**CS 465 - Homework 1 – Fall 2016**

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Part 3 (30% of grade for homework 1): Exercises related to rotating magnetic disks.

The goal of this homework is to provide you with an understanding of (1) how rotating magnetic disks operate and (2) their performance characteristics. If you do not understand the basic operation of rotating magnetic disks, please read section 5.2 of the textbook. For this homework, you will rely on the specifications of the Seagate Barracuda 7200.9 HDD Product Manual found at www.cs.gmu.edu/~menasce/cs465/seagate.pdf. Answer the following questions:

1. [5% of homework 1] Consider the ST3160811AS drive and answer the following questions:

SectorSize (Number of bytes per sector): 512 bytes/sector

RotSpeed: Rotational speed in RPM: 7200

Formatted capacity (in GBytes): 160

Cache buffer in Mbytes[1]: 8 Mbytes

Sread (Average typical read seek time (in ms)): <12.9

Swrite (Average typical write seek time (in ms)):<13.9

Shortest seek (aka track-to-track) read seek time (in ms): <0.8

Shortest seek (aka track-to-track) write seek time (in ms): <1.0

TransfRate (Sustained data transfer rate (in Mbytes/sec)): 300

2. [5% of homework 1] Consider a workload that consists of random reads[2] only. What is the average access time per sector? Show your computations first using the variable names (e.g., RotSpeed) given above and then substitute them for their numerical values (give your answer in seconds rounded to three decimal digits).

[1] Consider 1 Mbyte = 1,000,000 bytes.

Average access time = Read seek time + Average rotational latency + Transfer time
Read seek time = 12.9 ms. Since RotSpeed=7200 RPM=120 rev/s=8.33 ms, so average rational latency = 8.33/2=4.16 ms. Because sector size = 512 bytes, and Transfer Rate = 300 Mb/s, so Transfer time = 512 bytes/300 Mb/s = 0.0017 ms.
So Average access time = 12.9 + 4.16 + 0.0017 = 17.1 ms

3. [10% of homework 1] Consider item (2) above. Suppose you are asked to reduce the access time of your drive by 5%. You are asked to select among the following mutually exclusive options: (a) increase the transfer rate, (b) increase the rotational speed, and (c) decrease the average seek time. What should be the values of Sread, RotSpeed, and TransferRate to achieve such a reduction on average access time?
Based on (2), we want to reduce access time by 5%*17.1 = 0.855 ms.

(a) Since the transfer time = 0.0017 < 0.855, so we can't reduce access time by increase transfer rate.
(b) Since the average rational latency = 4.16 ms, we want it to be 4.16-0.855 = 3.305 ms. So the rational latency = 3.305*2 = 6.61 ms = 150.28 rev/s = 9077 RPM. So we can increase rotational speed by 9077-7200 = 1877 RPM to reduce access time by 5%.
(c) Since the read seek time = 12.9 ms, we can decrease the average read seek time by 0.855 ms which read seek time = 12.9-0.855 = 12.05 ms.

4. [10% of homework 1] Consider that track 0 of the disk is the outermost track of the disk and that initially the head is positioned on that track. Consider that the disk receives the following workload of write requests targeted to the following tracks (in this order): 4, 5, 10, 20, 15, 15, 12, 13.
(a) Assume that after the first write request is satisfied, all other requests are in the disk's queue. What is the average seek time per request of this workload considering that the disk processes the requests in the order of arrival (i.e., First

[1] Consider 1 Mbyte = 1,000,000 bytes.

In First Out)?

So Average access time = 12.9 + 4.16 + 0.0017 = 17.1 ms

The industry calculates average seek time as the sum of the time for all possible seeks divided by the number of possible seeks.

Shortest seek (aka track-to-track) write seek time (in ms): <1.0

$$\text{Average seek} = \frac{\text{The sum of the time for all possible seeks}}{Number\ of\ possible\ seeks} = \frac{(4+1+5+10+5+0+3+1)*1.0ms}{8} = 3.625\ ms$$

(b) Consider now that the disk scheduler orders the requests by increasing order of track number so that they can all be satisfied by moving the head in a single direction. What is the average seek time per request in this case?

$$\text{Average seek} = \frac{\text{The sum of the time for all possible seeks}}{Number\ of\ possible\ seeks} = \frac{(4+1+5+10+5+0+2+1)*1.0ms}{8} = 3.5\ ms$$

1 Consider 1 Mbyte = 1,000,000 bytes.