

COMPUTER HARDWARE

Hardware refers to any physical/tangible part of the computer that you can touch, feel, see and pickup.

Classification of computer hardware

- | | | |
|-------------------|-----------------------|--------------------------|
| 1) Input devices | 3) Processing devices | 5) Communication devices |
| 2) Output devices | 4) Storage devices | |

Input devices

Computer input refers to any data and instructions entered/ed into a computer for processing.

Computer input devices are components/devices that enable a user to enter/feed data and instructions into a computer for processing.

The two types of computer input are:

- a) Data
- b) Commands

Examples of Input devices

- | | | |
|----------------------------------|---------------------------------|--|
| 1) Keyboard | 10) Scanner | 19) Optical mark
recognition (OMR)
reader |
| 2) Mouse | 11) MIDI device | 20) Magnetic ink character
recognition (MICR)
reader |
| 3) Touchpad | 12) Sensor and remote
sensor | 21) Optical character
recognition (OCR)
reader |
| 4) Trackball | 13) Digital camera | 22) Touch screen |
| 5) Stylus and graphics
tablet | 14) Bar code reader | |
| 6) Joystick | 15) Digital video camera | |
| 7) Microphone | 16) Web camera | |
| 8) Light pen | 17) PC camera | |
| 9) Pointing stick | 18) Magnetic stripe reader | |

Keyboards

Keyboards are one of the most commonly used manual input devices. Keyboards are used to input text, numbers and instructions into the computer. Most keyboards use a **QWERTY** key layout.

Uses of the keyboard

- 1) Keyboards are used to input data into applications for example entering text into word processing applications.
- 2) Keyboards can also be used to enter commands into the computer for example Ctrl+P to print

Advantages of keyboards

- 1) Keyboards are more reliable and produce fewer errors than other input methods since information you input instantly appears on the screen so it is easy to know whether it is correct.
- 2) Entering data and instructions with keyboards is generally faster than with pointing devices.
- 3) It is not necessary to buy additional equipment because most computer systems are normally supplied with keyboards

Disadvantages of keyboards

- 1) People with wrist and hand problems find using keyboards painful to use.
- 2) Typing speeds are still very slow when compared to computer speeds.
- 3) It takes a lot of time to practice in order to type quickly and accurately.

Mouse

A mouse is the most widely used pointing device on personal computers. Pointing devices are part of hardware that are used to **control a pointer** (cursor) on a screen.

There are three different types of mice:

- 1) A *mechanical mouse* is prone to clogging which can affect accuracy. A ball mouse uses a ball to detect movement.
- 2) An *optical mouse* is more accurate than ball mice and are better for editing images. An optical mouse uses light to detect movements.
- 3) *Cordless mice* use wireless technology in order to communicate with the computer and are powered by batteries.

Mice have two buttons and a scroll wheel. These provide users with different functions:

Left button is used to select icons and click options

Right button is used to call up a drop-down menu of options

Scroll wheel is used to move up and down through a document.

Uses of the mouse

- 1) Opening, closing, maximising and minimising programs and files.
- 2) Moving, grouping and deleting files.
- 3) Controlling a pointer on screen to select icons or move around the page.
- 4) Editing images in terms of size and position on the screen.

Advantages of Mice:

- 1) Faster to select icons and options when compared to a keyboard.
- 2) Very easy to move a pointer around a screen and to navigate through documents even for beginners.
- 3) It does not take time to master the techniques of using the mouse.
- 4) Mice fit comfortably below the palm and their wheels below fasten movements

Disadvantages of Mice:

- 1) Mice need a flat surface in order to work properly
- 2) Ball mice can pick up dirt which will affect the accuracy of pointer movement.
- 3) A mouse needs more desk space to operate compared to a touchpad or trackball.
- 4) You need to move a hand from the key board to move the pointer or execute a command given
- 5) It is not easy and convenient to input text with a mouse
- 6) Issuing commands by using a mouse is slower than by using a keyboard
- 7) A mouse is not accurate enough when it comes to drawings that require high precision

Major problems that often affect the proper functioning of the mouse

- 1) Dirt disrupts motion of the ball in the mechanical mouse
- 2) Nature of the surface-not too rough or too smooth
- 3) Disconnection of the chord in case the mouse falls down
- 4) Connecting the mouse to the system unit one must be very careful to follow the directions of the pins

Solutions to the problems

- 1) Cleaning the ball and rollers regularly
- 2) Providing the correct roll surface or mouse pad
- 3) Avoid mouse falling or hanging on the chord by tying twists on both the mouse and keyboard

Touchpads: Users lightly brush their finger over the touchpad in order to control a pointer. Touchpads are built into laptops and perform the same functions as mice and as a replacement to a mouse. The touchpad enables users to control a screen pointer and the buttons allow users to select icons and call up options.

Advantages of Touchpads:

- 1) Easier than QWERTY keyboards when used to select options and icons.
- 2) Touchpads are built into laptops so there is no need for a separate mouse. This helps improve portability.
- 3) Can be used even when there is no flat surface available.
- 4) Won't get clogged with dirt (as can happen with ball mice) so performance is never reduced.

Disadvantages of Touchpads:

- 1) More difficult to control a mouse pointer when compared to a mouse.
- 2) People with wrist and hand problems (like RSI) can find touchpads painful to use.
- 3) Some operations are more difficult to perform when compared to a mouse. Drag and Drop for example.

Trackballs: Track balls are similar to mice but the ball is on the top of the device instead of the bottom. Screen pointers are controlled by rotating the large ball with your hand.

Advantages of trackballs

- 1) Pointer can be positioned more exactly which makes trackballs very useful for image editing.
- 2) Can be used even when there is no flat surface available.
- 3) Good for limited desk space because the user does not have to move the entire device.

Disadvantages of trackballs

- 1) More expensive than mice.
- 2) More difficult to learn to use than a mouse.
- 3) The ball mechanism of trackballs also requires more frequent cleaning than a mouse.

Remote Control: Remote controls are used to control other devices using wireless signals.

Advantages of Remote Controls:

- 1) Devices can be operated without having to go to them. This is useful for people with disabilities.
- 2) Remote controls can operate devices that are in an unsafe environment. For example: Explosives to demolish a building can be set off at a safe distance.

Disadvantages of Remote Controls:

- 1) People with limited hand movement can find them difficult to use.
- 2) The signal between the remote control and the device it operates can become blocked by obstacles.

Joysticks: Joysticks are also popular devices for gaming. The handle allows gamers to control on-screen characters and the buttons are used for things like firing weapons.

Uses of Joysticks:

- 1) Joysticks can control characters or objects in video games.
- 2) Can control industrial machinery (cranes for example)
- 3) Joysticks are used in simulators. For example flight simulators use joysticks in order for trainee pilots to control the simulated plane.

Advantages of Joysticks

- 1) Easier to control an on-screen cursor or move an in-game character than it is when using a keyboard.
- 2) Very simple to get used to and can be used by disabled people since Joysticks can be operated by hands or even feet.
- 3) The joystick allows fast interactions required in most games

Disadvantages of Joysticks

- 1) Difficult to use a joystick to select objects accurately on the screen.
- 2) People with hand/wrist issues (like RSI) can find them painful to use.
- 3) Difficult (but not impossible) to enter text. For example: some games allow you to select individual letters using the joystick in order to spell out your name when entering a high score.

Touch Screens: Touch screens enable users to input commands into a computer by pressing or touching buttons/icons on the screen. Touch screens are more suitable for use with a limited amount of options.

Uses of Touch Screens:

- 1) Mobile phones and PDA's use touch screens as a way of saving space (a separate keyboard would make the devices quite large).
- 2) Public information systems at airports or tourist information offices.
- 3) Interactive whiteboards in schools.
- 4) On-screen multiple choice tests (like driving theory tests) sometimes use touch screens.

Advantages of Touch Screens:

- 1) With a touch screen, no extra peripheral is needed except the monitor.
- 2) The touch screen allows easy access to commands which are identified by words or symbols on the screen.

Disadvantages of Touch Screens:

- 1) Limited number of options available on the screen (Only items already on the screen can be selected).
- 2) Expensive compared to other input devices.
- 3) Touch screens are not suitable for inputting a large amount of data because touch screens require a lot of arm movements

Scanners: Scanners are used to enter information on paper (hard copies) into a computer. Scanners can convert hard copies (printed documents, photographs) into digital data.

