**CS443 – Lab 4**

**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.

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

Total capacity of track = (block size + interblock size) \* blocks per track

= (B + G) \* 20

= (512 + 128) \* 20 🡺 **12,800 bytes**

Useful capacity = (block size \* blocks per track)

= (512 \* 20) 🡺 **10,240 bytes**

1. How many cylinders are there?

Cylinder: For disk packs, the tracks with the same diameters on the various surfaces.

In other words, a cylinder is the number of tracks per surface.

**There are 400 cylinders in total as it is similar to the number of tracks per surface.**

1. What is the total capacity and the useful capacity of a cylinder?

**Note: A disk pack consists of 15 double-sided disks 🡪 15 \* 2 = 30 tracker per cylinder**

Total capacity of cylinder = 30 \* total capacity of track

= 30 \* 12,800 🡺 **384,000 bytes**

Useful cylinder capacity = 30 \* useful track capacity

= 30 \* 10,240 🡺 **307,200 bytes**

1. What is the total capacity and the useful capacity of a disk pack?

Total disk pack capacity = 400 \* total cylinder capacity

= 400 \* 384,000 🡺 **153,600,000 bytes**

Useful disk pack capacity = 400 \* useful cylinder capacity

= 400 \* 307,200 🡺 **122,880,000 bytes**

1. 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 (or tr) in bytes/msec = (size of each track in bytes) / (time of one revolution in msec)

= (total capacity of track) / ((60 \* 1,000) / p) 🡨 p as disk pack

= (12,800) / ((60 \* 1,000) / 2,400)

= **512 bytes/msec**

Block transfer time (btt) in msec = (block size) / transfer rate

= (B / tr)

= 512 / 512 = **1 msec**

Average rotational delay (or rd) in msec = (60 \* 1,000) / (2 \* rpm)

= (60 \* 1,000) / (2 \* 2,400)

= **12.5 msec**

Bulk transfer rate (or btr) = (block size / (block size + gap size)) \* transfer rate

= (B / (B + G)) \* tr

= (512 / (512 + 128)) \* 512

= **409.6 bytes/msec**

1. 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?

**Note: Given that ‘s’ is seek time, the average time needed to find and transfer a block, given its block address, is estimated by:**

**(s + rd + btt) msec**

(30 + 12.5 + 1)

= **43.5 msec**

* Where ‘s’ is seek time
* Where rd is rotational time
* Where btt is block transfer time

1. 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).

Average time (may not be on same cylinder)

k \* (s + rd + btt) msec

20 \* (30 + 12.5 + 1) msec

**870 msec**

Time (all on cylinder)

s + rd + (k \* btt) msec

(30) + (12.5) + (20 \* 1) msec

**62.5 msec**

* Where k is number of blocks
* Where ‘s’ is seek time
* Where rd is rotational time
* Where btt is block transfer time

**Question 2:**

A file has r=200,000 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.

1. Calculate the record size R in bytes.

R = NAME + SSN + ADDRESS + PHONE + BIRTHDATE + SEX + MAJORDEPTCODE + MINORDEPTCODE + CLASSCODE + DEGREEPROGRAM + deletion marker

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

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

bfr = FLOOR[B/R] or FLOOR[block size / record size]

= (512) / (114)

= 4.49 🡺 **4**

* Where B is block size
* Where R is record size

b = number of records / blocking factor

= (r / bfr)

= 200,000 / 4

= **50,000 blocks**

1. 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

For linear search, it must be important to do b/2 comparisons for ‘b’ number of blocks since it calculates the average time.

Contiguously 🡺 s + rd + (k \* btt) msec

= 30 + 12.5 + ((50,000 / 2) \* 1)

= **25,042.5 msec**

* + Where k = b/2
  + Where s = seek time
  + Where rd = rotational delay
  + Where btt = block transfer time
  1. if the file blocks are not stored contiguously.

Similar to the top question, linear search will have b/2 comparisons for ‘b’ number of blocks to calculate the average time.

Not stored contiguously 🡺 k \* (s + rd + btt) msec

= (50,000 / 2) \* (30 + 12.5 + 1)

= **1,087,500 msec**

1. 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.

To calculate time it takes to search, it must do log2(b) comparisons with ‘b’ number of blocks.

Not contiguous: k \* (s + rd + btt) msec

= (log2(50,000)) \* (30 + 12.5 + 1) msec

= **679.02 msec**