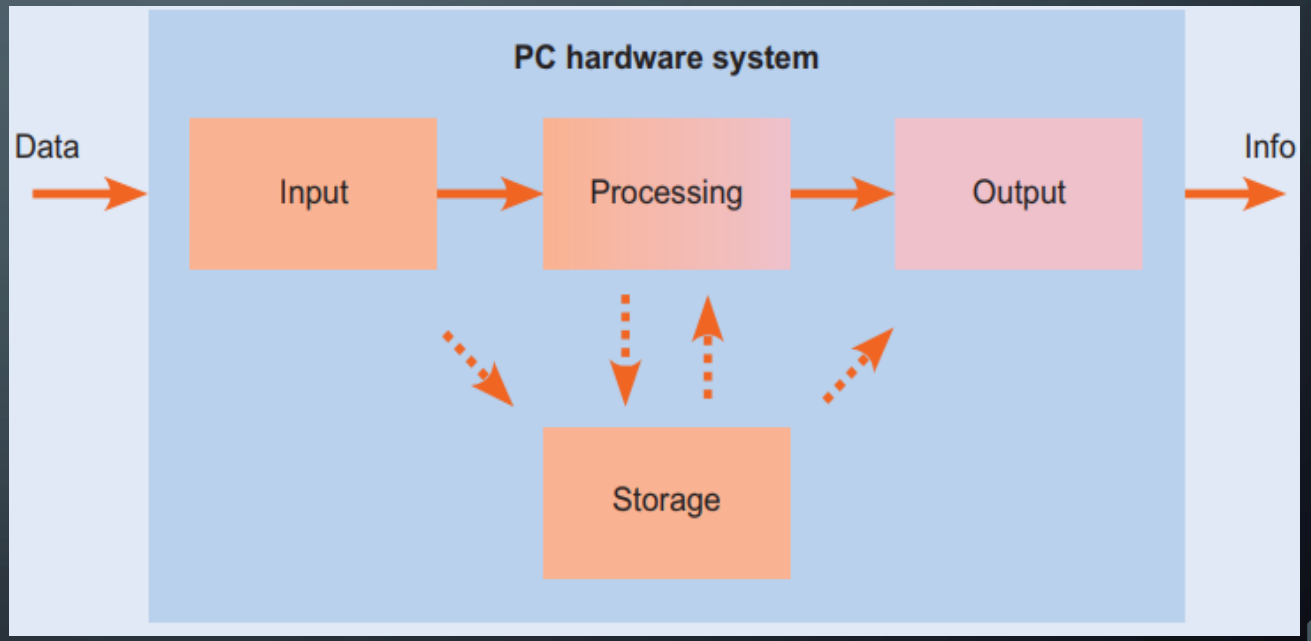
HARDWARE AND SOFTWARE

COMPONENTS OF A COMPUTER SYSTEM

- A system is a collection of interrelated components that work together towards a collective goal.
- A computer system is a number of interrelated components that work together with the aim of electronically converting(processing) data into information with little intervention from a human user.
- The components of computer system include
  - Hardware
  - Software

HARDWARE FUNDAMENTALS

- Hardware describes the physical components of a computer system
- The physical components of a computer system are:
  - input devices,
  - memory,
  - central processing unit,
  - output devices
  - and storage devices.
- Data are input, and then processed according to software instructions, then output the information. Information that needs to be stored permanently will be placed in storage.



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- **Input devices:** used to enter data, information or instructions into a computer-based information system.
- They convert data held in human-sensible form into a form that makes them machine-sensible.
- **Central processing unit (CPU):** performs processing by carrying out instructions given in the form of computer programs.
- controls all of the computer's main functions and enables users to execute programs or process data. In desktop computer (personal computers) It's usually found within the tower(base unit).
- **Primary storage or memory:** A temporary means of storing
  - data awaiting processing,
  - Instructions used to process data or control the computer system,
  - and data or information that has been processed.
- **Storage devices:** A permanent means of storing data and programs until they are required.
- **Output devices:** translate the results of processing – output – into a human-readable form.
- It may also transfer data requiring further processing to a storage device.

