Name: _____ USC ID: _____

Quiz 1: Storage Systems (10 points), 10 minutes

Consider a hard disk with maximum seek time of 15ms, patter speed of 7200RPM, (maximum) bandwidth of 100MB/sec. Assume 4KB per block.

1. [5 points] Compute the completion time and actual bandwidth for sequential access of 100MB of data. Show your work (i.e., how you derive the answer).

$$Average\ seek\ time = T_{seek} = \frac{1}{3} * \max seek\ time = \frac{1}{3} * 15ms = 5ms$$

$$Time\ for\ full\ rotation\ is\ \frac{60{,}000ms}{7200rot} = 8.33ms/rotation$$

$$Average\ rotation\ latency = T_{rot} = \frac{1}{2} * 8.33ms = 4.17ms$$

$$Transfer\ time = T_{trans} = \frac{100MB}{100MB/sec} = 1000ms$$

$$T = T_{seek} + T_{rot} + T_{trans} = 5ms + 4.17ms + 1000ms = 1009.17ms$$

$$Actual\ bandwidth = \frac{100MB}{1009.17ms} = 99.09MB/sec$$

2. [5 points] Compute the completion time and actual bandwidth for random access of 100MB of data. Show your work.

$$\#\text{Blocks} = \frac{100MB}{\frac{4KB}{block}} = 25{,}600\text{blocks}$$

$$T' = \#Blocks * (T_{seek} + T_{rot} + T_{trans}') = \frac{100MB}{\frac{4KB}{block}} * \left(5ms + 4.17ms + \frac{4KB}{100MB/sec}\right)$$

$$= 235.75sec$$

$$Actual\ bandwidth = \frac{100MB}{235.75sec} = 0.424MB/sec = 434.36KB/sec$$

Name: _____ USC ID: _____

Quiz 2: Storage Systems (10 points), 10 minutes (afternoon)

Consider a hard disk with maximum seek time of 12ms, patters rotating at 7200RPM, (maximum) transmission bandwidth of 100MB/sec. Assume 4KB per block.

1. [7 points] Compute the completion time and actual bandwidth for **random** access of 100MB of data. Show your work (i.e., how you derive the answer).

   1 k = 1024 !!!!

   # of blocks $= \frac{100\ MB}{4\ KB/block} = 25{,}600$ *blocks* ≠25000

   T_{seek} *= Average seek time =* $\frac{1}{3}$ *x maximum seek time =* $\frac{1}{3}$ *x 12ms = 4ms*

   Since time for a full rotation = $\frac{60000\ ms}{7200\ rotations}$ *= 8.33 ms,*

   $T_{rotation}$ *= Average rotation latency =* $\frac{1}{2}$ *x 8.33 ms = 4.17ms*

   $T_{transfer}$ *= Transfer time per block =* $\frac{4KB}{100\ MB/sec}$ *x 1000ms = 0.04ms*

   T = # of blocks x (T_{seek} *+* $T_{rotation}$ *+* $T_{transfer}$ *) = 25,600 x (4ms + 4.17ms + 0.04ms)*
   = 210,176ms = 210.176sec

   Actual bandwidth = $\frac{100MB}{210.176\ sec}$ *= 0.476MB/sec = 487.2107KB/sec*

2. [3 points] Which of the time: latency or transmission time, dominates the completion time? What if the workload is changed to "**sequential** access of 100MB of data"? Explain your answer.

   1. Latency time dominates when we access the data randomly since 8.17ms > 0.04ms for each block.

   2. Transmission time will dominate the completion time when it is changed to sequential access, because it doesn't need to seek and rotate for every block of data.

Name: _____ USC ID: _____

Quiz 2: Storage Systems (10 points), 10 minutes (morning)

Consider a hard disk with maximum seek time of 12ms, patters rotating at 1000RPM, (maximum) transmission bandwidth of 100MB/sec. Assume 4KB per block.

1. [7 points] Compute the completion time and actual bandwidth for sequential access of 100MB of data. Show your work (i.e., how you derive the answer).

   Completion Time = $T_{seek} + T_{rot} + T_{transfer}$

   Avg. Seek Time = 1/3*Max Seek Time = 1/3*12 = 4ms

   Time for 1 rotation = 60000 ms / 1000 rotations = 60 ms
   Rotational Latency = 60/2 = 30ms

   Transfer Time = 100 MB/100 MB * 1000 = 1000ms

   Therefore, completion time = $T_{seek} + T_{rot} + T_{transfer}$
   = 4+30+1000
   = 1034 ms

   Actual Bandwidth = |w|/completion time = 100MB/1034ms = 96.711 MB/s

2. [3 points] Which of the time: latency or transmission time, dominates the completion time? What if the workload is changed to "random access of 100MB of data"? Explain your answer.

