Disk Systems

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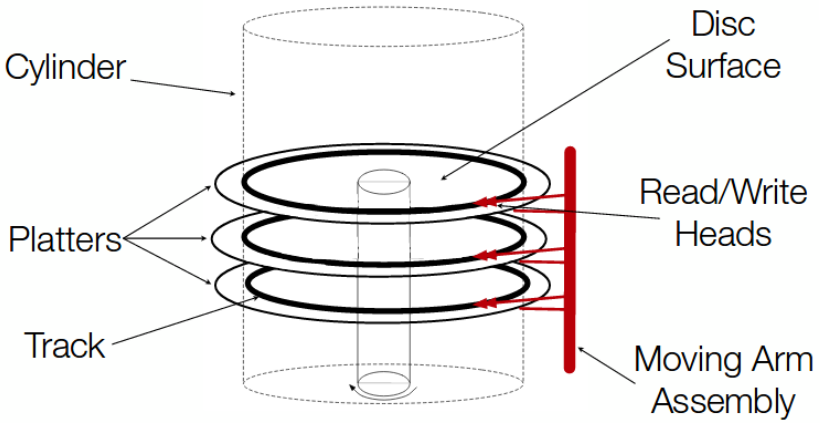
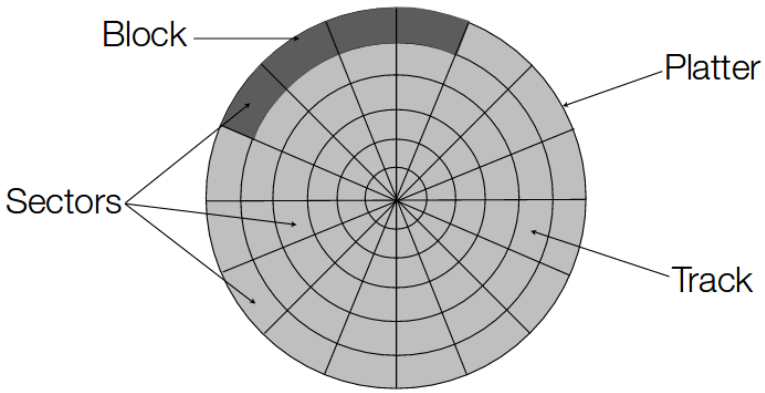
Secondary Storage

- Most secondary storage devices utilise magnetic media
- A read-write head is moved across the media
- Early tape systems accessed data sequentially, data is streamed in order from first bit to last sequential bit, access not practical for interactive systems
- More modern devices use magnetic disks, data can be accessed in any order (random access)
- Early magnetic disk system used large removable disks (platters)
- Over time these have gotten progressively smaller
- Floppy Disk removable storage media now largely replaced by semiconductor memory

Hard Drives

- Platters are formaed from billions of ferrite grains
- Limiting factors affecting actual storage density:
  - Interference at boundaries betwen logic 0 and 1 (opposing magnetic domains)
  - Heat.





Issues

- Main (semiconductor) memory provides almost uniform access time
- Can read/write any location equally quickly
- But access time for disk store depends on position of bits on actual disk relative to read/write head
  - Requires mechanical movements
  - Relavent regions of disc must be located
  - Aim to minimise amount of time spent searching

Typical Disk Access Operations

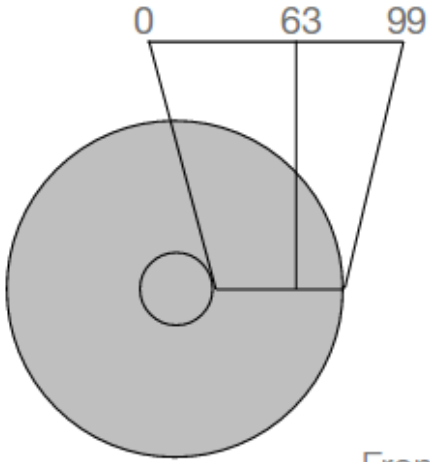
- OS specifies location of the data (head/cylinder/sector)
- Moving arm assembly moves disk arm to cylinder
- Time takken to move known as seek time
- Disk must be rotated until sector is under read/write head
- Time delay referred to ass rotational latency
- Data is read/written as sector moves past head
- Referred to as transmission time

Read-Write Latency

- Disk access time is a function of the three delays
  - Seek time + rotational latency + transmission time
  - These all vary depending on the relative position of the read-write head and sector of interest.
- Typically in the order of milliseconds
- In this time the CPU may have executed millions of instructions
- Many processes are becoming increasingly I/O bound:
  - CPU/Memory speeds are increasing rapidly (due to advances in semiconductor fabrication) while disk access has not increased proportionally.

