UNIT–1

Basic Concepts of Computer

Notes

(Structure)

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1.1 Learning Objectives

After studying the chapter, students will be able to:

- Elements of computers system setup;
- Discuss the components of a computer;
- Explain the different input and output devices;
- Explain the RISC and CISC architecture;
- Discuss the various generation of computers;
- Define Programming Languages;
- Describe the generations of Programming Languages;
- Define Operating System;
- List the characteristics of Operating System.

1.2 Introduction

The computer has revolutionized business and personal activities and even the way we talk and think. Nothing symbolizes modern life better than the computers. For better or worse, computers have infiltrated every aspect of our society. Today, computers do much more than simply compute. From the outset, the creation of the computer was based on the concept that a single unit would be used to perform complex calculations with greater speed and accuracy than humans could achieve. Probably, the first computer on the earth was Abacus, invented about 5,000 years ago in Japan and is still in use today. This device allows users to make computations using a system of sliding beads arranged on a rack. Early merchants used Abacus to keep trading transactions. But as the use of paper and pencil spread, particularly in Europe, Abacus lost its importance. In 1642, Blaise Pascal invented a numerical wheel calculator. This brass rectangular box, also called Pascaline, used eight movable dials to add sums up to eight figures long. Pascal's device used a base of ten to accomplish this. In 1694, Gottfried Wilhem von Leibniz, a German mathematician improved Pascaline by creating a machine that could also multiply. Like its predecessor, Leibniz's mechanical multiplier worked by a system of gears and dials. Partly by studying Pascal's original notes and drawings, Leibniz was able to refine his machine. It was not until 1820 that mechanical calculators gained widespread use. Charles Xavier Thomas de Colmar, a Frenchman, invented a machine

that could perform four basic arithmetic functions. Colmar's mechanical calculator, the arithometer could add, subtract, multiply and divide. With its more practical approach to computing, the arithometer was widely used until the First World War.

The word 'computer' owes its origin to a Latin word 'compute' which means 'to calculate'. Therefore, a computer is considered to be a calculating device that can perform arithmetic and logical operations. It is not just a calculating device; rather it has the capability to process logic operations like comparisons, etc. It acquires the data through an input device, processes it as per the instructions given and gives the information as output. A computer has memory and can store a lot of information. The stored information can be retrieved, used and operated upon as desired. Computations are done at an extremely fast speed with complete reliability and accuracy.

A computer is an electronic device that accepts data and instructions, processes the data according to the set of instructions, and produces the desired information. In fact, computer can be understood as a data processing machine. In other words, a computer is a problem-solving machine that accepts data, stores data, processes data, and presents results.

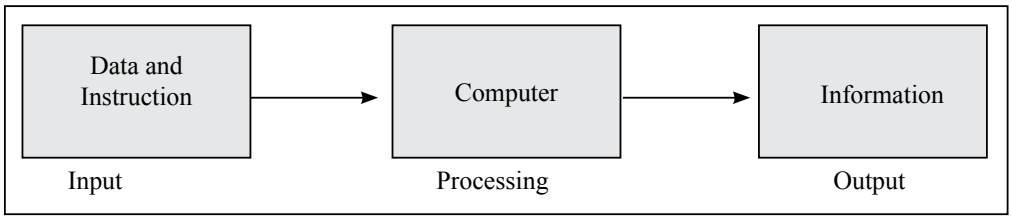

Fig. 1.1: Computer as a Processing System

Computer components can be broadly divided into two categories – Hardware and Software. Hardware refers to any physical component of a computer. For example, CPU, Monitor, Keyboard, Hard Disk, Floppy Disk, *etc.*, are physical components and thus, are hardware. Software refers to the programs which are required to operate the computer. For example, DOS (Disk Operating System), BASIC, COBOL, dBASE, an Accounting Software, *etc.*, are all software. An analogy of hardware can be the book which you are reading and then software would be the text written on this book. Another analogy could be – 'brain' is a hardware but 'memory stored in brain' is a software.

Both hardware and software are dependent on each other. CPU, Memory Unit, Hard Disk, *etc.*, are useless until they are provided instructions and data for storage and processing. Similarly, BASIC or COBOL language has no use until it is stored and processed by hardware components of a computer.

1.3 Definition of Computer

In a layman's language, a computer is a fast calculating device that can perform arithmetic operations. Although the computer was originally invented mainly for doing high speed and accurate calculations, it is not just a calculating device. The computer can perform any kind of work involving arithmetic and logical operations on data. It

gets the data through an input device, processes it as per the instructions given and gives the information as an output. We can define computer as follows:

Definition

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A computer is a fast electronic device that processes the input data according to the instructions given by the programmer/user and provides the desired information as an output.

The terminology used in the above definition is summarized in Table 1.1.

Table 1.1: Terminology Used in Definition of Computer

Term	*Meaning*
Data	A set of basic facts and entities which itself has no meaning
Information	Data has some meaning or value
Instruction	A statement given to computer to perform a task
Input	Data and instructions given to computer
Process	Manipulation data
Output	Information obtained after processing of data

1.4 Importance and Characteristics of Computers

After the human brain, a computer is the fastest machine on the earth. Computers can perform millions of calculations at an unbelievable speed. Computers are not only fast, they are very accurate and reliable too. For us, the smallest unit of time is a second but for a computer; a second is not the smallest unit. Rather, it can be divided into millisecond, microsecond, nanosecond and picosecond. A nanosecond is equal to one billionth or thousand-millionth of a second.

Computers play a vital role for processing of data in an organization. Those help in processing the volumes of data efficiently and accurately within a short time. A computer has the following characteristics which make it so important for an organization:

1. ***Fast:*** A computer is so fast that it can perform the given task (arithmetical or logical) in few seconds as compared to man who can spend many months for doing the same task. A computer can process millions of instructions per second.
2. ***Accurate:*** While doing calculations, a computer is more accurate than a human. A human can make mistakes in calculations but a computer does not make mistakes, if it is provided accurate instructions.
3. ***Diligence:*** A computer does not suffer from the human traits of tiredness and boredom. Man will be tired and bored while doing millions of calculations but a computer, being a machine, does this job very efficiently and without any tiredness and boredom.

4. ***High Memory:*** A computer has much more memory or storage capacity than human being. It can store millions of data and instructions, which can be retrieved and recalled even after a number of years. This is not possible in case of human brain.
5. ***No Intelligence:*** A computer is a machine and obviously has no intelligence of its own. Each and every instruction must be given to the computer for doing a task. Man has an intelligence and it is the man who invented computer and gives it all the instructions and logic to work. A computer cannot take decisions on its own and it is the main drawback of it.

1.5 Functions/Operations of a Computer

A computer can perform a variety of tasks. We use computers for programming, word-processing, spreadsheets, data management, graphics and communications. Much of the processing computers can be separated into two operations—arithmetic operations and logical operations. Processing is built around the computer's ability to perform arithmetic and logical operations. Software is a set of instructions written by humans and given to the computer. These instructions (programmes) tell the computer which operates to apply to the data, to ultimately produce informational output. Software directs the processing sequence and allows a computer to perform specific tasks.

1. ***Arithmetic Operations:*** Arithmetic operations are computations with numbers (addition, subtraction, division, multiplication, etc.).
2. ***Logical Operations:*** Logical operations are a comparison of any two numbers to determine if one is greater than, smaller than, or equal to the other. A computer can compare numbers, letters, or special characters. The computer can then take action based on the result of the comparison.

A computer is termed as a data processing machine. It accepts data and then stores or processes it immediately and displays the output for the user. The basic model of a computer shows the working of a computer. All computer systems perform the following five basic operations:

Input Function

The input function is the process of entering data and instructions into the computer system. The computer accepts the data and instructions from the user through various input devices like keyboard, mouse, scanner, etc.

Storage Function

A computer can store data and instructions for future use and processing. A computer has 'memory' and can store a large amount of data.

Processing Function

A computer can process the input or stored data as per the instructions by the user. It performs arithmetic and logical operations on data in order to convert them into desired output. Processing is the main function of the computer.

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Output Function

With the help of this function, a computer displays the processed results or output. The output is communicated to the user through various output devices like monitor, printer, etc.

Control Function

All the other functions performed by the computer are controlled by this control function. Control function guides the computer to process and give output in the right manner and proper sequence.

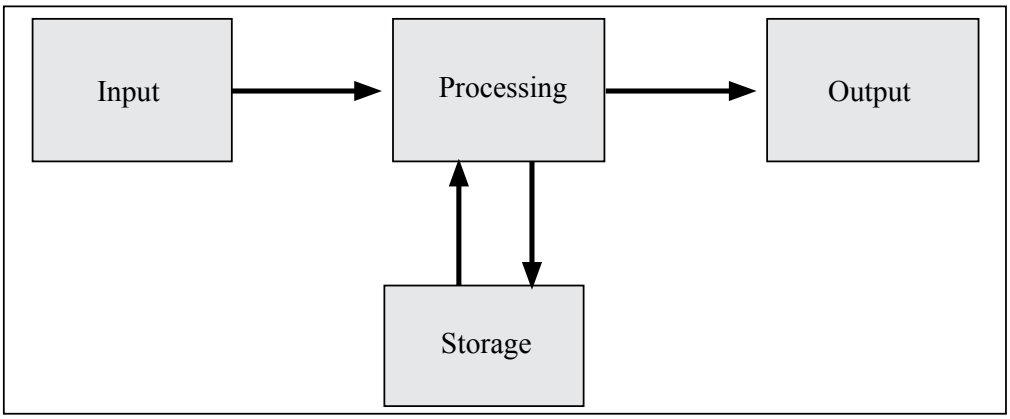


Fig. 1.2: A Simple Model of a Computer

The following diagram shows the interaction of the components of the simple model of a computer. The arrows indicate the flow of control in the form of data and instructions. An input unit provides the input for the processing to CPU (Central Processing Unit) which, after processing, directs the processed data to output unit for display to the user. The storage unit or the memory of computer stores the data.

1.6 Computers In Business

Computers can process vast quantities of business data at enormous speed with unfailing consistency and unimaginable flexibility.

These capabilities of computers open new approaches to problem solving and data processing.

Following six characteristics of computers make them indispensable for use in business:

1. ***Speed:*** Computers speed up data processing by many orders of magnitude as compared to the manual system.
2. ***Data Volume:*** Vast amount of data can be stored and processed very quickly.
3. ***Repetitiveness:*** The more repetitive the task, the more profitable it is to automate it.

4. ***Complexity:*** Problems with several interacting variables can be solved quickly and accurately.
5. ***Accurate Output:*** As high accuracy can be obtained as needed; also accuracy is not affected by boredom and fatigue and is not Subjective.
6. ***Declining Costs:*** There has been a steady decline in the cost of per unit of data processed.

1.7 Elements of Computer System Setup

The computers about which we have been discussing come in all shapes and sizes and can be used for various purposes. But all of them have certain characteristics in common. Two of the most important constituents of computers are — hardware and software.

Apart from these two main elements of the computer, *i.e.*, hardware, which represents the physical parts of the computer, and software that represents the programs that instruct the computer what is to be done, computers also include processing. Processing transforms data into information and involves data, people and procedures. Thus all these together are the five elements of the computing process (as a whole). These five elements are:

1. Hardware
2. Software
3. Data
4. People
5. Procedures

But all these elements have to be organized in such a way that each element works smoothly and efficiently, both individually and in coordination with others. During the computing process, computers integrate all these five elements.

Thus we can say that the computing process includes everything necessary to accomplish an activity or to perform a task. All the five elements of computing process are explained below in detail.

Hardware

The term 'hardware' refers to the physical parts of the computer or includes anything in the computer that we can touch. It consists of interconnected electronic devices that control everything in the computer.

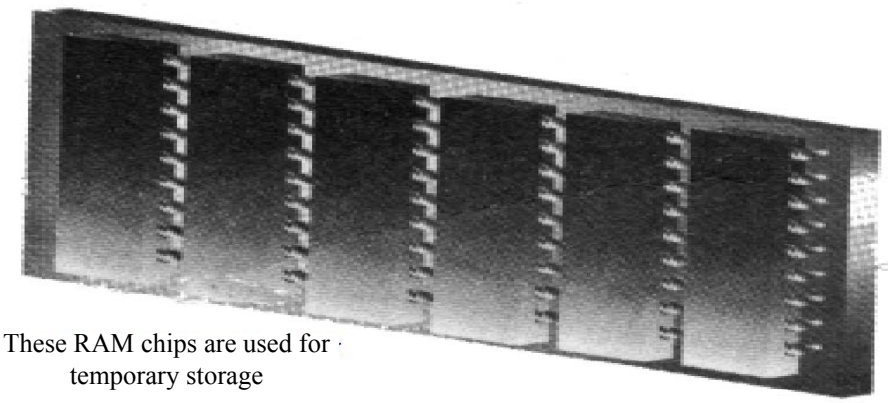
Hardware can be divided into four major categories. They are:

1. Processor
2. Memory
3. Input and Output Devices
4. Storage Devices

Processor

The complex procedure that transforms data into information (useful and meaningful data) is called processing. This type of transformation mainly includes two components—the processor and the memory.

The Processor acts like the brain of a computer. It organizes and carries out the instructions given to the computer by the user or the message passed on by the software. There are various types of processors available in the market. In PC, we use microprocessor(s) (a number of microprocessors can also be used in one PC). Microprocessors are made of silicon or some other material and are etched with many tiny electronic circuits. The microprocessor is plugged into the circuit board – a hard rectangular board that contains the total circuitry used to connect the processor to the rest of the hardware. This circuit board is called 'motherboard'. The number of chips and circuit boards (on which the processors are plugged in) is increased when the computer is to be made more powerful. The term Central Processing Unit (CPU), in real terms, is the processor of the computer. This is the "brain" of the computer, without which nothing can be done. It is very small in size and occupies just a few square inches of space.



These RAM chips are used for temporary storage

Fig. 1.3:

Memory

The software is loaded into the memory of the computer and runs from there only. Not only the software or programs, but also all the data are loaded into the memory for easy access. This memory is called Random Access Memory (RAM). When one talks about memory one often means RAM only.

The main thing to be kept in mind while working on the computer is that RAM is a volatile memory and everything disappears if power goes off or is turned off abruptly in the middle of work. Thus, it is always advisable to frequently save the work on the storage disk while you are working.

The amount of RAM in a computer tremendously affects the speed and power of the computer. The more the RAM, the greater is the power and speed of the computer. The measurement unit of memory is byte. The bigger units of bytes are:

Kilobyte (KB) ~ 1000 bytes [210 bytes = 1024 bytes to be precise]

Megabyte (MB) ~ 1000 KB ~ 10,00,000 bytes

Gigabyte (GB) ~ 1000MB ~ 10 'KB ~ 10' bytes

Nowadays PC's have 8 to 16 GB of RAM.

ROM

Read Only Memory holds permanent data or instruction that can only be read, and nothing can be written on it. Information is permanently recorded in it. It is a nonvolatile memory. ROM contains instructions to get the computer started when it is switched on. It also holds instructions for the control of the various peripheral units of the computer, such as graphic display, disk drive, etc. The controls of ROM are built into it at the time of its manufacturing.

Input and Output Devices

The computer accepts the instructions and delivers the results to the user by means of some devices. There are two main types of devices. Input devices are used to enter the instructions whereas output devices are used to see the results of processing. The term 'device' is generically used to refer to any piece of hardware.

Thus, input devices accept the instructions or the data from the user and output devices return the processed data back to the user in the form of visual display or on paper. New types of input devices keep on coming as technology and the users' demands grow. The most commonly used input device is the Keyboard, which accepts numbers, alphabets and commands from the user. Another input device is the Mouse that works with the action of a click or by moving. The diagrams or some drawing is made on the screen by pressing its button and moving it on the surface. Even the commands are executed by clicking it on the commands displayed on the screen. The other commonly used input devices are trackballs, joysticks, scanners, lightpens, microphones, digital cameras, etc. These will be discussed in detail later.

Both Mouse and Trackball are used almost in the same way. Both of them allow one to draw or to execute some action on the screen by a click. The Joystick is generally used to play videogames. A scanner is used as a photocopying machine. It copies the photographs, drawings or the text as it is into the computer memory, thus saving time of drawing or keying in manually.

Lightpen is used to directly draw the figures on the screen of the monitor. Microphones help in inputting our voice directly in the computer or inputting music from CDs or audiocassettes by attaching them to the computer. Digital cameras are used to bring in live images onto the screen, where some changes can also be made thereon. They are generally used in the barber's shops (to see the best hairstyle that suits the customer) or in the optical shops, etc.

The output devices are used to see the results of processed input. The title case output devices mainly used are the screen or VDU (Visual Display Unit) and the Printers. When the soft copy of the output is required it is seen on the screen of the monitor and

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if hard copy (on paper) is required, then the computer sends it to the printer. Apart from these two output devices, Speakers can also be used as output devices to produce sound, listen to audio CDs or music.

There are some more devices that act as both input and output devices. One such device is the Touch Screen which is a type of monitor that displays virtual buttons which you can touch.

Modem is an example of a communication device that is used to communicate through telephone lines. It performs both the functions. It is used to interconnect the computers. The process of interconnecting the computers is called networking. The network interface cards are used to connect the input of computers so as to share the data and the devices.

Storage Devices

Although the computer can be said to be complete with input and output devices, memory and CPU, and can function quite well, but when it comes to the need of storing data or even programs files for future use, some place is required to store them. Storage devices are used to store data permanently or semi-permanently.

Storage holds the data and the software brings into the memory (RAM) a particular program or data required at that point of time. After you have finished with the work, you again put back the programs and data (new one or processed) into the storage.

Storage can be differentiated from memory thus:

1. Storage is cheaper than memory
2. Storage has more space than RAM
3. Storage is not volatile whereas RAM is, i.e., data remains in the storage even if the power is switched off unlike RAM
4. Ram is faster than storage.

The most widely used storage medium is the magnetic disk, which is round in shape and flat. Read and write heads (similar to the heads of cassette players or VCRs) float above and below the disk near the surface. The disk spins around their center.

The device, which holds the disk, is called 'disk drive'. There are some drives which have built-in disks and these disks cannot be detached from them, whereas some drives are meant for removable/replaceable disks. Almost every PC uses non- removable disks, but additional removable diskette drives can also be used. The non-removable drive is the Hard Disk Drive (HDD) and the removable one is the Floppy Disk Drive (FDD). A computer can have any number of HDDs and FDDs as per the user's requirements.

DVD is the digital optical disk storage with 4.7 gigabyte storage capacity on single sided. DVD are the devises that can read DVD disk on computer. DVDs can be single or double sided and can have to layers on each side, a double sided, two layered DVD will hold up to 17 gigabytes of video, audio, or other information.

Pen Drive is a device used to data storage. It is a small portable flash memory card that plugs into a computer.

HDD can store far more data than a diskette can, so the HDD serves as the computer's primary filling cabinet. Diskettes are used to load new programs or data on to the HDD to transport the data or make the backup copies of the data of the HDD.

The floppy diskette or the removable disks are made of plastic, and, to protect them from dust and scratches, are kept enclosed in vinyl cases. Initially, floppies measured 8 inches; they were reduced to 5¼ inches and now we use 3½ inches diskettes. The size of diskettes is decreasing in diameter, but its storage size is increasing. The capacity of the 8" diskette was 360KB, and that of the 5½ inch was 1.2 MB, whereas the 3½ inch diskette stores 1.44MB of data. The name floppy was given because the vinyl cover (on 8" and 5" diskettes) used to be very flimsy or floppy.

Other types of storage devices include CD-ROM drives, tape drives, optical drives etc. CD-ROM is the most popular type of drive after Hard Disk Drives and Floppy Drives. Compact Disks are optical storage devices similar to audio CDs and can store approximately 640MB. In personal computers we generally use CD-ROM (Compact Disk Read Only Memory). The information on CD-ROM cannot be changed.

Since new writable CDs have come into the market, it has become very convenient to store large amount of data, making it easy to transport.

1.8 Strengths and Weaknesses of Computer

Strengths

Following list demonstrates the advantages of computers in today's arena.

- High Speed
  - Computer is a very fast device.
  - It is capable of performing calculation of very large amount of data.
  - The computer has units of speed in microsecond, nanosecond, and even the picosecond.
  - It can perform millions of calculations in a few seconds as compared to man who will spend many months for doing the same task.
- Accuracy
  - In addition to being very fast, computers are very accurate.
  - The calculations are 100% error free.
  - Computers perform all jobs with 100% accuracy provided that correct input has been given.
- Storage Capability
  - Memory is a very important characteristic of computers.
  - A computer has much more storage capacity than human beings.
  - It can store large amount of data.
  - It can store any type of data such as images, videos, text, audio and many others.

- Diligence
  - Unlike human beings, a computer is free from monotony, tiredness and lack of concentration.
  - It can work continuously without any error and boredom.
  - It can do repeated work with same speed and accuracy.
- Versatility
  - A computer is a very versatile machine.
  - A computer is very flexible in performing the jobs to be done
  - This machine can be used to solve the problems related to various fields.
  - At one instance, it may be solving a complex scientific problem and the very next moment it may be playing a card game.
- Reliability
  - A computer is a reliable machine.
  - Modern electronic components have long lives.
  - Computers are designed to make maintenance easy.
- Automation
  - Computer is an automatic machine.
  - Automation means ability to perform the given task automatically.
  - Once a program is given to computer, i.e., stored in computer memory, the program and instruction can control the program execution without human interaction.
- Reduction in Paper Work
  - The use of computers for data processing in an organization leads to reduction in paper work and results in speeding up a process.
  - As data in electronic files can be retrieved as and when required, the problem of maintenance of large number of paper files gets reduced.
  - Reduction in Cost
  - Though the initial investment for installing a computer is high, it substantially reduces the cost of each of its transaction.

Weaknesses

Computer is, no doubt, a marvellous tool. Yet it has some limitations. Some of the major limitations of computer are:

1. A computer cannot think on its own. It has to be given instructions to perform any operation. Research is currently underway to impart artificial intelligence to computer. Once this becomes possible, computers will be thinking on its own, then it will be a reasonable replication of human mind.

2. It does not have intuition. It cannot draw a conclusion without going through all intermediate steps.
3. It can do a task only if it can be expressed in a series of finite steps leading to the completion of the task.
4. Similarly, it cannot handle a situation where a finite number of steps generate an impossibly large number of computational operations.
5. It cannot learn from experience. It will commit the same error repeatedly and cannot learn from experience. But changes are taking place in this area as research progresses on artificial intelligence.

1.9 Difference Between Computer, Human Beings and Calculator

Computers and calculators are similar in the sense that both are calculating devices. But what is the difference between a computer and a calculator? Before the advent of computers, calculators were the tools that were made use of by the students to do computation while solving mathematical problems. Not that they are not used these days, in fact, by the time you switch on your computer, you complete the operation on the hand held device known as calculator.

Modern calculators are electronically powered either by dry cell batteries or solar cells. During nineties, there was a calculator in every student's pocket to aid and assist him in carrying out calculations involved in mathematical problems. With modern computers having a built-in calculator to carry on basic mathematical operations, calculators have all but gone from households today.

We know that a calculator can work only with numbers. But so can a computer. Modern calculators are extremely fast in carrying out complex calculations. But so are computers. Then what is the difference between the two?

Simply put, calculators can carry only one function at a time. Even when you need to solve a small problem, you need to press a number of buttons to arrive at the solution. On the contrary, a computer is capable of carrying out many operations at the same instant. Computer programs are a series of instructions that are given to computers and it can perform complex calculations with the assistance of those instructions. So if the necessary program is installed on the computer, you do not need to tell the computer what to do next as it can perform all the steps required in getting the answer. It will come with the answer at a lightening fast speed without you having to press any buttons, or mouse clicks in this instance. On the other hand, you need to keep on pushing buttons to solve even easy mathematical problems while using a calculator.

The word 'computer' has become very broad in modern times and has come to include smart devices such as smartphones, MP3 players, desktops and laptops. These devices all have a basic calculator that can perform simple mathematical operations, but they are capable of many more operations which are beyond the capacity of a calculator.

Characteristic	*Human*	*Calculator*	*Computer*
Speed	Slow	Fast	Very Fast
Accuracy	Possible to do errors	Good	Very Good
Memory	Less internal memory	No	Large Memory
Operation	All operations. But slow	Arithmetic	Arithmetic and Logical

1.10 Components of a Digital Computer

A digital computer can be broadly classified as a collection of four components. They are:

1. Input unit
2. Output unit
3. Central Processing Unit
4. Memory (Auxiliary)

A block diagram representation of the above is shown in the figure:

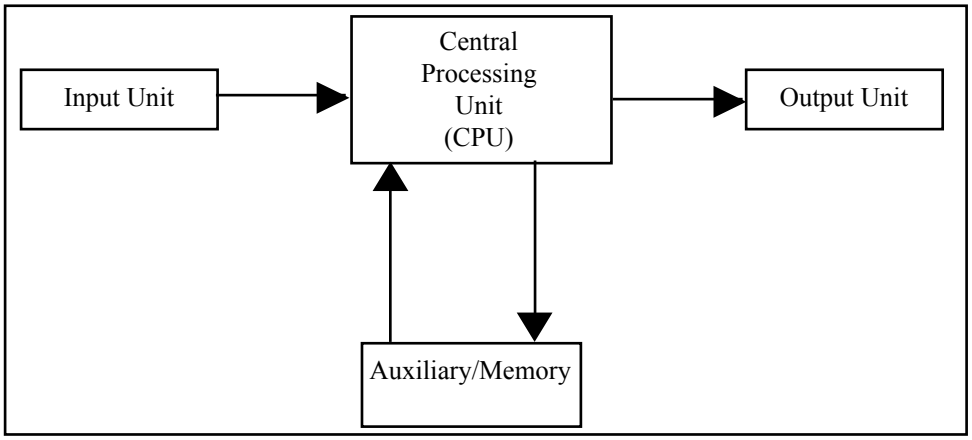

Fig. 1.4: Basic Components of a Digital Computer

The Input Unit

The Input Unit provides an interface between the users and the machine, for inputting data and instruction, etc. One of the most common examples is the keyboard. Data can be input in many more forms – audio, visual, graphical, etc.

Some common input devices are listed below:

1. Keyboard
2. Mouse
3. Voice data entry
4. Joy stick
5. Light pen

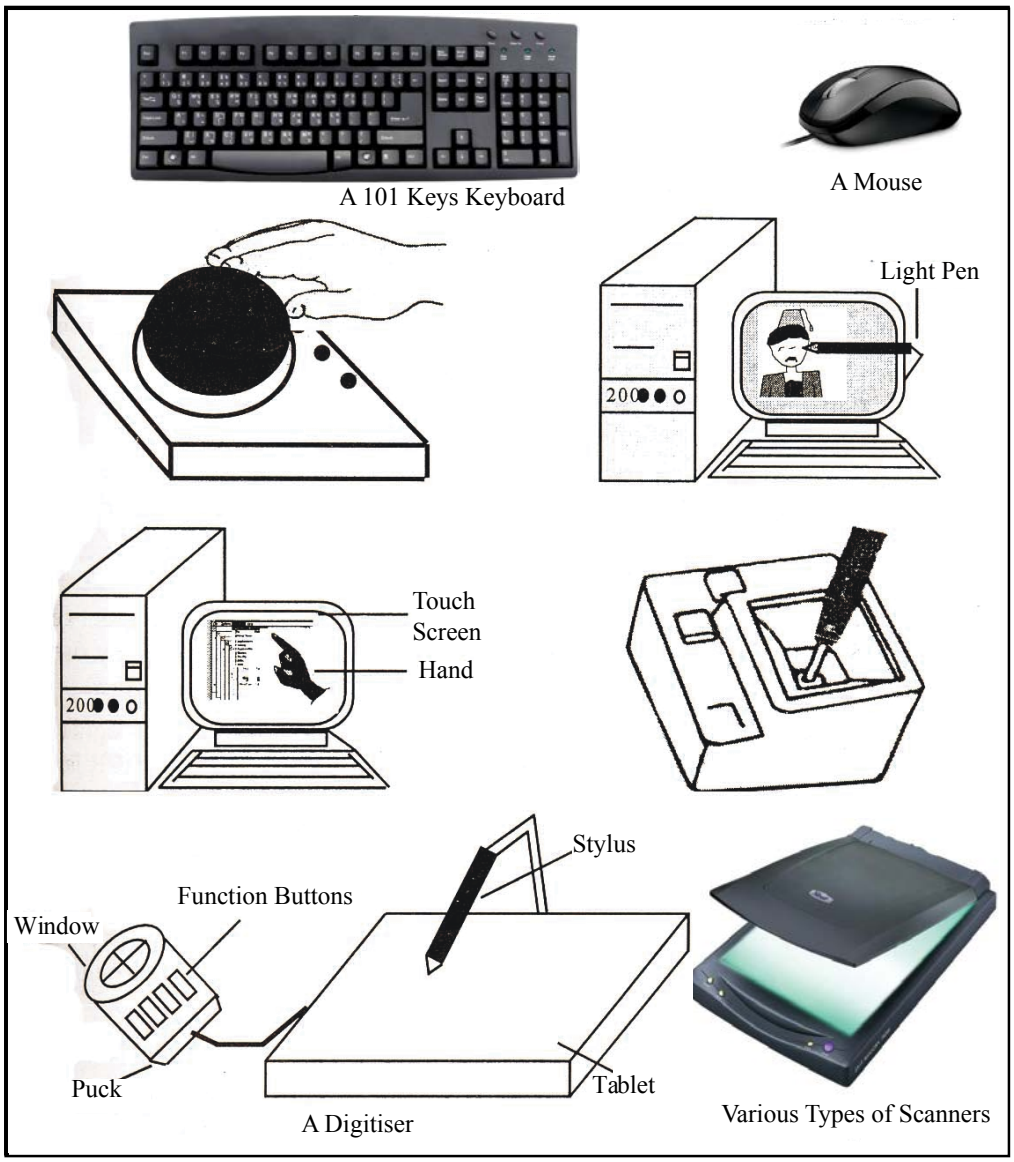

Fig. 1.5: Computer Input Unit

6. Scanner
7. Secondary storage devices such as floppy disks, magnetic tapes, etc.

The data in any form is first digitized, i.e., converted into binary form, by the input device before being fed to the Central Processing Unit (CPU).

The Output Unit

Like the Input Unit, the Output Unit also provides an interface between the user and the machine. A common example is the visual display unit (monitor) of a personal computer. The output unit receives the data from the CPU in the form of binary bits. This is then converted into a desired form (graphical, audio, visual, etc.) understandable by the user.

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Some common output devices are:

1. Visual Display Unit (Monitor)
2. Printers
3. Speakers
4. Secondary Storage Devices

The input and output unit collectively are referred to as 'peripherals'.

The input and the output units shall be discussed in more detail in the next chapter.

The Central Processing Unit

The central processing unit is the brain of a computer system. The input and the output devices may vary for different applications, but there is only one CPU for a particular computer. The specifications of a computer are basically characterized by its Central Processing Unit.

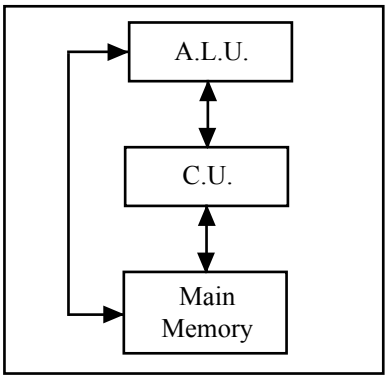

Fig. 1.6: The Central Processing Unit

The Central Processing Unit can be further divided into:

1. The Arithmetic Logic Unit (ALU)
2. The Control Unit
3. Main Memory

The arrows in the above Figures may represent data as well as control information flow.

The CPU processes the data it receives as input (either through input devices or through the memory). As mentioned earlier the CPU receives the data in the form of binary bits, which it can understand.

The CPU performs many tasks, some of which are listed below:

1. The CPU can perform arithmetic calculations such as addition, subtraction, etc.
2. The CPU can perform logical decisions.
3. The CPU with the help of other devices can perform data transmission.
4. The CPU can perform manipulating tasks such as word processing.

5. After performing the required task the CPU may place results in memory or send results to the output device according to the instruction given to it.
6. The CPU with the help of its control unit generates timing signals (also known as enable signals) which provide synchronization between the different devices and the CPU.

As mentioned earlier, the Central Processing Unit consists of:

1. The Arithmetic Logic Unit (ALU)
2. The Control Unit
3. The Main Memory Unit

The Arithmetic Logic Unit (ALU)

As the name may indicate the arithmetic logic unit performs all arithmetic and logic calculations on the data it receives.

Arithmetic Calculations

The arithmetic calculations may be addition, subtraction, multiplication, division, exponentiation, etc.

Logical Calculation

Logical calculations are basically decision making statements, for example, A>B decides whether A is greater than B or not; If A is greater than B the statement is true and logical '1' would be generated, otherwise a logical '0' would be generated. Some logical decisions decide the further routing of the program. This will be further explained by the figure:

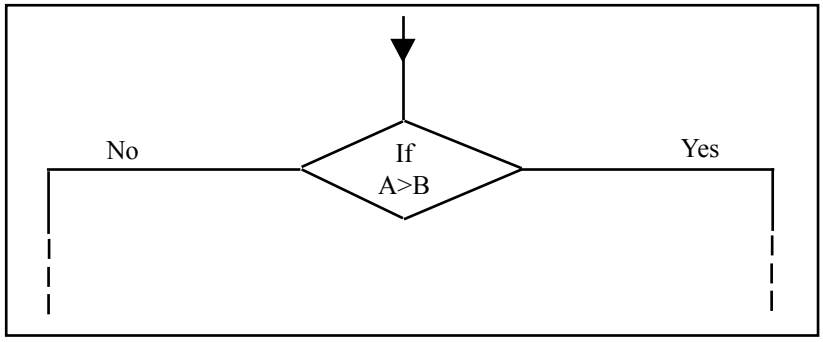

Fig. 1.7: Part of a Flow Chart

In the above Figure the decision box has split the flow chart into two.

The functioning of the arithmetic logic unit would be better understood when we discuss the 'accumulator'.

The Control Unit

The control unit controls the entire operations of the computer and the CPU. It controls all the other devices connecting the CPU, i.e., Input devices, Output devices, Auxiliary Memory etc. Hence, the control unit acts as the nerve centre of the computer.

Notes

The control unit upon receiving an instruction decides what is to be done with it. That is, whether it is to be sent to the ALU for further processing or to the output devices or to the memory, etc. In other words the control unit coordinates and controls all hardware operations.

The control unit has an electronic clock that transmits electronic pulses at equal intervals of time. The control unit gives instructions to other devices based upon these pulses. Suppose there are three instructions to be performed. Let the first instruction take three clock pulses to complete; when the fourth clock pulse is received the control unit would start processing the second instruction and so on. Suppose an instruction takes three and a half clock pulses to complete. In such a case the control unit could wait for the fourth clock pulse to complete and take up the next instruction with the fifth clock pulse.

The clock pulse basically provides synchronization between the different parts of the computer. The control unit generates millions of clock pulses per second. The speed at which an instruction is executed depends upon the clock speed which is in MHZ (10^6HZ).

The Main Memory Unit

The main memory, also known as the primary memory is a part of the central processing unit and is a combination of both RAM (random access memory) and ROM (read only memory). We shall discuss the RAM and the ROM later but for now we shall define them as follows:

RAM

The random access memory is a read write memory, i.e., information can be read as well as written into this type of memory. It is volatile in nature, i.e., the information it contains is lost as soon as the system is shut down unless 'saved' for further usage by the users. It is basically used to store programs and data during the computer's operation.

ROM

The read only memory, as the name may suggest contains information that can only be read, i.e., you can't write on this type of memory. It is non-volatile or permanent in nature. It is basically used to store permanent programs such as program for the functioning of the monitor.

The main memory is a fast-memory, i.e., it has small access time. It is because of its limited capacity that it is fast. The main memory contains the programs that are currently being worked on. It passes on this information to the control unit as and when required. In case the CPU wants to access some data that is present in a secondary storage device, this data is first transferred to the main memory and then processed.

The main memory is much more costly than the secondary storage devices. Although the ROM IC's of various computers do not vary much in their capacities, the RAM chips are available in wide ranges of storage capacities. In fact, the capacity of the random access memory is an important specification of a computer.

A larger RAM means larger programs (in terms of memory) can be loaded and executed. Suppose you want to run a 68-KB program on a machine with 64-KB. This means that the whole program can not be loaded into the main memory at once resulting in either the non-execution of the program or a very slow execution.

A 64-K memory means that there are approximately 64000 (65,536 to be precise) storage locations which can store 1 bit of data each.

Different memories can be classified on the basis of their concepts:

1. ***Access Mode:*** It means how easily they are accessible.
2. ***Access Time:*** The average time required to reach a storage location and obtain its content is called access time.
3. ***Transfer Rate:*** The transfer rate is the number of characters or words that a device can transfer per second after it has been positioned at the beginning of the record.
4. ***Capacity and Cost:*** The capacity and cost may depend upon the requirement and the budget.

The main memory has a very low access time and a very high transfer rate. It is limited in capacity and costlier than secondary storage devices.

The Cache Memory

Another important concept is that of the cache memory, which is also a part of the CPU.

The cache memory lies in the path between the processor and the main memory. The cache memory therefore, has lesser access time than the main memory and is faster than the main memory. A cache memory may have an access time of 100ns, while a main memory may have an access time of 700ns.

The cache memory is very expensive and hence is limited in capacity. Earlier cache memories were available separately but the latest microprocessors contain the cache memory on the chip itself.

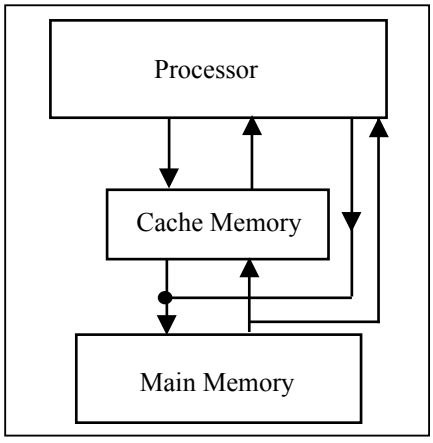

Fig. 1.8: Cache Memory

The need for the cache memory is due to the mismatch between the speeds of the main memory and the CPU. The CPU clock is very fast, whereas the main memory access

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time is comparatively slow. Hence, no matter how fast the processor is, the processing speed depends more on the speed of the main memory (the strength of a chain is the strength of its weakest link). It is because of this reason that a cache memory having access time closer to the processor speed is introduced.

The cache memory stores the program (or its part) currently being executed or which may be executed within a short period of time. The cache memory also stores temporary data that the CPU may frequently require for manipulation.

The cache memory works according to various algorithms, which decide what information it has to store. These algorithms work out the probability to decide which data would be most frequently needed. This probability is worked out on the basis of past observations.

We shall discuss the 'memory' later when we discuss the auxiliary memory.

Functioning of the Arithmetic Logic Unit

Register

A register is a combination of memory storage locations called flip-flops. Each flip-flop is capable of storing one bit of information. An n-bit register contains 'n' flip-flops and is capable of storing 'n' bits of information.

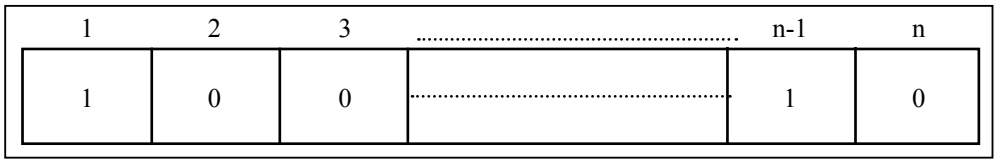

Fig. 1.9: n-bit Register

Accumulator

The accumulator is a register that is present within the arithmetic logic-unit. The accumulator stores data, which is either the result of an operation, or which is to be processed through arithmetic and logical operations.

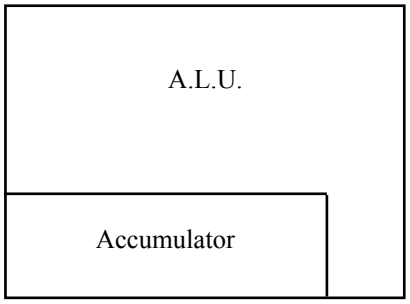

Fig. 1.10: The Detailed A.L.U.

Memory Data Register

The memory data register like the accumulator is used to store data. This register holds all data and instructions temporarily as they pass in or out of the main memory.

Memory Address Register

The memory address register contains the address of the memory location (in main memory) whose data is to be transferred into the memory data register.

In the Figure, the memory address register (MAR) contains the address of the third memory location, the dsata of which is transferred to the memory data register (MDR).

We shall try to explain the functioning of the ALU with the help of an example. Suppose two numbers are to be subtracted. The following steps are involved:

1. Let the first instruction cause the number 13 to be placed in the accumulator. When the control unit receives this instruction it decodes it and performs the controlling and coordination function by sending the number to the accumulator. A special purpose register that holds the instruction currently being processed by the control unit is called Current Instruction Register (CIR).
2. The second instruction asks the control unit to send the address of the second number stored in the main memory to the MAR.
3. The control unit then causes the contents of that specific address of the main memory to be copied to the MDR.
4. Once the numerical data is passed on to the MDR, the control unit signals the ALU to perform the SUBTRACT Operation which causes the number in the MDR to be subtracted from the number in the accumulator.

Functioning of the Control Unit

The control unit as said earlier is the nerve centre of the computer. Every instruction before being executed is first interpreted by the control unit. The sequence of operations involved in processing an instruction is known as the instruction cycle. The instruction cycle can be divided into two parts:

1. Fetch cycle
2. Execution cycle

Fetch Cycle

The control unit fetches the instruction from the memory data register and places it in the current instruction register.

Execution Cycle

The control unit then decodes this instruction in the current instruction register and sends the appropriate signal to the concerned device for the execution of the instruction.

The flowchart in the figure 1.9 describes the functioning of the control unit.

Let us now turn our attention back to the memory devices.

Memory

Auxiliary Storage Memory

Notes

The auxiliary storage memory, also known as the secondary memory is an external (to the CPU) memory. The auxiliary storage devices store system programs, large data files, assemblers, compilers and other programs. In other words, the auxiliary storage devices are used for bulk storage of data. The storage capacity of these devices is unlimited as an empty device can replace them once the existing device is completely filled. Even the individual storage devices, such as the magnetic tape have more capacity than the main memory.

The secondary memory is permanent in nature, i.e., the information stored in these devices is not lost unless specifically deleted. Secondary storage devices being permanent in nature can also be used for transportation of data from one computer to another.

Secondary storage devices are cheaper than the main memory. The information stored in the secondary memory is first transferred to the main memory and then processed by the CPU. The final result may then be placed in the secondary memory. It is because of this that the access time of the secondary memory is comparatively high. Hence, the data stored in the secondary storage devices take more time to process than the data already present in the main memory. In fact the access time for data stored in the secondary memory is one thousand times the data stored in the main memory.

Secondary memories may also be considered as input and output devices as they provide the information as input and store the final results in the output.

The secondary storage devices would be discussed in detail in a later chapter.

Memory Hierarchy

The figure 1.10 above is self-explanatory.

Types of Memory

Although various types of memory have been discussed in the previous sections the block diagram given below acts as a good visual aid for memorizing.

As promised earlier we shall now discuss the random access memory (RAM) and read only memory (ROM) in detail.

Random Access Memory (RAM)

The RAM as mentioned earlier is volatile in nature. It retains the stored information as long as the power supply is on. Its contents are lost when the power supply is switched off. The power requirement of the random access memory chips is comparable to that of the microprocessor itself. It is also partially due to this reason, that the RAM is very fast.

RAM is of two types:

1. Dynamic RAM (DRAM)
2. Static RAM (SRAM)

We shall discuss each of these in detail:

Dynamic RAM (DRAM): The dynamic RAM chips contain a transistor that acts as a gate to a capacitor, which is capable of storing electric charge. The charge on the

capacitor indicates a '1' bit and no charge indicates a '0' bit. The charge on the capacitor leaks away after a few milliseconds. Therefore, a dynamic RAM has to be refreshed periodically after every two milliseconds. A D-RAM uses its contents in a very short time even though the power supply is ON. A D-RAM consumes less power and has higher packing density. It is cheaper than the static RAM.

Static RAM (S-RAM): Static RAM's are also volatile in nature but they need no regenerator to retain the data. They retain the data as long as they receive the power. The static random access memory consumes more power and is more expensive. The static RAM chips are more complicated and hence require more space. Static RAM's are faster than the dynamic RAM's. Static RAM's have an access time of approximately 85 to 90ns while the dynamic RAM's may take 150 to 200ns to provide information. Static RAM's are recommended for medium sized memories while dynamic RAM's are recommended for large sized memories.

Read Only Memory (ROM)

The read only memory (ROM) contains non-volatile or permanent information. As the name suggests the information contained in this type of memory can only be read; it can not be altered or overwritten. Information is entered into the ROM chip at the time of manufacturing. ROM chips are used for applications which require a permanent information, e.g., a program for the functioning of the visual display unit, a program for controlling the working of a washing machine, *etc*.

With the advent of technology erasable ROM's have become available. We shall discuss these and other ROM's in the following section.

Types of ROM

- ***Programmable Read Only Memory (PROM):*** A PROM program is used to record information in the PROM chip. Information once programmed into the PROM chip is permanent and can not be changed or erased. The process of entering the information into the PROM chip is known as "burning the PROM." PROM chips are seldom used in modern day computers, but they still find their use in devices where a permanent ROM is required.
- ***Masked Read Only Memory (MROM):*** In the masked ROM, the information is permanently recorded by the masking and metallization process. It is not easy to perform this process as a large infrastructure is required, and therefore, it is usually the manufacturers who perform this process.
- ***Erasable Programmable Read Only Memory (EPROM):*** An EPROM is an erasable PROM. An EPROM can be (re) programmed using an EPROM programmer. Exposing it to high intensity ultraviolet light for 30 minutes (approximately) can erase the contents of an EPROM chip. An ultra-violet source with a wavelength of 2537A (angstrom) is used for this purpose. The process of changing the contents is not convenient, as the chip has to be removed from

Notes

the board for exposure to the ultra-violet light source. Another disadvantage is that the user can't erase the contents of a single memory location and the entire memory contents have to be erased. The EPROM chip is cheap, reliable and widely available.

- ***Electrically Erasable Programmable Read Only Memory (EEPROM):*** EEPROM is an electrically erasable PROM. Using electrical signals can alter the information and that is why the chip need not be removed from the board. One major advantage that this chip has over the EPROM is that even single memory can be altered, i.e., the entire memory need not be erased and reprogrammed unless required. The change in the contents of the EEPROM chip is made in milliseconds, which is much less than the erasing time for EPROM.
- ***Non-Volatile RAM:*** A non-volatile RAM combines a static RAM and EEPROM. Such a device operates as normal RAM but in case the power fails the entire contents of the RAM are stored in EEPROM. When the power is restored, the data from EEPROM is transferred back to the RAM.

Now that you have an idea of the computer's internal architecture. We shall discuss the RISC & the CISC.

1.11 Reduced Instruction Set Computer (RISC)

An important aspect of computer architecture is the design of the instruction set for the processor. The instruction set chosen for a particular computer determines the way that machine language programs are constructed. Early computers had small and simple instruction sets, forced mainly by the need to minimize the hardware used to implement them. As digital hardware became cheaper with the advent of integrated circuits, computer instructions tended to increase both in number and complexity. Many computers have instruction sets that include more than hundred and sometimes even more than 200 instructions. These computers also employ a variety of data types and a large number of addressing modes. The trend for computer hardware complexity was influenced by various factors, such as upgrading existing models to provide more customer applications, adding instructions that facilitate the translation from high-level language into machine language programs and striving to develop machines that move functions from software implementation into hardware implementation. A computer with a large number of instructions is classified as a Complex Instruction Set Computer, abbreviated CISC.

In the early 1980s, a number of computer designers recommended that computers use fewer instructions with simple constructs so they can be executed much faster within the CPU without having to use memory as often. This type of computer is classified as a Reduced Instruction Set Computer or RISC.

CISC Characteristics

The design of an instruction set for a computer must take into consideration not only machine language constraints, but also the requirements imposed on the use of high-

level programming languages. The translation from high-level to machine language programs is done by means of a compiler program. One reason for the trend to provide a complex instruction set is the desire to simplify the compilation and improve the overall computer performance. The task of a compiler is to generate a sequence of machine instructions for each high-level language statement. The task is simplified if there are machine instructions that implement the statements directly. The essential goal of a CISC architecture is to attempt to provide a single machine instruction for each statement that is written in a high-level language. Examples of CISC architectures are the Digital Equipment Corporation VAX computer and the IBM 370 computer.

The major characteristics of CISC architecture are:

1. A large number of instructions-typically from 100 to 250 instructions
2. Some instructions that perform specialized tasks and are used infrequently
3. A large variety of addressing modes-typically from 5 to 20 different modes
4. Variable-length instruction formats
5. Instructions that manipulate operands in memory

RISC Characteristics

The concept of RISC architecture involves an attempt to reduce execution time by simplifying the instruction set of the computer. The major characteristics of an RISC processor are:

1. Relatively few instructions
2. Relatively few addressing modes
3. Memory access limited to load and store instructions
4. All operations done within the registers of the CPU
5. Fixed-length, easily decoded instruction format
6. Single-cycle instruction execution
7. Hardwired rather than micro programmed control

A characteristics of RISC processors is their ability to execute one instruction per clock cycle. This is done by overlapping the fetch, decode and execute phases of two or three instructions by using a procedure referred to as pipelining. A load or store instruction may require two clock cycles because access to memory takes more register operations. Efficient pipelining, as well as a few other characteristics, are sometimes attributed to RISC, although they may exist in non-RISC architectures as well. Other characteristics attributed to RISC architecture are:

1. A relatively large number of registers in the processor unit
2. Use of overlapped register windows to speed-up procedure call and return
3. Efficient instruction pipeline
4. Compiler support for efficient translation of high-level language programs into machine language programs

1.12 Indian Computing Environment

Office work includes many administrative and management activities. The preparation, distribution, processing and review of documents are the common activities of an organization. Prior to the advent-of computers, these office activities were either performed manually or with the help of mechanical and electrical machines. During the past few decades, the basic nature of office has changed remarkably. Office automation deals in application of latest technologies in improving the overall proficiency of the office. We may define office automation as follows:

Definition

Office automation is the application of computer and related technologies like communication and networking to integrate the general office tasks so that the efficiency of office work is improved.

Office automation does not mean just to install computers and communication devices in an office, but it is much more than that. We will discuss in later part of this unit, how an office can be automated in a real sense.

1.13 Role of Computers in Management

Although all the work of a small or big office can be performed manually, it is very difficult or even impossible today for an organization to compete in the market without office automation. There are many essential requirements of today's office environment, which are listed below:

- To reduce cost of administrative overhead;
- To increase the efficiency of office tasks;
- To provide better service to the customers;
- To provide accurate information to the management;
- To provide best and fastest way of communication.

The above requirements cannot be achieved without using latest technologies and therefore, office automation is needed for an organization.

Office Functions Needed to be Automated

Many types of functions are performed in an office. The basic functions, which are needed to be automated in any office are:

1. ***Document Generation:*** In all offices, many documents are needed to be prepared, typed and printed. Typewriters, computers and printers are widely used in automating this routine task of offices.
2. ***Document Processing:*** Documents are also needed to be processed in order to extract useful information required for MIS and other official purposes. Many office automation tools like word processing, desktop publishing etc. are used to perform this task.

3. ***Document Distribution:*** All offices require an electronic distribution system for transferring documents and data within and outside the organization. The main office automation tools for distribution of documents are Photocopiers, Teletax and Fax machines.
4. ***Archival Storage:*** The office documents are also needed to be stored for a long period, so that they can be retrieved when required. This task is achieved by the use of different storage devices like tapes, disks, etc.

Office Automation Systems

For achieving the basic functions of an office, different types of office automation systems are used. These systems can be broadly classified into following four types:

1. ***Document Management Systems:*** These systems include computerized tools for generation, storage, processing and distribution of documents.
2. ***Communication Systems:*** These systems are used for sending messages, documents and data within and outside the organization.
3. ***Teleconferencing Systems:*** An electronic means of communication for conducting seminars and training programmes in an organization is achieved through various teleconferencing systems.
4. ***Support Systems:*** Besides the above major office automation systems, certain support systems for managing the activities of work groups are also used in some offices.

1.14 Generation of Computers

The computer evolved as a result of man's search for a fast and accurate calculating device. Abacus was the first manual calculating device, which was invented in Asia many centuries ago. In 1617, John Napier, a Scottish mathematician invented a mechanical calculator called 'Napier's bones'. Thereafter, many kinds of computers have been designed and built during the evolution of the modern digital computer. In order to provide a framework for the growth of computer industry, the computer era has been referred to in terms of generations. Computers are classified into following six types based on their historical advancement and electronic components used.

Zeroth Generation Computers

The zeroth generation of computers (1642-1946) was marked by the invention of mainly mechanical computers. Pascaline was the first mechanical device, invented by Blaise Pascal, a French mathematician in 1642. In 1822, Charles Babbage, an English mathematician, designed a machine called Difference Engine to compute tables of numbers for naval navigation. Later on, in the year 1834, Babbage attempted to build a digital computer, called Analytical Engine. The analytical engine had all the parts of a modern computer, i.e.; it had four components—the store (memory unit), the mill

(computation unit), the punched card reader (input unit) and the punched/printed output (output unit). As all basic parts of modern computers were thought out by Charles Babbage, he is known as Father of Computers. In later years, Herman Hollerith invented a machine for doing counting for 1880 US census, which was called Tabulating Machine. In 1944, Howard A. Eiken invented first American general purpose electro-mechanical computer, called Mark I and later on its successor, Mark II. The Zeroth generation of computers or the era of mechanical computers ended in 1946 when vacuum tubes were invented.

First Generation Computers

The first generation of computers (1946-1954) was marked by the use of vacuum tubes or valves for their basic electronic component. Although these computers were faster than earlier mechanical devices, they had many disadvantages. First of all, they were very large in size. They consumed too much power and generated too much heat, when used for even short duration of time. They were very unreliable and broke down frequently. They required regular maintenance and their components had also to be assembled manually. The first generation of computers became out-dated, when in 1954, the Philco Corporation developed transistors that can be used in place of vacuum tubes.

Examples:

- **ENIAC** (Electronic Numerical Integrator and Calculator) It was the first electronic computer using vacuum tubes. – 1946
- **EDSAC** (Electronic Delay Storage Automatic Calculator) It was the first stored-program computer. – 1949
- **EDVAC** (Electronic Discrete Variable Automatic Computer) It was a successor to EDSAC. – 1951
- **IAS** machine (Princeton's Institute of Advanced Studies) It was a new version of the EDVAC, built by von Neumann. – 1952

The basic design of IAS machine is now known as von Neumann machine, which had five basic parts, viz., the memory, the arithmetic logic unit, the program control unit, the input and the output unit.

Features

1. They used valves or vacuum tubes as their main electronic component.
2. They were large in size, slow in processing and had less storage capacity.
3. They consumed lots of electricity and produced lots of heat.
4. Their computing capabilities were limited.
5. They were not so accurate and reliable.
6. They used machine level language for programming.
7. They were very expensive.

Second Generation Computers

The second generation of computers (1954-64) was marked by the use of transistors in place of vacuum tubes. Transistors had a number of advantages over the vacuum tubes. As transistors were made from pieces of silicon, they were more compact than vacuum tubes. The second generation computers, therefore, were smaller in size and less heat was generated than first generation computers. Although they were slightly faster and more reliable than earlier computers, they also had many disadvantages. They had limited storage capacity, consumed more power and were also relatively slow in performance. Like first generation computers, they also required regular maintenance and their components had also to be assembled manually. Manual assembly of components was very expensive and later many attempts were made to reduce such manual assembly. It was in 1964, when it was discovered that a number of transistors could be sealed up into a tiny package, called Integrated Circuit (IC) or Chip. Second generation computers became outdated after the invention of ICs.

Examples:

- **PDP-l**, developed by DEC was the first minicomputer.
- **NCR 304** (National Cash Register), was first all-transistorized computer.

Features

1. Transistors were used instead of Vacuum Tube.
2. Processing speed is faster than First Generation Computers (Micro Second)
3. Smaller in Size (51 square feet)
4. The input and output devices were faster.

Third Generation Computers

The third generation of computers (1964-1980) was marked by the use of Integrated Circuits (ICs) in place of transistors. ICs were more compact than transistors, as hundreds of transistors could be put on a single small circuit. These computers removed many drawbacks of second generation computers. The third generation computers were even smaller in size which generated less heat and required very less power as compared to earlier two generation of computers. These computers required less human labour at the assembly stage. Although, third generation computers were faster and more reliable, they also had a few disadvantages.

They still had less storage capacity, relatively slow performance and thus could not fulfil the requirements of the users and programmers. The third generation computers became outdated around the year 1978 when it was found that thousands of ICs could be integrated onto a single chip, called LSI (Large Scale Integration).

Examples:

- **IBM 360**, developed by IBM in 1964 was the first product line designed as a family.

- **PDP-8**, developed by DEC in 1965 was the first mass-market minicomputer.
- **PDP-ll**, developed by DEC in 1970 was the first highly successful minicomputer.
- **CRAY-l**, developed by Cray in 1974 was the first supercomputer.
- **VAX**, developed by DEC in 1978 was the first super minicomputer.

Features

1. They used Integrated Circuit (IC) chips in place of transistors.
2. Semi conductor memory devices were used.
3. The size was greatly reduced, the speed of processing was high, they were more accurate and reliable.
4. Large Scale Integration (LSI) and Very Large Scale Integration (VLSI) were also developed.
5. The mini computers were introduced in this generation.
6. They used high level language for programming.

Fourth Generation Computers

The fourth generation of computers (1978-till date) was marked by use of Large Scale Integrated (LSI) circuits in place of ICs. As thousands of ICs could be put onto a single circuit, so LSI circuits are still more compact than ICs. In 1978, it was found that millions of components could be packed onto a single circuit known as Very Large Scale Integration (VLSI). VLSI is the latest technology of computer that led to the development of the popular Personal Computers (PCs), also called Microcomputers. All present day computers belong to the fourth generation of computers. These computers are very powerful having a high memory and a fast processing speed. Today's PCs are even more powerful than mainframe computers. Although fourth generation computers offer too many advantages to users, the major drawback of these computers is that they have no intelligence on their own. Scientists are now trying to remove this drawback by making computers which will have artificial intelligence.

Examples:

1. **IBM PC,** developed in 1981 was the first industry standard personal computer, having Intel 8088 memory chip.
2. **IBM PC/AT,** developed in 1982 was the first advanced technology PC, having Intel 80286 memory chip.
3. **386,** developed in 1985, had Intel 80386 memory chip.
4. **CRAY-2,** developed in 1985, was the fourth generation supercomputer.
5. **486,** developed in 1989, had Intel 80486 memory chip.
6. **Pentium,** developed in 1995, has pentium (80586) memory chip.

Features:

1. They used Microprocessor (VLSI) as their main switching element.
2. They are also called micro computers or personal computers.
3. Their size varies from desktop to laptop or palmtop.
4. They have very high speed of processing; they are 100% accurate, reliable, diligent and versatile.
5. They have very large storage capacity.

Fifth Generation Computers

The fifth generation computers (Tomorrow's computers) are still under research and development stage. These computers will have artificial intelligence. They will use ULSI (Ultra Large Scale Integration) chips in place of VLSI chips. One ULSI chip contains millions of components on a single IC. The most important feature of fifth generation computers is that they will use an intelligent software. This software will enable the user to tell computer 'What to do' and not 'How to do' by using intelligent programming and knowledge-based problem solving techniques. So, the programmers or users would not be required to give each and every instruction to the computer for solving a problem. These computers will also have user interface in form of speech in natural languages.

Example:

- Yet to develop but ROBOTS have few features of fifth generation computers.

1.15 Classification of Programming Languages

For the purpose of understanding the programming, languages can be categorized into Low Level and High Level languages as follows:

Low Level Languages

A low level language is a language in which each statement is directly translated into a single machine code. These languages can be further classified under two heads:

1. Machine Languages, 2. Assembly Languages

Machine Languages

Unfortunately, the computer's own binary-based language, or machine language, is difficult for humans to use. The programmer must input every command and all data in binary form, and a basic operation such as comparing the contents of a register to the data in a memory-chip location might look like this: 11001010 00010111 11110101 00101011.

Machine-language programming is such a tedious, time consuming task that the time saved in running the program rarely justifies the days or weeks needed to write the program. Therefore, the set of instruction codes, whether in binary or in decimal notation,

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which can be directly understood by the computer without the help of a translating program, is called *machine code* or *machine language program.*

Let us understand this: a computer understands information composed of only zeros and ones. This means that a computer uses binary digits for its operation. The computer's instructions are therefore coded and stored in the memory in the form of 0s and 1s. A program written in the form of 0s and 1s is called a *machine language program.* There is a specific binary code for each instruction. For example, to add the contents of register A and register B, the binary code is 10000000 for Intel 8085. The binary code (machine code or object code) for a certain operation differs from computer to another. Each microprocessor has its own instruction set and corresponding machine codes. Machine code is the fundamental language of a computer and is normally written as strings of binary 1s and 0s. However, a machine language program need not necessarily be coded as strings of binary digits (1s and 0s). It can also be written using decimal digits. However, the circuitry of the computer would be extremely complex and such computers have not been built.

Two Part Machine Code

The circuitry of a computer is wired in such a way that it immediately recognizes the machine language and converts it into electrical signals needed to run the computer. An instruction prepared in any machine language has a two-part format, as shown below:

LMC assembly language	*LMC machine code translations*
Get	901
Store 99	399
Get	901
Add 99	199
Put	902

Operation Code

The first part is the command or operation, and it tells the computer what function to perform. Every computer has an operation code or opcode for each of its functions.

Address

The second part of the instruction is the operand, and it tells the computer where to find or store the data or other instructions that are to be manipulated. Thus, each instruction tells the control unit of the CPU what to do and what is the length and location of the data fields that are involved in the operation. Typical operations involve reading, adding, subtracting, writing, and so on.

We know that all computers use binary digits (0s and 1s) for performing internal operations. Hence, a computer's machine language consists of strings of binary numbers.

This is the only language which the CPU understands directly. When stored inside the computer, the symbols which make up the machine language program are made up of 1s and 0s. We know that machine language is not a very easy language to learn, because it is difficult to read, understand and remember the long sequences of 0s and 1s. Since human programmers are more at ease with the decimal number system, they preferred to write the computer instructions in decimal numbers. An input device is then used to convert these to binary.

Advantages and Limitations of Machine Language

Programs written in machine language can be executed very fast by the computer. This is mainly because machine instructions are directly understood by the CPU and no translation of the program is required. However, writing a program in machine language has several disadvantages which are discussed below.

The internal design of computers is different from one another and needs different electrical signals to operate; the machine language is also different from one type of computer to another. It is determined by the actual design or construction of the Arithmetic Logic Unit (ALU), the control unit, and the size as well as the word length of the memory unit. Hence, it is important to note that after becoming proficient in the machine code of a particular computer, the programmer will be required to learn a new machine code and would have to write all the existing programs again, in case the computer system is changed.

Although machine language is easily used by the computer, it is very difficult to write a program in this language. It is necessary for the programmer either to memorize dozens of code numbers for the commands in the machine's instruction set or to constantly refer to a reference card. A programmer is also forced to keep track of the storage locations of data and instructions. A machine language programmer must also be an expert who knows about the hardware structure of the computer.

For writing a program in machine language, the programmer not only has to remember the *opcodes,* but also has to keep a track of the storage locations of data and instructions. It therefore becomes very difficult for him to concentrate fully on the logic of the problem. This frequently causes errors in programming.

It is very difficult to correct or modify machine language programs. Checking machine instructions to locate errors is about as tedious as writing them initially. Similarly, modifying a machine language program at a later date is so difficult that many programmers would prefer to code the new logic afresh instead of incorporating the necessary modifications in the old program. In short, writing a program in machine language is so difficult and time consuming that it is rarely used nowadays.

Assembly Languages

One method programmers devised to shorten and simplify the process is called assembly-language programming. By assigning a short (usually three-letter) mnemonic code to each machine-language command, assembly-language programs could be written

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and debugged-cleaned of logic and data errors - in a fraction of the time needed by machine-language programmers. Unlike the other programming languages, assembly language is not a single language, but rather a group of languages. Each processor family (and sometimes individual processors within a processor family) has its own assembly language.

In assembly language, each mnemonic command and its symbolic operands equal one machine instruction. An assembler program translates the mnemonic opcodes (operation codes) and symbolic operands into binary language and executes the program. Assembly language, however, can be used only with one type of CPU chip or microprocessor. Programmers who expended much time and effort to learn how to program one computer had to learn a new programming style each time they worked on another machine. What was needed was a shorthand method by which one symbolic statement could represent a sequence of many machine-language instructions, and a way that would allow the same program to run on several types of machines. These needs led to the development of the so-called high-level languages.

In contrast to high-level languages, data structures and program structures in assembly language are created by directly implementing them on the underlying hardware. So, instead of cataloguing the data structures, the program structures can be built (in assembly language you can build any structures you so desire, including new structures nobody else has ever created). Because of the close relationship between assembly languages and the underlying hardware, we will discuss hardware implementation as well as software.

Assemblers

Assembly language is the oldest non-machine language, allowing for a more human readable method of writing programs than writing in binary bit patterns (or even hexadecimal patterns). We know that a computer does not understand any program written in a language other than its machine language. Hence, the programs written in other languages must be translated into the machine language of the computer before they are executed. Such translation is performed with the help of software. A program which translates an assembly language program into a machine language program is called an assembler. An assembler which runs on a computer for which it produces object codes (machine codes) is called a self assembler (or resident assembler).

Cross Assemblers

A less powerful and cheaper computer may not have enough software and hardware facilities for program development. In such a situation, a faster and more powerful computer can be used for program development. The programs so developed are to be run on smaller computers. For such program development, a cross assembler is required. A cross assembler is an assembler that runs on a computer other than that for which it produces machine codes. These are further classified as: One-pass Assemblers and Two-pass Assemblers.

One-Pass Assemblers

It is an assembler which reads the assembly language programs only once. Such an assembler must be equipped with some means to assign addresses to the labels used in the assembly language program.

Two-Pass Assemblers

It is an assembler which goes through the assembly language program twice. On the first pass, the assembler reads the assembly language program and collects all labels. It assigns addresses to the labels counting their position from the starting address. On the second pass, the assembler produces the machine code for each instruction and assigns addresses to each instruction.

Advantage and Limitations of Assembly Languages

The advantage of assembly language over high-level languages is that the computation time of an assembly language program is less. An assembly language program runs faster to produce the desired result. Following are the major limitations or disadvantages of assembly languages:

Programming is difficult and time-consuming. In addition, assembly languages are machine dependent. The programmer must have detailed knowledge of the structure of the computer he is using. He must have the knowledge of registers and instruction sets of the computer, connections of ports to the peripherals, etc.

The program written in an assembly language for one computer cannot be used in any other computer, i.e., the assembly language program is not portable. Each processor has its own instruction sets and hence its own assembly language.

An assembly language program contains more instructions than a high-level language program. Each statement of a program in a high-level language (such as FORTRAN, PASCAL, etc.) corresponds to many instructions in an assembly language program.

In case of an assembly language, instructions are still written at the machine-code level—that is, one assembler instruction is substituted for one machine-code instruction.

Assemblers are available for just about every processor ever made. Native assemblers produce object code on the same hardware that the object code will run on. Cross assemblers produce object code on different hardware that the object code will run on.

Structure of Assembly Language

Format: Free form or column (depends on the assembly language)

Nature: Procedural language with one to one correspondence between language mnemonics and executable machine instructions.

Assembler languages occupy a unique place in the computing world. Since most assembly language statements are symbolic of individual machine-language instructions, the assembler-language programmer has the full power of the computer at his disposal in a way that users of other languages do not. Because of the direct relationship between

assembler language and machine language, assembler language is used when high efficiency of programs is needed, and especially in areas of application that are so new and amorphous that existing program-oriented languages are ill-suited for describing the procedures to be followed.

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Perhaps the most glaring difference among the three types of languages [high-level, assembly, and machine] is that as we move from high-level languages to lower levels, the code gets harder to read (with understanding). The major advantages of high-level languages are that they are easy to read and are machine-independent. The instructions are written in a combination of English and ordinary mathematical notation, and programs can be run with minor changes on different computers.

The second most visible difference among the different types of languages is that several lines of assembly language are needed to encode one line of a high-level language program.

There are a number of situations in which it is very desirable to use assembler language routines to do part of a job, and use some higher-level language for other parts. It makes sense to use higher-level languages such as FORTRAN, COBOL, or PL/I for parts of procedures for which they are well-suited, and supplement with assembler language routines for those parts of procedures for which the higher-level language is awkward or inefficient.

If one has a choice between assembly language and a high-level language, why choose assembly language? The fact that the amount of programming done in assembly language is quite small compared to the amount done in high-level languages. It indicates that one generally does not choose assembly language. However, there are situations where it may not be convenient, efficient, or possible to write programs in high-level languages. Programs written to control and communicate with peripheral devices (input and output devices) are usually written in assembly language because they use special instructions that are not available in high-level languages, and they must be very efficient. Some systems programs are written in assembly language for similar reasons. In general, since high-level languages are designed without the features of a particular machine in mind and a compiler must do its job in a standardized way to accommodate all valid programs, there are situations where to take advantage of special features of a machine, to program some details that are inaccessible from a high-level language, or perhaps to increase the efficiency of a program, one may reasonably choose to write in assembly language.

In situations where programming in a high-level language is not appropriate, it is clear that assembly language is to be preferred to machine language. Assembly language has a number of advantages over machine code aside from the obvious increase in readability. One is that the use of symbolic names for data and instruction labels frees the programmer from computing and recomputing the memory locations whenever a change is made in a program. Another is that assembly languages generally have a feature, called macros, that frees the programmer from having to repeat similar sections of code used in several places in a program.

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Kinds of Processors

Processors can broadly be divided into the categories of: CISC, RISC, hybrid, and special purpose.

Complex Instruction Set Computers (CISC) have a large instruction set, with hardware support for a wide variety of operations. In scientific, engineering, and mathematical operations with hand coded assembly language (and some business applications with hand coded assembly language), CISC processors usually perform the most work in the shortest time.

Reduced Instruction Set Computers (RISC) have a small, compact instruction set. In most business applications and in programs created by compilers from high level language source, RISC processors usually perform the most work in the shortest time.

Hybrid processors are some combination of CISC and RISC approaches, attempting to balance the advantages of each approach.

Special purpose processors are optimized to perform specific functions. Digital signal processors and various kinds of co-processors are the most common kinds of special purpose processors.

Executable Instructions

There are four general classes of machine instructions. Some instructions may have characteristics of more than one major group. The four general classes of machine instructions are: computation, data transfer, sequencing, and environment control.

