

CS 223 Computer Architecture & Organization

Input/Output

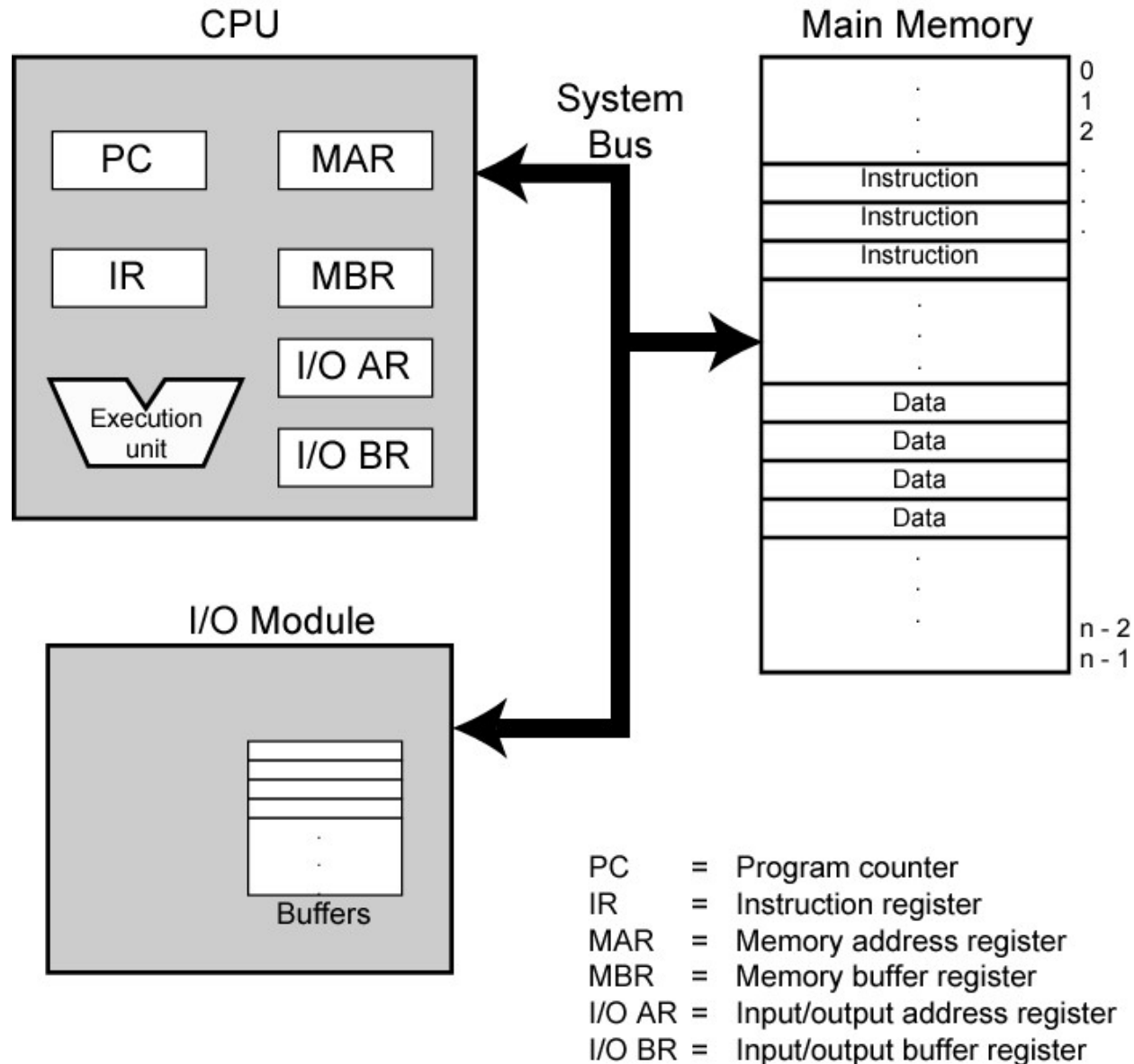


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Computer Components: Top Level View



