is scope for distributed application. Minicomputers are slowly being replaced by PCs though mostly used for maintaining accounting and inventory in large organizations. PDP-1 and IBM AS/400 are some examples of minicomputers.

1.6.3.4 Microcomputers

Microcomputers (also known as personal computers or desktop computers) are the smallest digital computers that can be used on the network or as stand-alone systems. These computers use microprocessors as their CPU and have high processing power. Microcomputers are used in homes and organizations for entertainment, education, communication, word processing, accounting, research, and inventory control purposes. There are two models of microcomputers: the desktop model and the portable model.

Desktop computers: These are large non-portable computers that are placed on a table or a desk and are plugged to a source of electricity. They have a motherboard, power supply, cables to connect the various devices to and from the computer system, a keyboard, drives, and a mouse.

Portable computers: These are small, portable, and lightweight computers. They run on a battery and do not require to be plugged to a source of electricity. Portable computers have a monitor, a built-in keyboard, and a touchpad. Compared to the desktop computers, these computers are less powerful and more costly as the built-in components are very expensive. Laptops and notebook computers are examples of portable models. Notebook computers are lighter, smaller, and costlier than laptops. Most of these are also more powerful than desktop PCs and include nearly all the components of a desktop PC. Sub-notebooks are notebook computers that omit some components (like CD-ROM drive) to cut down on weight and size. Personal Digital Assistants (PDAs) are also called handhelds or palm-tops. They pack much of a notebook's power into a much lighter package. Most of them include built-in software for managing list of contacts, scheduling appointments, and electronic mail.

Activity: Jack is the head of an autonomous institute of remote sensing and space administration. He is planning to set up a state-of-the-art weather forecasting center; he is also planning to set up an educational institute for students of space research. What type of computers should Jack procure for the weather forecasting center and the educational institute? Why?

Answer:

1.6.3.5 Servers

A server manages the network resources on a network. Servers run on a network of computers and enable sharing of printers and other equipment between the various computers on the network. They have huge memory size, larger storage capacity, and facilitate high speed communication. There are different types of servers: file servers that are dedicated to storing files; print servers that are used to manage one or more printers; network servers that manage network traffic; and database servers that store application data and process database queries.

Check Your Progress-3

10. Which of the following is false about supercomputers?
    a. Supercomputers have very high processing speeds as they have a single CPU.
    b. Supercomputers are designed to process huge amounts of scientific data.
    c. Supercomputers have huge primary memories and the most advanced processing capabilities.
    d. Supercomputers are designed with state-of-the-art computer architecture including cooling systems to dissipate internal heat buildup.
11. Speedometers use which categories of computers?
12. Which type of computers is appropriate for use in the field of artificial intelligence?
13. IBM ES-9000 is a _____ while IBM AS/400 is a _____.
    a. Minicomputer, Mainframe computer
    b. Mainframe computer, Microcomputer
    c. Microcomputer, Mainframe computer
    d. Mainframe computer, Minicomputer
14. What are servers?

1.7 Peripheral Devices

Input devices, output devices, and the storage units are the peripheral devices. These devices augment the basic services provided by a computer. The input/output devices act as a means of communication between the computer and the end user while the storage devices act as warehouses for the inputs and the outputs. Even when peripheral devices are connected to the computer, they are external to the processing unit. The computer will continue to work even when a peripheral device is disconnected.

1.7.1 Input Devices

Data and instructions are entered through the input devices into the input unit of the computer system for processing. Following are some of the main input devices:

1.7.1.1 Keyboard

The keyboard of a computer is similar to the keyboard of a typewriter. It consists of the alphanumeric keys like letters and numbers; punctuation keys like comma, colon, semicolon, etc; and special keys like control keys, arrow keys, function keys, etc. When a key is pressed, electronic signals are generated; the keyboard encoder detects these signals and sends them to the CPU. The keyboard with 101 keys is the most popular keyboard. Cordless or wireless keyboards are an advancement over the wired or corded keyboards. Cordless keyboards are sometimes combined with cordless mice or such similar pointing devices.

1.7.1.2 Mouse

Mouse is a handheld pointing device that controls the movement of the cursor on the monitor. Usually, a mouse has one to four buttons which are used for clicking on an icon, selecting a text or an object, dragging the selected items, etc. Some mice have scrollers that are used for scrolling purposes as a replacement of the keyboard scroll keys. The optical mouse, laser mouse, wireless or cordless mouse, etc., are advancements over the regular mouse. An optical mouse has the ability to work on any surface and does not require a special surface like a mouse pad. It does not have any moving parts which results in less wear and tear, and thereby resulting in less chance of failure. Dust cannot get inside the mouse and interfere with the tracking sensors. It moves smoothly and works faster on any surface. A laser mouse has a laser within it that enables smoother and accurate control of the cursor. A scroller, a thin and flexible wire, and customized buttons are the other features in a laser mouse. A wireless mouse does not require any wires or cords for connection with the computer system. It functions similar to wireless keyboards. Radio signals powered by batteries enable interface between the mouse and the computer system. The wireless optical mouse, wireless laser mouse, etc., are the advancements in the wireless mouse.

1.7.1.3 Touchpad

A touchpad is used in laptop computers in place of a mouse. A touchpad is a small, touch sensitive device placed in front of a keyboard. The cursor on the screen moves based on the movement of a finger. To click on a particular icon on the screen, the user has to tap the pad or use the buttons in front of the pad.

1.7.1.4 Joystick

A joystick is a controlling device used mostly for playing computer games or controlling robots in the manufacturing industry. It has a gearshift like

lever which is used to move the pointer or cursor on the screen. Joysticks are also used by flight simulators and other training simulators. Generally, joysticks are two-dimensional with two sides of movement. Three-dimensional joysticks are also available.

1.7.1.5 Trackball

A trackball is a pointing device that looks like a mouse that is lying on its back. It has a roller on top and selection buttons on the side. Compared to mouse, trackballs are more stationary, do not occupy much space, and can be placed on any surface.

1.7.1.6 Light pen

Light pens are pointing devices that look like pens and are connected to the visual display unit. A light pen consists of a small tube that contains a photocell and an optical system. When the tip of the pen touches the screen, the photocell sends the corresponding signal to the CPU indicating the screen location. These devices are used for selecting menu items or for drawing pictures.

1.7.1.7 Touch screens

Touch screens recognize human touch and are used in place of a keyboard. The users have to use their fingers to point out a selection on the screen.

1.7.1.8 Digitizer

The analog signals are converted into digital signals through a process called digitizing. This process is used for converting graphic representations into digital data. A digitizer uses digitizing to create drawings and pictures. It contains a digitizer tablet that is connected to a pen-like stylus. This stylus traces the image, stores it in the RAM, and displays it on the monitor.

1.7.1.9 Scanners

Scanners are designed to copy anything that is printed on a sheet of paper. They analyze a picture or text and then convert it into a digital image. Scanners use Charge-Coupled Devices (CCDs) to digitize an image formed by a lens. Most scanners are equipped with Optical Character Recognition (OCR) software that automatically decodes imaged text into a text file. Using this technology, most of the printed or typed documents can be scanned and converted into text files.

Scanners are of different types. Flatbed or desktop scanners work on a single sheet of paper at a time and are the most commonly used scanners in offices. Sheet fed scanners draw in the sheets by means of a roller mechanism. Handheld scanners are used to copy smaller originals, such as

photographs. These scanners are operated by hand and are not used much as the image quality is not good as compared to the flatbed scanners.

One of earliest scanning systems, the Magnetic-Ink Character Recognition (MICR) system, was developed in the 1950s. It is still used for processing checks and demand drafts in the banking industry. The bar code reader is the most familiar scanning device used in business. It is used in many retail and grocery stores to determine the item being sold and to retrieve the price of the item from a computer system. The bar code reader reads the Universal Product Code (UPC), which is a pattern of bars printed on the merchandize. The Optical Mark Reader (OMR) is another type of scanning device; it is popularly used for conducting examinations. The OMR senses the magnetized marks, enabling the reader to determine which responses are marked.

1.7.2 Output Devices

The output unit generates the final results of computation. Users can obtain these results through the output devices. Following are some of the output devices.

Activity: Shikha is an entrepreneur. She intends to purchase a computer system for her small business. She is aware that there are a variety of input devices that could be used in the system. But she is in a dilemma as to which input devices she should buy. Explain to her about the various input devices. Which of these devices would you recommend for Shikha?

Answer:

1.7.2.1 Monitors

The monitor is an on-screen display device that acts as an interface between the user and the computer system and enables the user to view the results of data processing. A video adapter displays the image on the monitor by converting the digital instructions given by the computer system to an analog signal that can be understood by the monitor. The signal in turn instructs the monitor to display the output and determines the overall quality of the image. The output on the screen is called as soft copy while the printed version is called the hard copy. The monitor has its own processing circuitry and memory called Video RAM (VRAM).

1.7.2.2 Printers

Printers are typically used to obtain computer output on paper. Most printers are connected to the user's computer through a printer cable. Other

printers called as network printers have built-in interfaces so that they can be used by any user on the network. Printers are classified as impact printers and non-impact printers based on the way they print characters.

Impact printers: In impact printers, the print head touches the paper and creates an impact on the paper. These printers can print a page, a line, or a character at a time. Impact printers are used for printing backup copies of huge amounts of stored data and for printing documents or forms that have multiple parts. These printers, however, have a poor print quality and are noisier than non-impact printers. Dot-matrix, daisy-wheel, and line printers are the three types of impact printers.

Dot-matrix printers are the cheapest printers and also have a low maintenance cost. The quality of printouts is generally poor.

Daisy-wheel printers are very noisy and they print very slowly. These printers cannot print graphics and do not have multi-font capabilities. The print wheel needs to be physically replaced in order to change the font.

Line printers are faster than dot-matrix and daisy-wheel printers. However, they are noisy, have limited multi-font capabilities, and produce lower quality printouts.

Non-impact printers: Non-impact printers are the most widely used printers for personal computers. These printers do not strike a print head on the ribbon and are therefore noise-free compared to the impact printers. Non-impact printers can print both text and graphics with good print quality. Thermal printers, laser printers, and inkjet printers are the types of non-impact printers.

Thermal printers produce inferior quality printouts and are used by fax machines, portable calculators, and such similar equipment that are powered by batteries.

Inkjet printers (or bubble jet printers) function like dot-matrix printers in which an image is formed out of tiny dots. These dots are much smaller in the inkjet printers than in the dot-matrix printers. Inkjet printers can print in color, are less expensive than laser printers, and produce excellent output similar to that produced by laser printers. However, inkjet printers are slow compared to laser printers and require a special type of ink.

In laser printers, a laser beam creates electrical charges on a rotating print drum. These charges attract tones, which are transferred to the paper and fused to its surface by a heating process. They are faster than inkjet printers, have multi-font capabilities, and produce high-quality printouts. Though the initial cost is high, laser printers cost less in the long run due to their low operational costs. Laser printers are of two types: monochrome

and color laser printers. Monochrome laser printers are standard printers that use only a single toner while color laser printers use four toners and can therefore print in color. Color laser printers are five to ten times as expensive as monochrome laser printers.

1.7.2.3 Sound Cards and Speakers

Sound cards and speakers allow users to receive an audio output from the computer system in the form of recorded sound files and synthesized speech.

1.7.2.4 Plotters

Plotters are used for printing quality graphics and drawings on paper. These devices are different from printers as they use a pen for drawing lines, thus, producing continuous lines. Plotters can also draw different colors by using colored pens. These devices are very expensive than the printers and are widely used for engineering applications and by engineers, architects, surveyors, etc. There are three types of plotters namely, flatbed plotters, drum plotters, and inkjet plotters.

In flatbed plotters, the paper is set on a flat surface and the pens are moved for drawing the image. These plotters print graphical images by moving the pen and can produce colored images. They produce accurate pictures. The size of the paper or plot is smaller and is restricted to the size of the surface of the plotter. Drum plotters print graphical images by moving both the drum and the pen. These plotters are bigger than the flatbed plotters. The pictures are not as accurate as those printed by flatbed plotters. In inkjet plotters, the pens are replaced by inkjets. These plotters have high processing speeds and can generate color prints.

1.7.3 Memory and Storage Devices

Memory refers to the internal storage areas in a computer and is measured in Kilobytes (KB). A bit represents a binary digit (0 or 1). Each byte stores a character or a symbol. The commonly used conversion factors are given here.

- 1 byte = 8 bits
- 1 KB = 1024 bytes or characters
- 1 Megabyte (MB) = 1 million bytes
- 1 Gigabyte (GB) = 1 billion bytes
- 1 Terabyte (TB) = 1 trillion bytes

Storage devices are used for storing the programs and data that are stored in files. The computer CPU transfers the file to its memory, which is a temporary workplace where one can work with the file contents. Certain

storage devices called read/write devices can read the recorded data as well as write new data. For instance, a Read-Only Memory (ROM) drive is a read-only device as it can read the recorded data while a CD Writer can read as well as write from the disc. Storage devices can be classified as sequential storage devices or random access storage devices based on the way they can access the requested data. In sequential devices like magnetic tape, the computer follows a fixed sequence to access the required file. In random access devices, the required file can be directly accessed. Sequential storage devices are slow and inexpensive while random access storage devices are faster and more expensive. Storage devices are of two types: primary memory and secondary storage devices.

1.7.3.1 Primary Memory

Primary memory is used for storing data that could be utilized for current purposes. Also called as the internal memory, it is accessible to the computer CPU and does not require any input/output channels. Many types of primary memory are volatile in nature, i.e., the entire data may be lost during power failure. Access to primary memory is faster than the access to secondary storage media. Following are the various primary memory media.

