Lab Validation Report

Consolidating Workloads with VMware and Pure Storage

Tested Workloads: Desktop Virtualization using Horizon View and Server Virtualization for Email and Databases

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Contents

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 Pure Storage and VMware.

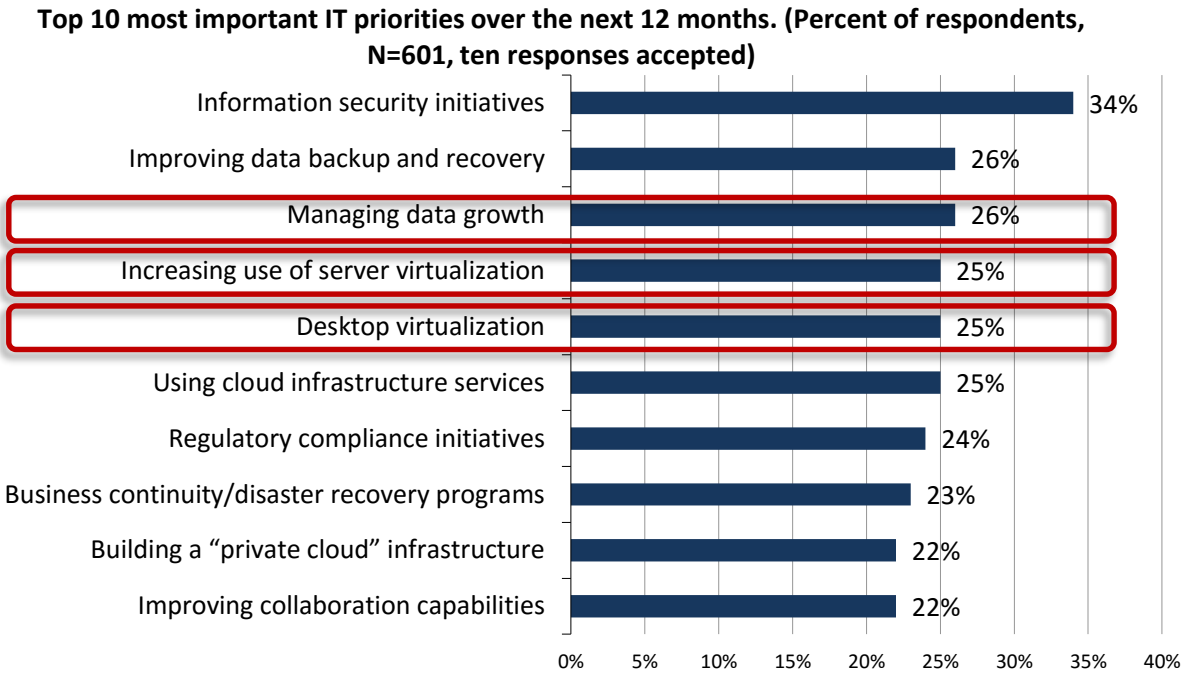
Introduction

This ESG Lab Validation report documents hands-on testing and validation of the Pure Storage FlashArray//m storage system. The goal of the report is to prove that Tier-1 application workloads such as desktop virtualization, databases, and email can be run on a shared, consolidated storage array without compromising service levels, delivering consistent sub-millisecond response times. A 5000 user enterprise was simulated to validate this premise, running on a single all-flash storage array. In addition, failure scenarios were introduced to test resiliency.

Background

The adoption of server virtualization is pervasive among enterprise and midmarket organizations today, and increased use of the technology was identified by one in four respondents as one of their most important IT priorities for 2015.[1] ESG's *2015 IT Spending Intentions* also revealed that desktop virtualization and data growth management are also in the top five most frequently cited IT priorities among respondent organizations, as they have been since 2011.

Figure 1. Top Ten Most Important IT Priorities for 2015



Source: Enterprise Strategy Group, 2015.

In ESG Lab's experience, desktop and application virtualization can present some of the most complex and demanding storage workloads in the data center. Organizations are tasked with providing a high-quality, predictable, and productive computing environment for an ever growing number and range of virtual desktop users. For organizations that have deployed or are considering deploying desktop virtualization, performance is one of the most important metrics to consider in gauging the success of their deployments.

In addition, enterprise application environments have become increasingly unpredictable as their underlying IT infrastructure grows in complexity, size, and criticality to the business. Mission-critical business application performance is highly sensitive to storage performance and latency, and highly dependent on the resilience of the enterprise IT environment. ESG confirmed in a recent research report[2] that flash-based systems have become prevalent in these environments due to their ability to provide extremely high performance at very low response times.

[1] Source: ESG Research Report, *2015 IT Spending Intentions Survey*, February 2015
[2] Source: ESG Research Report, *Next-generation Storage Architectures*, March 2015

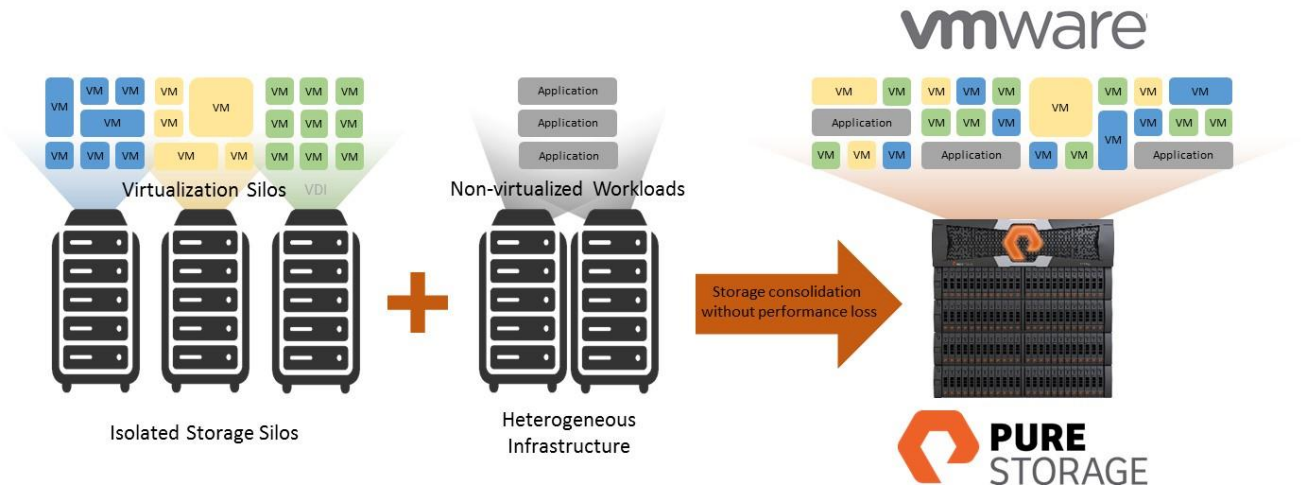
It's not surprising that many organizations deploying desktop virtualization are doing so with dedicated storage systems separate from the rest of their infrastructure. A number of factors drive IT's need to maximize the value of their flash-based storage, including the wide variety and number of client devices; "always-on" expectations for IT services; workforce mobilization; regulatory compliance mandates; tightening security requirements; and corporate demands.