Uses of Scanners

- 1) Used to scan hard copy / printed documents into a computer.
- 2) Old photos and important documents (like birth certificates) can be scanned into the computer. This means you still have a copy if the original is damaged or lost.

Advantages of Scanners:

- 1) Very fast to enter hard copies into the computer (compared to retyping with a keyboard).
- 2) Digital copies of the stored data can easily be duplicated and backed up.

Disadvantages of Scanners:

- 1) Scanned images are usually of lesser quality than the original document.
- 2) Scanned images can take up a lot of disk space (especially if you scan them at a high resolution).

Graphics Tablet and stylus: Graphics tablets are used by artists and designers to easily create and store digital graphics in a computer. A graphics tablet can be drawn on with a special pen called a '**stylus**'. Whatever is drawn onto the tablet can be seen on a computer screen.

Uses of Graphics Tablets:

- 1) Allow designers to produce digital images much more accurately than if they were using a mouse.

Advantages of Graphic Tablets:

- 1) The stylus can be pointed to different positions on the tablet quickly.
- 2) Very accurate drawings can be produced.
- 3) Useful where drawings and symbols are used instead of text.

Disadvantages of Graphic Tablets:

- 1) Very expensive when compared to a mouse.
- 2) Not useful for some input needs like entering data into the computer by clicking icons or menus.
- 3) The stylus and graphics tablet normally have to work together and cannot work separately.

Light Pens: Light pens are used by directly drawing or selecting icons on a computer screen. Light pens work by picking up light from the computer screen and then signaling to the computer exactly where the light was picked up.

Uses of Light Pens:

- 1) Used for selecting objects on a computer screen.
- 2) Used for directly drawing onto a computer screen.

Advantages of Light Pens:

- 1) More direct and precise than using a mouse.
- 2) Convenient for applications with limited desktop space.

Disadvantages of Light Pens:

- 1) Normally require a specially designed monitor to work with.
- 2) Can be quite uncomfortable to use as you have to hold your hand raised up to the computer screen for long periods.

Microphones: Microphones are used to input sounds into a digital computer.

Uses of Microphones:

1. Used to input sounds/speech for use in a range of applications: Speaking over the Internet using VoIP
2. Used in voice recognition software. For example: Converting speech into text, Issuing commands
3. Hands-Free mobile phones enable people to hold conversations on phone without using their hands
4. Used (along with headphones) in gaming so that gamers can talk to each other.

Advantages of Microphones:

1. Faster to read text into a computer than to type it in using a keyboard.
2. Microphones are relatively cheap to buy.

Disadvantages of Microphones:

1. Sound files can take up a lot of computer storage space.
2. Speaking words into a computer is not as accurate as typing.
3. Background noise can interfere with input of data using microphones.

Digital Cameras: Digital cameras capture and store images on a memory card and these images can easily be transferred onto a computer for viewing or editing.

Uses of Digital Cameras:

- 1) Used to capture digital images
- 2) Easy to transfer images to a computer for editing.
- 3) Images can be printed easily by Uploading to a computer and then printing.
- 4) Most digital cameras also allow for short, high-quality video clips to be produced.

Advantages of Digital Cameras:

- 1) No film to develop. This means that producing the photo is much quicker, less costly and money is saved.
- 2) Unwanted images can easily be deleted from the memory card.
- 3) Because the images are digital it is easy to make copies of them.
- 4) No need to print at all because the images can be viewed a computer screen. This saves paper and is better for the environment.
- 5) Memory cards can store thousands of digital photographs. Traditional photographs can take up a lot of physical storage space.
- 6) Digital images can easily be transferred using Bluetooth, email attachments and mobile phones.
- 7) Digital images can be improved and edited easily using software

Disadvantages of Digital Cameras:

- 1) Digital cameras are more sensitive to shocks and dropping.
- 2) Digital cameras are normally more expensive than ordinary film cameras.
- 3) Photo printing costs for digital cameras is generally higher.
- 4) Not all digital cameras produce images as high-quality as traditional cameras.
- 5) Camera user needs to have computer skills to be able to transfer and print digital photographs.

Web Cameras (webcams): Web cameras can capture both digital images and video that are sent over the internet.

Uses of Web Cameras:

- 1) Used to conduct face-to-face conversations with friends and family on the internet.
- 2) Used to hold video-conferencing meetings over the Internet.
- 3) Can capture image and video content for presentations and web sites
- 4) Some people use web cams as a cheap alternative to security cameras.

Advantages of Web Cameras:

- 1) Allow for long-distance face-to-face conversations. This removes the need for people to travel.
- 2) Video conference business meetings and job interviews can be conducted very cheaply over long distances.
- 3) Web cams can be left running constantly which makes them useful as security devices on properties.

Disadvantages of Web Cameras:

- 1) The image/video quality can sometimes be poor (low resolution).
- 2) Webcams do not have their own storage and so must be permanently fixed to the computing device.
- 3) Are usually in a fixed position and so cannot be easily moved around.

Magnetic Stripe Reader: Reads information from magnetic stripes found on Bank Cards, Membership Cards and Hotel Door Cards etc. Data contained on the card's stripe is read by pulling the card through the magnetic stripe reader. This is known as 'swiping'. The magnetic stripe reader then sends data from the card into the computer for processing.

Uses of a Magnetic Stripe Reader:

- 1) ATM's use these readers to process the information on bank cards.
- 2) EFTPOS (Electronic Funds Transfer Point of Sale) use the readers to transfer customer's money from their bank accounts when they purchase goods in stores.
- 3) Hotel rooms sometimes use magnetic stripe readers in place of door keys.

Advantages of using a Magnetic Stripe Reader:

- 1) Entering data is very fast. You just swipe the card through the machine.
- 2) No possibility of data entry errors as there is no typing involved.
- 3) The stripes on cards are not affected by water and so are not easily damaged.
- 4) Data held on the card cannot be read by eye so card details are safe.

Disadvantages of using a Magnetic Stripe Reader:

- 1) The magnetic stripe on cards can only hold a small amount of data.
- 2) Can be damaged easily by exposure to a strong magnetic field.
- 3) Magnetic stripes on cards are easily duplicated (known as card cloning). (if this happens you are prone to theft of funds in your bank)

Barcode Reader: Used to read information that is stored on product's barcodes (zebra striped marked on many retail products).

Uses of Barcode Readers:

- 1) Used in supermarkets, stores and warehouses where goods are marked with a barcode.
- 2) Used in libraries to scan in library cards and read numbers on books to find out which ones are on loan.
- 3) Used in keeping track of packages that are being delivered to different locations.
- 4) Also used in organizing luggage in airports (helps ensure that luggage is loaded onto the correct plane).

Advantages of Barcode Readers:

- 1) Very accurate as there is no manual typing involved.
- 2) Bar codes can be printed by normal printing methods
- 3) There is no need to write down the name of the item or its actual price.

Disadvantages of Barcode Readers:

- 1) Quite an expensive way to gather information.
- 2) Rely on undamaged bar codes in order to function (A bar code reader can misread if there is any dirt).
- 3) Only numbers can be coded
- 4) Bar codes cannot be read directly by people

Optical Mark Recognition (OMR): This is a system which automatically reads marks made in pen or pencil.

Uses of OMR

Used to read the shaded areas on documents such as: Multiple choice examinations, multiple choice questionnaires, Lottery tickets

Advantages of OMR

- 1) Extremely fast way of inputting information into a computer.
- 2) Very accurate as document's data is fed into the computer automatically with no manual typing.
- 3) Can save money as there is no need to employ workers to enter form information into a computer.
- 4) Large volumes of data can be collected quickly and easily without the need for specially trained staff

Disadvantages of OMR

- 1) Documents for OMR are difficult to design
- 2) The OMR reader needs to be reprogrammed for each new document design
- 3) OMR readers are relatively slow
- 4) The person putting marks on the documents must follow the instructions precisely
- 5) Any folding or dirt on a form may prevent the form from being read correctly

Optical Character recognition (OCR): OCR's allow us to scan text on paper (hardcopy) into a computer. Once into the computer, OCR software converts the scanned text into a digital format. OCR devices read special pre-printed characters and convert them in a form which can be understood by the computer.

