WHITE PAPER

The Total Cost of Ownership for an SSD-Enabled PC

Sponsored by: SanDisk Corporation

Jeff Janukowicz David Reinsel

July 2011

IN THIS WHITE PAPER

In this white paper, IDC explores the potential benefits of replacing hard disk drives (HDDs) with solid state drives (SSDs). The potential benefits are discussed in the context of a formal total cost of ownership (TCO) analysis that compares metrics from organizations deploying HDD-based laptop PCs with published specifications for the same SSD-related metrics. The metrics used in this analysis are associated with device performance, reliability, and environment as well as normal labor costs incurred by companies using systems that leverage these storage technologies within the PC. The result is a model-based operational cost comparison of HDD-based and SSD-based PCs.

Methodology

To develop a complete operational cost analysis, IDC identified several cost variables associated with the deployment, management, use, and support of corporate laptop PCs. The metrics chosen are common to both HDDs and SSDs so that there are no inconsistencies within the TCO model.

The variables populated into the analysis are culled from IDC's Business Value Database, which includes IT operational data from over 1,000 organizations. The comparable variables are based on published specifications in some cases and vendor-supplied data resulting from controlled laboratory tests in other cases. Real-world specifications were gathered through published reports and IDC's technology assessment that summarized our own experience using SSDs. IDC then modeled how these specifications would translate into the cost analysis.

PC operations are subject to a myriad of factors that influence costs, including usage environments, workloads, and IT practices and policies. Because of these factors, the actual operational cost may differ significantly from the costs calculated within this analysis. The goal of this analysis is to model the reduction in operational costs that a company can expect to see when replacing HDDs with SSDs in laptop PCs that are used in normal everyday work environments.

SITUATION OVERVIEW

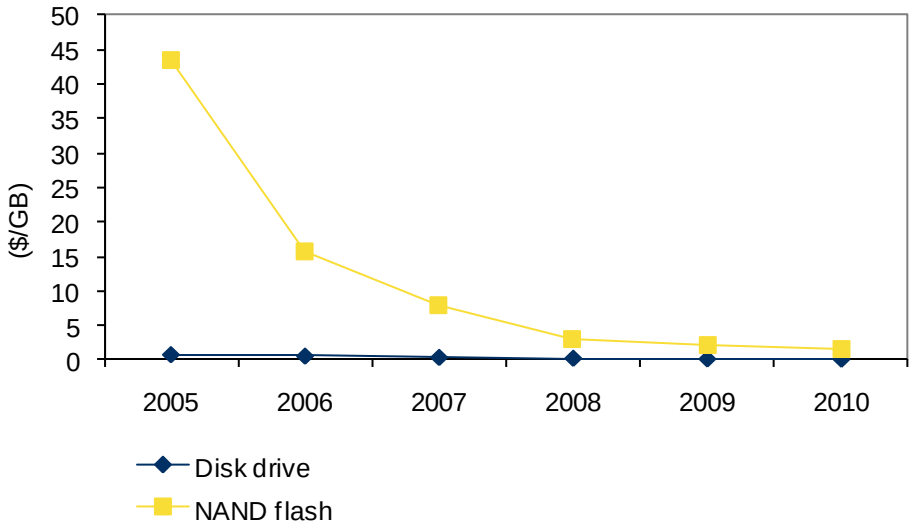
At first glance, it appears that SSDs are a more expensive storage solution than traditional HDDs. However, when both storage technologies are put into the context of TCO, the value proposition and true cost of an SSD-enabled PC are revealed.

Global Headquarters: 5 Speen Street Framingham, MA 01701 USA P.508.872.8200 F.508.935.4015 www.idc.com

It used to be said that there were only two guarantees in life: death and taxes. A third dynamic is just as assured: the decreasing cost of storage (measured in terms of dollar per gigabyte [$/GB]). Figure 1 illustrates the price erosion curves for HDDs and flash from 2005 to 2010.

FIGURE 1

HDD Versus Flash Price Erosion, 2005–2010



Source: IDC, 2011

It is this price erosion of NAND flash memory that has led to the development of flash-based SSDs as an alternative storage solution to HDDs. NAND flash has no moving parts and is a nonvolatile memory that can continue to store information in the absence of a power source, making it an ideal storage media in portable devices. As a technology, NAND flash has advanced significantly over the past decade thanks to a multitude of advancements in semiconductor technology.