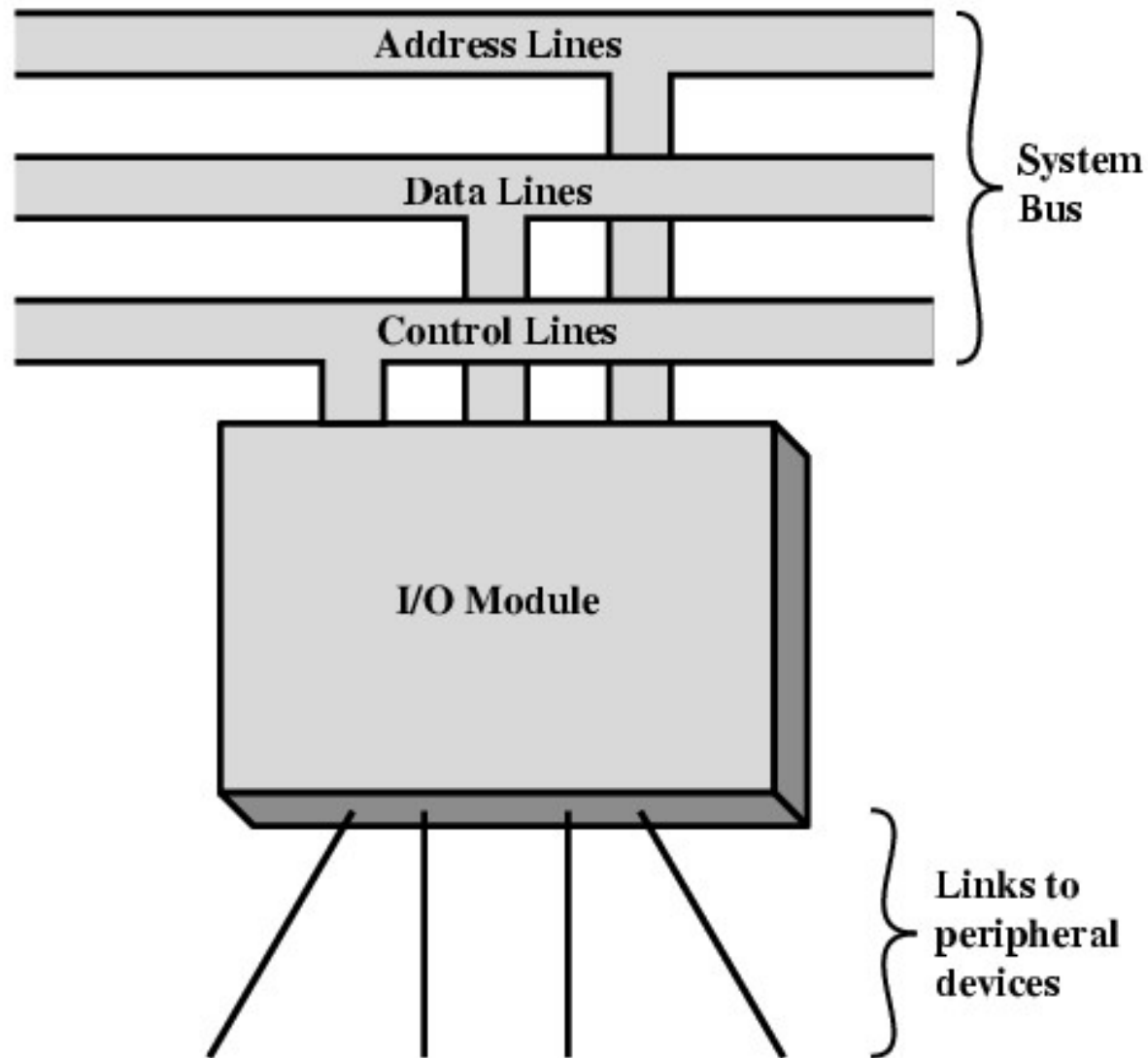
Input/Output Problems

- Wide variety of peripherals
 - Delivering different amounts of data
 - At different speeds
 - In different formats
- Different solutions for different devices
- All slower than CPU and RAM
- Controllers are placed outside CPU
- Need I/O modules

