

Lab Validation Report

VMware Horizon View with Tintri

A Simple, Fast, and Affordable VDI Solution from VMware and Tintri

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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 VMware.

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Introduction

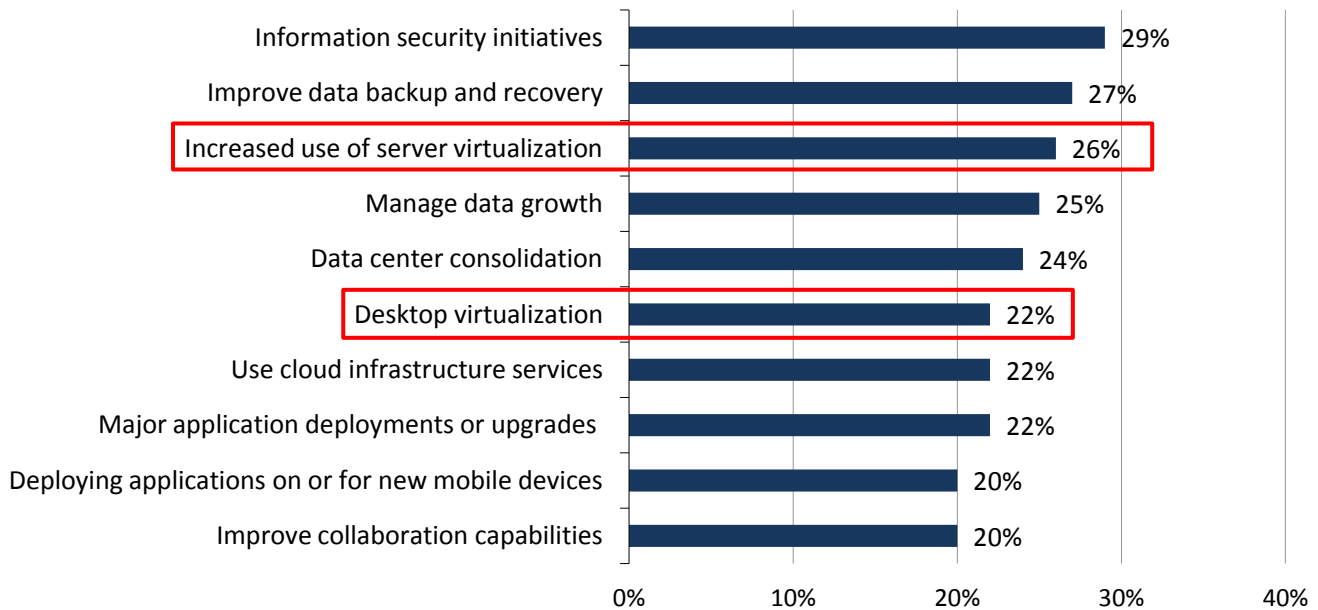
This report documents the results of ESG Lab’s hands-on testing of VMware Horizon View 5.1 with the Tintri VMstore platform. Testing focused on performance in the context of the end-user experience in a 1,000 seat virtual desktop environment. In addition, the ease of deployment, manageability, and cost-effectiveness of the Tintri solution in VMware environments were also examined.

Background

ESG recently asked businesses to identify the IT initiatives they believed would be most important to their organization over the next 12 months.¹ As shown in Figure 1, server and desktop virtualization were in the top ten responses, marking the fourth year that server virtualization has been at or near the top of the list of most important IT priorities in ESG’s annual IT spending intentions survey. This year, desktop virtualization has broken the top ten for the second time, with almost one in four respondent organizations citing it as one of their most important IT priorities.

Figure 1. Top-ten IT Priorities

Which of the following would you consider to be your organization’s most important IT priorities over the next 12 months? (Percent of respondents, N=540, ten responses accepted)



Source: Enterprise Strategy Group, 2013.

Desktop management is becoming a daunting task for even the most skilled IT organizations due to numerous factors, including the increasing variety and numbers of client device types, “always-on” expectations for IT services, workforce mobilization, increasing regulatory compliance mandates, tightening of security requirements, and corporate demands to increase operational efficiency.

A growing number of organizations are using virtual desktop infrastructure (VDI) technology to reduce the cost, complexity, and risk associated with desktop management. The challenge is to provide a high-quality, predictable, and productive computing environment for 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.

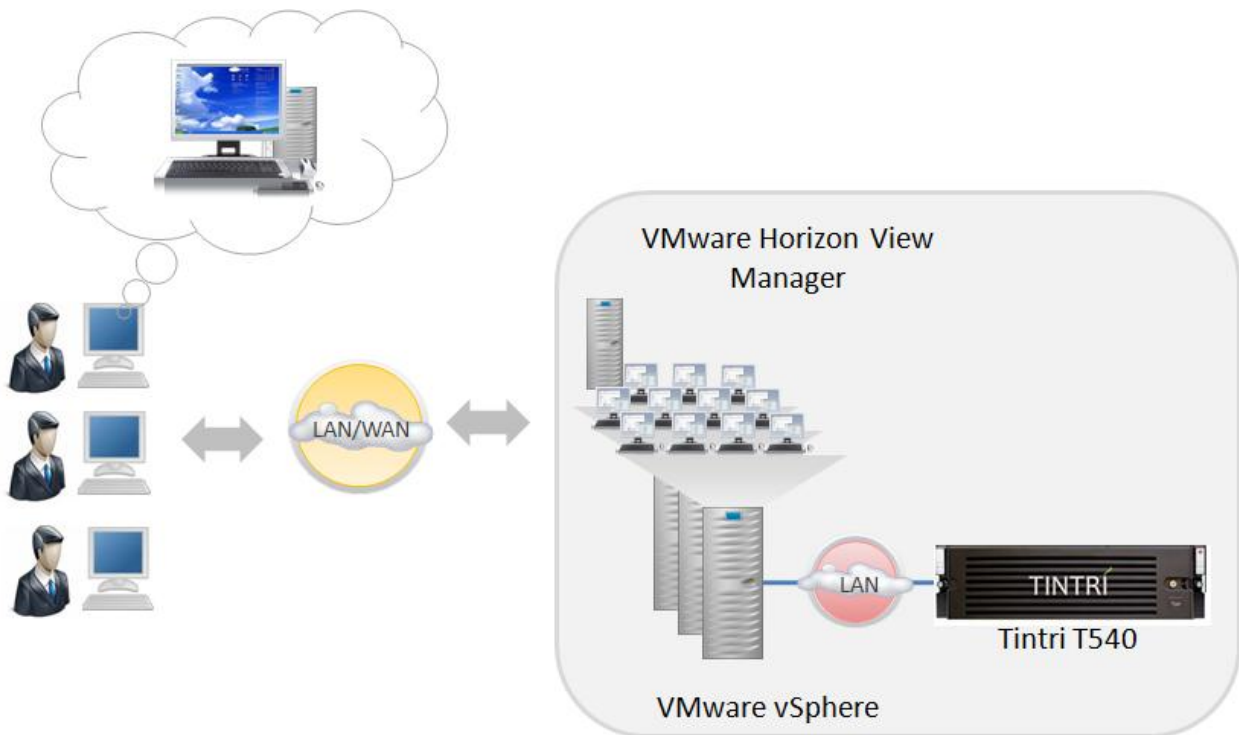
¹ Source: ESG Research Report, [2013 IT Spending Intentions Survey](#), January 2013

Virtual Desktop Infrastructure with VMware Horizon View and VMware vSphere

VMware Horizon View delivers desktop services to end-users while allowing IT to simplify and automate the management of thousands of desktops. VMware Horizon View securely delivers Desktop-as-a-Service to users from a central location with higher levels of availability and reliability than is possible with traditional PCs. VMware Horizon View provides end-users with the highest levels of mobility and flexibility by delivering secure access to applications and data on demand to any device.

