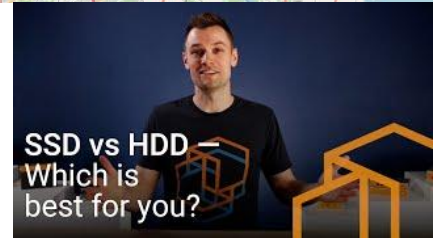# CSc 360
Operating Systems
Mass Storage

Wenjun Yang
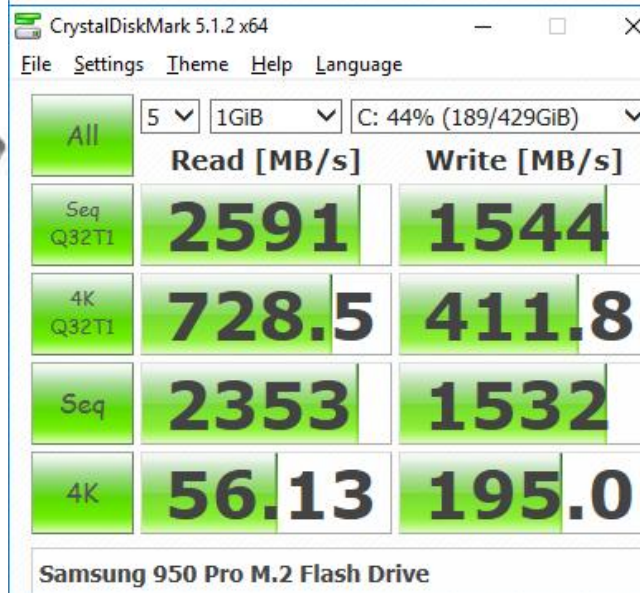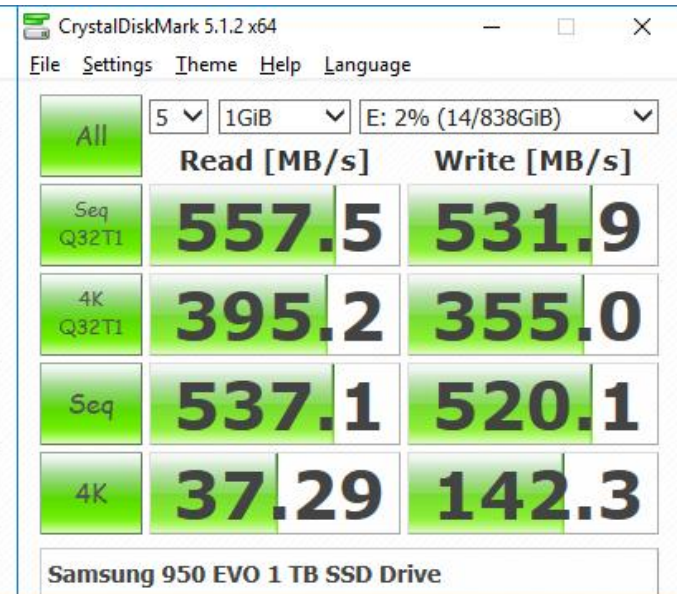