CS 140: Operating Systems Lecture 15: Disks

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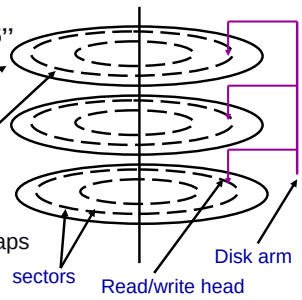
What do disks look like?

- **2-30 heads (platters * 2)**
  - **diameter 14'' to 2.5''**
- **700-20480 tracks per surface**
- **16-1600 sectors per track**
- **sector size:**
  - **64-8k bytes**
  - 512 for most pc's
  - note: inter-sector gaps
- capacity: 20M-750G



- main adjectives: BIG, sloowwwwww

Some modern disks drives

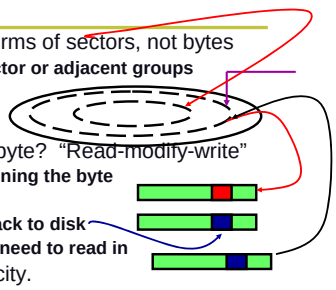
	deskstar HDS5725050	Cheetah ST373454LW
Capacity	500GB	73GB
Disk/Heads	5/10	2/4
Cylinders	103,182	50,864
Sectors/track	~946	~921
Speed	7200RPM	15000RPM
Latency (ms)	4.2	2.0
Avg seek (ms)	8.2/9.2	3.4/4.0
Track-2-track(ms)	0.8/1.3	0.2/0.4

Disk vs. Memory

Disk	Memory
Smallest write: sector	(usually) bytes
Atomic write = sector	byte, word
Random access: 5ms **not on a good curve**	50 ns **faster all the time**
Sequential access: 200MB/s	200-1000MB/s
Cost $.002MB	$.10MB
Crash: doesn't matter ("non-volatile")	contents gone ("volatile")

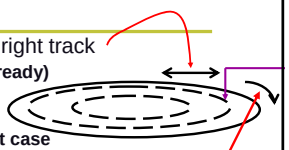
Some useful facts

- Disk reads/writes in terms of sectors, not bytes
  - **Read/write single sector or adjacent groups**
- How to write a single byte? "Read-modify-write"
  - **Read in sector containing the byte**
  - **Modify that byte**
  - **Write entire sector back to disk**
  - **Key: if cached, don't need to read in**
- Sector = unit of atomicity.
  - **Sector write done completely, even if crash in middle (disk saves up enough momentum to complete)**
  - **Larger atomic units have to be synthesized by OS**



Some useful costs

- Seek: move disk arm to the right track
  - **Best case: 0ms (on track already)**
  - **Worst: ~30-50ms (move over entire disk)**
  - **Average: 10-20ms, 1/3 worst case**
- Rotational delay: wait for sec to rotate under head
  - **Best: 0ms (over sector)**
  - **Worst: ~16ms (entire rotation)**
  - **Average: ~8ms (1/2 worst case)**
- Transfer bandwidth: suck bits off of device
- Cost of disk access? Seek + rotation + transfer time
  - **Read a single sector: 10ms + 8ms + 50us ~= 18ms**
  - **Cool: read an entire track? Seek + transfer! (why?)**



Some useful trends

- Disk bandwidth and cost/bit improving exponentially
  - **Similar to CPU speed, memory size, etc.**
- Seek time and rotational delay improving *very* slowly
  - **Why? require moving physical object (disk arm)**
- Some implications:
  - **Disk accesses a huge system bottleneck & getting worse**
  - **Bandwidth increase lets system (pre-)fetch large chunks for about the same cost as small chunk.**
    - **Result? trade bandwidth for latency if you can get lots of related stuff.**
    - **How to get related stuff? Cluster together on disk**
  - **Memory size increasing faster than typical workload size**
    - **More and more of workload fits in file cache**
    - **disk traffic changes: mostly writes and new data**

Flash RAM disks

- Disk storage devices made from FlashRAM
  - **Non-volatile random access memory**
  - **Read/Erase/Write operations**
- Issues for file systems:
  - **No-seek or rotational delays.**
  - **Currently large transfer delays.**
  - **Durability issues (limited number of writes per block)**