The Pure Storage FlashArray//m

With the advent of software-defined storage, questions have been raised about the value of custom hardware: in particular, whether storage hardware should be considered a commodity that leverages software exclusively for innovation and development. With the FlashArray//m architecture Pure Storage has responded, and their answer is a clear "NO."

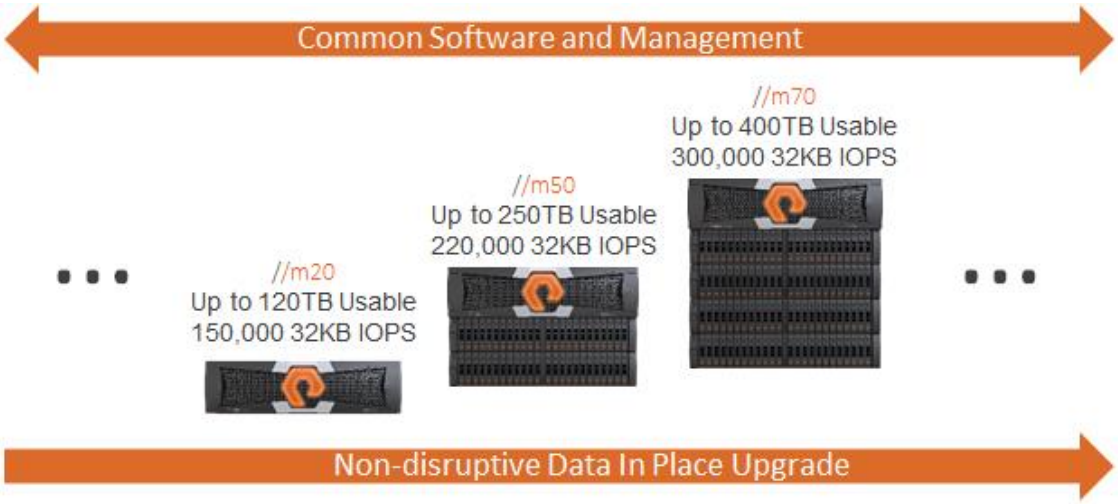
FlashArray//m is designed with performance, density, and power efficiency in mind, without compromising the modularity or upgradeability that Pure's customers have come to expect. FlashArray//m offers data-in-place non-disruptive upgrades of the software and hardware components without impact to performance.

Figure 2. Storage Consolidation with Pure Storage FlashArray//m



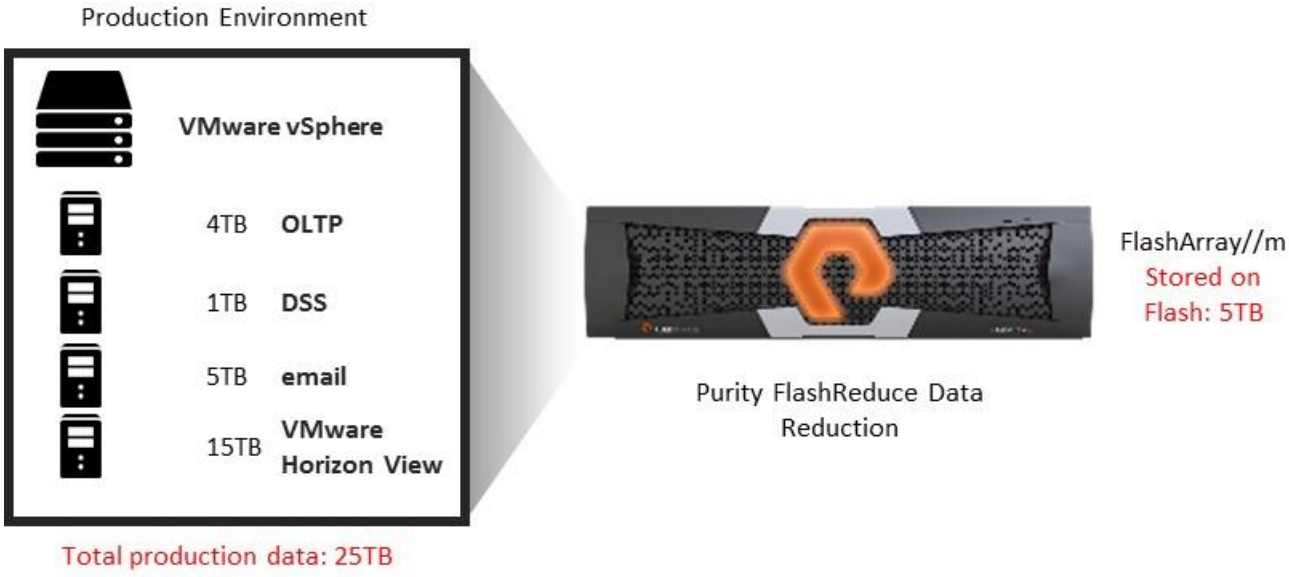
It's important to note that the performance numbers shown in Figure 3 are for 32KB IOPS. Many vendors commonly report 4KB IOPS results because systems can service higher numbers of smaller IO requests. ESG Lab has observed that real-world environments are dominated by I/O that averages around 32KB. FlashArray//m is designed to adapt automatically to any I/O block size to provide optimal performance, scalability, and data reduction without application tuning.

Figure 3. Pure Storage FlashArray//m



Pure Storage considers its data reduction technology, FlashReduce, to be a significant differentiator. FlashReduce automatically deduplicates and compresses live data as it is written to the array. Pure claims an average reduction ratio of 5:1, or 80%, but this varies across different types of applications. Figure 4 shows an example of what this would look like in a production environment. It's important to note that the numbers included here do not include thin provisioning savings; Pure Storage volumes are automatically thin provisioned, which would add to the savings.

