

## WHITE PAPER

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### Evaluating the SSD Total Cost of Ownership

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Jeff Janukowicz

Dave Reinsel

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#### IN THIS WHITE PAPER

In this white paper, IDC explores the benefits of solid state drives (SSDs) and how they impact the total cost of ownership (TCO) within the mobile PC environment. The technology factors that make SSDs a viable and beneficial option are discussed in this context. The metrics used in this TCO analysis are associated with the storage device performance, reliability, environmental metrics, and the labor costs incurred by companies using systems that leverage these storage technologies.

#### SITUATION OVERVIEW

The personal computer industry has shipped millions of units and integrated decades of technological improvements throughout its history. Today, the PC market is becoming more specialized as the market matures, and PC OEMs are seeking new ways to satisfy end-user requirements. One such area is related to primary storage. From the very start (or very close to the start), the PC industry has successfully leveraged mechanical rotating magnetic hard disk drives (HDDs). Over the decades, incredible advances in HDD capacity and cost per gigabyte have been enjoyed. These advances have helped establish the HDD and PC as indispensable to the end user.

However, new storage solutions such as advanced HDDs with encryption, hybrid hard drives, and SSDs are offering new ways to think about storage within the PC. These new solutions provide a better way to tailor the storage solution to individual applications and provide end users with an optimal experience. SSDs, while relatively new to the PC world, have been in the market for many years, satisfying applications that were not well suited for traditional hard drives. Recently, the benefits and economics of SSDs have made them a viable alternative for the mainstream PC market. That said, SSDs are not yet economical for all mainstream applications. A cost analysis between HDD- and SSD-based laptop PCs should be performed to decide if an SSD is right for any given application.

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#### The Cost of Owning a PC

The true cost of an IT asset is a combination of direct and indirect costs over the life span of that asset. In an examination of the notebook PC, a notebook TCO analysis is vital to ingest and understand all of these costs. As such, a cost-based analysis is not simply the purchase price of the PC but instead the associated direct and indirect costs related to the deployment, support, and retirement of a PC platform.

The cost factors associated with a complete life cycle of a given device include the following:

- ☒ **Acquisition.** The cost to acquire a notebook PC
- ☒ **Deployment.** The IT labor costs to deploy a notebook PC to an end user, including staging, setup, distribution, and initial support
- ☒ **Performance.** The costs associated with using a notebook PC, including end-user productivity when users do not have full access to their PC, such as during boot/shut down, the time to launch applications, data transfers, and other related variables, as well as downtime due to PC incidents or failures (In addition, power and extended battery life should be included into total device performance.)
- ☒ **Support and maintenance.** The cost to troubleshoot, repair, and maintain a notebook PC, including both IT labor and outsourced labor costs associated with the device
- ☒ **Retirement.** The IT labor and hardware/software costs associated with replacing the PC at the end of its life cycle (This is related to the refresh cycle of the device, and the early replacement [or lengthened refresh cycle] is a key variable within this cost factor.)

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## SSDs' Impact on TCO

SSDs are built utilizing nonvolatile semiconductor components (NAND flash technology) and an advanced device controller and are designed to appear to the system as a traditional hard drive. This provides system OEMs with a drop-in replacement for their primary storage solution with the advantages of solid state memory.

To evaluate SSD TCO within the notebook PC environment, IDC developed a model to analyze the cost of owning a notebook PC — incorporating many of the variables discussed above — and compared the utilization of HDDs and SSDs within this model. The variables populated into the HDD part of the analysis are amassed from IDC's Business Value Database, which includes IT operational data from over 1,000 organizations. The comparable SSD part of the analysis is based on published OEM specifications and vendor-supplied data largely resulting from controlled laboratory tests.

The outcome is a model of how numerous specifications translate into the overall cost analysis. IDC recognizes there are a multitude of factors that influence total cost, including usage environments, workloads, and IT practices and policies. However, the results from IDC's analysis suggest that SSDs do provide numerous key benefits compared with HDDs in the notebook PC system directly impacting the TCO:

- ☒ **Improved reliability.** SSDs possess a high tolerance for harsh environments. Typically, SSDs are designed with wide temperature and humidity ranges and high shock/vibration tolerances. In addition, SSDs are completely silent. SSDs have no mechanical parts to fail and offer up to a 6x published reliability

improvement in terms of MTBF over HDDs. We believe that this increased MTBF translates into less user downtime and lower support and maintenance cost over the PC's life cycle. Moreover, this same dynamic could increase the overall life of the PC, thus extending the PC replacement cycle.

