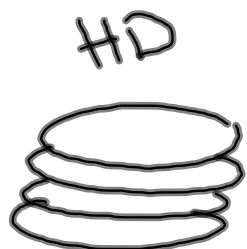
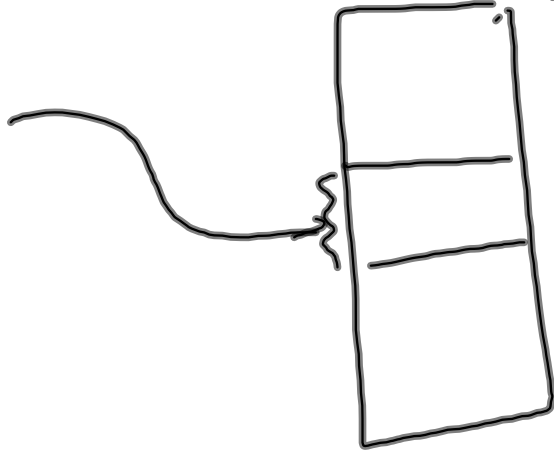
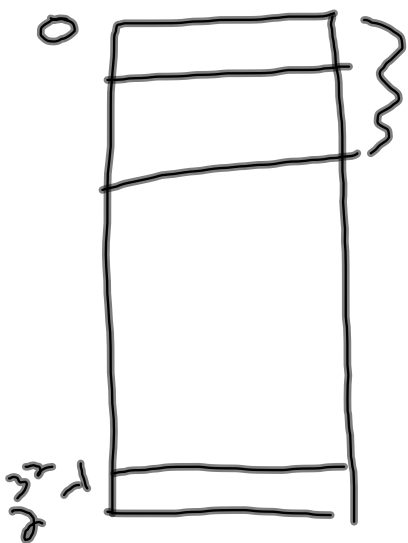
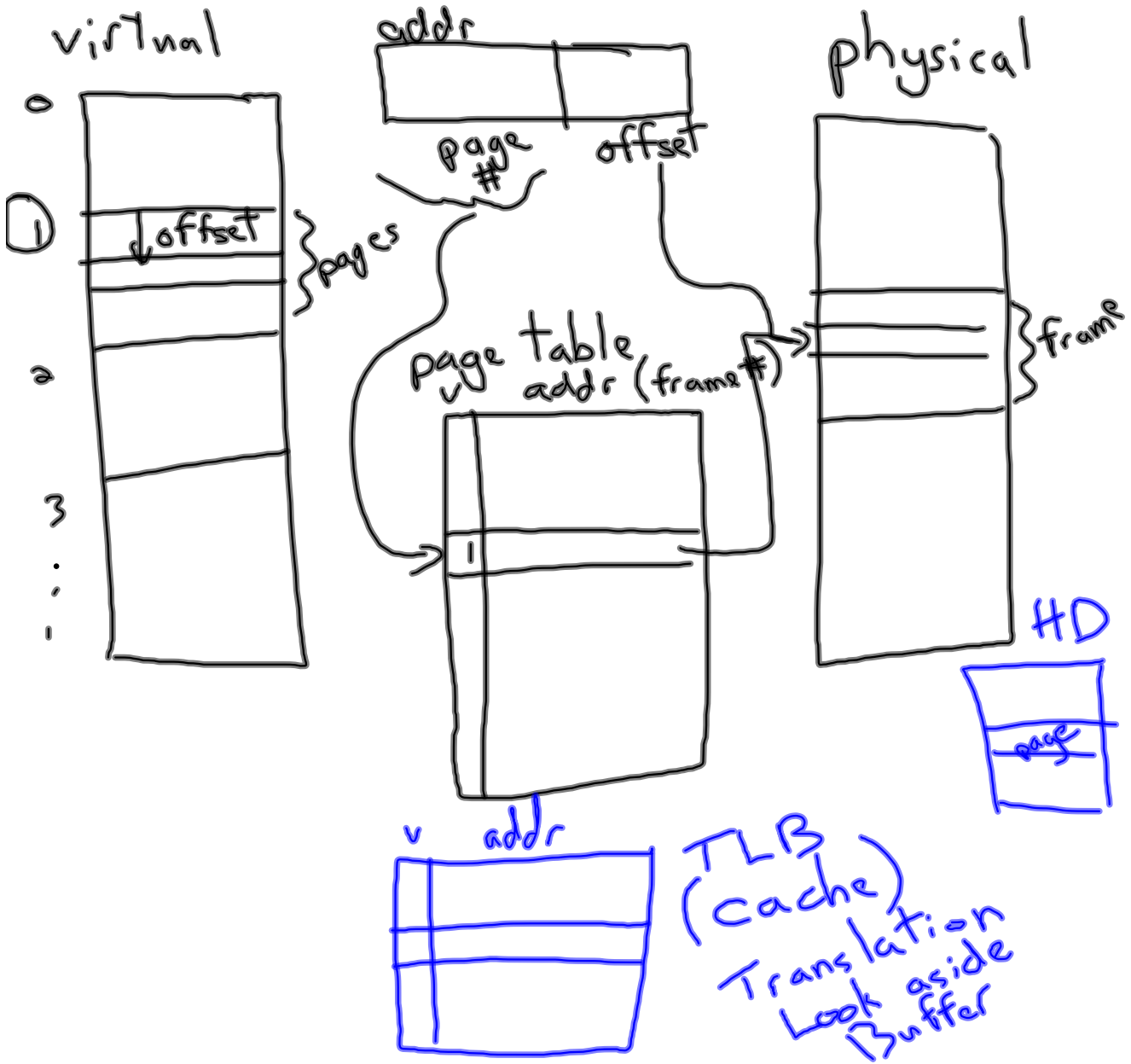


