Tutorial #4

[6 points] Consider a magnetic disk in which the physical addresses (2,4,9) and (3,5,4) are mapped to the logical addresses 1288 and 1859, respectively.

(a) What is the number of sectors per track?

(b) What is the number of heads per cylinder?

(c) What is the disk capacity (in GB) knowing that the capacity of each sector is 512 byte, and each platter surface has 16384 tracks.

(d) What is the maximum data transfer rate (in Mbps) knowing that the spindle speed is 5400 rpm.

Solution

(a) 1.5

(2,4,9) ⇝ 1288

$((2 * HPC) + 4) * SPT + 9 - 1 = 1288$

$\Rightarrow HPC * SPT = 640 - 2 * SPT \rightarrow ①$

(3,5,4) ⇝ 1859

$((3 * HPC) + 5) * SPT + 4 - 1 = 1859$

$\Rightarrow HPC * SPT = \frac{1}{3}(1856 - 5 * SPT) \rightarrow ②$

From ①, ②: $640 - 2 * SPT = \frac{1}{3}(1856 - 5 * SPT)$

$SPT = 640 * 3 - 1856 = \boxed{64}$

(b) 1.5

from ①: $HPC = \frac{640 - 2 * 64}{64} = \boxed{8}$

(c) 2

Disk Capacity = (total # of tracks/disk) = 16384 cylinder * 8 heads/cylinder * 64 sectors/head * 512 byte/sector

(d) Maximum data rate =

$$= \#\text{ of tracks/sec} * \text{track capacity}$$

$$= \frac{5400 \text{ track/min}}{60 \text{ sec/min}} * 64 \text{ sector/track} * 512 \text{ B/sec}$$

$$= 2,949,120 \text{ B/s}$$

$$= 2,949,120 * \frac{8}{10^6} \text{ Mb/s}$$

Mega bit per second (Mbps)

$$= 2,949,120 * \frac{8}{2^{20}} \text{ Mib/s}$$

Mebi bit per second

[9 points] Consider a magnetic disk with the following parameters: 300 GB capacity; 3 double-sided platters; 7200 rpm spindle speed; 32768 tracks per side; 4096 bytes per sector; 1 ms seek time for each thousand tracks traversed.

(a) What is the number of heads per cylinder?

(b) What is the number of sectors per track?

(c) Suppose the heads are initially positioned at cylinder 0 and then the disk receives a request to read a 120 KB block of data stored on consecutive sectors starting at logical address 4800499.

i. What is the physical address of the starting sector of the block?

ii. What is the seek time taken to satisfy this read request?

iii. What is the transfer time taken to satisfy this read request?

Solution

2. (a) 3 double-sided platters $\Rightarrow$ HPC = 3 * 2 = 6 (1)

(b) Capacity = HPC * Tracks per side * SPT * bytes per sector (2)

$300 * 2^{30}\ B = 6 * 32768 * SPT * 4096\ B$

$SPT = 400$

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i. The physical address (C, H, S) of the starting sector (whose LBA = 4800499) (2)

$C = LBA \div_{int} (SPT * HPC) = 2000$

$H = (LBA \div_{int} SPT) \bmod HPC = 1$

$S = (LBA \bmod SPT) + 1 = 100$

iii. Transfer time $= \frac{b}{rN}$

$$= \frac{\overbrace{120 * 2^{10}}^{b}}{\underbrace{(7200/60)}_{r} * \underbrace{400 * 4096}_{N}}$$

$= 625$ μsec

[4 points] Consider a 4-drive, 500GB-per-drive RAID array. What is the available data storage capacity for each of the RAID levels: 0, 1, 5, and 6?

RAID		storage capacity for data
RAID 0	4*500	2000 GB
RAID 1	2*500	1000 GB
RAID 5	(4-1)*500	1500 GB
RAID 6	(4-2)*500	1000

[4 points] A RAID array is to be built using a number of 200 GB disk drives. The target data storage capacity of the array is 1000 GB. For each of the following design goals, determine which RAID level should be the best choice and how many disk drives are needed to construct the array in each case.

(a) To minimize the cost.
(b) To maximize the i/o transfer rate.
(c) To maximize the data availability (*i.e.*, sustain multiple simultaneous disk failures)

solution

(a) to minimize cost

choose RAID #0

# of disk drives ≡ 5

(b) Maximum I/O transfer rate

RAID #3

# of disk drives = 6

(c) Maximize data availability

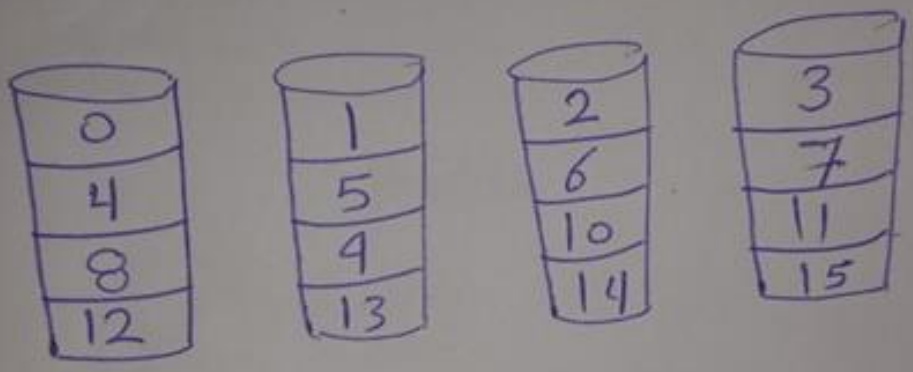
RAID #6

N = 7

[4 points] Four disks are configured as a RAID level 3 where strips are 16-bit long. Stripe #*i* contains four strips: strip #4*i*, strip #4*i*+1, strip #4*i*+2, and strip #4*i*+3. Calculate the hexadecimal values for strip #5 and strip #8 given the following information:

Strip #	0	1	2	3	4	5	6	7	8	9	10	11
Hexadecimal Value	...	...	215F	1357	FFFF	?	0000	7B21	?	0F0F	32D7	FFFF

Solution



strip#5 = FFFF ⊕ 0000 ⊕ 7B21

≡ **84DE**

strip#8 = 0F0F ⊕ 32D7 ⊕ FFFF

≡ **C227**