MANAGEMENT INFORMATION SYSTEMS

PART II

CPA SECTION 4
CCP SECTION 4
CS SECTION 4

STUDY TEXT

KASNEB SYLLABUS

GENERAL OBJECTIVE
This paper is intended to equip the candidate with knowledge, skills and attitudes that will enable him/her to apply information communication technology (ICT) to enhance business and other operations.

LEARNING OUTCOMES
A candidate who passes this paper should be able to:

- Effectively use ICT facilities in an organisation
- Apply the knowledge of ICT strategy and its role in facilitating competitive - advantage in business
- Use data communication networks, the Internet and e-commerce in optimizing business opportunities
- Implement information systems' security, controls and social ethical issues required in a business environment
- Implement ICT governance and risk management principles in business

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INTRODUCTION TO INFORMATION COMMUNICATION TECHNOLOGY

Introduction

The primary objective of an organization is to satisfy the needs of its clients. It is supposed to be effective and efficient whether it is profit motivated or not. These objectives are majorly achieved through computerization of the systems, which are fast and economical to organizations.

KEY TERMS

Computer - It may be defined as a device that works under the control of stored programs automatically accept, store and process data to produce information that is the result of that processing.

Input devices - Enters programs and data into a computer system

Central Processing Unit (CPU) - This is the part of the computer that processes data.

Output devices - They display information processed by the computer system.

Hardware - Refers to the physical, tangible computer equipment and devices

Software - This is a detailed step-by-step sequence of instructions known as programs which guide computer hardware

Multiprogramming - Multiprogramming is a rudimentary form of parallel processing in which several programs are run at the same time on a uniprocessor. Since there is only one processor, there can be no true simultaneous execution of different programs. Instead, the operating system executes part of one program, then part of another, and so on. To the user it appears that all programs are executing at the same time.

Multiprocessing - Multiprocessing is the coordinated (simultaneous execution) processing of programs by more than one computer processor. Multiprocessing is a general term that can mean the dynamic assignment of a program to one of two or more computers working in tandem or can involve multiple computers working on the same program at the same time (in parallel).

Multitasking - In a computer operating system, multitasking is allowing a user to perform more than one computer task (such as the operation of an application program) at a time. The operating system is able to keep track of where you are in these tasks and switch from one task to the other without losing information. Microsoft Windows XP, Vista , IBM's OS/390, and Linux.

are examples of operating systems that can do multitasking (almost all of today's operating systems can). When you open your Web browser and then open word at the same time, you are causing the operating system to do multitasking.

Multithreading - It is easy to confuse multithreading with multitasking or multiprogramming, which are somewhat different ideas. Multithreading is the ability of a program or an operating system process to manage its use by more than one user at a time and to even manage multiple requests by the same user without having to have multiple copies of the programming running in the computer

OVERVIEW OF COMPUTER SYSTEMS

What is a computer?

A computer is an information-processing machine. It may also be defined as a device that works under the control of stored programs that automatically accept, store and process data to produce information that is the result of that processing.
The forms of information processed include:

- Data – e.g. invoices, sales ledger, purchase ledger, payroll, stock controls, etc.
- Text – widely available in many offices with microcomputers
- Graphics – e.g. business graphs, symbols
- Images – e.g. pictures
- Voice – e.g. telephone
- Processing includes creating, manipulating, storing, accessing and transmitting of data.

Why use computers?

Use of computers has become a necessity in many fields. Computers have revolutionized the way businesses are conducted. This is due to the advantages that computer systems offer over manual systems.

The advantages include:

- ***Speed –*** Computers have higher processing speeds than other means of processing, measured as number of instructions executed per second.
- ***Accuracy –*** Computers are not prone to errors. So long as the programs are correct, they will always give correct output. Computers are designed in such a way that many of the inaccuracies, which could arise due to the malfunctioning of the equipment are detected and their consequences avoided in a way that is completely transparent to the user.
- ***Consistency*** – Given the same data and the same instructions, computers will produce exactly the same answer every time that particular process is repeated.
- ***Reliability –*** Computer systems are built with fault tolerance features, meaning that failure of one of the components does not necessarily lead to failure of the whole system.
- ***Memory capability*** – A computer has the ability to store and access large volumes of data.

- ***Processing capability*** – A computer has the ability to execute millions of instructions per second.
- ***Storage*** – Computers occupy less storage space compared to manual records.

COMPUTER APPLICATION AREAS

Some of the areas that computers are used include:

- **Communication** – digital communication using computers is popular and is being adopted worldwide as opposed to analogue communication using the telephony system. Computers have also enhanced communication through email communication, electronic data interchange, electronic funds transfer, Internet etc.
- **Banking** – the banking sector has incorporated computer systems in such areas as credit analysis, fund transfers, customer relations, automated teller machines, home banking, and online banking.
- **Organizational management** – the proliferation of management information systems have aided greatly the processes of managerial planning, controlling, directing as well as decision-making. Computers are used in organizations for transaction processing, managerial control as well as decision-support. Other specific areas where computer systems have been incorporated include sales and marketing, accounting, customer service, etc.
- **Science, research and engineering** – Computers are used: as research tools and in carrying out complex computations for simulation e.g. outer-space simulations, flight simulations as diagnostic and monitoring tools. for computerized maps using global positioning satellite (GPS) technology for modern mass production methods in the auto industry using computer driven technology.
- **Education** – computers incorporate databases of information that are useful in organizing and disseminating educational resources. Such e-learning and virtual or distributed classrooms have enabled the teaching industry to have a global reach to students. Computers are also used for marking uniform tests done in schools, school administration and computer aided instructions.
- **Management of information material** - The Internet has massive reference material on virtually every learning area. Computer systems have enabled the efficient administration of library materials for information storage and retrieval.
- **Manufacturing and production** – computer aided design (CAD), computer integrated manufacturing (CIM), process control systems among other technologies are among computer systems that have revolutionized the production industry. CAD and CIM are generic terms applied to the development and design of systems to support design work and to control manufacturing operations.
- **Entertainment** – use of computers in the entertainment industry has increased tremendously over the years. Computers enable high-quality storage of motion pictures and music files using high-speed and efficient digital storage devices such as CDs, VCDs

and DVDs. The Internet is also a great source of entertainment resources. Computer games have also become a major source of entertainment.

