LECTURE 2

INTRODUCTION TO COMPUTER SYSTEM

OBJECTIVE

The objective of this lecture is to help the participants achieve an adequate level of computing literacy and to introduce the different types of Computer systems and programming languages.

2.1 INTRODUCTION

In an information society, the collection, processing and distribution of Information have become the primary source of wealth and work.

The 1960s witnessed the birth and growth of the micro-electronics industry, micro-electronic advances have 'liberated' the computer as evidenced by the growing use of personal computers, also called microcomputers or desktop computers. Microelectronic advances have also transformed the world into an information society. In addition, microprocessors are being used to add intelligence, the apparent ability to act in an informed manner, to a variety of familiar products.

In the future, most workers will probably work in 'information carreers' using computers. Some debate exists about the type of computer education, or computer literacy, people need to function in information society. Computer professionals need to understand computer technology and how to write programs, or computer instructions. Most people, however, need computing literacy. the ability to use the computer as a tool to enrich their personal and professional lives.

2 1.1 What are Computers ?

Computers are made up of electronic and electromechanical devices. Electromechanical devices contain both electronic and mechanical parts. Another term for computer devices is hardware. Hardware is useless without software, the programs that direct information processing. Hardware and software used as a single unit make up a computer system. An information system, a computer system that serves a practical business purpose, is made up of hardware, software, and people.

Information systems process data to produce information. The term data refers to symbols used to represent a fact, event or thing. Information is the meaning given to a set data.

Hardware

The four types of hardware components are computer processors input devices, output devices, and secondary storage devices. The computer processor is made up of primary memory and the central processing unit. Primary memory provides temporary storage for data and programs. The central processing unit (CPU) performs all processing. The CPU is made up of the arithmetic-logic unit (ALU), which performs arithmetic, data manipulation, and logical processing operations, and the control unit (CU), which directs and coordinates all processing.

Input and output devices move data into and out of the compurer processor. The most common input device is the computer terminal, also called a video display terminal (VDT). Most VDTs use a cathode ray tube (CRT). Diskette readers use diskkttes as input media Magnetic tape readers use magnetic tapes as input media.

Common output devices include the CRT screen, printers and plotters. Hard copy, a permanent copy of computer output, is produced by printers and plotters. Computer terminals can function as both Input and output devices.

Because primary memory is relatively expensive, it is used only for temporary storage of data. Most data and programs are stored on secondary storage. The most common secondary storage media are magnetic tape and magnetic disk. The hardware devices that place data into and read data from, these media are called secondary storage devices.

Software

Applications software, the general term for practical computer applications, can be customized or bought ready-made in the form of software package. Systems software are programs that coordinate the flow of data, information, and programs within a computer system. The most important system software is the operating system, which functions as an office manager for the computer system.

People

In an information system, peopld act as both users and creators. Without users, there would be no data to process and no reason to use computers. Information system creators perform systems analysis, systems design and programming. A systems analyst recognizes an information system is needed, describes the business activities of the needed information system. A systems designer designs the information system. decides whether applications software needs to be customized and decides whether additional hardware is needed. A programmeer creates customized softwara (programs).

2.1.2. What Computers do ?

Computers transform data into information through an information processing cycle made up of input, processing, starage and retrieval, and output stages.

A computer can only accept data-in computer-readable form. Data in this form can be computed quickly and accurately and are available for further computer-based information processing.

In processing data computers need detailed instructions to perform simple arithmetic, text manipulation, and logic operations. Computers are used to process data because they are reliable and fast. Computer speeds are given in milliseconds, microseconds, and nanoseconds.

For storage and retrieval, data must be organized in a way that suits the applications. Data files are made up to data records, and data records are made up of data fields. In many cases, processing can be affected by retrieved information. Computers can be used quickly and accurately produce the paper work associated with routine business tasks. Computers can also be used to produce information that can help a person perform his or her job better. This

Information can be produced in many forms, including tables, graphs, and charts, in the subsequent sections, the hardware and software components have been dealt in further details. Various related terminologies encountered frequently have also been defined as and when they appear in the text.

2.2 HISTORY OF COMPUTERS

The earliest technologies used to process and store information included the abacus, paper, and the printing press. These technologies for the most part, had little impact on the common man. It was not until the 19th century, when mass production greatly reduced book prices, that information became a public good.

