COMPUTER HARDWARE

Computer hardware refers to the physical/tangible components or parts of the computer. Hardware is any physical part of the computer that you can touch, see and pickup.

Computer hardware is categorized in the following ways;

1. Input hardware devices
2. Processing devices
3. Output devices
4. Storage devices
5. Communication/ Networking hardware

1. INPUT DEVICES

Input devices are used to enter data/instructions or commands in a form that the computer can use. They send the data or commands to the processing unit.

According to the type of data they input, they can be grouped into the following:

a) Text input devices
b) Pointing input Devices
c) Imaging input Devices
d) Gaming input Devices
e) Audio input Devices
f) Biometric input Devices and
g) Other Specialized input devices

a) Text input devices

Text is a general word for all characters such as letters, numerical digits, symbols and marks that combine to form words, sentences, paragraphs and so on. There is a variety of devices that help us to input text into a computer**.** The following are the text input devices commonly used.

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(i) The Keyboard

A keyboard is an input device, consisting of a set of keys (buttons) used to operate a computer. Each press of a key corresponds to a single written character of text, but to produce some symbols, it requires pressing and holding several keys simultaneously. Usually a standard keyboard has between 80 to110 keys. A keyboard is the main and most reliable computer input device.

The QWERTY is referred to as the "Universal" keyboard. The name "QWERTY" comes from the first six letters in the top alphabet row (the one just below the numbers). There are other setups also available such as Dvorak, ABCDE, GKOS, QWERTZ and AZERTY Keypads, Keyers and chorded keyboards have fewer keys, specially designed for devices such a pocket sized computers.

Advantages of Keyboard

- Keyboards are very common (commonly supplied with computers)
- Entering data and commands with keyboard is faster as compared to the mouse
- Keyboards are more reliable

Demerits of Keyboard

- It takes a lot of time to practice in order to type quickly
- Keys can easily become faulty due to dust.
- Some keyboards keys are very hard to press, causing fingers to hurt.

(ii) Voice Recognition Equipment

Voice Recognition Equipment (a.k.a Speech recognition) converts spoken words to text. Computers with Speech recognition do not actually understand speech, but they are programmed to recognize a vocabulary of words, which can range from two words to millions of words.

Advantages

- No typing of data is necessary.
- Voice recognition can be used by people whose hands are disabled.
- Dictating text is faster than typing.
- Voice Recognition systems are also ideal for the blind

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Demerits of text input by speech Recognition

- Error rate is high, depending on user's accent.
- Words with the same pronunciations (Homophones) like see and sea cannot be distinguished
- Speech Recognition does cannot work in noisy environment
- The Voice Recognition software must be trained to recognize more words.
- It requires the user to speak in a writing style, i.e. even pronouncing the marks such as comma.

(iii) Optical Mark Recognition (OMR)

Optical mark recognition (OMR) devices read hand-drawn marks such as small circles or rectangles. A person places these marks on a form, such as a test, survey, or questionnaire answer sheet.

The OMR device first reads a master document, such as an answer key sheet for a test, to record correct answers based on patterns of light; the remaining documents then are passed through the OMR device and their patterns of light are matched against the master document.

(iv) Barcode readers/scanners

A bar code reader is an optical reader that uses laser beams to read bar codes that are printed on items usually in super markets.

A bar code is an identification code that normally consists of a set of vertical lines and spaces of different widths. The bar code represents some data that identifies the item and the manufacturer.

(v) Optical Character Recognition (OCR)

Optical character recognition (OCR) is a technology that involves reading typewritten, computer-printed, or handwritten characters from ordinary documents and translating the images into a form that the computer can understand. OCR devices include a small optical scanner for reading characters and sophisticated software (OCR software) for analyzing what is read

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(vi) Magnetic Ink Character Readers (MICR)

Magnetic-ink character recognition (MICR) reader is used to read text printed with magnetized ink.

MICR readers are mainly used by the banking industry for processing checks. Each check is inserted into an MICR reader, which sends the check information to a computer for processing.

(vii) Radio Frequency Identification (RFID) readers

Radio-frequency identification (RFID) is a technology that uses radio waves to transfer data from an electronic tag, attached to an object, through a reader for the purpose of identifying and tracking the object. RFID can work over a long distance. An RFID tag can be affixed to cars, computer equipment, books, mobile phones, etc.

(viii)Magnetic Strip Card Readers

A magnetic stripe card reader reads the magnetic stripe on the back of credit cards, bank ATM cards, and other similar cards. Exposure to a magnet or magnetic field can erase the information and contents of a card's magnetic stripe.

b) Pointing Devices

A pointing device is an input device, which allows users to move a pointer and make selections on the computer screen. A pointing device is any piece of hardware that is used to input spatial data into a computer.

There are many examples of pointing devices such as:

(i) The Mouse

A mouse is an input pointing device that is used to select and icons and items on the screen. The mouse is a hand held device that lets you point to and make selections of items on your screen.

In a PC mouse there are mostly 2-3 buttons. A ball under the mouse senses movement. An optical mouse uses a light-emitting diode and photodiodes to detect movement relative to the underlying surface.

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The Functions of a mouse

- The mouse is used as a pointer to move to, or select a particular section of the displayed window.
- It is used to complement the keyboard especially in a graphical interface environment
- Its right button provides an array of time saving shortcut menus.

There are two basic types of mice:

(i) **Mechanical:** Has a rubber or metal ball on its underside that can roll in all directions. Mechanical sensors within the mouse detect the direction the ball is rolling and move the screen pointer accordingly.

(ii) **Optical:** Uses a laser (light to detect the mouse's movement. but they are also more expensive. Mice connect to PCs in one of several ways: Serial mice connect directly to an RS-232C serial port or a PS/2 port. This is the simplest type of connection. PS/2 mice connect to a PS/2 port. USB mice connects to a USB (Universal Serial Bus) port

Advantages of using a mouse

- Moves cursor around the screen faster than using keystrokes
- A mouse is user-friendly for computer beginners.
- A mouse is easy and convenient to use with a graphical user interface.

Disadvantages of using a mouse include

- It is not easy and convenient to input text with a mouse.
- Issuing commands by using a mouse is slower than by using a keyboard.
- It needs some practice in order to control a mouse properly.
- A mouse is not accurate enough for drawings that require high precision.
- A mouse usually requires a flat surface to operate.
- A mouse needs more desk space to operate when compared with a trackball or a touchpad
- Requires moving hand from keyboard to mouse and back.
- Repeated motion can lead to carpal tunnel syndrome

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Operations of a mouse/What can a mouse do?

- **Clicking**: It is an act of pressing and releasing the left hand button of the mouse once.
- **Right clicking**: It is an act of pressing and releasing the right mouse button once
- **Double clicking**: Is the act of pressing a computer mouse twice quickly without moving the mouse
- **Dragging**: Is an act of pointing at an item, then hold down the left mouse button as you move the mouse.
- **Scrolling**. It is an act of navigating the window page up or down by moving the wheel like button.
- **Dropping.** This refers to the release of the left button mouse after dragging an item.

(ii) Cordless Mouse/Wireless mouse

The cordless mouse is a lot better than a normal mouse. It reduces the amount of work space needed to move the mouse around. This mouse runs on a battery. When you move the mouse it sends an infrared beam to a sensor which interprets it causing the pointer to move.

(iii) Stylus pen & digitizing tablet

Stylus pen- The pen lets you draw on what is called a digitizing tablet that mirrors the surface area of the computer screen. The pen can be used as a standard mouse (without wires connected to it) or also as a free flowing drawing device. The pen is useful for drawing since drawing graphics with a mouse tends to be somewhat difficult.

(iv) Trackball

The trackball is an upside-down mouse that remains stationary on your desk. It is the same principle as the mouse except that the rollers are reversed and the ball is on top. This ball does not need as much attention as the normal mouse because the only thing that touches it is your hand as the normal mouse touches a surface**.**

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(v) Touchpad

The touchpad has sensors that sense your touch. When they sense your touch they send a signal to the computer to move the mouse pointer to that location on the screen. Common on laptop computers.

(vi) Light pen

Light pen- is a form of a light-sensitive wand used in conjunction with a computer's CRT TV set or monitor. It allows the user to point to displayed objects, or draw on the screen, in a similar way to a touch screen but with greater positional accuracy. A light pen can work with any CRT-based display, but not with LCD screens, projectors and other display devices.

(vii) Touch Screens

A touch screen is a touch-sensitive input and display device. Users can interact with these devices by touching areas of the screen.

You touch words, pictures, numbers, letter, pointers or special locations identified on the screen. With some smart phones, portable media players, and other personal mobile devices, you can touch the screen to perform tasks such as dialing telephone numbers, entering text, and making on-screen selections.

Kiosks, which are freestanding computers, usually have touch screens. Many ATMs also have touch screens.

(viii)Track Point

A Track Point, also called a pointing stick, is a cursor control device located in the middle of the keyboard between the G, H, and B keys. The control buttons are located in front of the keyboard toward the user. The Track Point is operated by pushing in the general direction the user wants the cursor to move. Increasing pressure causes faster movement.

c) Imaging Devices

Imaging input Devices are devices that input images such as still photos, motion pictures, graphics, video etc. into the computer for processing.

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(i) Image scanner

A scanner is a light-sensing input device that converts hardcopy documents, drawings, or pictures to an electronic version (softcopy), which can then be stored on a disk. The electronic version of scanned material is in the form of rows and columns of dots called a ***bitmap***

Each dot on a bitmap consists of one or more bits of data.

Common types of scanners include:

- A **flatbed scanner** works like a copy machine except that it creates a file of the document rather than a paper copy.
- A **sheet feed scanner** has motorized rollers that can feed the source document across the scanning head during the scanning process.
- A **handheld scanner** can be manually passed over the image to be scanned.
- The quality of a scanner is determined by its resolution and color depth.