INPUT DEVICES

- modern computers make use of a wide variety of input devices
- choice of an input device will often depend upon the quantity of data to be entered
- large-scale data input may require the use of more specialized input devices ,
- In which case **direct capture**(A method of acquiring and storing data automatically with little or no human intervention.)device will be used to acquire and store data automatically.
- Example: using sensors on a production line to store and process data automatically.

Types of Input Device

- **Keyboard/keypad**: the most common input device.
- **Natural (or ergonomic)** keyboard keys can be located quickly and easily allowing comfortable prolonged use, making them a better alternative to **traditional keyboards** which are difficult and uncomfortable to use.
- It usually includes the following keys:
  - Typing keys: include A-Z and 0-9

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- Numeric keypad: used to enter numeric data or cursor movement, it consists 17 keys arranged same as calculators
- Function keys: twelve function keys (F1 – F12) each with unique meaning and specific purpose
- Control Keys: provide cursor and screen control, includes four directional arrow keys, Home, End, Insert, Delete, Page up, Page down, Control(Ctrl), Alternate(Alt) and Escape(Esc).
- Special Purpose Keys: contain keys such as Enter, Shift, Caps Lock, Num Lock, Space bar, Tab and Print Screen.

Figure 1: Example of an Ergonomic Keyboard

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- **Mouse:** A pointing device found on most modern personal computers, which feature Graphical User Interface(GUI).
- Although there are many different kinds of mouse, all use the same basic method of operation: moving the mouse over a flat surface causes a corresponding movement to a small pointer on the screen.
- Can be Wired or Wireless, both kinds have left and right button.
- The left button tells the computer to do do something while the right button gives the options available at a particular place.
- **Stylus and Graphics tablet:** Stylus is used with touchscreens such as smartphones, tablets and some laptop.
- A traditional stylus appears similar to a pen and offers more precision than a fingertip.
- A stylus often replaces a mouse where space is limited or a small screen is being used.
- **Graphics tablet:** Consists of a stylus and a flat drawing surface. The stylus is used to draw images onto the tablet. As the user works, the image is copied to the computer's screen.

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- **Trackball:** It is a pointing device that is controlled by rotating a small ball with the fingertips or palm of the hand.
- Often used when space is limited; often used to replace a mouse.
- **Joystick:** one of the most common input devices available, primarily used for leisure activities, such as playing computer and console games. Serious applications include medicine and engineering.
- **Optical Scanner:** An input device used to capture graphics and text from printed documents.
- Optical scanners can also be used to perform data entry by converting printed documents into text files that can be used by word processing packages and other programs.
- Optical character recognition (OCR): Software that attempts to recognize individual characters.
- Optical mark recognition (OMR): Detection and recognition of simple marks made on a document.
- **Bar code reader:** Measures the intensity of a light beam reflected from a printed bar code to identify the digits making up a unique identification number.
- Bar code: A means of displaying a unique identification number as a series of thick and thin lines.
- Universal product code: A standard for defining bar codes used frequently in retailing.

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- Radio-frequency identification(RFID) uses electromagnetic fields to automatically identify and track tags attached to objects. An RFID system consists of a tiny radio transponder, a radio receiver and transmitter. Expected to eventually replace bar code reader.
- **Touch Screen:** A transparent, pressure sensitive covering that is attached to the screen of the monitor. Users make selections and control programs by pressing onto the screen.
- Common business applications include interactive kiosks and bookings systems.
- **Video capture card:** records and stores video sequences (motion video) when connected to a digital video camera or other device. Often used for security applications, such as CCTV.
- It reduces the storage space needed to keep large amounts of video and makes it easier to review the data quickly.
- **Microphone/sound card:** It allows a personal computer to play speech, music and other sounds. A sound card can be used to capture sound, music and speech from a variety of sources.
- Voice recognition: The facility to control a computer program or carry out data entry through spoken commands via a microphone connected to a sound card.
- VoIP (Voice over IP): A technology that enables users to make and receive telephone calls via the Internet.

