KARNAVATI UNIVERSITY

Operating Systems

Course Code: **71203002004**

Introduction to I/O Systems

by -

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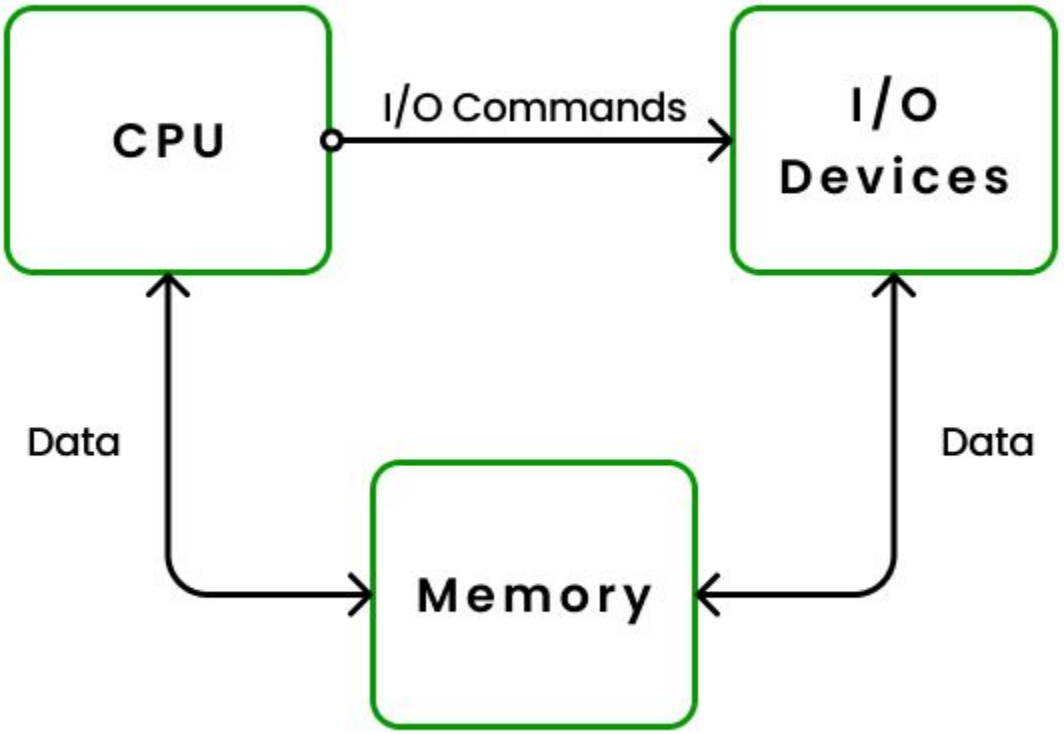
I/O System

- I/O (Input/Output) systems form a bridge between the user, operating system, and hardware devices.
- Examples: Keyboard, Mouse, Monitor, Printer, Disk Drives, Network Cards.
- The I/O subsystem of the OS ensures smooth and efficient communication between the CPU and these devices.


CPU
I/O Commands
I/O Devices
Data
Data
Memory

Why OS and I/O Devices Communicate

Input & Output Operations:

- Input devices (keyboard, mouse) send user commands to the OS.
- Output devices (monitor, printer) display results to the user.

Device Control & Configuration:

- The OS initializes devices, allocates resources (like interrupts/memory), and manages power settings.

Data Transfer & Storage:

- The OS manages data exchange between memory and storage (HDDs, SSDs).
- Ensures reliable reading/writing of files and smooth performance.

Why OS and I/O Devices Communicate

Peripheral Device Support:

- Communication enables use of USB devices, network adapters, printers, scanners, etc.
- The OS provides drivers and standard interfaces for all these devices.

System Monitoring & Control:

- The OS collects hardware data (temperature, voltage, clock timing) to maintain system stability.

Types of I/O Devices

Character Devices:

- Handle data one character at a time.
- Examples: Keyboard, Mouse, Serial Ports.
- Use character-by-character input/output (no data buffering).

Block Devices:

- Transfer data in fixed-size blocks.
- Examples: Hard Drives, SSDs, CD-ROMs.
- Support random access to data blocks.

Communication Methods Between OS and I/O Devices

Device Drivers:

- Software that connects the OS to hardware.
- Translates high-level OS commands into device-specific instructions.
- Provides a *standard interface* for all types of devices.

I/O Ports:

- Hardware addresses used for sending and receiving data to/from devices.
- OS uses these ports to control and communicate with specific hardware.