Input/Output Module

- Interface to CPU and Memory
- Interface to one or more peripherals

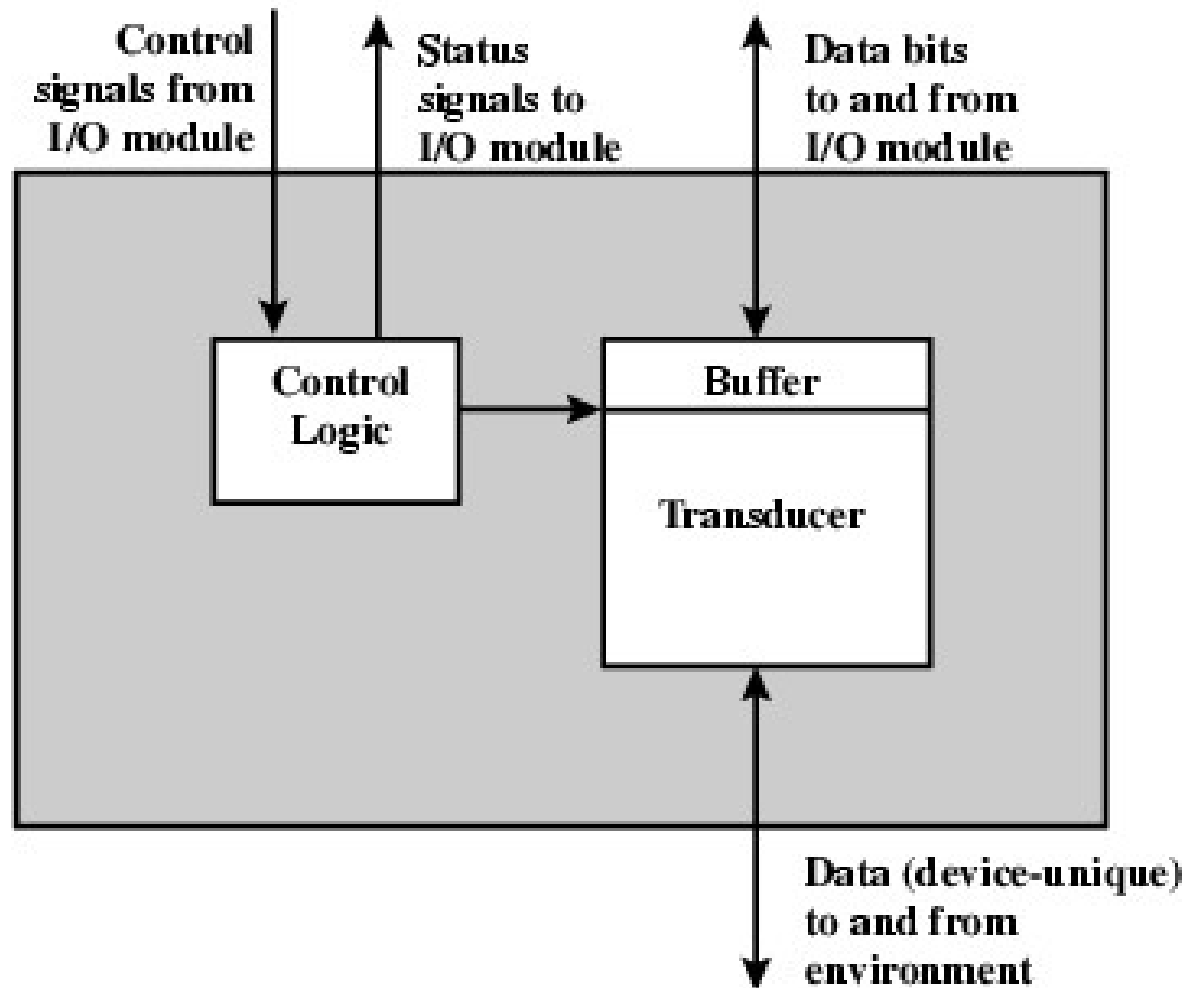
Generic Model of I/O Module



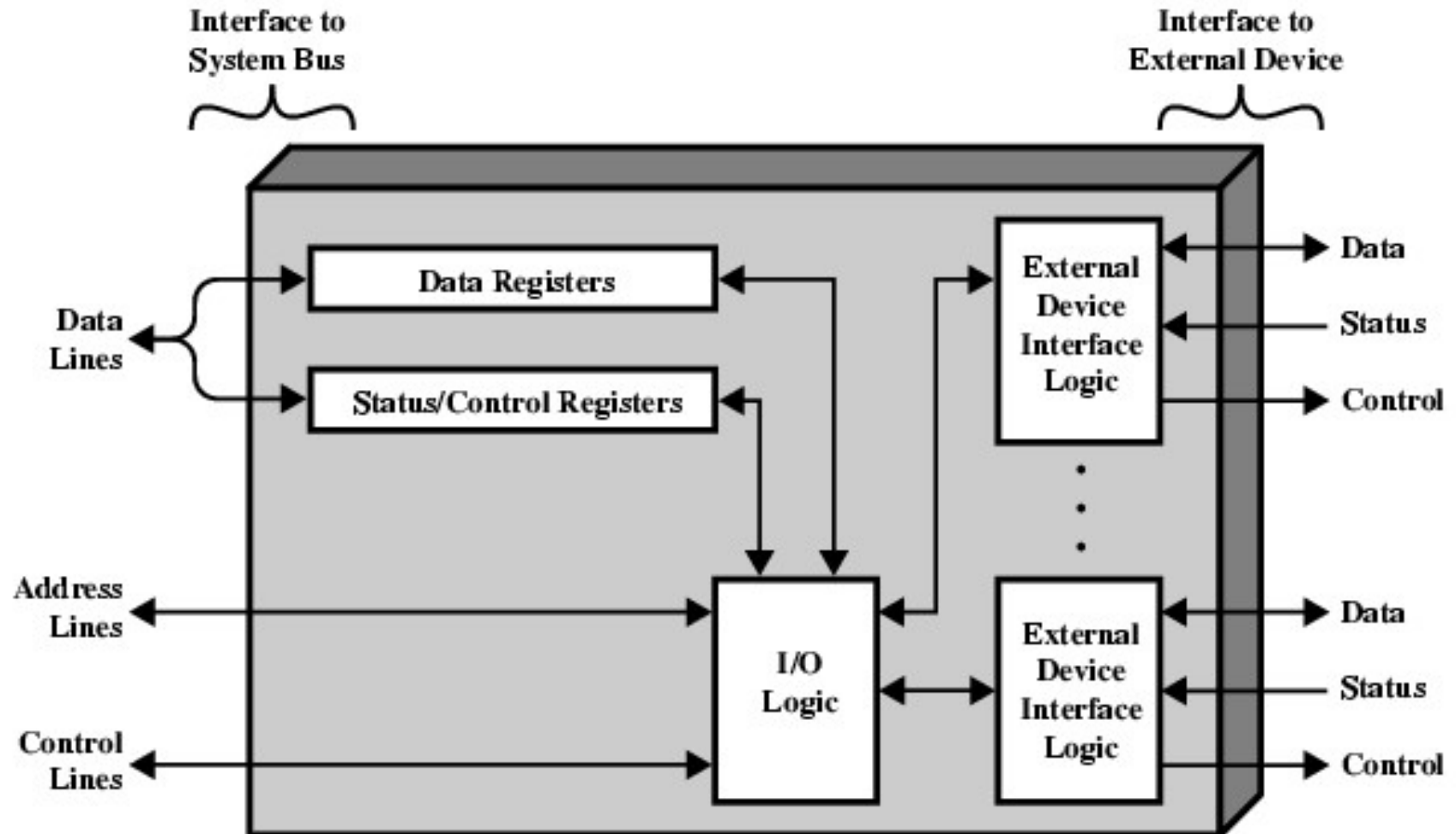
External Devices

- Human readable
 - Screen, printer, keyboard
- Machine readable
 - Monitoring and control
- Storage devices
 - Hard Disk, optical Disk, etc.
- Communication
 - Modem
 - Network Interface Card (NIC)

