Computer Labs: I/O Devices

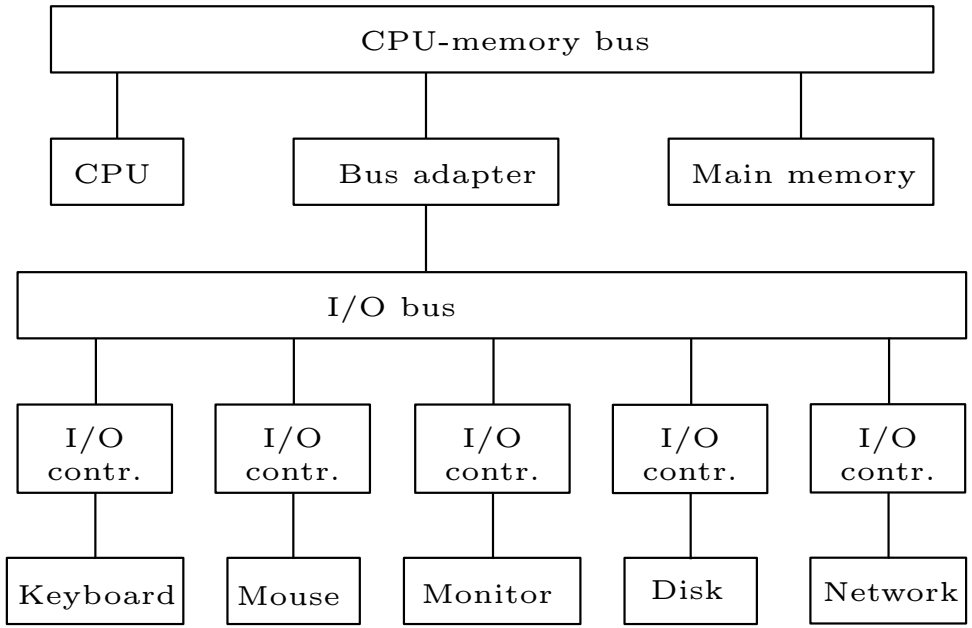
2º MIEIC

Pedro F. Souto (pfs@fe.up.pt)

September 23, 2019

I/O Devices

- I/O devices provide the interface between the CPU and the outside world.



I/O Controllers

- Each I/O device is controlled by an electronic component, usually called **controller** or **adapter**.
- I/O controllers typically include three kinds of registers:

  Control: used to request I/O operations

  Status: used to get the state of the device or pending I/O operations

  Data: used to transfer data to/from the I/O devices
- Programming at the register level may require a detailed knowledge of the device's operation

How does the CPU access an I/O controller?

Via memory-mapped I/O

- Portions of the address-space are assigned to I/O devices
- Access to an I/O device is done using the CPU's memory access instructions
- Can be used with any processor architecture

Special I/O instructions

- I/O uses different address-space and each I/O device is assigned a portion of that address space
- CPU must provide special instructions to access the I/O address-space (I/O instructions)
  - The Intel CPU's used in the PC have always provided them
  - The ARM processors do not
- I/O instructions are legal only when executing at a high privilege level, typically that of the kernel/supervisor mode

Intel's I/O Instructions

Port Is an abstraction of a device's controller register

- In the Intel documentation, a port is the name of an address in the I/O address space
- The I/O address space uses 16-bit addresses
- Two/four-consecutive 8-bit ports can be treated as 16/32-bit ports – should align them for performance

Instruction IN Input from port, i.e. read from an I/O register

- The source operand, i.e. the I/O port, is either a "byte immediate" or the DX register
- The destination operand is one of the AL, AX and EAX registers, depending on the size of the port being accessed

```
in      al,  80h          ; read byte from port 80h
```

Instruction OUT Ouput to Port, i.e. write to an I/O register

```
mov     dx,  3F8h
out     dx,  al           ; write byte to port 3F8h
```

PC's I/O address map