1. **Secondary Storage Devices**

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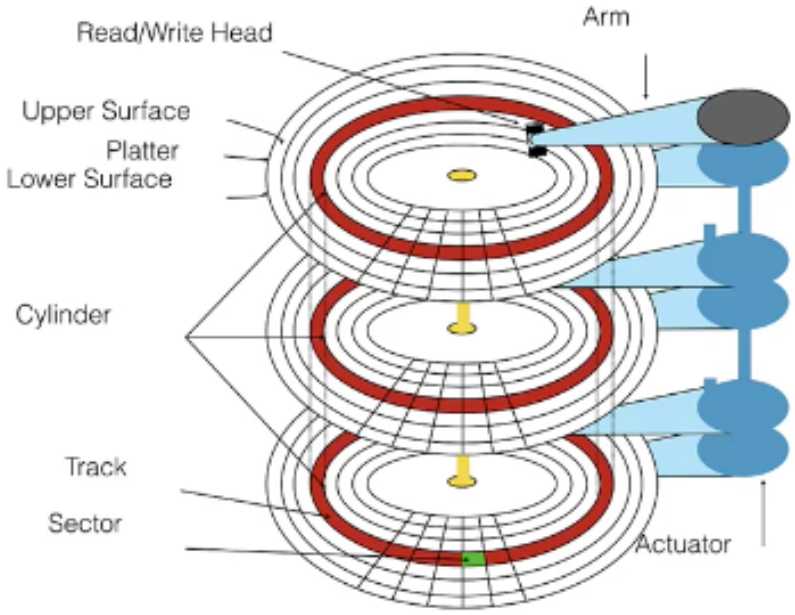
2. **Disk Components**



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

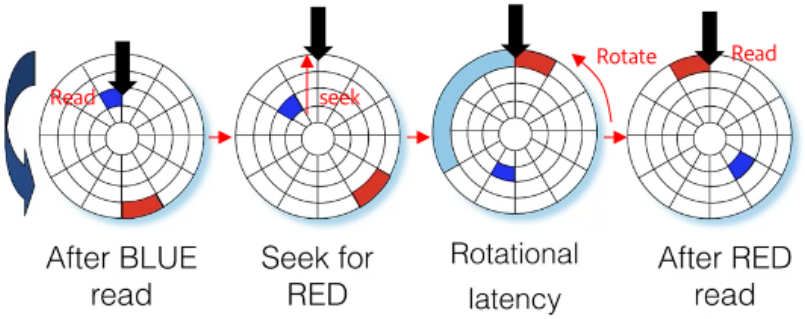
3. **Disk Performance**

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
  - $\sim$ 100MB/s, average sector transfer time of $\sim 5\mu s$
  - Improves rapidly ($\sim$ 40% per year)

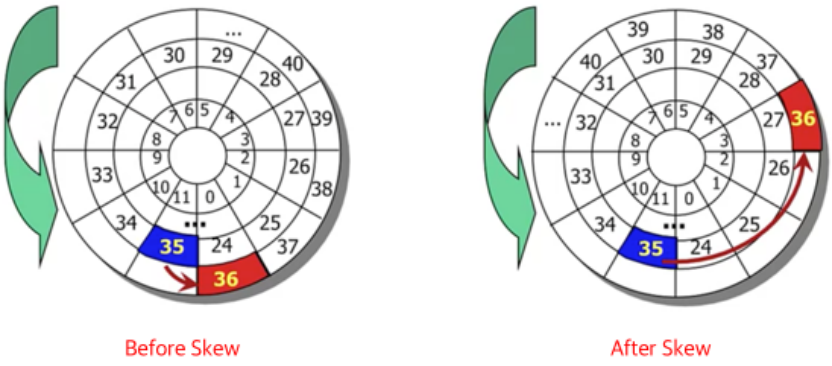
4. **Traditional Service Time Component**



- 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**

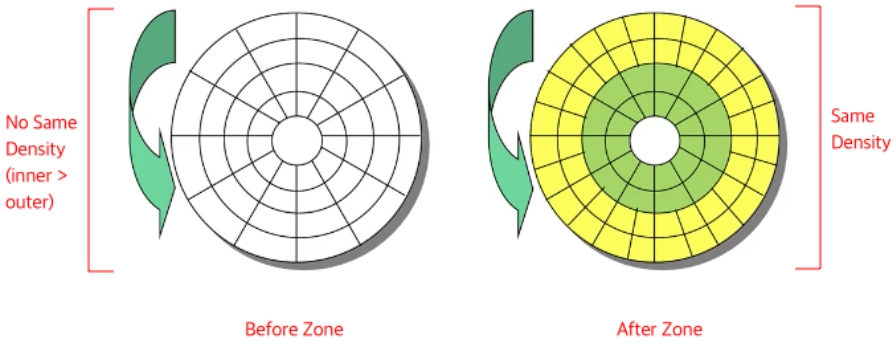
- **Track Skew**



  - Has to do with numbering on tracks

  - Is to reduce rotational latency

- **Zones**



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  - 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 $(8 - 16\text{MB})$
  - Is aware of disk geometry
  - May cache whole track
  - Boosts future reads on the same track

6. **Disk and the OS**

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