

## ESG Lab Review

# HP P4000 SAN: Affordable, Scalable, Reliable Storage

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**Abstract:** This ESG Lab Review documents the pay as you grow scalability and availability of the HP P4000 SAN. Topics explored include getting started with a Virtual SAN Appliance (VSA), online upgrades to physical appliances, proven support for more than 150,000 Microsoft Exchange users, and hyper-redundant fault tolerance.

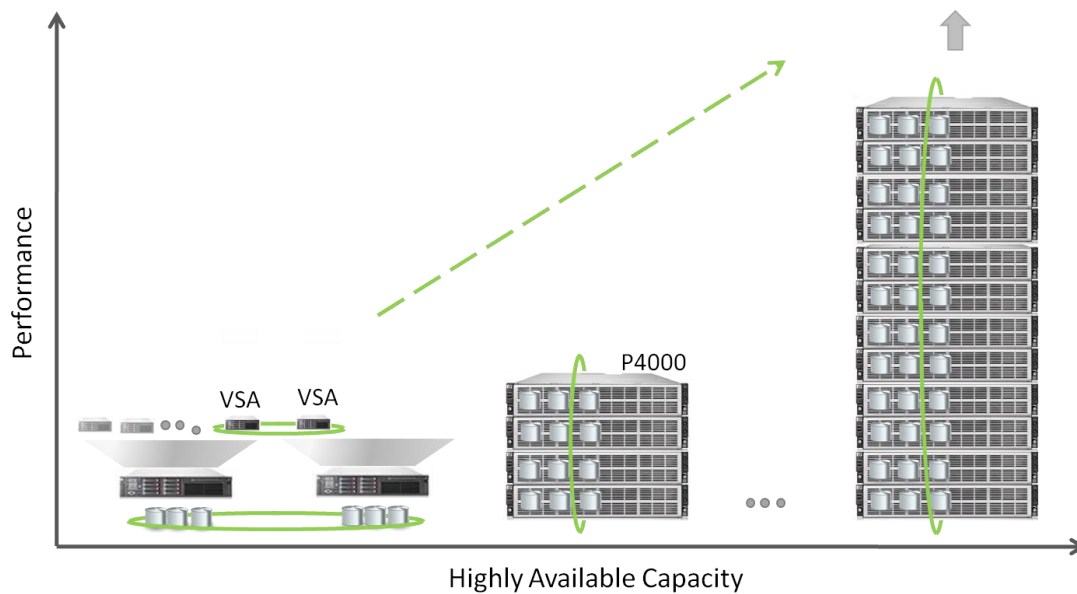
## The Challenges

Faced with exploding data growth thanks to accelerated server virtualization adoption and a desire to better protect and manage shared information assets, IT managers in organizations of all sizes are deploying shared storage solutions to meet growing storage requirements. In the enterprise, IT managers have traditionally turned to Fibre Channel (FC) attached storage arrays—while iSCSI offers a similar fit for many business needs, it is often thought of as an inexpensive alternative to FC. In fact, when ESG asked IT professionals to name the factors that are most important when justifying IT investments over the next 12-18 month, the top two responses were cost reduction (54%) and business process improvements (42%). Clearly, IT managers are looking for ways to reduce cost and increase efficiency. This report examines a cost effective, highly available shared storage solution that is ideally suited to meet the needs of small to medium-sized businesses and increasingly larger enterprises —especially those that have embraced server virtualization.

## The Solution: HP P4000 SAN

With a clustered storage architecture leveraging industry standard server and Ethernet technologies, the HP P4000 SAN is a shared storage solution that delivers cost effective scalability, performance, and high availability.

Figure 1. Pay as You Grow Scalability



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 commissioned by Hewlett Packard.

As shown in Figure 1, the HP P4000 SANs can scale from an entry level software solution powered by the P4000 Virtual SAN Appliance Software (VSAs) to an enterprise-class physical SAN based on a cluster of P4000 SAN appliances. . The P4000 VSA Software is, as of this writing, the only VMware certified Storage Virtual Appliance.<sup>1</sup> With a pay as you grow, all-inclusive licensing model and intuitive storage management, the P4000 SANs support online upgrades, firmware changes, modification of the SAN layout and advanced high availability to address the ever changing needs of the business.