A number of scientists built mechanical 'calculating machines' during the 15th, 16th, 17th and 18th centuries. Two of the more famous scientists were Blaise Pascal and Gottfried Leibnitz. Their efforts were plagued by two problems—an inability to obtain precisely machined parts and no real public demand for a machine that automated calculating. It was not until 1820 that a mechanical calculator, the Thomas Arithmometer, became a commercial success.

The first attempts to build automated computing machines occured during the 1930s in response to a growing need in scientific and engineering research to perform massive amounts of computations. The fiist fully electronic, general-purpose computers were built using vacuum tube technology.

Electronics technologies have gone through a number of improvements since the days of these early computers. With each major change, the power of computer systems Increased dramatically. It has become commonplace to refer to each transition to a new electronic technology as a computer generation.

2.2.1 First Generation Computer

The vacuum tube was the primary electronic component used in first general (1951-58) computers. Vacuum tubes were used for the computer system's processing and storage circuitry. Data input was through cards, and data output was produced on either paper or cards. By the end of the first generation, magnetic core was used for primary memory, while magnetic tapes were used for secondary memory. The major software advance that occured with first generation computers was the development of high-level programming languages, such as FORTRAN, Business computing was just getting underway during this first generation computers. A few computer specialists were around at this time, most computer use was performed directly by the users themselves.

2.2,2 Second Generation Computer

The transistor was the primary electronic component used in second generation computers. These small, but reliable, electronic devices led to the development of new electronic hardware, including the minicomputer and the communications satellite. Second generation (1959-63) computer systems used transistors for processing circuitry, magnetic cores for memory, and magnetic tapes for data input, output, and secondary storage. The first operating systems

appeared, and with them new forms of data processing such as interactive processiug, real-time computing, and time-sharing. More high-level programming languages were developed, including COBOL, BASIC, and PL/1. While business computing had now become commonplace, management applications were just beginning. With computer systems too complex for most users, computer specialists began to handle most data processing activities.

2 2.3 Third Generation Computer

The integrated circuit became the primary electronic component used in third generation (1964-70) computers. Among the first of the third generation computers were the various members of IBM's Systems 360 series of computers. Solid state circuitry was used for processing circuits and for primary memories. CRTs served as input and output devices and magnetic disks gained importance as secondary storage, The operating system was the dominant component within a computer system at this time, as it controlled most operations. Other high-level programming languages were introduced, including RPG and PASCAL. Business information systems were integrated through the use of common input and output data files. Management applications were now routine. Computer users, while not directing data processing operations, frequently handled input and output tasks. Most information processing activities, however, remained the domain of computer specialists, who were now being trained in colleges and universities.

2.2.4 Fourth Generation Computer

Large-scale integration (LSI) and very-language-scale integration (VLSI) are the primary electronic components of fourth generation (1971-present) computers. Hundreds or thousands of electronic circuits now reside on a single silicon chip. The most important electronic device developed during this computer generation has been the microprocessor, which led to the development of the microcomputer. While microcomputer hardware and operating systems have lagged behind those of larger computer systems, user friendly microcomputer applications software has begun to lead the software industry. Computer-based information systems now handle all aspects of business activities, from the automatic handling of day-to-day business transactions to supporting key top-management business decisions. Computer users are again involved with all aspects of business computing.

To summarise, three technological trends recurred throughout the computer's history. First, the time between the development of a new technology and its practical use is becoming shorter. Second, computer systems are becoming more intelligent. Third, computer technology is being made available to more people.

2.3 COMPUTER SYSTEM HARDWARE

2.3.1 Central Processing Unit

To process information, a computer needs very specific instructions that explicity state what is to be done, Special step-by-step instructions that lead to the same result every time are called algorithms. They are used as the basic for computer programs.

The computer processor unit is made up of a CPU and primary memory. The CPU contains the arithmetic-logic unit (ALU) and a control unit. The ALU is where all arithmetic and logic operations are performed. The control unit is used to sequence computer events according

to program instructions, such as moving data between primary memory and the CPU or between input/output devices and primary memory. Primary memory is used to hold data and program instructions.

The control unit is composed of a program counter, instruction register, instruction decoder and address register. Registers are storage locations within the CPU that are used as temporary staging areas. The ALU is composed of several registors, one of which functions as an accumulator to store ongoing results.

The program counter is used to keep track of where the next instruction is in primary memory. The process of retrieving an instruction is referred to as a fetch. Each program instruction is made up of an operation and address portion. The operation code refers to the action that needs to be taken, such as mutiply, store, or print. The address portion refers to where the data can be found or should be placed. The operation portion of the instruction is put into the instruction register. It is then interpreted by the instruction decoder, and the internal computer circuits are set to perform the action specified.

