

Topic 5: Computer Hardware

Introduction

Computer Hardware: Is the physical or tangible components that make up a computer system. They are classified into four categories namely input devices, output devices, storage devices and processor components (processing devices).

Input devices

Input devices convert user input which is in human readable form to machine language that a computer can process. These devices are identified as basic input devices and they include; Keyboards, mouse, digital cameras, barcode readers, microphones, scanners, touchpad and joystick;

Keyboard: is a keying device that converts typed numbers, letters and special characters into machine readable form before processing takes place. The keyboard has many types such as Traditional keyboard, flexible keyboard, Ergonomic keyboard and Braille keyboard. Ergonomic keyboard is designed to provide comfort and alleviate wrist strain. Braille keyboard is a keyboard designed for use by the blind.

Mouse: is a pointing device used for controlling a pointer cursor on the screen. Apart from the mouse other pointing device include; trackball, joystick, and light pen. Mouse has three types these include Standard or traditional mouse using a ball underneath, Optical mouse and cordless mouse that uses infrared waves or wireless connection to the system unit.

Digital cameras: capture images and store in a digital form. Pictures are mostly stored on a memory card instead of a film. The stored images can be edited, printed or uploaded to the internet.

Barcode readers: are used to capture data coded lines of varying thickness known as bar codes or Universal Product Code (UPC). Barcodes hold manufacturer's details and the product code but not the price details because prices vary from one place to another.

Microphones: is a voice input technology used to enter data in form of speech into the computer. Voice input has limitations in that it does not fully support speech related aspects such as accents, inflections and tones.

Scanners: is a device used for capturing data from an object and converting it into digital format. Scanning can be classified according to technology used to capture data. These are optical scanners and magnetic scanners. Examples include Optical mark recognition (OMR), Optical bar recognition (OBR), optical character recognition (OCR) and Magnetic ink Character recognition (MICR) scanners.

Touchpad: is a technology that allows the user to touch the screen using a finger or stylus in order to write or select an item. The screen consists of infrared light crisscrossing behind it. When the user touches a location on the screen, the finger interrupts the infrared light and the output is displayed on the screen.

Joystick: is an input device that looks like a lever used to control a pointer on the screen. It is purposely used for playing computer games. The user controls game actions by varying the pressure, speed and direction of the joystick.

Interactive whiteboard: is a large interactive display that connects to a computer. It is also known as a smart board. The computer display is projected onto the board's surface, where users control the computer and write using a pen or a finger. The board is typically mounted to a wall or on the floor stand. Smart boards are used in places such as classrooms, seminars, broadcasting studios and corporate board rooms.

Output devices

Output devices are peripheral devices that a computer uses to give out information produced after the processing operations. These devices can be classified into two categories namely soft copy and hard copy output devices.

Softcopy refers to a readable form of data, information or instructions that can be seen or heard; such as screen display and sound are intangible. Examples of such devices include monitors, LCD projectors and speakers.

Hardcopy refers to a copy of data that has been printed on paper. Hardcopy is tangible. Examples of hardcopy output include printers, plotters and facsimile (fax). Examples of output devices such as visual display units, printers, analog devices for speech generation and speakers are explained below.

Monitor

A monitor, also known as Visual Display Unit (VDU) or the screen, is used to display information in the form of text, pictures and video, enabling the user to monitor what is going on in the computer. There are three common types of monitors namely Cathode Ray Tube (CRT), Liquid crystal Display (LCD) and Gas plasma Display (GPD) monitors. LCDs and gas plasma display are generally referred to as flat panel displays.

Cathode ray tube monitors

A cathode Ray Tube (CRT) monitor consists of a long glass tube with an electron gun on one end and a screen on the other. The electron gun shoots electrons to illuminate the screen and is coated with tiny red, green and blue to make a pixel.

Liquid crystal Display (LCD) monitors

A Liquid Crystal Display (LCD) is made of a special liquid crystals. Unlike CRTs, LCDs are less bulky, consume less power and have little strain effect on the eyes. Due to this reasons, LCDs are gradually replacing the CRT monitors on desktop computers.

