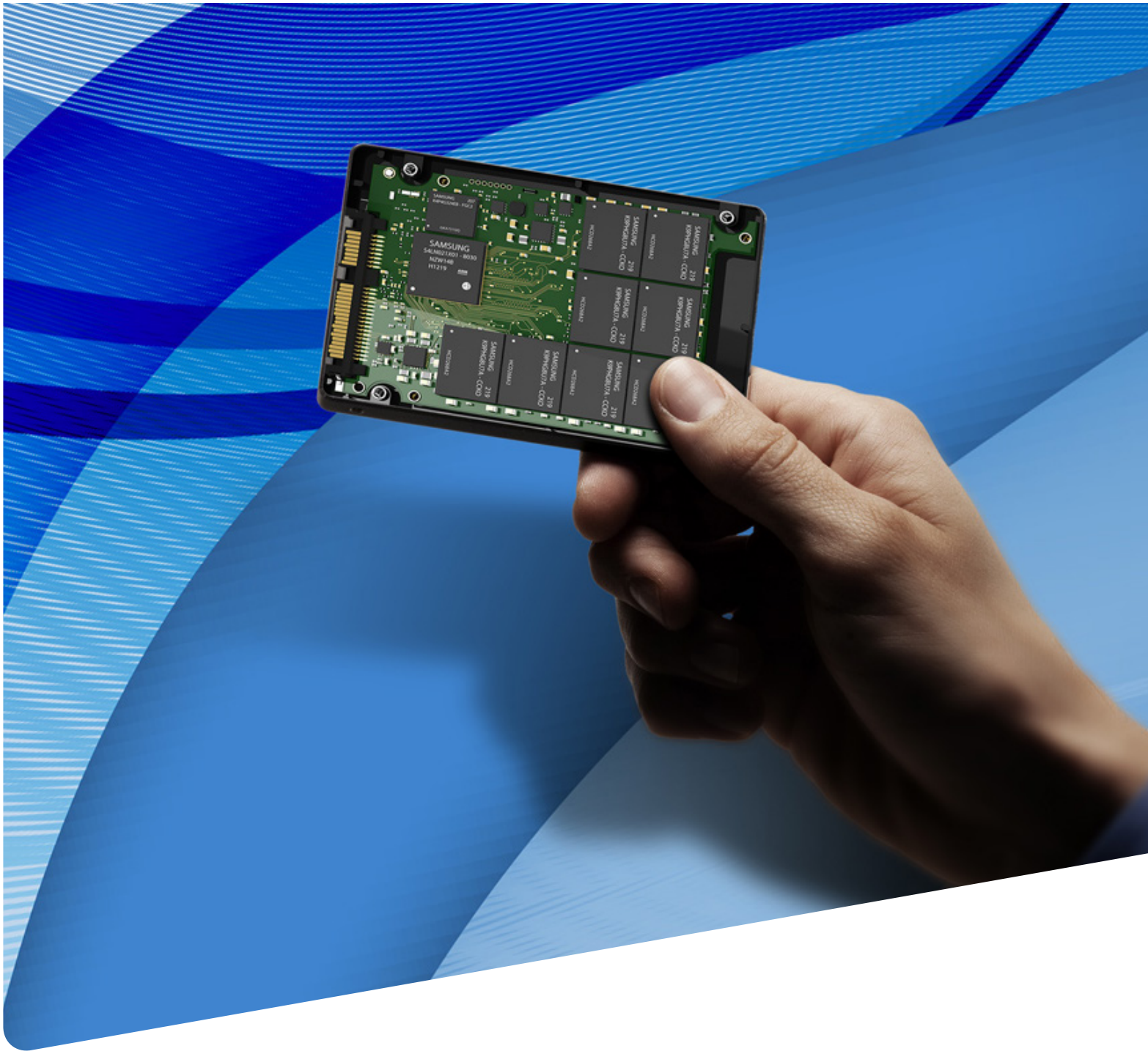
WHITE PAPER: THE SSD ADVANTAGE



The Benefits of SSDs on Computing Speed, Reliability and Performance

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INTRODUCTION: THE SSD ADVANTAGE