Computation: Implements a function from n-tuples of values to m-tuples of values. The function may affect the state. Example: A divide instruction whose arguments are a single-length integer divisor and a double-length integer dividend, whose results are a single-length integer quotient and a single-length integer remainder, and which may produce a divide check interrupt.

Data Transfer: Copies information, either within one storage class or from one storage class to another. Examples: A move instruction that copies the contents of one register to another; a read instruction that copies information from a disc to main storage.

Sequencing: Alters the normal execution sequence, either conditionally or unconditionally. Examples: a halt instruction that causes execution to terminate; a conditional jump instruction that causes the next instruction to be taken from a given address if a given register contains zero.

Environment Control: Alters the environment in which execution is carried out. The alteration may involve a transfer of control. Examples: An interrupt disable instruction that prohibits certain interrupts from occurring; a procedure call instruction that updates addressing registers, thus changing the program's addressing environment.

High Level Languages

To overcome the difficulties associated with assembly languages, high-level or procedure-oriented languages were developed. High-level languages often use English-like words - for example, LIST, PRINT, OPEN, and so on - as commands that might stand for a

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sequence of tens or hundreds of machine-language instructions. The commands are entered from the keyboard or from a program in memory or in a storage device, and they are intercepted by a program that translates them into machine-language instructions. The instructions written in a high-level language are called statements. The statements resemble more closely English and mathematics as compared to mnemonics in assembly languages. Examples of high-level languages are BASIC, PASCAL, FORTRAN, COBOL, ALGOL, PL/l, PROLOG, LISP, ADA, SNOBOL, etc.

High-level languages permit programmers to describe tasks in a form which is problem oriented rather than computer oriented. A programmer can formulate problems more efficiently in a high-level language. Besides, he need not have a precise knowledge of the architecture of the computer he is using.

Advantages

One of the biggest advantages of a high-level language is that it is machine independent. This is a very valuable advantage because it means that a company changing computers—even to one from a different manufacturer—will not be required to rewrite all the programs that it is currently using. In other words, a program written in a high-level language can be run on many different types of computers with very little or practically no modification.

High-level languages are independent of computer architecture. The same program will run on any other computer which has a compiler for that language. The compiler is machine-dependent and not language-dependent.

A problem oriented language is a computer language designed to handle a particular class of problems. For example, COBOL was designed for business applications. FORTRAN was designed for scientific and mathematical problems. Query languages are designed for phrasing questions (interrogation problems).

Translation

When a program is written in a high-level it has to be converted into the appropriate machine language program before it can be executed. The compiler software is used to compile and create the object codes in machine language. The compiler does not immediately produce machine language program. Suppose a programmer calls from main program, a subprogram from library of subprogram files, then he should submit the source codes for all these together, to the compiler. This will force a compilation of this subprogram whenever it is used by the program. Instead, if we compile the main program and subprogram separately and link them up as necessary for producing the final executable machine program, it will save duplication of compiler effort. The linking of these library programs, the main program is done by an operating system program called ‘linker’.

Interpreter

An Interpreter is a translator program for a high-level programming language that translates and program at the same time. The program is still interpreted in its original

source language, the way the programmer wrote it. The interpreter translates one program statement into language and then causes the machine language be executed. It then translates the next line, and so on, until the program is finished. Interpreted programs run more slowly than their counterparts, because the compiler translates the entire program all at once before the program is run. However, it is convenient to write a program using an interpreter. Each single line of code can be tested interactively, hence the program-test the results of a programming statement right away. Programs that are interpreted are not one program and must always be run with the interpreter in the computer. For example, if you run a BASIC source language program, the version of the BASIC interpreter must be in the computer.

Complier vs Linker

Usually a longer program is divided into a number of smaller subprograms called *modules.* It is easier to develop, test and debug smaller programs. A linker is a program that links (combines) smaller programs to form a single program. While developing a program, subroutines are frequently used. The subroutines are stored in a library file. The linker also links subroutines with the main program. Further, the linker links machine codes of the programs. It accepts the user's programs after the editor has edited the program and the compiler has produced the corresponding machine codes.

Interpreter vs Compiler

An interpreter is a program which translates statements of a high-level language program into machine codes. It translates one statement of the program at a time. It reads one statement of a high-level language program, translates it into machine code and executes it. Then it reads the next statement of the program, again translates and executes it. In this way it proceeds further till all the statements of the program are translated and executed. On the other hand, a compiler goes through the entire high-level language program once or twice and then translates the entire program into machine codes. A compiler is 5 to 25 times faster than an interpreter. An interpreter is a small program as compared to a compiler. It occupies less memory space, so it can be used in a smaller system which has limited memory space. The object program produced by the compiler is permanently saved for future reference. On the other hand, the object code of the statement produced by an interpreter is not saved. If an instruction is used the next time, it must be interpreted once again and translated into machine code. For example, during the repetitive processing of the steps in a loop, each instruction in the loop must be reinterpreted as the loop is executed.

Some of the popular high-level languages are briefly explained below:

FORTRAN

The first commercial programmer was probably Grace Hopper (1906-92), an American. After programming an experimental computer at Harvard University, she worked on the UNIVAC I and II computers and developed a commercially usable high-level programming language called FLOWMATIC. To facilitate computer use in scientific

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applications, IBM then developed a language that would simplify work involving complicated mathematical formulas. Begun in 1954 and completed in 1957, FORTRAN (FORmula TRANslator) was the first comprehensive high-level programming language that was widely used. It is a very useful language for scientific and engineering computations as it contains many functions for performing complex mathematical operations. It is a compact programming language. It is not suitable for processing large business files. It has a number of versions. Earlier, FORTRAN IV was very popular. In 1977 the American National Standards Institute (ANSI) published a standard for FORTRAN called FORTRAN 77 with the objective that all manufacturers should use the same form of the language.

ALGOL

In 1957, the Association for Computing Machinery set out to develop a universal language that would correct some of FORTRAN's perceived faults. A year later they released ALGOL (ALGOrithmic Language), another scientifically oriented language. It was suitable for scientific and engineering computations. It was used in some universities and computer centres, but not in industries. It was widely used in Europe in the 1960s and 1970s, it has since been superseded by newer languages, while FORTRAN continues to be used because of the huge investment in existing programs.

COBOL

It is an abbreviation for Common Business-Oriented Language. COBOL was developed specially for business data processing. It was introduced by the US industry/government committee in 1960. COBOL is used for large business and commercial applications such as handling of ledgers, accounts, payroll files, etc. It supports simple and limited numeric operations, but it can handle complex non-numeric operations. It is more suitable for manipulating alphanumeric characters than FORTRAN. It can be written in a quasi-English form that may employ commonly used business terms. Its English-like statements can be understood very easily, for example, SUBTRACT WITHDRAWALS FROM OLD BALANCE GMNG NEW BALANCE. Its demerit is that it is not a compact language. It is not easy to learn, and it cannot handle complex mathematical computations as FORTRAN does.

PASCAL

PASCAL, originally designed as a teaching tool, is now one of the most popular microcomputer languages. It is a high-level language named after Blaise Pascal a seventeenth century French mathematician; philosopher and inventor. The mechanical calculator was invented by him. This language was developed by Prof. Nicklaus Wirth at Switzerland's Federal Institute of Technology in the early 1970s. It is a multi-purpose language suitable for both scientific and business applications. Beside numbers, it can also manipulate vectors, matrices strings of characters, sets, records, files and lists. As PASCAL is a compact language, its compiler is quite suitable for a smaller system. Program design debugging is made simpler. It produces a very efficient machine-code

program. The program compiled from PASCAL runs several times faster than the same program compiled from FORTRAN BASIC. Like ALGOL, it is block-structured. It is an offspring of ALGOL. It is more versatile than BAS and more modular than FORTRAN. PASCAL is quite similar to C language, but it is not used in professional programming as C language is. It became an ANSI standard language in 1983.

Basic

BASIC (Beginner's All-purpose Symbolic Instruction Code) was developed at Dartmouth College in the early 1960s for use by nonprofessional computer users. The language came into almost universal use with the microcomputer explosion of the 1970s and 1980s. Condemned as slow, inefficient, and inelegant by its detractors, BASIC is nevertheless simple to learn and easy to use. Because many early microcomputers were sold with BASIC built into the hardware (in ROM memory) the language rapidly came into widespread use. As a very simple example of a BASIC program, consider the addition of the numbers 1 and 2, and the display of the result. This is written as follows (the numerals 10-40 are line numbers):

```
10 A = 1
20 B = 2
30 C = A + B
40 Print C
```

BASIC is a widely used language for simple computation and analysis. It is now by far the most popular high-level language used in personal computers. To translate BASIC instructions into machine-language codes, interpreters are frequently used in PC systems. However, BASIC language compilers are also available for these systems.

PL/I

It is an abbreviation of Programming Language/I. PL/I was introduced by IBM in 1965. It is a multi-purpose language suitable for both scientific and business applications. It is more powerful than FORTRAN. PL/I is designed to include the features of both FORTRAN (as a scientific language) and COBOL (type file processing techniques as a business data processing language). This has made the language flexible and sophisticated. PL/I became an ANSI standard language in 1976.

C

C, a language Bell Laboratories designed in the 1970s, is widely used in developing systems programs, such as language translators. It is a general-purpose high-level language. This language was designed by a group at Bell Telephone Laboratories, USA in the early 1970s. It has features similar to PASCAL. It permits manipulation of internal processor registers and hence a programmer can write low-level machine instructions. C has the features of assembly language programming. It is a small and concise language. It makes use of a library of functions that are equivalent to subroutines. C programs can use modular and structured concepts. A problem may be divided into smaller tasks

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and a function may be used to solve each task. C program may represent a grouping of functions that are linked together to produce the solution of the problem. The advantage of C is that the programs written in it can be shifted from one machine architecture to another without much difficulty. This language is used by system programmers to develop complex programs such as an operating system and application programs. AT and T (Bell Lab's parent company) produce the C compiler and UNIX operating system tools as a single software package. It has many versions which run on PCs and larger machines.

RPG

Report Program Generator (RPG) was developed in 1964, and it was one of the first program generators designed for business reports. RPG II, introduced in 1970, was an advanced version that was widely used as a programming language to develop business applications for small computers. RPG statements are written on pre-printed format and that provides the fixed columns for writing each of the statement. Programs like these were the forerunners of today's fourth-generation languages which allow users to process data without having to know how to be a programmer.

LOGO

LOGO was developed to introduce children to computers. It is an abbreviation for Logic Oriented Graphic Oriented. It was developed by Seymour Papert and Colleagues at MIT in the late 1960s. It is used in serious scientific work in universities. It has also been popularized as a first educational language that children can use to achieve intellectual growth and problem-solving skills. LOGO has graphics capability and children can easily use it to make drawings. They can draw, colour and animate images. It runs on PCs. It is also used to compose music, manipulate text, and manage data, etc.

LISP

LISP and PROLOG are widely used in artificial intelligence. This language was developed by McCarthy in the early 1960s. LISP is suitable for non-numeric operations involving logical operations. It is used extensively in artificial intelligence and pattern recognition. It is also used in designing computer games, proving theorems etc. LISP is capable of searching, handling and sorting long strings or lists of text. So it has often been used to implement computerized translators. It is used primarily on larger computers but LISP compilers are also available for PCs.

PROLOG

PROLOG is primarily used for artificial intelligence. It is a suitable language for developing programs involving complex logical operations. This language was developed in France. The Japanese have chosen it as a standard language for their fifth generation computer projects. It is quite suitable for handling large databases and for producing rules-based expert systems applications. PROLOG stands for PROgramming in LOGic. It is based on mathematical logic. PROLOG consists of a set of facts and rules that describe objects and relations between objects in a given domain. The statements that

are unconditionally true are called facts, while rules provide properties and relations which are true depending on given conditions.

Comparison of Assembly and High Level Languages

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Assembly languages are close to a one to one correspondence between symbolic instructions and executable machine codes. Assembly languages also include directives to the assembler, directives to the linker, directives for organizing data space, and macros. Macros can be used to combine several assembly language instructions into a high level language like construct (as well as other purposes). There are cases where a symbolic instruction is translated into more than one machine instruction. But in general, symbolic assembly language instructions correspond to individual executable machine instructions.

High-level languages are abstract. Typically, a single high-level instruction is translated into several (sometimes dozens or in rare cases even hundreds) executable machine language instructions. Some early high-level languages had a close correspondence between high-level instructions and machine language instructions. For example, most of the early COBOL instructions were translated into a very obvious and small set of machine instructions. The trend over time has been for high-level languages to increase in abstraction. Modern object-oriented programming languages are highly abstract (although, interestingly, some key object-oriented programming constructs do translate into a very compact set of machine instructions).

Assembly language is much harder to program than high-level languages. The programmer must pay attention to far more detail and must have an intimate knowledge of the processor in use. But high quality hand-crafted assembly language programs can run much faster and use much less memory and other resources than a similar program written in a high-level language. Speed increases of 2 to 20 times faster are fairly common, and increases of hundreds of times faster are occasionally possible. Assembly language programming also gives direct access to key machine features essential for implementing certain kinds of low-level routines, such as an operating system kernel or micro-kernel, device drivers, and machine control.

High-level programming languages are much easier for less skilled programmers to work in and for semi-technical managers to supervise. And high-level languages allow faster development times than work in assembly language, even with highly skilled programmers. Development time increases of 10 to 100 times faster are fairly common. Programs written in high-level languages (especially object oriented programming languages) are much easier and less expensive to maintain than similar programs written in assembly language (and for a successful software project, the vast majority of the work and expense is in maintenance, not initial development).

1.16 Input Units

Data must be entered into a computer before processing may take place. You can enter data into the computer in many ways. A device that allows the user to enter data into a computer is called input device. Most commonly used input devices are keyboards;

pointing devices such as mouse and track balls; and scanners. Many other special-purpose input devices are also available. Computers often have more than one input device attached. For example, most personal computers have both a keyboard and a mouse.

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Keyed Input

Most input data is entered into the computer by using a keyboard. This input method is similar to typing on a typewriter.

Most typewriters and computer keyboards are QWERTY keyboards. The alphabetic keys are arranged in a manner so that the upper-left row of letters begins with the six letters Q W E R T Y. Designers of other keyboards claim that their boards are easier to learn than the QWERTY keyboard. The Dvorak keyboard is one example. It is not widely accepted, however, because most people have already learned the QWERTY keyboard.

In different parts of the world, we find different keyboards. The coding used on the QWERTY and Dvorak keyboards works with an 8-bit code, which accommodates 256 different characters. Asian languages have many more characters. The Kanji alphabet, for example, has 50,000 characters. Japanese keyboards have to work with a 16-bit code to accommodate all the characters.

Computer keyboards also include keys that are designed to perform specific tasks instead of entering characters only. These special keys include function keys, directional keys and special-purpose keys such as Alt, Ctrl, Enter, Ins, and Esc. These keys enable the user to perform complex tasks easily while using the application. For example, many applications use a function key to access online help for the user.

Some new keyboards have even 110 keys, with three new keys designed to simplify working with Windows operating systems. Two of these keys, next to the Alt key, bring up the Start menu. The third key, next to the right Ctrl key, brings up a menu of functions that are frequently accessed in whichever application is currently being used.

Prolonged keyboard use can cause wrist problems, sometimes so serious as to require surgery. To help prevent these problems, ergonomic keyboards have been introduced in the market.

One special type of keyboard construction is the MEMBRANE-SWITCH KEYBOARD, in which a protective film covers the keyboard. Membrane-switch keyboards are reliable, durable and resistant to such hazards as liquids or grease. However, membrane keys require more pressure than keys on a standard computer keyboard. You have probably seen membrane-switch keyboards in fast-food restaurants. Membrane-switch keyboards are ideal in situations that require little actual keying.

Many computer systems are designed for SOURCE-DATA AUTOMATION. These systems place keyboards and display units at the most convenient spot for data entry. An example is the use of Point-of-Scale (POS) cash registers in retail stores. POS registers send data directly to a computer file for later processing. This technique has an advantage, because most so-called computer errors are actually keying errors. Capturing data at the source minimizes errors, because the people who key in the data are doing a variety of tasks and are, therefore, less likely to make errors due to boredom or loss of concentration.

A tiny chip, called keyboard controller, detects that a key has been pressed. The keyboard controller places a code into a part of its memory, called keyboard buffer, indicating which key is pressed. This code is called keys scan code. The keyboard controller then signals to the computer's system software that something has happened at the keyboard. It does not specify what has occurred, just that something has. The signal that the keyboard sends to the computer is a special kind of message called an interrupt request. The keyboard controller sends an interrupt request to the system software when it receives a complete keystroke. For example, it you type the letter 'D' the controller immediately issues an interrupt request.

When the system software receives an interrupt request, it evaluates the request to determine the appropriate response. When a key press occurs the system reads the memory location in the keyboard buffer that contains the scan code of the key that was pressed. It then passes the key scan code to the CPU.

Pointing Devices

Wherever possible many people use pointing devices instead of keyboards . An input device is used to move the pointer (cursor) on screen. Pointing devices minimize the amount of typing (consequently, the number of errors). Movements of the pointing device are echoed on the screen by movements of the mouse pointer and by other visual changes. The many pointing devices available include the mouse, the trackball, the light pen, the digitizing tablet, the touch screen and the pen-based systems. Some of them are shown below.

Fig. 1.11

Major Pointing Devices: Clockwise from the upper left are the mouse, the trackball, the pointing stick (red tip) and the touchpad.

Mouse and Track Ball

A mouse is a palm-sized device with a ball built into the bottom. It is usually connected to the computer by a cable (computer wires are frequently called cables) and may have from one to four buttons (usually two). A mouse may be mechanical or optical and comes in many shapes and sizes. When you move the mouse over a smooth surface, the ball

rolls, and the pointer on the display screen moves in the same direction. Apple Macintosh, with its graphical user interface, made the mouse popular. Today, most microcomputer systems, regardless of the manufacturer, use a mouse. With the mouse you can draw, select options from a menu, and modify or move text. You can issue commands by pointing with the pointer and clicking a mouse button. In addition to minimizing typing errors a mouse makes operating on a microcomputer easier for the novice. The underside of the mouse houses a device that detects the movement of the mouse relative to the flat surface on which it sits. The 2D motion of the mouse is typically translated into the motion of a cursor on the display.

A mouse is so called, primarily because the cord on early models resembled the rodent's tail, and also because the darting motion of the pointer on the screen appears to be mouse-like.

Fig. 1.11:

Operating a mechanical mouse. 1. Pulling the mouse turns the ball. 2. The X and Y rollers grip the ball and transfer the movement. 3. The optical encoding disks include light holes. 4. The infrared LEDs shine through the disks. 5. The sensors then gather the light pulses to convert to X and Y velocities.

How a Mouse Works

The most common type of mouse has a ball inside it that extends just below the housing. When you slide the mouse around on a flat surface, such as the desktop or a mouse pad, the ball rolls.

On two sides of the ball, at 90 degrees angle from each other, are two small rollers that touch the mouse and spin when the ball rolls. A sensor detects how much each roller spins and sends this information to the computer. The computer translates the information and changes the position of the on-screen pointer to correspond to the position indicated by the mouse.

Like the keyboard, the mouse does not send a message directly to the program that the computer is running. Rather, it sends an interrupt request to the CPU. The program that is running checks regularly to see whether a mouse has been used; if it has, the program reads a memory location to see what has happened, and then reacts appropriately.

Like all input devices, the mouse needs some connection to the host computer in order to transmit its input. Typically the mouse uses a thin electrical cord

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(e.g. an RS-232, ADB or USB cable) for this purpose. It was most likely the combination of the tail-like cord, its size, and shape, which led the inventors of the mouse to name it as such. Cordless ("tail-less") mice use wireless communication to transmit data via infrared, radio or Bluetooth.

There are several other methods of using a mouse apart from the most basic movement of the device to make a cursor move. A mouse click is the action of pressing and releasing (i.e., 'clicking') a button on a mouse in order to trigger an action, usually in the context of a Graphical User Interface (GUI), as in pressing an onscreen 'button' by 'clicking' on it, or in a computer game to fire a gun in a first-person shooter. The clicking noise is made due to the specific switch technology used nearly universally in computer mice. This switch, called a micro switch or a cherry switch, uses a stiff but flexible metal strip that is bent to actuate the switch. The bending of the metal makes a snapping or clicking noise in the same way as the safety button does on the lids of vacuum-packaged jars to indicate that they have been opened.

Single Clicking

It is the most common method of distinguishing mouse-based input. On a single-button mouse this involves using the mouse's one button. On the multiple-button mouse, it involves any one of the buttons, and is usually characterized by which button is pushed (e.g., left-clicking, right-clicking).

Double Clicking

A double-click occurs when the user presses the button twice in quick succession. This triggers an action separate from that of a single-click. For example, in the Macintosh Finder, the user single-clicks to select a file, and double-clicks in order to open that file. Usability studies have found that the double-click can be confusing and hard to use—for example, users with poor motor skills may not perform the second click fast enough, with the result that the action is interpreted as two single-clicks rather than a double-click. Ironically, the double-click was introduced because the previous solution—separate mouse buttons for separate actions—was also found to be confusing in user studies. Most multiple-button mice allow setting one button to emit a double click on a single press.

Triple-click

A triple-click occurs when the user presses the button three times in quick succession. This also triggers an action separate from that of a single click. It is most commonly seen in word processors to select a whole paragraph and in web browsers to select a whole line of text.

Click-and-Drag

A user "drags" a mouse by depressing and continuing to hold down a mouse button while moving the mouse across the surface.

A TRACK BALL is like an upside-down mouse. Used in the same way as the mouse, the trackball is frequently attached to or built into the keyboard. It is a pointing device

consisting of a ball housed in a socket which contains sensors to detect the rotation of the ball on two axes—like an upside-down mouse, but with the ball sticking out more. The user rolls the ball with his thumb, finger, or the palm of his hand to move the cursor. Trackerballs are common on CAD workstations for ease of use, and also on modern portable computers, where there may be no desk space on which to use a mouse. Some trackballs clip onto the side of the keyboard and have integral buttons, which have the same function as mouse buttons. The main advantage of a track ball is that it requires less desk space than a mouse. Some individuals in the computer industry believe that devices that do not require as much space to use will soon replace the mouse.

Fig. 1.12: Logitech Marble Mouse Trackball

A mouse is not a practical option for people using a laptop computer in a small space. Early alternatives, such as trackballs clipped to the side of the keyboard, have not proved satisfactory either. The Apple PowerBook uses a central trackball. The IBM ThinkPad replaces the trackball with a red plastic button, called trackpoint, located in the middle of the keyboard. You move the button with your thumbs. The newest Apple PowerBooks have a small square of plastic on the front of the keyboard which moves easily to control the pointer.

Touchpad

The TOUCH PAD is a stationary pointing device that many people find less tiring to use than a mouse or a track ball. The movement of a finger across a small touch surface is translated into cursor movement on the computer screen. The touch sensitivity surface may be just 1.5 – 2 inch square, so the finger does not have to move much. Its size makes it most suitable for notebooks and laptops.

Joysticks

A JOYSTICK is a pointing device often used for playing games. It has a gearshift-like lever that is used to move the pointer on the screen. On most joysticks, a button on the top is used to select an option. In industry and manufacturing, joysticks are used to control robots. Flight simulators and other training simulators also use them. Most joysticks are two-dimensional, having two axes of movement, just like a mouse, but three-dimensional joysticks also exist.

Joysticks are often used to control games, and usually have one or more push buttons whose state can also be read by the computer. Most I/O interface cards for PCs

have a joystick (game control) port. Modern joysticks generally use a USB interface for connecting to the PC.

An analog one is one that has continuous states, i.e., it returns an angle measure of the movement in any direction in the plane or the space. On the other hand, a digital joystick gives only on/off signals for four different directions, and for mechanically possible combinations (such as up-right, down-left). Additionally, joysticks often have one or more *fire buttons*, which are used to trigger some kind of action. These are digital.

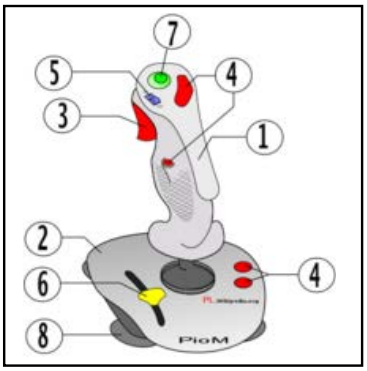

Fig. 1.13:

Joystick elements: 1. Stick 2. Holder 3. Fire button 4. Extra buttons 5. Autofire switch 6.Throttle 7. Hat Switch 8. Sucker

Touch–sensitive Screens

Perhaps the easiest way to enter data is with the touch of a finger. TOUCH SCREENS enable the user to select an option by pressing a specific part of the screen. Touch screens are commonly used in grocery stores, fast-food restaurants and information kiosks.

Pen-based Systems

Pen-based Systems are especially useful for people who do not like to type or for those who are frequently on the move. PERSONAL DIGITAL ASSISTANTS (PDA), such as the Apple Newton, are designed for people on the go. The Newton can link entries with data on stored files. For example, if you write, "Call Annie and Wish Happy Birthday", the Newton adds a line to your "To do" list and links Annie's phone number from your telephone directory. If your friend Ken moves, you can simply change his address and phone number. The Newton serves equally well as a calendar, a calculator and a notepad.

Pen-based systems are not perfect—they do not always register handwriting correctly. Pen-based computing is just a beginning to gain widespread acceptance. For example, many stores no longer ask you sign a carbon form to charge a purchase; instead you sign on a tablet that automatically records your signature.

Many engineers and architects use a different type of pen called LIGHT PEN. The light pen uses a photoelectric (light sensitive) cell to indicate the screen position to the computer. You operate the pen by touching it to the screen. Light pens are frequently used for Computer-Aided Design (CAD) applications.

Another tool used in CAD and other graphics applications is a digitizing tablet. A DIGITIZING TABLET consists of a grid on which designs and drawings can be entered. Most tablets are pressure-sensitive and the user draws directly on the tablet using a special pen called STYLUS or puck. Digitizing tablets are used to design cars, buildings, medical devices and robots.

1.17 Data Scanning Units

Optical Recognition Systems (ORS)

Optical Recognition Systems provide another means of minimizing keyed input by capturing data at the source. These systems enable the computer to "read" data by scanning printed text for recognizable patterns.

In the 1950s, the banking industry developed one of the earliest scanning systems for the purpose of processing cheques. The Magnetic Ink Character Recognition (MICR) system is still used throughout the banking industry. The bank, branch, account number and cheque number are encoded on the cheque before it is sent to the customer. After the customer has used the cheque and it comes back to the bank, all that needs to be entered manually is the amount. MICR has not been adopted by the other industries because the character set has only fourteen symbols.

Bar Code Readers

Of all the scanning devices, you are probably most familiar with BAR CODE READERS. Many retail and grocery stores use some form of the bar code reader to determine the name of the item being sold and to retrieve its price from a computer system. The code reader may be a hand-held unit or it may be embedded in a countertop. The bar code reader reads the Universal Product Code (UPC), a pattern of bars printed on merchandise. The UPC has gained wide acceptance since its introduction in the 1970's. Initially, workers resisted the use of the code because the system was used to check their accuracy and speed. Today, bar codes are used to update inventory and ensure correct pricing. Federal Express uses a unique bar code to identify and track each package. Federal Express employees can usually tell a customer within a matter of minutes the location of any package.

Many different types of barcode scanners are available. They can be distinguished in the following manner.

By Light Source

- **LED scanners,** also referred to as **CCD scanners**—even if the CCD is in fact the photo conductor.
- **Laser scanners,** much more expensive than LED scanners, but capable of scanning barcodes at a distance of up to 25cm (~10″).

By Housing

- **Hand-held scanner** with a handle and, typically, a trigger button for switching on the light source.
- **Pen scanners** (or **wand scanners**), a pen-shaped scanner that is swiped across a barcode.
- **Stationary scanners,** wall or table-mounted, under or beside which the barcode is passed. These are commonly found at the checkout counters of supermarkets and other retailers.

Optical Mark Readers

You will probably be familiar with Mark Sense Character Recognition systems if you ever take a written examination of the "fill in the bubble" type. Such forms are called Scantron forms. They use a #2 lead pencil; you darken the circular area with the pencil creating input suitable for an OPTICAL MARK READER (OMR). A #2 lead pencil works best because of the number of magnetic particles in that weight lead. The OMR senses the darkened marks, enabling the reader to determine which responses are marked. OMR is very helpful for researchers who need to tabulate responses to large surveys. Almost any type of survey or questionnaire can be designed to be suitable for OMR devices. An OMR unit can be attached to a microcomputer and the data transferred to a file directly.

Optical Scanners

OPTICAL SCANNERS can scan typed documents, pictures, graphics or even handwriting into a computer. Photographs scanned into a microcomputer appear clearly on the screen and can be displayed whenever desired. The copy that the computer stores never yellows with age. Early scanners could recognize only text printed in a special OPTICAL CHARACTER RECOGNITION (OCR) typeface. A scanner converts the image that it sees into numeric digits before storing it in the computer. This conversion process is known as DIGITIZING.

Depending on the volume and type of material to be scanned, you can use a drum scanner, a flatbed scanner, a sheeted scanner or even a small handheld scanner. The small, handheld scanners (priced at about $150) are used most frequently with microcomputers; however, only 5 per cent of all microcomputer systems are equipped with scanners. In 1995, manufacturers responded to user-reluctance to scanners by releasing a number of new, small paper scanners priced between $200 and $500. In 1994, full-page scanners cost between $500 and $700. Most of these new devices sit between the keyboard and the monitor, and can interface with a fax machine, send e-mail, and store documents on the disk for archive purposes.

Voice Recognition Devices

Voice input and control systems have the potential of revolutionizing the way we communicate with computers. Steady progress has been made in this area, although

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some problems still exist. The day may soon come when we will be able to talk to our computers the way the actors do in sci-fi movies like Star Trek.

Computer scientists and linguists have been working on VOICE RECOGNITION SYSTEMS for two decades. The major difficulty has been that different people speak with different accents and intonations. For this reason, most successful voice recognition systems require a period of "training" for the system to get accustomed to an individual's accent and intonation.

The first few systems could recognize only a few dozen words. A system recently released by IBM, known as Voice Type, is capable of recognizing as many as 32,000 words and is speaker-independent.

Voice recognition has unlimited possibilities and will make computers much easier to use. Speech recognition systems are already being used in many types of settings. In factories, workers use speech recognition systems to control robotic arms when the worker's own hands are busy. Speech recognition systems enable the physically disabled people to use computers. A microcomputer Voice User Interface (VUI), capable of recognizing input from a variety of individuals, will be considered standard soon.

VIDEO DIGITIZERS can capture input from virtually any type of video device, such as VCR, television and camcorder. Audio digitizers can digitize music or voice from a microphone. It is fairly easy to capture a portion of a television show, add some music that complements the picture and play back the result on a microcomputer to create a multimedia presentation.

1.18 Output Units

Output devices are varied and as innovative as input devices. From traditional printed output to audio output and robots, there is a multitude of forms of computer output.

Most output can be divided into two categories: soft copy and hard copy. Soft copy is ideal when you are writing a document, playing a game, watching a video clip, or reading the latest news. A soft copy is what you see on the monitor. It is temporary; after you have finished with it, there is nothing solid to hold. You can, however, transfer a soft copy to a disk to transport it. A hard copy on the other hand, can be touched and carried. It is usually some form of paper output. It is especially helpful if you need to have a colleague look at your work or you need to give your work to a supervisor or a teacher.

Monitors

When you think about viewing computer output, you probably visualize a monitor. Monitor output is a soft copy; when you have finished viewing it, you cannot move it. Monitor displays are the most common form of soft copy.

Sometimes while watching television, you may notice that the picture looks a little snowy. This condition occurs because the images are not solid but rather created by configurations of dots. These dots, or picture elements, combine to form the image you see. The more picture elements, also known as pixels, the better is the resolution

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of the image. The better the resolution, the clearer is the picture. Computer monitors are similar to television screens.

The large monitors that you see connected to desktop computers are Cathode-Ray Tube (CRT). Monitors that are used on laptops and notebook computers are known as flat-panel displays. Flat-panel displays weigh less and consume less electricity than CRTs. Common types of flat-panel displays include Liquid Crystal Displays (LCDs), Electro Luminescent (EL) displays and Gas Plasma (GP) displays. Flat-panel display monitors are still more expensive than CRTs, but eventually their prices are expected to decrease. (PixelVision recently released a 16-inch flat-panel display that includes a two million-colour palette and sells for $10,000.) Can you imagine monitor hanging on the wall like a painting? It may be common in a few years.

Most new monitors are SVGA (Super Video Graphics Adapters), with a pixel configuration of 800 by 600 at low-resolution mode and 1024 by 768 at high-resolution mode. The first number designates the horizontal pixel count, and the second is the vertical pixel count. The higher resolution, with more pixels, provides a clearer, more detailed image. Each pixel displays a single colour at a time. Each colour is represented by a numeric code. For example, bright red could be 12. If the monitor displays only 16 colours, the numeric code can be represented with only four bits. To display 256 colours (each with its own code) requires eight bits.

One monitor may look "sharper" than another, even though they may have the same pixel configuration. This is due to the dot pitch, which is the distance between pixels. A .28 dot pitch gives a crisper image than a .30 dot pitch. The .28 dot pitch is fairly standard. You should consider dot pitch while purchasing a monitor. The dot pitch is built in by the manufacturer and cannot be changed.

With users increasingly viewing video clips, animated objects and complex graphics, monitors have taken on a new importance. Users now must decide how large a monitor they need. Fourteen-inch to seventeen-inch monitors are commonly used with desktop microcomputer systems. Larger monitors are available, but are expensive.

Display in black and white (monochrome) or colour categorizes monitors. Monochrome monitors are rapidly becoming a thing of the past, as most applications today require colour. In fact, a display of 256 colours is usually necessary for working with informational CD-ROMs and clip-art collections.

In order to connect a monitor to a microcomputer, you must have a graphics adapter board (also known as a video card). Each type of monitor requires a different type of board. The graphics board plugs into an expansion slot inside the computer and the monitor plugs into the board.

In order to run today's graphics-intensive programs properly and quickly, most graphic boards come with some memory capability, known as video memory. It is important to realize that Video RAM (VRAM) must meet higher performance specifications than regular RAM. It is recommended that instead of using RAM on a video card, the user should place VRAM or dynamic RAM (DRAM), which is slightly slower than VRAM, on a video card.

The refresh rate of a monitor is also important and is affected by the video card. Even a steady image is constantly regenerated, or refreshed, from top to bottom. A slow refresh rate of 60 times per second (60Hz) can cause headache; 70Hz is a reasonable minimum. Some monitors, known as interlaced monitors, refresh every other line; non-interlaced monitors are easier on the eyes. The Motion Picture Expert Group (MPEG), has developed standards for video compression that improve the quality of the video on the monitor. MPEG drivers are available as software or as hardware (built-in video card).

Audio Output

Have you ever listened to a concert or watched a television show on a computer? Audio output is the second type of softcopy. New computer systems have such good audio systems that it is possible to listen to music while you work, have the computer tell you when the printer needs paper, play games that include sound, or compose music on the computer. In order to have high quality audio output, good quality sound cards as well as good speakers are needed.

New sound cards even include the capability to have the computer read a text file to you while you continue working on a different application. Voice input and output has proved helpful to individuals with speech and vision impairments. People with speech impairment can key a message into a computer and have the computer repeat it. Of course, computer generated voices are not human; they are synthesized. Speech synthesis, having the computer speak, is a much simpler process than speech recognition.

Printers

The second most common form of computer output is the printed document. Although a computer can operate perfectly well without a printer, it is certainly helpful for the user to have one. Because you can hold printed output, it is considered a form of hard copy.

Printers can be categorized by whether anything mechanical touches the paper; whether they do or do not produce a solid character or how many pages or a line, or a character they produce, at a time.

When a part of the printer presses the paper to form the character, the printer is considered an impact printer. Impact printers can produce carbon copies and are fairly loud, although covers are available to muffle the noise. In contrast, non-impact printers are quiet. However, because nothing presses on the page, a non-impact printer cannot produce carbon copy. This fact is usually not a problem because it is easy to produce multiple originals, but sometimes carbons are required for legal purposes.

Impact Printers

Impact printers can produce a page, a line, or a character at a time. Large computers use line printers. The main drawback of line printers is that they can produce only text and no graphics.

Many small computers use character printers. Although only one character can be produced at a time, many types of character printers can produce graphics as well as text. The most common character printers create images by using a dot pattern. These printers are

known as dot matrix printers. If you use a magnifying glass to look at a report created with a DOT MATRIX PRINTER, you can see the small dots forming each character.

LINE MATRIX is a type of line printer that uses an oscillating row of print hammers. The hammers form characters and graphics by impacting a ribbon and transferring dots of ink onto the paper. An impact printer is the one that prints a line at a time. Printronix pioneered this technology in 1974.

BAND (LINE CHARACTER) is a type of line printer that uses a fixed set of characters attached to a continuously revolving metal band. A set of hammers (one for each column) hits the paper, pushing it into the ribbon and against the character image on the band.

Non-impact Printers

Non-impact printers are increasing in popularity largely because of improvement in print quality coupled with decreasing cost. Non-impact printers can produce both text and graphics. Because nothing actually strikes the paper, non-impact printers are fairly quiet. Some of the most popular non-impact printers are laser printers and inkjet printers.

Laser Printers

Laser printers work in the same manner as copy machines. A laser beam creates electrical charges that attract the toner to form an image and transfer it to paper. A printer uses the laser and the electro photographic methods to print a full page at a time. The laser is used to "paint" a charged drum with light, to which the toner is applied and then transferred onto paper. Laser printers come in a variety of sizes; generally the larger and faster the printer, the more expensive it is. Large laser printers are used on mainframes and minicomputers where high quality graphic output is required. Small, "personal" laser printers are suitable for home use. Hewlett Packard recently began production of wireless printers. The HP5P (IBM) and the HP5PM (Mac) enable the user to beam a document from the laptop to an infrared receiver in the front of the printer. The laptop needs to have a built-in infrared transmitter installed, but no cables or wires are required.

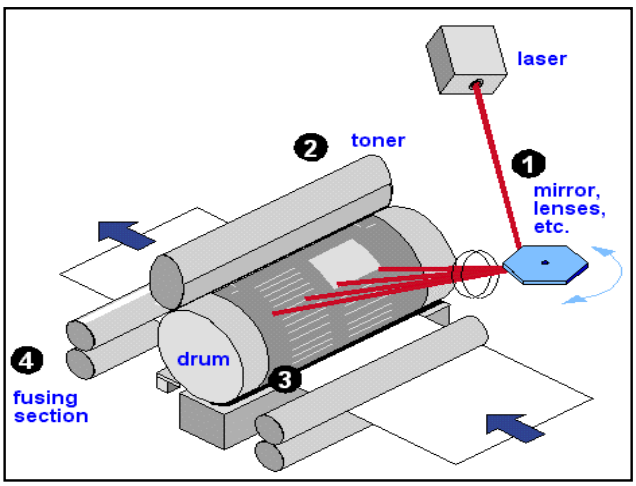

Fig. 1.14:

The Laser Mechanism: The laser printer uses electrostatic charges to (1) create an image on the drum, (2) adhere the toner to the image, (3) transfer the toned image to the paper, and (4) fuse the toner to the paper. The laser creates the image by "painting" a negative of the page to be printed on the charged drum. Where light falls, the charge is dissipated, leaving a positive image to be printed.

Inkjet Printers

Inkjet printers are also popular among microcomputer users. Although the resolution is lower on inkjet printers than on laser printers, it is higher than that of dot matrix printers. Inkjet printers are significantly less expensive than laser printers. Electronically charged ink is sprayed through a jet nozzle and passed through an electronic field, which deflects the ink to form a dot matrix character. Colour inkjet printers, which use multiple nozzles, are available at very reasonable prices. Canon recently released a colour inkjet printer that weighs 3 pounds and stands 2 inches high. The perfect choice of printer while travelling!

A well-equipped office at home or at workplace includes an inkjet printer, a fax machine (with its own telephone), a copier and a full sheet scanner. A recent addition to the market is one device that does all four functions. The technology to print a document that has been faxed to you and the technology to copy a document are similar to the technology to print a document from a PC. All three technologies use similar digital patterns and the mechanical aspects are nearly identical.

Other high quality printers include Thermal-wax printers, Dye-sub printers, Fiery printers and IRIS printers.

The thermal-wax printers are primarily used for presentation graphics and handouts. They operate with a ribbon-coated pane of coloured wax that melts and adheres to plain paper as coloured dots passed over a focused heat source. As the paper and the ribbon travel in unison beneath the thermal print head, the wax-based ink from the transfer ribbon melts onto the paper. When cool, the wax is permanent. This type of thermal printer uses a like-size panel of ribbon for each page to be printed, regardless of the contents of the page. Monochrome printers have a black panel for each page to be printed, while colour printers have either three (CMY) or four (CMYK) coloured panels for each page.

The dye-sub printer is a printer that produces continuous-tone images that look like a photographic film. It uses a ribbon containing an equivalent panel of dye for each page to be printed. Colour printers have either three (CMY) or four (CMYK) consecutive panels for each page, thus the same amount of ribbon is used to print a full-page image, as it is to print a tenth of the page. Special dye-receptive paper is used, and the consumables (ribbon and paper) cost more than other printer technologies.

The paper and the ribbon are passed together over the print head, which contains thousands of heating elements that can produce varying amounts of heat. The hotter the element, the greater is the amount of dye released. By varying the temperature, shades of each colour can be overlaid on top of each other. The dyes are transparent and blend into a continuous-tone colour.

Fiery printer servers are special type of computers that transmits documents to a digital colour copier, where they are printed.

IRIS printers are large-format colour printers from the Iris Graphics division of CreoScitex, that are used for digital proofing. Iris printers use a patented continuous inkjet technology to produce consistent, continuous-tone, photo-realistic output on several varieties of paper, canvas, silk, linen and other low-fibre textiles. Iris prints are widely noted for their colour accuracy and ability to match printing and proofing standards. They are also known for their low-cost consumables as compared to other technologies.

Plotters

A plotter, like a printer, produces hard copy output. Plotters, which produce high quality colour graphics, are usually categorized by whether they use pens or electrostatic charges to create images. A continuous curve plotter is used to draw maps from stored data. Computer generated maps can be retrieved and plotted or used to show changes over time. Plotters are generally more expensive than printers, ranging from about $1,000 to $75,000 (or even more).

A plotter uses a robotic arm to draw with coloured pens on a sheet of paper. The instructions that a plotter receives from the computer consists of the colour and the beginning and ending coordinates for a line. With this information, the plotter picks up the appropriate pen, positions it at the beginning of the coordinates, drops the pen down to the surface of the paper and draws to the ending coordinates. The plotter draw curves by creating a sequence of very short, straight lines.

1.19 Defining Operating System

Let us observe some of standard definitions of the operating system:

"An Operating System can be defined as the set of instructions or programs, which make the computer work."

The above definition gives the basic insight into the functionality of operating system. Let us examine another view about it:

"An Operating System or OS is a software program that enables the computer hardware to communicate and operate with the computer software."

The above definition emphasizes the role of OS as an Interface between user and computer. Yet, we can have another definition as:

"An Operating System is a software, which controls the computer and its peripherals and makes the computer ready to use by a process called booting."

As per this definition, OS puts life into the dead hardware.

Thus, an Operating System:

- Is a collection of programs
- Is an intermediary between a user of a computer and the computer hardware

- Makes the hardware usable in an efficient manner
- Makes the computer system convenient to use
- Is the manager of resources

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Therefore, an operating system is the most essential software that manages the operation of a computer. The operating system falls under the category of system software. Without an operating system, it is not possible to use the computer. The computer is useless unless it is provided essential software that makes it ready to use. We have seen that an operating system is a software, which makes the computer ready to use by a process called booting. Before discussing more on the operating systems, let us first see what exactly we mean by booting. When we switch on the computer, the instructions stored in ROM are automatically executed. These instructions help the computer to load the operating system from external storage device (disk) to internal storage (RAM). This process of loading of operating system from disk to RAM is called booting.

1.20 History of Operating Systems

To exactly see what operating systems are and what operating systems do, let us consider how they have developed over the last thirty years. By tracing that evolution you can identify the common elements of operating systems, and see how, and why they developed as they are now. Operating systems and computer architecture have a great deal of influence on each other. To facilitate the use of the hardware, operating systems were developed. As operating system were designed and used, it became obvious that changes in the design of the hardware could simplify the operating system. In this short historical review, notice how the introduction of new hardware features is the natural solution to many operating system problems.

Operating systems have been evolving over the years. Let us now take a brief look at this development. Since operating systems have historically been closely tied to the architecture of the computers on which they run, we will look at successive generations of computers to see what their operating systems were like. This mapping of operating systems generations to computer generations is admittedly crude, but it does provide some structure where there would otherwise be none.

Around twenty years ago Jobs and Wozniak, the founders of Apple, came up with the very strange idea of selling information processing machines for use in the home. The business took off, and its founders made a lot of money and received the credit they deserved for being daring visionaries. But around the same time, Bill Gates and Paul Allen came up with an idea even stranger and more fantastical: selling computer *operating systems*. This was much weirder than the idea of Jobs and Wozniak. A computer at least had some sort of physical reality to it. It came in a box, you could open it up and plug it in and watch lights blink. An operating system had no tangible incarnation at all. It arrived on a disk, of course, but the disk was, in effect, nothing more than the box that the OS came in. The product itself was a very long string of ones and zeroes that, when properly installed and coddled, gave you the ability to manipulate *other* very long strings of ones and zeroes. Even then new versions of operating systems are launched almost

every month in the market. The market for them is vast enough but people worry about whether it has been monopolized by one company. Even the least technically minded people in our society now have at least a gross idea of what operating systems do; what is more, they have strong opinions about their relative merits.

Every general-purpose computer requires some type of operating system that tells the computer how to operate and how to utilize other software and or hardware that are installed onto the computer. All software programs developed today require some type of an operating system to properly operate. MS-DOS, Unix and Windows are all examples of operating systems.

Because the history of computer operating systems parallels that of computer hardware, it can be generally divided into five distinct time periods, called generations, that are characterized by hardware component technology, software development, and mode of delivery of computer services the user, by hiding the hardware component from the user and thereby helping him to design application programs.

1.21 Functions of An Operating System

An operating system provides certain services to programs and to the use of those programs. The specific services provided will, of course, differ from one operating system to another, but there are some common types of function that we can identify. The main functions provided by most operating systems of today are as follows:

Process Management

A *process* is a program in execution. During execution, a process needs certain resources such as CPU time, memory space, files, and I/O devices. At a particular instance of time, a computer system normally consists of a collection of processes. The process management module of an operating system takes care of the creation and deletion of processes, scheduling of various system resources to the different processes requesting them, and providing mechanism for synchronization and communication among processes.

Memory Management

To execute a program, it must be loaded, together with the data it accesses, in the main memory. To improve CPU utilization and to provide better response time to its user, a compute system normally keeps several programs in main memory. The memory management module of an operating system takes care of the allocation and deal location of memory space to the various programs in need of this resource.

File Management

All computer systems are used for storage, retrieval and sharing of information. A computer normally stores such information in units called files. Processes can read information from files and can create new files for storing newly generated information. Information stored in files is made persistent by storing them on a secondary storage media such as a magnetic disk. Files provide a natural and easy means of information

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sharing. That is, a file can be created by one application and then shared with different applications at a later time. The file management module of an operating system takes care of file-related activities such as organization, storing, retrieval, naming, sharing and protection of files. It allows programs to use a set of operations that allocates and layouts the secondary storage devices.

Device Management

A computer system normally consists of several I/O devices such as terminal, printer, disk, and tape. The device management module of an operating system takes care of controlling all the computer's I/O devices. It keeps track of I/O request from process, issue commands to the I/O devices, and ensures correct data transmission to/from and I/O devices. It also provides an interface between the devices and the rest of the system that is simple and easy to use. Often, this interface is device independent, i.e., the interface is same for all types of I/O devices.

Security

Computer systems often store large amount of information, some of which is highly sensitive and valuable to their users. Users can trust the system and rely on it only if the various resources and information of a computer system are protected against destruction and unauthorized access. The security module of an operating system ensures this. This module also ensures that when several disjoint processes are being executed simultaneously, one process does not interfere with the others, or with the operating system itself.

Command Interpretation

A user communicates with the operating system, for using the various systems resources, via a set of command provided by the operating system. The operating system also provides a simple language, known as command language (CL) or job control language (JCL), using which a user can put several commands together from the command set to describe the resource requirements of the job. The command interpretation module of an operating system takes care of interpreting user command, supplied individually or in the form of command language, and directing the system resources to handle the request. With this mode of interaction with system, the user is usually not too concerned with the hardware details of the system, or with how the operating system will direct the hardware to handle certain request.

In addition to the above listed major functions, operating system performs few other functions such as keeping an account of which users (or processes) use how much and what kinds of computer resources, maintenance of log of system usage by all users, and maintenance of internal time clock.

1.22 Structure of Operating System

An operating system is basically designed in layered fashion. Or, in other words we can state that most modern operating systems organize their components into a number

of layers (levels), each built on top of lower layers. The bottom layer (layer 0) is the hardware, and the highest layer (layer n) is the user interface. The number of in-between layers and their contents varies from one operating system to another. How this is decided is explained below.

The main advantage of the layered approach is modularity. The layers are selected such that each layer uses the functions and services provided by its immediate lower layer. This approach greatly simplifies the design and implementation of the system because each layer is implemented using only those operations provided by its immediate lower level layer.

Kernel

The kernel of an operating system is its central controlling part that implements the most primitive of the system's functions. It is the only part of an operating system that a user cannot replace or modify. The precise interpretation of the system's functions that are a part of the kernel vary from one operating system to another. However, typical operating system kernels contain basic functions that are required for process management, memory management, device management, and low-level security features like access control. In some systems, the kernel is larger and provides for more than these functions, whereas in others, it is smaller.

Monolithic Kernel and Micro Kernel

The two commonly used models for kernel design in operating systems are monolithic kernel and micro kernel. In the monolithic kernel model, most operating system services such as process management, memory management, device management, the kernel provides file management, and security. As a result, the kernel has a large, monolithic structure.

On the other hand, in the micro kernel model, the main goal is to keep the kernel as small as possible. Therefore, in this model, the kernel is a very small nucleus of software that provides only the minimal facilities necessary for implementing additional operating system services. The only services provided by the kernel in this model are low-level device management, a limited amount of low-level process management, and some memory management. All other operating system services, such as file management, additional process and memory management activities, and security are implemented as user-level server process. Each server process has its own address space and can be programmed separately.

Resident and Non-Resident Operating System Modules

With all the functionalities of an operating system implemented, it becomes a large software. Obviously, all the functionalities of an operating system are not needed all the time. As the main memory capacity of a system is limited, it is customary to always keep in the system's memory only a very small part of the operating system and to keep its remaining part in the on-line storage device such as hard disk. Those modules of an operating system that are always kept in the system's main memory are called resident

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modules and those that are kept on hard disk care called non-resident modules. The non-resident modules are loaded into the memory on demand, that is, as and when they are needed for execution. The system kernel should not be confused with the resident modules of the operating system. The two are not necessarily the same. In fact, for most operating system they are different. The following two criteria normally determine whether a particular operating system module should be resident: Its frequent use, and whether the system can operate at all without it.

For example, file directories can be maintained on disk and loaded into the memory when required. Status information for inactive processes can similarly be swapped out on disk. In fact, the resident part of an operating system is a subset of its kernel.

Command Interpretation

The command interpretation module (known as command interpreter) of an operating system serves as an interface for the user to communicate with the computer via its operating system. It provides a set of commands using which the user can give instructions to the computer for getting some job done by it. The commands supported by the command interpretation module are known as system calls. When a user gives instructions to the computer by using these system calls, the command interpreter takes care of interpreting these commands and directing the system resources to handle the requests. Thus the command interpreter hides the hardware details of the system from the user. In this manner, it greatly contributes to the 'ease of use' objective of an operating system. The two broad categories of user interfaces supported by various operating systems are command-line interface and graphical user interface. They are briefly described below.

Command-Line Interface

This is the textual user interface in which the user gives instruction to the computer by typing command. That is, to enter a command, the user uses the keyboard to type words and symbols. For example, in Unix, the user has to type "delreport.txt" to delete the file named report.txt. If the user types a command incorrectly, the command interpreter will respond with a message indicating that it did not understand the command. When this happens the user has to just retype the command correctly. There is no problem in typing simple commands as illustrated in the example above. However, users often need to give detailed instructions to the computer about their jobs when they submit them for execution. For example, while submitting a job for execution, a user may need to supply the following information:

- His/her identification for security and accounting purpose.
- The software and hardware resource requirements of the job.
- The I/O device requirements of the job.
- The directories in which the data files to be used by the job are stored.
- The action, which the system should take in exceptional conditions, such as when the input data is missing or incorrect, or when an I/O device malfunctions.

To facilitate this, the system, which supports command-line interface, also supports some type of command language (CL) or job-control language (JCL). Users can write codes in the JCL to give instructions to the systems. These coded statements tell the operating system such things as the name of the job, the user's name and account number, the I/O devices to use during processing, the compiler to use if language translation is needed, where to find the data files, and so on. The command interpreter is designed to interpret the codes written in JCL and invoke appropriate system actions.

Graphical User Interface (GUI)

User interface plays an important role in ease of use. The more intuitive the user interface of a system is, the easier it is to use. An intuitive user interface allows a user to use the system effectively even if he/she has never seen it before. That is, how the user interface works is very obvious to any user. Such an user interface is called user friendly. Graphical User Interface (GUI) is a user-friendly interface that is much easier to learn and use than a command-line interface. Unlike command-line interface in which commands are textual, GUI commands are graphical (pictorial). A GUI provides to the user a screen full of graphic icons (small images on the screen) or menus and allows the user to make a rapid selection from the displayed icons or menus to give instructions to the computer. A point-and-draw device is normally used to point rapidly and select a particular graphic icon or menu item from the multiple options displayed on the screen. For example, we saw that in a system that uses command-line interface, to delete a file named report.txt we need to type a command like "delreport.txt." However, in a system that uses GUI, simply using a mouse to drag the icon that represents the file until it is superimposed on an icon shaped like a trashcan performs the same operation. Then releasing the mouse button that was used for dragging the file, causes the file to diaper into the bulging trashcan.

Shell

The command interpreter of an operating system that serves as its user interface is often referred to as the shell because it forms the outer layer of an operating system covering the other modules of the operating system. The shell can be a command-line interface or GUI. It is also possible to have many different shells for the same operating system. For example, an operating system can have a command-line shell as well as a GUI shell allowing the users to switch from one shell to another. Beginners often find it convenient to work with GUI shell, whereas advanced users find it more convenient to work with command-line shell. Some operating systems also support multiple command-line shells. It is like supporting multiple JCLs and allowing the user to use a language that he/she is most comfortable with. For example, many Unix operating systems support three command-line shells known as C shell, Bourne shell and Korn shell. Real-time Operating Systems: for many applications, successful processing means that the application produces correct results when its processing is completed. However, in real life, we often come across situation in which it is not only sufficient to obtain correct results, but the results must be produced within some specified time frame (deadline) to be useful.

Some of the examples of such application are:

- An aircraft must process accelerometer data within a certain period (say every 20 milliseconds) that depends on the specifications of the aircraft. Failure to do so could cause the aircraft to stray from its right course or may even cause it to crash.
- Failure to respond in time to an error condition in a nuclear reactor thermal power plant could result in a meltdown.
- Failure to respond in time to an error condition in the assembly line of an automated factory could result in several product units that will have to be ultimately discarded.
- A request for booking a ticket in a computerized railway reservation system must be processed within the passenger's perception of a reasonable time (say 3 minutes).

Systems that are designed for processing such application are called real-time systems. That is, a real-time system is a system that must satisfy the requirement of producing the desired results before a certain deadline. If it delivers the correct result, but after the deadline, the system is regarded as having failed. Thus, timely production of the result of processing is as important as its correctness in real-time systems. Operating systems that are designed to handle the processing requirements of real-time systems are called real-time operating systems. The goals of CPU scheduling in traditional timesharing computer system are optimal throughout, optimal resource utilization, and fairness. In contrast, the main goal of CPU scheduling in real-time systems is to allow as many time-critical processes as possible to be processed in time to meet their deadlines.

1.23 Network and Distributed Operating Systems

Over the past few decades, advancements in microelectronic technology have resulted in the availability of fast, inexpensive computers, and advancements in communication technology have resulted in the availability of cost-effective and highly efficient computer networks. The net result of the advancements in these two technologies is that the price-performance ratio has now changed to favour the use of interconnected multiple computers in place of the single, high-speed computer. Computer systems consisting of interconnected multiple computers are called distributed computing systems. That is, a distributed computing system is a collection of computer systems interconnected by a communication network in which each computer has its own local memory and other peripheral devices, and the communication between any two computers of the system takes place by passing message over the communication network. The operating system, commonly used for distributed computing systems can be broadly classified into two types – network operating systems and distributed operating systems.

The three most important features commonly used to differentiate between these two types of operating systems are system image, autonomy, and fault tolerance capability.

These features are explained below:

System Image

The most important feature used to differentiate between the two types of operating system is the image of the distributed computing system from the point of view of its users. In case of a network operating system, the users view the distributed computing system as a collection of distinct machines connected by a communication subsystem. That is, the users are aware of the fact that multiple computers are being used. On the other hand, a distributed operating system hides the multiple computers are being used. On the other hand, a distributed operating system hides the existence of multiple computers and provides a single-system image to its users. That is, it makes a collection of networked machines appear to its user as a virtual uniprocessor by providing similar type of user interface as provided by centralized operating systems.

Autonomy

In a network operating system, each computer of the distributed computing system has its own local operating system (the operating system of different computers may be the same or different), and there is essentially no coordination at all among the computers except for the rule that when two processes of different computers communicate with each other, they must use a mutually agreed on communication protocol. Each computer functions independently of other computers in the sense that each one makes independent decisions about the creation and termination of their own processes and management of local resources. Notice that due to the possibility of difference in local operating system, the system calls for different computers of the same distributed computing system may be different in this case. On the other hand, with a distributed operating system, there is a single system-wide operating system and each computer of the distributed computing system runs a part of this global operating system. The distributed operating system tightly interweaves all the computers of the distributed computing system in the sense that they work in close cooperation with each other for the efficient and effective utilization of the various resources of the system. That is, processes and several resources are managed globally (some resources are managed locally). Moreover, there is a single set of globally valid system calls available on all computers of the distributed computing system.

Fault Tolerance Capability

A network operating system provides little or no fault tolerance capability in the sense that if 10% of the machines of the entire distributed computing system are down at any moment, at least 10% of the users are unable to continue with their work. On the other hand, with a distributed computing system. Therefore, the fault tolerance capability of a distributed operating system is usually very high as compared to that of a network operating system.

1.24 Measuring Performance of a Computer System

The efficiency of an operating system and the overall performance of a computer system is usually measured in terms of the following:

Throughput

Throughput is the amount of work that the system is able to do per unit time. It is measured as the number of process that are completed by the system per unit time. For example, if n processes are completed in an interval of t seconds, the throughput is taken as n/t processes per second during that interval. Throughput is normally measured in processes/hour. Note that the value of throughput does not depend only on the capability of a system, but also on the nature of jobs being processed by the system. For long processes, throughput may be one process/hour; and for short processed, throughput may be 100 processes/hour.

Turnaround Time

From the point of view of an individual user, an..... important criterion is how long it takes the system to complete a job submitted by him/her. Turnaround time is the interval from the time of submission of a job to the system for processing to the time of completion of the job. Although higher throughput is desirable from the point of view of overall system performance, individual users are more interested in better turnaround time for their jobs.

Response Time

Turnaround time is usually not a suitable measure for an interactive system, because in an interactive system a process can produce some output fairly early during its execution and can continue executing, while previous results are being output to the user. Thus another measure used in case of interactive systems is response time, which is the interval from the time of submission of a job to the system for processing to the time the first response for the job is produced by the system. In any computer system, it is desirable to maximize throughput and to minimize turnaround time and response.

1.25 Types of Operating Systems

As computers have progressed and developed so have the types of operating systems. Many types of operating systems are available for computers, which can be divided into the following major categories:

Single-user Operating Systems

These operating systems are used for mainly computers having only one terminal (stand-alone PCs). MS-DOS (Microsoft-Disk Operating System) and PC DOS (Personal Computer Disk Operating System) are the two important single user operating systems. Both systems are almost identical and are simply called DOS. OS/2 and Windows NT are other popular single-user multi-tasking operating systems for microcomputers.

Microsoft DOS: MS-DOS, developed by 'Microsoft Inc.' in 1981, is the most widely used operating system of IBM compatible microcomputers. The latest version identification number of a release of software) of MS DOS is 7.

PC DOS: PC DOS is essentially the same operating system as MS-DOS, but developed and supplied by IBM for its personal computers.

Multi-user Operating Systems

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These operating systems are used for those computers (micro to mainframe), which have many terminals (multi-user systems). The popular operating systems used for multi-user systems are Windows 2000, Windows XP Professional, UNIX, NETWARE, MVS, OS/400, VMS and Linux. Multiuser operating systems are used on networks of computers and allow many different users to access the same data and application programs on the same network. It also allows users to communicate with each other. There are many different types of Network Operating System, each one suited to a different multi-user. This allows multiple users to utilize the computer and run programs at the same time. Operating systems that would fall into this category are:

Unix: AT&T at Bell Laboratories initially developed UNIX in 1969. Unix is a highly successful operating system for multi-user systems. Actually, it is more popular among scientific and engineering users rather than business users. In 1980, Microsoft developed its own version of UNIX for 286s and higher PCs, which is called XENIX. UNIX System V Release 4 is the latest version of UNIX.

NetWare: NetWare is a group of network operating system developed by Novell, Inc., that provides multi-user capabilities.

MVS (Multiple Virtual Storage): MVS is one of the most complex multi-user operating systems ever developed for IBM mainframes. In MVS, each job (timesharing user or batch program) is assigned its own virtual storage space.

OS/400: OS/400 is the IBM's operating system for its AS/400 computer.

VMS (Virtual Memory Storage): VMS operating system is used on DEC's VAX series of minicomputers.

Linux: Linux is a 32-bit UNIX-like operating system that has been developed recently for microcomputers. It is the world's first free operating system developed and maintained by thousands of people worldwide.

Further, modern computer operating systems may also be classified into three other groups, which are distinguished by the nature of interaction that takes place between the computer user and his or her program during its processing. The three groups are called batch, time-sharing and real time operating systems.

1.26 Batch Processing Operating Systems

Earlier, some computer systems were capable of doing only one thing at a time. They had a list of instructions to carry out – and these would be carried out, one after the other. These systems where things are done in a series is called serial system. At times, when there was a lot of work to be done, these works were pooled and the collections of these instructions would be given to the computer to work on overnight. Since the computer was working on batches of instructions, this type of operating system was

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called Batch. Processing Operating System. Batch-processing operating systems are good at churning through large numbers of repetitive jobs on large computers. Jobs like: printing of invitations for AGM, consolidation of marks and presenting result, working out the pay of each employee in a large firm; or processing all the questionnaire forms in a large survey.

In a batch processing operating system environment, users submit jobs to a central place where these jobs are collected into a batch, and subsequently placed on an input queue at the computer where they will run. In this case, the user has no interaction with the job during its processing, and the computer's response time is the turnaround time—the time from submission of the job until execution is complete, and the results are ready for return to the person who submitted the job.

Time Sharing Operating Systems

In this environment, a computer provides computing services to several or many users concurrently on-line. Here, the various users are sharing the central processor, the memory, and other resources of the computer system in a manner facilitated, controlled, and monitored by the operating system. The user, in this environment, has nearly full interaction with the program during its execution, and the computer's response time may be expected to be no more than a few seconds.

Multitasking Operating Systems

Multitasking operating systems are now very common. They enable the computer to run more than one piece of software at the same time. It is quite common to sit at your computer and have a word-processor open and running, as well as an Internet browser, and an audio CD player all at the same time. The operating system allows you to switch between the applications and even transfer data between them (for example, it helps you to copy a picture from an Internet site shown on your browser application and paste it into your DTP application).

Operating systems that allow multiple software processes to be run at the same time are called multitasking operating systems. Operating systems that would fall into this category are:

- Windows 2000
- Windows XP Professional
- Linux

Multitasking operating systems allow a user to do more than one thing at the same time.

Real Time Operating Systems

Real Time Operating Systems are designed to service those applications where response time is of the essence in order to prevent error, misrepresentation or even disaster. Examples of real time operating systems are those, which handle airlines reservations, machine tool control, and monitoring of a nuclear power station. The systems, in this

case, are designed to be interrupted by an external signal that requires the immediate attention of the computer system.

In fact, many computer operating systems are hybrids, providing for more than one of these types of computing service simultaneously. It is especially common to have a background batch system running in conjunction with one of the other two on the same computer.

Multiprogramming Operating System

A multiprogramming operating system is a system that allows more than one active user program (or part of user program) to be stored in main memory simultaneously. Thus, it is evident that a time-sharing system is a multiprogramming system, but note that a multiprogramming system is not necessarily a time-sharing system. A batch or real time operating system could, and indeed usually does, have more than one active user program simultaneously in main storage. Another important, and all too similar, term is 'multiprocessing'.

Multiprocessing Operating Systems

A multiprocessing system is a computer hardware configuration that includes more than one independent processing unit. The term 'multiprocessing' is generally used to refer to large computer hardware complexes found in major scientific or commercial applications.

This is an operating system that allows multiple processors to be utilized. Operating systems that would fall into this category are:

- Windows 2000
- Windows XP Professional
- Linux

A networked computing system is a collection of physically interconnected computers. The operating system of each of the interconnected computers must contain, in addition to its own stand-alone functionality, provisions for handing communication and transfer of program and data among the other computers with which it is connected. A distributed computing system consists of a number of computers that are connected and managed so that they automatically share the job-processing load among the constituent computers, or separate the job load as appropriate particularly configured processors. Such a system requires an operating system which, in addition to the typical stand-alone functionality, provides coordination of the operations and information flow among the component computers.

The networked and distributed computing environments and their respective operating systems are designed with more complex functional capabilities. In a network operating system the users are aware of the existence of multiple computers, and can log in to remote machines and copy files from one machine to another. Each machine runs its own local operating system and has its own user (or users).

A distributed operating system, in contrast, is one that appears to its users as a traditional uniprocessor system, even though it is actually composed of multiple

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processors. In a true distributed system, users should not be aware of where their programs are being run or where their files are located; all that should be handled automatically and efficiently by the operating system.

Network operating systems are not fundamentally different from single processor operating systems. They obviously need a network interface controller and some low-level software to drive it, as well as programs to achieve remote login and remote files access, but these additions do not change the essential structure of the operating systems.

True distributed operating systems require more than just adding a little code to a uni-processor operating system, because distributed and centralized systems differ in critical ways. Distributed systems, for example, often allow program to run on several processors at the same time, thus requiring more complex processor scheduling algorithms in order to optimize the amount of parallelism achieved.

Multithreading Operating Systems

Operating systems that allow different parts of a software program to run concurrently. Operating systems that would fall into this category are:

- Windows 2000
- Windows XP Professional
- Linux
- Unix

CUI vs GUI

Now we know that an operating system is that important system software which helps in running the computer system. It is an integrated set of specialized programs. The hardware cannot work without the operating system. In fact, an operating system provides an interface between the hardware and the user. It acts as a translator that conveys information between you and your computer system. An operating system performs all the functions of storage management and I/O (Input/Output) device management. The user is saved the effort and time of knowing hardware just because of the presence of an operating system.

Now let us look at more technical aspects of operating systems, i.e., Command User Interface and Graphical User Interface.

Command-Line User Interface (CUI)

By CUI, one means Command-Line User Interface. It actually means that the operating system provides command-line interface to the user. Command-Line is a prompt where the user types in the command instead of using the mouse to perform a command. A command-line operating system only uses a keyboard to navigate and does not utilize a mouse. Because command-line operating systems require commands to be used, these type of operating systems are much more difficult to learn for new users and can take time. However, a command line operating system can be a very valuable resource and should not be ignored. For example, users who have Microsoft Windows may find

trivial tasks such as renaming 100+ files in a folder a very difficult task, however this is something that can be done in a matter of seconds through a command line. The examples of CUI are MS-DOS and Unix. We will discuss these two operating systems in detail in the following chapters.

Graphical User Interface (GUI)

Both DOS and Unix are command-line operating systems. The greatest disadvantage of CUI is that one has to remember a list of tedious commands to perform any operation and mouse cannot be used. Another is the GUI. GUI stands for Graphical User Interface. It is based on graphics (icons, pictures and menus) instead of text; and uses a mouse as well as a keyboard as an input device. Today's major operating systems provide a graphical user interface. Applications typically use the elements of the GUI that come with the operating system and add their own graphical user interface elements and ideas. A GUI sometimes uses one or more images for objects familiar in real life, such as the desktop, the view through a window, or the physical layout in a building.

Elements of a GUI include things such as: windows, pull-down menus, buttons, scroll bars, iconic images, wizards, the mouse, and no doubt many things that have not been invented yet. With the increasing use of multimedia as part of the GUI, sound, voice, motion video, and virtual reality interfaces seem likely to become part of the GUI for many applications. A system's graphical user interface along with its input devices is sometimes referred to as its "look-and-feel." The GUI familiar to most of us today in either the Mac or the Windows operating systems and their applications originated at the Xerox Palo Alto Research Laboratory in the late 1970s. Apple used it in their first Macintosh computers. Later, Microsoft used many of the same ideas in their first version of the Windows operating system for IBM-compatible PCs.

1.27 Computer Software Concept

Computer software consists of sets of instructions that mould the raw arithmetic and logical capabilities of the hardware units to perform.

In order to communicate with each other, we use natural languages like Hindi, English, Bengali, Tamil, Marathi, Gujarati, etc. In the same way programming languages of one type or another are used in order to communicate instructions and commands to a computer for solving problems. Learning a programming language requires learning the symbols, words and rules of the language.

Program and Programming: A computer can neither think nor make any judgement on its own. Also it is impossible for any computer to independently analyze a given data and follow its own method of solution. It needs a program to tell it what to do. A program is a set of instructions that are arranged in a sequence that guides the computer to solve a problem.

The process of writing a program is called Programming. Programming is a critical step in data processing. If the system is not correctly programmed, it delivers information results that cannot be used. There are two ways in which we can acquire

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a program. One is to purchase an existing program, which is normally referred to as packaged software and the other is to prepare a new program from scratch in which case it is called customized software.

A computer software can be broadly classified into two categories-System Software and Application Software.

Today, there are many languages available for developing programs software. These languages are designed keeping in mind some specific areas of applications. Thus, some of the languages may be good for writing system programs/software while some other for application software. Since a computer can be used for writing various types of application/system software, there are different programming languages to perform some specific function for the organization. For example, a payroll system to compute the salaries of the employees of an organization is termed as application software.

