ESG Technical Validation

HPE SimpliVity Hyperconverged Infrastructure

Enterprise-class Performance and Scalability with Built-in Data Protection and Resiliency

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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.

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Introduction

This ESG Lab Validation documents the results of hands-on evaluation and testing of HPE SimpliVity's hyperconverged infrastructure. This report focuses on the simplicity, efficiency, and cost-effective scalability and resiliency of various HPE SimpliVity configurations including a 1,000 VM workload with aggressive local backup, remote data protection policies, and a globally-stretched, multi-data center configuration.

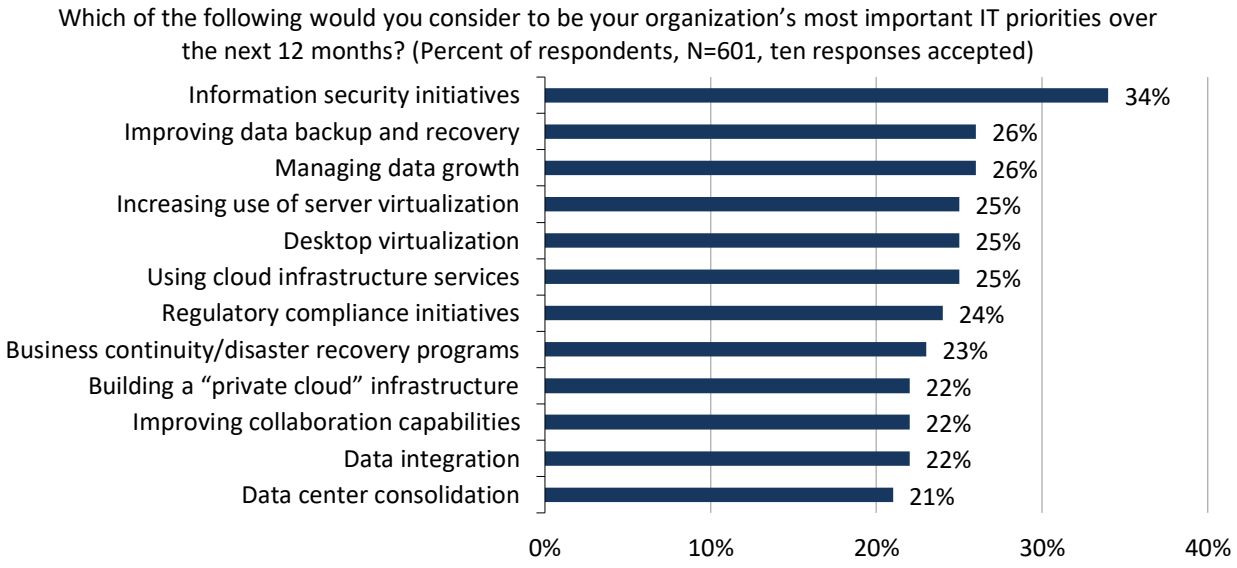
Challenges

A snapshot of today's modern IT environment is one of complexity, cost, and inflexibility that inhibit IT staff from effectively supporting the business. Many challenges exist, including:

- Islands of Functionality – IT consists of too many islands of functionality and resources, leading to low utilization and high labor costs. In the early 90s, primary storage went through a horizontal wave that consolidated the islands of primary storage devices, which were locked inside the server resources, into a shared device. VMware has done the same for servers. The next wave of infrastructure consolidation in the data center has arrived—consolidating compute, storage, and multiple, special-purpose appliances and software applications into a single, virtualized, and highly utilized, shared resource pool.
- Manageability – Today's traditional IT infrastructure has too many points of management. Each appliance has a standalone management interface and requires expensive specialized training.
- Mobility – In traditional IT infrastructure, data is not mobile. VMware has made the VM mobile, but the data associated with the VM is still limited in its mobility. Data needs to be more "lightweight" to be as mobile as a VM.
- Responsiveness – The time to data (restore, replicate, clone, etc.) both locally and remotely is too long. This introduces economical limitations in terms of required data management and protection best practices.
- Scalability – IT scales in very coarse increments. It is not practical to predict infrastructure requirements, especially multiple years out. Data center managers need a solution that can scale out with growing demand, with full protection, without the need for the costly over-provisioning of hardware resources.
- Cost – Purchasing and operating many infrastructure elements is costly, from both a CapEx (acquisition) and an OpEx (management) standpoint.

ESG research confirmed these challenges in a recent survey that asked organizations what their most important IT priorities were for 2015. As shown in Figure 1, commonly cited responses include improved data backup and recovery, increased use of server virtualization, managing data growth, and data center consolidation.[1]

Figure 1. Top 12 Most Important IO Priorities for Organizations in 2015



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

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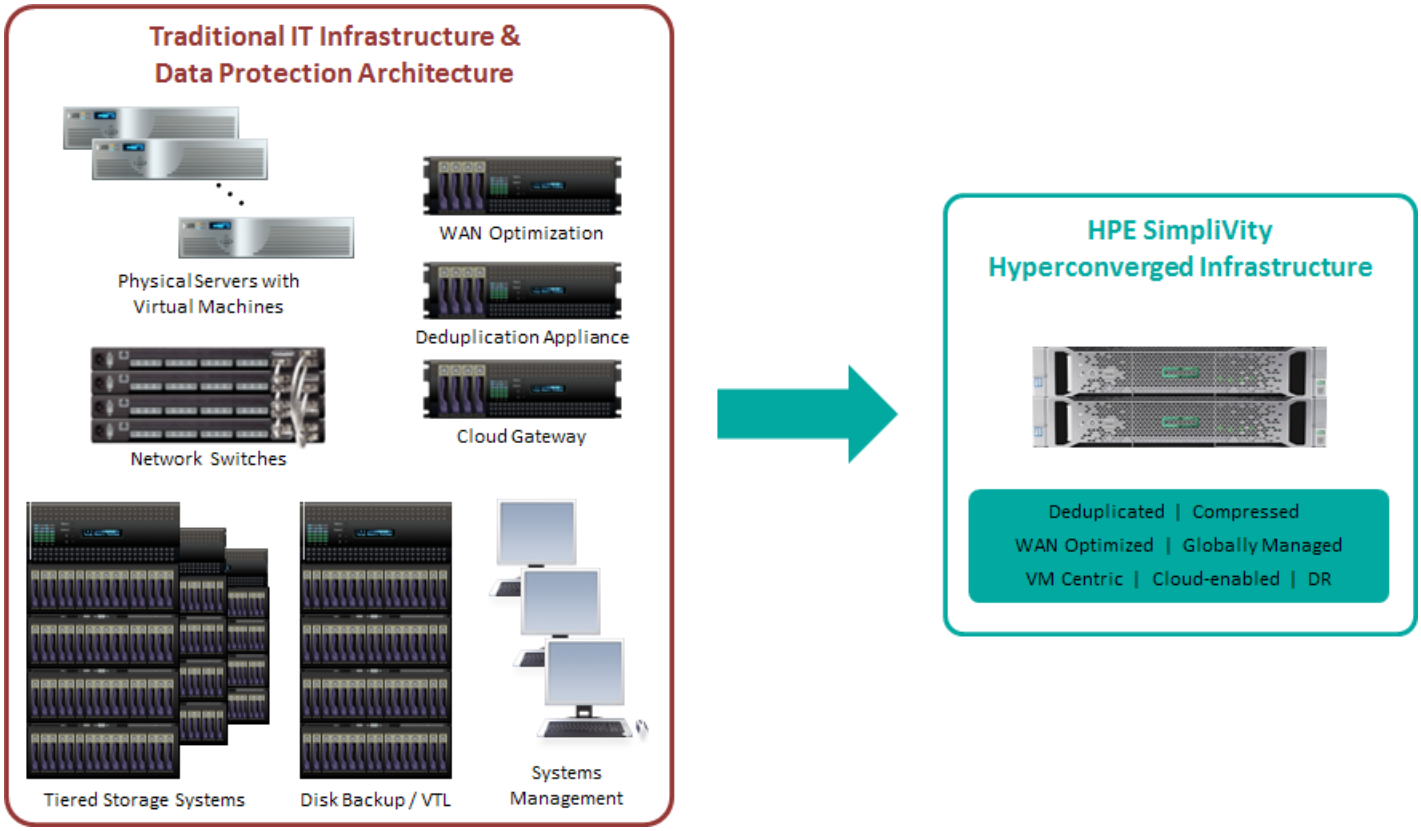
HPE SimpliVity Hyperconverged Infrastructure

In 2017, Hewlett Packard Enterprise (HPE) acquired SimpliVity and now offers HPE SimpliVity hyperconverged systems—complete hardware-software solutions that are designed, built, and supported by HPE. HPE SimpliVity hyperconverged technology lets organizations simplify IT. The all-in-one infrastructure platform combines compute, storage services, and networking in a single 2U appliance, while incorporating all of the traditional IT functions: WAN optimization, unified global VM-centric management, data protection, cloud integration, deduplication, built-in backup, caching, and scale-out capabilities. Inline deduplication, compression, and optimization are applied to all data at inception, reducing resource consumption (storage and CPU) while increasing application performance. Orderable under a single order number, the HPE SimpliVity 380 is a turnkey hyperconverged solution built on an HPE ProLiant DL380 compute platform. Systems can be clustered to form a shared resource pool that delivers high availability, mobility, and efficient scaling of performance and capacity.

The modularity of HPE SimpliVity enables high scaling in small server/storage increments. As HPE SimpliVity hyperconverged infrastructure nodes are added to an IT infrastructure, they become a multi-node cluster or—as HPE SimpliVity calls them—a Federation. A Federation is a self-healing and self-learning global "cluster of clusters" that can be managed from a single VM-centric user interface. The federation offers all of the functional and operational advantages of an HPE SimpliVity cluster at a global scale. The HPE SimpliVity Data Virtualization Platform spans the entire Federation, allowing all VM movement (including backups) between sites/clusters to leverage the HPE SimpliVity global deduplication/compression/optimization functionality. Figure 2 shows how HPE SimpliVity hyperconverged infrastructure simplifies the deployment of a traditional IT infrastructure and data protection architecture.

Figure 2. HPE SimpliVity Hyperconverged Infrastructure



Source: Enterprise Strategy Group, 2017

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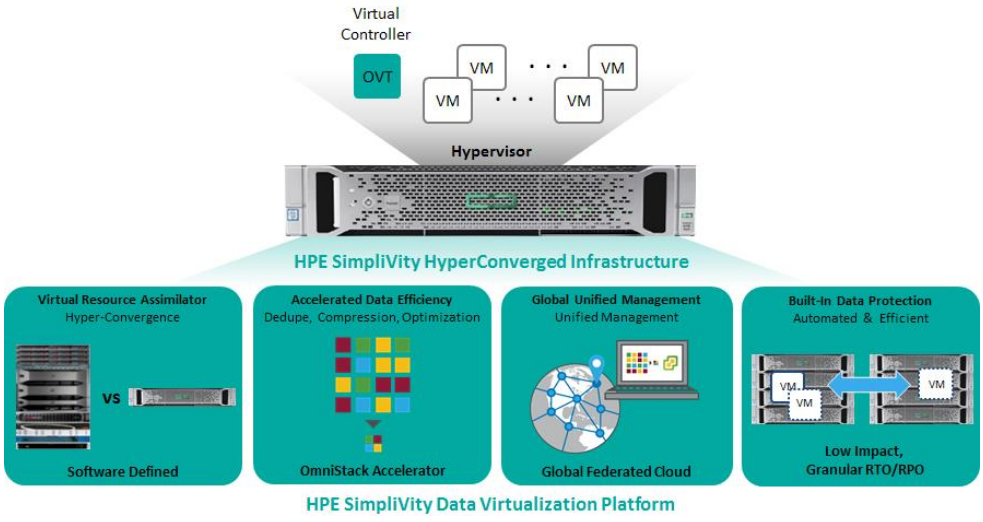
Key capabilities of HPE SimpliVity hyperconverged infrastructure include:

- Data virtualization provides global deduplication, compression, and optimization on all I/O at ingest across all nodes in a Federation, not only reducing the capacity requirements, but also improving the speed of data operations, and ultimately eliminating the need for WAN optimization appliances.
- Global management through a VMware vCenter plug-in greatly reduces management and administrative complexity by abstracting the policy from the infrastructure. The solution also works with orchestration and automation software from VMware vRealize Automation as well as any software that can consume REST APIs.
- VM centricity ensures that all operations (clones, backups, restores, moves) happen at a VM level within the data center, as well as across multiple data centers.
- Policy-based native data protection in the form of local and remote backups comes with the ability to restore anywhere in a Federation through advanced disaster recovery functionality that is abstracted away from the underlying infrastructure. The ability to perform file-level restores is supported as well.
- Scale-out and scale-in architecture where hyperconverged infrastructure nodes can be added to and removed from a Federation on demand while remaining centrally managed from the same management interface simplifies IT planning.
- Full VMware integration with technologies such as vMotion and Storage vMotion makes it easy to move workloads within the data center.
- High availability with no single point of failure offers enterprise-class reliability.
- Auto tiering of data across SSD and HDD storage tiers ensures that data lives on the optimal resource.
- Hypervisor agnosticism will eventually extend the technology to other hypervisors beyond VMware, with Microsoft Hyper-V support being on the short term roadmap.

