SSD vs. HDD: What's the Difference?

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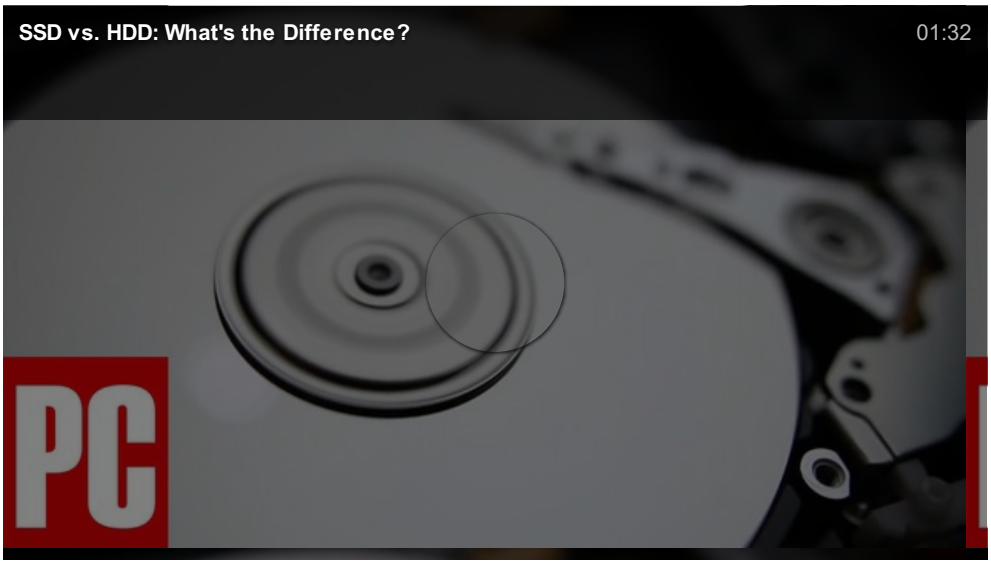
Until recently, PC buyers had very little choice for what kind of file storage they got with their **laptop**, **ultrabook**, or **desktop**. If you bought an ultrabook or ultraportable, you likely had a solid-state drive (SSD) as the primary drive (C: on Windows, Macintosh HD on a Mac). Every other desktop or laptop form factor had a hard disk drive (HDD). Now, you can configure your system with either an HDD, SSD, or in some cases both. But how do you choose? We explain the differences between SSDs and HDDs, and walk you through the advantages and disadvantage of both to help you come to your decision.

HDD and SSD Explained

The traditional spinning hard drive (HDD) is the basic nonvolatile 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 of 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 (e.g., 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 ultrabooks), 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.

A History of HDDs and SSDs

Hard-drive technology is relatively ancient (in terms of computer history, anyway). There are well-known pictures of the

infamous IBM 350 RAMAC hard drive from 1956 that used fifty 24-inch-wide platters to hold a whopping 3.75MB of storage space. This, of course, is the size of an average 128Kbps MP3 file, in the physical space that could hold two commercial refrigerators. The IBM 350 was only ulitized by government and industrial users, and was obsolete by 1969. Ain't progress wonderful? The PC hard drive form factor standardized in the early 1980s, with the desktop-class 5.25-inch form factor, and with the 3.5-inch desktop-class and 2.5-inch notebook-class drives coming soon thereafter. The internal cable interface has changed from Serial to IDE to SCSI to SATA over the years, but it essentially does the same thing: connects the hard drive to the PC's motherboard so your data can be processed. Today's 2.5- and 3.5-inch drives use SATA interfaces almost exclusively (at least on most PCs and Macs). Capacities have grown from multiple megabytes to multiple terabytes, an increase of millions fold. Current 3.5-inch HDDs max out at 10TB, with 2.5-inch drives at 3TB max.

The SSD has a much more recent history. There was always an infatuation with non-moving storage from the beginning of personal computing, with technologies like bubble memory flashing (pun intended) and dying in the 1970s and '80s. Current flash memory is the logical extension of the same idea. The flash memory chips store your data and don't require constant power to retain that data. The first primary drives that we know as SSDs started during the rise of netbooks in the late 2000s. In 2007, the OLPC XO-1 used a 1GB SSD, and the Asus Eee PC 700 series used a 2GB SSD as primary storage. The SSD chips on low-end Eee PC units and the XO-1 were permanently soldered to the motherboard. As netbooks, ultrabooks, and other ultraportable laptop PCs became more capable, the SSD capacities increased, and eventually standardized on the 2.5-inch notebook form factor. This way, you could pop a 2.5-inch hard drive out of your laptop or desktop and replace it easily with an SSD. Other form factors emerged, like the mSATA miniPCIe SSD card, M.2 SSD, and the DIMM-like SSDs in the Apple MacBook Air, but today many SSDs are still built into the 2.5-inch form factor. The 2.5-inch SSD capsacity currently tops out at 4TB, but will undoubtedly grow as time goes by.

