FEDERAL UNIVERSITY OF TECHNOLOGY, MINNA, NIGERIA

B.TECH. COMPUTER SCIENCE PROGRAMME

COURSE TITLE: **INTRODUCTION TO COMPUTER SCIENCE**

COURSE CODE: **CPT 111**

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INTRODUCTION

In the 21st century, computers have become indispensable tools in virtually all aspects of human lives. The development of handheld computers such as personal digital assistants (PDAs), tablet computers and smart phones has helped computers to become ubiquitous. This unit presents background information about computers by defining basic computer terms, providing a brief history of modern computing, and describing the parts of a computer system.

LEARNING OUTCOMES

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

- Define basic terms such as computer, data and information
- Explain the different generations of computers
- Describe the constituents of a computer system

WHAT IS COMPUTER?

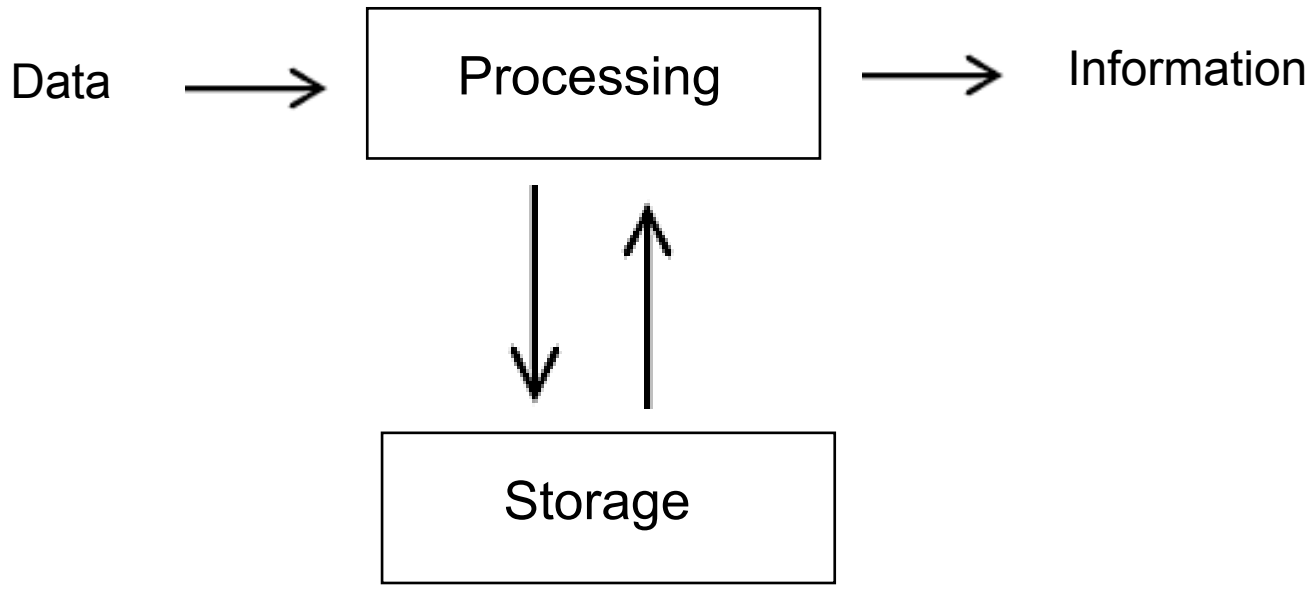
Computer: A computer is an electronic device that accept data, processes it and give out information in an incredible speed.

A computer can perform the following tasks:

- Accept data through an input device (e.g. keyboard or mouse)
- Process the data to convert it into information
- Display the information on an output device (e.g. visual display unit or printer)
- Store the information for future use in a storage device (e.g. hard disc or compact disc)

Data: Data refer to raw or unprocessed facts about a person, place or thing. Examples of data include name, age, height and profession. Data is the plural for datum.

Information: Information is processed data or data that has been converted into useful form e.g. the result of students in an examination or the net pay of an employee.



Schematic Diagram of a Compute

GENERATIONS OF COMPUTERS

Computer scientists and historians use the term computer generations to describe the stage-by-stage development of modern computing. Each generation is characterized by the technology used to fabricate computers at that time. These generation include:

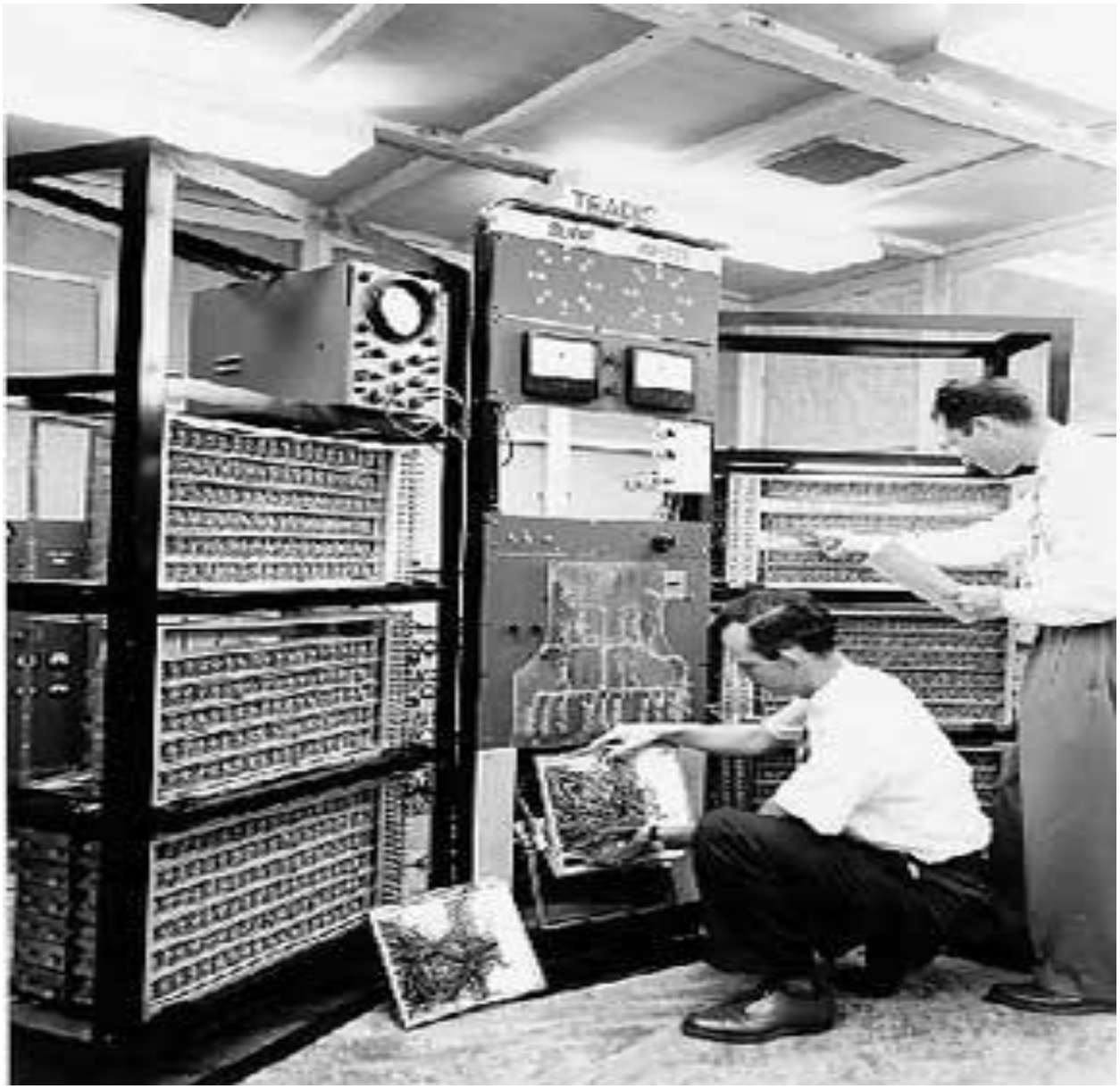
- The First Generation
- The Second Generation
- The Third Generation
- The Fourth Generation
- The Fifth Generation

The First Generation (1950s)

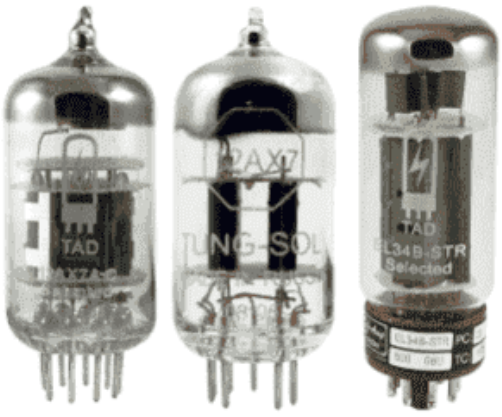
from 1946 to 1959, In 1951 Presper Eckert and John Mauchly delivered the Universal Automatic Computer (UNIVAC), the first successful general-purpose computer to the U.S. Census Bureau. The first computer generation used Vacuum tube as the basic component for memory and circuitry for CPU (Central Processing Unit). These tubes, like electric bulbs, produced a lot of heat and installations used to fuse frequently. Therefore, they were very expensive and only large organizations were able to afford it.

