

## Assignment 3 – solutions

### Problem 1.

What is the total capacity of RAID 0 with 10 drives?

RAID 0 - non-redundant (full capacity of drives) = drive capacity \* 10 = 1 TB \* 10 = 10 TB

What is the total capacity of RAID 5 with 10 drives?

RAID 5 - parity redundancy - uses 1 drive for parity so have 9 data drives = drive capacity \* 9 = 1 TB \* 9 = 9 TB

How many blocks are needed for spanned and unspanned records, respectively?

*Unspanned*

$$\left\lfloor \frac{\text{block size}}{\text{record size}} \right\rfloor = \left\lfloor \frac{4096}{2050} \right\rfloor = 1 \text{ record/block (unspanned)}$$

*Spanned*

$$\frac{\text{block size}}{\text{record size}} = \frac{4096}{2050} = 1.99 \text{ record/block (spanned)}$$

What is the block (space) utilization in both cases?

*Unspanned*

$$\text{utilization} = \text{used space} / \text{total space} = \frac{1 \text{ record per block} * 2050 \text{ bytes per record}}{4096 \text{ bytes per block}} = 0.5$$

*Spanned*

$$\text{utilization} = \text{used space} / \text{total space} = \frac{1.99 \text{ records per block} * 2050 \text{ bytes per record}}{4096 \text{ bytes per block}} = 0.995$$

Assume that the disk has a read bandwidth of 1 GB/sec. Suppose that data is stored sequentially. What is the time to read all records in the unspanned configuration?

*Unspanned*

$$\# \text{ of blocks in unspanned} = \frac{\# \text{ records}}{\# \text{ records per block}} = \frac{100,000}{1 \text{ record}} = 100,000 \text{ blocks.}$$

$$\text{Transfer time} = \frac{\# \text{ blocks} * \text{size of a block}}{\text{transfer bandwidth}} = \frac{100,000 * 4096}{1 \text{ GB/sec}} = 38 \text{ sec}$$

### Problem 2.

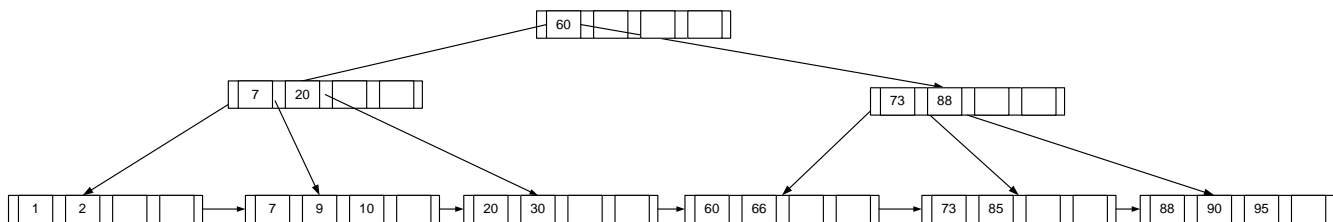
1. Bytes/track = (bytes/ sector) x (sectors/track) = 1024 x 100 = 102400 bytes = 100KB.
2. Bytes/surface = (bytes/track) x (tracks/surface) = 100KB x 4000 = 400,000KB.
3. Bytes/disk = (bytes/surface) x (surfaces/disk) = 400,000 x 10 x 2 = 80,000,000KB.
4. 4000, i.e., same as the number of tracks.
5. One complete rotation takes 1/7200 in a minute = 1/7200 x 60 seconds  $\approx$  0.0083 seconds = 8.3 ms.  
The average rotational delay is half of the rotation time, i.e., 4.15 ms.
6. A track has 100KB. It takes about 8.3ms to make a revolution. Hence, transfer rate is 100KB/8.3ms  $\approx$  12.05 KB/ms.

If you are asked to give the TOTAL transfer time then this is given by:

Total transfer time = seek time + latency + transfer time = 10ms + 4.15ms + 12.05ms = 26.2ms

### Problem 3.

Insert Tree:



Delete Tree:

