CS 222 Computer Organization & Architecture

Lecture 34 [26.04.2019]

Input-Output Subsystem

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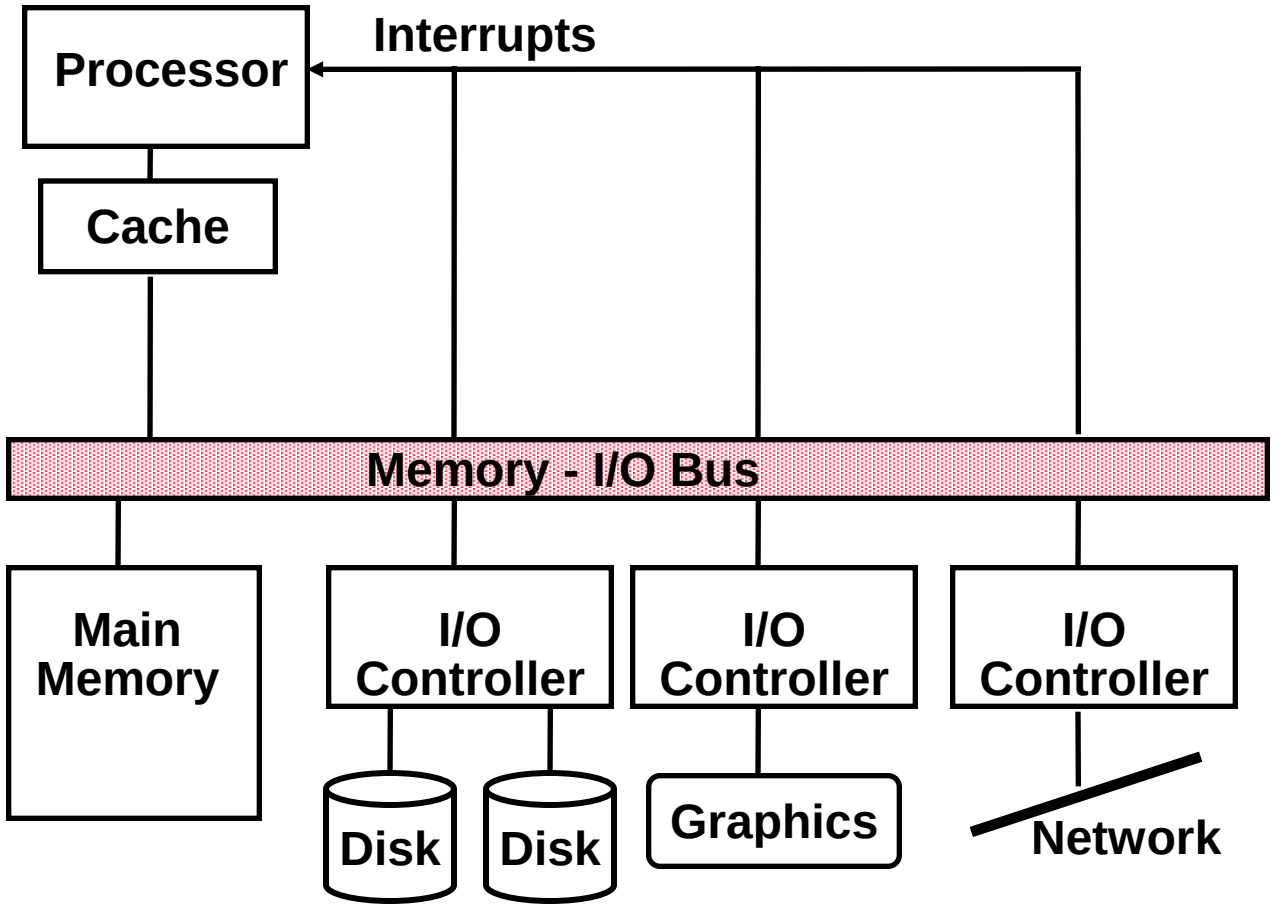
Typical I/O Subsystem