Random Access Memory (RAM): RAM is the main memory or the primary memory of the computer. In RAM, it is possible to randomly select a location where data and instructions can be directly stored and retrieved from. Also called as a read/write memory, RAM is faster than ROM. Each memory location has an address called the memory address through which the processor can store and retrieve data by directly going to a single location in the memory. Most memory chips of personal computers are Dynamic RAM (DRAM). This is volatile in nature and data is lost in case of power failure. Printers also have memory which is used for storing any information pertaining to printing.

*Cache memory: C*ache is a high-speed memory which can be part of the main memory or a completely independent high-speed storage medium. It makes the current programs and data available to the CPU at a rapid rate to increase the processing speed. Cache memory is much faster than RAM, expensive, and greatly enhances the overall performance of the computer. The microprocessor can access the cache memory more quickly than it can access the RAM. The microprocessor stores the frequently accessed program instructions and data in the cache memory. Primary cache and secondary cache are the two types of cache memory. Primary cache or level 1 cache is included in the microprocessor chip while secondary cache or level 2 cache is included on a separate printed circuit board.

Read-Only Memory (ROM): ROM is a non-volatile storage medium. It is considered to be a permanent and a highly secured storage medium. ROM is used to store information permanently and is used only to read. It is mainly used for storing system level programs that are required by a computer throughout. ROM chips are non-volatile in nature and contain instructions to start the computer. For example, ROM BIOS (Basic Input/output System) chip is a special chip that contains instructions to start the computer. Flash memory called flash BIOS is used by the computer to store ROM upgrades.

Registers: Registers are special memory units that handle the movement of information between the various units of a computer. These are temporary memory units that are used for storing words on a temporary basis. Registers enable faster transfer, access, and storage of data. These are part of the processor and are not considered to be as part of the main memory. Several types of registers are designed to handle specific functions.

1.7.3.2 Secondary Storage Media

Secondary storage media is used for storing data meant for future use. Also known as external memory, this media is not directly accessible to the computer CPU and requires the input/output channels. Secondary storage media is non-volatile, slower than the primary memory media, and is best used for storing information during a power failure. Following are the various secondary storage media.

Disk drives: Disk drives are random access devices that are very fast. They are the most widely used medium for storage for all types of computers. Disk drives enable the computer to read/write data onto them. Data is recorded on the disk in circular tracks, which are in turn divided into pie-shaped sectors. Two or more sectors combine to form clusters. The hard disk drives and the floppy disk drives are the most common types of disk drives.

Redundant Array of Inexpensive Disks (RAID): RAID is a data storage medium that uses multiple hard drives to share data among the various drives. Several drives are grouped together for various purposes. This conglomeration of drives provides redundancy if one of the drives fail. Therefore, several drives are grouped together and configured to the computer system as one large drive. This grouping of drives along with the various RAID levels yield better performance features. The individual drives contribute as a member of a RAID set and each drive contributes to the total throughput of information. This results in efficient utilization of the available bandwidth and a higher aggregate throughput. Compared to

single drives, RAID has high fault-tolerance capabilities and provides enhanced data integrity, throughput, and capacity.

Floppy disks: Floppy disks are disks coated with a magnetically sensitive film. Floppy disks contain a write-protection head that can be opened to protect data from being overwritten or deleted. This also enables the floppy to switch to the read-only mode. Compared to the hard disks, floppy disks are portable and less expensive. However, they have slower access rates and less storage capacity. These disks are becoming outdated due to their low reliability and low storage capacity.

Hard disks: Hard disks function like floppies but comparatively store more data and work faster. These are magnetic disks that store the computer operating system and applications and provide space for the user's data. Nowadays, the storage capacity of a hard disk is usually measured in gigabytes. Hard disks that use removable disk cartridges are not as fast and cannot store as much data as one-piece hard disks. Such hard disks are used as backup for data files that are less frequently used and for exchanging large data files with other computer users.

Magnetic tapes: Magnetic tapes store data in a sequential manner. These were once the most commonly used storage media and were used for storing huge data that is not frequently accessed.

Optical discs: Optical discs use laser to burn tiny holes on the disc surface to represent digital data. A laser-generated beam of light is used by the drive on the disc's surface to read the data. The drive detects the light fluctuations caused by holes and translates them into data that the computer can use. CD-ROM, Recordable CD (CD-R), CD-RW (Rewritable), DVD-ROM, and Magneto-Optic (MO) disks are the various types of optical discs. CD-ROM discs are read-only discs that are used for storing large amounts of data at low cost. They can store up to 650 MB of data. Among all the commonly available types of optical discs, DVD-ROMs are capable of storing huge data. However, Blu-ray disks and HD-DVD disks are now available with greater storage capacity.

USB pen drives: A USB pen drive (pen drive) is a portable device used for transferring files between USB (Universal Serial Bus) (an external bus used for connecting various peripheral devices) compatible systems. It takes the advantage of a USB connection which enables a large number of different devices to be attached to a single machine without any additional requirement for drivers or software. A pen drive is a convenient option for transferring files and storage. The pen drive also has the ability to operate at an efficient speed.

Check Your Progress-4

15. Which of the following is an input device?
    a. Mouse
    b. Printer
    c. Plotter
    d. RAM chip
16. _____ is a gearshift-like lever that is widely used for controlling robots or for playing computer games.
17. Which of the following is used in the banking industry for processing checks and demand drafts?
    a. Bar code reader
    b. Magnetic-Ink Character Recognition (MICR) system
    c. Optical Mark Reader (OMR)
    d. None of the above
18. Explain the functionality and characteristics of laser printers.
19. Match the following:

i. Flatbed plotters	p. These plotters print graphical images by moving both the drum and the pen.
ii. Drum plotters	q. In these plotters, printing speed is high and color printing is possible.
iii. Inkjet plotters	r. These plotters print graphical images by moving a pen and produce accurate pictures.

20. One gigabyte _____.
21. Which among the following is capable of storing the maximum amount of data?
    a. CD-ROM disk
    b. CD-R disk
    c. DVD-ROM disk
    d. HD-DVD disk

1.8 Overview of Hardware and Software

Hardware comprises all the physical devices in the computer system which can be physically felt like the CPU, the monitor, and the printer (i.e., the

input, storage, processing, and output devices). Software is a set of computer programs, procedures, and associated documents that describe how the computer is to be used. It is a collection of programs which enhances the capabilities of the computer. The computer software (programs) instructs the computer hardware. When a computer is switched on, an automatic program called a bootstrap loader is loaded onto the memory of the computer. This program guides the rest of the start-up process, which involves moving the essential programs from the computer's hard disk into the memory.

1.8.1 Interaction between Hardware and Software

The hardware and software of a computer complement each other and they cannot work alone without the support of each other to produce useful output. For example, the DVDs and the DVD player purchased from the market constitute the hardware and the movies recorded on the DVDs constitute the software. To watch the movie, it should be recorded on a DVD and played on the DVD player. In the same way, to perform a particular job, the relevant software should be loaded in the hardware before processing starts. Thus, both the hardware and the software are vital. Different software can be loaded and run on the same hardware to perform different tasks.

Computer software is broadly classified into two categories -- system software and application software. System software refers to programs that help the computer to function properly. An operating system (OS) is a type of system software. Most of the functions of an operating system are automatic. These functions tell the computer how to get its various components to work smoothly together. Before using a machine, the operating system must be loaded onto its memory that consumes a few minutes. Windows and Linux are popular operating systems software.

Application software refers to programs that are used for performing tasks ranging from word processing to browsing the World Wide Web. Productivity software is a type of application software which is designed to help people perform office tasks like word processing programs for written work, Internet client programs such as electronic mail (email) for electronic messaging, and web browsers for finding information on the Internet. MS Office is a popular office applications software available in the market.

1.9 Summary

- Computers are electronic devices which have the ability to accept user supplied data, store, and execute programmed instructions, perform mathematical and logical operations, and display results as per the specified format. They carry out four basic operations – Input, Processing, Output, and Storage (IPOS), which constitute the IPOS cycle.
- The history of computer development can be explained in terms of five generations of computers, namely, the first generation computers (1940-1956), the second generation computers (1956-63), the third generation computers (1963-71), the fourth generation computers (1971-91), and the fifth generation computers (1991 and beyond). Over the years, the computers have become smaller in size, less expensive, more powerful and efficient, and reliable.
- The keyboard, the mouse, and the microphone are examples of input devices which are used to enter data and instructions into the computer. The Central Processing Unit (CPU) carries out the processing function of the computer; in this process, the CPU uses the Random Access Memory (RAM). The Control Unit (CU) and the Arithmetic Logic Unit (ALU) are the two components of the CPU. The ALU performs arithmetic and logical operations on the data. The CU performs the four basic operations of: obtaining the instructions from the memory of the computer, decoding the instruction, executing the instruction, and writing the results onto the memory.
- Monitors, speakers, printers, etc., are output devices through which the final computed or processed information can be obtained. The data, instructions, and the final processed information can be stored on the hard disks, floppy disks, CD-ROMs, and other additional devices.
- Computers can be broadly classified on the basis of their utility, technology, size, and capacity. According to purpose, computers are classified into general purpose computers and special purpose computers. According to the technology used, computers are classified into analog computers, digital computers, and hybrid computers. According to size and capacity, computers are classified into supercomputers, mainframes, minicomputers, microcomputers, and servers.
- Peripheral devices are the devices that are attached to a computer system in order to augment the basic services provided by the system. The input devices, output devices, and the storage devices are the various peripheral devices of a computer system.
- Hardware comprises all the physical devices in the computer system which can be physically felt like the CPU, the monitor, and the printer (i.e., the input, storage, processing, and output devices). Software is a

collection of programs, whose objective is to enhance the capabilities of the computer.

1.10 Glossary

Arithmetic Logic Unit (ALU): A CPU component that carries out the arithmetic and logical operations on the data and temporarily stores the results in the RAM.

Binary digits (bits): The smallest unit of computer storage used to store data and programs in primary and secondary storage media.

Bootstrap loader: An automatic program that is loaded onto the memory of the computer when a computer is switched on. This program guides the rest of the start-up process, which involves moving the essential programs from the computer's hard disk into memory.

Cache memory: A high-speed memory that increases the speed of processing by making current programs and data available to the CPU at a rapid rate. Cache memory is a part of the main memory or a completely independent high-speed storage medium.

Central Processing Unit (CPU): The actual processing of the data is carried out in the Central Processing Unit (CPU), which is the brain of computer. The CPU stores the data and instructions in the primary memory of the computer, called the Random Access Memory (RAM) and processes them from this location. The CPU contains the control unit and arithmetic logical unit.

Complex Instruction Set Computer (CISC): A type of microprocessor architecture in which the CPU supports about two hundred instructions. The processing circuitry consists of many special-purpose circuits which carry out these instructions at high speed.

Computer hardware: It refers to all the devices in the computer like the CPU, the monitor, and the printer that can be physically felt.

Computer software: A collection of computer programs, procedures, and related documents that instruct the computer hardware and describe how the computer is to be operated.

Control processor design: Multiple CPUs or microprocessors execute more than one instruction at a time. The processors have built-in capabilities to provide backup facilities in case of a power failure.

Control Unit: The CU obtains the program instructions stored in the primary memory of the computer, interprets them, and issues signals that result in their execution. It helps in maintaining order and directs the operations of the entire system. It selects, interprets, and ensures the proper execution of the program instructions.

Digital computers: These computers are developed to serve general purposes, i.e., these computers are used for reservation systems, data processing, scientific investigation, games, desktop publishing, etc.

Digitizer: A device that uses the process of digitizing to create drawings and pictures. Digitizing is a process of converting analog signals into digital signals. It is used for converting graphic representations into digital data.

Disk drives: These are random access devices, they are reasonably fast. They enable the computer to both read as well as write data onto them.

Floppy disks: Circular plastic disks that are coated with a magnetically sensitive film. A sliding metal shutter protects the disc from fingerprints, dust, and dirt. Floppy disks contain a write-protection head that can be opened to protect data from being overwritten or deleted. This also enables the floppy to switch to the read-only mode. Compared to the hard disks, floppy disks are portable and less expensive. However, they have slower access rates and less storage capacity.

Hard disks: Magnetic disks which store the computer operating system and applications that provide space for the user's data. These disks work like floppy disks but store comparatively more data and work faster.

Hybrid computers: A combination of analog and digital computers. These computers store analog signals as numbers.

Input devices: Devices that are used for entering data and instructions into the input unit of the computer system like mouse, keyboard, etc.

Joystick: A controlling device which is most often used for playing computer games or controlling robots in the manufacturing industry. It has a gearshift like lever which is used to move the pointer or cursor on the screen.

Monitor: An on-screen display unit that acts as an interface between the user and the computer system. Also known as computer display, it enables the user to view the results of data processing.

Mouse: An input device connected to a computer terminal either with a wire or through wireless transmission. A mouse lets you enter data or commands without a keyboard.

Network computers: A type of computers that function in a way similar to personal computers but their operational cost is low as the software is accessed from a network and there is no need for any disk drives for storing the software.

Optical Character Recognition (OCR): The machine identification of printed characters through the use of light-sensitive devices.

Output interfaces: These interfaces convert the binary code produced by the computer into the human-readable form.

Output unit: Generates the final results of computation to the users through the output devices like the monitor, printer, etc. A monitor displays the final results of the processed data on the screen while a printer can be used for obtaining the output in a printed format.