The processing of a program instruction is called a machine cycle. It is composed of two parts. The first part is the instruction cycle (I-Cycle), in which the next program instruction is fetched from primary memory and then is decoded. The second part is the execution cycle (E-Cycle), in which the operation specified in the program instruction is carried out, and then the results of this action are stored.

A number system is simply a way of representing numbers. The number system we commonly use is the base 10 or decimal system. In the binary or base 2, the symbols used are limited to 1 and 0, which correspond to the binary nature of computer systems. Higher number, are shown by using place values. Each place value is called a binary bit or bit.

A modification to the pure binary number system has been developed for encoding alphabetic letters, special characters, and numbers. Two of the more popular coding schemes are the EBCDIC and ASCII, The combination of bits referring to a complete character is called a byte.

A basic building block of modern computer circuitry is the semiconductor chip. These chips are composed of thousands of transistors, which are electronic components that function as semiconductors. A semiconductor is a solid-state device that can be made to conduct electricity under certain conditions and act as an insulator inhibiting electrical flow at other times.

Individual transistors can be combined to encode and store information, or they can be used to carry out arithmetic or logic operations. Semiconductor chips are used for the CPU, for primary, and for interface devices. Interface devices are used to coordinate the flow of electrical signals between two hardware units.

Primary memory chips are designed as RAM or ROM. RAM stands for Random Access Memory, which means that instructions or data can be read from this memory or written into it. Thus, RAM is sometimes referred to as read/write memory. The type of RAM chips most commonly used today are volatile, meaning that the memory contents will be lost when the electrical power is turned off.

ROM. or Read Only Memory, can only be used to read permanently loaded instructions or data. It is common, for example to put a software language such as BASIC in ROM. Software that is stored in ROM hardware is called firmware. ROM uses storage technology that is nonvolatile, and thus is not affected by loss of power.

Erasable Programmable ROM or EPROM chips have been developed in which ultraviolet light can be used to erase the information stored on the chip. EEPROM or Electrically Erasable Programmable ROM chips can be used in situations where selected bytes of information need to be changed electronically.

A CPU that has been implemented on a single silicon chip is called a microprocessor. Microprocessor chips use many different internal designs, and the chips vary in appearance and capability. One of the specific ways in which they vary is in dataword length. This refers to the number of bits of data that can be retrieved from memory each machine cycle.

Computers differ in their computer power. This can be measured in a number of ways, such as the number of instructions that can be processed in a given time period. Other indicators of computer power are the dataword length and the size of primary memory.

For the most part, the smallest microcomputers and the largest supercomputers work in the same fundamental way. They use the von Neumann architecture, in which program instructions are stored in primary memory and used to sequence computer actions. But because the CPU is so much faster than any other computer components, an input/output bottleneck occurs when the CPU works in a strictly sequential manner. More advanced computer system use overlap processing, where data are being retrieved from storage while the CPU is performing another task. This allows multiprogramming, where the computer is processing more than one person's job on a time-share basis.

2.3.2 Input Devices

The foundation of computer processing is data. A major affort is expended in entering data into the computer and ensuring their accuracy. Organizations can enter data into a computer system in one of two modes. An event or transaction can be recorded and processed as it happens, in the transaction processing mode. Or, a batch of similar transactions can be grouped for input and processed at a latter time, in the batch processing mode. Transaction processing is used when time and currentness are important, as in-reservation systems for airlines and hotels. Batch processing is used when immediacy of results is not as important as processing efficiency.

Source documents, such as payroll time sheets, sales invoices, and credit card sales slips, are the source of data used as input for computer processing. Source data automation (SDA) is a process that avoids the keying and rekeying of data. These special machines read data directly from the source document and convert it to computerreadable form. Three major types of SDA are optical character recognition, magnetic character recognition, and voice recognition.

SDA devices that use light images to read data are classified as optical character recognition (OCR) machines. These include mark-sense readers, where data are encoded as dark (a filled-in space) or light (a space left blank) marks on a sheet, and bar codes, where numbers and letters are encoded by different combinations of bar widths and different

widths of space between bars. For more complex applications, special character type styles are used. Magnetic ink character recognition (MICR) has been the standard method used since the 1950s in the banking industry for processing checks using MICR characters. In voice recognition systems, the electrical signal pattern of spoken words is compared to that of the stored voice templates vocabulary. Most voice recognition machines are speaker-dependent, require a pause between words, and are limited to a vocabulary of around one hundred words. When devices such as SDA or key-to-media machines are used to copy data onto magnetic tape or disk for later use as and input medium to the main computer system, they are considered offline. When the devices are directly connected to the computer and controlled by the computer's CPU they are considered onine.