Figure 3. HPE SimpliVity Hyperconverged Infrastructure



Source: Enterprise Strategy Group, 2017

As shown in Figure 3, the solution is built on the HPE SimpliVity Data Virtualization Platform and encompasses three main innovations:

- Data Efficiency: A new data architecture dedupes, compresses, and optimizes all data at inception, inline, with no impact to performance. This is done through the HPE OmniStack Accelerator Card, which is a HPE SimpliVity specially designed PCIe card. Data is handled at a fine grain of 4KB-8KB once and forever, across all phases of the data lifecycle, tiers within the system (DRAM, flash/SSD, and HDD), data centers, and geographies. Median data efficiency in

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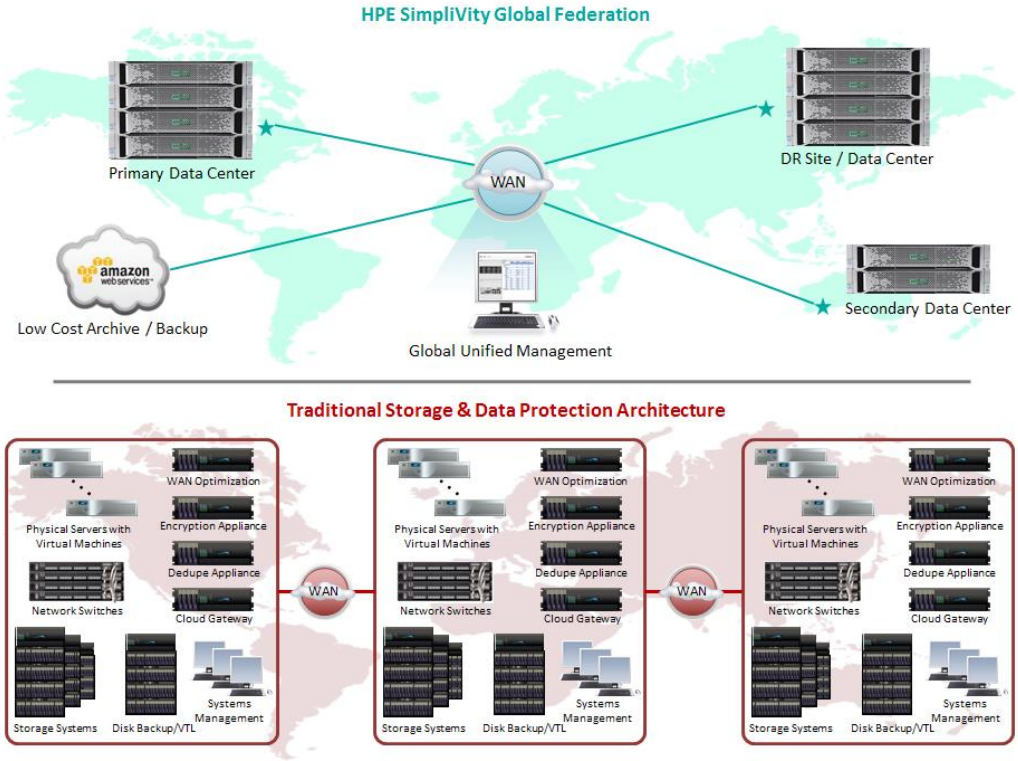
deployed environments has been 40:1, with one-third of HPE SimpliVity customers realizing data efficiencies of 100:1 or higher.[2]

- Data Protection: The solution provides fully integrated local and remote backups at the VM level. Remote backups, to another site or to the cloud, can occur in ten-minute RPO intervals. Given the data efficiency capabilities of the platform, the solution provides instant VM recoverability. Each backup is a full logical backup with no need to manage snaps or delta copies of the data.
- Global Federated Architecture: An intelligent network of collaborative systems provides scale-out capabilities with VM-centric global management through a single unified interface for the entire global infrastructure. This feature enables a single administrator to manage all data centers and branch offices located anywhere globally, while giving visibility and control to take action on a per-VM basis.

HPE SimpliVity's hyperconverged infrastructure can meet the scalability needs of any-sized organization and therefore can be deployed in a wide variety of use cases. A pair of systems can be deployed as a complete IT solution for SMB and a single node can be deployed for remote offices. This solution can grow into a small group of nodes or a Federation to provide a small- to medium-sized business with a "data center in a box" solution. The Federation can easily meet the requirements of a large enterprise by adding even more nodes within the data center and eventually deploying additional nodes into more geographically dispersed areas to meet disaster recovery requirements and to maintain a true global IT presence. HPE SimpliVity nodes can be used to meet the strict performance requirements of today's mission-critical IT applications, from high-performance databases through e-mail and collaboration applications to test and development deployments and VDI environments. Finally, HPE SimpliVity can provide an IaaS platform to quickly and easily deploy both public and private clouds.

Figure 4 expands on the simplification of a HPE SimpliVity hyperconverged infrastructure deployment by showing the difference between a globally deployed infrastructure with a HPE SimpliVity hyperconverged infrastructure solution and a traditional IT infrastructure and data protection architecture.

Figure 4. HPE SimpliVity Hyperconverged Infrastructure



Source: Enterprise Strategy Group, 2017

[2] See HPE SimpliVity page for more details: http://www.hpe.com/info/simplivity.

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HPE SimpliVity hyperconverged infrastructure can be deployed in a few forms depending on what best suits the needs of the customer:

- HPE SimpliVity 380, a turnkey hyperconverged solution built on an HPE ProLiant DL380 compute platform. Three enterprise all-flash models are currently offered, and over time more configurations will be available:
  - *Small* – Compact system geared to run all workloads in small to medium environments and ROBOs, offering 16 to 44 CPU cores and 6 to 12 TB of effective storage capacity.
  - *Medium* – General purpose system designed to run the majority of workloads across a wide range of environments from small IT to large enterprise sites, offering 16 to 44 CPU cores and 12 to 25 TB of effective storage capacity.
  - *Large* – High-performance system optimized to run ultra high-performance workloads for enterprises and cloud providers, offering 16 to 44 CPU cores and 20 to 40 TB of effective storage capacity.

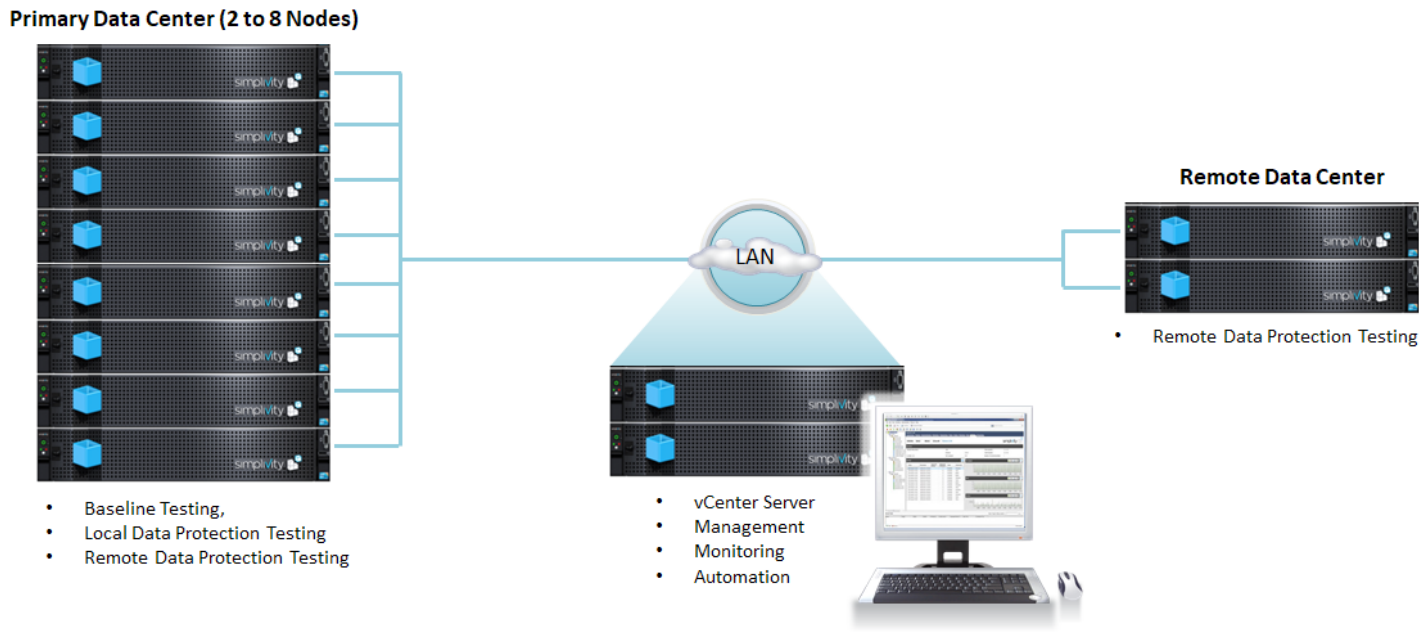
ESG Lab Validation

ESG Lab performed hands-on evaluation and testing of HPE SimpliVity hyperconverged infrastructure at HPE SimpliVity's site in Westborough, Massachusetts. Testing was designed to demonstrate the simplicity, efficiency, reliability, and fully protected performance scalability of the hyperconverged infrastructure with OmniStack technology. ESG Lab was also shown HPE SimpliVity technology's capability to globally scale. This was accomplished through a demonstration that highlighted up to five simulated HPE SimpliVity hyperconverged infrastructure data centers, including one that leveraged a public cloud.

Simplicity

ESG Lab configured eight HPE SimpliVity hyperconverged infrastructure instances in a single Federation for use in performance testing. A 10GbE network was used for all Federation data transfers, while a 1GbE network was used for managing the Federation. One thousand load generation VMs were configured and spread evenly across the eight HPE SimpliVity hyperconverged infrastructure instances. Each VM was configured with Windows Server 2012 R2, a single vCPU, 2 GB of RAM, and 100 GB of hard disk space. The performance testing infrastructure was reconfigured and tested with two to eight nodes along with a two-node cluster located in a remote data center for remote data protection testing. The ESG Lab test bed is shown in Figure 5.

Figure 5. ESG Test Bed



Source: Enterprise Strategy Group, 2017

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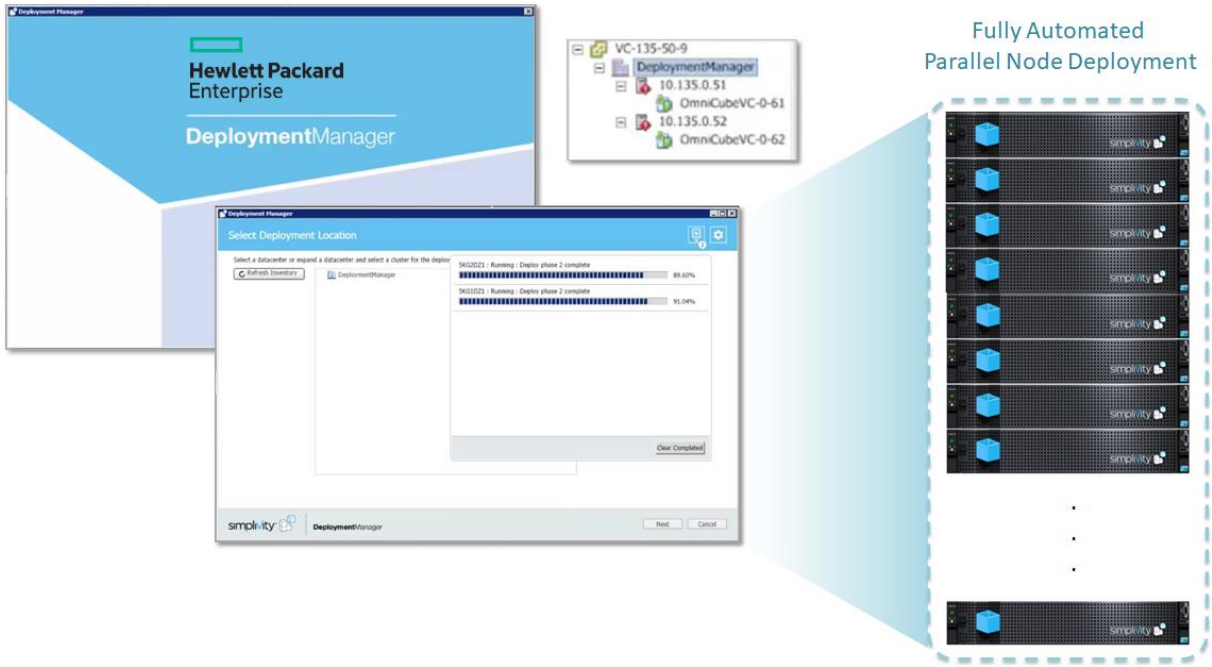
ESG Testing

ESG Lab began testing by preparing a client computer for the first time. The standard VMware components were installed including the vSphere client as well as HPE SimpliVity's vSphere plug-in. Finally, the HPE SimpliVity Arbiter was installed on the computer hosting vCenter Server. The Arbiter is an agent that enables key functionality for the Federation. Both the HPE SimpliVity plug-in and the Arbiter are included on a thumb drive that ships with the system along with HPE SimpliVity's Deployment Manager.