- **Retailing** – computers are used in point of sale systems and credit card payment systems as well as stock inventories.
- **Home appliances** – computers (especially embedded computers or microprocessors) are included in household items for reasons of economy and efficiency of such items. Major appliances such as microwave ovens, clothes washers, refrigerators and sewing machines are making regular use of microprocessors.

- **Reservation systems** – guest booking, accommodation and bills accounting using computers in hotels have made the process to be more efficient and faster. Airline computer reservation systems have also enhanced and streamlined air travel across major airlines. Major players in the industry have also adopted online reservation systems.
- **Health care and medicine** – computers have played such an important role in the growth and improvement of health care that the use of computers in medicine has become a medical specialty in itself. Computers are used in such areas as maintenance of patient records, medical insurance systems, medical diagnosis and patient monitoring.

HISTORY OF COMPUTERS

The first electronic computers were produced in the 1940s. Since then, many breakthroughs in electronics have occurred leading to great improvements in the capacity, processing speed and quality of computer resources. The evolution of computerization in business may be summarized .

- **1870s:** Development of the typewriter allows speedier communication and less copying.
- **1920s:** Invention of the telephone enables both Wide Area Networks (WAN) and Local Area Networks (LAN) communication in real time. This marks the beginning of telecommunication.
- **1930s:** Use of scientific management is made available to analyze and rationalize data.
- **1940s**: Mathematical techniques developed in World War II (operations research) are applied to the decision-making process.
- **1950s:** Introduction of copying facilitates cheap and faster document production, and the (limited) introduction of Electronic Data Processing (EDP) speeds up large scale transaction processing.
- **1960s:** Emergence of Management Information Systems (MIS) provides background within which office automation can develop.
- **1970s**: Setting up of telecommunication networks to allow for distant communication between computer systems. There is widespread use of word processors in text editing and formatting, advancement in personal computing - emergence of PCs. Use of spreadsheets.
- **1980s**: Development of office automation technologies that combine data, text, graphics and voice. Development of DSS, EIS and widespread use of personal productivity software.

- **1990s**: Advanced groupware; integrated packages, combining most of the office work clerical, operational as well as management.
- **2000s**: Wide spread use of Internet and related technology in many spheres of organizations including electronic commerce (e-commerce), e-learning, and e-health

Landmark Inventions

- ~500 B.C. - counting table with beads
- ~1150 in China - ABACUS - beads on wires
- 1642 Adding machine - Pascal
- 1822 Difference machine/Analytic Engine - design by Babbage
- 1890 Holerith punched card machine - for U.S. census
- 1944 Mark I (Harvard) - first *stored program* computer
- 1947 ENIAC (Penn)- first *electronic* stored progam computer
- 1951 UNIVAC - first *commercial* computer; 1954 first installation
- 1964 IBM - first all-purpose computer (business + scientific)
- 1973 HP-65, hand-held, programmable 'calculator'
- ~1975 Altair, Intel - first Micro-computer; CPU on a "chil

COMPUTER GENERATIONS

The capabilities of a personal computer have changed greatly since the introduction of electronic computers.

The classification of computers into generations is based on the fundamental technology employed. Each new generation is characterised by greater speed, larger memory capacity and smaller overall size than the previous one.

i. First Generation Computers (1946 – 1957)

- Used vacuum tubes to construct computers.
- These computers were large in size and writing programs on them was difficult.
- The following are major drawbacks of First Generation computers.
  - The operating speed was quite slow.
  - Power consumption was very high.
  - It required large space for installation.
  - The programming capability was quite low.
  - Cumbersome to operate – switching between programs, input and output

ii. Second Generation Computers (1958 - 1964)

- Replaced vacuum tubes with transistors.
- The transistor was smaller, cheaper and dissipated less heat than a vacuum tube.
- The second generation also saw the introduction of more complex arithmetic and logic units, the use of high–level programming languages and the provision of system software with the computer.

- Transistors were smaller than electric tubes and had higher operating speed. They had no filament and required no heating. Manufacturing cost was also lower. Thus the size of the computer got reduced considerably.
- It is in the second generation that the concept of Central Processing Unit (CPU), memory, programming language and input and output units were developed. The programming languages such as COBOL, FORTRAN were developed during this period.

iii. Third Generation Computers (1965 - 1971)

- Had an integrated circuit.
- Although the transistor technology was a major improvement over vacuum tubes, problems remained. The transistors were individually mounted in separate packages and interconnected on printed circuit boards by separate wires. This was a complex, time consuming and error-prone process.
- The early integrated circuits are referred to as small-scale integration (SSI). Computers of this generation were smaller in size, cost less, had larger memory while processing speed was much higher.

iv. Fourth Generation Computers (1972 - Present)

- Employ Large Scale Integrated (LSI) and Very Large Scale Integrated (VLSI) circuit technology to construct computers. Over 1,000 components can be placed on a single integrated-circuit chip.

v. Fifth Generation Computers

- These are computers of 1990s
- Use Very Large Scale Integrated (VLSI) circuit technology to build computers. Over 10,000 components can be incorporated on a single integrated chip.
- The speed is extremely high in fifth generation computer. Apart from this, it can perform *parallel processing*. The concept of *Artificial intelligence* has been introduced to allow the computer to make its own decision.

CLASSIFICATION OF COMPUTERS

Computers can be classified in different ways as shown below:

Classification by processing

This is based on how the computer represents and processes the data:

a) **Digital computers** are computers which process data that is represented in the form of discrete values by operating on it in steps. *Digital computers* process data represented in the form of discrete values like 0, 1, 2. They are used for both business data processing and scientific purposes since digital computation results in greater accuracy.

b) **Analog computers** are used for scientific, engineering, and process-controlled purposes. Outputs are represented in the form of graphs. *Analogue computers* process data represented by physical variables and output physical magnitudes in the form of smooth graphs.
c) **Hybrid computers** are computers that have the combined features of digital and analog computers. They offer an efficient and economical method of working out special problems in science and various areas of engineering.