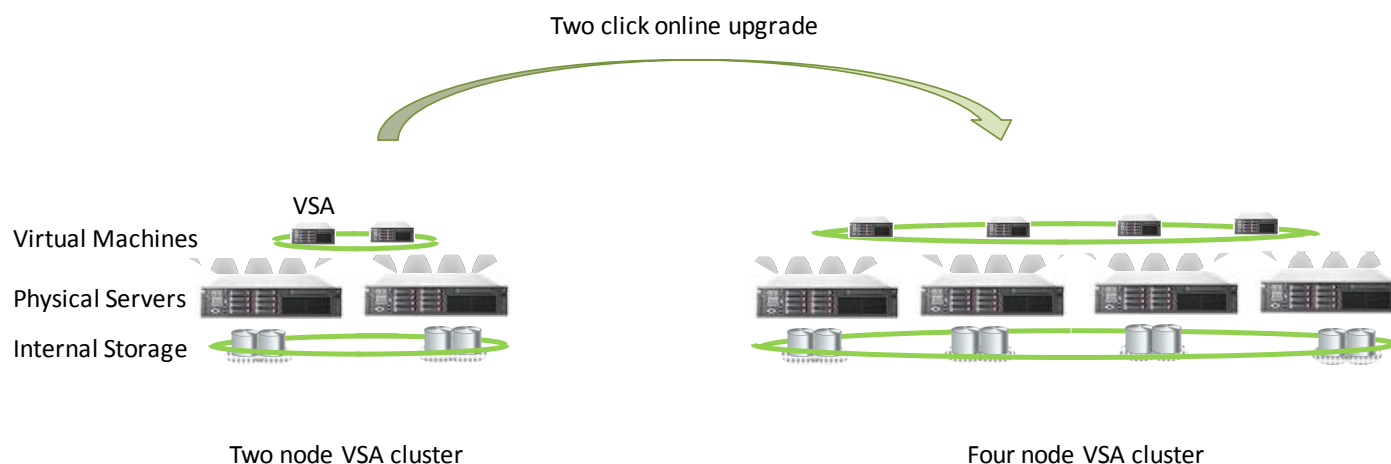
From the software-only VSA option (available as a free download for a 60 day trial) to the pre-packaged hardware of P4000 SAN appliances, the underlying power and enterprise-class functionality of the P4000 SAN is provided by SAN/iQ software:

- Storage clustering
- Network RAID 5,6,10,10+1, 10+2 (Volume level HA with up to 4 sets of striped, protected data)
- Remote copy and multi-site replication with bandwidth throttling
- Virtual and physical SAN appliances managed from one pane of glass
- An Enterprise-class feature set with all-inclusive pricing
- Three years of support included for P4000 SANs
- Pay as you grow pricing
- Non-disruptive online upgrades
- Wizard-driven ease of use
- Hardware RAID 5,6, and 10
- Thin provisioning
- SmartClones
- Application Integrated Snapshots

## Getting Started with Virtual SAN Appliances

The test bed shown in Figure 2 was used to demonstrate the ease of getting started with P4000 SAN technology using P4000 Virtual SAN Appliance Software (VSA). Testing began with a pair of HP ProLiant DL380 servers, each equipped with 2 GB of RAM and a pair of 36-GB hard drives for internal storage. The physical servers were pre-installed with free VMware ESXi software to create a platform for server virtualization. HP P4000 VSA, which is distributed as an industry standard VMware virtual appliance, was installed and run in a virtual machine on each of the two physical servers.

*Figure 2. Getting Started with Virtual Storage Appliances*



<sup>1</sup> <http://www.vmware.com/resources/compatibility/search.php?>

Note that the P4000 VSA software that has been installed as two virtual machines (towards the left in Figure 2) is working to create a clustered SAN with 2 nodes using capacity that is striped across the internal storage in two physical servers. It should also be noted that the VSA can run in parallel with a number of virtual machines to maximize the levels of server consolidation and savings. For example, virtual machines dedicated to common utilities (e.g., active directory) and common business applications (e.g., Microsoft Exchange) can be deployed within virtual machines alongside the VSA.