(ii) Digital Camera

A digital camera allows users to take pictures and store the photographed images digitally instead of storing on a traditional film.

When you take pictures, the images are electronically stored in the camera. Later, you transfer a copy of the stored pictures to your computer or printer by connecting a cable between the digital camera and your computer.

What are the advantages of a digital camera over a traditional film camera?

- Ability to store images on media
- Ability to edit images
- Faster at taking images
- Images can be sent to other devices via a network

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(iii) Digital video (DV) camera

A digital video (DV) camera, by contrast records video as digital signals instead of analog signals. To transfer recorded images to the computer hard disk, users connect DV cameras directly to a port on the system unit. After saving the video on a storage medium, you can play it or edit it and burn it to a DVD using software programs on the computer.

(iv) Camcorder

This is a light weight video camera that records data in digital form onto a storage device such as a videotape**.**

(v) Web cam

A Web cam, also called a PC video camera, is a type of digital video camera that usually sits on top of the monitor. Some laptop computers have built-in Web cams.

Webcams enable users to:

- capture video and still images,
- send e-mail messages with video attachments,
- add live images to instant messages,
- broadcast live images over the Internet,
- and make video telephone calls

d) Gaming input Devices

Gaming input devices are devices specifically designed to be used for playing computer games.

(i) Gaming keyboard

Gaming keyboards typically include programmable keys so that gamers can customize the keyboard to the game being played. The keys on gaming keyboards light up so that the keys are visible in all lighting conditions.

Some have small displays that show important game statistics, such as time to targets remaining**.**

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(ii) Gaming wheels

A gaming wheel is a steering wheel-type input device. Users turn the wheel to simulate driving a vehicle using programs on a computer. Most gaming wheels also include foot pedals for acceleration and braking actions. Gaming wheels include buttons, called triggers that you press to initiate certain events

(iii) Joystick

Joystick- Consists of a stick that pivots on a base and reports its angle or direction to the device it is controlling. Joysticks are often used to control video games, and usually have one or more push-buttons whose state can also be read by the computer**.**

(iv) Gamepad

A gamepad controls the movement and actions of players or objects in video games or computer games. On the gamepad, users press buttons with their thumbs or move sticks in various directions to trigger events. Gamepads communicate with a game console or a personal computer via wired or wireless technology.

(v) Light gun

A light gun is used to shoot targets and moving objects after you pull the trigger on the weapon. Instead of emitting light, most light guns work by detecting light. When the user pulls the trigger, the screen uses one of several techniques to send light, which is received by a receptor in the barrel of the gun.

(vi) Dance pad

A dance pad is a flat electronic device divided into panels that users press with their feet in response to instructions from a music video game. These games test the user's ability to step on the correct panel at the correct time, following a pattern that is matching with the beat of a song.

(vii) Motion sensing game controllers

These are devices that allow the user to guide onscreen elements by moving a handheld input device in predetermined directions through the air. Examples include the power glove, play station move gadgets, among others.

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e) Audio input Devices

Audio input is the process of entering any sound into the computer such as speech, music, and sound effects. To enter sound into a computer, it must have a sound card. Audio input devices are plugged into a port on the sound card**.**

(i) Sound Card

A sound card is a device that can be slotted into a computer to allow the use of audio components for multimedia applications. Without a sound card, Audio input and output is not possible**.**

(ii) Microphones

A microphone is an instrument for converting sound waves into electrical energy variations, which may then input into the computer for processing, recording or audio playback. Microphones are connected to the sound card in the system unit.

(iii) Musical Instrument Digital Interface (MIDI) devices

MIDI is the standard that defines how digital musical devices represent sound electronically. MIDI devices such as electronic pianos allow users to record and edit music. For example, you can set the beat speed, and add notes, to produce sound**.**

(iv) Dictaphone

This the earliest device most commonly used to record speech for later playback or to be typed into print. It was established by Alexander Graham Bell in Washington, D.C. in 1881.

e) Biometric input Devices

A biometric device translates a biological personal characteristic into a digital code that is stored or compared with a digital code stored in the computer.

(i) Fingerprint scanner

A fingerprint scanner captures curves and indentations of a fingerprint. Some grocery and retail stores now use fingerprint readers as a means of payment, where the customer's fingerprint is linked to an account or credit card.

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(ii) Face Recognition systems

A face recognition system captures a live face image and compares it with a stored image to determine if the person is a legitimate user. Some buildings use face-recognition systems to secure access to rooms.

(iii) Hand geometry system

Biometric devices measure the shape and size of a person's hand using a hand geometry system. Some large companies use this system as time and attendance devices or as security devices. Day-care centers use this system to verify parents who pick up their children.

(iv) Signature verification systems

A signature verification system recognizes the shape of your handwritten signature, as well as measures the pressure exerted and the motion used to write the signature. Signature verification system uses a specialized pen and tablet.

(v) Iris recognition system

These are devices that use *iris recognition technology* to read patterns in the iris of the eye. These patterns are as unique as a fingerprint. Iris recognition systems are used by government security organizations, the military and financial institutions that deal with highly sensitive data.

f) Other Specialized input devices

There are many other special input devices that are used for doing special customized tasks.

(i) Remote Control

Remote control devices emit a beam of infrared light, which carries data signals. Remote control is commonly used with TVs but many laptop computers being produced come with remotes and a form of input device, which allow you to operate the laptop from a distance.

(ii) Sensors

Chemical responses to the physical environment or movement can be converted to electrical signals by devices known as sensors, which input them it to the computer for processing. Various sensors can be used to measure heat, light, pressure, acidity, oxygen concentration, water flow, etc.

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2. PROCESSING DEVICES

Processing devices are the computer electronic components and chips housed in the system unit. They are used to interpret, manipulate, convert, translate and transform input data into information. Therefore a processing device handles the intermediate stage in the computer.

(i) The system unit

The system unit is a box-like case/chassis that houses all the internal components of the computer like motherboard, the disks and drive bays, the power supply and cooling systems. The system unit gives shape and appearance of the computer. It also protects the internal components against damage. The components in the system unit are connected to the motherboard. A drive bay is a rectangular opening inside the system unit that typically holds disk drives.

(ii) The Motherboard

The motherboard is a single circuit board that provides the path through which the processor communicates with internal and peripheral devices. The motherboard is also called the *system board*.

The components attached to the motherboard include the processor chip (the CPU), memory chips, support electronic circuitry, buses, and Expansion Slots for Adapter Cards.

(iii) The Power Supply Unit

The power supply is the component of the system unit that converts the wall outlet Alternating Current (AC) power of 110 to 240 volts into Direct Current (DC) power of 0.5 to 12 volts. Built into the power supply is a fan that keeps the power supply cool. Processor chips generate heat, which could cause the chip to burn up. **A heat sink** is a small ceramic or metal component with fins on its surface that absorbs and disperses heat produced by electrical components such as a processor.

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(iv) The Central Processing Unit (CPU)/

The central processing unit/ microprocessor/processor (CPU) is a chip that interprets, carries out the basic instructions and manages most of a computer's operations. It is at times referred to as the 'brain' of the computer. It has two basic sections: the control unit (CU) and the arithmetic/logic unit (ALU), which work together to perform the processing operations. Other CPU components are the Registers and the System Clock.

The basic sections of the CPU

- Control Unit
- Arithmetic Logic Unit
- Registers

(a) The control unit (CU)

The control unit is the component of the processor that directs and coordinates most of the operations in the computer.

It interprets each instruction issued by programs and then initiates the appropriate action to carry out the instruction. For every instruction, the control unit repeats a set of four basic steps called the machine cycle steps:

The machine cycle steps

The machine cycle steps: refers to the series through which data is converted into information in the central processing unit.

- **Step 1: Fetching the instruction.** The instruction to be executed is obtained from memory.
- **Step 2: Decoding the instruction**. The instruction is translated into commands the computer understand and sent to the ALU.
- **Step 3: Executing the instruction.** The commands are carried out.
- **Step 4: Storing results.** The results are stored in registers or memory.

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(b) Arithmetic/logic unit (ALU)

The ALU performs the arithmetic, comparison, and logical operations in a computer. It performs the execution step of a machine cycle.

Arithmetic operations include addition, subtraction, multiplication, and division.

Logical operations work with conditions and logical operators such as AND, OR, and NOT.

For example, if you wanted to search a student database for Candidates of Computer studies, you would search for any students classified under 'Computer studies AND listed under Candidates.

(c) Registers

Registers are high-speed working storage areas that temporarily hold instructions and data during processing. Registers work under the direction of the control unit to accept, hold, and transfer instruction or data and comparisons at high speed. Registers are not part of Memory or Secondary Storage: Registers hold data immediately related to the operation being executed. Memory is used to store data that will be used in the near future. Secondary storage holds data that may be needed later (in future)

Types of registers

- **Instruction register,** which contains the instruction being executed**.**
- **Address register,** which keeps track of where a given instruction or piece of data is stored in memory**.**
- **Storage register,** which temporarily holds data taken from or about to be sent to memory.
- **The Accumulator,** which collects the result of computations.
- **General-purpose register,** which is used for several functions, as assigned by the Control Unit

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(v) The system clock

The system clock is a small chip that is used by the CPU to synchronize the timing of all computer operations. The system clock generates electronic pulse or ticks at a fixed rate, which set the operating pace of components in the system unit. Each tick is called a clock cycle, which affects machine cycle time. The faster the clock, the more instructions the CPU can execute per second.

Clock speed

This refers to the speed at which a processor executes instructions. Clock speed is measured in hertz. **A *hertz*** *is one cycle or tick per second. A Megahertz (MHz) equates to one million ticks of the system clock per* second. Processor's speed is sometimes measured according to the number of MIPS (millions of instructions per second) it can process.

