Lab Validation Report

HP XP24000

Enterprise-Class Storage Virtualization for Mission-Critical IT

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ESG Lab Reports

The goal of ESG Lab reports is to educate IT professionals about emerging technologies and products in the storage, data management and information security industries. ESG Lab reports are not meant to replace the evaluation process that should be conducted before making purchasing decisions, but rather to provide insight into these emerging technologies. Our objective is to go over some of the more valuable feature/functions of products, show how they can be used to solve real customer problems and identify any areas needing improvement. ESG Lab's expert third-party perspective is based on our own hands-on testing as well as on interviews with customers who use these products in production environments. This ESG Lab report was sponsored by Hewlett Packard.

Introduction

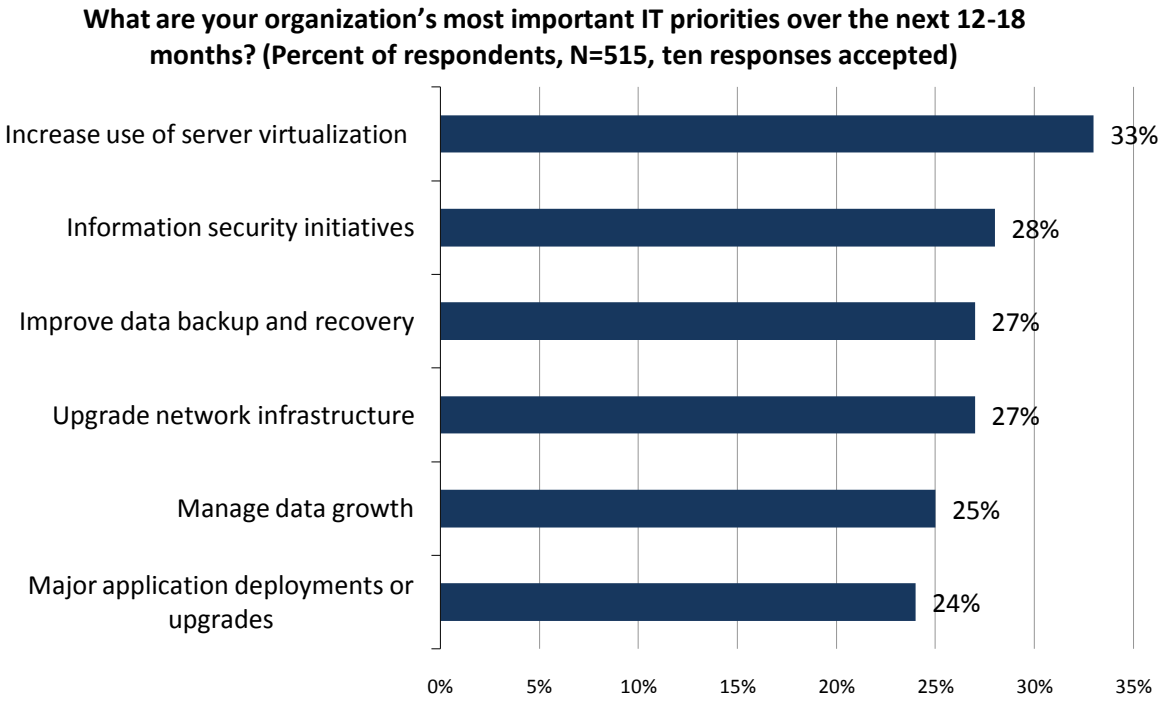
The HP StorageWorks XP24000 is HP's enterprise Tier 1 storage product. In this report, ESG Lab examines recently introduced XP24000 capabilities and features such as 1) external storage disaster recovery (ESDR), 2) solid state disk (SSD), 3) thin provisioning pool reclamation, and 4) dynamic pool rebalancing. ESG Lab has documented the results of hands-on testing of the HP StorageWorks XP24000 Disk Array in a number of other reports since its release in 2007. These earlier reports have examined a number of additional valuable capabilities, including external virtualization, thin provisioning, and bulletproof disaster recovery.

Background

Server virtualization has had a profound and positive impact on networked storage in recent years. Deploying applications on a virtual server infrastructure reduces costs as it increases efficiency—and storage virtualization further magnifies these benefits. A centrally managed pool of server and storage resources is easier to deploy and maintain, and a consolidated pool of network attached storage increases the flexibility, mobility, and resiliency of virtualized applications. As efficiency increases, IT is able to respond quicker to meet the needs of the business.

Due to the proven benefits of virtualization, it's no surprise that server virtualization is at the top of the list of priorities for IT managers in 2010. As shown in Figure 1, ESG research indicates that IT priorities in 2010 extend beyond the server domain to address age-old problems in the storage domain: managing data growth and improving recovery. Taken together, it's clear that best of breed server and storage virtualization technologies are ideally suited to help IT managers address key priorities in 2010.[1]

Figure 1. IT Priorities



Source: Enterprise Strategy Group, 2010.

[1] Source: ESG Research Report, *2010 IT Spending Intentions Survey*, January 2010.

Introducing the HP StorageWorks XP24000 Disk Array

The HP StorageWorks XP24000 is a field proven, enterprise-class disk array that can also be used for external storage virtualization.

Figure 2. The HP XP24000

The HP XP24000 provides a number of valuable capabilities that have been examined in previous ESG Lab reports:

- A massively parallel architecture with predictably scalable, fast performance
- Enterprise-class reliability and interoperability
- Full volume local and remote copies and logical snapshots
- Comprehensive disaster recovery solutions
- Virtual disk and cache partitions
- External storage virtualization
- High levels of internal and external capacity support
- Thin provisioning of internal and external storage from large logical pools of capacity

This report focuses on the relatively new capabilities of the XP24000 including:

- External Storage Disaster Recovery (ESDR)
- Thin provisioning pool reclamation
- Dynamic pool rebalancing
- Enterprise-class solid state disk

