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Class: 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)?

* (20 blocks/track \* 512 bytes/block size) = **10,240 bytes (useful capacity).**
* (20 inter-block gaps \* 128 bytes/inter-block gap size) = 2,560 bytes (Gap size for one track)
* Add 2,560 + 10,240 = **12,800 bytes (Total capacity of a track).**

1. How many cylinders are there?

* **There are 400 tracks per surface and each track would represent a cylinder so there are 400 cylinders.**

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

* **Total capacity:**

[(512 bytes \* 20 blocks per track) + (128 \* 20 inter-gap blocks per track)] \* (30 disks because each disk is double sided)] = **384,000 bytes.**

* **Useful capacity (without inter-block gaps):**

[(512 bytes \* 20 blocks per track) \* (30 disks because each disk is double sided)] = **307,200 bytes.**

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

* **Total capacity:**

[(512 bytes \* 20 blocks per track) + (128 \* 20 inter-gap blocks per track)] \* (30 disks because each disk is double sided)] \* 400 cylinders= **153,600,000 bytes**

* **Useful capacity (without inter-block gaps):**

[(512 bytes \* 20 blocks per track) \* (30 disks because each disk is double sided)] \* 400 cylinders = **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 = (size of each track in bytes) / (time takes for one revolution in msec)**

(size of each track in bytes) = (512 bytes \* 20) + (128 bytes \* 20) = 12,800 bytes on each track

(time takes for one revolution in msec) = (60 \* 1000) / (2400) = 25

**12,800 / 25 = 512 bytes / msec**

* **Block Transfer Time: btt = B/tr**

B = block size in Bytes = 512

tr = 512

**(512/512) = 1 msec**

* **Rotational delay: rd = (1/2) \* (1/p) min = (60 \* 1000)/ (2\*p) msec**

p = revolution per minute

**(60 \* 1000) / (2 \* 2400) = 12.5 msec**

* **Bulk transfer rate: btr = (B/(B+G)) \* tr bytes/msec**

G = inter-block gap size

B = Block size in bytes

**btr = (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?

(s + rd + btt) msec

S = seek time = 30 msec

Rd = rotational delay = 12.5 msec

Btt = 1 msec

**(30 msec + 12.5 msec + 1 msec) = 43.5 msec**

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 to transfer 20 random blocks (may not be on the same cylinder)**

k \* (s + rd + btt) msec

k = # of blocks = 20

s = seek time = 30 msec

rd = rotational delay = 12.5 msec

btt = block transfer time = 1 msec

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

* **Average time it would take to transfer 20 consecutive blocks (all in one cylinder)**

s + rd + (k \* btt) msec

s = seek time = 30 msec

rd = rotational delay = 12.5 msec

btt = block transfer time = 1 msec

k = # of blocks = 20

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

**The random blocks not on same cylinder will take a lot longer to transfer than the consecutive blocks all in one cylinder.**

**Question 2:**

A file has r=20000 STUDENT records of fixed-length. Each record has the following fields: NAME (30 bytes), SSN (9 bytes), ADDRESS (40 bytes), PHONE (9 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.**

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Name 30 bytes** | **SSN 9 bytes** | **Address**  **40 bytes** | **Phone**  **9 bytes** | **Birthdate**  **8 bytes** | **Sex**  **1 byte** | **MajorDeptCode**  **4 bytes** | **MinorDeptCode**  **4 bytes** | **Class Code**  **4 bytes, int** | **DegreePr**  **3 bytes** | **Deletion Marker**  **1 byte** |

**We also add one bit in between each field.**

R in bytes = (30 bytes + 9 bytes + 40 bytes + 9 bytes + 8 bytes + 1 byte + 4 bytes + 4 bytes + 4 bytes + 3 bytes + 1 byte) =113 bytes + 11 bytes (for the extra field spaces) = 124 bytes

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

**Blocking Factor: bfr = Floor(B/R)**

**bfr represents # of records that can be placed in one block.**

B = 512 bytes

R = 124 bytes

**Floor (512 bytes / 124 bytes) = Floor (4.129) = 4.**

**Number of file blocks b assuming unspanned organization:**

**b = r / bfr**

**r = 20,000**

**bfr = 4**

**20,000/4 = 5,000**

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**

**We assume that average time means we divide blocks size by 2 so 5,000/2 = 2,500.**

s+ rd + (k\*btt) = 30 msec + 12.5 msec + (2,500 \* 1) = **2542.5 msec**

* 1. **if the file blocks are not stored contiguously.**

k \* (s + rd + btt) = (30 msec + 12.5msec + 1 msec) = 2,500 \* (43.5) = **108,750 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.**

*If this is not average time we can just keep the 5,000 blocks with linear search:*

**Log base 2 (5,000) = 12.28 msec**

*If there is an average time we can just divide the 5,000 blocks/2 = 2,500.*

**Log base 2 (2,500) = 11.28 msec**