The P4000 SAN Centralized Management Console was used to add the two VSA appliances to a cluster, create volumes, and map those volumes to an iSCSI attached Microsoft Windows 2008 server. As documented in previous reports, ESG Lab found the management console used to create and manage P4000 volumes to be extremely intuitive and responsive.<sup>2</sup>

The cluster was then upgraded online from two to four P4000 SAN nodes. This phase of testing began with a background IO workload running on the Windows 2008 server. The upgrade was performed using an intuitive “add node” menu option. Two clicks and less than a minute later, the cluster had been expanded from two to four nodes. No interruption in IO access was noted as SAN/iQ began automatically rebalancing capacity and performance.

### **Why This Matters**

As an ever growing number of organizations have embarked on server virtualization to reduce costs and increase efficiency, IT managers are faced with a number of new storage challenges. Predictably fast performance, always-on upgradability, and storage that can match virtual servers’ growth, virtual machine movement, and virtual server high availability are crucial.

ESG Lab has validated that the SAN/iQ software at the heart of the HP P4000 SAN architecture can be installed as a VSA in a VMware-enabled virtual server environment. Getting started is easy since the VSA is deployed as an industry standard VMware appliance. Adding two servers with additional processing power and storage capacity was completed in two mouse clicks and in less than a minute.

When this report was published, the HP P4000 VSA was the only VMware certified ‘Storage Virtual Appliance and support for Microsoft Hyper-V is planned.

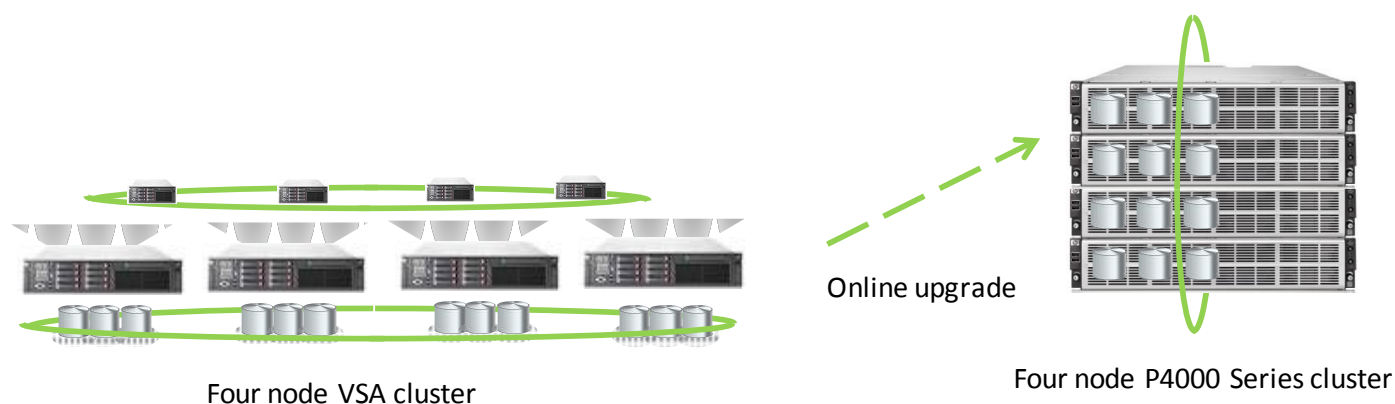
A no-cost VMware ESXi license combined with full featured P4000 VSA software (downloadable from HP for a no-cost 60 day evaluation) can be used to create an affordable server AND storage virtualization platform that is ideally suited for virtualized applications with moderate performance requirements.

<sup>2</sup> ESG Lab Validation Report: [LeftHand Networks Open iSCSI Platform](#), May 2006; ESG Lab Validation Report, [LeftHand Networks 100 TB SAN](#), July 2007; ESG Lab Validation Report, [HP LeftHand P4000 SAN – Optimizing Virtual Desktop Infrastructure with Citrix XenDesktop](#), July 2009.