The main features of first generation are: Vacuum tube technology, unreliable, supported machine language only, very cost, generate a lot of heat, slow input and output, huge size, need AC, non-portable, consume a lot of electricity.

Example of first-generation computers are: UNIVAC, International Business Machine (IBM-701, IBM-650) etc



The First-Generation Computer



Vacuum Tubes

The Second Generation(1960s)

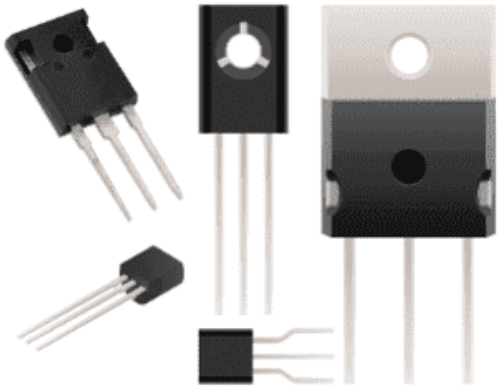
First-generation computers were highly unreliable because the vacuum tubes burned out frequently. Second generation computers were made of transistors, which are small electronic devices that can control the flow of electricity in an electronic circuit. Owing to the use of transistors, second generation computers were faster, smaller, and more reliable than first-generation computers. Even though second-generation computers still used punched cards for input, they had printers, tape storage, and disk storage. (from 1959 to 1965)

Second generation computers were programmed using high level programming languages like FORTRAN, COBOL etc

The main features of first generation are: use of transistors, Reliable in comparison to first Generation, generate less heat as compared to first, faster than first, still very costly, AC required, supported machine and assemble language.

Some computers of this generation include: IBM-1620, UNIVAC-1108

The Second-Generation Computer

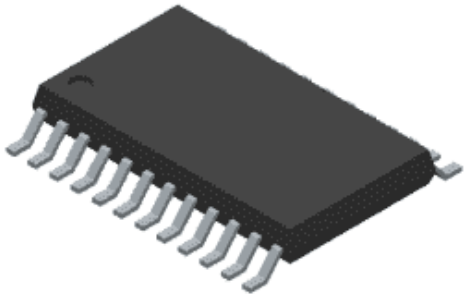


Transistors

The Third Generation (Mid-1960s to Mid-1970s)

The key distinction of third generation computers was there use of Integrated Circuits (ICs) in place of transistors. A single IC has many transistors, resistors, and capacitors along with the associated circuitry. IC was invented by Jack Kilbly. This development made computers smaller in size, more reliable in comparison to previous generation, faster, reliable, lesser maintenance, generate less heat, inexpensive that more organizations could afford to buy.

Another innovation of third generation computers was timesharing, a technique that allowed several people to simultaneously use a computer from their remote terminals. An example of third generation computers is IBM-360 series, Personal Data Processor (PDP-8) etc.



Integrated Circuits (ICs)

The Third-Generation Computer

The Fourth-Generation (1970s to 80s)

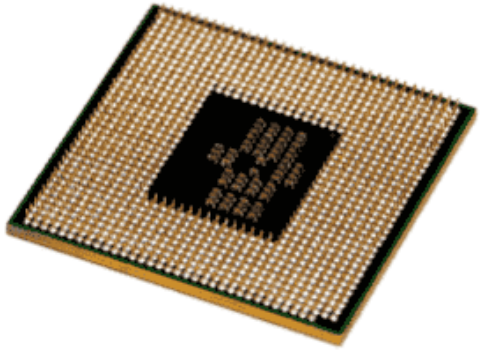
The fourth generation of computers began with the use of **microprocessors** in computer systems. The invention of the microprocessor revolutionized computers because hundreds to thousands of integrated circuits could be assembled on a single silicon chip, it was jointly developed by Federico Faggin, Marcian (Ted) Hoff, Stanley Mazor, and Masatoshi Shima. This ultimately enabled manufacturers to develop computers in a very compact size that could easily fit on the desk as well. Microprocessors were typically developed using **LSI** (large scale integration) and **VLSI** (very large scale integration) techniques. The VLSI circuits helped to combine about 5000 transistors and many other circuit components on a single chip, called a microprocessor. Due to microprocessors, fourth-generation computers were minimized, leading to the development of microcomputers.

The first microcomputers were not easy to use because users had to type commands on the command line to perform such actions as formatting a disk or starting a program. However, from the mid-80s, graphical user interfaces (GUIs) were incorporated into microcomputers, allowing users to interact withon-screen, icons, windows and pull-down menus using a pointing device such as a mouse. GUIs were easier to use than command line interfaces because they eliminated the need to memorize commands.

The main features of this generation are: VLSI technology used, portable and reliable, use of PC, very small size, no AC required, concept of internet was introduced, great development in the fields of networks etc.