Commensurate with these advances in storage technology are advances in other technologies, such as processing power, software, battery life, and wireless communication. Combined, these technology advancements have helped evolve mobile computing activities from performing simple calculations to today's portable PCs, media tablets, and mobile phones that are capable of connecting to a wireless network, running sophisticated applications, and connecting to content that is stored in the cloud.

As a result, our expectations for storage requirements are changing as markets evolve and technology advances. Local storage comes in all shapes and sizes, but for the past 30 years, HDDs have been the dominant choice for storage in the PC. Traditional HDDs, with their spinning media, have served the IT industry and its users well, and they continue to do so today. Yet, future customer requirements related to

price, performance, capacity, power consumption, and reliability align well with the benefits of solid state drives. In fact, millions of SSD-enabled PCs are already being leveraged by customers throughout the world.

MODELING THE LAPTOP PC ENVIRONMENT

Defining the Cost Variables and Relationships

Total cost analysis evaluates the complete life cycle of the technology:

- **Acquisition.** The cost to acquire the laptop PC (The acquisition cost is *not* considered in this analysis because it is a moving target, varies greatly among companies, and will be demand driven. In IDC's opinion, the cost of any new technology, such as the SSD-based PC, that seeks to replace legacy technology should be a "result" of the cost-benefit analysis versus an "input." In other words, device suppliers and system OEMs should use TCO analysis to help determine the premium threshold users are willing to tolerate based on the expected TCO.)

- **Deployment.** The IT labor costs to deploy PCs to users, including time to acquire, stage, set up, distribute, and support for 30 days

- **Maintenance.** The cost to troubleshoot, repair, and maintain the device, including both IT labor costs and outsourced labor costs

- **Performance.** The costs associated with using the device (PC user productivity is a measure of user salary lost when users do not have access to applications due to boot/shutdown times, application launches, data transfers, and other related variables, as well as lost time due to PC incidents or failures. In addition, power and extended battery life variables influence this part of the TCO model.)

- **Retirement.** The IT labor and hardware/software costs associated with replacing a device at the end of a cycle (Generally, this is related to the refresh cycle of the device. Early replacement [or lengthened refresh cycle] is a key variable within this cost bucket. Because we did not use acquisition costs in this analysis, we excluded hardware and software replacement as well.)

No single cost variable alone provides justification for substituting SSDs with HDDs in laptop PCs. However, certain relationships among the variables can multiply the benefits (or detriments) associated with a given variable. Hence a formal model must be defined using the appropriate variables and relationships to ascertain the most realistic cost-benefit picture.

Populating the Variables

Hard disk drives have been around for multiple decades and are the most economical way to store digital content that needs to be accessed quickly and efficiently. HDDs have been used in and throughout the IT infrastructure and have significant roles in the entire digital universe. Much is known about the integrity and life of an HDD, and this industry knowledge is leveraged to populate the many variables within the model.

Solid state storage devices have been around for many years, too, and have been used in military and industrial markets as an HDD alternative. However, SSDs are relatively new to the digital storage scene in the PC, and there is far less historical knowledge. Nevertheless, over the past few years, SSDs have matured and are used increasingly throughout the IT infrastructure.

To complete the operational cost analysis, IDC leveraged vendor-supplied data to populate the correct fields within the model. In addition, real-world data was gathered through published reports and IDC's technology assessment that summarized our own experience using SSDs.

Key Findings

SSDs can provide a tangible benefit in the context of a TCO analysis that compares metrics from an organization deploying HDD-based laptop PCs with published specifications for the same SSD-related metrics. These benefits can be summarized by improvements in device performance that translate to increased user productivity, higher reliability due to the reduction of costs associated with maintenance and repair, and power savings benefits. However, as stated previously, real-world scenarios and environments differ widely, as do end-user preferences and behaviors, and actual results will vary.