ESG Lab then used HPE SimpliVity's simple and automated Deployment Manager to deploy a node into a new Federation. After providing the address and credentials to connect to vCenter, the Deployment Manager automatically detected a powered-on node and provided step-by-step prompts to collect the necessary configuration information. The wizard guided ESG Lab through the setup of the administrative roles and credentials for the system, and then helped with configuring the management, storage, and Federation networks. The configuration procedure for the first node took around 30 minutes. After walking through the Deployment Manager the first time, the configuration was saved into a configuration file that could be used to automate deployment of additional nodes into the Federation.

Figure 6. Installing HPE SimpliVity Hyperconverged Infrastructure Installation with Deployment Manager



Source: Enterprise Strategy Group, 2017

Next, ESG Lab grew the Federation by adding nodes to the environment. Using the previously saved configuration file, ESG Lab was able to deploy the remainder of the nodes into the configuration in a matter of minutes by providing sequential IP addresses. Deployment Manager also provided the option to modify any of the saved parameters if necessary prior to deployment. The deployment was fully automated and deployed the remaining seven nodes into the Federation in parallel—the entire process took less than 20 minutes from start to finish. HPE SimpliVity's new Deployment Manager both greatly simplified and expedited the deployment process that ESG Lab had previously validated in 2013.

As each additional system was added to the Federation, the total available capacity grew accordingly. Once all eight HPE SimpliVity hyperconverged infrastructure instances were added to the Federation, ESG Lab used vCenter to easily manage the entire Federation from a single management interface. As ESG Lab created VMs, they were automatically distributed across all of the available nodes in the Federation. The entire installation was completed through HPE SimpliVity's vSphere plug-in without switching context to CLI or other management user interfaces. It should be noted that ESG Lab could have deployed all eight nodes simultaneously as would typically be done by customers, but wished to illustrate both the steps to create a new installation, as well as to grow a deployment.

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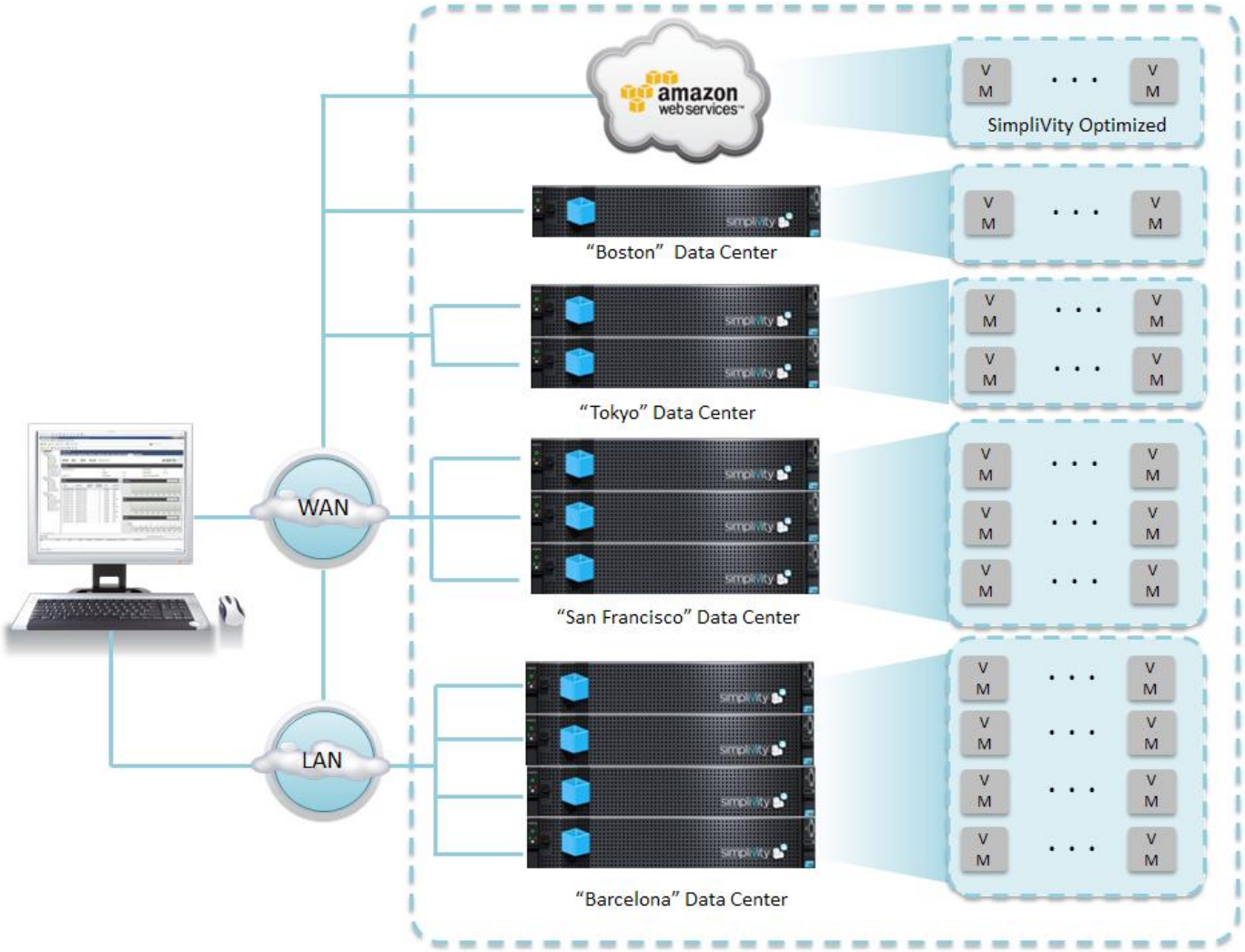
In addition to the eight-node Federation used primarily for testing, ESG Lab toured a HPE SimpliVity solution consisting of four data centers and an Amazon cloud (see Figure 7).

Figure 7. Global Federation of HPE SimpliVity



Source: Enterprise Strategy Group, 2017

ESG Lab quickly found that managing the simulated, globally spread environment was easy, intuitive, and responsive for anyone with VMware experience. ESG Lab was able to perform any function in the HPE SimpliVity hyperconverged infrastructure system using traditional vCenter operations, but the real power of the system was made clear when the specific HPE SimpliVity functionality was tested. A HPE SimpliVity management tab was available for both high- and low-level elements in the infrastructure. ESG Lab was also given the option to perform HPE SimpliVity-optimized management tasks such as backups, clones, and migrations. These tasks could all be done at the VM level simply by right-clicking on the desired VM and selecting one of the five clearly marked HPE SimpliVity tasks. A view of the test bed through vCenter is shown in Figure 8.

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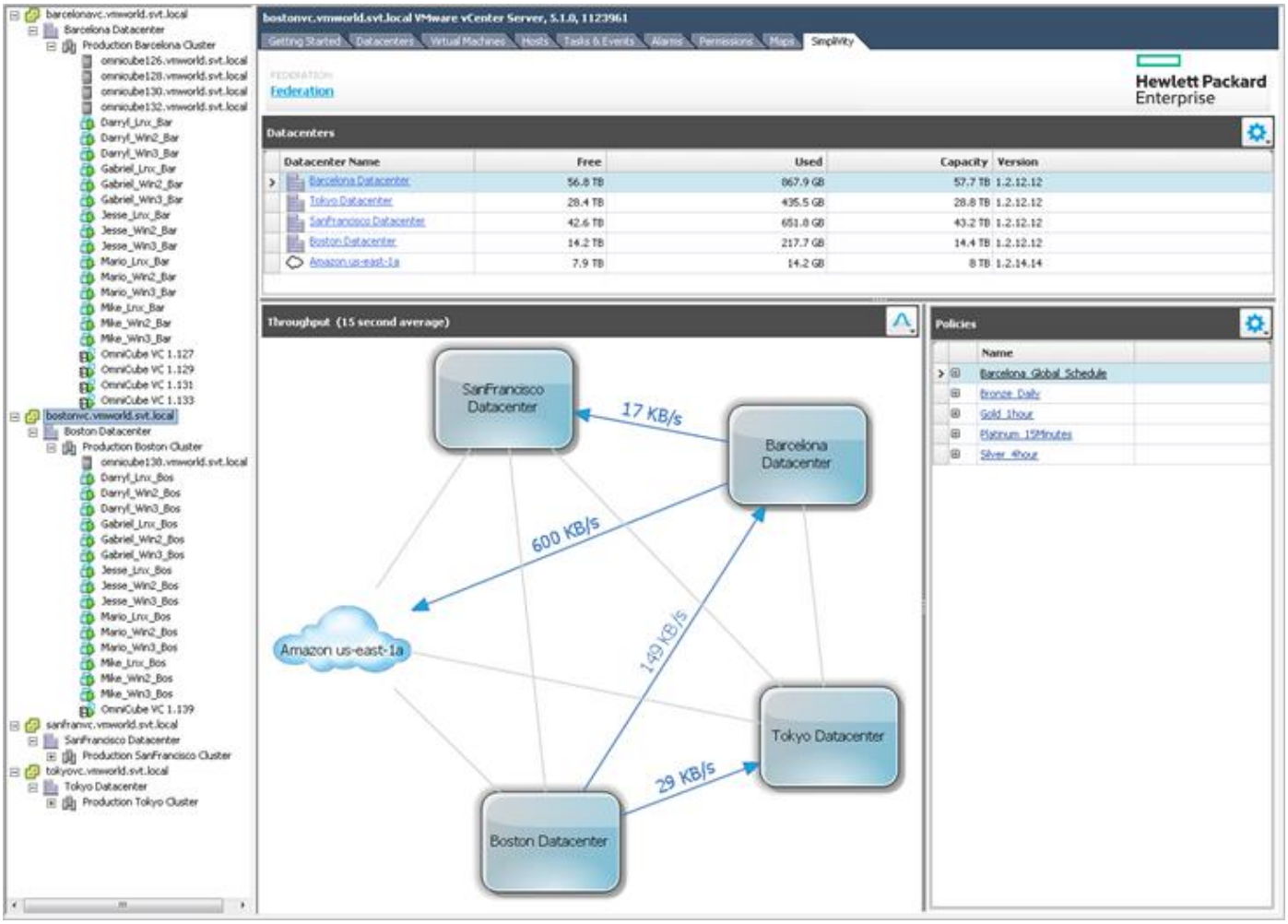
Figure 8. Global Unified Management



Source: Enterprise Strategy Group, 2017

Why This Matters

Traditional virtualized infrastructures made up of multi-vendor components are complex to plan, install, configure, manage, and maintain. ESG research indicates that server virtualization is a top IT priority for 2015, and a growing number of organizations are moving from "do it yourself" to fully-integrated solutions with a goal of simplifying management, reducing time to deployment, and lowering the total cost of ownership.[3]

ESG Lab validated that a HPE SimpliVity hyperconverged infrastructure system was easy to deploy and manage. The installation process was simple with the help of a configuration wizard that automated the usually complex tasks associated with setting up a complete virtual infrastructure. This included the setup of servers, storage, networking, and a fully-clustered HA VMware environment in less than 20 minutes. ESG Lab quickly grew a Federation from one to eight nodes and was easily able to manage the infrastructure through a single interface. The ease of management became even more apparent to ESG Lab when witnessing the impressive simplicity of managing a simulated, globally dispersed multi-data-center environment that included an Amazon public cloud.

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

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Efficiency

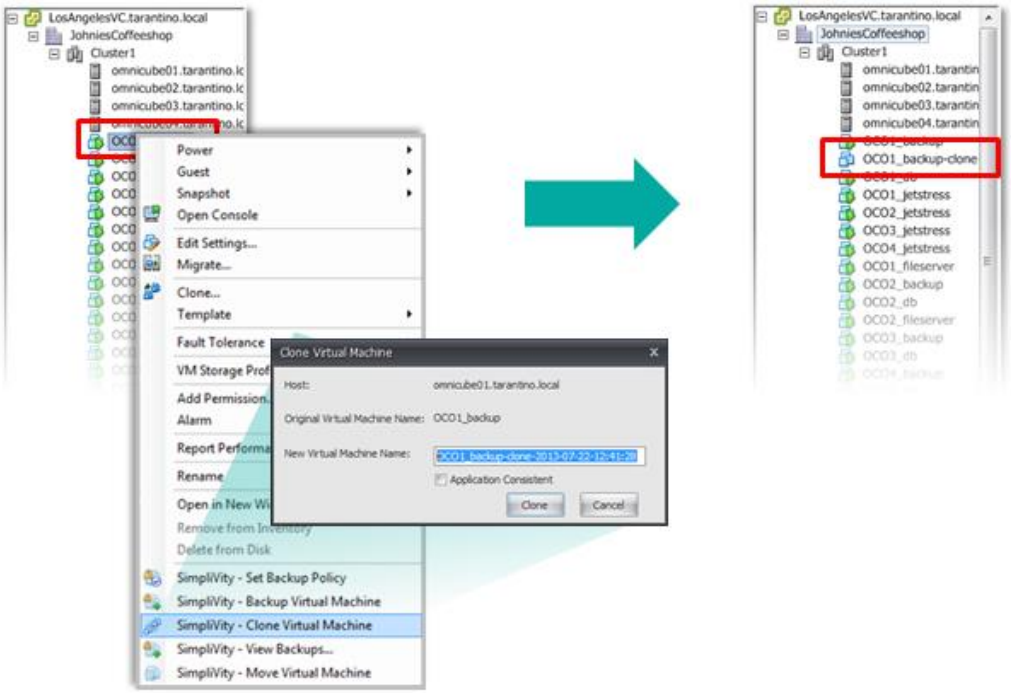
One of the key technologies powering HPE SimpliVity hyperconverged infrastructure is the Data Virtualization Platform, which enables all data associated with VMs in the Federation to remain in a capacity-optimized state. All data copied into or created in the Federation is deduplicated, compressed, and optimized in real time at a 4KB-8KB level of granularity. The OmniStack Accelerator, a purpose-built PCIe card developed by HPE SimpliVity, offloads this processing from the CPU. Deduplication was originally designed for backup and to optimize global data movement, save capacity, and deliver throughput.

