Disk scheduling Tutorial

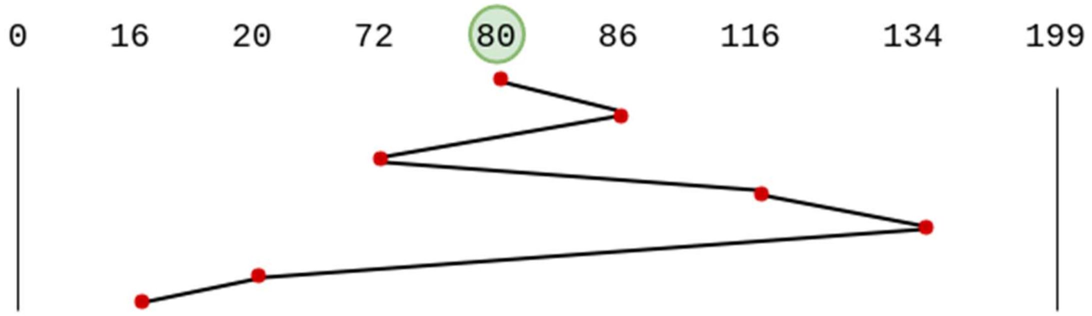
Q1. Consider a storage disk with 4 platters (numbered as 0, 1, 2 and 3), 200 cylinders (numbered as 0, 1, … , 199), and 256 sectors per track (numbered as 0, 1, … 255). The following 6 disk requests of the form [sector number, cylinder number, platter number] are received by the disk controller at the same time:

[120, 72, 2], [180, 134, 1], [60, 20, 0], [212, 86, 3], [56, 116, 2], [118, 16, 1]

Currently head is positioned at sector number 100 of cylinder 80, and is moving towards higher cylinder numbers. The average power dissipation in moving the head over 100 cylinders is 20 milliwatts and for reversing the direction of the head movement once is 15 milliwatts. Power dissipation associated with rotational latency and switching of head between different platters is negligible.

The total power consumption in milliwatts to satisfy all of the above disk requests using the Shortest Seek Time First disk scheduling algorithm is ______ .

Explanation: Head starts at 80.



Total Head movements in SSTF = (86-80) + (86-72) + (134-72) + (134-16) = 200

Power dissipated by 200 movements : P1 = 0.2 * 200 = 40 mW
Power dissipated in reversing head direction once = 15 mW
Number of time Head changes its direction = 3

Power dissipated in reversing head direction: P2 = 3 * 15 = 45 mW
Total power consumption (in mW) is P1 + P2 = 40 mW + 45 mW = **85 mW**

So, answer is 85.

Q2. A hard disk system has the following parameters :

- Number of tracks = 500
- Number of sectors/track = 100
- Number of bytes /sector = 500
- Time taken by the head to move from one track to adjacent track = 1 ms
- Rotation speed = 600 rpm.

What is the average time taken for transferring 250 bytes from the disk ?
(A) 300.5 ms
(B) 255.5 ms
(C) 255.0 ms
(D) 300.0 ms

Solution:

Answer: (D)

Explanation: Avg. time to transfer = Avg. seek time + Avg. rotational delay + Data transfer time

- **Avg Seek Time** – time taken to move from 1st track to 1sr track : 0ms, 1st to 2nd : 1ms, 2ms, 3ms,….499ms
  Avg Seek time =(∑0+1+2+3+…+499)/500 = 249.5 ms
- **Avg Rotational Delay** – RMP : 600 , 600 rotations in 60 sec (one Rotation = 60/600 sec = 0.1 sec) So, Avg Rotational Delay = 0.1/2= 50 ms
- **Data Transfer Time:** In One 1 Rotation we can read data on one track = 100 * 500 = 50,000 B data is read in one rotation. 250 bytes -> 0.1 * 250 / 50,000 = 0.5 ms

Therfore ATT = 249.5+50+0.5 = 300 ms

Q3. Suppose the following disk request sequence (track numbers) for a disk with 100 tracks is given: 45, 20, 90, 10, 50, 60, 80, 25, 70. Assume that the initial position of the R/W head is on track 50. The additional distance that will be traversed by the R/W head when the Shortest Seek Time First (SSTF) algorithm is used compared to the SCAN (Elevator) algorithm (assuming that SCAN algorithm moves towards 100 when it starts execution) is _________ tracks
(A) 8
(B) 9
(C) 10
(D) 11

Solution:

Answer: (C)

Explanation: In Shortest seek first (SSTF), closest request to the current position of the head, and then services that request next.