Performance/Productivity Improvement

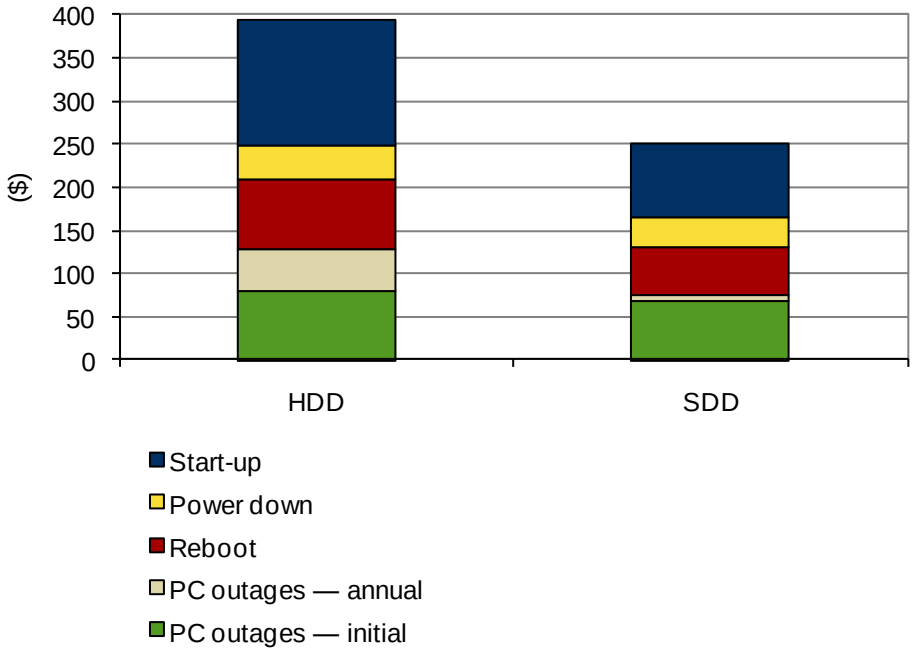
SSDs provide higher productivity due to their increased reliability, higher performance, and lower power consumption when relying on battery power. The published reliability improvement in terms of mean time between failure (MTBF) of SSDs over HDDs is higher, increasing productivity by reducing repairs and replacement. By utilizing solid state memory, SSDs can provide increased performance by offering quick data accessibility and fast data reads.

Our model suggests the following benefits of using SSDs (see Figure 2):

- User productive time is increased by improving access times to applications and overall PC functionality by 35% ($93 per user per year).
- Improved reliability reduces user productivity costs due to time without a PC by 40% ($52 per user per year).
- The extended battery life of SSDs (not included in Figure 2) means that users will add 11 hours of work time per year when traveling.

FIGURE 2

Annual Productivity Costs per User



Source: IDC, 2011

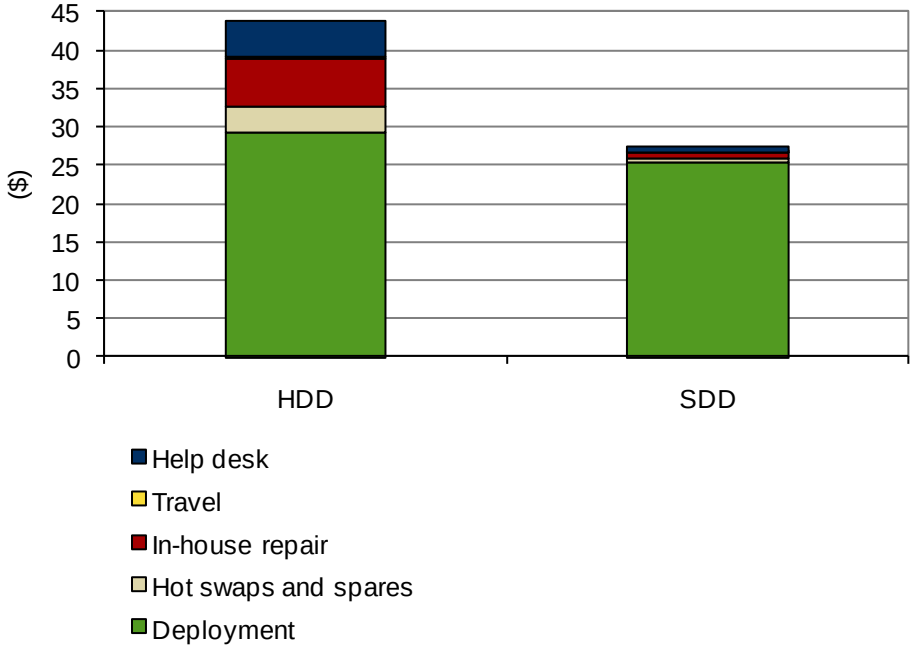
Maintenance/Refresh Cycles

The cost to maintain, repair, and replace is a large percentage of the costs associated with corporate laptop PCs (see Figure 3). With published MTBF for SSD in excess of 1 million hours, the benefits were bound to favor SSDs. IDC translated this 83% improvement to a 50% improvement to account for variations of best practices among IT organizations, understanding that not all laptop PC HDD-related incidents are MTBF related. This dynamic results in the following reduction in costs:

- Reduces annual IT labor costs to evaluate, fix, and repair crashed or improperly working disks and recover lost data by 86% ($13 per user per year)
- Reduces outsourced repair costs by 86% ($2.15 per user per year)
- Extends life cycle of PC by 14% ($3.96 per user per year)

FIGURE 3

Annual IT Labor Cost per PC



Source: IDC, 2011

Power Savings

Power costs continue to increase and there is no end in sight, at least for the next 10 years. Companies are looking to decrease energy costs in any way possible. Although the SSD-based PC power conservation is small, the savings do add up. IDC estimates that the total energy-related savings is almost $1.25 per user per year.

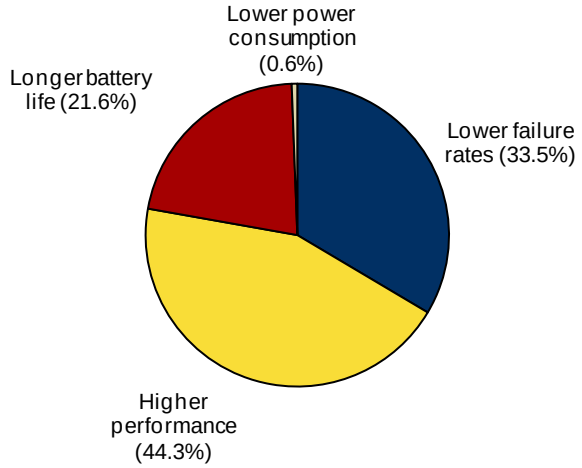
Closely related to power is the increased productivity in a mobile environment. Based on the SSD specifications, we estimate that the mobile user will gain up to 10% more hours to work. For the average mobile user, this totals about 11 hours per year. Productivity for each laptop user will average $45 annually due to increased battery life.

Total Cost Benefits and Potential ROI

The increased performance, reliability, and power savings all translate to a positive cost benefit for SSDs. Adding all of these cost benefits together results in a calculated annual cost reduction of up to $210 per user (see Figure 4).

FIGURE 4

Annual Savings per PC with an SSD



Total = $210

Source: IDC, 2011

The clear indication from this analysis is that the greatest benefit in migrating to SSD-based laptop PCs is the increased productivity related to the higher performance of the SSD. In the context of Figure 4, this benefit is revealed in the costs associated with lower productivity when using an HDD-based laptop PC versus an SSD-based PC.

The next highest cost savings with SSD-based laptop PCs comes from higher reliability, or lower failure rates. The savings comes from lower support/replacement costs, resulting in more user productivity — a dual benefit.

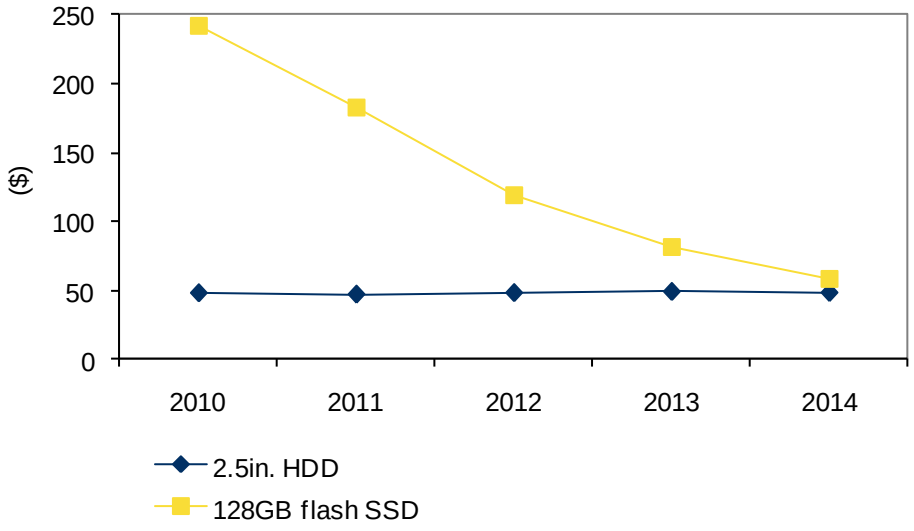
The longer battery life benefit varies with the number of travelers within any given company. However, increased productivity due to increased battery life is the essence of this metric. Again, in the context of Figure 4, the savings is related back to recouping the lower productivity of users using HDD-based laptops on battery power due to shorter battery life.

