

File System: Disk Scheduling Algorithms

Seek time: the time to move the head to the desired cylinder containing the desired sector.

Seek time is the reason for the differences in performance.

So our aim to → minimize seek time ≈ seek distance

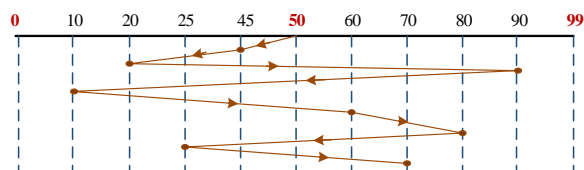
Example:

Request: 45, 20, 90, 10, 60, 80, 25, 70 ; Initial head on track 50; Moving toward larger cylinder number.

FCFS (First come First serve):

The I/O request are served in the order in which they arrived.

FCFS

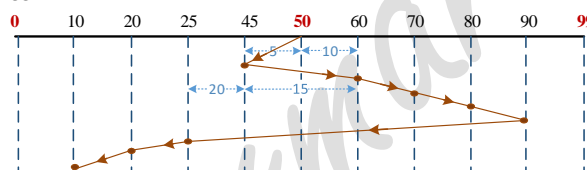


- Total seek distance = $(50 - 20) + (90 - 20) + (90 - 10) + (80 - 10) + (80 - 25) + (70 - 25) = 287$
- Fair scheduling algorithm but not an optimal one.
- No starvation

SSTF (Shortest Seek Time First):

Select the request with the minimum seek distance from the current head position.

SSTF

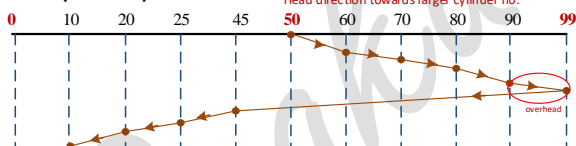


- Total seek distance = $(50 - 45) + (90 - 45) + (90 - 10) = 130$
- May cause starvation of some request.

SCAN or Elevator algorithm:

The disk arm starts at one position and moves toward the other end, servicing request until it gets to the other end of the disk, where the head movement is reversed and servicing the request.

SCAN (Elevator)



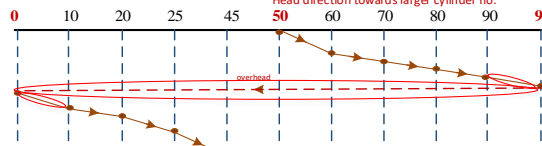
- Total seek distance = $(99 - 50) + (99 - 10) = 138$

C-SCAN (Circular SCAN):

It provides a more uniform wait time than SCAN.

It only schedules requests when the head is moving in one direction. Once the end of disk is reached, the head seeks to the beginning without serving any I/O.

C-SCAN



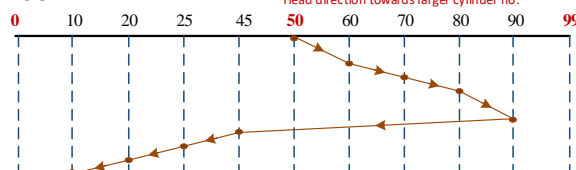
- Total seek distance = $(99 - 50) + (99 - 0) + (45 - 0) = 193$

LOOK:

LOOK is a common-sense improvement over SCAN.

Move the head only as far as the last request in that direction, if no more request, reverse the head direction.

LOOK



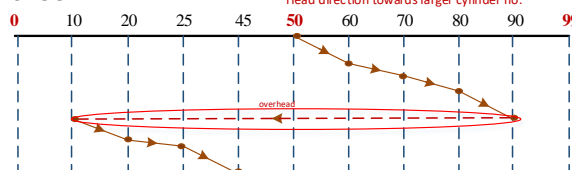
- Total seek distance = $(90 - 50) + (90 - 10) = 120$

C-LOOK:

C-LOOK is a common-sense improvement over C-SCAN.

Disk arm only travels as far as the last request in each direction, then reverse direction immediately, without first going all the way to the end of the disk.

C-LOOK



- Total seek distance = $(90 - 50) + (90 - 10) + (45 - 10) = 155$

Strategy	Advantages	Disadvantages
FCFS	<ul style="list-style-type: none"> ▪ Easy to implement ▪ Sufficient for light loads 	<ul style="list-style-type: none"> ▪ Doesn't provide best average service ▪ Doesn't maximize throughput
SSTF	<ul style="list-style-type: none"> ▪ Throughput better than FCFS ▪ Tends to minimize arm movements 	<ul style="list-style-type: none"> ▪ May cause starvation of some requests ▪ Localizes under heavy loads
SCAN / LOOK	<ul style="list-style-type: none"> ▪ Eliminates starvation ▪ Throughput similar to SSTF ▪ Works well with light to moderate loads 	<ul style="list-style-type: none"> ▪ Needs directional bit ▪ More complex algorithm to implement ▪ Increased overhead
N-Step SCAN	<ul style="list-style-type: none"> ▪ Easier to implement than SCAN 	<ul style="list-style-type: none"> ▪ The most recent requests wait longer than with SCAN
C-SCAN / C-LOOK	<ul style="list-style-type: none"> ▪ Works well with moderate to heavy loads ▪ No directional bit ▪ Small variance in service time ▪ C-LOOK doesn't travel to unused tracks 	<ul style="list-style-type: none"> ▪ May not be fair to recent requests for high numbered tracks ▪ More complex algorithm than N-step SCAN, causing more overhead.

File System: Disk Scheduling Algorithms

Question:

Suppose that a disk drive has 5000 cylinders, numbered 0 to 4999. The drive is currently serving a request at cylinder 143, and the previous request was at cylinder 125. The queue of pending request, in FIFO order, is

86, 1470, 913, 774, 948, 1509, 1022, 1750, 130

Starting from the current head position, what is the total distance (in cylinders) that the disk arm moves to satisfy all the pending requests, for each of the following disk – scheduling algorithms?

