SOLID STATE DRIVES: A COMPARATIVE STUDY

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Abstract

SSD have been a major breakthrough in the past year in the area of large memories. Most new tech are based on SSD.As their prices decline, their storage capacities increase, and their endurance improves, NAND Flash Solid State Disks (SSD) provide an increasingly attractive alternative to Hard Disk Drives (HDD) for portable computing systems and PCs.This paper draws a parallel comparison between the new and the old storage technologies respect to various attributes like their internal working , physical dimensions, mobility , performance, cost and lifetime .Both of the major technologies offer some major advantages but the new Solid State Drives(SSD) gains the upper hand.

Key Terms : SSD, HDD, NAND, Flash, USB, SLC, MLC

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INTRODUCTION

SSD is a device that uses NAND flash to provide non-volatile, rewritable memory. In computers, a solid-state drive can be used as a storage device, replacing the traditional hard disk drive. In fact, manufacturers produce SSDs with shapes and footprints that resemble HDDs so the two technologies can be used interchangeably. Even the I/O interfaces developed for hard disks are used by SSDs. But that's where the similarities end. If you cracked open the shell of a solid-state drive, you wouldn't see platters and actuator arms.

SSDs have no moving mechanical components. This distinguishes them from traditional electromechanical magnetic disks such as hard disk drives(HDDs) or floppy disks, which contain spinning disks and movable read/write heads. Compared with electromechanical disks, SSDs are typically more resistant to physical shock, run more quietly, have lower access time, and less latency.However, while the price of SSDs has continued to decline in 2012, SSDs are still about 7 to 8 times more expensive per unit of storage than HDDs.

Most SSDs use NAND-based flash memory, which retains data without power. For applications requiring fast access, but not necessarily data persistence after power loss, SSDs may be constructed from random-access memory (RAM). Such devices may employ separate power sources, such as batteries, to maintain data after power loss.

The key components of an SSD are the controller and the memory to store the data. The primary memory component in an SSD had been DRAM volatile memory since they were first developed, but since 2009 it is more commonly NAND flash non-volatile memory. Other components play a less significant role in the operation of the SSD and vary among manufacturers.

HOW SSD'S WORK

On the outside, solid-state drives look just like HDDs. They're rectangular in shape, covered in a brushed-metal shell and sized to match industry-standard form factors for hard drives -- typically 2.5 and 3.5 inches (6.4 and 8.9 centimeters). But beneath the silver exterior, you'll find an array of chips organized on a board, with no magnetic or optical media in sight. Much of that stuff could fit into a smaller space, but SSD manufacturers dress up their components in extra "housing" to make sure they fit into existing drive slots of laptops and desktop PCs.

Compared to the stark simplicity of a solid-state drive, the innards of a hard drive are a marvel of motion, sound and activity. Round platters, arranged on a spindle, can spin at 7,200 revolutions per minute. An actuator arm, branching into multiple read-write heads, races across the platters in too-fast to-be-seen bursts of speed. The arm connects to the actuator block, which holds the instructions for moving the read-write heads. As those instructions are called up, sometimes up to 50 times a second, the arm pivots at one end and moves the heads in unison over the platters. Once a head arrives at a certain location on a platter, an electromagnet produces a magnetic field, which aligns data-carrying domains in the underlying track. Each domain can be aligned in one of two possible directions -- 1 or 0. As these alignments change, they form patterns that correspond to discrete chunks of digital information.

The NAND flash of a solid-state drive stores data differently. Recall that NAND flash has transistors arranged in a grid with columns and rows. If a chain of transistors conducts current, it has the value of 1. If it doesn't conduct current, it's 0. At first, all transistors are set to 1. But when a save operation begins, current is blocked to some transistors, turning them to 0. This occurs because of how transistors are arranged. At each intersection of column and row, two transistors form a cell. One of the transistors is known as a control gate, the other as a floating gate. When current reaches the control gate, electrons flow onto the floating gate, creating a net positive charge that interrupts current flow. By applying precise voltages to the transistors, a unique pattern of 1s and 0s emerges.