Peripheral devices: Input / Output devices and various storage units that are attached to a computer system. These devices augment the basic services provided by the computer system. The input/output (I/O) devices act as a means of communication between the computer and the end user while the storage devices act as warehouses for the inputs and the output.

Personal Digital Assistants (PDAs): Also called handhelds or palm-tops, these computers pack much of a notebook's power into a much lighter package. Most of them include built-in software for appointments, scheduling, and electronic mail.

Plotters: Output devices that are used for printing quality graphics and drawings on paper. Plotters can draw different colors by using colored pens. These devices are very expensive compared to the printer and are widely used for engineering applications and by engineers, architects, surveyors, etc.

Primary memory: Also called the internal memory of the computer. This media is faster than the secondary storage media. Also, primary memory is volatile in nature, i.e., the entire data may be lost during power failure.

Primary storage media: Media used for storing data which could probably be used for current purposes. This memory is accessible to the CPU of a computer system and does not require any input or output channels.

Printers: Output devices that produce hard copies of information stored in computers on paper or on transparencies. Most of the printers are connected to the computer through a printer cable.

RAID: An acronym for Redundant Array of Inexpensive Disks. It is a data storage medium which makes use of multiple hard drives to share data among the various drives.

Random Access Memory (RAM): The main memory or the primary memory of the computer. Compared to Read-Only Memory, RAM is much faster and can read as well as modify data or information. Due to this reason, RAM is also referred to as read/write memory.

Read-Only Memory (ROM): In this memory, the information is permanently stored. Compared with RAM which is read/write memory, ROM can be used only to read. This is because ROM is mainly used for storing system level programs which need to be there in the computer system throughout. The instructions to start the computer are stored in ROM chips which are non-volatile.

Reduced Instruction Set Computer (RISC): A type of microprocessor architecture that accepts only a limited set of instructions. RISC enhances the processor's efficiency and uses a set of instructions that are less complex than those in Complex Instruction Set Computer (CISC).

Registers: As the CPU interprets and executes instructions, there is movement of information between the various units of a computer system. In order to handle this process smoothly and speed up the rate of transferring information, computers use a number of special memory units called registers. Registers are temporary memory units that are used for storing words. The registers are part of the processor which enables faster access and storage.

Scanners: Input devices that are designed to copy anything that is printed on a sheet of paper. They have the ability to analyze a picture or text and then convert it into a digital image. Optical Character Recognition (OCR) software that automatically decodes imaged text into a text file. Using this technology, most of the printed or typed documents can be scanned and converted into text files.

Secondary storage media: Medium used for storing data meant for use in the future. It is not directly accessible to the CPU of a computer system and requires the input and output channels. Secondary storage media is also known as external memory. This medium is non-volatile in nature and is slower than the primary storage media. It is best used for storing information during a power loss.

Server: A computer or device that manages the network resources on a network. It is considered more as a computer function than a type of computer. Servers run on a network of computers and enable sharing of printers and other equipment between the various computers on the network. They have huge memory size, have larger storage capacity, and facilitate high speed communication.

Storage unit: The storage unit of a computer system is designed to store the data generated at various stages of processing. Storage media like hard disks, floppy disks, etc., aid in storing the data in various forms.

1.11 Self-Assessment Test

1. Computers are electronic devices that perform certain basic operations under the direction and control of a program. How did computers evolve? Describe the different generations of computers.
2. Computers perform the four basic operations of input, processing, output, and storage. Explain these operations and describe the basic organization of a computer system.

3. Computers can be categorized into different types. What are the different bases of classifying computers?
4. Briefly explain the role of peripheral devices in augmenting the basic services provided by a computer system.
5. "The hardware and software of a computer interact with and complement each other in order to produce useful output." Explain.

1.12 Suggested Readings / Reference Material

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1.13 Answers to Check Your Progress Questions

Following are the answers to the Check Your Progress questions given in the unit.

1. **(d) Computers have the ability to perform only mathematical operations**

   Computers are electronic devices with the ability to accept user-supplied data; accept, store and execute programmed instructions; perform mathematical and logical operations and display results in the specified format. They perform the basic operations of input, processing, output and storage.

2. **Electronic Numerical Integrator and Calculator**

   Electronic Numerical Integrator and Calculator (ENIAC) was the first electronic computer. It was developed by Moore School of Engineering, University of Pennsylvania. It was developed to suit military requirements. Though it was fast, it could store and manipulate only limited amount of information and had a complex architecture. These limitations made it difficult to detect errors and change programs.

3. First generation computers used vacuum tubes; second generation computers used transistors; third generation computers used integrated circuits; fourth generation computers used large-scale/ very large scale integrated circuits. Parallel processing is associated with fifth generation computers.

4. **(d) Fourth**

   Computers in the fourth generation (1971–91) are smaller and more powerful than computers of previous generations. They also have the ability to form networks. The Internet and World Wide Web were developed during this generation of computers.

5. Fifth generation computers are based on artificial intelligence and possess voice recognition capabilities. These computers use parallel processing of semiconductors for advanced computing. Computers of this generation have the ability to respond to natural languages and are capable of learning and self-organization.

6. **Transform the data received as input into binary codes.**

   Input devices provide the computer with data in the form of binary codes (0's and 1's) regardless of the form in which they are

received. This transformation process is undertaken by input interfaces. This is because the primary memory of a computer is designed to accept data in this format.

7. (c) Central Processing Unit

The Central Processing Unit (CPU) carries out actual processing of data. The CPU is also called the computer's brain. It stores data and instructions in the primary memory of the computer, called the Random Access Memory (RAM) and processes data from this location.

8. The Control Unit maintains order and directs the operations of the entire system by selecting, interpreting and ensuring the execution of program instructions. It obtains instructions from the program stored in the main memory, interprets instructions and issues signals that result in execution.

9. In the support processor design, specialized microprocessors are used for performing a variety of functions. These microprocessors perform tasks ranging from input/output, memory management, arithmetic operations, multimedia processing and telecommunication. Channels are support microprocessors controlling data movement between the CPU and input/output devices.

10. (a) Supercomputers have very high processing speeds as they have a single CPU

Supercomputers like CRAY3, CRAYXMP, PARAM9000 and PARAM10000 have very high processing speeds. They operate at high speeds because they have several CPUs running simultaneously. They are widely used in areas like energy management, electronic design, and nuclear energy research.

11. Analog computers

Analog computers operate on physical quantities like temperature, speed, pressure, etc., which tend to change on a real-time basis. These computers solve problems by using the modified data constantly.

12. Hybrid computers

Hybrid computers are a combination of analog and digital computers. They store analog signals as numbers. The conversion from analog signals to numbers and vice-versa is done using analog-to-digital and digital-to-analog converters, respectively. These computers are used in the fields of artificial intelligence and computer aided manufacturing.

13. (d) Mainframe computer, Minicomputer

IBM 3090, IBM 4381, IBM 4300 and IBM ES-9000 are mainframe computers. PDP-1 and IBM AS/400 are examples of minicomputers.

14. A server can be defined as a computer or device that manages network resources on a network. Servers run on a network of computers and enable sharing of printers and other equipment between various computers on the network. They are more powerful, have huge memory size, have larger storage capacity and facilitate high speed communication.

15. (a) Mouse

Data and instructions are entered into the computer through the input unit for processing into information. Mouse, keyboard, and microphone are input devices used for entering data that has to be processed.

16. Joystick

Joystick is an input device widely used for playing computer games, controlling robots, flight simulators, and other training simulators. It has a gearshift-like lever used to move the pointer on the screen.

17. (b) Magnetic-Ink Character Recognition (MICR)

The Magnetic-Ink Character Recognition (MICR) system is one of the earlier scanning systems developed. It is used for processing checks and demand drafts in the banking industry.

18. Laser printers function like photocopy machines. A laser beam creates electrical charges on a rotating print drum. These charges attract tones that are transferred to paper and fused to the surface by a heating process. They are faster than other types of printers and produce very high-quality printouts.

19. Flatbed plotters print graphical images by moving a pen and produce accurate pictures. The drum plotters print graphical images moving both the drum and the pen. The pictures are not as accurate as the ones printed by flatbed plotters. In inkjet plotters, pens are replaced with inkjets. The printing speed of inkjet printers is high and these printers generate color prints.

20. 109 bytes

Memory capacities in computers are measured in terms of bits and bytes. Eight bits make up a byte. One byte is required to store a

character or a symbol. A gigabyte (GB) is equal to one billion ($10^{9)}$ bytes.

21. (d) HD-DVD disk

Among all the commonly various types of optical discs, the DVD-ROMs are capable of storing huge amounts of data. However, Blu-ray disks and HD-DVD disks are now available with greater storage capacity.

Unit 2
Operating Systems

Structure

2.1 Introduction

In the previous unit, we have discussed about computer hardware and computer software. We have learnt that the hardware (physical devices) and software (collection of programs) of a computer complement each other and they cannot work alone without the support of each other to produce useful output. In this unit, we will discuss about classification of software, and the operating system that plays an important role in the functioning of a computer.

Computer software is divided into system software and application software. System software comprises the Operating System (OS) and System Utilities and deals with managing system resources. The OS manages the hardware and software resources like processor, memory, disk space, input/output devices and files, and controls the interaction between the hardware and applications without the user interference. Several processes may be running simultaneously in a computer. To attain maximum efficiency, the OS has to ensure that the resources are available to all the processes. The OS ensures consistency in application interface when there is more than one computer accessing it. The Application Programming Interface (API) ensures that applications written on one system can be executed even on other systems that have different hardware specifications. This is possible as it is the OS and not the application that controls the application and hardware interactions. An application can run on different systems if the OS is the same. Each OS supports a particular

range of processors. Variations in the OS could make it impossible to execute an application.

In this unit, we will discuss how an operating system manages the system resources. We shall then move on to discuss about how an operating system acts as a user interface. Finally, we shall discuss the various types of operating systems.

2.2 Objectives

By the end of this unit, you should be able to:

- Explain how an operating system manages the system resources.
- Discuss the role of operating system as a user interface.
- Classify the different types of operating systems.

2.3 Managing System Resources

The way an OS manages system resources like CPU time, memory, and access to peripherals affects the overall quality of its performance.

2.3.1 Managing CPU Processes

The OS of a computer system manages the various processes. Operating systems are classified on the basis of the number of tasks that they carry out. Following are the various types of operating systems.

2.3.1.1 Single-tasking Operating Systems

Single-tasking operating systems run only one application program at one time. These operating systems will be very inconvenient for those who need to work with more than one application during a single session. To switch programs, they have to quit a program and then open another. MS-DOS is a single-tasking OS.

2.3.1.2 Multi-tasking Operating Systems

Multi-tasking operating systems allow a single user to work with two or more programs at the same time. The CPU does not run two programs at once; rather, it switches between them when required. In this OS, at any point of time, one program, called the foreground program, is active while the other, called the background program, is inactive. Multi-tasking is different from time sharing in which two or more users use the same computer simultaneously. Following are the various types of multi-tasking that are used for sharing the CPU time.

Cooperative multi-tasking: In this, different programs control the CPU at different points of time. The foreground program controls the CPU until the program's task is finished and then hands over the control of the CPU to other programs. To ensure that all the programs are running simultaneously, each program has to properly relinquish control at appropriate time. This enables the users to run two or more programs. If the foreground program crashes or stops working, the

crashed program does not give up the CPU. The computer will then hang forcing the user to restart the computer, losing any unsaved data in any of the programs.

Preemptive multi-tasking: In this, the OS allocates CPU time to all running processes and each process is given a portion of CPU time. After the expiry of the time, the OS preempts the process and gives the portion to another process. Any unsaved work in an application will be lost if that application crashes. However, failure of one application does not bring down the entire system. Preemptive multi-tasking enables the OS to regain control if an application stops running and crashes. It is used in Linux, Windows 95, Windows 98, and Windows NT, Solaris 2.0.

Multi-threading: With the help of multi-threading, the individual programs carry out several tasks simultaneously. Each task is called as a thread. As users continue to work on one task in an application, the other tasks keep running in the background. Linux, Mac OS 8, Windows 98, and Windows NT support multi-threaded applications.

Symmetric multi-processing: In this, when a program needs to execute a thread, the OS finds an idle processor and assigns the thread to this processor. This facilitates the use of two or more processors at a time. Symmetric multi-processing (SMP) is designed to work with multi-threading and is very easy to execute. Linux, Microsoft Windows NT, Windows 2000, and Mac OS 8 support multi-processing.

2.3.2 Managing Input / Output Processes

The OS controls the input and output processes. The input/output devices generate interrupts, which are signals that inform the OS that some activity has been performed. When an interrupt occurs, the OS invokes interrupt handlers (or interrupt service routines), which are mini programs that take action immediately. There are many brands and models of input and output devices like monitors, printers, speakers, etc. Each brand and model of a given device has its own unique characteristics. Therefore, the operating systems have device drivers that contain specific information about a particular brand and model.

2.3.3 Memory Management

Operating systems also manage the memory of the computer. An OS gives a portion of its memory called partition to each running program. Certain operating systems also implement virtual memory that allows the hard disk of the computer to be used as an extension of Random Access Memory (RAM). In virtual memory, program instructions and data are divided into fixed sized units called pages. When the memory is full, the OS starts storing copies of pages in a hard disk file called the swap file. When the pages are required, they are copied back into memory by sending some other pages to the swap file. Virtual memory enables users to work with more memory than that present in a computer and the paging operations called swapping slow down the speed of the computer.