Figure 4. Pure Storage FlashArray//m Data Reduction



Often, the perception of commodity hardware is associated, correctly or incorrectly, with lower storage costs. Ultimately, however, the goal should be to provide value to the customer. The values that Pure aims to provide are ambitious, including but not limited to:

- **Simplicity** — The modular design provides online data-in-place upgrades of hardware and software along with the support of capacity expansion shelves. All software features, including HA, DR, snapshots, and management, are included at no additional cost.
- **Manageability** — Pure1 provides integrated management and support in a single cloud-based platform, real-time storage analysis with proactive alerting, and monitoring from anywhere with no management installation or maintenance required.
- **Density** — support for up to 120TB usable capacity in a 3U chassis, 400TB in an 11U chassis.
- **Longevity** — leverages the modularity of the FlashArray//m for greater generational upgrade flexibility; controller upgrades every three years are included in maintenance, as are all software updates.
- **Power efficiency** — Pure is quite energy efficient; 120TB of usable capacity consumes less than 1kW.
- **Resilience –** Pure uses a redundant, hot-swappable hardware design with stateless controllers and distributed data mirroring across non-volatile RAM. Data are protected from failures modes specific to flash with a dual parity system called RAID-3D.

Consolidation derives economic savings in the data center and Pure enables this with their data reduction technology.

ESG Lab Validation

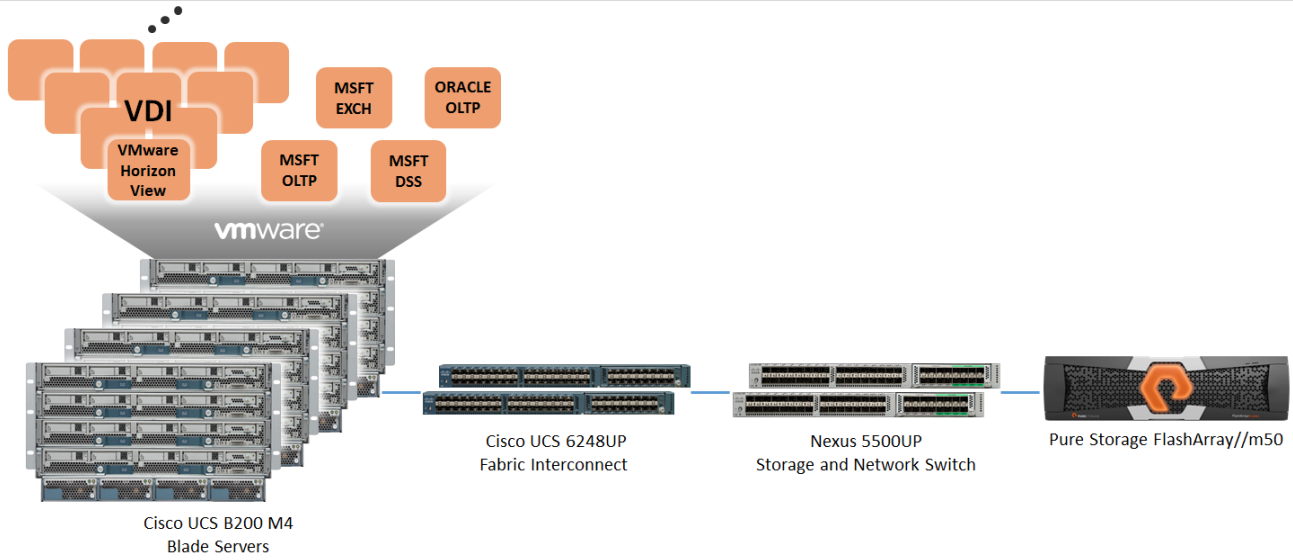
ESG Lab performed hands-on evaluation and testing of Pure Storage FlashArray//m with VMware at Pure Storage facilities in Mountain View, California. Testing was designed to validate the consolidation potential offered by a single FlashArray//m storage system with a focus on delivering high levels of predictable performance for multiple, simultaneously-running, tier-1 application workloads. The ability to sustain these high performance levels through various storage hardware failures was also tested.

Getting Started

ESG Lab began with a pre-wired and pre-configured test bed as summarized in Figure 5. A VMware vSphere 6.0 virtualized infrastructure was deployed on 32 Cisco UCS B2000 M4 blade servers, each leveraging a 12-core, 2.3 GHz processor with 256GB of RAM. Service profiles for all servers were created using a service profile template with vNIC and vHBA templates and the VMware adapter policy was selected for both. Boot-from-SAN functionality was configured by utilizing the private volume feature of the Pure FlashArray software. [3]

The servers were connected to redundant Cisco UCS 6248UP fabric interconnects via 10Gb Ethernet with the last eight ports of each interconnect configured as Fibre Channel (FC) ports. The interconnects were configured in End Host Mode for both FC and Ethernet and connected to redundant Nexus 5500UP storage and network switches, which were also configured to support both FC and Ethernet. The switches were then connected via two pairs of 8GB FC cables to a Pure Store FlashArray//m50 running Purity 4.5.1 software with two drive packs.

Figure 5. ESG Lab Test Bed Simulating a 5,000 User Enterprise



Five common, mission-critical applications were deployed within the VMware virtualized infrastructure, including a VDI environment, three unique database environments, and an e-mail environment. The VDI environment was managed and controlled by VMware Horizon 6, the virtual desktop host platform for VMware vSphere. Fifteen-hundred non-persistent, linked-clone virtual desktops were created from a Horizon View desktop image template, which leveraged a 32GB base image. Each desktop was configured with Windows 7 Enterprise edition (64-bit) and utilized two vCPUs, 4GB of RAM, one vmxnet3 vNIC adapter, and one LSI Logic virtual storage adapter. Installed applications included Microsoft Office 2010, Adobe Reader 11, Flash Player Active X, Doro 182, Internet Explorer, Archive-7Zip, and Windows Media Player.[4]

Two Microsoft SQL Server 2014 Enterprise Edition instances were created, one as an OLTP database and the other as a data warehouse for decision support. The OLTP database instance ran in a VM with 128GB of RAM, ten vCPUs, and four vSockets. A 300,000 user database was spread across a file group consisting of nine files and totaled 3.2TBs. The data warehouse database consisted of a primary data file that totaled 656GB with a log file of 297GB.