NAND flash comes in two flavours based on how many 1s and 0s can be stored in each cell. Single-level cell (SLC) NAND stores one bit -- either a 1 or a 0 --
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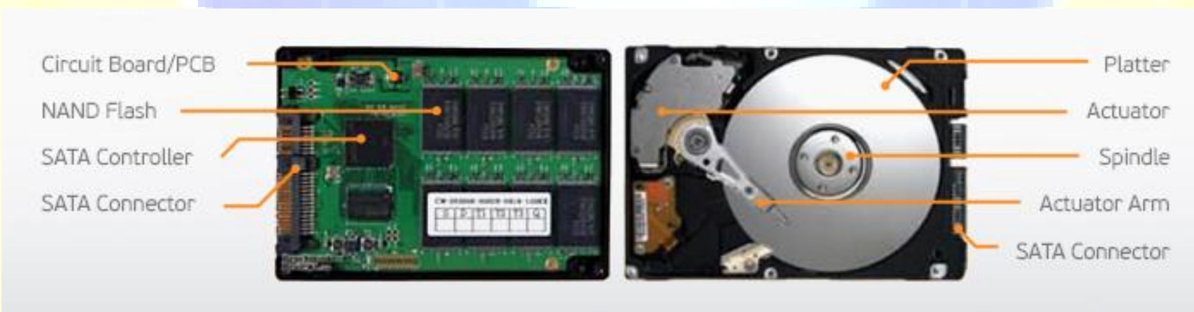
per cell. Multi-level cell (MLC) NAND stores two bits per cell. MLC flash delivers higher capacity, but it wears out more quickly (yes, wears out -- we'll cover that more in a couple of pages). Still, it's less expensive per gigabyte than SLC and, as a result, is the preferred technology in almost all consumer level SSDs. Cost has been one of the biggest hurdles of flash memory and, consequently, of solid-state drives. But in recent years, costs have dropped significantly. At the same time, advances in NAND flash development have taken what's good about the technology and made it even better

SSD VS HDD VS HYBRID DRIVES

The traditional spinning hard drive (HDD) is the basic non volatile storage on a computer. That is, it doesn't "go away" like the data on the system memory when you turn the system off. Hard drives are essentially metal platters with a magnetic coating. That coating stores your data, whether that data consists weather reports from the last century, a high definition copy of the Star Wars trilogy, or your digital music collection. A read/write head on an arm accesses the data while the platters are spinning in a hard drive enclosure.



An SSD does much the same job functionally (saving your data while the system is off, booting your system, etc.) as an HDD, but instead of a magnetic coating on top of platters, the data is stored on interconnected flash memory chips that retain the data even when there's no power present. The chips can either be permanently installed on the system's motherboard (like on some small laptops and netbooks), on a PCI/PCIe card (in some high-end workstations), or in a box that's sized, shaped, and wired to slot in for a laptop or desktop's hard drive (common on everything else). These flash memory chips differ from the flash memory in USB thumb drives in the type and speed of the memory. That's the subject of a totally separate technical treatise, but suffice it to say that the flash memory in SSDs is faster and more reliable than the flash memory in USB thumb drives. SSDs are consequently more expensive than USB thumb drives for the same capacities.

Hybrid hard drives blend HDD capacity with SSD speeds by placing traditional rotating platters and a small amount of high-speed flash memory on a single drive.

Hybrid storage products monitor the data being read from the hard drive, and cache the most frequently accessed bits to the high-speed NAND flash memory. The data stored on the NAND will change over time, but once the most frequently accessed bits of data are stored on the flash memory, they will be served from the flash, resulting in SSD-like performance for your most-used files.

Some of the advantages of hybrid storage products include cost, capacity, and manageability. Because only a relatively small solid-state volume is required to achieve significant performance gains, a large investment in a high-capacity SSD isn't necessary. Hybrid drives tend to cost slightly more than traditional hard drives, but far less than solid-state drives. And because the cache volume is essentially hidden from the OS, users aren't required to cherry-pick the data to store on the SSD to prevent it from filling up. The hybrid storage volume can be as big as the hard drive being used, and can serve as a standard hard drive. Boot times also see some improvement.

