

Lab Report

Dell EqualLogic PS Series Storage and TCO Analysis

Delivering Lasting Value with Streamlined Management and Improved Performance Scalability

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Contents

Executive Summary	3
Challenges and Trends	4
Multi-generational Software and Support	5
Ease of Management with EqualLogic Group Manager	5
Host Integration Tools for Virtualized Environments	7
Support and Monitoring with SAN Headquarters 3.0	9
Performance in VDI Environments	11
ESG Lab TCO Analysis	12
The Bigger Truth	15
Appendix	16
TCO Assumptions	16

ESG Lab Reports

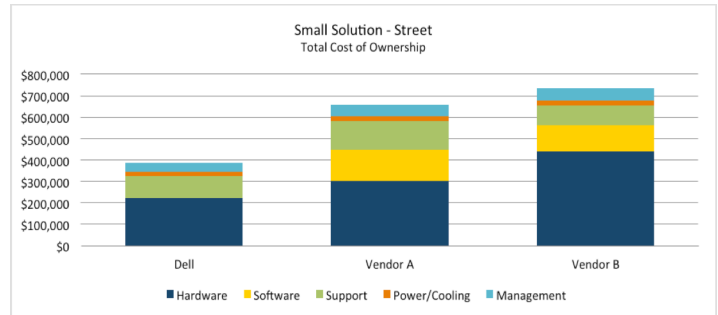
The goal of ESG Lab reports is to educate IT professionals about data center technology products for companies of all types and sizes. ESG Lab reports are not meant to replace the evaluation process that should be conducted before making purchasing decisions, but rather to provide insight into these 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 Dell.

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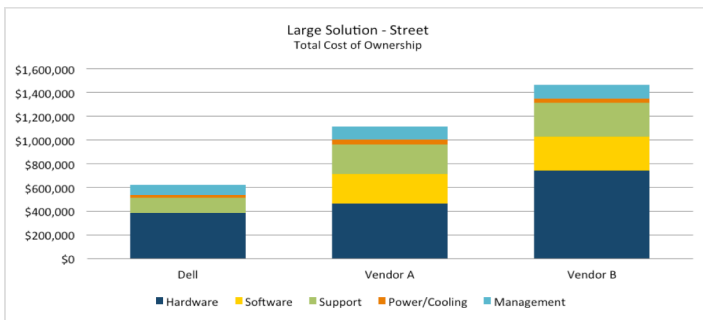
Executive Summary

Growing data sets and shrinking budgets are forcing organizations of all sizes to find ways to do more with less. Turning to server virtualization has helped, by enabling organizations to reduce costs and administration complexity throughout the entire infrastructure, but unforeseen complications can still arise, especially around storage. Large, virtualized environments put a heavy burden on the storage infrastructure by forcing it to handle various application workloads with differing performance requirements. This has made it difficult for storage architects to appropriately size a storage configuration to meet these high demands, which commonly leads to overprovisioning of storage and, therefore, higher acquisition costs. It stands to reason that the efficiency gains and overall cost savings seen from server virtualization can and should also be achieved from the storage infrastructure.

ESG Lab tested the latest [Dell EqualLogic PS Series](#) storage array with a focus on the manageability, scalability, and significant cost savings offered by the purpose-built solution to help lower total cost of ownership (TCO) in virtualized environments. Dell's rich set of software tools helped ESG Lab manage a large, virtualized environment more efficiently with EqualLogic Group Manager and host integration tools. SAN HQ's improvements made it easier for ESG Lab to monitor performance and support.



ESG Lab also compared the TCO of an EqualLogic solution with other leading storage vendors to further validate Dell's economic advantage. The TCO was calculated for a five-year span with small and large organization requiring 112 and 218 raw terabytes of storage capacity using currently available systems. First, ESG Lab looked at the cost of hardware, software, and support. It was clear that the cost to acquire a Dell EqualLogic PS Series solution was low. In fact, the cost of a small iSCSI SAN solution could save organizations as much as 60% when compared with other vendors. For larger configurations, just the cost of acquisition and support led to one vendor's solution costing *more than 2x* a Dell EqualLogic solution.



Cost savings were also realized from the simplicity of management offered by Dell EqualLogic storage. Many organizations have focused on simplifying storage management through integration, shifting provisioning tasks to the system and application level administrators. However, this approach can require a dedicated storage administrator. With Dell, enhanced management functionality is delivered in a way that does not require a dedicated storage system expert to manage the system.

Finally, the ability of EqualLogic to quickly and easily add new storage systems to existing storage infrastructures and evacuate data from one array to another help significantly minimize service costs. The cost to upgrade to a new system is only for setting up the new hardware, while the migration of old data costs nothing.