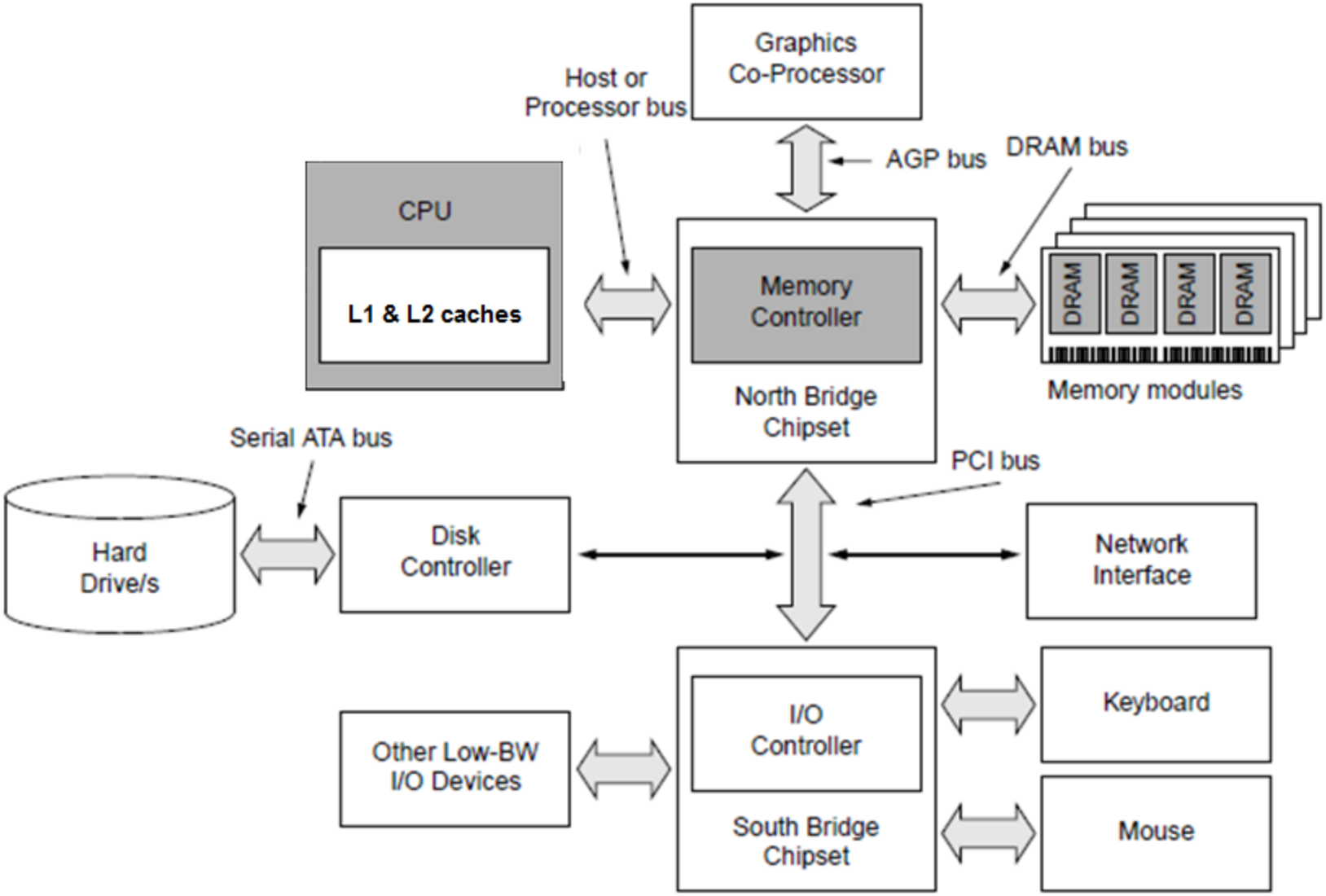
Problems in I/O Interfacing

- Wide variety of peripherals
  - Delivering different amounts of data
  - At different speeds
  - In different formats
- All slower than CPU and RAM
- Need I/O modules with some intelligence

Components of I/O Subsystem

- I/O Hardware
  - ports, buses, devices, controllers
- I/O Software
  - Interrupt Handlers, Device Driver, Device-Independent Software, User-Space I/O Software
- I/O Data transfer mechanisms
    - Polling, Interrupt and DMAs

Where is I/O controller residing ?

