Lecture 20: Hard disk internals

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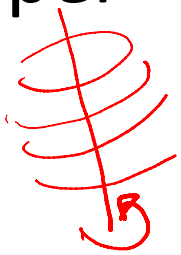
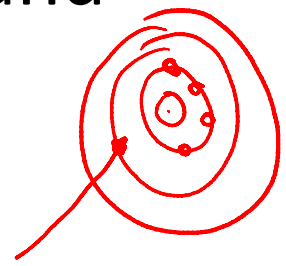
Hard disk

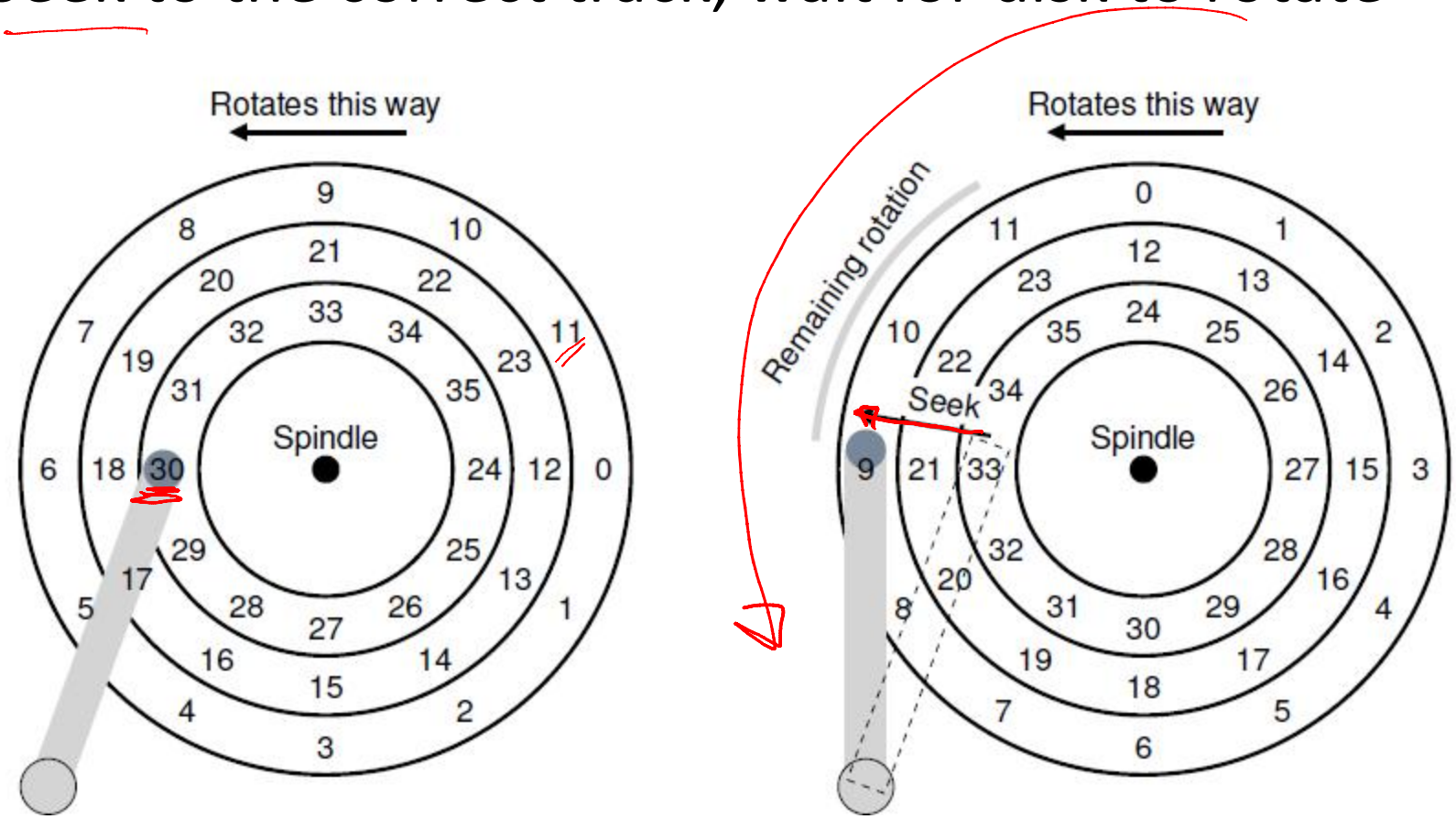
- Interface: a set of 512-byte blocks (sectors), that can be read or written atomically
- Internals: one or more platters, connected by a spindle, spinning at ~10K RPM (rotations per minute)
- Each platter has a disk head and arm
- A platter is divided into multiple tracks, and each track into 512-byte sectors





What happens when accessing a sector?