The VMware solution includes VMware vSphere virtualization software and VMware Horizon View for hosting desktops, user and session management, provisioning tools, and application delivery as well as service monitoring, reporting, and support. VMware desktop virtualization leverages PC over IP (PCoIP) technology, a server-centric protocol that does the majority of graphics rendering and processing on the VMware servers, transmitting only compressed bitmaps or frames to the remote clients over the LAN or WAN. Through VMware Horizon View Manager, VMware Horizon View provides a single management tool to provision new desktops or groups of desktops and a simple interface for setting desktop policies. View Composer, based on VMware Linked Clone technology, enables the rapid creation and re-composition of desktop images from a master image. When updates are implemented on the parent image, they can be pushed out to any number of virtual desktops in minutes, simplifying deployment and patches without affecting user settings, data, or applications. Figure 2 illustrates a virtual desktop environment utilizing VMware Horizon View with the Tintri VMstore.

Figure 2. VMware Horizon View with Tintri



Users connect to the VMware Horizon View Manager using either the VMware Horizon View client or any one of numerous certified third-party hardware and software clients.² VMware Horizon View Manager authenticates a user's credentials and then uses those credentials to automatically authenticate users as they log in to their virtual desktops, using volumes residing on the Tintri VMstore. The virtual desktop is delivered via the PCoIP optimized delivery protocol. The user has access to their personalized desktop, applications, and resources from anywhere while still benefiting from centralized desktop management in the data center.

² Source: VMware Resource, [VMware Compatibility Guide](#), 2013.

VMware Storage from Tintri

The Tintri VMstore is designed specifically for virtualized environments. Tintri is different from traditional storage systems in that it does not use conventional storage abstractions such as volumes, LUNs, or files. Tintri uses virtualization abstractions such as virtual machines and virtual disks directly. Each I/O request, reads, writes, or metadata operations map directly to the particular virtual disk on which it occurs. Tintri VMstore directly monitors and controls I/O for each virtual disk. By operating at the virtual machine and disk level, Tintri VMstore provides administrators with the same level of insight, control, and automation of storage as they have with CPU, memory, and networking resources in a VMware environment.

Tintri VMstore communicates with the VMware vCenter Server API to learn which virtual machines are active and reside on Tintri storage. The VMstore collects, records, and reports statistics such as capacity utilization, IOPS, throughput, and resource utilization by VM and by virtual disk. An administrator can immediately ascertain which virtual machines and virtual disks are responsible for the consumption of storage resources, and what performance the virtual machines are receiving, without additional layers of complexity.

ESG Lab's testing was designed to validate the business value of deploying a VMware Horizon View VDI configuration supported by Tintri VMstore including:

- Performance – Predictable, fast end-user performance for up to 1,000 virtual desktop users.
- Simplicity – Ease of deployment and management in a VMware vSphere environment.
- Cost Efficiency – Low cost of acquisition and ongoing management.

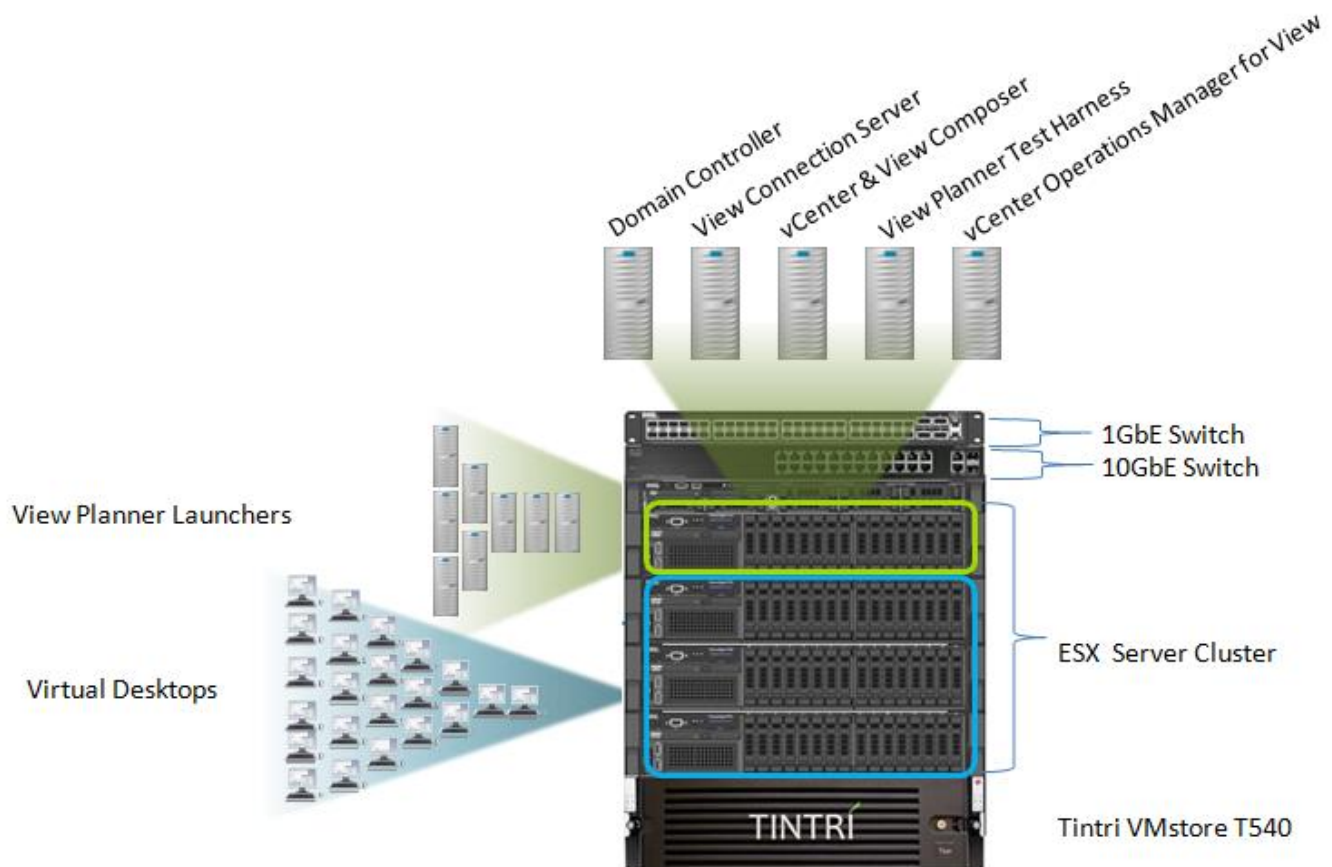
ESG Lab Validation

ESG Lab performed hands-on validation and testing of VMware Horizon View with the Tintri VMstore at a VMware lab in Palo Alto, California. Testing was designed to demonstrate the performance, scalability, ease of use, and cost efficiency of the solution for VDI environments.

