



**Al-Mustaqbal University**  
**College of Science**  
**Intelligent Medical System Department**

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جامعة المستقبل  
AL MUSTAQBAL UNIVERSITY

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## **Lecture 6**

# ***Input–Output Design and Organization***

**Subject: Computer Fundamentals**

**Level: First**

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## **What is an Input-Output Interface?**

The Input/Output Interface is a **hardware** component or system that manages the data transfer between the computer's internal memory or CPU and external devices. These devices can either be input devices (such as a keyboard or mouse) that send data to the computer, or output devices (such as a printer or monitor) that receive data from the computer. The I/O interface also supports serial and parallel communication, converting signals and ensuring compatibility between devices with differing data rates and formats.

## **Functions of Input-Output Interface**

Input-Output Interface performs various important functions that facilitate communication among the computer system and peripheral devices:

### **1. Speed Synchronization**

The interface synchronizes the speed of the CPU with input-output devices so that data is not lost because of variations in speed.

### **2. Processor Communication**

The interface processes processor commands and translates them, informs about the existing status, and identifies its specific address.

### **3. Signal Control**

It provides and manages control and timing signals required for data exchange to enable error-free communication between peripherals and the CPU.

### **4. Data Buffering**

The interface provides buffering, where data is held in temporary storage as it is transferred between devices and the CPU, enabling the disparity in the processing rate.



## **5. Error Detection**

The interface is able to identify errors in data transmission so that errors may be tagged and corrected before influencing the performance of the system.

## **6. Data Conversion**

It translates serial data to parallel data and vice versa, and digital data to analog signals and vice versa, and translates the format to the receiving device.

## **7. Status Reporting**

The interface tells the processor the status of the peripheral device.

## **Types of Input-Output Interface**

There are different kinds of input-output interfaces used in computer architecture. They can be classified into two broad categories:

### **1. Programmed I/O (PIO)**

Programmed I/O is a system where the CPU manually handles data transfers which means all the work is done by the central processing unit directly. It performs a data output or data input command to communicate with the peripheral devices and in the meantime, it will wait for the operation to end before carrying on with other works. Using this method will increase CPU load but, on the other hand, it is easy to make with only one processor that runs the I/O tasks and thus the CPU will be in charge of all the I/O.

### **2. Interrupt-Driven I/O**

The use of I/O based on interrupts allows the CPU to carry out other operations, thus decreasing the load on the CPU. Accordingly, when the device is set for the data transfer, it will send an interrupt signal to the CPU. The CPU will then stop doing what it is doing and execute the data input or data output command as required and, finally, it will continue the interrupted work.



### 3. Direct Memory Access (DMA)

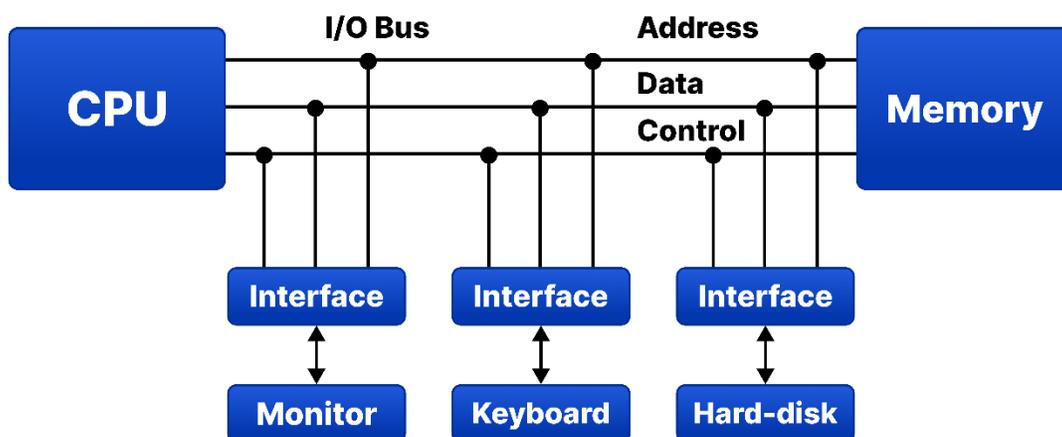
Direct Memory Access (DMA) is a method that bypasses the CPU and allows external devices to transfer data to the RAM directly and vice versa. The data transfer is under the supervision of the DMA controller, thus the CPU is free to do other work. The CPU load along with the duration for the process of heavy transactions such as big file copy and streaming between storage and memory are considerably reduced and made faster by this method.

### 4. Advanced Programmable Interrupt Controller (APIC)

An APIC helps a processor to keep track of all the interrupts it is receiving and tells it what to do in case a device wants to send data. Thus, this system is very efficient in solving a problem of a multi-core machine during the process of interrupt handling.

## Input-Output Bus and Interface Modules

The Input-Output bus and interface modules are important devices for the transfer of information between the CPU and external devices. The I/O bus links all the I/O devices to the system, while the interface modules serve as interpreters between the CPU internal bus and external devices.





### *I/O Bus*

- The I/O bus is made up of three main buses: data bus, address bus, and control bus.
- The data bus carries the actual data that is being transferred between the processor and peripherals.
- The address bus enables the processor to address a particular peripheral device that is connected to the I/O bus.
- The control bus carries control signals for data transfer, e.g., read/write, start/stop, and error detection.

### *Interface Modules*

- Each interface module is programmed to communicate with one particular peripheral device, like sensors, actuators, or input/output devices.
- Interface modules read the address lines to identify the addressed device and drive related data and control lines.
- Status commands are employed to request the status conditions in the interface and peripheral devices like BUSY, ERROR, or readiness of data.
- Data output commands move data from the processor to the peripheral device, and data input commands move data from the peripheral device to the processor.