Physical Sectors

Time to Read Data
- Seek Time
  - Time required to move head from one track to another
- Latency
  - Time required for disk to rotate to beginning of correct sector
- Transfer Time
  - Time required to transfer a block of data to the disk controller buffer

A sector can also referred to as Block.

Physical Format

Low level formatting
Tracks
- Concentric circles (placed by manufacturer)
Cylinders
- Matching tracks on each side of the platters

Disk Layout

- Constant Angular Velocity (CAV)
  - Number of bits on each track is the same
  - Bits are denser towards the center.
  - Drive speeds up when accessing tracks close to the center.
  - Drive slows down when accessing towards the outer edge (Track 0)

- Constant Linear Velocity (CLV)
  - All tracks have the same physical length and number of bits
  - Constant speed reading data off a track
  - Drive speeds up when accessing tracks close to the center
  - Drive slows down when accessing towards the outer edge (Track 0)

Physical Geometry

Time to Read Data
- Seek Time
- Latency
- Transfer Time

Total Time to Access a Disk Sector
- Total of average seek time, average latency time and sector transfer time

Multiple zone recording
- Zone Bit Recording (ZBR)
  - Zone-CAV
  - Recording (Z-CAV)
  - Compromise of CAV and CLV
  - ZBR: Minimum of sectors in a particular zone is constant
  - Data is buffered so the data rate to the I/O interface is constant

Low level formatting
Tracks
- Concentric circles (placed by manufacturer)
Cylinders
- Matching tracks on each side of the platters
Sectors
- Smallest addressable unit
  - Commonly 512 bytes
  - Newer operating systems support 4KB sectors
  - Smallest addressable unit 4096 bytes
  - Physical sector numbering begins with 1

Floppy disks
- 80 tracks per side
- 512 bytes file requires 2 sectors (512 = 2 * 256)
- Physical sector numbering begins with 1

For our calculations, we’ll assume we are working with CAV formatted drives.

For a disk with \( n \) cylinders or tracks
- \( \text{Average Seek Time} (\text{avgSeek}) \)
- \( \text{Average Latency Time} (\text{avgLatency}) \)
- \( \text{Average Transfer Time} (\text{xferTime}) \)

Total Access Time
- \( \text{avgSeek} + \text{avgLatency} + \text{xferTime} \)
- \( \text{avgSeek} = \text{time to move from one track to another} \)
- \( \text{avgLatency} = \frac{1}{\text{rotational speed}} \)
- \( \text{xferTime} = \frac{1}{\text{numSectorsPerTrack} \times \text{rotational speed}} \)

512 bytes file requires 4 sectors (512 = 4 * 128)

Newer operating systems support 4KB sectors
- Smallest addressable unit 4096 bytes
- Physical sector numbering begins with 1
**Physical Sectors**

- Sectors contain **512 data bytes**
  - Exact number of bytes per sector depends on disk controller and operating system
  - For current floppy and hard disks:
    - Actual bytes per sector: **571 bytes total**

**Disk Capacity Calculation**

- Total Sectors = cylinders * sectorsPerTrack * platters * headsPerPlatter
- Total Capacity = total Sectors * bytesPerSector

<table>
<thead>
<tr>
<th>Disk</th>
<th>Tracks or Cylinders</th>
<th>Sectors per Track</th>
<th>Platters</th>
<th>Heads Per Platter</th>
<th>Bytes per Sector</th>
<th>Total Capacity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low Density Floppy</td>
<td>80</td>
<td>9</td>
<td>1</td>
<td>2</td>
<td>512</td>
<td>720 KB</td>
</tr>
<tr>
<td>High Density Floppy</td>
<td>80</td>
<td>18</td>
<td>1</td>
<td>2</td>
<td>512</td>
<td>1.44 MB</td>
</tr>
<tr>
<td>Seagate Wren 3</td>
<td>969</td>
<td>36</td>
<td>5</td>
<td>2</td>
<td>512</td>
<td>175 MB</td>
</tr>
</tbody>
</table>