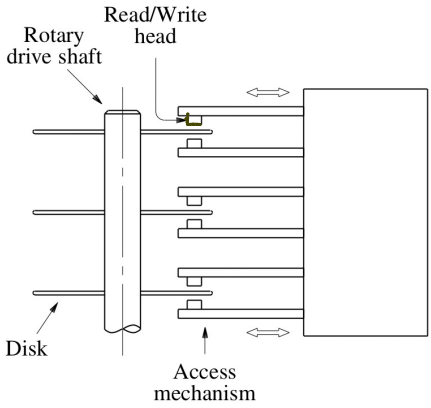
I/O Performance:

Magnetic hard disks.



(a) Mechanical structure

Disks – disk platters

Disk Drives – read/write head

Disk controllers – control circuitary.

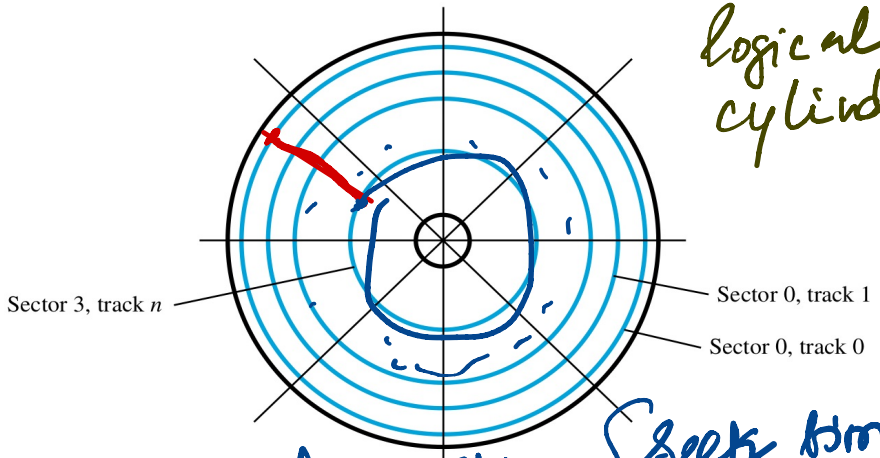


Figure 8.28 Organization of one surface of a disk.

Data are accessed by specifying the surface number, the track number and the sector number.

Read-write operations always start at sector boundaries.

Access time

There are two components involved in the time delay between the disk receiving an address and the beginning of the actual data transfer.

1. **Seek time** – is the time required to move read/write head to proper **track**

2. **Rotational delay / latency time:** is the time taken to reach the addressed **sector** after read/write head is positioned over the correct track.

Sum of these two delays is called as **access time**

Total communication time = Access time + data transfer
seek time + rotating delay

Problem: Consider a long sequence of accesses to a disk with an average seek time of 6 ms and an average rotational delay of 3 ms. The average size of a block being accessed is 8K bytes. The data transfer rate from the disk is 34 Mbytes/sec. **Example**

(*a*) Assuming that the data blocks are randomly located on the disk, estimate the average percentage of the total time occupied by seek operations and rotational delays.

(*b*) Repeat part (*a*) for the situation in which disk accesses are arranged so that in 90 percent of the cases, the next access will be to a data block on the same cylinder.

Solution.

Average size of block = 8 kbytes

$= 8 \times 2^{10}$ bytes

Data transfer rate = 34 Mbytes/sec

Time taken to transfer a block data $= \frac{8 \times 2^{10}}{34 \times 2^{20}}$ sec

$\frac{8}{34 \times 316}$ sec $= 2.29 \times 10^{-4}$

$= 2.29 \times 10^{-4} \times 10^{3} = \frac{8}{34 \times 2^{10}}$ sec

$= 2.29 \times 10^{-1}$

$= 0.229 = 0.23$ msec

a) Access time = Seek time + rotational delay

= 6 ms + 3 ms = 9 ms

Total time taken = 6 + 3 + 0.23

= 9.23 ms

The percentage of time occupied by both seek time and rotational delay in total time = $\frac{9}{9.23} \times 100 = 97\%$

b) 90% of the cases only rotational delay is involved,

∴ Total access time = 0.9 × 3 + 0.1 × 9 + 0.23 = 3.89 ms

The percentage of both seek & rotational delay is $\frac{3.6}{3.89} = 92\%$

8.23 **[M]** Consider a long sequence of accesses to a disk with 8 ms average seek time, 3 ms average rotational delay, and a data transfer rate of 60 Mbytes/sec. The average size of a block being accessed is 64 Kbytes. Assume that each data block is stored in contiguous sectors.

(*a*) Assuming that the blocks are randomly located on the disk, estimate the average percentage of the total time occupied by seek operations and rotational delays.

(*b*) Suppose that 20 blocks are transferred in sequence from adjacent cylinders, reducing seek time to 1 ms. The blocks are randomly located on these cylinders. What is the total transfer time?

Given:

Average seek time = 8 ms.

Average rotation delay = 3 ms.

Data Transfer rate = 60 Mbytes/sec

Average size of block = 64 Kbytes

Time taken to transfer a block of data $= \frac{64 \times 2^{10}}{60 \times 2^{20}}$ sec $= \frac{64}{60 \times 2^{10}}$ sec

a) 8 ms → 1 ms

$= \frac{64}{61,440}$ sec

$= 0.00104$ sec

$= 1.04$ ms

Total Communication time $= 8 + 3 + 1.04 = 12.04$ ms (11 ms)

a) $\frac{11}{12.04} \times 100 = \boxed{91.36\%}$

seek time + rotational delay

b) Total communication / transfer time 20 blocks } = Access time + transfer time for a block × 20

= seek time + rotational delay + Tot. transfer time × 20

= $\frac{1 \times 20}{100.8}$ + 3 × 20 + [1.04 × 20] ms

= 100.8 ms.