The Future of NAND Flash – Component Manufacturers

RFG POV: In the relatively short and fast-paced history of data storage, the buzz around NAND Flash has never been louder, the product innovation from manufacturers and solution providers never more electric. Thanks to mega-computing trends, including analytics, big data, cloud and mobile computing, along with software-defined storage and the consumerization of IT, the demand for faster, cheaper, more reliable, manageable, higher capacity and more compact Flash has never been greater. This is part two of a three-part series of short profiles on 20 vendors and solution providers that are delivering innovative Flash-related solutions to the enterprise marketplace.

The short profiles of 20 vendors and solution providers that are delivering innovative Flash-related solutions is not an exhaustive list – there are more than 30 vendors delivering all-Flash storage arrays alone. However, the profiled companies represent a cross-section of Flash solution providers, from SSD drive and controller manufacturers to system integrators and software companies.

Some companies, such as **IBM** and **Intel**, defy classification as they are a manufacturer or fabricator, system integrator, storage software provider, nanotechnology developer and more. While the following categories are broad, they are indicative of the breadth and strength of the enterprise Flash solutions provider landscape as it stands today, represented by established, global technology firms as well as by startups looking to disrupt the enterprise data storage market.

Flash & HDD Component Manufacturers

Companies in this category supply manufactured and/or fabricated components from Flash on DIMM and in PCIe cards used inside servers (PCIe cards are also being modified for use in Flash appliances that sit between the server and a SAN) to multiple grades of Flash (SLC, MLC, and TLC) used for enterprise-class storage arrays. Four of the manufacturers are also major suppliers of HDDs, and two are among the leading

designers of semiconductors and software (controllers) that accelerate storage functionality in the data center.

Diablo Technologies has been supplying memory and DRAM enhancements products for more than a decade. With its recently announced Memory Channel Storage™ (MCS™), ostensibly high-performance, persistent Flash on an "ULLtraDIMM" card, Diablo "combines the speed and scalability of the memory subsystem with the unique capability of NAND Flash and future non-volatile memory technologies." This technology breakthrough will enable new levels of application performance supported by next generation enterprise server and storage system designs. Designed for ultra-low latency applications, such as high-frequency trading, Diablo claims orders-of-magnitude faster processing speeds than Flash-based PCIe cards (3 to 5 microseconds vs. 25 milliseconds). Its technology advisory board includes engineers and computer scientists from EMC, IBM, Pure Storage and Samsung.
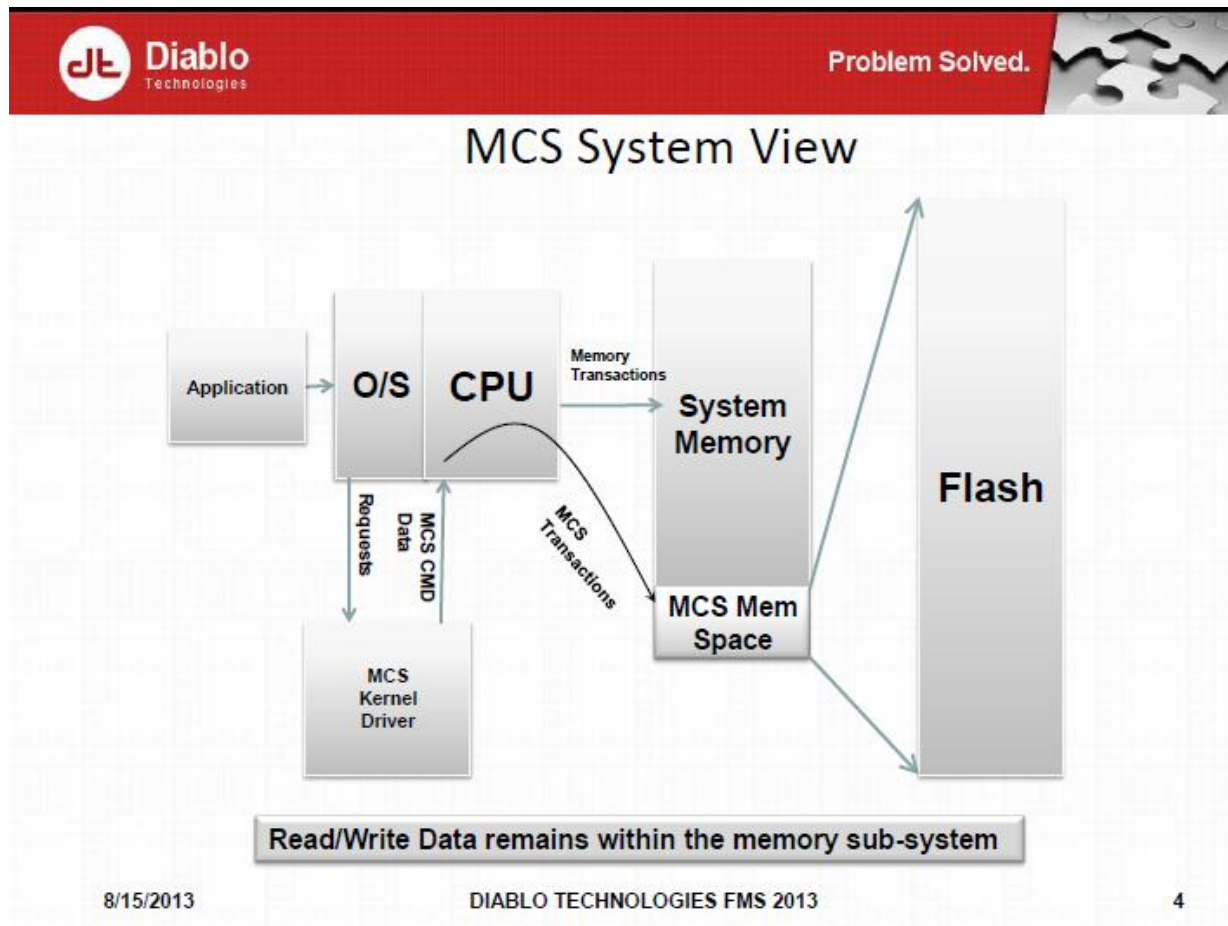
Intel dominates the server processor space and has made significant strides in developing and delivering their next generation of SSD-based storage solutions, including the recently announced DC S3500 (optimized for reads) and the DC S3700 (optimized for