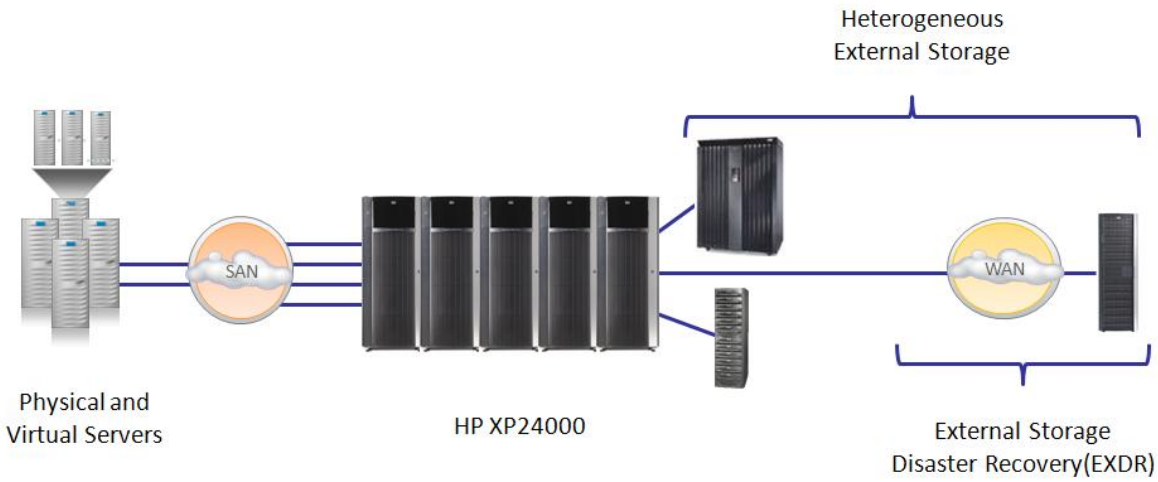
ESG Lab Validation

This report presents the results of ESG Lab testing and analysis of the HP StorageWorks XP24000 with a focus on valuable capabilities such as external storage disaster recovery (ESDR), solid state disk, thin provisioning pool reclamation, and dynamic pool rebalancing.

External Storage Virtualization

In previous reports, ESG Lab has documented how to configure and manage a heterogeneous mix of external storage systems from EMC (Symmetrix, CLARiiON), HP (EVA), and IBM (ESS) externally connected to an XP24000. Valuable XP24000 capabilities including thin provisioning, Business Copy, and Continuous Access-enabled remote replication have been tested with external storage virtualized by the XP24000. In this report, ESG Lab documents hands-on testing of a new external virtualization capability: External Storage Disaster Recovery (ESDR). Figure 3 shows how heterogeneous external storage can now be connected to an HP XP24000 for heterogeneous external storage capacity and External Storage Disaster Recovery.

Figure 3. The HP XP24000 with Heterogeneous External Storage and ESDR Support



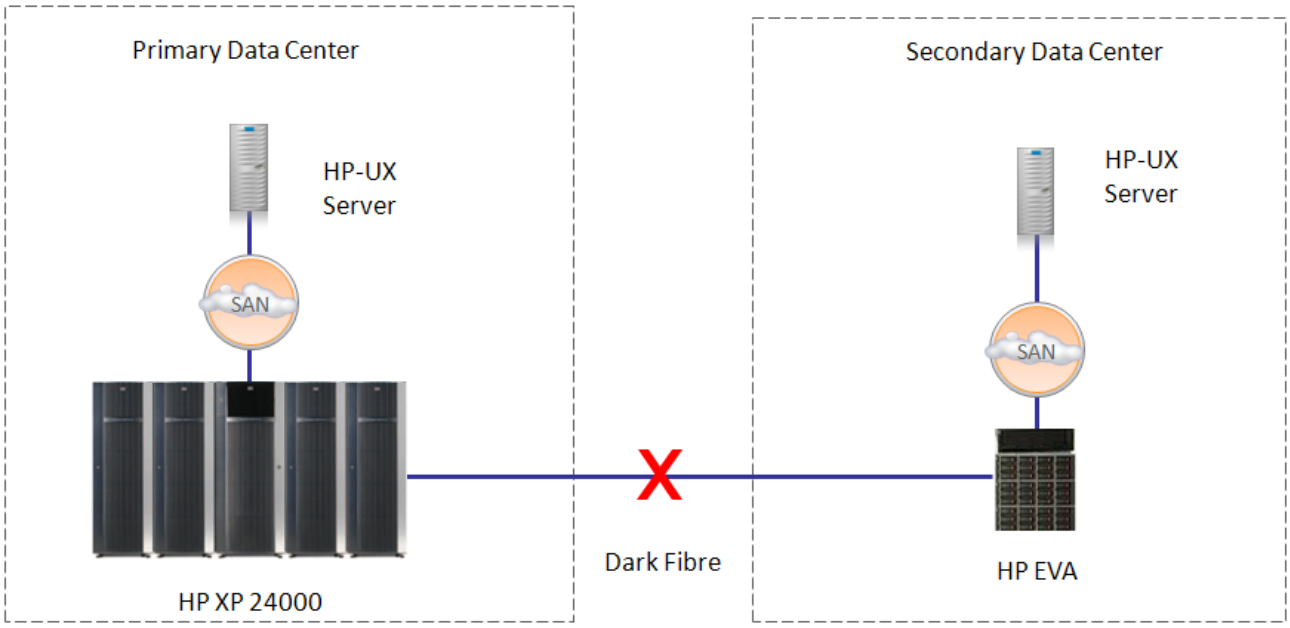
External Storage Disaster Recovery (ESDR)

External Storage Disaster Recovery (ESDR) extends the high availability capabilities of the XP24000 using an externally connected disk array located within a remote data center. ESDR mirrors to an externally connected storage array, rather than a second XP24000, at the remote site.

While ESDR can be used to dramatically reduce the cost of disaster recovery, it doesn't provide the same levels of automation and quick recoverability as replication between two XP24000 arrays. To understand the difference, let's start with a quick review of the industry standard terms, recovery point objective (RPO) and recovery time objective (RTO). RPO defines how much data you would lose in the event of a disaster. RTO defines how long it takes to recover from a disaster. With those definitions in mind, comparing ESDR to mirroring between two XP24000 arrays is easy: ESDR achieves the same RPO (zero data loss), but not the same RTO because automated recovery is not possible with ESDR.

ESG Lab tested ESDR using the configuration shown in Figure 4. An HP-UX server was attached to an XP24000 array in the primary data center using a 4-Gbps FC interface. HP StorageWorks Continuous Access software was used to synchronously replicate a volume in use by the server to an external HP EVA array in a simulated secondary data center. This test simulated a campus or metropolitan DR solution with dark fibre where the arrays are within 100km of each other to minimize latency to the application on the source side.

Figure 4. The ESDR Test Bed



The first step was the creation of the physical and logical paths between the XP24000 and the EVA for use by External Storage. A vdisk was then created on the EVA and presented to the XP24000. Next, the volume was discovered on the XP24000 via External Storage and paired via Continuous Access Synchronous with an internal XP24000 volume using the RAID manager utility.

Once the initial copy was complete, the volume was mounted as a file system on the HP-UX server. Several gigabytes of test data were copied into the volume and then the link was broken between the two sites to simulate a data center outage.

After the link failure, the volume was reconfigured so that it could no longer be accessed by the XP24000 in the primary data center. The volume, on the EVA, was presented to the server in the remote data center. The volume was discovered and mounted as a file system on the HP-UX server. Examination of files created before, during, and after the link failure were used to confirm that the disaster recovery was successful. An fsck command was run to verify that the file system data had been replicated without error.