Uses of OCR's:

- 1) Used in the processing of Passports and Identity Cards.
- 2) OCR is also used in the process of digitizing books.

Advantages of OCR's:

- 1) Written data and printed data can be read at the same time
- 2) Hard copies of documents can be read directly into a computer without retyping
- 3) The characters converted can be later edited by word processing software
- 4) Very fast way of entering hard-copy text into a computer.
- 5) Cheaper than paying an employee to manually re-type printed text into a computer.
- 6) Avoids typing errors as the process is automatic (no typing involved)

Disadvantages of OCR's:

- 1) OCR readers often do not work well with handwritten characters or those in unusual fonts.
- 2) Not 100% accurate. (relies on being able to read the original text)
- 3) As it is not 100% accurate, information needs to be manually checked for errors. This is time consuming.

Magnetic Ink Character Recognition (MICR): MICR is a system used to read information printed in special ink.

Uses of MICR:

- 1) MICR devices are mainly used to process cheques.
- 2) Some countries also use MICR devices to read the passport number on passports.

Advantages of MICR:

- 1) Cheques can be processed very quickly (up to 300 per minute).
- 2) Greater security than OCR because the special ink characters cannot be changed or forged.
- 3) No manual input therefore less errors.
- 4) Information can still be read even if someone writes over the magnetic ink characters.
- 5) Reading is accurate.

Disadvantages of MICR:

- 1) MICR readers and encoders are expensive.
- 2) The system can only accept a few different character sets.

Voice recognition systems: provide the computer with the capability to distinguish spoken words. Note that voice recognition implies only that the computer can take dictation, not that it understands what is being said.

Advantages of voice recognition

- 1) No typing of data is necessary
- 2) The system can be used by telephone or by people whose hands are occupied or disabled.
- 3) Are ideal for blind or visually impaired users.

Disadvantages of voice recognition

- 1) Error rate is still high at the moment
- 2) Recognition of words is slow
- 3) Words sound the same-see, sea cannot be distinguished
- 4) Not suitable for use in noisy places
- 5) Software must be trained to recognize specialist or technical words
- 6) Many people find it difficult to speak in a 'writing style'

MIDI (Musical Instrument Digital Interface) device: MIDI devices is used to create, record and play back musical compositions. MIDI is a standard that allows musical instruments to connect to the system unit.

Sensor and remote sensor: A sensor and remote sensor is an input device that can detect external changes in an environment.

Uses of sensors

- 1) Monitoring and control applications-burglar detection
- 2) Data collection and everyday applications-measuring pollution and automatic doors

Advantages of sensors

- 1) More accurate readings can be taken.
- 2) Monitor information constantly.
- 3) Respond to information immediately.
- 4) No need of humans to operate sensors in dangerous conditions like monitoring radiation levels.

Disadvantages of sensors

- 1) Faulty sensors can give incorrect results

Digital video cameras: Digital video cameras record motion digitally on a disk and have the capability to take still images as well.

PC camera: A PC camera allows home users to record, edit and capture video and still images and to make phone calls on the Internet.

Terminals: A terminal is a device with a monitor and a keyboard.

Examples of terminals

- 1) A dumb terminal has no processing power and is connected to a server to operate.
- 2) An intelligent terminal memory and a processor so can process data.

- 3) An electronic point of sale terminal (EPOS) is used to record purchases.
- 4) An electronic funds transfer point of sale (EFTPOS) terminal transfers funds from a customer bank account to a retailer's account.
- 5) An automated teller machine (ATM) is a self-service banking machine attached to a computer.

Pointing stick: A pointing stick is located in the middle of the keyboard and to control the pointer, you direct the stick with your finger. Most pointing sticks are pressure-sensitive, so the pointer moves faster when more pressure is applied.

PROCESSING DEVICES

Processing devices serve the function of interpreting and manipulating instructions and data into information in a computer.

The main processing hardware includes:

- 1) Central processing unit (CPU)
- 2) Main memory

Central processing unit (CPU) microprocessor/micro chip

The CPU is the brain of a computer responsible for performing all the processing within the computer.

Functions of the CPU

- 1) Processing data
- 2) Fetching and sending of commands and instructions
- 3) Performs arithmetic and logic operations
- 4) Temporary Storage/holding of data, instructions and results during processing

The more powerful the CPU, the faster the computer and the bigger the memory required.

The speed of the computer operations is determined by the system clock.

The faster the clock, the more instructions the CPU executes per second.

The clock speed is stated in Megahertz and Gigahertz.

Each tick is a clock cycle and this is a hertz.

Clock speed/clock rate is the speed at which a processor undertakes instructions.

In terms of computing power, the CPU is the most important element of a computer system.

There are the two major CPU designs

RISC-reduced instruction set computer: RISC is a design of the CPU that recognizes a relatively limited number of instructions.

CISC-Complex instruction set computer: CISC is a design of CPU that supports a large number of instructions but at relatively low processing speeds.

There are two primary manufacturers of computer processors with **Intel** and **Advanced Micro Devices (AMD)** leading the market in terms of speed and quality.

Pentium processors

The current family of Intel Pentium microprocessors includes Pentium II, Pentium III, and Pentium 4, Xeon, multimedia extensions (MMX), Celeron, Itanium series and core 2. The core 2 class is the current standard for processor chips.

AMD processors

The best performing AMD processors are the Athlon, Athlon Xp, Thunderbird and Duron series. These AMD processors are currently the most used microprocessors in high-end desktop systems, workstations and servers.

The main components of the central processing unit are:

- 1) Control unit
- 2) Arithmetic logic unit (ALU)
- 3) Registers

Control unit

The control unit directs all the operations that take place within the computer that is it tells the rest of the computer system how to carry out a program's instructions.

Uses of the control unit

- 1) Controls the entire operations of the computer system
- 2) Manages commands exchanged between the arithmetic logic unit and input/output devices and the memory.
- 3) Fetches, decodes and executes instructions

Operations of the machine cycle

Fetching: Is the process of obtaining a program instruction or data item from the memory

Decoding: Is the process of translating/change the instructions into commands a computer can execute/handle/work upon

Executing: Is the process of carrying out commands

Storing: Is the process of writing the results to the memory.

Arithmetic and logic unit (ALU)

ALU performs arithmetic operations and logical operations and controls the speed of those operations.

Arithmetic operations include:

- | | |
|----------------|-------------------|
| 1) Addition | 3) Division |
| 2) Subtraction | 4) Multiplication |

Logical operations are comparisons that the ALU compares two pieces of data to see whether one is:

- | | | | |
|-----------------------------|----|--------------------------|----|
| 1) Equal to | = | 5) Less than or equal to | <= |
| 2) Greater than | > | 6) AND | |
| 3) Less than | < | 7) OR | |
| 4) Greater than or equal to | >= | 8) NOT | |

Registers

Registers are high speed temporary storage locations used to hold data and instructions during processing.

Common types of registers

Program counter: Holds the address of the next instruction to be fetched from the memory.

Status register: Holds a collection of condition flags which describe the status of the most recent operation carried out by the CPU.

Instruction register: Holds the current instruction fetched from the memory.

Instruction decoder: Interprets the instruction currently held in the instruction register.

Accumulator: Holds the data item to be processed and the results of arithmetic and logic operations.

THE MAIN MEMORY

Also called primary storage, internal memory or main memory is the part of processing hardware that is used to temporarily store data and instructions about to be processed by the computer.

Data in the memory is represented as electronic voltage in space called *memory addresses*.

The role of the computer memory in storing both data and instructions is called the *stored program concept*.

Computer memory is the temporary storage space for data, programs, commands and instructions.

The three basic items stored in the memory include:

- 1) Operating system and system software
- 2) Application programs
- 3) Data being processed

Main memory:

- 1) Holds data for processing
- 2) Holds instructions for processing the data
- 3) Holds data after it is processed

TYPES OF COMPUTER MEMORY

Computers use two basic types of internal memory:

Read only memory (ROM): ROM has contents that can be read but cannot be written to during normal computer operations.

Random access memory (RAM): RAM is used to store programs being used by the user when the computer is working.