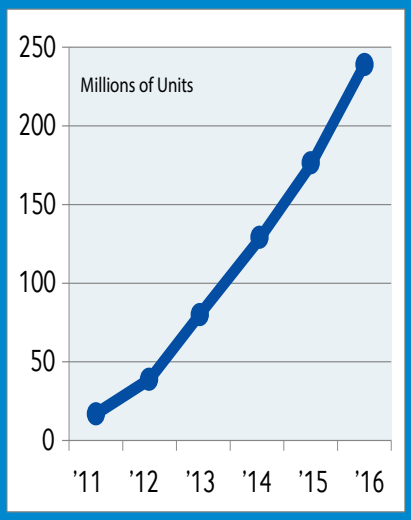
Solid state drives (SSDs) have offered significant performance advantages over conventional hard disk drives (HDDs) for some time but until recently IT managers and PC buyers had few options in what data storage devices they could use in desktops, laptops or workstations, either due to cost or to dominant system configurations that favored HDDs.

HDD's work by way of a mechanical drive head that must physically move to access locations on a rapidly-spinning magnetic disk. When the computer sends a request to retrieve data, the disk and arm must each move to the appropriate location for the data to be collected and sent to the CPU for processing. SSD's, on the other hand, have no moving parts, and is therefore capable of accessing any location on the drive with equally fast speed and precision. This means that the typical random data access time on a modern SSD is 0.1ms or less, whereas mainstream 2.5" consumer HDD's take about 10~12ms. Another way of putting this is that SSD's are 100 times faster at accessing data than an HDD.

Another advantage seen my SSD's is their consistent performance. Unlike HDD's which can suffer from data fragmentation, the use of integrated circuits instead of spinning platters allow SSD's to manage how the data is stored. This again leads to lower data access latency and need to run defragmentation programs used to manage the storage location on a HDD.

This paper explores the benefits of SDDs versus HDDs in meeting today's computing demands characterized by a burgeoning number of devices, applications, and user needs across diverse industries – which might make now the right time for businesses to embrace SDDs.

GLOBAL SSD UNIT SHIPMENT FORECAST



Source: IHS iSuppli Research, January 2013[2]

SSD ADOPTION GAINS PACE

Benefits like higher performance, better efficiency and cost effectiveness are driving SSD adoption in the current computing landscape that is seeing an explosion of devices, applications, big data analytics and cloud computing.

Many industry analysts have predicted that by 2015 the number of computing devices will triple, while data needs will increase six times over 2011 levels. Both the number of users and apps are similarly expected to double in just a few short years.[1]

All of these factors are accelerating demand for faster, more reliable storage solutions . An indication that SSDs have finally seen wider usage surpassing its early adopter niche is that units shipped have increased exponentially in the last few years. Since 2012, worldwide SSD shipments have been doubling year over year.

"SSD adoption continues to expand in both the client and the enterprise market as the industry looks to take advantage of many of the inherent benefits of the technology to provide faster, more efficient access to stored data," says Jeffrey Janukowicz, research director for Solid State Storage Technologies at IDC.[3]

Zsolt Kerekes, a veteran storage industry analyst who predicted in 2003 the exponential growth the market is seeing in SSDs now, said in November 2012 regarding the relative popularity of HDDs: "My analysis had led me to the conclusion that whatever products or technologies might come out of the hard drive market in future years - would have no significant impact on slowing down or preventing the ultimate growth of the solid state storage market."[4]

SSD DECLINING PRICES

The past two years have seen breakthroughs in how users and industry analysts are evaluating SSD market viability based on pricing. HDDs enjoy economies of scale pricing and the cost-per-gigabyte still favors HDDs, but SDDs are gaining ground.

SSD pricing seems to have hit a level where users are weighing the trade-off between higher priced SSDs for improved performance in faster boot-up and application load times, low latency, a noiseless computing experience, greater durability and other attributes that make it a competitive choice for users.