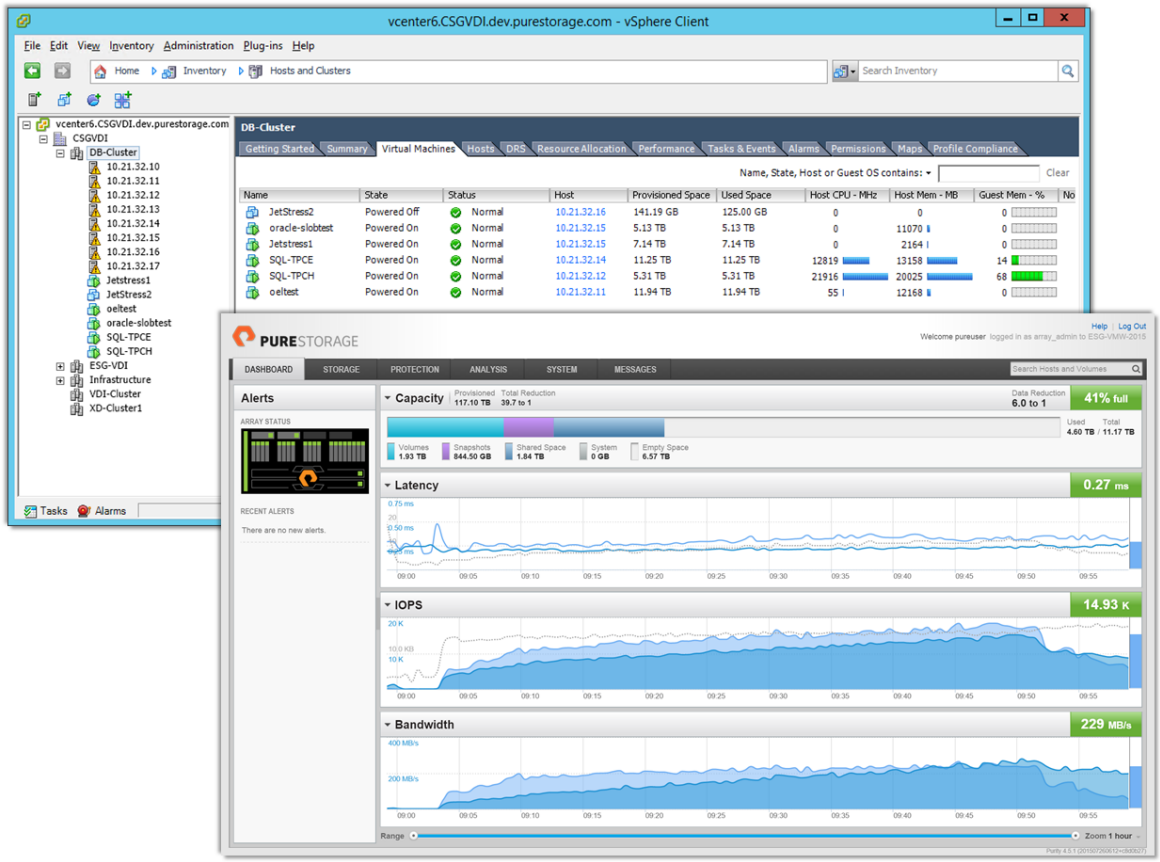
[3] For more information on this configuration, see the FlashStack Converged Infrastructure solution for VDI: http://www.purestorage.com/solutions/flashstack/

[4] Additional information about the test bed can be found in the Appendix.

For e-mail, testing leveraged a Microsoft Exchange Server 2013 environment that consisted of 5,000 mailboxes with a size of 1GB each. The e-mail database was configured with 4.91TB and a log file that was set to truncate. Lastly, a 1TB Oracle OLTP database was configured to support up to 128 concurrent users.

ESG Lab leveraged both the VMware vCenter and Pure Storage web management interfaces to manage and monitor the deployed applications. Figure 6 shows the five running virtualized applications in VMware vCenter, while the Pure Storage dashboard shows alerts, real-time performance metrics, and capacity information for those applications. It's important to note that the Pure Storage Dashboard is available as both a native web GUI and as a vSphere web client plug-in. In this report, all Pure Storage screenshots are taken from the native GUI.

Figure 6. Test Bed Monitoring from VMware vCenter and Pure Storage Web Management Interface



Once the workloads were up and running, ESG Lab also tested the resiliency of the solution by simulating various component failures with a goal of understanding the minimal performance impact on the collective workloads.

Why This Matters

In a dynamic IT environment, the ability to quickly provision and manage data services is crucial for enabling IT administrators to meet the demands of the business. As IT is being asked to do more with less, they need flexible, easy-to-use tools that enable efficient provisioning and management with minimal effort. This is especially true in virtual server environments, where application consolidation can help improve resource utilization while meeting strict budget requirements.

By leveraging a Pure Storage FlashArray//m as the underlying storage system, organizations gain peace of mind that all of their most demanding tier-1 virtualized applications can run simultaneously and still meet their performance and availability SLAs. Organizations gain the benefit of centralized storage management via the Pure Storage management interface, as well as consolidated VM management via the VMware vCenter management interface.

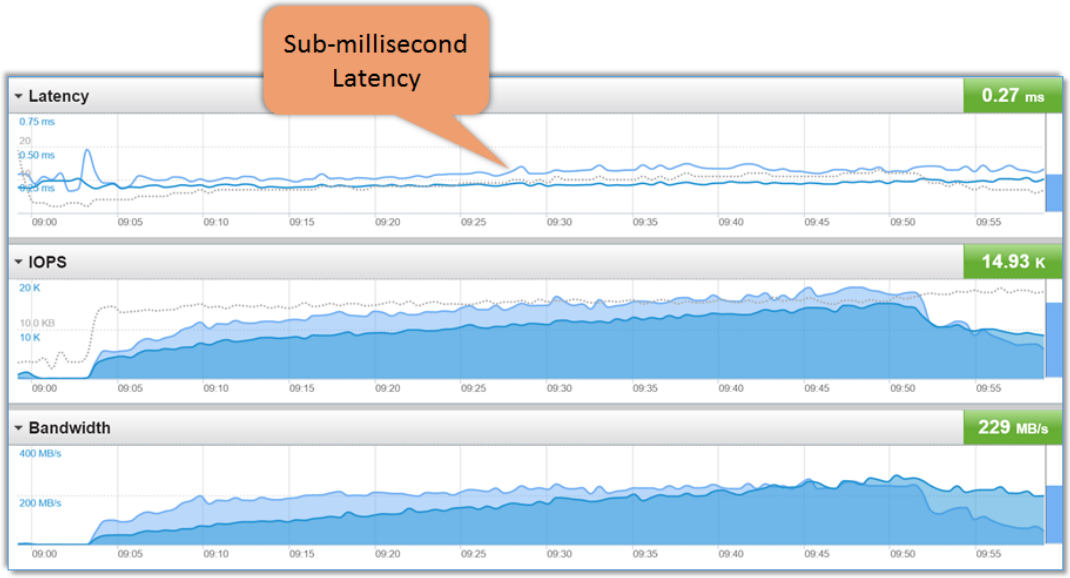
Consolidating Workloads

ESG Lab leveraged the virtualized infrastructure to run performance tests on each of the five deployed applications simultaneously with a goal of showing how the Pure Storage FlashArray//m can easily satisfy the demanding performance requirements of a consolidated, virtualized infrastructure. The test process consisted of starting one of the applications workloads, waiting for steady state, and then launching the next applications until all five were running simultaneously. Throughout the process, ESG Lab used the Pure Storage management interface to monitor latency, IOPS, and throughput of each individual application, as well as the cumulative performance metrics.

