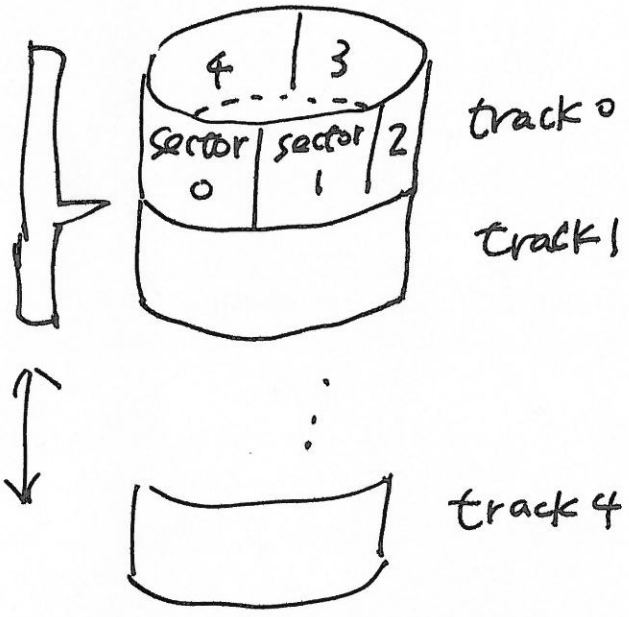
5. Search Strategies: Rotational Ordering

- Rotational Ordering—Once the read/write head is positioned as some track, re-order the requests to optimize the search time.

Once the read/write head has been positioned (on some specific track), reorder the requests to optimize the search time.



requests (head is initially at (0,0))

Track	Sector
0	1
1	4
1	3
2	0
2	3
2	4
3	2
3	0

seek time — 5 ms from track i to i+1

search time — 1 ms from sector j to j+1

transfer time — 1 ms

Without rotational ordering

requests	seek time	search time	transfer time
(0,1)	0	1	1
(1,4)	5	2	1
(1,3)	0	1	1
(2,0)	5	2	1
(2,3)	0	2	1
(2,4)	0	1	1
(3,2)	5	2	1
(3,0)	0	2	1
	15	13	8 (+ = 36ms

With rotational ordering:

(0,1)	1
(1,3)	2
(1,4)	1
(2,4)	0
(2,3)	1
(2,0)	2
(3,0)	0
(3,2)	2
	9 (So you save 4ms)

6. RAID (Redundant Array of Independent Disks)

- Motivation and key idea
  - 1. To close the widening gap between processor speeds and relatively slow disk drives.
  - 2. Instead of using large-capacity disk drives, we use multiple smaller-capacity drives.
  - 3. Distribute data to enable simultaneous access to data from multiple drives.
  - 4. Improve I/O performance and allow easier incremental increases in capacity.

RAID 3:

① It uses a parallel access technique.

② It only requires a single redundant disk.

Example: X_0, X_1, X_2, X_3 — 4 disk drives for data

X_4 — parity disk.

At the ith bit, we have

$$X_4(i) = X_3(i) \oplus X_2(i) \oplus X_1(i) \oplus X_0(i)$$

// $\oplus$ — addition with no carry, or exclusive OR.

If X_1 fails,

add $X_1(i) \oplus X_4(i)$ at both sides

$$X_4(i) \oplus X_1(i) \oplus X_4(i) = X_3(i) \oplus X_2(i) \oplus X_1(i) \oplus X_0(i) \oplus X_1(i) \oplus X_4(i)$$

$$\downarrow$$

$$X_1(i) = X_4(i) \oplus X_3(i) \oplus X_2(i) \oplus X_0(i)$$

X_1 is recovered!

RAID4. not commercially implemented, but its algorithm is used in RAID5, RAID6.

example. X_0, X_1, X_2, X_3 —— data disks

X_4 —— parity disk

Suppose a write (change) occurs at X_1, for each bit i

updated parity → $X_4'(i) = X_3(i) \oplus X_2(i) \oplus X_1'(i) \oplus X_0(i)$ 3 reads 2 writes

$= X_3(i) \oplus X_2(i) \oplus X_1'(i) \oplus X_0(i) \oplus X_1(i) \oplus X_1(i)$

$= X_4(i) \oplus X_1(i) \oplus X_1'(i)$ 2 reads 2 writes