When an SSD-based notebook PC is used, the improved reliability translates into a 35%, or \$30 per user per year, reduction in lost productivity cost due to time without a PC. Additionally, IDC's model suggests that the improved reliability reduces the annual IT labor costs to evaluate, fix, and/or replace failed or improperly working disks. The cost savings over HDD-based PCs is estimated to be 80%, or \$16 per user per year.

- ☒ **Increased performance.** SSDs can provide increased performance by offering quick data accessibility and fast data reads. IDC's cost-based analysis suggests that this performance uptick increases user productivity by faster loading of applications, increased access speed to data, and better boot/shutdown time.

This performance increase translates into a 37%, or \$96 per user per year, improvement in overall user productivity while utilizing an SSD-based notebook PC compared with an HDD-based PC.

- ☒ **Lower power consumption.** There are many factors that influence overall notebook power consumption, such as the processor, liquid crystal display, storage, and fan(s). With no mass to move, SSDs use less power than an HDD. Based on the SSD specifications, IDC estimates that the total energy-related savings is approximately \$1.50 per user per year.

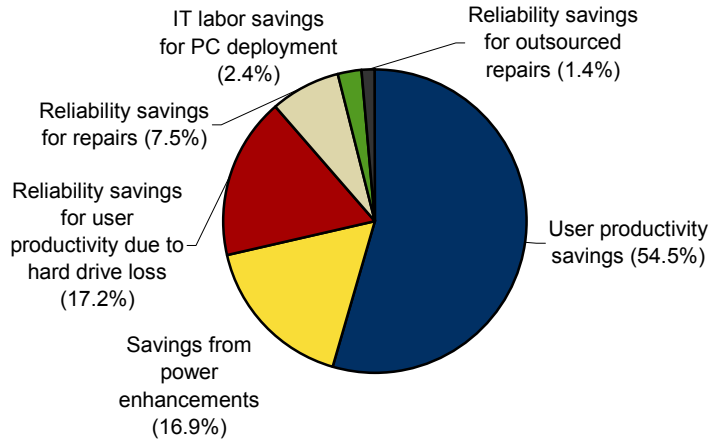
Due to the additional battery life provided by an SSD, we estimate that the typical mobile user will gain up to 6% more hours to work per year, or \$28 annually, from increased battery life.

Evaluating the ROI for migrating from an HDD to an SSD solution requires a comparison of these benefits, including the hardware/software premium of the notebook PC. The acquisition cost is not considered in this TCO analysis since it is a moving target and varies from company to company. However, companies can take this methodology and apply it to their individual usage case to determine if there is an advantage for SSD-based notebook PCs in their work environment. Companies can then use this TCO to justify the premium paid as a result of the higher acquisition cost of an SSD-equipped notebook PC.

Based on IDC's model, we estimate that adding all of these cost benefits together results in a calculated annual cost reduction of up to \$176 per user annually. Figure 1 illustrates a breakdown of the annual cost comparisons between HDD-based and SSD-based laptop PCs. This cost saving is the result of the increased user productivity, higher reliability, reduction of costs associated with support, maintenance, and retirement, and power savings benefits discussed above. It is important to note that in the context of ROI, these costs should be factored over the life span of the PC.

**FIGURE 1**

Potential Savings Using an SSD-Based Notebook



**Total = \$176**

Source: IDC, 2007

IDC's cost-based analysis model reveals how these costs can be translated into a direct savings when compared with an HDD-based notebook PC. Table 1 illustrates annual cost comparisons between HDD-based and SSD-based laptop PCs.

**TABLE 1**

Percentage Improvements Using a SSD vs. HDD Equipped Notebook PC

IT labor savings for PC deployment	14
Reliability savings for repairs	81
Reliability savings for outsourced repairs	80
Reliability savings for user productivity due to hard drive loss	35
User productivity savings	37
Savings from power enhancements	6

Note: Actual savings may vary depending on individuals' usage in their environment.