Getting Started

The configuration used in ESG Lab testing is shown in Figure 3. Four Dell PowerEdge R720 servers were installed in a VMware vSphere 5.1 cluster connected via 10GbE to a Tintri T540 VMstore with 12TB of capacity for datastores. A Dell Force10 S2410 10GbE switch was used for storage connectivity to the cluster, and a Cisco Catalyst 1 GbE switch was used for management and endpoint connectivity. The VMware environment was running ESXi 5.1, vCenter 5.1, View 5.2, and View Planner.³

Figure 3. The ESG Lab Test Bed



ESG Lab used the VMware Horizon View Planner tool to simulate a large virtual desktop environment. View Planner is designed for end-to-end VDI testing with a focus on the end-user experience. To this end, View Planner measures response time at the endpoint rather than at the virtual machine for scoring purposes. This is an improvement over older testing methodologies that measure at the virtual machine or infrastructure level.

The View Planner tool simulates application workloads for a number of user types (e.g., task workers, knowledge workers, and power users) by running applications typically found in a Windows desktop environment. During the execution of a workload, applications are randomly called to perform common desktop user operations.

³ Configuration and version details are listed in the Appendix.

View Planner then uses a watermark technique to quantify the user experience and measure application latency on a user client/remote machine. The standardized View Planner workload consists of nine applications performing a combined total of 44 user operations, then scoring based on the response time.

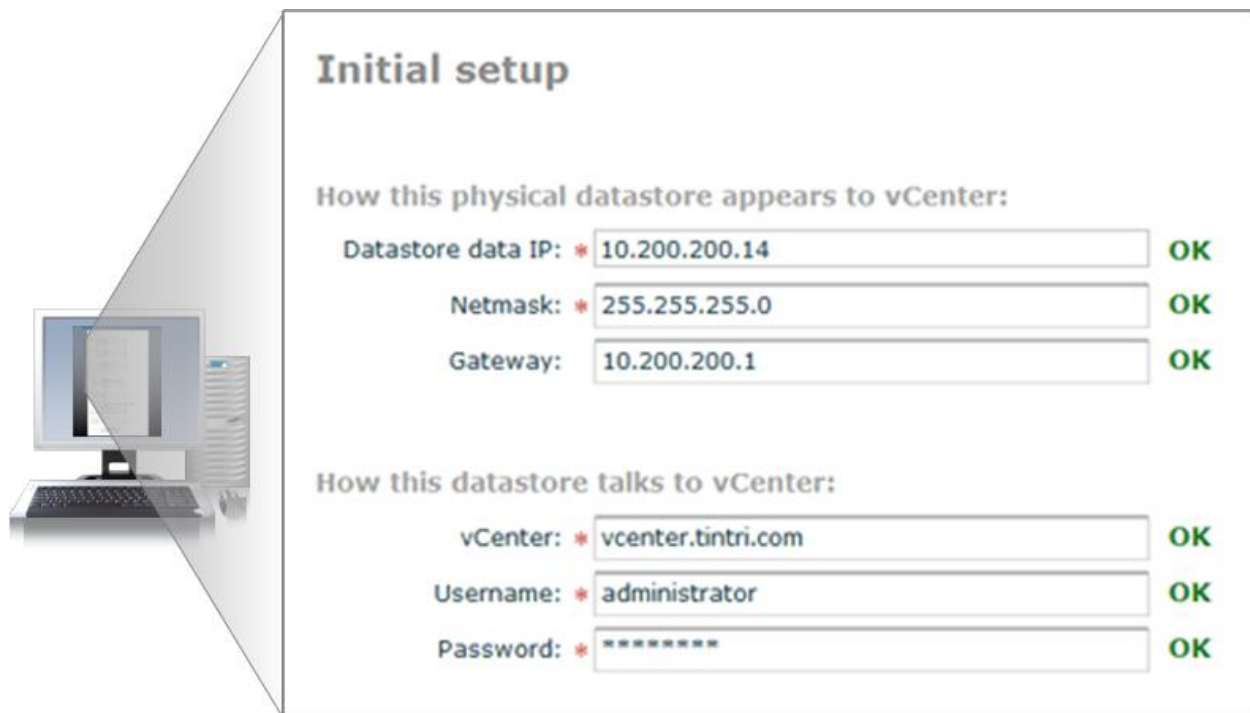
Easy to Deploy

ESG Lab explored the out-of-box setup experience of the Tintri VMstore in a VMware vSphere environment. This included basic network configuration, exploration of the administrator GUI, and provisioning of storage to the hosts in the test environment.

ESG Lab Testing

ESG Lab began ease-of-use testing by working with the VMware technical team to rack, connect power and network cables, and power up the Tintri VMstore. The first configuration step was to use the Tintri CLI to assign an IP address to the management interface. Once the appliance was visible on the network, a web browser was used to log in to the web console. Next, the extremely simple configuration wizard was used to set the IP address of the datastore, and enter the vCenter administrator credentials, as seen in Figure 4.

Figure 4. Quick and Easy Datastore Deployment with Tintri



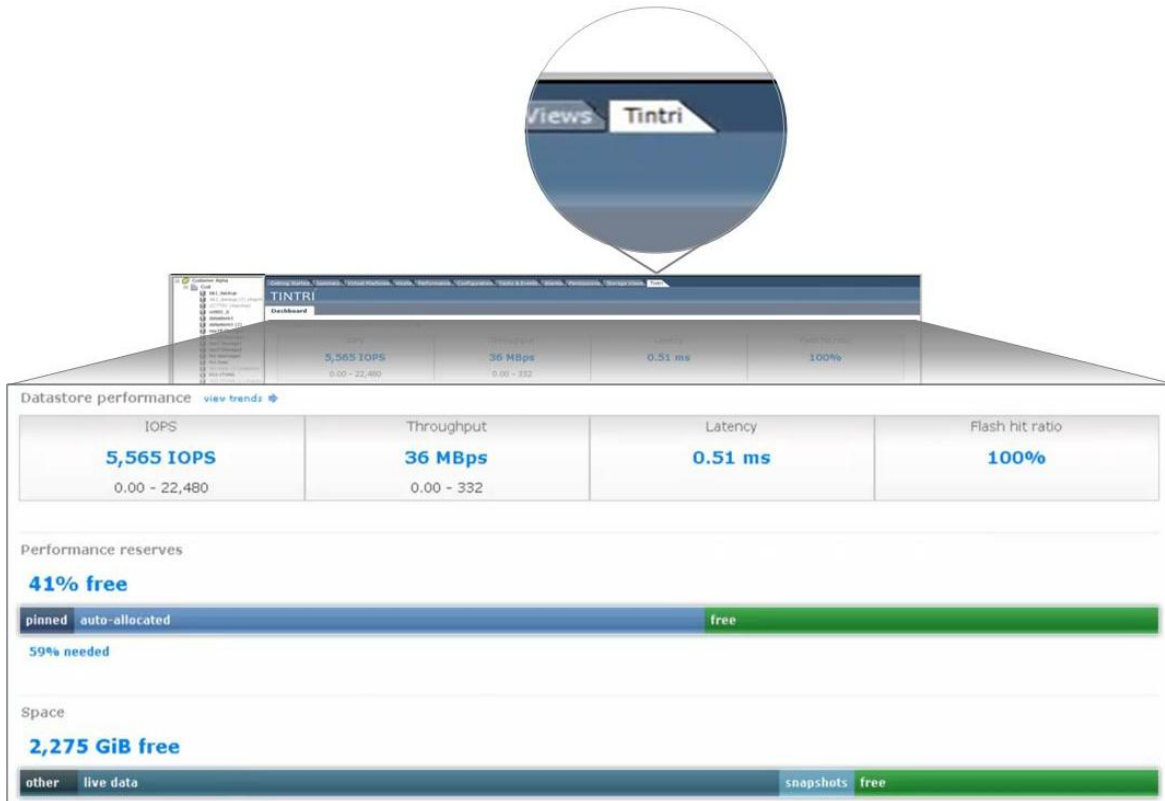
The screenshot shows the 'Initial setup' screen of the Tintri configuration wizard. It is divided into two main sections: 'How this physical datastore appears to vCenter:' and 'How this datastore talks to vCenter:'. Each section contains three input fields with corresponding 'OK' status indicators.