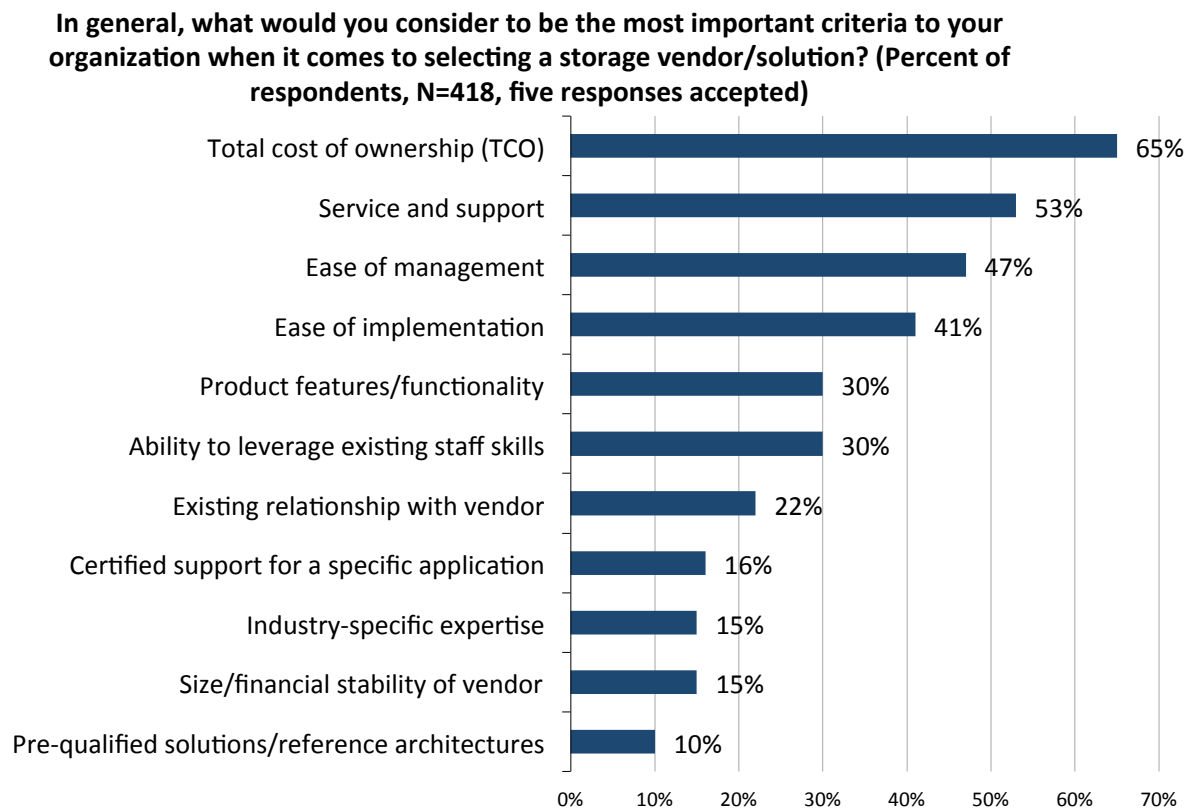
ESG Lab has confirmed that Dell EqualLogic storage is not only easy to configure and manage, but also offers a significant cost savings compared with other vendors. With an expansive software and tools package included at no additional cost and multi-generational hardware support, EqualLogic presents an affordable storage solution that remains unmatched in the SAN storage market.

Challenges and Trends

In today's storage infrastructures, many features and functionalities can help drive a purchasing decision. Increased performance, improved data availability, and optimized resource utilization (to name a few) help organizations determine whether they need a new system and which system best suits their needs. ESG asked over 400 IT and storage professionals what the most common reason was for their organization to purchase and deploy net-new storage systems. The most popular response, cited by 25% of respondents, was that they needed additional capacity but couldn't expand their existing system(s). Other responses included the scheduling of technology refreshes, the need for improved performance, and the consolidation of disparate storage systems.¹

Once the customer has decided they need a new storage system, what's next? The next hurdle is reviewing all options and prioritizing what is needed the most. In a recent ESG survey of IT professionals, respondents were asked to identify up to five features they would classify as "must haves" when purchasing a storage system. An overwhelming 59% of respondents considered high availability the most important "must have," which makes sense due to the fact that the tolerance for application and data downtime is decreasing.²

Figure 1. Important Criteria for Selecting a Storage Vendor/Solution



Source: Enterprise Strategy Group, 2013.

Though features and functionality serve as key deciding factors for a storage solution, a different driver ultimately forces the hands of many customers: total cost of ownership. In fact, 65% of respondents reported that total cost of ownership was the most important criteria they use when choosing a storage vendor/solution, while another 53% said that service and support capabilities were the most important (see Figure 1).³ When tied together with the fact that hardware costs was one of the most commonly cited storage challenges, it's not surprising that organizations are looking to save, while still being able to make upfront investments to increase storage infrastructure efficiency in the long run.

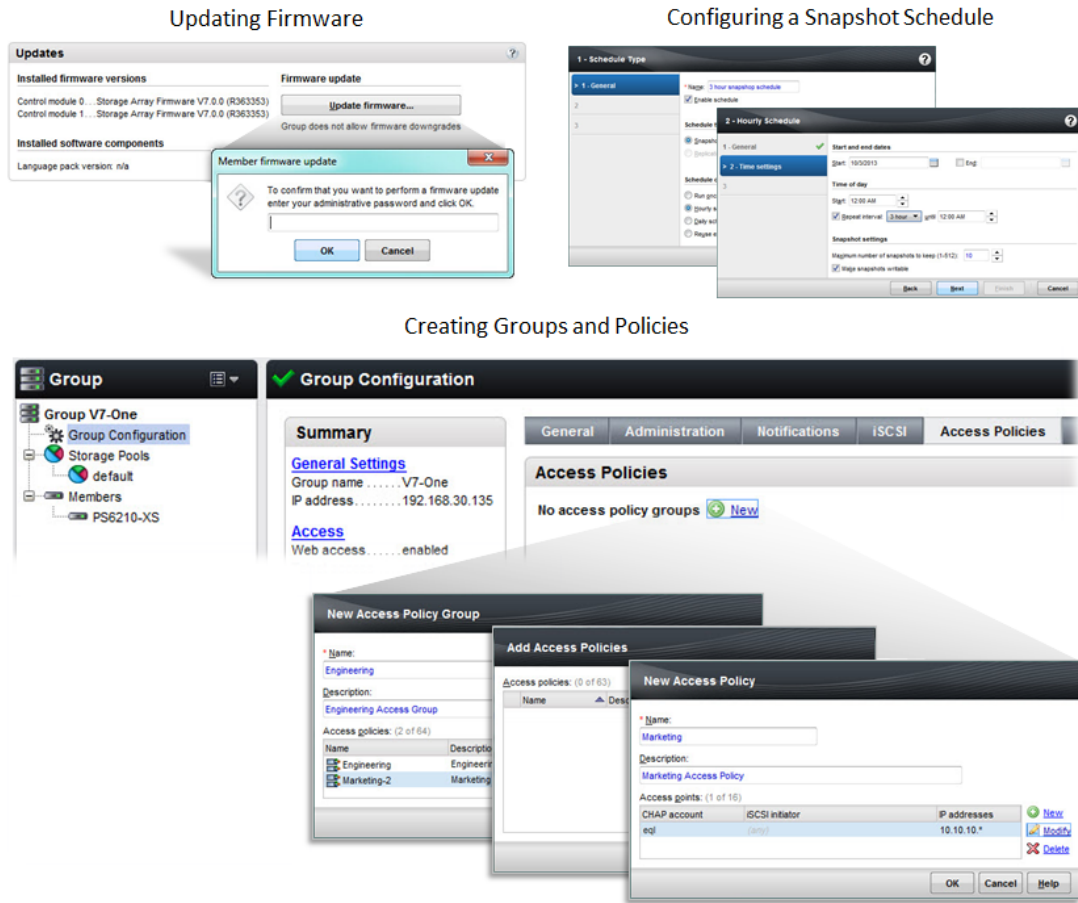
¹ Source: ESG Research Brief, [Data Storage Technology Purchasing Trends](#), April 2013.