(vi) Buses

The bus is a common electrical path that enables data flow between the various system components. A bus allows the various devices inside and attached to the system unit to communicate with each other.

All buses consist of two parts:

- ***The data bus*** which transfers actual data bits and
- ***The address bus*** which transfers information about where the data should go in memory.

(vii) Expansion slots and Adapter cards

An expansion slot is a socket on the motherboard that can hold an adapter card. *An adapter card*, also called expansion card, is a circuit board that increases the capabilities of the system or provides connections to peripherals. Some motherboards include all necessary capabilities and do not require adapter cards. Adapter cards are used for many supplemental capabilities, such as more memory, higher-quality sound devices, a modem, extra ports, or graphics capabilities.

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(viii)Plug and Play (PnP)

In the past, installing a card was not easy and required you to set switches and other elements on the motherboard. Today, many computers support *Plug and Play*. **PnP** refers to the computer's capability to automatically configure adapter cards and other peripherals as you install them when the computer is still running.

(ix) Ports

A port is the point at which a peripheral attaches the system unit. Through a port, the peripheral can send data to or receive information from the computer.

A peripheral device, such as a keyboard, monitor, printer, mouse, digital camera, and microphone, often attaches by a cable to a port on the system unit.

Note*: A peripheral device is hardware device connected/attached to the computer externally*.

Common ports on a computer

(a) **A serial port** is a type of interface that connects a device to the system unit by transmitting data one bit at a time. It usually used to connect devices that do not required fast data transmission rates, such as a mouse or keyboard.

(b) **Personal System PS/2 port,** sometimes called a mouse port, was developed by IBM. It is used to connect a computer mouse or keyboard. Most computers come with two PS/2 ports.

(c) **Parallel ports** allow the parallel transmission of data; that is, several bits are transmitted simultaneously. These ports provide the interface for such devices as high-speed printers.

(d) **USB (Universal Serial Bus)** ports are used in high-speed device interfaces.

(e) **Bluetooth ports** use radio waves to transmit data between two devices, without using cables.

(f) **Video graphics array (VGA)** is used to connect a monitor or a data projector. It is shaped like a letter D with 15 pins.

(g) **Audio interface** is used to connect speakers and microphone.

(h) **Fire wire** or IEEE 1394 has the same features as the USB but transmits data faster than USB. It is mostly used for streaming video from a digital video camera.

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(i) **Infrared**, also referred to as infrared Data Association (IrDA) is a wireless interface that uses infrared to connect to infrared-enabled devices.

(x) Connectors

A connector joins a cable to a port. A connector at one end of a cable attaches to a port on the system unit, and a connector at the other end of the cable attaches to a port on the peripheral. Most connectors are available in one of two genders: male and female.

- **Male connectors** have one or more exposed pins.
- **Female connectors** have matching holes to accept the pins on a male connector.

Memory (internal/primary storage)

While performing a processing operation, a processor needs a place to temporarily store instructions to be executed and the data to be used with those instructions.

The CPU cannot process data on an input device or disk directly; the data must first be available in memory. A computer's memory in the system unit is located physically close to the CPU to decrease access time. It provides the CPU with a working storage area for program instructions, data and information. Memory is also known as primary storage or internal storage. Memory usually consists of one or more chips on the motherboard.

Types of memory

The system unit contains two types of memory: volatile and non-volatile. The contents of *volatile memory are lost when* the computer power is turned off.

The contents of nonvolatile memory are not lost when power is turned off. RAM is the most common type of volatile memory. Examples of non-volatile memory include ROM, flash memory, and CMOS.

Below, we discuss these types of memory.

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(a) Random Access Memory (RAM)

Random Access Memory (RAM) is the memory chips that are mounted directly on the motherboard or mounted on peripheral cards that plug into the motherboard. The RAM chips consist of millions of switches that are sensitive to changes in electric current. When the computer is powered on, certain operating system files are loaded from a storage device such as a hard disk into RAM.

These files remain in RAM as long as the computer is running. As additional programs and data are requested, they are read from storage into RAM. The processor acts upon the data while it is in RAM. During the running time, the contents of RAM may change as the program is executed.

The amount of RAM a computer requires often depends on the types of applications you plan to use on the computer. A computer only can manipulate data that is in memory. A computer needs a certain amount of memory to store programs, data and information.

The more RAM a computer has, the faster the computer will respond.

A software package usually indicates the minimum amount of RAM it requires. RAM in computers purchased today ranges from 128MB, 512MB, 1GB to 64GB.

Basic types of RAM

- **Dynamic RAM (DRAM)** must be refreshed (or recharged) constantly by the CPU.
- **Static RAM (SRAM)** is faster and more reliable than any form of DRAM. The term static refers to the fact that it does not have to be re-energized as often as DRAM.
- **Magneto resistive RAM (MRAM),** stores data using magnetic charges instead of electrical charges. MRAM has greater storage capacity, consumes less power, and has faster access times.
- **Virtual RAM (VRAM):** Modern operating systems can use spare storage space on the hard disk as if it is working memory and this is referred to as Virtual memory or Virtual RAM

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Read-only memory (ROM)

Read-only memory (ROM) refers to memory chips storing permanent data and instructions. That is, the items stored in ROM chips cannot be modified—then, the name read-only.

ROM is usually nonvolatile. In ROM, the combination of circuit states is fixed, and therefore its contents are not lost if the power is removed. The data, instructions, or information stored on ROM chips often are recorded when the chip is manufactured. ROM chips that contain permanently written data, instructions, or information are called firmware. Firmware can be read and used, but cannot be changed by user.

Basic types of ROM

(a) **Programmable read-only memory (PROM)** is a blank ROM chip on which you can permanently place data and programs.

Once the data and instructions are programmed into PROM chip, the chip functions like a regular ROM and cannot be erased or changed. A variation of the PROM chip, called electrically erasable programmable read-only memory (EEPROM) chip, allows a programmer to erase the microcode with an electric signal.

Differences between RAM and ROM

RAM	ROM
1. Volatile, temporally	1.Non Volatile, permanent
2. Contents lost when power goes off	2. Contents remain when power goes off
3. Read and Write	3. Read Only
4. Can be increased	4. Cannot t be Increased
5. Not installed at Factory	5. Installed at Factory

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(b) Memory cache

A cache is a relatively small block of very fast memory designed for the specific purpose of speeding up the internal transfer of data and software instructions.

Cache uses internal storage technologies that are much faster than conventional RAM. Cache speeds up processing time because it stores frequently used instructions and data.

(c) Flash memory

Flash memory is a chip also that keeps its contents when the power is shut off. Flash memory can be erased electronically and reprogrammed. Most computers use flash memory to hold their startup instructions because it allows the computer easily to update its contents.

(xi) Complementary Metal-Oxide Semiconductor (CMOS)

CMOS technology provides high speeds and consumes little power. CMOS technology uses battery power to retain information even when the power to the computer is off. Battery-backed CMOS memory chips, for example, can keep the calendar, date, and time current even when the computer is off.

Units of Measuring Computer Memory

The smallest unit of measuring Computer Memory is a Binary digit (Bit). Binary digits are the numbers 1 and 0 which can be represented in a computer by switching voltage on and off. Eight little bits make one BYTE. The storage capacity of computers (RAM and ROM) and that of auxiliary storage units like disks are generally given in bytes. One BYTE stores approximately one character.

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3. SECONDARY STORAGE DEVICES

Secondary storage devices refers to the category of hardware devices that stores, holds and keeps data and information permanent in the computer. They are non-volatile devices.

When a user issues a command to start an application program, the operating system locates the program in secondary storage, and loads it into primary memory. In this Unit, we shall focus on secondary memory

Common terms related to storage devices.

(a) **A Storage medium** is the physical material on which a computer keeps data. There is a variety of storage media available.
(b) **Capacity** is the number of bytes (characters) a storage medium can hold.
(c) **A Storage Device** reads and writes data to and from a storage medium.
(d) **Reading** is the process in which a storage device transfers data, from a storage medium into memory.
(e) **Writing** is the process in which a storage device transfers data from memory to a storage medium (saving).
(f) **Access time**, is a measure of the amount of time it takes a storage device to locate an item on a storage medium.
(g) **Transfer rate** is the speed with which data, instructions, and information move to and from a device. Transfer rates for storage are stated in Kbps (kilobytes per second).

Categories of Secondary Storage Media

There is a wide variety of storage devices in the following categories.

- Magnetic storage media
- Optical storage media
- Solid-state storage devices

(a) Magnetic storage media

The term magnetic storage refers to the storage of data on a magnetized device. Therefore magnetic storage devices are devices that store data using magnetized technology.These media stored data using a combination of magnetic fields and binary data.

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Magnetic storage media represent data as magnetic spots on the tape or disk, with a magnetized spot representing a 1 bit and the absence of such a spot representing a 0 bit. As advances in technology allowed these drives to hold magnetic fields more efficiently, their size advanced from kilobytes - thousands of binary entries -- to terabytes --1,000,000,000,000 or more binary entries.

Common examples of magnetic media include:

- Magnetic tape
- Floppy disk,
- Zip and Jazz disks
- Hard disk drives (HDD)

(i) Magnetic tape

Magnetic tape is a magnetically coated ribbon of plastic capable of storing large amounts of data and information at a low cost. Tape storage requires sequential access, i.e. data must be accessed in the order in which it is stored. If the computer is to read data from the middle of a tape, all the tape before the desired piece of data must be passed over consecutively. Today, magnetic tape storage is no longer used for routine processing.

Advantages of using a tape for data storage:

- Can hold thousands of megabytes (MB) of data depending on the length of the tape.
- Useful for daily backups of all work and programs on a large network.
- Can be set to run automatically during the night and then will only be needed in an emergency.

