Block Devices

Disk Drive

\[
\text{Total I/O time} = T_{\text{rot}} + T_{\text{seek}} + r \cdot N_{\text{Bytes}}
\]

5400 - 15,000 RPM

Rotational Delay: 0 - 11 ms  
55 ms  
0 - 4 ms  
2 ms

Seek Delay: 1 - 12 ms  
6 ms  
1 - 3 ms  
2 ms  
Read rate: 50 - 100 MB/s
\[ \text{Total Time} = T_{\text{rot}} + T_{\text{seek}} + C = N \times \text{BYTES} \]

<table>
<thead>
<tr>
<th>RPM</th>
<th>5400</th>
<th>15,000</th>
</tr>
</thead>
<tbody>
<tr>
<td>T_{\text{rot}}</td>
<td>5.5</td>
<td>2</td>
</tr>
<tr>
<td>T_{\text{seek}}</td>
<td>6</td>
<td>2</td>
</tr>
<tr>
<td>C</td>
<td>50 MB/s</td>
<td>100 MB/s</td>
</tr>
</tbody>
</table>

**1 KB of data:**

5400: \[11.5 + \frac{1K}{50 \times 10^6} = \frac{1}{50} \text{ms} = 11.52 \text{ms}\]

15000: \[4 + \frac{1K}{10^7} = 4.01 \text{ms}\]

**1 MB of data:**

5400: \[11.5 + \frac{1\text{MB}}{50 \times 10^6} = 31.5 \text{ms}\]

15000: \[4 + \frac{1\text{MB}}{10^7} = 14 \text{ms}\]

**Disk Sectors:**

- **Zones:** Separates tracks with same number of sectors

  ![Disk Sectors Diagram](image)

  - Outer Zone
  - Inner Zone

  ![Zones Diagram](image)
Jeff Sotterley

Throughput:

Logical block addressing

LBA: logical block address

0 3 512 byte
1
2

\[ n \times 512 \text{ bytes} \]

Interfere:

SCSI

SATA

Packet-oriented
READ LBA, # Blocks

write LBA, #

status
data
data

status

Elevator Alg:

1 2 3 4

read all this data into buffer
(in case it's needed)

[Diagram of elevator algorithm]

[Diagram of data access pattern]

[Diagram of data manipulation]
Flash: 2-4 kB

Disk is rewritable

Flash: I O

Flash Translation Layer:

Write 1
Write 2
Projects:

- Literature & application (e.g., simulation)
- Transactional memory
- Page replacement (e.g., Clock/Pro)
- Miss ratio curve
- Parallel file system
- Garbage collection
- Virtual machines

More practical:
- HW2 simulator
- File system implementation