

Types of Computers

1-What is a computer

A computer is an electronic device that reads, stores, and processes data using programming instructions to produce output. The instructions are given in binary language, which only contains two values: 0 (off) and 1 (on). The programmable system of the computers follows algorithms to generate output efficiently.

Many types of computers are used today, such as desktops, Laptops, Tablets, and other devices like smartphones , and game consoles .

A complete computer system can be divided into three components: *Hardware*, *Software*, and *Data*.

- i. Hardware: is the physical parts of the computer. The computer hardware system consists of **four** components that are:
 - Input and output devices (keyboard, mouse, monitor, printer).
 - Central Processing Unit (CPU) to process data.
 - Memory is one or more sets of chips that store data and/or program instructions, temporarily or permanently. (RAM, ROM).
 - Storage devices: the computer permanently stores the results of its processing on a tape or disk (Hard Disk Drive (HDD), Solid Disk Drive (SSD), output devices (, printer), and peripherals (USB drives).



- ii. **Software** is a set of instructions or programs that direct the computer's hardware to perform specific tasks. The **Software** converts human commands (clicking an icon) into machine-readable instructions (binary code) that the computer can execute. Without software, the hardware cannot operate. Example:
- **Operating System** All computers require an *operating system* (e.g., Windows, Linux, macOS) to start functioning.
 - **Programmable software** (code editors)
 - **Application programs**: perform general-purpose tasks (word processors)
- iii. **Data** refers to raw facts like numbers, text, images, and sounds that are **processed by a computer** to produce meaningful results. The data is what gives purpose to both the hardware and software.

2- Bus System

The computer system transmits the **Data** via a communication **bus**. The **bus** is an electronic pathway that transmits signals and data between the hardware components of the computer.

The computer bus system is a collection of wires on the motherboard circuit that connect the CPU, Memory, chipset, and peripheral devices (I/O devices, storage) to transfer the data. The **computer system's internal buses** are classified according to the data type being transmitted, which are:

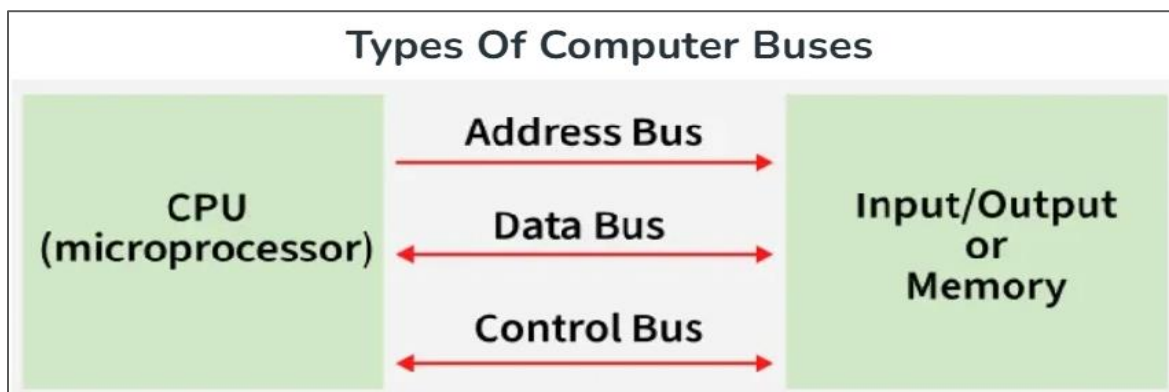
1. **Data Bus (DB)**: transfers data between the computer memory and the CPU or from I/O devices. It works bidirectional (transmit data between components)
2. **Address Bus (AB)**: transports memory addresses that the processor needs to access the data (read or write). The address bus is unidirectional.

3. **Control Bus (CB)**: Sends control signals from the CPU to other internal components like memory and I/O, to coordinate actions like reading, writing.

Signals include:

- **Read** or **write** signals
- **Interrupt** signals (e.g., the CPU stops a task to handle the interrupt then resumes the work)
- **Clock** signals (synchronizing operations). Example: On each tick of the clock, the CPU fetches the next instruction, executes it

Test Question: Is the *control bus* *unidirectional* or *bidirectional* ?!



Besides the **internal** buses , there are **external** I/O Buses, which connect peripheral devices to the CPU, such as Universal Serial Bus (USB) and Serial Advanced Technology Attachment (SATA), which connect the storage, such as a hard disk, CD, to the motherboard.

The amount of data that can be transferred over a bus is measured in bits per second (bps) or bytes per second (Bps). The bus system speed is one of the main factors that affect computer performance, it depends on the bus width. **Bus width** refers to the number of **bits** that can be transferred **in one operation**. Early processors used smaller address buses due to limitations in technology and cost it was (4-bit, 8-bit, 16-bit). As technology advanced, larger address buses became

necessary to support more powerful applications. With the technology advancement the bus width expanded to (32-bit, 64-bit). The frequency or the speed of a bus determines how many clock cycles there are per second, (may be one or more data transfers per clock cycle). **It's measured in Hertz (Hz) — usually in Megahertz (MHz) or Gigahertz (GHz) for modern systems.**

 A **clock cycle** is the smallest unit of time in a computer's operation, **1 Hz = 1 cycle per second.**

A faster bus speed means that data can move between the CPU and main memory more quickly. Let's solve this question: Compute the bus speed, where:

- **Bus Width** = 8 bits (is the number of bits the bus can carry per cycle)
- **Bus Frequency** = 200 MHz **cycles/sec** (is the number of cycles per second)

Tip: One Megahertz (MHz) = 1,000,000 Hz (which is million (Hz))

Solution: Bus Speed = Bus Width × Bus Frequency

1- Compute Bus Frequency 200 MHz in hertz → The bus can perform 200 million data transfers per second.