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- **Web camera(webcams):** allow the real-time capture of images and sound.
- The information captured by a webcam is usually compressed so that it can be transmitted via the Internet.
- This enables three basic applications:
  - **video e-mail(V-mail):** involves sending an e-mail message to which a video clip has been attached.
  - **video conferencing:** allows a group of users to communicate with each other simultaneously.
  - **Webcam monitoring:** involves setting up one or more webcams to watch a given person or place.
- **Magnetic Ink Character Recognition (MICR):** Capture and recognition of data that have been printed using a special magnetic ink.
- Normally associated with the banking industry, especially cheque processing.

Selecting Input Devices

- Three Basic criteria: Volume, Speed and Accuracy
- Other considerations: Complexity of data, Cost and Frequency of data entry

OUTPUT DEVICES

- The output produced by some devices is temporary in nature.
- Some forms of output may be used as the input for another process.
- There are a large variety of specialized output devices available.
- A computer-based information system will often feature several different output devices, such as monitor, sound card and printer.

Display Devices

- **Monitors:** It is the most common output device.
- Most modern monitors feature a Liquid Crystal Display (LCD), making them more **reliable** and **energy efficient** than their predecessors.
- Better energy efficiency can be obtained if LEDs (Light Emitting Diodes) are used to provide the backlight needed to illuminate the display.
- OLED (Organic Light Emitting Diode) technology does not need a backlight, allowing for better quality images and thinner screens.

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- Advantages include:
  - monitors are relatively inexpensive to purchase, repair or replace.
  - particularly suited to displaying certain kinds of information like charts and graphics.
  - cost of using the monitor as an output device is very low.
  - Information can be shown instantly with a negligible delay
- **Video Projector:** A computer system can be connected directly to a projector so that output is directed to a projection screen.

Printers and plotters

Printers

- **Laser printer:** A laser is used to charge sections of a rotating drum which is then used to print using toner powder achieving a combination of speed with high print quality.
- **Inkjet printer:** An inkjet printer uses a print-head containing 50 or more small nozzles that squirt ink onto paper by varying electrostatic charges produced by the printer

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- **Multi-function devices (MFDs):** New printers that offer additional functions such as scanning, faxing and photocopying, often come with an automatic document feeder, allowing them to scan, copy or fax as many as fifty pages at a time.

Plotter

- A plotter uses a number of different colored pens to draw lines upon the paper as it moves through the machine.

Other output devices

- **Sound:** In addition to music and sound output via speakers, a sound card can be used to output information in a variety of other forms. Examples include voice annotations and speech synthesis.
- **MIDI (musical instrument digital interface):** MIDI connections allow users to control musical instruments or synthesize any sounds or effects required in order to play the music.
- **Computer Output to microfilm (COM):** Information is processed via a computer and sent directly to a device that produces microfilm negatives.

Selecting output devices

- Some factors to consider when selecting an output device: appropriateness, permanence, speed, response time and cost.

STORAGE DEVICES

- Storage devices are used to store programs, data awaiting processing and the information resulting from computer processing.
- Storage devices are categorized as **primary storage** and **secondary storage**
- The capacity of a storage device is measured in terms of kilobytes, megabytes and gigabytes.
- A **bit** is a single binary digit and represents a 0 (zero) or a 1. The bit is the smallest unit of measurement.
- **Byte:** Made up of eight bits and represents the amount of space required to hold a single character.
- Kilobyte(KB)= 1024 Bytes ; Megabyte(MB)=1024 KB ; Gigabyte(GB)=1024 MB
- **Primary storage:** Data and instructions are temporarily loaded into memory such as random access memory.
- **Secondary storage:** Data are stored on a separate device where the information will be retained even if the machine is switched off. Floppy disks and hard disks are secondary storage which provides permanent storage.

SECONDARY STORAGE

- **Hard disk:** A magnetic medium that stores data upon a number of rigid platters that are rotated at very high speeds.
- used to store the computer's operating system, application software and data.
- the drive mechanism is enclosed within a vacuum to protect against dust and other contaminants. **Advantages**
- have large storage capacities, (160GB to more than3TB)
- considered a fast means of storing and retrieving data,
- relatively inexpensive to purchase or replace

Disadvantage: susceptible to damage from sudden shocks and excessive vibration.