Why This Matters

While it is easy to see the potential value of a multi-tiered storage environment, execution can be difficult. Using external storage virtualization support that has been validated by ESG Lab, the XP24000 provides a single view of the storage environment along with a powerful set of tools which can be used to automate the movement and replication of data between tiers of storage within—and between—data centers.

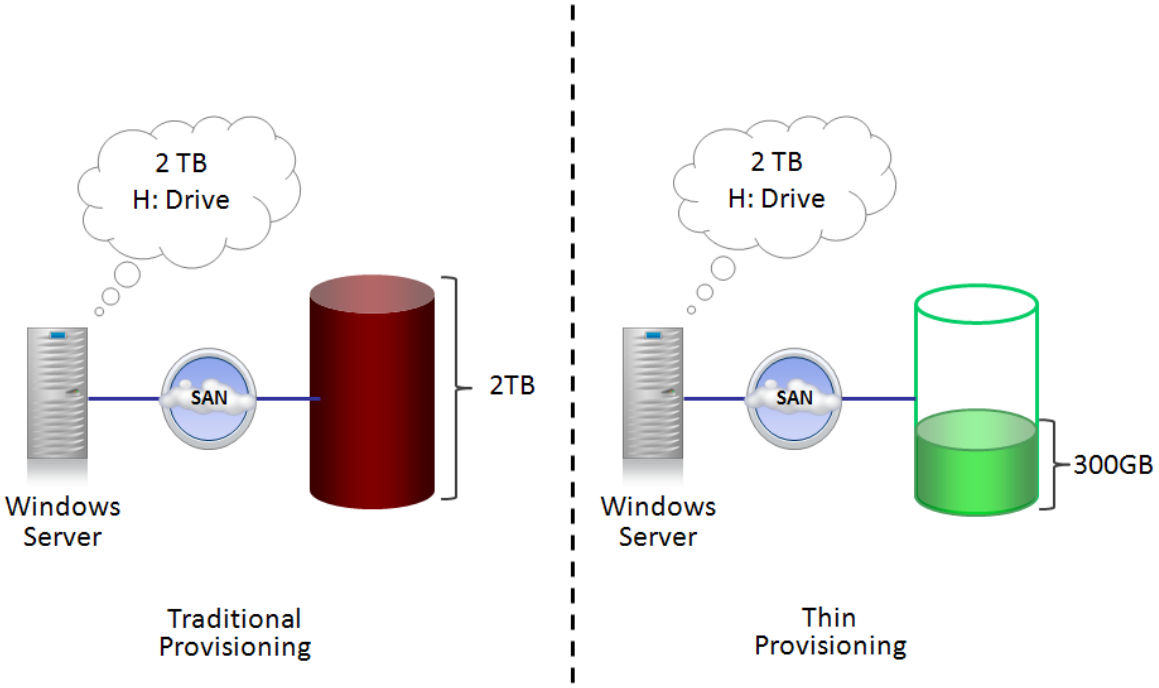
A growing number of organizations are replicating mission critical application data to a secondary site to avoid data loss after a disaster. HP StorageWorks External Storage Disaster Recovery (ESDR) leverages the external storage virtualization capabilities of the XP24000 to provide a cost effective disaster recovery alternative. While ESDR doesn't provide the same levels of automation and quick recoverability as replication between two XP24000 arrays, it does provide a cost effective alternative that precludes data loss in the unlikely event of a site level disaster.

HP StorageWorks XP Thin Provisioning

XP Thin Provisioning Software enables system administrators to deliver capacity on demand from a common pool of storage. It can be used to present a virtual pool of shared capacity that is larger than the actual amount of physical storage available, increasing storage utilization while reducing the cost of storage capacity. What differentiates XP Thin Provisioning from the rest of the offerings in industry is its ability to create thin provisioned volumes using storage located within the XP24000 (internal) or in an array that is connected to, and virtualized, by the XP24000 (external). This extends the value of thin provisioning to older or lower tier arrays that normally don't support this valuable capability.

The difference between traditional provisioning and XP Thin Provisioning is shown in Figure 5. In a previous ESG Lab report, this example was used to demonstrate how thin provisioning can be used to simplify—and optimize—storage provisioning for a an application that requires 300 GB of capacity at the time of deployment, but is projected to grow to 2 TB. Traditional methods would require the full 2 TB to be allocated from the beginning to avoid lengthy downtime for volume migration or expansion as the data set grows (shown in red). XP Thin Provisioning allows a 2 TB volume to be presented to the server with only 300 GB of physical capacity (shown in green). If and when the amount of capacity approaches 300 GB, exceeding pre-set or user-defined thresholds, additional physical capacity can be added online with no impact to users and applications.

Figure 5. Traditional vs. Thin Provisioning



HP Thin Provisioning is implemented using a powerful concept referred to as a "thin provisioning logical pool." A large number of drives can be part of a thin provisioning pool and the XP24000 automatically stripes data across all available disk drives in the pool. Implementing a pool over a large number of disk drives is generally known in the industry as "wide striping." ESG Lab testing presented in a previous lab report shows how a thin provisioned volume defined over eight array groups can handle up to 718% more random database IOs per second compared to a traditional volume defined over a single array group.[2] ESG Lab has also shown how thin provisioning works for both internal and externally virtualized volumes residing within one or more disk arrays connected to the XP24000.

[2] See: ESG Lab Validation Report, *HP XP24000: Enterprise-class Storage Virtualization for Mission Critical IT*, May 2008.