External Device Block Diagram



I/O Module Diagram



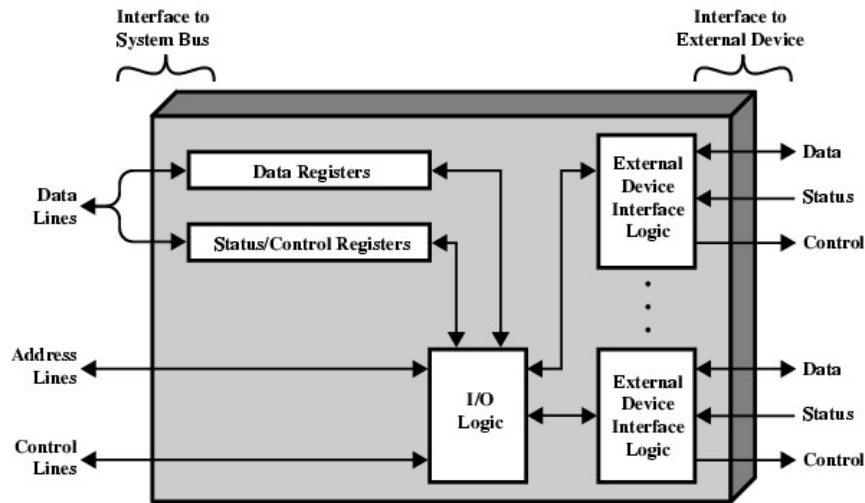
I/O Module Function

- Control & Timing
- CPU Communication
- Device Communication
- Data Buffering
- Error Detection

I/O Steps

- CPU checks I/O module device status
- I/O module returns status
- If ready, CPU requests data transfer
- I/O module gets data from device
- I/O module transfers data to CPU
- Variations for output, DMA, etc.

I/O Module Diagram

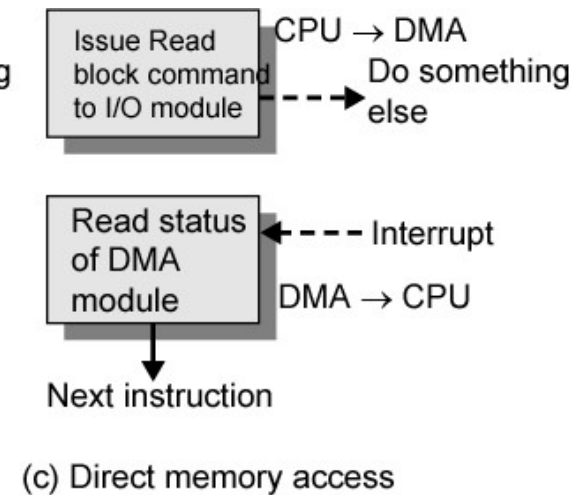
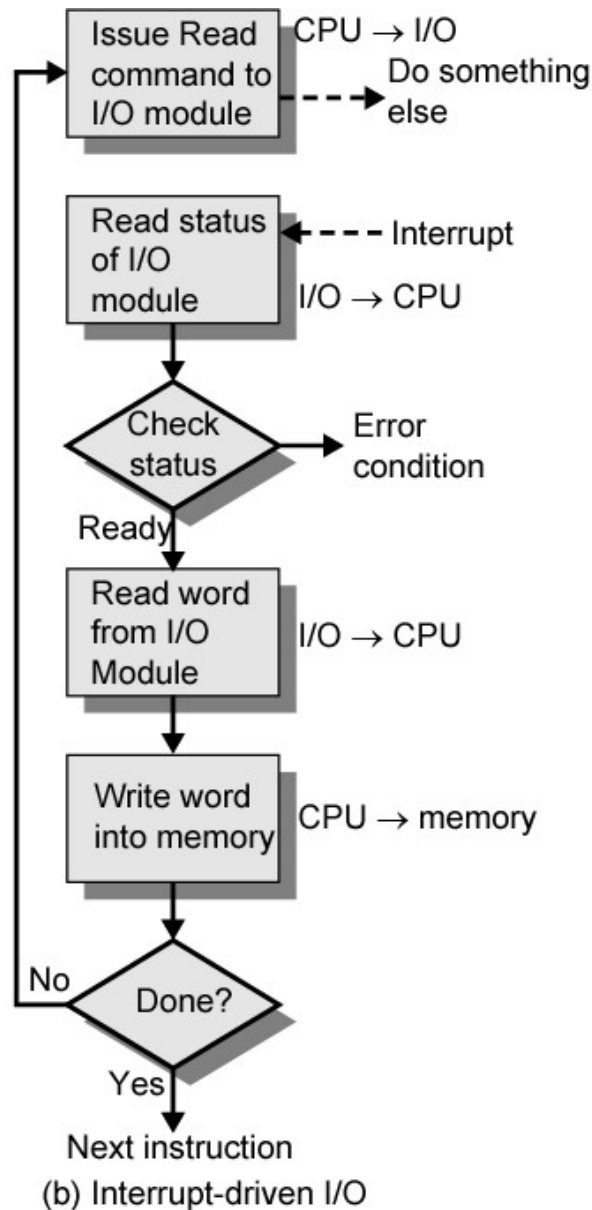
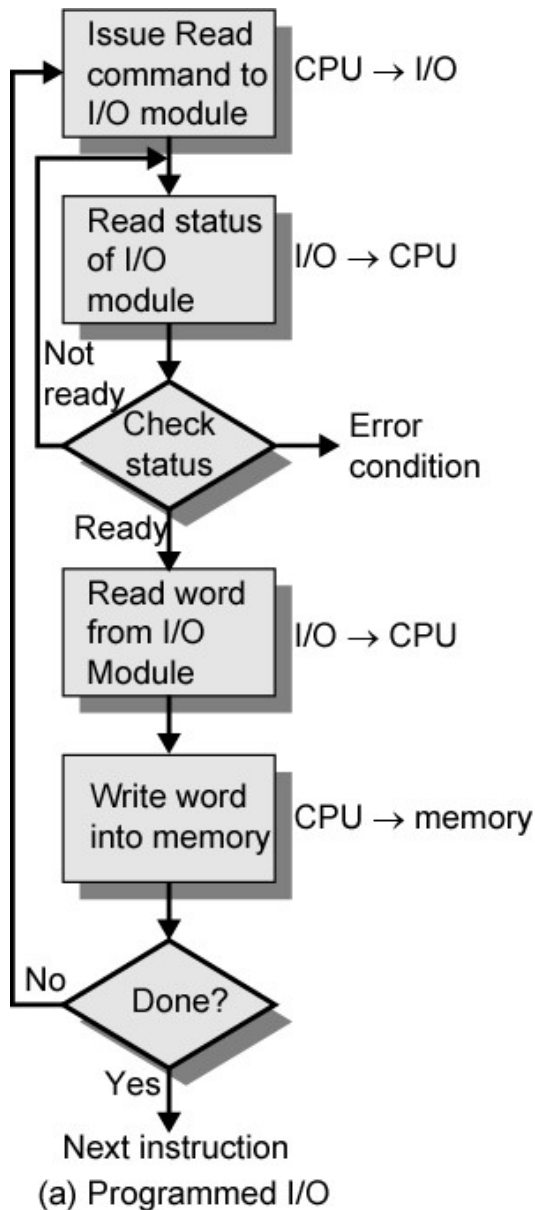