The first workload was driven by Login VSI to emulate the activity of 1,500 Horizon View virtual desktops. Login VSI is an industry-standard virtual desktop infrastructure (VDI) benchmarking tool that validates application performance and response times for various predefined VDI workloads with an ultimate goal of showing desktop density potential for a given set of hardware and software components. This is done by mimicking typical user behavior using well-known desktop applications like Microsoft Office, Internet Explorer, and Adobe Acrobat reader. For this phase of testing, a "heavy" workload was run to simulate the behavior of a typical "power user."

A log-on storm of the 1,500 virtual desktops was simulated, which represents a large number of end users launching their virtual desktops at the same time. This can often lead to high response times and degradation of services due to the overwhelming number of data requests. As shown in Figure 7, ESG Lab witnessed consistent, sub-millisecond latency as the workload ramped up and eventually hit steady state.

Figure 7. Horizon View Workload Ramp-up and Steady State



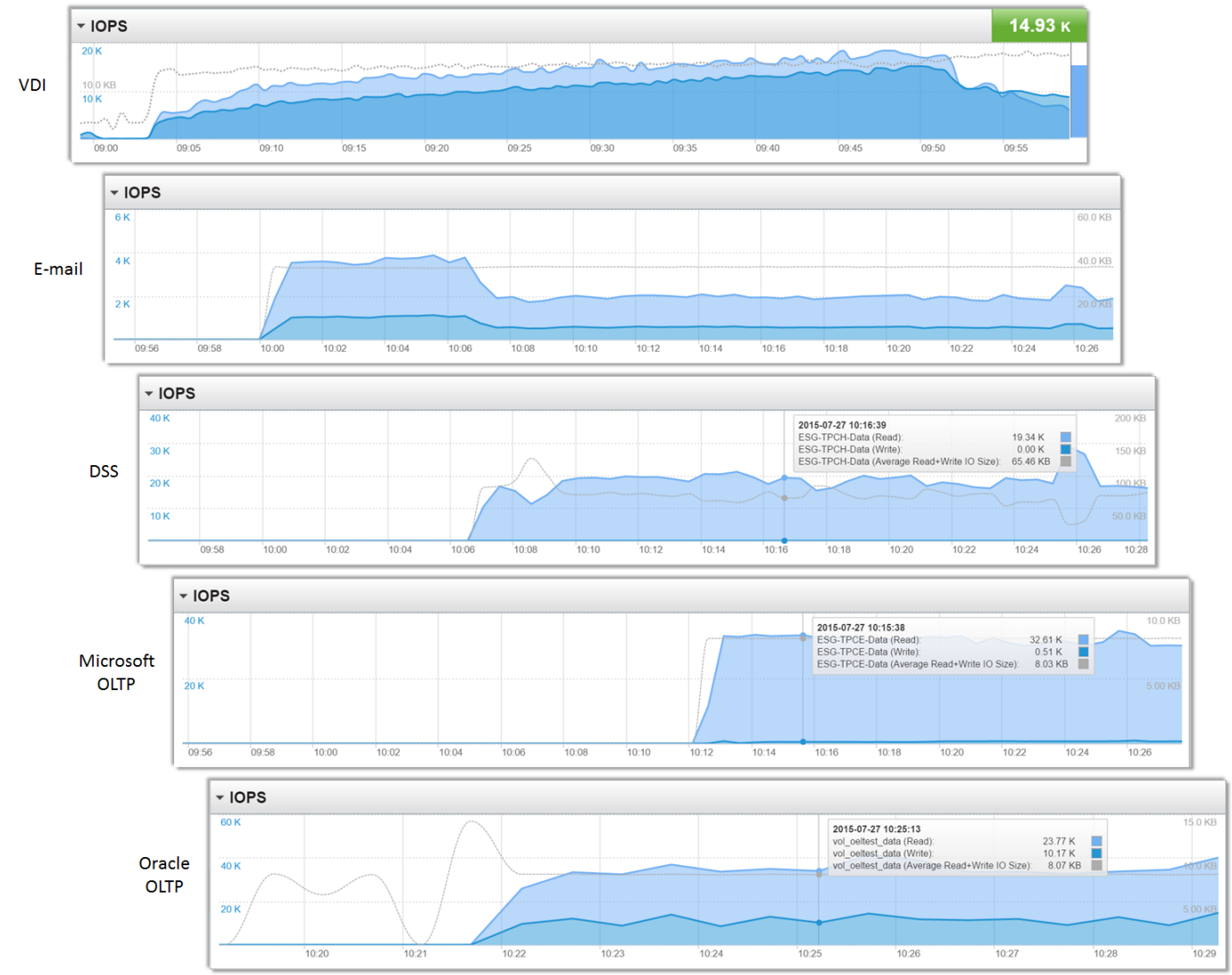
Next, the Microsoft Exchange Jetstress 2013 workload was used to emulate the storage activity of typical e-mail users. Jetstress simulates the Exchange database and log file loads produced by a specified number of users. Jetstress was configured to emulate up to 5,000 mailboxes per VM with a mailbox size of 1GB and an I/O rate of .5 IOPS per mailbox.

Next, the DSS workload was simulated using HammerDB, an industry-standard, open source database load testing and benchmarking tool. The test was configured with a scale factor of 700, 150 virtual users, 100 iterations, and a MAXDOP of 8. Once steady state was achieved, a proprietary Microsoft OLTP test tool was used to simulate the activity of thousands of Microsoft SQL Server users. The workload itself emulated the database activity of users in a typical online brokerage firm as they generated trades, performed account inquiries, and executed market research. The workload was composed of ten transaction types with a defined ratio of execution. Four of the transactions performed database updates, and the rest were read only.

