Parameters for problem 6.4

1 MB file consisting of 512-byte logical blocks is stored on a disk drive with the following characteristics:

Rotational rate: 10,000RPM ➔ 60sec/10,000rpm = 0.006 sec (per rotation) ➔ 6ms per rotation

$T_{avgRotation}$ = ½ $T_{maxRotation}$ = 6/2 ms = 3 ms

$T_{avgseek}$: 5 ms (average seek time)

Average number of sectors/track: 1,000

Surfaces: 4

Sector size: 512 bytes

Statement of Problem 6.4

For each case below, suppose that a Program reads the logical blocks of the file sequentially and that the time to position the head over the first block is Tavgseek + Tavgrotation

- A. Best case: Estimate the optimal time (in ms) required to read the file given the best possible mapping of logical blocks to disk sectors (i.e., sequential).
- B. Random case: Estimate the time (in ms) required to read the file if blocks are mapped randomly to disk sectors.

Solution to 6.4

- File has 1Mbyte=10^6 or 2^{20} bytes.
- How many disk blocks? 10^6 /512 = 1,954 or (2^{20} /512= 2048) logical blocks.
- Given $T_{avgseek}$ (5ms) and $T_{avgRotation}$ (3 ms) as before
- Transfer time:

$T_{avg\ transfer}$ = 60/10,000 RPM x 1/1,000 sectors/track x 1000 ms/sec = 0.006 ms

(to transfer one sector)

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A. Best case

- blocks are, mapped to contiguous sectors, on the same cylinder, that can be read one after the other without moving the head.
- Once the head is positioned over the first sector it takes two full rotations (1,000 sectors per rotation) of the disk to read all 2,000 blocks (approximately)
- Total time to read the file =
  - Tavg seek + Tavg rotation + 2 * Tmax rotation = 5 + 3 + 12 = 20 ms
  - transfer time is included in the two full rotations

B. Random case

- Blocks are mapped randomly to sectors,
- reading each of the 2,000 blocks requires
  - $T_{avg\ seek} + T_{avg\ rotation}$ ms
  - total time to read the file is
  - $(T_{avg\ seek} + T_{avgrotation}) * 2{,}000 = 8 * 2{,}000 = 16{,}000$ ms = 16 seconds!
  - (Transfer time for each block adds only 12ms total)