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- Variations for output, DMA, etc.

Input Output Techniques

- Programmed
- Interrupt driven
- Direct Memory Access (DMA)

Three Techniques



Programmed I/O

- CPU has direct control over I/O
 - Sensing status
 - Read/write commands
 - Transferring data
- CPU waits for I/O module to complete operation
- Wastes CPU time

Programmed I/O - detail

- CPU requests I/O operation
- I/O module performs operation
- I/O module sets status bits
- CPU checks status bits periodically
- I/O module does not inform CPU directly
- I/O module does not interrupt CPU
- CPU may wait or come back later

I/O Commands

- CPU issues address
 - Identifies module (& device if >1 per module)
- CPU issues command
 - Control - telling module what to do
 - e.g. spin up disk
 - Test - check status
 - e.g. power? Error?
 - Read/Write
 - Module transfers data via buffer from/to device

Addressing I/O Devices

- Under programmed I/O data transfer is very like memory access (CPU viewpoint)
- Each device given unique identifier
- CPU commands contain identifier (address)

I/O Mapping

- Memory mapped I/O
 - Devices and memory share an address space
 - I/O looks just like memory read/write
 - No special commands for I/O
 - Large selection of memory access commands available
- Isolated I/O
 - Separate address spaces
 - Need I/O or memory select lines
 - Special commands for I/O
 - Limited set

Reference

Computer Organization and Architecture –
Designing for Performance
William Stallings, Seventh Edition

Chapter 7: Input/Output
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