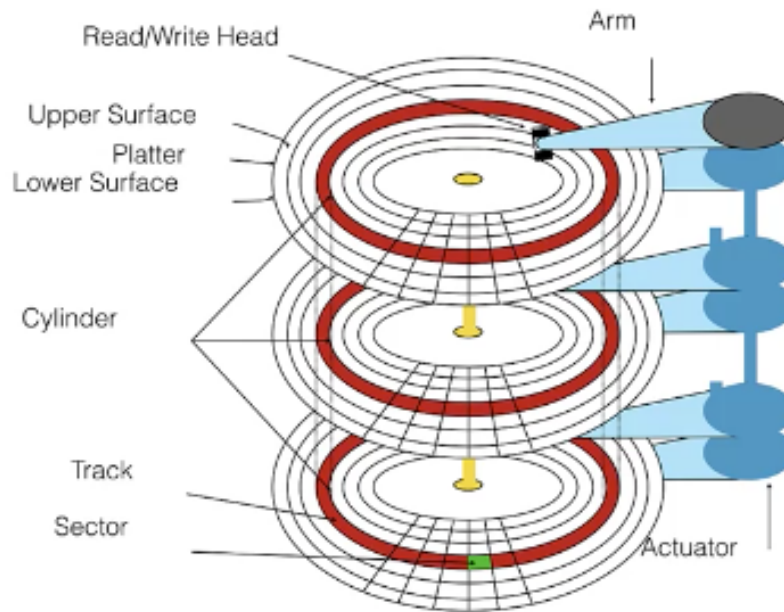


1. Secondary Storage Devices

- Focus will be on hard-drives

2. Disk Components



- Parts
 - **Platter:**
 - * Data can be stored in both upper and lower parts of the platter
 - **Cylinder:**
 - * Is a set of tracks that can be read without moving the arm
 - **Sector:**
 - * Size of disk block is multiple of sectors
- Disk surface crash



- Occurs when disk arm touching surface

- Results in permanent loss of information on the track

3. Disk Performance

IMPORTANT We should know the bulk part time of how this works

- **Seek:**

- Is the time it takes to move the disk arm to correct cylinder
- Depends on how fast disk arm can move
- Typical time: 1-15ms, depending on distance (avg 5-6 ms)
- Improves very slowly (7 - 10% per year)

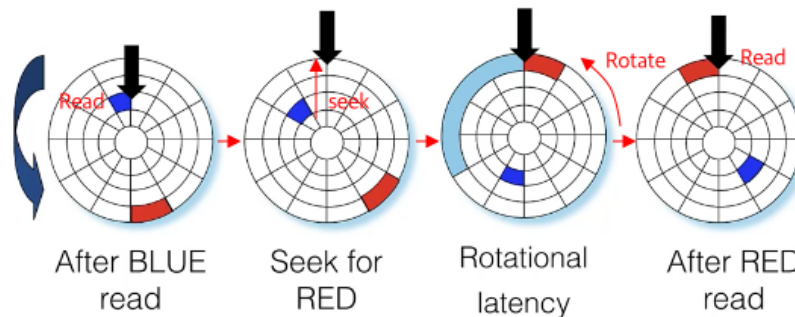
- **Rotation:**

- Is the time it takes to rotate under the head to get to correct sector
- Depends on rotation rate of disk
- Average latency of $\frac{1}{2}$ rotation

- **Transfer:**

- Is the time it takes to transfer data from surface to disk controller, electronics and sending it back to host
- Depends on density
- $\sim 100\text{MB/s}$, average sector transfer time of $\sim 5\mu\text{s}$
- Improves rapidly ($\sim 40\%$ per year)

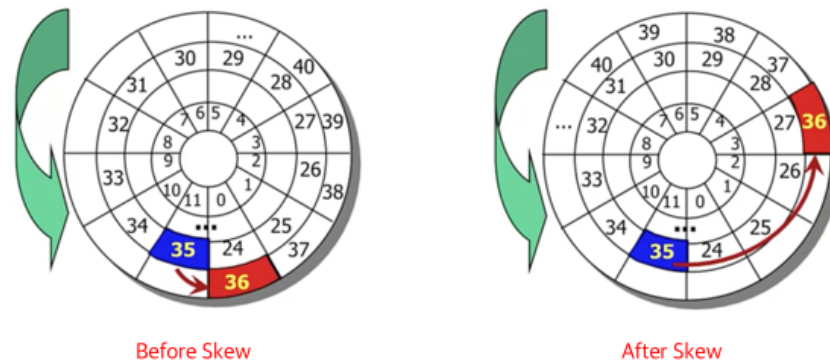
4. Traditional Service Time Component



- OS tries to minimize the cost of rotational latency, transfer time, and seek time
- Improvement attention especially on seek time and rotation latency

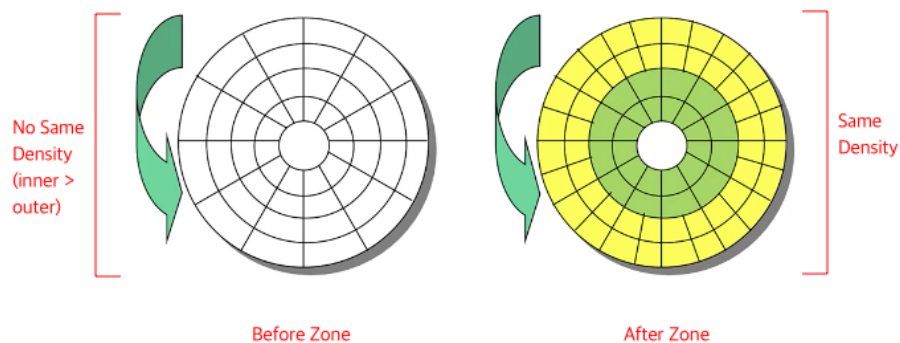
5. Some Hardware Optimizations

- **Track Skew**



- Has to do with numbering on tracks
- Is to reduce rotational latency

- **Zones**



- Is to make sure data is stored with same density
- Is done to maximize the capacity of hard drive
- Outer tracks → holds more sectors

- **Cache**

- Is also called **Track Buffer**
- Is a small memory chip embedded in hard drive (8 – 16MB)
- Is aware of disk geometry
- May cache whole track
- Boosts future reads on the same track

6. Disk and the OS

- The OS provides different levels of disk access to different clients
 - Physical disk (e.g surface, cylinder, sector)

IMPORTANT Logical disk (disk block #) ← what we will do for the first assignment

- Logical file (e.g file block, record, or byte #)

- **Enhancing Disk Performance**

- **Amortization**

- * Compensates positioning delay
 - * Grabs lots of useful data while at it
 - * Performance improvement upto factor of 10

- **Closeness**

- * Done by putting things close to each other
 - * Performance benefit in factors of 2

- **Allocation Strategies**

- Disk perform best if seeks are reduced and large transfers are used

- * Done by allocating data close together
 - * Reason why significant improvement in seek time and transmission time over the years

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