

Solid State Drives (SSD) Markets and Applications Quarterly Series: 1Q 2010

2009 – 2015

Report Number

MS300SSD1-2010

Executive Summary

SSDs in client, enterprise, and commercial applications continue to mature. Significant improvements have been made by SSD suppliers boosting overall performance and reliability through improved controllers. Newer companies such as Sandforce and Virident along with existing controller companies have announced new controllers and architectures that are improving the overall performance and reliability of SSDs.

New SSD industry associations have been formed and existing ones have added to their mission to standardize SSD generic designs amongst suppliers and establish a common criteria that SSDs must conform to for testing and interoperability.

New storage and memory architectures and technologies are being developed that could eventually change the landscape of storage in ten years time. Storage Class Memories is one that promises to fulfill the storage and performance requirements of the future. This report reflects the most recent changes in the SSD industry, the issues SSD suppliers and adopters must face in moving this technology forward.

In 2008 suppliers introduced 2 bit/cell (2b/c) MLC SSDs in 2008 for PC and consumer applications. The first were Mtron, STEC, Toshiba, and Samsung. Developments in early 2009 yielded significant improvements for 2b/c MLC SSDs for read and write performance, surpassing performance of some first generation SLC SSDs. Today they are the standard design-in for client applications and are now making in-roads in the enterprise applications. This is a clear indication that advancements in controller designs have made it possible to use MLC technology in more data intensive environments and at the same time to meet endurance and reliability requirements for these applications.

MLC 3 bits /cell (3b/c) were introduced in 2009 and is now in mass production by SanDisk and Toshiba and Samsung. Hynix and Micron/Intel are sampling 3b/c. In 2011, 3b/c SSDs will begin to see uses for applications that will be confined to environments that will have limited writes and mostly reads. Endurance and performance become major issues. 3b/c will have a 15% to 20% cost advantage over 2b/c NAND. 4 bits/cell MLC has recently come to market in very limited quantities by Toshiba and Sandisk. This technology is not expected be used in SSDs anytime soon , since it has greater issues with endurance and performance.

Adoption of SSDs in client and enterprise applications was slower than expected due to NAND price increases. On the client side, consumers want more capacity than SSDs offered for a given price, despite the improved performance advantage. With this in mind SSDs are not expected to significantly impact and displace HDDs in PC applications until 2015 with over 25% penetration compared to 1.3% penetration in 2009. There is a wild card that has recently surfaced from the HDD industry. Seagate recently announced a new generation 7200 RPM, 750GB Hybrid Drive called Momentus XT. It has 4GB of NAND flash managed by their “adaptive memory” feature. The demonstrated performance results when compared to SSDs are impressive. If other HDD suppliers follow with Hybrid Drives with comparable performance results it could be a game changer for adoption rates of SSDs in the client space.

Web-Feet Research, Inc. has analyzed the SSD market from its infancy tracking this potentially the disruptive technology for the storage industry. WFR takes a comprehensive view in analyzing the SSD technology, markets and applications it will be used in.

Storage hierarchy of SSDs in enterprise, notebook and netbook applications are examined establishing the foundation of memory and storage and how it relates to magnetic and solid state

storage. Although there is plenty of coverage on SSDs in blogs and other media, WFR differentiates its study by providing a detailed analysis of the client, commercial and enterprise end use markets for SSDs and incorporates the analysis of Hard Disk Drive storage for the same competing end use markets. Detailed forecasts for both SSD and hard disk drive storage for these end use markets are provided. Also included are the technical and implementation challenges facing SSDs with respect to: capacity, reliability, density, operating temperature, and mechanical ruggedness as they relate to flash component performance, cost and integration. Flash cache for client and enterprise applications is analyzed with forecasts for client side computing. SSD supplier profiles are provided. Beyond the SSD drive subsystem, additional parameters of the storage hierarchy are also examined.