Data Virtualization Platform (DVP) is a new generation of data virtualization that was designed for primary storage and is optimized for latency and IOPS. All data stored in the Federation and transferred between nodes is kept optimized at all times through the lifecycle of the data—there is never a need for the data to be returned to a non-optimized capacity state, unless it is moved away from the Federation back on to a traditional infrastructure. The value of DVP is to make HDD IOPS, WAN bandwidth, and SSD capacity more efficient. There are significant savings in the amount of data that must be stored and moved, maximizing the efficiency of VM operations such as clones, backups, migrations, disaster recovery, and archiving to the cloud. HPE SimpliVity has a ticker running on its website that provides updated information on median deployed data efficiency, which typically ranges from 25:1 to 40:1.

ESG Testing

ESG Lab demonstrated the functionality and efficiency of HPE SimpliVity hyperconverged infrastructure by first creating a single clone and then measuring the capacity savings as additional clones were created within the Federation. The first clone was created by right-clicking on an existing VM and selecting ***HPE SimpliVity – Clone Virtual Machine***. This brought up a dialog box that confirmed the source VM, allowed the assignment of a name to the resulting virtual machine, and presented a checkbox that enabled the clone to be application-consistent when checked. After confirming the operation by clicking on ***Clone***, ESG Lab noted that the entire clone operation was completed in less than nine seconds. It should be noted that the majority of the time taken to complete the clone operation was dictated by the time it takes to register the new virtual machine in vCenter, rather than the time it takes HPE SimpliVity to complete the operation. ESG Lab then tested the functionality of running the cloned machine by starting up the VM. The VM powered on quickly with no noticeable performance issues and was ready for use in the environment. The clone creation process is shown in Figure 9.

Figure 9. HPE SimpliVity Rapid Clone Creation



Source: Enterprise Strategy Group, 2017

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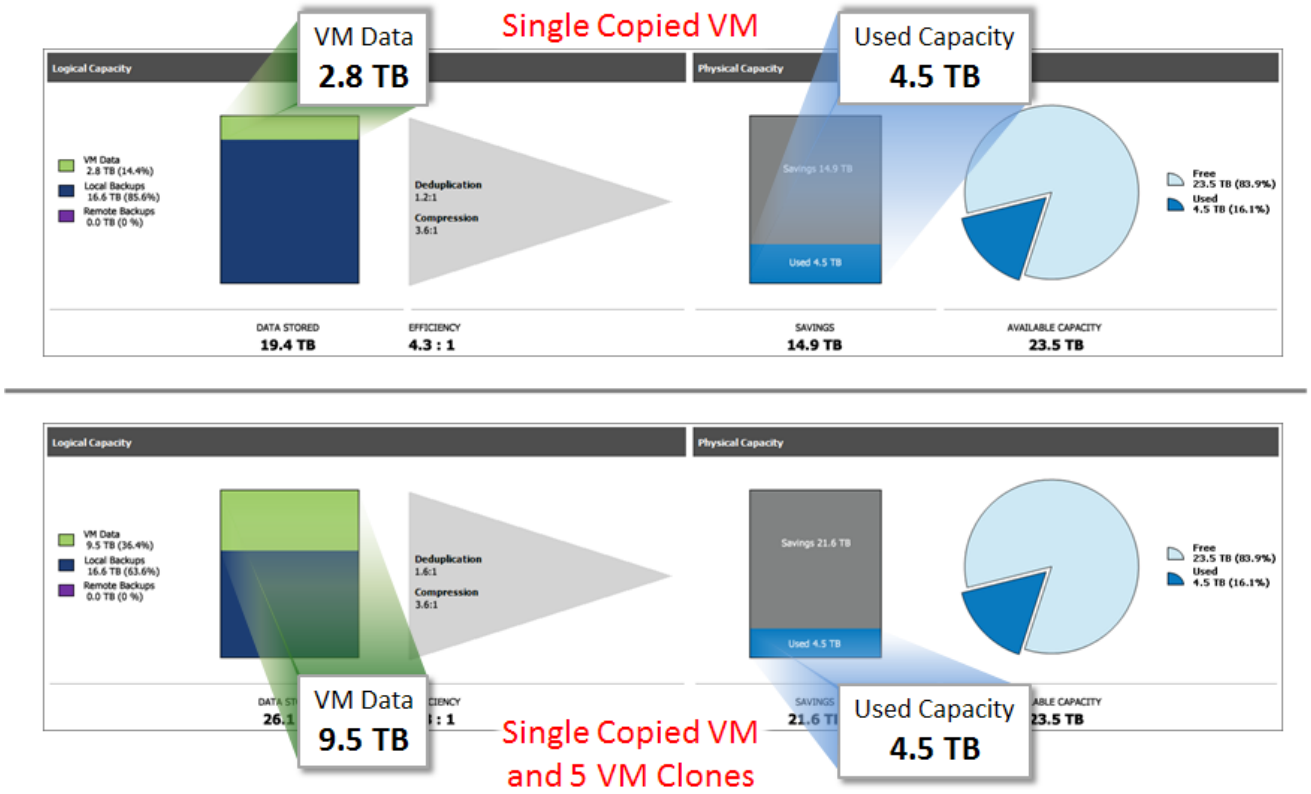
Next, ESG Lab measured the space efficiency of HPE SimpliVity hyperconverged infrastructure. A new instance of a VM was created and the logical space consumed was noted to be 30 GB. A complete directory structure of unique data was then copied to the VM from a physical server. The unique data set contained real files located on HPE SimpliVity's corporate file shares and totaled 870 GB of physical data. Once the data was copied to the C:\ drive of the virtual machine, the amount of consumed logical space was noted at 900 GB and consumed physical space was noted to be only 466.2 GB. This represented a 52% savings in capacity.

Further space efficiency was realized when ESG Lab created five rapid clones of a VM that consumed 1.34TB. Prior to testing, there was 2.8 TB of consumed logical capacity from VM data, 16.6 TB of consumed logical capacity from backup data, and 4.5 TB of consumed physical capacity on the Federation. The 2.8 TB of VM data included the 1.34 TB from the source VM. After creating five clones of the source VM in under a minute, the logical capacity of the VM data grew by an expected 6.7 TB (1.34 TB per VM) from 2.8 TB to 9.5 TB, but the consumed physical capacity did not grow at all, utilizing only the original 4.5 TB of disk storage. The results validated that the data stored on HPE SimpliVity hyperconverged infrastructure stayed in an optimized state and that the space efficiency of the system continued to grow as additional clones were taken (see Figure 10).

Figure 10. Capacity Efficiency with HPE SimpliVity's Rapid Clone Technology



Source: Enterprise Strategy Group, 2017

Finally, ESG Lab compared the speed at which a clone could be completed with HPE SimpliVity's rapid clone technology with the traditional ESX clone method. This helped ESG Lab to better understand how HPE SimpliVity's optimization technology translated to real-world administrative efficiency. Using a standard Windows Server 2008 R2 VM, ESG Lab created a clone using the traditional ESX clone methodology. Once the clone creation process was started and the progress was noted in the task panel of the vCenter administration screen, ESG Lab quickly made five clones of the same Windows Server 2008 R2 VM. Each HPE SimpliVity clone was completed in less than ten seconds, and all five were ready to be powered on while the traditional clone was still only 8% complete because it was necessary to copy the entire set of data associated with the VM.

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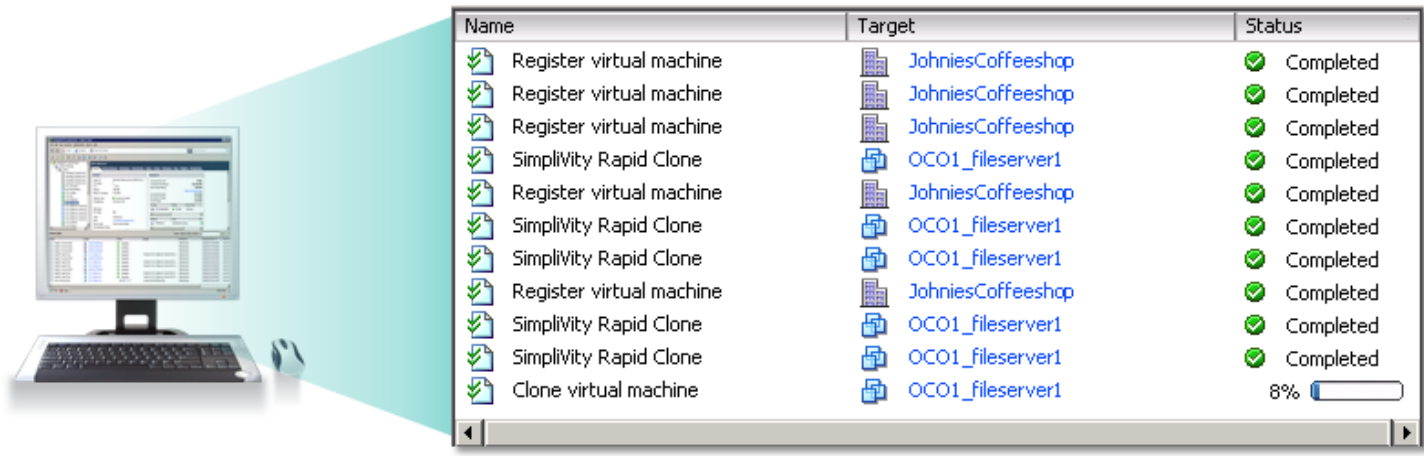
The Recent Tasks list from this phase of testing is shown in Figure 11. It is important to point out that this was a relatively small VM in terms of capacity, and a VM with more data associated with it would have taken even longer to clone in the traditional manner, yielding even greater advantages for the efficiency of HPE SimpliVity's rapid clone technology. Also, it was observed that the time to make a HPE SimpliVity clone was unchanged regardless of the size of the VM. A 1TB VM also cloned in less than ten seconds. HPE SimpliVity supports VMware vStorage API for Array Integration (VAAI) to offload the VMware clone operation to HPE SimpliVity rapid cloning technology.

Figure 11. HPE SimpliVity Rapid Clone Efficiency versus Traditional VM Clone



Source: Enterprise Strategy Group, 2017

It should be noted that similar efficiencies can be witnessed through all the HPE SimpliVity functions, including taking and scheduling backups, restoring data, migrating data between local and geographical locations, and performing disaster recovery operations.

Why This Matters

Data growth continues to challenge IT organizations. ESG research proves this point; respondents to ESG's annual IT spending surveys for the past three years have consistently chosen managing data growth as one of their most important IT priorities, putting it in the list of the top five most-cited IT priorities.[4] The costs of storing and managing duplicate file data can stress capital and operational budgets unnecessarily. Deduplication appliances are available, but many deduplicate data only at the backup and archive tier, compared with HPE SimpliVity's approach of deduplicating the data at the source. Deduplication appliances can add another point of management to the IT administrator's task list, another line item to the purchase order, and additional CapEx and OpEx costs.

ESG Lab Validated that both capacity and operational efficiency are built into data operations performed by HPE SimpliVity hyperconverged infrastructure. Data copied onto the system was stored efficiently, and remained in that state even when cloned several times and moved between nodes. ESG Lab witnessed how HPE SimpliVity hyperconverged infrastructure helped to facilitate administrative productivity by completing five HPE SimpliVity clones in less than ten seconds, while a traditional clone had only completed 8% of its clone operation. Contrary to the common belief that deduplication and compression can slow down storage performance, HPE SimpliVity's Data Virtualization Platform technology improved the efficiency by reducing the total number of IOPS to the storage, thereby making all operations faster.