1. ***System Programming Languages:*** System programs are designed to make the computer easier to use:

   An example of system software is an operating system, which consists of many other programs for controlling input/output devices, memory, processor, etc. To write an operating system, the programmer needs instruction to control the computer's circuitry (hardware part). For example, instructions that move data from one location of storage to a register of the processor. C and C++ languages are widely used to develop system software.

2. ***Application Programming Language:*** Application programs are designed for specific applications, such as payroll processing, inventory control, etc. To write programs for payroll processing or other applications, the programmer does not need to control the basic circuitry of a computer. Instead, the programmer needs instructions that make it easy to input data, produce output, do calculations and store and retrieve data.

Programming languages that are suitable for such application programs support these instructions but not necessarily the types of instructions needed for development of system programs.

There are two main categories of application programs: business programs and scientific application programs. Most programming languages are designed to be good for one category of applications but not necessarily for the other, although there are some general purpose languages that support both types. Business applications are characterized by processing of large inputs and large outputs, high volume data storage and retrieval but call for simple calculations. Languages, which are suitable for business program, development, must support high volume input, output and storage but do not need to support complex calculations. On the other hand, programming languages that are designed for writing scientific programs contain very powerful instructions for calculations but rather poor instructions for input, output etc. Amongst traditionally used programming languages, COBOL (Commercial Business Oriented Programming Language) is more suitable for business applications whereas FORTRAN (Formula

Translation - Language) is more suitable for scientific applications. Before we discuss more about languages let us briefly look at the categories of software, viz., system and application software.

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System Software

Language Translator

A language translator is a system software which translates a computer program written by a user into a machine understandable form.

Operating System

An operating system (OS) is the most important system software and is a must to operate a computer system. An operating system manages a computer's resources very effectively, takes care of scheduling multiple jobs for execution and manages the flow of data and instructions between the input/output units and the main memory. Advances in the field of computer hardware have also helped in the development of more efficient operating systems.

Utilities

Utility programs are those which are very often requested by many application programs. A few examples are: SORT/MERGE utilities, which are used for sorting large volumes of data and merging them into a single sorted list, formatting, etc.

Application Software

Application software is written to enable the computer to solve a specific data processing task. A number of powerful application software packages, which does not require significant programming knowledge, have been developed.

These are easy to learn and use as compared to the programming languages. Although these packages can perform many general and special functions, there are applications where these packages are not found adequate. In such cases, application program is written to meet the exact requirements. A user application program may be written using one of these packages or a programming language. The most important categories of software packages available are:

- Database Management Software
- Spreadsheet Software
- Word Processing Desktop Publishing (DTP) and presentation Software Graphics Software
- Data Communication Software
- Statistical and Operational Research Software.

1.28 Software Packages

A software package is an assemblage of files and information.

Database Management Software

Databases are very useful in creation maintaining query, the databases and generation of reports. Many of today's Database Management System are Relational Database Management System's. Many RDBMS packages provide smart assistants for creation of simple databases for invoices, orders and contact lists. Many database management systems are available in the market these days. You can select any one based on your needs, for example, if you have only few databases then package like dBase, FoxPro, etc., may be good. If you require some additional features and moderate work load then Lotus Approach, Microsoft Access are all-right. However, if you are having high end database requirements which require multi-user environment and data security, access right, very good user interface, etc., then you must go for professional RDBMS package like Ingress, Oracle, and Integra, etc.

Accounting Package

The accounting packages are one of the most important packages for an office. Some of the features, which you may be looking on an accounting, may be:

- tax planner facility
- facility for producing charts and graphs
- finding accounts payable
- simple inventory control facility
- payroll functions
- on-line connection to stock quotes
- creation of invoices easily

Communication Package

The communication software includes software for fax. The fax-software market is growing up. Important fax software is Delrina's WinFax PRO 4.0. Some of the features such as Remote Retrieval and Fax Mailbox should be looked into fax software. These features ensure that irrespective of your location you will receive the fax message.

Another important feature is fax Broadcast. This allows you to send out huge numbers of faxes without tying up your fax machine all day.

If you have to transfer files from your notebook computer to a desktop computer constantly, then you need a software program that coordinates and updates documents. One such software is Laplink for Windows. This software offers very convenient to use features. For example, by simply dragging and dropping a file enables file transfer. This software can work if a serial cable or a Novell network or a modem connects you.

Desktop Publishing Packages

Desktop Publishing Packages are very popular in the Indian context. Newer publishing packages also provide certain in-built formats such as brochures, newsletters, flyers, etc., which can be used directly. Already created text can be very easily put in these

packages, so are the graphics placements. Many DTP packages for English and languages other than English are available. Microsoft Publisher, PageMaker, Corel Ventura are few popular names. Desktop publishing packages, in general, are better equipped in Apple-Macintosh computers.

Information Providers

One of the very interesting information providers which will become popular in India also is Automap road atlas by Microsoft. This package may provide city-to-city driving instructions and maps. You may also get the best route, calculate the time it will take. Many information providers are the Internet access programs. Today, the Internet access packages come as a part of operating system, however, many other packages can be used for accessing information on the World Wide Web. One very simple to use popular tool of browsing Internet is Netscape Navigator.

Organisers, Contact Managers, PIMs

Some of the tasks of an office manager can be:

- to be able to track contacts
- to balance schedules
- to manage projects
- to prioritize tasks

These things can be easily done using organizers programs, which have a phone book model for maintaining lists of contacts. They also have a calendar for entering appointments and to-dos. Some of these packages are Okna's DeskTop Set for Windows, Lotus organizer, Microsoft Outlook, etc.

If you are interested in knowing more, than only names and addresses about your contacts such as details like the industry they are working with, the products they are manufacturing, their business with you last year, when did you last spoke to them, etc., then you must look to contact management software. One such software is "Symantec Act! for Windows".

If you want to go even further then you can look for a personal information manager (PIM). PIM is a tool that stores virtually any information such as reference materials, project details, etc. The PIM document contains outlines, folders and links. Most of the data in the PIMs is presented as an outline, for example, the clients may represent the top level, the date of an appointment with him at the next level, and the details of the meeting indented further below. This item can be linked to any other, allowing data to be entered only once and linked up to all other appropriate places.

Suites

Suites are a set of packages sold as a group package mainly for the business user. The suite package includes programs for Word-processing, Electronic Spreadsheet, Databases, and Presentation Graphics software and may be a mail software.

For example, Microsoft Office Professional for Windows includes programs as Microsoft Word, Microsoft, Excel and Microsoft Access, and a license for Microsoft Mail, etc. The word-processing, spreadsheet, and presentation-graphics software interfaces in a suite are well-integrated allowing easy data transfer among these applications. Today there is a growing family of Office-compatible products, which will be included in suites.

In the fast developing software era the list discussed above cannot be complete. Please refer to latest PC journals for most recent software trends.

1.29 Word Processor

Word processing includes typing in text and manipulating it so as to give a very systematic and organized look to your document, which enables easy reading. The application software or program which helps us in processing the text is called 'Word Processing Software', or simply 'Word Processor'. So, you can say that a word processor is nothing but a computer program that helps you to:

- type your text
- correct spelling mistakes and grammatical errors
- align text within margins
- offer a variety of font styles and font sizes
- see a preview of the text that you have typed in.

Popular Word Processing Packages

The commonly used word processing packages are:

- MS-WORD
- Word Star
- Word Perfect
- Professional Write

Uses of Word Processing

Normally, a word processor can accomplish the following tasks:

- Brochures
- Newsletters
- Reports
- Advertisement
- Resumes and Cover letters
- Books
- Directories
- World Wide Web Pages

There is absolutely no end to what a word processor can do. By now you must have realized that the word processing applications have become much more sophisticated than before.

1.30 Database Management Packages

Business processes are always associated with a huge amount of data. To store, manipulate and processes such data, some software packages are needed, which are collectively known as Database Management Packages/Software/Systems (DBMS). DBMS is defined as a software that organizes and maintains the data in a database for providing the information.

Microsoft Access is a Windows based Relational Database Management System (RDBMS). It has received huge acceptance by users because of its versatility and easy to use interface. MS-Access is best suited for maintaining any type of information. It can keep huge records of data ranging from keeping an address book to inventory details. Access finds its immense usage in registering telephone numbers, expense details, store or warehouse information. Whatever data is entered, it can be viewed from different angles using forms. Data can also be sieved and extracted based on certain conditions using queries. Reports help in analyzing the data and help you to come at certain meaningful inferences. The very frequently used operations can be automated by creating and saving macros.

What is a Database

A database is a collection of related information. An example of a typical database is a private telephone directory. It contains related information about each person like his name, address and telephone number. Other examples of a database include list of customers and suppliers, maintenance of stock in warehouses, collection of tapes in libraries, maintenance of members in a country club, etc.

Components of a Database

All the information stored in an Access database is kept in tables as illustrated in Table 1.2.

Table: A table is a collection of some specific kind of data. It is the basic element of the database. Data put in a table is organized in rows and columns.

Record: Each row is called 'record' and it contains the complete information about one particular item, e.g., in a telephone directory all the essential details about a single person like his name, address and city form one record.

Column: Each column is called 'field'. It holds information about a certain type for all records. A field could be a name, address, telephone number, etc.

In the example shown in Table 1.2, the table contains five records and five fields. Thus, each record contains a complete and wholesome information about one item. Each column contains the same type of information for all the records like S.No., Name, Address, etc. The field 'Name' contains the information related to 'Name' for all records. So, you can have any number of records as well as fields in your table. You can add more records to your table. In the similar manner, you can also expand the field list. Your database can have any number of tables. The 'Relational' concept allows to build relations between different tables.

Table 1.2: An Example of a Typical Table

RECORD → | FIELD ↓

S. No.	*Name*	*Address*		*City*
Phone 1.	Manoj Banal	160, A-2, Sector-3, Rohini	Delhi	5418765
2.	Shaveta Verma	GP-42, Vasant Enclave	Delhi	7117653
3.	Dinesh Kumar	K-4, Adhyapak Nagar	Delhi	5165433
4.	Monika Bansal	F-179, Moti Nagar	Delhi	5418776
5.	Vicky Mehta	WZ-143/4C New Mahavir Nagar	Delhi	5153148

1.31 Summary

A computer is an electronic device that can perform a variety of operations according to the instructions given by the programmer/user and provides the desired information as an output. Computers are fast, accurate, diligent, having high memory, but no intelligence.

Computers are classified as general purpose or special purpose computers according to the purpose of their requirement. According to the technology used, computers are classified as analogs which are used for scientific and engineering application, digitals which are considered as general purpose computers or hybrid computers, which incorporate the technology of both analog and digital computers. According to their size, computer can be classified as super computer, mainframe computer, minicomputer and micro computer.

CPU consists of ALU (Arithmetic Logic Unit) which is responsible for all arithmetic and logical operations. CU (Control Unit) controls the transfer of data and instructions among other units of computer registers, which are used to store data, instructions and memory addresses when ALU performs arithmetic and logical operations. Buses are used to transfer data between registers and clock which measures and allocates a fixed time slot for processing each and every micro operation.

Memory is the internal storage area, which holds the data and instructions during processing. The three types of main memory or Internal memory are RAM (Random Access Memory), ROM (Read Only Memory) and CMOS (Complementary Metal Oxide Semiconductor Memory).

Computers are used in business for data capturing in on-line as well as off-line mode, for storage and retrieval of information, for output and for transmission. Offices are needed to be automated to reduce cost of administrative overhead and to increase efficiency of office tasks and staff. The hardware components of microcomputer can be classified into motherboard, input devices, output devices, storage devices, cards, ports and cords and power supply. Various input devices are keyboard, mouse back ball, light pen, touch screen, Joy stick, digitizer, Scanner, Optical Mark Reader (OMR), Optical

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Character Reader (OCR), Bar Code Reader (BCR), Magnetic Ink Character Recognition (MICR) and voice input devices. Various output devices include monitor, printer, plotter and computer output micro file. Storage devices include hard disk, floppy disk, compact disk, Magnetic tape, video disk, Magneto optical drive, DVD ROM/RAM disk, etc.

The second generation computers were developed during 1959-1965. The invention of the transistor by three scientists of Bell Telephone Laboratories in 1947 greatly changed the development of computers. The third generation computers were developed during 1966-1973. The development of Integrated Circuit (IC) signalled the beginning of the third generation computers.

The fourth generation computers were developed during 1974-1990. This generation of computer is presently in use. The development of microprocessor signalled the beginning of the fourth generation of computers. The computers having artificial intelligence (AI) and high processing capacity.

One man communicates with another in a language, which another man can understand. Similarly, man communicates with computer in a language, which machine can understand. This language which consists of a set of commands, understandable by computer directly or after translating is known as Computer Programming Language. In early days of computers, only those languages were used for programming, which could be directly executed on computer.

Low-level languages are used for development of system software. As they are not used for applications development, managers or application programmers do not need to learn these languages.

Development of applications using low level languages requires a deep understanding of the hardware. In order to facilitate the programmers to write programs without knowing the internal details of computer components, many languages were developed.

Operating system (OS) is a program or set of programs, which acts as an interface between a user of the computer & the computer hardware. The main purpose of an OS is to provide an environment in which we can execute programs. The main goals of the OS are (i) To make the computer system convenient to use, (ii) To make the use of computer hardware in efficient way. Operating System is a system software, which may be viewed as collection of software consisting of procedures for operating the computer and providing an environment for execution of programs. It is an interface between user and computer. So an OS makes everything in the computer to work together smoothly and efficiently.

An operating system is an integrated set of specialized programs that is used to control and manage the resources and overall operation of a computer system. MS-windows is a GUI based operating system. In windows operating system, multiple applications can be simultaneously run in different windows. In MS-windows, the screen upon which icons, windows, etc., are displayed is known as desktop. A database refers to the collection of interrelated data and database management systems (DBMS) is a computer program that managers a database effectively and efficiently.

Notes

1.32 Glossary

- ***Computer:*** This is a machine which executes an algorithm stored in its memory to process data fed to it and produces the required results.
- ***Output Unit:*** A unit of a computer used to print or display computed results.
- ***Processor:*** A unit of a computer which interprets instructions, executes them using arithmetic and logic circuits and controls the operation of all the other units of the computer (also known as CPU).
- ***RAM (Random Access memory):*** A memory used as the main memory of a computer in which the time to retrieve stored information is independent of the address where it is stored.
- ***ROM (Read Only Memory):*** A memory in which information is permanently written. The information can be read quickly but cannot be changed.
- ***CPU:*** Central processing unit of a computer. It consists of circuits to perform arithmetic and logic and also has circuits to control and co-ordinate the functioning of the memory and I/O units of a computer.
- ***Printer:*** An output unit to print the results of computation. Line printers print one full line at a time using a character, chain or drum. Character printer print one character at a time serially.
- ***Processor:*** A unit of a computer which interprets instructions, executes them using arithmetic and logic circuits and controls the operation of all the other units of the computer (also known as CPU).
- ***Abacus:*** An abacus is a manual aid to calculate. It consists of beads or disks that can be moved up and down on a series of sticks or strings within a usually wooden frame.
- ***Generation of Computers:*** Generation in computer terminology is a change in technology a computer is/was being used.
- ***IC:*** Integrated circuits. An integrated circuit (IC) is a small electronic device made out of a semiconductor material.
- ***AI:*** Artificial Intelligence
- ***Microprocessor:*** A silicon chip that contains a CPU.
- ***Compiler:*** A system program to translate a high level language program to machine language.
- ***Computer:*** Computer is an electronic device which is used to store the data, as per given instructions. It gives results quickly and accurately.
- ***Input Unit:*** This unit is used for entering data and programs into the computer system by the user for processing.
- ***Storage Unit:*** The storage unit is used for storing data and instructions before and after processing.

- ***Output Unit:*** The output unit is used for storing the result as output produced by the computer after processing.
- ***Keyboard:*** The keyboard is very much like a standard typewriter keyboard with a few additional keys. The basic QWERTY layout of characters is maintained to make it easy to use the system. The additional keys are included to perform certain special functions. These are known as function keys that vary in number from keyboard to keyboard.
- ***System Software:*** This consists of all the programs, languages and documentations supplied by the manufacturer of the computer.
- ***Application Software:*** These programs are developed by the user in order to perform some specific function for the organization.

1.33 Review Questions

1. What do you mean by the term 'diligence' respect to computers?
2. What are the characteristics of computer?
3. Name the elements of computer system
4. List some commonly used input devices.
5. Describe the elements of computer system.
6. What is the difference between general purpose and special purpose computers?
7. What is the difference between analog and digital computers?
8. What are the major strengths and weaknesses of a computer?
9. What are the functions performed by the CPU?
10. Write a short note on the functioning of the control unit.
11. How does the cache memory decide what data it has to store?
12. Distinguish between dynamic and static RAM.
13. What is the difference between RAM and ROM?
14. What is the function of bus in CPU?
15. Why do we need office automation?
16. Describe various types of office automation system.
17. What are the limitations of fourth generation of computers?
18. Discuss the features of fifth generation computers.
19. What are Programming Languages? Why are they needed? Discuss.
20. What are Machine Languages? Elaborate.
21. What are Cross Assemblers?
22. Describe in detail various generations of computers.
23. Differentiate between second and third generation of computers
24. What are the advantages and limitations of Machine Languages? Discuss.

25. What are the advantage and limitations of Assembly Languages? Discuss.
26. Compare Assembly Language with High Level Language.
27. What is an Interpreter? Compare Interpreter and Compiler.
28. What are the Generations of Programming Languages? Elaborate.
29. What is the difference between impact and non-impact printers?
30. Describe various types of input devices and differentiate amongst them.
31. Why are Personal Digital Assistants becoming popular?
32. Write a brief note each on all the types of input devices.
33. Write a note on scanning devices.
34. What do you think can come after voice recognition devices?
35. What are the needs and functions of an operating system?
36. What are the different types of operating systems?
37. Explain the differences between CUI and GUI.
38. Discuss a case where CUI can be preferred to GUI.
39. Discuss the elements of a GUI.
40. Define application software.
41. What do you understand by utility software?
42. What do you mean by Software Packages?
43. What do you mean by operating system?
44. Describe the Database management package.
45. Describe computer software concept.

1.34 Further Readings

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UNIT–2

Computer Networks and Internet

Notes

(Structure)

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2.39 Simple Mail Transfer Protocol (SMTP)
2.40 Telnet – Remote Login
2.41 Hyper Text Transfer Protocol
2.42 Different Applications of Internet
2.43 Applications of Internet
2.44 Electronic Commerce
2.45 Digital Organization
2.46 Internet based Business Models
2.47 Customer-Centered Retailing
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2.49 Electronic Data Interchange (EDI)
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2.1 Learning Objectives

After studying the chapter, students will be able to:

- The various uses of computer networks from the most general types to the possible uses in more specific circumstances;
- Different technology involved in defining the network hardware that include transmission technology, Local Area Network (LAN), Metropolitan Area Network (MAN), Wide Area Network (WAN), wireless networks, etc.;

- Detail concept of network software and the significance of layering the communication process and related design issues for the layers;
- Discuss different types of Computer Networks;
- Describe the LAN, MAN,and WAN;
- Learn how a web is designed using HTML and FrontPage;
- Understand how DNS is able to provide the quick translation of text of the IP addresses into corresponding binary numbers;
- Learn about email and its various features;
- Discuss the concept of electronic commerce;
- Understand internet based business models;
- Discuss B2B, EDI, and B2C models;
- Understand role of intranets.

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2.2 Introduction

In data communication system, digital and analog communication together plays a very important integrated role irrespective of many advantages of digital communications over analog. Figure 2.1 shows the integrated role of digital and analog communication to complete data communication system.

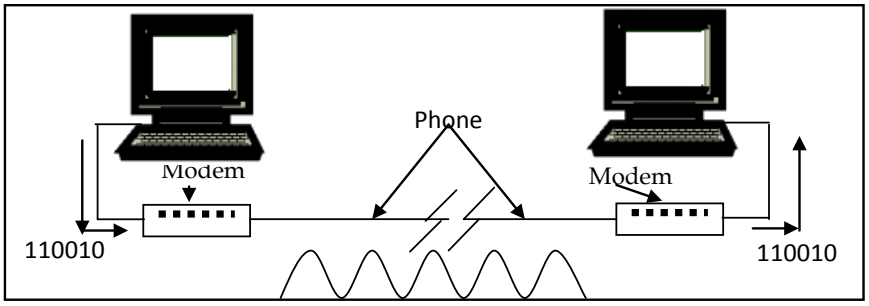

Fig. 2.1: Data Communication System

As these two signals are different in nature, how can these be connected together or communicated over the communication channel? This question can be understood by communication channels, which provide the link for data communications. Figure 1.1 shows that the link between modems is modulated analog signal created by the modem. Likewise we may consider Figure 2.2 where data communication system is presented in a wider sense. The communication from PC to modem is consisted of binary signal whereas the communication between Central Telephone Office (CTO) and modem takes place in modulated analog signal. The communication between CTO to another CTO is by digital signal using time division multiplexers, which are codecs. Thereafter CTO feeds modulated analog signal to modem and modem converts it into binary signal for the PC. We may now say that different types of signals emerging on the communication link and reaching to CTO on their way across a big city. These can be multiplexed to share the same communication link for transmitting to destination.

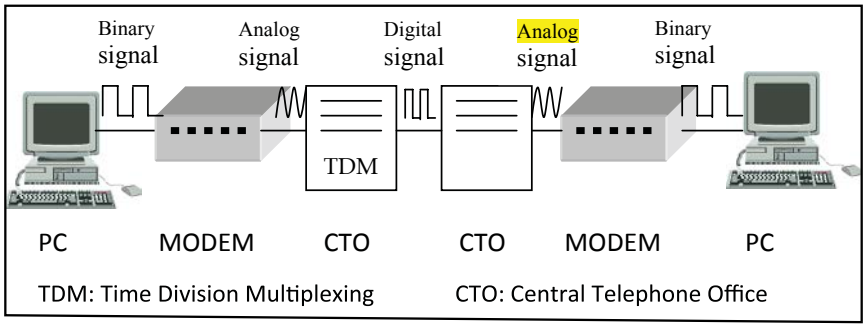

Fig. 2.2: Data Communication System

Development in data communication field has fuelled the use of computer networks in different fields of life. It enables the people to archive information at different websites and access them to as and when need arises. Computer networks to serve the people are available as Local Area Network, Metropolitan Area Network and Wide Area Network depending upon on technologies and their geographical span.

A network can be defined as the interconnection of two or more systems. The minimum number of systems required to make a network is two. Computer systems connected in a network can exchange information between themselves and share the use of hardware devices connected such as the printer, etc.

The World Wide Web and the Internet have impacted the world including business, social and political life in the last few years. It is expected that this trend will certainly continue well into the future too. You must be very much familiar with the term World Wide Web, which is also known as web or WWW or W3 and has established itself as the most popular part of the Internet by far.The upper three layers, viz., session, presentation and application layers are considered as user or application layers of the OSI models. They are implemented in software. In most of the protocols, the functions of these layers are converged into a single layer called 'application layer'. TCP is one of the examples of such types of protocols. The application layer, the highest layer of OSI model interacts with software applications which enable source and destination machines to communicate properly. It provides different services which are described herein.

It is radically changing how people learn, work, play, enjoy and consume. The centre of revolution is browser technology. The "technology" has moved from the "Back office" to the front line. Increasingly, technology is shifting the firm's relationships, with its customers from "face to face" to "screen to face" interactions. The impact of Internet on business is akin to previous innovations that transformed not just one business sector but every sector. The Internet concerns every sector of economy as it changes the way business should sensibly organize its activities and go to market. In this unit we will study the concept, advantages-disadvantages and history of e-commerce.

2.3 Use of Computer Networks

A network is connection of independent computers to communicate with one another over a shared network medium. A network may be consisted of two or more computers.

In other words, computer networks are collections of computers, software and hardware, which are connected to share resources together. A network connects computers using transmission media either in the forms of cables or wireless, specialized software and devices that manage data traffic. It enables to share files and resources, such as printers and send messages electronically to each other. Thus, the term computer network applies to the exchange of information among computers of individuals, groups or institutions and helps in processing of electronic voice or data communications.

Computer Networks have rapidly become an integral part of human life and in many cases, computer networks are considered as the solution to every problem not only within business but also in day-to-day life. The main purpose of computer networks is to enable people to exchange data and information over email, LAN, Intranet or Extranet etc. At the basic level, computer networks share resources, such as printers and storage space. On the advanced level, computer networks enables to carry video data for remote video conferencing. The following points can justify the use of computer networks:

2.4 Business Use

The business uses of computer networks include storage and retrieval of information, reducing the need for paper and moving towards paperless office and rationalizing the time for producing correspondence and accounts. In the context of business, generally computer networks provide the following uses:

- ***Sharing of resources:*** Computer networking allows sharing of resources. Connections of computers in a network will enable you to share files and devices such as printers, CD-ROM drives, etc. It makes available programs, data, and equipment available to anyone on the network irrespective of the physical location of the resource and the user. In case of over capacity utilization of the central processing unit (CPU) of any one computer in network, the computer networks helps in transferring loads to another computer in the network. This aspect of load sharing is the key to the grid computing.
- ***Reliability:*** It is also due to sharing of different resources as it provides alternative sources such as replicated files, multiple CPUs, etc. When one computer breaks down, you can use other computer available on the network with your replicated files etc available thereon. Thus, the system continues to operate but at reduced performance. This could be possible because there is no central computer as in the case of mainframe. This is very important property for applications of computer networks in financial services, air traffic control and many other applications.
- ***Saving money:*** Computer networks help in collecting data on either one server or many servers in the form of file servers in the same network. Thus, a computer network consisting of many powerful small computers, one per user will be able to access data collected in file servers. This provides a better price/performance ratio than mainframes. This model is called the client-server model where the users are called clients.

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- ***Scalability:*** Use of computer networks facilitates connections of different networks at multiple locations to communicate with the computers of other network. This is accomplished by using phone services and other mode of communication services.
- ***Powerful communication medium:*** Networks make communication among groups of people easy at remote locations through e-mail, chat, etc. It also facilitates rapid exchange of information and business data over the company's internal network. Use of the computer network and the Internet allows users to access to data from anywhere in the world.
- ***Integration of the business operations:*** It helps in Integrating the whole business operation into a networked operation, including sales activity, stock holding, quotations, ordering raw materials, control the production process, process invoices, process all the accounts, analyze business performance, quality control, etc.

Scientific Use - Computer Enhanced Collaborative Work (CECW)

Scientific use of computer networks can be traced back to the beginnings of the Internet for sharing resources and exchanging data. The Internet, as we know it today, was created in a laboratory.

In scientific applications, computer networks were useful for sharing data and using remote computers to carry out large computations. This may include the use of supercomputers in various locations. Apart from the "outsourcing" of computing power, the old system of using one powerful computer within a department to carry out large computations and many small hosts for the creation of reports is very common application of computer networks. Grid computing is an area in which networked computers can be used for the parallel processing of large computations using processors with local memory and shared memory. The distinction between processor and computer is that a computer is the combination of a processor, memory and peripheral devices. A processor is an integrated circuit in which the processing takes place.

2.5 Networks for Citizens

Computer network is an important information gathering and transferring tool for common citizens where interactions between a person and a remote database take place. They provide access to remote information such as:

- E-governance applications are aimed with the vision of providing citizen services in an integrated manner. To achieve this mission, the government and private sector develops citizen centric applications and provides access points in the forms of Community Information Centers. These services may also be accessed from home. Some of the applications include land records, agricultural products price, driving licenses, railway reservations etc.
- Reservations for trains, airplanes, hotels, restaurants, theaters, and so on, anywhere in the world with instant confirmation.

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- Networks have made possible online banking and shopping from home or office.
- Proliferation of computer networks is providing on-line and personalized electronic newspapers, journals, and libraries at your desktop.
- Networks allow us to be mobile because we can access our own computer while traveling or transfer files to some remote computer.
- Access to WWW (World Wide Web), which contains information about several topics, has changed the world into global village.

Person-to-person communication – It involves**:**

- Exchange of message via emails that may contain text, digitized voice, pictures, video images, etc.
- Newsgroups covering topics for a particular group.
- Real-time collaborative approaches such as videoconferencing and virtual meeting environments that allow remote users to communicate with negligible delay with seeing and hearing each other.

Entertainment - It involves:

- Video on demand allows the user to select any movie or TV program available in the video library for having it displayed on screen instantly.
- Interactive films where the user has an opportunity to select any scene of his/her choice to create his/her own film.
- Live and interactive TV enables users to participate in quiz shows, and so on.

Due to all these benefits and other also, computer networking becomes increasingly more important

2.6 Network Hardware

Computer networks can be classified based on transmission technology and scale.

Transmission technology – It includes the broadcast networks and point-to-point networks.

Broadcast networks – They have a single communication channel, which is shared by all the computers on the network and therefore, any message transmitted by a computer on the network is received by all the computers connected to the channel. However, that message may be intended for only one computer over the channel.

In computer networks, any message to be transmitted is first broken in several packets. The packets are, then, transmitted one after another. These packets at the receiving ends are assembled to recreate the message. Each packet contains the address of the source and destination computer so that the intended receiver may receive them. In broadcast networks, all computers connected to the common channel receive packets transmitted by a computer on the same channel. The address field within the packet indicates the address of the intended receiver. All the computers after receiving the

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packets check the address field. Only the intended computer process the packet, other computers discard it. In this manner, the transmission and reception of the packets in broadcast networks take place.

An example of such network is Ethernet. Figure 2.3 shows the broadcast network.

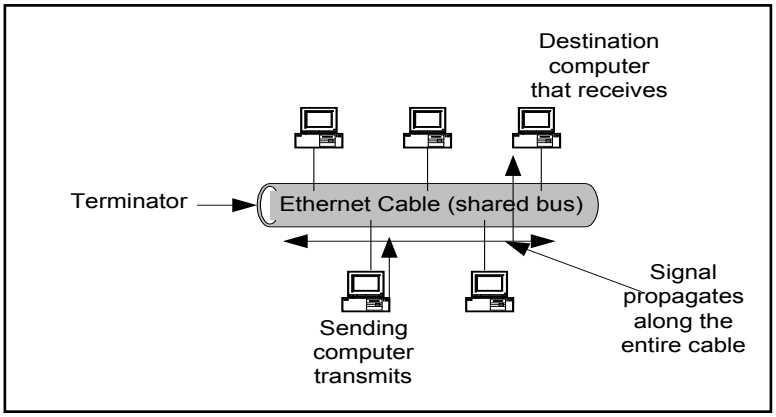

Fig. 2.3: Ethernet

Broadcast network are also used to transmit same message to all computers or selected computers. It could be possible by reserving some addresses for such purposes. When same message is intended to transmit to all computers, it is called broadcasting. When it is intended for selected computers, it is termed as multicasting.

Point-to-point connection – They provide separate communication channels for each pair of computers, which means that computers are connected together in point-to point manner consisting of many connections between individual pairs of computers. It provides multiple routes and intermediate computers between a pair of machines. Multiple routes and intermediate computers provide an opportunity to the packets traveling on network to opt different routes to reach at destination based on the easiest route. This calls for the necessity for routers as an intelligence device and routing algorithms.

The number of connections grows very quickly as number of computer increases. Figure 2.4 illustrates that two-computers need only one connection, three computers need three connections and four computers need six connections.

Figure 2.4 also illustrates that the total number of connections grow more rapidly than the total number of computers. Mathematically, the number of connections needed for N computers is proportional to the square of N:

Point-to-point connections required = $(N^2–N)/2$

Figure 2.5 shows a point-to-point connection for five computers located at two different locations, say, ground and first floor of a building.

As there are five PCs, therefore, a total number of ten connections will be required for point-to-point connection. Out of these ten connections six are passing through the same location and thereby making point-to-point connections an expensive one. By increasing the computer by one in the above configuration at location 2 as shown in Figure 1.5 will increase the total number of connections to fifteen. Out of these connections eight connections will pass through the same area.

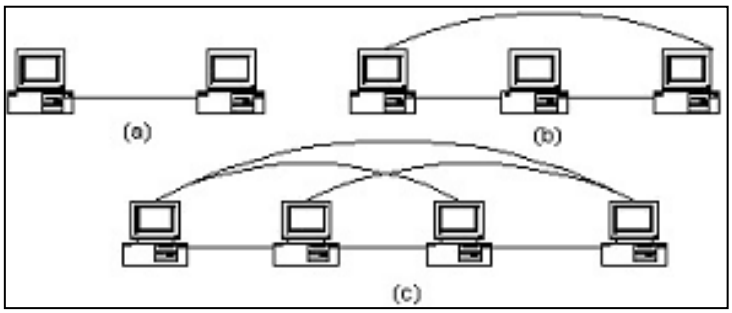

Fig. 2.4: (a), (b), (c): Number of connections for 2, 3, 4 computers respectively

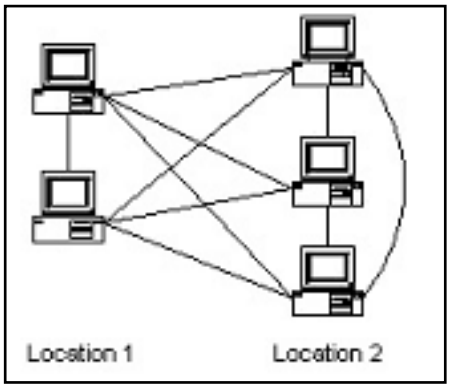

Fig. 2.5: Five computers at two different locations

In order to reduce the number of connections, some intermediate computer (routers) is introduced where connections from different groups of computers (network) terminate. The router routes those connections to the possible route of the destination computer.

In most of the cases, smaller and localized networks are broadcasting, whereas larger networks tend to use point-to-point connection.

2.7 Classification based on interconnected computers by scale

Local Area Network (LAN)

This technology connects people and machines within a site. A Local Area Network (LAN) is a network that is confined to a relatively small area as shown in Figure 1.6. Local Area Networks (LANs) are most often described as privately owned networks that offer reliable high speed communication channels optimized for connecting information processing equipment in a limited geographical area, namely, an office, buildings, schools or campus.

A LAN is a form of local (limited distance), shared packet network for computer communications. LANs interconnect computers and peripherals over a common medium in order that users might share access to host computers, databases, files, applications, and peripherals. They can also provide a connection to other networks either through a computer, which is attached to both networks, or through a dedicated device called a gateway.

Notes

The components used by LANs can be divided into cabling standards, hardware, and protocols. Various LAN protocols are Ethernet, Token Ring: TCP/IP, SMB, NetBIOS and NetBeui, IPX/SPX, Distributed Fiber Data Interchange (FDDI) and Asynchronous Transfer Mode (ATM).

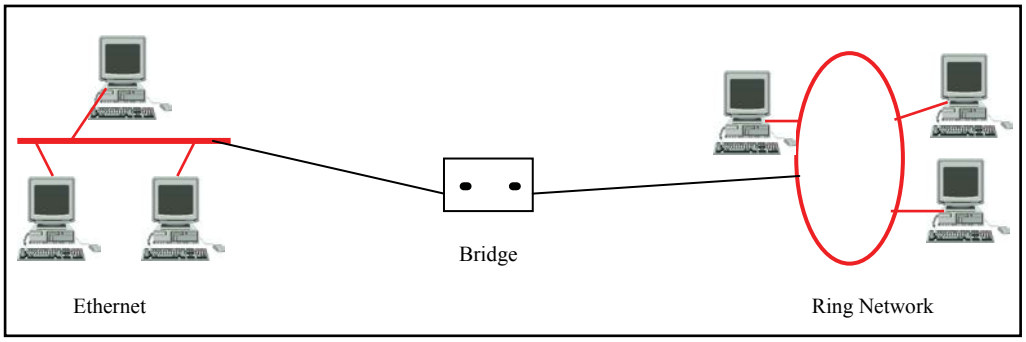

Fig. 2.6: Local Area Network

Briefly, based on size, transmission technology and topology LAN is characterized as below:

- ***Size:*** LAN has usually a span of not more than a few kilometers.
- ***Topology:*** It may have topologies as bus (e.g., Ethernet) as shown in Figure 1.1, ring (e.g., IBM token ring), etc. as shown in Figure 1.6.
- ***Allocation of the shared channel:*** Each computer is statically allocated a time slot to transmit, and gets its turn by round robin. To avoid waiting time in case of an idle computer, dynamic allocation of time is done where each computer is dynamically allocated a time slot on demand.

2.8 Metropolitan Area Network (MAN)

A Metropolitan Area Network (MAN) extends to larger geographic areas. It may include cities or school districts. By interconnecting smaller networks within a large geographic area, information is easily disseminated throughout the network. Local libraries and government agencies often use a MAN to connect to citizens and industries. It may also connect LANs together within a greater area than a LAN. The geographical limit of a MAN may span a city. Figure 2.7 depicts how a MAN may be available within a city.

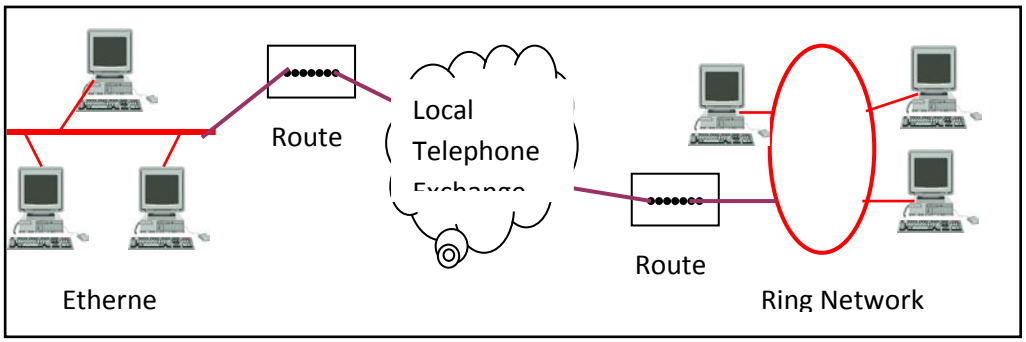

Fig. 2.7: Metropolitan Area Network

In MAN, different LANs are connected through a local telephone exchange using one or two cables but not switching elements. Some of the widely used protocols for MAN are RS””232, X.25, Frame Relay, Asynchronous Transfer Mode (ATM), ISDN (Integrated Services Digital Network), OC””3 lines (155 Mbps), ADSL (Asymmetrical Digital Subscriber Line) etc. These protocols are quite different from those used for LANs.

2.9 Wide Area Network (WAN)

This technology connects sites that are in diverse locations. Wide Area Networks (WANs) may connect larger geographic areas such as New Delhi, India or the world. WAN has no geographical limits. Dedicated transoceanic cabling or satellite up links may be used to connect this type of network. Hence, a WAN may be defined as a data communications network that covers a relatively broad geographic area to connect LANs together between different cities with the help of transmission facilities provided by common carriers, such as telephone companies. WAN technologies function at the lower three layers of the OSI reference model. These are the physical layer, the data link layer, and the network layer.

A WAN involves many cables or telephone lines, each one connecting a pair of routers. When a packet is transmitted from one router to another, it is received at each intermediate router in its entirety, stored there until the required output line is free, and then forwarded. A network using this principle is called point-to-point, store-and-forward, or packet-switched subnet.

Figure 2.8 illustrates the system of WAN, which connects many LANs together. It also uses switching technology provided by local exchange and long distance carrier.

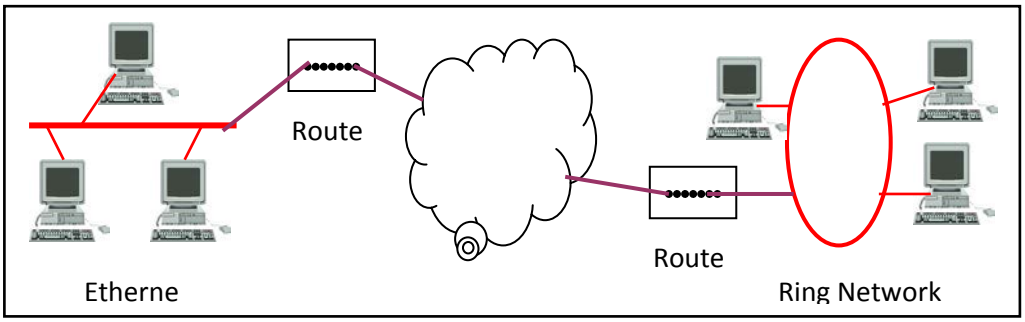

Fig. 2.8: Wide Area Network

Packet switching technologies such as Asynchronous Transfer Mode (ATM), Frame Relay, Switched Multimegabit Data Service (SMDS), and X.25 are used to implement WAN along with statistical multiplexing to enable devices to share these circuits. A WAN has host computers for running user programs and they are connected to subnet, whose job is to carry messages from host to host. The subnet has transmission lines (circuits, channels, or trunks) that move bits between hosts to host. Routers as switching elements are used to connect two or more transmission lines.

The difference between MAN and WAN may be understood only from the services being used by them. WAN uses both the local and long distance carrier while MAN uses only a local carrier. Hardware and protocols are same as in case of MAN.

The answer to the confusion between LAN and WAN technologies lies in how data is switched. It is the integration of LAN/and WAN integration that makes the network work. After all, people and machines not only need to be accessible locally, but from different sites as well.

Notes

2.10 Wireless Networks

Exponential growth rates in mobile communication systems, enhanced awareness in society and deregulation of former monopolized markets have paved the way for the easy use of mobile communication systems as well as a new set of issues, techniques and solutions. Digital Cellular networks are the wireless extensions of traditional PSTN or ISDN networks and allow for nationwide or even worldwide seamless roaming with the same mobile phone. Cellular networks have traditionally been the preserves of voice. However, data traffic is continuously growing. Most of the mobile phones have the ability to send and receive short text messages, and an increasing number now incorporate more advanced Internet capabilities such as World Wide Web (www) onto mobile and wireless devices. Mobile computers, laptop computers and personal digital assistants (PDSs) are the fastest-growing segment of the computer industry. New applications and new mobile networks have been bringing ubiquitous multimedia computing to the radios, PDAs, laptops and mobile phones. These device may also get converge and many more functions will be available on one device only.

There are numerous application using wireless networks and most of them come under value added services (VAS). Some of the applications are listed below:

- Mobile or portable offices, which allow frequently traveling people to send and receive telephone calls, faxes and emails.
- Due to the wireless technology, people on move are able to read remote files or login remote computers, etc from land, sea or air.
- Wireless technology is of great value to fleets of trucks, taxis and repair persons for keeping in contact with home, customers and office.
- GPRS technology is also helping managers and customers to keep track of their products, vehicles, locations etc.
- Wireless technology and GPRS has become important to rescue workers at disaster sites and to the military.

Wireless networking and mobile computing are related but not same. There exist different combinations of wired and wireless networking. A number of mobile and wireless devices are available in different forms depending upon various applications. Some of these devices are sensor, embedded controllers, pager, mobile phones, Personal Digital Assistant (PDA), palmtop, notebook etc. The availability of low cost microprocessors and digital switching made the wireless communication popular among the masses.

2.11 Internetworks

The availability of different operating systems, hardware platforms and the geographical dispersion of computing resources necessitated the need of networking in such a manner

Notes

that computers of all sizes could communicate with each other, regardless of the vendor, the operating system, the hardware platform, or geographical proximity. Therefore, we may say that internetworking is a scheme for interconnecting multiple networks of dissimilar technologies. Need of additional hardware and software is required to interconnect multiple networks of dissimilar technologies. This additional hardware is positioned between networks and software on each attached computer. This system of interconnected networks is called an internetwork or an Internet.

To develop standards for internetworking, ARPAnet, a project of DARPA introduced the world of networking with protocol suite concepts such as layering, well before ISO's initiative. This is NCP (Network Control Program) host-to-host protocol to the TCP/IP protocol suite. ARPAnet was basically a network based on leased lines connected by special switching nodes, known as Internet Message Processors (IMP). Many researchers were involved in TCP/IP research by 1979. The first real implementation of the Internet was when DARPA converted the machines of its research network ARPAnet to use the new TCP/IP protocols. After this transition, DARPA demanded that all computers willing to connect to its ARPAnet must use TCP/IP. The success of ARPAnet was more than the expectations of its own founders and TCP/IP internetworking became widespread. As a result, new wide area networks (WAN) were created in the USA and connected to ARPAnet using TCP/IP protocol. In turn, other networks in the rest of the world, not necessarily based on the TCP/IP protocols, were added to the set of interconnected networks. Computing facilities all over North America, Europe, Japan, and other parts of the world are currently connected to the Internet via their own sub-networks, constituting the world's largest network. In 1990, ARPAnet was eliminated, and the Internet was declared as the formal global network.

2.12 Network Software

Layering the Communications Process

Open Systems Interconnection (OSI) was set up as an international standard for network architecture to reduce their design complexity. Hence, most of the networks are organized as a series of layers or levels. Layering the communications process means breaking it down the communication process into smaller and easier to handle interdependent categories, with each solving an important and somehow distinct aspect of the data exchange process. Each layer has to offer specified services to the higher layers. Thus, layer on one computer carries on a conversation with corresponding layer on another computer in the network. The rules and conventions used in such communications are collectively known as the layer protocol. The entities comprising the corresponding layers on different computers are called peers, which communicate using the protocol. Between each pair of adjacent layers an interface exists that defines primitive operations and services the lower layer offers to the upper one.

The International Organization for Standardization (ISO) took the initiative in setting up OSI. OSI has two meanings. It refers to:

Notes

- Protocols that are authorized by ISO
- OSI basic reference model

OSI reference model divides the required functions of the network architecture into several layers and defines the function of each layer.

The group of layers and protocols is called the network architecture. These groups of layers are provided with enough information to allow a software/hardware implementation, which correctly obeys the appropriate protocol.

The objective of this detail is to develop an understanding of the complexity and sophistication that this technology has achieved, in addition to developing the concept for the inner workings of the various components that contribute to the data communications process. The details of the implementation and the specification of the interfaces are never part of the architecture because they are not visible from the outside.

The functions of layered architecture may be comprehended with an example of conservations taking place between two persons with different language of communication, say, English and French. A three-layered architecture as shown in Figure 2.9 explains the concept. Dotted lines from peers to peers indicate virtual connections.

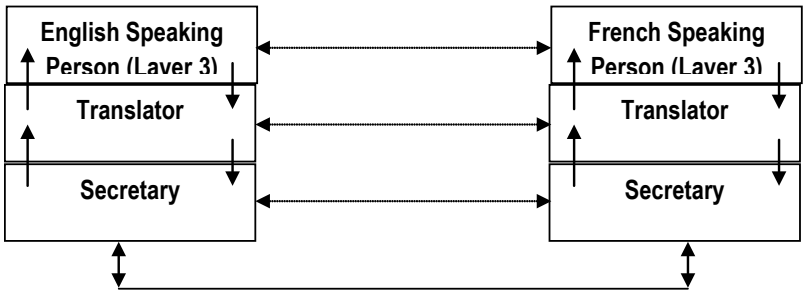

Fig. 2.9: Functions of layered architecture

- Two persons (peer processes in layer 3), one speaking English and the other speaking French, want to communicate.
- They are using a translator (peer processes at layer 2).
- A secretary (peer processes at layer 1) facilitates each translator for message transmission.
- The English person passes his message in English to his translator, who translates it into French or other language, depending on the layer 2 protocol.
- The translator then passes the message to secretary at layer 1 to transmit the message by telephone, email, or some other means, depending on layer 1 protocol.
- When the message reaches the destination, the peer secretary passes the message to the peer translator, who translates it into French and passed across the 2/3 interface to French speaking person.
- Thus an effective conversation takes place between two persons, not understanding each other's language. Similarly, two computers on different networks communicate with each other.

2.13 Design Issues for the layers

Notes

In information exchange between computers, communication processes need to have the following to accomplish these aspects of exchange process:

- ***Physical Data Encoding:*** The information exchanged between two computers is physically carried by means of electrical signals assuming certain coding methods. For two computers to reliably exchange data, they must have a compatible implementation of encoding and interpreting data carrying electrical signals.
- ***Multiplexing:*** This uses the same connection for multiple, unrelated conversations. For example, a few physical circuits are used for all virtual connections.
- ***Transmission Media:*** This concern deals with the type of media used (fiber, copper, wireless, and so on), which is dictated by the desirable bandwidth, immunity to noise, and attenuation properties. These factors affect the maximum-allowable media length while still achieving a desirable level of guaranteed data transmission.
- ***Flow Control:*** Data communication process allocates memory resources, commonly known as communications buffers for the sake of transmission and reception of data. It keeps a fast sender from swamping a slow receiver with data. Some kind of feedback from receiver is needed. A proper data flow control technique desires that the receiving process in transmission of data should send a "stop sending" signal to the sending computer whenever it does not have resources to cope with the rate at which data is being transmitted. On the other hand, when receiving device has sufficient resources available, it should send a "resume sending" signal. The resources available at receiving end to cope up with the sending computer are buffers availability. Figure 2.10 shows the mechanism of data flow control.

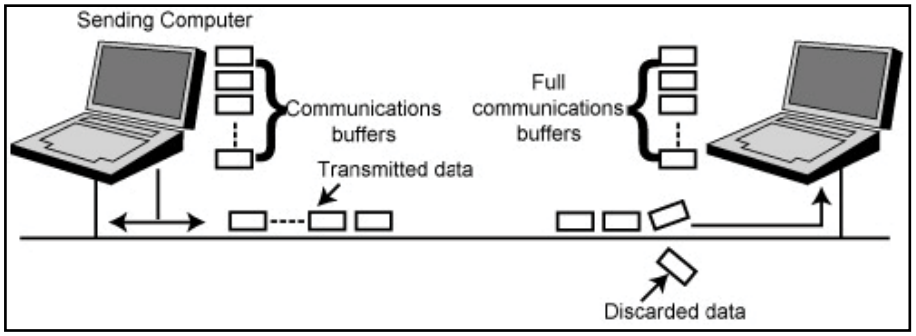

Fig. 2.10: Data flow control mechanism

- Receiving computer must be capable of distinguishing between information carrying signal and mere noise.
- ***A mechanism for identifying senders and receivers*** – Some form of addressing for both machines and processes to detect whether the information carrying signal

is intended for itself or some other computer on the network, or a broadcast (a message that is intended for all computers on the network).

- ***Error control*** – The receiving end after completion of receiving the information must also be capable of dealing with and recognizing the corruption, if any, this corruption could be in the form of noise or electromagnetic interference. Both sides must have the same error-detecting and error-correcting codes. In addition to this, some mechanism is needed to point out which messages have been correctly received and which have not.
- ***Logical channels*** – Protocols should provide at least two logical channels per connection.
- ***Message sequencing or ordering*** – Message are broken into pieces and are numbered before transmission. There should be a mechanism to put them back in order at the receiving end. These packets may take different routes to reach at destination computer and therefore not necessarily be in order.
- ***Routing*** – The routing approach calls on the implementation of various cooperative processes, in both routers and servers, whose main concern is to allow for the intelligent delivery of data to its ultimate destination. Data exchange can take place between any two workstations, whether or not both belong to same network as shown in Figure 2.11.

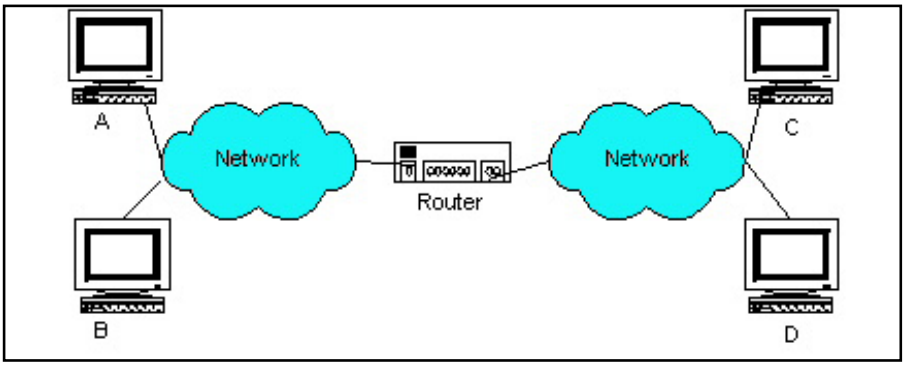

Fig. 2.11: Router connecting two networks

- ***Inter-process dialog control*** – When two applications engage in the exchange of data, they establish a session between them. Consequently, a need arises to control the flow and the direction of data flow between them for the duration of the session. Depending on the nature of the involved applications, the dialog type may be full duplex, half-duplex, or simplex mode of communication.
- ***Session Recovery*** – Another application-oriented concern is the capability to reliably recover from failures at a minimum cost. This can be achieved by providing a check mechanism, which enables the resumption of activities since the last checkpoint. Check pointing circumvents this requirement by re-transmitting only the affected files, saving time and bandwidth.
- ***Presentation Problems*** – Whenever two or more communicating applications run on different platforms, another concern arises about the differences in

the syntax of the data they exchange. Resolving these differences requires an additional process. Good examples of presentation problems are the existing incompatibilities between the ASCII and EBCDIC standards of character encoding, terminal emulation incompatibilities, and incompatibilities due to data encryption techniques.

Notes

2.14 Interfaces and Services

Each layer provides services to the immediate layer above it. There are some associated terms, which are used frequently.

- ***Entities:*** They are active elements. For example, processes, I/O chips, etc in each layer.
- ***Peer entities:*** They are entities in the same layer on different computers.
- ***Service provider:*** This function of layer provides certain services.
- ***Service user:*** This function of layer uses certain services.
- ***SAP (Service Access Points):*** It is the point from where services can be accessed. Each SAP has a unique address.

2.15 Connection-oriented and Connectionless Services

Connection-oriented service is similar to the telephone system where a dedicated channel is established between sender and receiver before transmission. They are suitable for communicating for a long time between senders and receivers. However, they are notable for wastage of bandwidth.

In connection-oriented service, each packet is associated with a source/destination connection. These packets are routed along the same path, known as a virtual circuit.

Connectionless service adopts the mechanism of the postal system. Each message is broken into packets and enclosed in an envelope. The envelope contains the full address. The envelope is then routed independently. The order of the packets is not guaranteed. They are suitable for sending short messages and notable to provide bandwidths in short time intervals.

In connectionless service, a router treats each packet individually. The packets are routed through different paths through the network according to the decisions made by routers.

2.16 Quality of Service

Reliable services guarantee the delivery of data, which is implemented by acknowledgements. However, this introduces overheads and thus reducing the efficiency. In case of file transfer, we need a reliable connection-oriented service while an unreliable connection-oriented service is appropriate for digitized voice traffic. Registered emails are example of reliable connectionless service with acknowledgement while an unreliable connectionless service without acknowledgement is appropriate for junk e-mail. They

have a high probability of arrival but no guarantee. In the client-server model, the request-reply command is another example of connectionless service.

Notes

2.17 Service Primitives

The connection-oriented or connectionless service is specified by a set of primitives available to a service user to interact with the service provider. These primitives enable the service provider to perform some action or report on an action taken by a peer entity. Primitives have parameters to define conditions. For example, *request* and *response* primitives, the sender and the receiver may negotiate some conditions like message size. They are part of the protocol. A confirmed service is defined with a request, an indication, a response, and a confirm primitives. An unconfirmed service has a *request* and an *indication* primitive only. An example using eight of service primitives along with an analogy with the telephone system is given below:

Eight Service Primitives	**Telephone System**
Request for a connection to be established.	Dial the phone number.
Signal the called party.	The called party phone rings.
Used by the called party to accept/reject calls.	The called party picks up the phone.
Tell the caller whether the call was accepted.	The calling party listens the ringing stop.
Request that data be sent.	The calling party talks with the called party.
Signal the arrival of data.	Both the parties listens each other.
Request that a connection be released.	The calling party hangs up the phone.
Signal the peer about the request.	The called party listens it and hangs up too.

2.18 The Relationship of Services to Protocols

Services and protocols are distinct concepts and are important to establish and release connections between sender and receiver.

A service is defined as a set of primitives that are nothing but actions or operations. They are provided to the upper layer by an immediate lower layer. It defines only nature of actions to perform by the layer upper to the service-initiating layer.

A protocol defines set of rules to describe the format and meaning of the frames, packets or messages that are exchanged by the peer entities within the same layer. Entities use protocols to implement their service definitions.

2.19 Goals and Applications of Computer Networks

Goals

Computer networks were initially developed to share files and resources among users. However, with the time, the role of computer networks in society has become a necessity. Goals of computer networks are given below:

***Resource sharing* –** Resource sharing is the primary goal of computer networking. This enables users to share programs, data and equipment that are available on the computer network without the regard to the physical location of the resource and the user.

***High reliability* –** Computer networks provide alternative sources of supply, if one source of supply in the network gets disrupted due to certain reasons. For example, all files are replicated on two or three machines, so if one of them is unavailable, the other copies could be available.

***Saving money* –** Saving of money by way of computer networks is also one of the important goals. It is found that small computers provide much better price/performance ratio than larger ones. If we compare between prices and the speed of mainframe computers and desktops, price/ performance ration goes in favor of desktop which are the essential building blocks of any computer networks. Mainframes are considered ten times faster than the fastest single chip microprocessors, but their cost are more than thousand times. This imbalance has prompted the system designers to build systems consisting of powerful personal computers, one per user, with data kept on one or more shared file server machines. This gave birth to the LAN that has many computers located in the same building.

***Performance* –** Computer networks aim to increase the systems performance as the workload increases by just adding more processors. In case of, the mainframes, when the system is full, it is replaced by a larger one, usually at great expense and with even greater disruption to the users. However, in computer networks the workload is distributed and the system can be scaled up without disrupting the normal work.

***Powerful communication medium* –** It is very much evident that computer networks played an important role in converting this world into global village. This could not be possible without the communication media that computer networks provided to citizens across the globe. A file, picture, news, etc, immediately after its update/modification on a network can be seen and shared by the other users on the network.

2.20 Applications

Applications of computer networks have been discussed at several places in this book in different ways and manners. Applications of the computer networks can be broadly classified under the following three categories:

Access to remote programs.

Access to remote databases.

Value-added communication facilities.

It is quite cheaper to call a remote computer through a computer network than connecting it directly. Normally, distant computers talk with each other using packet switched technology that offers lower rate than normal telephone call working on circuit switching technology. The circuit switching calls for dedicated circuit for the duration of the call and is expensive.

Access to remote database make possible to work globally. Any person even on travel will be able to access database of his or her organization.

Computer networks also facilitate video conferencing, teleconferencing, distant education, etc as value added communication facilities.

Notes

2.21 Computer Network Structure and Architecture

The development of computer networks took place in gradual manner and is built in a highly structured way. They are designed in such a way so that the network architecture and structure could reduce the design complexity and enable the system designer to scale up and upgrade the networks.

Network architecture defines the communications products and services, which ensure that the various components can work together. In the early days of data communication systems, the majority of communications were between the DTE and the host computer. Therefore, transmission control procedures were alone enough as communication protocols. However, recent computer systems link with other systems to form a network, resulting in a situation where in different protocols serving different purposes are required. Hence, the network architecture represents a systemization of the various kinds of protocols needed to build a network.

Computer manufacturers have developed different protocols as needed. This means that each type of computer needed to support different protocols. This also necessitated large development and maintenance costs. All computer manufacturers, therefore worked together to standardize and systemize protocols to link their models and thereby reduce the development and maintenance costs. This was how each manufacturer built own network architecture. Since the concept of the network architecture was first introduced to connect the computers of the same manufacture, the process has become easier. However, from user's perspective, the ideal form of network architecture is one, which enables machines of all manufacturers to connect to each other. Therefore, the need of standardization of network architecture arose.

Table 2.1: Network Architecture by Vendor

Manufacturer	Network Architecture
IBM	System Network Architecture (SNA)
DEC	Digital Network Architecture (DEC)
Borroughs	Borroughs Network Architecture (BNA)
UNIV AC	Distributed Communication Architecture (DCA)
Toshiba	Advanced Network System Architecture (ANSA)
NEC	Distributed Information Processing Architecture (DINA)
Honeywell	Distributed System Environment (DSE)

Following are the ways to achieve connection between different manufacturers:

- ***Protocol Converters -*** These are devices that translate from one native protocol into another, for example, from ASCII to IBM SNA/SDLC
- ***Gateways -*** These are hardware/software combinations that connect devices running different native protocols. In addition to protocol conversion, gateways

provide a gateway connection between incompatible networks. Examples include Ethernet-to-Token Ring gateways, X.25-to-Frame Relay gateways, and T-carrier-to-E-Carrier International Gateway Facilities (IGFs).

In addition to the above, Protocol Analyzers are available as diagnostic tools for displaying and analyzing communications protocols. Analyzers allow technicians, engineers and managers to test the performance of the network to ensure that the systems and the network are functioning according to specifications. LAN managers, for instance, use protocol analyzers to perform network maintenance and troubleshooting and to plan network upgrades and expansions.

Notes

Open Systems Interconnection (OSI) was set up as an international standard for network architecture. OSI Reference Model developed by the International standard organization deals with connecting open systems. Open systems are open for communication with other systems. The OSI model contains seven layers. A detailed discussion of the network architecture has been provided under the topic network software in this Unit only. The International Organization for Standardization (ISO) took the initiative in setting up OSI. OSI has two meanings. It refers to:

- Protocols that are authorized by ISO
- OSI basic reference model

OSI reference model divides the required functions of the network architecture into several layers and defines the function of each layer. Layering the communications process means breaking it down the communication process into smaller and easier to handle interdependent categories, with each solving an important and somehow distinct aspect of the data exchange process. The objective of this detail is to develop an understanding of the complexity and sophistication that this technology has achieved, in addition to developing the concept for the inner workings of the various components that contribute to the data communications process.

2.22 Local Area Networks (Lan)

Networks that connect computers lying within a small distance (such as a room, or within a building) from each other are called local area networks (or LANs).

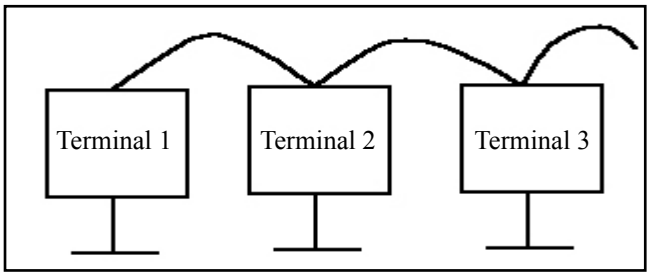

Fig. 2.12: Local Area Network

Local area networks normally use coaxial cables to connect the computers together. Two or more computers connected together can share, besides data, their peripherals such as printers, modems, etc. This cuts down a lot on the hardware equipment cost.

Notes

Besides coaxial cables, a plug-in card is also required for each computer. The coaxial cables connect the plug-in cards of the computers to form a network. A special software is also required for the network to operate.

All local area networks transfer data in digital form at a high speed and have a low implementation cost.

Some applications performed by a LAN are as follows:

1. File transfer and access
2. Accessing the internet
3. Providing Management Information System.

2.23 Metropolitan Area Networks (MAN)

A metropolitan area network uses the distributed queue dual bus. The metropolitan area network is larger than a LAN and it may cover areas as large as a city. The distributed queue dual bus system consists of two buses connected to all the computers.

The Figure below depicts the two buses connecting three nodes.

The dual bus helps the transmission of data in both directions simultaneously. Data going up uses Bus A and data going down uses Bus B.

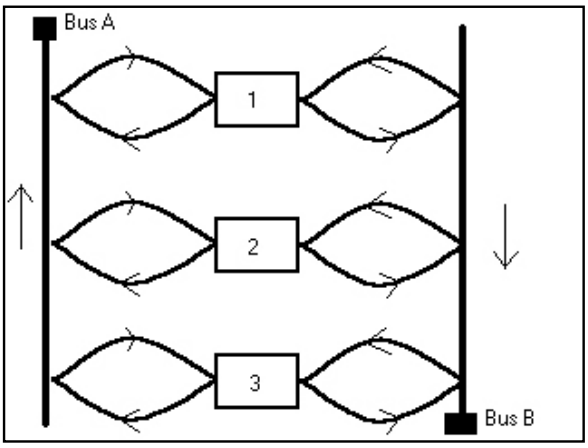

Fig. 2.13: Metropolitan Area Network

Suppose information has to be passed from terminal 3 to 1, it will use Bus A and if a reply has to be sent back (from 1 to 3) it will use Bus B.

2.24 Wide Area Networks (WAN)

A wide area network connects computers which are very remotely placed. It may connect across the countries or continents or the entire globe. Wide Area Networks are also referred to as Long Haul Networks (LHNs).

Wide area networks can either be point to point type or broadcast type. In a point to point type network, the source and the destination machines are connected to each other via several intermediate routers. A point to point type network may be separated

into two parts– the hosts and the subnet. The machines between which communication is to be established are called hosts. The hosts are connected to each other by what is known as the subnet. The subnet consists of the transmission lines (coaxial cables, fibre optic cables, etc.) and the intermediate switching elements also called 'routers'. The main function of a router is to receive the transmitted data and then select an appropriate channel to forward it to the destination host or to another router. When a data packet arrives at a router it is stored in the router until the output transmission line is free and is then transmitted or forwarded to destination host.

The broadcast type wide area networks (WAN) use a satellite or ground radio system. All or some routers have antennas through which they can receive the incoming signal from the satellite. When a ground radio system is being used the routers can communicate with each other. It may also be possible that in a network, while some routers receive their outputs through their antennas, others are point to point type.

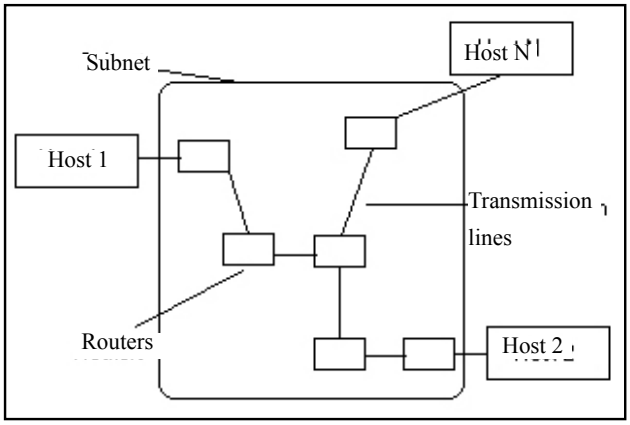

Fig. 2.14: The Complete Network

2.25 Routing

When data is to be transmitted between two remote machines using intermediate machines, certain routing techniques (such as a routing algorithm in the intermediate machine) have to be applied. The intermediate machines may be termed as one of the following:

1. Gateways or routers
2. Repeaters
3. Bridges

We shall discuss each of these in detail as follows:

Gateways or Routers

Gateway is one of several types of communication servers. The function of a gateway is to allow two or more dissimilar networks to communicate as a single logical entity. The two machines that have to transfer data between themselves may have different operating systems (OS) or their transport protocols may be different. It is then the job

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of the gateway to connect such machines. Gateways, in general, are also called routers. It may be possible that exist several routers between the source and the destination machine. When a packet of data is transmitted from one router to another it is stored in the intermediate router until the communication channel is free and then it is forwarded.

Repeater

A repeater receives the incoming signal, repeats it or amplifies it and retransmits the transformed signal. After certain distances the signal experiences a loss of power hence a repeater is required to boost the power of the signal. By using repeaters the network can be extended but only finite extension is possible due to physical constraints such as noise. As the signal travels a certain distance some form of disturbance (referred to as noise) is added to it. When the repeater amplifies the signal the noise also gets amplified, hence over a large distance it may be possible that the signal becomes unrecognizable.

Bridges

A bridge is a device that is used to connect two networks so that they are able to perform as one. A bridge can also be used to connect two networks that use the same technology, such as the Ethernet network and the Token Ring network. One of the main functions of the bridge is to partition one large network into two networks which subsequently increases the performance of the network.

We shall try to explain the functioning of a bridge with the help of the following example.

Nodes 1, 2 and 3 are connected to LAN 1 and nodes 4,5,6 and 7 are connected to LAN 2

Suppose node 1 on LAN 1 wishes to communicate with node 6 on LAN 2. The data packet transmitted from node 1 on LAN 1 contains the address of node 6 on LAN 2. When the data packet is received by the bridge node it is checked for its address. If node 6 was connected to LAN 1 the bridge would not have broadcast the message to the other side, i.e., LAN 2, and would have left the message alone. But, in this case, the bridge transmits the message to LAN 2 from where node 6 collects it.

Thus, as it is evident from the example, the bridge has partitioned the network into two and it is acting like a traffic policeman controlling the flow of traffic across an intersection.

Routing Techniques

Computer networks may use one of the following routing techniques:

1. Circuit Switching
2. Packet Switching
3. Message Switching

We shall discuss each of these methods in detail.

Circuit Switching

Circuit switching is analogous to a simple telephone call. A physical circuit is established between the two machines. Once the connection is established, the data transfer takes place and then the connection is released. Now, another location can be dialled and a new circuit can be established. The transfer of data using this type of switching technique is very fast but it is error prone. It is the responsibility of the user to check for errors and the integrity of the data.

Packet Switching

A Packet switching network divides the data to be transmitted into packets which are of a fixed size and carry error checking information with them. Each packet of data contains the address of its final destination when it is transmitted. As the packet moves through intermediate machines, it is inspected for its address and is accordingly routed to another intermediate machine. Messages being transmitted through this type of network are less error prone than those transferred through circuit switching networks. In case a particular packet is found corrupt on arrival, the destination machine can request the source machine for its retransmission.

Message Switching

In a Message switching network, the message as a whole is transmitted, i.e., it is not divided into packets. Each message contains the address of its final destination and it is upto the intermediate machines as to what path they want the message to go through. The message switching network is a store and forward network. Once the message arrives at an intermediate machine it is stored in the machine until the output line is free, and then transmitted. In case of heavy traffic on the transmission line, the messages are queued up and accordingly dispatched when their turn comes.

2.26 Network Topology

There are several different ways to organize the computers to form a network. These organizations of the computers in a network are referred to as network topology.

The different network topologies possible are:

1. Star Topology
2. Ring Topology
3. Bus Topology
4. Mesh Topology
5. Tree Topology

We shall discuss each of these in detail.

Star Topology

The star topology consists of a central computer to which all other computer terminals are connected. Two computers in this type of network cannot have direct communication. They can only communicate via the central computer. In case the central computer breaks down, the network becomes redundant.