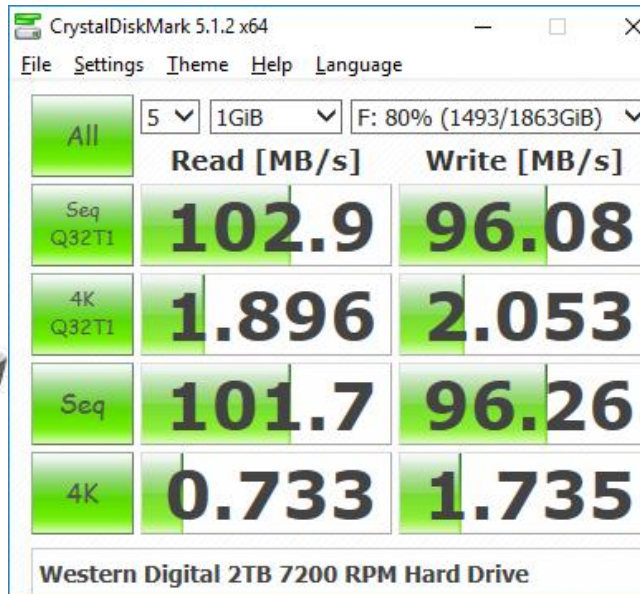
Fall 2025
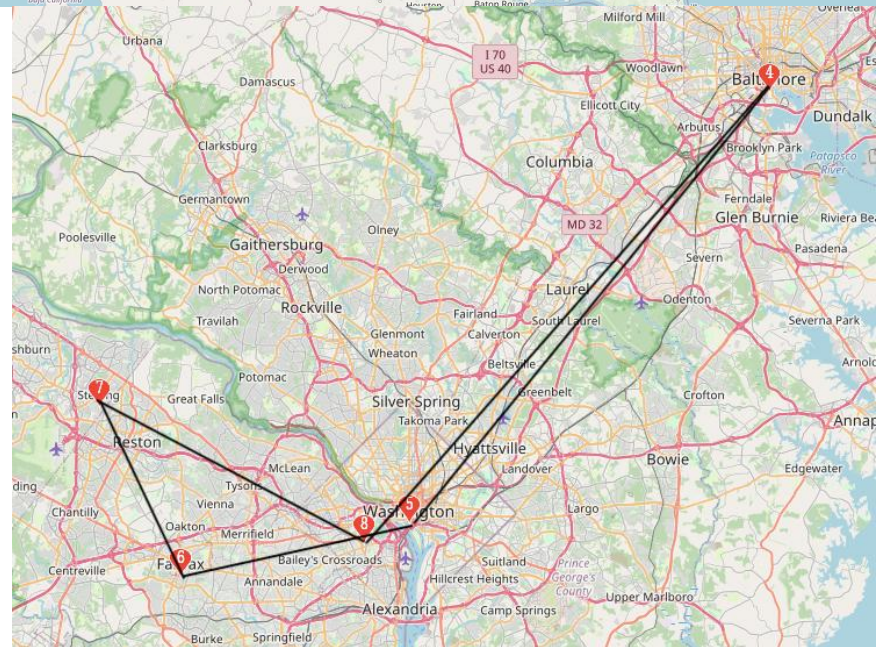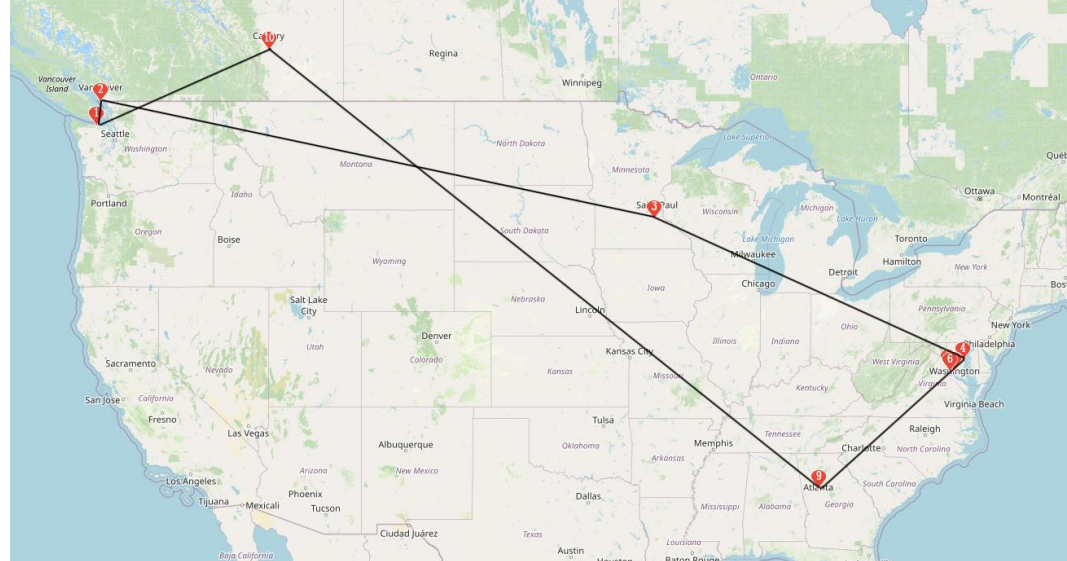
CSc 360