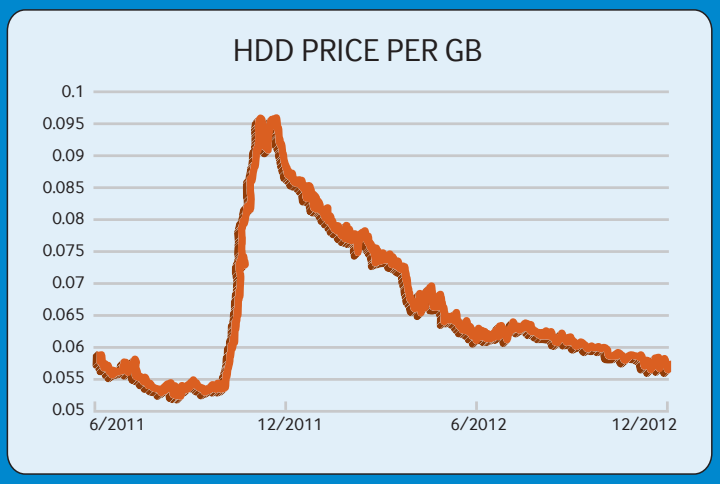
According to Janukowicz of IDC, there are a number of dynamics influencing the PC market, from the growth in media tablets and Ultrabooks to the introduction of Windows 8 and increased use of caching solutions such as dual drives (systems containing both an SSD and an HDD).

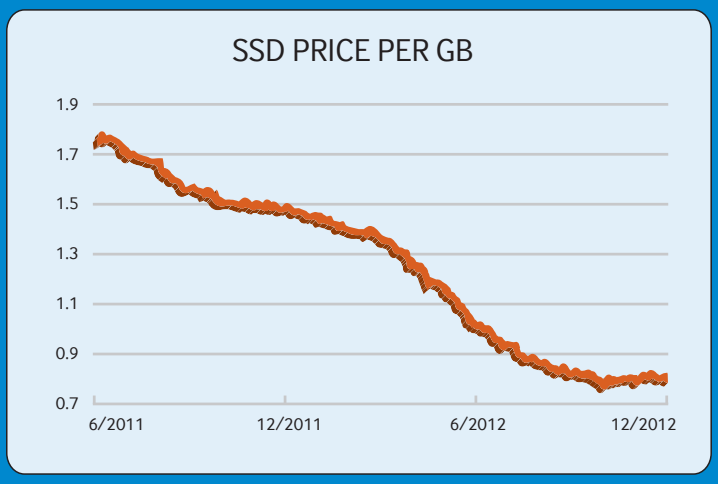
He concluded in his 2012 report on worldwide SSD shipments, that "the increasing use of flash in enterprise solutions, explosive growth of mobile client devices, and lower SSD pricing is creating a perfect storm for increased SSD shipments and revenue over our forecast. IDC believes the net effect of these dynamics supports increased SSD shipments."[6]

While sales for tablets and Ultrabooks are increasing, PC shipments are declining with the former trend favoring SDD adoption and the later impacting shipments of HDDs. Based on declining PC sales and other data, Tom Coughlin, a storage expert and contributor to Forbes magazine, believes that "a switch from client to enterprise storage capacity will fundamentally change the HDD and SSD markets."[7]

This change is being described as a complementary force in the market by other industry watchers such as Kevin Kwang of ZDNet. He cautions that, "SSDs will replace HDDs as a storage solution."[8]

NARROWING PRICE GAP





Source: Dynamite Data, April 2013[5]

The cost per GB of SSDs (right) has continued to decline while HDDs prices (left) for the same time period returned to earlier levels after a notable bump representing supply shortages caused by flooding in Thailand in late 2011. While SSDs remain more than 10 times the price of HDDs, the gap continues to narrow.

A TECHNOLOGY COMPARISON: SSDS VS HDDS

SSDs and HDDs technically do the same job – they both store data, files and applications, as well as boot computing devices. However, each has unique features, pros and cons. Here's a brief overview of the product attributes and price considerations impacting what kind of data storage works best.