Disadvantages of using tapes:

- Very slow, as need to wind tape (perhaps a long way) to find any specific position.
- Random data access is not possible.
- Magnetic Tape Data storage has a limited shelf life of about 2 years only.

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ii) The Hard Disk

A hard disk is a principal mass storage medium in a computer system that stores data magnetically.

Made of stronger thick non-flexible disk material (aluminum)or (ceramic)coated with magnetic materials and fixed permanently together with its drive mechanism inside the computer. Data is stored magnetically. Spinning at the required speed all the time it is very much faster to access than a floppy disk or CD-ROM (faster than 1 MB per second).

They can hold thousands of megabytes (gigabytes) of data. A hard disk is used for storing all programs and work files for very fast access by the computer.

Characteristics of hard disks

- They store mass volumes of programs and data thus increases the productivity of a computer
- They are faster in loading or retrieving data and programs than other forms of secondary storage.

(ii) Floppy disk (diskette)

A floppy disk, or diskette, is a portable, inexpensive storage medium that consists of a thin circular, flexible plastic disk with a magnetic costing enclosed in a square-shaped plastic shell.

A standard floppy disk is 3.5-inches wide and has storage capacities up to 1.44 MB. A floppy disk drive is a device that can read from and write to a floppy disk. Before you can write on a new disk, it must be formatted.

Formatting is the process of preparing a disk for reading and writing by organizing the disk into storage locations called tracks and sectors. It involves erasing and deleting all the data on the storage media

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Care for diskettes

- Keep diskettes away from magnet fields, such as near wire telephones, loud speakers, and other appliances, which contain magnets.
- Do not keep heavy objects on top of the diskettes.
- Do not fold or bend diskettes.
- While labeling or writing on the diskettes use felt tip pen, not pencil or ballpoint pen.
- Do not expose the disk to excessive heat or light.
- Do not pull out the diskette from its drive when the drive light is still on.
- Do not use alcohol thinners, to clean the disk surface.
- Do not touch the disk surface.
- Do not bang, drop etc
- Do not splash liquids eg water etc
- Keep out of moisture

Advantages of Floppy Disks

- Floppy diskettes are portable
- Floppy diskettes are cheap
- Random Data Access on a diskette is possible
- A floppy diskette can be write- protected from being changed.

Disadvantages of Floppy Disks

- Floppy diskettes are not reliable – they need to be handled with a lot of care, else risk losing data.
- Floppy diskettes are not durable.
- Data Access time is relatively slow.
- They have limited Storage capacity (only 1.44MB)

(iii) Zip drive

The Zip drive is a medium-capacity removable disk storage system with capacities of 100 MB to 750 MB that was introduced by Iomega in late 1994.

However it was never popular enough. Zip drives fell out of favor for mass portable storage during the early 2000s due to emergence of much better USB flash drives CDs, and DVDs.

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(iv) The Jazz drive

Similar the Zip drive, The Jazz drive was a removable disk storage system, introduced by the Iomega Company in 1995. The Jazz disks were originally released with a 1 GB capacity. The rising popularity and decreasing price of CDs and DVDs greatly hurt the success of the Jazz Drive and the Jazz line was ultimately discontinued in 2002.

(b) Optical Storage Media

Optical storage refers to recording of data by making marks in a pattern that can be read back with the aid of light, usually a beam of laser light.

The reflected light is converted into a series of bits that the computer can process. An *optical disc* is a flat, round, portable storage medium made of metal, plastic, and lacquer that is written and read by a laser. Optical discs used in personal computers are 4.75 inches in diameter. Smaller computers and devices use mini discs that have a diameter of 3 inches or less.

Care for Optical Disks

- The following should be done for the safety of data on Optical disks:
- Do not expose the disc to excessive heat or sunlight
- Do not eat, smoke or drink near a disc.
- Do not stack disks.
- Do not touch the underside of the disk.
- Always store the disc in a jewel box when not in use
- Always hold a disc by its edges.
- Do not drop the disk to the ground.
- Don't bend the disk.

a) A compact disc (CD)

A compact disc (CD) is a flat, round, portable, storage medium that is usually 4.75 inches in diameter and less than one-twentieth of an inch thick.

Compact discs store items by using microscopic pits and land that are in the middle layer of the disc. A compact disc stores items in a single track, which is also divided into evenly sized sectors, that spirals from the center of the disc to the edge of the disc.

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b) Picture CD

A Picture CD is a compact disc that only contains digital photographic images saved in the jpg file format. You can purchase Picture CDs that already contain pictures. A Picture CD is a multisession disc, which means you can write additional data to the disc at a later time.

c) CD-R (compact disc-recordable)

CD-R (compact disc-recordable) is a technology that allows you to write on a compact disc using your own computer's CD-R drive.

Once you have recorded the CD-R, you can read from it as many times as you desire. A CD-R is a multisession optical disc which allows you to write on part of the disc at one time and another part at a later time. However, you cannot erase the disc's contents.

d) CD-RW (compact disc-rewritable)

A CD-RW (compact disc-rewritable) is an erasable multisession disc that you can write on multiple times. Reliability of the disc tends to drop, however, with each successive rewrite. To write on a CD-RW, you must have a CD-RW drive and CD-RW software. A CD-RW drive has a lower read and write speed as compared to CD-Rs.

iii) Magneto-optical (MO) disk

This is a hybrid disk, which combines the best features of magnetic and optical disk technologies. It has the erase and rewrite capabilities of magnetic disks, but it also has the very high-volume density capabilities of optical disks. MO disks are not popular because they are too expensive, and not as reliable as magnetic media.

e) DVD-ROM

A DVD-ROM (Digital Video Disc-ROM) is an extremely high capacity compact disc capable of storing from 4.7 GB to 17 GB. A DVD-ROM drive or DVD player is required to read a DVD-ROM. Although the size and shape of a DVD-ROM and a CD-ROM are similar, a DVD-ROM uses one of the following three storage techniques to increase its storage capacity

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The first technique involves making the disc denser by packing the pits closer together. A second technique involves using two layers of pits, which doubles the capacity of the disc. Finally, some DVD-ROMs are double-sided, which means that they can be removed and turned over to read the other side.

Advantages & Disadvantages of CD

Advantages of compact disc over hard disk include

- A compact disc is more portable than a hard disk.
- Less prone to viruses than any other medium

Advantages of compact disc over floppy disk include

- The storage capacity of a compact disc is very much larger than that of a floppy disk.
- The average access time of a compact disc is faster than that of a floppy disk.

Disadvantages of compact disc include

- Some kinds of compact discs are read only (CD-ROM and DVD-ROM).
- The average access time of a compact disc is slower than that of a hard disk.

f) High Capacity DVD formats

A Blu-ray Discs-ROM (BD-ROM) has storage capacities of up to 300 GB. The HD (high-density) DVD-ROM has storage capacities up to 60 GB. A mini-DVD that has grown in popularity is the UMD (Universal Media Disc), which can store up to 1.8 GB of games, movies, or music.

(c) Solid-state Storage Media (SSS)

Solid state storage (SSS)/flash memory: is a type of computer storage media that is made from silicon microchips. SSS stores data electronically instead of magnetically. *Flash memory* stores the binary data of zeros and ones, but it does so with electrons that shuttle through the device's circuitry instead of magnetic poles on a disk. Because electrons store the data, the devices have no moving mechanical parts. This allows the drives to consume less power than traditional magnetic drives and to retrieve data faster.

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a) USB flash drive

A USB flash drive is a flash memory storage device that plugs in a USB port on a computer. USB flash drives are convenient for mobile users because they are small and lightweight enough to be transported in a pocket. Current USB flash drives have data storage capacities ranging from 256 MB to 64 GB. USB flash drives have become the mobile user's primary portable storage device, making the floppy disk nearly outdated.

b) Smart Card

Smart Card: Contains a processing microchip to provide it with intelligence as well as memory it is really a tiny computer, eg. the SIM card used in a mobile phone identifies you through a PIN number, identifies and connects to your service provider and provides a menu of options, as well as storing phone numbers and phone settings.A **smart card**, which is similar in size to a credit card or ATM card, stores data on a thin microprocessor embedded in the card.

An **intelligent smart card** contains a CPU and has input, process, output and storage capabilities.

Applications of smart cards include

- Storing a prepaid dollar amount (e.g., a prepaid telephone calling card).
- Storing patient records and other health-care information.
- Tracking information of customers and employees.

c) Memory card/Memory Stick

Flash memory cards are a type of solid-state media, which means they consist entirely of electronic components and contain no moving parts. Common types of flash memory cards include; *CompactFlash (CF), SmartMedia, miscroSD, miniSD, xD, Picture Card*, etc. They are commonly used in electronic devices such as digital cameras and mobile phones. They are tiny, re-recordable, and able to retain data without power. Depending on the device, manufacturers claim these storage media can last from 10 to 100 years.

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Other Types of Storage Media

a) Punched Cards

A punched card, punch card, IBM card, or Hollerith card is a piece of stiff paper that contains digital information represented by the presence or absence of holes in predefined positions. They were used through the 20th century in unit record machines for input, processing, and data storage. Early digital computers used punched cards, often prepared using keypunch machines, as the primary medium for input and storage of both computer programs and data.

b) Photographic film

Photographic film is a sheet of plastic such as polyester coated with a light sensitive emulsion that is used to record and store photographs. Normal film is shipped in small canisters (boxes) that protect it from the light. When exposed to light, it forms an invisible image. Chemical processes can then be applied to the film to create a visible image, in a process called film developing. A normal photographic film can hold up to 40 pictures.

c) Microfilm and Microfiche

These are media used to store microscopic images of documents on roll or sheet film. The images are recorded onto the film using a device called a computer output microfilm recorder. The stored images are so small they can be read only with a microfilm or microfiche reader. Microfilm and microfiche have the longest life of any storage medium. Libraries use these media to store back issues of newspapers, magazines, and genealogy records.

d) Data Logger

A remote input/output device, which stores data received from sensors that can then be input into a computer at another time or place. It can be left alone to collect data over a long period of time and in hostile places, such as on a satellite, at the bottom of the ocean or at the South Pole.