Section	Field	Value	Status
How this physical datastore appears to vCenter:	Datastore data IP:	10.200.200.14	OK
	Netmask:	255.255.255.0	OK
	Gateway:	10.200.200.1	OK
How this datastore talks to vCenter:	vCenter:	vcenter.tintri.com	OK
	Username:	administrator	OK
	Password:	*****	OK

The next step was to mount the Tintri datastore over NFS from the vSphere console. At this point, the datastore is ready for virtual machines. ESG Lab used vMotion to move the master desktop VM to the newly mounted datastore. Less than eight minutes and just ten mouse clicks after getting started, the Tintri appliance was ready to host VMware Horizon View desktops.

Once installed, Tintri VMstore can be monitored directly in the vSphere client, via the Tintri tab. The Tintri dashboard is shown in Figure 5. The dashboard gives a complete high-level snapshot of the performance and utilization of the VMstore in addition to a powerful capability to map the performance capacity of the datastore to VMs and their virtual disks. The "Performance Reserves" gauge fills up as VMs and virtual disks are added and consume storage performance resources like IOPs and bandwidth. This enables an administrator to quickly verify whether a particular datastore has available headroom to accommodate additional VMs.

Figure 5. Monitoring Tintri VM-aware Storage from the VMware vSphere Dashboard



Another interesting metric on the dashboard is the flash hit ratio, which reports how much I/O is being serviced out of SSD. Tintri systems provide a fairly large flash to hard drive ratio: The 8.5TB T445 contains 1.1TB of SSD and the 13.5TB T540 has 1.8TB. Tintri reports that VMstore typically delivers in excess of 99% of I/O from flash in the field. In ESG Lab testing, this was never observed to be less than 100%.

Why This Matters

Desktop and server virtualization are consistently in the top-ten IT priorities reported by ESG research respondents.⁴ Among organizations that support or plan to support highly virtualized environments, faster storage provisioning and increased simplicity of implementation and management are consistently among the top prerequisites for doing so.

ESG Lab has confirmed that the Tintri VMstore is extremely easy to deploy in support of VMware Horizon View. All storage configuration complexity is eliminated using automatic internal tiering and tight integration with vSphere. Administrators do not need to deal with RAID, striping, or host path management. ESG Lab was able to configure a Tintri VMstore in ten clicks and, in less than eight minutes, had virtual machines up and running in a vSphere environment.

The "performance reserves" and "space" gauges proved especially useful, providing an at-a-glance answer to the pressing VMware administrator question: Can I add more VMs to this datastore? If both the space and performance gauges have green left in them, the answer is yes.

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

Fast and Scalable

Server virtualization has long been used to consolidate server infrastructure, reduce data center floor space, and maximize utilization of existing assets. It has seen tremendous growth over the past decade, but server virtualization's considerable success is overshadowed by the potential of desktop virtualization. Desktop management is becoming a daunting task for even the most seasoned IT organizations due to numerous factors, including:

- The increasing variety and numbers of client device types.
- "Always-on" expectations for IT services.
- Workforce mobilization.
- Increasing regulatory compliance requirements.
- Tightening security requirements.
- Corporate mandates to increase operational efficiency.

A growing number of organizations are using virtual desktop infrastructure (VDI) technology to reduce the cost, complexity, and risk associated with desktop management while striving to provide a high-quality, predictable, and productive computing environment. Virtual desktop implementations are a particularly sticky challenge for IT: Keeping desktops available and online while providing a user experience that is as close as possible to a physical desktop are the two most important metrics in gauging the success of their virtualization deployments.

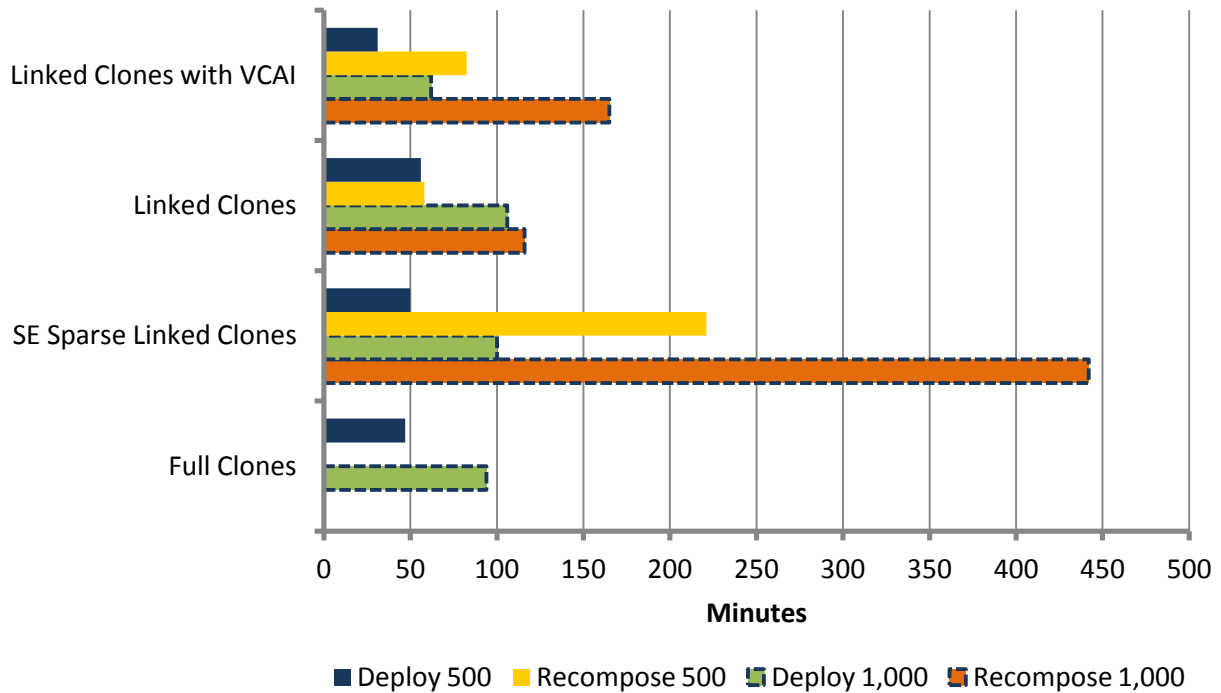
ESG Lab Testing

ESG Lab tested the Tintri VMstore, executing desktop pool operations such as deploying new desktops and recomposing operations to apply patches and updates to existing desktops. Deploying and recomposing desktops is a resource-intensive process, as VMware Horizon View Composer has to create or update each desktop from the master image. ESG Lab used VMware Horizon View Manager as the mechanism to determine when the Desktop Pool was fully deployed.

Figure 6 shows the results of deploy and recompose operations in four different virtual disk formats using Tintri VMstore projected out to 1,000 desktops. The host configuration available to ESG Lab for this testing was limited by host resources to 500 desktops, but previous tests conducted by VMware and audited by ESG Lab were consistent with these results. The fastest deployment was completed using Linked Clones with View Composer Array Integration (VCAI), in which 500 desktops were deployed in just 31 minutes, which works out to just over 967 desktops per hour or 1,000 desktops in 62 minutes.