Classification by purpose

This is a classification based on the use to which the computer is put.

a) ***Special purpose*** **computers** are used for a certain specific function e.g. in medicine, engineering and manufacturing.
a) ***General-purpose*** **computers** can be used for a wide variety of tasks e.g. accounting and word processing

Classification by generation

This is a time-based classification coinciding with technological advances. The computers are categorized as *First generation* through to *Fifth generation.*

a) ***First generation.*** These were computers of the early 1940s. They used a circuitry of wires and were vacuum tubes. Produced a lot of heat, took a lot of space, were very slow and expensive. Examples are LEO 1 and UNIVAC

b) ***Second generation***. These were computers of the early 1950s. Made use of transistors and thus were smaller and faster. (200KHz). Examples include the IBM system 1000.

c) ***Third generation***. These were computers of the 1960s. They made use of Integrated Circuits. They had speeds of up to 1MHz. Examples include the IBM system 360.

d) ***Fourth generation***. These were computers of the 1970s and 1980s. They used Large Scale Integration (LSI) technology. They had speeds of up to 10MHz. Examples include the IBM 4000 series.

e) ***Fifth generation.*** These were computers of the 1990s. They used very Large Scale Integration (VLSI) technology and had speeds of up to 400MHz and above.

Classification by power and size/ configuration

a) ***Supercomputers.*** These are the largest and most powerful. Used to process large amounts of data very quickly. Useful for meteorological or astronomical applications. Examples include Cray and Fujitsu.

a) ***Mainframe computers***. Large computers in terms of price, power and size. Require a carefully controlled environment and specialist staff to operate them. Used for centralized processing for large commercial organizations. Manufacturers include International Business Machine (IBM).

b) ***Minicomputers.*** Their size, speed and capabilities lie somewhere between mainframes and microcomputers. Used as departmental computers in large organizations or as the main computer in medium-sized organizations. Manufacturers of minicomputers include IBM and International Computer Limited (ICL).

c) ***Microcomputers.*** These are the personal computers commonly used for office and leisure activities. Examples include Hewlett Packard (HP), Compaq and Dell. They include desktops, laptops and palmtops.

Data representation in computers

Data exists as electrical voltages in a computer. Since electricity can exist in two states, on or off, binary digits are used to represent data. Binary digits, or bits, can be "0" or "1". The bit is the basic unit of representing data in a digital computer.

A bit is either a 1 or a 0. These correspond to two electronic/magnetic states of ON (1) and OFF (0) in digital circuits, which are the basic building blocks of computers. All data operated by a computer and the instructions that manipulate that data must be represented in these units. Other units are a combination of these basic units. Such units include:

- 1 byte (B) = 23 bits = 8 bits – usually used to represent one character e.g. 'A'
- 1 kilobyte (KB) – 210 bytes = 1024 bytes (usually considered as 1000 bytes)
- 1 megabyte (MB)– 220 bytes = 1048576 bytes (usually considered as 1000000 bytes/1000 KB)
- 1 gigabyte (GB)– 230 bytes = 1073741824 bytes (usually considered as 1,000,000,000 bytes/1000 MB)
- 1 terabyte (TB) – 240 bytes = 1099511627776 bytes (usually considered as one trillion bytes/1000 GB)

Bit patterns (the pattern of 1s or 0s found in the bytes) represent various kinds of data:

- Numerical values (using the binary number system)
- Text/character data (using the ASCII coding scheme)
- Program instructions (using the machine language)
- Pictures (using such data formats as gif, jpeg, bmp and wmf)
- Video (using such data formats as avi, mov and mpeg)
- Sound/music (using such data formats as wav, au and mp3)

Computer data is represented using number systems and either one of the character coding schemes.

Character Coding Schemes

(i) ASCII – American Standard Code for Information Interchange

ASCII is the most common format for text files in computers and on the Internet. In an ASCII file, each alphabetic, numeric, or special character is represented with a 7-bit binary number (a string of seven 0s or 1s). 128 possible characters are defined.

Unix and DOS-based operating systems use ASCII for text files. Windows NT and 2000 uses a newer code, Unicode. IBM's S/390 systems use a proprietary 8-bit code called EBCDIC. Conversion programs allow different operating systems to change a file from one code to another. ASCII was developed by the American National Standards Institute (ANSI).

(ii) EBCDIC – Extended Binary Coded Decimal Interchange Code

EBCDIC is a binary code for alphabetic and numeric characters that IBM developed for its larger operating systems. It is the code for text files that is used in IBM's OS/390 operating system for its S/390 servers and that thousands of corporations use for their legacy applications and databases. In an EBCDIC file, each alphabetic or numeric character is represented with an 8- bit binary number (a string of eight 0's or 1's). 256 possible characters (letters of the alphabet, numerals and special characters) are defined.

(iii) Unicode

Unicode is an entirely new idea in setting up binary codes for text or script characters. Officially called the Unicode Worldwide Character Standard, it is a system for "the interchange, processing, and display of the written texts of the diverse languages of the modern world." It also supports many classical and historical texts in a number of languages.

Number Systems

(i) Decimal system (base 10)

This is the normal human numbering system where all numbers are represented using base 10. The decimal system consists of 10 digits namely 0 to 9. This system is not used by the computer for internal data representation. The position of a digit represents its relation to the power of ten. E.g. 45780 = {(0×100) + (8×101) + (7×102) + (5×103) + (4×104)}

(ii) Binary system (base 2)

This is the system that is used by the computer for internal data representation whereby numbers are represented using base 2. Its basic units are 0 and 1, which are referred to as BITs (binary digits). 0 and 1 represent two electronic or magnetic states of the computer that are implemented in hardware. The implementation is through the use of electronic switching devices called gates,

which like a normal switch are in either one of two states: ON (1) or OFF (0).

The information supplied by a computer as a result of processing must be decoded in the form understandable to the user.

E.g. Number 15 in decimal is represented as 1111 in binary system:
$1111 = \{(1\times20) + (1\times21) + (1\times22) + (1\times23)\}$
$= 1 + 2 + 4 + 8 = 15$

(iii) Octal system (base 8)

Since binary numbers are long and cumbersome, more convenient representations combine groups of three or four bits into octal (base 8) digits respectively. In octal number system, there are only eight possible digits, that is, 0 to 7. This system is more popular with microprocessors because the number represented in octal system can be used directly for input and output operations. Complex binary numbers with several 1's and 0's can be conveniently handled in base eight. The binary digits are grouped into binary digits of threes and each group is used to represent an individual octal digit.