- Suppose disk head at 30, need to access 11
- Seek to the correct track, wait for disk to rotate



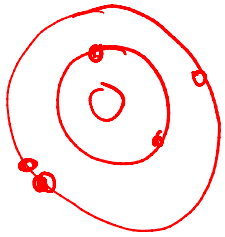
Time taken for I/O operation

- Time taken to read/write a block consists of
  - Seek time to get to the right track (few ms)
  - Rotational latency for disk to spin to correct sector on the track (few ms)
  - Transfer time to read sector (few tens microsec)
- Given high seek and rotational latency, usually rate of sequential access > rate of random access

	Cheetah	Barracuda
$R_{I/O}$ Random	0.66 MB/s	0.31 MB/s
$R_{I/O}$ Sequential	125 MB/s	105 MB/s

Figure 37.6: **Disk Drive Performance: SCSI Versus SATA**

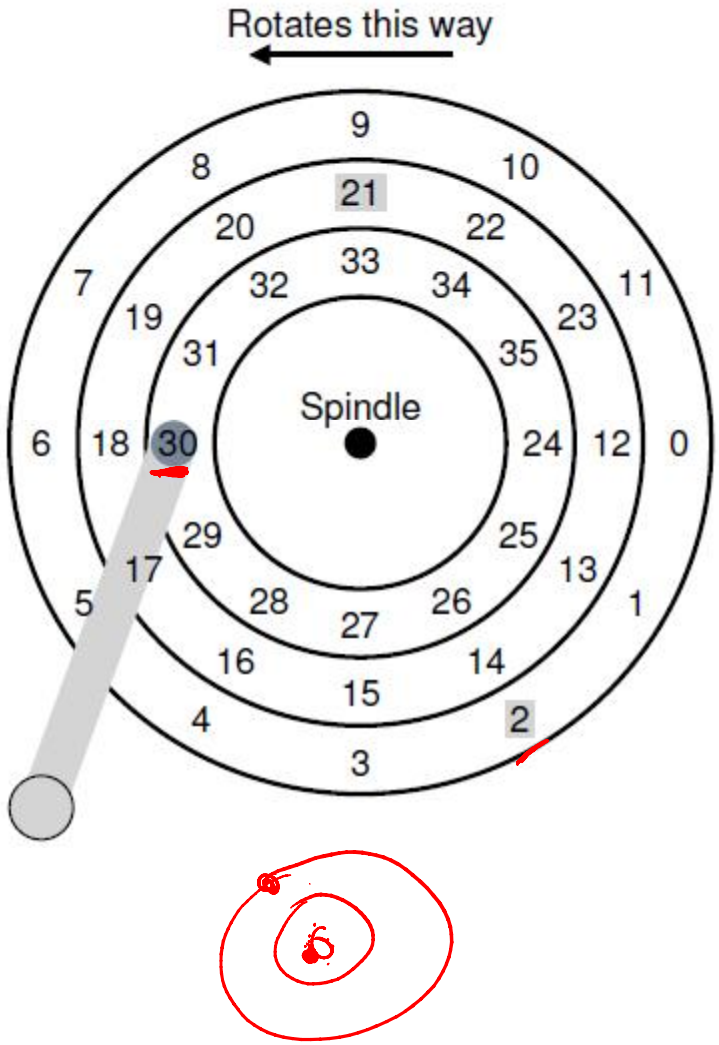
Disk Scheduling



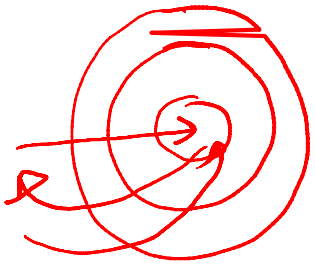
- Requests to disk are not served in FIFO, they are reordered with other pending requests
- Why? In order to read blocks in sequence as far as possible, to minimize seek time and rotational delay
- Who does scheduling? OS does not know internal geometry of disk, so scheduling done mostly by disk controller