Differences between RAM and ROM

<u>RAM</u>	<u>ROM</u>
1) Volatile	Non volatile
2) Read and write	Read only
3) Temporal	Permanent
4) Can be increased	Normally not increasable

READ ONLY MEMORY (ROM)

ROM is used to permanently store instructions that tell the computer how to boot (startup). These instructions are known as the BIOS (Basic input/output system) or the boot program.

Information stored in ROM is known as READ ONLY. This means that the contents of ROM cannot be altered or added to by the user.

ROM is Non-Volatile memory. This means that stored information is not lost when the computer loses power.

Contents of the read only memory are collectively called firm ware that is set during manufacture and cannot be altered.

Firmware contains permanently written data, instructions or information.

ROM is the smallest in size and contains programs that are built in during manufacture.

TYPES OF READ ONLY MEMORY

PROM-programmable read only memory: Programmable read-only memory is memory on which data can be written only once. Once a program has been written onto a PROM, it remains there forever.

EPROM-erasable programmable read only memory: Erasable programmable read-only memory can be written to only once and erased once for new contents to be stored and cannot be erased any more.

EEPROM-electronically erasable programmable read only memory: Instructions can be put in this memory as many times as one may like. The memory contains instructions up to when one decides to alter them.

Uses of ROM

- 1) ROM stores data and programs that must be kept permanent at all time
- 2) ROM stores system files that enable a computer to operate
- 3) ROM stores BIOS that enables a computer to start

RANDOM ACCESS MEMORY

RAM is used to temporarily store information that is currently in use by the computer.

RAM can be read from and written to and so the information stored in RAM can change all the time (it depends what tasks you are using the computer for).

RAM is a fast memory. Data can be written to and read from RAM very quickly.

RAM is Volatile Memory. This means that information stored in RAM is deleted as soon as the computer is turned off.

RAM forms a major portion of main storage and is in constant use for temporary storage.

The greater your machine's memory capacity the better because:

- 1) The computer can create and use much larger programs
- 2) The computer can hold copies of more than one program
- 3) The computer can operate faster and more efficiently
- 4) The computer will be able to use new software/programs

Uses of RAM

- 1) Provides storage of a copy of the system software program.
- 2) Provides temporary storage of a copy of an application program
- 3) Provides temporary storage of a copy of data items input from the key board and mouse.

Examples of RAM

- 1) Conventional memory
- 2) Upper memory
- 3) High memory area
- 4) Extended memory
- 5) Expanded memory

CHIPS USED FOR RAM

- 1) DRAM (Dynamic Random Access Memory)
- 2) SRAM (Static Random Access Memory).
- 3) FRAM-Ferro-electric random access memory

Other kinds memory used:

CMOS (Complementary metal–oxide–semiconductor): CMOS stores configuration information about the computer such as:

- | | | |
|------------------------|---------------------|--------------------------|
| 1) Type of disk drives | 3) Amount of memory | 5) Current date and time |
| 2) Key board | 4) Monitor | |

CMOS chips use battery power to retain information even when the computer is turned off. Information stored in CMOS can be changed. CMOS contents are updated whenever new components are installed.

Flash memory/flash ROM/flash RAM: Flash memory is a kind of non-volatile memory that can be erased electronically and reprogrammed. Flash memory is used to store programs and data on personal computers (PCs), cellular phones, printers, digital cameras and Personal digital assistants (PDAs)

Virtual memory: With virtual memory the operating system (OS) (programs that manage the use and allocation of hardware and software) allocates/distributes/assigns a portion of a storage medium usually the hard disk to function as additional random access memory (RAM). The amount of the hard disk used for virtual memory is called a **swap file**. The amount of data and programs, instructions exchanged at a given time is called a **page**.

Cache memory: Cache memory is an extra high speed memory that stores data that is frequently accessed. Cache memory is more expensive than any other memory but once contained in a computer, cache memory makes a computer more powerful.

Buffer memory: Buffer memory is a temporary storage area that holds data before the data is sent to a device. The purpose of most buffers is to act as a holding area enabling the CPU to manipulate data before transferring it to a device.

Video Memory (VRAM): VRAM is used to store display images for the monitor. The amount of video memory determines how fast images appear and how colours are available.

MEMORY MEASUREMENT, BINARY DIGITS, PARITY BITS, BINARY CODES

Computers are electronic devices powered by electricity which has only two states: off or on.

Computers use the binary system that has two digits 0 and 1.

0 is used to represent off and 1 is used to represent on.

Each of these digital values is called a bit the abbreviation for binary digit.

Computers process data in terms of bytes because the BIT is not informative.

Why is the binary number system used for computers?

Because the computer (CPU) understands only binary where every character is represented in binary form.

A byte is eight bits grouped together as a unit.

An address is a unique number that identifies the location of the byte in the memory.

A byte provides enough different combinations of 0s and 1s to represent characters that include numbers, letters and symbols.

A bit (binary digit) is the basic unit of information in a computer.

One character	8 bits
8 bits	1 byte
1 byte	8 bits

How many bits are in the following words?

DOCUMENTS	STREAM	FOOD
HOMELAND	ROM	

How many bytes are in the following capacities?

8 bits	64bits	256bits
16bits	96bits	712bits
32bits	128bits	896bits

How many bits are in the following capacities?

1byte	8bytes	32bytes
2bytes	16bytes	96bytes
4bytes	24bytes	128bytes

BINARY CODES: A binary code is a scheme for encoding data using a series of binary digits.

American Standard Code for Information Interchange (ASCII): Most computers use ASCII codes to represent text, which makes it possible to transfer data from one computer to another. ASCII controls the system bell and printing.

Extended Binary Coded Decimal Interchange Code (EBCDI Code): EBCDIC was used in large computers

Binary Coded Decimal Code (BCD Code): BCDC is the least used code and is almost out of date/not used.

Convert the decimal numbers to their binary equivalents.

40	42
----	----

Convert the binary numbers to their decimal equivalents.

101010	101000
--------	--------

PARITY BITS

Parity bits are bits added to data by a computer to ensure the accuracy of the data.

The computer checks the number of bits and the data during data processing to ensure that no bit is lost during the process and this is called performing a *parity check*.

The parity chip holds the parity bit or check bit that is used for error detection.

Parity checking refers to the use of parity bits to check that data has been transmitted accurately.

What is an instruction set?

An instruction set refers to the instructions available for the central processing unit to execute.

Also called a command set, the basic set of commands, or instruction, that a microprocessor understands.

Computer storage devices

A storage device records and retrieves items to and from a storage medium.

A storage media is the actual physical material that holds data and programs.

Writing is the process of saving information to storage devices whereas reading is the process of accessing information from storage devices. Writing of data = storing data also known as saving-Reading of data = getting our data back also known as opening. To save data, data is moved from memory to secondary storage.

Factors to consider when choosing a storage device

- | | | |
|---------------------------|-----------------------|-------------------------|
| 1) Storage capacity | 5) Price/cost | 7) Safety of the |
| 2) Brand/make | 6) Compatibility with | media/nature of work to |
| 3) Portability | system-IDE, USB, | be stored |
| 4) Durability/readability | SATA | 8) Data access speed |

Backing up data: Process of copying files, programs and data to a different storage device for future use.

(Making of copies of your files, data and information) A backup is a copy of your original file or data stored on another storage device.

Why back up data?

- 1) Original data could be accidentally copied over or deleted.
- 2) Data could be lost due to damage to the original storage device.
- 3) You could lose your original storage device.

How Are Backups Created?

- 1) Burning files to a CD
- 2) Copying files to an external hard-drive
- 3) Copying the files to another computer on a network

Forms of computer storage

- 1) Secondary storage (backing storage or auxiliary storage)
- 2) Primary storage (memory)

Secondary storage: Secondary storage is a type of storage designed to retain data and instructions in a relatively permanent form.

Secondary storage devices are storage devices designed to retain data and instructions in a relatively permanent form.

Secondary storage devices can be used as both input (*when part of their stored data is sent for processing*) and output devices (*when used to receive processed data*)

Advantages of secondary storage devices

- 1) Non-volatile meaning that saved data and instructions remain intact when the computer power is turned off
- 2) Backing storage provides a cheap and almost an unlimited amount of storage
- 3) Available in various capacities
- 4) Used for backup and transfer data from one computer to another.