Advantages and Disadvantages

Both SSDs and HDDs do the same job: They boot your system, store your applications, and store your personal files. But each type of storage has its own unique feature set. The question is, what's the difference, and why would a user get one over the other? We break it down:

Price: To put it bluntly, SSDs are more expensive than HDDs in terms of dollar per GB. For the same capacity and form factor 1TB internal 2.5-inch drive, you'll pay about $60 to $75 for an HDD, but as of this writing, an SSD doubles that to $130 to $150. That translates into 7 cents per gigabyte for the HDD and 14 cents per gigabyte for the SSD. Since HDDs are older, more established technologies, they will remain less expensive for the near future. Those extra hundreds may push your system price over budget.

Maximum and Common Capacity: As seen above, SSD units top out at 4TB, but those are still very rare and expensive. You're more likely to find 500GB to 1TB units as primary drives in systems. While 500GB is considered a "base" hard drive in 2015, pricing concerns can push that down to 128GB for lower-priced SSD-based systems. Multimedia users will require even more, with 1TB to 4TB drives as common in high-end systems. Basically, the more storage capacity, the more stuff (photos, music, videos, etc.) you can hold on your PC. While the (Internet) cloud may be a good place to share these files among your phone, tablet, and PC, local storage is less expensive, and you only have to buy it once.

Speed: This is where SSDs shine. An SSD-equipped PC will boot in seconds, certainly under a minute. A hard drive requires time to speed up to operating specs, and will continue to be slower than an SSD during normal use. A PC or Mac with an SSD boots faster, launches apps faster, and has faster overall performance. Witness the higher PCMark benchmark scores on laptops and desktops with SSDs, plus the much higher scores and transfer times for external SSDs versus HDDs. Whether it's for fun, school, or business, the extra speed may be the difference between finishing on time or failing.

Fragmentation: Because of their rotary recording surfaces, HDD surfaces work best with larger files that are laid down in contiguous blocks. That way, the drive head can start and end its read in one continuous motion. When hard drives start to fill up, large files can become scattered around the disk platter, which is otherwise known as fragmentation. While read/write algorithms have improved to the point that the effect is minimized, the fact of the matter is that HDDs can become fragmented, while SSDs don't care where the data is stored on its chips, since there's no physical read head. Thus, SSDs are inherently faster.

Durability: An SSD has no moving parts, so it is more likely to keep your data safe in the event that you drop your laptop bag or your system is shaken about by an earthquake while it's operating. Most hard drives park their read/write heads when the system is off, but they are flying over the drive platter at hundreds of miles an hour when they are in operation. Besides, even parking brakes have limits. If you're rough on your equipment, an SSD is recommended.

Availability: Hard drives are simply more plentiful. Look at the product lists from Western Digital, Toshiba, Seagate, Samsung, and Hitachi, and you'll see many more HDD models than SSDs. For PCs and Macs, internal HDDs won't be going away completely, at least for the next couple of years. You'll also see many more HDD choices than SSDs from different manufacturers for the same capacities. SSD model lines are growing in number, but HDDs are still in the majority for storage devices in PCs.

Form Factors: Because HDDs rely on spinning platters, there is a limit to how small they can be manufactured. There was an initiative to make smaller 1.8-inch spinning hard drives, but that's stalled at about 320GB, since the phablet and smartphone manufacturers have settled on flash memory for their primary storage. SSDs have no such limitation, so they can continue to shrink as time goes on. SSDs are available in 2.5-inch laptop drive-sized boxes, but that's only for convenience. As laptops become slimmer and tablets take over as primary Web-surfing platforms, you'll start to see the adoption of SSDs skyrocket.

Noise: Even the quietest HDD will emit a bit of noise when it is in use from the drive spinning or the read arm moving back and forth, particularly if it's in a system that's been banged about or in an all-metal system where it's been shoddily installed. Faster hard drives will make more noise than slower ones. SSDs make virtually no noise at all, since they're non-mechanical.

Overall: HDDs win on price, capacity, and availability. SSDs work best if speed, ruggedness, form factor, noise, or fragmentation (technically part of speed) are important factors to you. If it weren't for the price and capacity issues, SSDs would be the winner hands down.

As far as longevity goes, while it is true that SSDs wear out over time (each cell in a flash memory bank has a limited number of times it can be written and erased), thanks to TRIM command technology built into SSDs that dynamically optimizes these read/write cycles, you're more likely to discard the system for obsolescence before you start running into read/write errors. The possible exceptions are high-end multimedia users like video editors who read and write data

constantly, but those users will need the larger capacities of hard drives anyway. Hard drives will eventually wear out from constant use as well, since they use physical recording methods. Longevity is a wash when it's separated from travel and ruggedness concerns.

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