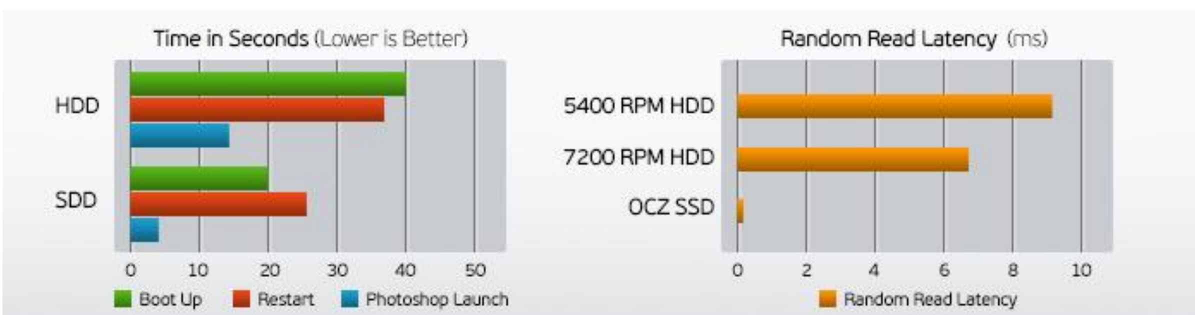
The OCZ RevoDrive Hybrid.

Where hybrid products falter is with new data. When writing new data or accessing infrequently used bits, hybrid products perform just like a standard hard drive, and new hybrid drives have a "break-in period" while the software learns which data to cache. Due to the fact that hybrid products rely on caching software, they can also be somewhat more difficult to configure.

For users who don't want the responsibility of managing multiple volumes or who don't constantly work with new data, a hybrid drive can be a great option to improve system performance—all *without* having to give up any capacity or having to deal with the headaches of using separate solid-state and hard-disk drives.

PERFORMANCE COMPARISON CHARTS

SSDs can have 100 times greater performance, almost instantaneous data access, quicker boot ups, faster file transfers, and an overall snappier computing experience than hard drives. HDDs can only access the data faster the closer it is from the read write heads, while all parts of the SSD can be accessed at once.



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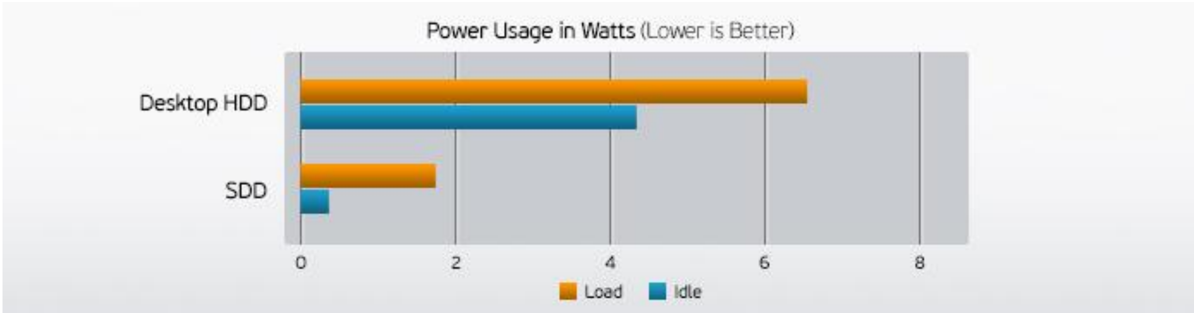
SSDs use significantly less power at peak load than hard drives, less than 2W vs. 6W for an HDD. Their energy efficiency can deliver longer battery life in notebooks, less power strain on system, and a cooler computing environment.



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Flash-based SSDs weigh considerably less than hard drives – only 77g vs. 752.5g for HDDs. SSDs won't weigh down your notebook when you're on the go or your desktop when rearranging your office!

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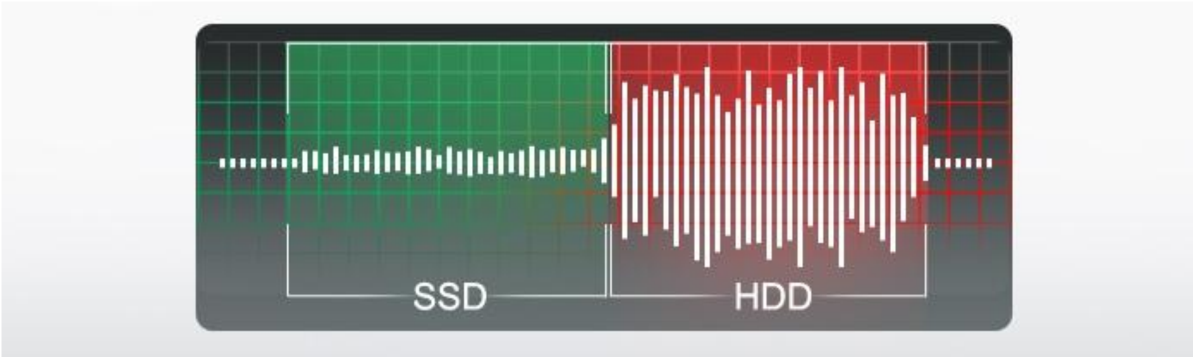
Though still a higher price/gigabyte than hard drives, SSDs offer cost savings in the long run for businesses with lower energy usage and greater productivity with higher Input/outputs Operations per Second (IOPS). One SSD delivers the performance of 100 hard drives.