Communication Methods Between OS and I/O Devices

Interrupts:

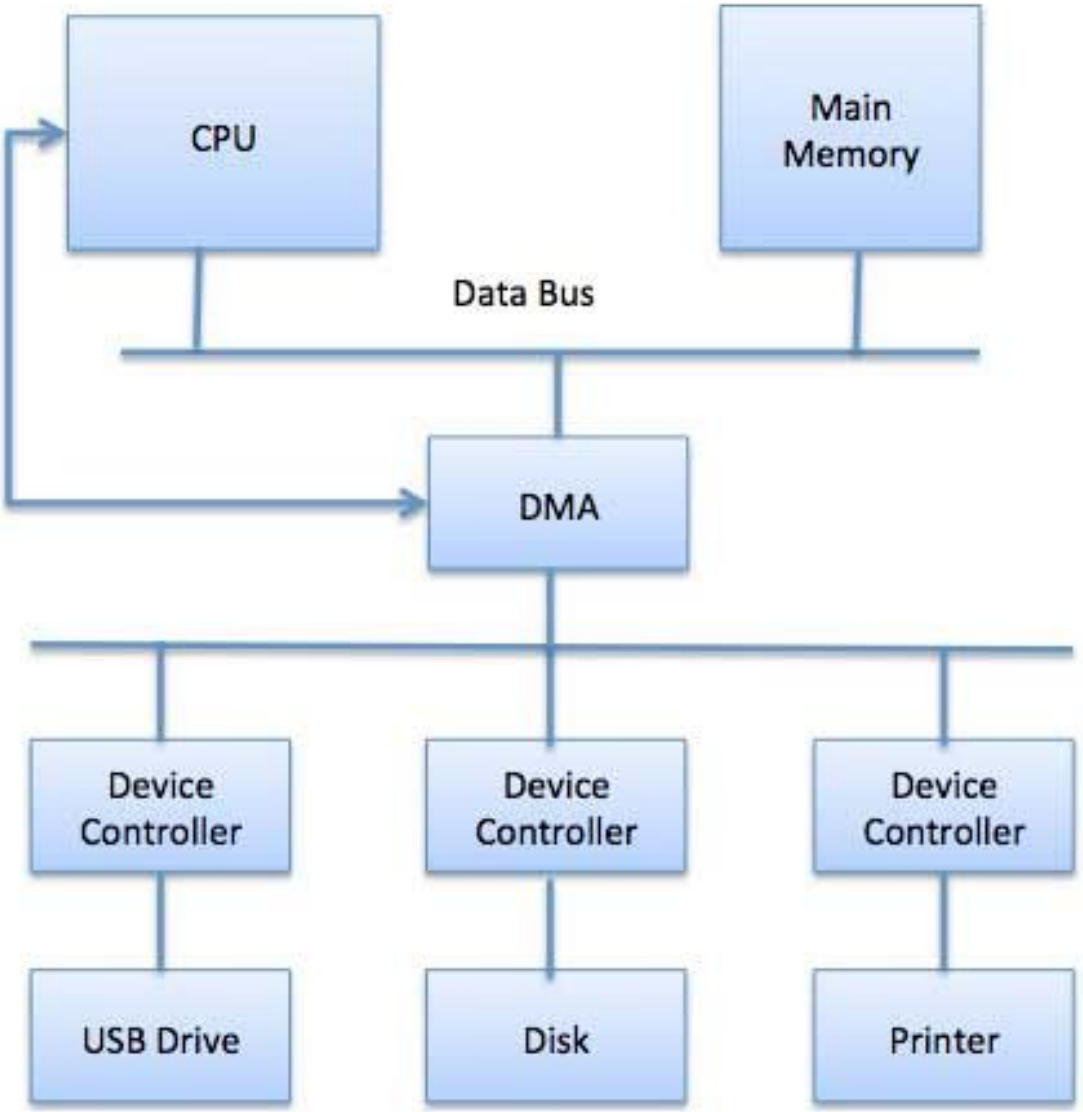
- Signals sent by devices to get the CPU's attention.
- Example: Keyboard press → generates interrupt → OS reads input.
- Helps CPU respond quickly without constant checking.

Direct Memory Access (DMA):

- Allows data transfer directly between device and memory without CPU involvement.
- Increases speed and efficiency.

I/O Scheduling:

- OS decides the order in which I/O requests are served.
- Aims to reduce waiting time and ensure fairness among processes.


CPU
Main Memory
Data Bus
DMA
Device Controller
Device Controller
Device Controller
USB Drive
Disk
Printer

Device Controllers

A device controller is the electronic interface between a device (like a printer or disk) and the computer system.

