Solid State Storage

Technology Brief

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Introduction

With low power consumption, superior read performance and increased usage in enterprise, solid state storage technology is a hot topic. Solid state storage technology can provide customer benefits in several different areas and in different architecture implementations. HP has segmented the market based on different connection methods (Memory, IO, hard disk replacement and external storage). HP is testing solid state storage technologies for servers and external storage applications and will start delivering products based on this technology by late 2008.

HP works closely with our partners to deliver storage and server solutions that allow our customers to accelerate their business growth while minimizing costs and risks.

The intent of this document is to describe solid state storage technology and its use case, as well as answer frequently asked questions.

Solid State Storage Technology Background

Solid state storage technology utilization has recently become a popular topic in the market despite the fact that it has been used in some enterprise applications for a number of years, especially where the workloads benefit significantly from very low latency access, and application benefits match the costs associated with the solution. The prevalence of USB Flash drive and mp3 players has helped drive the volume and hence a decrease in cost in the consumer space. Some hardware vendors have announced solid state storage technology based hard disk drives in laptops and servers.

Solid state storage technology offers significantly improved performance and lower energy consumption compared with hard disk drives, but also bears a cost premium. Going forward this cost premium is expected to decrease as volumes rise.

Today solid state storage technology device capacities are lower than currently available hard disk drive capacities, so solid state storage technology is attractive to applications that require extremely high performance, need relatively little capacity, and can justify a cost premium. Some of the workloads that use15k RPM hard disk drives today could take advantage of and cost-justify using this technology. We expect solid state storage technology to be used as a premium performance tier in well designed, balanced storage deployments. In this sort of comprehensive tiered device environment, solid state storage technology devices will co-exist with hard disk drive based enterprise storage systems.

There are many factors favoring solid state storage technology based devices. These include, but are not limited to:

- Lower power consumption compared to hard disk drives
- Improved performance
- Improved environmental tolerance

There are also challenges associated with the technology, compared to ubiquitous hard disk drives. These include, but are not limited to:

- Higher acquisition cost
- Lower life expectancy
- Lower capacities

When deploying any new technology, test and review must be exercised to get the underlying value out of the hype. Standards-based testing for specific environments can validate expectations of benefits from solid state storage technology usage. For example, there might be an expectation that high availability features are not required because solid state storage technology have no moving parts. Hard disk drives fail for many reasons and in practice, only a fraction of common failures can be directly attributed to the mechanical nature of disk drives. Also, RAID is used for more than simply protection against drive failures. In many cases solid state storage technology devices have complex firmware that is designed to ensure both endurance and performance, and hence these devices must be rigorously tested over several cycles to match enterprise applications requirements.

While solid state storage technology offers improved performance, all components along the entire data path affect storage subsystem performance. Solid state storage technology eliminates mechanical latency of a disk drive but overall performance will continue to be impacted by things like internal bus speeds, read/write electronics, host port speeds and so on. Net performance improvements are likely but translating "data sheet capabilities" into real-world application requires more than just hardware.

HP Strategy

HP is investing in solid state storage technology across our storage portfolio from server-integrated storage all the way up to our largest disk arrays, and will employ solid state storage technology in areas where the technology offers maximum customer advantages for use in direct attach with servers or external storage. For example, HP recently announced solid state drives for use in it's BL495c virtualization server blade. Solid state drives can play an important role in blades where power, cooling and space are at a premium.

Solid state storage technology will be incorporated into our extensive hot-plug drive portfolio that is widely deployed in HP servers and storage systems, this will seamlessly fit into a well-defined storage ecosystem (application, operating system, drivers, interconnects, packaging, and so on) while delivering the benefits of lower power consumption and/or improved performance. HP is also actively pursuing innovative uses of solid state storage technology outside established disk drive ecosystems to offer even greater gains in performance and power savings.

HP has a rigorous qualification and test process to ensure products based on this technology meet the customer use cases. We continue our evaluation of solid state storage technology and will integrate into server and external storage solutions. HP is also working with partners to ensure optimum performance and reliability, as well as industry leading features, functions and lower total cost of ownership.

Connection Methods

Solid state storage technology can be deployed in several different ways for specific use cases. See the table below.