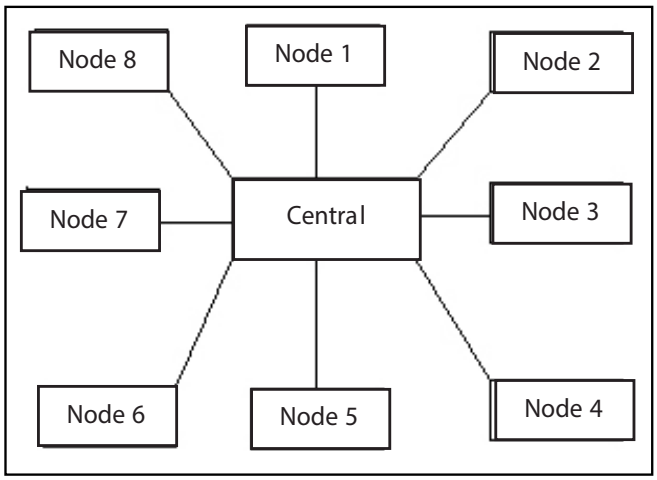

Fig. 2.15: Block Diagram Depicting a Network in Star Topology

One very important advantage of this type of network topology is that in case any one node is faulty or is having problems, it can be isolated from the network without affecting any other terminal.

The star topology is the most commonly used network topology in data communication today. The performance of the system is good for moderate load. However, when traffic is high, the system may have some problems.

A disadvantage of star topology is that two terminals can't interact directly, i.e., they have to go via the central computer. This leads to no privacy in the network.

Another disadvantage is the network's dependence on the main (central) computer. If the central computer breaks down the entire network stops functioning.

The star network requires that each and every terminal be connected using a different cable. This leads to a somewhat increased cost for the cable as well as the installation of the cables.

Ring Topology

In the ring topology, the different computers are connected to each other forming a closed loop (in the form of a ring). The data is passed from one computer to the other in a series until it reaches its desired destination.

There is no concept of a central computer in this case. The data is divided into packets when transmitted and each packet contains the address of the node that it is destined for. Unlike the star topology, this type of network requires lesser amount of cable and there are not much of installation problems either.

The biggest disadvantage of this type of topology is that the failure of one node may lead to the failure of the entire network. Since data from the source node passes through a series of nodes before reaching the destined node, the failure of even one node may lead to the network failure. However, the use of a bidirectional ring (data transfer in both directions is possible) can temporarily solve this problem by choosing a path that does not contain the faulty node. Unlike the star topology, it is relatively difficult to diagnose the faulty node in the ring network.

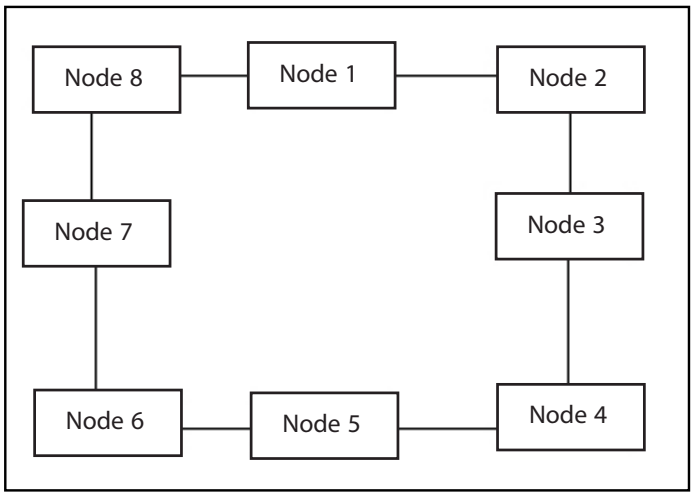

Fig. 2.16: Block Diagram Depicting a Network in Ring Topology

If the star topology provides less privacy, the ring topology provides zero privacy. However, the ring topology provides a better performance under heavy traffic as well.

It is also easy to add or remove terminals in a ring network which is not as easy in the case of a star network as only a certain specified terminal can be inserted into the central computer.

Bus Topology

The bus topology is also referred to as the multipoint topology. All nodes are connected to a bus that runs through the network.

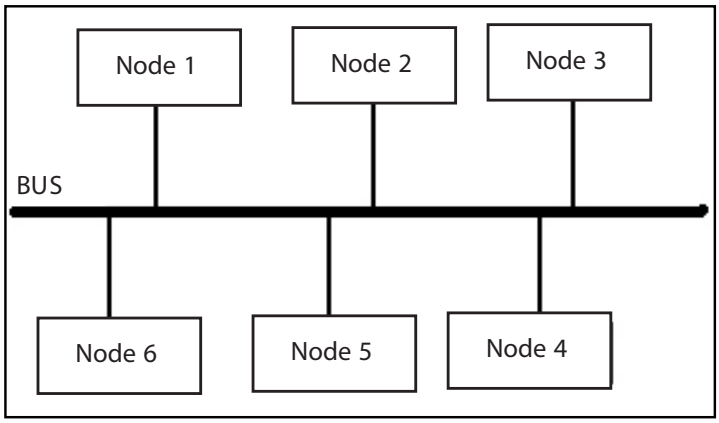

Fig. 2.17: Block Diagram Depicting a Network in Bus Topology

Each node is given a unique address. Information containing the address of the destined node is available at all the nodes but only the node with the specific address responds. The bus can transmit data in both directions.

If one node of the network goes faulty, the network can still remain working. However, the fault diagnosis of such a system is very difficult as each and every node has to be tested to find the faulty one. Once the fault is found, the computer node having the fault is usually not disconnected from the network, but repaired on the spot.

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The bus network topology is easy to extend as only new nodes have to be added along the bus. However, for a larger network, signal amplifiers known as repeaters may be used to strengthen the signal. The cable length and the installation do not pose much of a problem as the cable length required is short as compared to other topologies.

Mesh Topology

The mesh topology requires that every terminal be connected to every other terminal in the network. Hence, all the computers must have adequate number of interfaces for the connections to be made. Because of this requirement the installation is somewhat difficult. The length of cable required is also quite high as compared with other topologies.

Data transfer using mesh topology is faster than the earlier discussed topologies. Mesh networks are also quite fault resistant. If a particular path fails, data can be routed via alternate paths.

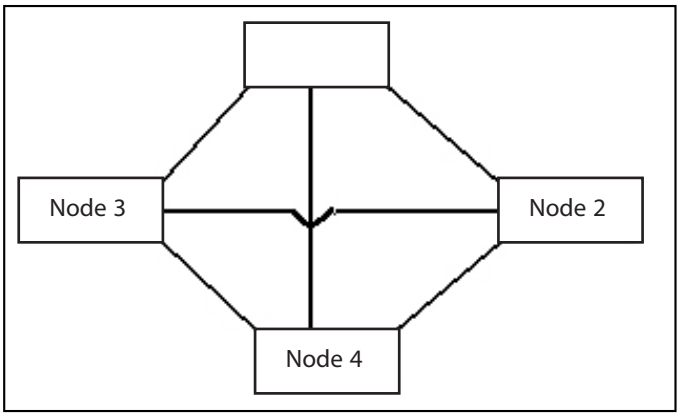

Fig. 2.18: Block Diagram Depicting a Network in Mesh Topology

To save on the cost of interconnections and to reduce the complexity of the system, we can make use of the hybrid mesh network. In this type of network, some of the main or more frequently used networks are connected to each other like a mesh network. The computer terminals are attached to these main terminals.

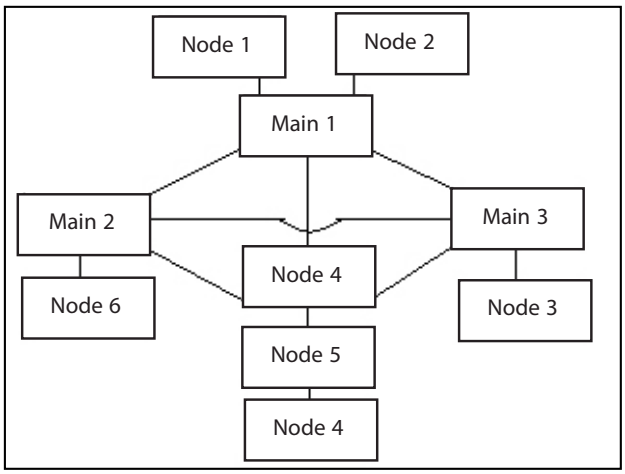

Fig. 2.19: : Block Diagram Depicting a Network in Hybrid Mesh Topology

Tree Topology

The tree topology requires the computers to be linked in a hierarchical way. Data transmission in this topology is relatively slow. The packets carrying the addresses of the destination nodes should have the complete address, i.e., all the nodes above it in hierarchy also have to be mentioned.

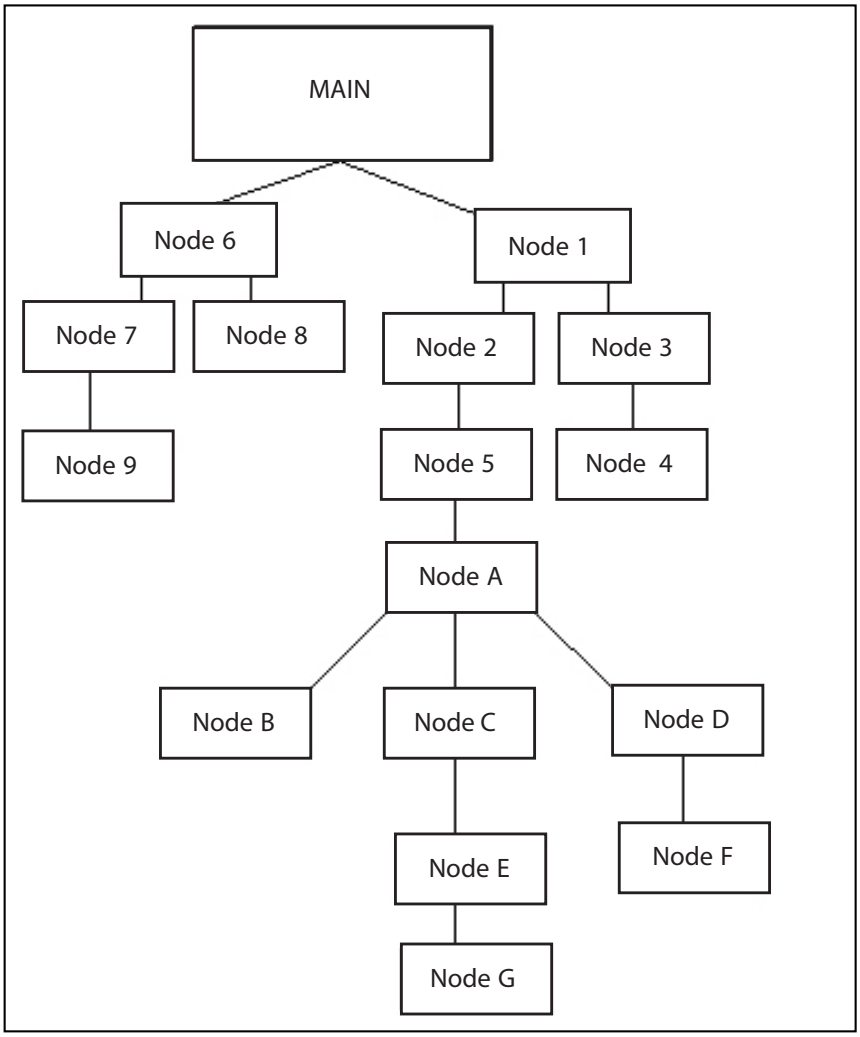

Fig. 2.20: Block Diagram Depicting a Network in Tree Topology

The tree network like the star network is dependent on the main computer. Hence, the failure of the main computer shall lead to the failure of the entire network.

The tree network is very flexible as any number of nodes can be added or removed easily.

2.27 Transmission Technology

There are two types of transmission technologies possible – broadcast networks and point to point networks.

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Broadcast Networks

In this type of network, a single communication channel is shared by all the machines in the network. A packet of data to be transmitted contains the address of the destination machine. A broadcast network is very similar to a railway announcement system. When a particular train departure is announced, everyone present at the station hears it, but only those who have to board the train respond to it. The Bus and the Ring Topology are examples of Broadcast Networks.

Point to Point Networks

As the name suggests, the machines are connected point to point. Data is routed from the source machine to the target machine via intermediate machines or directly.

Internetworks and the Internet

A collection of different networks connected together or a collection of hosts connected together by a subnet is called internetwork. The hosts may be further connected to other terminals through a LAN or a WAN. An internetwork can be as large as you can imagine.

The internet is a very large internetwork that is available world-wide. The internet is the largest network in the world. It provides the world-wide web service implemented by the HTTP protocol.

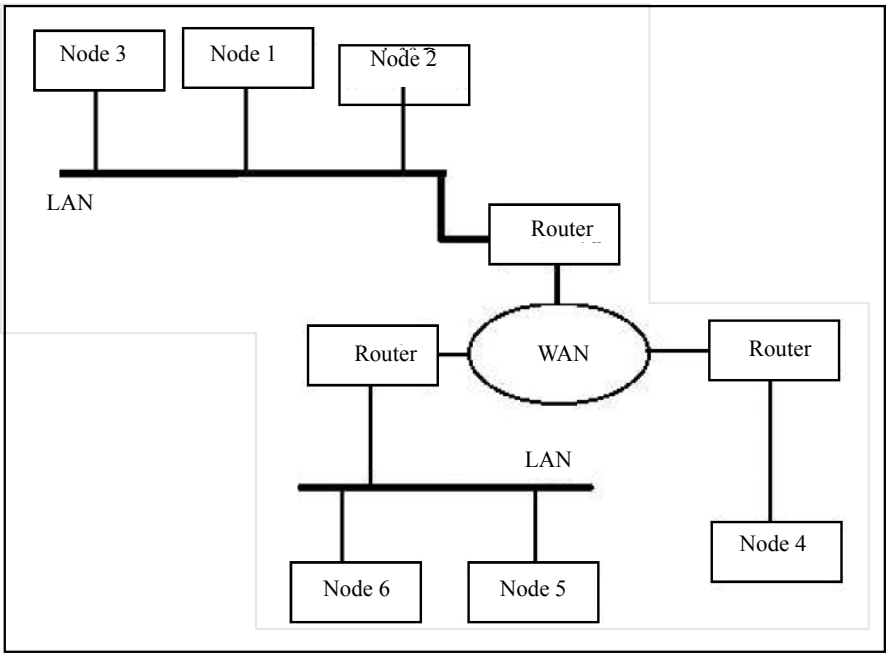

Fig. 2.21: Internetwork

Accessing the Internet

Before you access the Internet, you must have an account with an internet service provider (ISP). You call the ISP on its phone number through your modem (connected to the telephone line). Once a connection is established, you are required to provide

some kind of identification indicating the authenticity of your account. This is known as login procedure.

After the login procedure and the successful authentication of your account, you are connected to the Internet. At this point of time, you require a communication software (web/network browser) that uses the hyper text transfer protocol (HTTP). One of the key roles that a communication software performs is to decide the proper speed between the communicating terminals.

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2.28 Protocols

A protocol is a set of rules according to which the communicating computers communicate. If I wish to communicate with you, I can do so with the help of a commonly understood language, let's say English. However, if I can speak only French and you can understand only English then communication between us is going to be very difficult unless a third person volunteers to step in and act as a translator. Similarly, for computers to communicate, a common set of rules or protocols must be defined. The most common protocol used in networking is the TCP/IP (Transmission control protocol/Internet protocol). The Internet is predominantly based on TCP/IP.

Layers

The networks are organized as a series of layers. Each layer has a specific function depending upon the protocol being followed.

Each layer provides certain services to the higher layers. How the offered services are being implemented is not known to the higher layer.

Shown below in the figure is a 3-layer network. The layer 'n' on one machine is called a 'peer' of layer 'n' on the other machine. In other words, the corresponding layers on the two communicating machines are called peers. It may seem from the figure that data transmission takes place between corresponding layers between the two machines, but it is not so. The actual data transmission takes place through the physical medium.

The layers on the transmitting machines add some control information to the data that is to be transmitted and pass it down to the lower layer. The lower layer again adds some more control information (e.g., it attaches a header to identify the sequence of the data packet) and passes it down to the next lower layer. At the receiving end, these headers are stripped off by the corresponding layers and the data packet is passed on until it reaches the final layer. Each layer receives and decodes the information sent by its peer.

Interface

The term 'interface' here refers to the services the lower layer offers to the upper layer. Between the two layers is the interface. While designing a network, the functions that are to be performed by a particular layer should be very clear. Hence, well defined interfaces are a necessity for a successful network design. The upper layer passes what

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is known as an interface data unit (IDU) to the lower layer. The IDU may be divided into two parts - the interface control information (ICI) and the service data unit (SDU).

The service data unit contains the data being transmitted along with some control information that has been passed on from the still upper layers. The interface control unit contains control information (e.g., headers that are required by the peer entity on the receiving end).

Open Systems Inter Connection Reference Model

The basic reference model is the OSI model, declared in 1983 as an international standard. This model deals with connecting open systems (open for communication). The OSI model consists of seven functional layers on either machine.

At the top is the application layer, where end users interact with system or where application software is executed. At the bottom is the physical layer where logical information is converted into signals and transported through the physical transmission medium.

The function of each layer is defined keeping in mind the definition of the internationally standardized protocol. The number of layers in a particular model is variable. Only when a different level of abstraction is required should a new layer be created.

The active elements in each layer are called entities. It is the entities in each layer that interact with entities of other layers through well defined Service Access Points (SAP's) using specific interface protocols. A layer to the outside system behaves like a black box.

The number of layers should be large enough so that some sort of a similarity between the functions being performed in a particular layer is maintained.

As said earlier, the OSI model can be divided into seven layers each performing a distinct function. These layers are discussed in detail as follows:

The Physical Layer

The primary task of the physical layer is the transmission of raw bits over the communication channel. The physical layer has no knowledge of the structure of data that it is required to transmit. The physical layer does the following functions.

1. The physical layer involves the physical transmission of the data stream through the media. Connecting to routers, deciding the data rate and deciding which signal is to be transmitted first in case of multipoint signals, is the job of the physical layer.
2. The physical layer controls the mechanical characteristics of the transmission media.
3. Activation and deactivation of the physical connection.

The physical layer provides the following services to the data link layers:

1. The physical layer provides the data link layer with physical connections, data units and end points.

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2. Since the physical layer transmits and receives data in the form of bits an indication of the sequence of these bits is necessary. This is provided by the physical layer to the data link layer.
3. When errors are detected in received frames, the physical layer requests for the retransmission of the frame. Hence, the physical layer also performs error detection.

The Data Link Layer

The functions performed by the data link layer include:

1. The data link layer defines the protocol to detect and correct errors that may occur during data transfer.
2. The data link layer receives the data from the physical layer in the form of bits. It is in this layer where the frame boundaries are created and the raw data is sequenced into frames.
3. The data link layer establishes and releases the link and maintains a supervision of the physical connection.
4. In case of a fast sender and a slow receiver the data link layer informs the sender of the buffer space available at the receiver's end in order to control the transmission rate.
5. The data link layer also supervises the traffic regulation for transmission in both directions.

The data link layer provides the following services to the network layer:

1. Sequence control.
2. Indicating transmission errors.
3. Indicating the quality of service.

The Network Layer

The network layer performs the following functions:

1. The network layer handles the routing functions by selecting primary or alternate routes for transmitting data.
2. The network layer provides the addresses of intermediate nodes or systems through which data is transmitted.
3. The network layer performs the multiplexing tasks in case more than one type of signal is to be transmitted.

   Hence, in other words, the network layer controls the operation of the subnet.
4. In case of two heterogeneous systems having different protocols, the network layer provides a common addressing system.
5. The network layer forms data blocks and segments at the source and reassembles them at the destination.

The network layer provides the following services to the transport layer:

1. Provision of network address.
2. Provision of network connections.
3. Identification of network end points.
4. Indicating the quality of service.
5. Sequence control.

The Transport Layer

The transport layer performs the following functions:

1. The transport layer has the job of receiving data from the network layer and delivering it within the destination machines. Multiple programs may be using the network from a single computer. The transport layer manages (sends and receives) the data of multiple programs within the network.
2. The transport layer and the layers above it are end to end layers. The lower layers carry on the bit to bit transmission of data routing each data packet through different paths. It is from the transport layer and upwards that the data starts getting sequenced and a meaningful conversation occurs.
3. The transport layer performs the error detection (end-to-end) of the data transmitted and sends a request for retransmission when necessary.
4. Again, in case of a fast sender and a slow receiver, the transport layer performs the data flow control.

The services provided to the session layer include:

1. Data transmission.
2. Establishing and releasing transport connections.

The Sessions Layer

The functions performed by the sessions layer are:

1. The sessions layer allows users on different machines to establish sessions between them. The sessions layer handles the details of the user names, passwords and other user authorizations. Each login is considered a session.
2. The data transfer rates, the method of error control, the mode of transmission (simplex, half duplex, full duplex), etc., are decided by the sessions layer.
3. The sessions layer inserts checkpoints (in the form of headers) in the data packets it transmits, so that just in case the connection gets disconnected the process can be continued rather than having to restart it.
4. The sessions layer, like the transport layer, provides the data flow control.

The services provided to the presentation layer are:

1. Establishing and disconnecting the session.

2. Indication of errors.
3. Performing synchronization (inserting checkpoints).

The Presentation Layer

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The presentation layer performs the following functions:

1. The two interacting systems may be using different character code. For example, one system may be using the ASCII character code and the other might be using the EBCDIC character code. In order to ensure a meaningful exchange of data, the presentation protocol defines the rules on how the data will be presented and exchanged in a common neutral language.
2. The presentation layer, unlike the lower layers, is concerned with the syntax of the information transmitted. This layer performs the proper coordination of syntax and presentation profiles.
3. The presentation layer may also perform data encryption, data decryption and data compression, etc., if required.

The presentation layer provides the following services to the application layer:

1. Syntax translation.
2. Data formatting (encryption, compression, etc.)
3. Selection of syntax and presentation profile.

The Application Layer

The application layer performs the following functions:

1. The application layer provides the end user an interface with the system. This layer also controls the operating system functions.
2. The application layer performs an identification of the communication partners and establishes availability. The application layer also checks for authorization and validity.
3. The application layer checks for errors and requests for their correction.
4. The application layer, like the presentation layer, is concerned with the syntax of the data and hence, it performs a proper coordination of the syntax and presentation profiles.

The application layer provides the users with many services. Some of these are listed below:

1. File transfers
2. Database queries, insertions and deletions, remote job entry, etc.
3. Electronic mail

We shall discuss two of the above three most commonly used services in detail.

File Transfer

To perform a file transfer between two systems, the fundamental requirement is a common protocol. In this section we shall discuss about file transfer protocol (FTP). The file transfer protocol (FTP) is an application of the TCP/IP. The file transfer protocol gives the user an access to a remote machine file system. The user once given access can browse, upload or download files. The user needs an FTP client application and the remote host should have an FTP server component. The FTP client application enables the user to send commands to the FTP host. The FTP server component processes these commands and performs the necessary action. The FTP is also an Internet tool, since the Internet uses the TCP/IP. Thus, the file transfer protocol can also be used to copy files from an Internet site or for uploading a file to a remote net server.

Electronic Mail

Electronic mail is a fast and efficient method to exchange messages and other data. To interact through the electronic mail one needs to have an e-mail account. Once the account is created the user is assigned an electronic mail box. The user can send messages to other users through his mail account and can receive incoming messages in his mailbox. The messages are instantly delivered and it is not necessary for the recipient to be present while the mail is delivered to his mailbox; he/she can scan the mail later.

The electronic mail system allows a very easy merging of a particular message. Just typing the e-mail user names of all the recipients would deliver the message to each of them. Moreover, the user can put a restriction to the delivery of messages. It is also at the user's discretion as to which sender's message he wants to receive in his mail box.

Choosing the Right Kind of E-mail Service

E-mail accounts for more than 50% usage of Internet. By using the right kind of e-mail services one can save a lot of time and money. Here is a list of all the main types of e-mail services available on the net, along with their advantages and disadvantages (nothing is perfect!). Also listed are some of the free e-mail service providers for each type of service available on the Internet. Users with an internet account should go for POP mail. The choice depends on the user and what service suits him personally.

Types of E-mail Services

There are 3 main types of e-mail services, each having some advantages and disadvantages.

POP Mail

POP mail services store your incoming messages on a server and you download the messages using an e-mail software package (Eudora, Netscape messenger, Outlook express, etc.). Once they are downloaded, the messages are stored on your PC. POP mail services are similar to the e-mail service offered by most ISP's.

Advantages

1. You can work offline, compose or read messages, and just connect to send mail or download new messages.

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2. The mail program used by your browser (Outlook express for Internet explorer, Netscape messenger for Netscape) can be configured to receive and send all your e-mail automatically. This is very useful when you are browsing the net and find a link to an e-mail address where you want to send any mail. With the mail program properly configured, you can send the mail immediately without going to your web based e-mail service providers' site.
3. Since all messages are stored on your computer after you download them, you can refer to them at any time without connecting to the Internet and easily cut and paste the information into other applications.
4. Once downloaded, the messages can be automatically deleted from the server. Thus, only new messages would be available each time you connect to receive your mail.
5. You can also use powerful and intelligent e-mail software, which may include spelling check options, clever filtering options and all kinds of other features.

Disadvantages

1. The biggest disadvantage of POP mail is that you can not access your e-mail while "on the road", i.e., on another computer since you need the e-mail software configured for it.
2. If you sign up with a free POP mail service, you can generally expect to receive unwanted advertisements or spam mails in your mailbox.
3. The signing up and setting up procedure is not as easy as a web based e-mail but once configured you will find it easy to download and send mail.

Web-based E-mail

With web-based e-mail, your e-mail is stored by the free e-mail service provider you signed up with; thus you have to log into the site you signed up in order to gain access to your e-mail. Most of the large free e-mail providers offer web-based e-mail since it is relatively easy to implement. Different web-based free e-mail services come with different functionality, such as online spell-checkers, personal address books, distribution lists, etc.

Advantages

1. You can easily log in and collect your e-mail from any web browser.
2. There's no need to configure any program in order to access e-mail.
3. It is easier to register and no setup is required.

Disadvantages

1. It is time consuming, i.e., you got to go to the e-mail providers' site, log in, wait for all your messages to show up; then read each message individually and stay connected on the net while you do so. All this requires a lot of your time and consequently money on the connection.

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2. Many web-based services take advantage of advanced functions such as Java in order to provide an attractive interface. You will therefore, need to have latest web browsers in order to keep your range of options open (generally you need Netscape 3.x or better or IE 3.x or better).
3. Most web-based services cannot match the functionality of a good e-mail package. Some common problems are server down, high traffic, etc. (making access slow and reading and sending mail difficult & time consuming).
4. Advertising banners rotate as you read your e-mail. This can increase your access time.

Mail Forwarding Services

Mail forwarding services, as the name implies, do not offer you a NEW e-mail account. Rather, they pass e-mail to your existing account (POP or web-based), but offer a different mailing address. Therefore, you need an e-mail account before you sign up for mail forwarding services.

Advantages

1. E-mail forwarding services let you continue use your existing e-mail account given to you by your ISP. If you change the ISP at any time, just change the e-mail address your e-mail is forwarded to, and it will automatically be redirected to your new address.
2. Forwarding services let you choose a memorable or fun name, often much more distinctive than your current address.

Disadvantages

1. With an e-mail forwarding service, you are putting another layer between the sender and your email account. This means that you are twice as exposed to network problems; if either the forwarding service or your e-mail account is down, the e-mail will not get through.
2. Generally, mail forwarding services make money by gluing a small advertisement at the top or bottom of each e-mail message they forward (or sometimes both).

List of free e-mail service providers.

POP Mail

1. Amex Mail (www.amexmail.com)

   This service is provided by USA.NET
2. Crosswinds (http://home.crosswinds.net)

   Free POP mail address and free web space (unlimited for personal sites, 25MB for business sites). You cannot use your free e-mail address to run a mailing list. Not very reliable and server remains down at times.

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3. Newmail (www.newmail.net)

   Newmail offers web-based and POP mail services, plus 5MB of space for storing messages and address books, filters, etc. Does not offer SMTP.

4. PeachWorld Network(www.peachworld.com)

   You can send/receive messages up to 1.5MB here.

5. POPAccount(www.popaccount.com)

   Free web-based and POP mail service with no advertisements attached to POP mail messages.

6. SoftHome(www.softhome.net)

   I am personally using this service for the last 6 months and have had no problems whatsoever. Also till date their has been no spam mail in my inbox.

7. ForFree(www.forfree.at)

   Very fast-loading site; provides free POP3/SMTP e-mail, as well as free site hosting (5MB) and free mailing list services.

8. Freemail(www.freemail.everperfect.com)

   Does not display advertising in messages.

9. Friendly E-mail (www.mypad.com)

   Also offers free web-based e-mail and a choice of over 3 dozen different domain names.

10. HotPop(www.hotpop.com)

    Free POP mail. MIME format supported. There are no ads in the messages; instead HotPop will send you separate advertisement from selected advertisers. You can also forward e-mail to an existing account. HotPop comes with a choice of domain names. HotPop filters spam before it hits your mailbox.

Web-based E-mail

Most of you maybe using this service and may know lot of free e-mail providers but here is my own list:

1. MrPost (www.mrpost.com)

   Special service enables you to add web-based e-mail to your own site FREE of charge. Also offers web-based instant messaging and chat.

2. MyOwnE-mail (www.myownemail.com)

   Over 200 domain names to choose from. Free web-based mail, plus mail forwarding services at $11.95 per year.

3. MuslimE-mail (www.muslimemail.com)

   This free e-mail service also offers free web hosting for muslims and many other services. Other domain names are available at a premium.

4. GhanaMail (www.ghanamail.com/emurl)

A no-questions-asked web-based e-mail service. All you need to do to sign up and choose a user name and password.

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5. gurlmail (www.gurlmail.com)

   Another Who-Where-powered free e-mail service. Gives 4MB storage for e-mail messages.

6. HotMail (www.hotmail.com)

   The largest web-based free e-mail service, now a part of the Microsoft family. Most of you must be having a HotMail account. If you decide to go for POP mail after reading this article and do not want to change from Hotmail then there is a good news for you. Hotmail can support POP-mail-like functionality through a free third-party utility called CwebMail (available at www.cwebmail.com).

7. Eudora Web-Mail(www.eudoramail.com)

   Free e-mail service

8. Fastermail.com(www.fastermail.com)

   Free e-mail service.

9. 123india.com(www.123india.com)

   India's very own e-mail service.

Mail Forwarding Services

Automatically redirects your e-mail-address.

1. Easy To(http://easy.to/remember)

   An intriguing free service that provides free e-mail forwarding in the form username@easy.to. Seven domain names to choose from.

2. FlashMail(www.flashmail.com)

   FlashMail offers free web-based e-mail, POP mail, mail forwarding and retrieval of e-mail from an existing account, all via a very clean and simple interface.

3. Grabmail(www.grabmail.com)

   Free e-mail service offers 5MB of disk space, folders, an address book, vacation

   Auto responders, access to your existing POP mail accounts and more. Grabmail also offers mail forwarding facilities.

4. IName(www.iname.com)

   Also offers free web-based e-mail services; IName powers the free e-mail offerings of dozens of large sites.

5. NetForward(www.netforward.com)

   A choice of over 20 domain names. Free mail forwarding service that offers to remove the "tag-line" in messages for a one-time fee of $9.50.

6. Nederlands.com(nederlands.com)

   Free e-mail forwarding address at "Nederlands.com" or one of over 1,000 sub-domains.

7. USA.NET(www.usa.net)

   The company behind NetAddress, USA.NET also offers its own free e-mail under the usa.net domain.

8. Bigfoot(www.bigfoot.com)

   Bigfoot allows e-mail to be forwarded to up to 5 separate e-mail accounts automatically. It also offers various mail filtering options.

9. Bitmail(www.bitmail.com)

   Private users can choose any e-mail address they like; businesses can choose an e-mail address based on their telephone number. Only the first year's service is free.

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2.29 World Wide Web

It is an incredible mine of information! Once you start searching anything ranging from documents to pictures to software, it almost appears limitless. It provides you documents, sound files, view images, animation, and video, speak and hear voice, and view programs that run practically on any software in the world. Therefore, it facilitates the rich and diverse communication by enabling you to access and interact with text, graphics, animation, photos, audio and video. It has now become very simple for you to understand how the web works and what it is. Its implementation is based on client server system and employs your personal computer as client, web browser software, a connection to an Internet service provider, servers, routers and switches to direct the flow of information. You may be aware of all terms used in the formation of a web except web browser.

A browser is a software, which your computer uses to view WWW documents and access the Internet. The browser program residing in your computer facilitates you with the advantages of text formatting, hypertext links, images, sounds, motion, and other features. Internet Explorer and Netscape are some of the widely used browsers. Browsers have sub programs called plug-ins to handle the documents you find on the Web. It may also other plug-ins stored elsewhere in your computer.

Web is very simple to use. Whenever you wish to visit any website, say your institute's website, you simply enter the address or URL of the website in your web browser to forward your request to the web server of the institute to provide you the intended web page. The institute's web server then sends your request on the Internet to find the intended website. Once it is obtained, the web server returns the same to your computer where the browser loaded with different plug-ins interprets the data, displaying it on your computer screen. The intended web page, which is now available on your desktop, may have click able links. On clicking on the same, you may visit other pages. In this manner, the information scattered across the globe can be linked together.

It now becomes essential to explain as to how the different web pages with different text format and standards could be linked to a particular web page. The binding forces that hold the Web together are the hypertext and the hyperlink. The hyperlink allows electronic files on the Web to be linked so you can jump easily between them using hypertext protocol. As you have learnt that web browsers that enable you to access the Web also distinguish between web pages and other types of data on the Internet because web pages are written in a computer language called Hypertext Markup Language or HTML.

World Wide Web (WWW): The ***World Wide Web*** is an information space that provides resources, which are identified by global identifiers called Uniform Resource Identifiers (URI). There is software, which in conjunction with servers, proxies, spiders, browsers and multimedia applications enables a user to identify and explore resources on web space. In networking language, www is a client-server information system that utilizes the Internet to access computers containing millions of hypertext documents.

2.30 Advantages

Many companies have understood the advantages of having a presence on the World Wide Web and have successfully addressed their corporate objectives by integrating their website as part of their business strategy. We are aware that a website can generate awareness of the products and services of the company and provide a global storefront for the company 24 hours a day with automating many business procedures. It is relatively inexpensive and versatile for establishing and maintaining a website. Its interactive feature makes it superior to other advertising media. Below are some advantages offered by the WWW:

- ***Presence on the Web:*** It enables businesses to be in touch with several million people who have access to the World Wide Web with more and more added every day. No business can afford to ignore this many potential customers.
- ***Networking:*** It helps in developing lines of communication to enhance contact with potential clients and organizations. It helps in speedy and reliable communication and advertisement.
- ***Provide Business Information:*** It facilitates the websites to publish business services, hours, location, phone and e-mail for the public to view like any printed form of advertising. Unlike the conventional advertisement, the website provides instant communication with information about the business that may change regularly.
- ***Service to Customers:*** A website provides access to business information and services to their customers online that may not be available any other way. The customers can be from anywhere in the world and shop in online stores like never before and from the comfort of their homes. They can easily and quickly search the database to locate the exact item that they were looking for and purchase it online.
- ***Conduct Business:*** A website may provide means of doing business.
- ***Provide Files to Download:*** Details and information of products and services in the form of pamphlets, brochures, advertisements, and even a demonstration video can be downloaded from the company's website.
- ***Remote Office Access:*** It facilitates offices and employees to be in touch with one another from remote places to accomplish their tasks effectively.

2.31 Terminology Related to Internet

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- ***World Wide Web (the Web, WWW, W3):*** It is defined as a client-server information system using the Internet to access computers containing millions of hypertext documents. ***Web page:*** It is a single hypertext document written in Hypertext Markup Language (HTML) and described in HTML basics. This normally contains the basic information and links to navigate in the websites to which it belongs.
- ***Website:*** It is written in HTML and is a collection of linked Web pages on a Web server. Web server is the machine where a website is located or hosted. It may be organization owned or Internet Service Provider (ISP) owned.
- ***Home Page:*** It provides a point of entry to a Website with help. It also contains all relevant links of that particular website.
- ***Web Client:*** It refers to the computer and software used to access a website and web pages.
- ***Web Server:*** It is the computer or server which provides a space for hosting a website. The web client access web servers to retrieve information from a website.
- ***Web Browser:*** It is the client software used to explore and display web pages from a website.
- ***Search Engines:*** They are software that enables searching of the content available on Internet.
- ***Hypertext:*** It defines the documents containing embedded links (hyperlinks) to other documents or other parts of the same document.
- ***HTML:*** Hypertext Markup Language defines the rules for formatting a web page so that a web browser displays the page properly. The documents available on Web are developed, using the programming language called HTML, which may be considered as the foundation of the Web. It is the HTML and the other programming that make possible hyperlinks. The click ability feature of hyperlinks makes the web unique. The working of hypertext links depends upon the URL. Each hyperlink contains URL and you send a request by clicking on the link so that the requested document can be retrieved on your machine from other computer. It may be anywhere in the world. TCP/IP and HTML could make this possible. We may now define the HyperText Mark-up Language (HTML) as a standard format for documents on the WWW, which could be viewed by using WWW browsers.
- ***URL:*** It denotes Uniform Resource Locator. It is the address of a document on the World Wide Web. Web browsers enable a person to enter a known address of a web server or a specific document within that server. Addresses begin with http://, ftp://, gopher://, WAIS://, file:// etc.

- ***Protocols:*** They are sets of communication rules that enable client machines and servers to communicate accurately with each other.
- ***Hyper Text Transport* Protocol *(HTTP) :*** Hypertext Transfer Protocols are the rules that enable the transmission of web documents from one computer to another via the Internet. WWW is a client/server-computing environment. A client computer by clicking on a link requests a document from Web server. In order to serve the request of client, Web server uses a protocol called HTTP or Hyper Text Transport Protocol.

2.32 Web Browsers

A web browser is the software program used to access the World Wide Web, i.e., the graphical portion of the Internet. The first browser, called NCSA Mosaic, was developed at the National Centre for Supercomputing Applications lab at Illinois in the early 1990s. The easy-to-use point-and-click interface fuelled the growth of the Web. The web browser software program facilitates a user to display and interact with text, images, videos, music and other information typically located on a web page at a website on the www or a LAN. Text and images on a web page normally designed to provide hyperlinks to other web pages at the same or different website. Thus web browser enables point to point click to reach directly to the targetted web pages.

Some of the popular web browsers are Internet Explorer, Mozilla Firefox, Safari, AOL Explorer, etc. Web browsers belong to HTTP user agent category. Browsers also provide in accessing information provided by web servers in private networks or content in file systems.

Web browsers talk with web servers using HTTP (hypertext transfer protocol) to retrieve web pages. HTTP enables web browsers to provide information to web servers to retrieve web pages from them. Different web pages have a URL address starting with http:// for HTTP access. There may be different other URL types and their corresponding protocols and most of the browsers support them. FTP (file transfer protocol) is one of the examples of such types. Other examples are rtsp: for RTSP (real-time streaming protocol) and https: for HTTPS (an SSL encrypted version of HTTP).

The file format for a Web page is normally HTML (hyper-text markup language) and is identified in the HTTP protocol with a MIME content type. Most of the browsers support different formats such as the JPEG, PNG and GIF image formats including HTML. The combination of HTTP content type and URL protocol specification enables designers to embed images, animations, video, sound and streaming media into a web page or to make them accessible through the web page.

2.33 Search Engines

A search engine is an information retrieval system to access and retrieve information stored on WWW or a computer system attached to the Internet. Search engines enable to minimize the time required to find information and the amount of information on a

computer system. The computer system may be a standalone system or attached to the Internet. The search engines are popular among people as web search engines to explore information on the World Wide Web.

Search engines are interface to a group of contents that allows users to specify criteria about the content by providing some keywords so that the engine can find the several matching contents to the corresponding keywords out of million of webpages. The keywords provided are referred to as a search query. Several styles of search query syntax are used. Search query differs for different types of serch engines, whereas some search engines enable users to enter two or three words separated by space while other search engines may require users to provide entire documents, pictures, sounds, and various forms of languages. Some search engines attempt to enhnce the search queries to provide a quality set of items through a process known as query expansion.

Index-based Search Engine

In such engines, the list of items to meet the criteria specified by the query is typically sorted or indexed. Indexing contents by relevance from highest to lowest minimizes the time needed to explore the desired information. Some search engine uses probabilistic approach to rank contents based on measures of similarity, popularity or authority. Boolean search engines typically provide contents which match exactly without regard to order, although the term 'boolean search engine' may simply refer to the use of boolean-style syntax. Thus, in order to provide a set of matching contents that are sorted based on some criteria quickly, a search engine will typically collect metadata about the group of contents under consideration through a process called indexing. The advantge of index is that it needs a smaller amount of computer storage.

Types and Characteristics

Some of the popular search engines with their types and characteristics are given below:

Alta Vista: It is a crawler type which results ranked based on how many times search words appear in the text. It searches full text.

Excite: It is also a crawler type and uses meta tags.

Google: It is also a crawler type that performs based on the number of times other sites are linked to the ranked site.

Yahoo – It is crawler type and performs similar to Google.

2.34 Domain Name System (DNS)

Now we have two types of IP address in the form of decimal numbers and text for the same host. You know that lists of all IP addresses are maintained centrally by ICANN in the form of distributed database directory. There are several distributed servers, which maintain this list of IP addresses. The reasons behind the distributed servers are very logical and simple. It helps in disaster management and in diverting the load of the traffics in the form of requests from clients to other DNS servers located at different

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sites. DNS server maintains database in both forms that is textual and decimal notations. For example, DNS server maintains the address of google site as www.google.com and 2116.23.9.53.99. In this manner, DNS is used to provide host-to-IP address mapping of remote hosts to the local hosts and vice versa. It is now amply clear that the DNS maintains a distributed database to map between hostnames and IP addresses. Whenever a client requests a service from a site, the site runs DNS protocol to access the distributed database which is nothing but Domain Name Systems. Therefore, the DNS provides the protocol, which allows clients and servers to communicate with each other. DNS enables a system to use a resolver, which resolves the host name to IP address understandable by server.

You may be now thinking of how DNS is able to provide the quick translation of text of the IP addresses within fractions of seconds from a directory of billions of such addresses. This could be made possible by using Domain concepts, which uses hierarchical arrangements of text addresses translation.

You can see from Fig. 2.22 that at the top level is the root server, which has null label. Below this is another level domain or domain as com, edu, int and so on which are grouped together. Below this different sub domains or groups have been created. Table 16.1 below corresponds to some commonly appearing domain names with their respective sites. The DNS can accommodate almost all kinds of organizations by allowing each group to choose between geographical or organizational naming hierarchies.

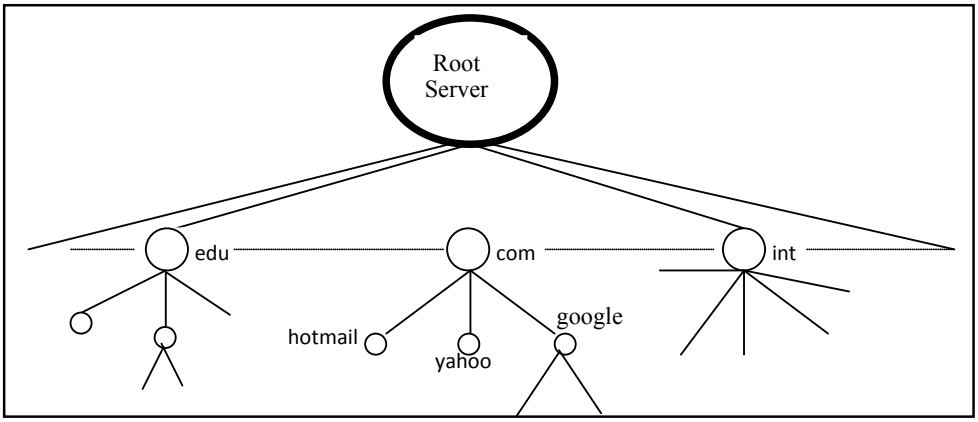

Fig. 2.22: DNS Hierarchy

Table 2.2: Internet Domains

Domain	***Indicative site***
Com	Commercial institute
Edu	Educational institute
Org	Nonprofit organization
Net	Network service provider
Gov	Government department
Mil	Military

Biz	Business
Country code	For example, in for India, us for the USA, au for Australia, jp for Japan and so on

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We know that the servers maintaining addresses are distributed and have locations throughout the world. Then this question arises as to how text addresses are organized in hierarchical arrangement. You may refer to Fig. 16.1 above and Table 16.1. The hierarchy is represented into zones and each zones is a hierarchy of one or more nodes without any overlapping. Each zone is represented by a server and undoubtedly with one backup server. Root server as shown in Fig. 16.1 is only one, which is just indicative; there may be several root servers at several locations in the world. Each root is aware of the location of each DNS server of specific domains.

The process is now very simple to understand. When you need to connect with a particular site, you first send your request to your local host. If your local host can provide the translation, your request is completed. If not, your local host then sends your request one level above in the hierarchy. If the server at one level above is able to handle the same, you get your intended website at your desktop through your local server. If not, then the server at one level above from your local server either sends your request again to another server or informs your local server that your request is failed and gives the address of another server to process your request. This process continues till a server is found who knows the address, otherwise, the request is filtered up to the root server. Depending upon the domain address, root server forwards the request to the one of the domain servers represented at the next level of hierarchy. This process continues and the information of text address is returned to Root server and then back to your local server.

2.35 Electronic Mail

Electronic mail is one of the most popular network services. The use of Electronic mail, or e-mail may probably be cited as the foremost reason for the popularity of Internet. The proliferation of cyber café can be credited to e-mail or World Wide Web. E-mail provides an efficient and fast means of communication with relatives, friends or colleagues throughout the world. You cannot only communicate with one person at a time or thousands but also you can receive and send files and other information in a short time. In an e-mail communication, the intended receiver or receivers of the message are not required to be present at their desktop at the time of receiving of the message by their computer. It works like a postal mail. In a postal mail postman puts the sender's message in your mailbox and when you come back from your work, you access your mailbox to retrieve the message. Therefore, we may consider it in a way a substitute of postal mail. However, it has many-many more superior features than postal mail. E-mail has two parts:

User Agent: It is the user interface to the mail system. The user agent system enables to provide ways to view, edit, and reply to messages, etc. It also accesses messages stored

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in a system mailbox. The user agent enables the user to use a text editor to create a file that the user agent hands over to the message transfer agent.

Message Transfer Agent (MTA): It is a software package that transports messages created by a user to destination mailboxes possibly on remote machines. The MTA has to perform more complex jobs than other applications:

1. MTA handles temporary failures when a destination machine is temporarily unavailable; it stores the message on the local machine for later delivery. Thus, the User Agent typically just stores messages into a storage area.
2. MTA distinguishes between local and remote recipients.
3. MTA needs to deliver copies of a message to several machines.
4. MTA has to allow mixing text, voice, and video in a message and appending documents and files to a message.

As discussed above, the email addresses consist of the following components:

Mailbox names: A mailbox is associated with one login id within a mail server to store the emails of the user. Therefore, a specific name is provided to the mailbox associated with each IDs.

Symbolic names: It refers to the name of a service rather than a specific user. For example, a postmaster is universally recognized as an address for post mail problems. In email system, the symbolic names are aliases for specific mailboxes.

Group names (mail exploders): It refers to an alias for a set of recipients. MTA consults an internal database to specify the mail addresses.

2.36 I.P. Address

IP address is short for Internet Protocol (IP) address. An IP address is an identifier for a computer or device on a TCP/IP network. Networks using the TCP/IP protocol route messages based on the IP address of the destination. Contrast with IP, which specifies the format of packets, also called datagrams, and the addressing scheme.

The Format of an IP Address

The format of an IP address is a 32-bit numeric address written as four numbers separated by periods. Each number can be zero to 255. For example, 1.160.10.240 could be an IP address.

Within an isolated network, you can assign IP addresses at random as long as each one is unique. However, connecting a private network to the Internet requires using registered IP addresses (called Internet addresses) to avoid duplicates.

Static Versus Dynamic IP Addresses

An IP address can be static or dynamic. A static IP address will never change and it is a permanent Internet address. A dynamic IP address is a temporary address that is assigned each time a computer or device accesses the Internet.

The four numbers in an IP address are used in different ways to identify a particular network and a host on that network. Four regional Internet registries -- ARIN, RIPE NCC, LACNIC and APNIC-- assign Internet addresses from the following three classes:

Class A - supports 16 million hosts on each of 126 networks

Class B - supports 65,000 hosts on each of 16,000 networks

Class C - supports 254 hosts on each of 2 million networks

The number of unassigned Internet addresses is running out, so a new classless scheme called CIDR is gradually replacing the system based on classes A, B, and C and is tied to adoption of IPv6. In IPv6 the IP address size is increased from 32 bits to 128 bits.

What is My IP Address?

To view your IP address you can use the ipconfig (IPCONFIG) command line tool. Ipconfig displays all current TCP/IP network configuration values and refreshes Dynamic Host Configuration Protocol (DHCP) and Domain Name System (DNS) settings.

To launch the command prompt from a Windows-based computer click: Start > All Programs > Accessories > Command Prompt. Type ipconfig and press the Enter key.

You can also use Google search to find your IP address. Type "what is my IP address" as a search query and Google will show the IP address of the computer from which the query was received as the top search result.

2.37 Intranet

An intranet is a private computer network built inside Organization Company or a university. Intranet uses internet protocols with some times wired and sometimes wireless medium network connectivity to securely share part of an organization's information or operations with its employees and students respectively. Intranet can also be described as the organizations own private inter accessible website that holds all the information on running matters of the organization. The same concepts and technologies of the Internet such as clients and servers running on the Internet protocol suite like Hyper Text Transfer Protocol (HTTP) and File Transfer Protocol (FTP) are used to build an intranet.

The use of intranet is increasing in the corporate sector day by day for the sharing of information and applications, collaboration between various companies to solve a common problem, teleconferencing, sharing the sophisticated corporate directories, sales and customer relationship management tools like MS project manager etc., to advance productivity.

2.38 File Transfer Protocol (FTP)

The File Transfer protocol is among the oldest protocols still used in the Internet. FTP is widely available on almost all browsers indicating that all computing platforms, including DOS, OS/2, UNIX, and up to the mainframe level have this service available. You can very well understand from its name that it facilitates the majority of file transfers across

the Internet. In other word, FTP is a file server access protocol that enables a user to transfer files between two hosts across the network or Internet using TCP. You may see the versatility of this application layer protocol, it accomplishes its job even intended hosts at separate locations could potentially be running different operating systems, using different file storage systems, and using different character sets. Accessing FTP sites over the Internet requires that the user must have the knowledge of the location and the name of the desired files.

Unlike Telnet, FTP does not require any familiarity with the remote operating system. The user is still required, however, to be familiar with the FTP command set built into the protocol itself so that he or she can productively manage the session.

Modern FTP servers known as ftpd support two different TCP connections, viz., control and data connections. First control connection is invoked for the entire duration of transfer of file or FTP session. It facilitates the exchange of commands issued by the client, and replies originating from server. Data connection is established as and when it is required. Its main function is to facilitate transfer of files and directory listings to and from the client at the client's request.

Whenever you wish to do FTP, you need to invoke a few commands. These commands basically are related to transfer a file from remote computer to your computer or from your computer to the remote computer. There are anonymous as well as authorized privileges with regard to transfer of a file from a server. In case of anonymous FTP servers, you can do FTP without authorization. You need to login with a username, which is anonymous, and a password that is your e-mail address. Apart from this, there are authorized servers for which you need to register before you are permitted to do FTP. After registration, you will get a password.

Trivial File Transfer Protocol (TFTP)

TFTP, like FTP, is also an Internet service intended for the transfer of files from one computer to another over a network. It does not provide password protection or user directory capability. Unlike FTP, however, TFTP does not rely on TCP for transport services. Instead, TFTP uses UDP to shuttle the requested file to the TFTP client. Furthermore, diskless devices that keep software in ROM to use it to boot themselves can use it. It is simpler than the File Transfer Protocol (FTP) but less capable. FTFTP facilitates to quickly send files across the network with fewer security features than FTP.

2.39 Simple Mail Transfer Protocol (SMTP)

Electronic mail (E-mail) is considered the most widely used TCP/IP application. The Internet mail protocols enable a client machine to exchange mail and message between TCP/IP hosts. Three standard protocols are applied to provide such mail application. The SMTP is one of them. The three standards are given below:

- ***SMTP:*** It is a standard for exchange of mail between two computers (STD 10/RFC 821), which specifies the protocol used to send mail between TCP/

IP hosts.

- ***Mail:*** It is a standard (STD 11) defining the format of the mail messages, syntax of mail header fields, a set of header fields and their interpretation and about a set of document types other than plain text ASCII to be used in the mail body.
- ***DNS-MX:*** It is a standard for the routing of mail using the Domain Name System (RFC 974).

SMTP, an application layer protocol, is used to send e-mail messages across the Internet. It utilizes TCP as the transport protocol to send email to a destination mail exchanger, referred to as mail server. A client machine sends email to a mail exchanger or an email is sent from mail exchanger to another mail exchanger. E-mail transmitted using SMTP is normally transmitted from one mail exchanger to another directly. E-mail was never designed to be instantaneous but it appears so often.

Mail Exchangers are nothing but the software application programs to support the SMTP protocol. Mail Exchangers such as sendmail or Microsoft Exchange wait for IP datagrams that arrive on the network interface with a TCP port number of 25. When a message is arrived, the mail exchanger checks to find out if it is for one of its users and accordingly move the mail to the user's mailbox. The data sent using SMTP is 7-bit ASCII data, with the high-order bit cleared to zero is found adequate in most instances for the transmission of English text messages, but is inadequate for non-English text or non-textual data. To overcome these limitations, Multipurpose Internet Mail Extensions (MIME) defines a mechanism for encoding text and binary data as 7-bit ASCII within the mail envelope and SMTP Service Extensions specifies a mechanism to extend the capabilities of SMTP beyond the limitations.

How SMTP Works

SMTP is end-to-end delivery in which an SMTP client machine contacts the destination host's SMTP server directly to deliver the mail. Unlike the store-and-forward principle that delivers the mail content to the destination host through a number of intermediary nodes in the same network, SMTP continues the mail content being transmitted until it has been successfully copied to the host's SMTP. In case of store and forward mechanism, the successful transmission from the sender only indicates that the mail content has reached the first intermediate hop. There are instances when mail is exchanged between the TCP/IP SMTP mailing system and the locally used mailing systems. Such applications are referred to as mail gateways or mail bridges. However, SMTP guarantees only delivery to the mail-gateway host, not to the real destination host, which is located beyond the TCP/IP network. In case of a mail gateway, the SMTP end-to-end transmission is host-to-gateway, gateway-to-host or gateway-to-gateway. SMTP does not specify the format of mail beyond the gateway.

- Each message of SMTP contains the following fields:
- A header or envelope that is terminated by a null line.

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Contents: Everything after the null or blank line is the message body with sequence of lines containing ASCII characters.

Simple Mail Transfer Protocol defines a client/server protocol. The client SMTP machine initiates the session by sending SMTP message and the mail server responds by receiving SMTP message to the session request.

Mail Exchange

The SMTP design is based on the model of communication illustrated in Fig. 2.23. After the client machine mail request, the sender-SMTP sets a two-way connection with a receiver-SMTP. The receiver-SMTP may be the destination machine or an intermediate machine (mail gateway). The sender-SMTP will initiate commands which are replied to by the receiver-SMTP.

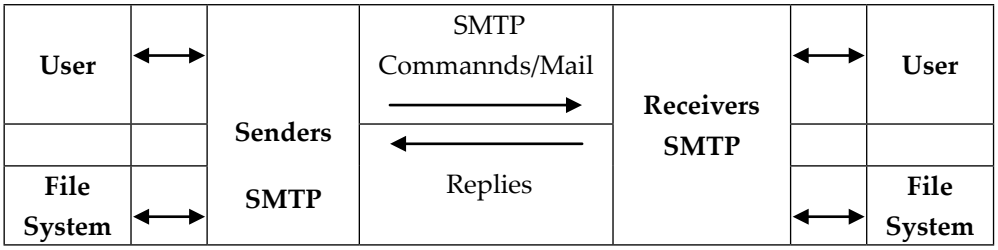

Fig. 2.23: SMTP Communication

1. The client machine SMTP sets a TCP connection with the destination machine SMTP and then waits for the server to send a service ready message or a service not available message.
2. HELO (HELO is an abbreviation for hello) is sent and the receiver machine will identify itself by sending back its domain name. The client machine SMTP uses this to verify if it reached the right destination SMTP. If the client machine SMTP supports SMTP Service Extensions, it substitutes an EHLO command in place of the HELO command. A destination machine SMTP which does not support service extensions responds with a 500 Syntax error, command unrecognized message. The client machine SMTP then retries with HELO, or if it cannot transmit the message without one or more service extensions, it should send a QUIT message. If a receiver-SMTP supports service extensions, it responds with a multi-line 250 OK message which includes a list of service extensions which it supports.
3. The client machine now initiates the start of a mail transaction by sending a MAIL command to the destination machine. This command has the reverse-path that is used to report errors. It should be noted that a path is more than just the user mailbox@ host domain name pair. Besides, it has a list of routing hosts.
4. The next step of the actual mail exchange provides the server SMTP with the destinations for the message, the message may go to more than one recipient. This is accomplished by sending one or more RCPT TO:<forward-path> commands.

Each of them will receive a reply 250 OK when the destination is known to the server or a 550 No such user here when it is not known to the server.

5. When all RCPT commands are sent, the sender forwards a DATA command to notify the destination machine that the message contents are following. The server replies with 354 Start mail input, end with <CRLF>.<CRLF>. It should be noted that the ending sequence that the client machine uses to terminate the message data.
6. The client machine now sends the data line by line ending with the 5-character sequence <CRLF>.<CRLF> line upon which the destination machine acknowledges with a 250 OK or an appropriate error message when anything went wrong.
7. Now, there are several possible actions:
   (i) The destination machine has no more messages to transmit, it will end the connection with a QUIT command. This command is answered with a 221 Service closing transmission channel reply.
   (ii) The destination machine has no more messages to transmit, but it is ready to receive messages (if any) from the other side. It will issue the TURN command. The two SMTPs now switch their role of sender/receiver and the client machine that was previously the destination machine now transmits messages by starting with step 3 above.
   (iii) The client machine wants to transmit another message and simply follows step 3 to transmit a new MAIL command.

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2.40 Telnet – Remote Login

A remote login facility enables a user to create a login session to a remote machine and then execute commands. Telnet is an Internet standard remote login protocol to connect a local terminal with a remote login session. It copies keystrokes to the remote machine and copies output from the remote machine to the source machine. Telnet is a program that allows a user with remote login capabilities to use the computing resources and services available on the host. It emulates the remote terminal on your desktop and therefore referred to as terminal emulation protocol of TCP/IP. Telnet can also be used to connect other ports serving user defined as well as well-known services. It works as client server model where it establishes a virtual connection using the TCP transport protocol. The telnet program requires two arguments, i.e., the name of a computer on which the server runs and the protocol port number of the server. After establishing connection, the Telnet server and client enter a phase of option negotiation to determine the options that each side will like to support for the connection. They are always free to change their options even after establishing the connection. This provides it a versatile terminal emulation due to many options. It can transfer binary data, support byte macros, emulate graphics terminals, and convey information to support centralized terminal management.

Telnet service is unique in the same that it is not platform-specific like other TCP/IP services. A DOS user running Telnet, for example, can connect to a UNIX host or a mainframe computer. The down side of using Telnet, however, is that, unless the user

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is familiar with the operating system running on the remote platform, he or she cannot use the desired resources easily. Telnet aims to provide three services:

- Telnet defines a Network Virtual Terminal (NVT) standard to describe a standard terminal. Client programs then interact with the NVT. The server translates NVT operations into specific commands to the actual hardware/ operating system.
- Telnet enables the remote machines connecting together to negotiate options with one another. Option negotiation makes agree both the remote machines on a common level of service.
- Telnet treats connections of the remote machines symmetrical and enabling them to use programs. Telnet also defines data and command sequences to deal with heterogeneity. The client machine translates keystrokes into NVT format and sends them to the server machine at remote location. The server machine translates NVT operations into the appropriate local representation.
- Some of the Telnet commands are given below:
  - Interrupt process (IP) – It terminates the running program.
  - Abort output (AO) – It refers to discard any buffered output.
  - Are you there (AYT) – This command allows client to send an out-of-band query whether to verify the remote end is still there.
  - Erase character (EC) – It refers to erase the previous character.
  - Erase line (EL) – It deletes the entire current line.
  - Synchronize – It clears data path to remote party.
  - Break – It is equivalent of the BREAK or ATTENTION key.

2.41 Hyper Text Transfer Protocol

In order to access any website, the web browsers are used which are assisted by the URL that uses the http scheme. It is the URL or the port number that assists the browser to link with a Website. The server indicates a computer connected to the Internet while the port number indicates a type of socket to which the browser plugs in to link with the web server. The web server not only provides the requisite web pages but also describes a computer program that runs on a computer to provide web pages. When a browser receives a URL will attempt to connect with the server computer having the required web pages by connecting to the specified port number. The URL can be provided to the browser either by typing it at its specified location or by clicking on the link available on some already displayed web page or document.

It is the role of the browser to connect with the server where the requisite requests from client or user is stored or available. When the web server receives the request from the browser, it replies back to the browser, which is client in this case. The information basically contains the HTTP protocol version, name of the server, the media type of the document and date, etc. The media type of the document is a quite important information

because the browser is required to know what kind of document this is before it can process it. HTML is the most common media type transferred over the Web. Other media types are GIF image and JPEG image. Several times a response like "HTTP 404 Not Found" is displayed, which means that the request document is not available at the link. There are different responses defined in HTTP. Briefly, in order to access a web page, HTTP involves browser that issues a request followed by a few headers. In response, the server replies back with a few headers and a document.

The web server basically maps the URLs to files on its hard disks. The web server interprets the path in any URL to map it with a filename on its hard disk. In order to make it work to map with the requisite file, the web server is configured to contain a "document root" directory relative to which all URLs are resolved as filenames. Let us take an example, suppose the URL is http://myspace.tutorial.in, and the document root is D:\WWWFiles\. When a user types the URL http://myspace.tutorial.in/ lesson1/ networking.htm into browser, the browser requests the server for the document /lesson1/ networking.htm. The web server begins searching in the directory D:\WWWFiles\lesson1 for a file called networking.htm. If the requisite file is available it responds with a header followed by the document. If it is not available, it responds a 404 Not Found followed by a helpful error message telling the user to search elsewhere.

2.42 Different Applications of Internet

In order to access any website, the web browsers are used which assist Internet is interconnection of large number of heterogeneous computer networks all over the world that can share information back and forth. These interconnected networks exchange information by using same standards and protocols

2.43 Applications of Internet

The internet is treated as one of the biggest inventions. It has a large number of uses.

1. ***Communication:*** It is used for sending and receiving message from one and other through internet by using electronic mail. Some of the websites providing this service are yahoomail.com Hotmail.com rediffmail.com etc
2. ***Job searches:*** Getting information regarding availability of job in different sectors and areas. You can publish your resume is online for prospective job. Some of the websites providing this service are naukri.com, monster.com, summerjob.com, recuritmentindia.com, etc.
3. ***Finding books and study material :*** Books and other study material stored around the world can be easily located through internet. Latest encyclopaedias are available online.
4. ***Health and medicine:*** Internet provides information and knowledge about field of health medicine people can have information about various disease and can receive help .patient can be taken to virtual check room where they can meet doctors.

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5. ***Travel:*** One can use internet to gather information about various tourist places . It can be used for booking Holiday tours , hotels, train and flights. Some of the web sites providing this service areindiatravelog.com, rajtravel.com, makemytrip.com.
6. *Entertainment:* One can download jokes, songs movies, latest sports, update through internet. Some of the web sites providing this service are cricinfo.com, movies. com espn.com
7. ***Shopping:*** Internet is also used for online shopping. By just giving accounts details you can perform the transaction. You can even pay your bills and perform bank related transaction.
8. ***Stock market updates:*** You can sell or buy shares while sitting on computer through internet. Several websites like ndtvprofit.com, moneypore.com, provide information regarding investment.
9. ***Research:*** A large number of people are using internet for research purposes.you can download any kind information by using internet.
10. ***Business use of internet:*** Different ways by which intenet can be used for business are:
    - Information about the product can be provided online to the customer .
    - It provides market information to the business.
    - It helps business to recruit talented people.
    - It helps in locating suppliers of the product.
    - Fast information regarding customers view about companies product.
    - Eliminates middle men and arranges a direct contact with customer.

2.44 Electronic Commerce

E-commerce is a selling and transfer process requiring several institutes. It is systematic and organized network for the exchange of goods between produces and consumers. The Net aims to establish the interconnections between producers and consumers directly and in this, the Internet embraces all those related activities which are indispensable for maintaining a continuous, free and uninterrupted distribution and transfer of goods. The Website or portals may be categorized into commercial and non-commercial.

Any website or portal that offers products and/or services for sale is a commercial website. There are thousands of commercial web sites on the Internet. Some of them have been successful, and some weren't so lucky. What elements make up a good commercial web site? Of course, web pages should look attractive to a customer. However, even the most attractive web pages will not make a person come back to a website where it takes too long to find the right product or where order forms don't work. In this unit we will discuss what functionality is needed for a successful commercial web site and what technology implements various web site elements.

Definition of Electronic Commerce

E-commerce is a general concept covering any form of business transaction or information exchange executed using information and communication technologies (ICTs). E-commerce takes place between companies, between companies and their customers, or between companies and public administration. E-commerce includes electronic trading of both goods and electronic material.

"e-commerce denotes the use of electronic transmission media (telecommunication) to engage in the exchange of products and services requiring transportation either physically or digitally, from location to location". —M. Greenstein and T.M. Feinman

"e-commerce describes the process of buying and selling (or exchanging) of products, services and information via computer networks including the internet".

—E. Turban and others.

E-commerce is the means to complete online transaction and integrate the supply chain into the transaction management process such as receiving orders, making payments and tracking down the deliveries or order.

According to World Trade Organization (WTO): "E-commerce as a commercial process includes production, distribution, marketing, sale or delivery of goods and services electronically."

E-commerce is used everywhere in everyday life. It ranges from credit/debit card authorization, travel reservation over a phone/network, wire fund transfers across the globe, point of sale (pas) transactions in retailing, electronic banking, electronic insurance, fund raising, political Campaigning, on-line education and training, on-line auctioneering, on-line lottery and so on.

2.45 Digital Organization

Given the wish of some designers to be able to digitally express form and to integrate their expressions into a process of analysis, what then happens to these design intentions in the context of office practice? One would expect creative design practices to exploit emerging digital technologies in imaginative ways that support the realization of their design visions. On the other hand, it is evident that offices of a more corporate nature are more readily influenced by administrative diktat and managerial doctrine and guidance. Sir Michael Latham's report, Constructing the Team, aimed to provide guidelines for the organization of the construction industry in the United Kingdom. If defined the responsibilities of designers, clients and contractors in terms of deliverable outcomes. The report also commented upon patient issues in the construction industry ranging from the role of clients through to tendering procedures, contracts, and resolving disputes, particularly in relation to payments. At various points in the report, comments in turn led to firmer recommendations on specific topics. It is evident that the Latham Report has already had a significant effect on working practices in the UK construction industry. A favour of its effect on design practice can be gleaned by looking at some of its observations and aspirations in more details.

Once a prospective client has decided that a project should proceed in principle, and roughly how much risk and direct involvement to accept, the project and design briefs can be prepared. The client who knows exactly what is required can instruct the intended provider. That may involve appointing a Project Manager, or a client's representative to liaise with the designers, or a lead designer, or a contractor for direct design and build procurement.

It could be argued that clients today have a better appreciation of quality than they may have had prior to the Latham Report. Some clients realize that the panache of projects is invariably design driven, and see architects as capable of managing projects themselves. Do project managers inhibit this design impetus?

- A lead manager
- The co-ordination of the consultants, including and interlocking matrix of their appointment documents which should also bare a clear relationship with the construction contract.
- A detailed check list of the design requirements in the appointment documents of consultants. This should also be se out in the main context documentation.
- Ensuring the client fully understands the design proposals.
- Particular care over the integration of the building services design, and the avoidance of "fuzzy edges" between consultants and specialist engineering contractors.
- The use of Coordinated Project Information
- Signing off the various stages when they have been achieved, but with sufficient flexibility to accommodate the commercial wishes of clients.

2.46 Internet based Business Models

The last thing you want to do is throw up a Website or a Web page, include an email address, and call it done! Regardless of the type of business, you have to determine what you're going to do behind the scenes and how your electronic commerce efforts will fit in with your regular business processes.

There is no simple step-by-step list of things you need to do to establish an E-commerce process, no "one size fits all" method. But remember these facts:

- It's not cheap.
- It's not easy.
- It's not fast.

Some companies have spent millions of dollars only to fold up their E-commerce operations because they just weren't working. Some companies have built a Website without thinking through the entire process; only to find out they have seriously hurt their normal operations. Some companies have realized that E-commerce was simply not the Holy Grail it was made out to be.

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You need to analyze what you want the mission of the Website to be. Are you going to have a Website that simply offers information about your company and its products? Are you going to sell only to consumers? What impact will that have on your current retail outlets? How are you going to get people to your Website in the first place? How are you going to keep them coming back? If you sell business-to-business, do you have the back-end processes in place to handle the increased sales? Who will host the Website: your company internally? A Web host service?

Who's going to create the Website, what services will you offer on it, and how are you going to keep your information secure?

We don't mean to discourage you from electronic commerce; just the opposite. Thousands of businesses are finding new opportunities to connect to customers, suppliers, and employees.

Table 2.3: Internet Business Models

Category	Example
Virtual Storefront	Amazon.com
Marketplace Concentrator	ShopNow.com
Information Broker	Travelocity.com
Transaction Broker	Ameritrade.com
Auction Clearinghouse	EBay.com
Digital Product Delivery	Bluemountain.com
Content Provider	WSJ.com
On-line Service Provider	Tuneup.com

The above table shows some ways companies use the Internet to conduct business. Even more intriguing is the disruption new, upstart companies are causing in traditional industries. MP3.com introduced the Rio music appliance, which uses music downloaded for free from Web sites. Recording companies are jumping through hoops trying to respond to this threat to their business.

2.47 Customer-Centered Retailing

Some of the most successful consumer E-commerce companies have found that it isn't enough to set up a Website to sell products: consumers want information about the products themselves and how to integrate the products into their lives.

Amazon.com, probably the most talked-about consumer retail Web site, doesn't just sell books and CDs. It also offers book reviews from other customers, links to other books related to the one they're purchasing and the opportunity to purchase gifts for friends and relatives which are then gift-wrapped and sent out. Amazon.com is moving into other markets such as online auctions and now owns part of an online grocery shopping service.

Disintermediation, removing the middleman, has allowed many companies to improve profits while reducing prices. Now we're starting to see a phenomenon called

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reintermediation, the process of creating new middlemen. Many people are concerned about selling products online because of the possibility of fraud.