[4] Source: ESG Research Reports, *2013, 2014, and 2015 IT Spending Intentions Survey.*

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Reliability and Built-in Data Protection

HPE SimpliVity hyperconverged infrastructure is designed with enterprise reliability in mind. Deploying it on highly available servers provides n+1 fault tolerance for key hardware components along with RAID-protected data storage. HPE SimpliVity hyperconverged infrastructure leverages all of the HA features built into VMware, including multipathing and VMware HA to provide access to VMs even in the event of a node or guest OS failure. Space efficiency and optimized backup capabilities allow for additional backup and recovery functionality that extends across data centers and into the cloud.

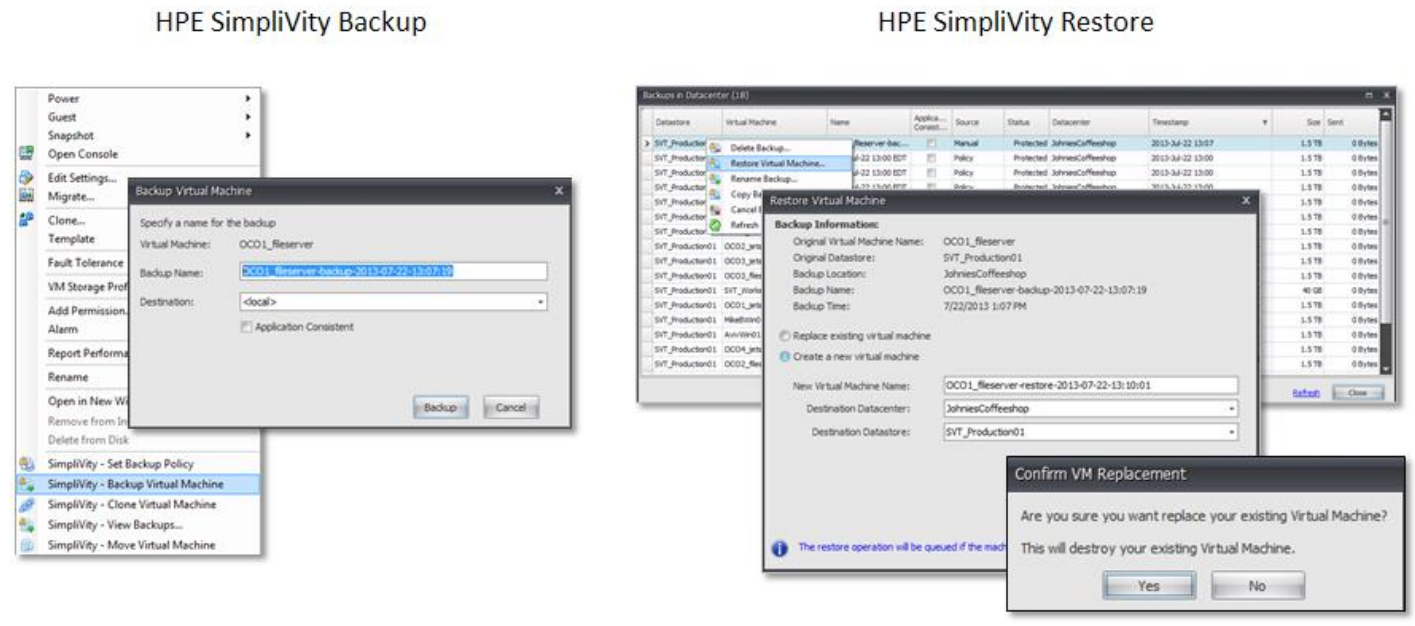
ESG Testing

ESG Lab tested the basic functionality of backing up and restoring a VM, restoring a file within a VM, as well as the reliability of HPE SimpliVity's hyperconverged infrastructure. ESG Lab also simulated a major disaster of losing an entire node with a goal of showing the quick recovery capabilities.

First, ESG Lab created a one-time backup of a VM to validate the basic functionality of HPE SimpliVity's software. The backup was created in two simple steps. ESG Lab right-clicked on the VM and from the pop-up menu selected ***HPE SimpliVity – Backup Virtual Machine***. After entering a custom name for the backup and selecting a destination data center, the backup started. The entire 1.5TB VM was backed up in under two seconds.

After the backup completed, ESG Lab was ready to test the restore functionality of HPE SimpliVity hyperconverged infrastructure. ESG Lab simulated a failure by "accidentally" deleting the VM from the vCenter inventory. By right-clicking on the data center and selecting ***HPE SimpliVity – View Backups in Datacenter***, ESG Lab was brought to an interface where all of the backups of the entire Federation could be seen with various sorting options. The previously backed up VM was available and by right-clicking on the backup and selecting ***Restore Virtual Machine***, the restore dialog box popped up. This box gave the option to replace the existing machine or create a new virtual machine. ESG Lab created a new virtual machine. After selecting the data center and datastore to which the virtual machine would be restored, a final confirmation appeared. After confirming the restore, the VM was available in less than nine seconds. The steps for backing up and restoring a virtual machine are shown in Figure 12.

Figure 12. Backup and Restore of a Virtual Machine



Source: Enterprise Strategy Group, 2017

After the basic functionality was tested, ESG Lab created a backup policy that could be applied to an entire virtual environment. HPE SimpliVity's hyperconverged infrastructure came preconfigured with several predefined backup policies with different levels of protection. By right-clicking on the Federation and selecting ***Create Backup Policy***, ESG Lab was presented with a dialog box to enter a new backup policy called *ESG_backup_policy01*. Next, rules were added to the new

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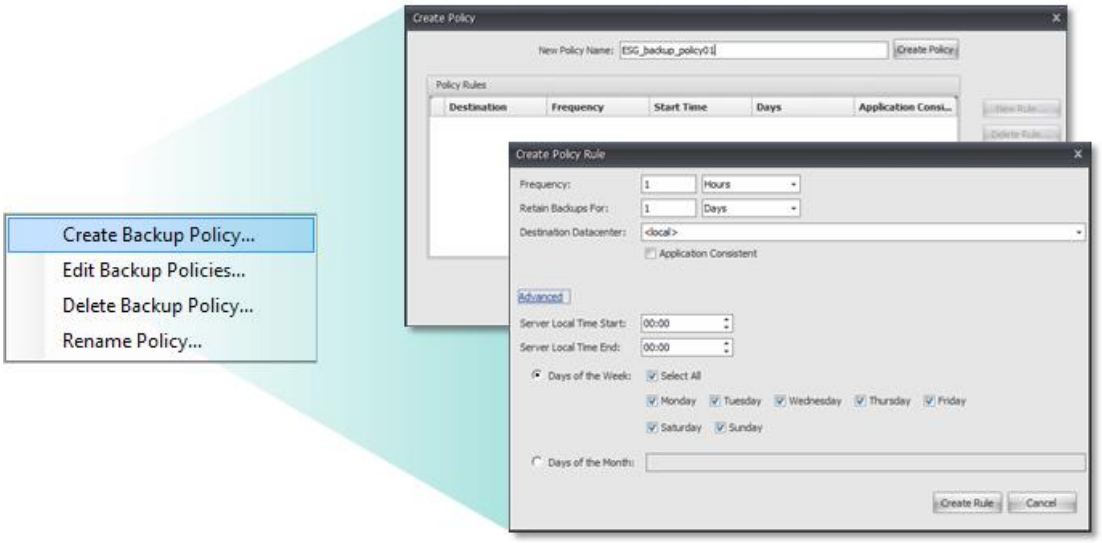
policy by clicking on ***New Rule*** in the dialog box. ESG Lab configured various options for backup frequency, retention period, and data center destination. The advanced options allowed for defining backup windows with start and stop times, and specific days of the week or month to complete a backup. The new policy was configured to take a backup every hour with a 30-day retention period. ESG Lab then clicked ***Create New Rule*** followed by ***Create New Policy*** and verified that the new backup policy showed up in the Backup Policy list. The process is shown in Figure 13.

Figure 13. Creating a Backup Policy



Source: Enterprise Strategy Group, 2017

Then ESG Lab created a custom, automated backup schedule to manage backups of virtual machines. The newly created backup policy was applied to a VM by right-clicking on the VM, selecting Set Backup Policy, choosing ESG_backup_policy01 from the drop down list, and then clicking on the Set Backup Policy button to activate the policy. ESG Lab verified that the policy was displayed as the active policy on the VM, and that a backup was taken of the VM every 60 minutes. Policies can also be applied in bulk, by selecting several VMs at once, resulting in significant administrative time savings.

After validating localized backup and restore capability, ESG Lab repeated the tests while backing up to, and restoring from, backups stored in a remote lab. With a moderately heavy mixed workload running, ESG Lab was easily able to create remote backups and restore from the remote backups with little to no noticeable impact to measured workload response time. With HPE SimpliVity, localized data protection policies and operations can easily be expanded to include data centers in different geographical locations. This includes everything from quickly sending backups to one data center, to restoring that same VM to a completely different data center in seconds. ESG Lab also learned that this speed and functionality can be extended to data centers that leverage the services of an Amazon cloud.

In some cases, it may not be necessary to completely restore an entire VM from a backup image, such as when a file is accidentally deleted or corrupted. For these cases, HPE SimpliVity allows administrators to perform a file-level restore operation. To test this functionality, ESG Lab created a new text file named my restore.doc on an active VM before manually backing up the VM to ensure the latest backup contained the new file. The file was then permanently deleted from the server. To recover the file, ESG Lab right-clicked on the manual backup from the list, and selected Restore Files and Folders, which brought up the File Restore Wizard. Using the wizard we were easily able to locate the file, select it for restoration, and choose the VM that we wished to present the file to. This could be done for a single file, multiple files, an entire directory, or even an entire filesystem. Once complete, a removable device (DVD) containing the folder and file was automatically attached to the target VM, and the file could read and copy to a new location. The entire file restoration process took less than one minute and is depicted in Figure 14.

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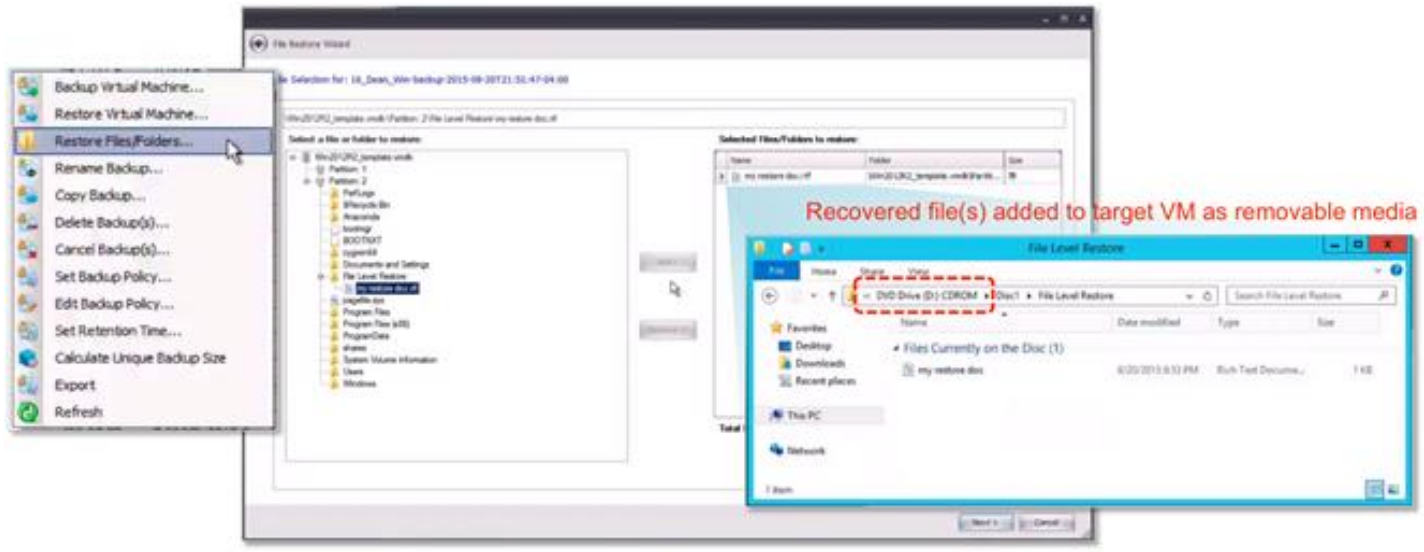
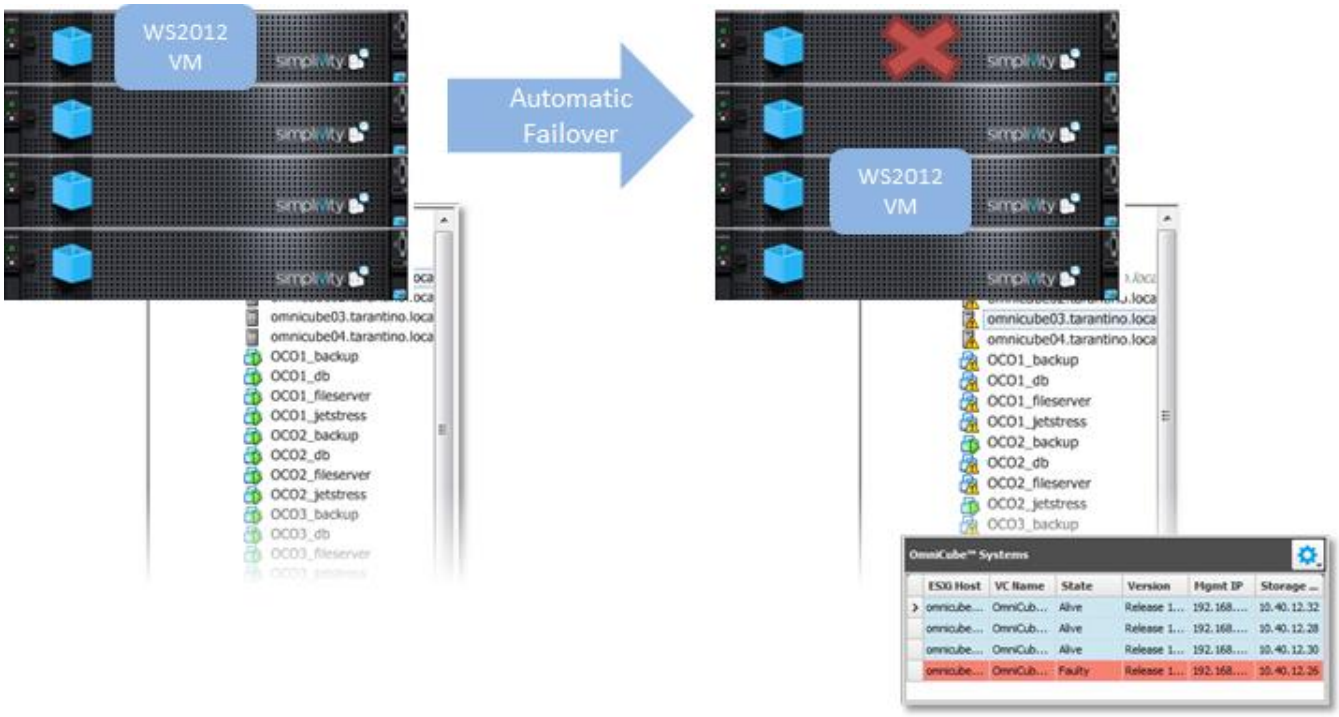
Figure 14. Restoring a Single File from a Backup Image to a Target VM