Shortest Seek Time First (SSTF)

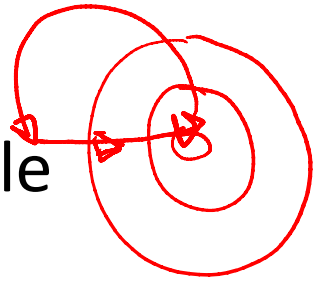
- Access block that we can seek to fastest
  - Go to 21 (one track away) before 2 (two tracks away)
- Problem: starvation (some requests that are far from current position of head may never get served)



Elevator/SCAN algorithm

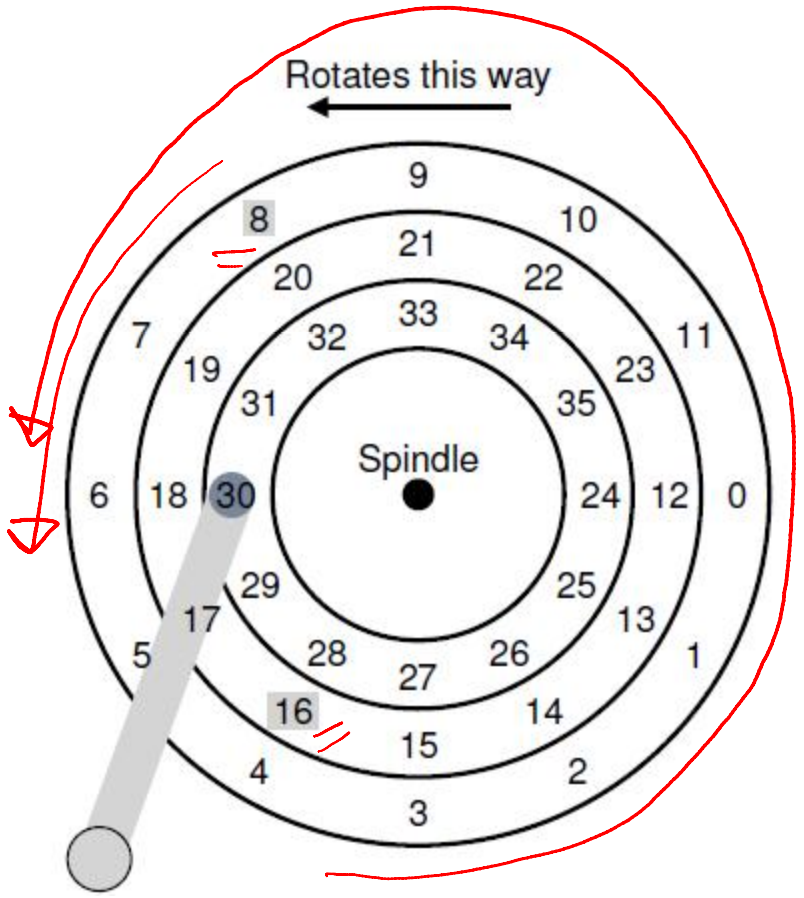


- Disk head does one sweep over tracks and serves requests that fall on the path
- Elevator/SCAN: sweep outer to inner, then inner to outer
- C-SCAN: sweep only one direction (say, outer to inner) and circle back, start again
  - Why? Sweeping back and forth favors middle tracks more
- F-SCAN: freeze queue while scanning
  - Why? Avoid starving far away requests



Shortest Positioning Time First (SPTF)

- Considers both seek time and rotational latency
  - Better to serve 8 before 16, even though seek time is higher
  - Why? 16 incurs a much higher rotational latency



Data storage on disk

- Bits stored on disk with some error detection/correction bits
  - Correct random bit flips
  - Detect corruption of data
- Disk controller or OS can handle some errors (e.g., blacklisting certain sectors)
- If errors cannot be masked, user perceives hard disk failures
- Technologies such as RAID (Redundant Array of Inexpensive Disks) provide high reliability and performance by replicating across multiple disks.