For the last workload, an OLTP workload was run on an Oracle database. The widely adopted and publicly available Silly Little Oracle Benchmark (SLOB) kit was used to efficiently generate realistic system-wide, random, single-block, and application-independent SQL queries. The SLOB benchmark tool exercised all components of the server and storage subsystems by stressing the physical I/O layer of Oracle through SGA-buffered random I/O without being limited to a specific load-generating application.

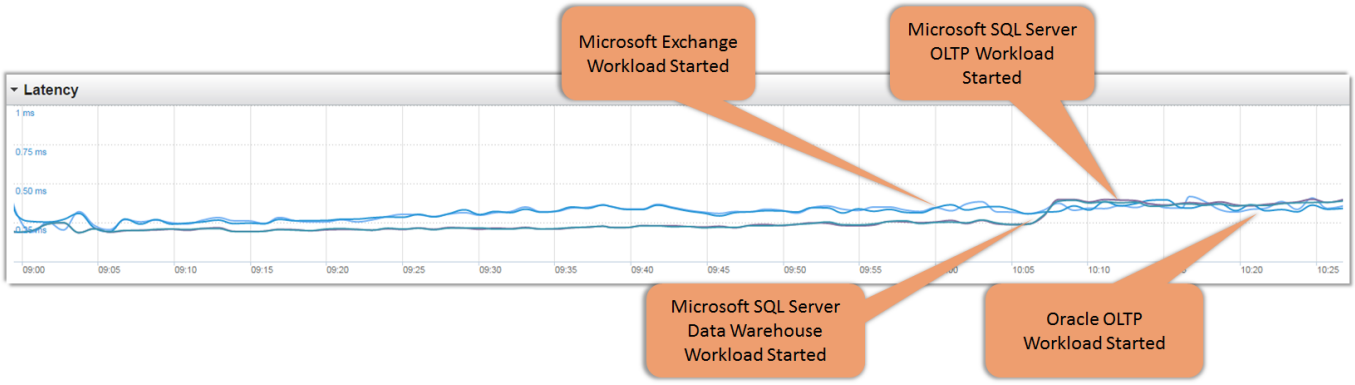
Figure 8 shows the total IOPS of each of the five workloads as they ramped up and hit steady state. The time intervals demonstrate that over the course of an hour and a half, all five applications were launched and hit steady state. It should be noted that latency was another performance metric that was measured and throughout the launching of each application, latency remained manageably low for each application, with response times remaining under 1ms in all cases.

Figure 8. Measuring Consolidated Workload Performance



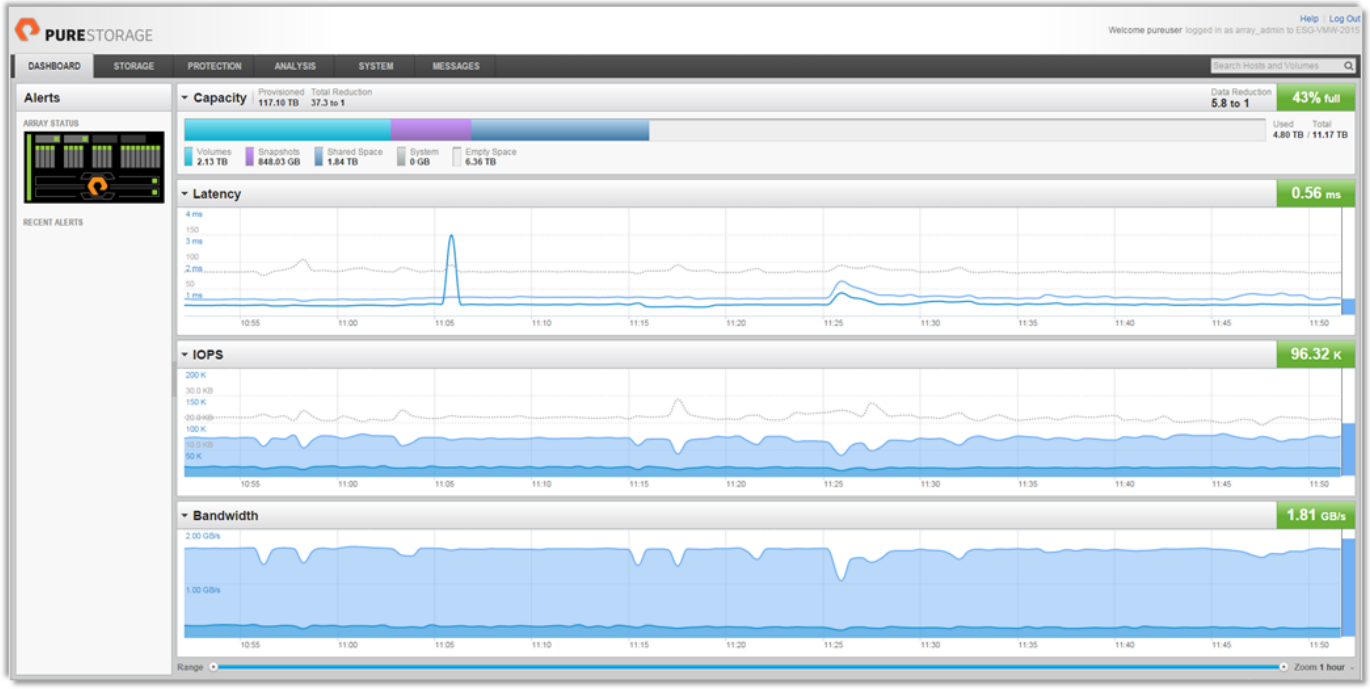
An important aspect of consolidating workloads is understanding the performance impact that each application could have on one another when run simultaneously. With that in mind, ESG Lab went back to the initial VDI workload and looked at each performance metric over the course of the hour and a half. As each application workload started and eventually hit steady state, there was little to no impact in performance to the initial VDI workload. This is crucial to delivering a virtual desktop environment that can meet the demands of end users who demand constant, uninterrupted access to their essential desktop applications. Figure 9 shows the I/O latency of the Horizon View workload as each application is started, with callouts pointing to the time intervals where workloads were started.

Figure 9. Measuring Consolidated Workload Performance



Once all the workloads were running simultaneously, ESG Lab navigated back to the main dashboard view of the Pure Storage management interface to view cumulative performance metrics. As shown in Figure 10, I/O latency of the simultaneously running simulated applications remained manageably low, while IOPS and throughput remained stable and predictable. The ability of the Pure Storage FlashArray//m to deliver consistent and predictable performance to all five application workloads simultaneously was impressive to ESG Lab. Each workload not only had different performance requirements, but put a different demand on the underlying storage platform, and the FlashArray//m was easily able to support it.