Computer terminals are the predominant data entry device. They can be designed for specialized industry application or can be used for data entry and a multitude of other general-purpose functions. Specialized terminals are used in retail, financial source data collection, and word processing applications. Smart terminals have their own memory and editing capability. This enables users to store several pages of text or data locally and edit them for correctness. Intelligent terminals have their own small CPU, so users can prepare programs and data and do processing as a stand-alone computer would. A workstation is an enhanced microcomputer that can perform data or word processing functions, work as a dumb terminal connected to a host computer, and do data communication tasks such as electronic mail.

The human-computer interface refers to the means of interaction between a human being and the machine. The basic problem that arises when people have to communicate with machines is that what is best and most comfortable for people is not always the most efficient use of a machine. Keyboards are the primary means through which humans interact with a computer.

To make it easier for users to interact with computer systems the computer can be programmed to display a menu or list of options as well as prompts. These are simple instructions that guide the user in what entries are needed. A cursor is a blinking symbol that shows where the next typed character will appear. To simplify word processing, spreadsheet analysis or data queries users needed an enhanced keyboard. To the typewriter keyboard has been added a numberic keypad, which functions as a quicker way to enter numeric data than using the top row of the keyboard. Arrow keys were added to facilitate the movement of the cursor. Function key were added to provide a way to command certain common tasks in one step, rather than making several keystrokes to accomplish the same thing.

2.3.3 Output Devices

For computer processed data to be any value, it must be in a form that users can understand. Historically, printed output was the primary way of showing computer processing results. While paper is still the dominant output medium, there are now many other alternative ways to communicate information.

Computer output can be classified in several different ways. Hard copy output such as paper printouts, provides the user with a permanent record. Soft copy output, such as the visual display on a terminal, or computer voice output provide a temporary record. These three forms of output can also be understood by human users, whereas the electronic data stored on magnetic

tape or disk are computer-readable. Information that is presented in the form of letters, numbers and special characters is alphanumeric. In contrast graphics are pictures or graphs depicting information.

Visual display of information is one of the most effective means for showing users 'the results of computer processing. The primary technology for producing and displaying the images on the terminal screen are the cathode-ray tube and the flat-panel.

Cathode-ray tubes (CRTs), like television picture tubes, electronically paint characters on a screen CRT screens can create images using raster scan or vector technology. CRTs are used in monochrome and color monitors.

Historically alphanumeric data has been the primary information output. The computer printer, with its capability to print alphanumeric data on paper has been the predominant means of generating hard copy output. More recently, the need for graphical displays has changed the type of printers that are in demand and also encouraged the development of plotters.

The growing popularity of graphics terminals has been accompanied by an increasing need for hard copy of the graphic developed on the computer terminal. Business graphics were first printed by plotting points using fully formed characters. This approach is used in multification dot matrix impact printers as in printers using nonimpact thermal and ink-jet technology.

Plotters are output devices that are specialized to produce graphics. Plotters use the vector concept to produce a picture made up of a series of straight lines. Plotter came in a wide variety of sizes ranging from small desktop models to enormus devices used to draw full-scale airplane designs. The two basic type of plotters are flat-bed and drum.

One of the options for producing hard copy output of data or graphical images is computer output microform (COM), Computer-generated voice output using speech synthesis techniques is used in taking terminals and voice message systems.

The typewriter has been the major apparatus for producing printed material used in business communication, but increasingly the computer printer is taking over this role. The major criteria used to select printers are performance, price print quality, flexibility, and operational costs.

A printer's performace is measured by its speed. The price for printers with increased print speed capability is generally significantly higher than for a low-speed model.

Print quality is a major consideration in printer selection. The degree of quality needed is dependent on the type of organizational application. Invoices, statements and correspondence going outside a company usually require clean, legible copy. The lower print quality of nonimpact dot matrix printers is acceptable for most organizations internal uses.

A printer's flexibility in handling range of tasks is a fourth selection criterian, How easy is it to use different forms ? The printer's ability to handle forms is another dimension of its flexibility. Many printers are designed to be used strictly for traditional data processing output, such as alphanumeric data printed on paper. The last major criterion for selecting a printer concerns operational cost. This covers both maintenance and supply considerations.