In SCAN (or Elevator) algorithm, requests are serviced only in the current direction of arm movement until the arm reaches the edge of the disk. When this happens, the direction of the arm reverses, and the requests that were remaining in the opposite direction are serviced, and so on.

Given a disk with 100 tracks

And Sequence 45, 20, 90, 10, 50, 60, 80, 25, 70.

Initial position of the R/W head is on track 50.

In SSTF, requests are served as following

Next Served	Distance Traveled
50	0
45	5
60	15
70	10
80	10
90	10
25	65
20	5
10	10

Total Dist = 130

If Simple SCAN is used, requests are served as following

Next Served	Distance Traveled
50	0
60	10
70	10
80	10
90	10
45	65 [disk arm goes to 100, then to 45]
25	20
20	5
10	10

Total Dist = 140

Less Distance traveled in SSTF = 130 - 140 = 10

Therefore, it is **not additional** but it is **less distance** traversed by SSTF than SCAN.

Q4.

Consider a disk queue with requests for I/O to blocks on cylinders 47, 38, 121, 191, 87, 11, 92, 10. The C-LOOK scheduling algorithm is used. The head is initially at cylinder number 63, moving towards larger cylinder numbers on its servicing pass. The cylinders are numbered from 0 to 199. The total head movement (in number of cylinders) incurred while servicing these requests is:

(A) 346
(B) 165
(C) 154
(D) 173

Answer: (A)

Explanation: The head movement would be:

63 => 87 24 movements

87 => 92 5 movements

92 => 121 29 movements

121 => 191 70 movements

191 --> 10 181 movement

10 => 11 1 movement

11 => 38 27 movements

38 => 47 9 movements

Total head movements = 346

So, option (A) is correct.

Q5. Consider a disk pack with 16 surfaces, 128 tracks per surface and 256 sectors per track. 512 bytes of data are stored in a bit serial manner in a sector. The capacity of the disk pack and the number of bits required to specify a particular sector in the disk are respectively:

(A) 256 Mbyte, 19 bits

(B) 256 Mbyte, 28 bits

(C) 512 Mbyte, 20 bits

(D) 64 Gbyte, 28 bits

Solutions:

Answer (A)

Capacity of the disk = 16 surfaces X 128 tracks X 256 sectors X 512 bytes = 256 Mbytes.

To calculate number of bits required to access a sector, we need to know total number of sectors. Total number of sectors = 16 surfaces X 128 tracks X 256 sectors = 2^19

So the number of bits required to access a sector is 19.

Q6. Disk requests are received by a disk drive for cylinder 5, 25, 18, 3, 39, 8 and 35 in that order. A seek takes 5 msec per cylinder moved. How much seek time is needed to serve these requests for following Disk Scheduling algorithm? Assume that the arm is at cylinder 20 when the last of these requests is made with none of the requests yet served.

FCFS

SSTF

SCAN

LOOK

FCFS (do nothing) :

reasonable when load is low
long waiting time for long request queues

Order: (20), 5, 25, 18, 3, 39, 8, 35
Seek: 15+20+7+15+36+31+27 = 151 cylinders, 755 ms.

SSTF (shortest seek time first):

minimize arm movement (seek time), maximize request rate
unfairly favors middle blocks

Order: (20), 18, 25, 35, 39, 8, 5, 3.
Seek: 2+7+10+4+31+3+2 = 59 cylinders, 295 ms.