Figure 10. Cumulative Performance of Five Virtualized Applications



The next phase of testing looked at the recomposition of all 1,500 virtual desktops on top of the other workloads. The recompose process is when a linked-clone VDI environment gets attached to a new replica, forcing users into a brand new virtual desktop environment. This is an intrusive operation that can cause existing users to lose connectivity to their virtual desktop. The four other mission-critical applications were started and once steady state was achieved, the 1,500 virtual desktop boot-storm started. Once complete, the recompose operation was initiated.

Figure 11 displays a view of the performance metrics after the other four workloads had reached a steady state. The virtual desktop ramp-up time took approximately 50 minutes. Next, the recompose was started, which led to a brief five minute interval where the linked-clone replicas were created. During this period of time, a latency spike of approximately 2ms occurred for less than one minute. The latency then returned to its normal sub-millisecond measurement throughout the rest of the recompose process.

Figure 11. Recomposing 1,500 Virtual Desktops in a Consolidated Virtualized Environment

Why This Matters

Leveraging virtualization to consolidate workloads can help drive higher levels of infrastructure efficiency through improved resource utilization, but when multiple applications share the same underlying storage system problems can quickly arise. A burst of I/O activity from one application (e.g., a long-running database query) can significantly impact all the other applications, leading to poor response times, lost productivity, and, in the worst case, lost revenue.

ESG Lab validated that five virtualized, mission-critical applications were easily consolidated onto a single Pure Storage FlashArray//m without impact on each other. As the simulated real-world workloads ramped up, performance of a demanding VDI infrastructure that supported 1,500 heavy users remained high. Specifically for consolidated, mixed workload virtual environments, the variety of I/O types and sizes can wreak havoc on the latency of each application, which is arguably the most important performance metric to pay attention to in these types of environments. ESG Lab confirmed sub millisecond response times for each application throughout all phases of testing, with the exception of a less than a minute bump in latency to just 2ms during a recompose.

High Availability and Resilience

The Pure Storage FlashArray//m platform leverages both hardware and software innovations designed to provide a highly available storage infrastructure that delivers uninterrupted access and full performance through both hardware and software upgrades as well as outages. The modular and fully redundant FlashArray//m hardware platform is highly available and field serviceable in a compact, energy-efficient package. Pure merges an active-active front-end with an active stand-by back end to minimize the impact of scheduled and unscheduled outages.

FlashArray//m also includes built-in data protection, with the ability to support thousands of capacity-efficient snapshots per volume for local protection and remote replication to enable deep data retention and off-site protection.

ESG Lab Testing

The FlashArray//m50 chassis used in ESG Lab testing contained two active controllers, two NVRAM modules, and two drive packs totaling 20 terabytes.

ESG Lab validated the reliability and serviceability of the FlashArray//m by injecting system faults, monitoring the system for alerts, and non-disruptively replacing failed components with the same I/O-intensive mixed application workloads running in the background. After each error injection and correction, ESG Lab waited for steady state before proceeding to the next test.

Figure 12. Error Injection Testing

As shown in Figure 12, the following errors were injected during ESG Lab testing:

1. Unplug a redundant FC host interface cable.
2. Remove an NVRAM module.
3. Reboot the secondary controller.
4. Reboot the primary controller.
5. Remove a field replaceable flash module.
6. Remove a second field replaceable flash module.

First, ESG Lab pulled one of the Fibre Channel cables to simulate a SAN failure. An alert was quickly displayed in the Pure1 management interface. After letting the system run for five minutes, the cable was plugged back in. There was a very small dip in IOPS at disconnection and again at reconnection, with no measurable change in response time as traffic rebalanced.

ESG Lab then pulled one of the two NVRAM modules. When the module was pulled, there was a spike in response time to 3ms for less than one minute, which quickly dropped back down to the steady state level of below 600µs. After a five-minute wait, the module was plugged back in.

Figure 13. Error Injection Testing—SAN and NVRAM

As seen in Figure 13 there was no measurable change in IOPS or bandwidth and no further effect on response time.

Next, ESG Lab rebooted the controllers in succession, a scenario that would be experienced during a software or controller hardware upgrade. Figure 14 shows the performance of the system as reported by the Pure1 console.

Figure 14. Error Injection Testing—Controller/Software Upgrade Simulation

There were minor, transient impacts on IOPS and bandwidth as the controllers rebooted, but I/O never stopped and only the reboot of the primary controller had any effect on response time, driving it up to just over for roughly two minutes.

Finally, ESG Lab simulated multiple flash module failures by pulling randomly selected flash modules. A single module failure was simulated, followed by a double module failure. As seen in Figure 15, neither the loss of one or two flash modules had any significant impact on IOPS, bandwidth, or response time.

Figure 15. Error Injection Testing—Pulling Multiple Flash Modules

In all cases, the application workload continued running without error and no entries were found in operating system event logs.

Why This Matters

Business continuity and disaster recovery were among the top ten most-cited IT priorities for organizations surveyed by ESG.[5] As IT strives to bring applications and services to customers and users dynamically and on-demand, virtualization of servers, desktops, and business applications increases both data storage requirements and complexity. Also, in the same ESG research report, one in four surveyed enterprises reported that purchasing new SAN storage systems was their most significant area of IT investment. This means organizations will have to contend with more data migrations and more sensitivity to data availability as storage and servers are consolidated into pools of IT resources. Users need the ability to provide servers and applications with high availability and data protection.

ESG Lab validated that the fully redundant architecture of the Pure Storage FlashArray//m is highly available and easily serviceable. ESG Lab was particularly impressed with the ability of the system to service a demanding mixed workload for a 5,000-user business through multiple major system failure simulations with minimal impact to I/O and sub-millisecond response times.

[5] Source: ESG Research Report, *2015 IT Spending Intentions Survey*, February 2015

ESG Lab Validation Highlights

- ☑ ESG Lab leveraged a single Pure Storage FlashArray//m50 and deployed five VMware virtualized, mission-critical applications: VMware Horizon View (VDI), Microsoft Exchange Server (email), Microsoft SQL Server (OLTP), Microsoft SQL Server (data warehouse), and Oracle (OLTP).
- ☑ ESG Lab observed a data reduction ratio of 6:1, or more than 83%.
- ☑ The performance of each application workload was monitored as it was started and ramped up to reach a steady state.
- ☑ The performance of the VDI workload, which is considered to be a difficult workload to consolidate with other mission-critical application workloads due to its "burstiness" and high levels of write activity, was unhindered as the other four applications ran simultaneously on the same array.
- ☑ Response times remained manageably low throughout all phases of testing, reaching an average level of .57ms during peak workload execution.
- ☑ Six different failures were simulated while all workloads were running, and aside from minor, transient effects, performance remained high and sustainable. Response times were remarkably consistent as well, exceeding 1ms on only two occasions, when the primary controller was rebooted, and when an NVRAM module was pulled.