Check Your Progress-1

1. Explain the function of application programming interface.
2. Which of the following statements describes the feature of time-sharing in an operating system?
   a. Only one application program is run at one time.
   b. The computer can execute more than one task in a single program.
   c. Two or more users use the same computer simultaneously.
   d. A single user can work with two or more programs simultaneously during a session.
3. In the _____ form of multi-tasking, the foreground program gains control of the CPU and retains this control until the program's task is finished.
4. Which of the following terms refer to the division of a program into distinct tasks?
   a. Pages
   b. Procedures
   c. Partitions
   d. Threads
5. Input and output devices generate signals that inform the operating system that some activity has taken place. Some mini-programs appear when such signals are generated. These mini programs are known as _____.
6. Match the following:

i. Virtual memory	p. Enables the operating system to regain control if an application stops running and crashes
ii. Swapping	q. Signals to inform the operating system that some activity has taken place
iii. Interrupts	r. Users can work with more memory than what is installed on the motherboard of the computer
iv. Preemptive multitasking	s. Paging operations which slow down the speed of the computer

2.4 Operating System as a User Interface

The OS acts as an interface between the user and the computer. From the user's perspective, priority is given to the quality of the user interface provided by the OS. The user interface, also called the shell, indicates that it surrounds the kernel of the OS. The kernel (also known as nucleus or core) is the central component of the OS that is responsible for managing the system resources and for facilitating communication between the various software and hardware components of the system.

2.3.4 Functions of User Interfaces

Following are some of the functions of user interfaces:

- Gain access (log on) to the system by providing a user name and a password.
- Start application programs.
- Manage disks and files by performing activities like formatting new disks, displaying a list of files in a directory, creating new directories/ files, renaming directories/files, deleting empty directories/files, and copying files from one directory or disk to another.
- Shut down the operations of the computer.

2.3.5 Types of User Interfaces

A user interface facilitates communication between the user and the hardware system. Following are the various types of user interfaces.

2.4.2.1 Command-line User Interface

Command-line user interface involves typing of commands using keywords that give instructions to the OS. It is a character-based user interface and requires a predefined set of rules called syntax to be followed while interacting with the system. Syntax indicates the operation that needs to be carried out to produce the desired output. For example, the command **copy a: book.txt c:** is used to copy a file 'book.txt' from the disk in drive A to the disk in drive C. MS-DOS and SCO UNIX operating systems use command-line user interface. This interface is mostly used for executing system administration tasks. It involves lot of memorization of commands and syntaxes and therefore not very popular.

2.4.2.2 Menu-driven User Interface

Menu-driven user interfaces do not require memorizing of keywords and syntaxes. On-screen, text-based menus display a range of options from which the users have to select the commands. In many systems, an option can be chosen by using arrow (scroll) keys and can then be activated by

pressing the enter key. In some systems, a mouse can be used to click and activate the desired option.

2.4.2.3 Graphical User Interface (GUI)

GUI is a program interface that utilizes graphical capabilities of the computer system that help in making the program simpler and easier to use. This user interface comprises a desktop, a pointer, a pointing device, icons, windows, and menus. GUIs are easy to use but require processors that significantly slow down the computer. Xerox PARC developed the first GUI in the 1970s. However, this was not a successful venture. The Macintosh line of computer systems released by Apple Inc. (Apple) in the 1980s featured a GUI, which became commercially very successful.

2.4.2.4 Default and Alternative User Interfaces

All operating systems provide default user interfaces that accept user commands and respond by giving out messages. Apart from the default interface, it is possible to use a different user interface. MS-DOS uses a default command-line interface. It also contains many programs that provide a menu-driven interface. For example, Windows 3.1 and MS-DOS were both integrated to give the advantage of a GUI to the users.

Check Your Progress-2

7. Which of the following is **not** a function of an operating system?
   a. Database management
   b. Managing system resources
   c. Controlling input/output processes
   d. Communicating between the user and the hardware

8. Which of the following statements is **true** regarding kernel?
   i. A kernel is the most central component of the operating system.
   ii. It is responsible for managing system resources.
   iii. It facilitates communication between various software and hardware components of the system.

9. A user interface communicates between the user and the hardware system. _____ is a character-based user interface.

10. Explain the features of a graphical user interface.

2.5 Types of Operating Systems

Various types of operating systems have been released in the recent decades. These include UNIX, MS-DOS, Mac OS, Microsoft Windows, Novell NetWare, and Linux.

2.5.1 UNIX

UNIX, developed at Bell Labs in early 1970s is a most popular multi-user, multi-tasking OS that uses client/server technology. It was initially developed to cater to the programmers' requirements, but is now widely used by educational institutions and businesses. UNIX was written in C and so provided easy portability across systems that had the C compiler. UNIX allowed programmers to access the system and share resources at the same time. UNIX has two versions: System V developed by AT&T and BSD4.x (x being version 1 to 3) developed at Berkeley University. UNIX, though used widely suffers from lack of compatibility with different versions, lack of user-friendliness, and complex cryptic commands.

2.5.2 MS-DOS

DOS stands for disk operating system. Microsoft Corporation developed DOS for IBM compatible personal computers. DOS uses command-line interface to interact with the user and permits only one user to perform a single task at one time. It contains utility programs to format, print, restore, copy and take backups. MSDOS.SYS (deals with hardware), IO.SYS (loaded during boot time) and COMMAND.COM (user interactive part) are the three main files in DOS.

2.5.3 Mac OS

Apple introduced the GUI in the Mac OS or Macintosh Operating System for the first time. Released in 1984, the original Mac OS consisted of an OS called system and a separate shell called the finder. Mac OS is considered to be the easiest OS for first-time computer users.

In March 2001, Apple officially released the Mac OS X Version 10.0. It incorporated the powerful features of UNIX with the simple features of the original Mac OS. Aqua is the user interface in Mac OS which is built on three graphics technologies: Quartz, OpenGL, and QuickTime. Aqua features the new finder and dock. The finder facilitates onscreen navigation and enables easy access to regularly used files while the dock allows an application to open automatically and immediately when the user logs in to the system. Darwin, a UNIX-based OS supports the Mac OS X and incorporates the stability and portability characteristics of UNIX. Other

features in the OS include protected memory, preemptive multi-tasking, advanced memory management, and symmetric multi-processing. Mac OS X is easy to use and learn and is best suited for Internet applications and computer graphics.

2.5.4 Microsoft Windows

Following are the Windows operating systems developed by Microsoft Corporation.

2.5.4.1 Windows 3.X

Windows 3.0, released in 1990, was the first version of Windows that enabled users to take full advantage of Intel's new 32-bit microprocessor, the 80386. This microprocessor offered protected mode, a new processing mode which allowed the users to access virtually unlimited amounts of memory.

Windows 3.0 included features like the program manager, file manager, and print manager.

In 1992, Windows 3.1 was released. The mouse was introduced as an input device. Windows for Workgroups 3.11 offered additional features like peer-to-peer workgroup and domain networking support which were used to connect personal computers, laptops, and also establish LAN connection.

2.5.4.2 Windows 95 and 98

Windows 95 supported a 32-bit processing capability that offered built-in Internet facilities, dial-up networking, and new plug and play features. Windows 95 also supported preemptive multi-tasking that enabled the OS to regain control if an application crashed. This OS offered enhanced graphical capabilities and support for mobile computing and integrated networks. Microsoft Windows 98 or Win 98 was an enhanced version of Win 95 that offered better stability, improved Internet connectivity, and updated drivers for new peripherals including DVD-ROM discs and devices that use universal serial port (USP) connections.

Windows Me

Microsoft Windows Me (Millennium Edition) was released in September 2000. The OS was an upgraded version of Win95 and Win98 and was marketed as the Home Edition. Some of the features in Windows Me included Internet Explorer, Windows Movie Maker, Windows Media Player, Movie Editor, etc. The OS was replaced by Windows XP in 2001.

2.5.4.3 Windows CE

Microsoft Windows CE is a Windows version designed for palmtop computers. It runs simplified versions of Windows 95 and 98 programs, such as Microsoft's own office applications, which are available in "pocket" versions for Windows CE. An active synchronization program allows users to quickly synchronize the corresponding utilities on their desktop computers.

2.5.4.4 Windows NT

Microsoft Windows NT is a 32-bit network OS specifically designed for client/server systems. This OS supported preemptive multi-tasking and was the first to support both client/server architecture and high-end personal productivity software. The OS was superior to many previous operating systems in terms of security, OS power, performance, desktop scalability, and reliability.

Microsoft released two versions of Windows NT: Windows NT Server and Windows NT Workstation. While the Windows NT server is designed for acting as a network server, Windows NT Workstation is designed for standalone or client workstations. The Windows NT Workstation version is designed for individual desktop computers and is faster than Win 95 and Win 98. The real benefits of the Windows NT workstation can be seen in a networked corporate environment, where NT desktops link to networks running the Windows NT Server.

The next version, Windows NT 3.5, incorporated support for OpenGL graphics standards and became highly suitable for high-end applications in software development. This OS offered a high level of data security. Windows NT Workstation 4.0 consists of a set of tools for developing and managing intranets. This version had enhanced networking capabilities that enabled secure and easy access to the Internet and corporate intranets. However, certain features like support of the drivers, and gaming features contained in Win 95 and Win 98 were absent. Due to this reason, it is mainly used for business and technical purposes.

2.5.4.5 Windows XP

Windows XP was developed based on Windows NT and Windows 2000. The two versions of Windows XP are Windows XP Home Edition and Windows XP Professional. Released in October 2001, this OS intended to provide comprehensive solutions to both home and business users. .

2.5.4.6 Windows Vista

Windows Vista, released in January 2007, was built to be used on PCs, notebook computers, and media centers. Some of the features in Vista include enhanced GUI, Windows Mail, Windows Movie Maker, Windows Meeting Space, Windows DVD Maker, Windows AERO, etc. 2.5.4.7 ***Mobile Operating System*** is a type of operating system which is specially designed for mobiles, tablets, smartwatches, etc. Mobile Operating Systems have some features of Computer Operating Systems with additional features for mobiles. Also, they are comparatively light and simple.

Exhibit 2.1 presents mobile operating systems of 2021.

Exhibit 2.1: The Mobile Operating Systems that Matter in 2021

Mobile Operating Systems do have basic features of Computer Operating Systems and additional features to manage mobile devices such as Smartphones, Palm Devices, Digital Assistants etc. Mobile Operating Systems are comparatively light and simple and consume less base memory. Mobile operating systems which are popularly known and widely used are:

1. Android OS

Google has developed Android OS. It is the most common operating system among the available mobile operating systems. Android OS is based on Linux Kernel. It is an open source and available free. Every new version of Android OS update is named after 'desserts' for example Cupcake, Donut, Eclair, Oreo, KitKat, etc.

2. Apple iOS

Apple IOS is designed and developed to run on Apple devices such as iPhones, iPad tablets, etc. After android, it is one of the most popular OS. The Salient feature of Apple IOS is that it has very strong security features and it is less vulnerable to any external threats.

3. Blackberry OS

Research In Motion (RIM) has designed Blackberry OS especially for Blackberry devices and Blackberry devices are mainly used by Corporate People.

4. Bada

Samsung has launched Bada Operating System into the market in the year 2010. Salient features of Bada OS are 3-D graphics, easy application installation, multipoint touch etc.

5. Windows Mobile Operating System

Microsoft has designed and developed Windows Mobile Operating Systems for use in pocket PCs and smartphones. It has many features of computer-based Windows OS and some additional features for mobile phones.

6. Symbian OS

Symbian OS is based on java language. It provides high level integration with communication protocols. Symbian OS was first used in Nokia Mobile Phones.

7. Tizen OS

Tizen OS is based on a Linux Kernel. It is an open-sourced web OS and it is open to everyone. It supports a wide range of devices not only mobile devices but also electronic devices such as home applications, signage boards and Television Sets.

Contd. .....

8. Harmony OS

It is a latest mobile OS and it was developed by Huawei. It is designed for special use in IoT devices.

9. Palm OS

Palm OS, also known as Garnet OS was developed by Palm Ltd. It is mainly used in Personal Digital Assistants (PDAs).

Source: https://www.g2.com/articles/mobile-operating-systems, May 21, 2021

Activity: Prakash works as a Marketing Manager in a medium-sized pharmaceutical firm. Recently, after getting a promotion and hike in salary, he decided to buy a computer for home use. Prakash wants a computer that will allow him to listen to songs, watch movies, browse the Internet, etc. He also wants to be able to complete office work at home in case of need.

Prakash wants you to help him (a) understand the features of the various operating systems and (b) to take a decision on which operating system to have installed in this new computer.

Answer:

2.5.5 Novell NetWare

Following is the NetWare operating systems developed by Novell and was popular till 2017.

2.5.5.1 NetWare 6.x

The NetWare 6.x series of operating systems include the versions 6.0 and 6.5.

NetWare 6.5 is an open source system and provides a browser-based interface making the synchronization of various business processes easier. Novell has added certain new features in NetWare 6.5 like centralized Web management, Virtual Office application, etc. The Virtual Office application allows its users to communicate and collaborate using the Internet. It provides various features like GroupWise, password management, document publishing, web page creation, etc.

2.5.6 Linux

Linux was developed by Linus Torvalds at the University of Helsinki, Finland as an extension of MINIX, a small UNIX operating system. The first version of Linux 0.01 was released in 1991. Linux was developed under GNU General Public License. So, the source code is available freely to the general public to use, change, and redistribute. However, companies can charge the users a fee for using the source code. Linux can be used for networking, software development, and as an end-user platform. Linux is gaining popularity because of its functionality, efficiency, inexpensiveness, and easy availability. The features that differentiate Linux from other operating systems are:

1. It is a robust 32-bit multi-tasking OS that can be used in a range of organizations, large and small.
2. It can be run on hardware ranging from a 386 processor to sophisticated fifth generation computers.