FCFS, SSTF, SCAN, LOOK, C-SCAN, C-LOOK.

Solution:

FCFS: 143, 86, 1470, 913, 774, 948, 1509, 1022, 1750, 130. The Total seek distance is **7081**

SSTF: 143, 130, 86, 913, 948, 1022, 1470, 1509, 1750, 1774. The Total seek distance is **1745**

SCAN : 143, 913, 948, 1022, 1470, 1509, 1750, 1774, 4999, 130, 86. The Total seek distance is **9769**.

LOOK : 143, 913, 948, 1022, 1470, 1509, 1750, 1774, 130, 86. The Total seek distance is **3319**.

C-SCAN : 143, 913, 948, 1022, 1470, 1509, 1750, 1774, 4999, 86, 130. The Total seek distance is **9813**.

C-LOOK : 143, 913, 948, 1022, 1470, 1509, 1750, 1774, 86, 130. The Total seek distance is **3363**.

GATE-CS-2016 (Set 1)

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)

GATE CS 2018

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 _____ .

- (A) 45 (B) 80 (C) 85 (D) None of these

Answer: (C)

GATE-CS-2015 (Set 1)

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

Answer: (C)

GATE-CS-2014-(Set-1)

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

Answer: (C)

GATE-CS-2009

Consider a disk system with 100 cylinders. The requests to access the cylinders occur in following sequence: 4, 34, 10, 7, 19, 73, 2, 15, 6, 20

Assuming that the head is currently at cylinder 50, what is the time taken to satisfy all requests if it takes 1 ms to move from one cylinder to adjacent one and shortest seek time first policy is used?

- (A) 95 ms (B) 119 ms (C) 233 ms (D) 276 ms

Answer: (B)

GATE-IT-2004

A disk has 200 tracks (numbered 0 through 199). At a given time, it was servicing the request of reading data from track 120, and at the previous request, service was for track 90. The pending requests (in order of their arrival) are for track numbers.

30 70 115 130 110 80 20 25.

How many times will the head change its direction for the disk scheduling policies SSTF(Shortest Seek Time First) and FCFS (First Come First Serve)

- (A) 2 and 3 (B) 3 and 3 (C) 3 and 4 (D) 4 and 4

Answer is (C)

GATE-CS-2004

Consider an operating system capable of loading and executing a single sequential user process at a time. The disk head scheduling algorithm used is First Come First Served (FCFS). If FCFS is replaced by Shortest Seek Time First (SSTF), claimed by the vendor to give 50% better benchmark results, what is the expected improvement in the I/O performance of user programs?

- (A) 50% (B) 40% (C) 25% (D) 0%

Answer: (D)

#GATE IT 2007

The head of a hard disk serves requests following the shortest seek time first (SSTF) policy. The head is initially positioned at track number 180.

Which of the request sets will cause the head to change its direction after servicing every request assuming that the head does not change direction if there is a tie in SSTF and all the requests arrive before the servicing starts?

- (A) 11, 139, 170, 178, 181, 184, 201, 265 (B) 10, 138, 170, 178, 181, 185, 201, 265
(C) 10, 139, 169, 178, 181, 184, 201, 265 (D) 10, 138, 170, 178, 181, 185, 200, 265

Answer: (B)

#GATE IT 2007

The head of a hard disk serves requests following the shortest seek time first (SSTF) policy. The head is initially positioned at track number 180.

What is the maximum cardinality of the request set, so that the head changes its direction after servicing every request if the total number of tracks are 2048 and the head can start from any track?

- (A) 9 (B) 10 (C) 11 (D) 12

Answer: (C)

File System Organization in OS

File System organization: FAT

GATE-CS-2014-(Set-2)

A FAT (file allocation table) based file system is being used and the total overhead of each entry in the FAT is 4 bytes in size. Given a 100×10^6 bytes disk on which the file system is stored and data block size is 10^3 bytes, the maximum size of a file that can be stored on this disk in units of 10^6 bytes is _____.

Answer: 99.55 to 99.65

File System organization: I-node

GATE CS 2019

The index node (inode) of a Unix-like file system has 12 direct, one single-indirect and one double-indirect pointer. The disk block size is 4 kB and the disk block addresses 32-bits long. The maximum possible file size is (rounded off to 1 decimal place) _____ GB.

- (A) 4 (B) 2 (C) 1 (D) 0.50

Answer: (A)

GATE-CS-2004

A Unix-style i-node has 10 direct pointers and one single, one double and one triple indirect pointers. Disk block size is 1 Kbyte, disk block address is 32 bits, and 48-bit integers are used. What is the maximum possible file size ?

- (A) 2^{24} bytes (B) 2^{32} bytes (C) 2^{34} bytes (D) 2^{48} bytes

Answer: (C)

GATE CS 2012

A file system with 300 GByte disk uses a file descriptor with 8 direct block addresses, 1 indirect block address and 1 doubly indirect block address. The size of each disk block is 128 Bytes and the size of each disk block address is 8 Bytes. The maximum possible file size in this file system is

- (A) 3 Kbytes (B) 35 Kbytes (C) 280 Bytes (D) Dependent on the size of the disk

Answer: (B)

GATE-IT-2004

In a particular Unix OS, each data block is of size 1024 bytes, each node has 10 direct data block addresses and three additional addresses: one for single indirect block, one for double indirect block and one for triple indirect block. Also, each block can contain addresses for 128 blocks. Which one of the following is approximately the maximum size of a file in the file system?

- (A) 512 MB (B) 2GB (C) 8GB (D) 16GB

Answer: (B)