It is important to note that full clones are independent of the master image, so a recompose operation does not apply.

Figure 6. Deploy and Recompose 1,000 Desktops



ESG Lab used the Tintri performance monitor to observe VMstore performance during the Linked Clone with VCAI deployment run, as seen in Figure 7. The yellow shaded area indicates read activity, and the blue area indicates write traffic. During this run, the VMstore was delivering more than 400MB/second of aggregate bandwidth.

Figure 7. Tintri Performance Monitor during Desktop Deployment

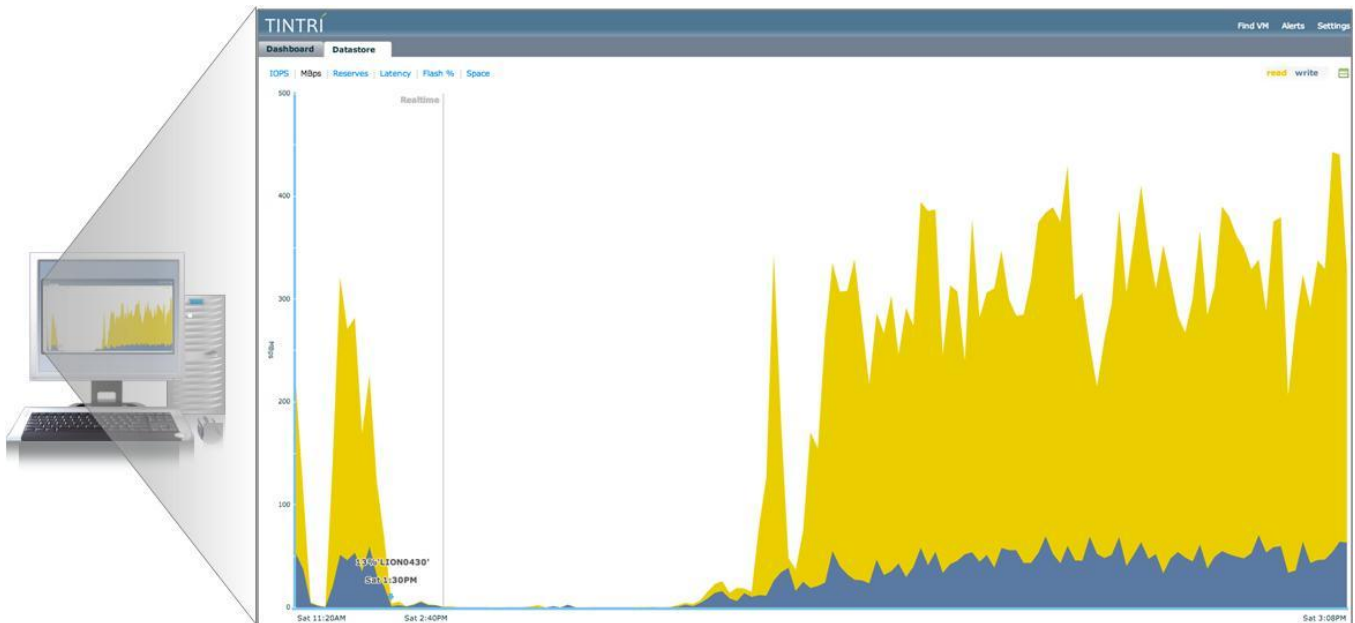


Table 1 details the results of the timing tests including the total capacity consumed on the VMstore using each volume type.

Table 1. Deploy and Recompose Timing for Virtual Desktops with Tintri

ESG Lab Tested	Deploy	Recompose	Capacity (GB)
500 Linked Clones with VCAI	31	82.5	1,462
500 Linked Clones	53	58	1,053
500 SE Sparse Linked Clones	50	221	1,200
500 Full Clones with VAAI	47	N/A	1,630
ESG Lab Audited/Projected	Deploy	Recompose	Capacity (GB)
1,000 Linked Clones with VCAI	62	165	2,924
1,000 Linked Clones	106	116	2,106
1,000 SE Sparse Linked Clones	100	442	2,400
1,000 Full Clones with VAAI	94	N/A	3,260

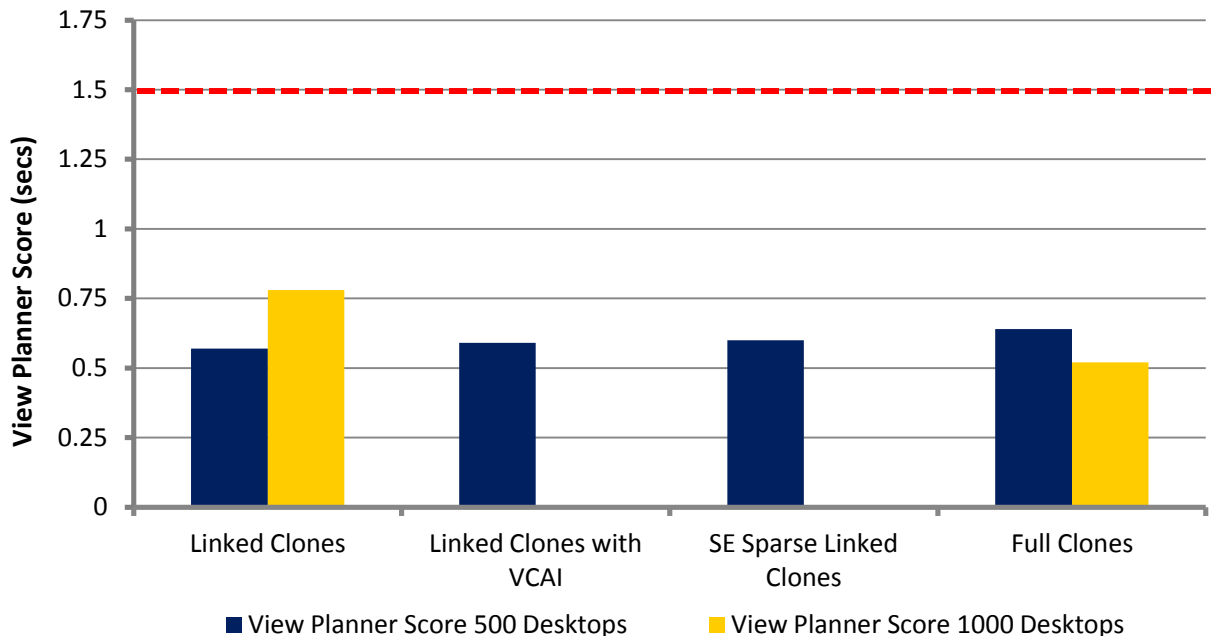
The capacity column shows the capacity consumed after deploying, recomposing, and completing the simulated workload and includes server capacity consumed, as all servers lived on the same datastore as the desktops. Individual desktops were provisioned with 40GB virtual disks, and at the end of testing, each desktop had consumed approximately 3.26GB of capacity. It's important to note that all testing including full clones was executed after the Tintri vStorage API for Array Integration (VAAI) was installed, meaning that vSphere offloaded cloning to the Tintri array in all cases. Without VAAI, the capacity required for full clones would have been much higher—on the order of 8-15GB per desktop.

