Magnetic Disk in Computer Architecture

Computer Organization and Architecture

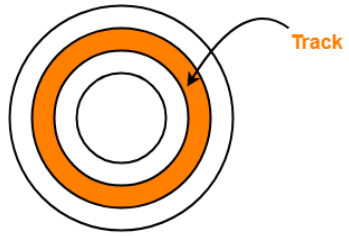
Magnetic Disk in Computer Architecture-

In computer architecture,

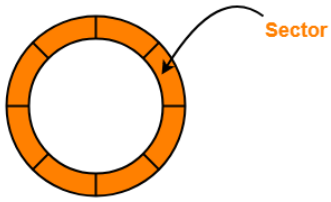
- Magnetic disk is a storage device that is used to write, rewrite and access data.
- It uses a magnetization process.

Architecture-

- The entire disk is divided into **platters**.
- Each platter consists of concentric circles called as **tracks**.
- These tracks are further divided into **sectors** which are the smallest divisions in the disk.

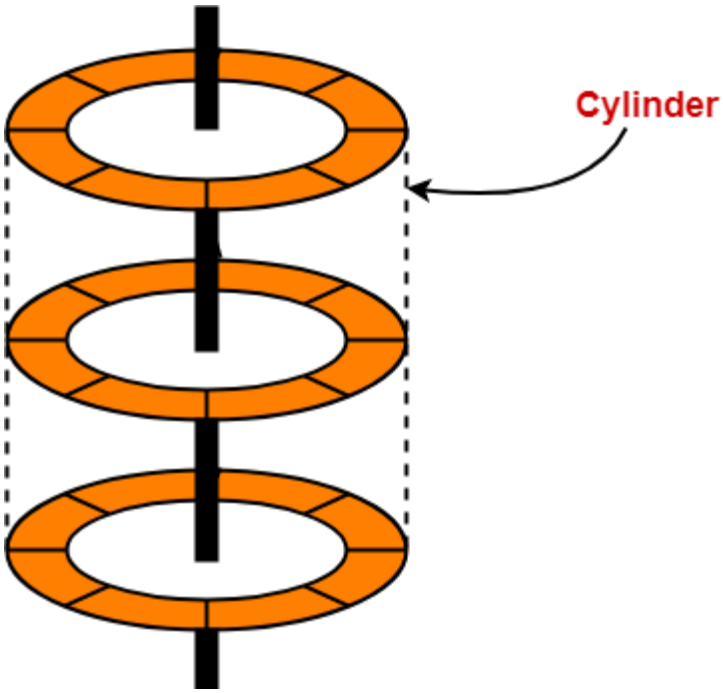


Disk divided into tracks

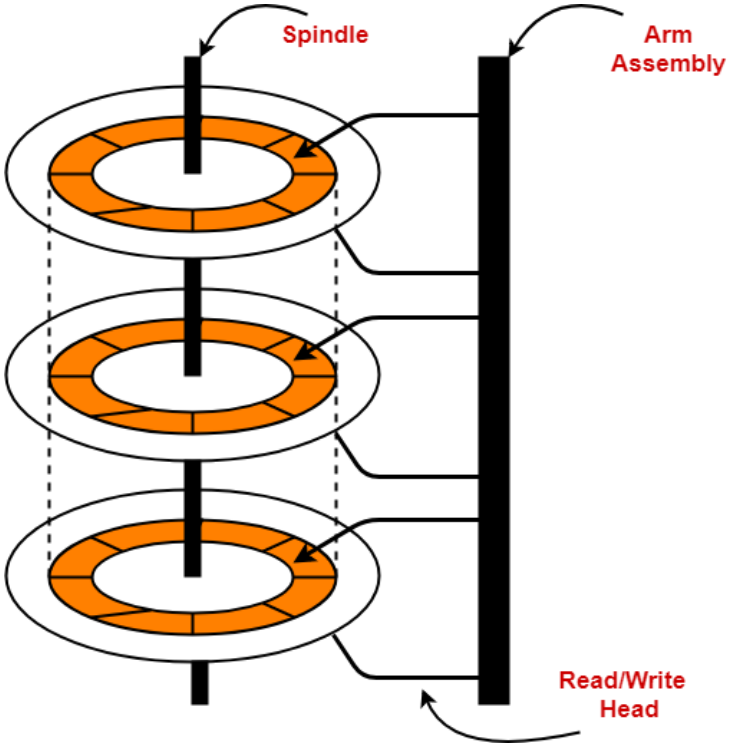


Track divided into sectors

- A **cylinder** is formed by combining the tracks at a given radius of a disk pack.



- There exists a mechanical arm called as **Read / Write head**.
- It is used to read from and write to the disk.
- Head has to reach at a particular track and then wait for the rotation of the platter.
- The rotation causes the required sector of the track to come under the head.
- Each platter has 2 surfaces- top and bottom and both the surfaces are used to store the data.
- Each surface has its own read / write head.



Disk Performance Parameters-

The time taken by the disk to complete an I/O request is called as **disk service time** or **disk access time**.