For example: the binary number 10001110011 can be handled as 2163 octal number.
That is 010 001 110 011
2 1 6 3

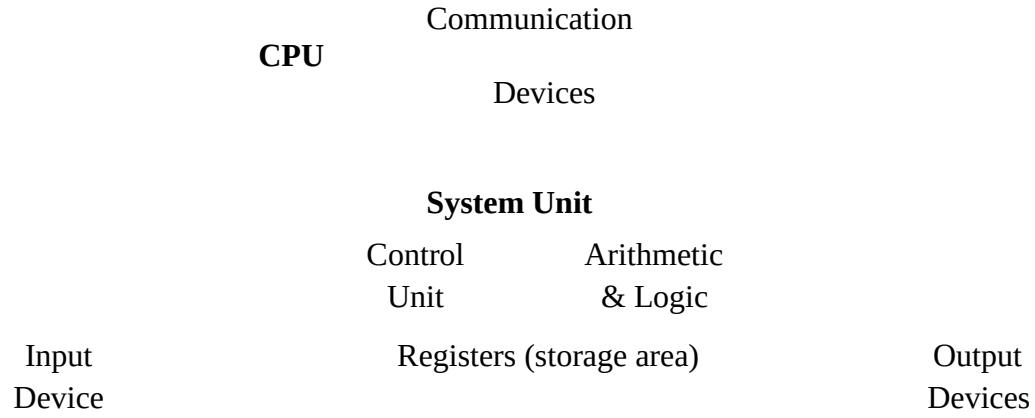
(iv) Hexadecimal (base 16)

The hexadecimal number system is similar to octal system with the exception that the base is 16 and there must be 16 digits. The 16 symbols used in this system are the decimal digits 0 to 9 and alphabets A to F. Hexadecimal numbers are used because more complex binary notations can be simplified by grouping the binary digits into groups of four, each group representing a hexadecimal digit. For example, the binary number 0001.0010.1010.0000 can be handled in base 16 as 12A0.

That is 0001 0010 1010 0000

Functional/Logical parts of a digital computer

Computer system



The system unit houses the processing components of the computer system. All other computer system devices are called peripherals, and are connected directly or indirectly into the system unit.

- **Input devices** – Enters program and data into a computer system.
- **Central Processing Unit (CPU) –** This is the part of the computer that processes data. Consists of main memory, control unit and arithmetic and logic unit.
- **Main Memory** – Temporary storage to hold programs and data during execution/ processing.
- **Control Unit** – Controls execution of programs.
- **Arithmetic Logic Unit (ALU)** – Performs actual processing of data using program instructions.
- **Output devices** – Displays information processed by the computer system.
- **Storage devices** – Permanent storage of data and programs before and after it is processed by the computer system.
- **Communication devices –** Enable communication with other computers

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COMPUTER HARDWARE

Refers to the physical, tangible computer equipment and devices, which provide support for major functions such as input, processing (internal storage, computation and control), output, secondary storage (for data and programs), and communication.

Hardware categories

A computer system is a set of integrated devices that input, output, process, and store data and information. Computer systems are currently built around at least one digital processing device. There are five main hardware components in a computer system: the central processing unit (CPU); primary storage (main memory); secondary storage; and input and output devices.

Basic elements of hardware

The basic elements that make up a computer system are:

a) Input

Most computers cannot accept data in forms customary to human communication such as speech or hand-written documents. It is necessary, therefore, to present data to the computer in a way that provides easy conversion into its own electronic pulse based forms. This is commonly achieved by typing data using the keyboard or using an electronic mouse or any other input device.

- **Keyboard** can be connected to a computer system through a terminal. A terminal is a form of input and output device. A terminal can be connected to a mainframe or other types of computers called a host computer or server. There are four types of terminals namely dumb, intelligent, network and Internet.

• Dumb Terminal
- Used to input and receive data only.
- It cannot process data independently.
- A terminal used by an airline reservation clerk to access a mainframe computer for flight information is an example of a dumb terminal

• Intelligent Terminal
- Includes a processing unit, memory, and secondary storage.
- It uses communications software and a telephone hookup or other communications link.
- A microcomputer connected to a larger computer by a modem or network link is an example of an intelligent terminal.

• Network Terminal
- Also known as a thin client or network computer.
- It is a low cost alternative to an intelligent terminal.
- Most network terminals do not have a hard drive.
- This type of terminal relies on a host computer or server for application or system software.

• Internet Terminal
- Is also known as a web terminal.
- It provides access to the Internet and displays web pages on a standard television set.
- It is used almost exclusively in homes.

• Direct data entry devices – Direct entry creates machine-readable data that can go directly to the CPU. It reduces human error that may occur during keyboard entry. Direct entry devices include pointing, scanning and voice-input devices.

• Pen input devices e.g. Light pen
Pen input devices are used to select or input items by touching the screen with the pen. Light pens accomplish this by using a white cell at the tip of the pen. When the light pen is placed against the monitor, it closes a photoelectric circuit. The photoelectric circuit identifies the spot for entering or modifying data. Engineers who design microprocessor chips or airplane parts use light pens.

• Touch sensitive screen inputs
Touch sensitive screens, or touch screens allow the user to execute programs or select menu items by touching a portion of a special screen. Behind the plastic layer of the touch screen are crisscrossed invisible beams of infrared light. Touching the screen with a finger can activate actions or commands. Touch screens are often used in ATMs, information centers, restaurants and stores. They are popularly used at petrol stations for customers to select the grade of fuel or

request a receipt at the pump (in developed countries), as well as in fast-food restaurants to allow clerks to easily enter orders.

SCANNING DEVICES

Scanning devices, or scanners, can be used to input images and character data directly into a computer. The scanner digitizes the data into machine-readable form.

- **The scanning devices used in direct-entry include the following:**
- **Image Scanner**– converts images on a page to electronic signals.
- **Fax Machine** – converts light and dark areas of an image into format that can be sent over telephone lines.
- **Bar-Code Readers** – photoelectric scanner that reads vertical striped marks printed on items.
- **Character and Mark Recognition Devices** – scanning devices used to read marks on documents.