Next, ESG Lab validated the end-user experience using the VMware Horizon View Planner tool. The View Planner tool simulates application workloads using actual applications on running desktops. During the execution of a workload, applications are randomly called to perform common desktop user operations and response time is measured for each action. ESG Lab ran the standard View Planner profile with all applications selected with medium video, 20 second think time, and five iterations.

View Planner uses a watermark technique to quantify the user experience and measure application latency on a user client/remote machine. The standardized View Planner workload consists of nine applications performing a combined total of 44 user operations. View Planner then scores the environment based on response times at the endpoints. The View Planner 95th percentile response time should be less than 1.5 seconds to pass the test. ESG Lab looked at View planner scores and the latency and performance reserves metrics on the VMstore dashboard during the View planner tests. View Planner test runs with 1,000 desktops were also audited by ESG Lab.

As seen in Figure 8, every option for desktop virtual disk configurations passed with outstanding sub-second scores, from .52 seconds for 500 full clones to .78 seconds for 1,000 linked clones.

Figure 8. View Planner Scores for 1,000 Desktops with Tintri VMstore



It's important to note that even with 500 desktops, the hosts in the test bed were more heavily loaded than VMware recommends for a production environment. Figure 9 shows the CPU and memory utilization for one of the hosts in the vSphere cluster during the Linked Clones run. The red line represents 80% utilization, which is VMware's recommended maximum for production hosts.

Figure 9. Host CPU and Memory Utilization During 1,000 seat View Planner Run.

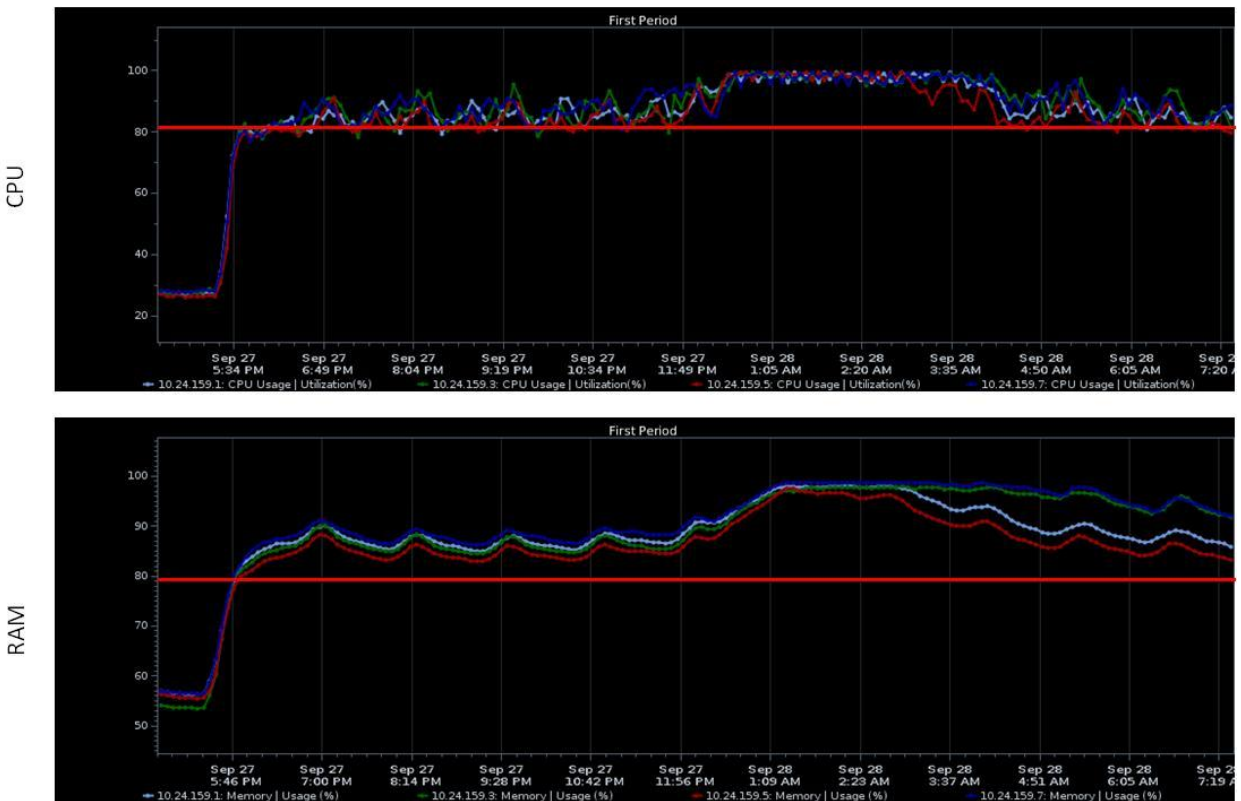


Table 2 details the results of the View Planner tests including the View Planner scores along with the vDisk latency as reported by the Tintri dashboard.

Table 2. View Planner Scores and Disk Latency for Tintri VMstore

Configurations Tested	View Planner Score (secs)	vDisk Latency (ms)
500 Linked Clones	0.57	8.3
1,000 Linked Clones	0.78	3.0
500 Linked Clones with VCAI	0.59	2.4
500 SE Sparse Linked Clones	0.60	3.5
500 Full Clones	0.64	2.4
1,000 Full Clones	0.52	2.2

What the Numbers Mean

- The VMware Horizon View environment with Tintri VMstore was able to support 1,000 desktops with excellent View Planner scores, regardless of the disk type utilized in View and vSphere.
- Tintri VMstore was able to satisfy 100% of I/O out of flash with more than 1,000 running virtual machines (servers and desktops).
- vDisk latency was excellent throughout testing, in most cases better than physical machines with 7,200 RPM disks.
- While the Tintri VMstore was fairly lightly loaded and appeared able to support higher numbers of desktops, the tested architecture was able to run 1,000 stable task-worker desktops with host CPU and RAM resources saturated during part of the testing. To scale beyond 1,000 desktops would require additional host and network resources beyond what was deployed for these tests.

Why This Matters

ESG research indicates that performance is a serious issue with virtual desktop infrastructure—38% of the IT managers surveyed by ESG research chose poor performance as a concern with implementing desktop virtualization, making it the number one response selected by potential users.⁵

Predictable performance scalability is a critical concern when multiple users running diverse applications share a storage system. A burst of I/O activity in one application (e.g., a number of users first logging on) can lead to poor response times and lost productivity for other users. A desktop virtualization environment potentially presents one of the most diverse and challenging mixes of application types and I/O access patterns to a storage array.

ESG Lab confirmed that the Tintri VMstore offers predictable, excellent performance that should make administrators and end-users very happy. Virtual desktop deploy and recompose operations for 1,000 desktops were completed in as little as 62 minutes, at up to 967 desktops per hour. Application access (the end-user experience) for 1,000 virtual desktops was outstanding, with View Planner scores as low as .57 seconds, nearly a second faster than the passing score of 1.5, with very low vDisk response times showing plenty of headroom to spare in the VMstore.

⁵ Source: ESG Research Report, [Desktop Virtualization Market Evolution](#), February 2013. All ESG references and charts in this Lab Validation Report have been taken from this research report, unless otherwise noted.

Cost of Ownership

ESG Lab modeled and analyzed the total cost of storage ownership for a 1,000 seat VMware Horizon View virtual desktop environment comparing traditional storage with Tintri VMstore. The costs were modeled using an average cost derived from multiple industry-leading midrange systems that could maintain sufficient IOPS to support 1,000 virtual desktops as tested for this report.