Example of 4th generation computers are: Personal Data Processor (PDP-11),

The Fourth Generation Computer



Integrated Circuits (ICs)

The Fifth-Generation (1980s to Date)

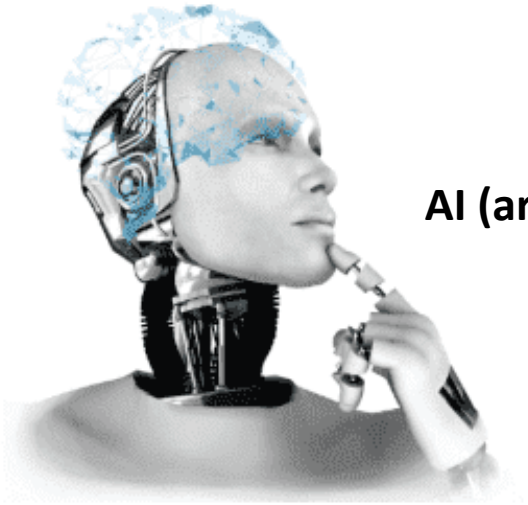
The fifth generation of computers is by far the most successful generation of computers. In this generation, there have been significant changes in computer technology that make computers extraordinary. Although the fifth generation is in progress, computers have received several major benefits compared to their predecessors.

Instead of VLSI technology used in fourth-generation computers, fifth-generation computers received a major upgrade and VLSI technology was replaced with ULSI (Ultra Large Scale Integration) technology. This revolutionized the development of microprocessors. This helped manufacturers assemble around ten million electronic components on a microprocessor chip.

In addition to ULSI technology, fifth-generation computers were also based on AI (artificial intelligence), which is still in the development stage, and parallel processing hardware. Artificial intelligence is an emerging technology in computer science that primarily helps to make computers more realistic. This means that it enables computers to think like humans; however, there is still room for much improvement.

The period of the fifth generation of computers is considered from 1980 to the present day, which simply means that the fifth generation is the ongoing generation of computers. Nowadays computers are using ULSI circuits, AI software, and parallel processing hardware. The main objective of all these technologies is to introduce technology in computers that can respond to natural languages.

Example of 5^{th} generation computers are: Desktop, Laptop, NoteBook,Tablet, Mobile phone etc.



AI (artificial intelligence)

Desktop Computer

Laptop Computer

COMPONENTS OF A COMPUTER SYSTEM

Every computer is part of a system. The complete computer system consists of four parts, namely: hardware, software, data and user.

Hardware

Hardware are the electrical and mechanical devices that make up a computer. They are the parts of the computer that can be touched and felt, such as keyboard, mouse, monitor, speaker and printer.

Software

Software is the set of instructions that tells the computer what task to do, and how to do it. A piece of software is referred to as a program. Some programs such as operating systems exist to help the computer perform tasks and manage its resources. Other programs such as word processors and spreadsheets allow users to create and manage documents.

Data

Data refers to individual facts that may not make sense on their own. The computer's job is to convert data into useful information

Users

The people who operate computers systems are referred to as users. Even though a computer may function without anyone sitting in front of it and operating it, no computer is completely autonomous. Human beings are still needed to design, build, program and repair computers. The computer is a device that transforms raw data into useful information. A complete computer system is made up of the physical components (hardware), instructions (software), operators (users) and data.