² Source: Ibid.

³ Source: Ibid.

Next, ESG Lab completed various tasks using the redesigned GUI, including updating PS storage array firmware, configuring snapshots, and creating new access policies and groups. Figure 3 highlights each of the tasks. ESG Lab focused on the Access Control Policies (ACP), which are new with the PS Series v7 firmware. In previous firmware versions, this technology was referred to as Access Control Lists (ACL), which defined access to a data volume by specifying information like IP address, initiator, and CHAP username. This process forced each ACL to be stored and bound to a single volume. As the configuration becomes larger (for example, in a clustered configuration) each volume ends up containing the same host information. With the new ACPs, all the policy information is stored a level above the data volumes, making it much easier to define and update new groups and policies.

Figure 3. Updating Firmware, Configuring Snapshots, and Creating Access Control Policies



Why This Matters

As data growth continues at an exponential rate, organizations are being forced to rethink their storage strategies and requirements. One of the main points of focus revolves around dealing with the management complexities that go hand and hand with a constantly growing storage environment. Organizations are looking for a storage solution that makes managing a large storage infrastructure easy, with tightly integrated tools and a smooth user interface, all while not breaking the bank.

ESG Lab validated that EqualLogic Group Manager provided an intuitive management interface to help easily configure and manage a large, multi-generational PS Series storage deployment. All 12 generations of PS Series storage arrays were easily updated to the latest v7 firmware, enabling many new features such as Access Control Policies, which help streamline the management of large-scale environments. Most impressive to ESG Lab was the fact that all of the management software capabilities come at no additional charge.

Host Integration Tools for Virtualized Environments

Dell EqualLogic Host Integration Tools (HITs) bring together hosts and applications from a variety of virtualization platforms with EqualLogic storage solutions. These easy-to-use toolkits can be leveraged with application data and virtual machines in VMware, Microsoft, and Linux environments to help organizations configure and deliver simplified management, fast performance, advanced data protection, and high availability.

ESG Lab focused on the Host Integration Tools for VMware (HIT/VMware) and for Microsoft (HIT/Microsoft). The goal of testing was to look at new features for managing virtual machines, provisioning storage, and protecting application data.

VMware

ESG Lab used a VMware vSphere Web Client to connect to vCenter Server. In the *Inventories* section of the vSphere Client, the Dell Virtual Storage Manager (VSM) plug-in was installed. VSM consolidates three pieces of software into a single vCenter plug-in:

- Datastore Manager brings together the creation and management of datastores in vSphere by automating storage provisioning.
- Auto-Snapshot Manager for VMware coordinates the creation, recovery, and scheduling of snapshots and replicas with vCenter to enhance protection, storage utilization, and performance of VMware-based virtual infrastructures.
- Virtual Desktop Deployment Utility enables rapid creation of VDI desktops and leverages EqualLogic's thin clone technology to deploy VDI desktops quickly and efficiently.

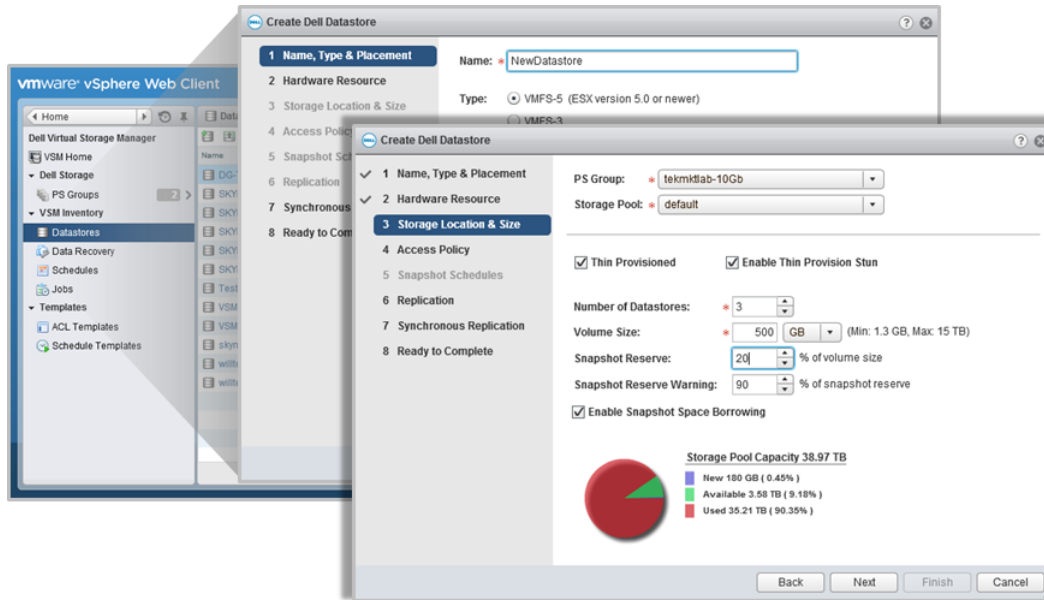
VSM was used to provision a new Dell datastore through the vSphere Client. Using the intuitive *Create Dell Datastore* eight-step wizard, ESG Lab created a new 500GB volume. Basic steps like providing a name, type, placement, and hardware resources were specified and the details are shown in Figure 4. The wizard also provided the ability to enable and configure access policies, snapshot scheduling, replication, and synchronous replication all directly from the vSphere Web Client.

Software for No Additional Charge

There is no additional charge for the valuable storage management and data protection software services included in every Dell EqualLogic system. Enterprise-class services, including remote replication and snapshots, are included with every EqualLogic array. This not only increases the value of an EqualLogic solution, but also simplifies purchasing and reduces the total cost of ownership.

