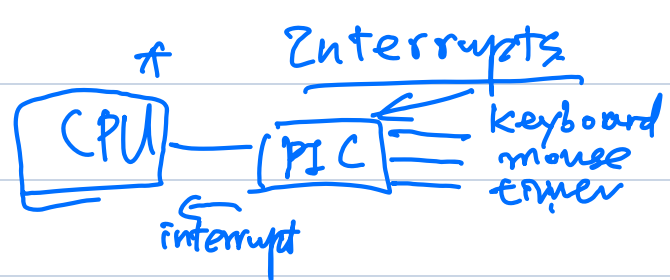
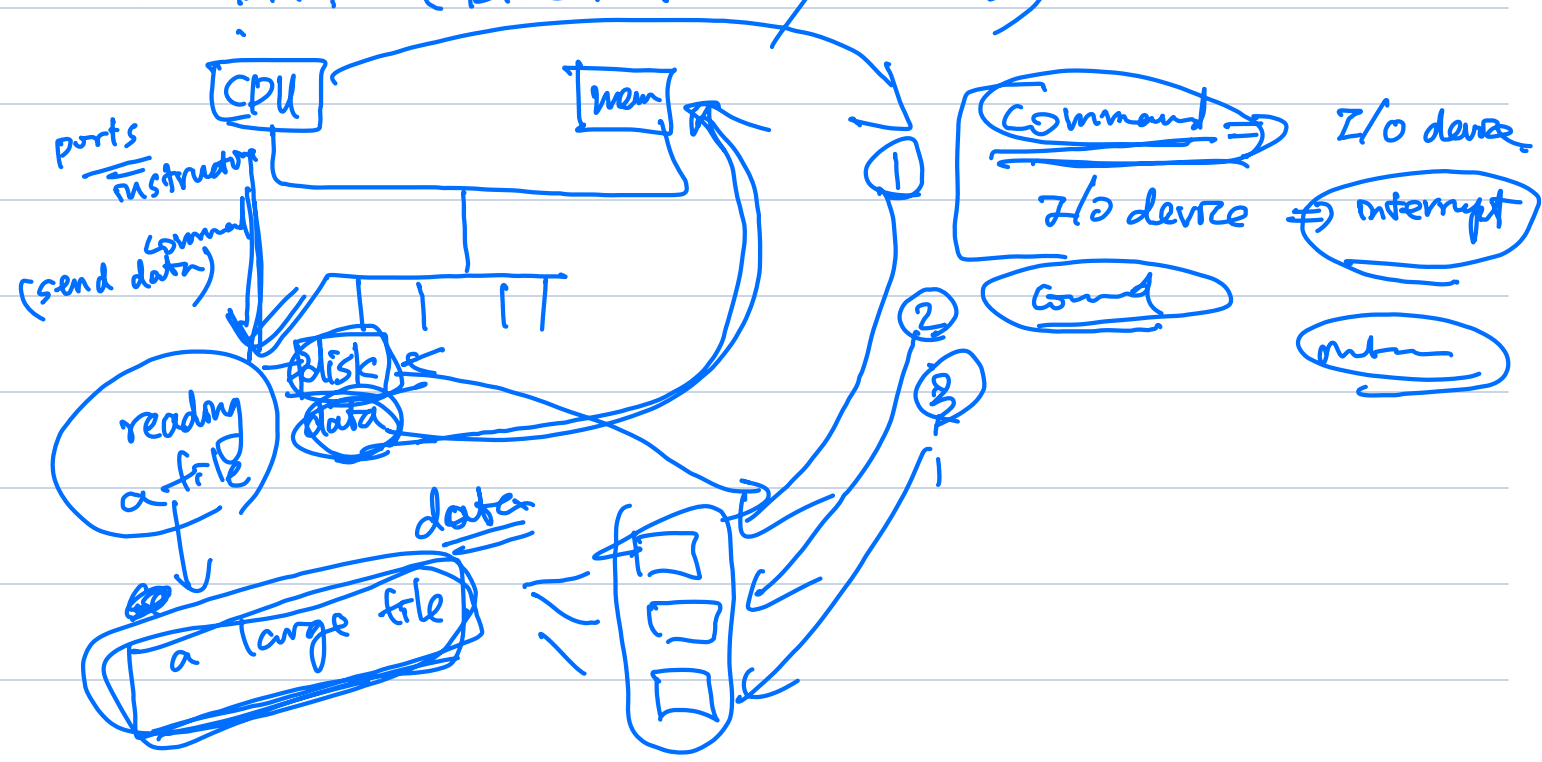