Disadvantages of secondary storage devices

- 1) Backing storage is slow because of the mechanical components involved
- 2) Agent of computer viruses
- 3) Can be affected by magnetic fields, vibrations and high temperatures

Secondary storage devices are categorized under:

- 1) Magnetic storage devices
- 2) Optical storage devices
- 3) Solid state storage devices

Magnetic storage devices

- | | | |
|--------------------|--------------|--------------|
| 1) Floppy diskette | 3) Zip disk | 5) Hard disk |
| 2) Magnetic tape | 4) Jaz disks | |

Optical storage devices

- | | |
|-----------------------|------------------------------|
| 1) Compact disks (CD) | 2) Digital video disks (DVD) |
|-----------------------|------------------------------|

Solid state storage devices

- | | | |
|-----------------|----------------|----------------|
| 1) Memory cards | 2) Smart cards | 3) Flash disks |
|-----------------|----------------|----------------|

Magnetics storage devices: Magnetic storage devices hold data magnetically.

Floppy diskette: Floppy diskettes provide an old method of portable data storage. Data is held on a thin plastic disk with a magnetic coating covered with a plastic protective case. The most widely used floppy disk is the 3.5 inch floppy diskette. Floppy diskettes are used where small files need to be transferred or stored.

Care for floppy diskettes

- 1) Keep the diskettes in a storage tray or protective case when not in use
- 2) Do not place heavy objects on the diskettes
- 3) Keep diskettes away from direct sunshine or excessive heat.
- 4) Do not use floppy diskettes near magnetic fields since data can be lost.
- 5) Do not use alcohol to clean the floppy diskette.
- 6) Do not use rubber bands or paper clips to tie the floppy diskettes together.
- 7) Diskettes should not be bent or sat on to avoid breaking them
- 8) The circular disk surface should not be touched since it is easily contaminated which can lead to data loss.

Advantages of using floppy diskettes

- 1) Can be used to transfer data from one computer to another
- 2) Are portable and inexpensive
- 3) Data on a floppy disk can be accessed randomly.
- 4) Data on a floppy disk can be write-protected from being changed accidentally using the write protection tab.

Disadvantages of floppy diskettes

- 1) Floppy diskettes are not durable since they can be destroyed by dust and dirt, magnetic fields.
- 2) Access time of a floppy is slow
- 3) Storage capacity of a floppy disk is limited

Before anything can be written on a new floppy disk, it must be formatted. Formatting is the process of preparing a disk for reading and writing by organizing the disk into storage locations. The write protect facility is useful to prevent accidental overwriting of data.

Magnetic tape: A magnetic tape is a magnetically coated plastic ribbon capable of storing large amounts of data and information at a low cost. Magnetic tapes are one of the oldest forms of data storage on computers. Magnetic tapes are used for applications which require extremely large storage capacity and for backup of files.

Advantages of magnetic tapes

- 1) Substantially less expensive
- 2) The storage capacity of a magnetic tape is much higher than that of a floppy diskette.

Disadvantages of magnetic tapes

- 1) Magnetic tapes are slow when writing and retrieving data
- 2) Magnetic tapes have a limited shelf life of about two years for reliable results.
- 3) Need another tape to update data

Zip disks: Another obsolete storage device, Zip disks are high capacity disks that resemble floppy disks however are slightly larger and thicker in size compared to floppy disks. Zip disks were used for data backup and moving large files between computers.

Jaz disks: These are small portable disks with high storage capacity and are used for storing data that requires large storage. Jaz disks were used for data backup and moving large files between computers. Were expensive and very unreliable.

Hard disks: A hard disk usually consists of several inflexible circular magnetic disks called platters on which data, instructions and information are stored electronically. A hard disk is also known as a hard disk drive (HDD). Hard disks are sealed tightly to keep out contaminants like dust and smoke which can lead to head crashes.

Hard disks are used to:

- 1) Data and files
- 2) Application software
- 3) System software like the operating system

Advantages of hard disks

- 1) Provide far much larger storage capacity
- 2) Provide faster and convenient data access time
- 3) Hard disks are cheaper than floppy diskettes per storage amount.
- 4) Since some reside inside the computer, they cannot be stolen or misplaced.
- 5) Data life of hard disks is long once in use
- 6) Hard disks are reliable and have better protection against dust and dirt.

Disadvantages of hard disks

- 1) Hard disks are expensive
- 2) Data becomes less secure if left on the hard disk
- 3) Virus attacks render data life limited in case of unprotected systems
- 4) Head crash may occur due to extreme shock or contaminants

Why a hard disk may fail to operate:

- 1) Aging
- 2) Violent shaking
- 3) Power failures
- 4) Virus attacks
- 5) Excessive heat and Humid conditions

Types of hard disks

Internal (fixed) disks: These are high speed and high storage capacity hard disks that cannot be removed from the disk drives.

External (removable) hard disks: These are special types of hard disks that may be inserted in the computer when there is need for storage and then removed thereafter.

Uses of external hard disks

- 1) Can carry data-backups all over the place
- 2) Transfer information, programs and pictures between computers

Advantages of external hard disks

- 1) Improved data cargo carrying capacity
- 2) More portable-small and light

Disadvantages of external hard disks

- 1) Have to be handled quite carefully
- 2) More expensive than other forms of removable storage.
- 3) Easy to be stolen or misplaced

Removable storage media: Removable media is any type of storage device that can be removed from a computer and is not incorporated into the computer itself. Examples of removable media include CDs, DVDs and Blu-Ray disks, as well as diskettes and USB drives.

Removable media makes it easy for a user to move data from one computer to another and can deliver the fast data backup and recovery times. The main drawback of removable media is that it's more expensive than many other forms of storage.

Solid state storage devices: Solid state storage devices are devices with no moving parts. Data and information are stored and retrieved electronically directly from these devices. This type of storage is expensive but is more reliable and requires less power and can be written to and updated. This technology is becoming widely used for specialized removable storage devices.

Memory cards: Memory cards are solid state storage devices widely used on computers.

Memory cards are used:

- 1) When data has to be read from small electronic devices like phones, PDAs and palmtops
- 2) When there is a likelihood of making changes to files
- 3) When there is need to access files on various electronic devices
- 4) When there is need to transfer files from one device to another
- 5) When you have a memory card reader

Advantages

- 1) Easy to transport since they are small in size
- 2) Robust and not easy to damage
- 3) Easy to connect to mobile devices through SD slots

Disadvantages

- 1) More expensive
- 2) Easy to lose or to have stolen due to their small size

Smart cards: Smart cards are devices that store data on a thin microprocessor embedded (fixed) in the card.

Smart cards are used for:

- 1) Storing prepaid cash amounts for example prepaid telephone calling card
- 2) Storing patients records and other health care information
- 3) Tracking information of customers and employees

Flash disks: Flash disks are small storage devices that can be held on a key ring or necklace. These devices conveniently connect directly to a computer's universal serial bus port to transfer data, files and information.

Flash disks are used:

- 1) When there is need to access files on various electronic devices with USB ports
- 2) When files have to be kept for a long time (quickly and easily backup files)
- 3) When more files have to be added from time to time
- 4) When there is need create a boot disk

Advantages of flash disks

- 1) More compact and durable shape, design
- 2) Hold much more data
- 3) Operate more reliably due to no moving parts
- 4) Compatible with almost any computer

Disadvantages of flash disks

- 1) No write protection feature so it is possible to accidentally copy over data
- 2) Small physical size means that they are easy to misplace or lose
- 3) More expensive per unit of data stored compared to hard disks

Optical storage devices: Optical storage devices store data on a disk as a number of data dots that can be read using light. Data is read by shining the laser beam onto the surface of the disk. The beam burns very tiny holes (pits) into a thin shiny surface to record data.

Care for optical disks

- 1) Do not leave the disks in direct sunlight or in hot, humid conditions.
- 2) Use a soft lint free cloth to remove spots, dust or finger prints and smears on the disk.
- 3) Store the disks in protective cases
- 4) Never stack disks on top of each other
- 5) Never touch the underside of the compact disk
- 6) Handle the disks only by the outer edges to prevent finger prints and smears on the disks

Advantages of optical disks

- 1) Are easy to store and are portable
- 2) Have high storage capacity of over 700MB
- 3) Are durable and can be stored for a long period of time.
- 4) Have high access speed and reduces access time
- 5) Can store text, graphics, video and sound as well as games.