Source: Enterprise Strategy Group, 2017

Finally, ESG Lab tested the resiliency of a four-node Federation by simulating a major failure of losing a node. Sixteen VMs were evenly distributed across the Federation and powered on. Once ESG Lab validated the location of each running virtual machine, one of the HPE SimpliVity hyperconverged infrastructure nodes was abruptly powered off. The four VMs contained in the faulted node were quickly transferred throughout the rest of the Federation in less than a minute. The VMs were quickly powered on and continued to function without any problems. Warnings were presented at a number of VMs to indicate that they failed over. The remaining HPE SimpliVity hyperconverged infrastructure instances in the Federation still served as ample protection to all 16 VMs. ESG Lab powered on the faulted node and the VMs were quickly redistributed across the entire Federation to best use all the available resources. A logical view of the automatic failover capabilities are presented in Figure 14, along with screenshots from vCenter before and after the failure.

Figure 15. HPE SimpliVity Hyperconverged Infrastructure Node Power Failure Resiliency



Source: Enterprise Strategy Group, 2017

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Why This Matters

Data protection of virtualized infrastructure is critical to IT operations. The ability of IT end-users to access information anytime from anywhere is not simply desired, it is expected. Downtime not only hurts business productivity, but also triggers costly payments when hard SLAs are in place for mission-critical applications. Because of this, it's no surprise ESG research indicates that, after information security initiatives, improving data backup and recovery is a second most-cited priority for IT organizations in 2015.

ESG Lab validated that HPE SimpliVity hyperconverged infrastructure backups were quick, efficient, and easy to create and restore from—even across data centers. Backups and restores took just two mouse clicks and were completed in seconds. ESG Lab demonstrated that the creation of VM-centric, automated backup policies were simple to configure and manage, while remaining flexible enough to effectively implement local and global data protection strategies. ESG Lab also was able to perform a file-level restore and witnessed the resiliency of the HPE SimpliVity Federation by being able to access the entire virtualized environment after an entire node was lost.

Protected Performance at Scale

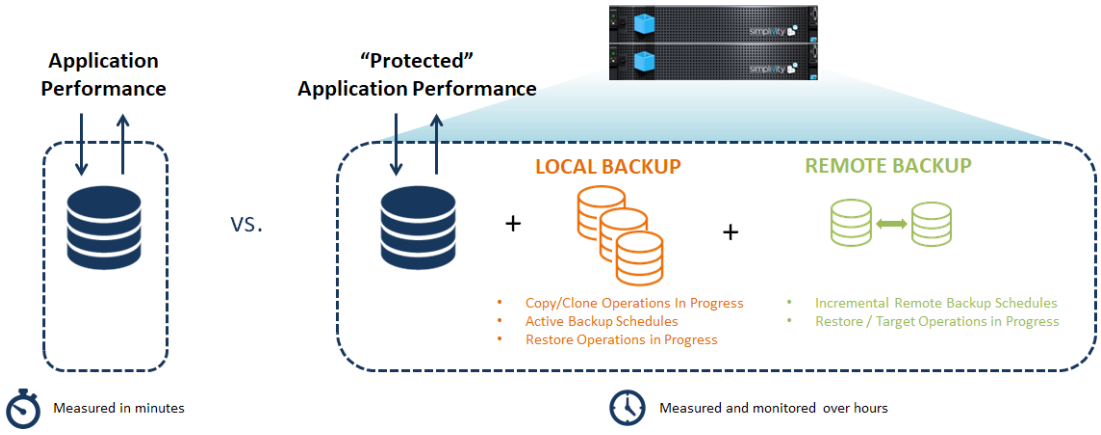
HPE SimpliVity hyperconverged infrastructure is designed to scale. As more nodes are added to a Federation, the more powerful and highly performing the Federation becomes. This is due to the fact that with each additional node also comes a virtual controller with more CPU, memory, and SSD and HDD capacity. The OmniStack Accelerator amplifies the performance and scalability of the Federation with each node providing hardware-optimized offload of CPU-intensive deduplication and compression tasks. The OmniStack Accelerator also increases efficiency and scalability as it reduces the amount of application and backup, recovery, and clone data that needs to be processed, stored, and transferred.

ESG Testing

ESG Lab validated the ability of HPE SimpliVity hyperconverged infrastructure to scale to meet application performance demands as additional nodes are added to the Federation. While many systems can demonstrate scalable performance, HPE SimpliVity hyperconverged infrastructure was designed to deliver predictable, scalable application performance, even while performing an aggressive mix of local and remote data protection and copy operations.

In a real-world deployment, the application must contend for system resources with all operations that are running on the system. Local and remote backup, restore, and copy operations would be running simultaneously with application requests. Thus, it is important to understand how a particular application might perform in a fully protected, real-world environment. "Protected" application performance should be measured while performing a real-world schedule of backup, restore, and copy operations over a period of time that is long enough to measure the steady state performance of a very dynamic environment—often over hours, or even days. Figure 16 compares application performance (or baseline) with "protected" application performance.

Figure 16. Application Performance versus "Protected" Application Performance



Source: Enterprise Strategy Group, 2017

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To get started, ESG lab deployed 125 VMs on every node. Each VM was 100 GB in logical size, with roughly half of this logical capacity to be used for testing (prefilled with 50 GB of unique data). ESG Lab tested two-, four-, six-, and eight-node configurations providing maximum configurations of 250, 500, 750, and 1,000 VMs. ESG Lab used the popular open source performance benchmark *Vdbench* to simulate an application workload that might be generated by a typical virtual machine deployed as an application server. The workload generated random 8KB transactions consisting of 70% reads and 30% writes. The workload was tuned to generate data with a 2:1 deduplication ratio, 20% cache hit ratio, and a fixed number of I/Os per second (IOPS) that represents the activity of a typical virtualized application. IOPS is a measure of the number of operations that a storage system can perform in parallel. When a system is able to move a lot of IOPS, it will tend to be able to service more applications and users in parallel. ESG Lab monitored the total number of IOPS and measured the average response times over test durations that ranged from two to 24 hours. ESG assumed that a typical application server in a virtualized environment would require that the average response times never exceed a threshold of 20ms. If the average response times rose above 20ms, end-users would be expected to notice a performance impact.

ESG Lab began by baselining the application performance of two, four, six, and eight nodes with no data protection or copy operations active. As expected, as HPE SimpliVity hyperconverged infrastructure grew to accommodate more active VMs, the system delivered linearly scalable IOPS performance and predictable response times that were around 8ms. The system was tested with various hardware configurations with 80 VMs per node (on less powerful nodes) and 125 VMs per node (on more powerful nodes).[5]

To validate that HPE SimpliVity hyperconverged infrastructure could deliver the same application performance while performing localized copy, backup, and restore operations, ESG Lab created three backup policies that might be seen in the real world. The three policies (gold, silver, and bronze) performed automated backups every ten minutes, every hour, and every four hours respectively. The same application performance benchmarks were then run over a period of several hours while running the aggressive backup schedule to 60% of the active VMs, cloning 16 concurrent VMs at any time, and fully restoring a total of 32 VMs. Initial testing used a more commonly deployed bronze policy with daily backups; however, this was shortened to every four hours in an effort to limit the necessary test duration. A summary of the local data protection operations active during application performance testing on 1,000 VMs is shown in Table 1.

Table 1. Local Data Protection Operations Active during Performance Measurements at 1,000 VMs

% of VMs Backed Up (60% of all VMs)	Active Backup Policies (% of all VMs following policy)	Clones (10-minute intervals through duration of test)	Restores (Spread randomly across test duration)
600 (8 nodes)	**Gold (10%):** Back up every 10 minutes **Silver (20%):** Back up every 1 hour **Bronze (30%):** Back up every 4 hours	16 concurrent clones	32 VMs restored
450 (6 nodes)	**Gold (10%):** Back up every 10 minutes **Silver (20%):** Back up every 1 hour **Bronze (30%):** Back up every 4 hours	12 concurrent clones	24 VMs restored
300 (4 nodes)	**Gold (10%):** Back up every 10 minutes **Silver (20%):** Back up every 1 hour **Bronze (30%):** Back up every 4 hours	8 concurrent clones	16 VMs restored
150 (2 nodes)	**Gold (10%):** Back up every 10 minutes **Silver (20%):** Back up every 1 hour **Bronze (30%):** Back up every 4 hours	4 concurrent clones	8 VMs restored

Source: Enterprise Strategy Group, 2017

[5] Eight-node testing with 125 VMs per node was not performed due to limited hardware availability. Based on scalability testing on smaller Federations with 80 VMs and 125 VMs per node, ESG is confident that the scalability that was validated with 80 VMs per node could also be achieved at 125 VMs per node.

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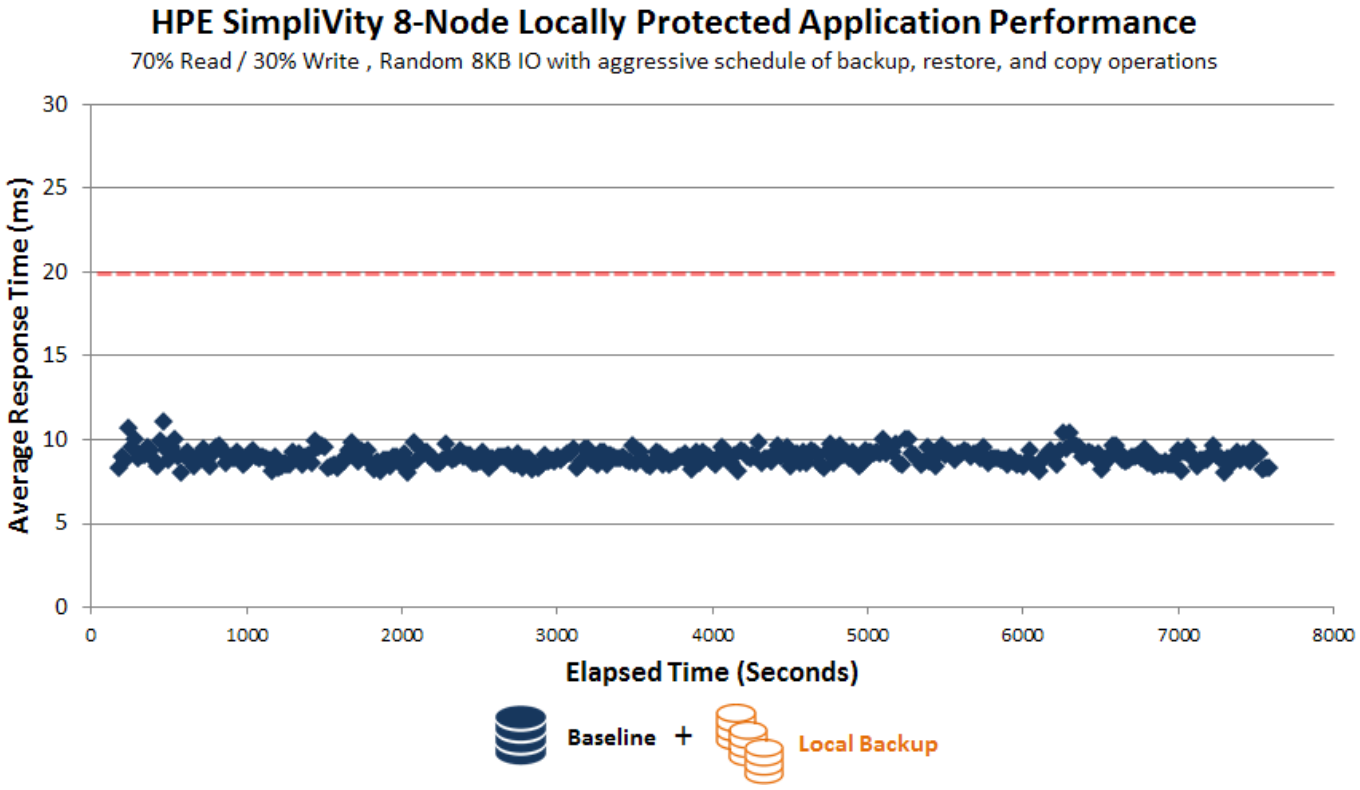
ESG Lab noted that even with the aggressive local data protection policies active, HPE SimpliVity hyperconverged infrastructure delivered consistent, low response times that were very close to the baseline performance. The average response times of several iterations of application performance tests across different node counts and run for various durations of time (up to days) were examined at polling intervals ranging from as low as one second to as high as one minute. As can be seen in Figure 17, the reported response times were consistently low (around 9ms), with no "spikes" in measured application response time as backup, restore, and copy operations were initiated.