One of the Dell customers with whom ESG Lab spoke summed it up well: *"The best thing about EqualLogic: You buy an array, and you don't have to pay any more money. It's one price and one price only."*

Figure 4. Host Integration Tools for VMware – Creating Dell Datastore

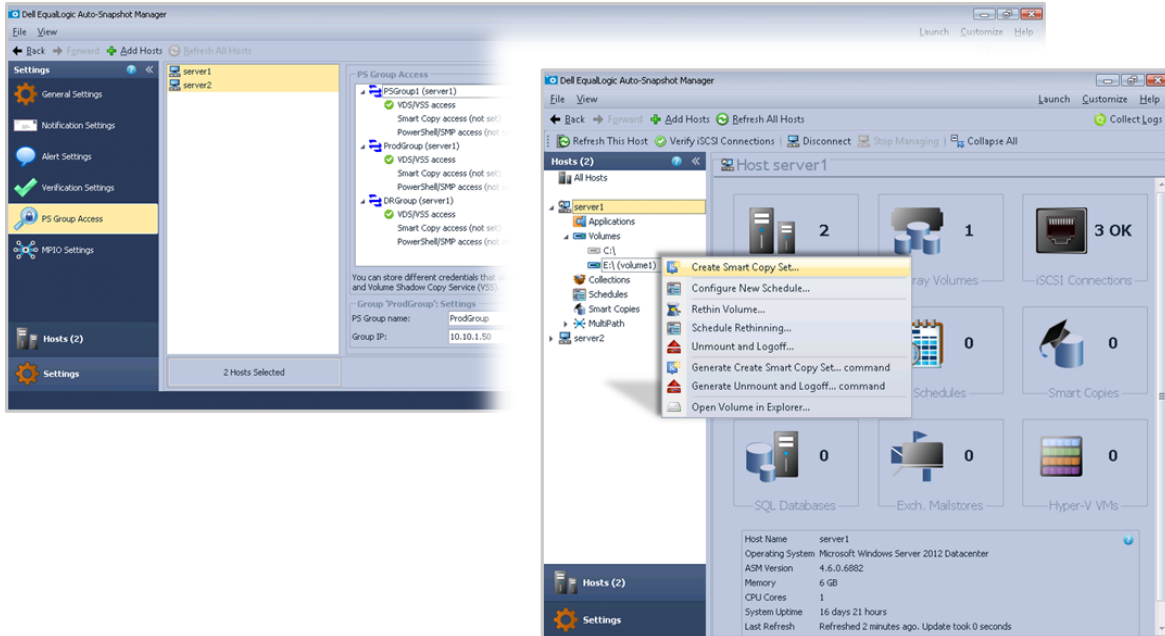


ESG Lab also tested the basic functionality of Dell's snapshot technology from the web client. A virtual machine was configured, a snapshot was taken, and then a data corruption was simulated on the volume. Using the Selective Restore from the Snapshot two-step wizard, ESG Lab easily selected the VM that needed restoring and the original volume to restore. In just a few clicks, the restore was initiated and in just minutes, the volume was completely restored.

Microsoft

ESG Lab looked at the new Auto-Snapshot Manager for Microsoft (ASM/Microsoft). First, a new virtual machine group was created named *PSGroup1*, which consisted of two Windows Server 2012 Datacenter virtual machines. The virtual machines were each configured with a single application volume (E: drive) provisioned on EqualLogic storage. Once the group and servers were displayed in ASM, ESG Lab quickly selected one of the volumes from *Server1* and easily created an application-consistent snapshot, called a Smart Copy. An easy-to-follow wizard was used to configure the initial Smart Copy, while ESG Lab later configured some advanced scheduling settings, like enabling a repeat task for a Smart Copy Set with a defined retention policy. Figure 5 highlights some of the steps throughout the process.

Figure 5. Host Integration Tools for Microsoft – Auto-Snapshot Manager



Why This Matters

According to ESG research, increased use of server virtualization and managing data growth are among the most-cited IT priorities reported by midmarket organizations, defined as having between 100 and 999 employees.⁴ As these organizations broaden their virtualized environments and their data continues to grow, they are looking for more integrated solutions with a low TCO, ease of implementation, and ease of management to help make their purchasing decisions easier.

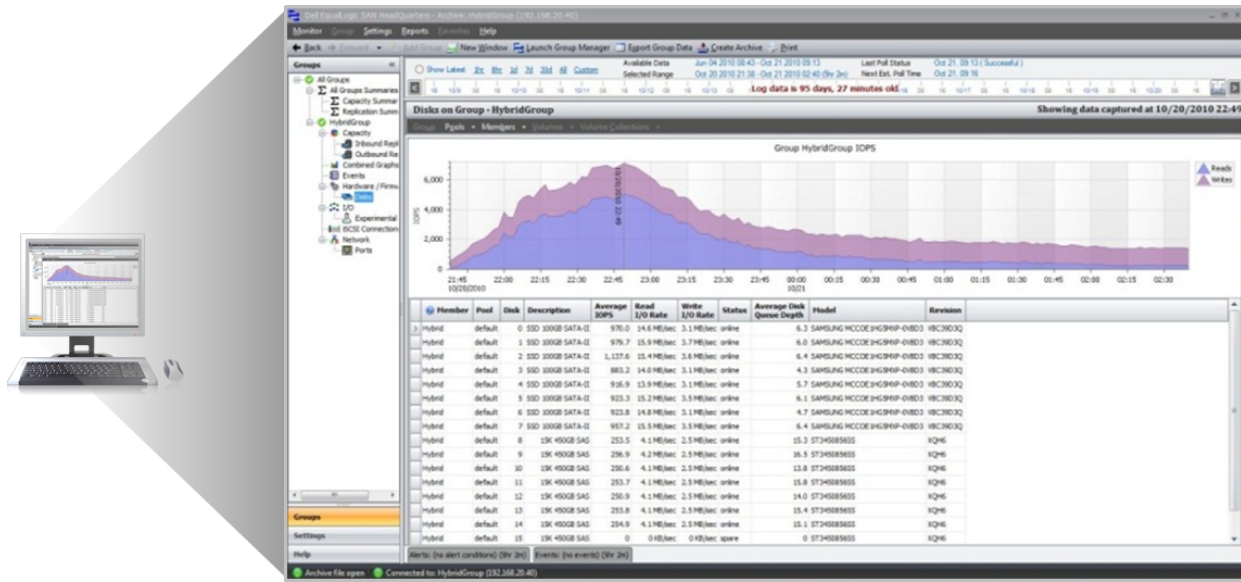
ESG Lab validated that EqualLogic host integration tools for VMware and Microsoft create an efficient and effective way to simply manage virtualized environments with even the strictest SLAs. The Dell Virtual Storage Manager for VMware provided a sound platform for provisioning, managing, and protecting all aspects of a virtualized storage infrastructure. With Microsoft, configuring and managing application-aware snapshots through Auto-Snapshot Manager was also easy and worked seamlessly with the latest Windows Server 2012 operating system.

