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.

	Make & Model	Capacity (GB)	Read 1 GB	Write 1 GB
1	Seagate ST34313A	4.311	578 J	255 J
2	Maxtor 86480D6	6.4	810 J	705 J
3	Fujitsu MPE3084AE	8.45	630 J	320 J
4	Quantum QML10000LD-A	10.2	529 J	211 J
5	IBM 07N6655	61.5	817 J	267 J
6	Seagate ST380011A	80	933 J	473 J
7	Seagate ST3250824A	250	778 J	276 J
8	Seagate ST96812A (laptop)	60	202 J	187 J

Table 1. *Drive details and energy consumption*

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.

Close attention was also given to the significant transitions between them (Figure 2). Results for tested drives are summarized in Table 1, and Figure 3 is an annotated, graphical representation of the power consumption of a representative drive (Drive 6) during a run of our test script.

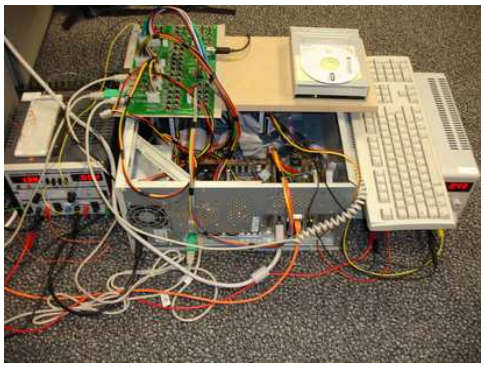

Figure 1. *Measurement environment*

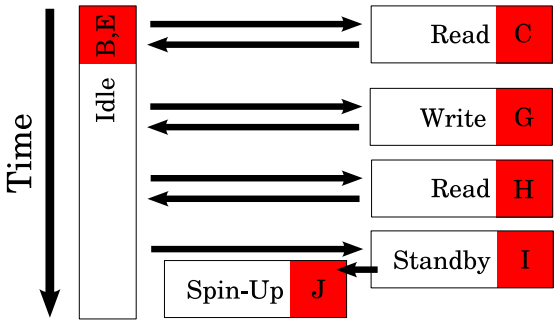

Figure 2. *Test Sequence for Figure 3*

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.

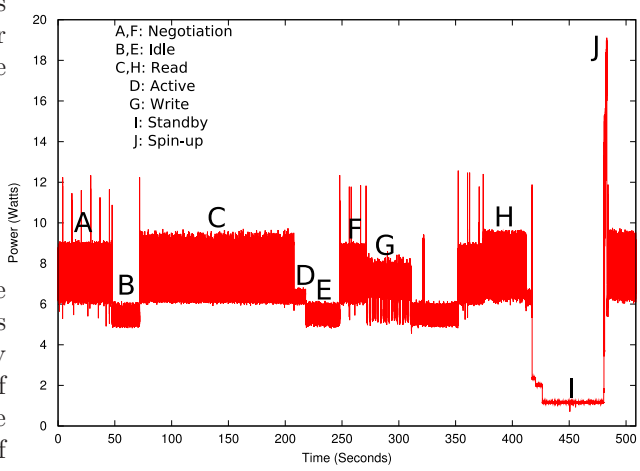

Figure 3. *Power Consumed by Drive 6*

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