2 3.4 Secondary Storages

We have learned that, for computer programs and data to be processed, they have to be put into primary memory. Read/Write primary memory such as RAM can only be used for temporary storage of information, since it is volatile. That is when the computer is turned off, the information in RAM is lost. In contrast, secondary storage is nonvolatile. Tapes or disks use magnetic recording techniques that retain the data when the power to the computer is turned off. Which type of secondary storage medium is most appropriate ? It depends on the type of programs that are being run, and whether they require sequential or direct access to the data records. With sequential-access media, you must check each record key, in sequence, for all prior records in order to gain access to the desired one. With direct, or random access, you can directly access that data record desired.

The medium that has come to clearly dominate the secondary storage market is the magnetic disk. This is primarily a reflection of the move from batch to transaction processing. With batch processing, the sequential access of records on magnetic tape was efficient. However, transaction processing requires direct access to a specific record, and this is what disks allow. Disks offer the additional flexibility of doing sequential processing if desired.

A third important variable of storage media is whether they are removable or fixed. Removable media, such as magnetic tape and many disk systems, allow the user to swap one set of data for another. However, removable media are generally susceptible to fingerprints, dust and being dropped, and thus have lower reliability than fixed media. For secondary storage systems where there is a need for high reliability and extensive storage capacity, fixed hard disk systems are used. Generally, these high precision systems use the Winchester technology, in which the read/write heads and disk plotters are sealed in an environment free from contaminants.

There are two basic forms of magnetic disks-hard disks and flopy disks, or diskettes. Hard disks are rigid aluminum plasters coated with a magnetic oxide. They come in a variety of physical sizes and the significantly different storage capacities. They can be further categorized in terms of being fixed or removable. A major disadvantage of Winchester hard disks has been that they could not be removed. However, removable Winchester disks have recently developed,

Disk packs are a multiplatter hard disk which can be loaded onto, and later removed from, a disk drive. These packs are very useful for data that don't have to be online at all times. A single-platter removable is called a disk catridge.

The storage capacity of a disk is a function of the number of tracks per surface, the bil density, and the number of recording surfaces. The speed with which data can be found and retrieved is a function of access time. Access time is the amount of time it takes from the point of requesting data until the data are retrieved.

Diskettes, or flopy disks, are made of flexible Mylar plastic coated with a thin layer of metallic oxide particles. These diskettes also come in several physical sizes, and all are designed to be removable.

Magnetic tapes are thin plastic tapes coated with magnetic material. They come in three forms reel-to-reel, cartridge, and cassette. All magnetic work in a similar fashion, very much like

audio cassettes. The storage capacity of a tape is determined by the number of bits per inch that can be recorded, the length of the tape and the bloking factor.

Traditionally, the CPU uses registors for processing and RAM primary memory for temporary storage. Hard disk systems are the dominant means of providing online secondary storage. For long-term offline storage, magnetic tape, diskettes streaming tape, and removable hard disk systems are used for archival and backup purposes. Recent advancement in memory technologies have made the memory hierachy even more pronounced with the addition of cache memory, RAM disks, and optical disks.

2.4 SYSTEM SUPPORT SOFTWARE

2.4.1 Operating Systems

Application software is programs written to meet the needs of users. System software is a series of programs written to simplify the interface between the programmer and the computer hardware. System software is generally composed of an operating system, language translators and utilities, data management, and data communication systems.

The overall purpose of the operating system is to control the activities of the computer systems. It serves as the traffic cop, directing and managing computer events. In addition, the OS provides a useful interface that allows the user to concentrate on what he or she wants to accomplish, rather than on the details of how the computer internally carries it out.

Three of the major functions of on OS are overall master control, resource management, and monitoring activities. A series of programs called a supervisor exercises master control of computer operations and coordinates the work within the computer system.

The supervisor initiates and controls the execution of jobs. This requires allocating computer resources and scheduling when they are to be used, a function known as resources management. Computer resource include the CPU memory, input/output devices, and support software. One of the primary computer resources that is shared is the CPU itself. The CPU can work on only one program at a time. But, because it is thousands of times faster than I/O devices or users working interactively with the system, it can be shared in a couple of different ways. With event interrupts the CPU work on a program until there is an I/O request. With time-slicing interrupts, the CPU switches to the next program at the end of a fixed time period.

Once the CPU is to be switched, the CPU scheduling scheme is used to select the next program. The first come first-serve scheme selects the job that has been waiting the longest. A priority scheme allows different program to be selected, based on need. The highest priority programs is selected next, regardless of whether other programs have been waiting longer.