Mass storage

- Magnetic disk
  - performance: data rate, access time
  - interface: ATA, SATA, SCSI, FC, etc
  - address: geometry (cylinder, track, sector)
- Magnetic tape
- Network attached storage (NAS)
- Storage area network (SAN)
  - iSCSI

* 1tb sata2 7200rpm 4.2ms 32mb 3.5in?

CrystalDiskMark 5.1.2 x64

File Settings Theme Help Language

All | 5 | 1GiB | F: 80% (1493/1863GiB)

	Read [MB/s]	Write [MB/s]
Seq Q32T1	102.9	96.08
4K Q32T1	1.896	2.053
Seq	101.7	96.26
4K	0.733	1.735

Western Digital 2TB 7200 RPM Hard Drive

CrystalDiskMark 5.1.2 x64

File Settings Theme Help Language

All | 5 | 1GiB | E: 2% (14/838GiB)

	Read [MB/s]	Write [MB/s]
Seq Q32T1	557.5	531.9
4K Q32T1	395.2	355.0
Seq	537.1	520.1
4K	37.29	142.3

Samsung 950 EVO 1 TB SSD Drive

CrystalDiskMark 5.1.2 x64

File Settings Theme Help Language

All | 5 | 1GiB | C: 44% (189/429GiB)

	Read [MB/s]	Write [MB/s]
Seq Q32T1	2591	1544
4K Q32T1	728.5	411.8
Seq	2353	1532
4K	56.13	195.0

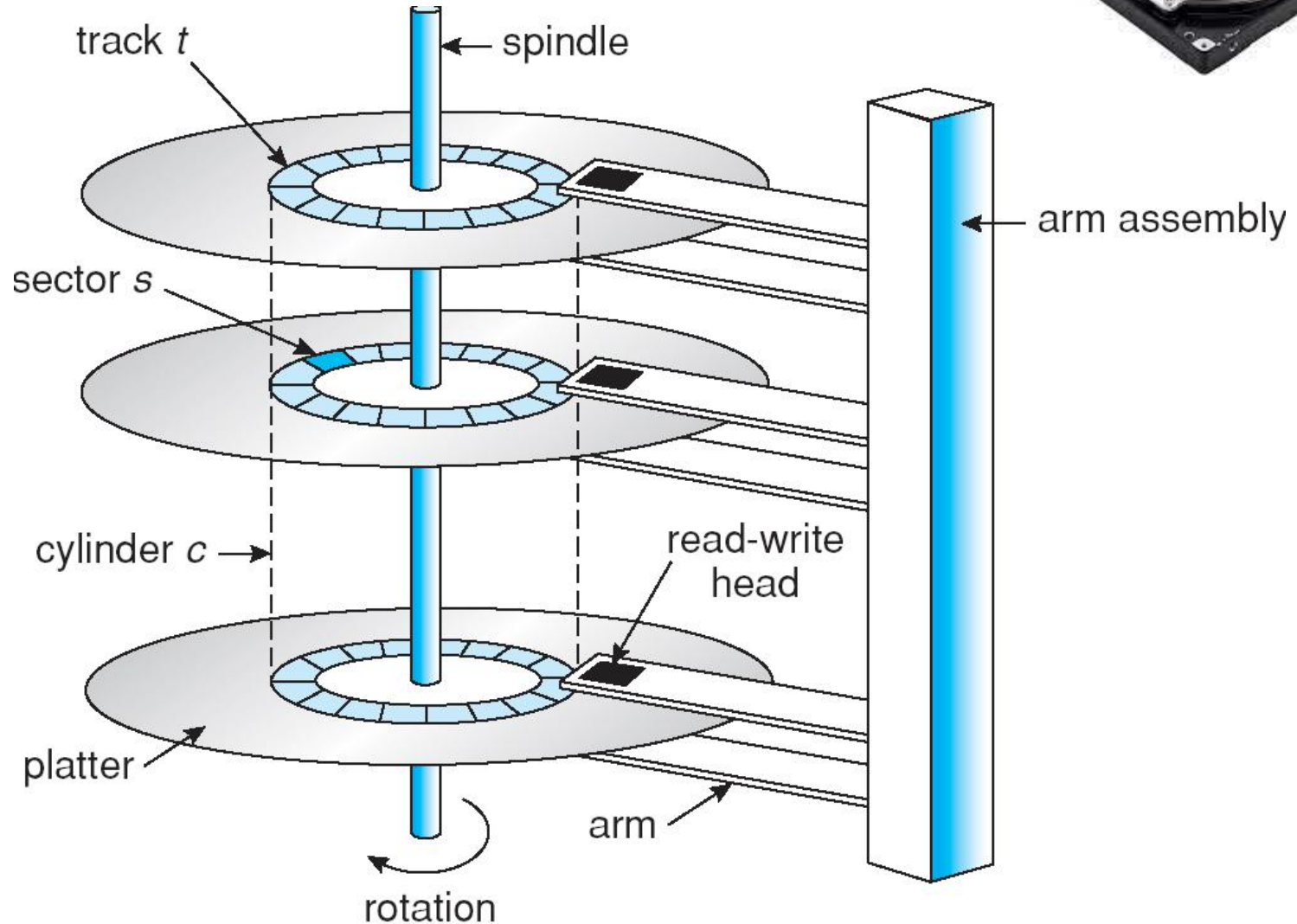Samsung 950 Pro M.2 Flash Drive

Performance Summary:

Hard Drive: 103 MB/sec read, 96 MB/sec write speed
SSD Drive: 558 MB/sec read, 532 MB/sec write speed
M.2 Drive: 2591 MB/sec read, 1544 MB/sec write speed

