Hard Drive Power Consumption Uncovered

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Motivation

Attempts to reduce power consumption have mainly focused on maximizing standby periods. This approach is based on the assumption that the mechanics of a drive dominate the electronics in terms of power consumed. Our fine-grained measurements indicate a more complex situation. We present results which show the importance of a detailed understanding of power consumption and identify the need for a more expressive API between the OS and hardware devices to maximize power efficiency.

Experimental Setup & Results

We have developed a measurement platform (Figure 1) to provide direct, online measurements of individual PC components. The platform provides twenty-four, 12-bit inputs, each sampled at 98 Hz. We have begun our investigation with hard drives and examined three drive states—read, write, and standby.

Table 1. Drive details and energy consumption

<table>
<thead>
<tr>
<th>Make &amp; Model</th>
<th>Capacity (GB)</th>
<th>Read 1 GB</th>
<th>Write 1 GB</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Seagate ST34310A</td>
<td>4.311</td>
<td>578 J</td>
<td>255 J</td>
</tr>
<tr>
<td>2 Maxtor 8648006</td>
<td>6.4</td>
<td>610 J</td>
<td>305 J</td>
</tr>
<tr>
<td>3 Fujitsu MPE3084AE</td>
<td>8.45</td>
<td>630 J</td>
<td>320 J</td>
</tr>
<tr>
<td>4 Quantum MQL1000LD-A</td>
<td>10.2</td>
<td>529 J</td>
<td>211 J</td>
</tr>
<tr>
<td>5 IBM 07N6655</td>
<td>61.5</td>
<td>817 J</td>
<td>267 J</td>
</tr>
<tr>
<td>6 Seagate ST380011A</td>
<td>80</td>
<td>933 J</td>
<td>473 J</td>
</tr>
<tr>
<td>7 Seagate ST3200824A</td>
<td>250</td>
<td>778 J</td>
<td>276 J</td>
</tr>
<tr>
<td>8 Seagate ST96812A (Laptop)</td>
<td>60</td>
<td>202 J</td>
<td>187 J</td>
</tr>
</tbody>
</table>

We have begun our investigation with hard drives and examined three drive states—read, write, and standby.

Region A and F Device negotiation quietly consumes a significant amount of power even though no work on the disk is being done.

Region C and G The power consumption of reads and writes are noticeably asymmetric. For 1 GB of data, reads cost at least twice as much as writes in 75% of our tested drives.

Region I Transitioning to standby significantly reduces the power consumption, however, the electronics continue to consume 1.5 W.

Region J The amount of energy required to spin-up a drive is fixed, regardless of the amount of time spent in standby.

R/W Asymmetry
- reads cost more than writes
- new power-saving possibilities

Newer vs. Older Drives
- newer ⇒ more energy efficient
- capacity and RPM propel industry
  (what about power efficiency?)

More Expressive API
- power model is more complex
- all drives are different
- more expressive API is needed

Figure 1. Measurement environment

Figure 2. Test Sequence for Figure 3

Figure 3. Power Consumed by Drive 6