writes). Via its recent acquisition of NEVEX, Intel now offers server-based Cache Acceleration Software (CAS) that employs a "most popular" cache algorithm and "heuristics on how often data is used combined with an aging curve that keeps most popular data longer." Intel states, "CAS is the only solution to target specific application workloads, including database/OLTP, virtualization, cloud and Hadoop Big Data, adding policy-based intelligence to server-side caching." Available today for Windows and Linux servers, CAS "selective optimization" boosts HDD performance to a near SSD experience level.

LSI is a leading provider of flash controllers. At FMS, LSI demonstrated new SandForce flash controller technologies critical to improving flash reliability, endurance and cost. A unique SandForce feature is its DuraWrite™ Virtual Capacity (DVC) that extends the available storage capacity beyond the physical capacity of the underlying flash memory. By increasing storage capacity for the same physical flash memory, DVC helps to reduce the cost per gigabyte of delivered capacity to the user. LSI also announced support for Toshiba's second generation advanced 19-nm NAND Flash memory (A19nm), enabling

SSD manufacturers to produce and deliver more affordable SSD products. LSI also demoed SHIELD technology, an advanced error correction method designed to deliver enterprise-class SSD endurance and data integrity even while using less expensive flash memory.

LSI DuraWrite™ Virtual Capacity (DVC)

- Increases the available storage capacity for typical data
- The lower the entropy, the higher the capacity increase
- Feature of current LSI SandForce™ Flash Controllers
- Available in select SSD manufacturer's SandForce Driven™ products
- Also upcoming releases of LSI Nytro Application Acceleration Solutions with dynamically expandable caching and increased storage capacity

DVC greatly lowers the cost per GB of available capacity to the user

Oracle® Database Application
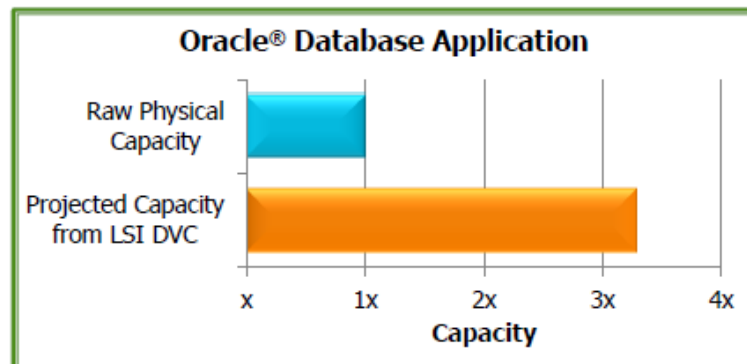
Source: Projection based on LSI internal testing of Oracle database entropy. Results published in LSI white paper, "Using DuraWrite™ Technology to Accelerates Flash Performance and Extend Write Lifetimes on the Nytro™ WarpDrive™ Application Acceleration Card", 2012