   Transfer time dominates the completion time since sequential access of data, thus no rotation/seeking needed once we find start point.

   If workload is changed to random access of 100 MB of data:

   No. of blocks to be transferred = 100/4*1000 = 25000

   Completion time = 25000 * (4 + 30 + 4/100) = 850000 + 1000 = 851000

   850000>>1000, therefore latency time dominates in this case since multiple seeking/rotation needed.

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INF 551 – Spring 2018

Quiz 2: Storage systems (10 points), 10 minutes

Consider a hard drive with the following characteristics:

Number of cylinders	512
Number of heads	8
Number of sectors per track	256
Size of sector	4KB
Number of sectors per block	1
(Maximum) bandwidth	100MB/s
Rotational speed	**7,200RPM**
Maximum seek time	15ms

a) [2 points] What is the capacity of the hard drive?

Capacity = #cylinders * #heads * #sector per track *size of sector
= 512 * 8 * 256 *4 KB = 2^9 * 2^3 * 2^8 * 2^2 * 2^10 Bytes
= 2^32 Bytes = 4 GB

b) [4 points] How much does it take to access 100 blocks **randomly** located on the disk? What is the actual bandwidth for this workload?

Random access: For each block

T_{seek} = Average seek time = 1/3 * Maximum seek time = 5 ms

$T_{rotation}$ = ½ rotation * Full rotation time
= ½ rotation * (60000 ms per minute) / (7200 Rotations per minute)
= ½ rotation * 8.33 ms / rotation
= 4.17 ms

$T_{transfer}$ = 4 KB / (100MB/s) = 4KB / (100KB/ms) = 0.04 ms

T = (T_{seek} + $T_{rotation}$ + $T_{transfer}$) * #blocks = 9.21 * 100 = 921 ms

Actual bandwidth = 100 blocks * 4 KB/sector * 1 sector/block / 921 ms
= 400/921 KB/ms = 0.43 KB/ms = 0.43 MB/s

c) [4 points] How much does it take to access 100 blocks **sequentially** located on the disk? What is the actual bandwidth for this workload?

Sequential access:

For the full process:

T_{seek} = 5 ms

$T_{rotation}$ = 4.17 ms

For each block:

$T_{transfer}$ = = 0.04 ms

T = T_{seek} + $T_{rotation}$ + $T_{transfer}$ * #blocks
= 5 + 4.17 + 0.04 * 100
= 13.17 ms

Actual bandwidth = 400/13.17 KB/ms = 30.37 KB/ms = 30.37 MB/s

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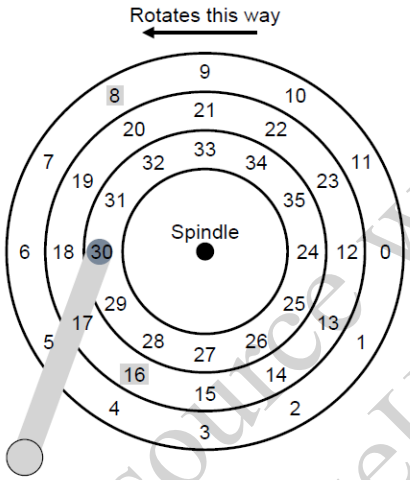
INF 551 – Spring 2016

Quiz 1: Storage systems (10 points)

10 minutes

Consider the following hard disk. Suppose the head is on sector #30 and the requests in the queue are 16 and 8 (which 16 arrived first). Suppose that the disk rotates at **6,000 RPM** and it takes **1ms** to travel a track. According to the SPTF (shortest positioning time first) algorithm, which request should be served first? Explain your answer by computing the positioning time for each request.



$10ms \times \frac{10}{12} + 1 = \frac{112}{12}$ ms

$10ms \times \frac{2}{12} + 2 = \frac{44}{12}$ ms $< \frac{112}{12}$ ms

Answer:

The disk rotates at 6,000 RPM, so

$$\text{Trotation} = \frac{\text{Time(ms)}}{\text{1rotation}} = \frac{\text{1min}}{\text{6,000 rot}} \times \frac{\text{60sec}}{\text{1min}} \times \frac{\text{1000msec}}{\text{sec}} = \frac{\text{60,000msec}}{\text{6,000 rot}} = \frac{\text{10msec}}{\text{rotation}}$$

Consider 30->16: we will need to travel 1 track and rotate over 10 sectors. So

The positioning time $T_{30\text{-}16} = T_{seek} + T_{rotation} = 1ms + \frac{10}{12} * 10ms \approx 9.33ms$

Consider 30->8: we will need to travel 2 tracks and rotate over 2 sectors. So

The positioning time $T_{30\text{-}8} = T_{seek} + T_{rotation} = 2ms + \frac{2}{12} * 10ms \approx 3.67ms$

Therefore, sector 8 will be served first.