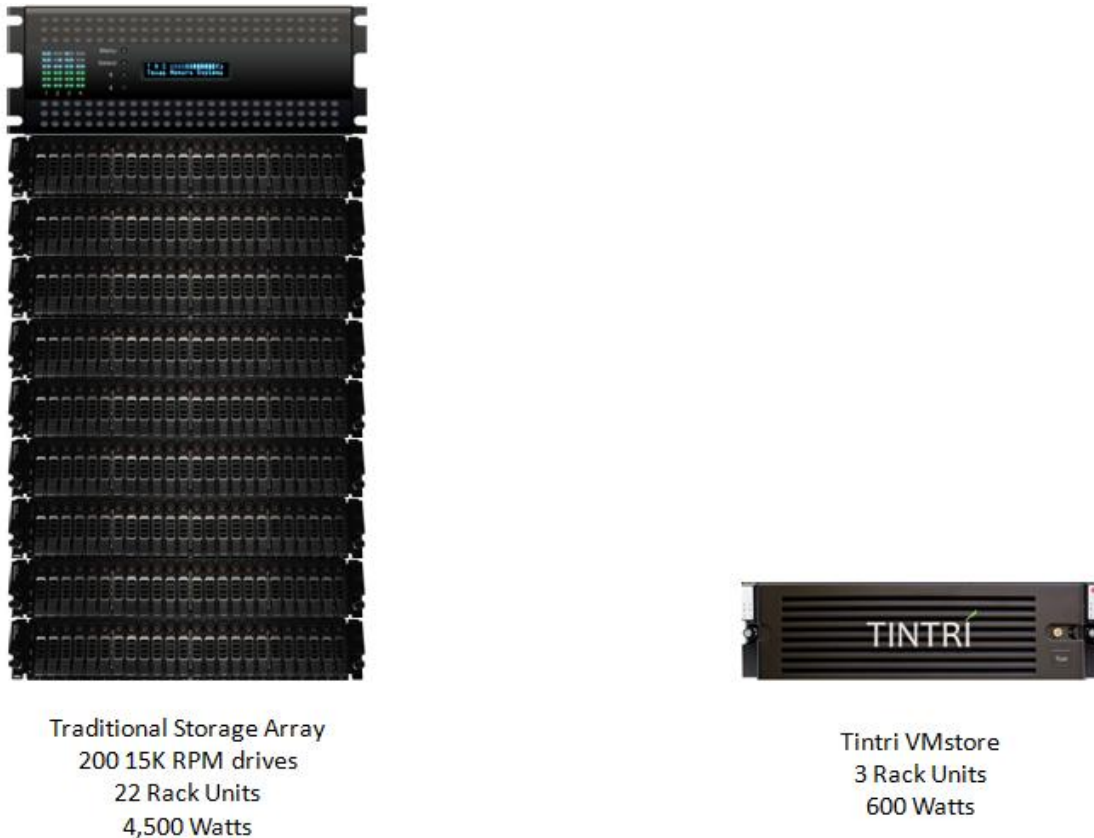
The ESG Lab analysis was quantitative in that it examined the cost of acquisition (hardware and software), support, management (including manpower), and power and cooling. ESG calculated the cost of acquiring and maintaining a system with sufficient 15K RPM drives to provide approximately 30,000 IOPS (the IOPS delivered by the Tintri VMstore during testing).⁶

Based on the assumption that each 15K RPM drive can sustain approximately 150 IOPS, it was determined that approximately 200 drives would be needed.

ESG Lab Analysis

Figure 10 shows a visual comparison of a conventional storage system on the left, with a 4U storage controller chassis and nine 2U drive shelves which would draw approximately 4,500 watts on average with all drives active. The Tintri VMstore, on the right, is one 3U chassis that draws only 600 watts on average.

Figure 10. Tintri VMstore vs. Traditional Storage.



Assuming that the conventional system is populated with 400GB enterprise SAS drives, it would house 80TB of raw storage, which is far more capacity than the environment would require, even using full clones.

⁶ For more details, please refer to the Appendix.

Figure 11. Virtual Desktop Storage Infrastructure Costs

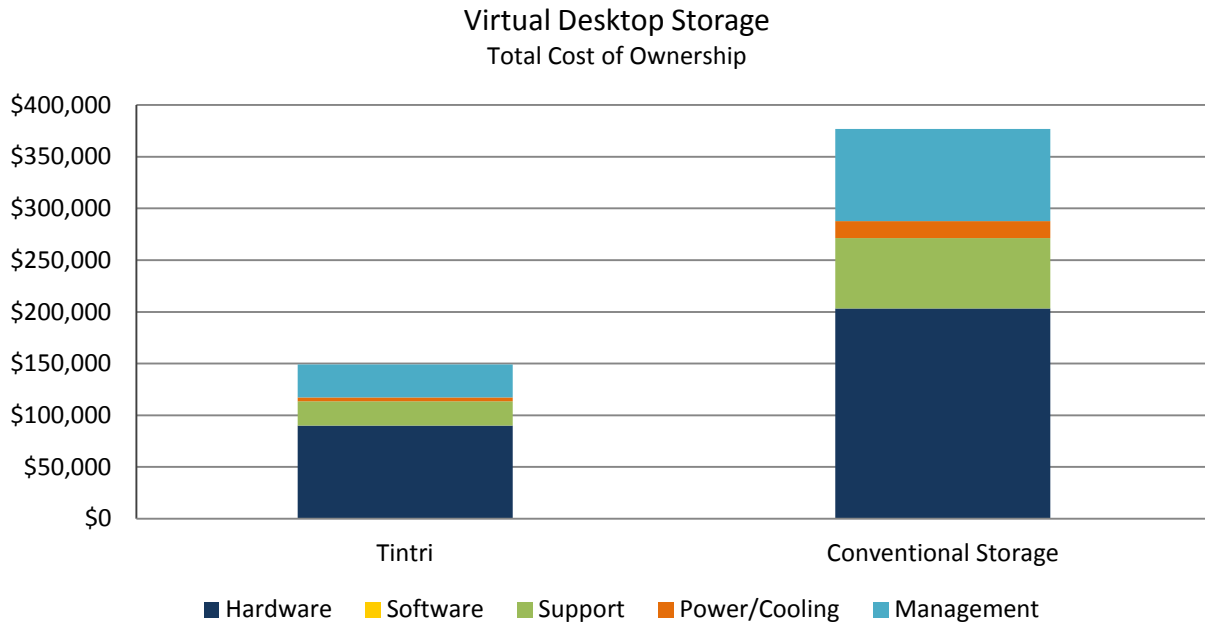


Table 3 details the results of the five year TCO model developed by ESG Lab.

Table 3. Five Year Storage Infrastructure Costs for 1000 Seat VDI Installation

VDI Storage Solution	Hardware/Software	Support	Power/Cooling	Management
Tintri VMstore T540	\$90,000	\$23,471	\$3,914	\$31,842
Conventional Storage	\$203,352	\$68,114	\$16,324	\$88,944

With an acquisition cost of less than half that of a conventional storage array to support 1,000 desktops, Tintri VMstore with VMware Horizon View can't help but reduce per desktop costs for VDI deployments.

Why This Matters

ESG research has established that cost is among the top challenges IT staffs face when it comes to managing PC environments and, subsequently, one of the top motivators for considering alternative desktop delivery strategies. As such, it is not surprising that total cost of ownership (TCO) was the most commonly cited desktop virtualization vendor/solution selection criterion among both current and potential users surveyed by ESG research.