Analysis and Reporting Methodology

This report analyzes the potential of the semiconductor storage technologies, in conjunction with the magnetic storage technologies. The report also assesses future developments of the storage industry and quantifies the different aspects of market growth from 2009 through 2014. It takes into consideration the major social, political, economic, and technology changes underway; and the impact these changes will have on the economy, on the storage industry in general, and on solid state technologies in particular.

Because of the growing complexity and scope of the data storage industry and markets, there is a need to put the qualitative and quantitative aspects of the development trends into a broader perspective. Therefore, this report considers the technological, commercial, and application development aspects of the storage industry. In particular, it explores, in general terms, the evolution of storage needs and requirements in the computing, communications and consumer industries.

Relevant primary data and information were collected from discussions with industry and company representatives. Secondary data and information have been obtained from public sources, such as company documents, press releases, annual reports and industry statistics, as well as from the existing Web-Feet Research database. Historic data have been crosschecked and correlated with industry statistics. Forecast data and their interpretation are based on analyses and assessments of Web-Feet Research. 227 pages.

Table of Contents

List of Figures

List of Tables

1	Executive Summary	15	SSD Opportunities in the Client Market Segment
2	Methodology / Formula / Data Notes	15.1	SSDs in Portable Computing Applications
3	Definition of SSDs	15.2	SSDs in Desktops
3.1	Platforms with SSDs	15.3	SSD Opportunities in the Consumer Market Segment
3.2	SSDs in PC Storage Applications	16	SSD Opportunities in the Enterprise Market Segment
3.3	SSDs in Enterprise Storage Applications	16.1	Storage Hierarchy of Enterprise Platforms
3.4	SSD Classification	16.2	SSD Opportunities in the Computer/Communications Market Segment
3.5	Storage Class Memories	16.3	SSDs in DAS Configurations
4	Systems Architecture	16.4	SSDs in NAS and SAN Configurations
4.1	Solid State Storage	16.5	SSDs in HDD RAID Configurations
4.2	Storage Hierarchy by Platform	16.6	SSDs in Blade Server Configurations
4.2.1	Storage Hierarchy of Mobile Devices and Personal Computers	16.7	Enterprise SSD Interface Forecast
5	Industry Associations for SSDs	17	SSD Opportunities in the Commercial Market Segment
5.1	JEDEC - Joint Electronic Device Engineering Council's	17.1	SSDs for Industrial/Embedded Applications
5.2	SSSI - Solid State Storage Initiative	17.2	SSDs for Medical Applications
5.3	ONFI – Open NAND Flash Interface	17.3	SSDs for Aerospace/Avionics Applications
5.4	IDEMA – International Disk Drive Equipment and Materials Association	17.4	SSDs for Military Applications
5.5	SSDA – Solid State Drive Alliance	18	Total SSD Demand Application and Revenue
6	MLC vs SLC Technology	19	Quarterly SSD Shipments and Revenue
6.1	NAND Flash Block Structure	20	Hard Disk Drive Technologies
6.2	MLC and SLC Technology Differences in SSDs	20.1	HDD Segmentation
6.3	Performance	20.2	HDD Technology Development Trends
6.4	Endurance	20.2.1	HDD Form Factor
6.5	Reliability	20.2.2	Magnetic Areal Density / Storage Capacity / Number of Platters
6.6	Error Rates	20.2.3	HDD Media Transfer Rate
6.7	MLC / SLC Comparison Metrics	20.2.4	System Interface Transfer Rate
6.8	Semiconductor Memory Component Density	20.2.5	HDD Ruggedness / Shock Resistance
7	SSD Controllers	20.2.6	HDD Mean Time Before Failure (MTBF)
7.1	SSD Controllers	20.2.7	HDD Environmental Characteristics
8	SSD Metrics	20.3	HDD Technology Metrics
8.1	SSD Average Capacity	20.3.1	HDD Relative Storage Cost
8.2	Semiconductor Memory Chip Price	20.4	Hybrid Hard Disk Drives and Flash Cache
8.3	SSD Media Transfer Rate	21	Hard Disk Drive Market Opportunities
8.4	System Interface Transfer Rate	21.1	HDD Market Forces
8.5	SSD Endurance	21.2	HDD Market Developments
8.6	SSD Ruggedness / Shock Resistance	21.2.1	Market Drivers, Accelerators and Inhibitors
8.7	SSD Mean Time Before Failure (MTBF)	21.2.2	HDD Market Segmentation
8.8	SSD Environmental Characteristics	21.2.3	Computers/Communications Market Segment
9	SSD Architecture	21.2.4	Consumer Market Segment
9.1	SSD Architecture	21.2.5	Commercial Market Segment
10	SSD vs. HDD Relative Storage Cost	22	Storage System Interfaces
10.1	SSD MLC and SLC Price Projections	22.1	Universal Serial Bus (USB)
11	Total Cost of Ownership	22.2	Fire Wire (IEEE 1394)
11.1	TCO in the Enterprise	22.3	Advanced Technology Attachment (ATA) / Serial ATA (SATA)
11.2	TOC Enterprise Model	22.4	eSATA
11.3	Performance Requirements	22.5	Small Computer System Interface (SCSI); Serial Attached SCSI (SAS)
11.4	Power Consumption	22.6	iSCSI
11.5	Energy Cost	22.7	Serial Storage Architecture (SSA)
11.6	Acquisition Cost	22.8	Fibre Channel-Arbitrated Loop (FC-AL)
11.7	System Reliability	22.9	Peripheral Component Interface Express (PCIe)
12	SSD and HDD Comparisons	22.10	Enterprise Interface Transition
12.1	F-SSD vs. HDD Capacity	23	Storage Subsystems
12.2	SSD vs. HDD Performance	23.1	Redundant Array of Independent Disks (RAID)
12.2.1	F-SSD vs. HDD Media Transfer Rate	23.2	Storage System Architectures
12.2.2	SSD vs. HDD Ruggedness / Shock Resistance	23.3	Direct Attached Storage (DAS)
12.2.3	SSD vs. HDD Environmental Characteristics	23.4	Storage Area Network (SAN)
12.2.4	SSD vs. HDD Mean Time Before Failure (MTBF)	23.5	Network Attached Storage (NAS)
12.2.5	SSD vs. HDD Technical Comparison	24	SSD Supplier Company Profiles
12.3	SSD Relative Performance and Product Positioning	25	Appendix A: Biography
12.3.1	SSD Relative Performance		
13	SSD vs HDD Performance		
13.1	SSDs used for Caching		
13.2	SSD and HDD Performance Comparisons		
14	SSD Market Opportunities		

