Lab Validation Report

An HP StorageWorks-Enabled Solution

Affordable End-to-end Storage for Mid-sized Organizations

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June 2010

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ESG Lab Reports

The goal of ESG Lab reports is to educate IT professionals about emerging technologies and products in the storage, data management and information security industries. ESG Lab reports are not meant to replace the evaluation process that should be conducted before making purchasing decisions, but rather to provide insight into these emerging technologies. Our objective is to go over some of the more valuable feature/functions of products, show how they can be used to solve real customer problems and identify any areas needing improvement. ESG Lab's expert third-party perspective is based on our own hands-on testing as well as on interviews with customers who use these products in production environments. This ESG Lab report was sponsored by Hewlett Packard.

Introduction

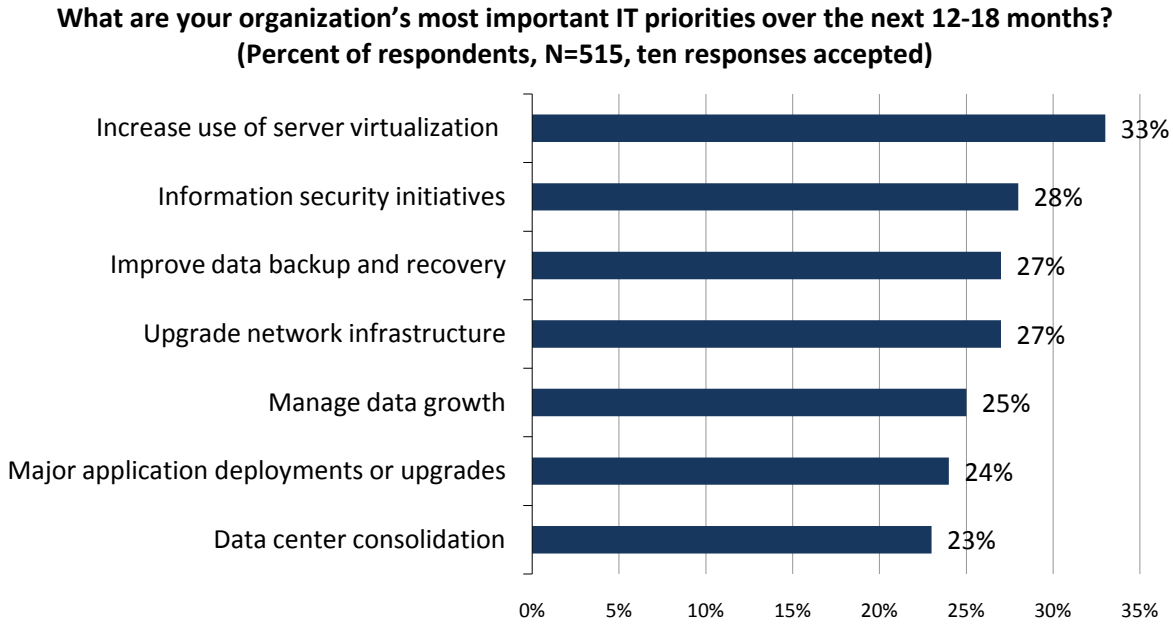
This report presents the results of hands-on testing and a cost of ownership analysis of an HP StorageWorks-enabled solution for medium-size organizations. It examines the cost-effective synergy of an end-to end converged infrastructure powered by an HP StorageWorks P4500 for primary storage, D2D2503 for capacity-optimized disk-based backup, D2D4112 for WAN-optimized replication of backups, and MSL4048 for off-site tape archival.

Background

ESG recently asked IT professionals to name the business initiatives which would have the greatest impact on IT spending decisions over the next 12-18 months. The number one response was cost reduction and simplification of business processes came in second. [1] Given the economic uncertainties of recent years, it's no surprise that IT managers are looking to reduce cost and complexity.

Where are IT managers focusing their efforts toward this goal of reducing cost and complexity? As shown in Figure 1, server virtualization is at the top of the list. As a growing number of organizations use server virtualization to reduce the cost and complexity of a consolidated IT infrastructure, improving backup and recovery, and finding ways to cost-effectively manage data growth have become top priorities as well.

Figure 1. Top Priorities for IT Managers



Source: Enterprise Strategy Group, 2010.