# Virtual Memory / Paging

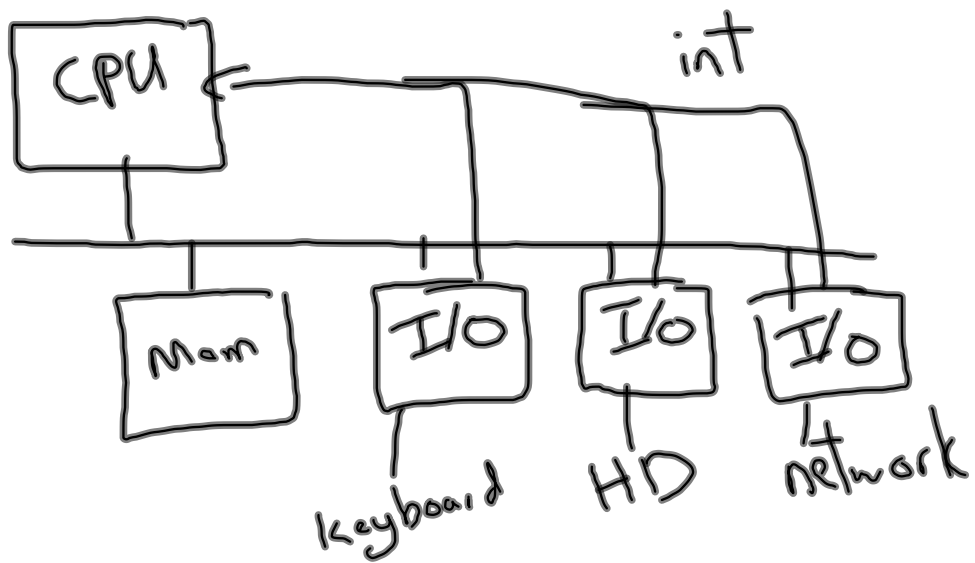
Process  
- virtual address  
space

Machine  
physical  
addr  
(mem)





# I/O



process  
request  
waiting

I/O (OS)