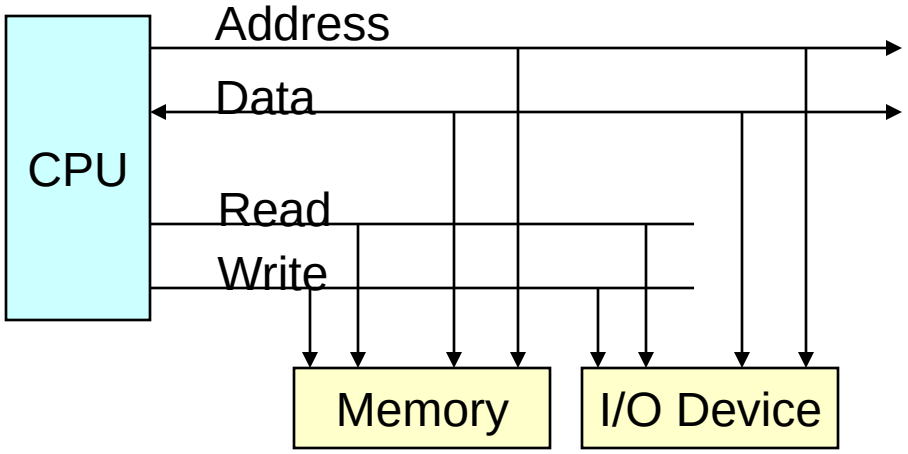


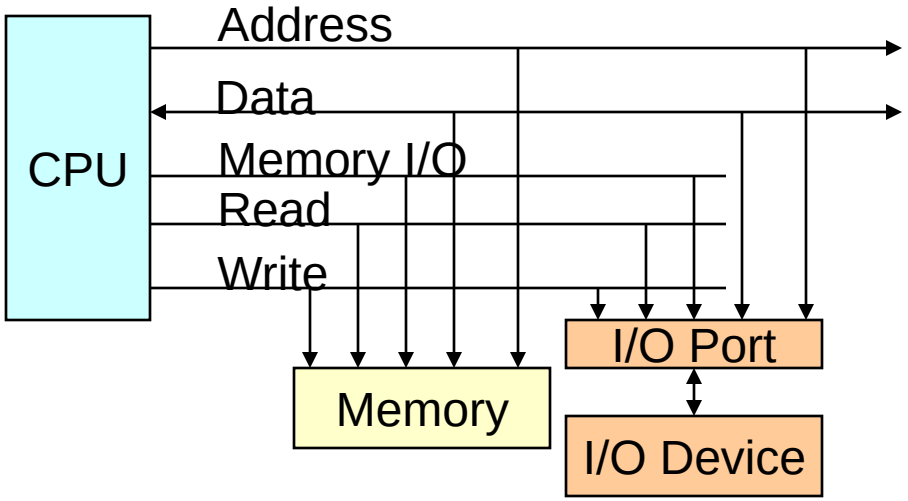
I/O Mapping

- 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 (I/O mapped I/O)
  - Separate address spaces
  - Need I/O or memory select lines
  - Special commands for I/O; Limited set