## Upgrading from Virtual to Physical SAN

An HP P4000 SAN supports online upgrades from virtual to physical appliances. Physical P4000 SAN nodes run the same SAN/iQ software as VSA-enabled virtual SAN nodes. P4000 SANs combine industry standard server and storage technology with SAN/iQ software into a pre-packaged storage solution. A cluster of P4000 SAN nodes is used to create a unified pool of storage that is accessed by servers via a virtual IP address over Ethernet using the industry standard iSCSI protocol. The test bed shown in Figure 3 was used to upgrade the four-node VSA cluster running within virtual machines to a physical SAN running on four P4000 SAN nodes.

Figure 3. Virtual to Physical HP P4000 SAN Upgrade



The upgrade process was performed online from the Centralized Management Console GUI. The same procedure that was used to add VSA nodes to the cluster was used to add the P4000 SAN nodes to the cluster. A similar operation was used to remove each of the VSA nodes from the cluster. From an administrator's standpoint, the upgrade was completed in less than five minutes. The amount of time required for the automated migration of data from the old cluster to the new cluster depends on the amount of data to be migrated, the amount of server level activity that is occurring during the migration, and the priority that the administrator has defined for background restriping. The background restriping priority level can be changed on the fly.

### Why This Matters

In a VSA deployment, SAN/iQ software and virtualized applications share the same processors, memory, IO, and storage. As a result, resource contention can arise as virtual applications and virtual storage contend for shared resources. As the environment grows, resource contention may require the addition of a dedicated HP P4000 SAN.

ESG Lab has confirmed that a VSA cluster can be upgraded online to take advantage of dedicated processing power, memory, and storage within a P4000 SAN. Because virtual and physical storage appliances share the same SAN/iQ software, the management interface is the same and adding resources to a virtual or physical P4000 SAN cluster is an intuitive online operation. Servers access a cluster of physical P4000 SAN appliances using the iSCSI protocol running over cost effective industry standard Ethernet infrastructure.