Disadvantages of optical disks

- 1) Breakage or a simple scratch may render the whole disk useless.
- 2) Can be attacked by viruses
- 3) Some kinds of compact disks are read only so their contents may not be changed like the compact disk read only memory.
- 4) The average access time of a compact disk is slower than that of a hard disk.

Examples of optical storage devices

- 1) Compact disks (CD)
- 2) Digital video disks (DVD)

Compact disks: Compact disks are the most widely used optical disks formats. Compact disks are flat, round, portable storage medium that store data using light beams. Compact disks are mostly used to store data and information such as video clips, software and sounds. CDs have a maximum storage capacity of 700MBs

Digital versatile disks (DVDs): DVDs are also called digital video disks. With these disks, more data can be packed on the disk. DVDs are suitable for recording motion pictures such as video because they offer better sound and picture quality. DVD-ROMs have a storage capacity of 4.7GB

Difference between CDs and DVDs

- 1) DVDs have higher storage capacity than CDs
- 2) DVDs are cheaper per unit data storage
- 3) DVDS guarantee higher quality features (sound and video)
- 4) CDs are cheaper (cost) than DVDs
- 5) Reading and writing CDs is faster than on DVDs

Variations of CDs and DVDs

- | | | |
|-----------------------|---------------------|------------------|
| 1) CD-ROM and DVD-ROM | 3) CD-RW and DVD-RW | 6) Blu-Ray disks |
| 2) CD-R and DVD-R | 4) DVD-RAM | |
| | 5) Photo CD | |

CD-ROM and DVD-ROM: These disks have data that cannot be written over (added to) but can only be read. These disks are bought with pre-loaded data already on them. Whatever is already loaded onto the disk cannot be removed or changed. DVD-ROMs hold large amounts of data like movies, modern games, and multimedia encyclopedia.

CD-ROMs are used for:

- 1) Applications that require prevention of deletion of data
- 2) Distribution of software, data and information by software companies
- 3) Distribution of music, movies and games
- 4) Book publishers distribute encyclopedia and reference books

Advantages of CD-ROMs and DVD-ROMs

- 1) Hold more data than floppy diskettes
- 2) Less expensive than hard disks
- 3) You cannot accidentally erase the read only data

Disadvantages of CD-ROMs and DVD-ROMs

- 1) Hold less data compared to hard disks
- 2) Slow data transfer and access rates compared to hard disks
- 3) You cannot add your own data to read only disks

CD-Rs and DVD-Rs: These disks are bought blank and data can be added to the disk (once) but not removed when it is on there. These disks are ideal for single burning or recording of data.

Uses of CD-Rs and DVD-Rs

- 1) CD-Rs are used for recording music play lists
- 2) DVD-Rs are used for recording video clips
- 3) Recording data for archival or backup purposes
- 4) Transfer data from one computer to another.

Advantages of CD-Rs and DVD-Rs

- 1) Impossible to accidentally delete recorded data
- 2) Cheaper than CD-RWs and hard disks
- 3) Easy to transfer information from one computer to another.

Disadvantages of CD-Rs and DV-Rs

- 1) Only recordable once so updating records may be impossible.
- 2) Very slow data transfer rate.
- 3) If an error occurs during burning, the disk is damaged and is wasted.

Both CD-ROMs and CD-Rs are referred to as (WORM) write once read many because they allow the user to record data on them once but read the data as often as necessary.

CD-RWs and DVD-RWs

Data can be added to these disks and also be erased over and over again. Are also called erasable disks and are ideal for applications that require updating of information and ability to record over old data.

Uses of CD-RWs and DVD-RWs:

- 1) Both are used for making backups of computer files
- 2) DVD-RWs are used for recording television programs and can be recorded over many times
- 3) CD-RWs are used for creating personalised playlists of music and then add/remove songs as you wish.

Advantages of CD-RWs and DVD-RWs

- 1) Can be re-used many times
- 2) Stored data can be updated
- 3) Even if burning of files fails, the disk can still be recorded on later and not wasted.

Disadvantages of CD-RWs and DVD-RWs

- 1) More expensive than CD-Rs and DVD-Rs
- 2) Possible to accidentally over write data when updating
- 3) Data transfer to the disks is very slow

DVD-RAM disks

With DVD-RAM disks, writing and reading of data can happen at the same time. DVD-RAM disks can be rewritten over many many times.

Uses of DVD-RAM disks

- 1) Video and data archiving
- 2) Recording TV programmes

Advantages of DVD-RAM disks

- 1) Can be re-used many times
- 2) Stored data can be updated
- 3) Even if burning of files fails, the disk can still be recorded on later and not wasted.

Disadvantages of DVD-RAM disks

- 1) More expensive than CD-Rs and DVD-Rs
- 2) Possible to accidentally over write data when updating
- 3) Data transfer to the disks is very slow

Photo CDs: Photo CDs use a special format to store digital images. Photo CDs are multisession meaning that new images can be added at any time.

BLU-RAY DISKS

The laser used to read the data is blue rather than red hence the name Blu-ray disk.

These disks can be rewritten to and have large storage capacities ranging between 25GB, 50GB and 100GB.

Uses of Blu-ray disks

- 1) Storing high definition video
- 2) Used in some home video consoles
- 3) Used to backup data on computers

Advantages of Blu-ray disks

- 1) Huge storage capacity needed for high definition movies
- 2) Data can be read/transferred very fast compared to other optical media.

Disadvantages of Blu-ray disks

- 1) Very expensive compared to other optical media
- 2) Only work in Blu-ray drives which limits the use of the disks.

Other storage devices

Online storage: Sometimes called an Internet hard drive-is a service on the web that provides storage to computer users for free or for a minimal monthly fee. (Google drive and dropbox)

Advantages

- 1) Files stored on an Internet hard drive can be accessed from any computer or device that has web access
- 2) Share large audio, video and graphics files with others on the Internet
- 3) Work as an offsite backups of data

Magneto-optical disk

This combines the best features of magnetic and optical disk technologies.

Has a high storage capacity of an optical disk but can be written over like a magnetic disk.

Microfilm and microfiche

Are used to store images of documents on roll of sheet film.

These are used to store:

- a) Copies of newspapers, magazines and records in libraries
- b) Storing inactive files in large organizations such as banks

Advantages of microfilms and microfiche

- a) Greatly reduces the amount of paper used
- b) Inexpensive
- c) Has the longest life of any storage medium

Characteristics of storage devices

- 1) Storage capacity
- 2) Transfer rate
- 3) Access time
- 4) Methods of access

Storage capacity

Storage capacity is the amount of data a storage device such as a disk or tape can hold.

How storage capacity is expressed

A **bit** is the basic unit of information in a computer. (Smallest unit of measurement of information) (Short for binary digit)

A **byte** is eight bits grouped together.

A **kilobyte** (KB) is $2^{10} = 1,024$ bytes

A **megabyte** (MB) is $2^{20} = 1,048,576$ bytes

A **gigabyte** (GB) is $2^{30} = 1,073,741,824$ bytes

A **terabyte** (TB) is $2^{40} = 1,099,511,627,776$ bytes

A **Petabyte** (PB) is $2^{50} = 1,125,899,906,842,620$ bytes

Transfer rate

Transfer rate is the time it takes a drive to transmit data and information from the drive to another device.

Access time

Access time is the amount of time it takes to locate an item on a storage medium.

Access time is the amount of time required to retrieve data from a storage device.

METHODS OF ACCESS

There are two methods of data access:

1. Direct access or random access
2. Sequential access or serial access

Random access or direct access: A particular data item or file can be located immediately without having to move consecutively through items stored in front of it. Direct access is used where fast access to data is needed. Direct access is used in storage media like memory sticks, memory cards, CDs and DVDs as well as hard disks.

Sequential access: Under sequenced access, records are accessed one at a time and in the order in which they were recorded. Serial access is used in old magnetic tapes) video cassettes, music cassettes) and batch processing systems. Serial access is slow but ideal for a lot of data storage.

Primary storage devices

Primary storage is a form of storage that provides temporary storage for information the computer is currently working on.