It is also being widely used in different computing platforms varying from its popular usage in the PC market to devices like mobile phones, supercomputers, etc.

Check Your Progress-3

11. **Answer the following questions** based on whether they are true or false.
    a. MS-DOS uses a graphical user interface to interact with the user. **(True/False)**
    b. MS-DOS contains utility programs to format disks, print files, copy files, etc. **(True/False)**
    c. MS-DOS enables the user to perform more than one task at a time. **(True/False)**
    d. COMMAND.COM, IO.SYS, and MSDOS.SYS are the main files in DOS. **(True/False)**
    e. Linux was developed as an extension of MINIX, a small UNIX operating system. **(True/False)**
    f. Linux is a single-tasking operating system that can be used in medium-sized organizations. **(True/False)**

g. Linux can be run on a wide range of hardware.
(True/False)

h. Though Linux is expensive, it is popular because of its efficiency.
(True/False)

12. Explain the functions of MSDOS.SYS.

13. Which of the Windows operating systems features AERO, a visual style that makes visuals clearer and pleasing?

2.6 Summary

- The operating system manages the hardware and software resources like processor, memory, disk space, input/output devices and files, and controls the interaction between the hardware and applications without the interference of the user.
- Based on the number of tasks that they carry out, operating systems are classified into single-tasking operating systems and multi-tasking operating systems. The various types of multi-tasking include cooperative multi-tasking, pre-emptive multi-tasking, multi-threading, and symmetric multi-processing.
- Operating systems also manage the memory of the computer. Various methods like partitioning, implementing virtual memory, and swapping are used by operating systems to manage the memory of the computer system.
- As a user interface, the operating system communicates between the user and the computer. Command-line, menu-driven, and graphical user interfaces are the different types of user interfaces in operating systems.
- The operating systems which are most commonly used include UNIX, MS-DOS, Mac OS, Microsoft Windows, Novell NetWare, and Linux.

2.7 Glossary

- **Application Programming Interface (API):** It ensures that applications written on one system can be executed even on other systems that have different hardware specifications.
- **Command-line user interface:** A character-based user interface. In command-line user interface, a prompt gets displayed on the screen at which the user needs to type commands using keywords that tell or instruct the OS to carry out a program or a function. The system then provides the output by displaying it on the computer monitor.
- **Cooperative multi-tasking:** A form of multi-tasking in which the users could run two or more programs. In cooperative multi-tasking,

different programs control the CPU at different points of time. The foreground program gains control of the CPU, retains this control until the program's task is finished, and then hands over the control of the CPU to other programs.

- **Graphical User Interface (GUI):** A program interface that makes use of the graphical capabilities of the computer system. These capabilities are in the form of pictures, symbols, or menu selections that represent the computer commands and help in making the program simpler and easier to use. GUI consists of a desktop, a pointer, a pointing device, icons, windows, and menus.
- **Kernel:** The central component of the operating system. The kernel is also referred to as the nucleus or the core of the operating system.
- **Menu-driven user interfaces:** A type of user interface in which the user does not need to memorize keywords and syntax. These interfaces provide the users with a list that contains a range of options from which they have to select the commands. On-screen, text-based menus show all the options available at a given point
- **Multi-tasking operating systems:** The operating systems enable a user to work with multiple programs simultaneously during a single session. The CPU does not actually run two programs at once; rather, it switches between them as needed. In this type of OS, one program called the foreground program is active while the other called the background program is inactive.
- **Multi-threading:** It extends the concept of multitasking by allowing individual programs to carry out several tasks simultaneously. Each task is called as a thread. With this, the computer can execute more than one task in a single program. Users can work on one task in an application while other tasks keep running in the background.
- **Operating system:** A set of programs that act as an interface between the user and the computer. The operating system is responsible for managing the resources of the system and for facilitating communication between the various software and hardware components of the system.
- **Preemptive multi-tasking:** A type of multi-tasking which enables the OS to regain control of the CPU if an application stops running and crashes. In preemptive multi-tasking, the OS allocates CPU time to all running processes.
- **Shell:** The outermost layer of a program. Shell is another term for user interface.
- **Single-tasking operating systems:** These operating systems can run only one application program at a time. Users who need to work with more than one application during a single session would find such an OS very inconvenient. To switch to another program, they would have to quit one program, and then start another.

- **Symmetric multi-processing (SMP):** This refers to the use of two or more processors at a time. SMP is the easiest to implement and is also designed to work with multi-threading. When a program needs to execute a thread, the OS finds an idle processor and assigns the thread to this processor.
- **System software:** An operating system program that provides control and support to the functions and processes of a computer system. It manages the system resources and assists in the proper functioning of the computer.
- **Time sharing:** In this, two or more users use the same computer simultaneously.
- **User interface:** The features of a program through which the user interacts or interfaces with it, is called the user interface. There are three types of user interfaces: command-line user interface, the menu-driven user interface, and the graphical user interface.

2.8 Self-Assessment Test

1. "The operating system of a computer manages the hardware and software resources and controls the interaction between the hardware and applications without user interference." Explain.
2. "The operating system of a computer manages memory and controls the input/output devices." Explain.
3. "The operating system of a computer acts as an interface between the user and the computer." Discuss.
4. Compare the distinctive features of two popular operating systems that you are familiar with.

2.9 Suggested Readings / Reference Material

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2.10 Answers to Check Your Progress Questions

Following are the answers to the Check Your Progress questions given in the unit.

1. Application Programming Interface (API) ensures that applications written on one system can be executed even on other systems with different hardware specifications. This is possible as it is the operating system and not the application that controls application and hardware interactions.

2. (c) Two or more users use the same computer simultaneously.

In time-sharing, two or more persons use the same computer simultaneously. Time-sharing is different from multi-tasking. Multi-tasking operating systems enable a single user to work with two or more programs simultaneously during a session. The CPU does not actually run two programs at once. Rather, it switches between them as needed.

3. Cooperative multitasking

Cooperative multi-tasking is an early form of multi-tasking in which users could run two or more programs. In this form, the foreground program gains control of the CPU and retains this control until the program's task is finished.

4. (d) Threads

Multi-threading enables computers to execute more than one task in a single program. Programmers divide a program into distinct tasks called threads. For example, one thread handles printing while another handles file retrieval. Users can therefore work on one task in an application while other tasks keep running in the background.

5. Interrupt service routines

Input and output devices generate interrupts, which are signals that inform the OS that some activity has taken place. In such an event, the OS invokes the interrupt handlers, which are mini programs that appear when an interrupt occurs. These interrupt handlers are also called interrupt service routine.

6. Virtual memory allows users to work with more memory than what is installed on the motherboard of the computer. Swapping is a paging operation that slows down the speed of the computer. Interrupts are signals, which inform the operating system that some activity has taken place. Preemptive multi-tasking enables the operating system to regain control if an application stops running and crashes.

7. (a) Database management

The operating system is mainly responsible for managing processes, memory and controlling input and output processes. It also acts as an interface between the user and the hardware.

8. i, ii, and iii

The operating system (OS) acts as an interface between the user and computer. The user interface is also called a shell that indicates that it "surrounds" the kernel of the OS. The kernel is the central component of the operating system. It is responsible for managing system resources and for facilitating communication between various software and hardware components of the system.

9. Command-line user interface

A user interface communicates between the user and the hardware system. The command-line user interface is a character-based user interface. In this case, a prompt is displayed on the screen on which the user needs to type commands using keywords that tell or instruct the OS to carry out a program or function. The system then provides output by displaying it on the computer monitor.

10. A user interface helps the user and the hardware system to communicate with one another. Graphical User Interface (GUI) is a program interface that uses the graphics capabilities of the computer system. In GUI, computer resources like programs, data files and network connections are represented by small symbols called icons. Actions can be initiated by clicking on an icon.

11. **Statements (a), (c), (f), and (h) are false while the rest are true.**

MS-DOS uses a command-line interface to interact with the user. It enables one user to perform a single task at one time. It consists of three main files – COMMAND.COM, IO.SYS, and MSDOS.SYS. It contains utility programs to format, print, restore, copy and take backups. Linux was developed as an extension of MINIX, a small UNIX operating system. It is a robust 32 bit multi-tasking operating system that can be used in a range of organizations, large and small. It can be run on hardware ranging from a 386 processor to sophisticated fifth generation computers. Linux is popular due to its functionality, easy availability, inexpensiveness, and efficiency.

12. MSDOS.SYS is the file in MS-DOS that handles application management tasks like file and record management, memory management, access to real time clock, etc.

13. **Windows Vista**

Windows Vista is a line of operating systems built to be used on PCs, notebook computers, and media centers. Vista contains a host of new features including an enhanced GUI and multi-media creation tools like Windows DVD Maker. Windows AERO is an important feature added in Vista. With AERO, visuals are clearer and more pleasing than previous versions of Windows.

Unit 3

Fundamentals of Information Systems

Structure

3.1 Introduction

The previous two units, Unit 1 and Unit 2, have acquainted you with computer systems and operating systems, respectively. These two units have provided you with the basic concepts that are applicable to information technology. An information system combines both technology and information to aid managerial decision making. In today's networked world, information systems play a crucial role in ensuring success of an organization. In this unit, we shall introduce you to the basics of information and information systems.

In every organization, information is used for a specific purpose and it affects the

process of decision making at various levels within the organization. Information is defined as processed data which is represented as documents and reports in a structured and meaningful format. Data is represented by facts and figures such as transactions in a database. Data is discrete in nature, that is, it does not make much sense by itself.

An information system is defined as a system that accepts inputs in the form of data resources, processes them, and provides output in the form of information products. People rely on information systems to communicate with each other, using a variety of physical devices (hardware), information processing instructions and procedures (software), communication channels (networks), and stored data (data resources).

In this unit, we will first discuss about the fundamental concepts relating to information. This would include the definition of information, the classification of information, the presentation of information, the various benefits of information, and the parameters of quality of information. We shall then move on to discuss the basics of information systems, the use of information systems in business, and the limitations of information systems. We conclude this unit by discussing the design of information systems.

3.2 Objectives

By the end of this unit, you should be able to:

- Define information.
- Classify information.
- Choose a method of presenting information.
- Demonstrate the various benefits of information.
- Explain the parameters of quality of information.
- Identify the functions and components of information systems.
- Justify the use of information systems in business.
- Identify the limitations of information systems.
- Evaluate the effectiveness of an information system from a design perspective.

3.3 Defining Information

Before defining information, it is necessary to understand the meaning of data and its relationship with information. Data refers to raw facts, concepts, or instructions that can be interpreted, stored, and processed into meaningful and useful information. This data is usually stored in data structures, files, or databases.

On the other hand, as stated by Gordon B. Davis and Margrethe H. Olson, information is the "Data that has been processed into a form that is meaningful to the recipient and is of real or perceived value in current or prospective actions or decisions."

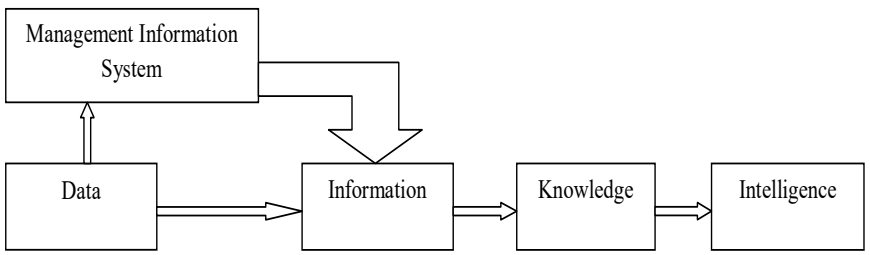
However, in certain cases, information for a particular situation may just be the raw data for another. For example, for the shipping department in a manufacturing firm, the shipping document is a source of information while for the stores department, it is raw data.

3.4 MIS, Information and Knowledge

Current day organizations make decisions based on the real data. This data creates needed intelligence for the organization to survive in the market. For example, Home Depot collects huge data from its cash registers, shelf counts and time clocks. It makes use of this data for generating intelligent research reports. Data is the raw figures or measurable facts related to events or things. Data collected should be useful for the organization. The characteristics of useful data in the organization include timeliness, relevance, completeness and quality.

Information is the processed data. It is the structured or recorded data useful for managerial decision making. There is more data in the organizations than information. There is more information in the organizations than knowledge. There is more knowledge in the organizations than intelligence. For example, in Home Depot, each customer's purchases are entered into the database of inventory system at the point of sale. At the end of the day, the inventory system is able to generate the inventory of the organization and the sales made in that day. The inventory system generates sales and stock reports whenever required. Here, the inventory system is nothing but the management information system providing useful information for management decision making. Using this system, Home Depot is able to check the stock levels in the stores and sales made in respective stores.

Figure: Relationship between Data, Information, Knowledge and MIS



Management Information System is the system which provides useful information for management decision making. It makes use of the organizational data, processes it and analyzes it. Knowledge is the collections of insights and previous experience coming out of information provided. It comes from the organizational memory. Knowledge is the details stored in memory. Day to day decision making of individual is based on the knowledge stored in memory. The relationship between data, information, knowledge, and intelligence is shown in the above figure. One becomes input to the other respectively. Management information system makes use of organizational data and provides useful information for organizational decision making. Management information systems are a kind of information systems. Other information systems include decision support system, knowledge based system, transaction processing system, expert system and real-time system. Employees and management in the organization uses management information system.