HDDs

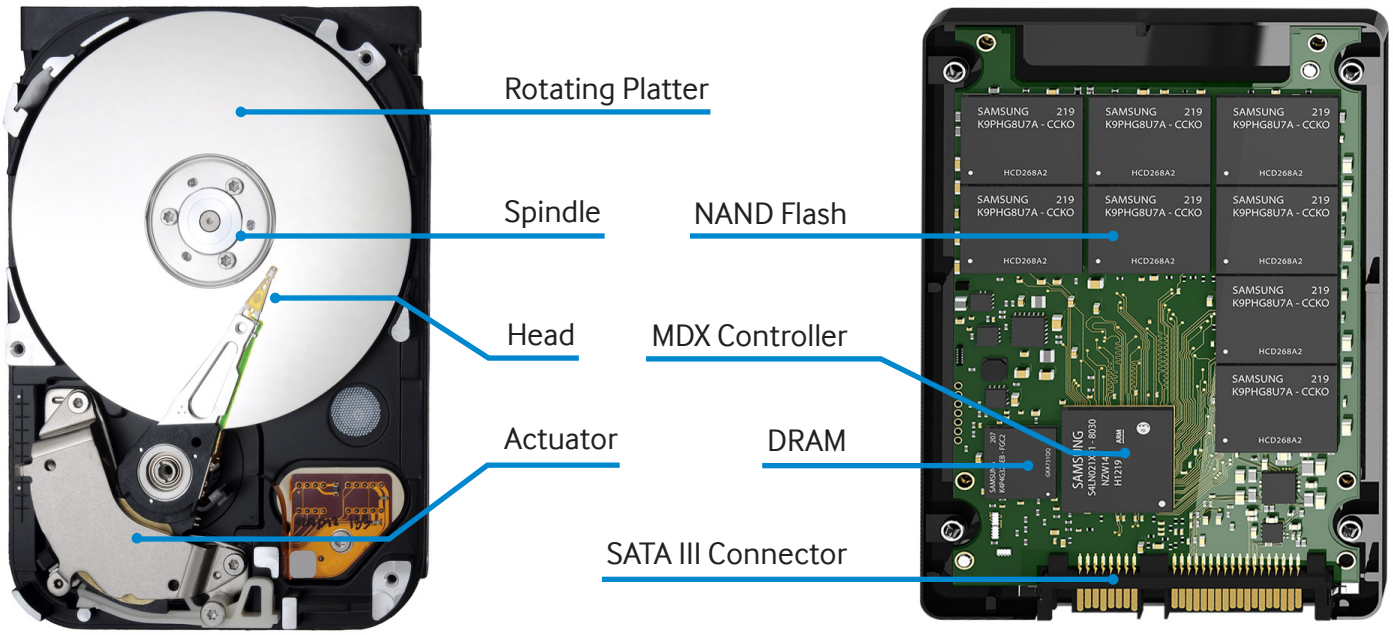
Hard disk drives were first introduced by IBM in 1956. They have improved continuously since and remain a dominant data storage technology. HDDs are read/write mechanical devices with moving parts that store data on a magnetic rotating platter. They use a complex arrangement of motor-driven spindles, actuator arms and other mechanical parts to position a recording head over the rapidly spinning magnetic-coated disks.

The major advantage of an HDD is its storage capacity. HDDs in laptops store 1 Terabyte (1,024 gigabytes) with a $/GB of around $0.075/GB compared to $1.00/GB cost for an SSD in a 240 GB model. If you want cheap storage and lots of it, using a standard hard drive is still the more appealing way to go. Some desktop hard drives store up to 4 TB of data and come in 2.5" – 3.5" disk sizes.

SSDs

Unlike HDDs that have moving parts, the internal components of SSDs (consisting primarily of the Controller and Flash Memory) are 'solid' or 'static.' Data can be stored in a permanent state when the power supply is removed. Because there are no moving parts combined with the differences in memory types (RAM is used in solid state technology while HDDs use sequential processing), SSDs support read/write data functions at much higher IOPS (Input-Output per Second) speeds than HDDs. Prior to the development and successful deployment of NAND Flash non-volatile memory, DRAM volatile memory was widely used to store data in SSDs.

Solid state drive storage has been an option from the beginning of personal computing but it didn't really take off until flash memory technology took hold in the early 2000s, with the rise of netbooks and Ultrabooks. SSD capacities have increased to a standard size of 2.5" which means they can easily replace hard drives in laptops and desktops. Other product improvements to interfaces such as SATA (the most commonly used interface standard) PCIe, SAS, USB, and others, combined with NAND flash memory process improvements, are making SDDs a more viable storage option.



UNRIVALLED SPEED & PERFORMANCE

Blazing Speeds
Speed is the clearest way that SSDs outshine HDDs. A SSD-equipped PC will boot some 22 seconds faster than the same system equipped with a hard drive. A hard drive requires time to spin up or fully load applications and programs for normal operation. A PC with an SSD boots faster, launches apps faster, and has higher overall performance.