In Read Performance:
SSD is 5x Faster than HDD
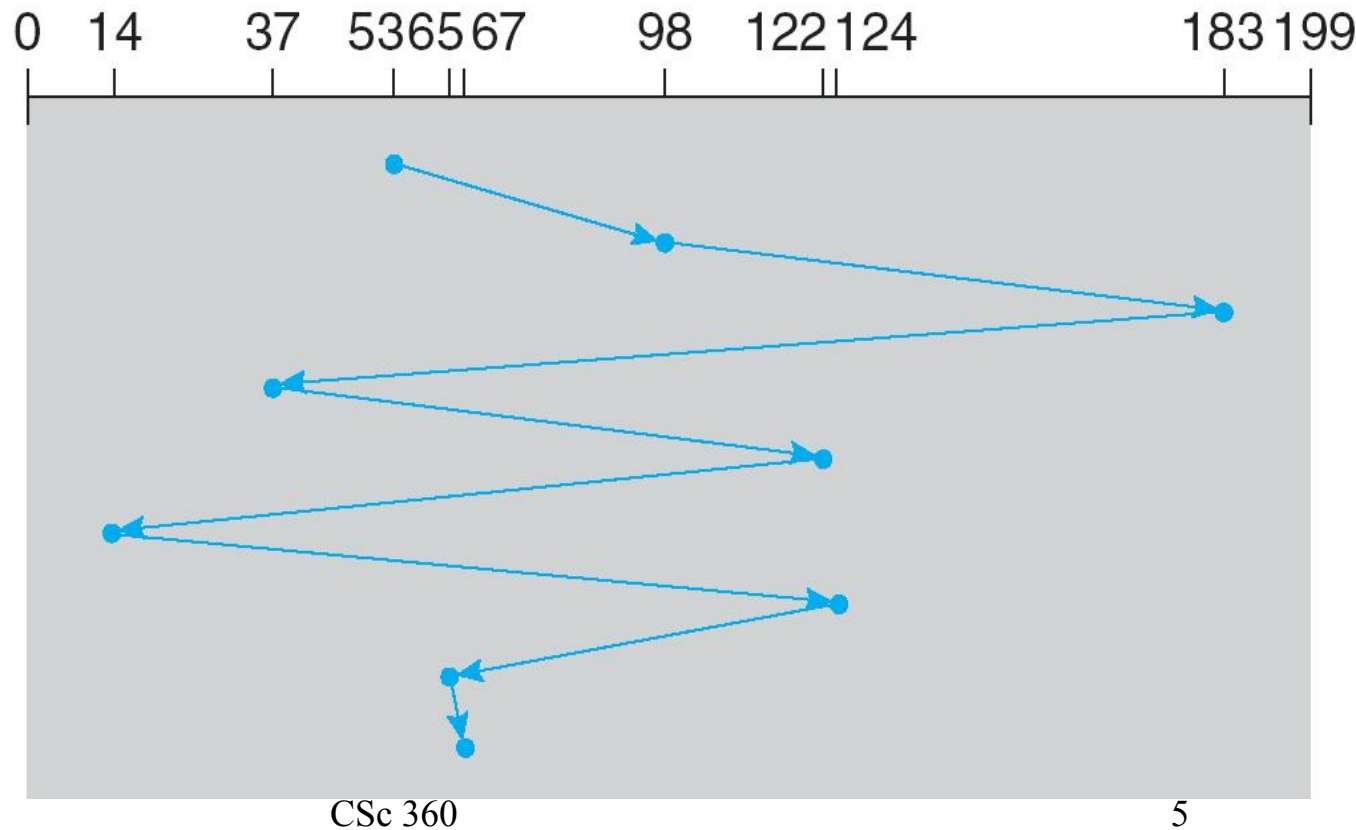**M.2 is 5x Faster than SSD**
M.2 is 25x Faster than HDD

* hdd vs ssd? slc, mlc, tlc, qlc? tbw?

Magnetic disk

track *t* ← spindle

sector *s*

cylinder *c* →

platter

arm

rotation

arm assembly

read-write head

* multi-arm? roll-back arm movement?