Support and Monitoring with SAN Headquarters 3.0

Dell EqualLogic SAN Headquarters (SAN HQ) is a tool that provides advanced support and monitoring of Dell EqualLogic storage systems. SAN HQ serves as a central management point to access detailed performance and event data across all EqualLogic groups within an IT infrastructure. Organizations can monitor real-time and historical performance data to help optimize resource utilization. SAN HQ can also help reduce backup windows and enhance data protection by monitoring replication performance. With a single view of the storage infrastructure, IT administrators can not only save time, but also, because SAN HQ comes at no additional charge, save money. Figure 6 shows a screenshot of SAN HQ.

⁴ Source: ESG Research Report, [2013 IT Spending Intentions Survey](#), January 2013.

Figure 6. Dell EqualLogic SAN Headquarters 3.0



New in SAN HQ 3.0 are improvements to SupportAssist to help enhance the Dell customer support experience. Improvements include:

- Tracking and status updates of EqualLogic service cases.
- Expansion of automatic support case creation and notifications.
- Collection of data directly from EqualLogic PS Series storage arrays.
- Reduction of manual operations needed for support and problem resolution.
- Enablement of proactive customer support.

Why This Matters

Requirements to monitor data continue to grow along with the data itself. Not having a view of the entire storage infrastructure makes it difficult for IT administrators to quickly respond to business needs and requirements. Using advanced monitoring tools to help examine performance and resource utilization would help, but finding a solution that is easy to use and cost-effective remains a difficult task.

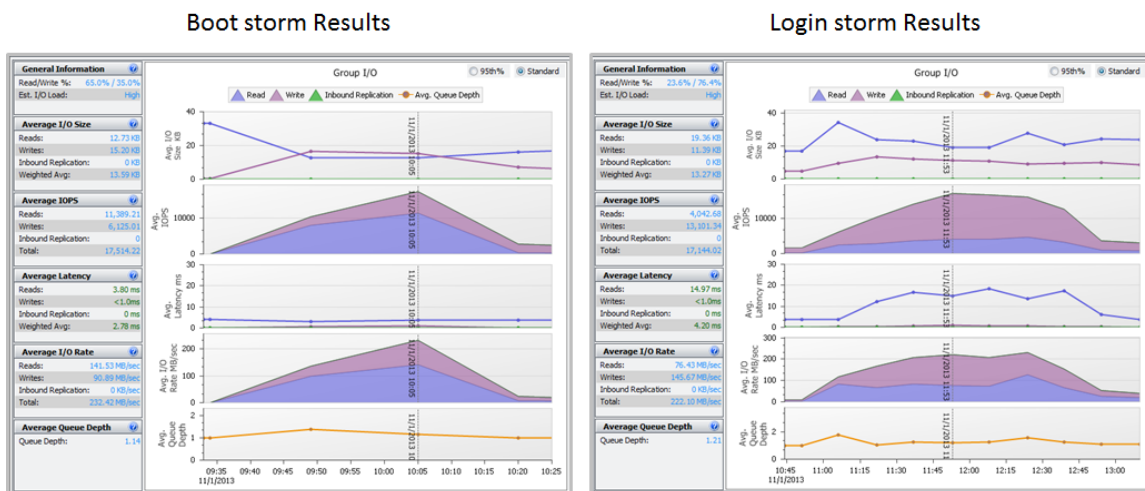
At no extra charge, SAN Headquarters is an advanced monitoring tool to help IT professionals not only save money, but also time. With a single interface to monitor all real-time and historical performance data within the storage infrastructure, ESG Lab was impressed with how system downtime could be minimized, resource utilization could improve, and cost could be held in check.

Performance in VDI Environments

For organizations looking to reduce the cost and complexity commonly associated with managing a large number of client machines, virtual desktop infrastructures (VDIs) offer a great opportunity. Organizations can improve provisioning times, reduce operational expenditures, improve user mobility, and enhance data security, but between high-capacity and performance requirements, VDI deployments can also place a heavy burden on storage infrastructures. EqualLogic leverages SSDs in its new hybrid storage arrays to store commonly used data, while persistent data gets stored on 10K SAS drives. Dell also offers a VDI configuration tool, which takes an organization's VDI requirements and recommends the appropriate reference architecture as an ideal starting point.

With a goal of understanding the benefits EqualLogic brings to VDI environments, ESG Lab audited performance results in a simulated 2,000-user VDI environment. Using a single EqualLogic PS6210XS hybrid storage array and VMware Horizon View, common VDI workloads including boot storms, login storms, and steady states were measured and monitored in SAN HQ. The results from boot-storm and login-storm testing are shown in Figure 7.

Figure 7. VDI Performance Test Results



The PS6210XS array delivered a high level of boot-storm performance, reaching a peak of 17,514 IOPS (8.7 IOPS per VM) with less than 3ms average latency. All 2,000 virtual desktops were fully booted and available in about 25 minutes. For the login storm, the 2,000 pre-booted virtual desktops were configured to launch over a period of about 30 minutes. Peak IOPS reached as high as 17,144 during the testing, which totals to 8.5 IOPS per VM. For steady state testing, the I/O profile was changed to 24% read and 76% write. The PS6210XS easily delivered the required IOPS of around 16,733 IOPS or 8.3 IOPS per VM with the average latency coming in around 4.7ms, well under the standard 20ms threshold.