Each I/O device has:

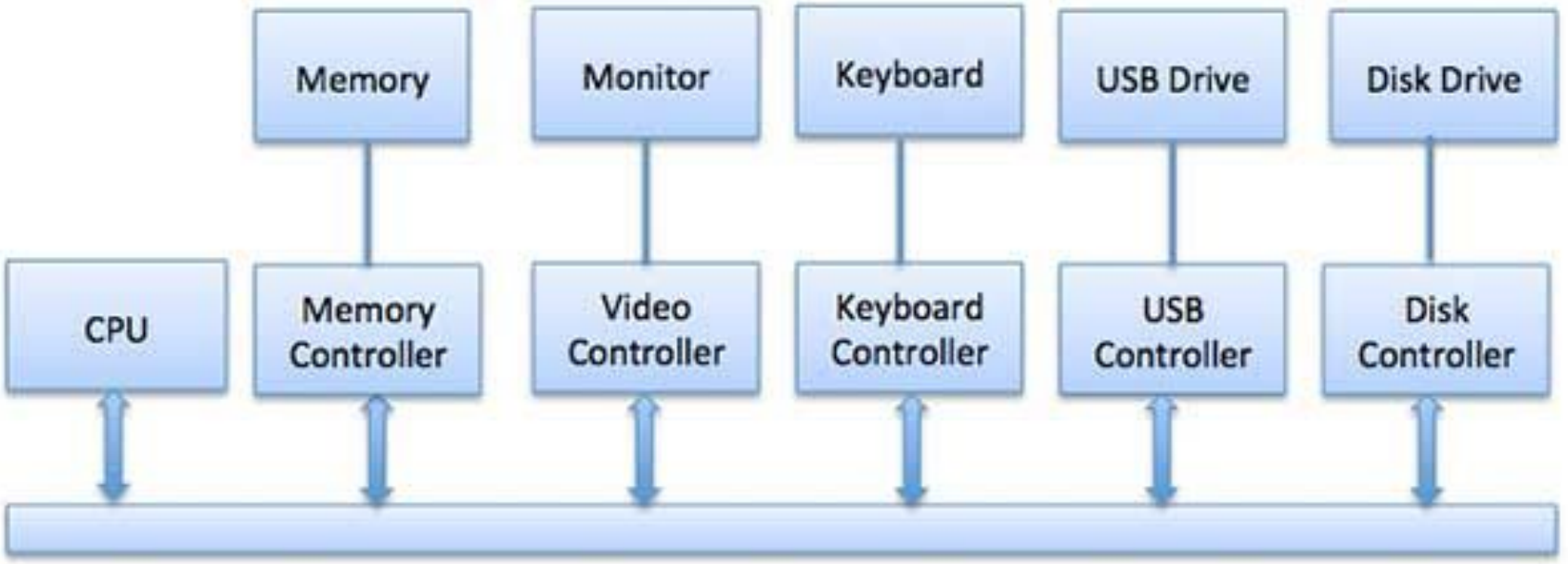
- A mechanical component (e.g., printer head, keyboard keys)
- An electronic component called the device controller

The controller communicates with the device driver in the OS.

Main functions:

- Convert serial bit stream → block of bytes
- Perform error correction
- Manage data buffering and control signals

One controller can manage multiple devices (e.g., USB controller).


Memory
Monitor
Keyboard
USB Drive
Disk Drive
CPU
Memory Controller
Video Controller
Keyboard Controller
USB Controller
Disk Controller

Synchronous vs Asynchronous I/O

Type	Description	Example
Synchronous I/O	CPU waits while I/O completes.	Reading from keyboard.
Asynchronous I/O	CPU continues executing other tasks while I/O happens in the background.	Disk or network operations.

Polling vs Interrupts

Mechanism	Description	Advantage / Disadvantage
Polling	CPU repeatedly checks if the device is ready.	Simple but wastes CPU time.
Interrupts	Device signals CPU when it needs attention.	Efficient; CPU only responds when needed.

Analogy:

- Polling: Teacher keeps asking every student if they need help.
- Interrupt: Student raises hand only when help is needed.

DISCUSSION & REVISION

1. The electronic component that connects an I/O device to the system bus is called a _____.
2. The software that allows the operating system to communicate with hardware devices is a _____.
3. In which type of I/O does the CPU continue executing while I/O operations proceed in parallel?
4. The hardware unit that transfers data directly between memory and devices without CPU involvement is called _____.
5. The method where the CPU repeatedly checks device status is known as _____.

REFERENCES

1. https://www.geeksforgeeks.org/operating-systems/communication-to-i-o-devices-in-operating-system/
2. https://www.tutorialspoint.com/operating_system/os_io_hardware.htm