Primary storage devices are devices that temporarily store information that the computer is currently working on. Primary storage devices provide only temporary or volatile storage that is lose all of the contents when the computer power is turned off.

Advantages of primary storage devices

- 1) High access speed
- 2) Relatively cheap
- 3) Always available in all working computers,
- 4) Not required in large quantity of capacity

Disadvantages of primary storage devices

- 1) Temporal
- 2) Expensive
- 3) Limited storage area
- 4) Delicate especially to electronic fields
- 5) .

Primary storage compared to secondary storage

Primary storage		Secondary storage	
1	Data can be processed from directly from storage	1	Data cannot be processed directly but must be moved into main memory
2	Located within CPU	2	Located outside the CPU
3	More expensive	3	Less expensive
4	Lower capacity	4	Higher capacity
5	Faster access time	5	Slow access time
6.	Volatile	6.	Non volatile

Examples of primary storage devices

- 1) Read only memory (ROM)
- 2) Random access memory (RAM)

Random access memory

Contents of RAM are lost when the computer is turned off therefore RAM is volatile. RAM stores data and programs currently in use when the computer is running. The computer will perform faster with more RAM.

ROM (Read Only Memory)

ROM Stores instructions that tell the computer how to start up. Contents of ROM are not lost when the computer is turned off therefore ROM is Non-Volatile memory. ROM cannot be written to (altered) but only read.

OUTPUT DEVICES

Output refers to data or information presented or removed from a computer.

Output devices are devices capable of displaying, presenting, removing or getting data and information from a computer to the user.

Forms of computer output

- 1) Soft copy
- 2) Hard copy

Soft copy: Soft copy refers to information/data displayed visually on the screen or is audio or voice form such as speech or music and this kind of output is not tangible. Soft copy exists electronically and displays for a temporary period of time.

Advantages of softcopy

- 1) Softcopy is more portable compared to hard copy
- 2) Softcopy is easily manipulated or edited
- 3) Softcopy can be protected using a password
- 4) Softcopy conserves physical space since it is stored on storage devices
- 5) Multiple copies of the same document can be kept in different versions and one can easily backtrack to an earlier version.

Disadvantages of softcopy

- 1) This can be costly as this is energy consuming
- 2) Information can be lost if there is a power outage, computer viruses or accidental deletion
- 3) Soft copies are usually irreplaceable

Hard copy: Hard copy refers to information/data that is in a permanent form that is in print out form. Hard copy is tangible. Hard copy is considered hard because it exists physically on paper, whereas a soft copy is considered soft because it exists only electronically.

Advantages of hard copies

- a) Hard copy cannot be easily changed without trace
- b) Hard copy can be read off line namely without a computer
- c) Hard copy is cheaper compared to softcopy which requires computer devices to be able to read the information
- d) Hardcopies last longer if stored in a safe place compared to softcopy which must be all the time changed with the technological developments taking place
- e) Hardcopies are universal as both rich and poor readers read them

Disadvantages of hardcopy

- a) Hard copy requires physical space to be stored.
- b) Hard copy is not as portable as some electronic devices.
- c) Hard copy takes a longer time to sort and find.
- d) Hard copies may be lost easily and are sometimes not retrievable.

Examples of output devices

- | | | |
|--------------------|--------------------------|--------------|
| 1) Monitors | 4) Facsimile machine | 7) Speakers |
| 2) Data Projectors | 5) Printers | 8) Terminals |
| 3) Plotters | 6) Multifunction devices | |

Speakers: Speakers are audio output devices that produce music, speech and other sounds from the computer.

Advantages of using speakers

- 1) Audio output devices are ideal for visually impaired people

Disadvantages of using speakers

- 1) Speakers are not suitable for use in noisy environment
- 2) Speakers are not suitable for use in very quiet environment where other people are working for example libraries
- 3) There is no permanent copy is produced
- 4) A computer can only repeat the same message exactly the same way therefore when the message is not understood the first time, it may not be understood the second time.

Fax machine: A facsimile is a machine that transmits and receives documents over a telephone line and prints out the document on paper.

Advantages of fax machines

- 1) Fax machines save paper
- 2) Fax machines allow a user to store received faxes on the computer
- 3) Received faxes can be e-mailed to others
- 4) Hard copies are available

Disadvantages of using fax machines

- 1) Sending a big document can be slow
- 2) There is waste of paper when junk/useless faxes are sent.

Multifunction device: A multifunction device combines the capabilities of a scanner, printer, fax and copying machine.

Advantages of multifunction devices

- 1) These devices offer space and cost advantages
- 2) Are significantly less expensive than purchasing each device separately

Disadvantages of multifunction devices

- 1) The quality and functionality are not quite as good as those of the separate single purpose devices
- 2) If the multifunction machine breaks down, the user loses all its functions.

Data Projector: A projector takes images displayed on the computer screen and casts/projects them on a larger screen so that people can see the image clearly.

Uses of Multimedia Projectors:

- 1) Can be used for training presentations to allow the whole audience to see images from a single computer.
- 2) Also used for large scale advertising of new products.
- 3) Home cinema systems where images from DVD's or televisions are projected to a large screen.

Advantages of multimedia projectors

- 1) Many people to clearly view the same presentation.
- 2) Enhance the viewer's experience since watching images on a large screen is better than a small screen.

Disadvantages of multimedia projectors

- 1) Lower image quality compared to a computer screen.
- 2) Very expensive to buy.
- 3) Cooling fans in the projector are noisy.

Plotters: Plotters print their output by moving a pen across the surface of a piece of paper. Plotters are suitable for architectural drawing, engineering applications and map making. Plotters create hard-copy in a very different way to printers.

Uses of Plotters:

- 1) Used to produce large, accurate drawings for example Blueprints of buildings (plans/designs), Maps, Giant posters and
- 2) Pens can be replaced with cutting tools to produce large signs.

Advantages of plotters

- 1) Plotters can produce much larger printouts than other printers.
- 2) The print quality is extremely high.
- 3) Plotters can also 'cut out' designs for use in sign making.

Disadvantages of using plotters

- 1) Plotters are only suitable for producing line drawings.
- 2) Plotters cannot produce the kind of text and images that an ink-jet or laser printer could.

- 3) Plotters have been largely superseded by large-format ink jet printers that can produce more detailed printouts and in full-colour

Terminals

Terminals are output devices that connect you to another type of computer called a host computer.

Visual display terminals/visual display units/monitors

Monitors are the most commonly used output devices.

Monitors present visual images of both the user's input (text and graphics) and computer output.

Monitors display information on the screen thus helping the user to monitor operations carried out by the computer.

Display devices can be monochrome or colour. Monochrome means that information displays in one colour on a different colour background for example white on black.

Colours are used to make screen displays more attractive and to highlight messages and menu options however **screens with a lot of colours take longer time to process and more memory is required to display a lot of colours.**

Resolution is the clarity and sharpness of imaged formed on the monitor.

Images are formed on the monitor by a series of dots or **pixels** (picture elements).

Dot pitch is the distance between each pixel.

Refresh rate indicates how often a displayed image is updated and redrawn on the monitor.

For a monitor to display information, it must be connected to a video card or graphics adapter.

Near letter quality (NLQ) is a quality of print that is not quite letter quality but is better than draft quality.

Drops per inch (DPI) the number of individual dots that can be placed in a line.

Examples of colour monitors

- 1) Colour graphics adapter (CGA)
- 2) Enhanced graphics adapter (EGC)
- 3) Video graphics adapter (VGA)
- 4) Super video graphics adapter (SVGA)

Types of monitors

Cathode ray tube (CRT) monitors: CRT monitors are the most common type of monitors used in office and homes. CRT's are becoming **rare** as TFT monitors are replacing them.

Uses of CRT Monitors

- 1) CRT Monitors allow users to instantly see outputs from the computer.
- 2) CRT's are also used with light pens to allow drawings to be created on screen.

Advantages of CRT monitors

- 1) Can produce fast and rich colour output
- 2) Can be viewed from a very wide angle
- 3) Are low cost monitors than LCD monitors

Disadvantages of CRT monitors

- 1) Emit higher radiations than LCD monitors
- 2) Consume more energy than LCD monitors
- 3) CRT monitors are bulky
- 4) CRT monitors occupy a considerable amount of space on the desktop.