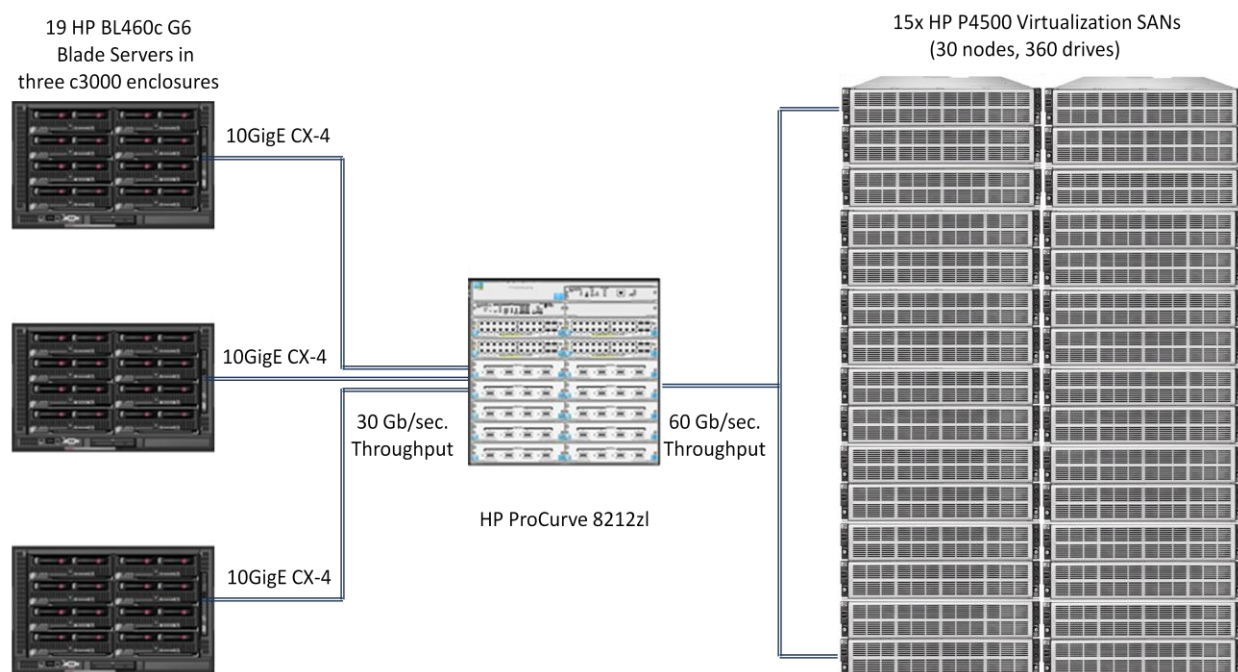
## Microsoft Exchange Scalability

ESG Lab validated the enterprise-class performance capability of the P4000 SAN architecture in a highly consolidated Microsoft Exchange environment via an audit of recently published Microsoft ESRP 2.1 results. The Exchange Solution Review Program (ESRP) is a Microsoft program designed to facilitate third party storage testing and solution publishing for Exchange Server. ESRP version 2.1 focuses on Exchange 2007. The program is a combination of a storage testing harness (Jetstress) and publishing guidelines for Microsoft Gold Certified and Storage OEM Partners. The Jetstress harness is a lightweight tool ideally suited for predicting storage performance in a Microsoft Exchange environment. It uses the jet engine database that Microsoft Exchange uses internally.

Manufacturers use the ESRP framework to test storage solutions and then submit results to Microsoft for review. Approved solution results are posted on the Microsoft Exchange ESRP website. ESRP is different from standard IO benchmarking suites in two important ways: first, ESRP employs the Jetstress utility to create real exchange traffic that runs against real Exchange databases exactly as in the real world. Second, the testing is designed to measure both the performance and reliability of a given solution. The performance test runs for two hours while the reliability test runs for 24 hours. Microsoft makes it quite clear that these tests should not be used for performance comparisons, but in practice, end-users routinely look to these tests to gauge how well a given storage solution will perform in an Exchange environment.

The configuration used by HP and approved by Microsoft during ESRP testing is summarized in Figure 4. Microsoft Exchange servers running on 19 HP BL460c blade servers were used to test 152,000 Exchange mailboxes being served by a single pool of storage spanning 15 HP two-node P4500 SAS Virtualization SANs. The P4500 SAS Virtualization SAN with two SAN nodes and 24 SAS disks was selected by HP as the building block of the ESRP test bed because it is one of the most popular models in the P4000 SAN portfolio.

*Figure 4. An ESRP Test Bed for 152,000 Microsoft Exchange Mailboxes*



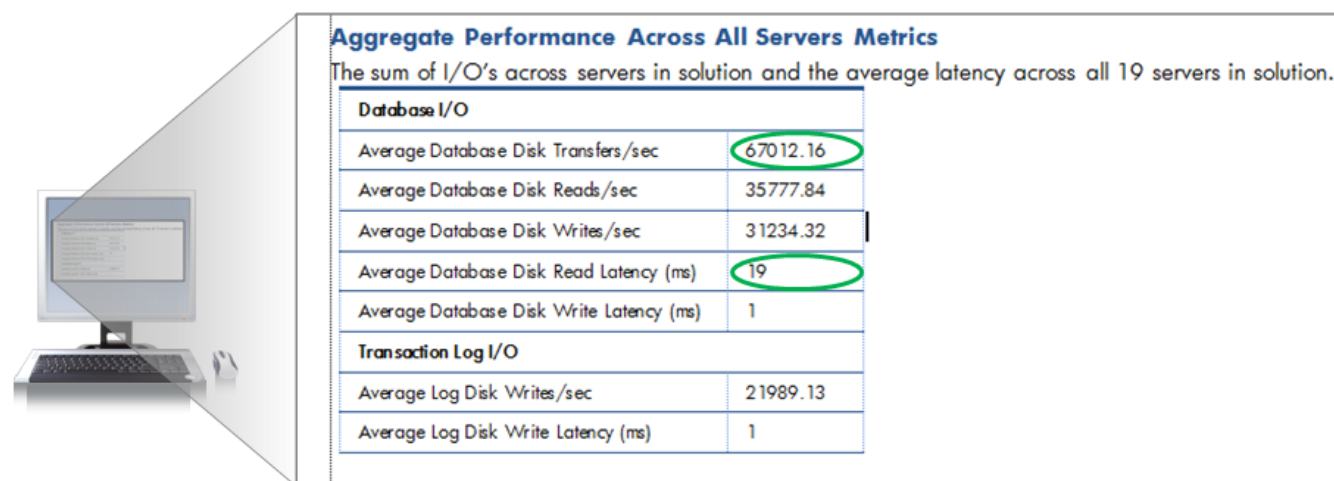
The test bed was configured to support 152,000 Microsoft Exchange 2007 mailboxes as follows:

- 15 HP P4500 SAS Virtualization SANs with 30 nodes and 360 disks in total.
- 19 active Exchange servers
- 8,000 users per Exchange server

- 200 MB mailbox quota
- 0.40 IOs per second(IOPS) per “heavy” user profile
- 24 storage groups per server
- 1 database per storage group

The aggregate performance shown below in Figure 5 is excerpted from the 80 page submission document. The full report is available for download from the Microsoft ESRP website.<sup>3</sup>

Figure 5. HP P4500 ESRP Results



### What the Numbers Mean:

- The P4000 SAN demonstrated an aggregate of 89,001 I/O per second overall with 67,012 Database I/O per second and 21,989 Transaction Log I/O per second.
- The average Database I/O per second result for each of the 19 JetStress clients (3,527) exceeded the targeted rate of 0.40 IOPS per mailbox (3,200 per Exchange server).
- The HP P4000 SAN completed the certification test with an average database read response time of 19 milliseconds. A response time goal of 20 milliseconds or less for database reads is required to pass the test. These values are defined by Microsoft as a limit beyond which end-users will feel that their e-mail system is acting slowly.

### Why This Matters

A storage system with poor scalability and slow response times can result in loss of sales, loss of customer goodwill, loss of productivity, loss of competitiveness, and increased costs. With more and more organizations relying on e-mail as one of the most significant business applications, IT managers need a storage system architecture that can deliver predictably fast e-mail response times—regardless of how many users rely on the system.

Microsoft-approved ESRP testing with 152,000 Exchange mailboxes has confirmed that the clustered, pay as you grow HP P4000 architecture can sufficiently handle a very large number of Exchange users with predictably fast response times.

<sup>3</sup> <http://technet.microsoft.com/en-us/exchange/bb412164.aspx>



## Hyper-Redundant Clustered Storage

The HP P4000 SAN extends the fault tolerance provided by traditional modular disk arrays using a combination of clustering and Network RAID technologies. Network RAID slices data and distributes it over multiple nodes in a P4000 cluster. Up to four copies can be created and the cluster can be “stretched” within a campus or metropolitan network to survive a data center level outage. As a result, a P4000 SAN can be configured to survive the failure of one or more drives, one or more network interfaces, and one or more nodes in a P4000 cluster. HP refers to this capability as hyper-redundant clustered storage.

As shown in Figure 6, a number of errors were introduced to test the fault tolerance of a four node HP P4000 cluster. A node failure and a network failure were injected as host IO was running against a hyper-redundant Network RAID-10 volume and an unprotected Network RAID-0 volume. Multiple drive failures were tested during a previous ESG Lab validation.

Figure 6. Error Injection Testing



The hyper-redundant Network RAID-10 volume was accessed from a Windows 2008 server as the E: drive. The unprotected Network RAID-0 volume was accessed as the F: drive. Files were copied to both volumes as catastrophic errors were introduced. The power cables were unplugged from one of the P4000 nodes in the four node SAN cluster. As expected, the unprotected RAID-0 volume stopped working and was no longer accessible from Windows Explorer. The RAID-10 volume remained accessible. The failure was noted on the SANIQ management console approximately 10 seconds after the error had been introduced. The cluster automatically healed itself and the F: drive became usable again after the failed node was powered back on. The test was repeated using a pulled network interface card between the server and one of the P4000 nodes. As expected, the RAID-0 volume was inaccessible until after the network cable had been plugged back in and the RAID-10 volume was available for the duration of the test.