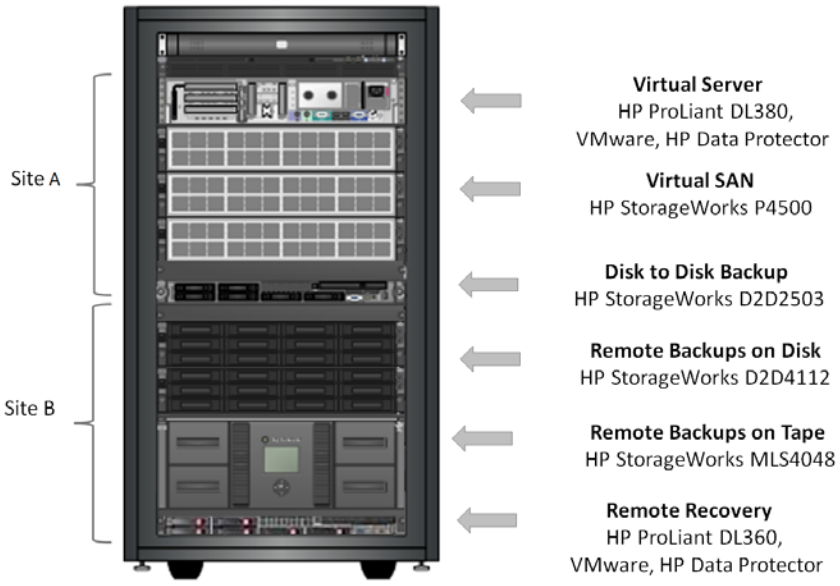
Nearly 50% of the IT managers within midmarket companies reported they have more than 10 TB of data that needs to be stored and protected.[2] And more than half of the respondents reported that data is growing at a rate of 20% or more per year. For those organizations, data volume is doubling every two to five years. With these challenges in mind, a growing number of IT managers are turning to powerful new technologies which can drastically reduce the cost and complexity of storing and managing data. The balance of this report examines an HP solution which uses innovative technologies to addresses several of the top issues noted in Figure 1 (increasing server virtualization, improving backup and recovery, managing data growth, and data center consolidation).

[1] ESG Research Report, *2010 IT Spending Intentions Survey*, January 2010.
[2] ESG Research Report, *2010 Data Protection Trends*, April 2010.

HP StorageWorks-enabled Converged Infrastructure for Mid-sized Organizations

The HP StorageWorks-enabled solution tested by ESG Lab is shown in Figure 2. This solution can be used to cost-effectively consolidate server and storage resources using powerful new technologies including server virtualization, iSCSI, clustered storage, backup to disk, data deduplication, and WAN-optimized replication.

Figure 2. The HP StorageWorks Solution Tested by ESG Lab



The key components of this end-to-end converged infrastructure are as follows:

- **HP ProLiant DL380:** The field-proven ProLiant family of HP servers provided the flexibility, performance, and enterprise-class uptime for a consolidated, virtual server environment.
- **VMware vSphere:** VMware vSphere software running on HP ProLiant servers was used to transform the IT infrastructure into a private cloud which enabled the automated delivery of IT infrastructure as a service.
- **HP Data Protector:** This data protection software package was used for simple and reliable backup and recovery operations in a virtual server environment.
- **HP StorageWorks P4500:** With a clustered storage architecture that leverages industry standard server and Ethernet technologies, the HP P4500 SAN was used as an iSCSI-attached primary storage solution that delivered cost-effective scalability, performance, and high availability.
- **HP StorageWorks D2D2503:** This disk-based backup system used data deduplication technology to reduce backup windows, provide fast and reliable restores, and reduce retained disk capacity up to 50 times.
- **HP StorageWorks D2D4112:** Working in concert with the StorageWorks D2D2503, the D2D4112 was used to store a WAN-optimized copy of backups at a second site for disaster recovery.
- **HP StorageWorks MSL4048:** This automated tape library, configured with a pair of SAS-attached LTO3 tape drives, was used to create portable copies of a subset of the backup data at the second site.

There are a number of benefits that can be achieved with this solution from HP. First and most obvious, is the fact that the solution is sold and supported by a single vendor. A bit less obvious is the fact that all of the hardware, with the exception of the tape library, is built with industry standard HP ProLiant servers. This reduces the cost of the solution as it avoids the use of proprietary controllers and disk enclosures.