SCAN (elevator algorithm):

service requests in one direction until done, then reverse
skews wait times non-uniformly (why?)

(assume 19 accessed before 20, max track is 40)
Order: (20), 25, 35, 39, (40), 18, 8, 5, 3.
Seek: 5+10+4+1+22+10+3+2= 57 cylinders, 285 ms.

LOOK:

Like scan but doesn't go to the end of the disk

(assume 19 accessed before 20):
Order: (20), 25, 35, 39, (40), 18, 8, 5, 3.
Seek: 5+10+4+21+10+3+2= 55 cylinders, 275 ms.

Q7.

Disk requests come in to the disk drive for tracks 10, 22, 20, 2, 40, 6, and 38, in that order. A seek takes 5 ms per track moved. In all cases, the arm is initially at track 20. How much seek time is needed for

a) First-come, first served
b) Shortest seek time first
c) Scan scheduling (initially moving upwards)

Solutions:

Answer:

- (10 + 12 + 2 + 18 + 38 + 34 + 32) = 146 tracks * 5 ms/track = 730 ms
- (0 + 2 + 12 + 4 + 4 + 36 + 2) * 5 ms/track = 60 tracks * 5 ms/track = 300 ms
- (0 + 2 + 16 + 2 + 30 + 4 + 4) * 5 ms/track = 58 tracks * 5 ms/track = 290 ms

Q8.

Consider the following parameters describing a disk:

Parameter	Description
C	Number of cylinders
T	Number of tracks per cylinder (number of platters)
S	Number of sectors per track
ω	Rotational velocity (rotations per second)
B	Number of bytes per sector

In terms of these parameters, how many bytes of data are on each disk cylinder?

Suppose that you are designing a disk drive, and that you hope to reduce the expected rotational latency for requests from the disk. Which of the parameters above would you attempt to change, and in what way would you change them?

Suppose you wanted to reduce the disk's data transfer time - which parameters would you attempt to change?

Answer:

- *bytes/cylinder = T * S * B*
- *to reduce rotational latency, increase the rotational velocity*
- *to reduce transfer time, increase the rotational velocity, or increase the quantity SB, which represents the number of bytes per track*

Q9. Suppose a disk has 201 cylinders, numbered from 0 to 200. At some time the disk arm is at cylinder 100, and there is a queue of disk access requests for cylinders 30, 85, 90, 100, 105, 110, 135 and 145. If Shortest-Seek Time First (SSTF) is being used for scheduling the disk access, the request for cylinder 90 is serviced after servicing ____________ number of requests.

(A) 1

(B) 2

(C) 3

(D) 4

Solution:

Answer: (C)

Explanation: In Shortest-Seek-First algorithm, request closest to the current position of the disk arm and head is handled first.

In this question, the arm is currently at cylinder number 100. Now the requests come in the queue order for cylinder numbers 30, 85, 90, 100, 105, 110, 135 and 145.

The disk will service that request first whose cylinder number is closest to its arm. Hence 1st serviced request is for cylinder no 100 (as the arm is itself pointing to it), then 105, then 110, and then the arm comes to service request for cylinder 90. Hence before servicing request for cylinder 90, the disk would had serviced 3 requests.

Hence option C.

Q10. A fast wide SCSI-II disk drive spins at 7200 RPM, has a sector size of 512 bytes, and holds 160 sectors per track. Estimate the sustained transfer rate of this drive

(A) 576000 Kilobytes / sec

(B) 9600 Kilobytes / sec

(C) 4800 Kilobytes / sec

(D) 19200 Kilobytes / sec

Answer: (B)

Explanation:

Number of rotations in 1 minute = 7200

In 60 seconds = 7200 rotations

In 1 second = 7200 / 60 = 120 rotations

So, in 1 second, SCSI-II disk is able to read 120 tracks.

Number of sectors in each track = 160

Size of each sector = 512 Bytes

Disk Transfer rate in 1 sec = 120 *160 *512

= 98,30,400 Bytes

In KBytes = 9830400 / 1024 = 9600 KB

Option (B) is correct.