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4. OUTPUT DEVICES

These are devices that are used to convey and display information to the user. **A display device** is an output device that visually conveys text, graphics, and video information. Output is data that has been processed into a useful form called information. Computers generate several types of output, depending on the hardware and software being used and the requirements of the user.

Commonly used output devices include

a) Display devices
b) Printers
c) Audio Output Devices
d) Other

Categories of Computer output

While working with a computer, a user encounters four basic categories of output:

- Text, (characters that are used to create words, sentences, and paragraphs)
- Graphics (non-text information such as drawings and charts)
- Audio (music, speech, or any other sound)
- Video (full-motion images played back at various speeds)

a) Display Devices/ Visual Display Units

A display device is an output device that visually conveys text, graphics, and video information. Information shown on a display device often is called soft copy, because the information exists electronically and is displayed for a temporary period of time. Display devices are also known as (Visual Display Units (VDUs). Commonly used display devices include

- CRT Monitors
- LCD Monitors
- Plasma monitors
- Projectors
- Headgears
- LED displays

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i) CRT Monitors

A CRT (cathode ray tube) monitor is a desktop screen that contains a large sealed glass cathode-ray tube. Inside the CRT, an electron beam moves back and forth across the back of the screen. This causes dots on the front of the screen to glow, producing an image on the screen. Each dot consists of a red, a green, and a blue phosphor, which combine to make up a pixel. **A *pixel*** *is a single point in an electronic image.*

Advantages of CRT Monitors

- They are less expensive.
- They operate at any resolution, geometry and aspect ratio without the need of rescaling the image.
- CRTs run at the highest pixel resolutions generally available.
- Produce a very dark black and the highest contrast generally available.
- Produce the very best color and gray scale.
- Have fast response times and no motion artifacts
- Can also be viewed from a wide angle.
- They are very durable/lasts long

Disadvantages of CRT Monitors

- They consume a lot of electric energy.
- Affected by magnetic fields from other equipment including other CRTs
- Have a rounded spherical or cylindrical shape
- Emit electric, magnetic and electromagnetic fields.
- They are large, heavy, and bulky.
- All color CRTs produce annoying Moiré patterns.
- They are subject to geometric distortion and screen regulation problems.
- Produce a lot of heat.

ii) Flat-Panel Displays

A flat-panel display is a lightweight display device with a shallow depth and flat screen that typically uses LCD (liquid crystal display) or gas plasma technology. Examples of flat -panel displays include LCD monitors, and plasma monitors. Many are widescreen, i.e. much wider than they are tall. Screens are measured diagonally from one corner to the other. Common sizes are 17”, 19”, 20”, 22”, 24” and 27”, 45” and 65 inch screens

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Advantages of LCD Monitors

- They consume less electrical energy.
- They are portable in size, light,thin,
- The image is perfectly sharp at the native resolution of the panel.
- There is minor distortion from other resolutions because the images must be rescaled.
- Produce very bright images.
- The screens are perfectly flat.
- Produce little energy

Disadvantages of LCD Monitors

- They are very expensive
- Limited viewing angle
- Each panel has a fixed pixel resolution format determined at the time of manufacture that cannot be changed.
- Have difficulty producing black and very dark grays.
- The bright end of the LCD intensity scale is easily overloaded.
- The internal Gamma and gray-scale of an LCD is very irregular.
- Can have many weak or stuck pixels which are permanently on or off.
- LCDs have fixed resolution and aspect ratio

iii) Data Projectors

A data projector takes the image that displays on a computer screen and projects it onto a large screen or wall so that an audience of people can see the image clearly. For example, many classrooms use data projectors so that all students easily can see an instructor's presentation on the screen. Presence of excess light affects data projectors and so they perform well in dark rooms.

Head Mounted Display (HMD) / Headgear

A headgear is made up of two tiny display and sound systems that channel images and sound from the source to the eyes and ears, thus presenting a stereo three dimensional sound effect in the virtual world.

The wearer may also put on a body suit that senses the body movement and relays the data into the virtual reality system which in turn adjusts the position of the user in the system.

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iv) Light Emitting Diodes (LED) displays

A LED display is a flat panel display, which uses light-emitting diodes as a video display. A LED panel may be a small display, or a component of a larger display. They are typically used outdoors in store signs and billboards.

More Terms associated with Display Devices

1. Resolution is the number of horizontal and vertical pixels in a display device. A higher resolution uses a greater number of pixels and thus provides a smoother, sharper, and clearer image. Resolution is measured in dpi (dots per inch)

2. Dot pitch, aka pixel pitch, is the distance in millimeters between pixels on a display device. Text created with a smaller dot pitch is easier to read.

(b) Printers

A printer is a device that produces a hard copy output such as text and graphics on a physical material like paper. Printed information (hard copy) exists physically and in a more permanent form than a soft copy on a display device. Printers with different speeds, features, quality, and capabilities are available in a range of prices.

Printers can be grouped into two categories:

- Impact printers
- Non-impact printers.

1. IMPACT PRINTERS

An impact printer forms characters and graphics on a piece of paper by a striking mechanism against an ink ribbon that physically contacts the paper. Impact printers are noisy because of this striking activity.

Large Businesses use impact printers because these printers can withstand dusty environments, vibrations, and extreme temperatures. Commonly used types of impact printers include Daisy wheel, dot-matrix, Braille and line printers.

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Characteristics/features of impact printers

- Very low consumable costs
- They are very noisy
- Useful for bulk printing due to low cost
- There is physical contact between the papers to produce an image.
- They are relatively very slow.
- They do not print transparencies
- Multiple carbon copies may be printed at once.
- Print quality is relatively low.

a) Daisywheel printer

This is a kind of impact printer where characters are arranged on the ends of the spokes of a wheel. The wheel (usually made of plastic) is rotated to select the character to print and then an electrically operated hammer bends the selected spoke forward slightly, squeezing in an ink ribbon between the character and the paper, as in a typewriter. One advantage of this arrangement over that of a typewriter is that different wheels may be inserted to produce different typefaces (font styles and sizes)

Low speed and noise are its disadvantages. The speeds are between 20 to 90 characters per second (cps)

b) Dot-matrix printer

A dot-matrix printer produces printed images when tiny wire pints on a print head mechanism strike an inked ribbon like in a type writer. When the ribbon presses against the paper, it creates dots that form characters and graphics. Most dot-matrix printers use continuous-form paper, in which thousands of sheets of paper are connected together end to end. The papers have holes along the sides to help feed the paper through the printer. Dot matrix printers provide cheap but low quality printing.

Advantages of Dot matrix printers

- They are versatile
- Print letters in italics or bold
- Relatively inexpensive
- Used to print carbon copies.

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Disadvantages of Dot matrix printers

- Very noisy
- Slow speed
- Space consuming

c) Drum printer

An old line printer technology that used formed characters around a cylindrical drum as its printing mechanism. When the desired character for the selected position rotated around to the hammer line, the hummer hit the paper from behind and pushed it into the ribbon onto the character.

d) Braille printers

A Braille printer, commonly known as a Braille embosser, is an impact printer that renders text as tangible dot cells which are felt and read by the blind.

Using Braille translation software, a document can be embossed with relative ease and efficiency. They need special Braille paper which is thicker and more expensive than normal paper. Once a copy produced, printing further copies is often quicker by means of a device called a "thermoform", which produces copies on soft plastic

e) Line printers

A line printer is a high-speed impact printer that prints an entire line at a time. The speed of a line printer is measured by the number of lines per minute (lpm) it can print. Some line printers print as many as 3,000 lpm. Mainframes, servers, or networked applications, such as manufacturing, distribution, or shipping, often use line printers.

2. NON-IMPACT PRINTERS

A nonimpact printer forms characters and graphics on a piece of paper without actually striking the paper. Some spray ink, while others use heat or pressure to create images. Commonly used nonimpact printers are ink-jet printers, laser printers, thermal printers, plotters, and mobile printers.

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Advantages of Non-Impact –printers.

- They print high quality images
- They are very speedy
- The printer does not make contact with the paper
- They print on most types of paper
- They can also print on transparencies.
- They do not make noise when printing.

a) Ink-jet printer

An ink-jet printer forms characters and graphics by spraying tiny drops of liquid ink onto a piece of paper. Ink-jet printers produce text and graphics in both black-and-white and color on a variety of paper types & sizes. The print head mechanism in an ink-jet printer contains ink-filled print cartridges. Each cartridge has very many small ink holes, or nozzles. The ink propels through a combination of the holes to form a character or image on the paper.

b) Laser printer

A laser printer is a high-speed, high quality nonimpact printer. Operating in a manner similar to a copy machine, a laser printer creates images using a laser beam and powdered ink, called toner, which is packaged in a cartridge. When printing a document, laser printers process and store the entire page before they actually print it. For this reason, laser printers sometimes are called page printers. Storing a page before printing requires the laser printer to have a certain amount of inbuilt memory.

c) Thermal printers

A thermal printer generates images by pushing heated pins against a coated heat-sensitive paper. The coating turns black in the areas where it is heated, producing an image. Basic thermal printers are cheap, but the print quality is low and the images tend to fade over time. Thermal printing technology is, however, ideal for use in small devices e.g. ATM receipt printers.