As of the publication of this report, HP has refreshed the entire D2D product family and introduced a new high-end member, the D2D 4312. The D2D 4312 has more processing power and offers higher capacity than previous generation D2D models. The new D2D product family is also running a new 64-bit data deduplication technology called HP StoreOnce. HP's vision for StoreOnce deduplication technology is that it will be ported to several HP platforms—including HP Data Protector. While ESG tested the previous generation D2D appliances, the scenarios depicted and conclusions drawn in this report still apply.

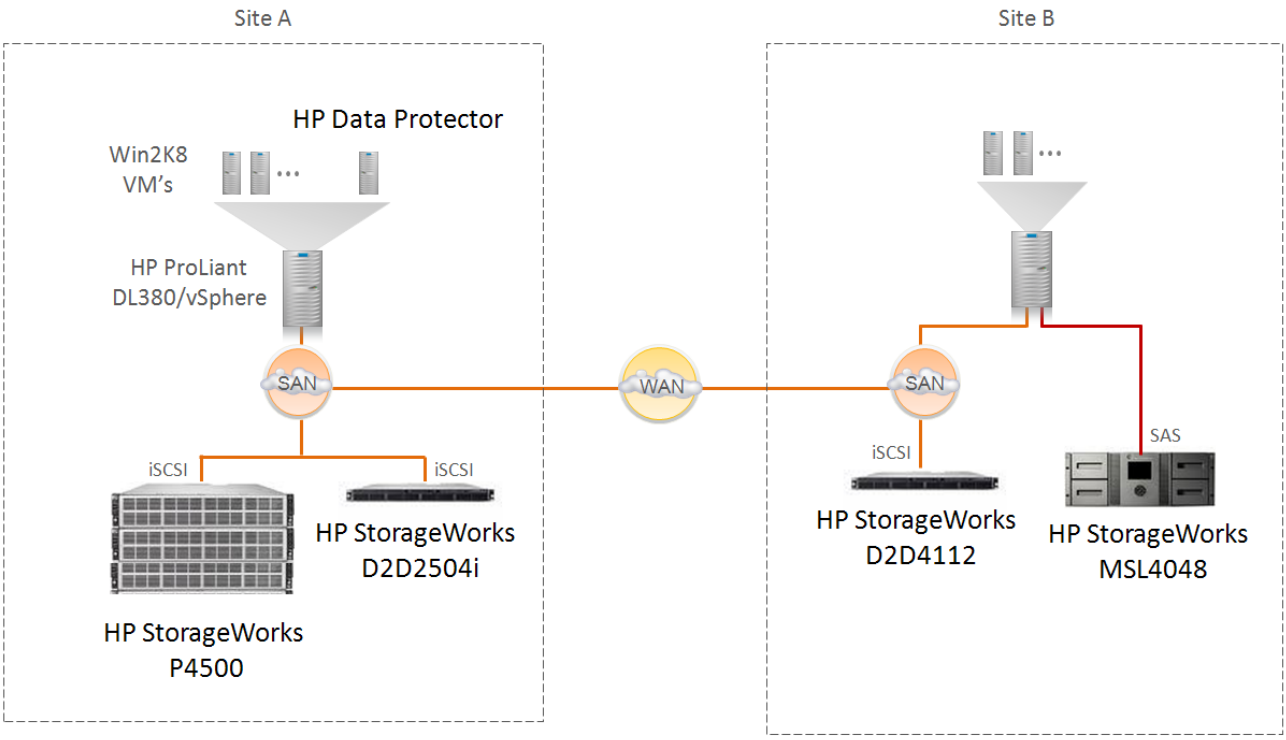
ESG Lab Validation

ESG Lab performed hands-on testing of a StorageWorks-enabled converged infrastructure at an HP facility in Fort Collins, Colorado. Testing was designed to demonstrate how virtual server, clustered storage, iSCSI, backup to disk, and deduplication technologies can be used to create a simple, cost-effective solution that is ideally suited for a typical mid-sized organization.