Marvell is a leader in providing storage controller technologies powering PCs, servers and enterprise-class storage systems. Marvell offers "quality, reliability, price sensitivity and relationships," even providing custom ASICs (application-specific integrated circuits) for enterprise customers, e.g., network switching solutions. Marvell's SSD controller technology, largely driven by an understanding of user demand and market dynamics, is keeping pace with rapid changes, "offering many advantages to enterprise markets, with innovative and scalable embedded processors that deliver high performance with low cost and power efficiency." Its SSD Central Processing Unit (CPU) technology is compliant with the ARM instruction set, providing improved performance and lower power consumption in a smaller footprint, anticipating a shift to converged HDD/SSD, scale-out storage servers.

CONTROLLER TECHNOLOGY
ADDRESSING THE NAND CHANGES AND EVOLVING REQUIREMENTS

- Single core to quad core
- 200 MHz to 600 MHz
- 40bit ECC to 128bit/code to LDPC
- Integrated security engines
- Power optimization
- DDRR-2 to DDRR-4 and LPDDR
- Asvnc/ONFI1- → ONFI3/Toggle 4
- Smaller package, POP, BGA, MCP
- HW automation for host commands to improve performance and reduce bottlenecks

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RISING DESIGN COSTS

90nm | 65nm | 40nm | 28nm | 16/14nm
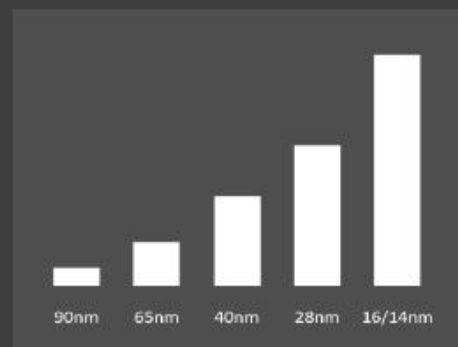
DRIVING FOR MERCHANT SILICON

MB/s

SeqR | SeqW | RndR | RndW

■ Product A   ■ Product B   ■ Product C

Samsung, the "world leader in advanced memory technology," made a splash at FMS, announcing it had begun mass production of its 3D V-NAND (vertical) Flash drive. Nearly 10 years in the making, Samsung states V-NAND "breaks through the current scaling limit for existing NAND Flash technology, achieving gains in performance and area ratio." The implications for enterprise SSD storage solutions include improved performance, higher density, fewer bit errors and lower power consumption. Samsung also anticipates the V-NAND will provide the enterprise marketplace with a more durable, longer lasting SSD, dramatically improving price performance, enabling rapid adoption as well as twice the write performance over conventional 10 nm-class floating gate NAND flash memory. To date, Samsung has more than 300 patent-pending 3D memory technologies worldwide.