\* memory-mapped I/O  
ports I/O.

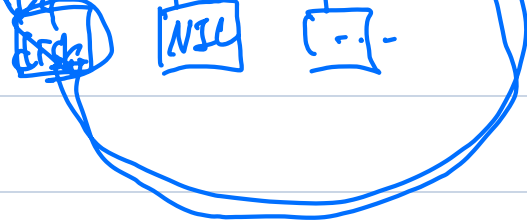


\* DMA (Direct Memory Access)



DMA. ( Direct Memory Access )





## \* Disk

\* Hard drive (HDD) : mechanical parts

\* Solid state (SSD) : non-mechanical.

- last longer

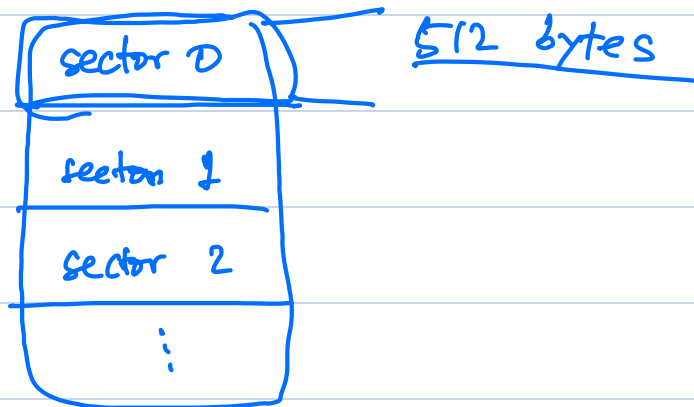
cheaper. slower

expensive faster

- shorter lifetime.

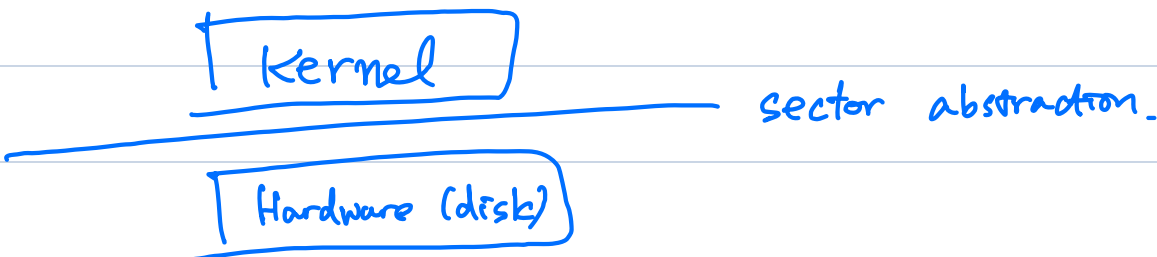
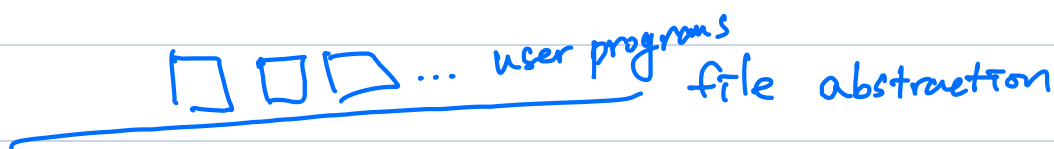
\* Kernel uses an abstraction of a disk.

