

1. Consider a hard disk with the following specifications.

- 6000 RPM
- 32 double-sided platters
- # of cylinders = 128
- B (block size) = 2 megabytes (2 MB)
- # of blocks per track = 64
- average seek time = 15 ms
- assume no interblock gap and 0 microcontroller overhead

A. total capacity of one track

$$T = 64 * (2\text{MB} + 0)$$

$$= 128 \text{ MB}$$

B. total capacity of one cylinder

$$32 * 2 * 128\text{MB} = 8192 \text{ MB}$$

$$\Rightarrow 8.192 \text{ GB}$$

C. total capacity of this disk

$$128 * 2 = 256 \text{ MB}$$

$$= 256 \text{ MB}$$

D. time to read one track

$$6000 \text{ RPM} / 60 \text{ min} \Rightarrow 100$$

$$\Rightarrow 100 / 1000$$

$$\Rightarrow 1 \text{ rotation} / 10\text{ms}$$

$$= 10\text{ms}$$

E. transfer rate in bytes/msec

$$64 * 2 \text{ MB} = 128 \text{ MB}$$

$$6000 \text{ RPM} / 60 \text{ min} \Rightarrow 1 \text{ rotation} / 10 \text{ ms}$$

$$\text{tr} = \text{track size} / \text{time for one disk revolution} = 128 \text{ MB} / 10 \text{ ms} \Rightarrow 1.28^8 \text{ bytes} / 10 \text{ msec}$$

$$= 1.28^7 \text{ bytes} / \text{msec}$$

F. block transfer time (transfer only)

$$\text{btt} = B/\text{tr} = 2\text{MB} / 1.28^7 \text{ bytes/msec} \Rightarrow 2^6 / 1.28^7$$

$$= .156 \text{ msec}$$

G. bulk transfer rate

$$\text{btr} = \text{tr} * (B/(B+G))$$

$$= 1.28^7 \text{ bytes/msec} * (2\text{MB} / (2\text{MB} + 0))$$

$$= 1.28^7 \text{ bytes/msec} * 1\text{MB} \Rightarrow 1.28^7 \text{ bytes/msec}$$

H. time to read 5 adjacent blocks

$$\text{TTR} = \text{seek} + \text{rotational delay} + \text{time to transfer 1 block} + \text{overhead}$$

$$= 15\text{ms} + 5\text{ms} + .156\text{ms} + 0 \Rightarrow 20.156\text{ms} * 5 \Rightarrow 100.78 \text{ msec} = 1 \text{ sec}$$

2. A file has $r = 20,000$ EMPLOYEE records of fixed length stored in a disk with the following disk parameters:

$$\text{- } B \text{ (block size)} = 1024 \text{ bytes}$$

$$\text{- } \text{btr} \text{ (bulk transfer rate)} = 896 \text{ bytes/msec}$$

$$\text{- } \text{latency (rotational delay)} = 5\text{ms}$$

- btt (block transfer time) = 1ms
- seek time = 10 ms
- microcontroller overhead = 2ms

Each record has the following fields:

- name: 64 bytes
- ssn: 9 bytes
- address: 128 bytes
- phones : 10 bytes
- birthdate: 8 bytes
- sex: 1 byte
- an additional byte is used as a deletion marker for each record (to indicate this record as deleted)

A Calculate the record size R in bytes

$$R = 64 + 9 + 128 + 10 + 8 + 1 + 6 = 226 \text{ bytes}$$

B Calculate the blocking factor bfr and the # of file blocks b, assuming an unspanned organization

$$\text{bfr} = B/R = 1024/226 = \text{floor}(4.53) = 4$$

$$b = r/\text{bfr} = 20000/4 = 5000$$

C. What is the wasted space (internal fragmentation) in each block?

$$B - \text{bfr} * R = 1024 - 4 * 226 = 230520 \text{ bytes} = 230.52 \text{ KB}$$

D. Calculate the average time it takes to find a record by a linear search on the file if the file blocks are stored contiguously

Linear search only uses half of the file blocks => $5000/2 = 2500$

$$s + rd + (2500 * (B/btr)) = 10 + 5 + (2500 * (1024 / 896)) = 2872.14 \text{ msec}$$

$$= 2.87 \text{ sec}$$

E. Calculate the average time it takes to find a record by a linear search on the file if the file blocks are not stored contiguously

$$2500 * (s + rd + btt) = 2500 * (10 + 5 + 1) = 40000 \text{ msec}$$

$$= 40 \text{ sec}$$

F. Calculate the worst time it takes to find a record by ssn if the file is ordered by ssn