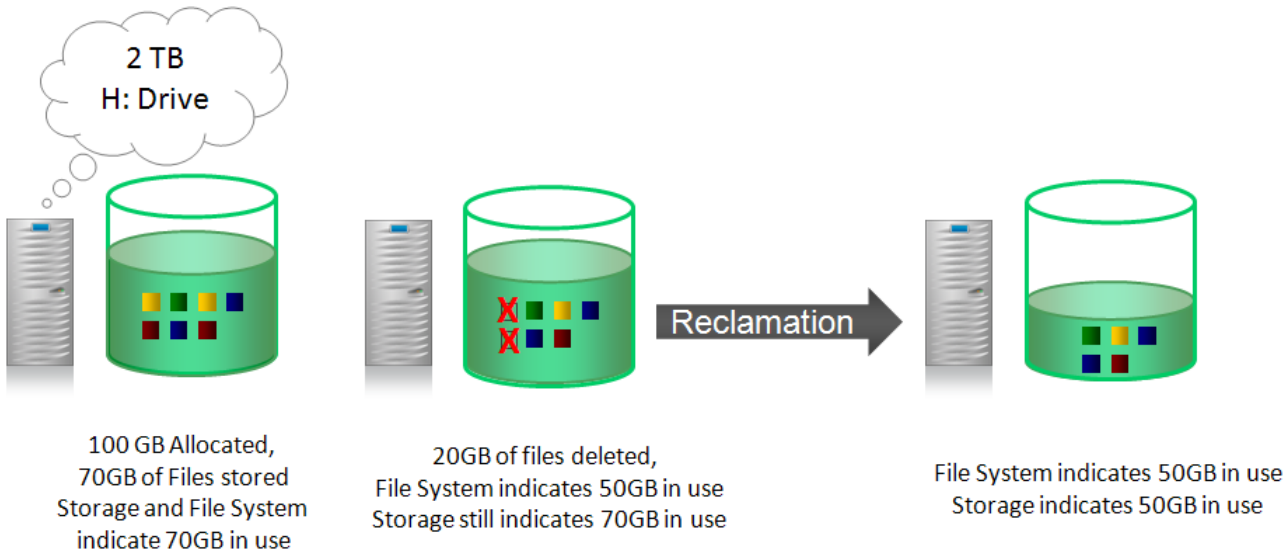
This paper will now examine two enhancements to XP24000 thin provisioning—Pool Space Reclamation and Dynamic Pool Rebalancing—in greater detail.

Pool Space Reclamation

Thin provisioning uses existing storage space more efficiently when building new volumes or storing new data, but challenges arise when converting fully provisioned volumes to thin volumes or maintaining thin volumes containing transient data which is written and deleted shortly after creation. The deleted data leaves gaps in the thin provisioned volume: the host file system has marked this data for deletion but the storage system still considers it 'in use.' The lack of communication between storage arrays and host based file systems can cause thin volumes to appear fuller than they are, triggering unnecessary volume extension and making thin volumes fat.

The XP24000 addresses the issue with both array- and host-initiated Thin Provisioning Pool Space Reclamation, a feature that allows administrators and users to safely free up Thin Provisioning Pool areas when allocated capacity within a file system is no longer needed. HP StorageWorks XP24000 Host Initiated Thin Provisioning Pool Space Reclamation works in concert with the Symantec Veritas Thin Reclamation API. As seen in Figure 6, deleted files can appear to occupy space in a thin provisioned volume until a reclamation process is run to move those blocks back to the free pool. In this example, the Symantec Thin Provisioning Reclamation API is used to pass file system level awareness of deleted file system capacity to the XP24000 so that deleted capacity can be reclaimed.

Figure 6. Thin Provisioning Pool Space Reclamation



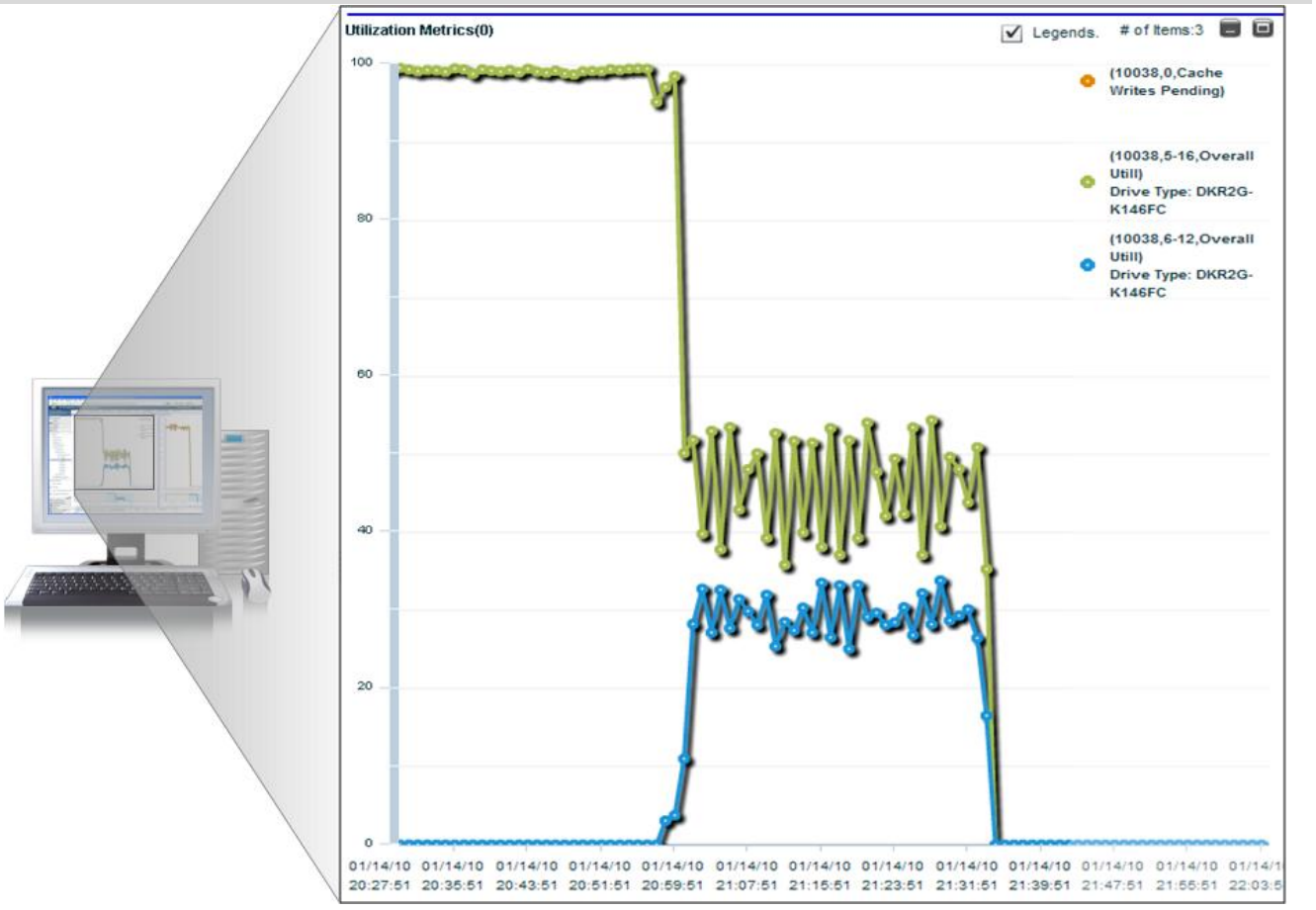
ESG Lab testing of StorageWorks XP24000 Host Initiated Thin Provisioning Pool Space Reclamation started with the creation of a 50 GB thin provisioned volume presented to a server running the HP-UX operating system. A Symantec VxFS file system was created on the volume using the mkfs command. A 48.7 GB file full of random data was created using the linux 'dd' command. The file was deleted and the reclamation process was run using the 'fsadm –R' command, which called the thin reclamation API and returned the space used by the deleted file. Reclamation was monitored using the 'vxdisk -o thin list' command. Five GB of capacity had been reclaimed approximately one minute after running the reclamation command. The balance of the capacity consumed by the deleted file (43.7 GB) was reclaimed over time as a low priority background task.