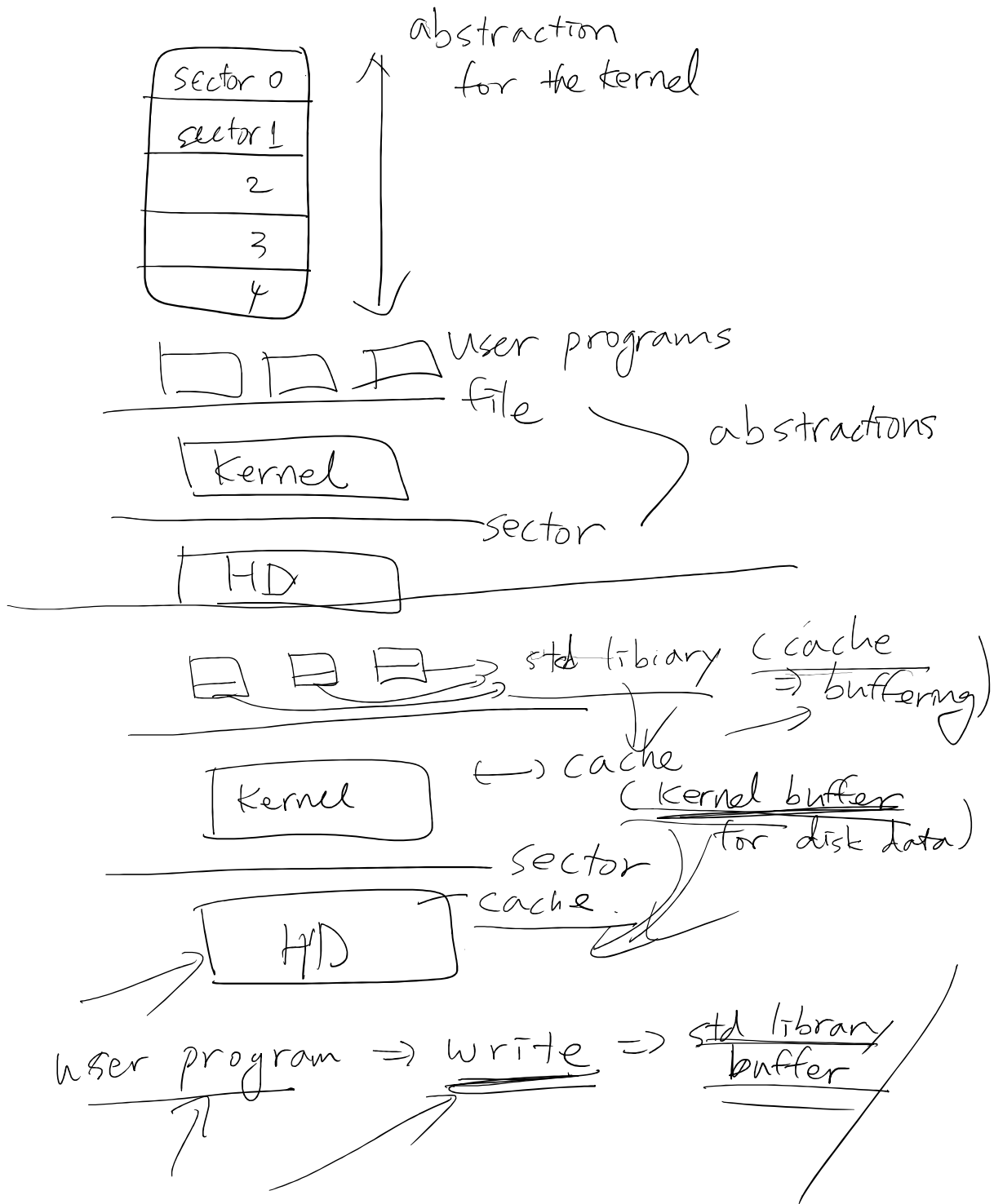
\* sector



\* User programs use an abstraction

\* file



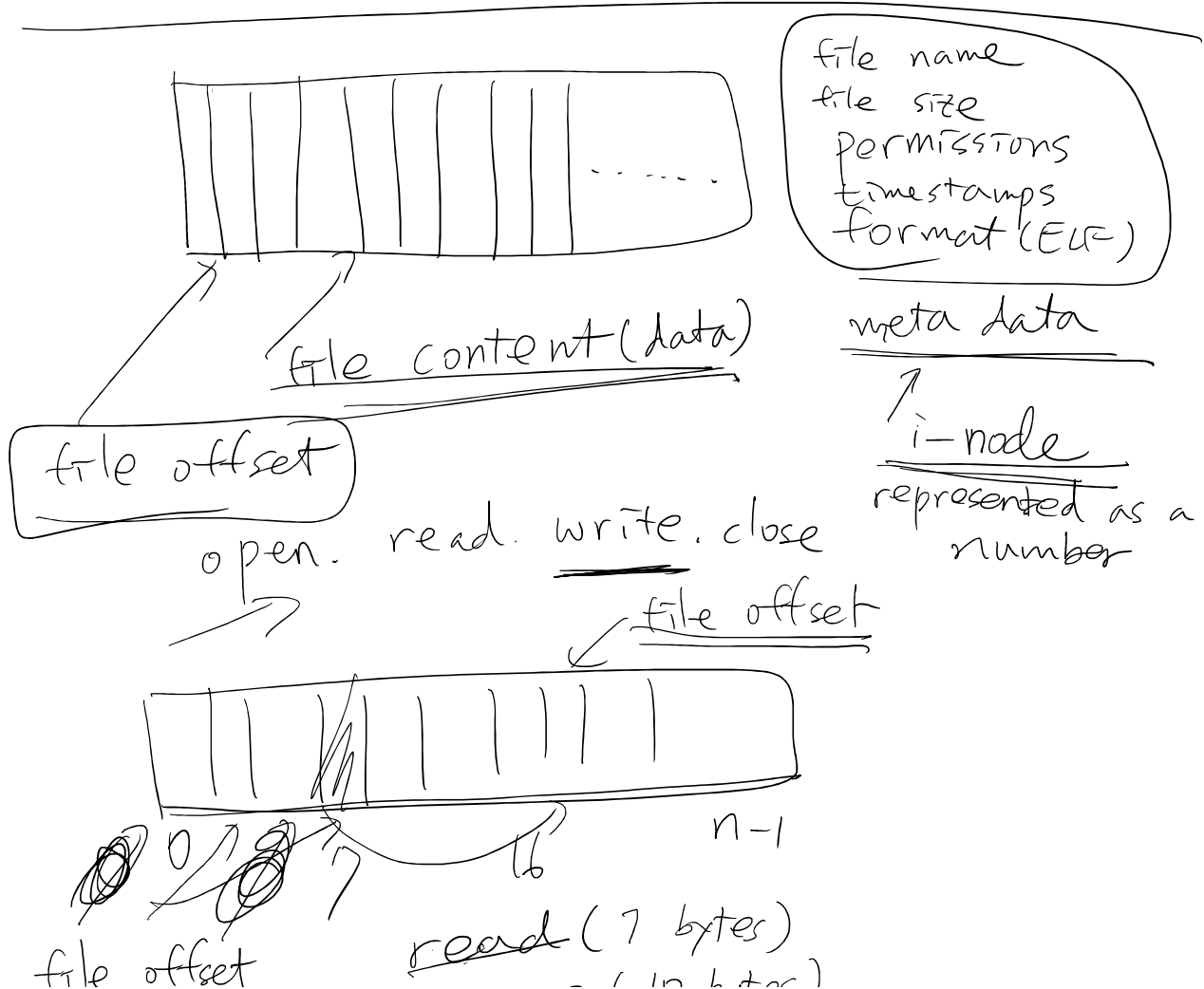
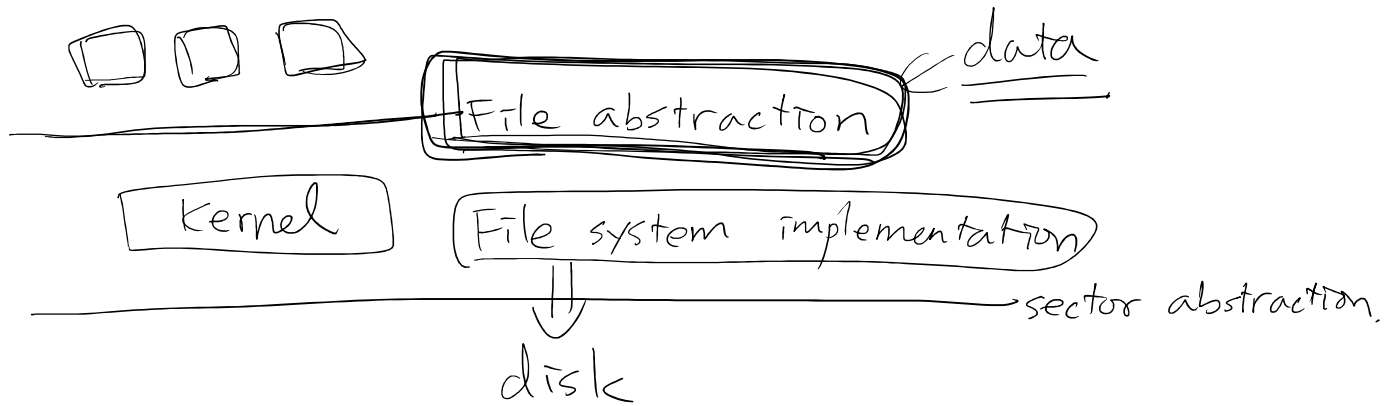
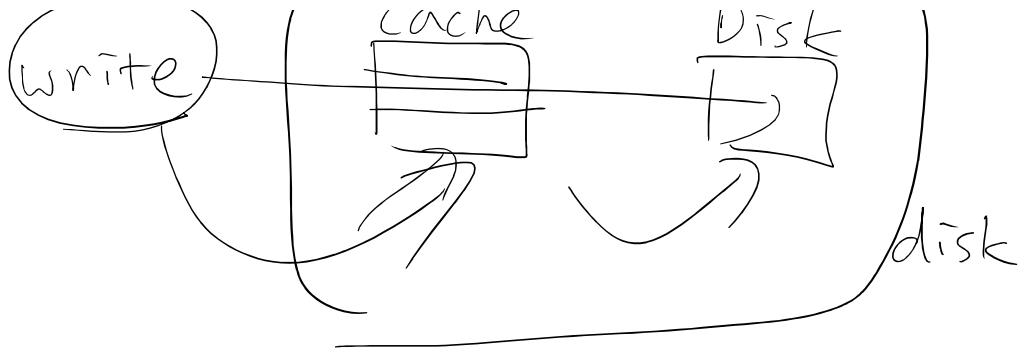


\* ~~write-back~~ write-back : write to cache  
 write-through : write to memory & cache

write

cache

Disk



file offset

read (7 bytes)

write (10 bytes)

lseek : move file offset.

---

Linux : everything is a file.

~~/dev~~ /dev / ..... (serial)  
                    devices  
                    CPU info  
                    mem info

/dev/pool .....  
                    process info (process id, running time, memory consumption)

/dev/serial

fd = open ("/dev/serial");  
      write (fd, "string");

/dev/keyboard

read ( )

network card (NIC)  
      write / read.

---

### Additional resources

Operating Systems: Three Easy Pieces Chaters 36 & 39

<https://pages.cs.wisc.edu/~remzi/OSTEP/#book-chapters>