I/O  
start access

finish access  
send interrupt

wake up

## Memory Mapped I/O

↳ device is "at" a mem addr

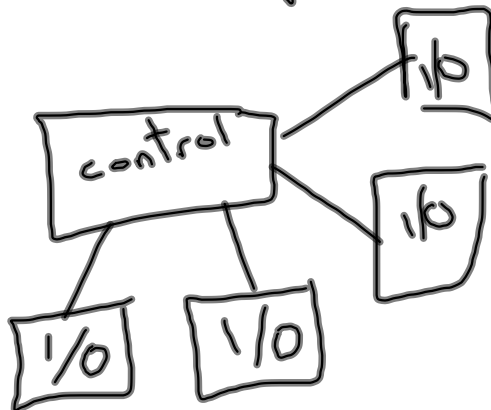
## Direct Memory Access (DMA)

↳ device stores data in memory  
w/o CPU

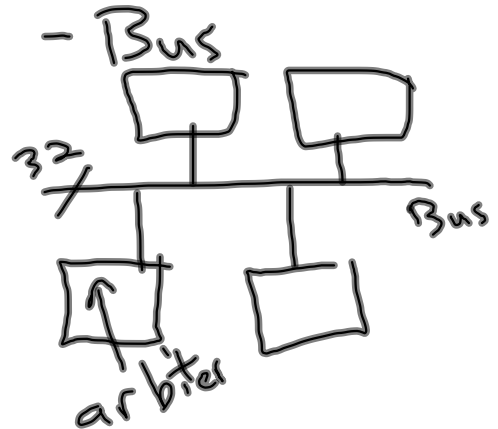
### Serial Access

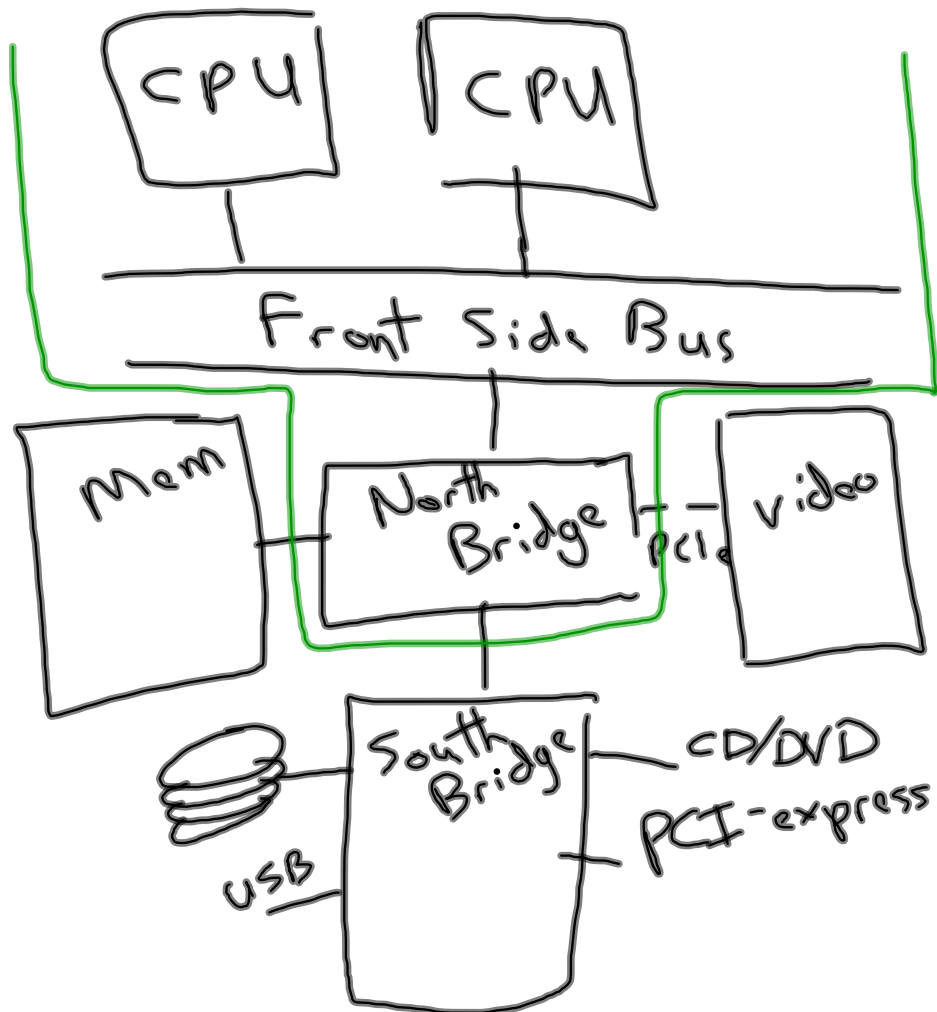
PCI-Express

Lane  
- 2 send  
- 2 rcv



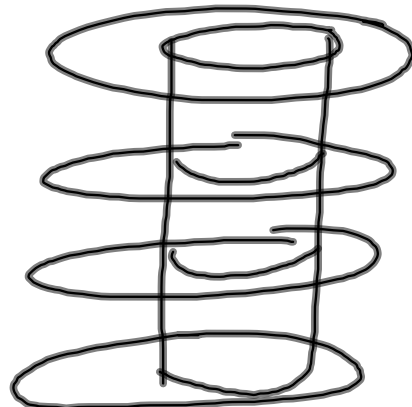