Flat-Screen Monitor (TFT or LCD)

These are thin flat screened monitors that are commonly seen today. TFT's are used with the newer desktop PC's, laptops and mobile phones.

Uses of TFT Monitors

- 1) TFT Monitors allow users to instantly see outputs from the computer.
- 2) TFT Monitors are used as screens in laptops and also mobile phones.

Advantages of TFT/LCD monitors

- 1) Flat screen monitors are portable.
- 2) Flat screen monitors are very thin and do not take up as much desk space as a CRT monitor.
- 3) Flat screen monitors produce much less glare than CRT's and so are friendly to the eye.
- 4) Flat screen monitors use less power than CRT monitors (cheaper to run).
- 5) Flat screen monitors emit less radiation than CRT monitors.
- 6) Flat screen monitors produce less heat than CRT's.
- 7) Flat screens are easy to mount onto the wall

Disadvantages of TFT/LCD monitors

- 1) More expensive than CRT monitors
- 2) Can only be viewed from a very narrow angle.

Examples of flat panel monitors

- 1) Gas plasma
- 2) Electroluminescent
- 3) Liquid crystal display

TFT and LCD are two of the technologies used in flat-screen monitors:

TFT is Thin-Film-Transistor

LCD is Liquid-Crystal Display.

Advantages of display devices such as monitors over printers

- 1) Are generally quiet
- 2) Need no paper
- 3) Output can be modified or changed easily
- 4) The time taken to display the images is fast

Disadvantages

- 1) Need separate devices to produce the hard copy
- 2) Unsuitable for users with visual problems
- 3) Information produced on the screen is only temporary and will be lost when the power of the display device is turned off.

Printers: Printers are output devices that produce text and graphics on a physical medium like paper. Printers are categorized by how images are formed that is whether or not the image is formed by physical contact of the print mechanism with paper.

Advantages of printers

- 1) Information produced is permanent

Disadvantages of printers

- 1) The time to get the printout is slow
- 2) Paper is wasted for obtaining the output
- 3) Printers are generally noisier than display devices

Factors to consider before buying a printer

- 1) Page per print out
- 2) Memory of at least 2MB
- 3) Price of cartridge or tonner
- 4) Availability of tonner or cartridge
- 5) Purpose for which the printer is going to be put to use
- 6) Printer drivers

There are two major categories/types:

- a) Impact printers
- b) Non-impact printers

Impact printers: Impact printers are a class of printers that work by banging a head or needle against an ink ribbon to make a mark on the paper. Impact printers use pins or hammers which hit a ribbon to transfer images to paper.

Examples of impact printers

- 1) Dot matrix printers
- 2) Daisy wheel printers
- 3) Braille printers

Dot matrix printers: Dot matrix printers use a pattern of dots formed by pins on a print head to form out a character on paper.

Advantages of dot matrix printers

- 1) Dot matrix printers are inexpensive
- 2) Dot matrix printers reliable
- 3) Dot matrix printers are faster than daisy' wheel printers
- 4) Dot matrix printers can print on continuous paper or multipart documents
- 5) Dot matrix printers have low per page cost

Disadvantages of dot matrix printers

- 1) Dot matrix printers do not offer high quality output
- 2) Dot matrix printers are generally noisy because of the striking mechanism
- 3) Dot matrix printers are relatively slow
- 4) Dot matrix printers are not easily serviced because they are based on old technology
- 5) Dot matrix printers are not readily available on market.

Daisy wheel printer: The daisy wheel is a disk made of plastic or metal on which characters stand out along the outer edge. To print a character, the printer rotates the disk until the desired letter is facing the paper. A hammer strikes the disk forcing the character to hit an ink ribbon leaving an impression of the character on the paper. You can change the disk wheel to print different fonts. *Daisy wheel printers cannot print graphics, are generally noisy and are slow.*

Braille printers: Braille printers produce characters that can be read by visually impaired people.

Non-impact printers: Non-impact printers are printers that use chemicals, lasers or heat to form the images on the paper.

Examples of non-impact printers

- 1) Deskjet printers
- 2) Laser printers
- 3) Thermal printers
- 4) Bubblejet printers

Inkjet printers: Inkjet printers form characters on paper by spraying tiny droplets of ink on paper to form out a character.

Advantages of Inkjet printers

- 1) Inkjet printers are reliable
- 2) Inkjet printers quiet
- 3) Inkjet printers have very good quality output
- 4) Inkjet printers relatively inexpensive

Disadvantages of Inkjet printers

- 1) Inkjet printers need special paper for highest resolution output
- 2) Inkjet printers have higher cost per page
- 3) Inkjet printers have very high costs of maintenance and buying
- 4) With Inkjet printers, nozzles can be blocked if unfiltered ink is used.

Thermal printers: Thermal printers use heating elements to produce images on heat-sensitive paper.

Advantages of thermal printers

- 1) Thermal printers offer high quality desktop colour printing
- 2) Thermal printers have low noise levels

Disadvantages of thermal printers

- 1) Thermal printers are relatively slow
- 2) Thermal printers require special paper that degrades with storage
- 3) Thermal printers use special paper that is expensive.

Laser printers: Laser printers use a laser light beam to produce images with excellent letter and graphics quality.

Advantages of laser jet printers

- 1) Laser jet printers produce high quality text and graphics
- 2) Laser jet printers have very productive speed Laser jet printers have low noise levels
- 3) Laser jet printers have excellent graphics capabilities
- 4) Laser jet printers have low maintenance requirements

Disadvantages of laser jet printers

- 1) Laser jet printers are expensive especially the colour printers
- 2) Laser jet printers are limited to cut sheet media
- 3) Laser jet printers are slow for graphics output.

Comparison of impact and non-impact printers

	Impact printers	Non-impact printers
Advantages	a) Print multipart forms since can easily print through many layers of paper	c) Much quieter because there is no striking mechanism d) Can produce high quality output

	b) Can normally withstand dusty environment, vibrations and extreme temperatures	
Disadvantages	a) Generally noisier because of the striking mechanism b) The quality of output is most ideal for labels, envelopes and invoices	c) Cannot print multipart forms

Control devices

Control devices are output devices that work in conjunction with sensor input devices and commands from computers in order to undertake a process.

Type of Sensor:	Used In:
Motor	Households: Automatic washing machines (to make drum spin) DVD player (to make disc spin) Air conditioners (to make fans spin) Industry: Controlling robot arms Computer systems: Spinning disks in hard disk drives Spinning cooling fans
Buzzer	Microwave ovens (to signal that the food is cooked) Alarm systems (loud siren to warn of intruders)
Heater	Central heating systems (to keep rooms correct temperature) Washing machines (To keep water the correct temperature) Automatic greenhouses (ensures air is correct temperature for plants)
Light / Lamp	Security lights Automatic greenhouse (to give plants correct amount of light)

Communication devices

Communication devices enable two or more computers to exchange data, instructions and information with each other.

Examples of communication devices

- a) Dial-up modems
- b) ISDN and DSL modems
- c) Cable modems
- d) Network interface cards (NIC)
- e) Multiplexers

Dial-up modems

A modem is a communication device that converts between analog and digital signals.

The word modem comes from:

MODULATION: To convert digital signals into analog signals.

DEMODULATION: To convert analog signals into digital signals.

A modem connected to a sending computer converts the computer's digital signals into analog signals which can travel over a communications channel like a telephone line.

ISDN and DSL MODEMS

Integrated services digital network is a set of standards for digital transmission of data over standard copper telephone lines.

Advantages of ISDN lines

- a) Provide faster transfer rates than dial up lines
- b) Faster web downloads and clearer video conferencing
- c) Produce very clear voice conversation

Digital subscriber lines provide high-speed connections to the internet over a regular copper telephone line.

ADSL-asymmetric digital subscriber line is a type of DSL that supports faster transfer rates when receiving data than when sending data.

Cable modems

A cable modem sends and receives data over the cable television network.

Cable modems transmit data at speeds much faster than dial-up and ISDN modems.

Network interface cards

Network interface cards enable a computer or device to connect to a network.

Multiplexers

Multiplexers are communication devices that combine two or more input signals from several devices into a single stream of data and transmit over a communication channel.