During a previous ESG Lab validation of the P4000 SAN, the system remained fully available as a series of errors was introduced on a stretched cluster configured within labs located on different floors within the same building. ESG Lab:

- Pulled a team bonded redundant Ethernet back-end interface;
- Pulled two drives;
- Powered off the entire upstairs half of the cluster;
- Re-plugged Ethernet;
- Powered up the entire upstairs half of the cluster;
- Replaced the two failed drives.

### Why This Matters

As virtual server and storage deployments grow in size and complexity, so too do the consequences of things going wrong. Regardless of the number and types of hardware failures that may occur during the lifecycle of electronically stored information assets, employees, managers, and customers expect that their data will always be available. ESG Lab has confirmed that the hyper-redundant cluster storage architecture of the HP P4000 SAN can be used to create a self-healing virtual storage solution that never needs to be turned off.

## The Bigger Truth

The use of server virtualization technology is on the rise among organizations of all sizes and in all industries around the world. In a recent ESG survey of IT professionals, 70% of organizations indicated that they have deployed server virtualization technology (51% in production, 19% in test/development), while 17% plan to do so.<sup>4</sup> Given the impressive economic benefits of server virtualization, the glut of affordable and under-utilized processing power, and growing power and cooling concerns, ESG predicts that the brisk adoption of server virtualization will continue for the foreseeable future.

As more and more applications rely on a server virtualization technology, IT managers are increasingly concerned about the cost, scalability, and reliability of the shared storage infrastructure relied upon by virtual servers to keep applications online. IT managers within small to medium-sized businesses are particularly concerned as they struggle to justify the time and costs of re-architecting existing IT infrastructure. Rock solid reliability, high availability, online scalability, and ease of management are vital concerns as more and more applications rely on a consolidated pool of shared storage.

ESG Lab has verified that the hyper-redundant clustered architecture of the HP P4000 SAN is ideally suited to address these concerns. HP's Virtual SAN Appliance Software, distributed as an industry standard VMware appliance and available for a free 60 day trial, lowers the cost of getting started. An all-inclusive licensing model, combined with the free VMware ESXi server virtualization stack, lowers the cost of entry even more. ESG Lab leveraged the pay as you grow scalability of the P4000 architecture to upgrade from a cluster of two virtual appliances to four virtual appliances and then again to four physical P4000 Series appliances. A recently published ESRP report that was approved by Microsoft and audited by ESG Lab proves that a single cluster of P4000 SAN appliances can scale to meet the needs of 152,000 Microsoft Exchange 2007 mailboxes. Last but not least, ESG confirmed that the hyper-redundant P4000 SAN architecture can deliver levels of fault tolerance that are not possible with traditional dual controller disk arrays as the SAN transparently rode through catastrophic node and network failures.

ESG Lab has tested dozens of storage solutions over the past five years. From our first evaluation in 2006 at LeftHand Networks through this most recent review in 2010 at Hewlett Packard, we've been impressed with the affordability, scalability, ease of use, and fault tolerance of the P4000 architecture. In particular, ESG Lab is extremely impressed by the 152,000 Microsoft Exchange ERSP result and the ability to non-disruptively upgrade from a virtual to a physical P4000 SAN. Most recently, ESG Lab noted that HP began shipping the G2 version of the P4000 Series hardware platform in February 2010. Once again, HP has made it easy for customers to take advantage of the latest advances in industry standard x86 motherboard and processor technology.

A scale-out clustered architecture that leverages industry standard hardware to create a shared pool of storage is a simply elegant approach that makes great sense. With a free software trial, an affordable, pay as you grow pricing model and advanced fault tolerance, HP lowers the traditional barriers to entry, cost and risk—of getting started with the HP P4000 SAN.

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<sup>4</sup> Source: ESG Research Report, *2010 IT Spending Intentions Survey*, January, 2010.