

Problem 1.

Assume that we are using a hard disk with the following characteristics:

- *Capacity: 1 TB*
- *Average seek time: 6 msec*
- *Spindle speed: 15,000 rpm*
- *Bytes per sector: 512*
- *Sectors per cluster: 8*
- *Sectors per track: 400*

Assume that we have a file of 20,000 records. Each record has 64 bytes.

Questions:

1. Average Rotational Delay = (Spindle Speed)*(min/sec)*(1/2)
$$= (15,000) * (1/60) * (1/2)$$
$$= \mathbf{0.002 \text{ seconds (or 2 msec)}}$$

2. Records per Sector = (Bytes per Sector) / (Record Size)
$$= (512) / (64)$$
$$= \mathbf{8 \text{ records}}$$

3. Clusters Needed for File = (File Size) / (Bytes per Cluster)

$$\text{File Size} = (\# \text{ of Records}) * (\text{Bytes per Record}) = \mathbf{1,280,000 \text{ bytes}}$$
$$\text{Bytes per Cluster} = (\text{Bytes per Sector}) * (\text{Sectors per Cluster}) = \mathbf{4096 \text{ bytes}}$$
$$= (1,280,000) / (4096)$$
$$= \mathbf{313 \text{ Clusters (rounded-up from 312.5)}}$$

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4. Total Time to Read a Track = (Seek Time)+(Average Rotational Delay)+(Transfer Time)

$$\text{Transfer Time} = (\text{Bytes per Track}) / (\text{Transfer Rate})$$

$$\text{Transfer Rate} = (\text{Bytes per Track}) / (\text{Time per Rotation})$$

$$\text{Bytes per Track} = (\text{Sectors per Track}) * (\text{Bytes per Sector}) = \mathbf{204,800 \text{ bytes}}$$

$$\text{Time per Rotation} = (\text{Spindle Speed}) * (\text{min/sec}) = \mathbf{0.004 \text{ seconds (4 msec)}}$$

$$\text{Transfer Rate} = (204,800) / 0.004 = \mathbf{51,200,000 \text{ bytes/sec (51.2 MB/sec)}}$$

$$\text{Transfer Time} = (204,800) / (51.2 \text{ MB/sec}) = \mathbf{0.004 \text{ sec (4 msec)}}$$

$$= (6 \text{ msec}) + (2 \text{ msec}) + (4 \text{ msec})$$

$$= \mathbf{12 \text{ msec}}$$

5. Total Time to Read a Track = (Seek Time)+(Average Rotational Delay)+(Transfer Time)

$$= (8 \text{ msec}) + (\text{Continuous Transfer Time})$$

$$\text{Continuous Transfer Time} = (\text{Single Track Transfer Time}) * (\# \text{ of Tracks Needed})$$

$$\# \text{ of Tracks Needed} = (\# \text{ of Sectors Needed}) / (\text{Sectors per Track})$$

$$\# \text{ of Sectors Needed} = (\text{Clusters Needed for File}) * (\text{Sectors per Cluster})$$

$$\# \text{ of Sectors Needed} = (\sim 313) * (8) = \mathbf{2504 \text{ sectors}}$$

$$\# \text{ of Tracks Needed} = (2504) / (400) = \mathbf{7 \text{ tracks (rounded up from 6.26)}}$$

$$\text{Continuous Transfer Time} = (4 \text{ msec}) * (7 \text{ tracks}) = \mathbf{28 \text{ msec}}$$

$$= (8 \text{ msec}) + (28 \text{ msec}) = \mathbf{36 \text{ msec}}$$

6. Time to Read One Cluster = (Seek Time)+(Avg. Rotational Delay)+(Transfer Time)

$$= (8 \text{ msec}) + (\text{Cluster Transfer Time})$$

$$\text{Cluster Transfer Time} = (\text{Bytes per Cluster}) / (\text{Transfer Rate})$$

$$\text{Cluster Transfer Time} = (4096) / (51.2 \text{ MB/sec}) = \mathbf{0.08 \text{ msec}}$$

$$= (8 \text{ msec}) + (0.08 \text{ msec}) = \mathbf{8.08 \text{ msec}}$$

7. (Random Storage into Clusters implies Reading all Records for the File Individually)

$$\text{Time to Read Entire File} = (\text{Time to Read One Cluster}) * (\# \text{ of Records})$$

$$= (8.08) * (20,000) = \mathbf{161,600 \text{ msec (161.6 seconds)}}$$