Dynamic Pool Rebalancing

When a thin provisioning pool approaches an allocation threshold, customers typically add more disks to provide capacity to grow the pool. The Dynamic Pool Rebalancing capability of the XP24000 automatically redistributes allocated pages in a thin provisioning pool when new capacity is added. It runs as a background task with a goal of restriping allocated capacity evenly across the entire pool. This improves performance for existing and future applications which rely on the shared capacity of the pool.

ESG Lab began testing Dynamic Pool Rebalancing in the XP 24000 by creating a thin provisioning pool. One RAID 1+0 RAID group was added to the pool and one 45 GB volume was created and presented to an HP-UX server. The volume was pre-populated with files and configured to run a continuous sequential workload using the "dp" tool, an HP developed I/O workload generator. IO was monitored using the HP StorageWorks XP Performance Advisor running on a Windows server. While IO was running to the volume, a second RAID group was added to the thin provisioning pool. Figure 7 shows the monitored performance of the volume before, during, and after Dynamic Pool rebalancing.

Figure 7. Thin Provisioning Pool Rebalancing



The first RAID group in the thin provisioning pool, represented in green, was pegged at 100% utilization and servicing about 180 MB/sec of sequential IO. The second RAID group, represented in blue, was sitting at 0% utilization. After the rebalance, the first RAID group's utilization dropped to between 40% and 50% and the second RAID group's utilization rose to approximately 35%. At this point, IO to the HP-UX server was stopped and restarted, using the "dp" tool. Utilization of both array groups rose to 100% and throughput was measured at 300 MB/sec on the HP-UX server.

Why This Matters

There are a number of reasons why thin provisioning matters. Less storage is required initially when purchasing a new storage system with thin provisioning. Since there is no stranded storage capacity with thin provisioning, less storage is required over the life of the storage system. Thin provisioning enables greater levels of consolidation as more applications and servers are attached to a single storage system. The time and resources required to perform storage provisioning tasks are reduced. Thin provisioning reduces power and cooling requirements as it reduces the number of hard drives that need to be deployed.

In a previous report, ESG Lab has confirmed that HP StorageWorks XP24000 Thin Provisioning of external storage extends all of these benefits to third party storage.[3] This expands upon users' investment in existing business continuity software and management tools by enhancing the value of the existing storage, software, and tools.

In this report, ESG Lab has confirmed that Thin Provisioning Pool Space Reclamation further improves storage utilization as it helps 'keep thin volumes thin.' The XP24000 integrates with the Symantec Thin Reclamation API using industry standard commands to automate the reclamation of deleted storage capacity. ESG Lab has also confirmed that Pool Rebalancing simplifies the management of a wide-striped pool of thin provisioned capacity. Automated rebalancing increases application performance, which increases service levels and reduces support costs.

[3] Ibid.

Enterprise Class Performance

The HP XP24000 enterprise-class storage system was introduced in May, 2007. It was architected to meet the high-performance requirements of midsized and large organizations. In previous reports, ESG Lab has confirmed that the massively parallel crossbar switch architecture of the XP24000 increases performance for real-world application workloads compared to the previous generation XP12000 with:

- 64% more OLTP database transactions
- 38% more Microsoft Exchange users[4]

At this stage in the report, ESG Lab examines the performance impact of solid state disk support and industry standard Storage Performance Council benchmark results.

Solid State Disk Support

XP24000 support for solid state disk (SSD) was introduced in November of 2008. SSDs store data using NAND flash memory technology. With response times that are order of magnitude faster than traditional hard drives, SSDs are designed for applications that require the ultimate in performance and speed. Because SSDs have no moving parts, they are more reliable, consume less electricity, and require less cooling than a traditional hard drive. XP24000 SSDs are packaged like HDDs and can be used with all of the advanced capabilities of the XP24000 including Business Copy, thin provisioning, tiered storage, and virtual volumes.

SSD is ideally suited for latency-sensitive, read-intensive workloads. Online Transaction Processing (OLTP) database applications supporting many users are a great example of an application that can benefit from the use of SSD. The performance of OLTP applications can be improved in a number of ways with SSD. Frequently used tables and indexes or the entire database application can be stored on SSD, enjoying all of SSD's aforementioned benefits.

While the performance advantages can be dramatic, solid state disk is more expensive than traditional hard disk drives for the same amount of capacity. Understanding of the IO characteristics of real world applications is recommended to make sure that you get the most out of this valuable resource.

SSD vs. HDD Performance Analysis

ESG Lab audited the results of HP's comparison of the performance of SSDs to traditional HDDs in an Oracle 11g, HP-UX 11i v environment. The Quest Benchmark Factory tool running on an HP DL585 server drove database workloads inspired by the industry standard Transaction Processing Council (TPC). The performance of 146 GB HDD and SDD configured in an eight drive (7D+1P) RAID group were compared.[5]

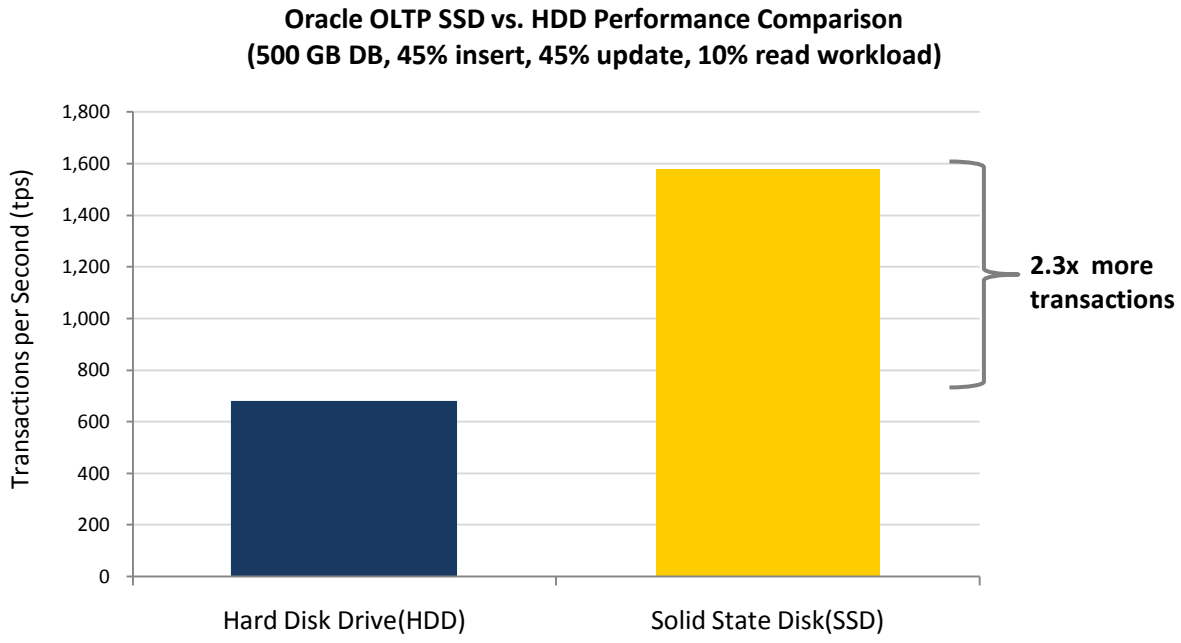
The performance analysis began with a comparison of the low level IO performance differences between SSD and HDD. As expected, SSD was dramatically faster than HDD for random read operations which make up most of the IO profile of common business workloads, including OLTP database applications. SSD drives also provided a performance boost for write operations, but not as much as reads due the latency of NAND flash update cycles, in addition to a performance improvement for the sequential workloads that are commonly used by database table scans and logs. Comparing SSDs to similarly configured 15K RPM FC drives, SSD provided:

- 16.5x more single threaded random reads (18,658 vs. 1,133 IOPS) with response times that were 16x faster (0.85 vs. 13.6 ms).
- 8.5x more single threaded random writes (4,987 vs. 582 IOPS) with response times that were 8.6x faster (1.6 vs. 13.7 ms).
- 2.12x more 64 KB sequential read throughput (712 vs. 336 MB/sec)
- 1.96x more 64 KB sequential write throughput (644 vs. 329 MB/sec)

[4] Ibid.
[5] See http://h20195.www2.hp.com/V2/GetPDF.aspx/4AA2-4723ENW.pdf for the complete configuration details.

The analysis continued as testing progressed from low level IO characterization to high level Oracle 11g database testing of a 500 GB database driven by the Quest Benchmark utility. In this example, the entire database was moved from eight HDD to eight SDD devices. The results for an OLTP workload are summarized in Figure 8.

Figure 8. The SSD OLTP Performance Advantage



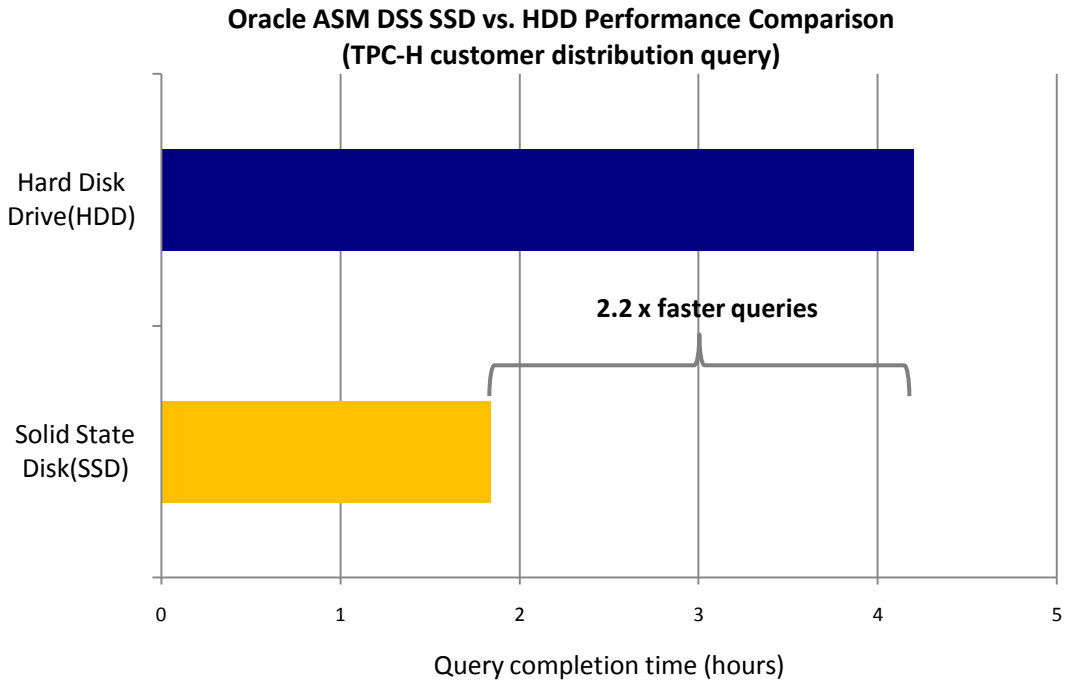
What the Numbers Mean:

- The SSD performance boost during real-world database testing is less than what was measured during low level IO performance characterization due to a number of factors, with the application overhead of the Oracle application (a.k.a., think time) playing a key role.
- Moving a database from HDD to SDD increased the number of supported Oracle database transactions from 672 to 1,578.
- The SSD solutions supported more than twice the number of transactions (2.3x) using the same number of devices.
- A 4 GB cache logical partition (CLPR) was used for the HDD and SSD tests. The caching benefit of CLPR boosted performance during both tests.
- The read-intensive OLTP results were much better than those for an update intensive OLTP application, with the logs residing on SSD which yielded a negligible performance improvement (5%).

Next, ESG Lab examined the impact that SSD can have on a long-running decision support system (DSS) query. While DSS queries are typically characterized by larger sequential block transfers, the resulting traffic pattern seen by the XP24000 tended more towards a random workload because Oracle ASM striped data across table spaces at creation time. A long running query, which determines the distribution of customers by the order they have been made, was derived from the industry standard TPC-H workload. As in the OLTP test, a 500 GB Oracle database was configured to reside entirely in SSD with a 4 GB CLPR. The elapsed time, in hours, for the query to complete is shown in Figure 9.[6]

[6] See http://h20195.www2.hp.com/V2/GetPDF.aspx/4AA2-4723ENW.pdf for the complete configuration details

Figure 9. The impact of SSD for DSS applications with Oracle ASM Striping



What the Numbers Mean:

- The HDD query took 4.2 hours to complete, compared to the SSD query which completed in 1.84 hours
- The SSD query ran 2.2 times faster and completed in less than half the time.
- With no moving parts, the SSD solution dramatically reduced power and cooling requirements.

Storage Performance Council Benchmark Results

In addition to running physical tests against the XP24000, ESG Lab audited HP's published results of the SPC application-level industry standard benchmark suites maintained by the Storage Performance Council. SPC-1 testing generates a single workload designed to emulate the typical functions of transaction-oriented, real-world database applications. Transaction-oriented applications are generally characterized by largely random IO and generate both queries (reads) and updates (writes). Examples of transactional applications include OLTP, database operations, and mail server implementations. SPC results can be roughly mapped by users into easily understood metrics. For a credit card database system, for instance, it might be the number of credit card authorizations that can be executed per second.