Issues to Consider

- ☑ The test results presented in this report are based on applications and benchmarks deployed in a controlled environment with industry standard testing tools. Due to the many variables in each production data center environment, capacity planning and testing in your own environment are recommended.
- ☑ Default server BIOS, operating system, and application settings were used during ESG Lab testing. While tuning of application workloads is common, this testing found that no tuning was necessary to successfully consolidate tier-1 workloads. ESG Lab is confident that the results presented in this report meet the objective of demonstrating the achievable performance levels of a highly virtualized, mixed workload environment.
- ☑ The modular FlashArray//m is a key component in Pure's Evergreen Storage ownership model, a model designed for data-in-place generational upgrades. The goal of Evergreen is to eliminate forklift upgrades with infrastructure that expands the useful life of storage from a few years to a decade or more. Evergreen expands Pure's Forever Flash program: Controller upgrades are included in ongoing maintenance and performed every three years, all software upgrades to new versions are included, and a trade-in credit is provided for existing controllers when purchasing additional capacity that necessitates a controller upgrade.
- ☑ Despite the value demonstrated in this report, some may still question Pure's decision to design custom storage hardware with the FlashArray//m. Many in the storage community are trending in the opposite direction, leveraging commodity hardware based on the apparent industry perception that commodity hardware equates to lower costs. While Pure can demonstrate cost savings with its data reduction technology, the real story is long-term value and easing the pain of future upgrades, which can sometimes be more of a challenge for IT organizations to digest. Still, generational upgrades are a perennial pain point. Ultimately, a portion of Pure's success with FlashArray//m will be tied to how well organizations are able to internalize the long-term value story.

The Bigger Truth

ESG research reveals that increased use of server and desktop virtualization technologies, along with data growth management, are all frequently cited important IT priorities.[6] The amount and variety of data that businesses need to store is growing rapidly, driving the growth in overall storage use and costs. Another key objective for any IT administrator is providing sufficient performance to give business users the best possible experience. This is especially important for virtual desktop deployments and mission-critical applications, which are becoming increasingly virtualized.

Advancements in server and network resources occur on a regular cadence, but as more users and workloads are added to the infrastructure and leverage a shared pool of underlying storage, I/O bottlenecks can quickly become a concern. This is due in part to the increase in I/O traffic, and also to the randomness of the I/O. As a result, IT is feeling more pressure to provide advanced solutions that can seamlessly scale capacity and performance and support continuous availability.

Pure Storage FlashArray//m is designed not just to offer value, but also to drive a more strategic solid-state discussion. The FlashArray//m is designed with the goal of "non-disruptive everything". This, combined with the Evergreen Storage model enables Pure to extend the value proposition of its storage architecture further into the future, allowing organizations to look past simple price-per-capacity or feature comparisons to include many of the other total cost of ownership benefits of solid-state.

ESG Lab testing validated FlashArray//m's ability to consolidate the most challenging business- and mission-critical workloads, including desktop virtualization, onto a single, high-performance, highly available platform. The environment ESG Lab tested consolidated a realistic business environment with 27.6TB of live data onto a single FlashArray//m50 array, supporting 5,000 seats of Exchange users, 1,500 VMware Horizon View virtual desktops, and hundreds of Oracle and SQL server users and consuming only 4.9TB thanks to Pure's data reduction technologies. The consolidated environment serviced all of these workloads with sub-millisecond response times and provided continuous access through multiple simulated failures. It's important to note that the performance described in this report was accomplished with inline data reduction, encryption at rest and snapshots enabled and in use. In addition, Pure1 provided simple, intuitive, cloud-based management and monitoring of the system, accessible from anywhere.

Pure has made the claim that if all tier-1 storage arrays sold over the past four years were replaced with FlashArray//m hardware, the resulting space and power savings would equate to 800 data centers and 3.86 Megawatts, roughly equivalent to two nuclear power plants. While claims like these are always based on multiple, layered assumptions, they do help Pure put the value of its hardware into perspective. And while smaller and midsized organizations may see less of a space and power efficiency benefit overall, there is still a benefit to be had. Organizations looking to build larger IT infrastructures will likely find the opportunity to reduce power and footprint at this level quite compelling. Consolidation drives economics in the data center, and Pure's data reduction technology also helps enable this.

ESG Lab is pleased to validate that the Pure Storage FlashArray//m delivers consistently high performance at extremely low response times and is clearly well suited to support a mix of demanding real-world business applications running in a performance-critical highly virtualized infrastructure. Comprehensive data management software, HA-DR functionality, and capacity efficiency technologies, all included in the base price, round out the offering. Organizations that have been considering the potential value of consolidating business- and mission-critical applications and users but have had concerns about performance and availability would be well served to take a closer look at Pure Storage FlashArray//m.

[6] Source: ESG Research Report, *2015 IT Spending Intentions Survey*, February 2015

Appendix

Table 1. ESG Lab Test Bed

Hardware	
Pure Storage FlashArray//m50	Two 16G Fibre Channel ports Purity Software Ver. 4.5.1
Cisco UCS Blade Server B200 M4	Quantity: 32 E5-2670 (12 core, 2.3 GHz) 256 GB memory Version 2.2.3f
Cisco UCS 6248UP (Fabric Interconnect)	Version 2.2.3f
Nexus 5500UP series (Storage and Network Switch)	Version 5.2(1)N1(6)
Software	
VMware vSphere 6.0	6.0.0 Enterprise-Build 2494585
VMware Horizon View 6.0	32GB desktop image template of Windows 7 Enterprise Edition (64-bit) 1,500 non-persistent, linked-clones • Two vCPUs • 4GB of RAM • One vmxnet3 vNIC adapter • One LSI Logic virtual storage adapter
Windows Server 2012	R2 Update
Microsoft SQL Server 2014	SP1
Microsoft Exchange Server 2013	
Oracle 12c	
Cisco UCS Blade Server and Infrastructure Bundle	Version 2.2.3f
Workload Drivers	HammerDB version 2.1.7 Internal OLTP tool supplied by Microsoft Microsoft Jetstress 2013 LoginVSI 4.1.3 SLOB 2.3

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