Memory Segment (Far Memory)
• Lowest latency, very high IOPS, cache line model • Limited capacity scale-up • Proprietary, customized to processor/memory technology • Connected through processor or memory bus (HTX, FSB, DDRx)
IO Segment (IO Card)
• Low latency, high IOPs, block based model • Limited capacity scale-up • Standard hardware, customized driver • Connected through IO Bus (PCIe)
Drive Segment (SSD)
• Categories: entry, midline, enterprise • Latency and IOPs dependent on category, block based model • Standard capacity scale-up • Connected through storage bus (USB, SATA, SAS)
External Attached Segment
• Fabric latency, high IOPs, block/file based model • WAN capacity scale-up/out • Connected through fabric (iSCSI, FC, SAS)

Use Cases

One of the key benefits of solid state storage technology in external storage applications is that it provides very low latency access to data. A possible deployment scenario would be in a tiered storage environment where solid state storage technology storage makes up less than 10 percent of an applications capacity. This differs from conventional hard disk drive technology in that it would require hundreds of spindles to provide sufficient IOPS performance.

Solid state storage technology benefits are best realized with less write-intensive operations than HDDs, as well as latency sensitive environments for both read and write intensive workloads.

Some use cases are:

- Hypervisor running a large number of virtual machines
- Virtual desktop infrastructure solution
- Content caching for near static data file/web servers
- Real time financial data processing and verification
- CAD/CAM
- 3D animation/rendering
- Seismic data processing
- Databases than need to run in memory for performance reasons
- Business intelligence and data mining

FAQs

Q1: How reliable is solid state storage technology?

A1: Initial testing indicates that solid state storage devices have a similar MTBF compared to conventional enterprise Fibre Channel or SAS hard disk drives. Unlike hard drives, solid state devices in the enterprise sector have very limited field reliability data to substantiate supplier claims. HP is doing the homework to ensure solid state storage products meet the expectations of enterprise server and storage environments.

Q2: What are the power requirements for Solid Sate Disks (SSD)?

A2: SSD's require less than half the power of a conventional enterprise hard disk drive. The more important metric is the power consumption per I/O operation. This is one-tenth to one-one hundredth of an enterprise hard disk drive, depending on the type of solid state storage technology in use.

Q3: How would Solid State Disks (SSD) used in external storage be different from solid state storage technology considered for deployment in servers?

A3: The SSD being considered for use in external storage systems are designed for high capacity, very low latency and high-IO rates for both read and write transactions. This approach results in an external storage that is quite different than SST used for within a server for applications with lower transaction rates and infrequent writes. The net result is a higher cost per external storage SSD but with a commensurate increase in transactional performance and durability on writes.

Q4: What are the primary applications for SSD?

A4: SSD's would likely be utilized as a tier of storage in storage environments where a portion of the data used in the application would benefit from very low latency access while the bulk of the data gets stored on more cost-effective midline and/or nearline hard disk drives. Database and file system metadata (journals, indexes, directories, and so forth) as well as cluster metadata (locks, logs, and so forth) are appropriate application areas.

Q5: How susceptible is solid state storage technology to environmental issues?

A5: Solid state storage technology is designed to operate in more extreme environments of up to 70 degree Celsius. SSD's have no moving parts; therefore, these components are less susceptible to operational and non-operational shock and to the affects of vibration.

Q6: What is the life expectancy of solid state storage technology?

A6: The underlying technology used is solid state storage technology, that is NAND Flash, has a limited number of write operations that can be performed before the heavily written segment of flash memory "wears out" and can no longer hold data reliably. Good wear-leveling" algorithms will ensure that there are no heavily written segments, thus improving life expectancy. Over provisioning memory (spare pools of memory) is also used to extend product life. Actual life expectancy depends on the specific use of the device.

Q7: How well does solid state storage technology perform read and write operations?

A7: It depends on the solution and how the supplier manages the flash technology. As the technology continues to mature, read and write performance levels exceed those of hard drive products.

Q8: How do solid state storage technology capacities compare to enterprise hard drives?

A8: Solid state storage based hard drives using SLC NAND flash are offered at capacities between 20–50 % that of enterprise hard drives. The gap is expected to narrow as the technology matures.

Q9: How does the cost of Solid state storage technology compare to enterprise hard drives?

A9: Solid state storage technology based hard drives are offered at $/GB price points 5–20X times that equivalent hard disk drives.

Q10: How much of a performance increase will be seen at application level when using solid state storage technology?

A10: Mileage will vary greatly! While many applications may appear limited by bandwidth and IO performance of disk drives in the storage system, other bottlenecks often exist in the application stack. In addition to a caching effect in the application, OS and storage systems may already provide some of the same performance accelerations that solid state storage technology provides. For applications that currently utilize many enterprise hard disk drives to deliver sufficient I/O rates, but only utilize a small portion of the capacity of these drives, external storage solutions utilizing this technology may improve power consumption and application performance significantly. Review will be needed to determine how to accelerate application performance best, and where solid state storage technology may provide the greatest benefit and ROI.

Q11: Does solid state storage technology require fault tolerance solutions?

A11: Solid state storage products have a failure rate. If your application cannot tolerate a failure than fault tolerance is recommended

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