Source: IDC, October 2007

When IDC analyzed TCO, there were a number of additional factors that could not be quantified due to lack of data, wide variation in user cases, or an inability to quantify. For example, increases due to quicker application launches and file opens were not included because user cases vary.

In addition, increased satisfaction that may result from a faster running system may improve employee performance and productivity.

Finally, some companies are enamored by the prospect of not having to pay thousands of dollars to retrieve data from a failed disk drive. While this cost is high, IDC believes that the frequency of this event is few, albeit there are businesses that subsist in retrieving data from failed drives, hence there is an associated cost benefit for SSDs. Therefore, in this most recent cost-based analysis, IDC has chosen not to include the cost benefits associated with this dynamic.

## CHALLENGES

IDC recognizes the OEM benefits and challenges in changing today's primary PC storage technology. HDDs have been around for decades and are the most economical way to store digital content that requires quick and efficient access. HDDs have been and continue to be used throughout the IT infrastructure, and a long history of use highlights their integrity and expected life cycle.

While SSDs are not new, they are relatively new to digital storage in the PC environment. There is far less industry knowledge and experience on how SSDs will perform under the same PC workload environments in which HDDs have persevered successfully over the past several decades. SSDs also have a number of challenges to mass adoption that must be noted:

- ☒ **Cost.** SSDs are priced at a premium versus traditional HDDs from a price-per-gigabyte perspective. Without a positive ROI for replacing HDDs with SSDs, end users will be hard pressed to justify the cost premium for SSD-based systems.
- ☒ **Reliability.** NAND technology has a limited number of write cycles for any given cell. Today's SLC NAND is generally specified at 100,000 write/erase cycles per block. SSD OEMs do use advanced techniques to help mitigate this issue to outlast the normal PC life span. Yet, from a technology perspective, NAND still falls short when compared with magnetic HDDs, which have virtually unlimited write cycles per bit.
- ☒ **Performance.** Most industry testing would point toward SSDs having superior performance over HDDs in all areas, except for write-intense applications. Environments that have significant sequential write cycles will favor HDDs until this metric is improved or addressed satisfactorily for SSDs.
- ☒ **Capacity.** Due to memory density limitations in given form factors and the need to make them affordable, SSDs tend to have limited capacity per unit. Additionally, SSDs based on MLC technology, which increases capacity density, are not widely available in the marketplace and have a negative impact on reliability.

## CONCLUSION

The IT environment is complex. Notebook PC demand is increasing, as are performance and reliability expectations, yet IT budgets remain flat. When storage in the notebook PC environment is evaluated, many factors need to be considered. One critical dynamic is to provide an acceptable amount of capacity to ensure a positive and productive end-user environment. Advances in the underlying solid state memory technology and rapidly decreasing cost per gigabyte of flash memory have allowed the emergence of more affordable SSDs and have opened up new market opportunities. Moreover, the capacity growth in PCs has slowed down over the past several years, allowing SSD solutions to increasingly meet end-user capacity requirements.

IDC's cost-based analysis model reveals a tangible benefit to deploying SSD-based PCs over HDD-based PCs when comparing years of numerous cost metrics related to HDD-based laptop PCs with published specifications for the same SSD-related metrics. These cost benefits are derived from the following factors: increased user productivity, higher reliability of SSDs, decreased support and maintenance, and lower power consumption. In aggregate, IDC estimates that the annual cost savings of SSD-based laptop PCs over traditional HDD-based laptop PCs could be as high as \$176 per user annually. Obviously, use scenarios can push the cost benefits higher or lower, but when they are evaluated over the life cycle of the PC in a TCO analysis, it helps justify transitioning to an SSD-based PC.

Although IDC does not expect a massive displacement of HDDs by SSDs in mainstream PC applications any time soon, we do believe SSDs provide notebook PC OEMs with another capable and competitive storage solution. In some applications, more affordable SSDs will be exactly what is required and may find significant adoption. In most cases, however, we believe organizations must analyze their usage environments closely. The presented TCO analysis in this white paper helps quantify the benefits of SSD-based PCs for organizations that are looking to increase user satisfaction, increase PC robustness, and/or improve other PC metrics that ultimately may favor SSDs.

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