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CS443

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

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

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

* (512 \* 20) = 10,240 bytes

1. **How many cylinders are there?**

400 cylinders since there are 400 tracks per surface on a disk.

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

Since a cylinder contains 15 tracks on each side, totaling to 30 tracks per cylinder ...

Total cylinder capacity = 30 \* total track capacity

* 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 capacity = 400 \* total cylinder capacity

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

Useful disk 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 (tr):

Formula: (size of each track in bytes) / (time takes for one revolution in msec)

* + 12,800 bytes / (60 \* 1,000 / 2,400) = 512 bytes / ms

Block transfer time (btt):

Formula: block size / transfer rate

* + 512 / 512 = 1 ms

Average rotational delay (rd):

Formula: (60 \* 1,000) / (2 \* rpm)

* 60,000 / (2 \* 2,400) = 12.5 ms

Bulk transfer rate (btr):

Formula: ((block size / (block size + gap size)) \* transfer rate

* (512 / (512 + 128)) \* 512 = 409.6 bytes / ms

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?**

Formula: (s + rd + btt) ms

where s = seek time, rd = rotational delay, btr = bulk transfer time

* (30 + 12.5 + 1) = 43.5 ms

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).**

May not be on the same cylinder

Formula: k \* (s + rd + btt) ms

where k = number of blocks, s = seek time, rd = rotational delay, btt = bulk transfer time

* 20 \* (30 + 12.5 + 1) = 870 ms

All in one cylinder

Formula: s + rd + (k \* btt) ms

where k = number of blocks, s = seek time, rd = rotational delay, btt = bulk transfer time

* 30 + 12.5 + (20 \* 1) = 62.5ms

**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.**

1. **Calculate the record size R in bytes.**

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[(block size / record size)]

* FLOOR[(512 / 114)] = FLOOR[4.49] = 4

b = number of records / blocking factor

* 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 b blocks, on average we need to do b/2 comparisons for linear search.

Contiguous: s + rd + (k \* btt) ms

where k = b / 2, s = seek time, rd = rotational delay, btt = bulk transfer time

* 30 + 12.5 + ((50,000 / 2) \* 1) = 25,042.5 ms
  1. **if the file blocks are not stored contiguously.**

For b blocks, on average we need to do b/2 comparisons for linear search.

Noncontiguous: k \* (s + rd + btt) ms

where k = b / 2, s = seek time, rd = rotational delay, btt = bulk transfer time

* (50,000 / 2) \* (30 + 12.5 + 1) = 1,087,500 ms

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.**

For b blocks, we need to do at most log2(b) comparisons for binary search.

Noncontiguous: k \* (s + rd + btt) ms

where k = log2(b) , s = seek time, rd = rotational delay, btt = bulk transfer time

* (log2(50,000)) \* (30 + 12.5 + 1) = 679.02 ms