Let's say you want to sell an antique car through your Web site. A stranger in Ohio e-mails you with an offer of $10,000. You hesitate to seal the deal because you don't know anything about this individual. You can use an electronic escrow service that will hold the buyer's funds to ensure he receives the merchandise while you make sure you get paid. Online auction services such as eBay.com offer a form of reintermediation through their Web sites to get buyers and sellers connected. That's the great thing about the Internet: One door closes and another door opens!

Information Technology (IT) has been applied to support information sharing between organizations and to streamline corporate purchasing. Such IOISs , as they are often referred to, can form electronic marketplaces where buyers and sellers in a vertical market can exchange information and make transactions. Before the commercial application of the Internet and the World Wide Web, proprietary information systems such as electronic data interchange (EDI) systems were the major means by which firms exchanged business documents electronically in a standard machine-processable format. Although the EDI systems continue to enable firms to achieve more efficient data and information management and to improve supply chain management, there are still a lot of companies that do not yet use EDI due to the relatively high costs of implementing and running such systems.

Internet-based e-procurement systems and business-to-business (B2B) electronic marketplaces are different from proprietary IOISs that involve EDI. They are open systems that enable firms to reach and transact with suppliers and customers in virtual markets without investments in dedicated systems. Figure 2.24 displays the above three IT-enabled procurement mechanisms.

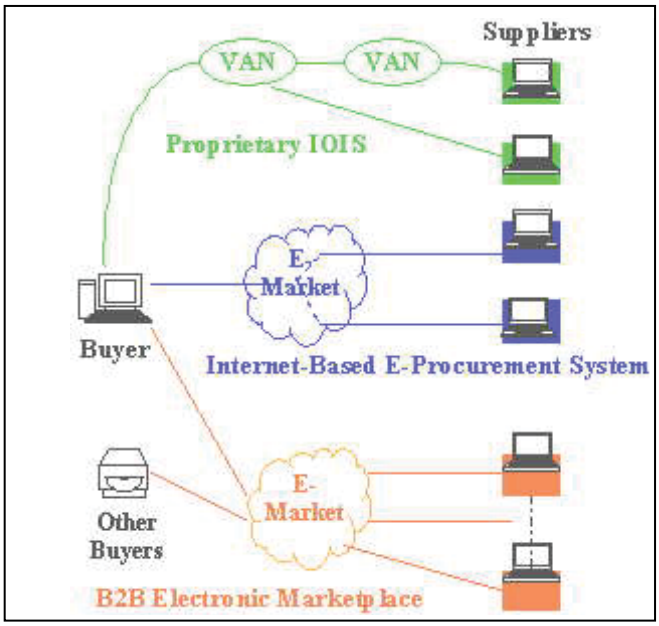

Fig. 2.24: IT-Enabled Procurement Mechanisms

According to a recent report, the value of goods and services sold via B2B electronic markets will reach $2.7 trillion by year 2004, representing some 27% of the overall B2B market and almost 3% of global sales transactions. This growth is slated to occur in the context of a global market for B2B transactions worth $953 billion, growing to about $7.29 trillion by 2004. With more corporate procurement completed online every month, the number of virtual marketplaces in the United States has soared from 300 in June 1999 to more than 1000 in 2000. It is clear that by offering lower prices and a wider range of suppliers, electronic markets are changing the way firms procure their materials, equipments and supplies.

By connecting in the new electronic marketplaces of the World Wide Web, a buyer firm is able to streamline its purchasing activities electronically, even when not all of its suppliers can automatically process electronic orders.

Example: H-E-B Food Stores, a $7-billion supermarket chain, purchases its wholesale supplies via Inc2Inc.com (www.Inc2Inc.com), a new electronic marketplace, instead of using proprietary extranets. H-E-B Food Stores does this because it has suppliers who do not have automated computerized systems, but still they can be integrated for purchasing via the Internet and a Web system. In this way, H-E-B Food Stores is still able to transact with those suppliers, even when the company is in the midst of automating its purchasing processes. Recognizing the benefits from its initial testing, the firm plans to move 80% of its procurement online.

B2B electronic markets function as digital intermediaries that focus on industry verticals or specific business functions. They set up virtual marketplaces where firms participate in buying and selling activities after they obtain membership.

Example: CheMatch.com (www.chematch.com) is a B2B exchange for buying and selling bulk commodity chemicals, polymers and fuel products. Firms subscribing to CheMatch.com can log onto its virtual exchange floor, and then post requests to buy and offers to sell, and respond to offers. When two firms agree to transact, the transacting terms are faxed to both parties and the deal is settled. The marketplace creates value by bringing buyers and sellers together to create transactional immediacy and supply liquidity, and by supporting the exchange of demand and supply information.

E-procurement systems are usually integrated with corporate enterprise systems and organizational intranets. They typically consist of two parts. One part resides on the top of the company's intranet behind its firewall, where employees can search and place order for desired supplies. The purchase orders, after they have been approved and consolidated, are sent out to a third party, usually a neutral electronic marketplace. This is where the second part of the e-procurement system resides. At the electronic marketplace, these orders are transformed into various formats according to different protocols so that they can be received and processed by different suppliers. The major benefits of adopting e-procurement systems are reduced operating costs and searching costs, which lead to high returns on investments.

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How Internet Business Models Work

While there are many e-commerce business models, most depend on two fundamental building blocks: businesses (B) and consumers (C). From this foundation, you can derive four basic models: B2B, B2C, C2B, and C2C. Somehow, most businesses (both online and off) fall into one or more of these categories, although they use a wide variety of ways to link buyers, sellers, and manufacturers. A business might sell goods it has manufactured itself, resell those made by another company, or simply act as a middleman, connecting the buyer and seller. The revenue streams flowing between these parties is potentially even more complex, because one company might (and should!) have numerous sources of revenue, ranging from product sales to affiliate commissions and advertising income.

The various model of Internet business are:

Business-To-Consumer

The business-to-consumer (B2C) business model is perhaps the most familiar e-commerce model. Vendors sell goods and services over the Web to connected consumers.

Web retailer Amazon.com is an example of a purely online model. Classic brick-and-mortar businesses such as Williams-Sonoma have become bricks-and-clicks shops, selling products online that are also old in their physical outlets.

Example: Gear.com, Barnes&Noble.com, and Gateway.com

Business-To-Business

Business-to-business (B2B) commerce is less in the public eye than B2C but is a rapidly growing segment of the Internet economy. In this model, businesses offer goods and services to other businesses over the Internet. For instance, Safetylogic.com provides corporations with an easy way to distribute safety materials to satellite plants and fill out OSHA reports online. We will discuss B2B in detail later in the unit.

Example: Extensity.com, StaplesLink.com, Lexis-Nexis

Consumer-To-Business

Consumer-to-business (C2B) describes a system where consumers use an online agent to look for a product or service that suits their needs. Priceline.com is a prime example of the C2B model.

Example: ShopBot.com, AutobyTel.com

Consumer-To-Consumer

Consumer-to-consumer (C2C) businesses act as agents between consumers with goods and services to sell. Online auction site eBay is perhaps the most prominent online C2C company.

Example: Excite classifieds, Yahoo! Auctions

Peer-To-Peer

Peer-to-peer (P2P) is a relatively new e-commerce model. Not unlike C2B and C2C, online agents assist in P2P transactions. P2P businesses transact exchanges of information (such as files or dollar amounts) between PCs or hand-held computing devices.

Example: 1. Napster is currently the most prominent example of an online P2P business.

2. PayPal, ProPay, Ecount.

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2.48 Business-2-Business (B2B) Model

Traditionally, when one thinks of business paradigms, one of the first things that springs to mind is the concept of companies selling to consumers. The department chain store or the big box store down the street are prime examples of this business model. Historically, this meant that the business had a brick-and-mortar location where it employed its own personnel. Even with the advent of the Information Age, this model changed only slightly, with information technology being used to support the way that business was done by making standard operations more efficient.

Example: Manual cash registers have been replaced in most modern businesses by high tech models that keep track of various aspects of transactions including tender type (i.e., whether the transaction was cash, check, charge, etc.) and amount paid as well as inventory control information or other administrative data. Such automated information collection makes closing the store at night and balancing the books a much easier task and can also help store and chain managers to make decisions about the type of inventory to carry, new services that could be offered to customers, and demographics that can be used in marketing efforts.

However, information technology not only allows organizations to perform various business processes more efficiently, in many cases it also allows them to reengineer organizational processes by improving the effectiveness and efficiency of the various processes within an organization. With advances in information systems, however, this model can now be taken a step further. Electronic business-to-consumer paradigms allow a business to market and sell directly to consumers.

Example: Business model include Amazon.com, (the online purveyor of books and a wide variety of other items) and Travelocity (the online travel agency) businesses that sell electronically directly to consumers.

However, not all businesses sell directly to consumers, nor should they. Automobile parts manufacturers frequently sell to the automotive industry rather than to the car owner. Precious stones' miners sell to the gem industry where the stones are cut and sold, in turn, to jewelers and suppliers who, in turn, sell to suppliers.

Pharmaceutical companies sell to directly or indirectly to pharmacies and hospitals who sell the products to customers. As with business to consumer paradigms, the model of business-to-business (B2B) commerce has been revolutionized by advances in information technology and systems.

Despite the increasing popularity of business-to-consumer e-commerce with its ease of ordering and comparing items online, many experts predict that business-to-business transactions will exceed those of business-to-consumer e-commerce. This makes sense.

Example: Although a consumer may order a book over the Internet, the business from whom the book is purchased not only has to interact with the purchaser but also with the publisher who printed the book. The publisher, in turn, needs to interact with the paper and ink suppliers, the maintenance firm that keeps the printing presses running, the authors who submit their manuscripts online, and so forth.

Business Models for Conducting B2B E-Commerce

Just as there are different business models for non-electronic businesses, there is also more than one model for business-to-business e-commerce. In general, a business model is an organization's approach to doing business. Although there are many different business models available, most business models have several core concepts in common.

- At the level of the most basic business model, an organization must have something of value to offer to the marketplace, whether it be goods, products, or services.

Example: A bookstore may offer books and magazines as well as various services such as special ordering. To be successful, the thing which the organization offers its customers needs to be of value – something that the customer either wants or needs (or both).

- Another part of the business model is the customer – the target market to whom the organization is trying to sell its offering. The business model needs to articulate how the business will gain, maintain, and foster relationship with customers.
- In order to get the product into the hands of the customer, the organization also needs an infrastructure in place. The infrastructure includes such things as having the right mix of people and skills necessary to produce the product as well as to run the business. This may include not only the people working directly for the organization, but partners as well who provide skills or services that business does not provide for itself but that are necessary to get the product into the hands of the customer. This may include companies that provide complementary skills necessary to make the product (e.g., suppliers) as well as supply chain partners that provide raw materials, supplies, or components or that distribute, warehouse or sell finished products.
- The business model also needs to include consideration of the company's income and cash flow as well as its cost structure.

Systems for Improving B2B E-Commerce

Business-to-business e-commerce is still in a state of flux as enterprises learn how to leverage information technology in general and the Internet in particular into systems that help them more efficiently and effectively does business. Observers are looking at several.

- First, to make business-to-business e-commerce worthwhile, systems need to evolve to handle not only simple transactions but complex ones as well.

To facilitate this need, standards will need to be developed and put into place.

- In addition, as markets become more competitive, transaction fees will most likely decrease or even disappear. Among other implications, this means that providers will need to shift from dealing in transactions to offering more comprehensive solutions to business needs.

For example, products can be bundled with related information and services in an effort to forge customer loyalty and long-lasting relationships.

New business-to-business models will continue to appear as technology continues to evolve and enterprises seek creative solutions.

Among new business-to-business e-commerce models that are beginning to emerge are the mega exchange that maximizes liquidity and sets common transaction standards, the specialist originator that deals with complex and relatively expensive products, the e-speculator model that has a high degree of product standardization and moderate to high price volatility, the solution provider in which product costs are only a small portion of the overall costs, and the sell-side asset exchange with high fixed costs and a relatively fragmented supplier and customer base.

Examples for Online Business-to-Business (B2B) Model

Consider an automobile or home appliance spares manufacturing company having an online store to cater the requirements of the retailers. Each of the following two examples implements the concept of b2b business model.

Ningbo GOLNA PARTS Co., Ltd is a 10 year old manufacturers and exporters in the home appliance components in Ningbo of China, which is the electric appliance producing base and also 2nd biggest container port in China.

The products include washing machine spare parts, refrigerator spare parts, air conditioner spare parts, vacuum cleaner spare parts, heater spare parts, etc. The company owns modern production lines and Hi-tech quality control equipment. With scientific management, professional engineers, highly trained technicians and skilled workers.

2.49 Electronic Data Interchange (EDI)

EDI was developed in early 60s as a means of accelerating the movement of documents related to shipments and transportation. However, from the beginning of 80s it is now widely used in various other sectors like automotives, retails, and international trade. Its relevance and usage is growing at a very fast pace.

EDI is based on a set of standardized messages for the transfer of structured data between computer applications. It may have many applications e.g., sending the test results from the pathology laboratory to the hospital or dispatching exam results from exam boards/university to school/college, but it is primarily used for the trade exchanges: order, invoice, payments and many other transactions that can be used in national and international trade exchange.

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Notable users of EDI are vehicle assemblers, ordering components for their production lines, and supermarkets (and other multiple retailers), ordering the goods needed to restock their shelves. EDI allow the stock control/material management system of the customer to interface with the stock control/production systems of the suppliers without the use of paper documents or the need of human intervention.

The EDI is used for regular repeat transactions. EDI is a formal system and it does not really have a place in the search and negotiation phases. EDI, when initially introduced was seen by many as a universal, or at least a generalized form of trading.

In the event its adoption has been limited to a number of trade sectors where the efficiency of supply chain is of vital importance. EDI is apart of schemes for just-in-time manufacture of quick response supply.

Notes Mature use of EDI allows for a change in the nature of the product or service being offered mass customization is such an instance.

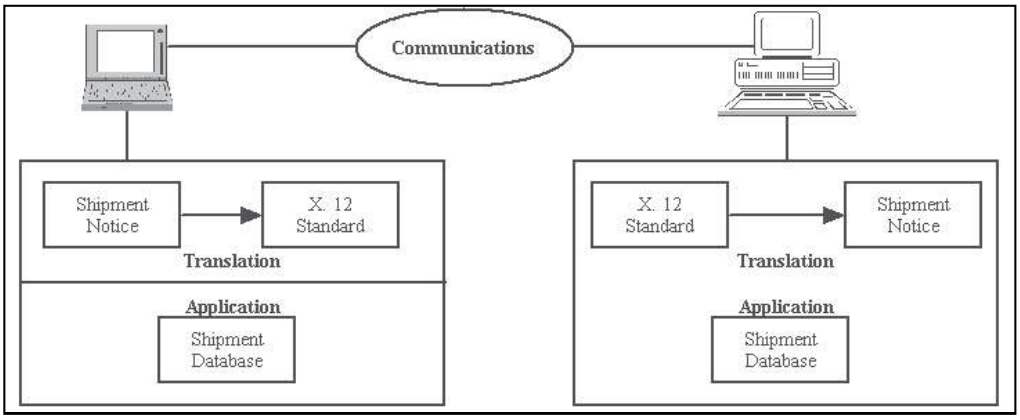

Fig. 2.25: The EDI Process

Definition of EDI

- Electronic Data Interchange is the transmission, in a standard syntax, of unambiguous information of business or strategic significance between computers of independent organizations. (The Accredited Standards Committee for EDI of the American National Standards Institute)
- Electronic Data Interchange is the interchange of standard formatted data between computer application systems of trading partners with minimal manual intervention. (UN/EDIFACT Training Guide)
- Electronic Data Interchange is the electronic transfer, from computer to computer, of commercial and administrative data using an agreed standard to structure an EDI message.

2.50 Business 2 Consumer (B2C)

Business-to-consumer (B2C, sometimes also called Business-to-Customer) describes activities of businesses serving end consumers with products and/or services.

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Example: B2C transaction would be a person buying a pair of shoes from a retailer. The transactions that led to the shoes being available for purchase, that is the purchase of the leather, laces, rubber, etc. as well as the sale of the shoe from the shoemaker to the retailer would be considered (B2B) transactions.

More and more organizations are transforming their businesses using Internet technology in B2C relationships. The extent to which the Internet technology is used in an organization for B2C relationships depends on the relative Internet maturity of the organization, its customers, the Internet usage in its geographical market area, the nature of the organization's products/ services and the relative urgency to which the Internet is used to either achieve competitive advantage or to catch up with the competition. Accordingly, an organization may be resorting to a B2C e-commerce model, covering one or more of the following broad e-commerce activities:

- ***Informational (public):*** Making information regarding the organisation and its products available on the Internet for whoever wants to access the information.
- ***Customer self-service (informational):*** Making information, such as products/services and prices, available on the Internet for the customers of the organization.
- ***Customer self-service (transactional other than payments):*** In addition to making information available on the Internet, accepting customer transactions, such as orders and cancellations, through the Internet, but payments are handled through conventional means.
- ***Customer self-service (payments):*** Accepting customer transactions including payments or fund transfers (in the case of banks) through the Internet.
- ***Customer reporting:*** Providing reports, such as statement of accounts and order status to customers online.
- ***Interactive self-service:*** Providing interactive responses through e-mails for requests/ queries logged through a website.
- ***Direct selling:*** Selling products and services directly to prospective buyers through the Internet.
- ***Auctioning:*** Auctioning the products online.

Examples for Online Business to Consumer (B2C) Model

Consider an online music store selling audio CDs and DVDs to end users or customers through orders on Internet. Each of the following two examples implements the concept of B2C business model.

Example: http://www.hamaracd.com

A venture of Saregama India Ltd, An RPG enterprise Company.

HamaraCD.com is a unique concept where you have amazing option and complete freedom of creating your own audio CDs of your favourite songs. Your selection can be further personalized with your preferred image, CD Title and a message of your choice.

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By far, HamaraCD today is the largest, most popular and possibly the only legitimate site offering CD customization facility for Indian songs globally.

Example: http://www.amazon.com

Amazon.com is the leading online retailer of products that inform, educate, entertain and inspire. The Amazon group also has online stores in the United States, Germany, France, Japan and Canada.

What does Amazon.com do?

Amazon.co.uk is famous for selling books, but did you know that we now sell millions of other products too? From cameras to coffee machines, exercise videos to Elvis CDs, there's something for everyone. We also enable independent sellers to sell new and used items on our website via Amazon.co.uk Marketplace. In addition, we give you a variety of resources to help you make your choice, including customer reviews and personal recommendations.

Amazon.com, Inc. is a publicly traded company. NASDAQ:AMZN.

2.51 Role of Intranets

An intranet is a private network that is contained within an enterprise. This is a network that is not available to the world outside of the Intranet. If the Intranet network is connected to the Internet, the Intranet will reside behind a firewall and, if it allows access from the Internet, will be an Extranet. The firewall helps to control access between the Intranet and Internet to permit access to the Intranet only to people who are members of the same company or organisation.

In its simplest form, an Intranet can be set up on a networked PC without any PC on the network having access via the Intranet network to the Internet.

Example: Consider an office with a few PCs and a few printers all networked together. The network would not be connected to the outside world. On one of the drives of one of the PCs there would be a directory of web pages that comprise the Intranet. Other PCs on the network could access this Intranet by pointing their browser (Netscape or Internet Explorer) to this directory – for example, U:\inet\index.htm.

From then onwards they would navigate around the Intranet in the same way as they would get around the Internet.

How Intranets Support Electronic Business

Intranet can help the organizations create a richer, more responsive information environment. Intranet corporate applications bases on the Web page model can be made interactive using a variety of media, text, audio, and video. A principal use of intranets has been to create on-line repositories of information that can be updated as often as required. Product catalogs, employee handbooks, telephone directories, or benefits information can be revised immediately as changes occur. This "event-driven" publishing allows organizations to respond more rapidly to changing conditions than

traditional paper-based publishing, which requires a rigid production schedule. Made available via intranets, documents always can be up to date, eliminating paper, printing, and distribution costs.

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Intranets and Group Collaboration

Intranet provide a rich set of tools for creating collaborative environments in which members of an organization can exchange ideas, share information, and work together on common projects and assignments regardless of their physical location.

Some companies are using intranets to create enterprise collaboration environments linking diverse groups, projects, and activities through the organization.

Example: The Global Village intranet of U.S. West (which merged with Qwest Communications International) is a prominent example.

Intranet Applications for Electronic Business

Intranets are springing up in all the major functional areas of the business, allowing the organization to manage more of its business processes electronically.

Intranet applications have been developed for each of the major functional areas of the business.

Finance and Accounting

Many organization have extensive TPS that collect operational data on financial activities, but their traditional management reporting systems, such as general ledger systems and spreadsheets, often cannot bring this detailed information together for decision making and performance measurement. Intranets can be very valuable for financial and accounting information on-line in an easy-to-use format.

Human Resources

Human resource can use intranets for on-line publishing of corporate policy manuals, job postings and internal job transfers, company telephone directories, and training classes. Employee can use an intranet to enroll in healthcare, employee saving, and other benefit plans if it is linked to the firm's human resources or benefits system to take on-line competency test.

Sales and Marketing

One of the most popular applications for corporate intranets is to oversee and coordinate the activities of the sales force. Sales staff can dial in for updates on pricing, promotions, rebates, or customer or to obtain information about competitors. They can access presentations and sales documents and customize them for customers.

Manufacturing and Production

In manufacturing, information-management issues are highly complex, involving massive inventories, capturing and integrating real-time production data flows, changing relationships with suppliers, and volatile costs. The manufacturing function typically

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uses multiple types of data, including graphics as well as text, which are scattered in many disparate systems. Manufacturing information is often very time sensitive and difficult to retrieve, because files must be continuously updated.

Caution Developing intranets that integrate manufacturing data under a uniform user interface is more complicated than in other functional areas.

Roles of Intranet in Organization

The internet is to the internal system of the organization what the internet is to its external environment. That is it links internal data networks of the company but prevents access to other outside the company. It also facilitates data gathering from with the company. For example surveys can be easily conducted through the intranet to assess employee moral or popularity of benefit packages. The intranet can be creatively put to use. Cronin remarked that Ford's intranet success is so spectacular that the automaker's in-house website could save billion dollars and fulfill a cherished dream of building cars on demand. Cronin went on to explain how the carmaker's product development system documents thousand of steps that go into manufacturing, assembling and testing vehicles.

By opening its intranet to major suppliers, Ford customized every car and truck while reducing cost at the same time. For instance suppliers could provide car seats in the sequence of colors needed so that blue seats are ready just when the blue cars reach the seat installation station. By opening up its intranet to suppliers and coordinating the delivery and assembly of thousands of components some auto companies tried to move closer to manufacturing on demand.

If intranets are to be truly successful, they need to have a clear purpose within the organization. The more this purpose is aligned with business and organizational needs, the easier it is to get the resources and budget needed.

Purposes of an Intranet

There are four fundamental purposes of an intranet:

- Content
- Communication
- Collaboration
- Activity

Historically, intranets have focused on content and communication, providing a platform for corporate information and news. To be successful, however, there needs to be a balanced focused on all four elements. Activity (the intranet as a 'place for doing things' rather than just a 'place for reading things') is particularly important in terms of building a business case for the intranet.

2.52 Summary

A network can be defined as the interconnection of two or more systems. The minimum number of systems required to make a network is two. Computer systems connected in

a network can exchange information between themselves and share the use of hardware devices connected such as the printer, etc. A system with one main controlling unit known as the master and many slave terminals is not a network. Networks that connect computers lying within a small distance (such as a room, or within a building) from each other are called local area networks (or LANs). Local area networks normally use coaxial cables to connect the computers together. Two or more computers connected together can share, besides data, their peripherals such as printers, modems, etc. This cuts down a lot on the hardware equipment cost.

Besides coaxial cables, a plug-in card is also required for each computer. The coaxial cables connect the plug-in cards of the computers to form a network. A special software is also required for the network to operate. Networks that connect computers lying within a small distance (such as a room, or within a building) from each other are called local area networks (or LANs). A metropolitan area network uses the distributed queue dual bus. A wide area network connects computers which are very remotely placed. It may connect across the countries or continents or the entire globe.

The World Wide Web that has become a de facto standard for any professional belonging to any discipline finds its extensive use and utility in providing information stored in a computer system attached to the Internet or www. Different web designing techniques are used to make the information in a presentable form to the users. Some of the web designing techniques such as HTML has become a standard for web pages. In addition to the above, In HTML webpage design, the limited use of colors often makes the appearance of the colors more powerful. It is also possible to add an image or a plain color as background with the help of its specifications in the <body> tag. Form also gives navigability to a website. Forms are objects that enable to enter information in the form of text boxes, drop-down menus or radio buttons. Front Page provided by Microsoft, however, provides an excellent tool for designing WebPages with very minimal knowledge of HTML has been replaced by more advanced tools. FrontPage enables to work in a

E-commerce is a general concept covering any form of business transaction or information exchange executed using information and Communication technologies (ICT's). Electronic Commerce is a term popularized by the advent of commercial services of the Internet. E-commerce is a selling and transfer process requiring several institutes. It is systematic and organized network for the exchange of goods between produces and consumers. Any web site or portal that offers products and/or services for sale is a commercial website. E-commerce is highly economical. Doing e-business on the Internet is extremely cost effective.

2.53 Glossary

- *Archive :* A computer site advertises and stores a large amount of public domain, shareware software and documentation.
- ***Service primitives:*** The primitives enable the service provider to perform some action or report on an action taken by a peer entity.

- ***Web Browser:*** It is the client software used to explore and display web pages from a website.
- ***Web Client:*** It refers to the computer and software used to access a website and web pages.
- ***Simple Mail Transfer Protocol (SMTP):*** It enables a client machine to exchange mail and message between TCP/IP hosts.
- ***Video:*** It is nothing but the motion pictures that requires millions of bits. Multimedia packages contain digital video that is usually produced from analog video.
- Business to Business (B2B): B2B indicates to the full spectrum of e-commerce operation that can occur between two organisations.
- ***Consumer to Business (C2B):*** Consumers can band together to form and present themselves as a buyer group to business in a consumer-to-business (C2B) relationship.
- ***E-commerce:*** It is a general concept covering any form of business transaction or information exchange executed using information and communication technologies.
- ***Electronic Mail:*** Sending and receiving text messages between networked PCs over telecommunications networks. E-mail can also include data files, software, and multimedia messages and documents as attachments.

2.54 Review Questions

1. What are the major factors that have made the use of computer networks as an integral part of the business?
2. How is LAN characterized? Explain.
3. What are the different technologies available for implementing WAN?
4. What are the important design issues for the information exchange among computers?
5. What do you mean by Computer Networks?
6. What are the different types of Computer Networks?
7. Why are the WAN's also referred to as long haul networks (LHN's)?
8. List down the disadvantages of using Star topology.
9. Define broadcast and point to point type networks. Write example of each.
10. What do you understand by the term 'protocol'?
11. Differentiate between LAN and WAN by listing down the merits and demerits of each over the other.
12. Differentiate between Pop mail and Web mail.

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13. Which type of e-mail service would you prefer? State reasons.
14. What is the correct HTML tag to make a text bold?
15. How an image can be inserted in HTML?
16. How a HTML document can be created from normal word document?
17. How MIDI file and wave file are differentiated?
18. Define the role of frames in html?
19. Provide a link of another site and define links to send an email to different people. Take relevant example.
20. What is relevance of Front Page in designing web pages when most of the web pages are designed in HTML?
21. How is the HTML document used for making a hyperlink? Explain with example.
22. How does SMTP work in transferring mails from one computer system to another computer system attached to different networks?
23. What is animation? Explain with examples.
24. What is e-commerce? Give a definition of your own and discuss the history of e-commerce.
25. What are the advantages and limitations of e-commerce? Do you think the advantages outweigh the limitation?
26. What are the different types of e-commerce? Describe each type.
27. Internet based business model helpful for business improvement. Explain
28. What do you think online transaction is safe mode of transaction? Explain
29. What are the basic need of any conventional organization for convert it into the digital organization?

2.55 Further Readings

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UNIT–3

Notes

Introduction to Information System

(Structure)

3.1 Learning Objectives
3.2 Introduction
3.3 Information Systems
3.4 Digital Convergence
3.5 Changing Business Environment
3.6 Information and Knowledge Economy
3.7 Contemporary Approach to Information Systems
3.8 Management Challenges
3.9 Definition of Decision Support System
3.10 Relation of DSS with MIS
3.11 Evolution of DSS
3.12 Characteristics of DSS
3.13 Classification of DSS
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3.15 Functional Perspective of Information Systems
3.16 Enterprise Systems
3.17 Strategic Uses of Information Systems
3.18 Firm-Level Strategy and Information Technology
3.19 Components
3.20 DSS Analysis Techniques
3.21 Expert System
3.22 Fuzzy Logic Systems
3.23 Neural Networks Artificial Neural Systems
3.24 Genetic Algorithm
3.25 Hybrid AI Systems

3.26 Intelligent Agents
3.27 Summary
3.28 Glossary
3.29 Review Questions
3.30 Further Readings

3.1 Learning Objectives

After studying the chapter, students will be able to:

- Define Decision support system;
- Discuss the relation of DSS with MIS;
- Discuss the concept of information system;
- Understand the concept of digital convergence and changing business environment;
- Understand types of information systems in the organization;
- Recognize the functional perspective of IS;
- Understand the concept of enterprise systems;
- Understand the concept of expert systems;
- Discuss fuzzy logic systems;
- Explain neural networks;
- Understand the concept of genetic algorithm.

3.2 Introduction

Management Information System is an old management tool, which has been long used by people for better management and scientific decision-making.

Management Information System is mainly dependent upon information, which is a vital ingredient of any Management Information System. Information is the most critical resource of Management Information System. We all know that information is a vital factor for our existence. Just as our body needs air, water and clothes, we are as much dependent upon information. To make life more interesting and to achieve the feeling of being a part of the social system, we want to know our surroundings and for that we need information. Information is an important input for achieving our goals such as learning to help each other and to become integral part of society.

The classification of Information Systems can be done on the basis of business functions also. This classification is done to achieve the maximum efficiency in business functions. There are lot many considerations we have to bother while we do business. The role played by the Internet and Information Technologies to support electronic

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commerce, enterprise communications and collaboration, and Web-enabled business processes both within a networked enterprise, and with its customers and business partners will definitely require specialized Information Systems for Business functions.

Decision support systems (DSS) are interactive software-based systems intended to help managers in decision-making by accessing large volumes of information generated from various related information systems involved in organizational business processes such as office automation system, transaction processing system, etc.

DSS uses the summary information, exceptions, patterns, and trends using the analytical models. A decision support system helps in decision-making but does not necessarily give a decision itself. The decision makers compile useful information from raw data, documents, personal knowledge, and/or business models to identify and solve problems and make decisions.

3.3 Information Systems

Now, it is time to see the real meaning and concept of Information Systems. Too often you hear someone say, "Oh yeah, I know how to use a computer. I can surf the Web with the best of them and I can play Solitaire for hours. I'm really good at computers." Okay. So that person can pound a keyboard, use a mouse at lightning speed, and has a list of favorite Web sites a mile long. But the real question is "Is that person's information literate?" Just because you can pound the keyboard it doesn't necessarily mean that you can leverage the technology to your advantage or the advantage of your organization. An organization can gather and keep all the data on its customers that a hard drive can hold. You can get all the output reports that one desk can physically hold. You can have the fastest Internet connection created to date. But if the organization doesn't take advantage of customer data to create new opportunities, then all it has is useless information. If the output report doesn't tell the management that it has a serious problem on the factory floor, then all that's been accomplished is to kill a few more trees. If you don't know how to analyze the information from a Web site to take advantage of new sales leads, then what have you really done for yourself today?

Most of us think only of hardware and software when we think of an Information System. There is another component of the triangle that should be considered, and that's the people side, or "liveware."

We talk about the input, processing, output and feedback processes. Most important is the feedback process; unfortunately it's the one most often overlooked. Just as we discussed above, the hardware (input and output) and the software (processing) receive the most attention. With those two alone, you have computer literacy. But if you don't use the "liveware" side of the triangle to complete the feedback loop, you don't accomplish much. Add the "liveware" angle with good feedback and then you have the beginnings of information literacy.

An information system differs from other kinds of systems in that its objective is to monitor/ document the operations of some other system, which we can call a target system. An information system cannot exist without such a target system.

Example: Production activities would be the target system for a production scheduling system, human resources in the business operations would be the target system of a human resource information system, and so on. It is important to recognize that within a vending machine there is a component/sub-system that can be considered an information system. In some sense, every reactive system will have a sub-system that can be considered an information system whose objective is to monitor and control such a reactive system.

The Need for Information Systems

Ask managers to describe their most important resources and they'll list money, equipment, materials, and people - not necessarily in that order. It's very unusual for managers to consider information an important resource and yet it is. This unit will help explain why you need to manage this resource as closely as any other in your organization.

The Competitive Business Environment

For many years computer technology was relegated to the backrooms or basements of a corporation. Only the "techies" worried about it and were often the only ones who really knew how it all worked. Now computers are all over the organization - one on every desk. It's not enough for you to know how to pound a keyboard or click a mouse. It is not even enough for you to know how to surf the Web. Now every employee, including you, must know how to take advantage of Information Systems to improve your organization and to leverage the available information into a competitive advantage for your company.

Why Business Need Information Technology?

Information Technology is reshaping the basics of business, customer service, operations, product and market strategies, and distribution are heavily, or sometimes even entirely, dependent on IT. The computers that support these functions can be found on the desk, on the shop floor; in the store, even in briefcases. Information technologies, and its expense, have become an everyday part of business life. The fundamental reasons for the use of information technology in business are:

- Support of business operations
- Support of managerial decision making
- Support of strategic competitive advantage.

Emergence of the Global Economy

Next time you purchase a product, any product, look at the fine print and see where it's made. It could be China, or the Philippines, or India, or even USA. You can disagree with many manufacturing jobs that are being moved from other U.S. to foreign countries. But look at the vast number of jobs that are being created in this country. Maybe they aren't the traditional factory jobs we're used to. In fact, many of our new jobs are in the information industry. Many of them service entirely new markets that didn't exist just

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a few years ago. There was no position called "Webmaster" in 1991 because the Web didn't exist. But now, that particular job category is one of the fastest growing in the overseas. The global economy I am talking about is being made possible by technology. And that's why it's so important that you understand how to use Information Systems Technology instead of just computer technology.

Transformation of the Business Enterprise

You can't help but know about the entire job cuts occurring in our country. It seems like every week we hear about thousands and thousands of people losing their jobs. Back in the 80s most of the job losses were in the blue-collar sector. In the 90s it seems many of the cuts were being made in the white collar, management jobs. Why? Think about it. Technology, to a large extent, has driven organizations to change the way they operate and that includes the way they manage. We're going to take an in-depth look at how organizations work and how they've been transformed by technology.

But it isn't always bad! You just have to ask yourself this question: "With all the job losses in the last few years, many driven by technological changes, why has the Indian unemployment rate dropped to it's lowest in decades and remained so low?"

3.4 Digital Convergence

Digital convergence is an approach by which all types of media and communication will be digitized allowing them to be used through a single worldwide network. The speed and computing capacity of technology continues to advance at dizzying speeds and in ways we can hardly imagine.

Interactive Multimedia

One trend highly touted by the experts is that of the "information appliance." Do we need to have a separate device for watching television, another one for listening to music, a different one called a telephone, and yet a whole separate device for computing? Some people say we can do all of that with one central appliance with a variety of input and output devices.

If you watch the mergers taking place in the corporate world between the telephone companies and cable TV companies, you can start to understand another major change that may be in store for us. The companies are working toward a convergence of the "entertainment outlets" we know as television and the Internet. Why can't we download a movie off the Internet whenever we're ready to watch it instead of having to follow a TV channel's set schedule? This idea may be a reality in a few years.

The music industry is struggling with the issue of music downloaded from websites. How do the musicians protect their copyrighted work while making the music more accessible to the public? How do the music publishing companies protect their business from disintermediation, the process of eliminating the middleman from transactions?

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Role of Information Technologies on the Emergence of New Organizational Forms

During the last years, a consensus is emerging that to survive in the competitive turbulence that is engulfing a growing number of industries, firms will need to pinpoint innovative practices rapidly, to communicate them to their suppliers and to stimulate further innovation. In order to be competitive, companies are forced to adopt less hierarchical and more flexible structures, and to define strategies able to combine reduced costs, high quality, flexibility and a quick answer to customer requirements. Nowadays, there are very few companies with enough resources to form its value chain on their own.

Therefore, some changes are taking place within individual companies and in their relations with other organizations, creating new structures in which relationships between customers and suppliers are suffering considerable changes. One of these changes is concerned with the formation of networks in which there is a division of labour that allows each company to exploit their distinctive advantages, and be more competitive globally.

In a network model, a set of juridically independent companies establish cooperative long-term links in order to achieve a higher level of competitiveness. The enterprises that belong to a network have not all the elements needed for manufacturing a product or providing a service under their absolute control. Therefore, the success of this kind of structures is conditioned by the coordination degree obtained along the realization of inter-organizational activities, which requires an efficient communication system among the partners. The Information Technology (IT) represents a supportive element that facilitates the transfer of information across organizational boundaries. In this paper we analyze the inclusion of the Interorganizational Information Systems (IOS) concept within the network model and discuss the role IT plays in enabling organizational transformation towards emergent forms of organization.

In order to attain relatively low costs in the last two decades the enterprises followed strategies of backward-forward integration, based on the improvement of the effects of the experience curve and the scale economies. We consider that this internal growth may be inadequate to face the new situations appearing in the nineties and, no doubt, those that will appear in the next century. The individual enterprise has less capability for foreseeing the consequences of the different business decisions; however, the need for competing in a more and more complex context requires the adoption of quick decisions, which facilitate the flexibility of the enterprise. New technologies, fast changing markets and global competitiveness are revolutionizing relationships both within and between organizations. Thus, the new environment requires from the enterprises a strategy able to agglutinate reduced costs, high quality, flexibility, and a quick response to the needs of the customer.

Nowadays, the enterprises have to compete in a more and more turbulent scene, which obliges them to adopt less hierarchical and more flexible structures. During the last years, a major transformation in the strategy of many enterprises has been observed with a tendency to disintegration. This is accompanied by a need for increasing the

quality of the products or services offered, which requires more interdependency among the different corporate units. As a consequence of it, several transformations both inside the enterprises and in the relationships between them are taking place, which establishes new structures through which the relationships among competitors, customers and suppliers are changing substantially. One of these changes is the cooperation established among different enterprises, which allows them to develop their competitive capability. Companies are forming strategic alliances because there is an increasing acknowledgement that organizations operate in a relational context of environmental connectedness and that organizational survival and performance depend upon connections with other organizations.

The co-operation among enterprises allows their flexibility and their innovative capacity to be increased. Current products are based on so many critical technologies that most of the enterprises cannot keep constantly updated in all of them.

The Network Structure

The concept of the network's form of organization has been particularly popular with management writers for its potential to build the flexible organization with the ability to meet the challenges of a changing and global environment. Despite both the abundant available literature and the existence of a certain consensus on some aspects, there is still too much ambiguity in the concepts used in this area. Taking into account the formation of networks, which is an interesting field of recent development with strong repercussions on the inter- organizational relationships, it is necessary to clear the existing terminological confusions in order to formulate its theory and to improve its implementation.

Starting from the definition, a network is a specific kind of relationship joining a particular group of people, objects, or events. Two factors needed for constituting a network can be obtained from this definition; first, a network is formed by a group of elements; second, these elements establish specific relationships among them. We must show that the establishment of a co- operative network is not a purpose itself but "it must be a dynamic structure that allows consolidating the competitive position of its members".

By means of a network structure, the competitive position of the enterprises can be reinforced as these concentrate on what they do best, and on what maintains their success in the market. In this way, other enterprises make the activities left, in which they have distinctive competencies too. The enterprises outsource those activities that are ballast and bureaucratize them.

The enterprises that belong to a network have not all the elements needed for manufacturing a product or providing a service under their absolute control. Within the networks, the involved elements belong to independent enterprises and are placed along the value system of a product or service.

All this drives to an organizational structure in which the enterprises generate

more value in those areas where they have specific competencies. The success of these emergent organizational forms seems to be based, on a great extent, on an effective co-ordination by means of the use of advanced information systems, which are based on the Information Technologies (IT). There is an increasing interest in the relationship between the emerging organizational ways and the function of the IT/IS insofar as the progresses in each field have influenced the others.

Information Technology on the Emergence of Networks

At the moment, the most spectacular and potentially powerful uses of the information systems technology go beyond the individual borders of the enterprises. In fact, the most important function of IT in the nineties is the better management of the interdependencies among the enterprises. Information Technology has to be the most powerful instrument to reduce the co-ordination costs». While the traditional uses of IT tried to facilitate the internal processes of the enterprises, the Interorganizational Information Systems (IOS) are addressed towards the efficiency of a group of enterprises.

Most of the studies about IOS have focused on the incidence of IT on the flows of information among the organizations, its capability of reducing the transaction costs, and its potential to achieve competitive advantages. Many authors have verified that:

- IT influences the nature, punctuality and detail level of the information shared by enterprises
- IT reduces the transaction costs, while it provides a better management of the risks
- IT reduces the co-ordination costs.

In order to benefit from the advantages of IT, the enterprises have to keep in mind that IT cannot be isolated from its organizational context». We do not agree with the existence of causation between the implementation of IT and the organizational changes in the enterprise driving to an increase in the competitiveness of the enterprises. On the contrary the technological and organizational implementations are both sides of the same issue, since they depend on and determine each other». We think that, although IT might have the above mentioned positive effects on the organizations, the will and capabilities of the directors of the company are needed in order to make the most of those advantages.

In order to make the most of the whole potential of the IOS, it will be required that the managing directors get involved with the project, since they have a wider and more strategic view of the company. In this way, a system coherent with the objectives of the company would be implemented. This system would allow taking even more profit from IT, what would have positive repercussions on the enterprise and would facilitate the achievement of its objectives. The active participation of the Management Board in the planning of the IOS brings a problem related to the fact that IT is a relatively new resource that did not exist when most of the current managers were trained. Therefore, they usually do not feel comfortable with these new technologies.

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As a proof of this, we will consider an example.

Example: McKesson was a dealer company of chemical products. This company knew that its success was linked to that of its customers, which were small stores, so it established a close relationship with them. By means of an appropriate use of Information Technologies, it helped its customers to maximize their profits, since it gave them useful information for competing with the big pharmaceutical chains, which were getting a greater market share. The McKesson Corporation directors' idea was so successful that many other enterprises of the sector tried to imitate it, but they made a terrible mistake. They thought that the network created by McKesson was just a computerized system with terminals connected in other enterprises.

The secret of the success of this company were not the computer links; information technology did not create the network. The network's success was due to the fact that the directors of McKesson were aware of both the relationships along the added value chain and the need to strengthen as much as possible every link within the chain, so cooperative behaviors could be established in order to provide the share of information and the quick response to the changes of the demand.

Example: Widely mentioned in the literature on Information Systems, is the one of the American Hospital Supply Company whose success has shown up the need to consider the network established not only as a mere system of electronic data exchange, but also as a better implementation of the technology found within a context of changes in the commercial relationships between the enterprise and its main customers.

A positive consequence of the revolution of communication and Information Technologies is that there are more available options for designing the labour now, because the technology can be used to increase the capacities of the workforce, and the information can be transferred to those places were the labour is carried out. Workers do not need to be located according to parameters of time and space to co-ordinate any more.

We consider that technology, although it is not the ground for the emergence of a new and innovative way of organizing the enterprises, plays an important role in its operation.

Technology allows doing things in a different way, which provides the directors some organizational possibilities that would be unthinkable without its implementation. Thus, using a mathematical expression, we can state that Information Technologies are necessary but they are not enough to achieve greater business competitiveness.

The Role of IOS within the Network Structure

The enterprises involved in an alliance must decide whether to use the manual management of all the exchanged data, or to complement that management with the interconnection of their respective computer applications. This interconnection may bring, however, compatibility problems in the integration of the data from the different enterprises, since those applications would have possibly been designed without taking into account any requirement of integration among enterprises. The establishment of co-operation networks implies the need for wider communication in the organizational

field, as well as the requirement of capability to integrate the information systems from different enterprises.

The enterprises inside a network cannot operate properly if they have not the possibility to communicate quickly, accurately, and over long distances. Within a network, it does not make any sense to restrict the application of modern computer technologies to the individual borders of each enterprise. The Management Board of the enterprises in the network must, on the contrary, consider the possibilities of coordinating the processing of data outside the limits of their own organizations by means of an IOS.

The application of the IT which provides the electronic integration among the shareholders of an industry may make easier the outsourcing of activities, as well as be a basic part of the proper operation of the reticular structures. An IOS may play an important role in the coordination of interdependent activities, which would be carried out by distant organizational units. Thus, the enterprises can reduce their dependency on strategies of backward-forward integration in order to ensure the control over the production process.

The concept of network emphasizes the interdependency among enterprises, which is provoked by the presence and the sharing of the following key attributes: objectives, experience, labour, taking of decisions, responsibility, trust, and acknowledgement or reward. The enterprises within a network will adopt a common objective, namely to provide a quicker and better service to the final customer. With this aim in view, independent organizations will have to establish close interrelationships, in which Information Technologies have a vital role to play. In this way, the aim of optimizing the flow of profits along the supply chain could be achieved too. IOSs are, basically, new means to facilitate the relationships among organizations; they are, therefore, a strategic instrument.

However, an IOS allows to obtain operative advantages too, such as:

- Reducing paperwork and manual operations;
- Reducing the stock levels;
- Accelerating the product and material flow;
- Standardizing of procedures;
- Accelerating the flow of information about changes on the demand;
- Reducing telecommunication costs.

The IT is a basic support that facilitates the co-ordination of different enterprises through EDI systems, shared databases, e-mail, video conferences, which will allow them to work together. They will be able to share information on the markets, on the needs for materials, on stock levels, production schedules, and delivery programs. A key factor in an efficient exchange of information within a network is the computer connection of its members. The computer links accelerate the transference of information, since it provides the automatic transmission of data between physically distant computers. These links can be used as a strategic instrument to increase the competitiveness of the enterprise, binding it electronically with its customers and suppliers through inter-organizational

systems. The electronic connection facilitates the approaching of the linked enterprises, which means that the companies may provide the customers direct access to the internal databases, as well as just-in-time stock control.

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3.5 Changing Business Environment

The powerful worldwide changes have altered the environment of business. These changes in the business environment and climate are classified into political, social, economical and technological categories.

Environmental, organizational, and technological factors are creating a highly competitive business environment where customers are the focal point. Further, environmental, organizational, and technological factors can change quickly, sometimes in an unpredictable manner.

Therefore, companies need to react often and quickly to both the problems and the opportunities resulting from this new business environment. This dramatic change is due to a set of business pressures or drivers. They maintain that in order to succeed (or even to survive) in this dynamic world, companies must not rely only on traditional actions such as lowering cost, but also encourage innovative activities by empowering employees.

Organizations are composed of five major components:IT, organizational structure and corporate culture, management and business processes, organization's strategy, and individuals and roles. These components are in stable condition, called equilibrium, as long as no significant changes occur in the environment or in any of the components. However, as soon as a significant change occurs, the system becomes unstable.

IT and Organizational Design

An important and fast growing technological innovation during this century is computer-based information systems. Computer-based information systems (CBIS or only IS) provide an opportunity for businesses to improve their efficiency and effectiveness, and even to gain a competitive advantage. IT is also a catalyst of fundamental changes in the structure, operations and management of organizations. Most businesses in the industrial world could not compete, and many could not even survive without computers and software. Now IT is an integral part of the products and services delivered to customers.

Competition leads to environmental uncertainty and increases both the need for and the rate of innovation adoption. By adopting IS, businesses will be able to compete in three ways:

- IS can change the industry structure and, in doing so, alter the rules of competition;
- IS can also create competitive advantage by offering business new ways to outperform their rivals; and
- IS spawns new businesses, often from within existing operations of the business.

IT-enabled Organizational Transformation

There is a growing body of conceptual papers and case studies on IT-enabled organizational transformation in the information systems literature. Most of the studies suggest that the use of IT without concomitant organizational changes is unlikely to yield significant gains in terms of organizational performance.

Four R's of Business Transformation

Business Transformation can be defined as "The orchestrated redesign of the genetic architecture of the corporation, achieved simultaneously – although at different speed – along the four dimensions of reframing, restructuring, revitalization and renewal." By this definition a biological model has been developed that we call the Four R's of transformation are:

- Reframing is the shifting of a company's conception of what it is and what it can achieve with new visions and a new resolve.
- Restructuring is a girding of corporate loins, getting it to achieve a competitive level of performance by dealing with the body of corporation and competitiveness. The need to be lean and fit is the primary consideration.
- Revitalization is about igniting growth by linking the corporate body to the environment.
- Renewal deals with the people side of transformation, and with the spirit of the company.

It is about investing individuals with new skills and new purposes, thus allowing the company to regenerate itself.

Five Levels of IT-induced Reconfiguration

The figure below is a schematic representation of these five levels along two basic dimensions – the degree of business transformation and the range of potential benefits from IT. Organizations thereby proceed to higher levels of transformation as the

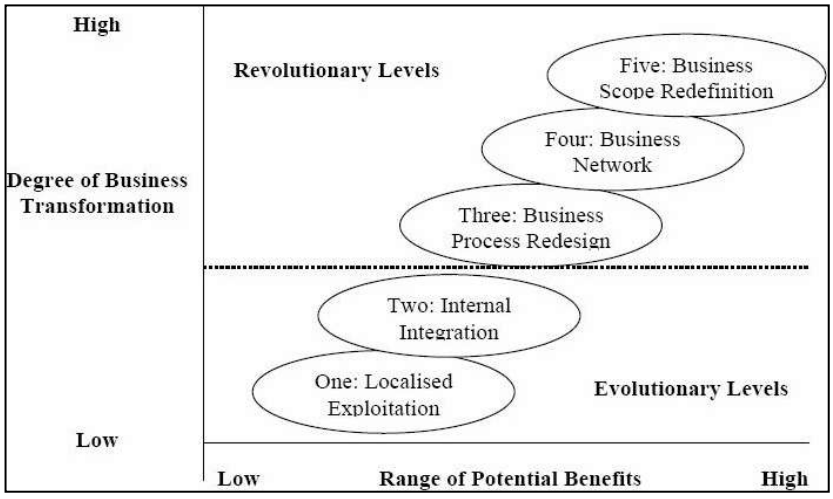

Fig. 3.1: Levels of IT-induced Reconfiguration

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demands of competition and value creation for customer increases. The first two levels are evolutionary, requiring relatively incremental changes in the existing organizational processes. In contrast, the other three levels are conceptualized as revolutionary, requiring fundamental changes in the nature of business processes.

These five levels are explained as following:

- ***Level 1:*** Localized Exploitation (Automation), which is concerned with the exploitation of IT within business functions.
- ***Level 2:*** Internal Integration, a logical extension of the first in the sense that IT capabilities are exploited in all the possible activities within the business process. Two types of integration are critical here: technical integration and the organizational integration by using common IT platform to integrate the organization's business processes to enhance efficiency and effectiveness.
- ***Level 3:*** Business Process Redesign, involving the reconfiguration of the business using IT as a central lever.
- ***Level 4:*** Business Network Redesign concerned with the reconfiguration of the scope and tasks of the business network involved in the creation and delivery of the products and services.
- ***Level 5:*** Business Scope Redefinition concerned with the underlying principle of a corporation, pertaining to the possibilities of enlarging the business mission and scope (through related products and services) as well as shifting the business (through substitution of traditional capabilities with IT-enabled skills).

3.6 Information and Knowledge Economy

Information work is the art of creating and processing information. We use the term "art" because some companies do a very good job of creating, processing, and managing their information; others do such a poor job that these tasks become a detriment to the success of the organization. Which kind of company do you want to work for or own?

The two groups of employees primarily concerned with KWS are the data workers who process and distribute information and the knowledge workers who create knowledge and information. There are several ways to distinguish these two groups. You can also distinguish the two by the type of work they perform and how they create and use information. Here are some questions to help you:

- Do they create original ideas, or do they process, record, and store someone else's?
- Do they make their own original decisions regarding the information?
- Do they establish procedures to create and process the information, or do they follow someone else's procedures?

The office, as we know it in the traditional sense, is the setting for the generation and processing of information. As the above figure shows, it's where different roles mesh into a smooth "machine" of producing information, knowledge, and ideas instead of a product that you can touch, feel, or smell.

Distributing Knowledge – Office and Document Management Systems

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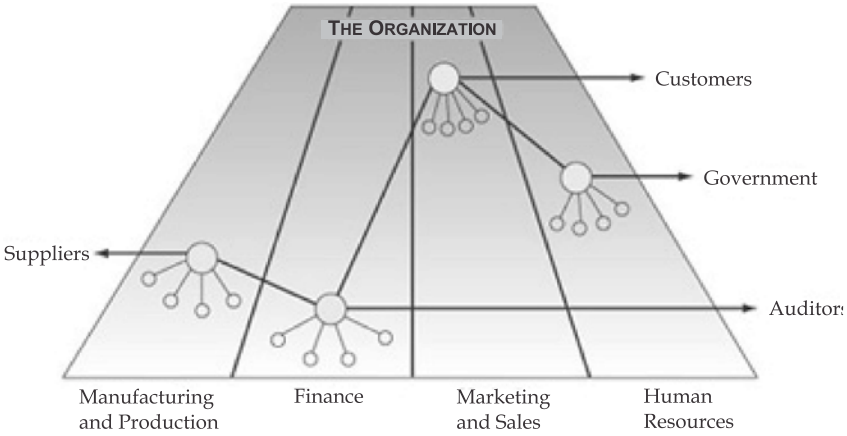

Fig. 3.2:

Office Activity	Technology
Managing documents	Word processing, desktop publishing, document imaging, web publishing, work flow managers
Scheduling	Electronic calendars, groupware, intranets
Communicating	E-mail, voice mail, digital answering systems, groupware, intranets
Managing data	Desktop databases, spreadsheets, user-friendly interfaces to mainframe databases

The table describes typical Office Automation Systems and the activities they support, all of which are vital to the success of the organization. While some OAS still rely on stacks and stacks of paper, modern technology emphasizes digital sourcing, storage, and distribution. As computers and associated technology become more embedded into the normal workflow of offices, more is being done without paper. For instance, a clerical worker can create a document, send it to co-workers or supervisors for their input via email, have it returned electronically, correct it, and distribute it online.

But no matter how much we talk about a paperless society, we are actually generating more paper than ever. One of the emerging technologies that is enhancing the productivity and ease- of-use of Office Automation Systems and reducing paper problems is the document imaging system, which converts documents and images into digital form so they can be stored and accessed by computer.

Documents not in use are stored on-line on an optical disk system called a jukebox. The index server maintains the information the system will use to locate, access, and retrieve a document.

Example: An example of document imaging systems is bank checks. Most banks don't return canceled checks any more. They make a digital image of the check, store it electronically, and then destroy the piece of paper. If you ever need a copy of one of your old checks, you have to request it. While the initial use of paper isn't reduced, the cost of processing and mailing the checks to the customer is gone altogether.

The advantages of using document imaging systems lie in the chance to redesign workflows. If companies aren't willing to do this, then they are laying out a lot of money to buy and install a system that they'll never fully use.

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Creating Knowledge – Knowledge Work Systems

Now we'll review many different Knowledge Work Systems (KWS) so that you have a clear understanding of how they differ from OAS and other Information Systems. These systems help create new products or improve old ones, and they're also used to integrate new data into the flow of information that is so vital to an organization.

It's important that you understand the functions KWS perform. They:

- Keep the organization up-to-date in knowledge
- Serve as internal consultants
- Act as change agents

3.7 Contemporary Approach to Information Systems

There are several different approaches to Information Systems: technical, behavioral, socio- technical. Think of this analogy: A "techie" looks at most things associated with computing as a series of zeroes or ones. After all, everything in a computer is ultimately reduced to a zero or a one. So using the technical approach, you could say that 2 + 2 = 4. The behavioral approach, on the other hand, takes into account the very nature of human beings. Nothing is totally black and white. Therefore, the behavioral approach to the same equation would be "2 + 2 = maybe 4 or perhaps 3.5 to 5.5, but we'll have to put it before the committee and see what the next quarter's figures say." Neither approach is better than the other, depending on the situation. Neither approach is more right than the other, depending on the situation.

An organization can't afford to view its information resources as belonging to either the techies (technical approach) or the non-techies (behavioral approach). Responsibility for information belongs to everyone in the organization. This is the socio-technical approach, that is, a combination of the two. Everyone has to work together to ensure that Information Systems serve the entire organization.

To help you understand the importance of viewing Information Systems through the socio- technical approach, look at what the current trade journals are saying. David Haskin, writing in the April 1999 issue of Windows Magazine, quotes Steve Roberts, vice president of information technology for Mind Spring Enterprises, an Atlanta-based Internet service provider: "The gap in understanding between technical and non technical people is the biggest challenge I've seen." Haskin goes on to say, "Because technology is the bedrock on which successful businesses are built, the stakes in making this relationship work are high. Failing to use the correct technology can put you at a competitive disadvantage, and glitches in existing technologies can bring a business to a grinding halt."

Information Systems and the use of technology belong to everyone in an organization. This concept is best carried out through a socio-technical approach, which

allows both the technical and behavioral approaches to be combined for the good of the organization.

Information systems are socio-technical systems. Through they are composed of machines, devices, and "hard' physical technology, they require substantial social, organizational, and intellectual investments to make them work property.

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The study of information systems deals with issues and insights contributed from technological and behavioral disciplines.

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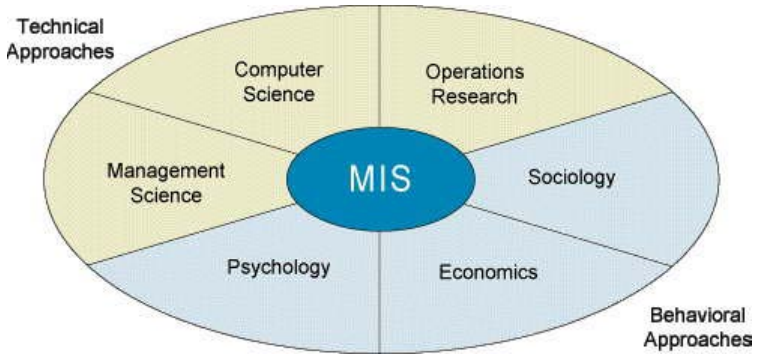

Fig. 3.3: Contemporary Approaches

Technical Approach

The technical approach to information systems emphasizes mathematically based models to study information systems, a well as the physical technology and formal capabilities of these systems.

The disciplines that contribute to the technical approach are:

- Computer science,
- Management science
- Operations research

Computer science is related with instituting speculations of computability, methods of computation, and techniques of efficient data storage and access.

Management science highlights the expansion of models for decision-making and management practices.

Operations research concentrates on mathematical techniques for optimizing chosen parameters of organizations like transportation, inventory control, and transaction costs.

From a technical approach, an information system is observed from a mathematical point of view. Mathematical models are used to study information systems and to elucidate how they can be applied. By means of a technical perspective, management would like to establish speculations of computability which can be utilized to recognize how to apply information systems.

Let us consider an analogy: A "techie" looks at most things linked with computing as a sequence of zeroes or ones. After all, everything in a computer is eventually diminished to a zero or a one. So by means of the technical approach, you could state that 2 + 2 = 4.

Behavioural Approach

An important part of the information systems field is concerned with behavioral issues that arise in the development and long-term maintenance of information systems. Issues such as strategic business integration, design, implementation, utilization, and management cannot be explored usually with the model used in the technical approach.

Approach of this Text – Socio-technical Systems

MIS combined the theoretical work of computer science, management science, and operations research with a practical orientation toward building systems and applications. Technology must be changed and designed in such way as to fit organizational and individual needs. At times, the technology may have to be "de-optimized" to accomplish this fit.

3.8 Management Challenges

Is this new technology worth the headaches and heartaches associated with all the problems that can and will arise? Yes. The opportunities for success are endless. The new technologies do offer solutions to age-old problems. Improvements are possible to the way you operate and do business.

The Strategic Business Challenge

Companies spend thousands of dollars on hardware and software, only to find that most of the technology actually goes unused. "How can that be?" you ask. Usually because they didn't pay attention to the full integration of the technology into the organization. Merely buying the technology without exploiting the new opportunities it offers for doing business smarter and better doesn't accomplish much. Think and rethink everything you do and figure out how you can do it better. Change is inevitable, and information must be managed just as you would any other resource.

Creating a digital firm and obtaining benefit is a long and difficult journey for most organizations. Despite heavy information technology investments, many organizations are not realizing significant business value from their business systems, nor or they become digitally enabled. The power of computer hardware and software has grown much more rapidly than the ability of organizations to apply and to use this technology. To fully benefit form information technology, realize genuine productivity, and take advantage of digital firm capabilities, many organizations actually need to be redesigned. They will have to make fundamental changes in organizational behavior, develop new business models and eliminate the inefficiencies of outmoded organizational structures. If organizations merely automate what they are doing today, they are largely missing the potential of information technology.

The Globalization Challenge

The world becomes smaller every day. Competition increases among countries as well as companies. A good Management Information System meets both domestic

and foreign opportunities and challenges. The rapid growth in international trade and the emergence of a global economy call for information systems that can support both producing and selling goods in many different countries. In the past, each regional office of a multinational corporation focused on solving its own unique information problems. Given language, cultural and political differences among countries, this focus frequently resulted in chaos and the failure of central management controls. To develop integrated, multinational, information systems, businesses must develop global hardware, software and communication standards; create cross-cultural accounting and reporting structures; and design transnational business processes.

The Information Architecture Challenge

You have to decide what business you are in, what your core competencies are, and what the organization's goals are. Those decisions drive the technology, instead of the technology driving the rest of the company. Purchasing new hardware involves more than taking the machine out of the box and setting it on someone's desk. Remember the triangle of hardware, software, and persware. Take care of the people and they will take care of the rest! Information architecture describes how to incorporate technology into the mainstream processes in which the business is involved. How will the new Information System support getting the product produced and shipped? How will Advertising and Marketing know when to launch ad campaigns? How will Accounting know when to expect payment?

Many companies are saddled with expensive and unwieldy information technology platforms that cannot adapt to innovation and change. Their information systems are so complex and brittle that they act as constraints on business strategy and execution.

Meeting new business and technology challenges may require redesigning the organization and building new information architecture and information technology infrastructure.

A conceptual design for the execution of information technology in an organization, together with its hardware, software, and network technology platforms, data resources, application portfolio, and IS organization.

The Information Systems Investment Challenge

Too often managers look at their technological investments in terms of the cost of new hardware or software. They overlook the costs associated with the non-technical side of technology. Is productivity up or down? What is the cost of lost sales opportunities and lost customer confidence from a poorly managed E-Business Web site? How do you determine if your Management Information System is worth it?

A major problem raised by the development of powerful, inexpensive computers involves not technology but management and organizations. It's one thing to use information technology to design, produce, deliver and maintain new products. It's another thing to make money doing it. How can organizations obtain a sizeable payoff from their investments in information systems? How can management make sure that the management information systems contribute to corporate value?

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The Responsibility and Control Challenge

Remember, humans should drive the technology, not the other way around. Too often we find it easier to blame the computer for messing up than to realize it's only doing what a human being told it to do. Your goal should be to integrate the technology into the world of people.

Humans do control the technology, and as a manager, you shouldn't lose sight of that.

How can we define information systems that people can control and understand? Although information systems have provided enormous benefits and efficiencies, they have also created new problems and challenges of which managers should be aware. The following table describes some of these problems and challenges.

Management's focus must continually change to take advantage of new opportunities. They require lots of attention and planning for smooth execution.

Table 3.1: Positive and Negative Impacts of Information Systems

Positive Impact of Information Systems	Negative Impact of Information Systems
Information system can perform calculations or process paperwork much faster than people.	By automating activities that were previously performed by people, information systems may eliminate jobs.
Information systems can help companies learn more about the purchase patterns and the preferences of the customers.	Information systems may allow organisations to collect personal details about people that violate their privacy.
Information systems provide new efficiencies through services such as automated teller machines (ATMs), telephone systems, or computer controlled airplanes and air terminals.	Information systems are used in so many aspects of everyday life that system outages can cause shutdowns of businesses or transportation services, paralyzing communities.
Information systems have made possible new medical advances in surgery, radiology, and patient monitoring.	Heavy uses of information systems may suffer repetitive stress injury, technostress, and other health problems.
The internet distributes information instantly to millions of people across the world.	The internet can be used to distribute illegal copies of software, books, articles, and other intellectual property.

3.9 Definition of Decision Support System

Decision support systems provide solutions to the unstructured problems using simulation techniques and system models. Decision Support Systems (DSS) are a class of computerized information system that support decision-making activities. DSS are interactive computer-based systems and subsystems intended to help decision makers use communications technologies, data, documents, knowledge and/or models to complete decision process tasks.

In this unit we will discuss various intelligent techniques such as expert systems, fuzzy logic systems, Neural networks, genetic algorithm, hybrid AI systems, and intelligent agents.

3.10 Relation of DSS with MIS

A properly designed DSS is an interactive software based system intended to help decision makers compile useful information from raw data, documents, personal knowledge, and/or business models to identify and solve problems and make decisions. The DSS basically helps in the information system in the intelligence phase where the objective is to identify the problem and then go to the design phase for solution. The choice of selection criteria varies from problem to problem.

Information Support for Decision Making Process

Simon's model of decision making proposes three stages in the decision making process. MIS plays its role in all the three stages. Given below is a brief description of these three stages of the decision making process and the role of MIS.

Intelligence Stage: In this stage, an information system may provide information about internal as well as external environments. Internal information is generated from the functional areas, whereas external information is collected from various sources, such as databases, newspapers, government reports, personal contacts, etc. Availability of a large amount of information makes it necessary to scan the environment and data sources to get the relevant information. Thus, information systems can be used to scan the business environment of an organization.

In order to get the required information in the intelligence phase of decision making, MIS must be designed so as to answer pre-specified as well as ad hoc queries (unique, unscheduled, situation specific) made by the decision maker. In other words, information system design may have various models (like historical planning and extra organizational) and a query language capability (decision support system capability).

Design Stage: At this stage, various alternatives are developed and evaluated. In the case of structured decisions, information systems can support by quantifying and automating a decision making process. On the other hand, for semi-structured to unstructured decisions, information systems can support such decision making by providing

1. the ability to make ad hoc queries for information in the organizational databases,
2. the ability to reach a decision in an interactive process (decision support system capability).

Thus, information systems should be designed to incorporate various models of business operations and advanced statistical, optimization techniques, etc., so that these could be used to manipulate information already collected in the intelligence stage to develop and evaluate various alternatives.

Choice Stage: It is the choice stage in which a course of action is selected and feedback is collected on the implemented decision. Information systems can provide summarized and organized information to the decision makers at this stage. Several models may be used to select the most appropriate alternative and thus help decision makers select the best course of action. Information systems can also help the decision maker monitor the successful

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implementation of a decision by providing feedback. During the process of decision making chooses to return to any information system. An information system, to support the choice stage of the decision-maker, should have optimization models and suggestion models.

In business, information systems support business processes and operations, decision-making, and competitive strategies.

The Functional Support Role

It can also be called Data Base Management System wherein maximum utilization in an efficient manner based on the organizational needs is obtained by analyzing, processing and referencing of Data Base. Not only for the business, but for all kinds of organizations such as Disaster Management Organization for using it as Disaster Management Information System.

Business processes and operations support functions are the most basic. They involve collecting, recording, storing, and basic processing of data. Information systems support business processes and operations by recording and storing accounting records including sales data, purchase data, investment data, and payroll data. Processing such records into financial statements such as income statements, balance sheets, ledgers, and management reports, etc., recording and storing inventory data, work in process data, equipment repair and maintenance data, supply chain data, and other production/operations records processing these operations records into production schedules, production controllers, inventory systems, and production monitoring systems recording and storing such human resource records as personnel data, salary data, and employment histories, recording and storing market data, customer profiles, customer purchase histories, marketing research data, advertising data, and other marketing records processing these marketing records into advertising elasticity reports, marketing plans, and sales activity reports recording and storing business intelligence data, competitor analysis data, industry data, corporate objectives, and other strategic management records processing these strategic management records into industry trends reports, market share reports, mission statements, and portfolio models. The bottom line is that the information systems use all of the above to implement, control, and monitor plans, strategies, tactics, new products, new business models or new business ventures.

The Decision Support Role

The business decision-making support function goes one step further. It becomes an integral part – even a vital part – of decision-making. It allows users to ask very powerful "What if…?" questions: What if we increase the price by 5%? What if we increase price by 10%? What if we decrease price by 5%? What if we increase price by 10% now, then decrease it by 5% in three months? It also allows users to deal with contingencies: If inflation increases by 5% (instead of 2% as we are assuming), then what do we do? What do we do if we are faced with a strike or a new competitive threat? An organization succeeds or fails based on the quality of its decisions. The enhanced ability to explore "what if" questions is central to analyzing the likely results of possible decisions and choosing those most likely to shape the future as desired. "Business decision-making

support function" is a phrase likely to quicken the pulse of no one but an accountant, but, in fact, it is all about turning wonderful dreams into solid realities.

The Communication Decision Support System Role

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Information systems can support a company's competitive positioning. Here are three levels of analysis:

1. The supports for help in piloting the chain of internal value. They are the most recent and the most pragmatic systems within the reach of the manager. They are the solutions to reductions of costs and management of performance. They are typically named "Business Workflow Analysis" (BWA) or of "Business Management Systems p2p". Tool networks, they ensure control over piloting the set functions of a company. The real-time mastery in the costs of dysfunctions causes distances from accounts, evaluation and accounting that are presented in the evaluation and qualitative reports.
2. All successful companies have one (or two) business functions that they do better than the competition. These are called core competencies. If a company's core competency gives it a long term advantage in the marketplace, it is referred to as a sustainable competitive advantage. For a core competency to become a sustainable competitive advantage it must be difficult to mimic, unique, sustainable, superior to the competition, and applicable to multiple situations. Other examples of company characteristics that could constitute a sustainable competitive advantage include: superior product quality, extensive distribution contracts, accumulated brand equity and positive company reputation, low cost production techniques, patents and copyrights, government protected monopoly, and superior employees and management team. The list of potential sustainable competitive advantage characteristics is very long. However, some experts hold that in today's changing and competitive world, no advantage can be sustained in the long run. They argue that the only truly sustainable competitive advantage is to build an organization that is so alert and so agile that it will always be able to find an advantage, no matter what changes occur.
3. Information systems often support and occasionally constitute these competitive advantages. The rapid change has made access to timely and current information critical in a competitive environment. Information systems, like business environmental scanning systems, support almost all sustainable competitive advantages. Occasionally, the information system itself is the competitive advantage. One example is Wal-Mart. They used an extranet to integrate their whole supply chain. This use of information systems gave Sam Walton a competitive advantage for two decades. Another example is Dell Computer. They used the internet to market custom assembled PC's. Michael Dell is still benefiting from this low-cost promotion and distribution technique. Other examples are eBay, Amazon.com, Federal Express, and Business Workflow Analysis.