The ESG Lab Test Bed

A two-site solution was tested with an HP ProLiant DL380 server running VMware vSphere software in Site A. Virtual machines running Microsoft Windows Server 2008 as a guest operating system were used to simulate a number of typical applications (e.g., Microsoft Exchange). HP Data Protector software was installed on one of the VMware vSphere-enabled virtual machines.

Figure 3. The ESG Lab Test Bed



An iSCSI-attached HP StorageWorks P4500 was used to meet the primary storage needs of virtualized applications running on the HP ProLiant server. HP Data Protector was used for backup and recovery of deduplicated data residing on an iSCSI-attached HP StorageWorks D2D2503 appliance in Site A. Deduplicated backup data was replicated over a simulated WAN to a second D2D appliance in Site B. A SAS-attached HP StorageWorks MSL4048 autoloader with two LTO3 tape drives was used to create portable backup images at Site B.

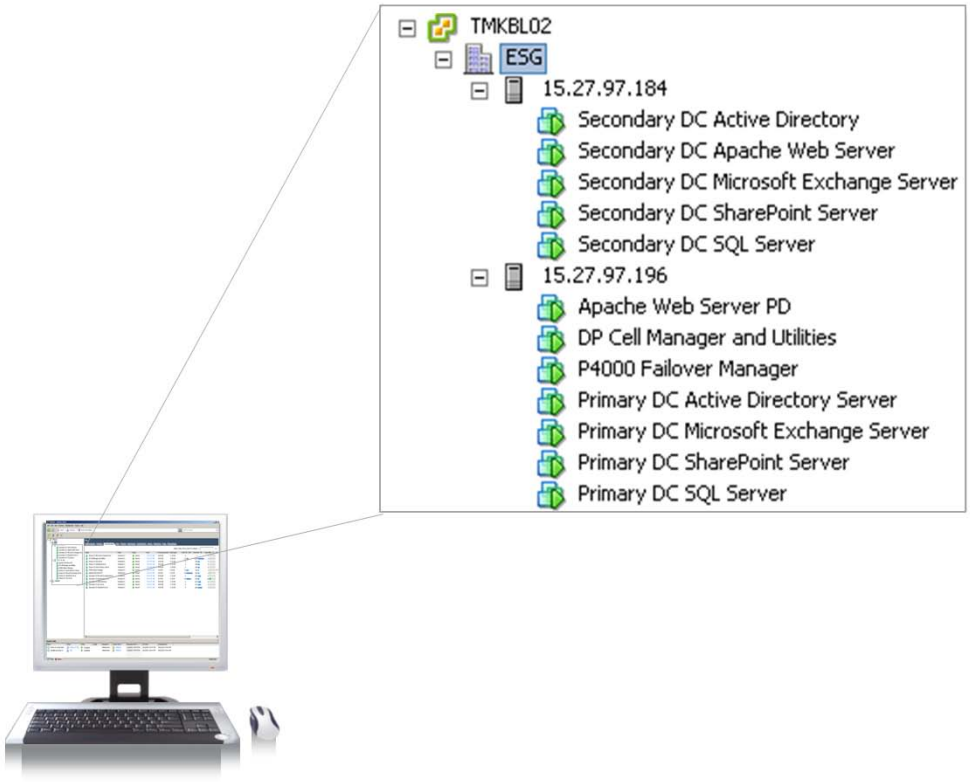
Why This Matters

Architecting and deploying an integrated IT infrastructure takes time and can be risky—especially for busy managers in mid-sized organizations. A multi-vendor solution adds risk and may lead to delays when trying to fix a problem in production. ESG Lab has confirmed that HP supports an end-to-end converged infrastructure that is purpose-built for mid-sized organizations.

Getting Started

ESG Lab testing began with a tour of a pre-wired test bed. The VMware vCenter screen shot shown in Figure 4 shows how the primary and secondary sites were configured with the following virtual machines: Microsoft Active Directory, Apache Web Server, Microsoft Exchange Server, Microsoft SharePoint Server, and Microsoft SQL Server.