Why This Matters

A top concern with virtual desktop infrastructures revolves around performance. In fact, in a recent ESG survey, IT managers indicated that performance was one of their largest challenges when it comes to implementing desktop virtualization.⁵ Critical concerns like predictable performance scalability remain on the top of IT administrator's minds with a multi-user, shared VDI environment running many diverse applications. A burst of I/O activity like a boot storm or login storm can quickly bring the virtual desktop environment to its knees, leading to poor response times and lost productivity for everyone.

ESG Lab has confirmed that the EqualLogic PS6210XS storage array delivered scalable and predictable VDI performance in a 2,000-user VDI environment. The hybrid storage array helped simplify deployment with a configuration tool, improve performance with intelligent storage tiering, and reduce deployment costs through the use of cost-effective, high-capacity storage media.

⁵ Source: ESG Research Report, [Desktop Virtualization Market Evolution](#), February 2013.

ESG Lab TCO Analysis

ESG Lab modeled and analyzed the total cost of storage ownership over five years for two theoretical customers at the small and large ends of the “medium-sized business” segment. The smaller company was modeled requiring approximately 112TB of block-based storage capacity to meet the needs of common business applications, and the larger company was modeled with a requirement of approximately 218TB. Each model began the first year with lesser capacity and performance needs and the requirements for each increased in the third year. The capacities listed above represent the final storage capacity at the end of the five-year analysis period.

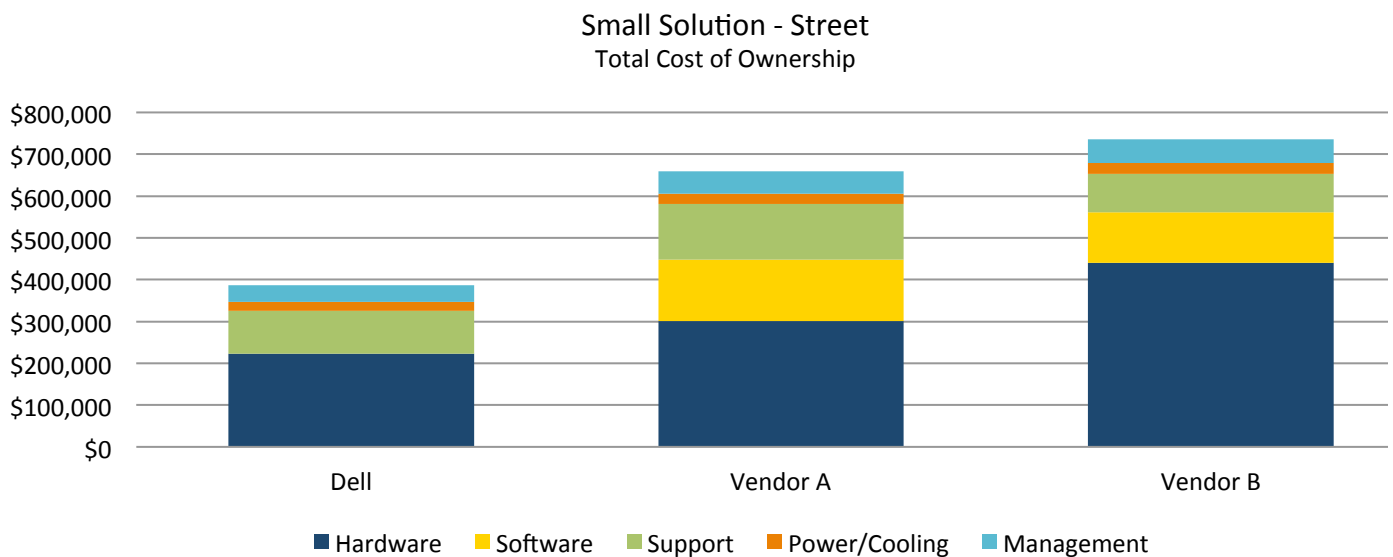
The model included the use of SSDs along with SAS and SATA drives. A requirement of 5%-7% of SSD capacity was required in all configurations with the exception of the initial small configuration deployment. SSD capacity was required to be used both for caching (SLC or equivalent required) and as an automatic storage tier (MLC was accepted to reduce cost). It should be noted that Dell EqualLogic was the only solution to leverage SLC for both applications. The ratio of drive types required for each configuration is listed in the Appendix.

In both scenarios, the companies each had a remote site to support remote replication for disaster recovery (DR). Performance spindles (SSD and SAS) were replicated to SAS drives with an 85% capacity requirement on the remote side. NL-SAS spindles were replicated to NL-SAS drives on the DR side with a 100% capacity requirement. To reduce costs, the DR configuration was allowed to deploy a slightly lower performing storage system, required less software, and did not require the use of any flash or auto-tier capability.

The ESG Lab analysis was quantitative in that it compared the cost of acquisition (hardware and software), support, management (including manpower), and power and cooling over five years. ESG compared a Dell EqualLogic iSCSI SAN solution with competing solutions from two other industry-leading storage vendors. The latest generation PS6210 series used during ESG Lab hands-on testing formed the basis for the comparison. The five-year timeframe included the need for an equipment upgrade at the three-year mark due to an unanticipated spike in capacity and performance requirements.⁶