Disk scheduling

- FCFS

- Example

  – total head movement

  – 640 cylinders

queue = 98, 183, 37, 122, 14, 124, 65, 67
head starts at 53

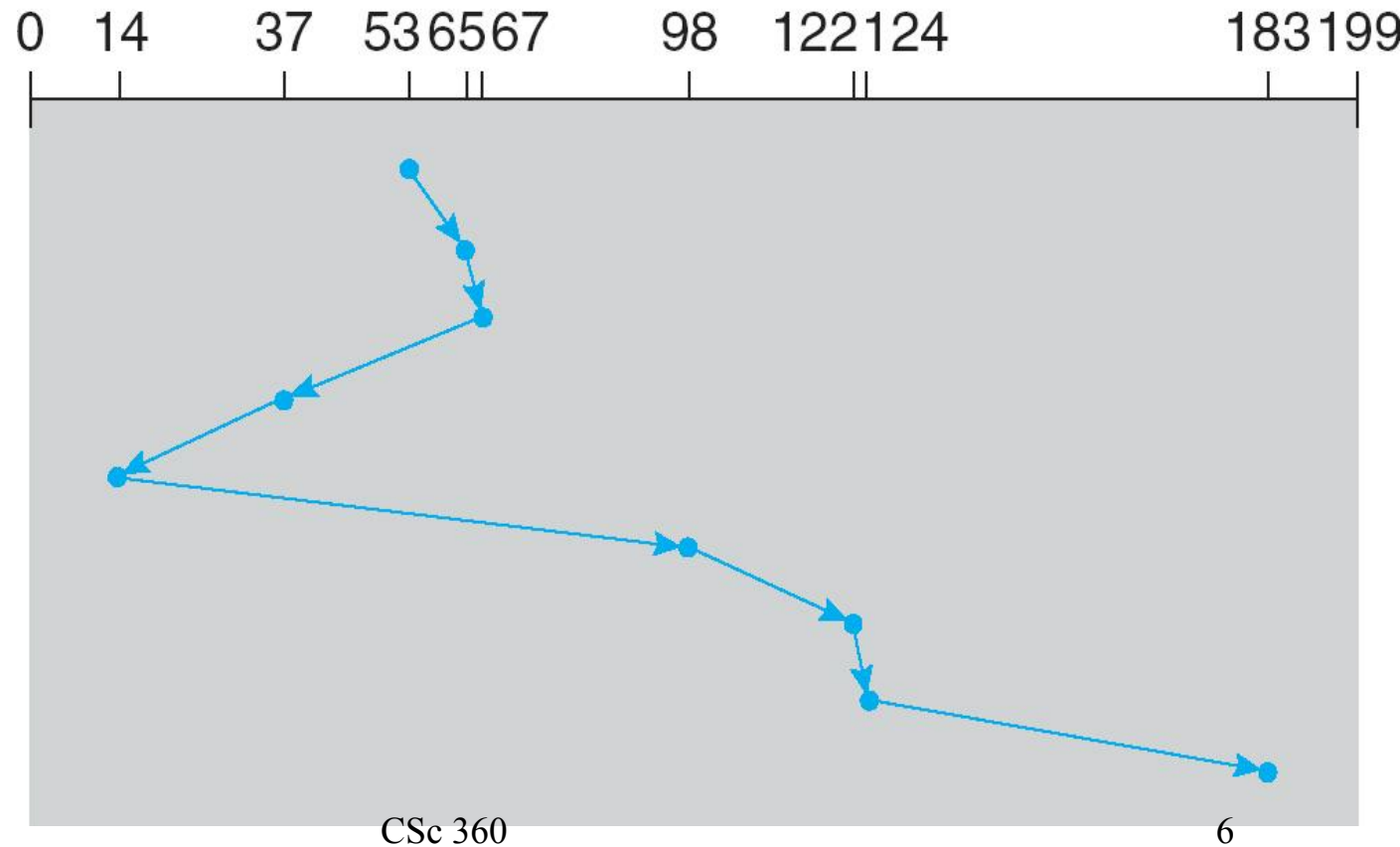* fcfs in cpu scheduling? fifo in page replacement?