3.5 Classification of Information

Information can be classified into facts, opinions, concepts, procedures, processes, principles, objective information, subjective information, primary information, and secondary information. Apart from this, it can be also be classified into several types on the basis of its nature, usage, application, structure, and form.

3.5.1 Basic Classification

Information can be classified into objective information/facts, subjective information/ opinions, concepts, procedures, processes, principles, primary information, and secondary information. This classification is shown in table 3.1.

Table 3.1: The Basic Classification of Information

Type	Definition
Objective information/Facts	Information which is unique and true in nature. This type of information defines all aspects of an issue and helps in identifying an object, a person, a place, a thing, etc.
Subjective information/Opinions	Information based on what appears to be true regarding a particular object, place, person, or a situation and is solely based on personal opinion and judgment.
Concepts	A feature or a characteristic which is common and/or is shared among a group of items, ideas, or entities.

Contd. .....

Type	Definition
Procedures	A series of steps showing how to carry out tasks.
Processes	The method of doing a work or an operation.
Principles	Information pertaining to the guidelines, rules, criteria, and heuristics that are used for predicting an outcome to a particular situation.
Primary information	The information collected directly from the source for a specific project or purpose is referred to as primary information.
Secondary information	If information has been collected earlier for some other project or purpose and is being used to meet the newly identified needs by analyzing, interpreting, translating, and/or examining, it is referred to as secondary information.

3.5.2 Based on Nature

Based on its nature, information can be classified into quantitative information, qualitative information, formal information, and informal information. This classification is shown in table 3.2.

Table 3.2: Classification of Information Based on its Nature

Type	Definition
Quantitative information	Information which is quantitative in nature like numbers, statistics, scores, etc. This type of information provides factual, unbiased data.
Qualitative information	Information collected through personal and direct methods like personal interviews, observation, focus groups, case studies, etc., in order to understand the perceptions and interpretations of individuals and situations.
Formal information	Information presented in a structured format, usually for official purposes.
Informal information	Information presented in an unstructured format and is usually unofficial in nature.

3.5.3 Based on Usage

Information can be divided into several types on the basis of its usage. It can be used for informing about a particular situation, happening, etc. (news on TV/Radio/ Internet, etc); as a medium of persuasion

(advertisements, etc); for providing education to people (through e-learning, computer-based training, web-based training, etc); as a medium of entertainment (games, music, movies, etc); and for making decisions (information systems used for decision making like decision support systems, etc).

3.5.4 Based on Application

On the basis of its application, information can be classified into planning information, control information, and knowledge information. This is shown in table 3.3.

Activity: In order to stay ahead of the competition, Pratik Baby Products Ltd. has recently come out with a baby oil that is rich in proteins and vitamins. The company's research scientists have demonstrated that this oil will keep the baby's skin much softer and also help in the baby's growth. To catch the attention of new mothers, the company has advertised on television and distributed free sachets of the new product through medical shops, along with leaflets describing its benefits.

How do you classify the use of information by the company in this given situation?
What are the other possible ways in which the company can use information to improve its marketing effectiveness?

Answer:

Table 3.3: Classification of Information based on its Application

Type	Definition
Planning information	The documents having the details of operational standards and quality standards.
Control information	Information needed to put in place a feedback mechanism.
Knowledge information	Information collected through library reports and research studies to build up the knowledge base.

3.5.4.1 Based on Structure

On the basis of its structure, information can be classified into detailed information, summarized information, sampled information, and aggregated information.

3.5.4.2 Detailed Information

It contains very specific details regarding a particular object, person, place, company, or an issue.

3.5.4.3 Summarized Information

It is a summary of several items and cannot be used for arriving at conclusions about a single entity in the group.

3.5.4.4 Sampled Information

It is obtained by examining a set of items that are randomly selected. For instance, before releasing a product in the market, it is tested by distributing it to a selected set of customers from a larger population. The information obtained from such a test is called as sampled information. This information assumes that the sample taken truly represents the population under consideration.

3.5.4.5 Aggregated Information

This information is gathered from several sources and is very detailed in nature. However, unlike detailed information, which provides details about a particular entity in a group, aggregated information provides details regarding all the entities in a group.

3.5.4.6 Based on Form

Based on the way it can be presented, information can take various forms like aural or sound (pitch, tone, words, song), visual (moving and still images, pictures, graphs, text), tactile or touch (for instance, a doctor touches the skin of the patient to find out if he/she has fever), olfactory or scent (smell), and taste.

3.5.4.7 Classification by Professor John Dearden

Professor John Dearden of Harvard University classified information into action and no-action information, recurring and non-recurring information, and internal and external information.

3.5.4.8 Action and No-action Information

Action information is defined as information which induces some action whereas no-action information is the information which does not induce any action.

3.5.4.9 Recurring and Non-recurring Information

Information which is generated at frequent intervals of time (like quarterly sales report) is referred to as recurring information, whereas that generated once at the end of any particular time period (like a market research study) is referred to as non-recurring information.

3.5.4.10 Internal and External Information

Information which is generated within the organization (like employee details, inventory reports, etc) is called internal information, whereas that which is collected from agencies and sources external to the organization (like details about the competitors, their products, etc.) is called external information.

3.5.5 Other Classifications

Apart from these classifications, information can also be classified into organizational information, database information, and operational or functional information. Information that is available to the entire organization is termed as organizational information. On the other hand, when the information needs to be shared and hence is stored in a database, it is called database information. Finally, when the same information is used for carrying out various operations in an organization, it is termed as operational information.

Check Your Progress-1

1. Which of the following types of information provides an understanding of perceptions and interpretations of individuals and situations?
   a. Knowledge information
   b. Aggregated information
   c. Objective information
   d. Qualitative information
2. A market research firm studied some aspects of consumer behavior by administering a questionnaire to a set of consumers randomly selected from the larger population. The information collected through this method is called _____.
3. What is objective information?
4. Give an example of aggregated information.

3.6 Real-Time Systems

Real-time systems are the systems bound by the response time limits. They process data and response needs to be generated within a specified time. Otherwise, the consequences can be the system failure. There is no correct answer for processing in real-time systems after the time period is over. Thus, they are time sensitive systems. In these systems, the time at which output is produced is important. The real-time systems take input from real world events and produce output related to that event. The time of output is significant in real-time systems. The success of the real-time system is measured based on the correctness of the output and the time the output is generated.

Example real time systems include air traffic control system, air ticketing system in airport, and temperature controller of a nuclear power plant. Real-time systems are of two types. They are soft real time systems and hard real time systems. Soft real-time systems function sometimes even after time limit is over. Hard real-time systems lead to catastrophic failures if time limit is over. (Example: air crashes). VxWorks, pSOS, OS9, RT-Unix and Chorus are examples of real-time operating systems.

Case Tools

CASE (Computer Aided Software Engineering) tools are useful for the development and maintenance of software applications. CASE tools can support all phases of a software development life cycle starting form functional requirements, analysis, and design, coding and testing. They also support object oriented analysis and design. These tools can be used for data modeling, domain modeling, process design, data flow, data structure design and drawing entity-relationship diagrams. Case tools such as GraphiText, DesignAid, Excelerator, ADW, Bachman, IEF, Turbo Analyst and IEW came into the market. The typical case tools include UML editors (Unified Modeling Language), code generation tools, reverse engineering tools, reengineering tools, refactoring tools, model transformation tools, structured system analysis and design tools, object oriented analysis and design tools, configuration management tools, version control tools, requirements management tools and documentation tools..

3.7 Presentation of Information

Information refers to processed data that is represented by documents and reports in a structured and meaningful format. This information should be

properly presented to the user. Presentation of information depends upon the various methods of data collection and transmission of information.

3.7.1 Methods of Data Collection

Some of the common methods of data collection are:

3.7.1.1 Observation

This method is used for collecting firsthand information and the information thus obtained depends upon the accuracy with which the observation has been made and on the observer.

3.7.1.2 Experiment

In this method, the variables selected for conducting the experiment are kept under observation or control based on a specific parameter. These variables are observed over a period of time and conclusions are drawn based on their behavior, reaction, and other such aspects that are based on the research purpose in question. These conclusions are gathered to form information through experimentation.

3.7.1.3 Survey

It is a method of data collection in which the required data is collected from the entire population or at least a sample representative of the large population.

3.7.1.4 Subjective Estimation

In this method, views and opinions are collected from a few experts in a particular field and these act as the data sources. It is used for making an analysis for those issues which are difficult to describe in actual, objective, or numeric terms, and also in situations where other sources of data are not available.

3.7.1.5 Transaction Processing

It is the basic or primary data used by organizations and is generated from transactions. Being raw in nature, this data needs to be processed and integrated.

3.7.1.6 Obtaining Information from External Sources

Secondary information can also be purchased from external sources at a price. Such information is usually in the form of research studies, trade journals, publications, government agencies, etc. This data has been collected from the research point in view and pertains to the time it was conducted. Therefore, it is not advisable to place too much reliance on it as it may not be exactly suited to the desired purpose and time period.

3.7.2 Transmission of Information

Information can be transmitted from one person to another via the communication system. The various components of this system are the sender (the person sending the message), the receiver or recipient (the person to whom the information is sent), a communication medium or transmission channel (a link between the sender and the receiver), a modulator (for converting the message into a signal for sending it through the communication medium), and a demodulator (for converting the signal into the original message). Moreover, when a sender sends a message across to a receiver, there are some distortions or noise.

Activity: Subhas Drugs Ltd. wants to launch an entirely new drug in the market for treating attention deficit disorder in teenagers. But before that, the company wants to find out what the attitude of teenagers and their parents is toward this disorder and its treatment. The company has thus started consulting some well-known physicians and specialists working in this field. What is this method of collecting information known as? Do you think that the company is using the correct method for gathering the required information? Justify your answer.

Answer:

3.7.3 Summarization and Message Routing

Summarization and message routing are the two methods that increase the sending and receiving efficiency of a communication system.

3.7.3.1 Summarization

Summarization refers to presenting information in a condensed form keeping the actual meaning of the content intact. In a business organization, information can be summarized based on:

- Management position.
- Management functions like production, finance, marketing, personnel, etc.
- The importance or relevance attached to the top level, middle level, and lower level managements in an organizational hierarchy.
- Exceptional circumstances or situations.

3.7.3.2 Message Routing

Message routing refers to sending information to all the people who may be responsible for any decision or action that in turn may affect the organization. Information becomes irrelevant or ineffective if it does not reach the people it is intended for and/or when it does not reach them at the right time.

3.7.4 Information Discretion

Individuals have the tendency to exercise their discretion over the content or distribution of information by means of message delay, message modification or filtering, inference or uncertainty absorption, and presentation bias. This in turn may adversely affect the information that is being transmitted.

3.7.4.1 Message Delay

In this method, the message is delayed so that the action that needs to be taken gets delayed. It is usually done by avoiding information overload through distortion or inhibition, or by suppressing transmission.

3.7.4.2 Modification or Filtering

This is done so as to modify the data or deliberately hide certain information. The degree of distortion of the message varies depending upon the communication channels and the methods of distribution of information. Organizations should have formal communication channels and procedures in place to avoid distortion by organizational elements.

3.7.4.3 Inference or Uncertainty Absorption

Uncertainty absorption refers to the failure to understand the right message since the inferences made are purely subjective and each person has his/her own views. This can be avoided by relying upon the inference without making any individual estimates.

3.7.4.4 Presentation Bias

There are three types of presentation bias namely, bias in order and grouping in presentation, exception selection limits, and selection of graphics layout. Bias in order and grouping occurs since there are several ways of ordering or arranging the data. The way in which data is ordered, grouped, and arranged will have an influence on decision making. In case of exception selection limits, only those items which show deviation from the desired result are shown to the decision maker. Also, if the exception limit has not been defined properly, it may mislead the decision maker.

The graphical representation method makes use of graphs to represent data diagrammatically to ensure better understanding. However, graphs may

induce bias due to four factors; these are choice of scale, choice of graphs, choice of size, and choice of color. The choice of scale in a graph affects the perception of differences in the trend charts. The choice of size of a graph influences bias when the size of the graph is reduced and the differences are minimized. The choice of color may also induce bias since certain colors draw more attention than the others. Presentation bias usually takes place due to poor system design and can be avoided or corrected by developing a system that has a flexible reporting system.

Check Your Progress-2

5. Explain the subjective estimation method of data collection.
6. What is summarization? List the various factors to be considered for summarizing information in a business organization.
7. Which of the following methods is used to ensure that the information reaches all the entities that need it?
   a. Message delay
   b. Filtering
   c. Message routing
   d. Uncertainty absorption
8. What factors influence the degree to which a message is distorted because of modification or filtering?
9. When a sender sends a message across to a receiver, some distortion or noise occurs in the process, reducing the efficiency of the communication medium. What are the various methods that increase the sending and receiving efficiency of the system?

3.8 Benefits of Information

In management, information plays a crucial role. It helps in management control, motivation, decision making, and in building models. In a business organization, the value of information depends upon whether it is able to convey something which we are unaware of, whether it brings about some action, and finally, whether the action taken leads to good profits. The value of information, however, is affected by factors like completeness, timeliness, correctness, consistency, appropriateness, validity, usability, uniqueness, relevance, and accessibility.

Information helps in ensuring proper management control. The three types of controls that exist in an organization are preliminary controls, screening

controls, and post action control. While the preliminary controls ensure that the right information is collected, the screening control ensures that the information collected is used in the right way. Finally, the post action control ensures that the information collected reaches the right audience.

Information helps in decision making. But this process has a great deal of uncertainty and risk. In an organization, decisions are usually taken based on past experiences and their outcome.