Disk Scheduling

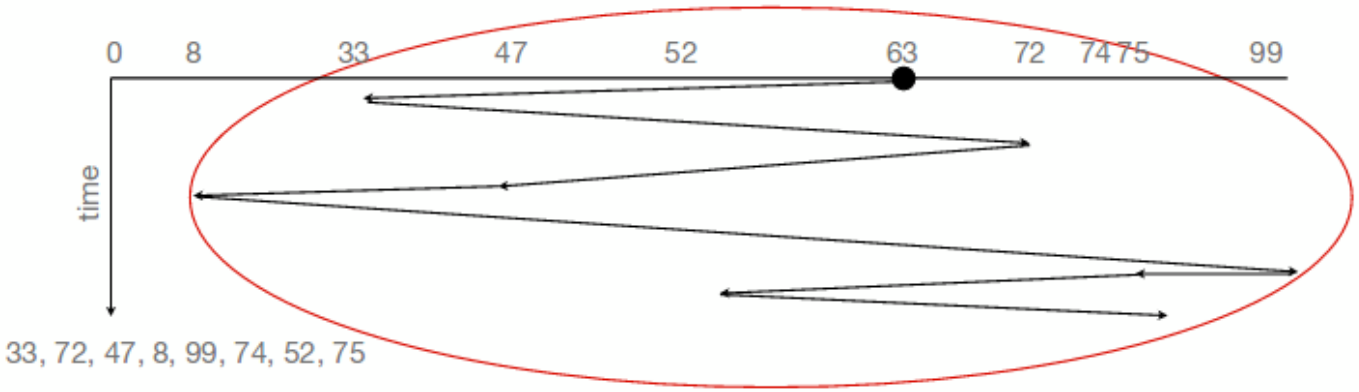
- Disk access requires scheduling:
  - Many processes can request disk access much faster than they can be serviced
  - Both absolute and relative locations of data are important.
    CPU/memory speeds are increasing rapidly, disk access has not.
- Scheduling disk access imposes additional delay.
- For examples, assume cylinder requests are in order:
  - 33,72,47,8,99,74,42,75
- Assume read-write head is initially positioned at cylinder 63:



From Deitel et al.

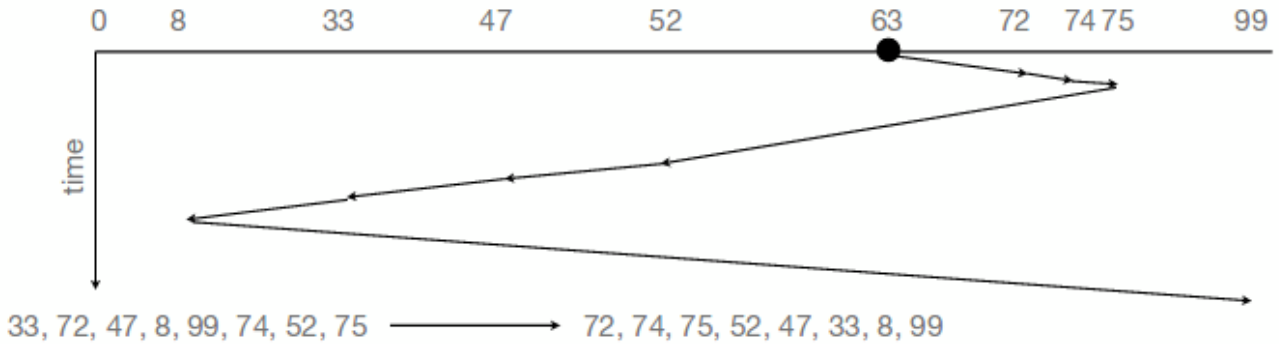
First come first served

- Requests are serviced in order they come.
- A fair policy
- Results in long waiting times if load is high
- Tendancy to switch between tracks/sectors