About Web-Feet Research

Web-Feet Research (WFR) offers a full complement of technology consulting services, management consulting services and market research for nonvolatile memory, solid state storage technologies and mobile hard disk drive products. Special emphasis has been focused on the development and growth of Flash memory, Flash cards and SSD markets.

The company has consistently identified the emerging trends in the electronics industry and has been the first to forecast their impact in the Flash and nonvolatile memory markets since its inception in 2000. Some of WFR's firsts are in the following areas: SSD, Flash cache/Hybrid Flash, Embedded Flash Drives, Ultra Low Cost PC, Mobile storage, MP3, NAND MCP, USB Drives, Flash SIM cards, micro Flash cards, 3-bit/4-bit per cell NAND, serial NOR Flash and Storage Class Memories.

The subscription services offered by Web-Feet Research concentrate on the Non-Volatile Memory and Storage Portfolio, which is segmented into three services: Manufacturing / Technology, Storage Systems, and Memory Components.

The company also organizes annual public and on-site presentations, the NVM conferences, which supplement the consulting and research services. These conferences focus on technology evolution, product development, storage markets and industry / economic trends.

Web-Feet Research also provides custom studies, technology evaluation and competitive analyses of mobile, portable and stationary technologies, products and industry trends. The professional services and syndicated studies give Web-Feet Research, its clients and its clients' clients a competitive edge in their respective markets.