Gas plasma displays

Gas plasma displays resemble LCDs only that they make use of gas instead of liquid crystals. They contain millions of pixels that are illuminated by charged neon gas. Unlike LCDs, images

displayed on gas plasma do not suffer from angle distortion. Currently the technology is mainly used to produce high definition TVs (HDTV), and wall display screens.

Data projectors

Projectors are used to display output from a computer on a plain white screen like a wall or whiteboard. It is a creative way of presenting computer output to an audience. This technology is gradually replacing the traditional overhead projectors.

Speakers

Speakers are sound output devices which produces sound such as beeps, audio or digital. Some computers come with inbuilt speakers, hence eliminating the need to connect external speakers.

Printers

Printers are primarily used to produce information on a piece of paper. The quality of a hardcopy depends on the printer's printing mechanism. Printers are classified according to different printing mechanism. The two categories are impact and non-impact printers.

Impact printers

Impact printers print using striking mechanism. This means that they strike the paper in order to form an imprint on it. Two examples of impact technologies are dot matrix and daisywheel printers.

Dot matrix printers: Dot matrix printers have a set of pins on the printer's head which strikes on an ink ribbon placed over the paper.

Daisy wheel printers: Daisy wheel printers have a removable flower-like wheel consisting of spokes with embossed characters. When printing, the wheel is rotated to align the required character and the characters are hit with a hammer.

Although impact printers are cheaper to run and print for long periods without breaking, they produce low quality printouts.

Non-impact printers

Non-impact printers are faster and quiet than the impact printers. They print using ink, thermal or laser mechanisms. The four types of non-impact printers are inkjet, thermal, laser and photo printers.

Inkjet printers: Inkjet printers print by spraying tiny ink droplets onto a paper to create an image. A colour inkjet printer may have black and tricolor cartridges that contain cyan, magenta and yellow (CMY) compartments. The cartridge has nozzles that do the actual spraying of ink on the paper.

Although inkjet printers are cheaper to purchase and produce better quality printouts, they are more expensive to run due to high cost of replacing the cartridges.

Thermal printers: Thermal printers use thermal technology to heat ink which is normally in wax or resin form to melting point before fusing it onto the paper. Thermal printers are mostly used in point of sale terminals to print receipts and barcodes.

Although thermal printers produce high quality printouts, they are expensive to purchase and run.

Laser printer: Laser printers operate by shining a laser beam to create an image on the rotating drum. As the beam hits the drum, it ionizes some regions which attract ink toner particles. The toner is fused onto a piece of paper through heating.

Laser printers are very fast compared to the inkjet and thermal printers. They are cheaper to run and produce high quality printouts. However, they are expensive to purchase.

Photo printer: Photo printers are special purpose printers designed to print photos.

Plotters

A plotter is a large type of hardcopy output device. Plotters are mostly used for printing geographical, architectural and engineering drawings e.g. maps, advertisement posters to be placed on billboards, machine parts etc.

Factors to consider when purchasing a printer

The choice of purchasing a printer depends on a number of factors which include:

1. **Print quality:** dot matrix printers are good for bulk printing or draft documents, laser printer is good for printing official documents while thermal printers are good for checkout counter receipts.
2. **Initial cost:** Though the prices of printers have come down, laser and thermal printers are still expensive compared to inkjet printers.
3. **Running cost:** The cost of maintaining an inkjet printer is higher than that of maintaining laser printers.
4. **Speed:** the speed of a printer is measured in pages per minute.
5. **Colour printing:** most printers support black and colour printing. However, colour printers, especially lasers are relatively more expensive.

Peripheral device interfaces

Peripheral device interfaces refers to connecting a peripheral device to a computer through ports using either cables or wireless connectivity. Examples include Parallel interface, serial interface, Universal serial bus (USB) interface, Small computer system interface (SCSI), Personal system 2(PS/2) interface, video Graphics Array (VGA) interface, Audio interface, Fire wire interface, Infrared and Bluetooth and power interface.

Parallel Interface

Parallel cables transmit information simultaneously using a set of many conductors (wires). For example, if a cable uses 8 lines to transmit data at the same time, it is said to be an 8-bit parallel cable. The advantage of using such cable is that they transmit data faster over a short distance.