Information also helps in building backgrounds, models, and motivation. It helps in building knowledge within the organization so that decisions can be taken internally. The flow of information in the organization also decides on its business model and these models enable learning and building of expertise within the organization. Information also helps in motivating the employees since they would feel good and get motivated on receiving information about their work being appreciated by the superiors.

3.9 Quality of Information

The term 'quality' is subjective in nature and hence the parameters should be clearly defined for judging the quality of information. The various parameters of quality are:

- *Validity,* i.e., whether the information can be used for decision making or analysis.
- *Consistency* refers to uniformity or continuity in data collection.
- *Reliability* refers to the credibility and accuracy of the sources of data collection and the methods of presenting the data.
- *Impartiality*, i.e., whether the information is free from errors and bias.
- *Age* refers to the suitability or usefulness of the data for current times.

However, very often, more importance and preference is attached to the quantity rather than the quality of information. This in turn leads to errors and bias which may create distortions in the data.

3.9.1 Errors

Errors may occur due to incorrect methods of data collection, incorrect data measurement methods, failure to follow the correct procedure for data processing, mistakes in recording or making corrections to the data, loss of data, non-processed or semi-processed data, incomplete data, intentional misrepresentation of data, or incorrect master file.

However, errors are not always intentional and certain measures can be taken for minimizing them. Some of these measures include internal controls, internal and external audits, additional parameters that state the

level of confidence with regard to the accuracy of information, and instructions about the measurement and processing of information. Among these measures, the first two parameters can be used to reduce the uncertainty of information and the last two ascertain the credibility of the information.

3.9.2 Bias

Bias generally occurs due to the tendency of people to hide certain sensitive issues that affect them. They either try to tamper the message or intentionally exclude certain portions so that the information is not complete. Sometimes, bias may also take place unconsciously or unintentionally. This can be avoided if the top management establishes a formal communication structure.

Apart from this, there are also certain situations where incomplete information is given and the inference that is specified provides little room for verification. Bias may also occur during the presentation of data which might have an influence on the user. Finally, the design of the information system may also lead to bias. In order to avoid distortion, the information systems should be flexible enough, while ensuring that the costs are kept low.

Check Your Progress-3

10. _____ is an important quality parameter that is used to determine the applicability, suitability, or usefulness of pre-existing data to meet current requirements.
    a. Age
    b. Validity
    c. Impartiality
    d. Consistency

11. Match the following quality parameters of information with their descriptions.

i. Reliability	p. Uniformity or continuity in data collection
ii. Impartiality	q. Credibility and accuracy of the sources of data collection and the methods of presenting the data
iii. Consistency	r. Absence of bias

3.10 Basics of Information Systems

An information system is a system that accepts inputs in the form of data resources, processes them, and provides output in the form of information products. They are designed to help managers analyze data and take decisions.

3.10.1 Functions of Information Systems

Some of the important functions carried out by information systems are:

3.10.1.1 Accepting Input in the Form of Data Resources

The input function of the information system carries out the data entry activities of recording and validating. The data pertaining to the business transactions are recorded either on a physical medium like paper, or are fed in directly into the computer system. To ensure that the data has been recorded correctly, it needs to be validated on a regular basis.

3.10.1.2 Processing the Data Resources Into Information Products

The data resources entered into the computer system are processed so as to be transformed into information products. The various processing activities that take place in the computer system are calculation, comparison, classification, and condensation. All these activities organize, analyze, and manipulate the data resources and convert them into information products that are required by the end users. The quality of data stored in the information system should be maintained on a continuous basis by taking up activities like validating, correcting, and revising.

3.10.1.3 Storing the Data Resources

Storage is an information system activity in which the data resources and the information products are preserved or stored in an organized manner for use in the future.

3.10.1.4 Generating Output

Information systems aim at producing appropriate information products for end users. Some of the common information products include messages, reports, forms, and graphic images which may be provided through video displays, audio responses, paper, or multimedia.

3.10.1.5 Controlling the Performance of the System

Controlling the performance of the information system is very crucial. An information system should provide feedback about all its activities, namely, the input, processing, output, and storage activities. This feedback should be monitored and evaluated from time to time in order to check whether the system is meeting the established standards or not.

3.10.2 Components of Information Systems

The information system components include people resources (end users and information system specialists), equipment (hardware and software resources), data resources (data and knowledge bases), and network resources (communications media and network support). These resources carry out the input, processing, output, storage, and control activities, and convert the data resources into information products.

3.10.2.1 People

People are indispensable for the operation of information systems. These resources include the end users (customers, managers, salespersons, etc., who use information products for a variety of needs) and the information system specialists (the systems analysts, programmers, technicians, computer operators, etc., who build, develop, and run the information systems).

3.10.2.2 Equipment

Equipment refers to the hardware and software resources.

Hardware resources: Hardware resources include all the tangible objects or machines like the computer systems and the peripherals on which the data is recorded and is processed like computers and data media.

Software resources: The software resources of an information system constitute all the sets of instructions that are required for processing the data into information. These resources include programs and procedures. These programs and procedures accept input in the form of data resources, process them into information, and disseminate this information to the end users.

Programs are sets of operating instructions that direct and control the hardware of the computer system. The two types of software programs in a computer system are system software and application software. System software provides control and support to the functions and processes of a computer system. Application software, on the other hand, consists of programs that direct the processing of data into information for a particular use by the end users.

Procedures are sets of instructions (for taking a backup, shutting down a system, using a software package, etc.) required by people to operate the information system and process the information.

3.10.2.3 Data

Data are raw facts and figures that are unorganized and are processed later to generate information. Data resources provide details about the various business transactions, proceedings, and units. It can take the form of

alphanumeric data (e.g., alphabets, numbers, and other characters), text data (e.g., sentences, paragraphs), image data (e.g., graphics, figures), and audio data (e.g., human voice, sounds).

In an information system, the data resources are organized as databases and knowledge bases. While a database holds data resources which are processed and organized, a knowledge base holds knowledge in different forms like rules, facts, and examples of cases that deal with successful business practices.

3.10.2.4 Network

Network resources include the telecommunication networks like intranets, extranets, and the Internet. These resources assist the communication flow in the organization and are therefore necessary for the computer-based information systems. The various telecommunication network components like computer systems, communication processors, and other devices should be interconnected by a medium of communication and should be controlled by the communication software such as network operating systems and Internet browsers.

In an organization, the network resources include the communication media and network support. The communications media comprises twisted-pair wire, fiber-optic cable, coaxial cable, satellite communication systems, and microwave systems. The network support on the other hand includes the support from all the other resources of an information system, namely, the people resources, hardware resources, software resources, and data resources.

Check Your Progress-4

12. What are programs?
13. System software and application software are types of _____.
    a. Programs
    b. Procedures
    c. Data resources
    d. Network resources
14. _____ comprises communications media like twisted-pair wire, fiber-optic cables, coaxial cables, satellite communication systems, and microwave systems.

15. Network resources in an organization include its communication media and network support. Which resources in an information system support network support?

3.11 Use of Information Systems in Business

In an organization, information systems play three vital roles, namely, supporting business operations, guiding managerial decision making, and providing strategic and competitive advantage to the organization. Information requirements differ and depend on the various levels in the organization hierarchy, namely, the operational, tactical, and strategic levels. The nature of decisions taken also differs from one level to another.

At the operational level, a large quantity of data generated by business transactions with the customers, suppliers, etc., is processed.

At the tactical level, more attention is given to those decisions that have a medium-term impact on the organization's performance. This level requires information in the form of consolidated reports regarding the performance of the various business units of an organization. A comparison is then made between the plans and the actual performance, and remedial measures are taken thereof in case of any deviation.

At the strategic level, the decision makers require information from the external environment in addition to those gathered from the internal sources for taking decisions in uncertain situations.

On the basis of their applications in business, information systems are classified into Transaction Processing Systems (TPS), Management Information Systems (MIS), Decision Support Systems (DSS), and Executive Information Systems (EIS). Many organizations make use of Artificial Intelligence (AI) for improving accuracy in production/ operations or decision making.

In an organization, information systems are used for the following purposes:

Market Research: This department collects information pertaining to the market potential, behavior of consumers, and the competitive market conditions. This information is used by the top management to take decisions on making strategic changes.

Purchasing: This department procures raw materials. To make purchases, it requires information regarding the sources of supply, favorable bids, terms of delivery, and quantity discounts. The procurement information is required by the warehouse manager and the accounts department.

Production: This department keeps a record of all the details pertaining to the utilization of resources and scheduling of activities during the production process. The periodic reports prepared by the plant manager would help him/her to chalk out methods or ways to lower the production overheads. The production department also provides inputs to the quality control department.

Sales: This department is responsible for generating revenues for the organization. Its main objective is to plan and control the sales and generate reports which would enable the sales department to make an assessment and take corrective actions, if required.

Accounting: The accounting department is responsible for storing data pertaining to the organization's profit and loss account, cash flows, inventory control, payroll, allocation of costs, and classification of expenses. This information is required by the top management when it plans to make new investments, and by a plant manager to control the overhead costs related to production and labor.

Personnel: The personnel or the human resources department keeps records of the service contracts, fringe benefits, etc., of the employees in the organization. The management would need information about the details of employees working on a part time and full time basis.

Finance: The finance department takes care of an organization's borrowing and funding. For the top management, this information is useful to maximize the wealth of the shareholders.

Public Relations: The public relations department acts as a liaison or link within the organization and also between the organization and its external entities.

The importance of information systems in business is that it:-

- Helps in simplifying the complex tasks, thus reducing the dependence on experts or consultants
- Enhances the efficiency with which the tasks are performed
- Improves the quality and effectiveness of operations by lowering the probability of errors to a large extent
- Reduces the time required to fix or correct the errors
- Improves the communication links in the organization
- Provides various tools which provide support to the management and help them in decision making
- Relieves employees from performing certain tedious tasks, and thus enabling them to be employed in other and better jobs

- Results in better quality of output

The world of Information Technology (IT) is constantly evolving and has seen unprecedented growth. Businesses worldwide have also readily accepted technological innovations that have led to immense benefits especially in terms of cost saving and enhanced efficiencies.

The world of Information Technology (IT) is constantly evolving and has seen unprecedented growth. Businesses worldwide have also readily accepted technological innovations that have led to immense benefits especially in terms of cost saving and enhanced efficiencies. Exhibit 3.1 presents outlook of IT trends in 2021.

Exhibit 3.1:Trends Transforming The Information Technology Industry Outlook In 2021

Let's quickly summarize the key IT trends that have shaped the world of business:

1. **Cloud Computing**: Cloud computing is one of the biggest trends that has offered a cheaper, faster and more scalable way of storing and accessing digital resources.
2. **Mobile Apps:** Wide proliferation of smartphones has made it possible to access Internet 24x7, paving way for conducting business online through mobile applications.
3. **Big Data Analytics:** The digital world has led to emergence of Big Data analytics. There is a growing demand for professionals who can apply predictive, prescriptive and descriptive analytics on Big Data for understanding a situation, make informed decisions and adopt timely preventive measures.
4. **AI based Smart Technology & Automation**: Artificial Intelligence (AI) is being implemented on a large scale across diverse set of industries and functions. Adoption of process automation and smart machines in business, and use of chatbots are applications of AI in action.
5. **Virtual and Augmented Reality**: Virtual reality is now moving beyond gaming and is being used to offer unique digital experience to customers. Augmented reality is one step further that involves interactive experience of a real-world environment.
6. **Blockchain Data**: Blockchain which was mostly used in the context of cryptocurrency, is now being implemented by industries across the world for a variety of uses such as supply chain, financial services, government, retail, etc.
7. **Cyber Security**: Cyber security has become all the more significant in today's times with the widespread adoption and innovation of digital technology at a much rapid pace.

Contd. ...

8. **Growth of IoT Networks**: The Internet Of Things (IoT) allows digital devices to be connected by Internet building interconnected objects that can gather and transmit data via wireless network on their own. From Smart homes to Smart cities, the field of IoT is constantly evolving.
9. **Quantum Computing Applications**: Quantum Computing could solve certain types of problems much quicker than traditional computers, especially those containing a large number of variables and possible outcomes, such as simulations or optimization problems.
10. **Edge Computing**: Edge computing is a part of a distributed computing in which information processing is located close to the edge i.e., where it is produced or consumed, leading to greatly enhanced response times.
11. **Open-Source Solutions:** Open-Source programs have been in use for some time now and will continue to be widely used, as users become more technology savvy to be able to modify the code as per their need.

Source: https://linchpinseo.com/trends-in-the-information-technology-industry/

Check Your Progress-5

16. Which of the following statements about information systems are **true**?
    i. Information systems support business activities.
    ii. Information systems guide managerial decision making.
    iii. Information systems can bring strategic competitive advantage to the organization.
    iv. Information systems are organized combinations of people, equipment, data, and network resources.
    a. Only i and ii
    b. Only i, ii, and iii
    c. Only i, ii, and iv
    d. i, ii, iii, and iv
17. Match the following levels of management with their informational requirements.

i. Senior management	p. Summarized
ii. Middle management	q. Raw or slightly processed
iii. Operational management	r. Highly summarized

3.12 Limitations of Information Systems

Despite the fact that information systems play a very crucial role in an organization, they too are not without limitations. Some of these limitations are:

- Development of useful information is not an easy task as it involves a lot of money, time, and effort.
- The technology standards change a lot due to new developments. This may lead to non-standardized systems.
- The manufacturers of hardware components of information systems have a different set of standards and they modify it from time to time.
- Change in the hardware components would make it difficult to share information between systems.
- It may give rise to some amount of resistance from the employees due to the fear of not being able to understand the use of systems, fear of being laid off, etc.
- Some employees, particularly those at the managerial level, may feel threatened about the change brought about by information systems with regard to the way information flows within the organization.
- Inability to present all types of information particularly those that are related to human beings. For instance, employee counseling, which is a part of employee evaluation, has to be done on a personal basis and an information system cannot be used for carrying out such a process.