Benefits of V-NAND Based SSD
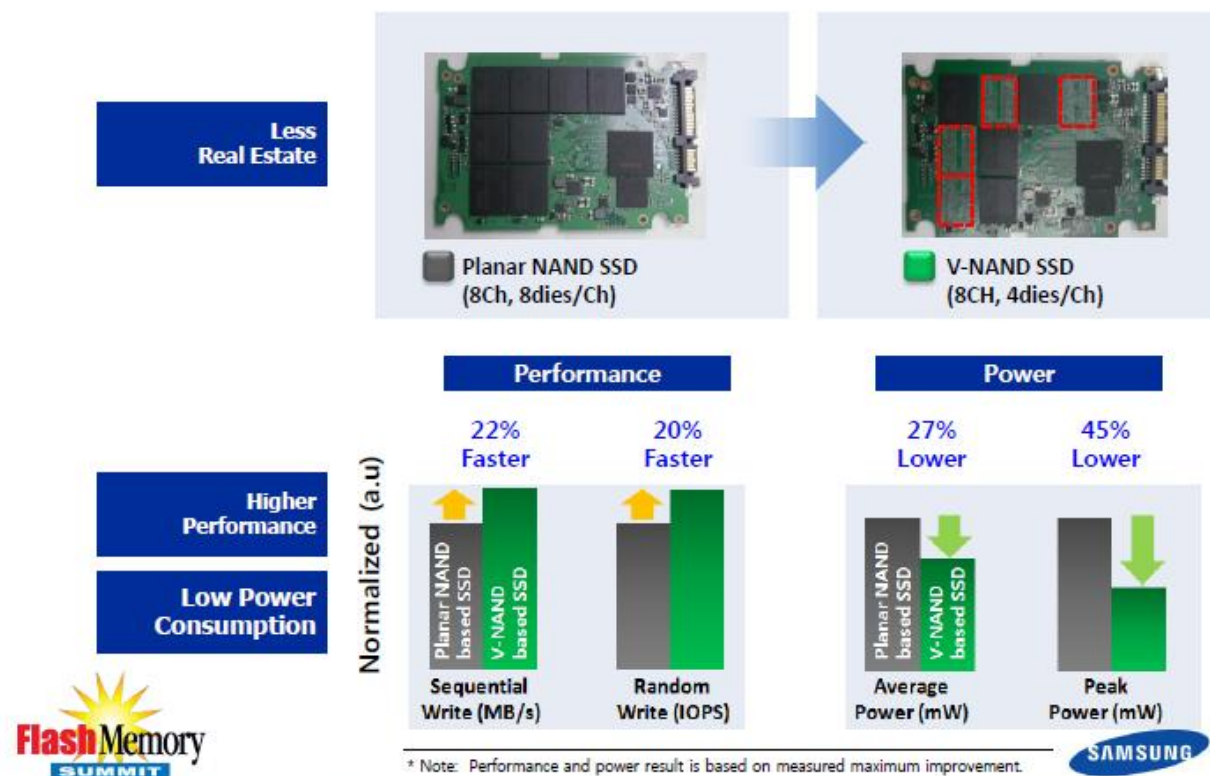
SanDisk has definitively demonstrated its desire to be a dominant player in the enterprise Flash market, making a number of strategic moves, including an investment in all-Flash array vendor WHIPTAIL and the acquisition of Smart Storage Solutions, which was finalized this month. With Smart comes a partnership with Diablo Technologies on the development of ULLtraDIMM – Flash on the DIMM – significantly reducing write latency and immediately saving data in "power safe" storage within the controller, and return of status is not gated by writing to Flash. "By drastically reducing the IO path delays, Flash DIMM can achieve write latency of less than 10 microseconds." Today, Flash capacity DIMM is 1.2 TBs but is anticipated to increase in the near future. SanDisk FlashSoft™ is caching technology that also improves SSD performance.
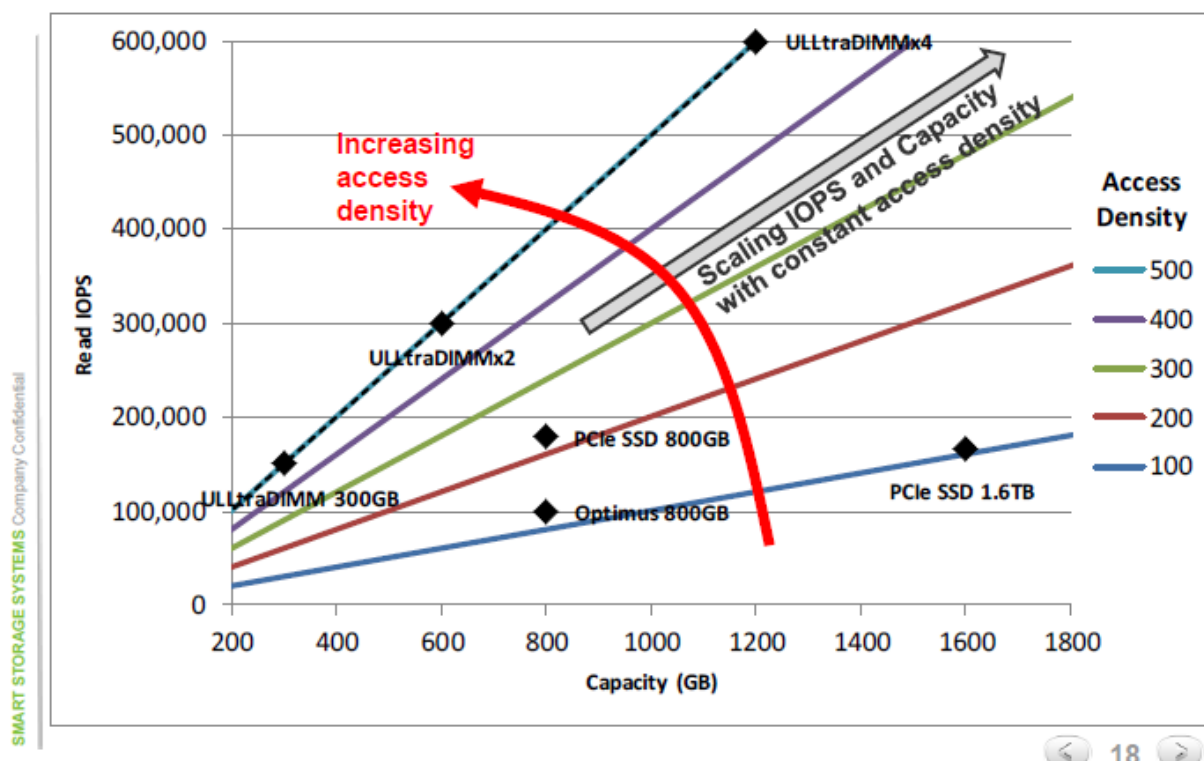
Toshiba has a horse in just about every data storage race. Flash, invented by an engineer working at Toshiba in the 1980s in Japan, is key to Toshiba's enterprise storage strategy, and so is HDD. "Enterprise computing systems – servers, workstations, SAN and NAS systems, RAID, and storage subsystems – demand a delicate balance of performance, efficiency, availability, and capacity. With these factors in mind, Toshiba delivers a full range of enterprise storage HDDs and SSDs which enable customers to architect optimized solutions across all tiers of the enterprise." Toshiba believes