With the move to multiuser computer systems came a need to share memory in more efficient ways. The allocation of memory is called memory management. In order to accommodate multiple programs in memory at one time, a way of allocating memory space and a means for moving programs in and out of memory had to be developed.

One allocation method is fixed partitions, in which primary memory is divided into sections of predefined size to accommodate user programs. To better handle a variety of programs of different sizes, variable size partitions are used. With this allocation method, regions are defined dynamically, depending on the needs of a given program.

Swapping allows the OS to accommodate more programs at any one time than there are partitions or regions. This is accomplished by switching complete programs between primary memory and secondary storage. Virtual memory enables betters memory management by keeping in primary memory only the active program instructions. The remainder of the program is kept on disk, available on demand.

When large computer systems are being shared by many users and managed for efficiency. it is necessary to monitor system performance and to protect the system from unauthorized users or system error. One of the functions of the computer staff is to monitor computer performace. By selecting the CPU scheduling scheme, changing priorities, and adding more or faster computer resources, the staff can alleviate bottlenecks and improve performance.

CPU utilization thoughout, response time and reliability are four major criteria used to judge computer performance. CPU utilization is the percentage of time that the CPU is actually, working. A computer system's through-put is the number of programs completed per time period.

From the user's point of view, a major criterion for interactive systems is response time. This is the interval between a user's request and the computer's response. The percentage of time that the computer is up relative to the time it is scheduled to be up and running is a measure of reliability. Protection has been defined in terms of how access to programs and data stored in the computer is controlled once the user is using the computer. Security is defined in terms to the external threats from unauthorized users. One major problem is how the operating system authenticates that the user is who he or she purport to be the most common approach is to use passwords. There are several major design factors that can be used to distinguish among operating systems. Was the OS designed to be used primarily with batch or interactive processing jobs ? Was it designed to accommodate single or multiple users ? Was it designed for a specific computer or for a family of computers ?

There are many different type of operating systems. The early OS made the complete computer system available to one program, which would be processed from start to finish. In concurrent operations, at a given point in time, one program will be using one computer resource while another program uses a different computer resources.

The basis for multiprogramming is interrupt processing. These batch-oriented systems have the CPU process a program until it must wait for an I/O event to occur. Time sharing systems were designed to allow direct communication between the user and the computer system These interactive, multiuser systems sequence tasks based on time slices.

The tremendous demand for computing power, the need for increased reliability, and the decreasing price of hardware have led to operating systems designed for use with computer systems that have multiple processors.

In some of the more advanced computer systems, operating systems have been developed that are able to provide a virtual machine environment. Within limits, each user is given the illusion that he or she is working with the very computer and OS needed to run an application program or work with the computer interactively. Operating system can also be adopted for use on different microcomputer.

While there hasn't been any official committee that has specified industry parameters, several defacto standards for microcomputer operating systems have developed. A defacto standard is one that venders informally accept, generally because it has come to dominate a market segment of this business. For the 8-bit microcomputer, it is the CP/M operating system; for the 16-bit micro, it is the MSDOS; and for the 32-bit micro, UNIX appears to the dominant OS. Many operating systems are now being implemented in firmware, as permanently coded instructions within a ROM.

A critical point to understand is that application programs of software package such as payroll, wordprocessing, spreadsheet are designed to be use with a specific operating system. In turn, most operating system are designed for use with a particular microprocessor. The general rule is that application software is not portable. That is, it cannot be used with just any computer system.

2.4.2 File System

The way in which data are arranged is termed as data organization. Characters are represented by a byte generally in the EBCDIC or ASCII code within the computer. A collection of related characters forms a data item or field. An occurrence of all data items is called a record. A file is a collection of similar types of records. A primary key is a data item that has a unique value that can be used to identify a single record. An integrated collection of files is called a data base. Different data organizations affect how efficient it is to access or locate specific data base. Different data organizations affect how efficient it is to access or locate specific data records and what types of questions can be easily answered.

There are two primary reasons for needing to access data within a file or a data base. One is to be able to retrieve selected data to be used in producing desired information. The other is updating, the process by which records are added, deleted, or modified within the file.

The primary role of data management software is to provide an easier way for the programmer to create and maintain files and receive data from them. There are two levels of data management software file access methods (FAM) and data base management systems (DBMS).

File access methods are support software that enables a programmer to organize data into files and provides means for accessing data records to be used in processing application programs. However, they provide a limited way of sharing data that are contained in more than one file.

There are several types of FAM and they differ primarily in the file organization they allow and the means they provide for accessing the data. The simplest file organization is the sequential file organization in which the records are sequenced by the primary key and are accessed in sequence. Another approach to file organization is called indexed file organization.