A parallel cable connects to a parallel interface port commonly referred to as Line Printer (LPT). Parallel cables are used to connect printers, optical scanners and some removable storage drives such as zip drive.

Serial interface

Serial ports also known as COM or RS232 ports, support transmission of data one bit at a time, hence it is slower than the parallel port. Although they are slower, they are more reliable than parallel ports because they can support data transmission to devices connected 15m away. Serial cables are generally used to connect devices such as the mouse and some printers.

Universal serial bus (USB) interface

Universal serial bus is a new standard serial interface that is set to replace the conventional parallel and serial cables and ports. Currently, most peripheral devices from printers to mobile phones are coming with USB as the default interface. Although it transmits only 1-bit at a time, it provides high-speed and quality data transmission over distances of approximately 5metres. The two types of USBs namely low speed USB (1.1) and a relatively faster high speed USB (2.0). A USB port can be used to connect as many as 127 peripheral devices to a computer daisy chained to a single port known as the root hub.

Small Computer System Interface (SCSI)

Small computer system interface port and interface cables transmit data in parallel but are faster than the parallel cables. Another advantage of the SCSI port is that one SCSI port allows us to connect to multiple devices.

Personal system 2 (PS/2) interface

Originally, most computers use the 5-pin DIN to connect a keyboard to the system unit but the smaller 6-pin mini-DIN also known as PS/2 interface has replaced this technology. Currently most desktop computers come with two PS/2 ports, one for mouse and the other for the keyboard.



Video graphics array (VGA) Interface

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

Audio Interface

Audio interface is used to connect speakers and microphone.

Fire wire interface

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.







Infrared and Bluetooth

Infrared, also referred to as infrared, Data Association (IrDA) is a wireless interface that uses infrared to connect to infrared-enabled devices. On the other hand, Bluetooth is also wireless interface that uses short range radio broadcast to connect to any Bluetooth- enabled device.

Power supply

The power supply unit and adapter is used to convert AC to DC current. Though computers are connected to AC power supply, internal components require DC power. Desktop PCs use power supply unit mounted on system unit casings. You connect the power supply using a power cable.

The table below shows summary of standard symbols used to denote an interface.

Symbol	Port
	Parallel
	Serial
	USB
	SCSI
	PS/2 for mouse
	PS/2 for Keyboard

Storage devices

Secondary storage, refers to as auxiliary storage, are devices that provide alternative long term storage for programs, data and information. They are regarded as secondary because unlike primary storage, they are not directly accessible by the CPU. Secondary storage devices can be classified according to:

- a) *Portability as removable and fixed*
- b) *Technology used to store and retrieve data as magnetic, optical, magneto-optical and solid state.*

In this section, we balance the two devices by indicating whether a device or media is removable and the technology used to store data on it.

Removable storage

Removable storage media are those that are not housed inside the computer. Data is read and written into the media using a device known as drive. Examples of removable storage include magnetic tapes, floppy disk, optical disks and solid state devices.

Magnetic tapes

A magnetic tape is made using a thin ribbon of Mylar coated with a thin layer of magnetic material composed of iron oxide. The tape resembles the music cassette used in home tape recorders. Data is read from or written using a tape drive. Examples of magnetic tapes include: reel to reel tapes, cassette tapes and cartridge tapes.

Disadvantages of using magnetic tapes

1. Magnetic tapes are slow because of the linear storage of data records on the tape. This means that you have to access the proceeding records before you get what is required.
2. There is a space between successive data records called inter-record Gap (IRG), which results in wastages of storage space.

Floppy disks

A floppy disk or simply a diskette is made up of small flexible round disk coated with magnetic iron oxide. This disk is covered with a plastic protective case. However it is important to note that diskettes are becoming unpopular due to the entry into the market of affordable mass storage media such as flash disks and memory cards.



Zip disk

A zip disk is a high capacity magnetic diskette that resembles a floppy disk. However compared to a 3.5 floppy disk, a zip disk has a higher storage capacity and is physically thicker. A zip disk can hold as much as 250MB. Zip disk come with separate portable external drives.

Jaz disks

Jaz disks resemble zip disks in every sense only that they can hold as much as 2GB. Data is read or written using internal or external jaz drives.

