Virtual Memory / Paging

- Process virtual address space

- Machine physical address

HD

(mem)
I/O

CPU

Mam

I/O

I/O

I/O

keyboard

HD

network

Process

request

I/O (OS)

start access

I/O

finish access

send interrupt

wake up
Memory Mapped I/O
- device is "at" a mem addr

Direct Memory Access (DMA)
- device stores data in memory
  w/o CPU

Serial Access
- PCI-Express

Parallel access
- Bus
  - 32
  - arbitration

Lane
- send
- recv
Disks

access time
- seek time 
  move r/w
  head to track
- rotational latency
- transfer time
RAID

RAID 0 - striping

RAID 1 - mirror

RAID 4

RAID 5