2.4.3 Data Communication

The movement of data from one location to another is called data communication. The types of communication hardware and support software necessary to move those data differ, depending primarily on the distance involved. Terminal is the generic name for the myriad of possible input and output devices. The hardware linking the terminals and a computers are called transmission media. With a microcomputer, the transmission medium is generally a cable. The cable hocks to the computer at an input/output port. The number of devices that can be connected to a computer is a funciion of the number of I/O ports, A serial connection requires a different types of I/O port than does a parallel connection. The two de facto standards for microcomputers are called RS 232-C and Contronics.

An interface unit is needed for each peripherial device to translate computer I/O commands into devices specific instructions. With some larger computer system the interface function is divided into common I/O tasks and device-specific tasks. Device-specific tasks are performed by an I/O control unit such as a disk controller. The common tasks are performed by a channel device. A channel unit is a common link between the computer and its peripheral.

Telecommunication is the transmission of data over long distances. The telephone voice network uses continuous frequency waves called analog signals. In contrast, the computer is limited to processing a discrete pattern of 1s and Os called digitals signals. A modem is a device that converts digital patterns to analog signals and allows the sending of computer data over telephone lines. A carrier signal is the basic signal used to transmit data over telecommunication links, and its modulated by slight changes to its amplitude or frequency to represent data.

The data rate or speed of a telecommunication link is the amount of data that can be sent per time period. It is measured in bits per second (bps). Frequencies are stated in cycles per second (cps) or Hertz (Hz). To be able to send data in a telecommunication network, start and stop information, origin and destination information, an error check bits must be added to the encoded data to form a data packet. These added data are used to aid in sending and receiving data, checking for errors, and for routing messages through a network.

In the asynchronous mode of data transmission, one character at a time is sent over the communication link. The parity bit method of error checking is used primary with Async. With the synchronous mode of data transmission, a block of characters is sent. Here, the most commonly used error-checking method is Cyclic Redundancy Coding (CRC).

Multiplexing means having several communication signals share the communication channel using time or frequency divisions. Bandwidth is the range of frequency that can be used with a particular communication channel. It is used as a measure of information carrying capacity. Electronic pathways that connect the various communication devices are called a network is confined to a building or an office complex it is designated as a local area network. It serves new needs that are based primarily on the evolving for microcomputers.

The pattern formed by the way devices are connected to form a network is called topology. The three most common network topologies used with LAN are the star, the ring and the bus. With computer networks, the most common access methods are pulling, taken passing and contention. There are several different types of wires or cables that can be used to connect

devices in a network to form a data path. The most common are twisted pairs, coaxial cable, and CATV.

A server is any device that interfaces a peripheral to a network and allows the sharing of that peripheral by other network units. A gateway is an interface device that provides the translations necessary to link two different types of networks. Bridges are interface devices that link similar types of LAN networks.

The major functions that communication support software provides are terminal access protocols, error detection and correction, and security. A protocol is a set of rules and procedures used for transmitting data between two hardware devices in a net work.

2.5 APPLICATION SOFTWARE

2.5.1 Program Development

Program development tasks place in the systems acquisition stage of the systems life cycle. The proceding systems analysis and systems design stages should have determined a set of software requirements that describe the program's output, inputs, files, and processing functions. These software requirements direct and guide the program development process.

Good communications are just as important to program development as they are to systems development. Many programming techniques and tools have been developed to improve communications among the people involved with a programming project.

The goal in business programming is to develop programs that are correct and maintainable. A correct program completely and accurately performs the information processing activities laid out in the systems design. A maintainable program can easily be changed at some future time. Writing understandable programs help achieve both of these objectives.

Programming involves three distinct activities. Program design provides a clear, logical structures to a program. A design with a clear, logical structure is made up of a number of modules each of which performs a well-defined task. Program coding translates a program design into a program using a programming language. If a good program design exists coding is an almost mechanical task. Whenever possible, it is best to postpone selecting a programming language until the program design is complete. Testing commonly termed debugging, checks the correctness of a program design and code. Both syntax errors and logical errors are located and corrected. While program design always occurs first, most programmers move back and forth among these programming activities.

A program should be documented throughout the progamming process. This documentation should be both external and internal to the program code.

Most of today's business programming projects are performed by programming teams. Effective project management is very important. Chief programming teams are used. Also, an effort is made to encourage egoless programming, in which programmers freely criticize each other's work. Some of the techniques used are the structured walk through and the inspection team.