Shortest seek time first

queue = 98, 183, 37, 122, 14, 124, 65, 67

head starts at 53

- SSTF
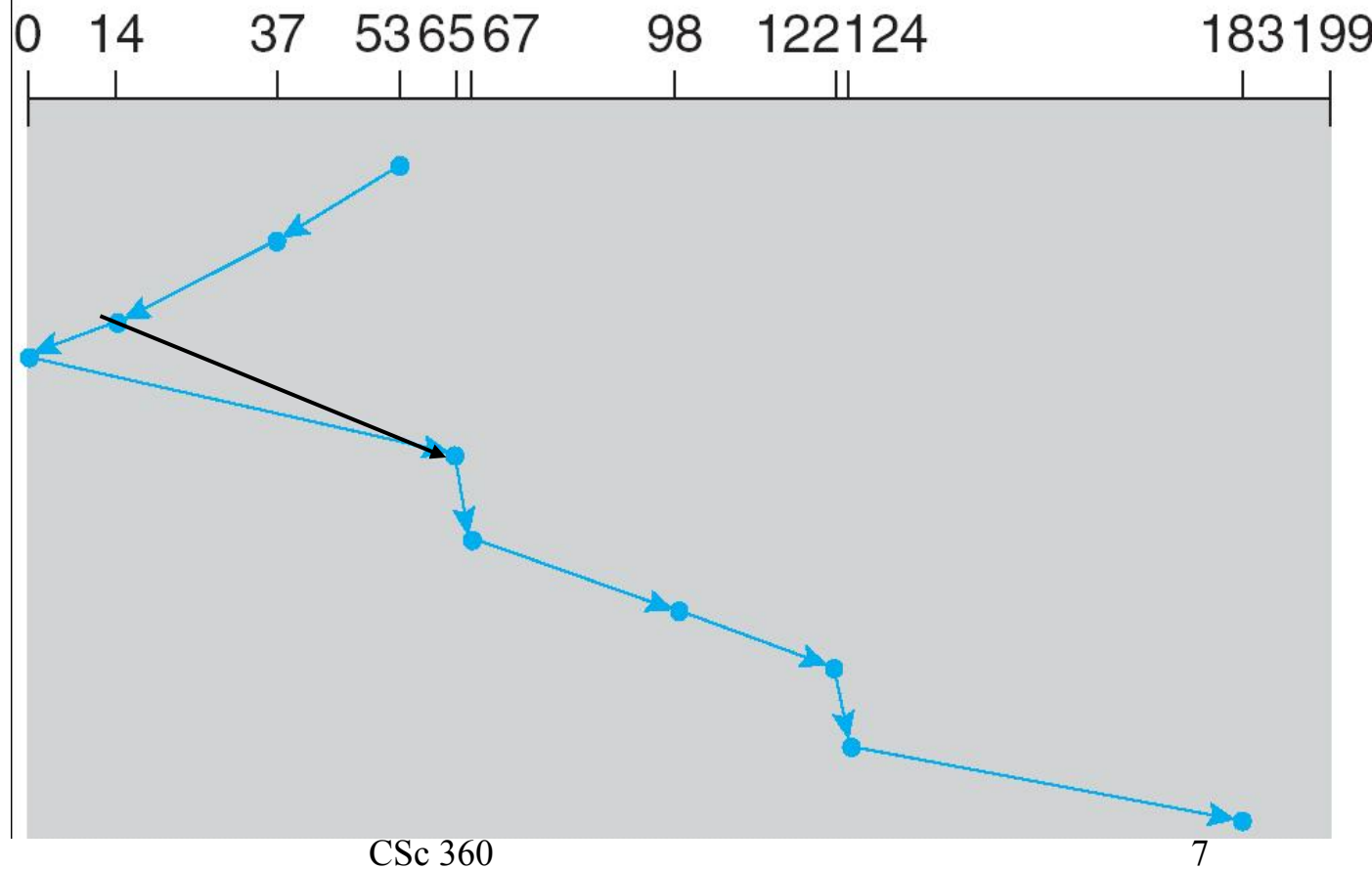 - similar to SJF
- Example
  - 236 cyl
- Starvation

* how to deal with starvation?

