Operating System Homework 11

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11.11 None of the disk-scheduling disciplines, except FCFS, is truly fair (starvation may occur).
a. Explain why this assertion is true.
b. Describe a way to modify algorithms such as SCAN to ensure fairness.
c. Explain why fairness is an important goal in a multi-user system.
d. Give three or more examples of circumstances in which it is important that the operating system be unfair in serving I/O requests.

Answer:

a. For SSTF, it is easier to starve, when the later disk request is more near to the head than the earlier. For SCAN/LOOK, the side near to the head is easier to be served. For C-SCAN/C-LOOK, requests are served in ascending order, while starvation is avoided, it is not truly fair. In FCFS, serving in the order that the request arrives, each request is served fairly.

b. One way is the search tracks as a loop, just like C-SCAN algorithm, the other is that we can add a timing device or data structure, a request should be served first when it waits enough time.

c. Avoid starvation, prevent users from waiting long time.

d. <1> Some no-maskable interrupts have a higher priority to serve, such as devices related with power.

<2> System will handle page fault first, when the user's I/O request and page fault occur at the same time.

<3> In real-time systems, I/O requests from those real-time processes should be served first.

11.13 Suppose that a disk drive has 5,000 cylinders, numbered 0 to 4,999. The drive is currently serving a request at cylinder 2,150, and the previous request was at cylinder 1,805. The queue of pending requests, in FIFO order, is:

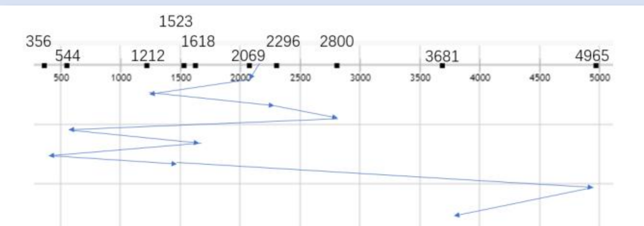
2,069; 1,212; 2,296; 2,800; 544; 1,618; 356; 1,523; 4,965; 3,681

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?

a. FCFS b. SCAN c. C-SCAN

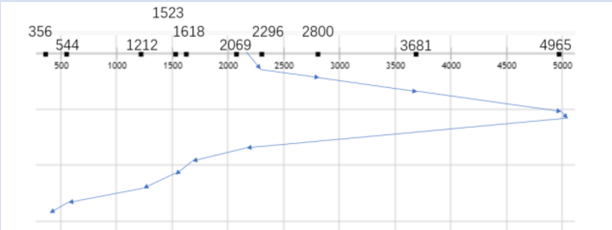
Answer:

a. FCFS



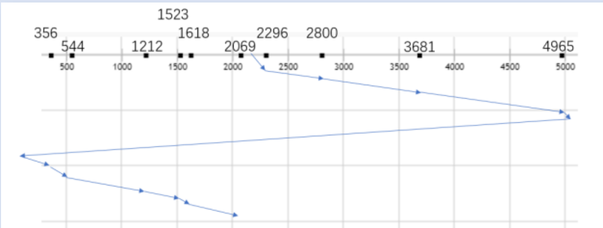
The FCFS schedule is: 2150, 2069, 1212, 2296, 2800, 544, 1618, 356, 1523, 4965, 3681, the total seek distance is 81 + 857 + 1084 + 504 + 2256 + 1074 + 1262 + 1167 + 3442 + 1284 = 13011.

b. SCAN



The SCAN schedule is: 2150, 2296, 2800, 3681, 4965, 4999, 2069, 1618, 1523, 1212, 544, 356, the total seek distance is 146 + 504 + 881 + 1284 + 34 + 2930 +451 + 95 + 311 +668 + 188 = 7492.

c. C-SCAN



The C-SCAN schedule is: 2150, 2296, 2800, 3681, 4965, 4999, 0, 356, 544, 1212, 1523, 1618, 2069, the total seek distance is 146 + 504 + 881 + 1284 + 34 + 4999 + 188 + 668 + 311 + 95 + 451 = 9561.

11.14 Elementary physics states that when an object is subjected to a constant acceleration a, the relationship between distance d and time t is given by $\mathrm{d} = \frac{1}{2}at^2$. Suppose that, during a seek, the disk in Exercise 11.14 accelerates the disk arm at a constant rate for the first half of the seek, then decelerates the disk arm at the same rate for the second half of the seek. **Assume that the disk can perform a seek to an adjacent cylinder in 1 millisecond and a full-stroke seek over all 5,000 cylinders in 18 milliseconds.**

a. The distance of a seek is the number of cylinders over which the head moves. Explain why the seek time is proportional to the square root of the seek distance.

b. Write an equation for the seek time as a function of the seek distance. This equation should be of the form $t = x + y\sqrt{L}$, where t is the time in milliseconds and L is the seek distance in cylinders.

c. Calculate the total seek time for each of the schedules in Exercise 11.13. Determine which schedule is the fastest (has the smallest total seek time).

Answer:

a. $\mathrm{d} = \frac{1}{2}at^2 => t = \sqrt{\frac{2d}{a}}$

b. We have $t = x + y\sqrt{L}$, bring the value "***Assume that the disk can perform a seek to an adjacent cylinder in 1 millisecond and a full-stroke seek over all 5,000 cylinders in 18 milliseconds***" into it:

$$1 \quad = x + y\sqrt{1}$$

$$18 = x + y\sqrt{4999}$$

Then we get: x = 0.7561, y = 0.2439, so $t = \mathbf{0.7561} + \mathbf{0.2439}\sqrt{L}$

c. The total seek times are: t_{FCFS} = 28.58 ms, t_{SCAN} = 21.87 ms, $t_{C\text{-}SCAN}$= 24.60 ms, SCAN schedule is the fastest.

11.15 Suppose that the disk in Exercise 11.13 rotates at 7,200 RPM.

a. What is the average rotational latency of this disk drive?

b. What seek distance can be covered in the time that you found for part a?

Answer:

a. The average rotational latency = $\frac{1}{2} * \frac{60\ s}{7200\ rpm}$ = 4.167 ms

b. $t = x + y\sqrt{L} => L = (\frac{t-x}{y})^2$, L = 195.58 $\approx$ 196 tracks.