CS 443

LAB 4

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Question 1:

Consider a disk with the following characteristics: block size B=512 bytes, interblock gap size G=128 bytes, number of blocks per track=20, number of tracks per surface=400. A disk pack consists of 15 double-sided disks.

(a) What is the total capacity of a track and what is its useful capacity (excluding interblock gaps)?

Track's total capacity (include both B & G)
Block size + inter-block gap size = B + G = 512 + 128 = 640 bytes

Track's *total* capacity = 20(512 + 128) = 12,800 bytes

Track's useful capacity (include only B)

Track's *useful* capacity = 20(512) = 10,240 bytes

(b) How many cylinders are there?

Total number of cylinders
= total number of tracks per surface
= 400

(c) What is the total capacity and the useful capacity of a cylinder?

Cylinder's total capacity (include both B & G)
= (#disks) x (#surfaces) x (#blocks per track) x (B + G) =

(15 x 2 x 20) x (512 + 128) = 600 x 640
= 384,000 bytes

Cylinder's useful capacity (include only B)
= (#disks) x (#surfaces) x (#blocks per track) x (B) =

(15 x 2 x 20) x (512) = 600 x 512
= 307,200 bytes

(d) What is the total capacity and the useful capacity of a disk pack?

Disk pack's total capacity (include both B & G)
= (#surfaces) x (#tracks per surface) x [(#blocks per track) x (B+G)]

= (15 x 2) x (400) x [20 x (512 + 128)]
= 153,600,000 bytes

Disk pack's useful capacity (include only B)
= (#surfaces) x (#tracks per surface) x [(#blocks per track) x (B)]

= (15 x 2) x (400) x [20 x (512)]
= 122,880,000 bytes

(e) Suppose the disk drive rotates the disk pack at a speed of 2400 rpm (revolutions per minute); what is the transfer rate (tr) in bytes/msec and the block transfer time (btt) in msec? What is the average rotational delay (rd) in msec? What is the bulk transfer rate (btr)?

Transfer rate (tr)

$$\text{tr} = \frac{\text{track size (bytes)}}{\text{p (msec)}}$$

$$\text{p} = \frac{\text{(\#seconds) x (\#msec)}}{\text{rpm}} = \frac{60 \text{ x } 1000}{2400} = 25 \text{ (msecs per revolution)}$$

$$\text{tr} = \frac{12800}{25} = 512 \text{ bytes/msec}$$

Block transfer time (btt)

$$\text{btt} = \frac{\text{B (bytes)}}{\text{tr (bytes/msec)}}$$

B = block size (in bytes) = 512

$$\text{btt} = \frac{512}{512} = 1 \text{ msec}$$

Average rotational delay (rd)

$$\text{rd} = \frac{\text{p (msec)}}{2}$$

$$\text{rd} = \frac{25}{2} = 12.5 \text{ msec}$$

Bulk transfer rate (btr)

$$\text{btr} = \left(\frac{\text{B}}{\text{B} + \text{G}}\right) \text{x tr}$$

$$\text{btr} = \left(\frac{512}{640}\right) \text{x } 512 = 409.6 \text{ bytes/msec}$$

(f) Suppose the average seek time is 30 msec. How much time does it take (on the average) in msec to locate and transfer a single block given its block address?

avg. time needed to find & transfer a block **given its address**
$= (\text{s} + \text{rd} + \text{btt})$ msec

$$= 30 + 12.5 + 1 = 43.5 \text{ msec}$$

(g) Calculate the average time it would take to transfer 20 random blocks (may not be on the same cylinder) and compare it with the time it would take to transfer 20 consecutive blocks (all in on cylinder).

k = 20

avg. time needed to transfer **noncontiguous** blocks
not necessarily on the same track/cylinder
$= k(s + rd + btt)$ msec

$= 20(43.5) = 870$ msec

avg. time needed to transfer **consecutive** blocks **using btr**
(**on same** track/cycliner)
$= s + rd + (k \times \frac{B}{btr})$ msec

$= 30 + 12.5 + \left(20 \times \frac{512}{409.6}\right) = 67.5$ msec

Comparison

By looking at the above calculations, the time to transfer random (or noncontiguous) blocks not necessarily on the same track or cylinder takes almost 13 times more than it would if the system was transferring consecutive blocks. The time gap between the two results is 802.5, which is a significant difference. This is because the time to locate random blocks takes longer than it would if the blocks were next to one another.

Question 2:

A file has r=200000 STUDENT records of fixed-length. Each record has the following fields: NAME (30 bytes), SSN (9 bytes), ADDRESS (40 bytes), PHONE (10 bytes), BIRTHDATE (8 bytes), SEX (1 byte), MAJORDEPTCODE (4 bytes), MINORDEPTCODE (4 bytes), CLASSCODE (4 bytes, integer), and DEGREEPROGRAM (3 bytes). An additional byte is used as a deletion marker. The file is stored on the disk whose parameters are given in Question 1.

(a) Calculate the record size R in bytes.

R = 30 + 9 + 40 + 10 + 8 + 1 + 4 + 4 + 4 + 3 + 1 = 114 bytes

(b) Calculate the blocking factor (bfr) and the number of file blocks b assuming an unspanned organization.

Blocking factor (bfr)

$$bfr = \left\lfloor \frac{B}{R} \right\rfloor$$

$$bfr = \left\lfloor \frac{512}{114} \right\rfloor = 4 \text{ (records per block)}$$

Number of file blocks (b)

$$b = \left\lceil \frac{r}{bfr} \right\rceil$$

r = # of total records = 200,000

$$b = \left\lceil \frac{200000}{4} \right\rceil = 50{,}000 \text{ file blocks}$$

(c) Calculate the average time it takes to find a record by doing a linear search on the file if

1. **the file blocks are stored contiguously, and**
2. **if the file blocks are not stored contiguously.**

Linear search = $\frac{b}{2}$ searches

k = 50,000/2 = 25,000 (blocks to search)

Stored contiguously

avg. time needed to transfer **consecutive** blocks **using btr**
(**on same** track/cycliner)
$= s + rd + (k \times \frac{B}{btr})$ msec

$$= 30 + 12.5 + \left(25000 \times \frac{512}{409.6}\right) = 31,292.5 \text{ msec}$$

Not stored contiguously

avg. time needed to transfer **noncontiguous** blocks
not necessarily on the same track/cylinder
$= k(s + rd + btt)$ msec

$$= 25000(43.5) = 1,087,500 \text{ msec}$$

(d) Assume the file is ordered by SSN; calculate the time it takes to search for a record given its SSN value by doing a binary search.

blocks to search using binary search = k = $\lceil \log_2 b \rceil = \lceil \log_2 50{,}000 \rceil = 16$ blocks

Binary search = noncontiguous block access

avg. time needed to transfer **noncontiguous** blocks
not necessarily on the same track/cylinder
$= k(s + rd + btt)$ msec

$$= 16(43.5) = 696 \text{ msec}$$