Solid state devices are engineered for users who want instant-on capabilities for all of their devices. Current SSDs boasts random access latency times of 0.1ms or less, whereas the fastest consumer HDDs take 6.83ms or more.

Samsung's SSD 840 Pro series, for example, is capable of delivering up to 540MB/s and 450MB/s of sequential read and write speeds for ultra-fast file transfers—including random speeds of up to 100K IOPS for the fastest real-world performance (based on PC Mark 7 performance test versus leading competitors).[9]

SSDs provide workstation-class performance for seamless video editing or other data-heavy computing tasks. Zip through simple e-mail searches up to 5 times faster; and, trim file transfer time by almost a third. Programs like Photoshop and PowerPoint load twice as fast as on HDD counterparts.

Due to the fundamentally different technologies used to store and retrieve data, SSDs dramatically speed up the computing experience. SSDs access stored information in microseconds, 10 to 100 times faster than even the speediest HDD. As a result, an SSD-equipped PC can perform thousands of operations while a HDD-equipped system is still waiting for its disk to spin to the proper location and its head to be positioned over the right sector. RAM and other solid state components like NAND flash memory and the controller are all measurably better compared to HDDs based on seek times.

And, even though a speed difference between SSDs and HDDs is measured in fractions of seconds, seconds start to add up and make a difference for more and more users in workstation, enterprise and IT environments.

PERFORMANCE GAINS

Performance is the ability to access any drive location without sacrificing speed. SSD users experience dramatic improvements in boot time, application loads, and copying files. Up to 58% of storage activity is made up of 4K random writes, which measures how well a drive will perform when writing small chunks of random data (e.g. changing a small piece of a document or text file and then saving the changes). Users spend a majority of their time not copying large files or installing applications, but multitasking and working with various documents and media files – all influenced by IOPS speed.

An SSD can offer up to an 800% improvement in IOPS over a traditional HDD. Dramatic added value SSD performance benefits include:

- **Double File-Compilation Power** - An SSD boasts 2x faster file-compilation times than HDD
- **Cut Downtime by Half** - SSDs cut simple tasks such as virus scans by almost 50 percent
- **Reduce Power Consumption** - SSD requires less energy than a conventional HDD and can add |an average of 50 minutes to battery life
- **Master Multitasking** - SSD smoothly juggles interleaving programs regardless of size or complexity. Application and program load times is 3X faster than with HDD
- **Cut Video-Editing Time** – Similarly, render video file clips over 30 percent faster with SSD

Based on PC Mark 7 performance versus leading SSD maker competition, the Samsung 840 Pro 256 GB achieved random speeds up to 100K IOPS, the fastest in the field. Read and write speeds hit 540MBs and 450 MBs.

INCREASED RELIABILITY AND MORE

Key SSD Benefits

Reliability
While SSDs enjoy a Mean Time between Failures (MTBF) of up to two million hours for consumer drives, high-quality consumer HDDs offer a MTBF of only 0.5-0.6 million hours. Samsung's SSDs, in particular, enjoy one of the lowest Annual Failure Rates (AFR) in the industry of 0.05%. With trusted reliability backed with a 5-year warranty for long-term performance and advanced data security with AES 256-bit full disk encryption, the Samsung 840 Pro is quickly proving its workhorse attributes in the industry.

Durability
An SSD can withstand 10X more vibration than an HDD and up to 1500G of shock (compared to less than 70Gs for a typical HDD). SSDs exceed expectations in handling shock, vibration, and temperature extremes, an appealing benefit for PC road warriors.

Since a SSD has no moving parts, it is more likely to keep your data safe if the device is dropped or knocked around while 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. SSDs are recommended for road warriors who can be rough on equipment.

No Noise Pollution
SSDs are noiseless since they are static devices without any mechanical or moving parts. HDDs on the other hand are mechanical devices with moving parts that make noise. With a plethora of sleek new devices like smart phones, notebooks and net books, noisy PCs and laptops will become a thing of the past as users experience computing devices with a zero noise-pollution attribute.

Ultra Low Power Consumption for Longer Battery Life
Samsung has made major leaps forward in power efficiency with the 256 GB 840 Pro series. It boasts the lowest idle power consumption of any SSD, an extremely important achievement considering SSDs can sit idle most of the time (a positive side-effect of their extremely fast processing speeds). Samsung's new MDX controller consumes only 40mwatt of power during idle mode - half that of an MCX, its predecessor, and up to 97% less than other SSD controllers.

