BOOSTING SAN PERFORMANCE WITH DELL EQUALLOGIC PS6000S SOLID-STATE DRIVE ARRAYS

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Solid-state drives (SSDs) now offer a new tier of high-performance, highly reliable Dell™ EqualLogic™ PS Series storage for performance-hungry enterprise applications. The Dell EqualLogic PS6000S array provides cost-effective SSD-based storage that can easily integrate into multi-tiered storage area network (SAN) environments—providing a simplified, scalable way to help meet the performance demands of targeted applications.

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As online transaction processing (OLTP) and other key enterprise applications take on increasing workloads, administrators are pressed to find ways of handling the performance demands on their storage systems. Traditional mechanical hard disk drives (HDDs) have built-in performance characteristics such as seek time and rotational latency that can make it difficult to keep up with escalating needs from transaction-intensive applications.

To deliver adequate performance, many IT administrators rely on work-arounds such as wide striping data on a large number of high-speed disks or short stroking data only on the outer portion of a spinning disk platter. Although these tactics may get the job done, they often leave large amounts of storage underutilized, which can lead to increased complexity and costs from over-purchasing capacity and extra power and cooling for the additional disks.

A new option now available for Dell EqualLogic PS Series storage is solid-state drive (SSD) technology. SSDs offer exceptional performance—enabling significantly faster random read/write response time compared with traditional mechanical HDDs—along with enhanced reliability, energy efficiency, and space efficiency. Historically, SSD technology has often been cost prohibitive, but it can now offer an effective option for targeted application workloads that require top-flight storage performance.

To help organizations take advantage of SSD technology, the Dell EqualLogic PS6000S storage array provides outstanding performance in a cost-effective SSD-based array that can easily integrate into multitiered EqualLogic Internet SCSI (iSCSI) storage area networks (SANs). The EqualLogic PS6000S array is part of the EqualLogic PS6000 series of arrays, which support a range of Serial ATA (SATA), Serial Attached SCSI (SAS), and SSD options that administrators can combine into a high-performance, cost-effective storage platform that is scalable, reliable, and easy to manage.

UNDERSTANDING THE BENEFITS AND CHALLENGES OF SSD TECHNOLOGY

SSD technology can be an optimal solution for administrators who need to provide high-performance storage for specific application workloads such as OLTP database applications. SSDs offer several key advantages over traditional mechanical storage devices, including the following:

- **High performance:** Unlike mechanical HDDs, SSDs have no moving parts. As a result, they have no rotational latency and minimal seek time, and

can deliver significantly faster random read/write response time compared with mechanical HDDs.

- **Low power consumption:** Because SSDs have no moving parts and no motor, they characteristically consume less power and generate less heat than mechanical HDDs. SSDs also usually draw power only during actual read and write operations, consuming little or no power when idle.
- **Enhanced reliability:** Because SSDs have no moving parts, they are less prone to damage from shock or vibration than mechanical HDDs. Consequently, SSDs characteristically are designed to offer higher mean time between failure (MTBF) than mechanical HDDs, making them suitable for rugged environments such as military operation zones and industries in which field deployment can subject the hardware to dust, vibration, and other harsh conditions. The MTBF specified for the 50 GB SSD offered in the Dell EqualLogic PS6000S array, for example, is 2,000,000 hours.
- **Enhanced cost-effectiveness:** Although SSDs typically have a higher cost-per-gigabyte ratio than mechanical HDDs, when used for targeted high-performance application data hotspots—such as tempdb and index tables in Microsoft® SQL Server® or Oracle® database applications—they can turn out to be a cost-effective alternative for achieving comparable or enhanced performance levels to wide striping or short stroking mechanical HDDs. Also, because of their inherent seek and rotational delays, adding HDDs cannot reduce latency to necessary levels for certain workloads.
- **Small form factor:** SSDs also have a much smaller form factor and typically weigh less than mechanical HDDs, helping to reduce some of the physical burdens on data center rack and floor infrastructure.

Despite the many benefits of SSD technology, SSD deployments do present some challenges. For example, SSDs currently offer lower capacity than mechanical HDDs, and that capacity comes at a relatively high cost per gigabyte. Consequently, they are typically practical only in targeted circumstances. Also, it is essential that administrators follow best practices for optimal deployment when integrating SSDs into existing SANs, to help avoid the potential for diminished performance within the overall storage infrastructure.