Figure 17. Predictable Application Performance with a Heavy Schedule of Active Local Backup, Restore, and Copy Operations



Source: Enterprise Strategy Group, 2017

Next ESG Lab validated how HPE SimpliVity hyperconverged infrastructure could be scaled to offer similar levels of predictable, fully protected application performance as additional nodes were added to the cluster. Starting with a two-node cluster, ESG Lab measured the application performance with 125 VMs per node, while also fully protecting the VMs using the same aggressive active local protection policies and operations described previously in Table 1. The two-node cluster delivered the IOPS necessary to support the 125 fully protected VMs with a consistent and predictable average response time around 13ms, well under the 20ms threshold. Two nodes were then added to the cluster along with an additional 250 VMs and the test methodology was repeated using the appropriately scaled number of IOPS and data protection operations. Finally, the test was repeated twice more—first with 6 nodes and 750 VMs, and then with 8 nodes and 1,000 VMs. In each case, the average response time of the fully protected application environment remained very close to 13 ms, while the IOPS performed by the increasing number of VMs scaled linearly. Due to the scale-out design of HPE SimpliVity hyperconverged infrastructure, ESG Lab believes that the performance would have continued to scale as nodes were added to the cluster well beyond the eight nodes that were made available for testing. Figure 18 shows the results of the fully protected application performance scalability tests.

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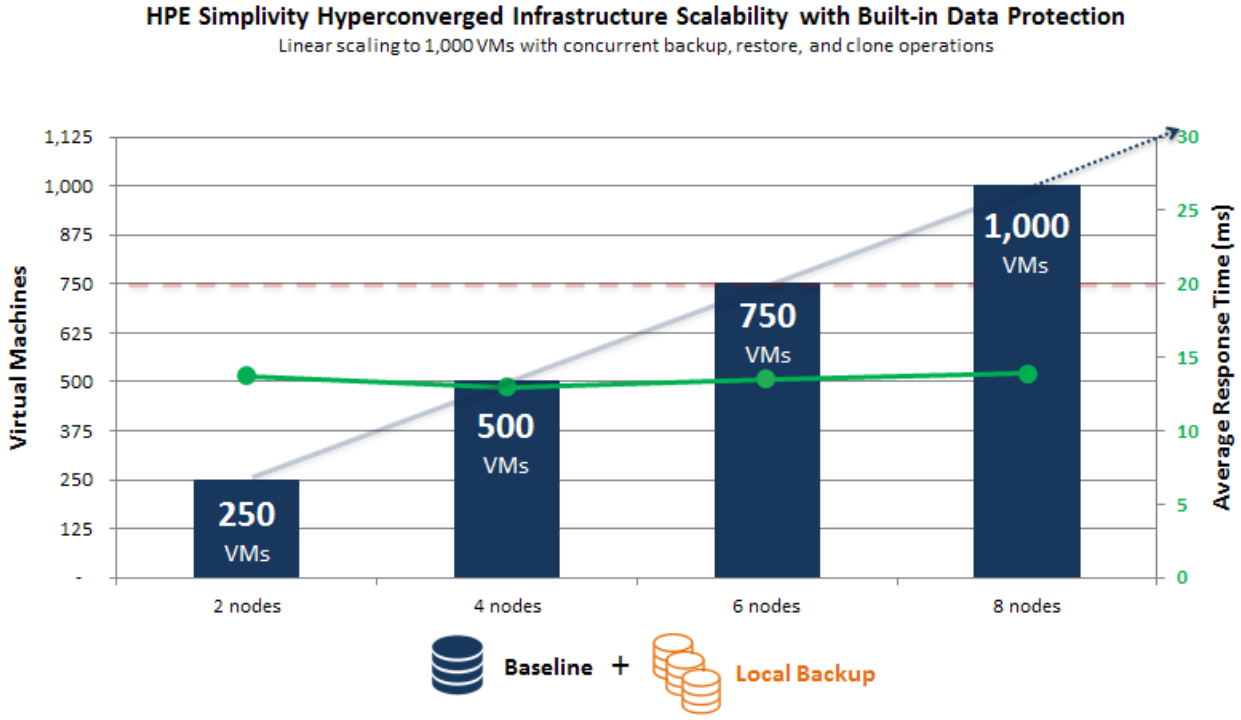
Figure 18. Application Performance Scaling with a Heavy Local Data Protection Schedule Active



Source: Enterprise Strategy Group, 2017

Finally, ESG Lab validated that in addition to delivering predictable, fully protected application performance with local backups and restores, HPE SimpliVity hyperconverged infrastructure can also deliver very similar levels of performance when backing up and restoring from a remote site. Because data stored in HPE SimpliVity hyperconverged infrastructure is always deduplicated, compressed, and WAN optimized, the amount of data that must be replicated between sites is kept to a minimum.[6] Using the same methodology used in the previous tests, ESG Lab measured the application performance of an eight-node cluster first with no data protection, then with the aggressive local data protection schedule shown in Table 1, and finally with the same local data protection schedule while also continuously performing a single backup operation and a single restore operation from a remote site.

Table 2. Data Protection Operations Active During Remote Data Protection Impact Testing

Test Case	Application Performance	Local Backup Operations	Remote Backup Operations
Baseline	70%/30% 8KB, 640 VMs 50% Dedupe, 20% Cache Hit	None	None
Baseline + Local Protection	70%/30% 8KB, 640 VMs 50% Dedupe, 20% Cache Hit	60% Backups, 16 Active Clones, 32 Restores	None
Baseline + Local Protection + Remote Protection	70%/30% 8KB, 640 VMs 50% Dedupe, 20% Cache Hit	60% Backups, 16 Active Clones, 32 Restores	1 Active Backup and 1 Active Restore Operation

Source: Enterprise Strategy Group, 2017

[6] It should be noted that performance of any remote backup and restore operation, optimized or not, is also dependent on the speed and availability of the network between the sites and the distance between sites.

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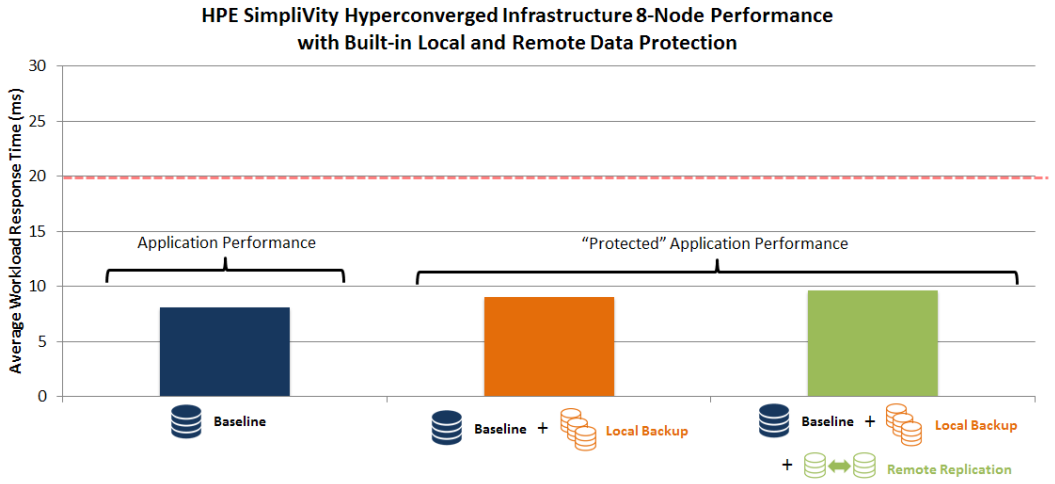
The remote site used in the test consisted of a two-node cluster that was located in a remote lab. The same application workload was used for all three test cases, and in each case, the solution delivered the necessary number of IOPS to satisfy the application requirements. The eight-node HPE SimpliVity hyperconverged infrastructure delivered average response times across the duration of the test that were well under the 20ms threshold, even when performing both local and remote data protection operations. ESG Lab observed that the backup, restore, and copy operations were taking place and monitored the individual response time measurements across the duration of the two-hour test to ensure that there were no "spikes" in response time that exceeded the 20ms threshold.

What the Numbers Mean

- ESG Lab Validated that HPE SimpliVity hyperconverged infrastructure can deliver predictable application response times while fully protecting the application with built-in data protection operations consisting of backups, restores, and copy operations.

Figure 19. Mixed Application Workload Performance Scalability



Source: Enterprise Strategy Group, 2017

- HPE SimpliVity hyperconverged infrastructure continues to scale "fully protected" application performance linearly as additional nodes are added to the cluster, and as more VMs are deployed to contribute to the application infrastructure.
- ESG Lab saw that HPE SimpliVity hyperconverged infrastructure can provide not only scalable and predictable protected application performance using local data protection techniques, but also local *and* remote data protection.

Why This Matters

Predictable performance scalability is a critical concern when complex applications with a mix of workloads share a system's resources, especially in a virtualized environment. A burst of processing or I/O activity in one area (e.g., a database consistency check) can lead to poor response times, lost productivity, and, in the worst case, lost revenue. Virtualized tier-1 applications can potentially present the most diverse mix of application types and I/O access patterns a single server may encounter. But providing performance for the application alone is not enough—valuable tier-1 applications must be protected. ESG research shows that nearly one-third of organizations have a challenge in understanding the impact of backup operations on the performance of applications sharing physical resources.[7]

Traditional data protection techniques add heavy workloads to the system and negatively impact application performance. ESG Lab has confirmed that the scalable software-defined architecture of HPE SimpliVity hyperconverged infrastructure delivered predictable performance for a virtualized environment while also fully protecting the environment using a combination of built-in local and remote data protection. This "fully protected" application performance scaled linearly as additional nodes were added to the system, each with a pair of OmniStack Accelerators that accelerated data efficiency with hardware-optimized deduplication and compression.

[7] Source: ESG Research Report, *Trends in Protecting Virtualized Environments*, August 2015.

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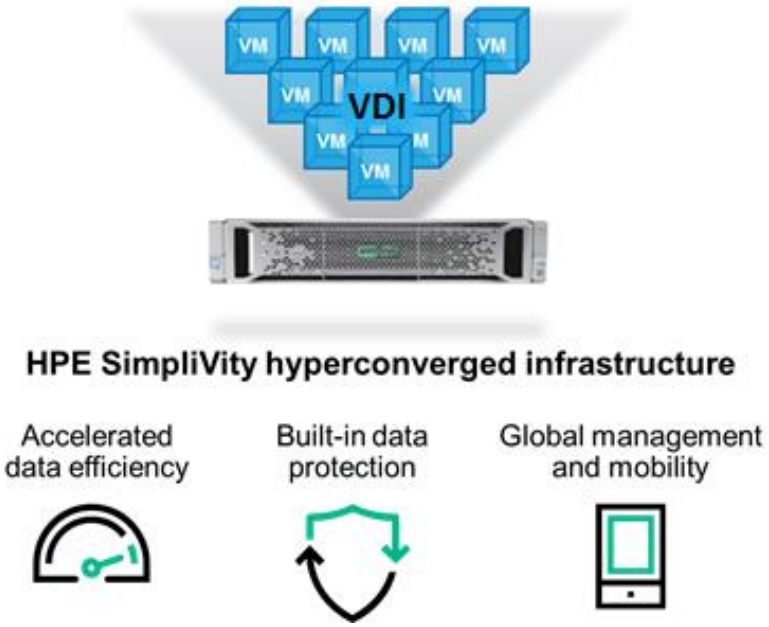
Validated VDI Performance

HPE SimpliVity continues to optimize the provisioning, deployment, and protection of dynamic VDI environments. With HPE SimpliVity OmniStack, traditional VDI pain points related to deployment, management, performance, protection, and cost are greatly reduced. HPE SimpliVity's industry-proven OmniStack technology provides an enhanced end-user experience in VDI environments by delivering up to 250 low-latency, highly available virtual desktops on a single node. And it drastically simplifies the customer transition from pilot deployments to working production VDI environments by offering an easy-to-deploy, easy-to-scale VDI solution.