the cloud will increasingly do the "heavy lifting" for data storage and will continue to rely on HDDs to store the vast majority of content. Meanwhile, if Flash overtakes HDD, even for online data and content archiving applications, Toshiba is confident its SSD solutions will meet the demand when it materializes.
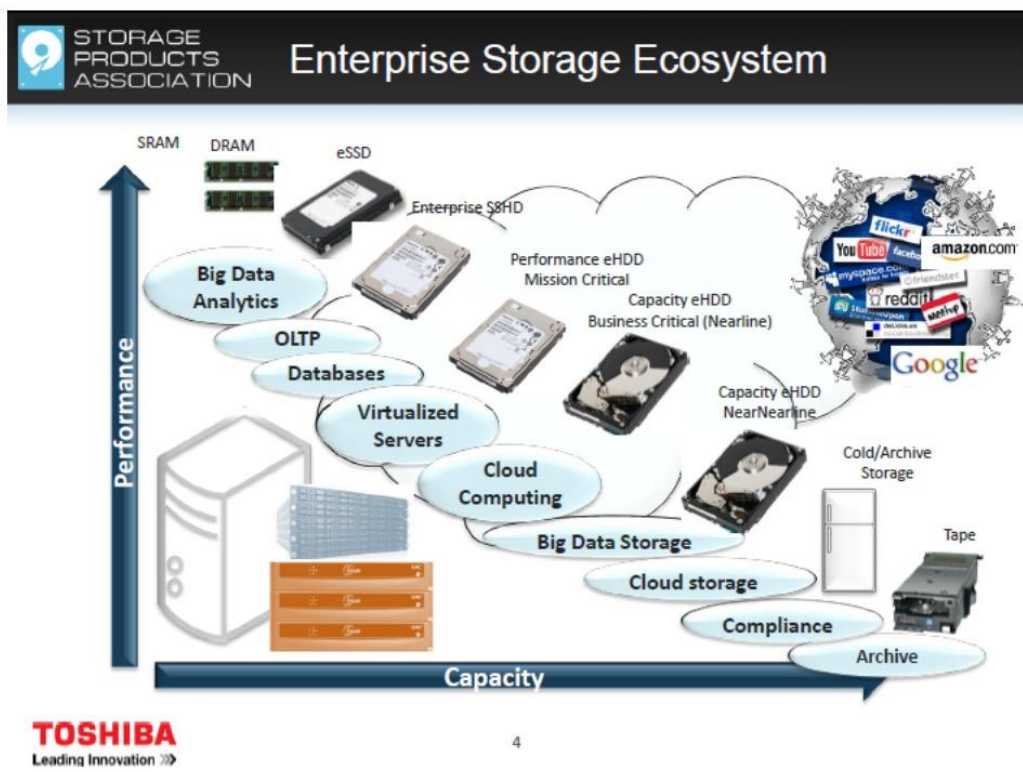
Conclusion

The Flash storage market is expected to grow exponentially over the next few years as enterprises look for faster, less expensive, more reliable, manageable, higher capacity and more compact storage solutions. The Flash component manufacturers have only just begun to deliver solutions that will greatly change the way storage solutions are architected and implemented.

RFG POV: The new offerings from the component manufacturers are still in an early stage and, as a result, the rate of change has yet to hit the knee of the curve. The storage landscape is quite fluid and newer innovative solutions can be expected to alter where data and storage is best located, cost, and performance characteristics. IT executives and staff should understand the storage trends and directions and then analyze current and future storage capacity and performance requirements for each application type before selecting a target storage architecture and near-term implementation initiatives.

Additional relevant research is available. Interested readers should contact Client Services to arrange further discussion or interview with Mr. Gary MacFadden, Principal Research Analyst.