3.11 Evolution of DSS

Decision Support Systems have evolved over the past three decades from simple model-oriented systems to advanced multi-function entities. During the 1960's, most Decision Support Systems were fairly based on powerful (and expensive) mainframe computers which provided managers with structured, periodic reports. MIS theory developments during the 1970's saw Decision Support Systems evolve into more elaborate computer-based systems that supported production, promotion, pricing, marketing and some logistical functions. By the early 1980's Decision Support Systems enjoyed more interests from academics and the framework for Decision Support Systems was greatly expanded by the end of the decade. It was only during the 1990's that a paradigm shift occurred in Decision Support Systems and more complex systems, which incorporated, advanced database technology and client/server capabilities, were emerging from many areas in business processes. As many organizations started to upgrade their network infrastructure, object oriented technology and data warehousing started to make its mark on Decision Support Systems. The rapid expansion of the Internet provided additional opportunities for the scope of Decision Support Systems and consequently many new innovative systems such as OLAP and other web-drive systems were developed.

3.12 Characteristics of DSS

The characteristics of DSS are that these are more flexible and adaptable to rapidly changing decision making requirements than other popular management information and reporting systems. The criterion of DSS is to provide managers with a set of capabilities or alternatives which they can sieve out to generate information to enable decisional processes. The characteristics of DSS are:

1. ***Identifiable:*** DSS may be independent systems that collect or replicate data from other information systems OR subsystems of a larger, more integrated information system.
2. ***Repeated Use:*** DSS is intended for repeated use. A specific DSS may be used routinely or used as needed for ad hoc decision support tasks.
3. ***Ancillary:*** DSS can support decision makers at any level in an organization. They are NOT intended to replace decision makers.
4. ***Interaction:*** DSS is computer-based system designed for interactive use by decision makers or staff users who control the sequence of interaction and the operations performed.
5. ***Facilitation:*** DSS facilitates and supports specific decision-making activities and/or decision processes.
6. ***Comprehensive Data Access:*** It allows users to access data from different sources concurrently, leaving organizations the freedom to choose the data warehouse that best suits their unique requirements and preferences.
7. ***Supports Individual and Group Decision Making:*** It provides a single platform that allows all users to access the same information and access the same version

of truth, while providing autonomy to individual users and development groups to design reporting content locally.

8. ***Decision Impact:*** DSS is intended to improve the accuracy, timeliness, quality and overall effectiveness of a specific decision or a set of related decisions.
9. ***Task-oriented:*** DSS provides specific capabilities that support one or more tasks related to decision-making, including intelligence and data analysis; identification and design of alternatives; choice among alternatives; and decision implementation.
10. ***Easy to Develop and Deploy:*** DSS delivers an interactive, scalable platform for rapidly developing and deploying projects. Multiple projects can be created within a single shared metadata. Within each project, development teams create a wide variety of re-usable metadata objects.
11. ***Integrated Software:*** DSS's integrated platform enables administrators and IT professionals to develop data models, perform sophisticated analysis, generate analytical reports, and deliver these reports to end users via different channels (Web, email, file, print and mobile devices).
12. ***Flexibility:*** DSS features are flexible and can be altered according to need providing a helping hand in the work process.

3.13 Classification of DSS

DSS has been classified in different ways as the concept matured with time. As and when the full potential and possibilities for the field emerged, different classification systems also emerged. Some of the well known classification models are given below:

According to Donovan and Madnick (1977) DSS can be classified as,

- Institutional-when the DSS supports ongoing and recurring decisions
- Ad hoc-when the DSS supports a one off-kind of decision.

Hackathorn and Keen (1981) classified DSS as,

- Personal DSS
- Group DSS
- Organizational DSS

Alter (1980) opined that decision support systems could be classified into seven types based on their generic nature of operations. He described the seven types as:

- ***File Drawer Systems:*** This type of DSS primarily provides access to data stores/data related items.
- ***Data Analysis Systems:*** This type of DSS supports the manipulation of data through the use of specific or generic computerized settings or tools.
- ***Analysis Information Systems:*** This type of DSS provides access to sets of decision oriented databases and simple small models.
- ***Accounting and Financial Models:*** This type of DSS can perform 'what if analysis' and calculate the outcomes of different decision paths.

- ***Representational Models:*** This type of DSS can also perform 'what if analysis' and calculate the outcomes of different decision paths, based on simulated models.
- ***Optimization Models:*** This kind of DSS provides solutions through the use of optimization models which have mathematical solutions.
- ***Suggestion Models:*** This kind of DSS works when the decision to be taken is based on well-structured tasks.

Modern classifications of DSS are:

Model Driven DSS is a DSS that uses a model (quantitative) based on heuristics, optimization, simulation, etc., for deriving solutions to problems. It has access to the models and has flexibility of changing the parameters of the model. Real data or transactional data from databases of TPS is then passed through the model to arrive at the solution. The system is capable of producing different scenarios.

Data Driven DSS is a DSS that gives access to time-series internal data. Data ware houses that have tools that provide facility to manipulate such data are examples of advance systems. Executive Information Systems are examples of data-driven DSS.

Communications-driven DSS is a DSS that uses network and communications technologies to support decision-relevant collaboration and communication. In such systems, communication technologies are the most important component.

Document-driven DSS is a DSS that uses computer storage and processing to provide document retrieval and analysis.

Knowledge-driven DSS is a DSS that collects and stores 'expertise' so that it can be used for decision-making when required.

Distinction: DSS and Programmed Systems

These are in contrast with programmed decision systems which supplant human decision making rather than supporting human decision making process. The example of programmed decision systems that assist routine structured decisions are re-ordering inventory, triggering reminder notices, selecting audit samples, approving loans, etc. The outputs of DSS are not predefined and therefore cannot be pre-formated because needs for types of information required for an unstructured problems cannot be exactly determined and are always subject to change. The property of well designed DSS is that it is flexible to generate immediate responses to a variety of disjointed queries with the assistance of inbuilt formulas, functions, sorts, graphs, formal models and other statistical tools.

3.14 Types of Information Systems in the Organization

Management Information Systems comprise many sub-systems and are influenced by the organization's structure, activities, risk profile, and technological capabilities. Within an organization set up, depending on the level of management, the information systems perform various activities and play certain roles. Information systems support

top management in setting long-term goals, policies and achieving strategic competitive advantage. For middle management, information systems help in taking tactical decisions. For lower level management, an information system processes daily transactions. The role of information systems has developed during the years. The original conception was of automation of existing manual and pre-computer mechanical processes. This was quickly succeeded by the rationalization and integration of systems.

In both of these forms, information system was regarded primarily as an operational support tool, and secondarily as a service to management.

We may look in some detail information systems below:

Transaction Processing System

Transaction processing systems were among the earliest computerized systems. Their primary purpose is to record, process, validate, and store transactions that take place in the various functional areas/of a business for future retrieval and use. A Transaction Processing System (TPS) is an information system that records company transactions (a transaction is defined as an exchange between two or more business entities).

Transaction Processing Systems (TPS) are cross-functional information systems that process data resulting from the occurrence of business transactions.

Transactions are events that occur as part of doing business, such as sales, purchases, deposits, withdrawals, refunds, and payments. Transaction processing activities are needed to capture and process data, or the operations of a business would grind to a halt.

Example: Let us look at a simple example of a business transaction. McDonald's, which sells a large number of hamburgers everyday, orders raw materials from its suppliers. Each time the company places an order with a supplier, a transaction occurs and a transaction system records relevant information, such as the supplier's name, address, and credit rating, the kind and quantity of items purchased, and the invoice amount.

Types of Transactions

There are mainly two types of transaction and these are:

- Internal transaction
- External transaction

Internal Transactions: Those transactions, which are internal to the company and are related with the internal working of any organization.

Example: Recruitment Policy, Promotion Policy, Production Policy, etc.

External Transactions: Those transactions, which are external to the organization and are related with the external sources, are regarded as External Transaction. For example sales, purchase, etc.

When a department orders office supplies from the purchasing department, an internal transaction occurs, when a customer places an order for a product, an external transaction occurs.

Characteristics of Transaction Processing Systems

Various characteristics of TPS are:

- A TPS records internal and external transactions for a company. It is a repository of data that is frequently accessed by other systems.
- A TPS performs routine, repetitive tasks. It is mostly used by lower-level managers to make operational decisions.
- Transactions can be recorded in batch mode or online. In batch mode, the files are updated periodically; in online mode, each transaction is recorded as it occurs.
- There are six steps in processing a transaction. They are data entry, data validation, data processing and revalidation, storage, output generation, and query support.

Features of TPS

Various features of TPS are:

- A TPS supports different tasks by imposing a set of rules and guidelines that specify how to record, process, and store a given transaction. There are many uses of transaction processing systems in our everyday lives, such as when we make a purchase at retail store, deposit or withdraw money at a bank, or register for classes at a university. Almost all organizations, regardless of the industry in which they operate, have a manual or automated TPS.
- A TPS is the data lifeline for a company because it is the source of data for other information systems, such as MIS and DSS (Decision Support Systems). Hence, if the TPS shuts down, the consequences can be serious for the organization.
- A TPS is also the main link between the organization and external entities, such as customers suppliers, distributors, and regulatory agencies.
- TPS exist for the various functional areas in an organization, such as finance, accounting, manufacturing, production, human resources, marketing quality control, engineering, and research and development. Until a few years ago, many companies viewed the TPS for each business function as separate entity with little or no connection to other systems in the company. Today, however, many companies are trying to build cross-functional TPS to promote the free exchange of information among different business units. This is a desirable goal, but is still very difficult to achieve.

Decision Support System

A broad description of a decision support system is human and computer interaction used in decision-making. A Decision Support System (DSS) is an interactive computer-based system, which helps decision-makers utilize data and models to solve unstructured problems. Decision support systems couple the intellectual resources of individuals with

the capabilities of the computer to improve the quality of decisions. It is a computer-based support system for management decision-makers who deal with semi-structured and unstructured problems.

A decision support system is an information system whose primary purpose is to provide knowledge workers with information on which to base informed decisions. The decision support systems take the data and present it in various formats to aid the individual or group in reaching a decision. The decision support systems are generally used by the highest level of management as an aid for the unstructured decisions they have to make. A decision support system provides facilities for verification of information integrity, and for discovery of discrepancies in received information. Statistical methods and rule-based systems provide some tools for the analysis and pre-processing of data used for generation and evaluation of alternative decisions.

A decision support system is a computer-based system consisting of three interacting components:

1. ***A language system:*** A mechanism to provide communication between the user and other components of the DSS,
2. ***A knowledge system:*** The repository of problem domain knowledge embodied is DSS either as data or procedures, and
3. ***A problem processing system:*** The link between the other two components, containing one or more of the general problem-handling capabilities required for decision-making.

So, a decision support system is:

(a) An information system

(b) Which is used by managers

(c) In making decisions

(d) And to support, not to replace people

(e) Used when the decision is semi-structured or unstructured

(f) Incorporate a database of some sort

(g) It also incorporates models

Management Information System

An Management Information System (MIS) is a subset of the overall internal controls of a business covering the application of people, documents, technologies, and procedures by management accountants to solve business problems such as costing a product, service or a business-wide strategy. Management information systems are distinct from regular information systems in that they are used to analyze other information systems applied in operational activities in the organization. Academically, the term is commonly used to refer to the group of information management methods tied to the automation or support of human decision making, e.g. Decision Support Systems, Expert systems, and Executive information systems.

It has been described as, "MIS 'lives' in the space that intersects technology and business. MIS combines tech with business to get people the information they need to do their jobs better/ faster/smarter. Information is the lifeblood of all organizations - now more than ever. MIS professionals work as systems analysts, project managers, systems administrators, etc., communicating directly with staff and management across the organization."

An 'MIS' is a planned system of the collecting, processing, storing and disseminating data in the form of information needed to carry out the functions of management. In a way it is a documented report of the activities those were planned and executed. According to Philip Kotler "A marketing information system consists of people, equipment, and procedures to gather, sort, analyze, evaluate, and distribute needed, timely, and accurate information to marketing decision makers."

The terms MIS and information system are often confused. Information systems include systems that are not intended for decision making. That area of study should not be confused with computer science. IT service management is a practitioner-focused discipline. MIS has also some differences with Enterprise Resource Planning (ERP) as ERP incorporates elements that are not necessarily focused on decision support.

Management Information System (M.I.S.) is basically concerned with processing data into information which is then communicated to the various Departments in an organization for appropriate decision-making.

Fig. 3.4: Management Information System

Data collection involves the use of Information Technology (IT) comprising: computers and telecommunications networks (E-Mail, Voice Mail, Internet, telephone, etc.)

Computers are important for more quantitative, than qualitative, data collection, storage and retrieval; Special features are speed and accuracy, and storage of large amount of data.

Telecommunications provide the means for one-way or two-way communication and for the transmission of messages. A combination of IT is used: telephone, computer, processor, printer, etc. A lot of time and money are saved and the security of data and messages is ensured.

MIS provides several benefits to the business organization: the means of effective and efficient coordination between Departments; quick and reliable referencing; access to relevant data and documents; use of less labour; improvement in organizational and departmental techniques; management of day-to-day activities (as accounts, stock control, payroll, etc.); day-to-day assistance in a Department and closer contact with the rest of the world.

Executive Support System (ESS)

Executive Support Systems (ESS) supply the necessary tools to senior management. The decisions at this level of the company are usually never structured and could be described as "educated guesses." Executives rely as much, if not more so, on external data than they do on data internal to their organization. Decisions must be made in the context of the world outside the organization. The problems and situations senior executives face are very fluid, always changing, so the system must be flexible and easy to manipulate.

The Role of ESS in the Organization

Executives often face information overload and must be able to separate the chaff from the wheat in order to make the right decision. On the other hand, if the information they have is not detailed enough they may not be able to make the best decision. An ESS can supply the summarized information executives need and yet provide the opportunity to drill down to more detail if necessary.

As technology advances, ESS are able to link data from various sources both internal and external to provide the amount and kind of information executives find useful. As common software programs include more options and executives gain experience using these programs, they're turning to them as an easy way to manipulate information. Many executives are also turning to the Web to provide the flexibility they need.

The Nature of Executive's Work

We now know the basics of ESS. Now before continuing further I want to discuss the nature of an executives work. This means that which type of work executives normally do or perform for which they require not a DSS but ESS. This is highly required before building an ESS because without the knowledge of executives work we cannot decide about the system which is suitable for him.

Basically manager's role is divided into three categories:

- Interpersonal Role: Roles like figurehead, leader, and liaison
- Informational Roles: Roles of monitor, disseminator, spokesperson
- Decisional Roles: Entrepreneur, disturbance handler, resource alligator, negotiator.

Most of the ESS support all these roles for executive's successful working. If we pay attention then we can see that for interpersonal roles and informational roles with very few advances to DSS the executives can start using ESS. But executives mainly require the ESS for decisional roles.

We divide the work of executives in relation to the decision roles into 2 phases. Phase 1 is the identification of problems or opportunities. Phase 2 is the decision of what to do about it. The figure below provides the flowchart that describes about the process of information flow in decisional roles.

Functional units like finance, production, accounting, and personnel, etc. generate the internal information. The external information comes from the sources such as online databases, newspaper, industry newsletters, government reports, personal contacts, etc.

We know that the combined information is very important because that is the source needed for successful competition and survival. As the data is large the information is needed to be scanned further. The collected information is then checked and verified for its correction that is it is evaluated for the further use of the organization. Finally, the evaluated information is sent for qualitative or quantitative analysis. Then the executive makes a decision whether an opportunity occurs or problem occurs. If there is a problem then information is given as an input for the next step else it is again scanned for further evaluation. Finally the executives take the decision.

Benefits of ESS

As more executives come up through the ranks, they are more familiar with and rely more on technology to assist them with their jobs. Executive Support Systems don't provide executives with ready-made decisions. They provide the information that helps them make their decisions. Executives use that information, along with their experience, knowledge, education, and understanding of the corporation and the business environment as a whole, to make their decisions.

Executives are more inclined to want summarized data rather than detailed data (even though the details must be available). ESS rely on graphic presentation of information because it's a much quicker way for busy executives to grasp summarized information.

Because of the trend toward flatter organizations with fewer layers of management, companies are employing ESS at lower levels of the organization. This trend will probably continue as more managers become knowledgeable about the power and flexibility of ESS.

Advantages of ESS

Advantages of ESS are:

- Simple for high-level executives to use Operations do not require extensive computer experience.
- Provides timely delivery of company summary information.
- Provides better understanding of information.
- Filters data for better time management.
- Provides system for improvement in information tracking.

Disadvantages of ESS

Disadvantages of ESS are:

- Computer skills required to obtain results.
- Requires preparation and analysis time to get desired information.
- Detail oriented Provides detailed analysis of a situation.
- Difficult to quantify benefits of DSS, How do you quantify a better decision?
- Difficult to maintain database integrity.
- Provides only moderate support of external data and graphics capabilities.

3.15 Functional Perspective of Information Systems

Information systems can be classified by the specific organizational function they serve as well as by organizational level.

Notes

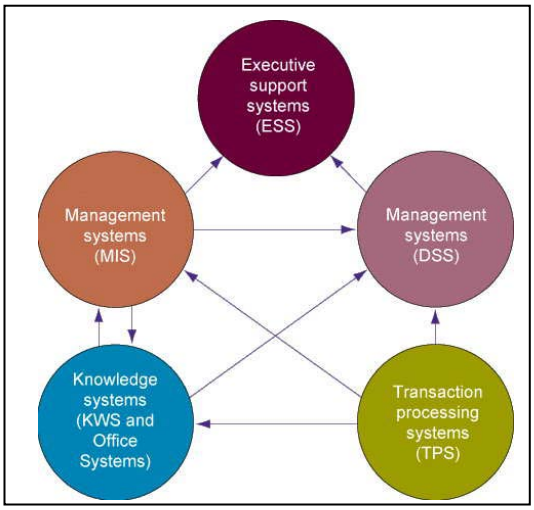

Fig. 3.5: Interrelationships Among Systems

The various types of systems in the organization have interdependencies. TPS are a major producer of information that is required by the other systems which, in turn, produce information for other systems.

Sales and Marketing Systems

The sale and marketing function is responsible for selling the organization's products or services. Marketing is concerned with identifying the customers for the firm's products or services, determine what they need or want, planning and developing products and services to meet their needs, and advertising and promoting these products and services.

Manufacturing and Production Systems

The manufacturing and production function is responsible for actually producing the firm's goods and services. Manufacturing and production activities deal with the planning, development, and maintenance of production facilities; the establishment of production goals; the acquisition, storage, and availability of production materials; and the scheduling of equipment, facilities, materials, and labor required to fashion finished products.

Finance and Accounting Systems

The finance function is responsible for managing the firm's financial assets, such as cash, stocks, bonds, and other investments, in order to maximize the return on these financial assets. The finance function is also in charge of managing the capitalization of the firm. In order to determine whether the firm is getting the best return on its investments, the finance function must obtain a considerable amount of information from sources external to the firm.

Notes

Human Resources Systems

The human resource function is responsible for attracting, developing, and maintaining the firm's workforce. Human resources information systems support activities such as identifying potential employees, maintaining complete records on existing employees, and creating programs to develop employees' talents and skills.

Strategic-level human resources system identify the employee requirements (skills, educational level, types of positions, number of positions, and cost) for meeting the firm's long term business plans.

3.16 Enterprise Systems

A large organization typically has many different kinds of information systems that support different functions, organizational levels, and business processes. Many organizations are also building enterprise systems, also known as Enterprise Resource Planning (ERP) systems, to provide firm wide integration.

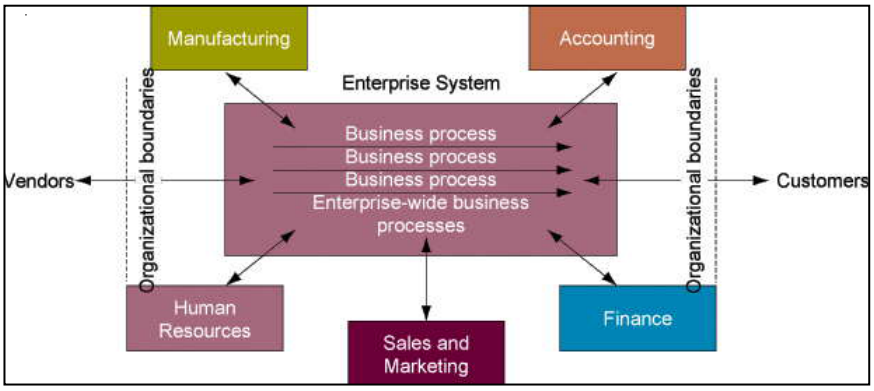

Fig. 3.6: Enterprise Systems

Enterprise systems can integrate the key business processes of an entire firm into a single software system that allows information to flow seamlessly throughout the organization. These systems may include transactions with customers and vendors.

Enterprise Systems (ES) are large-scale, integrated application-software packages that use the computational, data storage, and data transmission power of modern Information Technology (IT) to support processes, information flows, reporting, and data analytics within and between complex organizations. In short, ES are Packaged Enterprise Application Software (PEAS) systems, where all three adjectives, "packaged", "enterprise", and "application", in combination, restrict the set of things that can be called ES. Although some people have equated the terms "enterprise system" and "Enterprise Resource Planning (ERP) system", since the term "ERP" now has a reasonably clear meaning it is convenient to use the term "enterprise system" to refer to the larger set of all large organization-wide packaged applications with a process orientation including Enterprise resource planning (ERP), Customer Relationship Management (CRM), Supply Chain Management (SCM). Enterprise systems are built on, though do not include, software platforms such as SAP's NetWeaver and Oracle's Fusion and, usually,

a relational database. In addition, although data warehousing or business intelligence systems are enterprise- wide packaged application software often sold by ES vendors, since they do not directly support execution of business processes, it is often convenient to exclude them from the definition of ES.

ES is a special class of enterprise application software (namely packaged enterprise application software), which, in turn, is a type of enterprise software. Here, the adjective "enterprise" is used to connote "enterprise class" software, i.e., software designed for use in large organizations. Clearly, under the preceding definition, ES is also a special class of application software (namely packaged enterprise application software).

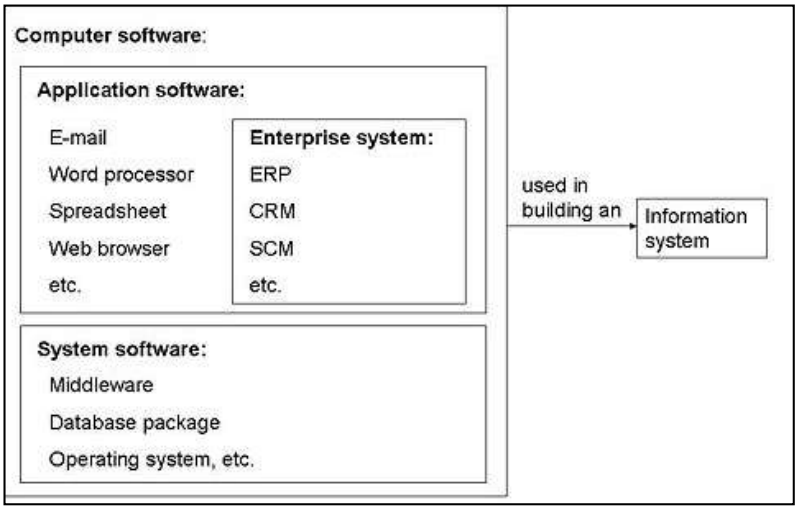

Fig. 3.7: Enterprise Systems

Computer-based systems built using ES are types of Enterprise Information System, or Management Information System, which, in turn, are types of information system (IS). The distinction between ES and IS is that "ES" refers to software, whereas an IS is a social system that uses IT, i.e., an IS includes people—often in an organizational setting—as well as IT.

Benefits of Enterprise Systems

The various benefits of enterprise systems are:

- ***Firm Structure and Organization:*** One Organization: Companies can use enterprise systems to support organizational structures that were not previously possible or to create a more disciplined organizational culture.
- ***Management:*** Firm wide Knowledge-based Management Process: In addition to automating many essential business transactions, such as taking orders, paying suppliers, or changing employee benefit status, enterprise systems can also improve management reporting and decision making.
- ***Technology:*** Unified Platform: Enterprise systems promise to provide firms with a single, unified, and all-encompassing information system technology platform and environment. Enterprise systems promise to create a single, integrated repository that gathers data on all the key business processes.

Notes

- Business: More Efficient Operations and Customer-driven Business Process: Enterprise systems can help create the foundation for a customer-driven or demand organization. By Notes integrating discrete business processes such as sales, production, finance, and logistics, the entire organization can efficiently respond to customer requests for products or information, forecast new products, and build and deliver them as demand requires.

The Challenge of Enterprise Systems

Although enterprise systems can improve organizational coordination, efficiency, and decision making, they have proven very difficult to build. Employees must take on new job functions and responsibilities. Enterprise systems require complex pieces of software and large investment of time, money, and expertise.

Daunting Implementation

Enterprise systems bring dramatic changes to business. They require not only deep-seated technological changes but also fundamental changes in the way the business operates.

High Up-front Cost and Future Benefits

The costs of enterprise systems are large, up-front, highly visible, and often politically changed. Although the costs to build the system are obvious, the benefits often cannot be precisely quantified at the beginning of an enterprise project. One reason is that the benefits often accrue from employees using the system after it is completed and gaining the knowledge of business operations heretofore impossible to learn.

Inflexibility

Enterprise system software tends to be complex and difficult to master, with a worldwide shortage in people with the expertise to install and maintain it. The software is deeply intertwined with corporate business.

Realizing Strategic Value

Companies may also fail to achieve strategic benefits from enterprise systems if integrating business process processes using the generic models provided by standard ERP software prevents the firm from using unique business processes that had been sources of advantage over competitors.

Enterprise Information Systems

Enterprise Information System is generally any kind of computing system that is of "enterprise class". This means typically offering high quality of service, dealing with large volumes of data and capable of supporting some large organization ("an enterprise").

Enterprise Information Systems provide a technology platform that enables organizations to integrate and coordinate their business processes. They provide a single system that is central to the organization and ensure that information can be shared across all functional levels and management hierarchies. Enterprise systems are invaluable in

eliminating the problem of information fragmentation caused by multiple information systems in an organization, by creating a standard data structure.

A typical Enterprise Information System would be housed in one or more Data centers, run Enterprise software, and could include applications such as Content management systems and typically cross organizational borders.

The word enterprise can have various connotations. The term may be used to mean virtually anything, by virtue of it having become the latest corporate-speak buzzword.

3.17 Strategic Uses of Information Systems

Organizations are now investing heavily in information systems and information technology. However, there is a general dissatisfaction with the benefits that accrue from this investment. Argues that information systems and technology can be centrally instrumental in achieving corporate goals but only where the organization has a clearly defined corporate and competitive strategy, and understands the information needs that underpin these strategies. It demonstrates the interrelationships between strategy and information systems.

An effective strategy is not necessarily one that promises maximum efficiency or least total cost, but rather one that fits the needs of the organization and strives for consistency between the organization's capabilities and the competitive advantage being sought by the organization. The successful application of strategy in the contemporary global environment requires an organization to have an effective strategic management process. In turn, an effective strategic management process increasingly depends on the effective application of advances in information technology.

3.18 Firm-Level Strategy and Information Technology

Think of a picture puzzle with all its separate pieces scattered on the table. Separately, the pieces don't make a very pretty picture. But if you fit them together, they make quite a beautiful piece of art. So too for businesses. Separately, the various units of a business don't function well and certainly aren't successful on their own. But if you fit them all together, so they work in conjunction, you can create a successful business. Information technology can help you do this.

What does a business do better than anyone else? Does it make the best jeans in the world? Do they produce the best movies? Does it deliver flowers faster and fresher than any of the competition? Whatever its main product or service is, that's its core competency. Successful companies can use information technology to improve their core competencies by sharing information across business units. They can also use technology to expand their core competencies by using knowledge stored in their information systems.

Firstly we will recognize the definition of firm and business to understand firm-level strategy in a clear manner.

Notes

A microeconomic notion specifies that a firm is a corporation that exists and makes decisions so as to make the most of profits. The speculation of the firm goes along with the speculation of the consumer, which specifies that consumers search for maximizing their on the whole utility.

Business is defined as an organization or enterprising unit occupied in commercial, industrial or professional activities. A business can be a for-profit unit, like a publicly-traded firm, or a non- profit organization involved in business activities, such as an agricultural cooperative. Businesses communicate with the market to verify pricing and demand and then assign resources as per the models that require maximize net profits.

Industry-Level Strategy and Information Systems

The industry level strategy and information system based on:

- Competitive Forces and Network Economics
- Information Partnerships

Competitive Forces and Network Economics

Look at the relationship between America OnLine and Microsoft. On one hand, they are fierce competitors, going head to head in attracting Web users to their respective Web sites. On the other hand, they work together to supply Web users with desktop icons for accessing the Web. How is it that they can compete so vigorously in one area and yet cooperate so well in another? Because both make sense and make money for each company.

Information Partnerships

Many times it's more productive and cheaper to share information with other companies than to create it yourself. Information partnerships between companies, even competitors, can enhance a company's products by aligning them with an industry-wide standard. Vehicle tire manufacturers form information partnerships to share information about standard widths and sizes of tires. Can you imagine how difficult it would be for consumers and other businesses if each tire maker built tires differently?

Other companies form information partnerships to add extra elements to their products which they couldn't offer on their own. Lots of companies offer credit cards with their logo and company information. They then share customer information with the credit card companies. Both companies win because they can offer extra services and products not available if they had to act alone.

Industry is defined as a fundamental category of business activity. The term industry is sometimes used to illustrate a very specific business activity (such as semiconductors) or a more common business activity (such as customer durables). If a company contributes in numerous business activities, it is generally considered to be in the industry in which most of its profits are derived.

Competitive Force Model

The most renowned support for scrutinizing competitiveness is competitive forces model. It has been used to produce approaches for companies to augment their competitive frame. It also illustrates how IT can increase the competitiveness of corporations. The model identifies the chief forces that could jeopardize a company's position in a specified industry. Even though the particulars of the model vary from one industry to another, its common structure is worldwide.

The five chief forces can be generalized as follows:

1. The threat of entry of new competitors
2. The bargaining influence of suppliers
3. The bargaining influence of customers (buyers)
4. The risk of alternate products or services
5. The competition between present firms in the industry.

The strength of every force is determined by factors associated to the industry's structure. While the Internet has changed the nature of business, it has also modified the nature of competition. Some have recommended semi radical variations in the model. For example, Harmon et al. (2001) suggest adding a sixth force- negotiating influence of employees-to the original five. Porter himself quarrels that the Internet doesn't vary the model, but that it is only another tool to be used in looking for competitive advantage. Alternatively, "The Internet per se will hardly ever be a competitive advantage. Many of the companies that achieve success will be the ones that utilize the Internet as a complement to traditional manners of competing, not those that set their Internet initiatives besides their recognized functions".

There are some recommended ways the Internet influences competition in the five factors:

1. ***The threat of new competitors:*** For many of the firms, the Internet enhances the threat of new competitors. Initially, the Internet penetratingly decreases conventional obstruction to entry, like the require for a sales force or a physical storefront to sell goods and services. All a competitor needs to do is set up a Web site. This threat is particularly sharp in industries that carry out an intermediation role in addition to industries in which the primary product or service is digital. Secondly, the geographical goal of the Internet facilitates remote competitors to bring rivalry into the local market, or even an indirect competitor to compete more directly with an existing firm.
2. ***The bargaining power of suppliers:*** The Internet's influence on suppliers is mixed. On the one hand, buyers can locate substitute suppliers and evaluate prices more easily, diminishing the supplier's bargaining influence. Alternatively, as companies utilize the Internet to combine their supply chain and link digital exchanges, participating suppliers will flourish by locking in consumers and rising switching costs.
3. ***The bargaining influence of customers:*** The Web extensively enhances a buyer's use to information regarding products and suppliers, Internet technologies can decrease customer switching costs, and buyers can more simply acquire from

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downstream suppliers. These factors signify that the Internet significantly enhances customers' bargaining influence.

4. ***The threat of alternate products or services:*** Information-dependent industries are in the greatest danger here. Any industry in which digitalized information can substitute material goods must observe the Internet as a threat.
5. ***The competition among existing firms in the industry:*** The visibility of Internet functions on the Web makes proprietary systems harder to keep undisclosed, decreasing differences between opponents. In many of the industries, the propensity for the Internet to lower variable costs in relation to fixed costs supports price discounting simultaneously that competition transfers to price. Both are forces that support destructive price competition in an industry. The on the whole impact of the Internet is to enhance competition, which pessimistically influences profitability.

IS Techniques to Gain Competitive Advantage

Competitive advantage may be achieved with many techniques in business. Information technology is one area that may provide several opportunities. In general, MIS techniques may not be better than other methods. However, some firms have experienced considerable success from using these techniques, so they are well worth considering.

Additionally, the rapid changes in technology often lead to competitive advantages if your firm is the first to find a creative use for the new technology. The other side of the coin is that untested new technologies may not work as planned. Hence, the pioneer is taking a risk: If the project fails, the development costs may put the firm at a competitive disadvantage.

The question we wish to examine is how information systems can take advantage of these techniques. The fundamental mechanisms for gaining competitive advantage are barriers to entry, switching costs, lower production costs, product differentiation, control over distribution channels, innovation, and quality control.

Sources of Barriers to Entry

The sources of entries are:

- Economies of scale (size)
- Economies of scope (breadth)
- Product differentiation
- Capital requirements
- Cost disadvantages (independent of size) Distribution channel access Government policy.

Barriers to Entry

The additional costs of creating a sophisticated information system make it harder for firms to enter the industry.

- ***Distribution Channels:*** Control over distribution prevents others from entering the industry. Consumers are reluctant to switch to a competitor if they have to learn a new system or transfer data.

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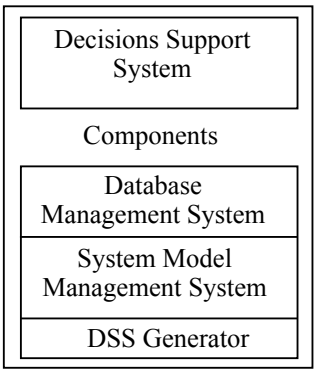
- ***Lower Production Costs:*** Using technology to become the least-cost producer gives an advantage over the competition.
- ***Product Differentiation:*** Technology can add new features to a product or create entirely new products that entice consumers.
- ***Quality Management:*** Monitoring production lines and analyzing data are important aspects of quality control. Improving quality leads to more repeat sales.
- ***The Value Chain:*** Evaluating the entire production process identifies how value is added at each step. Combining steps or acquiring additional stages of the value chain can lead to greater profits.

Comparison between Computer Systems and Decision Support Systems: Computer systems are Management Information Systems that are programmed using the computer, to help departments in their daily work and solve recurring problems with the extraction of the required reports and statistics on a regular basis. While decision support systems offer different alternatives to solve new and non-repeated problems (semi-programmed) clarifying the advantages and disadvantages and the financial cost of each alternative, this is done by building separate data warehouses.

3.19 Components

The basic components of DSS are not predefined and therefore cannot be pre-formatted because needs for types of information required for an unstructured problem cannot be exactly determined and are always subject to change. The property of well designed DSS is that it is flexible. To generate an effective computerized DSS, the DSS generator, the model management system, the database management system and the dialogue management system are used. The DSS generator is the software used to develop DSS and coordinate its processing tasks. The model management system enables the creation, maintenance and application of quantitative and statistical prototypes or models to manipulate the DSS data as per the needs of the decision maker. The database management system enables the decision maker to create, maintain and query DSS database by the processes of retrieval, data reconfiguration (sorting, exchanging columns and joining data, graphical presentations), selection and projection tasks. The dialogue management provides user interfaces such as window based pull down menus and screen formats that support flexible and interactive outputs .



3.20 DSS Analysis Techniques

The fundamental DSS analysis techniques are implemented through the use of statistical tools, optimizing tools, what if analysis and artificial intelligence routines.

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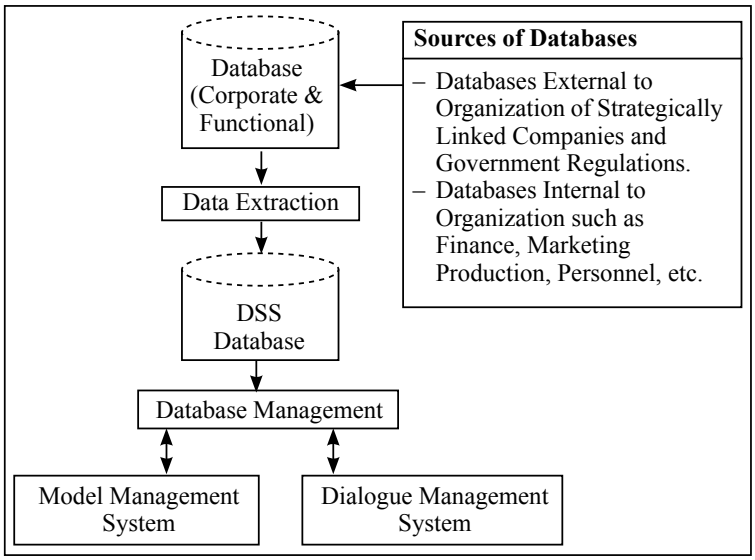
Statistical Tools

Enable

- Data handling tasks such as sorting and distributing data on the criterion used by a decision maker;
- Automated regression analysis used to discern trends for relevant predictions;
- Automated correlation analysis used to determine strength of association among number of variables;
- Analysis of variance (ANOVA) used to show whether the groupings of observations are statistically significant;
- Non-parametric statistics used for samples of data where underline probability distribution is not determinable ;
- Cluster analysis used for classification of observations into groups such that similarities within groups are minimized;
- Factor analysis used to reduce a large number of variables into smaller number of factors retaining the crux of information;
- Forecasting prediction for future derived from the statistical inferences from most of the analysis techniques defined above.



Important optimizing tools have already been discussed under the purview of operational research systems. These recommend certain choices to the decision maker and generate an assortment of predictive information and optimizing techniques.

What if Analysis or Sensitivity Analysis

What if analysis or sensitivity analysis is a non-probabilistic simulation technique that enables the decision maker to reformulate a problem repeatedly until feasible, concrete and viable information is arrived at.

Decision maker can utilize a popular DSS generator Execucom IFPS (Integrated Financial Modeling System)/Plus to set more than one set of estimates to forecast optimum success rate in launch of new product or diversification of business group into new ventures of business by use of what if analysis.

The basis of calculation is based on prudent questions such as:

- What if debt to equity ratio is maintained at 20 per cent too high for the new business?
- What if sales projections are set 5 per cent too low?
- Spreadsheets are also suited for what if analysis. Decision maker can continue to vary the underlying assumptions and use this interactive session to arrive at certain concrete strategic decisions.

Role of Artificial Intelligence and Expert Systems in DSS

The role of AI routines or expert systems in decision support is significant as these systems pinpoint why the business lapse or deviation in anticipated results occurred after inspecting the actual results in comparison to forecasts through knowledge based attributes. For instance the intelligent DSS can suggest that the net profits for a particular period decreased owing to an abnormal increase in price of raw materials or mismanagement of cash handling or inappropriate tax planning. DSS generator IFPS/ plus is endowed with such Artificial intelligence routine features.

Group Decision Support Systems and Executive Information System

Of late, GDSS (Group Decision Support Systems) and EIS (Executive Information System) are gaining rapid popularity. GDSS involve group members geographically dispersed to interact with decision support system as well as communicate with one another under Local Area Network or Wide Area Network of computer system, videoconferencing and e-mail and work simultaneously to concretely arrive at the best decisions. EIS is designed to support top level managers to review decisions and use heuristic approach to arrive at the best decision and disseminate the set of top level decisions for strategic planning and implementation with appropriate comments through e-mail. Commander EIS (from Comshare Inc.), Executive Edge (from Execucom System Co.) and Express EIS (from Information resources Inc.) are some of the specialized EIS software packages popular worldwide.

3.21 Expert System

First of all we must understand that an expert system is nothing but a computer program or a set of computer programs which contains the knowledge and some inference capability of an expert, most generally a human expert, in a particular domain. As expert

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system is supposed to contain the capability to lead to some conclusion based on the inputs provided, information it already contains and its processing capability, an expert system belongs to the branch of Computer Science called Artificial Intelligence.

Mere possessing an algorithm for solving a problem is not sufficient for a program to be termed an expert system, it must also possess knowledge i.e., if there is an expert system for a particular domain or area and if it is fed with a number of questions regarding that domain then sooner or later we can expect that these questions will be answered. So we can say that the knowledge contained by an expert system must contribute towards solving the problems for which it has been designed.

Also knowledge in a expert system must be regarding a specific domain. As a human being cannot be an expert in every area of life, similarly, an expert system which tries to simulate the capabilities of an expert also works in a particular domain. Otherwise it may be require to possess potentially infinite amount of knowledge and processing that knowledge in finite amount of time is an impossible task.

Taking into consideration all the points which have been discussed above, let us try to give one of the many possible definitions of an Expert System.

An Expert System is a computer program that possesses or represents knowledge in a particular domain, has the capability of processing/manipulating or reasoning with this knowledge with a view to solving a problem, giving some achieving or to achieve some specific goal.

An expert system may or may not provide the complete expertise or functionality of a human expert but it must be able to assist a human expert in fast decision making. The program might interact with a human expert or with a customer directly.

Expert System Definition

A model and associated procedure that exhibits, within a specific domain, a degree of expertise in problem solving that is comparable to that of a human expert.

An expert system is a computer system which emulates the decision-making ability of a human expert.

Simply put, an expert system contains knowledge derived from an expert in some narrow domain. This knowledge is used to help individuals using the expert system to solve some problem.

The narrow domain is mentioned since it is quite difficult to encode enough knowledge into a system so that it may solve a variety of problems. We have not reached the point yet where this can be done.

The traditional definition of a computer program is usually:

algorithm + data structures = program

In an expert system, the definition changes to:

inference engine + knowledge = expert system

Basic Properties of an Expert System

The basic properties of expert system are:

- It tries to simulate human reasoning capability about a specific domain rather than the domain itself. This feature separates expert systems from some other familiar programs that use mathematical modeling or computer animation. In an expert system the focus is to emulate an expert's knowledge and problem solving capabilities and if possible, at a faster rate than a human expert.
- It perform reasoning over the acquired knowledge, rather than merely performing some calculations or performing data retrieval.
- It can solve problems by using heuristic or approximate models which, unlike other algorithmic solutions are not guaranteed to succeed.

AI programs that achieve expert-level competence in solving problems in different domains are more called knowledge based systems. A knowledge-based system is any system which performs a job or task by applying rules of thumb to a symbolic representation of knowledge, instead of employing mostly algorithmic or statistical methods. Often the term expert systems is reserved for programs whose knowledge base contains the knowledge used by human experts, in contrast to knowledge gathered from textbooks or non-experts. But more often than not, the two terms, expert systems and knowledge-based systems are taken us synonyms. Together they represent the most widespread type of AI application. The area of human intellectual endeavour to be captured in an expert system is sometimes called the task domain.

refers to some goal-oriented, problem-solving activity. Domain refers to the area within which the task is being performed. Some of the typical tasks are diagnosis, planning, scheduling, configuration and design.

Example: A program capable of conversing about the weather would be a knowledge- based system, even if that program did not have any expertise in meteorology, but an expert system must be able to perform weather forecasting.

Characteristics of Expert System

1. Expert system is an application of artificial Intelligence which incorporates knowledge and problem solving skills of a human being into an information system.

2. Expert system can replace human beings.

3. Expert systems are not designed for one level of management because their primary goal is to provide expertise to whole organization.

4. Expert system has three components such as knowledge base, the inference engine and the user interface.

Need of Expert System

There are many reasons to use an expert system. Here are some of the primary reasons:

- Helps preserve knowledge-builds up the corporate memory of the firm.
- Helps if expertise is scarce, expensive, or unavailable.

- Helps if under time and pressure constraints.
- Helps in training new employees.
- Helps improve worker productivity.

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Expert systems are necessitated by the limitations associated with conventional human decision- making processes, including:

- Human expertise is very scarce.
- Humans get tired from physical or mental workload.
- Humans forget crucial details of a problem.
- Humans are inconsistent in their day-to-day decisions.
- Humans have limited working memory.
- Humans are unable to comprehend large amounts of data quickly.
- Humans are unable to retain large amounts of data in memory.
- Humans are slow in recalling information stored in memory.
- Humans are subject to deliberate or inadvertent bias in their actions.
- Humans can deliberately avoid decision responsibilities.
- Humans lie, hide, and die.

Coupled with these human limitations are the weaknesses inherent in conventional programming and traditional decision-support tools. Despite the mechanistic power of computers, they have certain limitations that impair their effectiveness in implementing human-like decision processes. Conventional programs:

- Are algorithmic in nature and depend only on raw machine power
- Depend on facts that may be difficult to obtain
- Do not make use of the effective heuristic approaches used by human experts
- Are not easily adaptable to changing problem environments
- Seek explicit and factual solutions that may not be possible.

Building Block of Expert System

There are basically four steps to building an expert system:

- Analysis
- Specification
- Development
- Deployment

The spiral model is normally used to implement this approach. The spiral model of developing software is fairly common these days. Expert system development can be modeled as a spiral, where each circuit adds more capabilities to the system. There are other approaches, such as the incremental or linear model, but we prefer the spiral model.

Analysis

The purpose of analysis is to identify a potential application. Possible applications include diagnostics, a controller, etc. During analysis the developer must also assess the suitability of knowledge-engineering technology for this application. You must ask yourself the question Will something else work better? This is true for applying any type of artificial intelligence to solve a problem.

Specification

The specification step is where the developer defines what the expert system will do. Here the developer must also work with the expert to learn enough about the task to plan system development. The expert is a human who is identified as being the domain expert in a particular field. The developer must familiarize himself with the problem so that system development can be performed. The developer will spend a significant amount of time in this phase acquiring knowledge.

Defining what an expert system should do can be challenging. It may be difficult to obtain reliable information. Some experts may solve problems differently, or tell the developer what they think he wants to hear. The experts may envision a different functionality for the system than the developer, who better understands the limitations of the software. It is also important to assure the experts that the purpose of the expert system is not to replace the experts, but to proliferate their knowledge and expertise throughout the organization. It is up to the human experts to continually refine their knowledge and find better ways of solving problems.

Development

The development step consists of several important tasks. Here, the developer must learn how the expert performs the task (knowledge acquisition) in a variety of cases. There are basically three kinds of cases the developer should discuss with the expert: current, historical, and hypothetical. Current cases can be covered by watching the expert perform a task. Historical cases can be discussed by discussing with the expert a task that was performed in the past. And, hypothetical cases can be covered by having the expert describe how a task should be performed in a hypothetical situation.

The knowledge acquisition process, which started in the specification phase, continues into the development phase. The developer must extract knowledge from the previous case discussions. The types of knowledge the developer looks for can be grouped into three categories: strategic, judgemental, and factual. Strategic knowledge is used to help create a flow chart of the system. Judgemental knowledge usually helps define the inference process and describes the reasoning process used by the expert.

Deployment

In the deployment phase the developer installs the system for routine use. He also fixes bugs, updates, and enhances the expert system.

3.22 Fuzzy Logic Systems

Fuzzy Logic Systems are defined as computer-based systems that can access data that are incomplete or only partially accurate. These systems can solve unstructured problems with incomplete knowledge by producing approximate inferences and solutions.

Fuzzy Logic is a technique of reasoning that appears similar human reasoning as it permits for approximate values and inferences (fuzzy logic) and incomplete data (fuzzy data) rather than depending only on Crisp data, like binary (yes/no) options.

Fuzzy Logic in Business

Instances of applications of fuzzy logic are various in Japan, but rate in the United States. The United States has tended to favor by means of AI solutions such as expert systems or neural networks. Japan has executed many fuzzy logic applications, especially the use of special-purpose fuzzy logic microprocessors chips, known as fuzzy process controllers.

Example: Fuzzy logic applications in Japan include:

- Riding in subway trains and elevators
- Riding in cars that are guided or supported by fuzzy process controllers
- Trading shares on the Tokyo Stock Exchange by means of a stock-trading program depending on fuzzy logic

Japanese-made products that use fuzzy logic microprocessors comprise auto-focus cameras, auto-stabilizing, camcorders, energy-efficient air conditioners, self-adjusting washing machines, and automatic transmissions.

3.23 Neural Networks Artificial Neural Systems

Neural networks are defined as computing systems modeled on the human brain's mesh-like network of interlinked processing elements, known as neurons. Neural networks can be executed on microcomputers and other computer systems through software packages, which simulate the actions of a neural network of many processing elements. Specialized neural network co-processor circuit boards are also obtainable. Special-purpose neural net microprocessor chips are used in some application areas. Uses comprise:

- Military weapons systems
- Voice recognition
- Check signature verification
- Manufacturing quality control
- Image processing
- Credit risk assessment
- Investment forecasting
- Data mining

Obviously, neural networks are much easier than the human brain (measured to have more than 100 billion neuron brain cells). Similar to brain, however, such networks can

process many parts of information at the same time and can study to identify patterns and program themselves to solve associated problems on their own.

3.24 Genetic Algorithm

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The use of genetic algorithms is a rising application of artificial intelligence. Genetic algorithm software accesses Darwinian (survival of the fittest); randomizing, and other mathematical functions to create an evolutionary process that can capitulate increasingly better solutions to a problem. Genetic algorithms were initially used to create millions of years in biological, geological, and ecosystem evolution in just a few minutes on a computer. Now genetic algorithm software is being accessed to model numerous scientific, technical, and business processes. Genetic algorithms are especially useful for conditions in which thousands of solutions are probable and must be calculated to form a best possible solution. Genetic algorithm software accesses sets of mathematical process rules (algorithms) that mention how combinations of process components or steps are to be produced. This may comprise:

- Trying random process combinations (mutation)
- Merging parts of several good processes (crossover)
- Choosing good sets of processes and discarding poor ones (selection).

3.25 Hybrid AI Systems

Hybrid system is defined as a software system which employs, in parallel, a mixture of methods and techniques from artificial intelligence subfields as Neuro-fuzzy systems, hybrid connectionist-symbolic models, Fuzzy expert systems, etc.

Every natural intelligent system is considered as hybrid since it accomplishes mental functions on both the symbolic and sub symbolic stages. From the previous few years there has been an growing conversation of the significance of A.I. Systems Integration. Relying on ideas that there have already been produced simple and particular AI systems and now is the time for integration to generate broad AI systems.

Example: Hybrid is a hierarchical control system where the lowest, reactive layers are sub-symbolic.

3.26 Intelligent Agents

An intelligent agent (also called intelligent assistants/wizards) is software replacement for an end user or a process that accomplishes a specified requirement or activity. An intelligent agent accesses an incorporated and learned knowledge base regarding a person or process to make decisions and finish tasks in a manner that accomplishes the intentions of a user. One of the most well recognized uses of intelligent agents is the wizards located in Microsoft Office and other software suites.

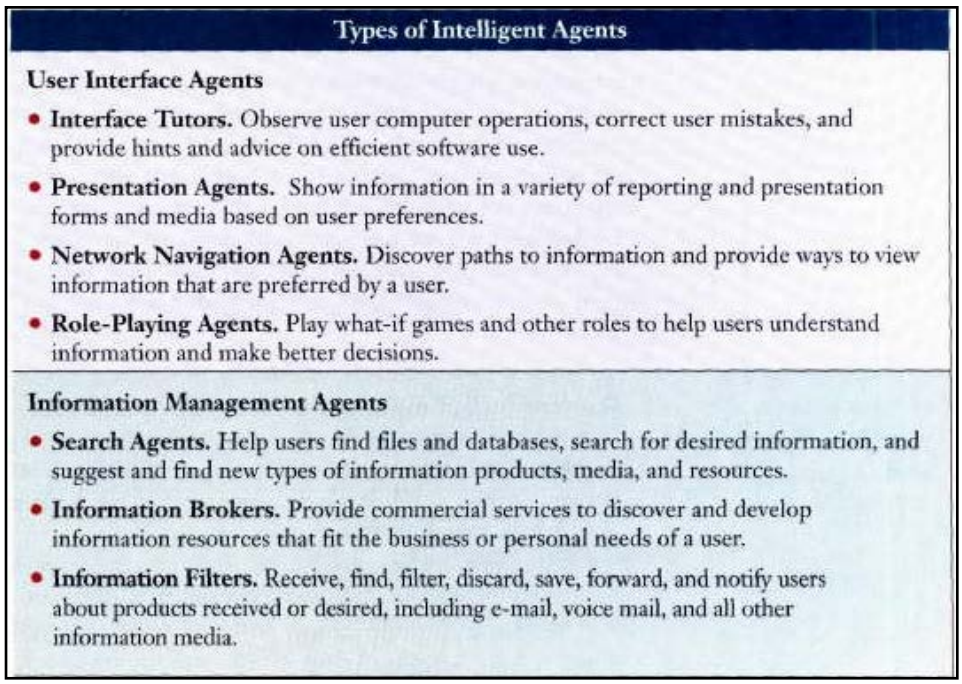

Fig. 3.8:

The use of intelligent agents is expected to grow quickly as a way for users to:

- Simplify software use.
- Locate websites on the Internet and corporate intranets
- Assist customers do comparison-shopping between the many e-commerce sites on the Web.

3.27 Summary

Information is the most critical resource of Management Information System. Information Literacy is more than just clicking a mouse, pounding the computer keyboard, or surfing the Web. Digital convergence is an approach by which all types of media and communication will be digitized allowing them to be used through a single worldwide network. Information systems can be grouped into business function categories; however, in the real world information systems are typically integrated combinations of functional information systems.

Management Information Systems comprise many sub-systems and are influenced by the organization's structure, activities, risk profile, and technological capabilities.

Transaction Processing Systems (TPS) are cross-functional information systems that process data resulting from the occurrence of business transactions. A Decision Support System (DSS) is an interactive computer-based system, which helps decision-makers utilize data and models to solve unstructured problems. An 'MIS' is a planned system of the collecting, processing, storing and disseminating data in the form of information needed to carry out the functions of management.

Executive Support Systems (ESS) supply the necessary tools to senior management. The decisions at this level of the company are usually never structured and could be described as "educated guesses."

Decision support systems (DSS) are interactive software-based systems intended to help managers in decision-making by accessing large volumes of information generated from various related information systems involved in organizational business processes such as office automation system, transaction processing system, etc.

A properly designed DSS is an interactive software based system intended to help decision makers compile useful information from raw data, documents, personal knowledge, and/or business models to identify and solve problems and make decisions. The DSS basically helps in the information system in the intelligence phase where the objective is to identify the problem and then go to the design phase for solution. The choice of selection criteria varies from problem to problem.

An expert system is nothing but a computer program or a set of computer programs which contains the knowledge and some inference capability of an expert, most generally a human expert, in a particular domain. An expert system is a computer system which emulates the decision-making ability of a human expert. Expert systems are necessitated by the limitations associated with conventional human decision-making processes.

3.28 Glossary

- ***Information System:*** A collection of elements that capture data and convert it in information and disseminate to the decision-makers in an organization.
- ***Information Technology:*** Hardware and software that perform data processing tasks, such as capturing, transmitting, storing, retrieving, manipulating or displaying data.
- *Input:* Consists of data, instructions and involves capturing and assembling elements that enter the system to be processed.
- ***Accounting Systems:*** Information systems that record and report business transactions, the flow of funds through an organization, and produce financial statements. This provides information for the planning and control of business operations, as well as for legal and historical record-keeping.
- ***Computer-***Aided Manufacturing: The use of computers to automate the production process and operations of a manufacturing plant. Also called factory automation.
- ***Decision Support System:*** Provides solutions to the unstructured problems using simulation techniques and system models.
- ***Unstructured Decisions:*** Decisions which are not well-defined and have no pre-specified procedure.
- ***Intelligence Stage:*** An information system may provide information about internal as well as external environments.

Notes

- ***Expert System:*** An Expert System is a computer program that possesses or represents knowledge in a particular domain, has the capability of processing/ manipulating or reasoning with this knowledge with a view to solving a problem, giving some achieving or to achieve some specific goal.
- ***Fuzzy Logic Systems:*** Fuzzy Logic Systems are defined as computer-based systems that can access data that are incomplete or only partially accurate.
- Digital Convergence: It is an approach by which all types of media and communication will be digitized allowing them to be used through a single worldwide network.

3.29 Review Questions

1. Why is there considerable resistance in organizations towards introduction of information systems?
2. How are information systems changing the management process? What specific managerial roles can information systems support?
3. How can information systems support an organization's business operations, decision making by their managers and give them a competitive advantage? Identify examples within your organization to illustrate your answer.
4. What are the key management challenges involved in building, operating and maintaining information systems today?
5. Most of the studies suggest that the use of IT without concomitant organizational changes is unlikely to yield significant gains in terms of organizational performance. Comment.
6. How IT provides help in the design of organization?
7. What are the roles of information technology on the emergence of new organizational system?
8. Discuss the features of transaction processing system with the help of suitable example.
9. What are the major uses of information system in the enterprise? Explain sales and marketing information in detail.
10. Why we use Computer Integrated Manufacturing (CIM) in manufacturing information system. Give suitable reason.
11. What do you think Executive Support System (ESS) make some effect on the organization?
12. Briefly explain the advantage and disadvantage of ESS in detail.
13. Discuss any five information systems in a business organization.
14. What are enterprise systems? Illustrate the benefits of enterprise systems.
15. Define Decision support system.

16. What are the Characteristics of DSS?
17. List the Objectives of decision support system
18. What are the Components of decision support system?
19. Describe the characteristics of a Decision Support System.
20. Discuss the relation of DSS with MIS
21. Explain the evolution of DSS.
22. What are the components of a Decision Support System?
23. Discuss the various classifications of DSS.
24. Distinguish with examples: Decision Support System and Programmed System.
25. Discuss role of AI and Expert Systems in DSS.
26. What do you mean by expert system? Why organization need expert system?
27. Explain the fundamental properties of expert system.
28. Enlighten the various traits of expert system.
29. What are the steps included in building an expert system? Explain each of them.
30. What is intelligent agent? Also discuss the use of intelligent agents.
31. Elucidate the concept of hybrid AI Systems

3.30 Further Readings

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UNIT–4

Notes

Management Information System

(Structure)

4.1 Learning Objectives
4.2 Introduction
4.3 Meaning of Management Information System
4.4 Nature of Management Information System
4.5 Characteristics of MIS
4.6 Subsystem of an MIS
4.7 Requirements of Management Information System
4.8 Significance of Management Information System
4.9 Utilization of Models
4.10 Role of Management Information System
4.11 MIS Structure Based on Organizational Function
4.12 MIS Master Plan- Contents and Description
4.13 Nolan Stage Model
4.14 Three-Stage Model of Planning Process
4.15 Application in CRM
4.16 Summary
4.17 Glossary
4.18 Review Questions
4.19 Further Readings

4.1 Learning Objectives

After studying the chapter, students will be able to:

- The concept and definition of Management Information System;
- The requirements and problems of Management Information System;
- The significance and role of Management Information System;
- Know MIS structure and its activities;

- Understand the MIS based organization function;
- Know the synthesis of MIS structure.

4.2 Introduction

Notes

Management Information System is an old management tool, which has been long used by people for better management and scientific decision making.

Management Information System is mainly dependent upon information, which is a vital ingredient of any Management Information System. Information is the most critical resource of Management Information System. We all know that information is a vital factor for our existence. Just as our body needs air, water and clothes, we are as much dependent upon information. To make life more interesting and to achieve the feeling of being a part of the social system, we want to know our surroundings and for that we need information. Information is an important input for achieving our goals, such as learning to help each other and to become integral part of society.

Actually, information system is not a new concept; it is as old as the hills. From the Biblical times, humans have been making the use of information generated through information systems in all times. There have been systems that generated and communicated information. Kings and rulers had their own ways of designing information systems to retrieve information. The main objective of these information systems was to ascertain the well being of their people in the kingdom and to effectively and efficiently manage the kingdom. The church had its own information system. In India, Tainali Rama, Akbar and many others had impressive managemnet information systems in operation. Similarly, the merchants of Venice had their own fully functional appropriate management information system in place.

The characteristics of information generated through the information system have been changing as per needs. As the trade and commerce changed its nature, the information system had to be modified accordingly.

Later examples include East India Co. which had its own information system. The allied forces during the Second World War also had elaborate information system.

So throughout the centuries, information system has been an important element of all human activities. This importance has only grown many folds over the time.

Management information system supports management activity. This means that the structure of an information system can be classified in terms of a hierarchy of management planning and control activities.

4.3 Meaning of Management Information System

Management Information System is a combination of three English letters.

M Which stands for Management.

I Which stands for Information.

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S Which stands for System.

With the help of these three letters we can make a number of combinations, viz.,

MI Management Information means information regarding management. (qualification of management, number of managers, policies, etc.)

MS Management System means the basic structure of the management, like the hierarchical order of management.

IS Information System, which provides information.

SM System Management means how to manage a system whether it is a business organization, computer system, etc.

SI System Information means the information regarding the system like what are the different parts of a system, how they relate to each other, etc.

IM Information Management means how to manage a particular information.

MIS: Management Information System.

Before going into the details of what Management Information System is, we ought to know the meaning of three different terms which form Management Information System.

Management

We can define management in many ways, like:

"Manage Man Tactfully" or Management is an art of getting things done by others.

But for the purpose of Management Information System, management comprises the process and activity that a manager does in the operation of their organization, i.e., to plan, organize, direct and control operations.

Information

Information simply means processed data or in the layman's language, data which can be converted into meaningful and useful form for a specific user.

System

1. System can be defined as a set of elements joined together for a common objective.
2. A group of interrelated or interacting elements forming a unified whole, e.g., business organization as system.
3. A group of interrelated components working together towards a common goal by accepting input and producing output in an organized transformation process.

Management Information System*:* There are a number of definitions of Management Information System given by different authors. Some of them are:

1. According to Jerome or J. Kanter "Management Information System is a system that aids management in making, carrying out and controlling decisions". Here Management Information System is a system that aids management in performing its job.

2. According to G. B. Davis, Management Information System is "an integrated man/ machine system for providing information to support the operations, management and decision making functions in an organization." Here the system utilizes hardware and software, manual procedures, management decision model and database.
3. After the introduction of computer, some people define Management Information System as computer based information system.
4. As a system based on the database of the organization evolved for the purpose of providing information to the people in the organization.

In simple terms Management Information System is an information system that provides information to support managerial decision making.

A more comprehensive definition is that Management Information System consists of people, equipment and procedures to gather, sort, analyze, evaluate and distribute, timely and accurate information to the decision maker.

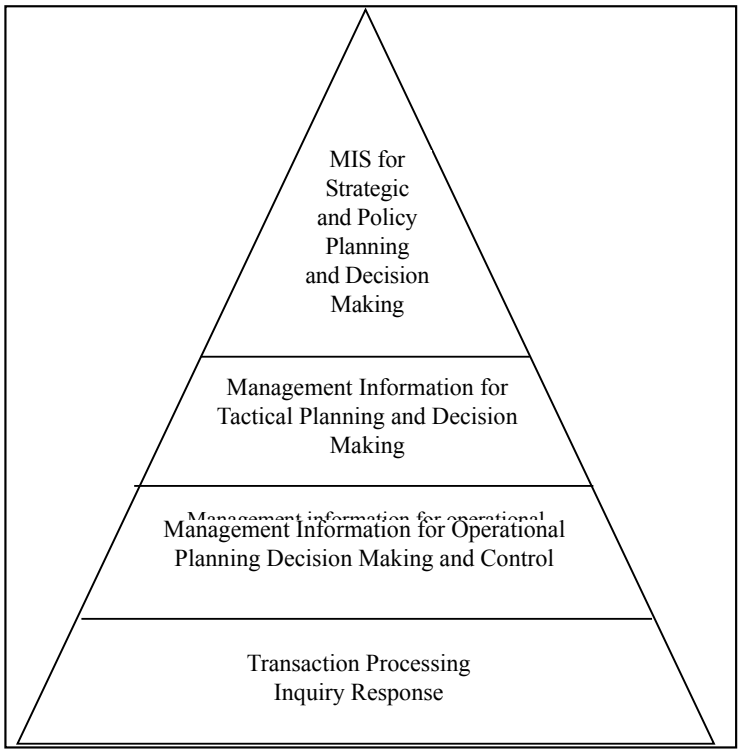

Fig. 4.1: MIS

4.4 Nature of Management Information System

The concept of Management Information System is gaining popularity from last decade or two, although it is an old management tool. Management Information System is a necessity of all organizations. Its nature is changed due to change into business scheme.

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1. ***Report-orientation:*** In the early years, the function of Management Information System was to process data from the organization and present it in the form of reports at regular intervals. But after sometime the difference between data and information merged. Information being the finished product was prepared after processing the raw data. So because of this fact the concept of Management Information System is further modified, as information rather than voluminous data has become the requirement of the user. Although data can be analyzed by different persons separately giving various shades and shapes to the information. So the system concept is now individual-oriented.
2. ***Action-oriented:*** This concept was further modified due to the need that information should be such that it leads to some action, decision or investigation or research.
3. ***Exception-oriented:*** After having action-oriented nature of Management Information System it was realized that there must be some specific or selective approach to the action or the analysis of data. So the concept of exception was introduced indicating that Management Information System is related to the exceptional situations of business rather than routine matters.
4. ***Database Orientation:*** As we know our environment is dynamic in nature so the change in every system is a must. So is the case with Management Information System as the business environment becomes competitive. The concept was then evolved that the system should be capable of handling a need-based exception reporting. This need may be of individual group or organizational. To fulfil, this need, a common database is prepared which can be used by each and every individual accordingly. So the concept of Management Information System based on DATABASES is emerged and proven to be effective.
5. ***End User Orientation:*** After successfully implementing these changes, the concept of end user computing using multiple databases emerged. This concept brought a basic change in the nature of Management Information System, that is decentralization of system and independency of user over computer professionals or experts. Now the user uses the database to collect the information and uses that information accordingly. The concept of Management Information System has been moulded to a system which handles the databases, provides computing facilities to the end user, and gives a variety of decision making tools to the user of the system.
6. ***Academic Discipline Orientation:*** Management Information System is based on the information gathered for analyzing the data. While analyzing the data it relies on many academic disciplines like theories, principles, concepts from management, organization behaviour, computer science, psychology and human behaviour. The principles of these academic fields are used in designing a Management Information System, in preparing its different modules, etc.

The Management Information System entails specific objective if it is prepared with systematic planning and designing.

A systematic approach is made after analyzing the basic needs, goals and objectives of an organization. To use different social sciences like theories of communication etc., Management Information System has to depend on the system theory which provides solution to every problem by adopting a systematic path.

The concept therefore is a mixture of theories of management, information and concept of system and the end product of this mixing is Management Information System.

Basically, Management Information System is a combination of several subsystems based on the databases in the organization. These subsystems are for storing, organizing, processing and so on.

Management Information System is a product of multi-disciplinary approach to the business management. The major disciplines that contribute to the study of Management Information System are mainly Computer Science, Operation Research, Management Science, Sociology, Political Science and Psychology. In general we can divide the field of Management Information System into two broad approaches, i.e., technical and behavioural. Management Information System is a hybrid product of these two approaches that makes it a socio-technical system. We can better understand it with the help of the following diagram:

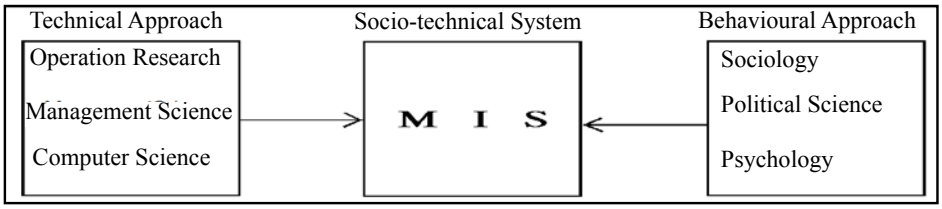

Fig. 4.2: Socio-technical Approach for MIS

Technical Approach

Technical approach Management Information System emphasizes mathematically based or systematic models to study Management Information System as well as the hardware aspect of it. The major role player of technical approach is computer science which provides ways of computation as well as how to store large volume of data and its retrieval. Management science gives the concept of decision support and the models for management practices. Operations Research comprises how to optimize the resources of the management.

Behavioural Approach

But, due to high expectation of human beings, now Management Information System field is concerned with behavioural problems also.

The behavioural problems can not be handled by the mathematical model used in technical approach. The major role player of this approach is sociology that focuses on the impact of Management Information System on groups, organizations and society as a whole. Psychology is concerned with how each stake holder in an organization responses to the information system and cognitive models of human reasonings. Political

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science is concerned with what is the political scene/scenario in the country, what is the manifesto of ruling party, etc.

So Management Information System combines the theoretical work of computer science, management science and O.R. with a practical orientation towards building systems and applications. It also pays attention to behavioural issues. So Management Information System is to be kept in close supervision because it needs to be modified according to the changes in the business organization.

The Management Information System concept is of dynamic nature and the modified model of Management Information System meets all the needs of organization as it passes through various stages. And a good Management Information System is that which serves modified information requirement of every stage so that scientific and better decision making is possible.

After understanding the nature of Management Information System, we now deal with the characteristics, prerequisites, myths, advantages and disadvantages of Management Information System.

4.5 Characteristics of MIS

The basic characteristics of an effective Management Information System are as follows:

1. ***Management-oriented:*** As we all know that the basic objective of Management Information System is to provide information support to the management in the organization for decision making. So an effective Management Information System should start its journey from appraisal of management needs to mission and goal of the business organization. It may be individual or collective goals of an organization. The Management Information System is such that it serves all levels of management in an organization, i.e., top, middle and lower level.
2. ***Management Directed:*** When Management Information System is management-oriented, it should be directed by the management because it is the management who tells their needs and requirements more effectively than anybody else.

   Manager should guide the Management Information System professionals not only at the stage of planning but also on development, review and implementation stages so that effective system should be the end product of whole exercise in making an effective Management Information System.
3. ***Integrated:*** By integration we mean a comprehensive or complete view of all the subsystems in the organization of a company. Development of information should be integrated so that all the functional and operational information sub-systems should be worked together as a single entity. This integration is necessary because it leads to retrieval of more meaningful and useful information.
4. ***Common Data Flows:*** The integration of different subsystems will lead to a common data flow which will further help in avoiding duplicacy and redundancy

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in data collection, storage and processing. For example, customer orders are basis for many activities in an organization, viz., billing, sales for cashing, etc. So, by common data flows, we mean to use common input, processing and output procedures. Data is collected by a system analyst from its original source only one time. Then he utilizes that data with minimum number of processing procedures and uses the information for production output documents and reports in small numbers and eliminates the undesirable data. This will lead to elimination of duplication that simplifies the operations and produce an efficient information system.