It is also helpful for a programmer to periodically interact with a program's users to exchange ideas on the program's input and outputs.

Structured programming refers to an approach to program design that results in a clear, logical design structure. As with structure design structured programming makes use of the principles of abstraction, modularity, and stepwise refinement.

One major goal of structured programming is to design programs that follow a single-entry single exist processing flow. This is accomplished by restricting most processing flows to one of three patterns : the sequential, selection and iteration flow pattern. There are two forms of the iteration flow pattern, do while loop and repeat unitl loop.

The two most common program design tools are the flowchart and pseudocode. Flow-charts visually protary a programs processing flow by showing the operations to be performed, the order in which they will be performed, and the conditions that affect this order. Many programmes, especially those following the principles of structured programming, have become disenchanted with the use or flowcharts in program design. With pseudocodes, programs are designed in everyday English, with processing flow shown by identing the English phrases in a standard way. Not only is it easy to follow the structured programming principles with pseudocodes, programs can be designed interactively using word processing software,

Most programming languages make a similar set of basic processing operations available to a programmer. One secret developing good programming practices is to learn the programming concepts behind the processing operations.

Data types represent alternative ways data are physically stored within a computer system. To common sets of data types include numeric and alphanumeric data of integer and real data. Data structures represent alternative ways a set of data can be organized. The simplest data structures are constants and variables. Constants are single memory locations whose contents do not change during program execution. Variables are single memory location whose contents can change. Three other common data structures are records files and arrays. An array links a number of data items. One dimensional arrays can be thought of as row or columns of data. Two-dimensional arrays can be thought hf as tables of data.

There are five basic types of data operations. Arithmetic operations perform calculations on numeric data. Relational and logical operations determine whether or not a particular condition exists. Memory manipulation operations work directly on data structures. Input/output operations read and write data.

Processing flow controls direct the order in which a program performs its processing operations. With unconditional control, popularly termed 'GO TO' the program flow immediately 'jumps' from one program segment to another, With conditional controls the program flow 'jumps' over or to a program segment only when a condition is met.

Many business information systems follow a standard processing flow with three main program segments. Initial processing readies the computer system for processing and procedures output headings. Main processing performs what is normally thought of as the program's processing operations, data are entered and processed and information systems output are produced. Final processing completes the processing by calculating and printing summary outputs and releasing any computer system devices that were used.

2.5.2 Programming Languages

Programming languages serve as the means by which a programmer communicates a

program design to a computer system. Three levels of programming language are in common use; assembly languages, high-level language, and very high-level languages.

As most programs are not coded in machine language, they are translated into machine language by systems software. The initial version of a program is called to the source code and the translated version is called the object code. With assembly languages, an assembler performs the translation. With high-level languages, computers or interpreters perform the translation. A compiler translates a program all at once. But does not execute it. An interpreter translates a program one statement at a time and then executes it prior to translating the next statement.

Assembly languages which are developed to relieve the tedium and reduce the errors of machine language programs, are essentially a more readable form of machine languages programs, are essentially a more readable form of machine language. High level languages have more powerful commands that are 'problem-oriented' rather than 'machine-oriented' and that translate into multiple machine language instructions. Very high-level languages consists of even more powerful commands that enable programmers to specify what processing task are to be performed, rather than how the tasks are to be performed. However, programmers lose some control over the manner in which processing occurs as they make use of each higher level of programming language. Every programming language is designed to achieve certain goals. These goals represent the design features of the language. Eight design features are particularly useful in comparing the strengths and weaknesses of different programming languages the extent to which language is general purpose provides for hardware control as interactive, provides sophisticated control structures and sophisticated data structures in non-procedural is easy to use, and is standardized.

The six most popular high level languages used for business programming are FORTRAN, COBOL, BASIC, PL/I, RPG and PASCAL, FORTRAN is primarily used for scientific and engineering problem solving. COBOL is a business-oriented language that is well suited for processing large data files and handling repetitive data processing operations. BASIC is a general-purpose programming language that is very easy to learn and to use PL/I is a more powerful, but also more complex general purpose programming language, RPG is an easy to-learn, business-oriented language that is well suited to repetitive data processing operations, PASCAL is a general purpose programming language that offers very sophisticated control and data structures.

Three new high-level languages that are likely to be successful are Ada, C, and Modula-2.

Six fac'ors should be considered in selecting programming language for a particular programming project the nature and performance objectives of the program, the availability and portability of the language, and program development and maintenance needs.

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