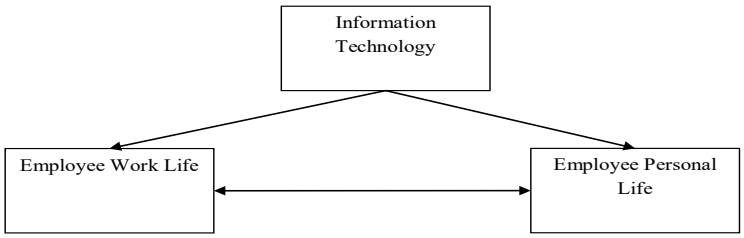
In order to avoid resistance from the employees in the organization, it is important to set the goals of the organization, conduct training sessions for the employees, involve employees in building the system, and to counsel them from time to time to avoid any sort of resistance.

3.13 Impact of IT on Work-Life Balance

Information technology has impact on both work life and personal life of an individual. Also the work life has impact on personal life, and personal life and emotions have impact on work life in current days. This relationship is shown in following figure. Technologies such as laptops, mobile phones, smartphones, e-book readers, and tablet computers have impact on life of individuals in any part of the world. Usage of laptops at home by parents who have minor kids impacts family life. Using ICT (Information and Communications Technology) children can reach their parents immediately in case of emergency and parents are aware of where

their children are. The ICT can also set apart families. For example, at dinner time, each answering their mobile phones and responding to mails can tear apart the family.

Figure: Impact of IT on both Personal and Work Life



With the advent of Internet, the employees of the organization are working from anywhere and anytime. This is a threat to information security of the organization and also the health of the employees gets affected. In Germany, Deutsche Telekom instructed their employees not to check mails after business hours during certain time periods on week days. Volkswagen is planning to deny access to mails after business hours. The effective use of IT can increase employee and organizational productivity. It can reduce the stress levels of the employee and balance the work life with personal life.

- In 2018, a survey done in the US showed that 55% of Generation X respondents said that work flexibility is important, compared to 49% of Generation Z respondents, 53% of Millenials, and 50% of Boomers. 51% of respondents between the age 45 – 60 years old and 70% of respondents between 18 – 34 years old said that they regularly take advantage of flexible work setup respectively. 18% more executives across all industries worked remotely at least once a week. 55% of founders/C-level executives and 48% on VP level avail of the flexible work schedule. 8% of men around the world are more likely to work remotely than women. 78% of people who have college degrees would prefer flexible time.

  The best practice is to set boundaries around our use of technology. For example, family members should ensure that they check mails only during certain timings while on vacation. Technology can hurt or help the individuals. It depends on the individual's usage of technology and discipline.

3.14 Information System Design

The decision theory influences the choice of the decision makers. Information plays a crucial role as uncertainty is an integral part of decision making. Data that is received and stored can be viewed from two perspectives. One, there is no information content until there is a choice

and two, information content is necessary if there is a need for making a choice.

An effective information system should be able to:

- Build a knowledge base
- Reduce errors by conducting proper validation
- Have the ability to provide information that will reduce ambiguity and uncertainty
- Minimize noise and other distortions by making an appropriate presentation
- Ensure that the design of the information system does not encourage any misuse of information

Information system should be used mainly in planning, performance control, and building a knowledge database. It should take into consideration the purpose of application and the structure, culture, attitudes, beliefs, and strengths and weaknesses of the organization. It should be developed to meet the needs of the entire organization, keeping in mind the different information needs at different organizational levels.

3.15 Human Factors in Information Systems

Software development is more of people related activity. There are many human or soft factors affecting the information systems development. These factors impact the information systems throughout the project life cycle. Mainly the internal stakeholders such as team members, project manager, senior management and the external stakeholders such as customer, vendor or supplier and regulatory agencies impact the success of information systems in the organization. The behavior of top management and project manager can impact the productivity of software development team.

The project manager leadership style, personality, team member attitude and behavior can impact the success of information systems in the organization. Effective communication is very important for the success of information systems. The project manager has to manage communications and human resources in the organization. As part of this responsibility, the project manager has to:

- Recruit team members
- Induct team members into the team
- Provide training to team members
- Develop skills and performance of team members

- Conduct performance appraisals to team members
- Give regular feedback to team members on their performance and behaviors
- Manage communications in the team
- Resolve conflicts between the team members and other stakeholders.

In executing the above responsibilities, the project manager has power and authority given by the organization. The factors such as organizational culture, organizational climate, team climate, team cohesion, team conflicts, organizational structure, top management support, external and internal environment of the organization impact the information systems development in addition to the technical factors. The project manager has to resolve conflicts between team members using conflict resolution techniques. Properly managed conflict can increase team productivity. The personal life of team member also has impact on information systems success. His mood, behavior, attitude, skills and maturity level have impact on information systems development. In a research it was found that the extrovert project manager and programmers can increase the team's performance. Similarly introvert system analyst can think more about the system architecture and interconnections.

The team members and project manager have to report the project status ethically. The economic situation, social pressures, cross cultural aspects, job situation, job market and political situation can impact the behaviors of programmers in information systems development. The system availability, reliability, response time, speed and accuracy can also impact the behavior of individuals in information systems. Customer satisfaction has major impact on the information systems' team behavior and project manager behavior. Effective communication, information flow, and proper project monitoring and tracking can make the information systems development successful.

3.16 Summary

- Information is data that has been processed into a form that is meaningful to the user.
- Information can be classified based on its nature, usage, application, structure, and form. Further, information can be classified into action and no-action information, recurring and non-recurring information, and internal and external information. It can also be classified into organizational information, database information, and operational or functional information.

- The common methods of data collection include observation, experiment, survey, subjective estimation, and transaction processing. Information can also be obtained from external sources.
- The transmission of information between one person and another takes place with the help of the communication system.
- Summarization and message routing are the two methods that increase the sending and receiving efficiency of the system. Individuals tend to exercise discretion over the content or distribution of information by message delay, message modification or filtering, inference or uncertainty absorption, and presentation bias.
- In organizations, information helps in management control, decision making, motivation, and in building models. Quality of information is also a vital issue. The term 'quality' is subjective in nature and hence its parameters should be clearly defined in order to judge the quality of information. Giving too much importance to the quantity of information rather than the quality leads to errors and bias.
- An information system accepts data resources as input and processes it and delivers information products as output. Information systems consist of people, equipment, data, and networks to perform input, processing, output, storage, and control activities that convert data resources into information products. Information systems perform three vital roles in any type of organization. They support business operations, support managerial decision making, and provide competitive advantage to the organization.

3.17 Glossary

- **Communications media:** Various network resources in an organization that include the communication media and network support. The communications media include the twisted-pair wire, fiber-optic cable, coaxial cable, satellite communication systems, and microwave systems.
- **Information System (IS):** A system that accepts inputs in the form of data resources, processes them, and provides output in the form of information products.
- **IS specialists:** These include systems analysts, programmers, technicians, engineers, network managers, IS manager, data entry operators, and computer operators in an organization. The IS specialists build, develop, and run the information systems.
- **Message routing:** Sending information to all the people who may be responsible for any decision or action that may affect the organization. Message routing ensures that the information reaches all the entities that need it.

- **Operational information:** A type of information which is used for conducting various operations in an organization.
- **Procedure:** A series of steps that indicate or show how a task is to be performed. Procedures are sets of instructions that are required by people to carry out a particular task. These can be in the form of instructions for taking a backup, shutting down a system, using a software package, filling up a form, etc.
- **Process:** The method of work or operation. Processes are used for finding solutions to a problem or for making an inference about something based on how the process takes place.
- **Programs:** Sets of operating instructions that direct and control the hardware of the computer system.
- **Subjective estimation:** Method of collecting data from experts in a particular field. In this method, the views and opinions of a few experts are collected and this acts as a source for data. It is used for conducting an analysis regarding issues that are difficult to be described in actual, objective, or numeric terms.
- **Summarization:** A method of presenting information in a condensed form without changing the actual meaning of the content.
- **Survey:** A method of data collection in which the required data is collected from the entire population or at least from a sample representative of the larger population. A questionnaire is usually used for collected such data. The quality of the questionnaire prepared determines the quality of information.
- **Uncertainty absorption:** It is the failure to infer the right message. Inferences made are purely subjective in nature and each person draws his/her own conclusions. Uncertainty absorption can be avoided by people if they rely upon the original message without making any individual inferences or estimates.

3.18 Self-Assessment Test

1. Data can be collected in several ways and also from several sources. What are the different methods that can be used for collecting data?
2. An information system is designed to enable managers analyze data and take decisions. In this regard, what are the various functions of the information system? Also briefly describe the various components of an information system.
3. The information required differs from level to level within an organization. Information systems play a crucial role in the

organization. In this regard, discuss some of the uses and limitations of an information system.

3.19 Suggested Readings / Reference Material

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3. Introduction to Information Systems - 6th edition, R.Kelly Rainer; Wiley & Sons, Inc.2016
4. Information Technology: An Introduction for Today's Digital World , Richard Fox, Chapman and Hall/CRC; 2nd edition (August 21, 2020)
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5. Jay, A., 10 New ERP Trends & Forecasts for 2020/2021 – *A Look Into What's Next. https://financesonline.com/erp-trends/*2019
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3.20 Answers to Check Your Progress Questions

Following are the answers to the Check Your Progress questions given in the unit.

1. (d) Qualitative information

Qualitative information refers to information gathered through personal, direct and open-ended methods. Methods like personal interviews, observation, focus groups, case studies, etc., are used to

gather such information. The quality of the information is enhanced by adding individual experiences. For instance, user interviews can be taken to understand how user-friendly a particular software is.

2. Sampled information

Sampled information is obtained by examining a subset of items from the population. This subset is usually randomly selected. This type of information assumes that the sample truly represents the larger population under observation. Information obtained from the given situation is sampled information as the questionnaire was administered only to a limited set of people from the entire population.

3. Objective information refers to bits of information that are unique and true. For instance, statements like 'the production capacity of the company increased by 20% compared to the previous year' or 'the company earned revenues of US$ 5 billion' are examples of objective information. These statements are concrete and can be proven.

4. A comprehensive report on the Indian automobile industry

An industry report on the Indian automobile industry is an example of aggregated information. This report would include the performance and contribution of the industry to the economy, the various players in the industry, their individual performance, contribution, market share, etc. It comprises information about the automobile industry as a whole as well as about individual players in the industry.

5. Subjective estimation is a method of collecting data from experts in a particular field. Views and opinions from a few experts are collected and this serves as a data source. This method is employed in situations where no other data sources are available. For instance, this method is used to gather views of experts on subjects like the future of artificial intelligence, the future of green energy, etc.

6. Summarization is a method that presents information in a condensed form without changing the meaning of the original content. It is used for increasing the sending and receiving efficiency of communication. In a business organization, information must be summarized keeping in mind the management position, management functions, organizational levels, and exceptional circumstances or situations for which the information might be required.

7. (c) Message routing

Message routing refers to the process of sending information to all the people who may be responsible for any decision or action that may affect the organization. This method ensures that the information reaches all the entities that need it.

8. Message modification or filtering is done to modify data or deliberately hide certain information. The degree to which the message gets distorted because of modification or filtering depends on the channels of communication used and methods of distribution of information. Organizations should have formal communication channels and procedures to avoid distortion by members of the organization.

9. Message routing and summarization

Message routing and summarization are two methods that increase sending and receiving efficiency of the system. Message routing refers to the process of sending information to all those people who may be responsible for any decision or action affecting the organization. This method ensures that all entities that need the information get it.

10. (a) Age

The quality parameter of age determines whether the information is useful for the present or not. Information should be regularly updated from time-to-time.

11. Quality is subjective in nature; its parameters should be clearly defined in order to judge the quality of information. The various parameters of quality are validity, consistency, reliability, impartiality, and age. Reliability refers to the credibility and accuracy of the sources of data collection and the methods of presenting the data. Impartiality refers to the information which is free from bias. Consistency refers to uniformity or continuity in data collection.

12. (c) Software resources

The software resources of an information system constitute all the instruction sets required for processing data into information. These resources include programs and procedures. Programs are sets of operating instructions that direct and control computer hardware,

while procedures are sets of instructions required by people for operating information systems and processing information.

13. The software resources of an information system include programs and procedures. Programs are sets of operating instructions that direct and control hardware. There are two types of software programs: system software and application software.

14. (d) Network resources

Network resources facilitate flow of communication in the organization and are essential for computer-based information systems. Communication media and network support are network resources. Communications media include twisted-pair wire, fiber-optic cable, coaxial cable, satellite communication systems, and microwave systems.

15. The various network resources in an organization include its communication media and network support. Network support includes support from all other resources of an information system, namely, people, hardware, software and data resources. All these resources provide direct support to the functioning of a communications network.

16. (d) i, ii, iii, and iv

Information systems accept inputs in the form of raw data, process it and provide output in the form of information. Information systems perform three vital roles in any type of organization. They support business operations, guide managerial decision making, and provide strategic and competitive advantage. Information system comprises various resources such as people, equipment, data, and network resources.

17. At the senior management level, the informational requirements are highly summarized. At the middle management level, the informational requirements are summarized. Executives at the operational level, require raw or slightly processed information.

IT & Systems

Course Components

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