ESG Lab audited the results of a ten-node HPE SimpliVity Federation that simulated a growing VDI deployment for a global organization. The industry-standard VDI benchmarking tool Login VSI was used for testing. LoginVSI 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. The results of testing can be found in greater detail in an eight-page ESG Lab Review focused on how HPE SimpliVity can be leveraged in VDI deployments. Highlights of the VDI test results include:[8]

- A HPE SimpliVity cluster made up of five nodes was used to test the performance and efficiency of a 1,000-linked-clone VDI environment, and two five-node clusters in a federation were used to test a 2,000-linked-clone environment.
- Provisioning and deploying the 1,000 virtual desktop environment to a login-ready state with VMware Horizon View 6 was impressively quick, completing in just 70 minutes. Two thousand (2,000) desktops in a federation were deployed in less than 90 minutes.
- High levels of fully protected VM density were achieved by consolidating 200 virtual desktops per node in a five-node cluster (total of 1,000 virtual desktops), and in a ten-node federation (total of 2,000 virtual desktops) without impacting performance or the end-user experience.
- More impressively, after injecting a simulated node failure into one of the five nodes in a cluster, all 1,000 desktops were sustained on the surviving four nodes (250 virtual desktops per node) with minimal performance degradation and no perceptible impact on end-user experience.
- Login VSI was used to emulate a login storm, which occurs when a large number of end-users attempt to log in to their virtual systems within a short period of time. This serves as a way to identify the maximum number of hosted virtual desktops that can be powered on before experiencing degradation of service from the saturation of network and storage resources. The five-node cluster and ten-node federation supported 1,000 and 2,000 logins respectively with a VSImax average of around 1,000 ms, which was roughly 1.7x faster than the acceptable threshold set by Login VSI.

[8] ESG Lab Review, *HPE SimpliVity Hyperconverged Infrastructure for VDI Environments*, June 2017.

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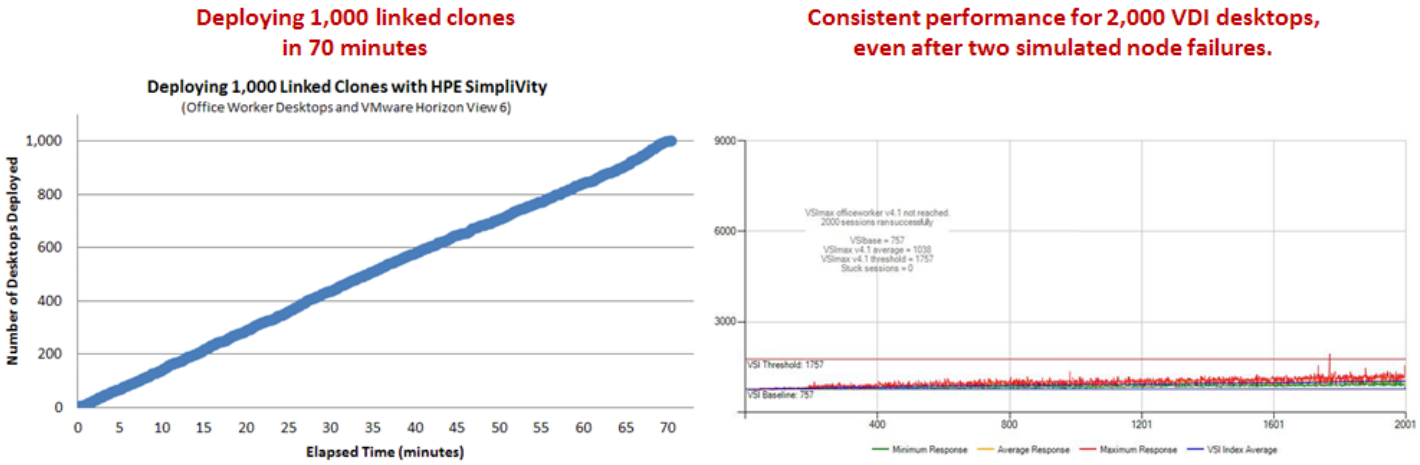
Figure 20. LoginVSI Results: 1,000 Virtual Desktops in a Five-node Cluster (and 2,000 in a Ten-node Federation)



Source: Enterprise Strategy Group, 2017

Why This Matters

Performance is a top concern when it comes to virtual desktop infrastructures and ESG research has shown that IT managers view performance as a top challenge when it comes to implementing desktop virtualization.[9] Predictable performance scalability is a critical concern when multiple users are running diverse applications on a shared VDI infrastructure. A burst of I/O activity from one desktop (e.g., a user logging on) can lead to poor response times and lost productivity for other users. To get the most of their VDI investments, IT managers are looking for a scalable VDI solution that's easy to deploy and manage as it cost-effectively scales to the meet the performance needs of thousands of VDI users without impacting the end-user experience.

ESG Lab has validated that HPE SimpliVity OmniStack easily supported the demanding requirements of a VDI environment by delivering predictable, scalable performance for a 1,000 virtual desktop deployment with a five-node cluster and 2,000 virtual desktops in a ten-node federation. Provisioning times and login storms both yielded impressive results, while an injected node failure had no impact on the end-user experience. This predictable global scalability makes it easy to plan and deploy VDI desktops for globally dispersed organizations.

[9] Source: ESG Research Report, *Trends in Protecting Virtualized Environments*, August 2015.

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ESG Lab Validation Highlights

- ☑ ESG Lab validated that HPE SimpliVity hyperconverged infrastructure was easy to install and deploy. Adding additional HPE SimpliVity hyperconverged infrastructure instances to a Federation was also quite easy using HPE SimpliVity's Deployment Manager.
- ☑ ESG Lab demonstrated that a HPE SimpliVity hyperconverged infrastructure solution was easy to manage with no additional training necessary for administrators with working knowledge of the vCenter interface. ESG Lab showed that many data centers in geographically dispersed locations can be managed as one global Federation using the same simple interface, including seamless integration with Amazon cloud services.
- ☑ ESG Lab validated that HPE SimpliVity's novel data architecture (powered by the OmniStack Data Virtualization Platform), including deduplication, compression, and optimization of all data across all data lifecycle phases, storage media, and geographies, reduced IOPS, storage capacity (and therefore associated power and space requirements), cost of bandwidth across sites, and overall time to data.
- ☑ ESG Lab validated that data operations performed at a VM level on HPE SimpliVity hyperconverged infrastructure were performed more efficiently and quickly than in a traditional virtualized environment, saving valuable time and resources.
- ☑ ESG Lab validated that HPE SimpliVity hyperconverged infrastructure is reliable and resilient by confirming that it survived critical hardware failures while offering unique data protection capabilities that extend to data centers across the globe.
- ☑ ESG Lab confirmed that HPE SimpliVity hyperconverged infrastructure delivered predictable performance for a virtualized environment while also fully protecting the environment using a combination of built-in local and remote data protection.
- ☑ HPE SimpliVity hyperconverged infrastructure scaled linearly to meet the higher demands of "fully protected" application performance as nodes were added to the cluster and as additional VMs were added into the application environment.
- ☑ HPE SimpliVity hyperconverged infrastructure easily supported the demanding requirements of a VDI environment by delivering predictable, scalable performance for a 1,000 virtual desktop deployment with a five-node cluster and 2,000 virtual desktops in a ten-node federation.

Issues to Consider

- ☑ HPE SimpliVity currently offers a hyperconverged infrastructure solution built on an HPE ProLiant DL380 compute platform.
- ☑ The HPE SimpliVity solution was built to be hypervisor-agnostic, currently supporting VMware with support for Microsoft Hyper-V on the short-term roadmap.
- ☑ The performance test results presented in this report are based on benchmarks and configurations deployed in a controlled environment. Due to the many variables in each production data center environment, capacity planning and testing in your own environment is recommended.
- ☑ Every application environment is different. While the characteristics of a VM used in this paper (1vCPU, 2 GB RAM, 100 GB Storage), as well as the workload and data protection operations, were chosen in good faith to represent a typical environment, your environment is unique. ESG recommends that you work with your HPE SimpliVity representative to properly size your "fully protected" application requirements.

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The Bigger Truth

Data centers have become too complex and too expensive. In order to take advantage of the increased technological demands over the years, companies have added layers of complexity by investing in specialized technologies that perform a single function and then grouping them into an existing infrastructure. Servers, storage, networking, archive, backup, replication, WAN optimization, and deduplication/compression appliances are often sourced from single-function vendors and dropped into the existing infrastructure through a web of cables and switches. Each technology requires additional service contracts, licensing costs, rack space, power, and cooling—not to mention a set of dedicated resources capable of administering and maintaining the components. Functionality and scalability are limited by interoperability issues and often times the simple requirements of one set of administrators create headaches for the others.

It is clear that consolidation of technologies into a single unit minimizes both capital and operational expenditures, but what should also be emphasized is that by storing and maintaining your data in a more efficient manner (granular, deduped, compressed, and optimized through its entire lifecycle), the IT infrastructure can be as efficient as possible. Organizations will require less hardware and less bandwidth for data transfers, and save valuable administrative time resulting in greater productivity and faster responses to business needs. HPE SimpliVity's Data Virtualization Platform achieves this by deduping, compressing, and optimizing data at inception across the entire global Federation. This means that efficiency is built into every operation—the initial storing of the data, taking and scheduling backups, making clones, migrating data between local and geographical locations, and performing restore and disaster recovery operations.

ESG Lab validated that a data center built on HPE SimpliVity hyperconverged infrastructure technology is efficient, reliable, and highly scalable, and can perform nearly every function required by a modern data center in a highly optimized manner, starting with a complete data center running on two nodes, all the way up to globally distributed data centers running numerous HPE SimpliVity hyperconverged infrastructure nodes. ESG Lab validated the ability of HPE SimpliVity to greatly increase the speed of common data protection operations, while reducing the administrative complexity associated with those same data protection operations. With the ability to offer the same level of administrative simplicity, data efficiency, and complete functionality across data centers around the globe, along with low-cost cloud capabilities, HPE SimpliVity's hyperconverged infrastructure is noteworthy.

ESG Lab demonstrated that HPE SimpliVity hyperconverged infrastructure can scale to meet the "fully protected" application performance demands of virtualized application environments. Adding nodes to the cluster not only linearly increased the number of VMs that can be deployed in the scalable application environment, but also increased the number of IOPS available to the application, and the number of local and remote data protection operations that can be supported. Both local and remote data protection operations were performed more efficiently, with little impact to overall application response times. This notion of providing a scalable "fully protected" application performance building block makes it easy to plan for the future growth of application environments.

IT is certainly a balancing act. The technology available in today's data centers provides IT end-users with service levels and administrative functionality that may have been thought impossible years ago. Data centers run more efficiently, cost-effectively, and globally, while better analysis and reporting tools highlight the benefits they bring to the business. Though this improved data center effectiveness can sometimes be costly, the underlying complexity and administrative inefficiencies are traditionally the tolls paid in exchange for providing such a high level of service and functionality.

Through infrastructure consolidation, increased effectiveness of both physical and human resources, and decreased complexity, HPE SimpliVity can help organizations take on the challenges of maximizing efficiency while reducing costs. Infrastructure virtualization provided the first *step* in the right direction. ESG Lab feels the HPE SimpliVity's hyperconverged infrastructure powered by OmniStack technology can help organizations take the next *leap*.

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Appendix

Table 3. ESG Lab Test Bed

SimpliVity Hyperconverged Infrastructure	
3 x SimpliVity OmniCube CN-3400 2 x Intel Xeon CPU E5-2680v3 with 2.5Ghz (12 Cores per CPU), 384 GB RAM VMware vSphere 6 Enterprise Plus vMotion: Enabled VMware HA: Enabled & Configured 4 x 400GB SSD Drives 20 x 1TB NL-SAS Drives	5 x SimpliVity OmniCube CN-3400 2 x Intel Xeon CPU E5-2697v3 with 2.6Ghz (14 Cores per CPU), 768 GB RAM VMware vSphere 6 Enterprise Plus vMotion: Enabled VMware HA: Enabled & Configured 4 x 400GB SSD Drives 20 x 1TB NL-SAS Drives
Virtual Machines	
Operating System	Up to 1,000 x Windows Server 2012 R2 SP1 – 64Bit
vCPU	1 vCPUs per VM
vRAM	2 GB of RAM per VM
Storage per VM	100 GB
Application	50GB Dataset per VM Vdbench workload: 8KB Random Requests, 70% Read, 30% Write 50% Deduplication, 20% Read Cache Hit, 20% Write Cache Hits

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