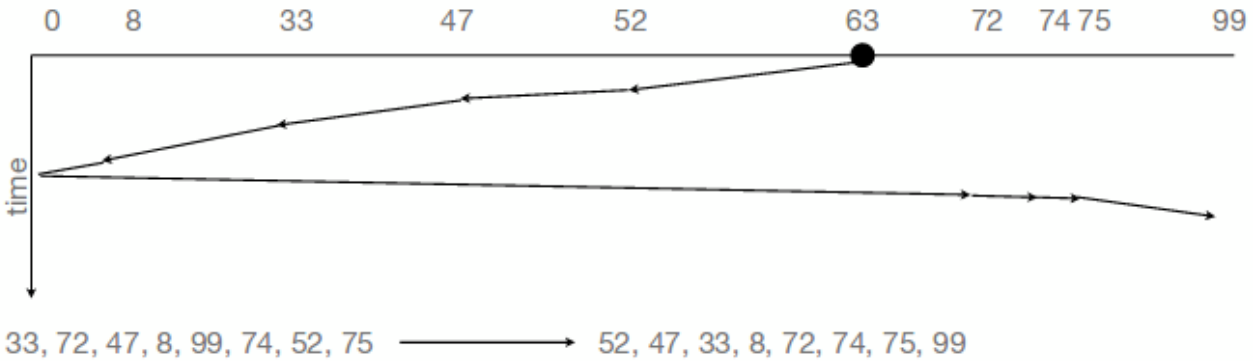
Shortest-seek-time-first

- Schedule request closest to current location of r/w head
- Achieves high throughput
- Does not ensure fairness
- Relatively high variance in response time



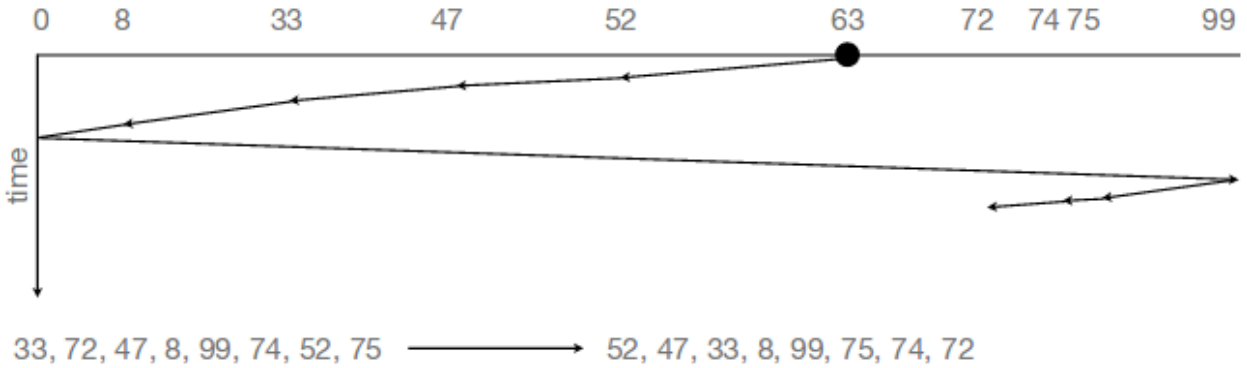
Elevator Algorithm (SCAN)

- Choose shortesk seek time in preferred direction
  - At inner/outer cylinder switch direction
- Offers high throughpput, low mean response time, and lower variance of response time
- Could suffer indefinite postponement (but unlikely)
- Bias towards middle cylinders
- Unnecessary seek operations are performed to scan to the inner/outer most cylinder