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d) Plotters

Plotters are printers used to produce large, high-quality, vector graphic drawings such as blueprints, maps, posters, and signs. These printers are usually very costly, and are used in specialized fields such as engineering, and graphic art. They use ink-jet printer technology, on a much larger scale, to print professional quality displays.

e) Mobile Printers

A mobile printer is a small, lightweight, battery powered printer that allows a mobile user to print from a notebook computer, Tablet PC, PDA, smart phone or other personal mobile device while traveling. They fit easily in a briefcase alongside a notebook computer. Mobile printers mainly use ink-jet, thermal, wax-transfer, or dye-sublimation technology.

Terms associated with Printers

1. Toner is a powder used in laser printers and photocopiers to form the printed text and images on the paper.

2. dpi. (Dots per inch) is a measure of the number of individual dots printed in a line within the span of 1 inch (2.54 cm). The DPI value correlates with image resolution.

3. Hard copy is a permanent reproduction, on the form of a physical object, of any media suitable for direct use such as paper.

4. Ink Cartridge. This is a component/container for the liquid ink that is deposited onto during printing of characters on a paper. Used mainly by inkjet printers.

5. Toner Cartridge: This is a component/container for the liquid ink that is deposited onto during printing of characters on a paper. Used mainly by laser printers.

6. Page orientation is the way in which a rectangular page is focused on for normal viewing.

The two most common types of orientation are *portrait* and *landscape*.

A page in portrait orientation is taller than it is wide, with information printed across the shorter width of the paper.

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A page in landscape orientation is wider than it is tall, with information printed across the widest part of the paper.

AUDIO OUTPUT DEVICES

Audio output devices are the components of the computer system that produce music, speech, or other sounds, such as beeps.

a) Computer Speakers

Computer Speakers typically have tone and volume controls, allowing users to adjust settings. To boost the low bass sounds, surround sound speaker systems also include a woofer, with one or two center speakers and two or more satellite speakers that are positioned so that sound emits from all directions. Some Computer Speakers use Wireless technology.

b) PC internal Speakers

Most personal computers have a small internal speakers that basically output beeps and low-quality sound.

c) Headphones and Earphones

In a crowded computer laboratory environment, speakers might not be applicable. Instead, users can plug head-phones or earphones in a port on the sound card, in a speaker, or on the front of the system unit. With the headphone or earphone, only the individual wearing the headset hears the sound from the computer.

Other Output Devices

There are very many kinds of emerging output devices. Some are both input and output devices. Examples include:

- Fax (or facsimile) machine
- Interactive whiteboard.
- Machine Tools.
- LED displays.
- Multifunction peripherals.

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a) Fax (or facsimile) machine

A fax machine is a device that transmits and receives typed or hand written documents over telephone lines. A stand-alone fax machine scans the original document, converts the image into digitized data, and transmits the digitized image. A fax machine at the receiving end reads the incoming data, converts the digitized data into an image, and prints or stores a copy of the original image. Fax capability also can be added to a computer using an external fax modem.

b) Interactive whiteboard (IWB)

An interactive whiteboard is a touch-sensitive device, resembling a dry-erase board that displays the image on a connected computer screen. The presenter can use bare hands, a special tablet, or remote control to interact with the device. Notes written on the interactive whiteboard can be saved directly on the computer. Interactive whiteboards are used frequently in classrooms as a teaching tool.

Three basic technologies exist for displaying computer images on an interactive whiteboard:

(1) Front projection:
A separate projector displays an image from the computer screen on the interactive whiteboard;

(2) Rear projection:
A projector built into the back of interactive whiteboard displays an image from the computer screen on the whiteboard; and

(3) An interactive whiteboard fits over an LCD screen or a plasma display.

c) Machine Tools

A machine tool is a machine for shaping metal or other rigid materials, usually by cutting, boring, grinding, or shearing. Through Computer-aided manufacturing (CAM) computers are used to control the output of machine tools and related machinery in the manufacturing of work pieces.

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d) Multifunction peripheral (MFP)

A multifunction peripheral (MFP) is a device that performs a variety of functions that would otherwise be carried out by separate peripheral devices.

As a rule, a multifunction peripheral includes at least two of the following:

- A printer
- A scanner
- A photocopier
- A fax machine

Merits and Demerits of MFPs

Advantages of a multifunction device are that

- It takes up less office space.
- It is significantly less expensive than if you purchased each device separately.

The major disadvantage of the machine is that if it breaks down you lose all functions.

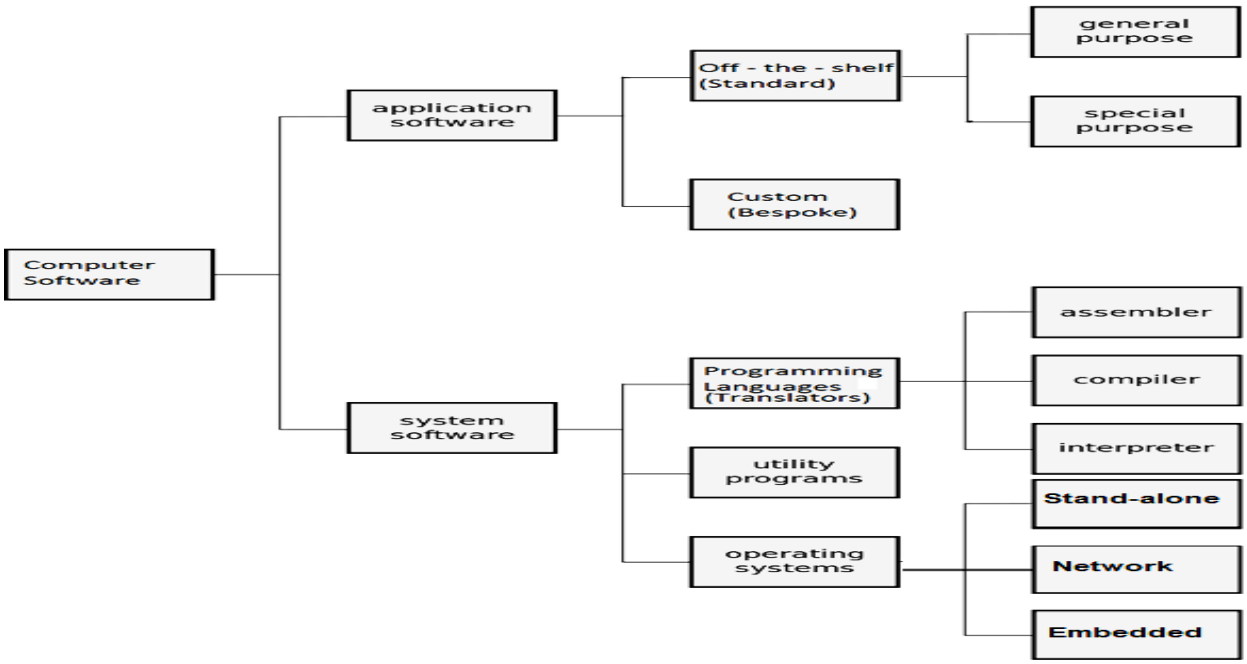
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TOPIC: COMPUTER SOFTWARE

Computer software refers to the electronic instructions and procedures that command and control the operation of a computer.

Illustration of computer software



TYPES OF SOFTWARE

There are mainly two types of software.

- System Software
- Application software

SYSTEM SOFTWARE

System software refers to a category of software that enables the computer to work and as well control devices connected to it.

Or it refers the software that performs tasks related to the operation and performance of the computer system.

System software is a set of programs designed to manage operations of the computer and avail computer resources to the user.

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Functions of system software

- Booting the computer
- Making sure that all hardware elements are working properly
- Performing operations such as retrieving, loading, executing and storing application programs
- Storing and retrieving files
- Performing a variety of system utility functions.

CATEGORIES OF SYSTEM SOFTWARE

There are three categories of system software.

- Operating system
- Utility programs
- Programming languages

OPERATING SYSTEM SOFTWARE

Operating system is a type of system software that performs daily activities of a computer. These are programs that manage the computer resources.

Types of operating system

- Stand-alone operating system: is a type of operating system that works on a personal computer. E.g. windows XP, windows vista, UNIX, Linux, Mac OS, etc.
- Network operating system (NOS): is the operating system that supports a network and always resides on the server. E.g. windows server 2003, UNIX server, Linux server, Novell NetWare, etc.
- Embedded operating system: is an operating system that resides on ROM chips and typically used on handheld computers and small devices. Examples include: Palm OS, Google's Android, Windows Embedded CE, Embedded Linux, Symbian OS, Windows mobile, etc.

Other Examples of Operating System Software:

- Windows 7, 8, 8.1, 10, 2.0, 3.1, 95, 98, Me, NT, etc.

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- Ubuntu
- MS DOS (Microsoft Disk Operating System)
- ETC.

Function of Operating System (OS)

- Provides a user interface.
- It helps in processor management e.g. multitasking and time sharing.
- Control the use of peripheral devices.
- It provides an environment that enables installation of application software
- Controls the booting process of a computer
- Monitors system performance.
- Helps in administering security
- It helps in file management.
- Responsible for scheduling computer tasks/jobs
- Helps to establish network connections.
- It helps in connecting devices to work with computer (configuring of devices). Some devices need device drivers. Plug and play devices are recognized automatically. A device driver is a program that accepts instructions and then converts them into commands that the device understands. Each device connected to the computer (keyboard, mouse, printer, etc) has its own device driver.

Forms of Operating System User Interfaces

There are three forms of Operating user interfaces.

- Command-Line user Interface (**CLI**)
- Graphical User interface (**GUI**)
- Menu Driven Interface (**MDI**).

Command-Line User Interface (CLI):

With a command line interface, a user types keyboard or press special keys on the keyboard to enter data and instructions. The set of commands a user uses to interact with the computer is called command language. Examples are DOS, UNIX, Linux.

