

Communication with I/O Devices

1 Overview

The CPU interacts with devices such as keyboards, mice, printers, displays, network cards, and storage units through I/O subsystems.

2 Main I/O Communication Methods

2.1 Programmed I/O

- The CPU actively controls and checks the I/O device (polling).
- **Steps:**
 1. CPU sends a command to the device.
 2. CPU waits and repeatedly checks if the device is ready.
 3. Once ready, data is transferred.
- **Drawback:** The CPU is blocked and wastes time while waiting.

Pros: Simple

Cons: Inefficient, especially for slow devices

2.2 Interrupt-Driven I/O

- The I/O device interrupts the CPU when it is ready.
- **Steps:**
 1. CPU sends a request and continues other tasks.
 2. When the I/O device is ready, it sends an interrupt signal.
 3. CPU suspends its current task, handles the interrupt using an Interrupt Service Routine (ISR), and then resumes its previous task.

Pros: Efficient

Cons: Requires interrupt handling logic

2.3 Direct Memory Access (DMA)

- Used for high-speed data transfer (e.g., disks, network).
- A DMA controller transfers data directly between memory and the I/O device without CPU intervention.
- The CPU only initializes the DMA transfer and remains free during the transfer.

Pros: Best performance

Cons: Requires dedicated DMA hardware

Mode	Who controls transfer	CPU Free?	Speed	Best For
Programmed I/O	CPU	✗	Slow	Simple devices
Interrupt-Driven I/O	Device via interrupt	✓	Medium	Keyboard, Mouse
DMA	DMA Controller	✓✓	Fast	Disk, Network, Audio

Table 1: Comparison of Data Transfer Modes

3 Data Transfer Modes

4 I/O Mapped vs Memory-Mapped I/O

4.1 Memory-Mapped I/O

- I/O devices share the same address space as RAM.
- CPU uses regular instructions to access devices (e.g., MOV, LOAD, STORE).

4.2 I/O-Mapped I/O

- I/O devices have a separate address space.
- Special I/O instructions are used (e.g., IN, OUT).

5 Summary

- The CPU communicates with I/O devices through interfaces/controllers.
- Modes of communication:
 - Programmed I/O (polling)
 - Interrupt-driven I/O
 - Direct Memory Access (DMA)
- Addressing methods:
 - Memory-mapped I/O
 - I/O-mapped I/O