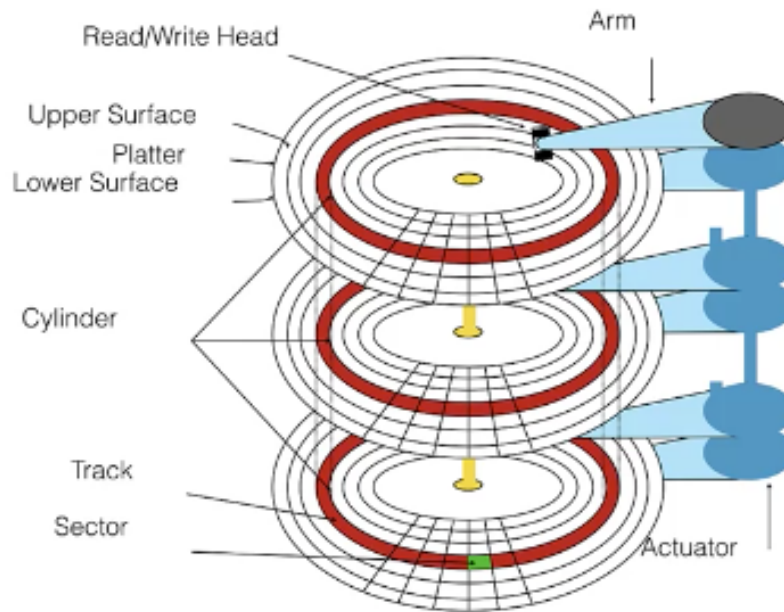


## 1. Secondary Storage Devices

- 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

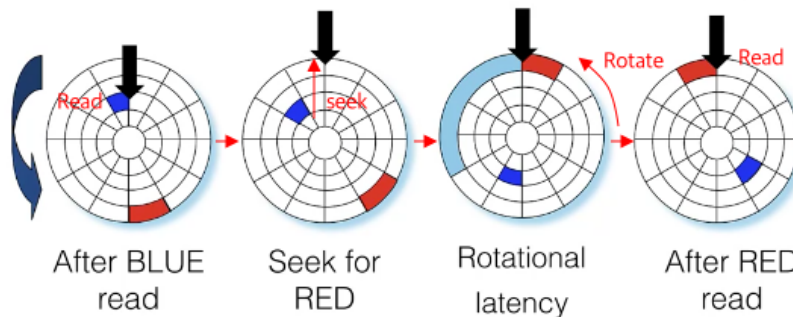
- Results in permanent loss of information on the track

### 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)

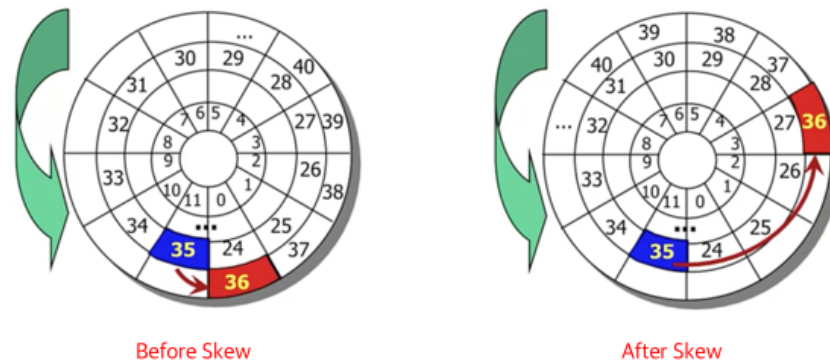
### 4. Traditional Service Time Component



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

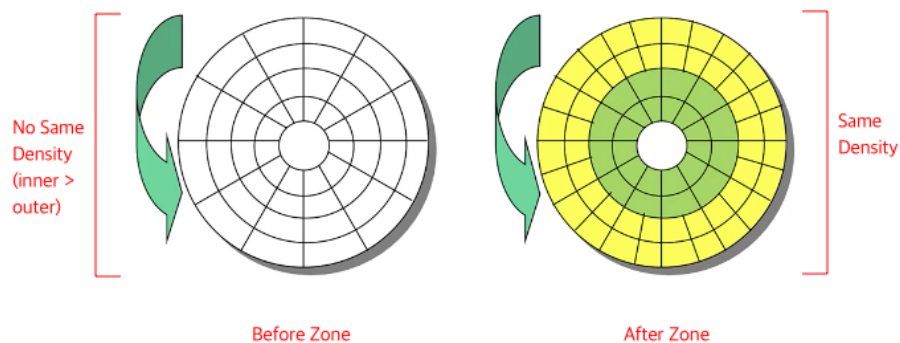
### 5. Some Hardware Optimizations

- **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**

- File system needs to be aware of disk characteristics for performance
  - \* **Allocation Algorithm** → enhances performance
    - e.g Extent-based allocation, indexed based allocation, linked-based allocation
  - \* **Request Scheduling** → reduce seek time
    - e.g. FCFS, SSTF, SCAN, C-SCAN
- Disk characteristics yields to goals:
  - \* **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

- **Fast File System**

- Is a disk aware file system
- Addresses 2 data and inode placement problems
  1. Fragmentation
  2. The travel of back and forth between inode and data blocks