High capacity floppy

High capacity floppy disks simply known as HiFD disk are high capacity diskettes that can store up to 200MB of data. HiFD drive can also read the magnetic 1.44MB diskette.

Laser servo 120 Super disks

Laser servo 120 super Disk technologies (LS-120), is a diskette that resembles the 3.5 inch diskette but uses optical technology. It has a greater storage capacity and speed of data retrieval (it can store up to 240 MB). The LS-120 drive can read and write both the 3.5 inch floppy disk and the 120MB Super disk.

Care of magnetic storage media

To avoid accidental loss of data or information held on magnetic media, the following rules must be observed:

1. Do not expose a magnetic media to strong magnetic fields. This would dis-orient the magnetic dipole causing erasure of recorded data.
2. Do not expose a magnetic media or excessive heat. Heat energy leads to loss of magnetic strength in materials, hence magnetically recorded data can easily get lost.
3. Do not drop magnetic media on the ground because the impact weakens magnetism.
4. Do not bend or fold a magnetic media or put heavy weights on them to avoid breaking or damaging it.
5. Do not touch the magnetic surfaces.
6. Do not remove a media from the drive when it is still being accessed by the computer because this may result to data loss.

Optical Storage media

Optical storage media are so called because data is written and read from them using a laser beam. A laser beam is a very strong concentrated light. Two reasons why optical storage media are used:

1. They store very large volumes of data.
2. Data stored in them is more stable and more permanent than the magnetic media.

Compact disk (CD)

Compact disk hold large quantities of data and information. One disk can hold as much as 700MB. They are mostly used to store data and information that requires a lot of space such as video clips, software, sounds etc. Currently compact disks are available in three forms namely:

Compact disk-read only memory (CD-ROM): Compact disk read only memory contains data that can only be read but cannot be written on. To record data the recording surface is made into pits and lands (bumps). When a laser beam fall on the land, this is interpreted as 1, otherwise a zero is recorded.

Compact disk-recordable (CD-R): Compact disk recordable (CD-R) are coated with a special dye which changes colour to represent data when burned using a laser beam. Once data is burned on a CD-R it becomes read only.

NB. CD-ROMs and CD-Rs are referred to Write Once Read Only Many (WORM). Data is only recorded once but can be read as many times as possible. CD-Rs can also allow adding of data records on the Compact disk recordable but does not allow erasing of data.

Compact disk-rewritable (CD-RW): unlike the CD-Rs, these type of compact disk allows the user to record, erase and rewrite new information just as one would with floppy disks.

Digital Versatile disks

Digital Versatile Disk (DVD), also known as digital video disk resemble compact disk in every aspect. The only difference is that they have a higher storage capacity of up to 4.7GB. They are suitable for recording motion pictures such as videos because they offer better sound and picture quality than the CDs.

Optical card

An optical card resembles an MICR card but data is read and written optically on a stripe. These types of cards are mostly used in banking and other business organizations to record customer details.

Optical tape

This is similar to magnetic tape only that data is stored y using optical technology.

Solid state storage media

Solid state is a non-volatile storage that employs integrated circuits rather than mechanical, magnetic or optical technology. Examples of solid state devices are memory stick and flash disk.

Fixed storage media

The hard disk is mounted inside the computer, therefore it is referred to as fixed disk. However, this is not absolutely the case because some hard disks are removable i.e. external hard disk (backup). The hard disk is also known as hard drive and it is made up of metallic disk platters together with a read/ writes head, housed in a protective metal case. The hard disk has the highest storage capacities in all storage devices up terabytes (TB).

The read/write head floats just above the surface of the rapidly rotating disk to read or write data.

Most computer hard disk is connected to the motherboard via a channel called controller. Some of these controllers are Integrated Drive Electronic (IDE), enhanced IDE or SATA (Serial Advanced Technology Attachment).

Processing devices

The central processing unit (CPU) also known as the processor is the most important component of the computer. It is actually regarded as the brain of the computer because all processing

activities are carried out inside the processor. In microcomputer, the CPU is housed inside the system unit. It is mounted on a circuit board known as the motherboard or the system board. The CPU consists of three functional elements namely the control unit, Arithmetic and logic unit (ALU) and main Memory.