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You are provided with a virtually empty screen with a blinking cursor where commands are keyed and the computer executes them after pressing the enter key.

Advantages of Command User Interface:

- Commands are executed faster.
- Consumes limited Random Access Memory.
- Cannot easily be affected by viruses.
- Ideal for programming and expert users.
- Commands can be grouped together.

Disadvantages of Command User Interfaces:

- Commands are not easily memorized.
- Requires a lot of knowledge to master the commands.
- Commands have to be typed correctly.
- A mouse cannot be used

Graphical User Interface (GUI):

Today, most of the computer programs have a GUI.

Graphical user interface is an interface which allows the user to use visual images such as icons, buttons and other graphical objects to issue commands. It is the most user friendly, because it does not require one to know any command language.

An icon is a pictorial representation of an item like program, file, folder etc. on the computer memory.

Advantages of Graphical User Interface:

- It is user friendly i.e. it is easy to learn and work with.
- There is no need to type and memorize any command language.
- The interface is similar for any application.
- You are provided with a coloured screen with icons each representing a program.
- A mouse may be used.

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Disadvantages of Graphical User Interface:

- Requires more RAM.
- Requires more memory space to hold the files.
- Difficult to automate for expert users.
- Easily affected by viruses.
- Not good for programmers.
- It is slow compared to CLI.

Menu Driven Interface (MDI):

This interface provides a list of items for entering instructions/commands. It is more user friendly than CLI. The user does not need to cram the keywords for commands.

Factors to consider for choosing an operating system:

- The type of the computer in terms of size and make.
- The hardware configuration of the computer such as the memory capacity, processor speed and hard disk capacity should meet the minimum requirements for the OS to run.
- The user friendliness. This depends on the skills of the intended computer users.
- The OS should have adequate information and help guides for the user reference.
- The number of users it can support.
- The number of processors and hardware devices it can support.
- Reliability and security of the OS.
- The programs (application programs) should be supported by the OS. E.g Microsoft 2010 cannot run on Windows 2000.
- The cost price of the OS.
- Availability of basic utilities and accessory programs within the operating system.

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UTILITY SOFTWARE

This is part of system software which are designed to configure, analyze, optimize and maintain a computer in good working state. Utilities add functionality to the computers or help computers to perform better.

Examples of Utilities include:

Antivirus utility: used to scan, detect and eliminate computer viruses from the computer storage system and memory.

Backup utility: makes a copy of all information stored on the hard disk onto another storage medium e.g. external hard disk, DVDs, etc.

Screen savers: these prevent phosphor burn-in on CRT and plasma monitors by filling it with moving images or patterns when the computer is not in use. Screen savers can be used for entertainment, advertisement, or security.

Disk defragmenters: These detect computer files whose content is scattered in several locations on the hard disk and move fragments to one location to increase efficiency and allow faster data processing.

Diagnostic utility: compiles technical information about the computer's hardware and other system programs and then prepares a report outlining any identified problems.

Sort and merge utilities: these help to organize data in a given order and also combine two more ordered files in to one file.

Disk compression utilities: these shrink or reduce the size of the file thus increasing the capacity of the disk. A compressed (zipped) file occupies a small space. The zipped files have **.zip** file extension. A compressed file can be downloaded and uploaded in a short time.

This utility also is responsible for decompressing the files.

Uninstaller utilities: removes an application program and its associated entries within the file system.

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Disk checkers: these scan an operating hard drive for logical (file system) and physical errors.

Cryptographic utilities: used to encryption and decryption of streams of files during data transmission.

System archives: These output a stream or a single file when provided with a directory/set of files.

Memory testers: these check for memory failures.

Disk partition utilities: these divide a drive into multiple logical drives, each with its own file system which can be mounted by the operating system to be treated as an individual drive.

Search utility: this locates a file in the computer basing on the criteria used.

File synchronization utilities: these maintain consistency between two sources. They enable redundancy or making copies of data.

System profilers: provide detailed information about the software installed and hardware attached to the computer.

Network utilities: these analyze a computer's network connectivity, configure network settings, check data transfer or log events.

File Managers: provide a convenient method of performing routine data management tasks like creating, deleting, renaming, copying, moving, merging and modifying files.

ETC.

DEVICE DRIVERS

A device driver is a small program that tells the operating system how to communicate with the connected device. Each device on a computer (e.g. a mouse) has its own specialized set of commands and thus requires its own specific driver. The operating system loads each device's driver when the computer boots up.

To communicate with the hardware devices, the operating system relies on device drivers.

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PROGRAMMING LANGUAGES

These refer to the languages used to write a computer instruction, program software. A person who writes a program is called a programmer.

Functions of Software Programmer

- He writes a computer program
- He maintains a computer program
- He upgrades a computer

TYPES OF PROGRAMMING LANGUAGES

Programming languages are of two types

- Low level programming language
- High level programming language

Low level languages

This is a computer program written in machine code language, the language understood by a computer. It is also referred to as binary language because it consists of only two digits. The digits of 0s and 1s

Types of low-level languages

- Machine code language (First generation)
- Assembly language (Second generation)

Assembly (low-level) languages

This is a language which consist of mnemonic symbols (English like words) used to represent the binary digits of zeros and ones of machine language. Assembler languages are used to develop system software.

However computers can only understand machine language, thus assembler languages must be translated into machine language for execution.

Advantages of Low level languages/Machine code

- Machine code program are executed faster.

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- They don't require either a compiler or interpreters except assembly
- They are suitable to developing operating systems.

Disadvantages of Low level languages

- They are difficult to learn and understand.
- The instructions are expressed in binary form (0 and 1s)
- The programs are machine dependent hence difficult to be used by other machines of different family.

High level programming languages

This is a computer program written in official language (known to man) but should be converted to machine code for a computer to understand.

High level languages consist of statements or sequences text including words, numbers and punctuation, much like written natural languages.

Advantages of High level Languages

- They are machine independent and can be used by other computers.
- They are user friendly and problem oriented.
- They are easier to learn, write, correct and revise than assembler and machine languages.
- They can be used for development of application software.

Disadvantages of High level Languages

- They require to be translated to machine code
- They are not executed faster.

Examples of high level languages

- ❖ COBOL
- ❖ PASCAL
- ❖ Python
- ❖ Java Script
- ❖ Java
- ❖ C
- ❖ Ruby
- ❖ C++
- ❖ C#(C-sharp)
- ❖ PERL
- ❖ FORTRAN
- ❖ PHP

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LANGUAGE PROCESSORS/TRANSLATORS

Language processors: These have to translate high level languages to machine code languages which the processor can understand. They are software designed to translate from high level language to low-level language.

Examples of language processors

A compiler: a compiler is a program which translates a whole source program from high level language to low level language which can easily be understood by the computer.

An interpreter: This is a program that translates the source program line by line while the program is running from high level language to low level language.

The assembler: This translates assembler instructions from assembley language to machine code language or the binary code.

The linkers: These combine compiled programs and determine where the program will be located in the memory.

Language editors

These are applications/software used to write computer language/codes. Some also compile.

Examples of language editors

- Notepad
- Trouble c
- Borland
- Sublime Text
- Dev C, C++
- CodeBlocks
- Notepad ++

Common terms used in programming

Source code is a program instruction written as text file by the programmer that must be translated by a compiler or interpreter or assembler into an object code before execution.

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Source code cannot be understood by the computer until it has been translated into machine code.

Execution is the process by which a computer system performs the instructions of a computer program.

Object code is a program code in machine language that is ready for execution by the computer.

Bug is a logical problem in the program source code that stops the program to give wrong results/ from running

Debugging is the process of detecting, checking and identifying problems and errors in the source code.

APPLICATION SOFTWARE

This is a software program that performs a specific and user function. Application software is installed on operating system.

Application software consists of programs designed to perform specific tasks for end-users. For example typing a letter.

TYPES OF APPLICATION SOFTWARE

Application software is categorized into two:

- Off-shelf packages
- Customized programs/ Bespoke/ Tailor-made programs

OFF SHELF PACKAGES

- These are programs already written and ready to be run upon their purchase.

Main categories of off shelf packages

Word processors

These are programs that enable you to perform word processing functions, they are document production applications.

Word processing software

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An application software with which a user creates, edits save, format And print letters reports and other documents. E.g. word processing software, EZ word, word perfect etc

Spreadsheet software

An application with which a user can organize data in rows and columns create graphs and can perform calculations e.g. Ms excel, Lotus 123, VisiCalc

Presentation software

An application with which a user can organize content on a slide for viewing by the audience. Ms power point, Harvard graphics, Corel presentation

Database software

An application with which one can store lots of data for future manipulation

Desktop publishing software

Application software with which one can design publications like news papers, wedding cards certificates etc

Imaging software application software with which done can edit, retouch a photograph.

Web browsing software

Web browsing software used for displaying and viewing webpages from the internet or html documents on computers.

Examples Include:

- Mozilla Firefox,
- Internet Explorer
- Safari
- Opera
- Netscape Navigator
- Chrome

Web authoring software

Web authoring software – These are used by webmasters for building websites. Examples include:

- Microsoft FrontPage,
- Adobe Dreamweaver,

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- Microsoft Expression Web,
- Antenna Web Design Studio
- Sublime text 3

Media Players for Audio and Video

Media Players for Audio and Video playback on computers. Examples include:

- Windows Media Player,
- Nero Showtime,
- Jet-Audio,
- Power DVD,
- VLC Media Player
- Virtual DJ, e.t.c.

Graphics software

Graphics software – Used by graphic designers to create and design artistic graphics and to manipulate visual images on a computer such as

logos, cartoons etc.

Examples include

- Paint,
- Adobe Photo shop,
- Corel Draw,
- Adobe Illustrator etc.