Further improvements come from the use of cache memory, which offers higher performance while consuming 30% less power when active and 93% less power when idle than regular DDR2 or DDR3 memory. Because of these improvements, batteries last up to 50 minutes longer for Samsung 840 Pro Series SSD users.

An SSD draws an average of only 2-3 watts of power, whereas an HDD requires an average of 6-7 watts. Also, because SSDs complete tasks with incredible speed, the drive saves energy by going into idle mode. These attributes translate into noticeable battery life improvement.

Encryption
Safeguard data while keeping up with demanding workloads. The Samsung-designed multi-core controller and firmware ensure long-term sustained computing with superior write performance for non-compressible data like images, music and videos. AES 256-bit full disk encryption provides advanced data security backed by a 5-year limited warranty to deliver reliable security. (Incompressible data performance based on AS-SSD Sequential Write performance versus leading competition.)[10]

THE SAMSUNG ADVANTAGE

Samsung has been manufacturing semiconductors for over 20 years, providing the technology behind many of the electronic marvels that have changed the way people live and work today. Samsung has also been the number one supplier of SSDs in the preinstalled storage business for more than six years.

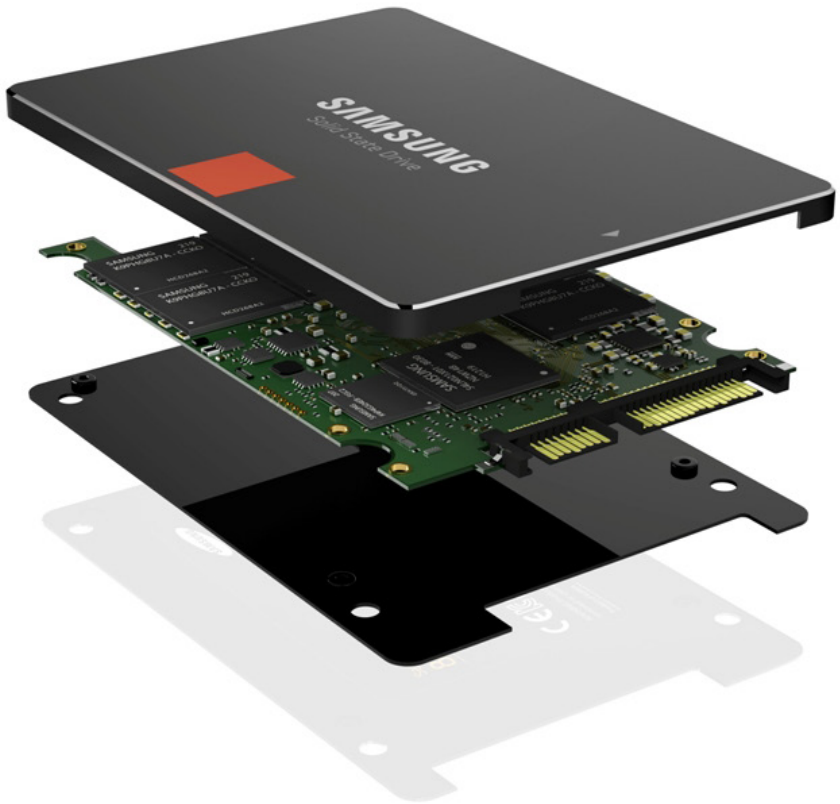
Designing an SSD is no trivial task – experience matters. Samsung SSDs have undergone rigorous testing by some of the most demanding clients, and reliably succeeded in delivering speed and performance. One of the key factors contributing to this quality and reliability is the end-to-end integration in bringing new SSDs to market. Unlike most SSD vendors, Samsung designs and manufactures every major SSD component, from NAND chips and Controllers, to DRAM and Firmware. This means each component that makes up an SSD is fully optimized to work seamlessly with its counterparts. The benefits to the end-user from this end-to-end integration include:

- One of the industry's lowest product failure rates
- Few firmware updates helping to reduce down-time and keep costs down
- Quick manufacturing improvements helping to further reduce costs
- Ability to develop next-generation technology to further improve customer adoption

A prime example of the advantages of this integration, Samsung's SSD 840 Pro Series is one of the fastest and most reliable products on the market. Capable of delivering up to 540MB/s and 450MB/s of sequential read and write speeds for fast file transfers – including random speeds of up to 100K IOPS – the SSD 840 PRO Series provides workstation-class performance for the most demanding business applications.