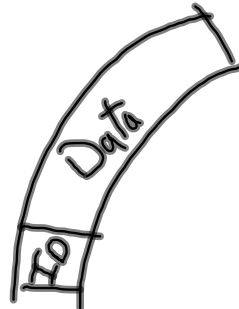
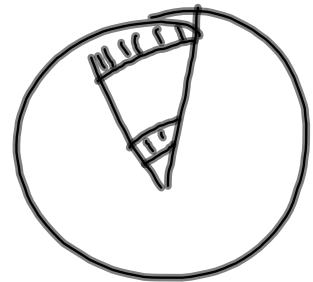
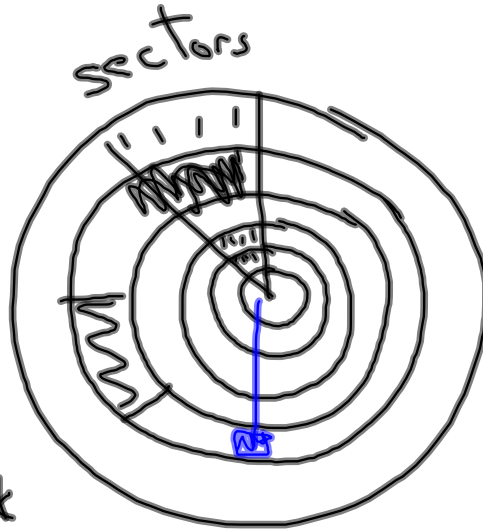
### Parallel access





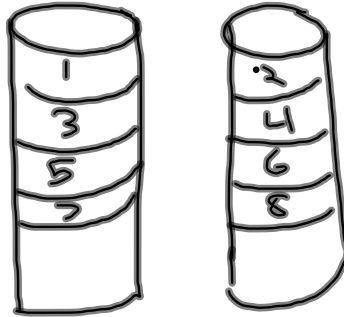
# Disks

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

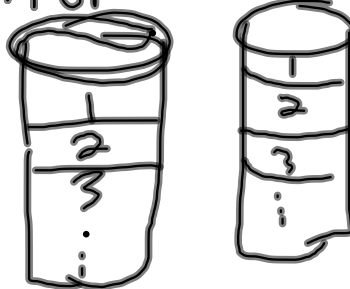


# RAID

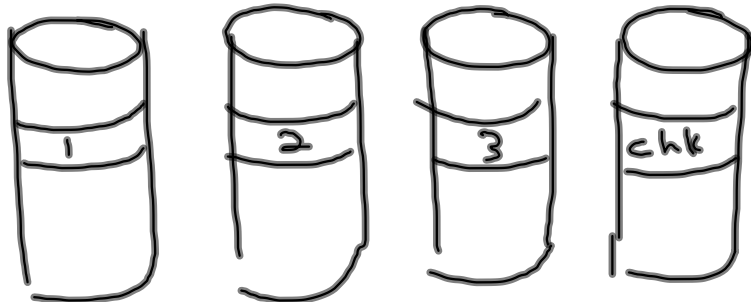
RAID 0 - striping



RAID 1 - mirror



RAID 4



RAID 5