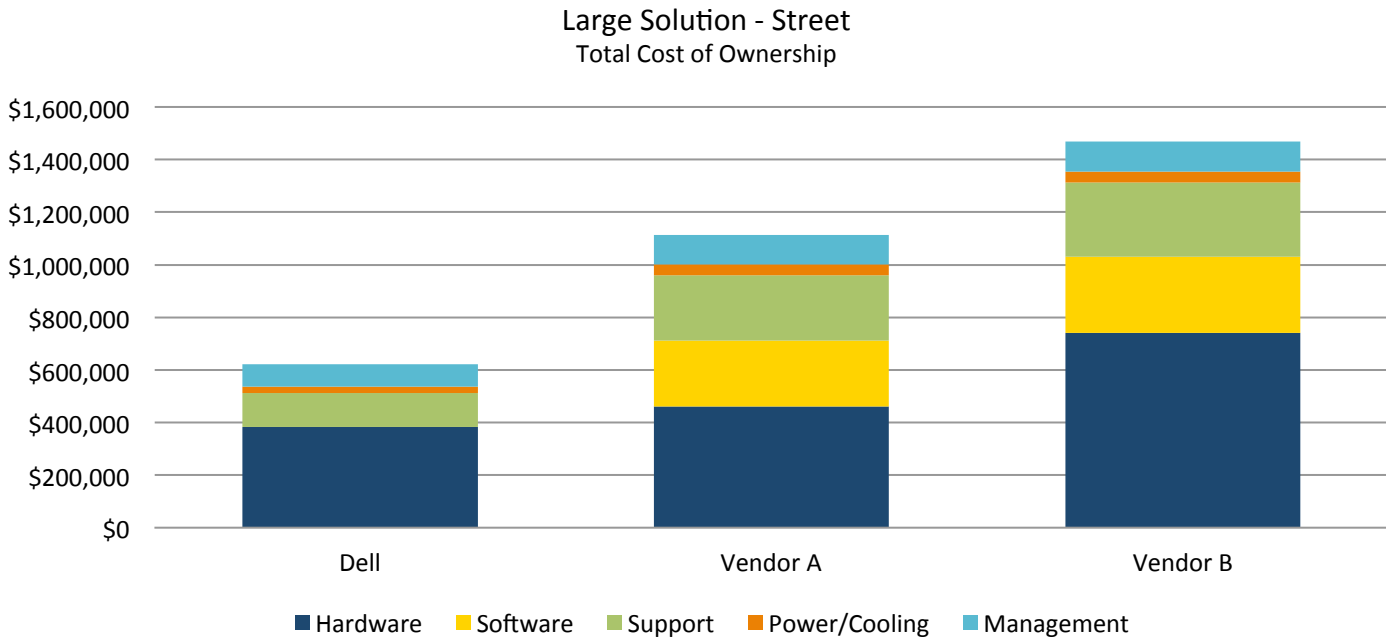
Figures 8 and 9 compare Dell with two other leading storage vendors for a small and a large storage solution. ESG Lab used a modeled street price including a 45% discount, as opposed to a list price, because the street price better represents what a customer would actually pay based on common discounts and savings opportunities.

Figure 8. Small Storage Solution – Street Price Comparison



⁶ For more details, please refer to the Appendix.

Figure 9. Large Storage Solution – Street Price Comparison



Dell EqualLogic’s total cost of ownership is impressively lower over a five-year period than its competitors. The price difference can be attributed to a combination of cost savings in hardware, software, support, and management. The primary price-differential factor can be summed up in one word: easy.

Hardware savings are realized by taking advantage of the multigenerational compatibility of all Dell EqualLogic hardware. The highest performing 64-bit hardware was combined with the most cost-effective 32-bit high-capacity hardware to design the perfect system to address each configuration. Because all hardware works seamlessly together, the unexpected increase in capacity and performance requirements do not necessitate disruptive upgrades. Because Dell hardware is designed to work together seamlessly and run the same code, Dell is able to limit its own support costs and pass these savings on to its customers.

As mentioned, Dell software is provided at no additional fee. EqualLogic Group Manager, HIT kits, VMWare integration, and SAN Headquarters are included with all PS series hardware. The simple, easy-to-use wizards help provision, manage, monitor, analyze, and protect all of the organization’s data. Dell continues to improve and increase the capabilities of its software, and customers can be assured that future software functionality will not require additional expenditures.

Serviceability also accounts for a significant difference in cost when comparing Dell with other storage vendors’ systems. The savings come from the easy-to-use software tools and EqualLogic’s ability to utilize hardware across generations—the last 12 generations of EqualLogic hardware can run the latest firmware and be mixed within the same storage pool. Moreover, after adding a new EqualLogic array, an older array can be evacuated and retired in one click, thereby completely eliminating costs associated with the migration of old data to new systems. It also provides significant cost savings when adding a new system to an existing deployment.

Finally, while many IT vendors have made efforts to reduce the complexity of management, some complex tasks still require vendor-specific storage specialists or the intervention of professional services to provision, manage, and configure the storage infrastructure. These same tasks can be achieved on Dell EqualLogic much easier because of the management simplicity that the software provides. A storage generalist is sufficient for nearly all tasks, resulting in significant savings in administrative manpower.

Table 1. TCO Five-year Cost Breakdown for Small Configuration

Small Configuration	Dell EqualLogic	Vendor A	Vendor B
Hardware	\$222,151	\$301,226	\$440,836
Software & Licenses	\$0	\$147,030	\$120,654
Support	\$103,416	\$133,339	\$91,934
Power & Cooling	\$20,606	\$23,317	\$26,014
Management & Service	\$40,896	\$54,787	\$56,506
Total	\$387,068	\$659,698	\$735,944

Table 2. TCO Five-year Cost Breakdown for Large Configuration

Small Configuration	Dell EqualLogic	Vendor A	Vendor B
Hardware	\$382,467	\$461,072	\$740,232
Software & Licenses	\$0	\$250,087	\$290,628
Support	\$129,270	\$247,639	\$282,258
Power & Cooling	\$25,464	\$42,979	\$40,123
Management & Service	\$84,726	\$110,675	\$114,275
Total	\$621,927	\$1,112,452	\$1,467,517

What the Numbers Mean

- Dell EqualLogic has the lowest total cost of ownership.
- In the small storage solution, Dell (\$387,068) costs 41% and 47% less than nearly identical offerings from Vendor A (\$659,698) and Vendor B (\$735,944).
- In the large storage solution, Dell (\$621,927) costs 44% and 58% less than nearly identical offerings from Vendor A (\$1,112,452) and Vendor B (\$1,467,517).
- Dell charges no additional license or maintenance fees for any software used with PS series storage systems. This can be seen in the yellow bars in Figures 8 and 9. Many times, when things are offered for no additional charge in one area, another area increases to make up the difference. As revealed in Tables 1 and 2, Dell has not increased costs in other areas to make up for the free software.
- The management costs associated with Vendor A and Vendor B are up to 28% higher than with Dell. This includes the cost of migrating old data, system upgrades after three years, and manpower. This also assumes that you use the simplest management option and take advantage of the latest integration software from all vendors.
- The latest generation PS6210XS storage system takes advantage of the largest SLC SSDs available today (800GB). In the TCO analysis, the Dell EqualLogic storage array utilizes higher performing SLC drives in the SSD storage tier, while the other vendors' solutions included lower performing MLC drives.
- With lower hardware costs and no software costs, Dell support costs are also significantly lower than those of both competing vendors.