Accounting software

Accounting software helps companies to record and report their financial transactions. With accounting soft-ware, you perform accounting activities related to the general ledger, accounts receivable, accounts payable, purchasing, invoicing, job costing, payroll functions, etc. Examples include Quick Books

Audio and video editing software

Audio editing software lets users produce studio quality soundtracks. With video editing software, you can modify video clips: you can reduce the length of a video clip, reorder a series of clips, or add special effects such as words that move horizontally across the screen etc.

- Adobe Premier Video Editor
- Ulead Video Editor
- Adobe Audition for –audio

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- Fruity Loops Studio-audio

Images viewing software

This refers to computer applications primarily used for previewing digital photographs on the computer screen.

Many have basic features such as viewing thumbnails, slideshows, printing and simple editing such as cropping and resizing.

Examples of Image viewers include: Microsoft Office Picture Manager, Windows Photo viewer, Picasa photo viewer, etc.

Reference software

Reference software provides valuable and thorough information for all individuals. Popular reference software includes encyclopedias, dictionaries, health/medical guides, and travel directories.

Examples include: Encyclopaedia Britannica 2011 Ultimate Reference DVD

Microsoft Student with Encarta Premium, e.t.c.

Note Taking software

Note taking software enables users to enter typed text, handwritten comments, drawings, or sketches anywhere on a page and then save the page as part of a notebook .The software can convert handwritten comments to typed text or store the notes in handwritten form. Examples include Microsoft Office OneNote

Text Editors

Text editors are simple word processors that are generally used to type without any special formatting. Text editors are mainly used to create small notes, memos and programs. Examples of common text editors are: Notepad,

Notepad++, Sublime Text, Gedit etc.

Gaming Software

These are programs developed as electronic game that involve human interaction with a user interface to generate visual feedback on a computer.

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Common computer games include solitaire, chess titans, Racing, StarCraft, Need for Speed, GTA Vice City, and Alien Shooter.

Email Software / Email client

Email software (Commonly known as email client) is a computer program used to access and manage a user's email account.Web applications that provide message management, composition, and reception functions are sometimes also commonly referred to as webmail.

Popular locally installed email clients include Microsoft Outlook, Pegasus Mail, Mozilla's Thunderbird, KMail, Evolution and Apple Mail. Popular web-based email clients include: GMail, Yahoo! Mail, mail.com, Lycos mail, and Hotmail.

Advantages of off-shelf packages

- They are relatively cheaper than bespoke packages.
- They are readily available for purchase.
- They are user friendly; many have a graphical user interface, sample manuals provided on purchase.
- The user does not face research and development costs or problems since the package is already in operation.
- The user faces limited risk since the user has an option to seek information from existing users about the package before making a decision to purchase.

Disadvantages of off-shelf packages

- They hardly full fill users' specific needs perfectly.
- They are standardized implying it may be hard to make adjustments.
- They may not be recommended where a particular company wants to gain competitive advantage over others.
- Where the package does too much compared to the company needs, the amount of extra space occupied in the hardware can lead to memory wastage.
- The package may also be limited to a particular operating system like Microsoft Office for Windows operating system.
- It may be easy to manufacture viruses that may tamper with such application programs.

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CUSTOMIZED/TAILOR-MADE/BESPOKE PROGRAMS

These are tailor made programs constructed to meet specific user requirements. They are specifically designed to meet user requirements.

Merits of customized programs

- Ability to satisfy user's specific needs
- The company will be able to perform tasks with its software that its competitors cannot do with theirs thereby gaining a competitive advantage.
- They can easily be modified or upgraded.
- Ownership is to the company that ordered for the software.

Disadvantages of customized software

- Time taken to develop the package may be long yet requirements could be urgent.
- The cost of paying programmers makes them expensive. The organisation has to incur development and consultancy costs in this case.
- They are not flexible i.e. not meant to do various tasks.
- They are expensive to maintain. When they breakdown programmers who are expensive have to be called in
- In-case of breakdown, the company may be brought to a standstill
- There is a greater probability of bugs in bespoke programs.
- They are not compatible with all computer types i.e. they are designed for specific computer types.
- The program may not run which means that the programmer has to design another one. This could even lead to more costs on the side of the user as well as causing delays

Shareware

Shareware is copyrighted software that is distributed at no cost for a trial period. To use a shareware program beyond that period, you send payment to the program developer. In some cases, a scaled-down version of the software is distributed free, and payment entitles the user to the fully functional product.

Copyrighted software

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Copyrighted software refers to computer programs with restrictions regarding use, modification, and redistribution. You have to pay for copyrighted software and must not copy it without permission from the manufacturer. Copying copyrighted software without paying for it is clearly unethical and illegal.

Freeware

Freeware is copyrighted software provided at no cost by an individual or a company that retains all rights to the software. Therefore, other programmers cannot include freeware in applications they intend to sell.

Open-source

Open source software is software provided for use, modification, and redistribution. This software has no restrictions from the copyright holder. Open source software usually can be downloaded from the Web at no cost.

Public-domain software

Public-domain software has been donated for public use and has no copyright restrictions. Anyone can copy or distribute public domain software to others at no cost.

Web-based software

Web-based software refers to programs hosted by a Web site. Users access and interact with Web-based software from any computer or device that is connected to the Internet. Many Web sites allow free access to their programs; some charge a fee. Examples of Web-based software include e-mail,

Website builders, online games, travel and mapping software ,e.t.c.

Special Purpose (Specialized) Software

This refers to computer programs developed and dedicated to accomplish particular jobs only. Programs that run on special purpose computers like ATMs are special purpose software.

Other Examples of specialized software include:

- Business – Transaction and Sales Management software.
- Science and Engineering software etc..

General purpose

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This refers to a Wide a variety of application programs that perform many common tasks.

• Varieties of General purpose application programs include Word processing programs, Spreadsheet programs, web browsers, Graphics programs, etc.

Software suite

A software suite is a collection of several applications that are bundled together and sold or distributed as a single package. The software programs may have correlative features and functionality or they may be completely different from one another but share a similar theme.

When you install the suite, you install the entire collection of applications at once instead of installing each application individually. At a minimum, suites typically include the following software applications: word processing, spreadsheet, database, and presentation graphics,

Examples of software suites

- Microsoft Office
- Libre Office Productivity Suite.
- Open Office.Org
- Word Perfect Office X5
- Zoho
- Quickoffice & OfficeSuite
- ProOffice Free 3.0
- KOffice
- Lotus Smart Suite
- Adobe Master Suite

Advantages of using software suites

- Costs significantly cheaper than buying each of the application package separately
- Easy to learn and use because applications within a suite usually use a similar interface and share common features such as clip art and toolbars.
- Easy installation because all the various applications can be installed at once.

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Common Terminologies used in Software

Software needs to be accessed before it can be used. There are many terms used for the process of accessing software including running, executing, starting up, opening, and others. A program can also be referred to as an application and the two words are used interchangeably.

Software license

This is a document that provides legally binding guidelines for the use and distribution of software.

Software agreement

This refers to the legal contact between licensor and /or author and the purchaser of a piece of software which establishes the purchaser's' rights.

Software piracy: This is an illegal duplication of copyrighted software.

Software bug refers to an error in the programming code that does not permit it to function well.

Beta software is a type of software provided to people for testing purposes.

Software release is the process of issuing/letting the software or application for publication, use and distribution.

Software version refers to variation of an earlier or original type with minor changes to the existing version or type. Eg. ITunes 12.0, ITunes 12.2.3

Hot fix: This is a software program that is designed to fix a bug or security hole in software program.

Spy ware: This is a software application that is designed to gather information about a person or organization without their knowledge that may send such information to another entity.

Software Patch: This is a software program that is designed to modify, correct, and fix problems in software.

Software update: This is a software application that provides fixes for features that are not working as intended or adds minor software enhancements and compatibility.

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Software upgrade: This is a process of replacing a product with a newer version of the same product.

Firmware: This is a permanent software that is programmed or embedded in a hardware usually read-only-memory by the manufacturer.

Characteristics of Good computer software

- ...provides the required functionality.
- ...is usable by real (i.e. simple) users.
- ...is predictable, reliable and dependable.
- ...functions efficiently.
- ...has a "life-time" (measured in years).
- ...provides an appropriate user interface.
- ...is accompanied by complete documentation.
- ...can be easily customized/configured.
- ...can be "easily" maintained and updated.

Factors to consider before obtaining a software program

- Correctness — does the software do what it is suppose to do (according to the design specs)?
- Robustness — how does the software respond to unexpected conditions (wrong input)?
- User-friendliness — is the software easy to use by users from the intended audience?
- Adaptability — how difficult is it to modify the software to adjust to an ever-changing world?
- Cost effectiveness

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Characteristics of good software

- **Suitability**. This is the essential Functionality characteristic and refers to the appropriateness (to specification) of the functions of the software.
- **Accurateness**. This refers to the correctness of the functions, an ATM may provide a cash dispensing function but is the amount correct?
- **Interoperability**. A given software component or system does not typically function in isolation. It concerns the ability of a software component to interact with other components or systems.
- **Compliance**. Where appropriate certain industry (or government) laws and guidelines need to be complied with. This s addresses the compliant capability of software.
- **Security**. This relates to unauthorized access to the software functions.
- **Fault tolerance**. The ability of software to withstand (and recover) from component, or environmental, failure.
- **Understandability**. Determines the ease of which the systems functions can be understood, relates to user mental models in Human Computer Interaction methods.
- **Learnability**. Learning effort for different users, i.e. novice, expert, casual etc.
- **Maintainability**. Characterizes the amount of effort to change a system.
- **Stability**. Characterizes the sensitivity to change of a given system that is the negative impact that may be caused by system changes.
- **Replace ability**. Characterizes the plug and play aspect of software components, that is how easy is it to exchange a given software component within a specified environment.

End of software.

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