Problem 1

Consider a disk with the following characteristics (these are not parameters of any particular disk unit): 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)?

(b) How many cylinders are there?

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

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

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

(f) Suppose the average seek time (time to go to the correct track mechanically) 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?

(g) Calculate the average time it would take to transfer 20 random blocks and compare it with the time it would take to transfer 20 consecutive blocks using double buffering to save seek time and rotational delay.

Solution:

(a) Total track size = 20 * (512+128) = 12800 bytes = 12.8 Kbytes
Useful capacity of a track = 20 * 512 = 10240 bytes = 10.24 Kbytes

(b) Number of cylinders = number of tracks = 400

(c) Total cylinder capacity = 15*2*20*(512+128) = 384000 bytes = 384 Kbytes
Useful cylinder capacity = 15 * 2 * 20 * 512 = 307200 bytes = 307.2 Kbytes

(d) Total capacity of a disk pack = 15 * 2 * 400 * 20 * (512+128) = 153600000 bytes = 153.6 Mbytes
Useful capacity of a disk pack = 15 * 2 * 400 * 20 * 512 = 122.88 Mbytes

(e) Transfer rate tr= (total track size in bytes)/(time for one disk revolution in msec)
tr= (12800) / ((60 * 1000) / (2400)) = (12800) / (25) = 512 bytes/msec
block transfer time btt = B / tr = 512 / 512 = 1 msec
average rotational delay rd = (time for one disk revolution in msec) / 2 = 25 / 2 = 12.5 msec

(f) average time to locate and transfer a block = $s + rd + btt$ = 30+12.5+1 = 43.5 msec

(g) time to transfer 20 random blocks = 20 * (s + rd + btt) = 20 * 43.5 = 870 msec
time to transfer 20 consecutive blocks using double buffering = s + rd + 20*btt = 30 + 12.5 + (20*1) = 62.5 msec

Problem 2

A file has r=20,000 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 Problem 1 .

(a) Calculate the record size R in bytes.

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

(c) Calculate the average time it takes to find a record by doing a linear search on the file if
(i) the file blocks are stored contiguously and double buffering is used, and
(ii) the file blocks are not stored contiguously.

(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.

Solution:

(a) R = (30 + 9 + 40 + 9 + 8 + 1 + 4 + 4 + 4 + 3) + 1 = 113 bytes

(b) $bfr = \lfloor B/R \rfloor = \lfloor 512/113 \rfloor = 4$ records per block
$b = \lceil (r/bfr) \rceil = \lceil 20000/4 \rceil$ = 5000 blocks

(c) For linear search we search on average half the file blocks= 5000/2= 2500 blocks.

(i) If the blocks are stored consecutively, and double buffering is used, the time to read 2500 consecutive blocks
= $s + rd + (2500 * (B/btr))$

= s + rd + (2500 btt)= 30+12.5+2500*1= 2542.5 msec

(ii) If the blocks are scattered over the disk, a seek is needed for each block, so the time is: $2500 * (s + rd + btt)$ = 2500 * (30 + 12.5 + 1) = 108750 msec = 108.75 sec

(d) For binary search, the time to search for a record is estimated as
$\lceil \log_2 b \rceil * (s + rd + btt)$
= $\lceil \log_2 5000 \rceil * (30 + 12.5 + 1)$
= 13 * 43.5 = 565.5 msec = 0.5655 sec