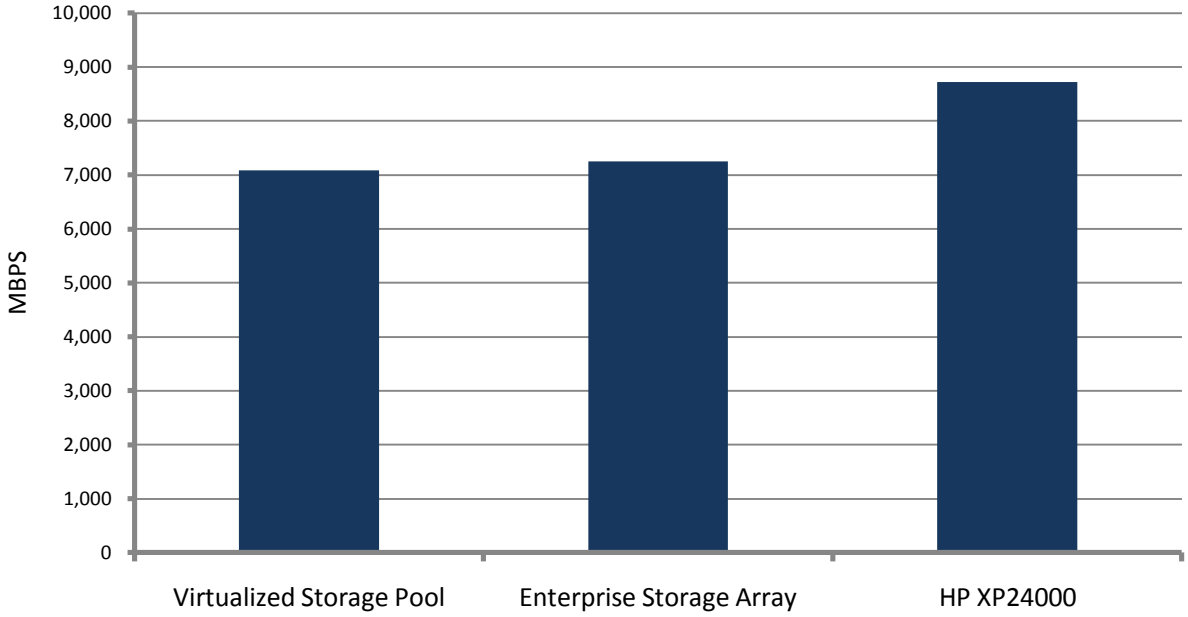
HP has published an outstanding result of 200,245 SPC-1 IO requests per second at 100% load with an average response time of only 4.99 milliseconds. When this report was published, this represents the best SPC-1 result for a disk based enterprise class storage controller.[7]

ESG Lab also examined the results of SPC-2 testing by HP. The SPC-2 benchmark was designed to simulate the demands on a storage subsystem during the execution of business critical applications that require large scale, sequential movement of data. Applications which generate large sequential IO patterns that are similar to those used during SPC-2 testing include data mining, business intelligence, scientific computing, large scale financial analysis, and video on demand.

[7] http://www.ideasinternational.com/benchmark/ben020.aspx?b=99084824-4650-44ce-996b-93b06f10bef1

HP has published an outstanding result of 8,725 SPC-2 MBPS. As of this publication, this represents the best result for a disk-based enterprise class storage controller. Figure 10 shows the top three results published on www.storageperformance.org when this report was written. The 'Virtualized Storage Pool' described in Figure 10 is an external controller that aggregates and virtualizes volumes from a number of midmarket storage arrays while the 'Enterprise Storage Array' is a tier 1 storage array from another vendor. [8]

Figure 10. SPC-2 Results



As shown in Figure 10, HP's result was 20% higher than the next highest result, but this is only part of the story; Table 1 documents how the HP XP24000 posted the highest performance number using a significantly smaller storage configuration with a significantly better price/performance ratio. Price/performance is calculated by dividing the total cost in dollars of the solution tested by the number of SPC-2 MB/sec achieved.

Table 1: The Top Three Published SPC-2 Results

	Virtualized Storage Pool	Enterprise Storage Array	HP XP24000
SPC-2 MB/Sec	7,084	7,247	8,725
Addressable Capacity	101,155 GB	32,642 GB	18,401 GB
Physical Capacity	112,754 GB	76,800 GB	38,955 GB
SPC-2 Price/Performance	$463.66 per MB/sec	$277.22 per MB/sec	$187.45 per MB/sec

What the Numbers Mean

- SPC-2 aggregate performance of the XP24000 was 8,725 MB/sec (8.7 GB/sec), the highest published result as of this writing.
- Compared to the second and third highest results, the XP24000 achieved this number with significantly fewer drives at a significantly lower cost per MB/sec.

[8] http://www.ideasinternational.com/benchmark/ben020.aspx?b=be6bfb4c-c519-476d-84f4-4b46791ae5e1

- An HP XP24000 has the bandwidth required to service up to 238,251 concurrent Internet video (MPEG) streams or 18,613 Standard Definition Broadcast TV streams.[9]

SPC benchmark results are audited by the Storage Performance Council and peer reviewed to ensure consistency. Executive Summary and Full Disclosure Reports for each SPC benchmark result are publicly available for download and review.[10] While this can be useful for comparison between vendors, it is important to note that not all vendors participate and publish results. ESG Lab hopes that participation by HP will encourage other vendors of enterprise-class storage systems to participate.

Why This Matters

Mechanically spinning disk drives are the slowest component in the application compute chain. IT managers with extreme performance requirements have historically tackled this problem by deploying the fastest and most expensive drives, using less than the full capacity on each drive. This can be a tremendous waste of capital costs (drives) and operating costs (space, power, and cooling).

ESG Lab has confirmed that targeted use of SSD for critical application data sets (e.g., an OLTP database shared by many user) can not only be used to dramatically increase performance, it can also be used to reduce the total cost of ownership for performance-critical applications.

Finally, ESG Lab was particularly impressed with HP's peer-reviewed, industry standard SPC-2 benchmark results, which demonstrate that the XP24000 is delivering industry leading performance while providing exceptional storage economics to end-users.