5. ***Heavy Planning-element:*** The preparation of Management Information System is not a one or two-day exercise. It usually takes 3 to 5 years and sometimes a much longer period. So the system expert has to keep in mind two things: first, he has to keep future objectives as well as firm's information well in advance and also secondly, he has to keep in mind that his Management Information System will not be obsolete before it gets into action.
6. ***Subsystem Concept:*** When we want to see a problem into sub-parts, we are able to give better solution to the whole problem. Although Management Information System is viewed as a single entity but for its effective use it should be broken down into small parts or subsystems so that more insight and attention is paid to each subsystem. Priorities will be set and phase of implementation will be made easy. While making or breaking down the whole Management Information System into subsystems, it must be kept in mind that the subsystem should be easily manageable.
7. ***Common Data Base:*** This is the basic feature of Management Information System to achieve the objective of using Management Information System in business organizations. It avoids duplication of files and storage which leads to reduction of cost. Common database means a "super file or master file" which consolidates and integrates data records formerly stored in many separate data files. The organization of database allows it to be accessed by each subsystem and thus, eliminates the necessity of duplication in data storage, updating, deletion and protection.
8. ***Computerized:*** We can use the Management Information System without computer. But the use of computers increases the effectiveness and efficiency of the system. We can handle the queries more quickly and efficiently with the computerized Management Information System. The other benefits are accuracy, storage capacity and timely information.
9. ***User friendly/Flexibility:*** The Management Information System should be flexible, i.e., there should be room for further modification because Management Information System takes much time in preparation and our environment is dynamic in nature. Management Information System should be such that it should be used independently by the end user so that they do not depend on the experts.
10. ***Information as a Resource:*** Information is the major ingredient of any Management Information System. So it should be treated as a resource and managed properly.

4.6 Subsystem of an MIS

The process of MIS development is quite complex and one is likely to lose insight frequently. Thus, the system, though viewed as a single entity, must be broken down into digestible sub-systems which are more meaningful at the planning stage.

Central Database

A central database is the mortar that holds the functional systems together. Each system requires access to the master file of data covering inventory, personnel, vendors, customers, etc. If the data is stored efficiently and with common usage in mind, one master file can provide the data needed by any of the functional systems. It seems logical to gather data once, to properly validate it and to place it on a central storage medium that can be accessed by any other sub-system.

MIS has been introduced as a broad concept referring to a federation of sub-systems. Two approaches to define the sub-systems of an MIS are according to the organizational functions which they support and according to managerial activities for which they are used.

Organizational Functional Sub-systems

Because organizational functions are somewhat separable in terms of activities and are defined managerially as separate responsibilities, MIS may be viewed as a federation of information systems – one for each major organizational function. There may be common support systems used by more than one subsystem, but each functional system is unique on its procedures, programs, models, etc. Typical major sub-systems for a business organization engaged in manufacturing are:

Major functional subsystem	*Some typical uses*
Marketing	Sales forecasting, sales planning, customer and sales analysis
Manufacturing	Production planning and scheduling
Logistics	Planning and control of purchasing, inventories, distribution
Personnel	Planning personnel requirements, analyzing performance, salary administration
Finance and accounting	Financial analysis, cost analysis, capital requirements planning, income measurement
Information processing	Information system planning, cost–effectiveness analysis
Top management	Strategic planning, resource allocation

The database is the primary means of integration of various subsystems. A data item that is stored or updated by one sub-system is then available to the other sub-systems. For instance, the sales and inventory information used by the marketing sub-system is supplied through the logistics sub-system; the same data is used by the manufacturing sub-system for production planning and scheduling.

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Activities Sub-systems

Another approach to understanding the structure of an information system is in terms of the sub-systems which perform various activities. Some of the activities sub-systems will be useful for more than one organizational function sub-systems.

Activity subsystem	*Some typical uses*
Transaction processing	Processing of orders, shipments, and receipts
Operational control	Scheduling of activities and performance reports
Management control	Formulation of budgets and resource allocation
Strategic planning	Formulation of objectives and strategic plans.

Note that these activities sub-systems correspond to the levels of the pyramid structure that defines MIS.

4.7 Requirements of Management Information System

To get the synergistic impact of Management Information System in business organization a Management Information System must bear the following prerequisites:

1. ***Database:*** As we know it is a super file which has all records or data related to a particular organization at one place. It will lead to reduction of redundant duplication. However, this master file is sub-divided into the major information sub-sets needed to run a business. These sub-sets are (a) Customer calls file (b) Supplier file, (c) Employee file, (d) Inventory file and (e) General ledger accounting file.

   Database should be user-oriented and should be capable of being used as a common data source for different users and avoid duplication of efforts in storage and retrieval of necessary data and information.

   Database should be authorized to be viewed by an authorized person. So it should be controlled by a separate authority that is a DBA (Database Administrator).

   The maintenance of database requires computer hardware, software and computer professionals who are experienced and qualified too. In addition to this, it requires good data collection system having system experts who know the various techniques of data collection as well as knowledge of the working of company.

2. ***Qualified System and Management Staff:*** In a Management Information System we have two types of experts: one computer and system expert who prepares the system and other the management staff who directs the system experts about their needs and requirements from a Management Information System.

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Both of them should have expertise in their respective fields. But they must possess certain knowledge of other fields also. For example, system experts must have some knowledge of management concepts so that they can better understand what the management wants from them.

Same is the case with management experts. They must have some basic knowledge of computer, so they can help the computer experts in designing as well as independently use the system.

This prerequisite is a very ideal situation but it has to face the problem of procurement of suitable experts. The problem is overcome by recruiting fresh candidates because they can work with the experienced people that are already working on the project. Or we could hire a qualified person and retain them also.

3. ***Top Management Support:*** To use or implement the Management Information System effectively, it must have the top management support. Top management support is also required for some behavioural aspects of the subordinates because they are ready to perform those activities which are supported by the top management. The other reason why top management support is essential is because the resources involved in Management Information System are very large and it is the policy matter which is decided by the top management only.

   To gain the support from top management, the persons who are in favour of installing Management Information System in the organization must place the cost and benefit analysis of having a Management Information System and other supportive facts before the top management. This action of subordinates will lead to change in the attitude of top management towards Management Information System and they will give their full support.

4. ***Active Participation of Operating Management:*** As the support of top management is a prerequisite, the active participation of operating management is also a basic requirement of successful implementation of Management Information System. There is some behavioural problem among the operative staff, that after implementing Management Information System their service would no more be required and they would need the help of some outsider while performing their work. These problems can also be handled by educating the operative management about the benefits of Management Information System.

5. ***Control and Maintenance of Management Information System:*** Control of the Management Information System means to control the operation of the system as it was designed to operate. Sometimes users develop their own procedure or shortcuts to use the system that may reduce its effectiveness. To check such practices, the management at each level should devise check mechanism for information systems control.

   Maintenance means alterations and modifications according to the need and requirement of the user. So there must be some scope of improvement in the system.

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6. ***Evaluation of Management Information System:*** The Management Information System should be evaluated at regular time intervals to meet the future needs. The evaluation process must have the following steps:
   (i) Evaluate whether flexibility exists in the system to cope with any expected or unseen information requirement in future.
   (ii) Take the feedback from users as well as designers about the capabilities and shortcomings in the system.
   (iii) Guiding the appropriate authority about the criterion to be taken to maintain the effectiveness of Management Information System.

4.8 Significance of Management Information System

Management is the function of planning, organizing, staffing, directing and controlling. To perform these major functions, a manager has to lay down the policy, communicate, motivate and take decisions in different business situations. The management has to take long term as well as short term decisions in order to achieve the overall goal of an organization. This decision making is better and sound, if the organization is small or every thing is under the control of management. This is a rosy picture which is theoretically possible but in real life situation where things are complex and uncertain as well as dynamic in nature, the management has to depend more on scientific decision making rather than based on his own judgment only.

For scientific decision making, it is necessary that they should be based on the data concerning the past performance viewed in present situation and projected for emerging future trends. This type of decisions are arrived after collecting, processing and analyzing data and after that providing information rather than being based on the intuition or judgment of the management. To achieve this goal, every effort needs to be made to devise means for obtaining data, storing it in such a manner that all relevant data can be accessed with ease and processed to meet the desired objective of assisting in decision making. Management Information System is the tool which helps the management by providing the relevant information in the right form to the right person and at the right time.

Right person means the various users of information in an organization like clerk, an assistant, an officer, an executive or a manager.

To meet the objective of providing information, the Management Information System has to work in an integrated manner. It is a complete solution in a sense that it is composed of an integrated database, a system for using the database to develop required timely information and a plan to utilize that information in future management plan and action. Management Information System not only deals with the planning, coordinating, evaluating and controlling of general processing, but also using and disposing the corporate and operation information.

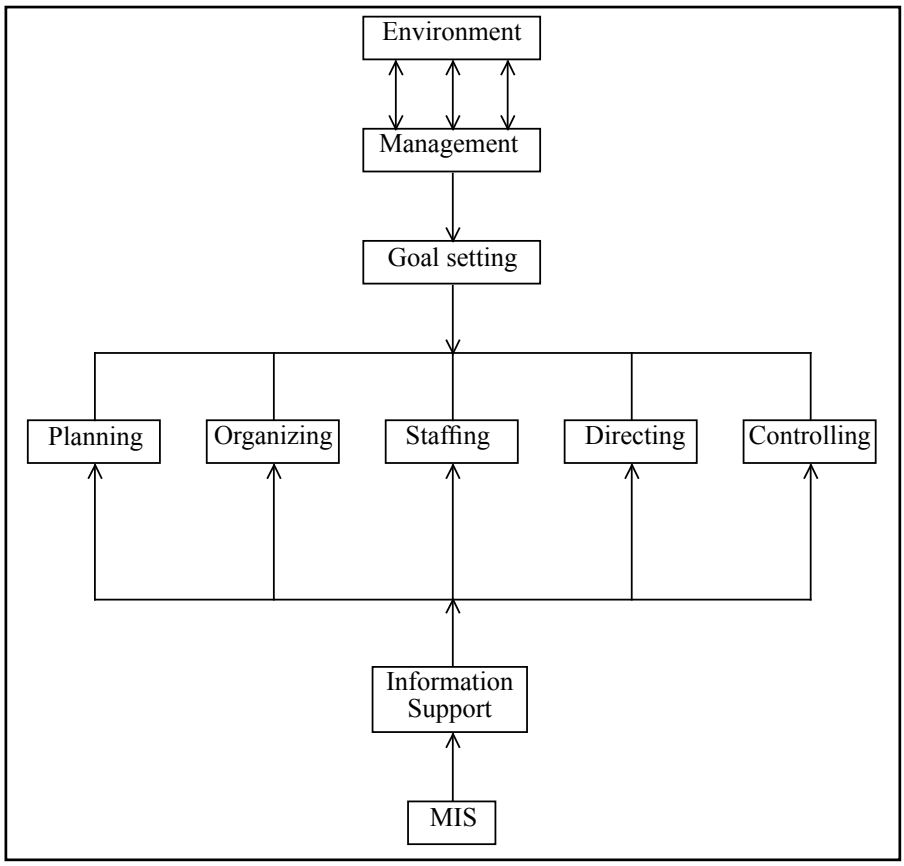

Fig. 4.3: Purpose of Management Information System in Management

Management Information System is a complex system made by different subsystems in which data is processed to produce information which is used by each level of management either operational, middle or top level of management. To understand the need and purpose of Management Information System in an organization, we can take the help of Fig. 4.3.

The management after analyzing its environment sets the goals and objectives to be accomplished and for this information is required. To perform each task of planning, organizing, staffing, directing and controlling all other information needs are provided or supplemented by the Management Information System. So the objective of Management Information System is to set the objective to be achieved. Information needed to evaluate performance must be traced out and must be applied effectively. An effective mechanism must be developed, installed and maintained and the overall system's adequacy as a basis of information for management decision must be reviewed and appraised continually.

Management Information System is the product of continuous and careful efforts done by experts to meet the informational needs of management. It helps in performing day to day functions, enhances strategic decision making for planning and control. So the main purpose of Management Information System is to support the management in decision making, broadly in the management processes.

4.9 Utilization of Models

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It is usually insufficient for human recipients to receive only raw data or even summarized data. Data usually needs to be processed and presented in such a way that the result is directed towards the decision to be made. To do this, processing of data items is based on a decision model. For example, an investment decision relative to new capital expenditures might be processed in terms of capital expenditure decision model.

Decision models can be used to support different stages in the decision making process. "Intelligence" models can be used to search for problems and/or opportunities. Models can be used to identify and analyze possible solutions. Choice models such as optimization models may be used to find the most desirable solution.

In a comprehensive information system, the decision maker has available a set of general models that can be applied to many analysis and decision situations plus a set of very specific models for unique decisions. Similar models are available for planning and control. The set of models is the model base for MIS.

Data Models

The underlying data model plays an important role in database design. The physical or logical structure of a database is spelt out by the data model. A data model is a collection of conceptual tools used for describing data, data relationships, data semantics and data constraints. Evolution of different data models is still in progress, as the primary objective is to evolve a high level data model. The model should enable the designer to incorporate a major portion of semantics of the database in the schema. Numerous data models have been proposed which can be broadly classified into following categories:

1. Object based data models
2. Record based data models
3. Physical data models

1. ***Object Based Data Models:*** These models are used in describing data and data relationships in accordance with concept. In general, the object based data models are gaining wide acceptance for their flexible structuring capabilities. Various data integrity constraints can be specified explicitly by using the object-based models. The Entity relationship model which is an object based model is widely used in practice as an appropriate database design tool.
2. ***Record Based Data Models:*** These models are used to specify the overall logic structure of the database. With some models a higher level description of the implementation of the structure of the database can also be specified explicitly. The data integrity constraints cannot be specified explicitly with these models. The three widely accepted record based data models are Relational model, Network model and Hierarchical model.
3. ***Physical Data Models:*** These models are used to have higher level description of the storage structure of the database and their access mechanism. With the physical

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model it is possible to implement the database at the system level. A very few physical data models have been proposed so far. Two of these well known models are the unifying model and the frame memory model.

Models are generally most effective when the manager can use interactive dialog to build a plan or to iterate through several decision choices under different conditions.

4.10 Role of Management Information System

Management Information System is the networking of information that supports management decision making.

The role of Management Information System in business is to identify the information needs of different level of management and prepare a system to satisfy those needs successfully. Actually information is a vital resource in managing business effectively and efficiently. So, it is the main function of Management Information System to gather, sort, analyze and use the information for better decision making. The role of Management Information System can be shown with the help of Fig. 4.4 as under:

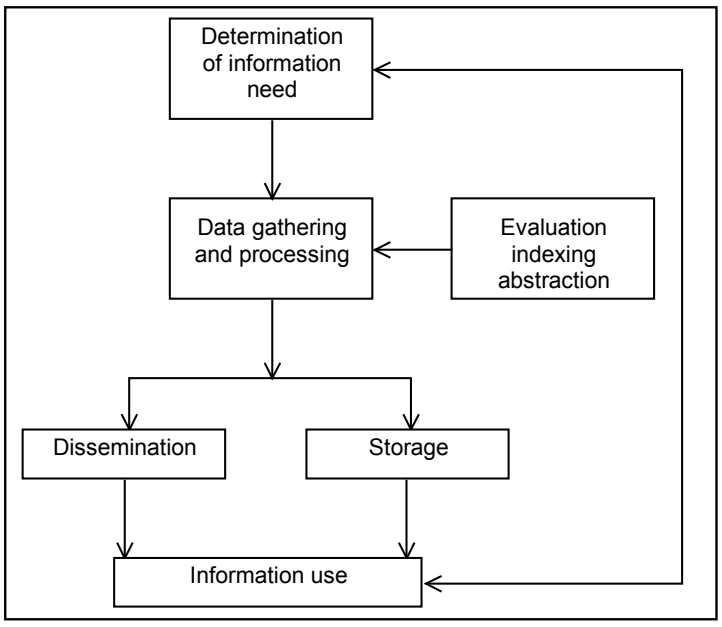

Fig. 4.4: Role of MIS

The role of Management Information System begins with the identification of required information needs by different persons in an organization, and ends with the collection of information and its processing. It has to evaluate the information relevance according to the needs and give it to the right person in the right form at the right time for making better decisions or managing the enterprise efficiently. The excess of information or irrelevant information of this moment can be stored for some future need. After using the information, the user may be identified.

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For example in today's complex and competitive market scene, information on the policies of the competitor regarding product, promotion, pricing and placing its product is very much required by the management.

In the layman's language, Management Information System plays the same role that heart plays in the human body. The heart supplies blood to various parts of the body for its regular working. It also purifies the blood and helps human beings in the period of crises. Same is the case with Management Information System. Management Information System collects the data, processes it to supply relevant, accurate and timely information to all subsystem of business organization like finance, marketing, production, personnel and R&D.

Management Information System satisfies the information needs of all levels of management, i.e., top, middle and operation level as well as the information needs of individual, group and organization.

To satisfy the diverse needs, Management Information System develops different subsystems like query, analysis, modelling and decision support system.

However, the role of Management Information System is changing in the present scenario as the new relationship between organization and information system has emerged that can be well understood by Fig. 4.5.

In modern times, interdependence is growing between the business strategies, rules and procedures on one side and software, hardware, database and telecommunication of information on the other side. A change in any of these components often requires change in other components. This relationship is critical when management plans for the future.

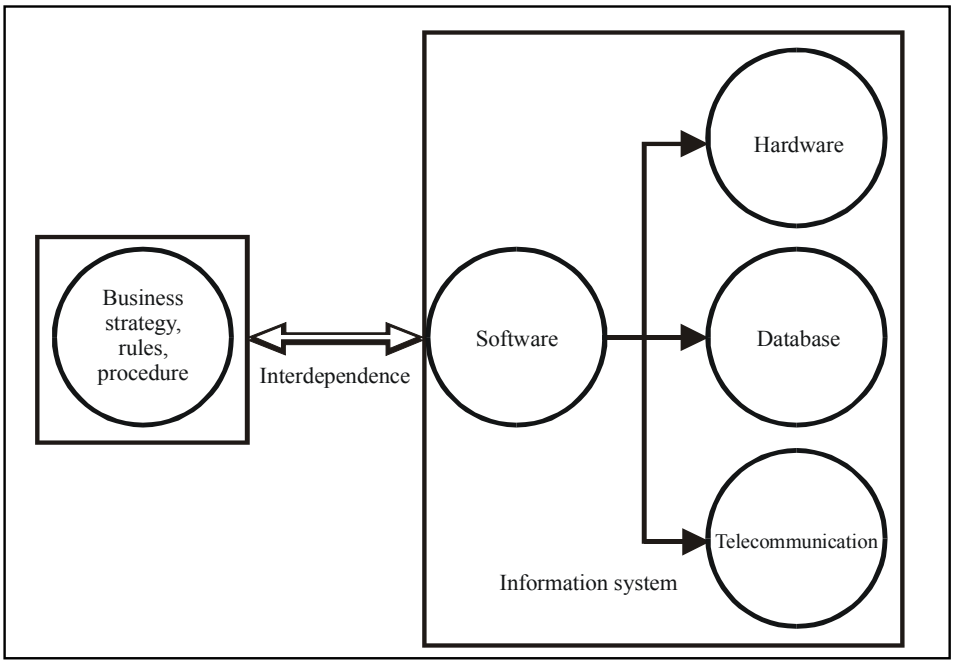

Fig. 4.5: Role of MIS Strategy

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This is a new concept regarding the role of information system because in early times, the Management Information System dealt with technical operational issues. Managers were bound to delegate authority to the concerned lower level technical workers. But because today's systems directly affect how managers decide and how top management plans, the responsibility cannot be delegated to the technical decision maker these days, Management Information System plays a strategic role in the life of the firm.

1.0 Hierarchy of Management Activity

The following categories of management planning and control were defined by Anthony:

Level	***Comments***
Strategic planning	Definition of goals, policies, and general guidelines charting course for organization. Determination of organizational objectives.
Management control and tactical planning	Acquisition of resources. Acquisition tactics, plant location, new products. Establishment and monitoring of budgets.
Operational planning and control	Effective and efficient use of existing facilities and resources to carry out activities within budget constraints.

The three levels of management activity can be differentiated on the basis of the planning horizon for each level. Strategic planning deals with long range considerations. The decisions to be made are concerned with the choice of business direction, market strategy, product mix, etc. Management control and tactical planning has a medium term planning horizon. It includes acquisition and organization of resources, structuring of work, and acquisition and training of personnel. It is reflected in the capital expenditure budget, the three-year staffing plan, etc. Operational planning and control is related to short term decisions for current operations. Pricing, production levels, inventory levels, etc., are a result of operational planning and control activities.

A particular manager may have responsibility for a mix of management activities, but proportions shift with management level. For instance, a shop floor supervisor will spend most of his or her time on operational planning and control. An executive vice president will devote, by comparison, more time to strategic planning.

The activities and information processing for the three levels are interrelated. For example, inventory control at the operational level depends on accurate processing of transactions; at the level of management control, decision made about safety stock and reorder frequency are dependent on correct summarization of results of operations; at the strategic level, results in operations and management control are related to strategic objectives, competitor behaviour, and so forth to arrive at inventory strategy. There is a marked contrast between characteristics required of information for strategic planning and

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for operational control, with management control and tactical planning being somewhat in the middle. Given these differences, information system support for strategic planning should be quite different from information system support for operational control.

Decisions vary as to the degree of structure within each level of management activity, although the majority of decisions at the operational control level are relatively structured and the majority of decisions at the strategic planning level are relatively unstructured. Examples of structured and unstructured decisions at each management level are given below. Table 4.1 also shows that information systems to support structured versus unstructured decisions are characteristically different. Structured decision systems provide decision rules and exception reports but are relatively inflexible as to content and format. Decision support systems (DSS), on the other hand, are characterized by flexible access to the database. Such components are required to "support" the manager in the decision making process, rather than attempting to provide solutions or make decisions for the user.

Table 4.1: Types of Decision by Management Activity

		Operational control	***Management control***	***Strategic planning***
Structured decision systems Decision support systems	Structured ↕ Unstructured	Inventory reorder decisions, production scheduling, selection of vendor, hiring of new supervisor	Pricing of bids, selection of credit line institutions, allocation of advertising, internal organization of a department	Acquisition of a company, addition of new product line, entry into new market, new organization of company

The following three sections summarize the characteristics of information systems support for the three levels of the hierarchy of management planning and control.

Information Systems for Operational Control

Operational control is the process of ensuring that operational activities are carried out effectively and efficiently. Operational control makes use of pre-established procedures and decision rules. A large percentage of the decisions are programmable. The procedures to follow are generally quite stable. The operating decisions and resulting action usually cover short time periods (a day to a week). Individual transactions are often important, so that the operational system must be able to respond to both individual transactions and summaries of transactions.

Processing support for operational control consists of:

1. Transaction processing
2. Report processing
3. Inquiry processing

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These three types of processing contain various decision making routines which implement pre-specified decision rules or provide output describing the decision that will be taken unless the user responsible overrides it. Some examples will illustrate the type of decision procedures that can be designed into operational control system.

- An inventory withdrawal transaction produces a transaction document. The transaction processing program can also examine the balance on hand, etc., and decide (using pre-established criteria) if a replenishment order should be placed. If so, the order quantity is calculated by use of an order quantity algorithm, and an action document is produced which specifies the need for an order plus the order quantity. The human recipient (e.g., inventory analyst) may accept the order as it is or may choose to override the programmed decision by cancelling it or adjusting the order quantity.
- An inquiry to a personnel file describes the requirements for a position. The computer search of the employee file uses pre-programmed rules to select and rank candidates.
- A telephone order clerk taking an order enters the data online using a visual display terminal. In the case of a stock out, programmed decision rules are applied to identify substitute items which the order taker can suggest to the customer.
- A programmed decisions rule in a report processing procedure may cause issuance of special reports to provide information in a problem area. An example might be a report showing orders still outstanding after 30 days, produced as a result of an unusually high (the limit pre-specified) 30-day balance.

The database for operational control and operational decision making contains primarily internal data generated from transactions. The data items are generally quite current. Care must be taken to interpret data being recorded from operations, since the sequence of processing is often significant; for example, additions to inventory are processed before withdrawals in order to avoid the appearance of being out of stock when new stock has been received.

Information System for Management Control

Management control information is required by managers of departments, profit centres, etc., to measure performance, decide on control actions, formulate new decision rules to be applied by operational personnel, and allocate resources. Summary information is needed; it must be processed so that trends may be observed, reasons for performance variances may be understood, and solutions may be suggested. The control process requires the following types of information:

1. Planned performance (Standard, Expected, Budgeted, etc.)
2. Variances from planned performance
3. Reasons for variances
4. Analysis of possible decisions or courses of action.

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The database for management control consists of two major elements; one the database provided by operations and the other the plans, standards, budgets, etc., which define management expectations about performance. There may also be some external data such as industry comparisons and cost indices.

The processing requirements to support management control activities are the following:

1. Planning and budget models to assist managers in finding problems in direction and preparing and revising plans and budgets. This includes projections of effects of current actions.
2. Variance reporting programs to process scheduled reports showing performance and variances from planned performance or other standards such as competitor performance.
3. Problem analysis models to analyze data to provide input for decision making.
4. Decision models to analyze a problem situation and provide possible solutions for management evaluation.
5. Inquiry models to assist in responding to inquiries.

The outputs from the management control information system are plans and budgets, scheduled reports, special reports, analysis of problem situations, decisions for review, and inquiry responses.

Strategic Planning

The purpose of strategic planning is to develop strategies by which an organization will be able to achieve its objectives. The time horizon for strategic planning tends to be fairly long, so that fundamental shifts in the organization may be made. For example:

1. A department store chain may decide to diversify into the mail order business.
2. A department store chain with stores in the central city may decide to change to a discount type of operation in the suburbs.
3. A company manufacturing industrial products may decide to diversify into consumer lines.

Strategic planning activities do not have to occur on a periodic, regular cycle as do management control activities. They can be somewhat irregular, although some strategic planning may by scheduled into the yearly planning and budgeting cycle. Data requirements for strategic planning are generally for processed, summarized data from a variety of sources. There is need for considerable external data. Some examples of types of data that are useful in strategic planning illustrate the nature of the data requirements:

1. Outlook for the economy in the company's current prospective areas of activity
2. Current and prospective political environment
3. Current capabilities and performance of the organization by market, country, etc. (based on current policies)
4. Prospects for the industry in each economy
5. Capabilities of competitors and their market shares

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6. Opportunities for new ventures based on current or expected developments
7. Alternative strategies
8. Projections of resource requirements for the alternative strategies.

This database contains some "hard" facts, but much is based on judgment. Much of the data cannot be collected on a regular basis, and much of it cannot be specified completely in advance. For this reason, some have argued that it is impossible (or certainly impractical) to have a management information system for strategic planning activities. They point out the difficulty of efficiently coding, storing, and retrieving the multitude of rumours, facts, hunches, etc., that enter into an assessment of prospects for an industry, a market, or an economy.

An alternative to this view is that information system support cannot be as complete for strategic planning as it is for management control and operational control, but the system is one source of information that can provide substantial aid to the process of strategic planning. For example:

1. The evaluation of current capabilities is based on internal data generated by operational processing requirements, but it may need to be summarized in a special way for planning use.
2. The initial projections of future capabilities can be developed by analysis of past data. This first approximation is adjusted by management of the basis of judgment and experience.
3. Fundamental market data on the industry and competitors can probably be kept in the organization's database.
4. Databanks of public information regarding the industry and competitors may be purchased in machine readable form for use with planning and decision models.

4.11 MIS Structure Based on Organizational Function

The structure of management information system can also be described in terms of organizational functions. Though there is no standard classification of functions, a typical set of functions in a manufacturing organization includes production, sales and marketing, finance and accounting, materials, personnel and information systems. Each of these functions, as already discussed, has unique information needs and each requires information system support designed specifically for it. Moreover, a management information system is essentially an integration of information systems that are designed to support the functional sub-systems of the organization. Each functional sub-system requires applications to perform all information processing related to the function, although this may involve calling upon a database, a model base, and some computer programs which are common to all functional sub-systems. Within each functional sub-system, there will be applications for transaction processing, operational control, managerial control, and strategic planning.

Sales and Marketing Sub-systems

The sales and marketing function generally includes all activities related to the promotion and sales of products or services. The transactions are sales orders, promotion orders,

etc. The operational control activities include the hiring and training of the sales force, the day-to-day scheduling of sales and promotion efforts, and periodic analyses of sales volumes by region, product, customer, etc. Managerial control concerns comparisons of overall volumes by region, product, customer, etc. Managerial control concerns comparisons of overall performance against a marketing plan. Information for managerial control may include data on customers, competitors, competitor products, and sales force requirements. Strategic planning for the marketing function involves consideration of new markets and new marketing strategies. The information requirements for strategic planning include customer analysis, competitor analysis, consumer survey information, income projection, demographic projections, and technology projections.

Production Sub-system

The responsibilities of the production or manufacturing function include product engineering, planning of production facilities, scheduling and operation of production facilities, employment and training of production personnel, and quality control and inspection. Typical transactions to be processed are production orders (based on an explosion of the sales orders and inventory requirements into component parts), assembly orders, finished parts, tickets, scrap tickets, and time keeping tickets. Operational control requires detailed reports comparing actual performance to the production schedule and highlighting areas where bottlenecks occur. Management control requires summary reports which compare overall planned or standard performance to actual performance for such classifications as cost per unit and labour used. Strategic planning for manufacturing includes alternative manufacturing approaches and alternative approaches to automation.

Logistics Sub-system

The logistics function encompasses such activities as purchasing, receiving, inventory control, and distribution. The transactions to be processed include purchase requisitions, purchase orders, manufacturing orders, receiving reports, tickets for inventory, shipping orders, and bills of lading. The operational control function uses information contained in reports such as past-due purchases, past due shipments to customers, out of stock items, overstocked items, inventory turnover reports, vendor performance summaries, and shipper performance analyses. Managerial control information for logistics consists of overall comparisons between planned and actual inventory levels, costs for purchased items, stock-outs, inventory turnover, etc. Strategic planning involves the analysis of new distribution strategies, new policies with regard to vendors, and "make versus buy" strategies. Information on new technology, distribution alternatives, etc., is required.

Personnel Sub-system

The personnel sub-system includes hiring, training, record keeping, payment, and termination of personnel. The transactions result in documents describing employment requisitions, job descriptions, training specifications, personnel data (background, skills, experience), pay rate changes, hours worked, paychecks, benefits, and termination notices. Operational control for personnel requires decision procedures for action such

as hiring, termination, changing pay rates, and issuing benefits. Management control of the personnel function is supported by reports and analyses showing the variances resulting from differences between planned and actual performance for such classifications as number of employees hired, cost of recruiting, composition of skills inventory, cost of training (by employee, by program), salary paid, distribution of wage rates, and conformance with government equal opportunity requirements. Strategic planning for personnel is involved with evaluating alternative strategies for recruiting, salary, training, benefits, and building location to ensure that the organization obtains and retains personnel necessary to achieve its objectives. The strategic information required includes analyses of shifting patterns of employment, education, and wage rates by area of the country (or world).

Finance and Accounting Sub-system

Finance and accounting are somewhat separate functions but are sufficiently related to be described together. Finance is responsible for ensuring adequate organizational functioning at as low a cost as possible (in a manner consistent with other objectives). This function covers granting of credit to customers, collection processes, cash management, and financing arrangements (loans, sales of stock, leasing). Accounting covers the classification of financial transactions and summarization into the standard financial reports (income statement and balance sheet), the preparation of budgets, and classification and analysis of cost data. Budget and cost data are input for managerial control reports, which means that accounting provides input for managerial control applications in all functions. Among the transactions associated with finance and accounting are credit applications, sales, billings, collection documents (statements), payment vouchers, cheques, journal vouchers, ledgers, and stock transfers. Operational control over the function itself requires daily error and exception reports, records of processing delays, reports of unprocessed transactions, etc. The managerial control level for accounting and finance utilizes information on budgeted versus actual cost of financial resources; cost of processing accounting and error rates. The strategic planning level for accounting and finance involves a long run strategy to ensure adequate financing, a long range tax accounting policy to minimize the impact of taxes, and planning of systems for cost accounting and budgeting.

Information Processing Sub-system

The information processing function is responsible for ensuring that the other functions are provided the necessary information processing services and resources. Typical transactions for information processing are requests for processing, requests for corrections or changes in data and programs, reports of hardware and program performance, and project proposals. Operational control of information processing operation requires information on the daily schedule of jobs, error rates, and equipment failures; for new project development it requires daily or weekly schedules of programmer progress and test time. Managerial control over information processing requires data on planned versus actual utilization, equipment costs, overall programmer performance, and

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progress compared to schedule of projects to develop and implement new applications. Strategic planning for information systems involves the organization of the function (such as centralized or decentralized), the overall information system plan, selection of strategic uses of information, and the general structure of the hardware and software environment. For example, a major strategic decision might be implement microcomputer workstations for all analysts, planners, and managers.

Office automation may be defined as a separate system or included within information processing. Office automation includes a wide range of support facilities for knowledge work and clerical activities. Examples are word processing, electronic mail, electronic filing, and data and voice communications.

Top Management Sub-system

The top management function (chief executive officer plus staff) operates separately from the functional areas, but also includes the functional vice presidents acting in a top management capacity, such as in management committees. The transaction processed by top management is primarily inquiries for information and support of decisions. The transaction documents, therefore, tend to be letters and memoranda. Responding to the inquiries and making decisions requires either access to the database and decision models of the organization or transmittal of the requests to other parts of the organization. The information for operational control in the top management function includes meeting schedules, correspondence control files, and contact files. Managerial control by top management uses information which summarizes the management control being exercised by other functions to evaluate whether the functions are performing as planned. This requires access to the plans and actual performance of all the functions. Strategic planning activities relate to matters such as direction of the company (which business it should be in) and plans for ensuring necessary resources. The strategy determined by top management sets the framework for strategic planning within function and also coordinates planning to remove major inconsistencies. Strategic planning at the top management level requires a wide variety of summarized external and internal data. Information system support for strategic planning may include ad hoc retrieval of data, ad hoc analyses, and decision support systems.

Synthesis of MIS Structure

The MIS structure has been described in terms of support for decision making, management activity, and organizational function. These three approaches will now be synthesized into a management information system structure. This is essentially a conceptual framework which allows one to describe an existing or planned information system. There is also a physical structure which defines the way an MIS is implemented.

Conceptual Structure

The conceptual structure of a management information system is defined as a federation of functional sub-systems, each of which is divided into four major information processing components, transaction processing, operational control information system support,

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managerial control information system support, and strategic planning information system support. Each of the functional sub-systems of the information system has some unique data files which are used only by that sub-system. There are also files which need to be accessed by more than one application and need to be available for general retrieval. These files are organized into a general database managed by a database management system.

A further amplification of the structure is the introduction of common software. In addition to application programs written especially for each sub-system, there are common applications which serve multiple functions. Each sub-system has linkages to these common applications. There are also many analytical and decision models that can be used by many applications. These form the model base for the information system.

The sub-system has unique programs and unique files for its basic activities. It shares the use of common applications software, a model base, a database, and the database management system. The database management system controls all files in the common database, and may also be used for storage and retrieval of the files unique to a function. The combination of all sub-systems forms the management information system for the organization.

Within the three management activity classifications of a functional sub-system of the information system, applications can be classified as to the type of management information support provided. These can be monitoring information, action information, and decision support.

The amount of information processing resources required varies by level of management activity. Transaction processing is substantially more significant in terms of processing time, data volume, etc., than strategic planning. This concept of the large transaction processing base and fairly small strategic planning component can be visualized as a pyramid. The lower part of the pyramid describes structured, well-defined procedures and decision, while the top part of the pyramid represents more ad hoc, unstructured processes and decisions. The bottom levels of the pyramid are of more use to clerical personnel and lower level managers, while the higher levels apply primarily to top management.

Physical Structure

The physical structure of an MIS would be identical to the conceptual structure if all applications consisted of completely separate programs used by only one function, but this is frequently not the case. Substantial economies can be achieved from:

Integrated processing

Use of Common Modules

Integrated processing is achieved by designing several related applications as a single system in order to simplify the interconnections and reduce the duplication of input. A good example is an order entry system. The recording of an order initiates a sequence of processing, each step using new data but also much of the data from prior processing.

The major steps in a typical sequence are:

Step	*New data entered*	*Documents produced*
Order entry	Sales representative identification, customer identification, Items ordered, Quantity of each item	Order acknowledgement Credit exception notice Order register Picking document Items out of stock Items to be ordered
Shipping invoicing	Actual quantity shipped Freight cost	Shipping document Invoice register Sales journal Back-order register
Collection	Amounts received Returns and allowances	Customer statements Returns and allowances register Accounts receivable aging
Analysis		Sales by representative, district, customer, or other category

Note that a large number of documents and reports are prepared from the initial entry of the order plus later entry of actual quantity shipped, freight, amounts received on account, and returns and allowances. The assumption is made that the customer name, address, and credit status, plus price of each item, are contained in customer files and billing files. The documents and reports from order entry are not associated and finance functions.

Modularity is the design of an information system as a number of small sets of processing instructions called modules. Some modules are used only once in a single application; others are used in a large number of applications. The use of modules even in cases where each has a single purpose is desirable because it improves control over system development and modification. The modules can be written and tested separately, allowing more efficient maintenance by identification of the boundaries of the module being changed. The use of modules is thus an application of system principles.

The physical structure of an information system is affected by the use of common modules for many processing operations. For example, a common input data validation routine may be used for all applications. If an application consists of major modules for input, input validation and error control, processing, and output, the use of a common module of input validation and error control means that no application is complete without using this module.

Some Issues of MIS Structure

There are several issues regarding the structure of management information systems about which there is an ongoing debate. Among these are the extents of formal versus informal information systems, manager resistance to formal information systems, the extent of integration of files and processing, the extent of user – machine interaction, and generalized versus individualized systems.

Formal Versus Informal System: The management information system as described in this chapter encompasses only part of the total information processing that takes place

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in an organization. The complete information processing system of an organization consists of both public systems and private systems. "Public" is used in the sense of being known to relevant persons in the organization and available to all who have authority to access the information. Private systems are kept by individuals. These may supplement or duplicate the public systems, and they may be unsanctioned and discouraged or sanctioned and encouraged. There is a formal information system which is manifested by documents and other records, usually indicating compliance with pre-specified rules and procedures. The informal information system may process information that is vital to organizational functioning but without formal records of that process.

The management information system defined earlier, with its pre-specified procedures and programs for applications, is a part of the formal public system. It is organizationally public and access is dependent only upon having appropriate organizational authority to enter or retrieve data or to receive reports or inquiry responses. There is also an informal public system that serves all persons in the organization who connect with it. The informal system has few predetermined rules. Examples of the public informal information system are electronic mail, telephone calls, conversations at gathering points such as the water cooler, notes on the bulletin boards, articles and other publications distributed in the office (perhaps annotated), and presentations by external information sources such as sales representatives.

In addition to these formal and informal public systems, many private information systems tend to exist in organizations. Some of these are quite formal, at least for the individual owner and any support staff who help maintain it. For example, an industrial sales manager might maintain a separate file of performance data on sales representatives which she uses to augment the information received from the formal sales information system. The manager's secretary might collect and maintain the data (for instance, from the sales representatives' daily customer call reports), but the information is available only for the sales manager's use, possibly without the sales representatives' knowledge. This is a formal private system. It is based not upon the function or the job title but upon the person who occupies the position. Many individuals also have their own private informal information systems. Primarily through personal contact they maintain a flow of information which may be critical to decision making but is available to them as individuals rather than as occupiers of a formal position.

The public information system of an organization tends to be larger than the private system, but the latter includes a significant portion of organizational information flows. The effect of a comprehensive information system of the type described is to increase the scope of the formal, public system. This increase reduces the need for private, formal systems and probably reduces the need for both public and private informal systems. It belongs to the position rather than the person, so that when a new person comes into a position he or she will have in place the necessary information support to function in that position.

Increasing the scope of the public formal system also has associated costs. There are the costs of eliciting requirements, designing the system, programming, testing,

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and writing procedures for operating and using the system. Because of the high cost of developing systems, the tendency has been to only automate systems that can be justified as public systems so that the costs are shared over many users. However, the trends to end user computing means users have access to terminals or personal computers and powerful application development languages which facilitate them to develop their own systems. Many applications developed by users on personal computers are highly individualized, and are thus formal, private system.

There is an ongoing debate as to how much organizational information processing can effectively be made part of the formal system and how much should remain in the informal systems. It can be argued that many important decisions are based on information received through informal channels that cannot be formalized, especially at top management levels. A well-known study by Mintzberg shows that as much as 80 per cent of chief executive's time is spent in verbal communication. A study of information systems managers by Ives and Olson showed a similar pattern. This is especially noteworthy because these managers cannot be said to be unfamiliar with the capabilities of the formal, public information system.

Advocates of increasing the scope of the formal public system claim that if it can reduce the time spent by managers in informal communication, their productivity will increase and thus benefit the organization. Skeptics of this view claim that the only information systems that will affect managerial productivity are enhancements to informal systems such as electronic mail and to formal private systems such as user developed decision supports systems.

Extent of Integration: Some advocates of "total systems" have argued for complete integration of all formal information processing, the experience to date suggests that such a tightly integrated system is impractical. There are too many factors to consider all at once, and maintenance is difficult. For this reason, information systems tend to have a modular design with integration only where required (as in the order entry system example). Inconsistencies among sub-systems are reduced by the use of standards and the common database.

Data integration is accomplished by the use of a common database. A common database does not necessarily eliminate the need for separate files. Some files are significant only to one application and therefore may be designed for and maintained by that application.

Data requirements for different levels of management activity also suggest the need for more than one database rather than complete integration. For example, the data collected from external sources and stored for strategic planning is so different from internal data for operational control that some different databases may be desirable.

Extent of User-Machine Interaction

The information system structure does not specify online user machine interaction; it indicates only support for various operational and management activities. Online processing of transactions is often desirable because the transaction is completed

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immediately. Inquiries are generally more effective if immediate response is available. The use of analysis, planning, and decision models is frequently enhanced if the analyst, planner, or decision maker can interact directly with the computer program, asking "What if" questions during problem analysis. With the decreasing costs of both computer and communications technology, the trend is to online interactive processing for both transaction processing and decision support systems.

The computer system that supports online transaction processing may not be able to support interactive models. However, having an information system does not imply that a single computer system must be used. An organization may use its in-house computer for transaction processing but provide alternatives for interactive models such as providing a small in-house interactive system, renting time on an outside computer through timesharing, or providing personal computers. These approaches encourage managers and staff specialists to develop their own support models, rather than depending on the staff of the information processing functions to provide them.

4.12 MIS Master Plan- Contents and Description

The master plan typically has two components – (a) a long-range plan for three to five years (or more) and (b) a short-range plan for one year.

The plan provides a basis for resource allocation and control. The long-range portion provides general guidelines for direction and short-range portion provides a basis for specific accountability as to operational and financial performance. The master development plan establishes a framework for all detailed information system planning.

In general, it contains four major sections:

1. Information system goals, objectives and architecture;
2. Inventory of current capabilities;
3. Forecast of development affecting the plan;
4. The specific plan.

Information System Goals, Objectives and Architecture

This section of the plan might contain the descriptions of the following:

1. Organizational goals, objectives and strategies
2. External environment
3. Internal organizational constraints such as management philosophy
4. Assumptions about the business risks and potential consequences
5. Overall goals, objectives, and strategy for information system
6. Architecture of the information system.

Current Capabilities

It includes such items as the following:

1. Inventory of:

(iv) Hardware
(v) Generalized Software
(vi) Application systems
(vii) Personnel

2. ***Analysis of*:**
   (i) Expense
   (ii) Hardware utilization
   (iii) Software utilization
   (iv) Personnel utilization
3. Status of projects in process
4. Assessment of strengths and weaknesses

Forecast of Developments Affecting the Plan

Planning is affected by current and anticipated technology. The impact of such developments as PCs, LAN, DBMS and Office automation should be reflected in the long-range plan.

Software availability should also be forecast and the impact on future systems anticipated.

Methodology changes may also be forecast. Environmental developments such as government regulations, tax laws, and competitor actions can also be included insofar as they affect information systems.

The Specific Plan

The Specific Plan is prepared for the next year. The plan should include:

1. Hardware acquisition schedule
2. Purchased software schedule:
   (i) System software
   (ii) Applications software
3. Application development schedule
4. Software maintenance and conversion schedule.
5. Personnel resources required and schedule of hiring and training.
6. Financial resources required by object of expenditure (hardware, software, personnel, etc.) and by purpose (operations, maintenance, new development, etc.).

4.13 Nolan Stage Model

Information system planning is focused on determining the information needs and also ensuring that information system planning aligns with the overall business planning.

For information system planning R.Nolan has given a model known as Nolan stage model. It initially had four stages of growth and later on it was reviewed, and as a

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result there is an addition of two intermediate growth stages. The Nolan model basically describes in which stage organization's information system exists. This will provide a base for planning to proceed to next stage of the growth. We can see the contribution of this model for MIS planning after going through each stage of Nolan's model.

The Nolan stage model explains the evolution of information system within an organization by considering the various stages of growth. This model was developed in the mid of seventies. Expenditure on information technology increases as the information system passes through various stages. Various stages of Nolan's stage model is shown in Fig. 4.6.

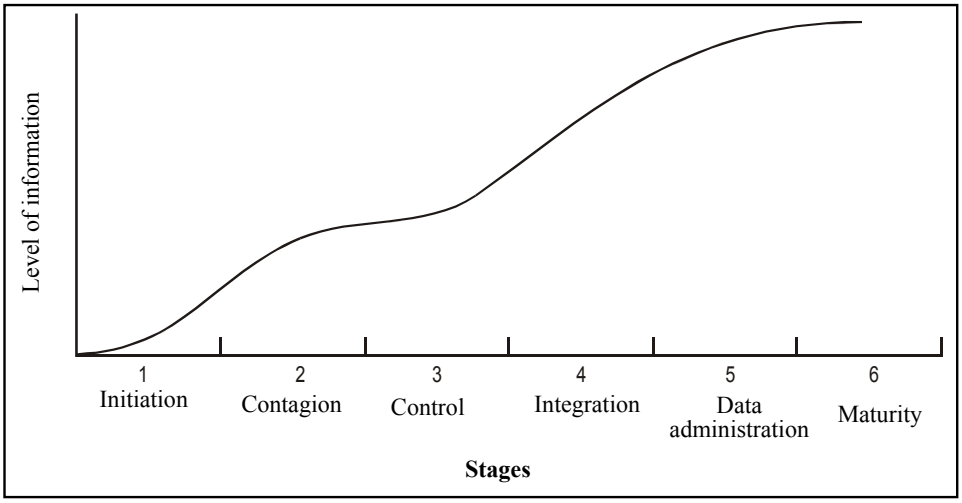

Fig. 4.6: The Six Stages of Nolan's Model

Stage 1: Initiation

This is the first stage of Nolan's model. This stage depicts that computer system is used for transaction-processing which is basically the bottomline of the organization hierarchy. At transaction processing level typically, high volume of data processing is done in terms of accounting the business transactions, billing and payroll, etc. So very little planning of information system is required. The users are mostly unaware of the technology. So new applications are the development with the help of traditional languages like Cobol, Fortran, etc. System analysis and design has very few methodologies.

Stage 2: Contagion

This is the second stage of Nolan's growth model, also known as expansion stage. It is related to unplanned and uncontrolled growth. Actually at this moment the users have developed their interest to know the possibilities of it but still, they do not know much about its pros and cons. The growth of large number of IT applications with minimum check on whether they are required or not, are the key features of this stage. Technical problems with the development of programs appears. There was very little control of the development of information system as well as expenditure associated with IT.

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Stage 3: Control

This is the third stage of Nolan's stage model. Because of the unplanned growth, of a large number of IT applications as well as projects, a need arose to manage the information system and also the reorganization of data processing department. The data processing manager becomes more accountable or responsible to justify the expenditure on information system development. The growth of projects is controlled by imposing changes on user department for information system development project and the use of computer services. Users are witnesses of progress in the development of information systems. Pent-up repressed demand and frustration occur in user departments. Organizations are unable to apply cost-effectiveness criteria.

Stage 4: Integration

This is the fourth stage of Nolan's model, known as integration stage. At this stage data processing has a new direction. Information systems are more information oriented, i.e., they lay importance on information product. Because of this concept and to facilitate it, there is an introduction of interactive terminals in the user department, the development of database and the introduction of data communication technology has taken place. The controlled user departments are now in a position to satisfy the repressed demand for information support. So there is a tremendous growing demand for IT applications. As a consequence of this, there is a hike in expenditure also. A new problem has emerged, i.e., redundancy of data.

Sage 5: Data Administration

This is the fifth stage of Nolan's stage model. This stage did not exist in the initial model. This stage has come into existence to overcome and also to control the problem of data redundancy. At this moment it is realized that data is an important resource of the organization. So it should be duly planned and managed. This stage is characterized by the development of an integrated database serving whole organization's information need. It also develops an IT application to successfully access these databases. Users become more accountable for the integrity and appropriate use of the data and information resources.

Stage 6: Maturity

This is the sixth stage. This was added to the enhanced model. This stage indicates towards a mature organization, which took information system as an integral part of the organization functioning. It indicates that the application portfolio is complete and a representative of an organization's activity. Actually, application portfolio matches with the overall objectives of the organization. Planning of the information system was coordinated and comprehensive because top management realized that information was an important resource. Manager of information system is on the same footing as other managers of the organization. Thus, planning of development of information system in the organization is built into the organization's overall development.

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There is a summarized view of Nolan's stages and growth process at each stage in Table 4.1.

Table 4.1: Stage of Nolan's Model along with Growth Processes

	Stage 1	***Stage 2***	***Stage 3***	***Stage 4***	***Stage 5***	***Stage 6***
Growth process	Initiation	Contagion	Control	Integration	Data administration	Maturity
Application portfolio	Cost reduction application	large number of applications	restructuring of existing application	data base technology	integration of applications	total integration effective information flow.
Data-processing	specialized for technology administration	user's need base	middle base program management	user IS management	data	data resource accounts team
Data-processing planning and control	less	more/less	formalized	tailored system	share data system	data resource strategic planning
User of awareness and IS Accountability	unaware	Superficially enthusiastic	arbitrarily held accountable	accountability learning	effective accountable	acceptance joint user

Use of Nolan's Model in Information System Planning

Nolan's stage model gave an evolutionary explanation for information system development within an organization. In fact Nolan's model is a contingency model that identifies a pattern of growth that an organization needs to go through before achieving maturity. Every stage witnessed a learning process. It was not possible to skip any of the stages in the growth process. While progressing to next stage, the organization must go through each stage proceeding it. For example, if one wants to move to stage 4, one has to go through stage number 1, 2 and 3.

The model has been used for planning purpose. The model can be applied to identify the current stage of the growth. Also planning changes to move in a controlled manner to the next stage. This has implications for what has to be achieved in order to progress to the next stage. Planning is required in the areas of application portfolio, technology used, the planning and control structure and the level of the user awareness and involvement. Manager should go for planning because it will speed up the progress process, i.e., move to the next stage and also accompanying organizational learning.

We know the model was developed way back, i.e., during 1970s and after that there was a tremendous change in the field of information technology. So this model incorporated the changed technology concepts in 1980s and 1990s information system.

Nolan's model was mainly criticized on the following grounds.

1. It ignores the fact that advances in information technology made user self sufficient or now they are not dependent on computer centres.
2. It ignores the fact that there has been tremendous development in the area of communication and local area networks which is used to PCs and other technologies together.
3. It ignores the fact that new software development tools support the user.

Despite this criticism, the model finds its validity in many applications of information system planning till today. Every organization realizes that their information system has to undergo these stages. But how long it stays in each stage depends upon the learning process of the organization. This model is used for IS planning where there is a shift of emphasis between the user and the computer centre in the process of growth and where there is more from concentration on processor technology to data management. At last we may say that this model helps a manager to be proactive.

4.14 Three-Stage Model of Planning Process

A number of techniques have been proposed for information system planning. A problem is to evaluate the place of a technique in the flow of activities for developing a long-range information plan and long-range information architecture. The three-stage model of information system planning developed by Bowman, Davis and Wetherbe (1983) clarifies the basic planning activities, the order of activities and alternative techniques and methodologies that apply.

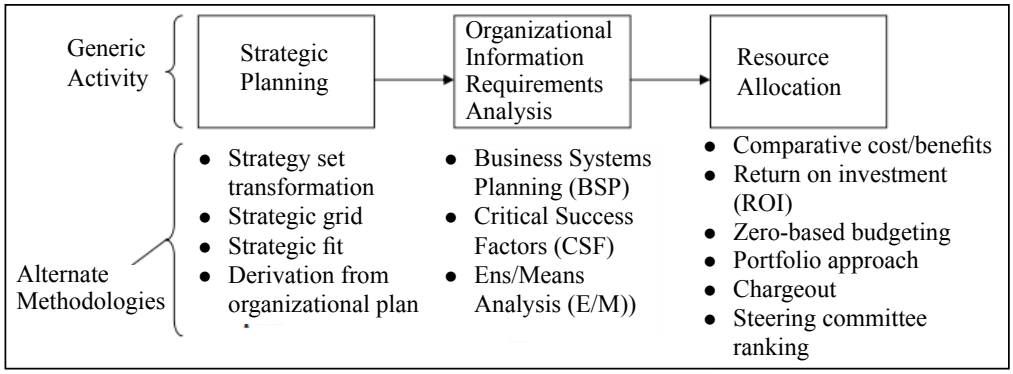

Fig. 4.7: Three-Stage Model of Information System Planning Process

Strategic Planning Stage

The objectives of the strategic planning stage of information system planning are to create objectives, goals and strategies that align with the organizations' objectives, goals and strategies. Four techniques useful in this strategic alignment are:

1. Derivation of organization plan,
2. Use of strategic grid,
3. Fit with organization culture,
4. Strategic set transformation.

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Strategic Fit with Organization Culture

Each organization has its own culture and subunits within the organization. The sub units possess their own culture which may be called subculture. It may be well articulated or relatively obscure. Strategic planning needs to be in line with organization culture. It should not be alienated from the cultural trend existing in the organization.

Derivation of Information System Strategy from Organizational Plan

If the organization has a plan that reflects organization goals, objectives, and strategies, information system goals, objectives, and strategy can be derived from it. Each objective, goal, and strategy in the plan is analyzed for required information system support. These can then be organized into information system goals, objectives, and strategies.

The McFarlan–McKenney Strategic Grid

The grid defines four types of information system planning situations depending on the strategic impact of the existing information systems applications portfolio and the strategic impact of the portfolio of applications planned for development. The cells define the position of the information systems activity relative to the organization.

Strategic: Information system activities are critical to the current competitive strategy and to future strategic directions of the enterprise. Information systems applications are part of new strategic directions.

Factory: Information system applications are vital to the successful functioning of well-defined, well-accepted activities. However, information systems are not part of future strategic directions.

Support: Information system applications are useful in supporting the activities.

Organization: Information systems are not part of future strategic directions.

Turnaround: This is a transition state from support to strategic. The organization has had support-type applications but is now planning for applications vital to strategic success of the organization.

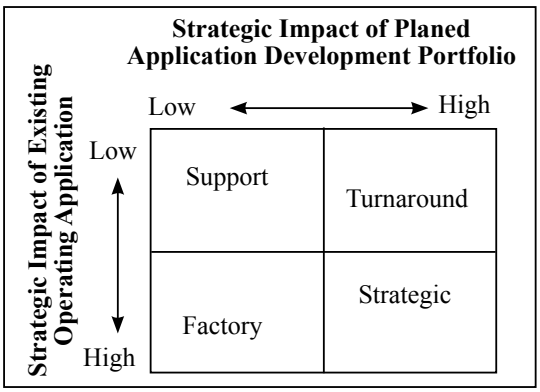

Fig. 4.8:

Goals, objectives, and strategies for information systems should fit with the culture in order to avoid high resistance and high risk of failure. Clues of culture can be obtained from the following sources:

- Stories
- Meetings
- Top management behaviour
- Physical layout
- Ritual
- Documents

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Strategic Set Transformation

Strategy set transformation is used to produce goals and strategy for the information system by the following steps:

1. Explain the organization's strategy set
   (i) Outline the organization's claimant structure. The client, claimant, or stakeholders in the organization are identified. Examples are owners, customers, suppliers, and employees.
   (ii) Identify goals for the claimants.
   (iii) Identify organizational goals and strategies for each claimant group.
2. Validate the organizational goals and strategies by asking management to critique the statements. The organizational objectives, strategies, and strategic organizational attributes form the organizational strategy set.
3. Transform the organizational strategy set into the information system strategy set.
   (i) Identify one or more information system objectives for each organizational strategy and for each relevant organizational objective and attribute.
   (ii) Identify information system constraints from organization strategy set and from information system objectives.
   (iii) Identify information system design strategies based on organizational attributes, information system objectives and information system constraints.

Changing Trend of Organizational Cultural and MIS Plan

In fact the concept of culture and clarification of its nature is not an idle academic pursuit. It has practical relevance. Along with developing the concept of culture, it requires to know what needs to be changed for culture to change. In fact in the perspective of organizational activities, culture is a peculiar phenomenon. It is commonly agreed that in an organization culture exists and it is a useful concept. But fewer agree on exactly what it is. According to Krober and Kluckhohn (1952), "Culture consists of explicit and implicit, of and for acquired and transmitted by symbols, consisting the distinctive achievements of human groups, including their embodiments in artefacts; the essential

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core of culture consists of traditional (historically derived and selected) and especially their attached values; culture systems may, on the one hand, be considered as product of action, on the other as conditioning element of future action." This idea of culture includes from many different approaches.

In general, definition of culture is to deal primarily either with the way we act or the way we think. At one extreme, culture may be defined as, "the way we do things around here." Deal T. E. and Kennedy A. A. (1982) At the other end it may be defined as, "the way we think about things around here or the fabrics of meaning with which human beings interpret their experience and guide their actions", Geertz C. (1973). Between these extremes, some authors have defined culture in terms of both thought and behaviour. An example would be, "the commonly shared beliefs, values and characteristic patterns of behaviour that exist within an organization." Margulis N. Raia A. P. (1978) Practical managers tend to view culture primarily in terms of behaviour. Managers are primarily interested in making practical change in people's work, goals, method, and behaviours. By contrast academicians tend to view culture primarily in cognitive terms. Academicians are generally more concerned with "why culture changes?" than with "why change culture?" Deal and Kennedy (1982) and Peters and Waterman (1982) have made statements about the nature of organization culture mainly based on statements of CEOs and senior executives of large multinational organizations; these interesting executive stories are probably truly the myths of culture. Many of these cultural statements are more the products of corporate PR machine. Schein E. H. (1985) has defined culture as an unconscious and largely invisible entity which by definition is almost to measure, study or change. Aspects of culture are unconscious and in a sense invisible. Advanced research shows that one needs to define culture as unconscious and invisible – cultures are commonly held and relatively stable beliefs, attitudes and values that exist within the organization. This may be considered to be the working definition of culture. Culture thus may be thought as "the way people think about things around here". Our working definition identifies an entity that clearly impacts upon organization effectiveness. That is defined in this way; culture is tied to behaviour and consequently is of practical relevance. Culture is capable of change and it can be empirically studied. Further emphasis upon beliefs, attitudes and values as the major elements of culture enables us to draw upon previous empirical research on the nature of belief, attitude and value formation and change in developing our understanding of culture and the ways in which it can be changed.

Mechanism of Change in Organization Culture and MIS Plan

Changes in organization culture take place in many cases during implementation of strategic changes. It is likely to be the self-sealing, embedded product of past strategy and, unless carefully managed, will act to negate any future strategy which requires a major change in the way people think or do things around. Organization culture undergoes change when common beliefs, attitudes and values that exist when organization is subjected to change. In case studies conducted in organizations subjected to cultural

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change it has been observed that cause of cultural change appears because of six reasons, viz., by changing people in the organization; by changing position of people in organization; by changing beliefs, attitudes, values directly; by changing behaviour; by changing the systems and structure; and changing the corporate image. Hence goals, objectives and strategy of information systems should fit with the culture in order to avoid high resistance and high risk of failure. If the culture is not clear to information systems planners, clues can be obtained from sources such as (i) Stories, (ii) Meetings, (iii) Top management behaviour, (iv) Physical layout, (v) Ritual, (vi) Documents. These clues can be organized into rules of the game and classified into organizational tasks and relationships. The fit between culture and proposed information system plan can be assessed. Explicit decisions can be made to ignore the culture (not favourable), drop the strategy, seek a better fitting strategy or plan (most difficult) actions to change. Conclusion: The complexity of the information resources environment suggests that planning of MIS is vital to success of an organization. The development of an information plan for information resources is a vital of a good management. There are varieties of approaches to organize planning. The approach chosen should include appropriate participation and review by the organization to ensure that the plan meets organizational needs and that it has organizational support. The cultures of different organizations differ with respect to the value attached to data and information; these also differ with respect to data discipline. Even differences in accuracy can be observed within the organization. Accounting has a higher level of accuracy than sales, which reflects not only data processing system but also training, and culture of the function. Accountants have a culture which emphasizes accuracy (reinforced by training and "tales of finding the function of a rupee error"); sales people have a culture that focuses on the sales, without concern for even several hundred rupees – planning needs to take care of this.

4.15 Application in CRM

CRM is a multifaceted process, mediated by a set of information technologies that focuses on creating two-way exchanges with customers so that firms have an intimate knowledge of their needs, wants, and buying patterns. In this way, CRM helps companies understand, as well as anticipate, the needs of current and potential customers. Functions that support this business purpose include sales, marketing, customer service, training, professional development, performance management, human resource development, and compensation. Many CRM initiatives have failed because implementation was limited to software installation without alignment to a customer-centric strategy.

It is a process or methodology used to learn more about customers' needs and behaviors in order to develop stronger relationships with them. There are many technological components to CRM, but thinking about CRM in primarily technological terms is a mistake. The more useful way to think about CRM is as a process that will help bring together lots of pieces of information about customers, sales, marketing effectiveness, responsiveness and market trends.

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CRM helps businesses use technology and human resources to gain insight into the behavior of customers and the value of those customers.

There are many aspects of CRM which were mistakenly thought to be capable of being implemented in isolation from each other.

CRM is the philosophy, policy and coordinating strategy connecting different players within an organization so as to coordinate their efforts in creating an overall valuable series of experiences, products and services for the customer.

Fig. 4.9: CRM Cycle

While there are numerous reports of "failed" implementations of various types of CRM projects, these are often the result of unrealistic high expectations and exaggerated claims by CRM vendors.

Many of these "failures" are also related to data quality and availability. Data cleaning is a major issue. If the company CRM strategy is to track life-cycle revenues, costs, margins and interactions between individual customers, this must be reflected in all business processes. Data must be extracted from multiple sources (e.g., departmental/ divisional databases, including sales, manufacturing, supply chain, logistics, finance, service, etc.), requiring an integrated, and comprehensive business processing system to be in place with defined structures and data quality. If not, interfaces must be developed and implemented to extract data from different systems. This creates a demand far beyond customer satisfaction to understand the full business-to-business relationship. For this reason, CRM is more than a sales or customer interaction system.

The experience from many companies is that a clear CRM requirement with regard to reports (e.g., input and output requirements) is of vital importance before starting any implementation. With a proper demand specification, a great deal of time and money can be saved based on realistic expectations of systems capability. A well operating CRM system can be an extremely powerful tool for management and customer strategies.

Privacy and Data Security

One of the primary functions of CRM software is to collect information about customers. When gathering data as part of a CRM solution, a company must consider customer

privacy and data security with respect to legal and cultural environments. Some customers prefer assurance that their data is not shared with third parties without their consent and that it cannot be illicitly accessed by third parties.

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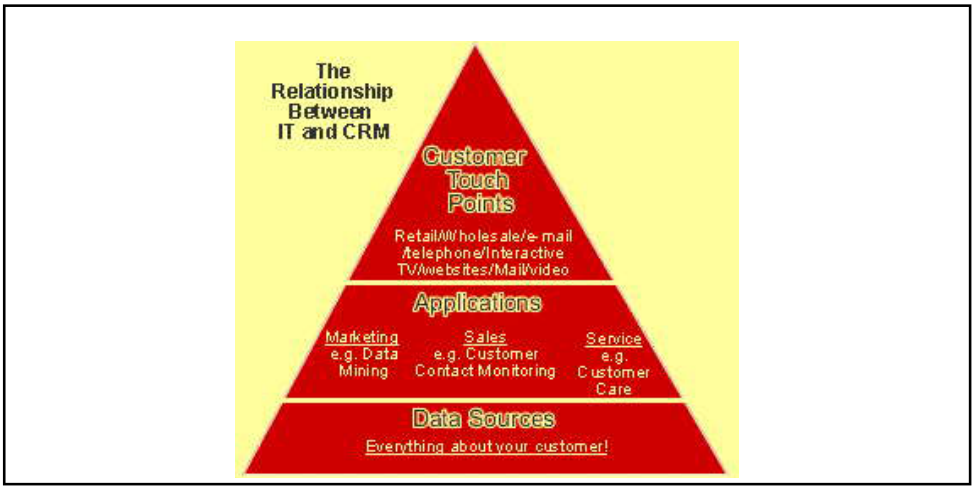

Fig. 4.10: Relationship between IT and CRM

CRM Applications

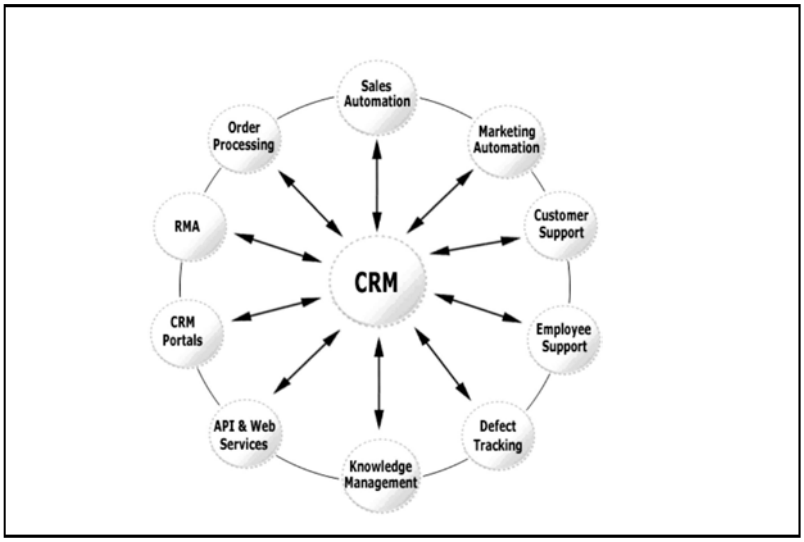

Fig. 4.11: CRM Applications

eCRM or Web based CRM

- ***Self Service CRM:*** Self service CRM (eCRM) software enables web based customer interaction, automation of email, call logs, web site analytics, campaign management.
- ***Survey Management Software:*** Survey Management Software automates an enterprise's Electronic Surveys, Polls, Questionnaires and enables understand customer preferences.

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Customer Service

- Call Center Software
- Help Desk Software

Partner Relationship Management

- Contract Management Software-Contract Management Software enables an enterprise to create, track and manage partnerships, contracts, agreements.

Example: Upside Software, Accruent Software, diCarta, I-Many.

- Distribution Management Software

Using CRM, a business can

- Provide better customer service
- Increase customer revenues
- Discover new customers
- Cross sell/Up Sell products more effectively
- Help sales staff close deals faster
- Make call centers more efficient
- Simplify marketing and sales processes

The types of data CRM projects collect

- Responses to campaigns
- Shipping and fulfillment dates
- Sales and purchase data
- Account information
- Web registration data
- Service and support records
- Demographic data
- Web sales data.

Systems help the managers interactions with customers by improving sales, marketing and customer support processes. Companies are now realizing that customer service is a key differentiator to reduce customer agony and increase customer loyalty.

Companies engaged in mobile commerce products and services are on a relentless quest to create a so-called "killer app," a must-have product or service that could guarantee breakthrough success.

Unfortunately, the m-commerce products and services now available, from the speed of connection to the ease of navigation, have disappointed many m-commerce customers. On top of that, users have experienced a near-universal lack of simplicity, relevance and personalization. Only one application, short messaging service (SMS), has become popular in Europe. Accenture's experience reflects that SMS at best accounts for only 10 percent to 12 percent of average revenue per user.

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For mobile operators, overcoming these negative customer experiences—and ensuring future customer interactions are successful and positive—is the critical next step in fulfilling m-commerce's promise of vast opportunity and significant revenue. In other words, success will not be about the killer app, but about the killer process.

Killer app Elusive, Probably Impossible

Online purchases are a good example of the customer service challenges facing mobile data operators. According to Accenture research, ordering a book with a credit card requires about 140 keystrokes or clicks for a customer using a personal computer, versus nearly 350 for a customer using a phone equipped with wireless application protocol (WAP).

M-commerce customers have a low tolerance for such cumbersome processes. As early adopters of new technology, they are willing to pay a premium price and are ready to become emotionally involved with the products and services they use. In return, however, they expect immediate results and high value. If a product fails to meet their expectations, they take it personally and are quick to criticize, drop the technology and inform their friends and colleagues about the negative experience.

Customers will Choose their Personal Killer app

To satisfy these key customers, mobile phone operators have been in perpetual competition to take advantage of the existing technology to create a killer app, which has eluded operators so far. And the likelihood of future success is slim, due to the complexity and range of customer needs.

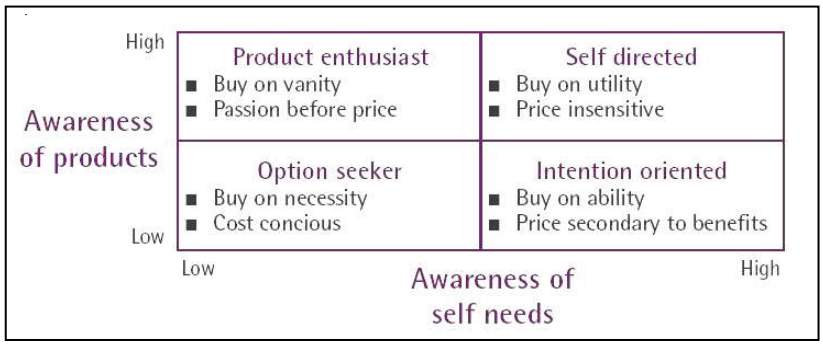

Fig. 4.12: Understanding Mobile Commerce Customers

Instead, we believe each customer will choose his or her own killer app. For some, the killer app may be e-mail; for others, it may be restaurant recommendations or sports results.