- **SSD(Solid State Drives):** uses **flash memory** to replace the mechanical parts found in a typical hard disk drive
- considered expensive and unnecessary for routine office tasks. (Disadvantage)
- Operate much faster than an equivalent hard disk drive and are considered more robust.(Advantage)

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- **Hybrid disk drive:** A hard disk drive that contains a small amount of flash memory that can be used to speed up intensive tasks such as loading the operating system.
- **Flash drive:** Data are stored in flash memory, in an EEPROM (electrically erasable programmable read-only memory) chip that can retain its contents for as long as ten years before it begins to degrade.
- It is a portable storage device that connects to a computer via a standard USB port.
- Flash drives have no moving parts, so are reliable and robust.
- relatively inexpensive to buy and offer storage capacities of up to 128 Gb and beyond
- data can be transferred to and from a USB drive at high speed.
- Flash memory is in two main forms of a **memory card** (as used in a digital camera and Mobile Phones) and as a **USB drive**.
- **Optical disc:** The data on an optical disc are encoded as a series of dips and raised areas.
- Optical discs come in two main formats. **Compact discs (CD)** typically store 700 Mb of data. **Digital versatile discs (DVD)** offer higher storage capacities, typically 4.7 Gb per side.

PRIMARY STORAGE

- relatively expensive, memory is the fastest form of storage available
- There are two broad categories of computer memory: **volatile** and **non-volatile**.
- **Volatile memory:** Anything held in this kind of memory is lost once the power to the computer system is switched off.
- **Non-volatile memory:** Non-volatile memory retains its contents until altered or erased.
- **Random access memory (RAM):** RAM is used as volatile, working storage by a computer, holding instructions and data that are waiting to be processed.
- The more RAM a computer system is equipped with, the faster and the more powerful it becomes
- **Read-only memory(ROM):** Contents of ROM are fixed and cannot be altered. It is nonvolatile.

Other Forms of Computer Memory

- **EPROM (erasable programmable read only memory):** This is a form of ROM memory that retains its contents until changed using a special device known as a 'burner'
- **SDRAM (synchronous dynamic random access memory):** is a common form of RAM found in many personal computers.

PRIMARY STORAGE

- **DDR SDRAM(double-data-rate synchronous dynamic RAM):** used in new machines it is roughly twice as fast as SDRAM.
- latest machines use variations on DDR(DDR 3 and DDR 4) memory that offer even higher performance.
- **CMOS**, **NMOS** and **PMOS** memory are used as semi-permanent means of storage in a variety of different devices.
- This kind of memory is generally used in computer systems as a means of storing any special settings needed to control the operation of the computer or a peripheral.
- **Cache memory:** Used to improve performance by anticipating the data and instructions needed by the processor and storing them in the cache.
- Applications of Memory: television sets, satellite receivers, DVD recorders, burglar alarm systems, alarm clocks, washing machines, microwave ovens….etc. (Most Digital Devices)
  Selecting storage devices
- The selection of a storage device will normally be based upon **Speed**(Access time and Data transfer rate), **Storage Capacity** **and** **Cost of Storage.**

PROCESSORS

- **Central Processing Unit (CPU):** Uses instructions from software to control the different components of a computer. (Also called the brain of the computer)
- Consists of two components: a control unit and an arithmetic logic unit (ALU).
- The **Control Unit** fetches instructions from software that has been loaded into memory, decodes them and then executes them. And controls the operation of all hardware.
- The **ALU** carries out arithmetical calculations (+, -, *, /)and make comparisons between values.
- The speed of a processor will usually depend upon two factors: clock speed(measured in MHz) and bus width(the amount of data that can be transferred at a time using the bus that connects it with other components of the computer).
- As a general rule, the faster the processor, the faster and more efficient the computer.
- Multi-core processor: The latest CPUs combine two or more cores (processors) within a single physical device. Example: dual core, core i3, i5 …etc.
- **Graphics processing unit (GPU):** Describes circuitry integrated into a new form of processor, the APU. Ideal for computer graphics and machine-learning tasks.
- The GPU removes the need for a separate graphics card.