Scan

- AKA
  - elevator

- Example
  - 236 cyl
    - shortcut 208 cyl

queue = 98, 183, 37, 122, 14, 124, 65, 67

head starts at 53 *going toward 0*

0   14   37   53 65 67   98   122124   183 199
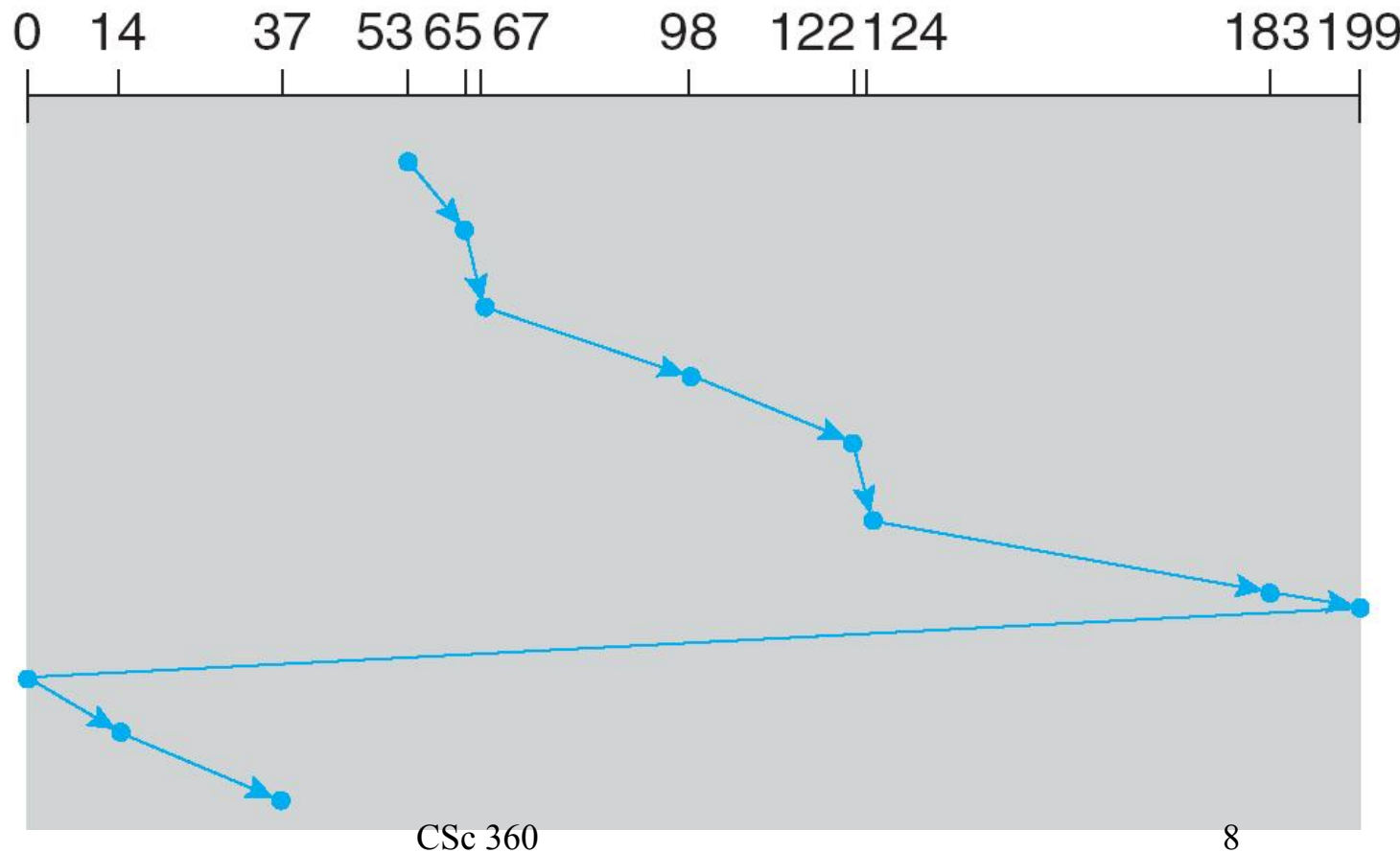
* going up?