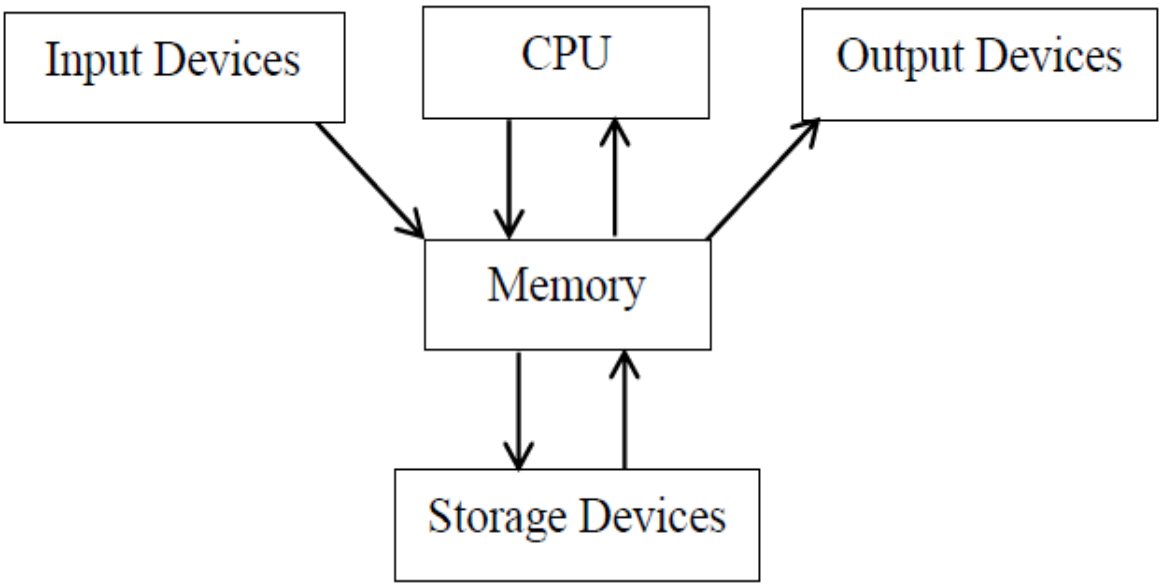
COMPUTER HARDWARE

Computer hardware refers to the mechanical and electronic parts of a computer that can be touched and seen. Hardware is what the layman often refers to as the computer.

The following hardware components are required by all general-purpose computers:

- Central processing unit (CPU) for executing instructions
- Memory for storing data and programs, at least temporarily
- Input devices for sending data and instructions into the computer
- Output devices for bringing retrieving information from the computer
- Storage devices for retaining large amounts of information permanently.

This is how the different hardware components interact in a general-purpose computer.



Parts of the Computer Hardware

CENTRAL PROCESSING UNIT (CPU)

The central processing unit or simply the processor, is the part of the computer that executes program instructions and controls the operation of all other hardware components. It is sometimes described as the computer's brain. In a microcomputer, the CPU is contained in a single chip and referred to as a microprocessor. The CPU is made up of three parts- the arithmetic-logic unit, control unit and registers.

Arithmetic-Logic Unit: The arithmetic-logic unit (ALU) performs two types of operations – arithmetic operations and logical operations.

Registers: registers are high speed storage locations within the CPU that temporarily hold data and instructions during processing.

Control Unit: it coordinates other hardware components

MEMORY

General-purpose computers have two kinds of memory:

- Random Access Memory (RAM) and
- Read Only Memory (ROM).

Random Access Memory (RAM)

RAM is the working memory of the temporary area for holding raw data for processing, instructions for processing the data, and information. It is the working memory of the computer. When a program is started, it is loaded from storage to RAM. The program remains in RAM until it closed. When data is entered into the computer through the input device, it is first stored in RAM. During processing, data and instructions are fetched from RAM and stored in CPU registers. At the end of processing, results are stored in RAM before they can be displayed to the user.

There are two reasons why RAM is a temporary storage:

- RAM is volatile, meaning that it requires electric power to hold data. When the computer is turned off, everything stored in RAM disappears.
- Data stored in RAM can easily be changed

Read Only Memory (ROM)

ROM is a type of memory that holds the built-in instructions that tell the computer what to do when it is turned on. Unlike Ram which is temporary and volatile, ROM is permanent and non-volatile. Instructions stored in ROM cannot be changed, and they are preserved even when the computer is turned off.

STORAGE DEVICES

Storage devices are non-volatile, long-term memories. Unlike Ram whose contents are lost when power supply goes off, storage devices preserve their contents even when there is no power supply. As a result, storage devices are commonly used to transfer data and programs from one computer to another. They can also be used to back up valuable data, so that the data can be restored after a computer crash results in loss of data. information held in storage devices can be easily replaced.

Examples of storage devices are hard disks, optical discs and flash drives.

INPUT DEVICES

An input device is any machine used to send data and instructions into the computer. Examples of input devices are keyboard, mouse, joystick, digital cameras and scanners

- **Keyboard:** The keyboard is the most important input device on a computer. Computer keyboards have the same layout as standard typewriters. The layout is called QWERTY, because the first six letters on the top row of letters are Q, W, E, R, T and Y. in addition to typing keys, computer keyboards have arrow keys for navigation, function keys for computer-specific tasks, and a calculator-like numeric keypad.
- **Mouse:** A mouse is a device for controlling the movement of a pointer or cursor on the screen. It consists of a ball which is rolled on a surface. The mouse derives its name from its resemblance to a real mouse.
- **Joystick:** A joystick resembles a car's gear stick. Moving the stick in any direction results in a corresponding movement of an on-screen object such as a pointer. Joysticks are mostly used for playing computer games.

- **Digital cameras:** They are used to capture still or moving images, which can be transferred to a computer and manipulated using image or video processing software.

OUTPUT DEVICES

Output devices retrieve information from the computer and present it to the user. Examples of output devices are monitors, printers, speakers etc.

