

Guide to Disk Drive Calculations

Below is a list of different calculations related to calculating **I/O Service Time**. Note that only some of these calculations may be needed.

1. Calculate the maximum rotational latency (time to rotate platter 360 degrees once).

Disk Speed: $S \text{ rpm} = S/60 \text{ rps}$

Maximum Rotational Latency (one full revolution) = $1 / (S/60 \text{ rps})$

Example 1:

Disk Speed: $12000 \text{ rpm} = 200 \text{ rps}$

Maximum Rotational Latency: $1 / 200 = 5\text{ms}$

Example 2:

Disp Speed: $7200 \text{ rpm} = 120 \text{ rps}$

Maximum Rotational Latency: $1 / 120 = 8.3\text{ms}$

2. Calculate the average rotational latency **IF** sector information is not given (i.e., platters current position and sector to be read).

Average Rotational Latency = Maximum Rotational Latency / 2

Example 1:

Maximum Rotational Latency: 5ms

Average Rotational Latency: $5\text{ms} / 2 = 2.5\text{ms}$

Example 2:

Maximum Rotational Latency: 10ms

Average Rotational Latency: $10\text{ms} / 2 = 5\text{ms}$

3. Calculate the number of bytes per platter (single or double-sided).

Disk Capacity: $C \text{ bytes}$

Number of Platters: P

Bytes Per Platter = C / P

Example 1:

Disk Capacity: 2^{32} bytes

Number of Platters: 4

Bytes Per Platter: $2^{32} / 2^2 = 2^{30}$

Example 2:

Disk Capacity: 2^{12} bytes

Number of Platters: 2

Bytes Per Platter: $2^{12} / 2^1 = 2^{11}$

4. Calculate the number of bytes per track.

Disk Capacity: C bytes
Bytes Per Platter: P bytes
Tracks Per Platter Side: T
Sides Per Platter: s

$$\text{Bytes Per Track} = (P / s) / T$$

Example 1:

Disk Capacity: 2^{32} bytes
Bytes Per Platter: 2^{30} bytes
Tracks Per Platter Side: 2^{12}
Sides Per Platter: 1
Bytes Per Track: $(2^{30} / 1) / 2^{12} = 2^{18}$ bytes

Example 2:

Disk Capacity: 2^{32} bytes
Bytes Per Platter: 2^{30} bytes
Tracks Per Platter Side: 2^{12}
Sides Per Platter: 2
Bytes Per Track: $(2^{30} / 2^1) / 2^{12} = 2^{29} / 2^{12} = 2^{17}$ bytes

5. Calculate the number of blocks or sectors per track.

Bytes Per Track: B bytes
Bytes Per Sector/Block: b bytes

$$\text{Number of Blocks/Sectors Per Track} = B / b$$

Example 1:

Bytes Per Track: 2^{18} bytes
Bytes Per Block: 2^{12} bytes
Number of Blocks Per Track: $2^{18} / 2^{12} = 2^6$

Example 2:

Bytes Per Track: 2^{18}
Bytes Per Sector: 2^8
Number of Sectors Per Track: $2^{18} / 2^8 = 2^{10}$

6. Calculate the time to rotate platter one block/sector.

Maximum Rotational Latency: M ms
Number of Blocks/Sectors Per Track = n

Cost To Rotate One Block/Sector = M / n ms

Example 1:

Maximum Rotational Latency: 10 ms
Number of Blocks Per Track: 32
Cost to Rotate One Block: $10 / 32 = 0.3125$ ms

Example 2:

Maximum Rotational Latency: 12 ms
Number of Blocks Per Track: 8
Cost to Rotate One Block: $12\text{ms} / 8 = 1.5$ ms

7. Calculate the time to rotate N blocks/sectors.

Number of Blocks/Sectors to Move: N
Cost to Rotate One Block/Sector: R ms

Cost To Rotate N Blocks/Sectors = NR ms

Example 1:

Number of Blocks/Sectors to Move: 10
Cost to Rotate One Block: 0.3125 ms
Cost to Rotate N Blocks: $10 * 0.3125\text{ms} = 3.125$ ms

Example 2:

Number of Blocks/Sectors to Move: 3
Cost to Rotate One Block: 1.5ms
Cost to Rotate N Blocks: $3 * 1.5\text{ms} = 4.5$ ms

8. Calculate average seek time.

Maximum Seek Time: K ms

Average Seek Time = $K / 2$ ms

Example 1:

Maximum Seek Time: 10 ms
Average Seek Time: $10 \text{ ms} / 2 = 5$ ms

Example 2:

Maximum Seek Time: 8 ms
Average Seek Time: $8 \text{ ms} / 2 = 4$ ms

9. Calculate time to seek one track.

Maximum Seek Time: K ms

Number of Tracks: T

Cost to Seek Single Track = K / T ms

Example 1:

Maximum Seek Time: 10 ms

Number of Tracks: 10

Cost to Seek Single Track: $10 \text{ ms} / 10 = 1 \text{ ms}$

Example 2:

Maximum Seek Time: 10 ms

Number of Tracks: 100

Cost to Seek Single Track: $10 \text{ ms} / 100 = 0.1 \text{ ms}$

10. Seek time

Number of Tracks to Move Head: M

Number of Tracks: T

Maximum Seek Time: K ms

Seek Time = $M / T * K$ ms

Example 1:

Number of Tracks to Move Head: 10

Number of Tracks: 100

Maximum Seek Time: 10 ms

Seek Time: $10 / 100 * 10 \text{ ms} = 0.1 * 10 \text{ ms} = 1 \text{ ms}$

Example 2:

Number of Tracks to Move Head: 50

Number of Tracks: 100

Maximum Seek Time: 10 ms

Seek Time: $50 / 100 * 10 \text{ ms} = 0.5 * 10 \text{ ms} = 5 \text{ ms}$

Alternate Calculation:

Number of Tracks to Move Head: M

Cost to Seek One Track: O

Alt. Seek Time = $M * O$

Example 1:

Number of Tracks to Move Head: 50

Cost to Seek One Track: 0.1 ms

Alt. Seek Time = $50 * 0.1 \text{ ms} = 5 \text{ ms}$

11. Transfer Time

Maximum Rotational Latency: R
Number of Sectors to Read: S
Number of Sectors Per Track: sT

Transfer Time = $S / sT * R$ ms

Example 1:

Maximum Rotational Latency: 12 ms
Number of Sectors to Read: 3
Number of Sectors Per Track: 24
Transfer Time: $3 / 24 * 12$ ms = $0.125 * 12$ ms = 1.5 ms

Example 2:

Maximum Rotational Latency: 12 ms
Number of Sectors to Read: 12
Number of Sectors Per Track: 24
Transfer Time: $12 / 24 * 12$ ms = $0.5 * 12$ ms = 6 ms

Alternate Transfer Time:

Cost to Rotate One Sector: oR
Number of Sectors to Read: S
Alt. Transfer Time = $S * oR$

I/O Service Time = Rotational Latency + Seek Time + Transfer Time

1. If the question does not state the specific position of the platter with respect to which sector is to be read, use **Average Rotational Latency**.
2. If the question does not state the specific position of the head with respect to which track is to be read, use **Average Seek Time**.
3. **DO NOT** use Average Rotational Latency when calculating **Transfer Time**.