Character and Mark Recognition Device Features

Can be used by mainframe computers or powerful microcomputers.
There are three kinds of character and mark recognition devices:

- Magnetic-ink character recognition (MICR)
  Magnetic ink character recognition, or MICR, readers are used to read the numbers printed at the bottom of checks in special magnetic ink. These numbers are an example of data that is both machine readable and human readable. The use of MICR readers increases the speed and accuracy of processing checks.

- Optical-character recognition (OCR)
  Read special preprinted characters, such as those on utility and telephone bills.

- Optical-mark recognition (OMR)
  Reads marks on tests – also called mark sensing. Optical mark recognition readers are often used for test scoring since they can read the location of marks on what is sometimes called a mark sense document. This is how, for instance, standardized tests such as the KCPE, SAT or GMAT are scored.

Voice–input devices

Voice-Input Devices can also be used for direct input into a computer. Speech recognition can be used for data input when it is necessary to keep your hands free. For example, a doctor may use voice recognition software to dictate medical notes while examining a patient. Voice recognition can also be used for security purposes to allow only authorized people into certain areas or to use certain devices.

- Voice-input devices convert speech into a digital code.
- The most widely used voice-input device is the microphone.
- A microphone, sound card and software form a voice recognition system.

Note:

Point-of-sale (POS) terminals (electronic cash registers) use both keyboard and direct entry.

- **Keyboard Entry** can be used to type in information.
- **Direct Entry** can be used to read special characters on price tags.

Point-of-sale terminals can use wand readers or platform scanners as direct entry devices.

- Wand readers or scanners reflect light on the characters.
- Reflection is changed by photoelectric cells to machine-readable code.
- Encoded information on the product's barcode e.g. price appear on terminal's digital display.

b) Storage

Data and instructions enter main storage and are held until when needed to be worked on. The instructions dictate action to be taken on the data. Results of the action will be held until they are required for output.

c) Control

Each computer has a control unit that fetches instructions from main storage, interprets them, and issues the necessary signals to the components making up the system. It directs all hardware operations necessary in obeying instructions.

d) Processing

Instructions are obeyed and the necessary arithmetic and logic operations are carried out on the data. The part that does this is called the Arithmetic and Logic Unit (ALU).

PROCESSING DEVICES

1. The Central Processing Unit – CPU

The CPU (Central Processing Unit) controls the processing of instructions. The CPU produces electronic pulses at a predetermined and constant rate. This is called the clock speed. Clock speed is generally measured in megahertz, that is, millions of cycles per second.

It consists of:

- Control Unit (CU) – The electronic circuitry of the control unit accesses program instructions, decodes them and coordinates instruction execution in the CPU.

- Arithmetic and Logic Unit (ALU) – Performs mathematical calculations and logical comparisons.
- Registers – These are high-speed storage circuitry that holds the instruction and the data while the processor is executing the instruction.
- Bus – This is a highway connecting internal components to one another.

2. Main Memory

The primary storage, also called main memory, although not a part of the CPU, is closely related to the CPU. Main memory holds program instructions and data before and after execution by the CPU. All instructions and data pass through main memory locations. Memory is located physically close to the CPU to decrease access time, that is, the time it takes the CPU to retrieve data from memory. Although the overall trend has increased memory access time, memory has not advanced as quickly as processors. Memory access time is often measured in milliseconds, or one thousandths of a second.

e) Output

Results are taken from main storage and fed to an output device. This may be a printer, in which case the information is automatically converted to a printed form called hard copy or to a monitor screen for a soft copy of data or information.

Output devices

Output is human-readable information. Input (data) is processed inside the computer's CPU into meaningful output (information). Output devices translate the machine-readable information into human-readable information.

• Punched cards: characters are coded onto an 80-column card in columns by combining punches in different locations; a special card reader reads the cards and translates them into transactions for the computer. These are now used only for older applications.

• Paper tape punch
Output printouts on paper, often referred to as hard-copy output. Categorized according to:

(i) Printing capacity
- Character printers – Print one character at a time.
- Line printers – Print one line at a time.
- Page printers – Print a whole page at a time.

(ii) Mode of printing
- Dot matrix printers
  Forms images via pins striking a ribbon against a paper. The print head typically have 9 or 24 pins. The images are relatively of poor quality since dots are visible upon close inspection. Though inexpensive compared to other types, they are noisy and low-end models are slow (speed varies with price).

- Ink jet printers
  Forms images by “shooting” tiny droplets of ink on paper. They offer relatively good image quality with so many small dots that they are not noticeable, even upon close inspection. They are relatively quiet compared to dot matrix and most can print color images.

- Laser jet printers
  Form images using copier technology – a laser/LED (Light Emitting Diode) lights up dots to be blackened and toner sticks to these dot positions on the paper. They have excellent image quality – so many small dots that they are not noticeable, even upon close inspection. They are quieter than ink jet printers.

- Thermal Printers
  Form images using heat elements and heat–sensitive paper. It is very quiet and not widely used by home PC users. Some very expensive colour models are available. “Ink” in these computers is wax crayons.

Plotters
Plotters are typically used for design output. They are special-purpose output devices used to produce charts, maps, architectural drawings and three-dimensional representations. They can produce high-quality multi-colour documents or larger size documents. Plotters produce documents such as blueprints or schematics.

Monitors
Output device for soft-copy output (temporal screen display of output, which lasts as long as the monitor’s power is on). They are the most frequently used output devices. Some are used on the desktop; others are portable. Two important characteristics of the monitor are size and clarity.

Voice-output devices
- Voice-output devices make sounds that resemble human speech.
- Voice-output devices use prerecorded vocalized sounds to produce output.
- The computer “speaks” synthesized words.
- Voice output is not as difficult to create as voice input.
- Most widely used voice-output devices are stereo speakers and headphones.
- Devices are connected to a sound card in the system unit.
- Sound card is used to capture sound as well as play it back.

Examples of voice output uses:
- Soft-drink machines, telephone, and in cars.
- Voice output can be used as a tool for learning.
- Can help students study a foreign language.
- Used in supermarkets at the checkout counter to confirm purchases.
- Most powerful capability is to assist the physically challenges

Auxiliary/Secondary Storage devices

Secondary storage devices store a larger amount of data or instructions than does main memory, on a more permanent basis. On a per megabyte basis, secondary storage is also cheaper than primary storage. Secondary storage is also infinitely extendable, unlike main memory, which is finite. Secondary storage is not volatile. Secondary storage is also more portable than primary storage – that is, it is possible to remove it from a computer and use the device and its contents in another.

Types of secondary storage devices

- **Magnetic disks –** Stores bits as magnetic spots. Magnetic disks are similar to magnetic tapes in that areas are magnetized to represent bits. However, the disks' read/write head can go directly to the desired record, allowing fast data retrieval. Magnetic disks can range from small and portable, such as diskettes with 1.44MB of storage capacity, to large capacity fixed hard disks, which are more expensive and less portable.

  - Floppy disks (diskettes)

    - 5 ¼ floppy disks
    - 3 ½ floppy disks – The most common size with a capacity of 1.44 MB. They are not very fast and durable.

  - Hard disks/Fixed disks – Also called hard drives. Their capacity range from 20 to 120 GB. They are fast and durable though not foolproof. Most are internal, but disks that use removable cartridge are available. Disk compression can be used to increase capacity but slows down performance.

- **Optical Disks –** Store bits as "pits" and "lands" on surface of disk that can be detected (read) by a laser beam.
  - CD-ROM (Compact-Disk Read Only Memory) – Only read and cannot be erased for rewriting. Has a capacity of 650 MB
  - CD-R (Compact-Disk Recordable) / WORM (Write Once, Read Many) – Usually blank at first and can be written only once. Has a capacity of 650 MB
  - CD-RW (Compact Disk ReWritable) – Can be written and read more than once. Has a capacity of 650 MB.
  - DVD-ROM (Digital Video Disks) – They are similar to CDs except that they have high quality sound and high-resolution video. Has a normal capacity of 4.7 GB and up to 17 GB if double-sided with double layering. Use laser technology. They are a relatively new technology usually used in the entertainment industry.

- **Magnetic Tapes –** Magnetic tape is similar in composition to the kind of tape found in videotapes and audiotapes. A plastic film is coated with iron oxide, which is magnetized to represent bits.
  - Tape cartridges – Used in personal computers. Has up to 20 GB per tape (probably even more).
  - Tape reels – Used in minicomputers and mainframes.

- **Other Backup Options** Zip drive/disk – Uses special diskettes that hold 100 MB, 250 MB or 750 MB SyQuest drive – Uses special cartridges that hold 200 MB
- **RAID** - RAID stands for Redundant Arrays of Independent or Inexpensive Disks. RAID technology is fault tolerant; that is, it allows data to be stored so that no data or transactions are lost in the event of disk failure. RAID involves using multiple hard disks in a special controller unit and storing data across all the disks in conjunction with extra reconstruction information that allows data to be recovered if a hard disk fails.
- **Storage Area Network (SAN) –** A storage area network connects servers and storage devices in a network to store large volumes of data. Data stored in a storage area network can be quickly retrieved and backed up. The use of storage area networks is likely to increase in the near future.
- **Computer Output Microfilm (COM) -** Companies that must store significant numbers of paper documents often use computer output microfilm. These devices transfer data directly from the computer onto the microfilm, thus eliminating the intermediate step of printing the document on paper. Newspapers and journals typically archive old issues in this manner, although some are now using optical storage devices.

Storage capacity abbreviations

- KB - kilobyte - 1000 (thousand)
- MB - megabyte - 1,000,000 (million)
- GB - gigabyte - 1,000,000,000 (billion)
- TB - terabyte - 1,000,000,000,000 (trillion)

Communication devices

- Modem - Modems allow computers (digital devices) to communicate via the phone system (based on analog technology). It turns the computers' digital data into analog, sends it over the phone line, and then another modem at the other end of the line turns the analog signal back into digital data.
- Fax/modem - basic digital/analog modem enhanced with fax transmission hardware that enables faxing of information from computer to another fax/modem or a fax machine *(NOTE: a separate scanner must be connected to the computer in order to use the fax/modem to transfer external documents)*

Computer Memory

Although memory is technically any form of electronic storage, it is used most often to identify fast, temporary forms of storage.
Memory capability is one of the features that distinguish a computer from other electronic devices.
Like the CPU, memory is made of silicon chips containing circuits holding data represented by

on or off electrical states, or bits. Eight bits together form a byte. Memory is usually measured in megabytes or gigabytes.
A kilobyte is roughly 1,000 bytes. Specialized memories, such as cache memories, are typically measured in kilobytes. Often, both primary memory and secondary storage capacities today contain megabytes, or millions of bytes, of space.

Types of Memory

1. **RAM (Random Access Memory) /RWM (Read Write Memory)** – Also referred to as main memory, primary storage or internal memory. Its content can be read and can be changed and is the working area for the user. It is used to hold programs and data during processing. RAM chips are volatile, that is, they lose their contents if power is disrupted. Typical sizes of RAM include 32MB, 64MB, 128MB, 256MB and 512MB.
    a. EDO – Extended Data Out
    b. DRAM – Dynamic RAM
    c. SDRAM – Synchronous