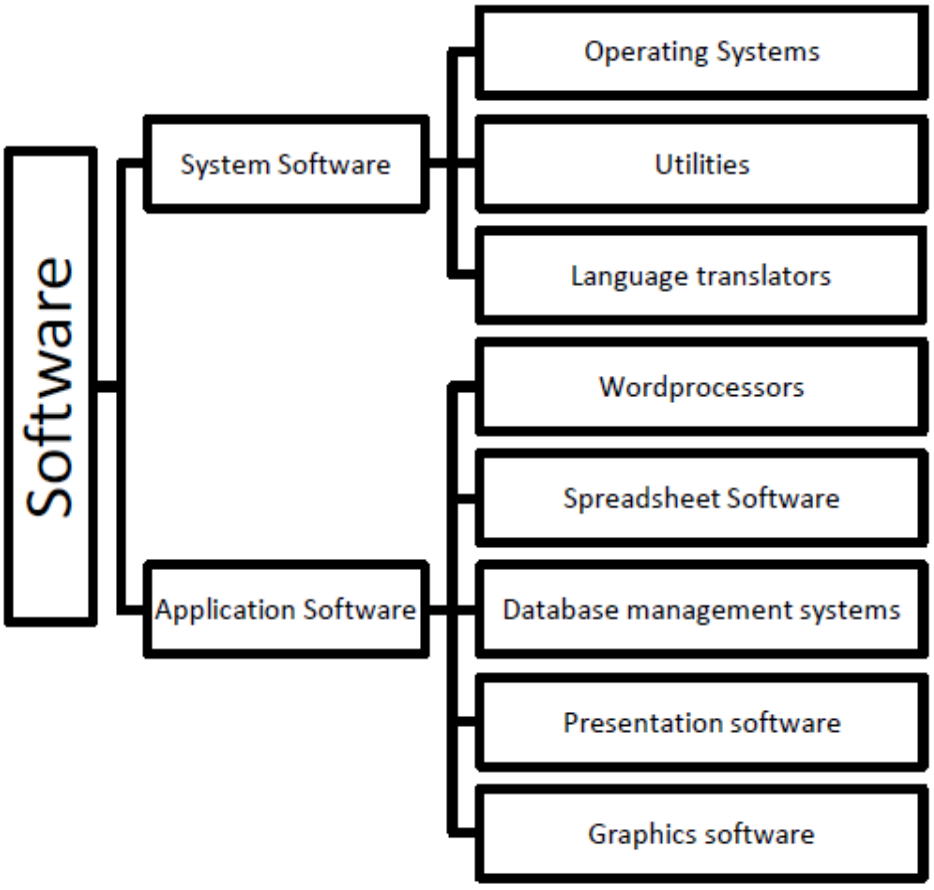
- **Monitors:** The monitor is the computer's display screen. It is also known as visual display unit. The two commonly used technologies for monitors are liquid crystal display and light emitting diodes, which have replaced cathode ray tube monitors that resembled bulky old-fashioned televisions.
- **Printers:** A printer is a device that expresses text or illustration on paper and other media. The two most commonly used types of printers today are inkjet and laser printers. Inkjet printers work by spraying ink on papers to produce text and characters. On the other hand, laser printers pass abeam on a cylindrical drum, which collects powdered ink (toner) and transfers the toner to paper. Laser printers work in the same way as photocopiers.
- **Speakers:** A speaker is a device that expresses audio or sound to the user.

COMPUTER SOFTWARE

Unlike hardware which refers to the physical parts of the computer that can be touched, software is the set of instructions that tell the computer what to do. We will discuss the two major categories of computer software, namely application and system software, as well as the types of software in each category.

- **System Software:** These are the software that interact with the computer at a very basic level. They help the computer to carry out its basic operating functions such as managing files, interacting with input/output devices, and removing viruses from the computer. Examples of system software are operating systems, utilities and language translators.

- **Application Software:** These are the software that help users to do real work such as creating documents, editing photos or tracking finances. Application software do not interact with the computer directly. Rather, they do so through system software such as operating systems and utilities.
- **Email software** for managing the flow of data to/from an electronic post office box.



Overview of types of software

Operating Systems

Operating systems are the most important programs that run on a computer, because they control all activities that take place in a computer. Operating systems perform basic tasks such as keeping track of files, management of memory allocated to programs and data, and controlling input/output devices such as keyboard and printer.

Examples of operating systems for general-purpose computers are Microsoft Windows, Mac OS, UNIX and Linux. Handheld devices use operating systems such as Windows Mobile OS, iOS and Android OS.

Utilities

A utility is a program designed to perform tasks such as optimizing a computer's performance, protecting data and facilitating communication. Examples of utility programs are:

Antivirus software

Backup software

Compression utilities (or zip software)

Email software

Language Translators

Computers understand only machine language, in which instructions are written as strings of zeros and ones. However, programming in machine language is tedious and error-prone for humans. As a result, programs are usually written in high level languages which contain English commands and mathematical symbols that humans are familiar with.