As mentioned previously, price is not the only metric companies will consider when weighing their options (granted, it is a major input) — the decision matrix can be quite complex. Yet when IDC evaluates storage requirements over time, we see them rising in general, but not as aggressively as in the past. This is notable in corporate environments where storage capacity requirements are not subject to the growing needs of consumer data, and thus lower capacity points, such as 128GB, can be quite acceptable. Corporations have motivations for limiting the amount of local storage within a laptop PC, not the least of which is limiting the amount of data that can be carried outside the security of the corporate walls. In addition, limiting local storage capacity can limit a corporate PC's usage for noncorporate data/activity.

Given minimal operating system storage requirements, 128GB likely satisfies a large majority of corporate laptop PC users' needs (see Figure 5).

FIGURE 5

Comparison of HDD and Flash-Based SSD ASPs, 2010–2014



Source: IDC, 2011

CHALLENGES/OPPORTUNITIES

Based on IDC's own internal testing, we believe there are significant performance improvements to be realized by adopting faster storage devices. However, technology transition can be obvious but not necessarily automatic. For example, the transition from VHS to DVD was an obvious one, and it happened naturally over time based on the benefits offered by DVD technology as well as the cost declines in DVD technology. That said, DVD technology has not replaced tape in datacenters because of a completely different usage model.

Flash-based storage has a number of well-entrenched market segments (e.g., digital cameras and mobile phones) and has been able to hold its own as well as increase its presence in the personal media player (or MP3 player) markets. The success factors can be complex, even if the benefits seem obvious. On paper, the benefits of SSD-based laptop PCs seem obvious; in reality, there are a number of challenges to adoption that must be addressed:

- **Capacity requirements of laptop PCs are one piece of the equation.** SSDs will always lag behind HDDs in capacity and cost per capacity, especially at higher capacity points. The key, however, is that there is an acceptable amount of capacity to ensure a positive end-user experience in an SSD-enabled PC (such as 128GB).

- **Overcoming misconceptions about the technology.** SSDs and HDDs are fundamentally different storage devices. Whether it's measuring SSD performance or reliability, the industry is coalescing around specifications, such as JEDEC, to make it easier for businesses and to help them choose the best products for their needs.

- **Cost concerns to fit within the end user's budget.** There is no question that there is a premium associated with the price of an SSD when compared with HDD for the same capacity point. Cost is a function of capacity and the budget for storage within the device's bill of materials.

CONCLUSION

The future of storage is heading away from the spinning magnetic HDD inside many of our portable computing devices and toward SSD. At first glance, it appears that SSDs are a more expensive storage solution than traditional HDDs. However, when both storage technologies are put into the context of TCO, the value proposition and true cost of an SSD-enabled PC are revealed.

IDC has created this industry cost-based analysis to aid companies in identifying the important variables impacting decisions around using SSD-based and HDD-based laptop PCs. In addition, we've modeled the interaction of these variables to give the commodity purchasing manager a tool to aid in this decision. It should be noted in this context, however, that every use case is different and users can benefit more or less than suggested by this model. Next-generation operating systems, applications, and system designs likely will be able to exploit the advantages of new storage technologies more than legacy system configurations and software.

That said, based on today's PC configurations, the increased reliability and durability alone are an excellent reason to consider an SSD-enabled PC, and there is little doubt that SSDs possess a number of benefits that justify their use in certain laptop PC scenarios, especially those that have lower storage requirements, increased performance requirements, or low power consumption needs or that seek a unique form factor to fit in today's "thin and light" mentality. IDC expects that these segments are likely to find SSD solutions increasingly attractive as prices fall over time.