Samsung multi-core controller and firmware ensure sustained computing with superior write performance for non-compressible data. Weighing only 2 oz. and 100-percent Samsung designed and manufactured, the 840 PRO Series features industry-leading energy efficiency that supports increased battery life to further enhance the productivity of workers on the go.

As part of its strategy to expand into the consumer market, Samsung also introduced the Samsung SSD 840 EVO Series making use of the industry's most compact 10-nanometer class 128Gb high-performance NAND flash memory. Featuring Samsung's proprietary multi-core MEX controller, the 840 EVO achieves unrivaled value for performance with improved sequential read and write speeds and demonstrates Samsung's commitment to being the technology pioneer in SSDs.



CONCLUSION: WILL SSDs REPLACE HDDs?

"It's unclear whether SSDs will totally replace traditional spinning hard drives especially with cloud storage as a factor," noted Richard Leonarz, senior product manager for memory at Samsung Electronics America. "What is clear is that more users are aware that replacing the hard drive in their laptop or PC makes sense given increasing data needs of typical users."

With the introduction of Samsung's 256GB 2.5" 840 Pro series SSD, IT managers and professional users with high-end computing storage needs have an affordable, high performance storage device engineered for long-term use and designed to meet real-world demands for speed, reliability, durability, security and an overall enhanced performance option to standard hard disk drives.

For now, SSDs win hands down on speed, performance and reliability combined with more nuanced benefits that are becoming increasingly important to IT managers and other users such as no noise pollution, longer battery life and lower energy consumption.

NOTES

1 "Solid State Drive Market Revenue Set to More than Double this Year on Renewed Ultrabook Hopes" by IHS iSuppli Research analyst, Ryan Chien, January 23, 2013.
2 "39 Million SSDs Shipped WW in 2012, Up 129% from 2011 - IHS iSuppli," Storage Newsletter, January 24th, 2013.
3 "Worldwide Solid State Storage 2012-2016 – Forecast & Analysis" by Jeffrey Janukowicz, Research Director, Solid State Drives and Hard Drive Components, June 2012.
4 "How will the hard drive market fare in a solid state storage world?" by Zsolt Kerekes, Editor, Storage Search – November 13, 2012.
5 "Storage Pricewatch: HDDs back to pre-flood prices, SSDs grow as $/GB holds steady," by Joel Hruska, Extremetech.com April 19, 2013; charts by Dynamite Data, LLC (2013).
6 "IDC Research Expects Record Worldwide Solid State Shipments in 2012," IDC Research, January 9, 2012.
7 "The Impact of Declining PC Sales on Storage Devices," by Tom Coughlin, storage expert and Forbes contributor, Forbes, April 11, 2013.
8 "SSD Adoption to Grow, Share Space with HDDs" by Kevin Kwang, ZDNet, February 26, 2010.
9 "Samsung SSD 840 Pro (256GB) Review," by Anand Lal Shimpi, Anantech.com, September 24, 2012.
10 IBID
11 "Samsung 840 Pro 256GB SSD specs," PCWorld, 2013.

QUICK PROFILE

Samsung 840 Pro Series Solid State Drives

Form Factor: 2.5-inch

Capacity: Available in 128GB, 256GB & 512GB

Host Interface: Serial ATA interface of 6.0Gbps; compliant with ATA/ATAPI-8 Standard

Sequential Read Speed: Up to 540MB/s for 256GB & 512GB models; up to 530MB/s for 128GB model

Sequential Write Speed: Up to 520MB/s for 256GB & 512GB models; up to 390MB/s for 128GB model

Random Read Speed: Up to 100K IOPS for 256GB & 512GB models; up to 97K IOPS for 128GB model

Random Write Speed: Up to 90K IOPS

Power Consumption: 0.15W

Encryption: AES 256-bit Full Disk Encryption; Class0 Self Encryption Drive; user can set HDD password in BIOS setup mode

Operating Systems: Windows Vista or Later

Environmental Specs: Operating Temperature of 32°F to 140°F

Weight: 0.15lb

Warranty: 5 years

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