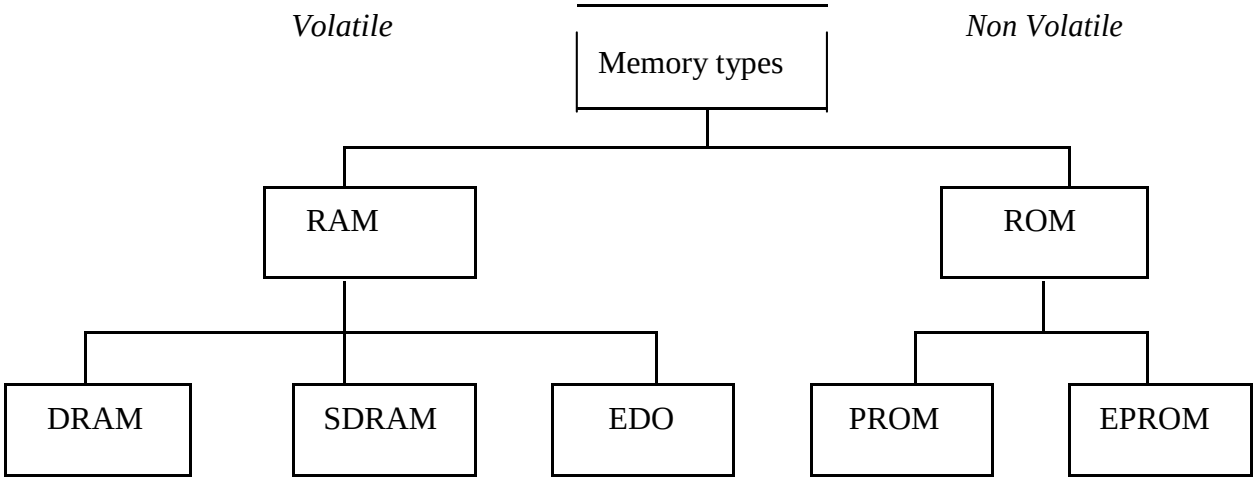
2. ROM (Read Only Memory) – Its contents can only be read and cannot be changed. ROM chips are non-volatile, so the contents aren't lost if the power is disrupted. ROM provides permanent storage for unchanging data and instructions, such as data fromthe computer maker. It is used to hold instructions for starting the computer called the bootstrap program. ROM chips, the contents, or combination of electrical circuit states, are set by the manufacturer and cannot be changed. States are permanently manufactured into the chip.
   PROM: The settings must be programmed into the chip. After they are programmed, PROM behaves like ROM – the circuit states can't be changed. PROM is used when instructions will be permanent but they aren't produced in large enough quantities to make custom chip production (as in ROM) cost effective. PROM chips are, for example, used to store video game instructions.
   Instructions are also programmed into erasable programmable read-only memory. However, the contents of the chip can be erased and the chip can be reprogrammed. EPROM chips are used where data and instructions don't change often, but non volatility and quickness are needed. The controller for a robot arm on an assembly line is an example of EPROM use.

    a. PROM (Programmable Read Only Memory) – It is written onto only once using special devices. Used mostly in electronic devices such as alarm systems.
    b. EPROM (Erasable Programmable Read Only Memory) – Can be written onto more than once.

Types of Memory

RAM (Random Access Memory) /RWM (Read Write Memory) – Also referred to as main memory, primary storage or internal memory. Its content can be read and can be changed and is the working area for the user. It is used to hold programs and data during processing. RAM chips are volatile, that is, they EDO RAM ROM

3. **Cache Memory** - This is high-speed memory that a processor can access more quickly than RAM. Frequently used instructions are stored in cache since they can be retrieved more quickly, improving the overall performance of the computer. Level 1 (L1) cache is located on the processor; Level 2 (L2) cache is located between the processor and RAM.



OPERATING SYSTEMS

The functions of an operating system include:

- Performing common hardware functions
- Accepting input and store data on disks and send data to output devices
- Providing a user interface
- Providing hardware independence
- Managing system memory
- Managing processing
- Controlling access to system resources
  - Protection against unauthorized access
  - Logins and passwords
  - Managing files
  - Physical storage location
  - File permissions
  - File access

Examples of operating systems include:

- DOS – Disk Operating System
- Windows 3.1, 95, 98, NT, 2000, ME, XP
- Linux, Unix, MAC OS, System/7

SOFTWARE

Software is detailed step-by-step sequence of instructions known as program which guide computer hardware. A computer program is a sequence of instructions that tell the computer hardware what to do. Programs are written in (programming) languages, which consist of a set of symbols combined according to a given syntax.

A program must be in main memory (RAM) to be executed. These invisible, intangible components of a computer that direct and control the operations of the hardware when processing data are referred to as software.

Software is classified into two major types: System and Application software.

System software

System software consists of programs that coordinates the activities of hardware and other programs. System software is designed for a specific CPU and hardware class. The combination of a particular hardware configuration and operating system is called a computer platform. These programs manage the “behind the scenes” operation of the computer.

Examples

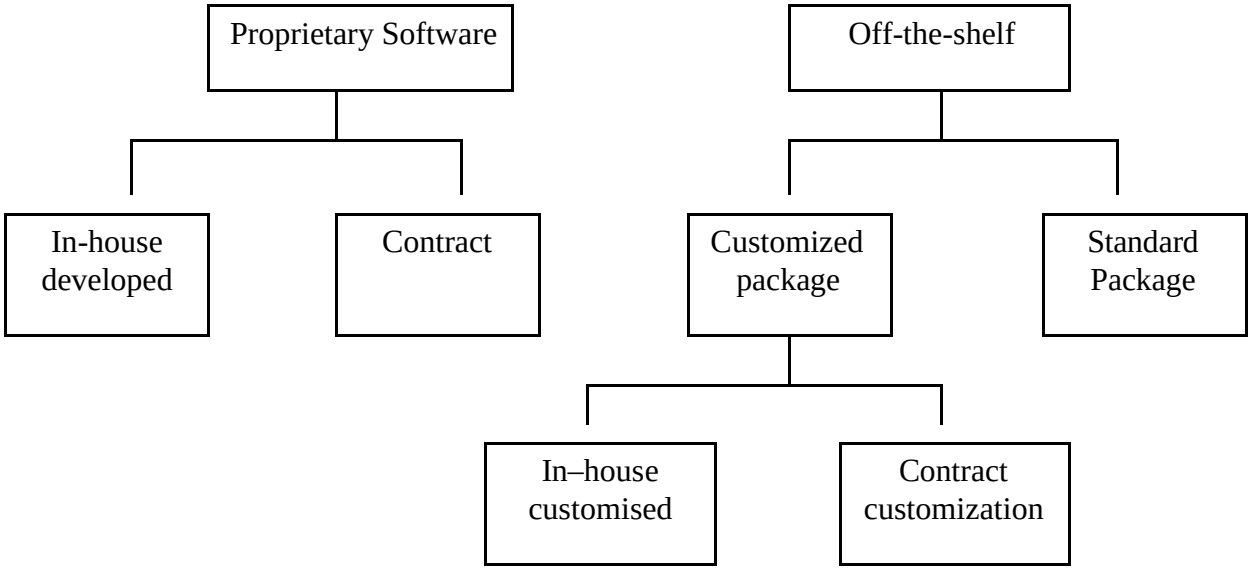
Utility Programs - Utility programs often come installed in computer systems or packaged with operating systems. Utilities can also be purchased individually. Utility programs perform useful tasks, such as virus detection, tracking computer jobs and compressing data.