The Bigger Truth

Finding ways to constantly improve operational efficiency is a staple in any IT environment. Among the most difficult challenges to achieving this goal is meeting the ever-changing demands of continuously growing data sets while spending the least amount possible. This “do more with less” mentality instantly backs IT administrators into a corner, forcing them to prioritize certain features and functions. The biggest question then becomes, “What if my organization needs *all* of the features and functions on my priority list?”

Dell EqualLogic storage is designed to be simple. Simple to manage, simple to scale, and simple to maintain. The latest announcement of the PS6210XS storage system shows that simple can also be powerful. Dell continues to lower operational costs by simultaneously enriching and simplifying its software, while also streamlining its support process. Though every organization has unique requirements, EqualLogic has released a solution that can meet even the lengthiest requirements list.

ESG Lab confirmed that the latest Dell EqualLogic PS Series storage solution and firmware help simplify deployment and management of storage, while improving performance monitoring and scalability, all at an affordable price. EqualLogic Group Manager was used to manage 12 generations of PS Series storage arrays. Provisioning storage, configuring snapshots, and creating access group policies was made simple through an intuitive GUI and easy-to-follow wizards. This simplicity transitioned over to VMware and Microsoft virtual environments with improvements to their respective host integration tools. SAN HQ 3.0 improved performance monitoring of real-time and historical data, and enhanced the customer support experience through SupportAssist. ESG Lab used the improved SAN HQ to measure high levels of VDI performance with a hybrid storage array that mixed both SSD and SAS drives to meet the demanding requirements put on storage when handling virtual desktop boot storms, login storms, and steady states.

ESG Lab confirmed that, over a five-year period, Dell EqualLogic has the lowest TCO for small and large sized storage configurations when compared with other leading IT storage vendors. Thanks to an aggressive pricing model with all-inclusive software and licensing, the cost of acquisition was significantly lower than the competition. By providing a simpler way to manage, maintain, and upgrade a continuously growing infrastructure, organizations can save hundreds of thousands of dollars in operational costs over a system’s lifetime. The EqualLogic architecture and pricing model was designed many generations ago and continues to deliver one of the lowest TCOs in the industry today.

Dell EqualLogic storage solutions continue to impress ESG Lab, with not only their simplicity, but also, more importantly, their affordability. This extends past the initial cost of acquisition to the notable return on investment, as proven by ESG Lab’s model. As organizations push toward operating at maximum efficiency at the lowest cost, they would be hard pressed to not consider the simplicity, manageability, flexibility, and affordability of the latest Dell EqualLogic PS Series storage solution.

Appendix

TCO Assumptions

A modeled five-year TCO of a small and large organization (primary site and DR site) was created by ESG Lab comparing Dell EqualLogic with two other leading storage vendors in the same market.

The small configuration model assumes that a growing company makes a cost-effective purchase in the first year without knowledge of future growth requirements. In the third year, both the company’s capacity and performance requirements have grown. The company addresses the capacity requirements with NL-SAS drives and the performance requirements with additional 10K SAS drives and a small amount of flash (5% of total capacity). The model assumes that the flash is deployed to be used in both a caching and auto-tiered functionality.

At the DR Site, 85% of the total primary site performance storage capacity (SSD+10K SAS) is required. All performance capacity at the DR site is stored on 10K SAS disks—no flash is required at the DR site. NL-SAS capacity at the DR site is 100% of the primary site.

The capacity and drive technology mix for the small configuration is shown in Table 3.

Table 3. TCO Modeled Primary Site Storage Requirements: Small configuration

Site Size	Year of Ownership	Total Managed Storage Capacity	Percent of Total Storage Capacity		
			SSD	10K SAS	7.2K NL-SAS
Primary Site	1	38TB	0%	35%	65%
	3	112TB	5%	30%	65%
DR Site	1	36TB	0%	33%	67%
	3	105TB	0%	33%	67%

The large model assumes that a larger established organization demands more predictable and scalable performance. In addition to the SAS and NL-SAS mix, the first-year purchase includes a small amount of flash (7%), which is deployed for both caching and for use in auto-tiering. The third-year purchase includes a larger purchase of NL-SAS capacity, additional 10K SAS drives, and assumes that a minimum level of 5% SSD capacity is maintained.

The capacity and drive technology mix for the large configuration is shown in Table 4.

Table 4. TCO Modeled Primary Site Storage Requirements: Large Configuration

Site Size	Year of Ownership	Total Managed Storage Capacity	Percent of Total Storage Capacity		
			SSD	10K SAS	7.2K NL-SAS
Primary Site	1	73TB	7%	28%	65%
	3	218TB	5%	18%	77%
DR Site	1	69TB	0%	33%	67%
	3	210TB	0%	33%	67%

Aside from hardware, software, and support costs for both, the model also took into account power and cooling and management expenses. Power and cooling costs were estimated to be 9.3 cents per kWh based on the average retail cost of electricity in the U.S. in December 2010 as documented by the U.S. Energy Information Administration (<http://www.eia.gov/electricity/state/>).

Pricing data was gathered from publicly available sources and quotes were provided to ESG Lab by two resellers as of December 2013.

Management costs were calculated based on average salaries and common tasks associated with the management of an IT infrastructure. It was assumed that three levels of users perform management tasks:

- Dedicated storage administrators or professional services to perform complex system administration (\$55/hour)
- Experienced IT administrators to perform basic storage functions and VMWare and MS Integrated administration (\$45/hour)
- Basic IT staff to perform application integrated tasks and repetitive storage functions (\$40/hour)

Average salaries were calculated by comparing a number of related IT roles across various IT organizations. (<http://www.salarydom.com>).

ESG modeled the expected management contribution from each level of user based on knowledge of each storage vendor's current software portfolio. The tasks ESG Lab modeled were: monitor, plan, provision, expand, tier, snap setup, snap recover, DR setup, DR test, network configuration. Two other larger tasks included in the management costs were the migration of old data to the newly deployed infrastructure and the addition of a new system to an existing infrastructure. Each task was assigned an amount of time to complete (in minutes) and a monthly frequency.



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