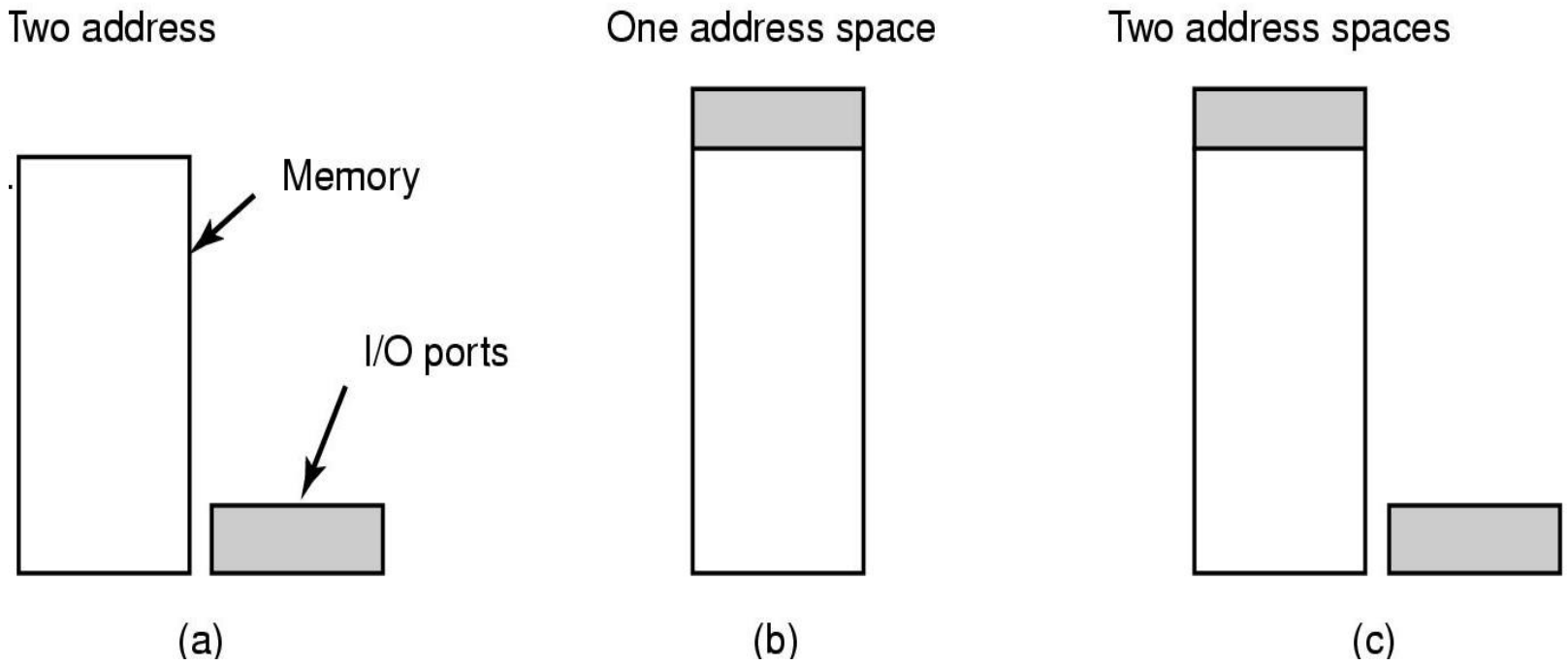
I/O Mapping

- CPU needs to talk to I/O
- **Memory-mapped I/O**
  - Devices mapped to reserved memory locations - like RAM
  - Uses load/store instructions just like accesses to memory
- **I/O mapped I/O**
  - Special bus line
  - Special instructions