Language translators are system software that convert high level language programs to machine language programs which the computer understands. Examples of language translators are:

- **Compilers** which translate all instructions in a high-level language program to machine language before executing any instruction.
- **Interpreters:** which translate and execute an instruction in a high-level language program before moving to the next instruction.
- **Word Processors:** A word processor is a program for producing documents such as letters, memos, reports and manuscripts. Word-processing software allow you to create, edit, format and spell-check documents on the screen before orienting on paper. Example Microsoft Word
- **Spreadsheets**: A spreadsheet is an arrangement of rows and columns containing values that can be manipulated. Electronic spreadsheets allow users to simple or complex formula, they can be used for performing tasks such as budgeting, tracking finances, calculating loan payments, computing student grades and estimating project costs. Example Microsoft Excel
- **Database**: A database is a collection of data stored on one or more computers. A database can contain data such as details of books in a library, university student records, or bank customer details and user can store, modifying, finding and reporting data contained in a database. Example Microsoft Access
- **Presentation Software**: Presentation software enable users to combine text, graphs, photos, sound clips and animation into series of electronic slides.
- **Graphics software:** Graphics software allow users to create, edit and manipulate graphics. These graphics could be pictures, images, drawings, icons or photographs.

Operating Systems

Operating systems are the most important software that run on a computer. They manage the computer hardware, and act as an intermediary between the computer user and the hardware. This unit describes the history of operating systems, beginning with computers that didn't have any operating systems, and ending with operating systems used in of today's computers. Like most man-made systems, the many features of operating systems were introduced as engineers' experience accumulated over time.

Operating systems vary greatly. For example, personal computer operating systems are designed to support games, business applications and so on. On the other hand, operating systems for mainframe computers are designed to maximize the utilization of hardware.

Historical Evolution of Operating Systems

Serial Processing: From the late 1940s to the mid-1950s, the earliest computers had no operating systems, thus the programmer interacted directly with the hardware. Programs written in machine were loaded via a card reader (i.e., the input device). If a program successfully completed execution, the output appeared on a printer. However, if the program halted due to an error, the error condition was indicated by some display lights. The programmer and/or computer operator had to supply all the instructions to carry out even the most basic tasks. There were two main problems with the earliest computers.

i. Because users had to reserve computer time, the computer remained idle if a user's program completed execution before the allocated time. On the other hand, if a user ran into problems, he/she might be forced to leave the computer once the allocated time was used up, even though the program has not completed execution.

ii. Considerable time was needed to setup a program to run. A single program could involve loading a high-level program and compiler into memory, saving the compiled program, and so on. If an error occurred in the process, the user had to go back to the beginning of the sequence.

This mode of operation is referred to as serial processing, since users had to access the computer in series.

Simple Batch Systems: The first operating systems were batch systems which appeared in the mid-1950s. Batch systems used a simple operating system known as a monitor, which eliminated the need for users to directly access the processor. Instead, a user submits a program or job to the computer operator on tape or disk. The operator queues up the jobs, and later submits an entire batch of jobs to the monitor on an input device. Each program is designed to return to the monitor upon completion, so that the monitor can load the next job. The major bottleneck of batch processing systems were input/output operation: all computation had to stop to let an I/O operation take place.

Multi-Programmed Batch Systems: Even though job sequencing is automatically handled in simple batch systems, the processor is often idle. The reason is that I/O devices are slow compared to the processor. A processor may spend up to 90% of its time waiting to read from/write to a file. Multiprogramming or multitasking systems allow the monitor as well as several other programs to be loaded into the computer memory. Processor idle time is minimized because while one program is performing I/O, another program can make use of the processor. This approach is used in many modern operating systems.

Time-Sharing Systems: Multiprogramming allows batch systems to be efficient, but it doesn't allow the user to interact with the computer during processing. User interaction is essential in certain jobs such as transaction processing. Timesharing allows the processor time to be shared among multiple users. Each user accesses the computer through a terminal. The operating system allocates a small time slice to each job, and then moves to the next job. The process is repeated until all jobs are completed. Because the time slot is very small, the operating system returns to each job after a short time, causing each user to think that only his/her job is running on the computer.

Types of operating systems

There are a wide variety of operating systems in use today. Some of these types of operating systems are:

Mainframe Operating Systems: Mainframes are the room-sized computers still found in major corporate data centers. Operating systems for mainframes are geared towards processing multiple I/O-intensive jobs at the same time.

Server Operating Systems: Server operating systems run on servers, which could be large personal computers, or even mainframes. They serve multiple users at once

over a network and allow the users to share software and hardware resources. Servers can provide one or more of the following types of services: file service, print service, or Web service.