Four Principles for Building Mobile Customer Relationships

Principle 1: Target your customers to build critical mass: Because of multiple complex products, targeting customers is no longer as simple as dividing them into high-volume business users and low-volume prepaid consumers. Instead, mobile operators should begin by learning more about customers to understand their product awareness and needs and then segment them into "needs categories".

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The next step is adding attributes, such as age and occupation, and using the resulting customer profiles to define a customer acquisition strategy for achieving critical mass. During this step, operators must identify "innovators", the highly influential people who buy products shortly after launch, and "talkers", people who have extensive personal networks of family, friends and work colleagues. The innovators and the talkers have the ability to win over non-users; they should be targeted first in any marketing effort (see Figure).

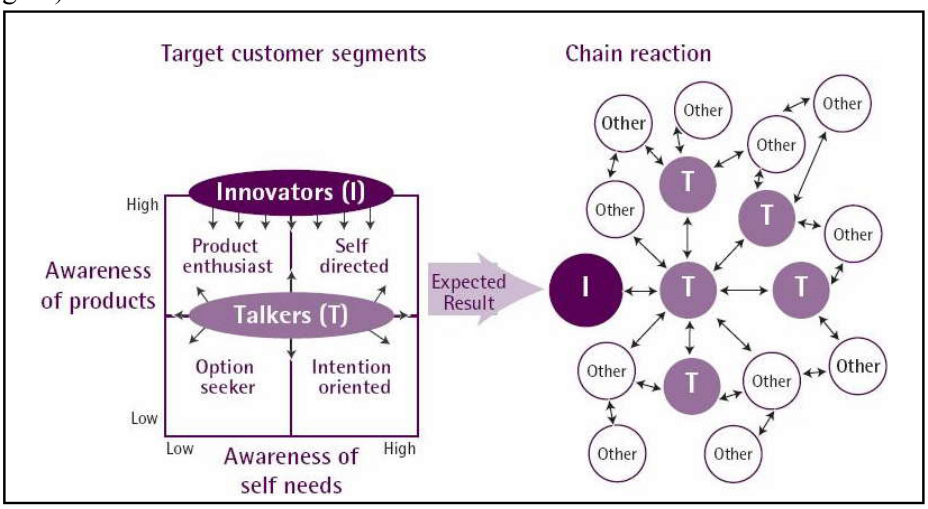

Fig. 4.13: Innovators and Talkers Chain Reaction

Principle 2: Match products to customers: Instead of chasing after the one "perfect" product, mobile operators should seek the right product for the right customer.

Operators should start by seeding the market with basic products to test readiness for other products. Next, they should create open technology platforms and set relationship rules for content and go-to-market partners.

Principle 3: Make acquisition a positive experience: Customer experience can be tested at three stages: awareness, relevance and purchase.

- The awareness stage requires trust in a brand name associated with mobile data—either the operator's or a new brand for a particular offering—and messages targeted to specific customer segments.
- In the relevance stage , companies must go beyond traditional media and use opinion leaders and other innovative channels to deliver tailored messages that demonstrate how the product meets each segment's needs.
- At the purchase stage, the operators' main goal must be a smooth interaction that eliminates last-minute surprises and meets all expectations regarding performance, service, and payment and usage terms.

Principle 4: Develop customers – one at a time: Once customers are acquired, they must be developed to increase depth and scope of usage and leverage lifetime value. There are five steps to effective development:

- Understand the customer, including usage patterns, needs and preferences.

- Obtain permission to provide relevant personalization. In addition, given privacy issues being examined by a number of European governments, operators should provide a privacy statement.
- Educate customers to help them evolve from simple to complex m-commerce applications.
- Maintain and reinforce permission so that customers do not feel taken for granted.
- Direct customers to appropriate new products and services.

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Web based CRM Vs Hosted CRM

The expense and complexity of large-scale on-premise hosted CRM implementations has lead companies to investigate the cost of on demand CRM solutions. For some smaller companies, the SaaS (Software as a Service) offerings of providers such as Sales force, Netsuite, and Salesboom may make sense, particularly if companies are not expected to continue beyond a few years. For companies that plan to grow and remain in business, the on demand CRM solution may actually be more expensive and not meet the needs of the business. One of the important limitations of web based CRM is a lack of customizability. The truth about the software is that it may cost a great deal to customize for a particular customer's needs, and few programmers are available to do the customized programming.

Management CRM have helped thousands of clients discover and adopt new CRM solutions providing CRM training and support and their businesses have excellent ROI.

4.16 Summary

Management Information System is not a new term to us. It is an old concept. Actually every civilization has its own way to acquire, sort, use and manage information. Management Information System concept is of dynamic nature and the modified model of Management Information System meets all the needs of organization. Management Information System can be defined as consisting of people, equipment and procedures to gather, sort, analyze, evaluate and distribute timely and accurate information to the decision makers.

To get the synergistic impact of Management Information System on business organization, a Management Information System must have a database, qualified system and management staff, Top management support, active participation of operating management, control and maintenance of Management Information System. But there are certain problems with Management Information System like non-availability of experts, how to select sub-systems, non-cooperation from staff, high turnover of staff, difficulty in quantifying the benefits.

Significance of Management Information System in the Business Organization is such that it provides right information to right person at right time. Management Information System is a strategic edge in the hands of the manager over the competitive environment.

Programmed or structured decisions have traditionally been made through habit, by operating procedures or with other accepted tools. More modern techniques for making such decisions involve Operations Research (OR), mathematical analysis, modelling and simulation, etc. Decisions of this kind can be delegated to lower levels in an organization or can be automated.

We all know the law of nature, that everything either man, animal or an event has a definite starting or beginning and it also has a definite ending or termination. Likewise, the computer based information system or Management Information System has its starting or beginning and after passing through so many activities it has a completion stage. As life is a continuous process, management information system development also follows the same principle, means development of management information system is also a continuous process, because after utilizing some of the information, the need for next information arrives.

Using the system approach to develop information system involves a multistep process called the information system development cycle, also known as system development life cycle or phases/stages of Management Information System. The steps taken to develop Management Information System are designing of Management Information System, so that they all are analogues to each other. Reader need not get confused when he or she comes across any of these terms regarding development of Management Information System or information system.

The master plan typically has two components - (a) a long-range plan for three to five years (or more) and (b) a short-range plan for one year. The plan provides a basis for resource allocation and control. The long-range portion provides general guidelines for direction and the short-range portion provides a basis for specific accountability as to operational and financial performance.

The master development plan establishes a framework for all detailed information system planning. Information system planning is focused on determining the information needs and also ensures that information system planning aligns with the overall business planning.

For information system planning R.Nolan has given a model known as Nolan stage model which initially had four stages of growth and later on it was reviewed. As a result there is an addition of two intermediate growth stages. The Nolan model basically describes in which stage organizations information system exists. This will provide a base for planning to proceed to next stage of the growth. We can see the contribution of this model for MIS planning after going through each stage of Nolan's model.

4.17 Glossary

- ***Management Information System Concept:*** It is of dynamic nature and the modified model of Management Information System meets all the needs of organization.
- ***Physical Data Models:*** These models are used to have higher-level description of the storage structure of the database and their access mechanism.

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- ***System:*** A series of functions or activities within an organization that work together for the aim of the organization.
- ***Operational Control:*** The process of ensuring that operational activities are carried out effectively and efficiently.
- ***Conceptual Structure of MIS:*** A federation of functional sub-systems.
- ***Logistics Function:*** Activities such as purchasing, receiving, inventory control, and distribution.
- ***Master Development Plan:*** The master development plan establishes a framework for all detailed information system planning.
- ***Information System Planning***: Information system planning is focused on determining the information needs and also ensures that information system planning aligns with the overall business planning.
- ***Nolan Stage Model:*** The Nolan stage model explains the evolution of information system within an organization by considering the various stages of growth.
- ***Subculture:*** Each organization has its own culture and subunits within the organization possess their own culture which may be called subculture.
- ***Strategic Planning:*** Strategic planning needs to be in line with organization culture.

4.18 Review Questions

1. Define MIS and write about to importance.
2. What is the need for a database?
3. Explain the utilization models of MIS.
4. Define the term Management Information System. Also describe its various features.
5. What are the advantages and disadvantages of Management Information System?
6. Do you think that there are certain prerequisites to implement a successful Management Information System in an organization? Justify your answer.
7. Is Management Information System a product of various academic disciplines?
8. What are the major misconceptions regarding Management Information System?
9. Why is Management Information System looked upon as a strategic need of management today?
10. What do you understood by the term MIS? How does it assist managers in their day-to-day functioning?
11. Discuss various functions of MIS System.
12. Define MIS.
13. What do you mean by Conceptual Structure?
14. What is Physical Structure?
15. What are the components of MIS?

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16. Describe various components of MIS.
17. Distinguish between structured and non-structured decisions.
18. Explain the process of decision making in MIS.
19. What are the syntheses of MIS structure?
20. Discuss MIS structure based on Management activity and organizational function.
21. What do you mean by MIS Plan?
22. Define Nolan stage plan.
23. What is the three-stage planning process model?
24. What do you mean by strategic fit?
25. Describe the Nolan six-stage planning model.
26. Describe the three-stage planning process model

4.19 Further Readings

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UNIT–5

Developing MIS System

Notes

(Structure)

5.1 Learning Objectives
5.2 Introduction
5.3 Computer Software Systems
5.4 MIS Development Process
5.5 Implementations of Management Information System
5.6 Methods of Implementing Management Information System
5.7 Implementation Steps of Management Information System
5.8 Evaluation of Management Information System
5.9 Structure for Evaluation of Management Information System
5.10 Maintenance
5.11 Problems Related to the Maintenance of Management Information System
5.12 Measures to Overcome these Problems
5.13 Problem in Developing MIS
5.14 Problems and Solutions in Implementing Management Information System
5.15 Inference
5.16 Role of MIS
5.17 Components of a Good MIS Solution
5.18 Functionality and Expandability
5.19 Flexibility
5.20 Usability
5.21 Reports
5.22 Standards and Compliance
5.23 Administration and Support
5.24 Technical Specifications and Correctness
5.25 Cost
5.26 Summary
5.27 Glossary
5.28 Review Questions
5.29 Further Readings

5.1 Learning Objectives

After studying the chapter, students will be able to:

- Discuss the MIS development process;
- Describe various phases of development;
- Explain implementation of Management information system;
- Discuss Risk based Approaches MIS development;
- Explain the problem in developing MIS;
- Discuss the component of the good MIS solution;
- Describe the problems and solutions in implementing management information system.

5.2 Introduction

Management Information System (MIS) can be defined as collecting and processing of raw data into useful information and its dissemination to the user in the required format. It consists of information, which impacts managements to feel the pulse of the organization and take decisions accordingly. In fact a full MIS consists of all the systems that the institution uses too generate the information that guide management's decisions and actions.

Microfinance Institutions (MFI'S), over the past few years, have been paying increasing attention to information systems. They are increasingly realizing that information lies at the very heart of microfinance. The practitioners as well as donors have become aware of the vital need for formal and informal financial institutions to manage large amounts of data. As a result, there is a massive drive to improve the effective understanding and use of these data. Needless to say that it is no possible to collect and collate large volumes of data without adopting new technology. As a result the MFIs are watching the developments in information technology very closely.

5.3 Computer Software Systems

A commercial organization performs various activities. The important ones among them include financial accounting, inventory control, and payroll. Most of these activities are carried out manually. As the dimensions of these activities increase, the organization may prefer to mechanize the activities to operate smoothly. Computer manufacturers have come to the rescue of business organizations. They have developed packages/ programs, for carrying out the activities like payroll preparation, inventory control, invoicing system, and financial accounting. This unit discusses these four important computerized applications in detail.

When we consider the payroll problem, it is obligatory on the part of every employer to pay the wages to employees within a prescribed time limit. When the number of

employees is large, it is preferred to have a computerized system of preparing the pay bills rather than manual ones. A computer software package on payroll thus becomes an integral part of a large business organization.

Similarly, financial accounting is another field where computerization can play an important role. The financial accounting package is one which helps the organization in preparing various financial reports, ledgers, and journals of monetary transactions.

In a large production-oriented organization, it is essential to have a control over the investment in inventory of raw materials. A computerized inventory control system can reduce considerable amount of time in processing the data which is necessary to control inventory.

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5.4 MIS Development Process

Software development for business applications is not an easy task. In developing a large software (e.g., MIS), many people are involved and many months or even years are spent. However, a small application (e.g., Payroll) can be developed in few weeks or months by a single or few programmers. For such small systems, software development activities maybe done implicitly without proper documentation. But, for large systems, these activities must be done explicitly with proper planning and documentation. Whether a system is small or large, software development revolves around a life cycle that begins with the recognition of users' needs and understanding their problem. A plan is made for solving the problem and then a sequence of activities are performed step by step. The basic activities or phases that are performed for developing software are:

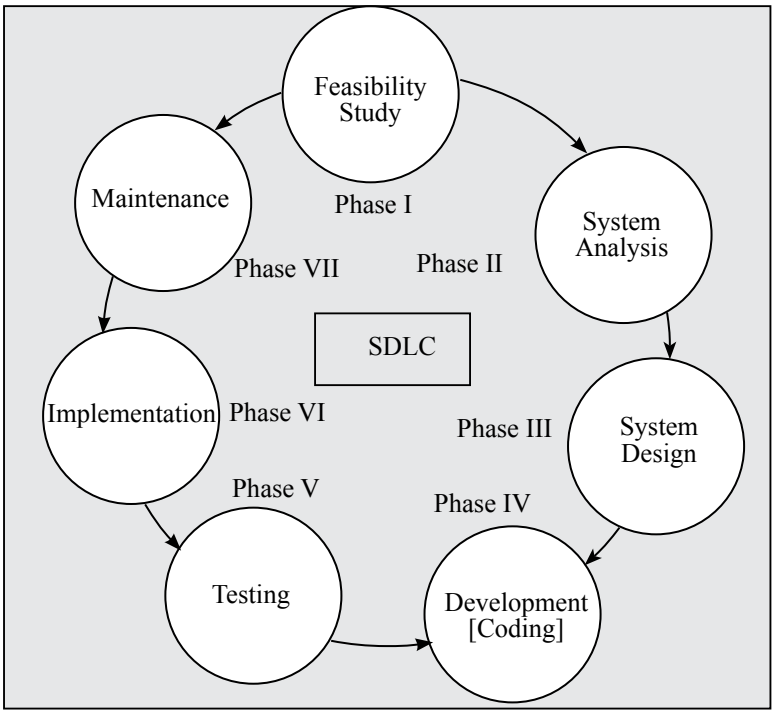

Fig. 5.1: Seven Phases of Software Development Life Cycle

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1. ***Systems Analysis:*** When the systems analyst decides that the requested system is feasible and the management agrees to continue the development process, the next phase of SDLC is determination of systems requirements. This phase includes studying of existing system in details and collecting data in order to find out the requirements of the users.
2. ***Systems Design:*** After collecting and studying user's requirements, the system is designed. This phase involves identification of inputs data, output reports and the procedures to process the data.
3. ***Development of Software:*** When the design (properly documented) is accepted by the requested department, the programmers start designing of data structures and writing of program. The programmers test their individual programs and integrate them into a single system.
4. ***Systems Testing:*** Testing is the most vital phase of SDLC. In this phase, the system as a whole is tested with different techniques to ensure that the software is bug free.
5. ***Implementation:*** The tested system is installed at the user's place and implemented. This is generally considered the last phase of SDLC. However, the systems development work continues until the users of requested department accepts the candidate system.
6. ***Maintenance:*** After implementation, the systems need be maintained in order to adapt the changing business needs. Maintenance is sometimes not considered as a phase of SDLC, but it is an essential part of a software project that never ends.

The different phases of Software Development Life Cycle (SDLC) are illustrated in Fig. 23.2.

It may be possible that the candidate system fails due to any major mistake occurred in any of the development phase. In that case, any or all of the phases are needed be reviewed again, so that the system is completely accepted by the requested department. This is the reason, why 'life cycle' term is used in software development phases. We will discuss about each phase in detail in subsequent sections.

Examples of SDLC

The phases of System Development Life Cycle are often sequenced in many different ways so as to achieve different objectives. These variations give rise to different Development Models. Each model aims at achieving its specific goals by arranging the SDLC phases in appropriate ways. Some of the popular SDLC are described below.

Waterfall Model

This model of system development is the simplest in the sense that it follows all the development phases in discrete steps one followed by the other. A phase does not begin unless the previous phase has concluded as shown on the next page. The development phases do not overlap and are mutually exclusive.

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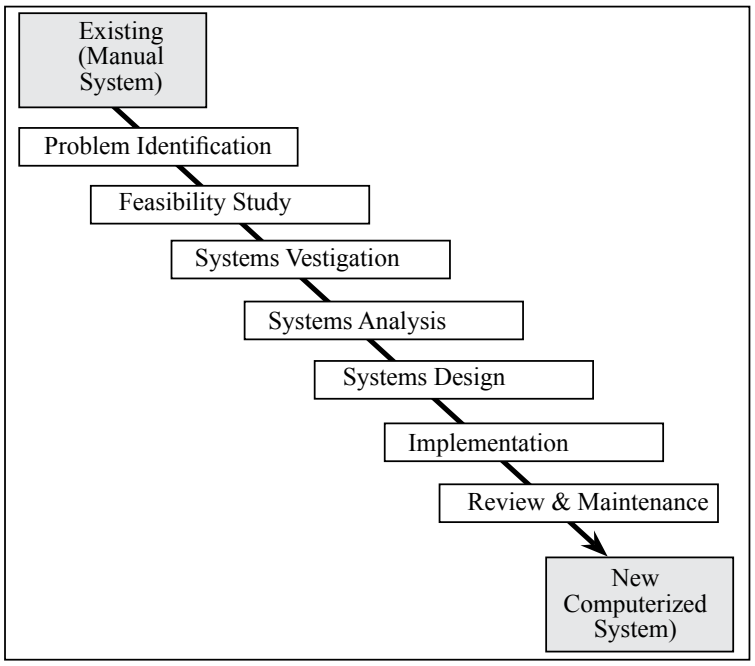

Fig. 5.2:

The name – waterfall – signifies that once a phase is over it is not the development does not enter it again much the same as water does not flow upwards in a waterfall.

Advantages of Waterfall Model

- It is most suitable for small systems in which the needs of the users' are more or less understood.
- It is resource efficient as once a phase is over the same resources can be employed in the next phase.
- It is easy to assess the progress of development as the development takes place through neatly separated phases.

Disadvantages of Waterfall Model

- Changes in the requirement are inevitable during the development process. This model does not cater to changes readily. It is difficult to accommodate changes because once a phase is over it cannot be redone to incorporate any change.
- Development is time-taking as phases cannot be initiated in parallel.
- It is unsuitable for systems in which the users' needs are not properly understood.

Prototype Model

The SDLC approach to system development is most suited in cases where the users' requirements can be ascertained in the beginning of the project. However, in cases

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where the users are not sure what they want (note that users are very often not computer experts) another approach to development – prototyping – is more suitable.

In prototyping approach, a rough copy, which has the feel and look of the new system, is developed with only limited functionality. The users are allowed to interact with this prototype and the desired modifications are recorded. These new features are added and again users are allowed to interact with the modified system. The procedure is repeated until the required system is evolved. Prototype approach is illustrated in the Figure 5.3.

Generally there are two types of prototypes:

- Throw away Prototype
- Permanent or Evolutionary Prototype

Throwaway Prototyping: Throwaway or Rapid Prototyping refers to the creation of a model that will eventually be discarded rather than becoming part of the finally delivered system. After preliminary requirements gathering is accomplished, a simple working model of the system is constructed to visually show the users what their requirements may look like when they are implemented into a finished system. The most obvious reason for using Throwaway Prototyping is that it can be done quickly. Throw away prototype is presented to the users just to investigate a particular need. Once the need is determined the prototype is discarded. It is not modified but the modification is done to the original prototype which will ultimately turn into the final system.

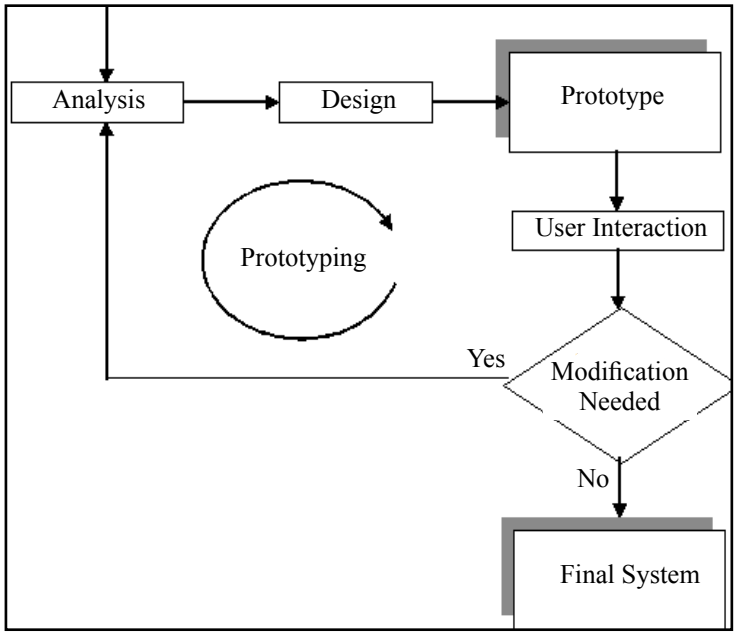

Fig. 5.3:

On the other hand, Permanent or Evolutionary prototype is refined gradually through the users' interaction and finally takes the shape of the final system.

Types of Prototyping: System prototyping are of various kinds. However, all the methods are in some way based on two major types of prototyping:

- ***Evolutionary Prototyping:*** Evolutionary Prototyping (also known as Breadboard Prototyping) is quite different from Throwaway Prototyping. The main goal when using
- Evolutionary Prototyping is to build a very good prototype in a structured manner so that we can refine it or make further changes to it. The reason for this is that the Evolutionary prototype, when built, forms the heart of the new system, and the improvements and further requirements will be built on to it. It is not discarded or removed like the Throwaway Prototype. When developing a system using Evolutionary Prototyping, the system is continually refined and rebuilt.
- ***Incremental Prototyping:*** The final product is built as separate prototypes. At the end the separate prototypes are merged in an overall design.

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Advantages of Prototyping

- It is very effective in identifying the users' need.
- Users' response is very close to what they actually need.
- It is more convenient for the users' to work and tell with working model of the system.
- The development is easy and precise.
- The users' get the look and feel of the upcoming system and therefore training them becomes easier.
- The prototype is very likely to end up into the system that users' want.
- Prototyping and SDLC may be used in a combined approach wherever applicable.

Disadvantages of Prototyping

- Increased project duration because of increased user interaction.
- The approach needs special Software such as fourth generation languages.
- Cost and duration of the development is not easy to estimate in advance.

RAD Model

Rapid Application Development or RAD is a software system development process that involves use of Computer Aided Software Engineering tools (CASE). It was developed by James Martin in the 1980s as a variant to prototype model.

CASE tools are employed to generate a system prototype to reflect the users' primary needs. The prototype thus produced is iteratively modified to incorporate the new and additional needs of the user. In the process Visual Basic and Delphi can be

used as RAD tool. RAD model aims at reducing development time, though sometimes at the expense of generating efficient executable code.

Advantages of RAD Model

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- Speed of development is increased greatly through methods including rapid prototyping, virtualization of system related routines, the use of CASE tools, and other techniques.
- Decreased end-user functionality arising from narrower design focus, hence reduced complexity.
- Larger emphasis on simplicity and usability of GUI design.

Disadvantages of RAD Model

- Scalability is reduced as the capabilities are ascertained in the beginning of the development.
- Since a RAD developed system starts as a prototype and evolves into a finished application the final product suffers from reduced features.
- Features also reduce due to deferring the inclusion of the features in later versions in order to finish a release in a short amount of time.

5.5 Implementations of Management Information System

Implementation is an important managerial activity related to adoption, management and routinization of an innovation. Implementation is an activity which starts when the system is developed and ready to install in the organization. So implementation is a process of inducting a newly developed Management Information System into the organization for the use by the end user, owners, etc. In the absence of proper implementation even the most sophisticated system will be a failure. Before implementation the designer or the developer has to make an environment to get support from all levels of management or in other words to avoid resistance. The user needs training to learn. So in addition to developing the technical skills, the training should also motivate the users. For implementation process, the system analyst plays the role of a change agent. Basically, the system analyst is the catalyst for the entire change process and he is responsible for ensuring that changes are acceptable to all the persons in the organization. The favourable implementation outcome can be subjected to various factors such as the role of users in the implementation, the extent of management support for the implementation effort, the complexity and level of risk involvement in the implementation activity and the quality of management of the implementation process.

5.6 Methods of Implementing Management Information System

Once the design of Management Information System is complete, it should be implemented. Implementing a new system requires a conversion from the previous system. Approach to conversion is shown in Fig. 5.4.

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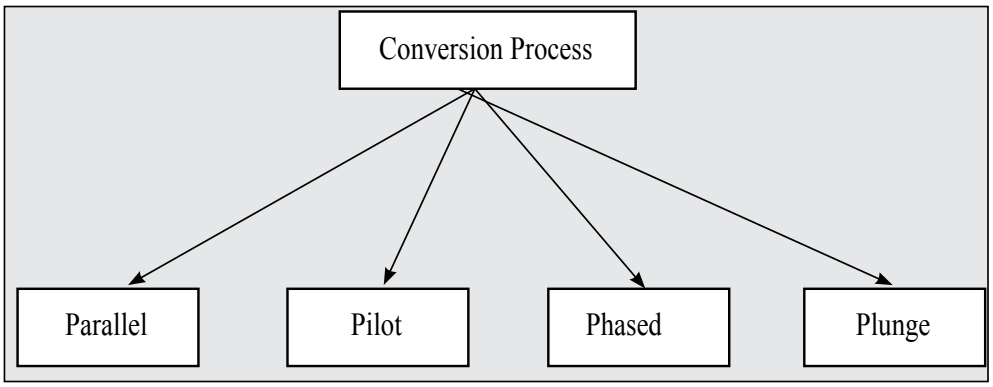

Fig. 5.4: Approaches to Conversion Process

Parallel

When new and old systems run in parallel for a trial period and a comparison of both is done. If the proposed system gives a satisfactory solution to information need, it is accepted and old one becomes obsolete.

Pilot

In this the new system is introduced at one location or site only for trial. If its performance is according to the need it is introduced in whole of the company or organization.

Phased

Introduce the system in phases, i.e., the new system is introduced at one site at a time. This method is useful when upgrading of an old system is being done.

Plunge

It is also known as immediate cut over or change-over. Introduce the new system as and when it is ready to work and remove the old one directly.

Except for the timing and for obvious variations, the implementation steps for all four methods may be covered together.

It should be pointed out that occasionally, design and implementation are carried on simultaneously. Such a process provides operational testing of the design on a continuous basis, but it limits consideration of major design alternatives. It is a trial-and-error process. Completion of conceptual and analytical design in advance of equipment installation offers many advantages besides cost.

So above are the four basic methods of implementing Management Information System in an organization after the completion of the design.

5.7 Implementation Steps of Management Information System

The implementation of the Management Information System is the culmination of the design process. It is necessary to document the system as installation takes place, so

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that there will be an up-to-date reference to designs during the designs phase. The final documentation should be complete, formal and accurate version of the Management Information System. The major implementation activities are shown in a flowchart in Fig. 23.5.

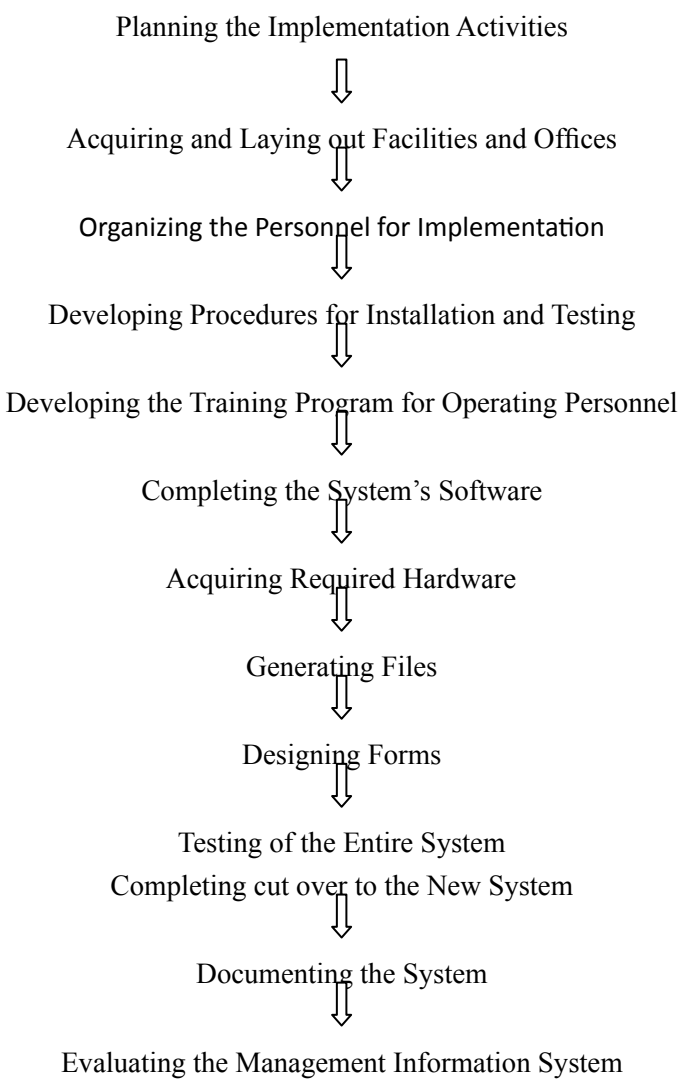

Fig. 5.5: Implementation Process

1. ***Planning the Implementation Activities:*** The three main phases in implementation take place in series; these are the initial installation; the test of the system as a whole; and the evaluation, maintenance, and control of the system. On the other hand, many implementation activities should be undertaken in parallel to reduce implementation time. The planning and the action to implement the plan should be bound closely together. Planning is the first step of management, not the last one. Further, the Management Information System design and the urgent need for the system at the time the design is complete will weigh heavily on the plan for implementation. And, finally, the planning process is a function of line management,

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at least as far as key decisions or alternative plans are concerned. The systems analyst may prepare plans to assist managers, but managers must have the last say. At the same time, managers require the services of the systems analyst to make detailed plans. The managers prefer to make decisions based upon the most recent information: the Management Information System specifications, the proposed plans of the systems analyst, and the current operating situation.

2. ***Acquiring and Laying out Facilities and Offices:*** The Management Information System project managers must prepare the rough layouts of the Management Information System and estimates of particular floor areas he or she feels will be needed. The manager should then prepare cost estimates and submit a proposal for management's approval.

   Facilities and space planning should begin as soon as approval of gross space allocations is obtained. The urgency for such planning is twofold. First, there may be a long lead time if new partitions, electrical work, air conditioning, or even new buildings are required. Secondly, the detailed work flow depends upon the physical arrangements of the buildings. The training of operations personnel will be more successful if it is based on exact physical relationships among the people and the equipment.

   Space planning must take into account the space occupied by people, by equipment and the movement of people and equipment in the work process. Related to these are the number and kinds of exits; location of utilities, outlets, and controls; environmental requirements for the equipment; safety factors; and working conditions for the personnel. A large investment in good working conditions will repay its cost many times.

3. ***Organizing the Personnel for Implementation:*** Once the implementation tasks are defined in the planning phase, management usually assigns a project manager to guide the implementation. A manager of management information systems may assume this responsibility by virtue of a permanent assignment. In smaller companies, someone from the finance/accounting department, or even the computer centre manager, may be placed in charge. A project manager, who is responsible for the entire Management Information System development and implementation, usually works best.

   The role of a line manager must be made clear. Because the purpose of the Management Information System is to increase the amount and quality of their contributions, the system is really their system. Top management must take explicit steps to make the middle managers aware of this and of the necessity for their involvement in implementation. Essentially, the system specialists are there to assist management with the implementation; they are assigned to the project as needed for this purpose.

   Besides assigning responsibilities to the line managers, systems specialists, and

computer programmers, top management should make sure that line functional personnel have active parts in the implementation. These are the people who will operate the system, and they also must feel that it is their system.

Proper organization by assignment of specific leadership and task responsibility diffused widely throughout the whole organization can prevent the moans and wails so often heard after a new Management Information System is installed and fails. Mature people respond to work assignments that call for their full talents. They must have a hand in shaping and constructing the system.

4. ***Developing Procedures for Installation and Testing:*** The project leader has the network plan available for proceeding with the implementation. The leader must now call upon key people in the project to prepare more detailed procedures for system installation.

   Procedures for evaluating and selecting hardware must be spelled out. Procedures for buying or constructing software should be established. Procedures for phasing in parts of the Management Information System or for operating the Management Information System in parallel must be developed. Obviously there are many procedures that must be delineated in advance if the entire implementation is to be saved from chaos.

   It is necessary to develop the testing procedures on the basis of the design and test specifications. The procedures should prescribe:

   (i) Which segments of the system will be tested

   (ii) When such tests are to be performed

   (iii) Test problems to be run

   (iv) Who will perform the tests

   (v) How will the tests be run

   (vi) Who will evaluate the test results and approve the system segment or recommend modification?

5. ***Developing the Training Programme for Operating Personnel:*** A program should be developed to impress upon management and support personnel the nature and goals of the Management Information System and to train operating personnel in their new duties. In the case of management, many of those who participate in the development of the system, two short seminars are usually adequate.

   Particular attention should be paid to the training of first-line supervisors. They must have a thorough understanding of what the new Management Information System is like and what it is supposed to do. Because, in essence, they oversee the operation of the system, they must learn how it will operate. They are faced with many changes in their work and they must obtain acceptance of changes from their subordinates.

   Certain professional support personnel—such as computer centre personnel, marketing researchers, production planners, and accounting personnel who provide

input to the Management Information System or are concerned with processing data and information—should also attend one or several orientation meetings. Because these people will be working with only a small part of the Management Information System, the seminars should be designed to provide them with an understanding of the complete system. This will furnish direction for their own jobs and give them a perspective that may reduce the likelihood of blunders.

Finally, longer and more formal training programs should be established for people who perform the daily operational tasks of the Management Information System. These are the clerks, the computer operators, the input and output machine operators, file maintenance personnel, and possibly printing production and graphic arts personnel.

6. ***Completing the System's Software:*** After developing the training programme for operating personnel, the next step in implementation of Management Information System is completing the system software by the organization. Today many software packages are commercially available. Therefore, for small companies all software might be purchased. In large companies with specialized forecasting, planning, operating, and control models, most software must be developed internally or under contract. In either case, the software development must take into account the nature of the hardware.

   Purchase of software packages has a pitfall. Often, so much modification of the software is required to fit the company that it would have been cheaper to have developed the entire software internally.

   If the software development route is pursued, an additional set of activities emerges. Systems designers and programmers provide the flow diagrams and the block diagrams during the detailed design stage. Some modification may be required, however, as the implementation stage progresses. In the implementation stage, the coder converts block diagrams into sequences of statements or instructions for the processing (computer) equipment.

7. ***Acquiring Required Hardware:*** The acquisition of computer system equipment is a complex subject more suitable for a specialized personnel. Basically, the design of the computer system and the architecture available from the vendors are closely tied together. Once a choice of CPU and peripheral equipment is made, a major decision is whether to buy or lease. Capital expenditure analysis is only one of many factors involved in this decision. Others are prestige, usage, anticipated replacement schedule, and vendor's options.

   An alternative used by smaller companies is simply to lease computer time from a service bureau.

8. ***Generating files:*** In the implementation stage, the actual data must be obtained and recorded for the initial testing and operation of the system. This requires a checklist of data, format of data, storage form and format, and remarks to indicate when the data have been stored. The implementation also requires the development

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of a procedure for updating each piece of the data and for updating entire sections of the file as required. This collection of data used in routine operations is often called the master file.

When data are obtained from the environment—as are economic, competitive, and financial data, or vendor sources—a procedure for obtaining the data may be developed along with the initial acquisition. Responsibility for file maintenance for each file item should also be assigned.

In the detailed design phase, each item of data for the files is specified and the retrieval methods (indexes) are developed. In the implementation stage, forms must be designed so that the data may be analyzed by the programmers and coders for storage in the computer. Thus, the file name, maximum number of characters required to record each data element, frequency of access, volume of operations on the element, retention characteristics, and updating frequency are examples of relevant information required to translate a specification into a file element.

The development of files or databases belongs in the conceptual realm of information system designers and storage and retrieval experts. The translation of specifications for files into computer programs is a function of computer specialists.

9. ***Designing Forms:*** A vast amount of detailed data, both external and internal to the company, must be collected for input to the Management Information System. If control over marketing is to be exercised or sales forecasting is carried out, then somewhere, everyday, a salesperson must sit in a room and fill out a form summarizing the day's activities. Obviously, the form ensures that the right information is supplied in a manner that simplifies processing for computer storage.

   Forms are required not just for input and output but also for transmitting data at intermediate stages. In a personnel system, input to the computer may consist of all known applicants for all known jobs within a company. The computer may provide sorted output to match jobs and applicants. The personnel recruiting specialist may then have to add a statement of his or her activities—on a form, which is attached to the computer output. The entire package is then forwarded to the manager of personnel.

10. ***Testing of the entire System:*** As each part of the total system is installed, tests, should be performed in accordance with the tests specifications and procedures. Tests during the installation stage consist of component tests, subsystem tests, and total system acceptance tests. Components may consist of:

    (i) Equipments old or new

    (ii) New forms

    (iii) New software programme

    (iv) New data collection methods

    (v) New work procedures

    (vi) New reporting formats

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11. ***Completing Cut over to the New system:*** Cut over is the point at which the new component replaces the old component or the new system replaces the old system. This usually involves a good deal of last-minute physical transfer of files, rearrangement of office furniture, and movement of work stations and people. Old forms, old files, and old equipment suddenly retire.

    The systems designer may observe the cut over and smoothing out of system operations in a short time.

    The debugging process associated with the cut over to the new system may extend for several months. Programmes may require improvement, forms may need to be changed for more efficient operation, or employees may desire transfer to different jobs within the system. In particular, the operational testing of the system over a period of several months exposes it to a volume and variability of data and conditions that could not be practically achieved in pre-acceptance testing. Production records such as productive time and non-productive time give indications of future maintenance requirements and idle-time costs.

12. ***Documenting the System:*** The next step in the implementation is documentation of the system in an organization. The documentation of Management Information System includes preparation of written description of the scope, purpose, information flow components, and operating procedures of the system. It also includes the flowchart and layout charts, desk equipment, forms, output reports and formats, data processing procedures, etc. It also consists of the method for controlling and revising the system.

    Documentation is necessary for replacing the sub-systems and evaluating and upgrading the system.

13. ***Evaluating the Management Information System:*** After the documentation of the system, the next step is evaluating the Management Information System. The evaluation should be done for each step of the system. Evaluation should not be delayed beyond the reasonable time of debugging. It should be made by the customers as well as by the designers.

    So above are the various steps, which help us in implementation of Management Information System of an organization/company.

5.8 Evaluation of Management Information System

After the Management Information System has been operating smoothly for a short period of time, an evaluation of each step in the design and of the final system performance should be made. There is always the pressure to go on to new jobs, but the feedback principle should apply to the work of the Management Information System as well as to the product. Thousands of rupees are invested in the Management Information System, and it is a good business to measure the value of the results.

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Evaluation should not be delayed beyond the time when the systems analysts have completed most of the debugging. The longer the delay, the more difficult it will be for the designer to remember the important details.

The evaluation should be made by the customers as well as by the designers though it is less important than the previous evaluations. The financial specialists should evaluate the project in terms of planned cost versus actual cost of design, implementation, and operation. They should also attempt to identify cost savings and increased profits directly attributable to the Management Information System.

A clear-cut method for measuring the costs and benefits of a new Management Information System has not yet been found. We present here a structure that, when adapted to a specific company, will permit partial evaluations.

5.9 Structure for Evaluation of Management Information System

The measurement of costs or benefits of Management Information System is the measurement of a change or difference between the old and the new. The measurement of change must be related to the basic goals of the Management Information System, the principal activities that further these goals, or many minor activities that further these goals. In other, words, we may measure the many changes accomplished throughout the system. The former is obviously the most desirable.

What we have is a hierarchy of levels at which we consider measuring costs and benefits. For a particular Management Information System, the designer may select the levels at which measurement is to take place based upon specific objectives of the total system is attempted at the system level. At the system level, judgment of broad concepts might be taken into account as follows:

1. ***System Integrity:*** How well are the subsystems integrated into the total system without redundancy? How flexible is the system? How easily may the system be expanded?
2. ***Operating Integrity:*** How skilled are the people operating the system when backup is there to prevent system breakdown in the event of loss of key personnel or equipment failure?
3. ***Internal Integrity:*** How well does the system do what it is supposed to do? How valid are system outputs? How secure is the system against human error, manipulation, sabotage, or theft?
4. ***Procedural Integrity:*** How good is the documentation of the system and procedures? Are procedures such that employees are motivated to follow them? How well are procedures followed in practice? What controls ensure that procedures are followed?

5.10 Maintenance

In the maintenance of Management Information System of organization, control and maintenance of the system are the responsibilities of the managers. Control of the system

means the operation of the system as it was designed to operate. Sometimes operators will develop their own private procedures or will short-circuit procedures designed to provide checks. Often people make unauthorized changes to improve the system, changes that are not approved or documented. Managers themselves may not be factoring into decisions information supplied by the system, such as sales forecast or inventory information, and may be relying on intuition. It is upto management at each level in the organization to provide periodic spot-check of the system for control purpose.

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Maintenance is closely related to control. Maintenance is the ongoing activity that keeps the Management Information System at the highest levels of effectiveness and efficiency within cost constraints. In other words, maintenance of the Management Information System is directed towards reducing errors due to design, environment changes, and improving the system's scope and services. These activities are sometimes classified as (1) emergency maintenance, (2) routine maintenance, (3) requests for special (one-time) reports, and (4) systems improvements.

Maintenance may be applied to the following activities of Management Information System of an organization.

1. Change in policy statements
2. Change in reports
3. Change in forms
4. Change in procedures
5. System controls and security needs
6. Change in hardware
7. Software addition or modification
8. Change in economic conditions
9. New technology
10. Industry and competitive conditions
11. Change in government polices, regulations, and legislation

Maintenance may be applied to the following activities or entities:

1. ***Change in Policy Statements:*** Change in policy statements often takes place in the organizations with the passage of time. The manager should change the policy relating of Management Information System according to the different situations, so that there should be proper environment for the maintenance. The change must be made according to the required standard of the organization as there should not be obstacles achieving the goals of the organization.
2. ***Change in Reports:*** When a manager of an organization replaces an outgoing manager, he should change the reports of the outgoing manager according to his convenience. But before changing the reports, it must be kept in mind that, it should not affect adversely on the maintenance of Management Information System. The change in reports of the outgoing manager must be done with the proper consent

of the related staff. There must be regular change in reports of maintenance of Management Information System.

3. ***Change in Forms:*** For the proper maintenance of Management Information System, there must be change in forms of reports of maintenance of Management Information System. The change in forms is done with the change in environment of the organization, so that the new forms should not be contrary to the existing reports.
4. ***Change in Procedures:*** The procedures of the maintenance of Management Information System must be changed with the change in form, software and hardware in an organization. The new procedure must be related to the new forms and easily adoptable in new software and hardware. The pros and cons of new procedures must be taken into account before implementing it. The procedures must not be contrary to the goals of the organization.
5. ***System Controls and Security Needs:*** The system controls and maintenance of the system are the responsibilities of the line manager of an organization. Sometimes, there are unauthorized changes in the existing system for its improvement, which is not accepted in the organizations. Maintenance is closely related to control. It helps in improving the system's scope and services, and reducing the error due to the environment changes. Each system is to be tested in accordance with the test specifications and procedure prevailing in the particular organization. Each new form may be tested relatively independent of the system to which they belong.
6. ***Change in Hardware:*** There should be proper change in the acquisition of computer system equipment with the passage of time. The design of the computer system and the architecture available from vendors are closely tied together. Once a choice of a new CPU and peripheral equipment has been made, then make a decision whether to buy or lease. The capital expenditure analysis must also be taken into consideration. Other factors like usage, anticipated replacement schedule and vendor's options should also be taken into account.
7. ***Software Addition or Modification:*** There is a continuous need for change in software packages. There should be proper planning, forecasting, operating, and control models, so that software must be developed internally or under contract. The addition or modification of software must be taken into account depending on the nature of the hardware.

   It would have been cheaper to have developed the entire software internally in the organization.
8. ***Change in Economic Conditions:*** Changes in general economic conditions play a major role in defining financial information systems. If the system is properly designed, it should meet the needs of all users, not just the accounting and finance departments. General economic conditions dictate corporate policy in several areas, and the ability to internalize these changes is an important part of a good systems design. As these changes are only partly predictable, the system should

be evaluated periodically to ensure both proper inclusion and measurement of new conditions. Changes in the unemployment rate, both nationally and locally, could affect the direct labour cost and could also affect the time frame for completion of planned projects. Changes in inflation and interest rates have even more far-reaching impacts. A rise in interest rates may hinder customers attempting to obtain short-term credit to purchase a company's product. The same rise in interest rates may stop a company from expanding plant capacity, stockpiling inventories, or replacing and updating fixed assets. This list is not all inclusive, but it should be noted that periodic systems evaluations will help to ensure that these and similar items are included.

9. ***New Technology:*** The development of computer technology, applications programs, and management techniques have progressed at such a rate as to make farcical the articles of only a few years ago suggesting that total information systems would always be myths. Data communications system interactive systems with video displays, tremendous storage capacities, and higher-speed computers are staggering to old-line managers. This new technology is being introduced and used by different institutions.

10. ***Industry and Competitive Conditions:*** Change in industrial conditions should be treated in the same manner as changes in economic conditions; however, the timing of reactions of these changes may be more important. The expansion or collapse of a market for a company's products is of such importance that failure to react on a timely basis may mean failure of the business as a whole. Competitive strategies, price policy, hiring, and capital budgeting are but a few of the areas affected by changes in business conditions. New technology, either in production of products or in the creation of alternative products, may affect even the basic concepts that form the corporate objectives.

    New standards for measurement such as package sizes or the metric system may have great financial impact. Industry innovations in reporting or gathering data, such as point-of-purchase data collection in retailing and video responses to stock price information in brokerage houses, are other examples. These and the changes cited earlier require anything from routine to major changes in the Management Information System.

11. ***Change in Government Policies, Regulations, and Legislation:*** Large companies require specialists or lawyers to keep management appraised of the numerous change in reporting requirement, compliance requirements, and pressures for change. For example, banks must be aware of new regulations, maximum interest rates, interest rates established through Federal Reserve activities, minimum down payments required on loans and mortgages, acceptance rules. Manufacturing companies must be aware of change in pension rules, financial disclosure, and so on. Healthcare facilities must be aware of legislation and rulings with regard to state and federal government payments for the elderly, indigent, and so on. In other words there is

a continuous flow of rules from government that requires constant updating of the Management Information System in a company.

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5.11 Problems Related to the Maintenance of Management Information System

Maintenance is the ongoing activity that keeps the Management Information System at the highest levels of effectiveness and efficiency within cost constraints. The problems which can arise in the area of maintenance of Management Information System are as follows:

1. ***No Plan for Maintenance:*** The first and foremost problem in maintenance of the Management Information System is lack of proper planning. Inadequate planning slows down the work of maintenance. Without proper planning there are a lot of unnecessary events, which increase the total loss of maintenance and ultimately reduces the profit of the organization.
2. ***No Process Allocation for Maintenance:*** Another major problem relating to maintenance is that there are no resources allocated particularly to the maintenance of Management Information System. So for the regular upkeeping of the Management Information System, one has to depend upon other departments regarding the resources. Without the proper resources allocation, there is always a lack of fund, which ultimately deteriorates the maintenance.
3. ***Lack of Management Interest, Understanding and Commitment:*** The another area of negligence is lack of management interest, understanding and commitment to the Management Information System department. Due to non-interest of management, they are not interested in the development of Management Information System. They are also not bothered about the various commitments made by them to the Management Information System department. They are least interested about the functioning of Management Information System.
4. ***Lack of User Understanding and Cooperation:*** The lack of user understanding and cooperation towards the functioning of Management Information System is another problem in the maintenance of Management Information System. Most of the users are not in a position to understand the importance of maintenance of Management Information System, so they pay least attention towards the proper and smooth running of the Management Information System and its timely maintenance.
5. ***Lack of Qualified Personnel:*** The another problem comes into picture is lack of qualify personnel for the maintenance of Management Information System. The main reason is that, nobody takes the maintenance as a serious problem. Everyone takes it as an ordinary problem. In the case of any breakdown, non-functioning or interruption in the working of Management Information System, the organization has to depend on its unqualified or semiskilled staff or, on the professionals available in the market, which is a very time consuming and costly method of maintenance.

6. ***Inadequate Documentation:*** Inadequate documentation is also a very big problem in the maintenance of Management Information System. Due to lack of proper documentation, the maintenance is not done properly and not upto the mark. It effects are on the performance of Management Information System department, which may cause decrease in the overall efficiency of the organization.

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5.12 Measures to Overcome these Problems

These are some of the problems which are generally faced by maintenance department of Management Information System in an organization. The following measures should be taken to overcome these problems:

1. ***Proper Planning for Maintenance:*** Maintenance cannot be performed in a haphazard manner, information basis or on a first-come, first-served basis. Four steps are necessary for a good maintenance program:
   (i) Log all requests for change. Only written requests should be accepted and included in the log.
   (ii) Assign priorities to all requests. These will be determined by urgency of the project for the Management Information System, long-range benefits, time and resources required, and, in some cases, management dictum.
   (iii) Prepare annual and short-range (usually monthly) plans.
   (iv) Document maintenance as it occurs when a project is completed, revise the Management Information System design manual.
2. ***Responsibility for Maintenance:*** Specific responsibility for maintenance should be assigned to a supervisor and team of Management Information System analysts, programmers, and forms specialists. Fragmentation of responsibility to Management Information System analysts, the computer experts, and the forms coordinator, without at least a unifying committee, can lead to compounding of Management Information System maintenance as primarily computer program maintenance, it is not. The most important maintenance activities may precede, or not even include, program maintenance.
3. ***Initiation of Maintenance Projects:*** Maintenance activity may be initiated by error reports, a user's change request, a member of the maintenance team, or company management. Usually, specially designed forms for error reports and for change requests must be completed. A barrier to solicit information on errors or for changes is the detail required on the form. It may be more useful to have a very simple form that calls for only the requests of correction or change and a brief statement of the need. Once a maintenance analyst receives such a form, a more detailed documentation may be filled out after an interview.
4. ***Adequate Documentation:*** The another measure which should be taken for the proper maintenance is adequate documentation, so that there should be proper and smooth functioning of the Management Information System. Adequate documentation also helps the organization in increasing its efficiency.

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5. ***Qualified Personnel:*** There should be proper qualified personnel for the proper maintenance of Management Information System. With the availability of qualified personnel, the organization need not look here and there for its maintenance of Management Information System and working of the organization is also very smooth and proper. The qualified personnel can immediately remove any problem faced by the Management Information System department.

These are some of the measures that should be taken to overcome the problems faced in the maintenance of Management Information System.

5.13 Problem in Developing MIS

Despite the availability of technology today there is a problem in developing a good and problem free MIS software for the MFIs. The diverse nature of microfinance creates an intriguing complexity for software application development. Some of the complexities in developing a single or a small number of software to meet the needs of the MFIs are discussed below.

1. ***Many Institutional Models:*** The organizational forms is a function of the specific of social , political, economics , regulatory and legal environments throughout the world. There are a variety of organizational forms that are assumed by the MFIs for carrying on their work. The MFIs can be in the form of credit union, cooperatives, Non governmental Organizations (NGO) and even banks. All have their own varied type of requirement for MIS and its automation.
2. ***Different Lending Methodologies:*** MFIs have vastly different lending methodologies across the globe and even within the same country. Some MFIs follow individual lending some follow village banking methodology and yet others may be following solidarity group lending . In Indian for example some MFIs follow the e Grameen Model as per the example of the Grameen Bank, Bangladesh while other follow Self Help Group Model as propagated by the institutions like National Bank for Agriculture and Rural development (NABARD)
3. ***Methodology on Interest Payment:*** The practices for calculating interest and the periodicity for its payment vary according to the product and organisation. These variations can occur even within the same organisation depending on the product and the area of operation.
4. ***Other varied requirements:*** There are variations in terms of the currencies languages and reporting requirements of the MFIs.

5.14 Problems and Solutions in Implementing Management Information System

In the previous section, certain prerequisites of an effective Management Information System are mentioned. But there are certain problems, challenges and constraints for which we are suggesting possible solutions. Some of them are as follows:

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1. ***Non-availability of experts:*** This is the main challenge before the planner of Management Information System that it is difficult to find experts who can determine the basic objective of the organization expected to result from a Management Information System and then implement them to produce an effective Management Information System. But this problem can be solved by providing necessary training to the existing staff or by proper selection of new entrants in the organization.
2. ***Selection of sub-systems:*** Experts face the problem of how to select the sub-system of Management Information System to be installed and operated upon. For this, the experts must see what is the need and importance of a function for which Management Information System has to be installed in the organization for the first time.
3. ***Non-standardized system:*** Because of the different objectives of business organization, the approach adopted by experts for designing and implementing Management Information System is a non-standardized one. To deal with this problem nothing can be done at the initial stage but as time passes the standardization may be arrived for the organization in the same industry.
4. ***Non-cooperation from staff:*** This is the most critical problem in implementing a Management Information System effectively in the organization. The fears of retrenchment, exposure before subordinates are some of the main reasons of this non-cooperation. However, this can be handled by proper education, giving lectures, communicating with them about the benefits of the system and also by involving some of the middle level managers in the process of development and implementation.
5. ***High turnover of experts:*** High turnover among the experts is a major challenge. There are many attractive reasons like high pay packets, promotion, future prospects, behaviour of top linking managers, etc. Organizations retain them by providing better working conditions and paying at par with other similar concerns.
6. ***Difficulty in quantifying the benefits:*** Management Information System is basically a service and to quantify the benefits of a service is very difficult. It is difficult to quantify the benefits and also compare them with the cost of achieving these benefits. So the persons who want to introduce Management Information System concept has to face the questions by different managers about its utility in the organization. Although we cannot quantify the benefits but one thing we should keep in mind is that Management Information System is a tool which is essential to fight out competition and the state of uncertainty that surrounds the business organization these days.

5.15 Inference

All these wide variations complicate the development of software that can be picked off the shelf and implemented in most of the MFIs. It creates great burden on software companies creating quality application that is affordable and meets all the

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requirements of the MFIs. In fact this is the major problem faced by those responsible for providing automation in the industry.

The need of technology cannot be overstated but the complexity and diversity forces one to take a hand look at the following:

1. What is the role of MIS in improving the sustainability of MFIs?
2. What are the basic components of sound microfinance packages for MFIs?
3. Why are there so few solutions available?

5.16 Role of MIS

Sustainability

Let us look at what does the MIS do for the sustainability of MFIs?

The answer is Nothing., MIS will not do much for the sustainability of microfinance if institutions ignore good business practices. The following are some of the widely stipulated best business practices :

1. Focus on profitability
2. Quality loans
3. Provision for loan loss reserve
4. Community accepted and appropriate accounting procedures
5. Gathering and reporting of accurate and timely information.

These good business practices should be in place before any MFI even thinks about MIS software. Without quality business practices. MIS will do little if anything to sustain these institutions. In fact, MIS can complicable the situation by creating a financial drain and propagating but allow you to do bad business more efficiently.

If, however, the MFIs follow good business practices, MIS will go a long way in sustaining these institutions. Some examples of what MIS can do for good MFIs are:

1. Increased productivity and efficiency
2. Lower transaction cost per loan
3. Greater outreach in rural and urban areas
4. Faster delivery of more products and services
5. More accurate and timely reporting
6. Better decision making

Uses of MIS

1. Since it can be programmed to follow business rules uniformly, MIS reinforces discipline in accounting and portfolio tracking.
2. Computers can link all data pertaining to a customer or customer group hence MIS can provide a consolidated view of each customer or group.

3. MIS allow for single entry of data that can then be used by many people. Data once entered can be accessed, manipulated and used by all users. Thus MIS reduces duplication of effort and increases speed of work.
4. MIS integrates information and process.
5. MIS supports workflow and procedures for users.
6. MIS can be ported to remote areas via laptop or palm technology.
7. MIS application can be customized or enhanced to support new products and institutional growth.

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5.17 Components of a Good MIS Solution

The catch is that most MIS solutions provide only some of the functionality and capabilities needed for sustainability and outreach.

This can be better understood by knowing the components of a good MIS solution. They can be organized under the following categories:

1. Functionally and Expandability
2. Flexibility
3. Usability
4. Reporting
5. Standards and Compliance
6. Technical Specification and Correctness
7. Cost

5.18 Functionality and Expandability

The MIS solution for the MFIs should have some sort of functional completeness and integration. The areas that must be covered by the solution should be:

1. ***Accounting packages:*** The solution should have an accounting component wherein the data can be captured regarding the financial transactions of the MFI.
2. ***Portfolio tracking:*** The solution should have a module for entering the details of the various products of the MFI and its linking individual borrowerwise in order to enable the organization to track its loan portfolio and product mix.
3. ***Deposit Monitoring:*** The solution should have the data about the depositors of the MFIs wherein tracking could be done individual unit wise depending of the practice being followed by the MFI. In case it is accepting deposits from the individuals then it should be capable of handling data individual borrower – wise or in case it is accepting deposits from the groups then it should be capable of handling data groupwise.
4. ***Customer Information Systems:*** The software should be capable of capturing non-financial data about the customer also. e.g. The software should be able to capture

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the details like name , address, family history and other demographic information which is needed to maintain proper records and identifying the customer.

The software should be capable of handling large volumes of data so that it is to handle the growing needs of the organization. In fact the software should be capable of growing with the organization. This is critical as MFIs can grow very fast.

5.19 Flexibility

MIS can be built around Accounts or around Customer. In modern financial software's it is much more preferable to have a Customer centric design as the MFIs need to be as much customer focussed as possible in order to sustain themselves. In such a design the information regarding a customer or group is easily accessible.

Secondly, the software should be parameter driven i.e. it should allow the user to put in business rules for the MIS. It should also be able to accept new products and customers.

Thirdly, the solutions should be able to handle multiple institution types. It should not be limited to one type of institutional model as diversity is the hallmark of MFIs. The solution should be capable of being implemented in an variety of organisational forms. Further, it should also be able to deal with variety of organizational structure like single unit or multi branch structures.

Fourthly, since the MFIs have a variety of lending methodologies hence the software should not restrict itself to one or two types of methodologies, as that will limit its acceptability with the clients.

Fifthly, the software should be able to handle various interest rates of loans and deposit products. It should be able to make accurate calculations of interest and repayments based on these interest rates. It should be able to handle various payment types and frequencies based on the customer. This is important because MFIs can have a variety of repayment facilities for different customers. The software should be able to handle various types of customer accounts. As discussed earlier, the MFIs operate in diverse environments hence the software should be able to handle multiple languages and currencies.

5.20 Usability

The success of the software depends, more than anything else, on its deployment and adaptability at ate user end. Since most of the MFIs do not have a specialized Mis department or computer professionals, the MIS software should be user friendly. To begin with the software should have a familiar and friendly user interface. The software should be window based as that is the most popular operating system in today's world.

The display on the screen should be logical. there should be consistency in terms of language format and functions. The data entry should be easy and straightforward for the user to understand.

The software vendor should provide some amount of training while implementing the software. User documentation and on-line help should be provided in order to enable the MFIs to maintain continuity at its level in case of employee turnover or when some new problem creeps up. The software should as far as possible facilitate straightforward workflow and not create unnecessary complications. In case software requires any MFIs change too much in terms of its workflow then it will probably not be used.

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5.21 Reports

The reports required by any MFIs can be classified into 4 categories, viz.

1. ***General Reports:*** By general reports we mean reports like the performance on the budgetary front like comparative report on actual expenses vis-à-vis the budgeted expense or say report on consolidated performance of the MFI.
2. ***Management Reports:*** These are the types of reports that are generally for the usage of management for decision making and monitoring the performance of the MFIs, e.g., report providing the statistical summary about the MFI, statement of cash flows, delinquencies, etc.
3. ***Financial Reports:*** These are the standard reports about the financial transactions by the MFIs, e.g., trial balance, daily transactions, audit reports, etc.
4. ***Customer Reports:*** These are customer specific reports, e.g., account statement, balance inquiries, etc..

The software should have the capabilities for generation and linking of these reports automatically. Most software's do contain a host of predefined reports.

Depending on the nature of work and the organizational structure different MFIs have different modes and timings for generation of reports. Hence, the system should be capable of generating the reports online or in batch mode on real time or set schedule basis. The software should have the flexibility of generating ad hoc, i.e., user defined reports in addition to the predefined reports. To facilitate meaningful inquiry into the database the software should also provide for some tool based report generation capability.

5.22 Standards and Compliance

The software should have been built on the foundation of sound accounting practices as accepted by the environment in which the MFI is operating. Some of the desirable features of the accounting soundness of the software could be:

1. It should comply with the Generally Accepted Accounting Principles (GAAP) or International Accounting Standards (IAS) and the local requirements.
2. It should provide for the real time or batch mode updating of the ledgers as per the convenience of the MFI.
3. It should also provide partial posting of the entries in order to allow for distribution of the work of data entry.

4. It should have the capability for categorizing the loan given by the MFIs. For e.g. it should be able to categorize a certain loan into current or delinquent so as to curb operation on the delinquent accounts.
5. The software should be capable of maintaining the accounts either on cash or accrual basis as per the practice followed by the MFI.
6. It should be capable of calculating the interest automatically as per the practice followed by the MFI. Interest may be calculated on the basis of current payment, late payment deposit or loan accounts etc.

In addition to the sound accounting practices, the software should also be able to meet the regulatory norms applicable on the MFI. These regulatory norms can be from the side of donor or local authorities. The software should have the facility for modifying old norms and adding new ones as and when required e.g. the software should be capable of accepting changes in the tax rates as applicable. The software should be especially complaint to the regulations of Central Bank of the country and should be able to generate the required reports for submission to the Central Bank.

The software should preferably be also integrated with external entities, e.g. in future we may see the development of a national payment system. This is especially useful, as several times the person in the MFI will ensure that the MFIs does not violate any such requirement inadvertently.

5.23 Administration and Support

There are many administrative and support issues that make or mar the success of software in any organisation. Some of them are discussed here under.

1. ***Security:*** Since the database is the heart and soul of the MIS the software should be capable of restricting access to it by login id, etc. it should have in built safeguards to restrict access to the database restrict its modification and manipulation by unauthorized users, it should also be adequately protected against virus attack.
2. ***Backup and Recovery:*** The system should have the feature the user to take a regular backup. The system should have the feature of enabling full or incremental backup so that the user is adequately protected against system failure or sabotage. In case of a failure, the system should be able to restore transactions, balances and statements, etc. from the data backed up by the user. In short it should be easy for the user to restart the system accurately from the stored data.
3. ***Fault tolerance:*** The system should be tolerant to the glitches like unreliable power supply that occur during the course of operation. It should continue to function and notify the user during problem periods. In case of total failure the system should be able to restart accurately when the problem has been resolved.
4. ***Period processing:*** The software should be capable of handling the data in terms of fixed period of operation, for e.g. one financial year or quarter, etc it should be able to relate the data to the multiple periods as reporting may be required to be

done for various periods, it should accurately and automatically post the calculations at the end of the period with minimum human intervention.

5. ***Support Infrastructure and Maintenance:*** The support infrastructure and maintenance service should be available. They need to be accessible to the user and should be provided timely in order to keep the system running at peak efficiency at all times.
6. ***Versions and Upgrades:*** No software can be such that it needs no upgrades in future. Hence the MIS software should be upgraded and new functionalities should be added to it as the organization and its needs grow. It is preferable that the new functions should be added as per pre- determined schedule as it helps in managing the cost of the upgrades.

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5.24 Technical Specifications and Correctness

1. ***Technical and Architecture:*** The software should be built on the platform of a sturdy relational database as they provide the facility of making customized queries to database by the usr. A host of database under this category are available in the market today, e.g. Oracle Paradox, etc. The programming language should be current robust and modern e.g. C, C++, Java etc. so that the software is stable despite unreliable infrastructure.
2. ***Performance:*** The software should be capable of supporting multiple simultaneous users without compromising the performance in terms of speed. System should also not slow down as the database grows in size. The user should get fast response time from the interface and the reports should be generated quickly so that the user does not have to wait for inordinately long time to get his job done.

5.25 Cost

The price and cost of software can be argued from the point of view of value to the institution. The price of the software should be commensurate to the level of complexity or functionality. The price should be such that the MFI gets a high return on investment. The cost of the software may be worked out in terms of the cost per user or cost per customer such that its ownership represents value to the institution. For e.g. if it costs an MFI $ 14 per loan account and it has 50000 customer then an expenditure of $ 1 per customer i.e. total $ 50000 spent on IT will not be a very big expenditure for it.

Why So Few Solutions?

Despite the popularity of MFIs and the acknowledged need of good MIS solutions there are very few of them available in the market. The primary reason for this poor availability is money. There is little financial incentive for software companies to develop microfinance solutions for two primary reasons. One is the diversity and

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complexity across institution and countries in term or organizational form, lending methodologies, legal and regular environments, currency and language. Second is a lack of ability or willingness to pay for robust solutions by the MFIs.

Due to poor financial position of the majority of the MFIs, they are not able to pay for robust solutions. This makes it unattractive for the software companies to enter in this market. It is economics more than anything else.

What Should We Do?

Thus, what can be done to improve the situation? In a nutshell, the following could be the possible course of action.

1. ***Good Business Practices:*** The MFIs should first focus on building good microfinance practices as only they can sustain the MFI. This is the most important prerequisite for the future of the MFIs and the success of MIS in them.
2. ***Strategies with Information Technology:*** The organizing should elevate its view on Information Technology to a strategic level.

   Information Technology should be woven in the organizational operation and decision-making process in such a manner so that it becomes a core competency of the organization.
3. ***Value based approach:*** The MFIs should take a value- based approach to MIS solution not a cost or price approach. They should see the expenditure in Information Technology as an investment and not expense.
4. ***95% rule:*** Instead of trying to get or build a software which caters to the 100% needs of the MFI they should take a software which will satisfy 95% of the needs for the simple reason that organisations spend most of the money in getting that additional 5% functionally.
5. ***Buy high quality software:*** The MFIs should desist from buying poor quality software as they may ultimately lead to heavy loses in terms of data and time. Hence, it is advisable that MFIs should buy only high quality and stable software solutions.
6. ***Customization:*** The MFIs should try to manage as far as possible with the features provided in the software. They should customize only when absolutely necessary, as it is costly every time one tries to modify the programme code.
7. ***Avoid Internal Development:*** Unlike the popular perception it is not a good idea to try and develop the solution internally. This is so because, one, the MFI will not have as qualified developers as a software company and, two they may use their valuable human resources more profitable else where.

5.26 Summary

For development of a large software for any business application, many people are involved and many months or even years are spent. Whether a system is small or large, software development revolves around a life cycle that with the recognition of user's

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needs and understanding their problem. The various phases involved include feasibility study, system analysis, system design, and development of software, system testing, implementation and maintenance. If the candidate system fails due to any major mistake occurred in any of the development phase, any or all of the phases are needed to be reviewed again, so that the system is completely accepted by the requested department. Implementation is a next stage to design stage which relates to introduce a new system in place of old system. Actually implementing a new system requires conversion from old to new system. For conversion process we have four different approaches such as:

- Pilot
- Parallel
- Plunge
- Phased

After the introduction and running of the Management Information System in the organization for some time, say for one month or six months, an evaluation of each step in the design and of the final system, performance should be done. Evaluation should not be delayed beyond the time when the system analyst has completed most of the debugging. The evaluation should be made by the customers, managers, end users and employees of the organization.

The measurement of cost and benefit of a Management Information System is the measurement of a change or difference between the existing and the new system. The structure for evaluation of Management Information System comprises system integrity, operating integrity, internal integrity and procedural integrity. Maintenance is closely related to control. Maintenance is the ongoing activity that keeps the Management Information System at the highest level of efficiency and effectiveness.

A Management Information System is an information system that evaluates, analyzes data and also ease the operation of organization. Accounting packages solution should have an accounting component wherein the data can be captured regarding the financial transactions of the MFI. The solution should have a module for entering the details of the various products of the MFI and its linking individual borrowerwise in order to enable the organization to track its loan portfolio and product mix.

The solution should have the data about the depositors of the MFIs wherein tracking could be done individual unit wise depending of the practice being followed by the MFI. In case it is accepting deposits from the individuals then it should be capable of handling data individual borrower – wise or in case it is accepting deposits from the groups then it should be capable of handling data groupwise. Customer Information Systems software should be capable of capturing non- financial data about the customer also. e.g. The software should be able to capture the details like name , address, family history and other demographic information which is needed to maintain proper records and identifying the customer.

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The software should be capable of handling large volumes of data so that it is to handle the growing needs of the organization. In fact the software should be capable of growing with the organization. This is critical as MFIs can grow very fast.

The software should be capable of handling the data in terms of fixed period of operation, for e.g. one financial year or quarter, etc it should be able to relate the data to the multiple periods as reporting may be required to be done for various periods, it should accurately and automatically post the calculations at the end of the period with minimum human intervention.

5.27 Glossary

- ***System Analysis:*** Study of existing system in detail and collecting data in order to find out the requirements of the users.
- ***System Design:*** Identification of input, output and procedures to process the data.
- ***System Testing:*** Testing of the whole system with different techniques to ensure that the software is bug free.
- ***Strategies:*** A strategy is a general direction in which an objective is to be sought.
- ***Management Information System:*** A Management information system, or MIS, broadly refers to a computer-based system that provides managers with the tools to organize, evaluate and efficiently manage departments within an organization.

5.28 Review Questions

1. What are the seven phases of SDLC? Draw diagram.
2. What is system testing? Why is it required?
3. What will happen if a system fails?
4. Explain system development life cycle of MIS.
5. Discuss various implementation strategies for implementing newly - developed Management Information System.
6. Describe the various phases of software development process.
7. Explain the different approaches of MIS Development.
8. Discuss the various activities of implementation process. Explain them with an example.
9. Define the meaning of evaluation of Management Information System.
10. What type of structure do you use for the evaluation of Management Information System?

11. Is system maintenance necessary? Explain various activities where it may be applied.
12. What are the major problems related to maintenance of Management Information System and how a system analyst overcomes these problems?
13. What are role of MIS.
14. Discuss the Functionality and Expandability
15. Define flexibility and usability in terms of MIS.
16. Explain the problem in developing MIS.
17. Discuss the component of the good MIS solution.
18. Describe the problems and solutions in implementing management information system.

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5.29 Further Readings

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