$$200 \text{ MHz} \times 1,000,000 = 200,000,000 \text{ Hz}$$

2- Multiply the bus width by the frequency = 8 bits × 200,000,000 Hz

$$= 1,600,000,000 \text{ bits per second (one billion and 600 million)}$$

Tip: To convert the result to byte per second, divide the number by 8 bits

$$1,600,000,000 \text{ bits/sec} \div 8 = 200,000,000 \text{ bytes/sec}$$

3-Types of Computers

Computer types range from powerful supercomputers for complex tasks to tiny embedded systems built for specific functions. Each type is designed in different:

Size , Functionality , Purpose , Performance, Data Handling , applications

All digital computer carries out main **functions** which are input/output, store/process data, and execute instructions. The following is an overview of the common computer types

 **Mainframe:** A powerful multi-user computer capable of supporting many hundreds or thousands of users simultaneously. Used in airline reservation systems and banks.



 **Supercomputer:** An extremely fast computer that can perform hundreds of millions of instructions per second. Used in:

Space exploration , Weather modeling  and AI training.

 **Server Computers** are computers that combine data and programs. applications are stored and shared on the server computer. Such computer does not solve big problem like a supercomputer but it solves many smaller ones, such as send information (**Google**). Example server computers:

Web Server, Database Servers, File Servers and Mail Servers

 **Workstation:** A powerful, single-user computer. It's like a personal computer, but it has a more powerful microprocessor and high quality monitor. example

Computer Aided Desing (CAD), 3D and large video editing and Scientific Simulation

 **Embedded Computers:** Description: Embedded computers are specialized computers that are designed to perform specific tasks and are often built into other devices. Example:

Smartphones Smart TVs, Car Control Systems, Medical Services

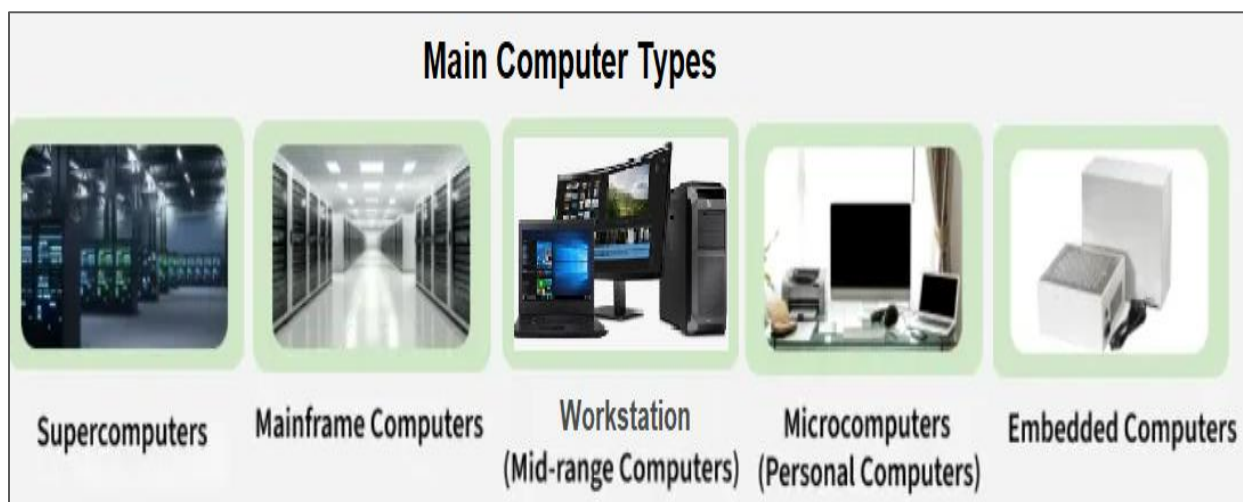


 **Personal computer:** A small, single-user computer based on a

microprocessor. In addition to the microprocessor, a personal computer has a keyboard for entering data, a monitor for displaying information, and a storage device for saving data. **Examples:**

Desktop PCs , Laptops, Tablets,

H.W: What is a minicomputer? is it still used these days?



4- Classifications of Computer Architecture:

One of the main developments that influenced the design of today's computers is setting the principles of computer architecture, during the (first generation).

There are two main types of digital computer architecture:

1- Harvard architecture

2- Von Neumann architecture

Harvard architecture is a computer architecture model where **instructions and data are stored in separate memory units** and accessed via separate buses. This allows the CPU to fetch instructions and data **simultaneously**, by enabling parallel access to instructions and data. The instruction may be fetched while data is being

read or written. Harvard architecture improves performance, making it particularly suitable for applications that require high-speed processing, such as embedded systems, digital signal processing and real time applications. The main **advantage** of Harvard architecture is that the CPU can access instructions and read/write, at the same time. While the **disadvantage** is:

- The design **complexity**, especially for the main board manufacturers to implement, requires special hardware facilities.
- Harvard architecture requires a control unit for two buses, since there are separate buses for both instruction and data (**Data Bus, Instruction Bus**), (**Data Address Bus, Instruction Address Bus**). Their implementation costs are comparatively higher than Von Neumann architecture.



From 1939 to 1944 Aiken, in collaboration with IBM, developed the first fully functional computer, known as the Harvard Mark I.

2-Von Neumann architecture: One of the most important models is the Von Neumann architecture, which is the foundation of most modern computers. this architecture introduced the concept of storing both data and instructions in the same memory and using a single bus for both. The **advantage** of this design is in its **simplicity because** all data and instructions are stored in a single memory.

While the **disadvantage** is that

- Parallel executions of programs are not allowed because it use serial instruction processing
- Using a shared bus: the data and control instructions cannot be obtained simultaneously, because only one “bus” can be accessed at a time. This results in the CPU being idle.