Components that contribute to the service time are-

1. Seek time
2. Rotational latency
3. Data transfer rate
4. Controller overhead
5. Queuing delay

1. Seek Time-

- The time taken by the read / write head to reach the desired track is called as **seek time**.
- It is the component which contributes the largest percentage of the disk service time.
- The lower the seek time, the faster the I/O operation.

Specifications

Seek time specifications include-

1. Full stroke
2. Average
3. Track to Track

1. Full Stroke-

- It is the time taken by the read / write head to move across the entire width of the disk from the innermost track to the outermost track

2. Average-

- It is the average time taken by the read / write head to move from one random track to another.

Average seek time = 1 / 3 x Full stroke

3. Track to Track-

- It is the time taken by the read-write head to move between the adjacent tracks.

2. Rotational Latency-

- The time taken by the desired sector to come under the read / write head is called as **rotational latency**.
- It depends on the rotation speed of the spindle.

Average rotational latency = 1 / 2 x Time taken for full rotation

3. Data Transfer Rate-

- The amount of data that passes under the read / write head in a given amount of time is called as **data transfer rate**.
- The time taken to transfer the data is called as **transfer time**.

It depends on the following factors-

1. Number of bytes to be transferred
2. Rotation speed of the disk
3. Density of the track
4. Speed of the electronics that connects the disk to the computer

4. Controller Overhead-

- The overhead imposed by the disk controller is called as **controller overhead**.
- Disk controller is a device that manages the disk.

5. Queuing Delay-

- The time spent waiting for the disk to become free is called as **queuing delay**.

NOTE-

> All the tracks of a disk have the same storage capacity.

Storage Density-

- All the tracks of a disk have the same storage capacity.
- This is because each track has different storage density.
- Storage density decreases as we from one track to another track away from the center.

Thus,

- Innermost track has maximum storage density.
- Outermost track has minimum storage density.

Important Formulas-

1. Disk Access Time-

Disk access time is calculated as-

> Disk access time
>
> = Seek time + Rotational delay + Transfer time + Controller overhead + Queuing delay

2. Average Disk Access Time-

Average disk access time is calculated as-

> Average disk access time
>
> = Average seek time + Average rotational delay + Transfer time + Controller overhead + Queuing delay

3. Average Seek Time-

Average seek time is calculated as-

> Average seek time
>
> = 1 / 3 x Time taken for one full stroke

Alternatively,

If time taken by the head to move from one track to adjacent track = t units and there are total k tracks, then-

Average seek time

= { Time taken to move from track 1 to track 1 + Time taken to move from track 1 to last track } / 2

= { 0 + (k-1)t } / 2

= (k-1)t / 2

4. Average Rotational Latency-

Average rotational latency is calculated as-

Average rotational latency

= 1 / 2 x Time taken for one full rotation

Average rotational latency may also be referred as-

- Average rotational delay
- Average latency
- Average delay

5. Capacity Of Disk Pack-

Capacity of a disk pack is calculated as-

Capacity of a disk pack = Total number of surfaces x Number of tracks per surface x Number of sectors per track x Storage capacity of one sector

6. Formatting Overhead-

Formatting overhead is calculated as-

Formatting overhead = Number of sectors x Overhead per sector

7. Formatted Disk Space-

Formatted disk space also called as usable disk space is the disk space excluding formatting overhead.

It is calculated as-

Formatted disk space = Total disk space or capacity – Formatting overhead

8. Recording Density Or Storage Density-

Recording density or Storage density is calculated as-

Storage density of a track

= Capacity of the track / Circumference of the track

From here, we can infer-

Storage density of a track ∝ 1 / Circumference of the track

9. Track Capacity-

Capacity of a track is calculated as-

Capacity of a track

= Recording density of the track x Circumference of the track

10. Data Transfer Rate-

Data transfer rate is calculated as-

Data transfer rate

= Number of heads x Bytes that can be read in one full rotation x Number of rotations in one second

OR

Data transfer rate

= Number of heads x Capacity of one track x Number of rotations in one second

11. Tracks Per Surface-

Total number of tracks per surface is calculated as-

Total number of tracks per surface = (Outer radius – Inner radius) / Inter track gap

Points to Remember-

- The entire disk space is not usable for storage because some space is wasted in formatting.
- When rotational latency is not given, use average rotational latency for solving numerical problems.
- When seek time is not given, use average seek time for solving numerical problems.
- It is wrong to say that as we move from one track to another away from the center, the capacity increases.
- All the tracks have same storage capacity.

To gain better understanding about magnetic disk-

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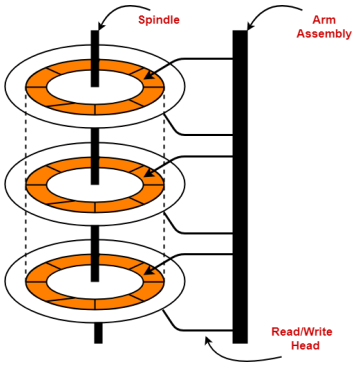
Summary



Article Name	Magnetic Disk in Computer Architecture
Description	Magnetic Disk is a storage device. Disk performance parameters- Seek time, Rotational Latency, Data Transfer Rate. Disk Formulas- Seek time Formula, Rotational Latency Formula etc.
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