Control unit

Control unit coordinates all processing activities in the CPU as well as input, storage and output operations. It determines which operation or instruction is executed next. To coordinate these activities, the control unit uses a system clock. The system clock sends electric signals as means of communication; the number of pulses per second determines the speed of a microprocessor. The faster the clock pulses, the faster the CPU, hence the faster the computer can process data.

Arithmetic and logic unit (ALU)

The arithmetic and logic unit is a unit of central processing unit where all arithmetic and logical operations are carried out. The basic arithmetic operations includes; additions, subtraction, multiplication and division. Logic operations are based on the computer's capacity to compare two or more values. For example, it may compare whether a piece of data is greater than or less than, equal to or not equal to etc.

In order for the ALU to be able to process data, it has special temporary storage location called **register**, which hold the data just before processing. It also holds the results after processing.

Main memory

Main memory also known as primary storage is a type of storage that is directly accessible by the processor. Computer memory can be classified into Read Only Memory (ROM) and Random Access Memory (RAM).

Read Only Memory (ROM)

Read Only Memory is used to store programmed instructions and data permanently or semi permanently. Data and instructions stored in ROM are those which remain unchanged for long period of time e.g. POST instructions, special purpose computers, computerized fuel pumps instructions etc.

Depending on permanence of the instructions or data written on it there are four Types of Read Only Memory namely:

Mask Read only memory: Once the content is written on it by the manufacturer, it cannot be changed.

Programmable Read Only Memory (PROM): This allows the user to alter it only once after the content is written on it.

Erasable programmable read Only Memory (EPROM): this has a transparent quartz window through which its content, can be erased by exposing it to ultra violet (UV) light, and then reprogrammed for another use.

Electrically erasable Programmable read Only Memory (EEPROM): this type of ROM can be erased and reprogrammed using electricity. Example of EEPROM is the memory that stores the basic input/output system (BIOS).

Characteristics of read only memory (ROM):

1. One can only read its content but you cannot write on it unless it is a special type of ROM.
2. It is an on-volatile i.e. its content is lost when the computer is switched off.
3. Stores permanent or semi-permanent instructions from the manufacturer called firmware. It can store semi-permanent instructions because some variations of ROM chips can be programmed according to the user's specification.

Random Access Memory (RAM)

Random access memory also known as working storage is used to hold instructions and data needed by the currently running applications. The information in RAM is continually read, changed, and removed. It is referred to as random access because its content can be read directly regardless of the sequence in which it was stored. As opposed to ROM, the content in RAM is held temporarily and its content is lost once the computer is turned off. Therefore, before switching off the computer, it is important that one stores (saves) his/her work in a device that offers relatively permanent storage facility.

Characteristics of random access memory (RAM) are:

1. Data can be read (retrieved) and written (stored) in it.
2. RAM is temporary (volatile) storage because its content disappears when the computer is switched off.
3. Its content is user defined i.e. the user dictates what is to be contained in the RAM.

The two main types of RAM are:

Static RAM

Static RAM (SRAM) is fast type of memory mostly located inside a microprocessor. For this reason, SRAM is used on special purpose memories such as cache memory. Cache memory is used to enhance the processing speed by holding data and instructions that are instantly required by the processor.

Dynamic RAM

Dynamic RAM (DRAM) is relatively slower type of RAM compared to SRAM. The term dynamic refers to the tendency for the stored charge to leak away, even with constant power supply. For This reason, DRAM requires periodic recharging (refresh) to maintain its data storage.

Special purpose memories

Some minute types of memories are included inside a microprocessor or input/output devices, in order to enhance its performance. These memories include buffers, registers and cache memory as discussed earlier.

Cache memory

Cache memory is a fast type of RAM. There are three types of cache memory namely:

1. **Level 1-Primary cache;** located inside microprocessor
2. **Level 2-External cache;** that may be inside microprocessor or mounted on the motherboard;

3. **Level 3-cache;** is the latest type of cache that works with L2 to optimize system performance.

Buffers

Buffers are special memories that are found in input/output devices. Input data is held in input buffer while processed output is held in output buffer. For example, computer printers have buffers where they can store massive documents sent by the CPU for printing hence freeing the CPU to perform other urgent tasks as the printer continues to print in the background.

Registers

Registers hold one piece of data at a time and are inside the CPU. Examples of registers are: accumulator, instruction register, address register and storage register.

Accumulator: this temporarily holds the results of the last processing step of the ALU.

Instruction register: this temporarily holds an instruction just before it is interpreted into a form that CPU can understand.

Address register: This temporarily holds the next piece of data waiting to be processed.

Storage register: This temporarily holds a piece of data that is on its way to and from the CPU and the main memory.

Memory capacities

Memory and storage capacity is measured in special units called bytes. A byte is equivalent to a single character i.e. a group of 8bits is called a byte. Characters can be a number from 0 to 9, letter A to Z a special symbol.

Memory quantities can be expressed in;

1. Kilobyte (KB) - Approximately one thousand bytes, but the actual size is 1024. This is because the computer uses base 2 systems (0 and 1, i.e. 2^n).
2. Megabytes (MB)-Approximately one million bytes but the actual size is 1048576.
3. Gigabyte (GB)-Approximately one billion bytes but the actual size is 1073741824.
4. Terabytes- Approximately one trillion bytes but the actual size is 1099511627776.

Overall functional organization of the CPU

The arithmetic and logic unit, the control unit and the main memory use electrical pathways or links referred to as buses. There are three types of buses namely:

Control bus: This is the pathway for all timing and controlling functions sent by the control unit to other parts of the system.

Address bus: This is the pathway used to locate the storage position in memory where the next instruction data to be processed is held.

Data bus: this is the pathway where the actual data transfer takes place.

Trends in processor and speed

Basically, a processor consists of an inbuilt set of instructions known as instruction set. Processors are classified into two categories namely Complex Instruction set computer (CISC) and reduced instruction set computers (RISC). The brand of microprocessors under processor trends include; Intel, Advanced Micro Devices (AMD), Cyrix and sun Microsystems.

Note: To determine the performance of the clock speed, it is measured in Hertz (Hz). A hertz is a unit of frequency which measures the number of cycles per second in a signal. A processor clock speed can be in kilohertz (kHz), megahertz (MHz) and gigahertz (GHz).

Criteria for selecting a computer system

Before purchasing a computer, hardware or software resources, it is advisable to do a requirement analysis of all the requirements necessary in order to balance between cost and user needs. Requirements analysis involve identify user needs, hardware and software evaluation.

Hardware considerations

Microprocessor type and speed

The processing power, speed and cost of a computer mainly depend on the type of microprocessor and its clock speed. Some of the microprocessor available today include microprocessor Intel Duo core, I Core3, 5, 7, Pentium IV, Intel Celeron, AMD Athlon and AMD Duron. Consider an acceptable speed that meets the user requirements at a fair price i.e. 3.4GHz processor speed.

Memory Capacity determines what operating system and application programs can be installed. Although, a computer may have a superior processor, it may not perform as expected if it has low memory capacity. Because of the current multimedia applications, a good computer should have sufficient memory to handle the heavy applications that require a lot of memory space in order to run i.e. 4GB-8GB of RAM.

Warranty

A warranty is an agreement between the buyer and the seller that spells out terms and conditions of, after selling a product in case of failure or malfunction.

Cost of computer system

The cost of a computer system depends on

1. It's processing capability.
2. Whether it is branded or clones. Branded computers are more expensive than their equivalent clones.
3. Its size. Portable computers are more expensive than.

Upgradability and compatibility

The hardware bought must be compatible across platforms and easily upgradable. For example, some older computers cannot support large hard disk and high speed serial bus devices (USB and fire wire) available in the market.

Portability

Portable computers such as laptops PDAs are ideal for people who do not take most of their time in office.

Special user needs

When selecting computer hardware, consider the unique user needs. For example, if a user is physically challenged, consider buying voice input devices.

Monitor

Depending on performance, choice of a monitor may depend on size, resolution and the technology used on it. Currently, flat panel displays like LCD, LED are gradually replacing CRTs.

Multimedia capability

Multimedia capability refers to the ability for a computer to process and output text, sound and pictures. A multimedia system consists of speakers, CD/DVD drive, sound card and SVGA.