Language processors – Compilers and interpreters

Application software

Applications software include programs designed to help end users solve particular problems using the computer or to perform specific tasks.

Sources of software



Proprietary Software

Is a computer software which is legal property of one party. The terms of use for other parties is defined by contracts or licensing agreements.

Advantages of proprietary software

- You can get exactly what you need in terms of reports, features etc.
- Being involved in development offers a further level in control over results.
- There is more flexibility in making modifications that may be required to counteract a new initiative by a competitor or to meet new supplier or customer requirements. A merger with another firm or an acquisition will also necessitate software changes to meet new business needs.

Disadvantages of proprietary software

- It can take a long time and significant resources to develop required features.
- In house system development staff may become hard pressed to provide the required level of ongoing support and maintenance because of pressure to get soft ware

Off-the-Shelf Software

Off-the-shelf is a term for software or hardware, generally technology or computer products that are ready-made and available for sale, lease or license to the general public.

Advantages of off-the-shelf software

- The initial cost is lower since the software firm is able to spread the development costs over a large number of customers.
- There is lower risk that the software will fail to meet the basic business needs
- You can analyze existing features and performance of the package
- Package is likely to be of high quality since many customer firms have tested the software and helped identify many of its bugs.

Disadvantages of off-the-shelf software

- An organization may have to pay for features that are not required or never used.
- The software may lack important features, thus requiring future modifications or customization. This can be very expensive because users must adopt future releases of the software.
- Software may not match current work processes and data standards.

Application software is further classified into general-purpose software and applications which include:

- ***Word processing*** – Create, edit and print text documents, e.g. MS Word and Word Perfect.
- ***Spreadsheets*** – Provide a wide range of built-in functions for statistical, logical, financial, database, graphics, data and time calculations, e.g. Lotus 1-2-3, Excel and Quattro Pro.
- ***Database management systems (DBMS)*** – Store, manipulate and retrieve data. e.g. Access, FoxPro and dBase.
- ***Online Information Services –*** Obtain a broad range of information from commercial services. e.g. America Online and CompuServe
- ***Communications*** - Ms Outlook for email
- ***Browsers*** e.g Internet Explorer and Eudora
- ***Graphics*** – Develop graphs, illustrations and drawings. e.g. PaintShop, FreeHand and Corel
- ***Project Management –*** Plan, schedule, allocate and control people and resources needed to complete a project according to schedule. e.g. Project for Windows and Time Line.
- ***Financial Management*** – Provide income and expense tracking and reporting to monitor and plan budgets, e.g. Quicken
- ***Desktop publishing*** - used to create high-quality printed output including text and graphics; various styles of pages can be laid out; art and text from other programs can also be integrated into published pages, e.g. PageMaker and Publisher.
- ***Presentation packages*** like MS PowerPoint

Note

A software suite, such as Microsoft Office, offers a collection of powerful programs including word processing, spreadsheet, database, graphics among others. The programs in a software suite are designed to be used together. In addition, the commands, t icons and procedures are the same for all programs in the suite.

PROGRAMMING LANGUAGES

Programming languages are collections of commands, statements and words that are combined using a particular syntax, or rules, to write both systems and application software. This results in meaningful instructions to the CPU.

Generations of programming languages

Machine Language (1st Generation Languages)

A machine language consists of binary digit, that is, zeroes (0) and ones (1). Instructions and addresses are written in binary (0,1) code. Binary is the only "language" a CPU can understand. The CPU directly interprets and executes this language, therefore making its execution of instructions fast. Machine language programs directly instructed the computer hardware, so they were not portable. That is, a program written for computer model A could not be run on computer model B without being rewritten. All software in other languages must ultimately be translated down to machine language form. The translation process makes the other languages slower.

Advantage

- The only advantage is that programs of machine languages run very fast because no translation program is required for the CPU.

Disadvantages

- It is very difficult to programs in machine language. The programmer has to know details of hardware to write the program.
- The programmer has to remember a lot of codes to write a program, which sometimes result in errors.
- It is difficult to debug a program.

Assembly Language (2nd Generation Languages)

Uses symbols and codes instead of binary digits to represent program instructions. It is a symbolic language meaning that instructions and addresses are written using alphanumeric labels that are meaningful to the programmer.

The resulting programs still directly instruct the computer hardware. For example, an assembly language instruction might move a piece of data stored at a particular location in RAM into a particular location on the CPU. Therefore, like their first generation counterparts, second generation programs were not easily portable.

Assembly languages were designed to run in a small amount of RAM. Furthermore, they are low level languages; that is the instructions directly manipulate the hardware. Therefore, programs

written in assembly language execute efficiently and quickly. As a result, more systems software is still written using assembly languages.

The language has a one-to-one mapping with machine instructions but has macros added to it. A macro is a group of multiple machine instructions, which are considered as one instruction in assembly language. A macro performs a specific task, for example adding and subtracting. A one-to-one mapping means that for every assembly instruction, there is corresponding single or multiple instructions in machine language.

An assembler is used to translate the assembly language statements into machine language.

Advantages:

- The symbolic programming of Assembly Language is easier to understand and saves a lot of time and effort of the programmer.
- It is easier to correct errors and modify program instructions.
- Assembly Language has the same efficiency of execution as the machine level language This is because this is a one-to-one translator between assembly language program and its corresponding machine language program.

Disadvantages:

- One of the major disadvantages is that assembly language is machine dependent. A program written for one computer might not run in other computers with a different hardware configuration.

High-level languages (3rd Generation Languages)

Third generation languages are easier to learn and use than were earlier generations. Thus programmers are more productive when using third generation languages. For most applications, this increased productivity and compensates for the decrease in speed and efficiency of the resulting programs. Furthermore, programs written in third generation languages are portable, that is, a program written to run on a particular type of computer can be run with little or no modification on another type of computer. Portability is possible because third generation languages are “high-level languages”; that is, instructions do not directly manipulate the computer hardware.

Third generation languages are sometimes referred to as “procedural” languages since program instructions, must give the computer detailed instructions of how to reach the desired result. High-level languages incorporated greater use of symbolic code. Its statements are more English– like, for example print, get and while. They are easier to learn but the resulting program is slower in execution. Examples include Basic, Cobol, C and Fortran. They have first to be compiled (translated into corresponding machine language statements) through the use of compilers

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