Solid State Drives

“The good news, what to watch out for, and where the solid-state craze is taking us.”
by Pete Choppin

I am thrilled this week to be able to write about solid-state drives. Ever since I heard that the storage technology was moving to a purely electronic system without moving parts to fail or slow performance, in addition to the read/write access time being more than double that of the fastest hard disk drives in bench tests (see Computerworld's review, June '09), my geek meter began flashing and, like many of my IT friends, I just had to have one.

Depending on who you talk to, the rush to solid-state storage is on the horizon, just over it, right around the corner, or already upon us. Analysts, journalists and hardware fanatics can't seem to come to an agreement on exactly where we are in the process. One thing seems certain, though. It's not a question of *if* solid-state storage will take over from traditional mechanical hard drives, but *when*.

This is not to say that the mechanical hard drive is on the way out. The steady pace of platter development is still yielding impressive increases in performance and capacity. But as the price of solid-state alternatives continues to drop, SSDs are sure to carve out a niche in the mobile space, where their superior shock tolerance and low power consumption are as important as their storage capacity. Solid-state drives won't just dominate notebooks, though. The near-instantaneous seek time of flash memory offers tantalizing performance potential for any workload.

But before I start getting too excited, let's first break this down into exactly what all the hype is about solid-state. We'll also talk about the good news, what to watch out for, and where this is all taking us.

What Exactly Is 'Solid State?'

Solid state refers to the electronics that make up the circuitry on the main board of the drive. A solid-state drive (SSD) is made entirely of semiconductors.

I am sure someone out there is thinking the USB flash drive has been around for quite some time now and that the SSD is simply a modified USB flash drive (without the USB interface) that is built into a computer, and they are nothing more than the portable external devices we are so familiar with. This is sort of true, for the most part. There are, however, some important differences to understand in order to be aware of how an SSD performs and why there is such a dramatic price difference between the two technologies.

Also, there is a difference in the form factor of the drives. While a flash drive is designed to be external to the computer system, an SSD is designed to reside inside the computer in place of the traditional mechanical hard drive.

NAND and SDRAM

Solid state disks use either NAND flash or SDRAM (non-volatile and volatile storage respectively). NAND flash is so-called because of the NAND-gate technology it uses and is common in USB flash drives and many types of memory cards. NAND flash-based drives are persistent and can therefore effectively mimic a mechanical disk drive. Synchronous dynamic random access memory (SDRAM) is volatile and requires a separate power source if it is to operate independently from a computer.

Capacity is also a factor that differentiates the USB flash from solid state. Because the SSD is designed to replace traditional hard drives, their storage capacity needs to be able to handle an entire operating system as well as the applications and data typically used on desktop and laptop computers. This can be a problem where cost is a concern, as we will look at later.

The Good News

Obviously, one of the most impressive things about solid state is the stability. The NAND flash memory cells found in SSDs can last for years beyond the three-to-five-year life expectancy of a magnetic hard drive. Because hard drives include numerous moving parts, they are vulnerable to wear and tear over time, especially if dropped or jostled.

An SSD can still break if you drop it, but as a whole, the lack of moving parts makes them less prone to damage. If left unbothered, a solid-state drive can last up to 60 years longer than a hard drive in a similar desktop environment. And as an added bonus, SSDs don't produce any noise and generate very little heat.

Another plus is performance. Unlike the mechanical hard drive, SSDs don't have to wait for a physical arm to move read and write heads to specific points on a spinning magnetic platter. Reading from flash memory is a virtually instantaneous process, giving SSDs the ability to reach faster random read times and greater read throughput than magnetic hard drives.

The Not-So-Good News

Well, not all the SSD news is good, although it is getting better all the time. NAND flash is still a relatively expensive technology, making for a high cost per gigabyte. Some manufacturers have managed to lower the cost of SSDs by using multi-level cell (MLC) technology to cram more bits of data onto a single memory cell. The problem is, MLC technology incurs a performance hit over single-layer cell (SLC) technology. The voltage complexities involved in maintaining the multi-bit cells can significantly slow the speed of write operations.

And just a caution: Unless a manufacturer specifies what kind of flash memory powers its drives, you won't know whether you're getting high-performance SLC or low-performance MLC flash. The price tag is the only distinguishing factor outside of benchmarks. MLC drives are among the cheapest SSD drives available (typically half the price of SLC SSDs).

Also, SSDs can suffer from inferior random write and sequential write times because the data on an SSD is stored in kilobyte-size blocks. Adding more data to a block is a time-consuming process: The SSD copies the entire contents of the block to RAM, changes the data in the block, erases the original block of data on the SSD, and writes the changed block back to the SSD.

The Future of Solid State

So where are we headed with all this? All signs are showing the market is moving closer to affordable and more reliable solid-state technology, especially with mobile devices. Laptops, notebooks and PDA devices all are taking full advantage of SSD benefits such as less weight, shock-proof features and much lower power consumption.

Also, expect to see upgrades in controllers and NAND flash push SSD prices lower over time, but don't hold your breath for either hard drives or SSDs to ever oust the other from the marketplace. According to Michael Yang, flash product marketing manager for Samsung, NAND flash capacities will continue to grow at a rate of 40 to 50 percent each year. This puts SSD development on par with the 40 percent capacity growth touted by top hard drive manufacturers.

Single-layer cell (SLC) and multi-layer cell (MLC) technology will continue to make up the flash cell foundations of solid-state drives. But according to Yang, SSDs will start moving away from the conventional form factors—1.8-inch, 2.5-inch and 3.5-inch drive sizes—established by the magnetic hard drive market. This could bring forth SSDs of all shapes and sizes, an appealing prospect for notebook vendors that want more internal customization options.

A Word of Caution

Solid-state drives may seem to be *the* solution to less reliable and slower-performing traditional hard drives—especially for a total geek, such as myself, who loves new and cool technologies. But you need to know what you are buying, just like any new technology. You might not realize what you're getting when you purchase an SSD. The nuances of an SSD's construction can make a huge difference in its performance.

Here's My Take

The potential for this technology is, frankly, astounding. Just think—storage technology where there are no moving parts to break or slow performance, access is literally light speed, and lifespan of the drive is six to 10 times that of conventional storage media. We're only on the cusp of the solid-state storage revolution.

However, right now the MLC-based drives just aren't worth their low prices. While their read speeds are certainly impressive compared to those of the fastest hard drives, poor write performance holds them back. I wouldn't use an MLC-based device as the primary volume for my operating system. The capacity just isn't there yet. The Windows folder alone on my Windows 7 Ultimate system registers just shy of 14GB. Office 2010 will want 3GB. You've probably got several gigs of your own apps that need to be installed. Keep in mind that you want to leave at least 20 percent of your SSD free for optimal performance. I really don't recommend anything less than 64GB for a boot drive these days and though you can certainly find solid-state drives in that capacity, they carry a high price tag.

There will come a day when solid-state drive technology is a more compelling desktop option. Maybe NAND flash will get cheaper to produce or larger-capacity SSDs will start bumping

down prices on the lower-capacity end of the SSD spectrum. Don't expect this turnaround to occur for a while yet. This is only the beginning of the storage war.

Related Resources

- From Tom's Hardware Guide
- Review from Computerworld