Clearly organizations are willing to make initial upfront investments in desktop virtualization solutions in order to increase efficiency and cost savings in the long term.

ESG Lab has determined that organizations can leverage Tintri VMstore to support a virtual desktop infrastructure at a lower cost per desktop than conventional storage up front while providing ongoing value by reducing operational expenses such as space, power, cooling, and management.

ESG Lab Validation Highlights

- ☑ The Tintri VMstore is extremely easy to deploy in support of VMware Horizon View. All storage configuration complexity is eliminated using automatic internal tiering and tight integration with vSphere. Administrators do not need to deal with RAID, striping, or host path management. ESG Lab was able to configure a Tintri VMstore in ten clicks and, in less than eight minutes, had virtual machines up and running in a vSphere environment.
- ☑ VMstore's "performance reserves" and "space" gauges proved especially useful, providing an at-a-glance overview of system loading and utilization.
- ☑ ESG Lab confirmed that the Tintri VMstore offers predictable, excellent performance. Virtual desktop deploy and recompose operations were executed at up to 967 desktops per hour. Application access (the end-user experience) for 1,000 virtual desktops was outstanding, with View Planner scores as low as .52 seconds, nearly a second faster than the passing score of 1.5, with very low vDisk response times showing plenty of headroom to spare in the VMstore.
- ☑ Tintri VMstore can be implemented to support VMware Horizon View VDI with a lower initial cost per desktop than traditional storage and a lower total cost of ownership over time.

Issues to Consider

- ☑ Testing for this ESG Lab report was conducted in a controlled lab environment. Due to the many variables in each production data center, capacity planning and testing in users' own environments is recommended.
- ☑ There are two major potential barriers to entry to a virtual desktop environment: disk and network performance. While Tintri addresses the disk performance challenges extremely well, organizations deploying or planning to deploy desktop virtualization will be well served to evaluate their network for potential bandwidth, latency, or congestion issues.

The Bigger Truth

Simplification and productivity top the list of factors driving the adoption of VDI technology amongst those organizations surveyed by ESG research. Administrators are looking to simplify the repetitive, hands-on tasks of OS and application deployments, upgrades, patch management, and provisioning while improving remote users' computing experiences. Given the budgeting and manpower challenges being driven by global economic concerns, it's not surprising that nearly half of the respondents to an ESG research survey indicated that reducing capital and operational expenses is driving an interest in VDI.

When ESG asked its survey respondents about current usage of and plans for VDI solutions, a significant 33% said their organization currently has a VDI initiative (in the form of an active production or test implementation), with an additional 36% saying they have plans to deploy the technology. Seventeen percent of respondents said they had no current plans to deploy VDI, but would consider the technology. Since VDI technologies are relatively new, the fact that 33% of organizations surveyed already have some initiative underway is a significant development.

While the benefits of VDI are compelling and adoption of VMware Horizon View has ramped up quickly over the past few years, ESG research indicates that performance is a top concern. As a matter of fact, 22% of IT managers currently using desktop virtualization selected poor performance (application response time) as a challenge that they have experienced with their desktop virtualization solution, making it the second most popular response.

A modern CPU can execute over a million instructions in the time it takes to perform a single random hard drive access. For I/O-intensive virtual desktop application workloads that are mostly random in nature and tend to have more writes than reads, this difference in performance has caused a number of problems in IT organizations around the globe. What good is the ability to execute a million instructions per second if the processor is waiting for disk access that takes hundreds of times longer? The traditional approach of adding more hard drives to solve the performance problem increases the cost, space, power, and cooling requirements of the storage solution.

Tintri VMstore uses high-performance flash drives in combination with high-capacity hard drives to narrow the gap between processor and I/O access performance. Automated internal tiering and optimization are used to deliver cost effective price/performance that's ideally suited for virtual desktop workloads. ESG Lab has confirmed that Tintri has created a cost effective, robust, high-performance storage solution that is incredibly easy to configure and use, and integrates seamlessly with VMware vSphere and VMware Horizon View. Validation testing has confirmed that a single Tintri VMstore, in only 3U of rack space and consuming about 600 Watts of power, can be used to support at least 1,000 virtual desktop users with low latency and extreme simplicity that makes it quick and easy to deploy.

ESG Lab found the Tintri VMstore to be one of the easiest shared storage solutions to deploy and assimilate into a vSphere environment, integrating tightly with VMware Horizon View to provide extremely simple administration combined with a high-performance user experience. If you're planning a VDI deployment or you've run into an I/O performance challenge that can't be met cost effectively with your existing solution, ESG Lab recommends that you take a serious look at VMware Horizon View with Tintri VMstore.

Appendix

Table 4. ESG Lab Test Bed

Hardware	
Tintri VMstore T540	Version 1.4.3.5
ESXi server for management and Infrastructure	Dell PowerEdge R610, 16 cores, 128GB RAM
ESXi server for virtual desktops	Four Dell PowerEdge R720, 16 cores, 256GB RAM
Ethernet switches	Dell Force10 S2410, Cisco Catalyst 4948
Software	
Hypervisor	VMware ESXi 5.1, build 799733
Management	VMware vCenter 5.1, build 880471
VDI Infrastructure	VMware Horizon View 5.2, build 947625
Workload generator	VMware Horizon View Planner
Virtual Machines	
vCenter/View Composer Server 4 vCPU, 8GB RAM, 1xVMxnet3 100 GB virtual disk	Windows Server 2008 R2 64-bit
View Connection Server 4 vCPU, 8GB RAM, 1xVMxnet3 40GB virtual disk	Windows Server 2008 R2 64-bit
View Planner 1 vCPU, 3GB RAM, 1xVMxnet3 15GB virtual disk	CentOS 6 32-bit
vCenter Operations Manager 2 vCPU, 9GB RAM, 1xVMxnet3 40GB virtual disk	SUSE Linux Enterprise 11 64-bit
vCenter Operations Manager UI 2 vCPU, 7GB RAM, 1xVMxnet3 130GB virtual disk	SUSE Linux Enterprise 11 64-bit
Active Directory Domain Controller 2 vCPU, 6GB RAM, 1xVMxnet3 50GB virtual disk	Windows Server 2008 R2 64-bit
Test Parameters	
Master desktop image: VMware virtual hardware v8 1vCPU, 2GB RAM, 1xVMxnet3 adapter 40GB virtual disk	Windows 7 Enterprise SP1
Installed Applications	MS Office 2012 (32 bit), Adobe Reader X, Firefox6, Internet Explorer 9, 7Zip

TCO Assumptions

A modeled five-year TCO of a virtual desktop storage solution was created by ESG Lab comparing Tintri VMstore with a conventional storage system based on current offerings from leading storage vendors in the same market. List pricing was used for all hardware and software.

In addition to hardware, software, and support costs, the model also took into account power/cooling expenses 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. as documented by the U.S. Energy Information Administration (<http://www.eia.gov/electricity/state/>).

Pricing data was gathered from publicly available sources.

Management costs were calculated based on average salaries, as well as common tasks associated with the management of an IT infrastructure. It was assumed that a general IT administrator with an hourly rate of \$40/hour can manage a Tintri VMstore, and a senior storage administrator with an hourly rate of \$55/hour is needed for traditional storage solutions (<http://www.salarydom.com>). The tasks ESG Lab modeled were: monitor, plan, provision, expand, tier, snap setup, snap recover, and network configuration. Each task was assigned an amount of time to complete (in minutes), as well as a monthly frequency.



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