[9] The content bit rates used for these calculations are documented in the Appendix.
[10] http://www.storageperformance.org/results/benchmark_results_spc1

ESG Lab Validation Highlights

- ☑ ESG lab confirmed that HP StorageWorks External Storage Disaster Recovery (ESDR) leverages the external storage virtualization capabilities of the XP24000 to provide a cost effective disaster recovery solution. An HP EVA disk array that was externally connected to—and virtualized by—an HP XP24000 disk array was used for a manual failover and recovery of services at a remote date center after a simulated site level disaster.
- ☑ XP Thin Provisioning volumes were configured using a centrally managed pool of thin provisioned capacity drawn from both internal and external third-party storage.
- ☑ XP24000 integration with the Symantec Thin Reclamation API was used to reclaim deleted storage capacity within a VxFS file system deployed on a HP-UX server connected to an HP XP24000 storage system.
- ☑ ESG Lab confirmed that Pool Rebalancing simplifies the management of a wide-striped pool of thin provisioned capacity. Automated rebalancing reduced disk utilization as it increased the aggregate throughput of an existing volume from 180 MB/sec to 300 MB/sec.
- ☑ ESG Lab confirmed that solid state disk (SSD) can be used to increase the performance capabilities of resource bound applications that rely on Hp XP24000 disk capacity. Moving a database from 15,000 RPM FC hard drives to the same number of solid state disk drives increased the number of supported Oracle database transactions from 672 to 1,578.
- ☑ Solid state disk supported more than twice the number of transactions (2.3x) using the same number of devices.
- ☑ Audited SPC-2 results verified the XP24000's excellent performance capabilities in an open, peer-reviewed forum.

Issues to Consider

- ☑ HP Thin Provisioning is not supported, or needed, on mainframes. Due to the historically small number of devices recognized by the IBM Z-OS operating system and a plethora of mature capacity management and reporting tools available to mainframe storage administrators, the capacity utilization problem that XP Thin Provisioning was designed to solve on open systems platforms is better solved in mainframe environments using existing tools and processes.
- ☑ HP XP24000 External Storage Disaster Recovery (ESDR) is not supported for mainframe devices. In ESG Lab's opinion, this is not an issue for organizations that rely on HP XP24000 storage to meet the storage needs of mission critical mainframe applications. Traditional replication between XP24000 arrays with HP Continuous Application software providing automated failover is a better solution for mission critical mainframe applications.
- ☑ Application-specific best practices are recommended. Thin provisioning is a relatively new concept and there is a lot of confusion about how well it works with real world applications. ESG Lab has spoken with dozens of early adopters who have realized significant savings in production environments using a wide variety of applications. With that said, ESG Lab suggests that customers work with HP to ensure that application-specific best practices are being met. In particular, applications and utilities that pre-allocate space and write towards the end of a drive can negate the benefits of thin provisioning. As an example, a full format of an NTFS file system on a Windows server pre-allocates space and writes data over the entire file system. As a result, ESG Lab adhered to the best practice of using the Microsoft quick format option when formatting NTFS file systems during the ESG Lab Validation.

The Bigger Truth

ESG believes that infrastructure virtualization has to live within multiple layers of the data center. Server virtualization affords the ability to leverage under-utilized server hardware while addressing growing power and cooling issues in the data center by allowing organizations to deploy less physical hardware to address data processing requirements. The XP24000's internal and external storage virtualization synergizes with these benefits, allowing organizations to purchase and deploy far less physical storage with thin, just in time provisioning of multiple tiers of storage providing advanced performance, data protection, replication, and virtualization.

In previous reports, ESG Lab has examined the enterprise-class storage system and storage virtualization capabilities of the XP24000. The XP24000 provides a series of capabilities that individually provide great value. When these capabilities are conjoined, it raises the stakes, offering value as a single storage system, as an enterprise-class storage virtualization platform, and as a component of a 'disaster-proof' IT infrastructure provided by a leading, world-class storage vendor.

HP has continued to innovate and extend the capabilities of the XP24000 since its introduction in 2007. The field proven external storage virtualization capabilities of the XP24000 can now be used for cost effective external storage disaster recovery (ESDR). The value of thin provisioning has been enhanced with thin pool reclamation and dynamic pool rebalancing. Solid state disk can now be used to improve the performance of resource bound applications. Last, but not least, ESG Lab has confirmed that HP has published excellent industry standard SPC-2 performance benchmark results with industry leading price performance.

It is also important to point out that HP is a total solutions provider with an extensive portfolio of IT solutions and services. Products are important, but they are not a panacea and professional services are often required to develop best practices in order to leverage solutions to their fullest. Additionally, HP can provide a wide range of IT solutions in conjunction with storage including servers (virtual and physical), management software, applications, and networking infrastructure. HP also provides a complete ecosystem of storage solutions that span enterprise-class, midrange, and entry level storage systems; disk archiving solutions; disk-to-disk backup; backup software; tape systems; etc. The XP24000 extends the value of virtualization by supporting advanced storage virtualization and disaster recovery solutions on both internal and external storage. Extending these capabilities to lower tier applications and departments that may not have a budget for enterprise storage brings value to the business in the form of higher application availability and lower capital and operating costs. External virtualization creates a network of otherwise isolated storage systems in order to move and replicate data between them. Internal virtualization enables IT to more fully optimize individual storage systems and make them far easier to manage. Storage virtualization leverages storage assets to be greater than the sum of their parts. With that said, storage virtualization is only one factor to consider when choosing an enterprise-class storage solution. A holistic combination of features, functionality, reliability, service and support are needed to realize the full potential of an enterprise-class storage virtualization platform. In ESG's view, HP truly understands this and the XP24000 embodies these goals.

Appendix

Table 2. ESG Lab Test Bed

The OLTP Test Bed	
Server	IBM p595 Model 9119, 24 1.65 GHz Power5 CPU, 96 GB RAM, 64 4Gbps FC adapters, AIX version 5.3 ML3
Storage	XP24000, 256 GB cache, 12 GB shared memory, 8 front-end directors, 8 back-end directors, 1024 146 15 RPM FC drives, Microcode 60-00-31
The Microsoft Exchange Test Bed	
Server	Dual Xeon 2.8 GHz, 4 GB RAM, Windows 2003
Storage	XP24000, 256 GB cache, 12 GB shared memory, 8 front end directors, 8 back-end directors, 1024 146 15 RPM FC drives, Microcode 60-00-31
The XP Thin Provisioning Pool vs. Host Based LVM Test Bed	
Server	Dual Xeon 2.8 GHz, 4 GB RAM, Windows 2003
Storage	XP24000, 128 GB cache, 12 GB shared memory, 8 front-end directors, 8 back-end directors, 1024 146 15 RPM FC drives, Microcode 60-00-31
The SSD Test Bed	
Server	Rx6600 Server with dual quad core processors and 32 GB of RMA running HP-UX 11.31, Oracle 11g, Quest benchmark Factory 5.5
Storage	XP24000 microcode version 60-04-15-00/00, 146 GB 15 K RPM FC drives vs. 146 GB SSD devices.

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