For example, when SSDs are deployed in a traditional frame-based, dual-controller architecture, limitations in controller capacity or expandability may restrict SSD performance. Because SSDs in this type of deployment are served by the same controllers that support non-SSD devices, the increase in I/Os per second (IOPS) from the SSDs can potentially overwhelm the I/O capacity of the controllers as drives are added. The resulting bottleneck or controller resource contention can diminish the performance of non-SSD devices and contribute to a reduction in the overall performance, effectiveness, and scalability of the entire SAN.

To avoid such pitfalls, IT organizations must carefully consider how incorporating SSDs into their SAN arrays can affect their storage architecture, and take into account the needs of their other application storage. One work-around is to deploy multiple islands of arrays to accommodate SSDs and HDDs separately. However, that approach can add cost and complexity to the storage infrastructure by increasing points of management and negating some of the consolidation advantages that moving to a shared SAN provides.

Instead, SSD arrays can be particularly effective when deployed as part of a tiered environment that delivers targeted storage performance and capacity according to differing workload requirements. For example, an optimized tiered storage environment might combine SATA drive arrays for high-capacity, moderate-performance workloads (tier 2 storage); SAS drive arrays for moderate-capacity, high-performance workloads (tier 1 storage); and SSD arrays for extremely high-performance workloads with limited capacity (tier 0 storage).

FOLLOWING BEST PRACTICES FOR SSD DEPLOYMENTS

Although SSDs can offer dramatic performance advantages, their cost and capacity limitations make them most effective when deployed as a targeted solution in particular use cases. To determine whether a particular scenario is well suited for SSD deployment, administrators must consider several factors, including capacity, performance requirements, and block size. For example, SSDs can be a key solution for workloads with high performance requirements, including low latency and high IOPS, combined with limited capacity.

Compared with traditional HDDs, SSDs are also particularly well suited to situations in which the transfer block size is small, such as OLTP applications. In these cases, SSDs can greatly mitigate the seek and rotational latency delays inherent in mechanical HDDs, and can sometimes be the only viable option in situations where HDD strategies such as wide striping and short stroking cannot satisfactorily eliminate latency or increase transaction throughput. Applications with data sets that have very high read-only or high read/write ratio workloads, such as tempdb and index tables, have the potential to benefit tremendously from SSDs. In contrast, performance benefits provided by SSDs may be less compelling for online analytical processing (OLAP) or data warehousing types of applications that have large-block sequential reads and large storage requirements.

SSDs are also a good option for high-IOPS, low-latency scenarios such as virtual desktop infrastructures in which end-user desktop images are moved to a centralized server and virtualized. Because virtual desktop infrastructure deployments typically generate a high volume of server-based storage transactions, the storage I/O rate is often very high, while at the same time response time must be kept very low to facilitate end-user productivity.

Additionally, some virtual desktop scenarios, such as the VMware® View approach, utilize a linked-clone architecture in which a master desktop image is designed to be accessible by all users. The master desktop image is stored on the SAN, and user-specific data is stored separately and linked to the master copy. Because the master copy requires high IOPS and low latency, this kind of virtual desktop deployment can also be well suited for an SSD-based solution.

INTEGRATING SSD ARRAYS IN A MULTITIER STORAGE ENVIRONMENT

The Dell EqualLogic PS6000S SSD array can be combined with added or existing EqualLogic SAS and SATA arrays to form

BENCHMARKING DELL EQUALLOGIC PS6000S SSD ARRAYS

Solid-state drives (SSDs) have the potential to deliver outstanding performance relative to traditional mechanical hard disk drives (HDDs), especially for targeted high-performance workloads. The Dell EqualLogic PS6000S SSD arrays are priced similarly to midrange EqualLogic PS6000E Serial ATA (SATA) arrays, and in certain usage scenarios, the EqualLogic PS6000S SSD array can deliver higher performance at a lower cost than a traditional high-performance HDD array.

