I/O Management

- Interactive systems are often more concerned with I/O than computing
- I/O devices
  - Vary widely in functionality and speed
  - Standard software and hardware interfaces help to incorporate new devices
  - New devices are constantly introduced
- Device driver
  - Bridge between OS subsystems and I/O devices
  - Encapsulate device particularities delivering an uniform interface
I/O Hardware

- **Port**
  - Host connection point for I/O devices

- **Bus**
  - Shared set of wires and a protocol that allows several devices to be simultaneously connected to the host

- **Controller**
  - Controls the operation of ports, buses and devices
  - From simple electronics to complex processors
  - Interacts with host through registers
    - Control, status, data in/out
    - I/O ports, memory mapped, CPU register mapped
I/O Operation

- **Polling**
  - Host 'polls' status registers to determine the status of a device
  - Busy-waiting
    - Loop reading a status register
    - Overhead on multitask systems
    - Simplicity and efficiency on single-task systems

- **Interrupts**
  - Avoids busy-waiting
  - I/O device receives a service request and generates and interrupt when the request has been accomplished
  - Transparent to processes
I/O Data Transfers

- **Programmed I/O**
  - Data is transferred to/from I/O device by having the CPU to write/read data registers on the device controller
  - One word at a time

- **Direct Memory Access (DMA)**
  - Data is transferred by dedicated circuitry (DMA controller) without CPU assistance
    - Source and destination pointers + count
    - Multi-word (burst) transfers
    - Interrupt on completion or error
  - Concurs with CPU for memory
  - Pitfall
    - Address translation logical -> physical or DVMA
I/O Hardware
Application I/O Interface

- Indirect via I/O subsystems
  - A disk can be indirectly accessed through the files contained on it
  - A network adapter can be indirectly accessed through the TCP/IP stack (socket)

- Pseudo-file
  - Device drivers become handlers of operations on 'special files' that are plugged into the file system (/dev/mouse, /dev/hda, etc)

- Specific system calls
  - OS provides specific system calls to interact with I/O devices (eg ioctl on Unix)