I/O Mapping



(a) Separate memory & I/O address space

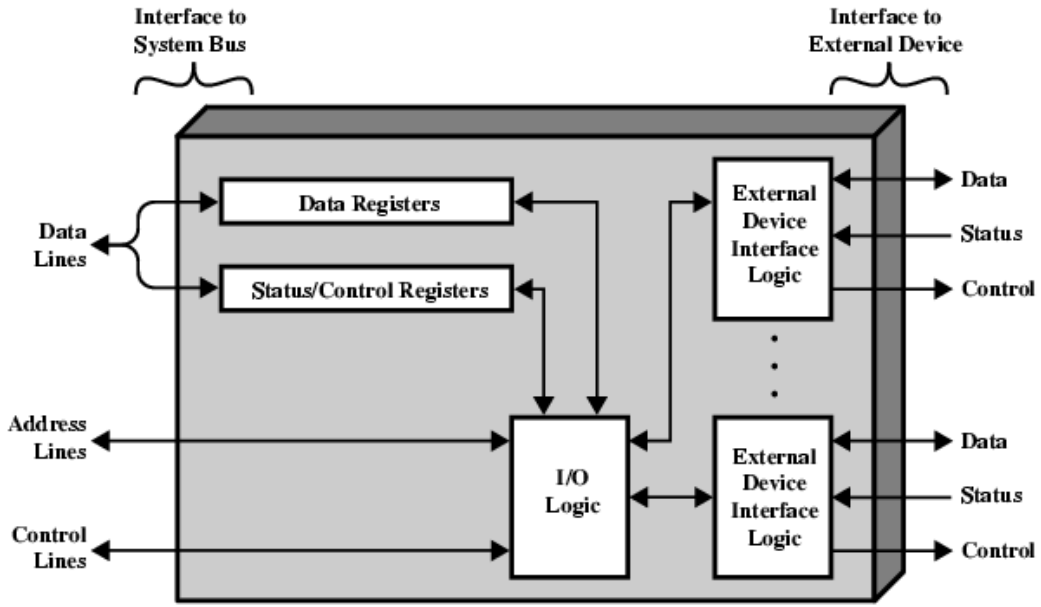
(b) Memory-mapped I/O

(c) both

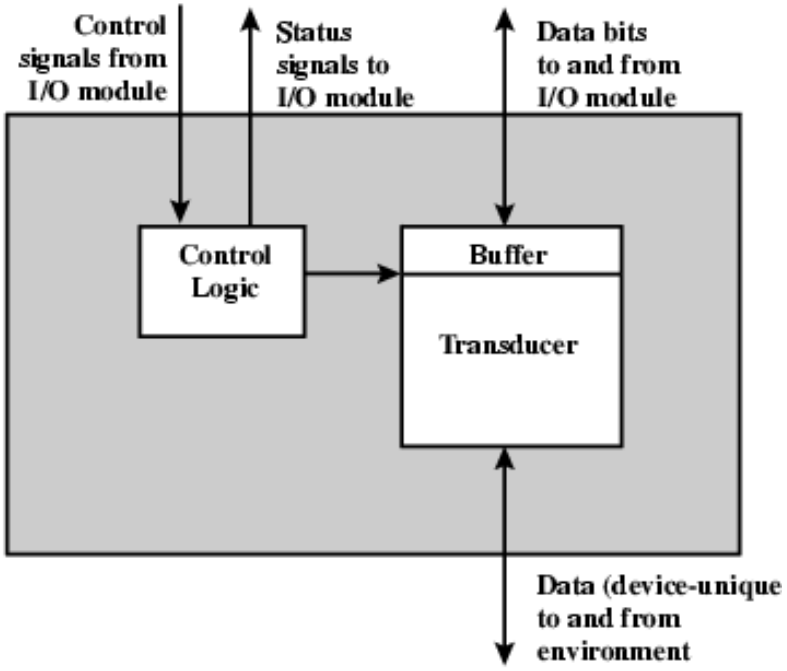
I/O Basics

- I/O module interface I/O to CPU and Memory
- **I/O controller ←→ I/O devices ports**
  - Transfers data to/from device
  - Synchronizes operations with software
- **Status/ control registers**: device status, errors
- **Data registers**
  - Write: CPU/RAM data → device [eg Transmit]
  - Read: CPU← device [eg Receive]

I/O Module and Device Interface



I/O Module



External Device Module

Functions of I/O Module

- Control & Timing
- Processor Communication
- Device Communication
- Data Buffering
- Error Detection (e.g., extra parity bit)

Basic I/O Steps

- CPU checks I/O module device status
- I/O module returns status
- If ready, CPU requests data transfer by sending a command to the I/O module
- I/O module gets a unit of data (byte, word, etc.) from device
- I/O module transfers data to CPU
- Variations of these steps for different I/O mechanisms like poling, interrupt and DMA based I/O.

I/O Data Transfer techniques

- Programmed I/O
- Interrupt-Driven I/O
- Direct Memory Access (DMA)

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