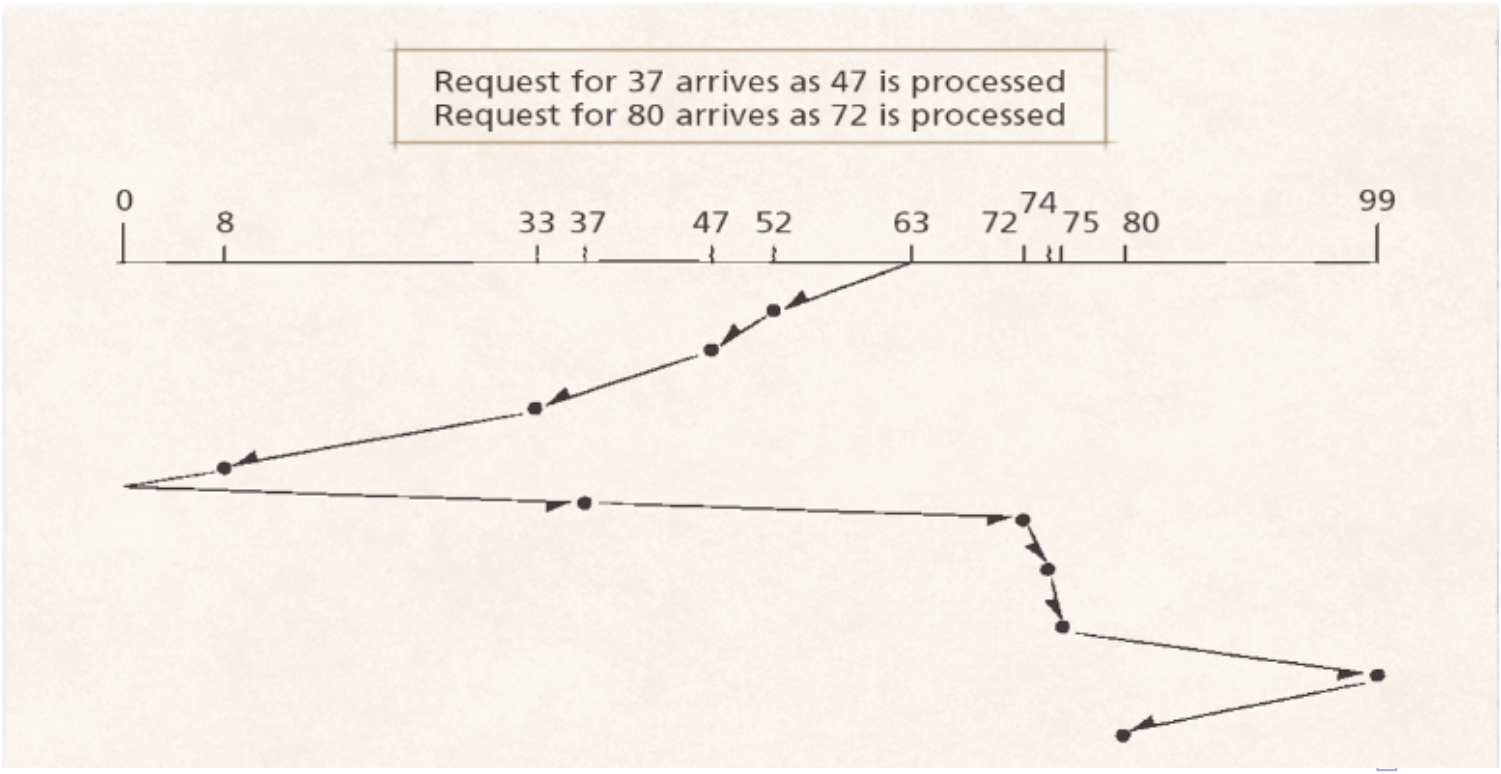
Circular-SCAN (C-SCAN)

- Modification of SCAN strategy
- Choose shortest seek time in inward direction
  - At inner most cylinder, jump back to outermost
- Further reduces variance of response time
- Removes bias towards middle cylinders
- Performs unnecessary seek operations
- Could suffer from indefinite postponement (but unlikely)



Freeze-SCAN (F-SCAN)

- Modification of SCAN
- Choose shortest seek time in inwards direction
  - Service only requests present at the beginning of sweeep
  - Order incoming requests during sweet for optimum service
  - Process waiting requests on return
- Solves problem of indefinite postponement



Where it's performed

- The OS could filter requests before sending to the disk controller.
  - OS has knowledge of the overall system load requirements
- Disk controllers themselves are becoming increasingly intelligent
  - Takes burden off OS
- Likely that both perform scheduling

Other performance factors

- Better placement of files on disk:
  - Ensure disk is defragmented to minimise seek time
  - Scheduling overhead can degrade performance
  - Consider transferring blocks rather than sectors
- Utilise data compression/decompression
  - Less data needs read/written for same information storage
  - Assume decompression time is less than inflated read/write time
- Use disk cache buffer
  - Memory to store data to be written
  - Only write during periods of relatively light load
  - Give preference to read operations
  - Need to worry about consistency
- Store multiple copies of frequently accessed data:
  - Read from copythat is closes to r/w head
  - Need to worry about consistency
  - Reduces effective disk capacity
- Utilise RAID (Redundant Array of Independent Disks)
  - Data stored on multiple drives for fast access.

Summary

- Disk access is slow (several milliseconds)
  - Function of 3 effective delays
- Physical layout of bits on drive are addresses as:
  - Surface
  - Cylinder
  - Sector
- OS works at block level
  - Typically many sectors per block

The End