With no moving parts, SSDs run at near silent operation and never disturb your computing experience during gaming or movies, unlike loud, whirring hard disc drives



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Flash Storage vs. SSD – What's the Difference?

The terms flash storage and SSD (solid state disk) storage are often used interchangeably to describe a type of storage that has no moving parts and can be erased and reprogrammed. Though closely related, they're not exactly the same thing.

What is Flash Storage?

Flash technology dates back to the 1980s when it was invented by Dr. Fujio Masuoka from Toshiba. One of his colleagues is reported to have suggested the name "flash" because the process of erasing the contents reminded him of acamera's flash. Though there are no moving parts to wear out, flash memory has a limited amount of program-erase cycles (P/E cycles) before the integrity of the storage deteriorates.

What is SSD Storage?

SSD arrived long before flash was invented. Early forms of solid state disks, which were referred to as auxiliary memory units, were used in the 1950s but fell out of favor when less expensive drum storage units emerged. In the 1970s, SSDs were occasionally incorporated into the semiconductors that powered supercomputers, but they were cost prohibitive. The 1980s saw the introduction of solid state storage cartridges and memory modules. However, some issues such as the loss of content when the storage chip was not powered meant that usage was limited unless a backup battery was provided.

When flash technology emerged, the flash-based SSD soon followed in the mid-1990s. This solved the power requirements related to maintaining the contentsof the memory.

Today, flash and SSD technologies are everywhere. Tiny cards inside your digital camera allow you to save hundreds of high resolution photos and videos; USB drives allow you to store many gigabytes of data on a tiny stick and then take it with you; modern ultrabooks come with SSD instead of bulky hard disks, making these devices thin and light.

In addition to being able to pack a lot of capacity onto a tiny chip, flash and solid state storage devices are fast. Startup is nearly instantaneous; they deliver consisted read and write speeds; they don't require special cooling and can handle higher temperatures than hard disks; because there are no moving parts, they are also resistant to shocks and vibrations; there are no moving parts to fail; and their power consumption is about half as much as a hard disk drive.

However, like early forms of SSD storage, costs remain high. When compared to hard disk drives on a per gigabyte basis, the cost differences are astounding.

Though costs have dropped, the gap between SSD and hard disk drive prices remains expansive.

What is Hybrid Storage?

One solution that bridges that gap is hybrid storage. Hybrid storage uses a combination of flash storage and traditional hard disk drives to create a storage solution with the performance and reliability of SSD and the capacity and cost advantages of hard disk drives. The concept here is that data used most often resides on the faster, high performance flash drives while data that just needs to be stored until needed resides on traditional hard disks.

In the battle between flash storage vs. SSD vs. hard disks, the clear winner is ablend: hybrid storage.

CONCLUSION

In the present world, where every person using a computer is a storage aficionado , everyone has probably heard a lot about SSDs, those friendly solid-state disks promising dramatically improved performance over their magnetically inclined brethren.

In this paper we have compared them with hard disk drives (HDDs) and also with the hybid drives which are a combination of the two.

There is no doubt that SSDs perform faster and are more quiet , shock resistant , energy efficient and lightening quick due to their NAND storage. there are still disadvantages like drive slowdowns , controller failures and manufacture recalls. and adding to these anxiety-producing headlines, there's a price premium. While most magnetic drives average around a nickel or dime per gigabyte, even consumer-grade SSDs still run $1-2 per gigabyte, often for drastically smaller-capacity drives.

A lot of companies are manufacturing SSDs these days even with all the disadvantages associated with their use. for some users , though, the reward is worth the risk. It also remains to see whether a couple of companies will emerge victorious, as did Seagate and Western Digital with HDDs, or whether SSDs will continue to come from a wide variety of manufacturers. As we all know , today's winners can be tomorrow's losers. The only thing we can say with much certainty is that SSDs show a lot of promise, and we're just beginning to tap it.

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