Circular scan

queue = 98, 183, 37, 122, 14, 124, 65, 67

head starts at 53   going toward 199 for service

- Circular list of cylinders

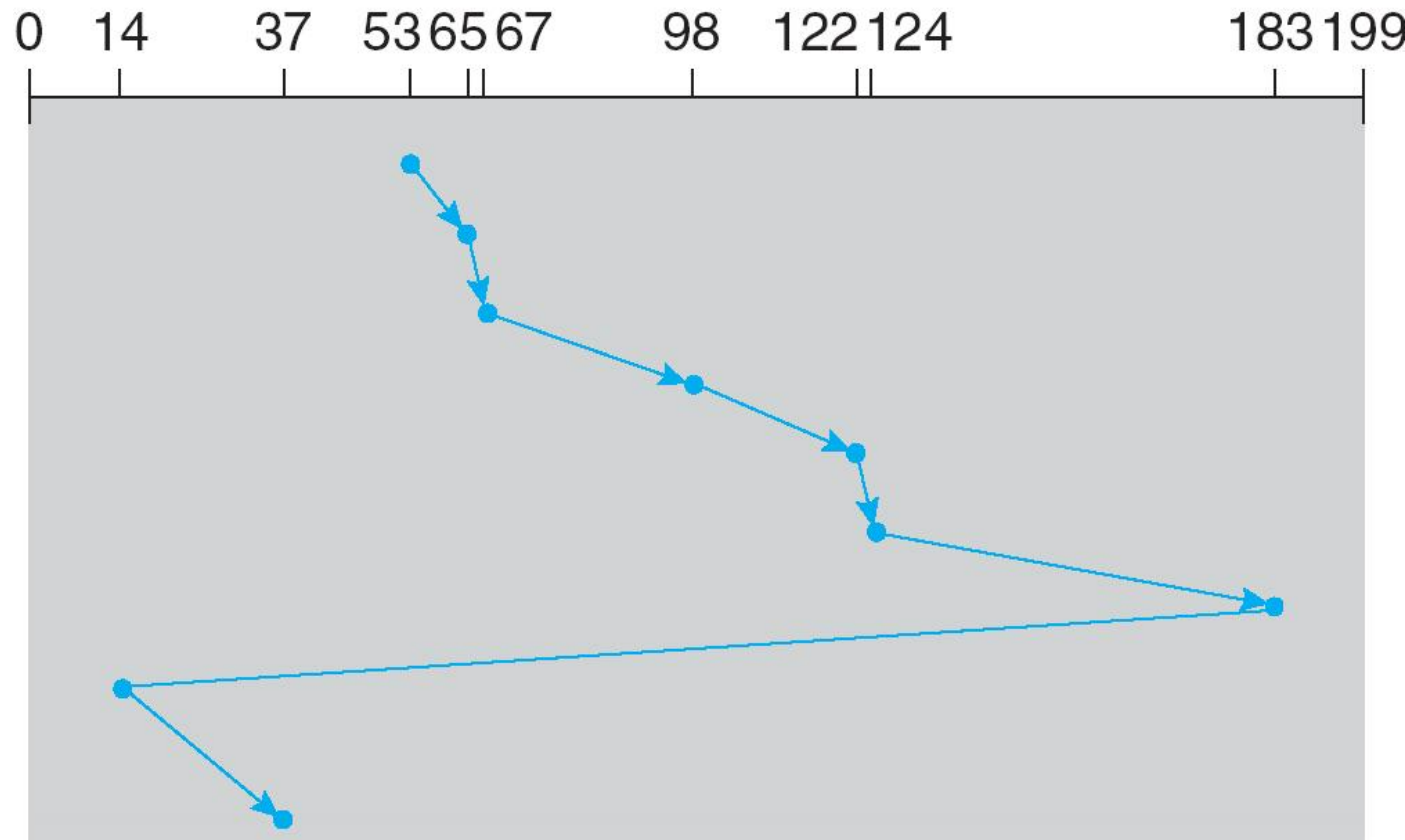- Example
  - 382 cyl!
  - fairness

0   14   37   53 65 67   98   122 124   183 199

* only going up?

Circular look

- No need to reach the end

- Choice?
  - requests
    - dynamic
    - type
  - file allocation

queue   98, 183, 37, 122, 14, 124, 65, 67

head starts at 53 going toward 199 for service

* what's the "disk scheduling" problem for ssd?

Disk management
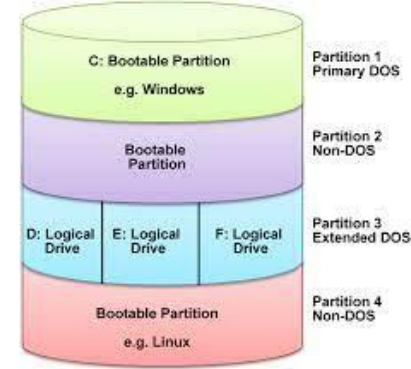
- Physical formatting
  - creating physical sector structures
- Partition
- Logical formatting
  - creating an empty file system
- Boot block
- Handle bad sectors: sector sparing, slipping

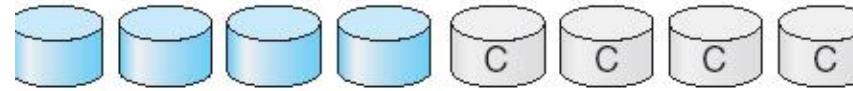* why volume is better than partition, particularly for ssd?

Swap-space management

- Swap space
  - disk space as an extension of main memory
- Swap-space location
  - a regular big file
  - swap partition
- Swap-space management
  - text vs data segment
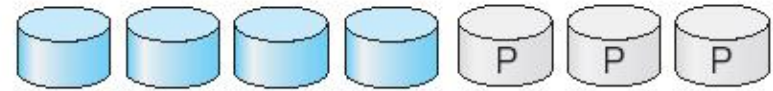 - proactive vs reactive allocation

* why ssd can speed up your entire computer?

RAID

- **Performance through parallelism**
  - stripping
- **Reliability through redundancy**
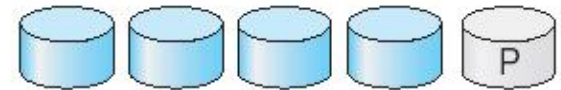 - mirroring
  - error correcting

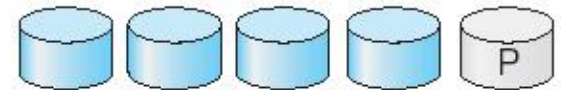(a) RAID 0: non-redundant striping.

(b) RAID 1: mirrored disks.

(c) RAID 2: memory-style error-correcting codes.

(d) RAID 3: bit-interleaved parity.

(e) RAID 4: block-interleaved parity.

(f) RAID 5: block-interleaved distributed parity.

(g) RAID 6: P + Q redundancy.

This lecture

- Disk management
  - disk organization
    - geometry address
  - disk head scheduling
    - FCFS, SSTF, SCAN, C-SCAN, C-LOOK
  - swap-space
  - RAID

Next lecture

- I/O systems
  - OSC7Ch13