MAJOR CATEGORIES OF COMPUTERS

- A traditional view of computers suggests four basic categories of computer(based on size):
- **Supercomputers:** focused on performing tasks involving intense numerical calculations such as weather forecasting, nuclear simulations, theoretical astrophysics, and complex scientific computations..
- **Mainframe:** are powerful computers used for large-scale data processing. Ideal for big organizations like banking, telecom sectors, etc.,
- **Minicomputer:** offer an intermediate stage between the power of mainframe systems and the relatively low cost of microcomputer systems.
- **Microcomputer:** considered less powerful than minicomputers and mainframes, but are more flexible and relatively inexpensive to purchase. Often referred to as the 'client' machine.

Types of microcomputers

- **Desktop computer:** Intended for office use to support the day-to-day activities of an organization's employees.
- **Portable computer:** A self-contained computer. Example: Notebook (laptop), tablets, smartphone…etc.

SOFTWARE FUNDAMENTALS

- Software: A series of detailed instructions that control the operation of a computer system.
- Software exists as programs that are developed by computer programmers.
- Software is less tangible than hardware – the instructions that make up a program are translated into binary instructions (a series of 0 and 1 digits) for the processor hardware.
- Two major categories of software: **systems software** and **applications software**.

Systems software

- This form of software manages and controls the operation of the computer system as it performs tasks on behalf of the user.
- Consists of three basic categories: operating systems, development programs and utility programs.
- **Operating System (OS):** Software that interacts with the hardware of the computer in order to manage and direct the computer's resources.
- functions as an intermediary between the functions the user needs to perform, for example a spreadsheet calculation, and how these translate to and from the hardware in the form of responding to mouse clicks and displaying information on the screen.

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- Operating systems can be controlled by either a text-based(CLI) or a graphical interface(GUI).
- Command line interpreter (CLI): Passes instructions from a user to a computer program in the form of brief statements entered via the keyboard.
- Graphical user interface (GUI): Provides a means for a user to control a computer program using a mouse to issue instructions using menus and icons.
- WIMP: **W**indows, **I**cons, **M**ouse and **P**ull-down menus is often used to describe a GUI environment.
- The basic functions of the operating system include: allocating and managing system resources, scheduling the use of resources and monitoring the activities of the computer system.
- **Utility Programs:** Utility programs provide a range of tools that support the operation and management of a computer system.
- **Development Programs:** Allow users to develop their own software in order to carry out processing tasks.
- Programming languages can be described in terms of their generations in the development of computer programming systems. Example: 1st generation to 5th gen. (current) which relates to Artificial intelligence.

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Applications software

- A set of programs that enable users to perform specific information processing activities.
- Can be divided into two broad categories: general-purpose and application-specific.
- **General-purpose applications:** are programs that can be used to carry out a wide range of common tasks.
- A word processor(a kind of productivity software), for example, is capable of producing a variety of documents that are suitable for many different purposes.
- **Productivity software:** This describes a category of computer software that aims to support users in performing a variety of common tasks.
- Use of some general-purpose applications for business tasks that are carried out in an office:
- **Document production and graphics software**. Example: Microsoft Word
- **Spreadsheets** – software for processing numerical information. Example: Microsoft Excel
- **Databases** – software for storage and retrieval of information. Example: SQL Server

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- **Multimedia software.** Used for computer-based training and customer service in retail applications.
- **Software for using the Internet**. Example: e-mail and the use of web browsers.
- **Management applications** - Software for personal information management and team working.
- **Application-specific software:** Comprises programs intended to serve a specific purpose or carry out a clearly defined information processing task.
- Software designed to carry out payroll processing or manage accounts are examples of application-specific programs.
- Other Example include:
- **Enterprise systems(ES):** aim to support the business processes of an organization across any functional boundaries that exist within that organization. Examples of ES includes enterprise resource planning (ERP), customer relationship management (CRM), supply chain management(SCM), supplier relationship management (SRM), product lifecycle management (PLM) and Materials requirements planning (MRP)

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