Multiprocessor Operating Systems: Multiprocessor operating systems are needed to help connect multiple CPUs into a single system. They differ from server operating systems, because they have special features for handling communication, connectivity, and consistency.

Personal Computer Operating Systems: Personal Computer operating systems provide good support to a single user. They support multiprogramming, and are widely used for word processing, spreadsheets, and Internet access.

Handheld Computer Operating Systems: Handheld computers include mobile phones as well as PDA (Personal Digital Assistants), which are used for performing a small number of functions, such as an electronic address book and memo pad. The operating systems that run on these handhelds have the ability to handle telephony, digital photography, emails, Internet access, and other functions.

Embedded Operating Systems: Embedded systems run on the computers that control devices that are not usually thought of as computers. Since they do not accept user-installed software. Examples are car engines, MP3 players, TV sets, microwave ovens, and DVD recorders. Embedded systems differ from handheld devices, because entrusted software will not run on embedded systems. For example, you cannot download new applications to your microwave oven, since all the software is already stored in the ROM.

Sensor Node Operating Systems: Sensors are small battery-powered computers with built-in radios. These nodes are tiny computers that communicate with each other and with a base station using wireless communication. They have limited power and must work for long periods of time unattended outdoors, frequently in environmentally harsh conditions. Sensor networks are used to detect fires in forests, measure temperature and precipitation for weather forecasting, protect the perimeters of buildings, guard national borders, and so on. The operating system for sensor networks needs to be small and simple because the nodes have little RAM and battery lifetime is a major issue.

Real-Time Operating Systems: Real-time systems have time as a key parameter. These systems must provide absolute guarantees that a certain action will occur by a certain time for example, if a car is moving down an assembly line, certain actions must take place at certain instants of time. If a welding robot welds too early or too late, the car will be ruined.

Functions of Operating Systems

The operating system acts as an interface between application software and the hardware. The key functions of an operating system include:

User Interface: Virtually all operating systems provide a user interface (UI) for users to interact with the computer. For example, a command line interface allows users to enter text commands, whereas a graphical user interface allows users to interact with on-screen objects and menus using a pointing device.

Program Execution: An operating system performs several tasks in order to execute a program: it loads the instructions and data into memory, it allocates the processor to the program, and so on.

I/O Operations: A running program may require I/O from a file or I/O device. In order to ensure efficiency and protection, users cannot control I/O directly. Instead, the operating system provides a means to carry out I/O.

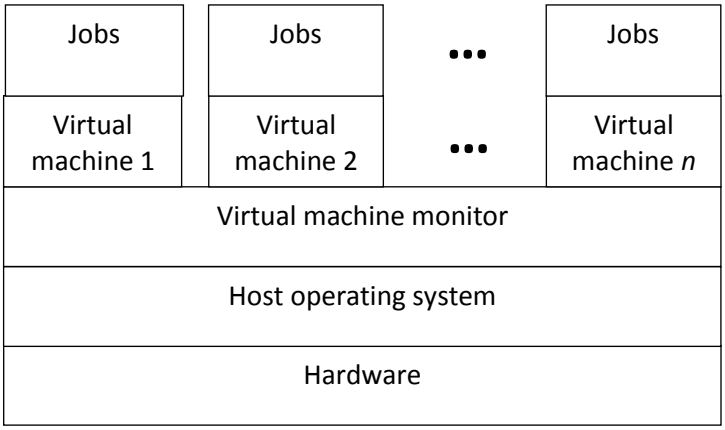
File System Manipulation: Operating systems provide file systems that allow users and programs to create, list, search for, delete, read and write files and directories.

Resource Allocation: Operating systems handle the allocation of resources to multiple users and/or multiple jobs running at the same time. Such resources include CPU, main memory and file storage.

Protection and Security: Protection is concerned with controlling the access of legitimate users/jobs to the computer resources. On the other hand, security involves safeguarding the computer system from outsiders. An example of protection is when the operating system prevents several jobs running at the same time from interfering with one another or with the operating system. An example of security is when the operating system requires users to authenticate themselves by means of passwords, in order to gain access to system resources.

Virtual Machines

A virtual machine (VM) abstracts the hardware of a single computer (such as CPU, memory and disk drives) into a number of execution environments, making it seem like each execution environment is running its own private computer. Virtualization allows a single computer to run multiple operating systems, or multiple sessions of an operating system. A host operating system can support several virtual machines. A virtual machine monitor (VMM) runs on top of the host operating system, or is incorporated into it. Each virtual machine runs a separate virtual operating system. In order to execute a job, the VMM hands over processor control to a virtual machine operating system.



Virtual machine concept