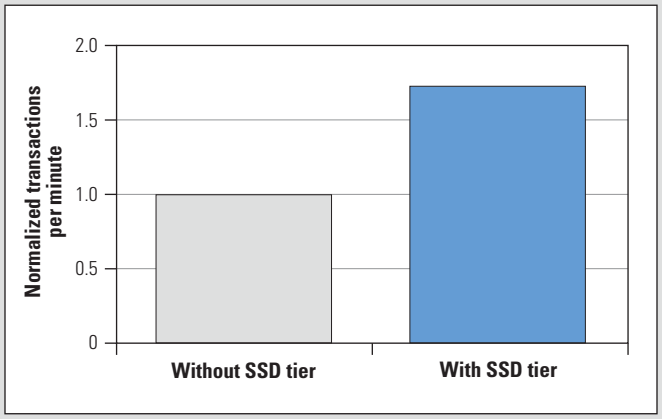

Figure A. *Comparing transactions per minute with and without an SSD tier*

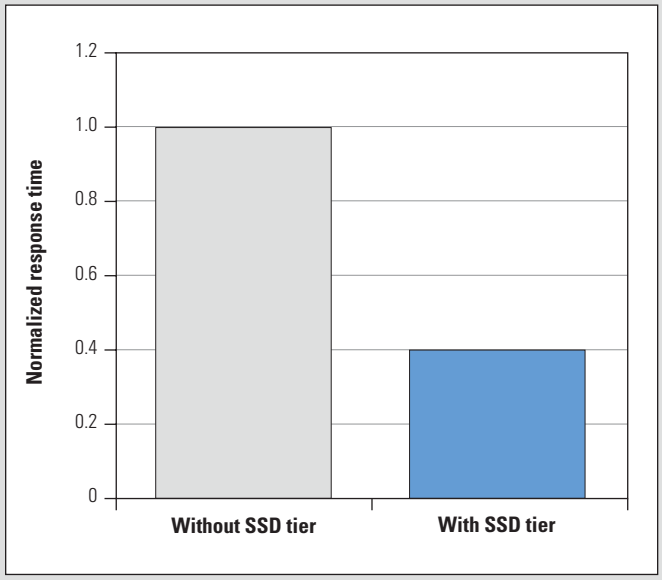

Figure B. *Comparing response times with and without an SSD tier*

To evaluate the performance of the EqualLogic PS6000S SSD array relative to traditional HDDs, in March 2009 Dell's Oracle Solutions team utilized the Benchmark Factory for Databases simulation tool from Quest Software to benchmark the performance of two EqualLogic PS Series Internet SCSI (iSCSI) storage area network (SAN) deployments, one with a tier of SSD storage and one without SSD storage. The test environment configuration included two Dell PowerEdge™ M710 blade servers, each with two quad-core Intel® Xeon® processors at 2.67 GHz, 24 GB of RAM, and four dual-port Broadcom NetXtreme II 5709 Gigabit Ethernet network interface card ports for iSCSI traffic. The external storage consisted of two EqualLogic PS6000XV arrays and one EqualLogic PS6000S array in RAID-10 configurations with two spare drives in each member, using 15,000 rpm Serial Attached SCSI (SAS) drives in the EqualLogic PS6000XV arrays and 50 GB SSDs in the EqualLogic PS6000S array. The network interconnect included two stacked 48-port Dell PowerConnect™ 6248 copper Gigabit Ethernet Layer 3 switches for the SAN. In addition to the 64-bit Oracle Real Application Clusters (RAC) 11.10.7 Enterprise Edition workload, the OS and device drivers included the Microsoft Windows Server® 2003 Release 2 (R2) Enterprise x64 Edition OS with Service Pack 2 (SP2), Microsoft iSCSI Software Initiator 2.0.8, and the EqualLogic Multipath I/O device-specific module.

One deployment used only the two EqualLogic PS6000XV arrays with SAS drives, and the other deployment used one EqualLogic PS6000XV array with SAS drives and one EqualLogic PS6000S array with SSDs, with the read-intensive data sets isolated on the SSDs. The database configuration for both deployments was a two-node Oracle RAC cluster with a database schema size of 130 GB.

The test team calculated both the transactions per minute (TPM) and average transaction response time of the two deployments, each performing the same Oracle online transaction processing (OLTP) workload. In the test configuration, the SAN that included the SSDs demonstrated superior throughput and response time compared with the SAN that did not include the SSDs. Compared with the baseline system configured entirely with mechanical SAS drives, the SAN that included the SSDs delivered up to a 75 percent increase in TPM or up to a 60 percent reduction in average transaction response time (see Figures A and B). Of course, actual performance will vary based on configuration and usage patterns.

The excellent I/O throughput and extremely fast response time demonstrated in these test results indicate that the EqualLogic PS6000S SSD array is suitable for high-performance, low-latency workloads such as OLTP database applications.

a tiered storage environment (see Figure 1). This approach enables IT organizations to provide a customized balance of cost-effective capacity and performance with exceptional throughput and response time (see the "Benchmarking Dell EqualLogic PS6000S SSD arrays" sidebar in this article). In addition, the modular Dell EqualLogic peer storage architecture is designed for seamless integration of multiple EqualLogic arrays, regardless of which hardware generation they belong to or which type of drive they contain.

The EqualLogic storage architecture can overcome the obstacle of controller resource contention from SSDs that may affect traditional storage designs. Because each EqualLogic storage array in a SAN—including the EqualLogic PS6000S array—comes with its own set of controllers with cache memory and network links to service the I/O needs of its disks, SAN performance can continue to scale even as arrays with any drive type are added. By segmenting a pool of SSD arrays, administrators can help ensure that their high-priority workloads have a dedicated set of controllers. Conversely, important but less demanding workloads from other drives also retain their own sets of controller resources. In this way, EqualLogic arrays can take advantage of the performance gains made possible by SSDs while avoiding performance degradation that may result from contention for controller or network port resources, or from the increased complexity and management overhead that may be incurred when administrators deploy separate SAN islands.

Ease of integration can be another benefit of including SSD technology in the EqualLogic storage architecture. EqualLogic PS6000S arrays, like other EqualLogic PS Series arrays, are designed to be rapidly deployed in an EqualLogic SAN without incurring downtime.

INNOVATING STORAGE INFRASTRUCTURE WITH SSD ARRAYS

SSDs have emerged as an excellent high-performance storage option for certain enterprise application workloads. As part of the Dell EqualLogic PS Series of virtualized storage arrays, the EqualLogic PS6000S SSD array can help organizations simply, scalably, and cost-effectively meet escalating application performance demands with enhanced reliability and energy efficiency.

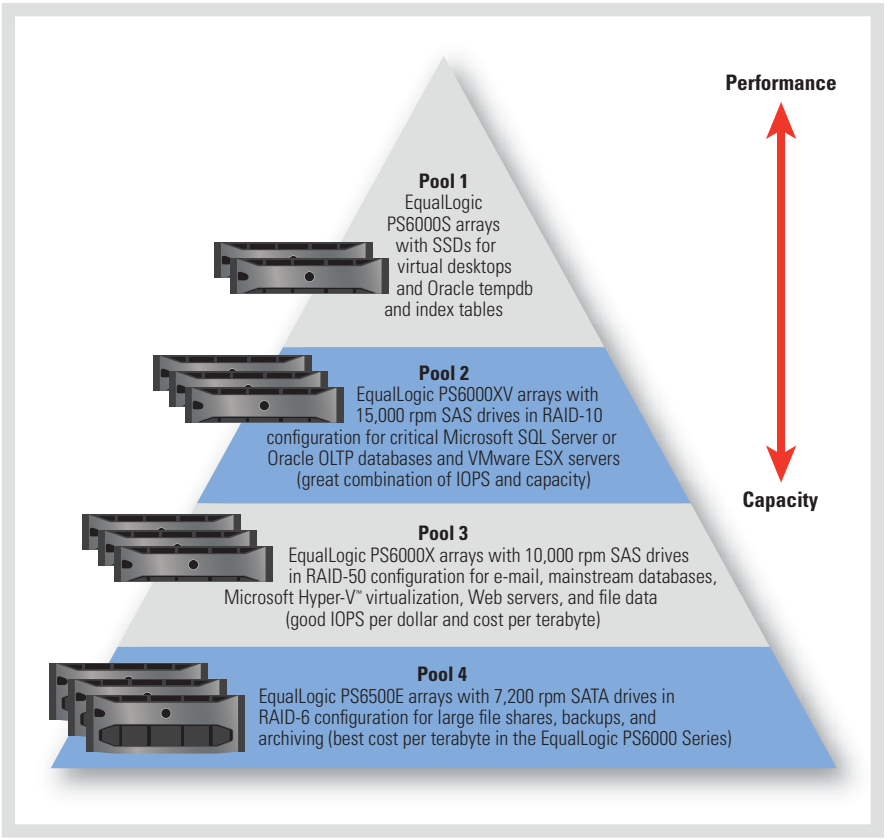

Figure 1. *Matching Dell EqualLogic PS6000 series storage options to workload performance needs*

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