Figure 4. A VMware vCenter View of the Test Bed



HP StorageWorks P4500 (Virtualization SAN Solution)

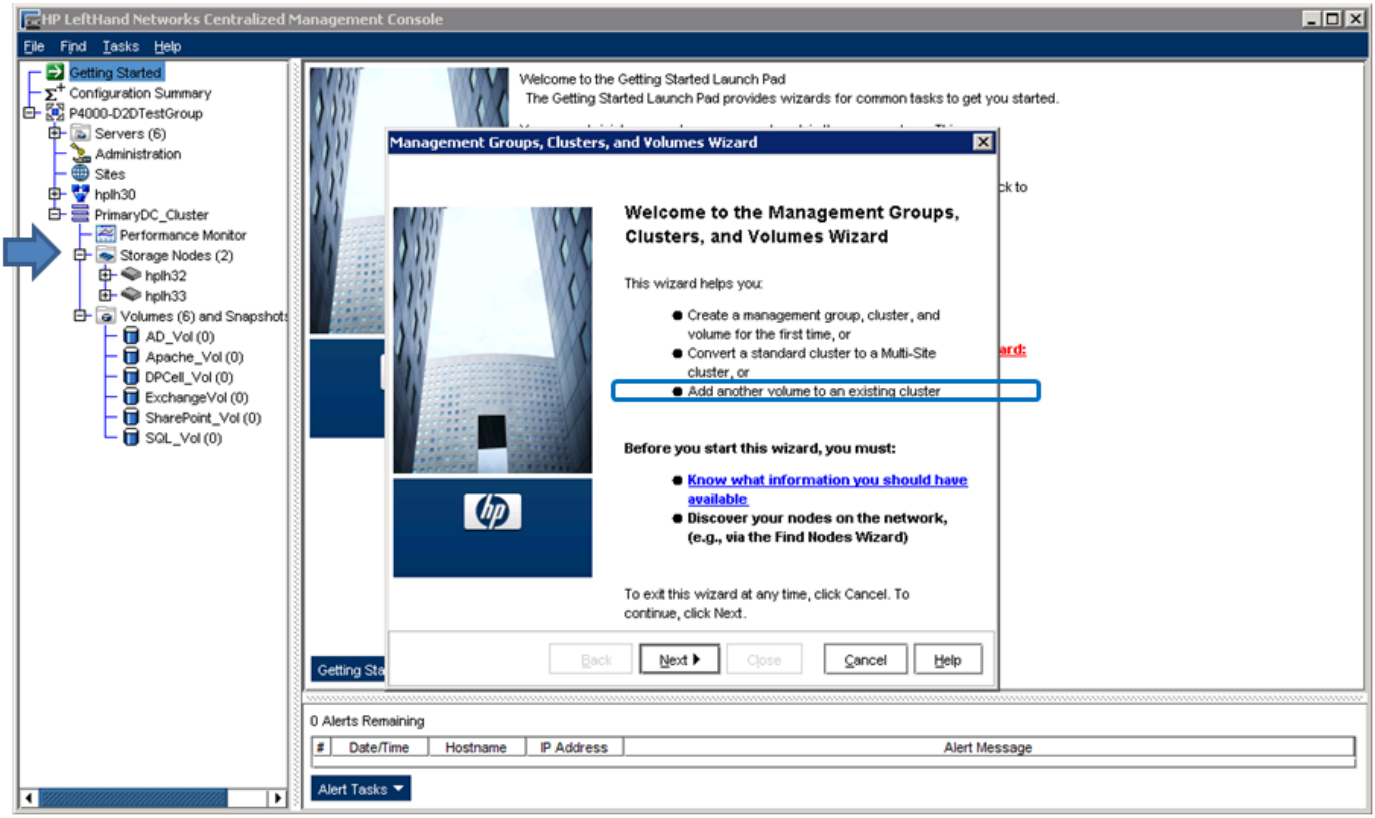
The HP P4000 SAN is an iSCSI-attached primary storage solution that uses intelligent software running on a cluster of industry standard servers to provide cost-effective scalability, performance, and high availability.

ESG Lab Testing

ESG Lab examined the configuration of a two-node HP StorageWorks P4500 serving the storage needs of virtual machines on the iSCSI-attached HP ProLiant server. A third P4500 node was added online to the existing cluster. A new volume was configured and presented to a vSphere-enabled guest machine.

The wizard-driven user interface shown in Figure 5 was used to add the third node to the existing two-node cluster. Note that the intuitive navigation tree towards the left shows the two nodes in the cluster before the upgrade (hph32 and hph33).

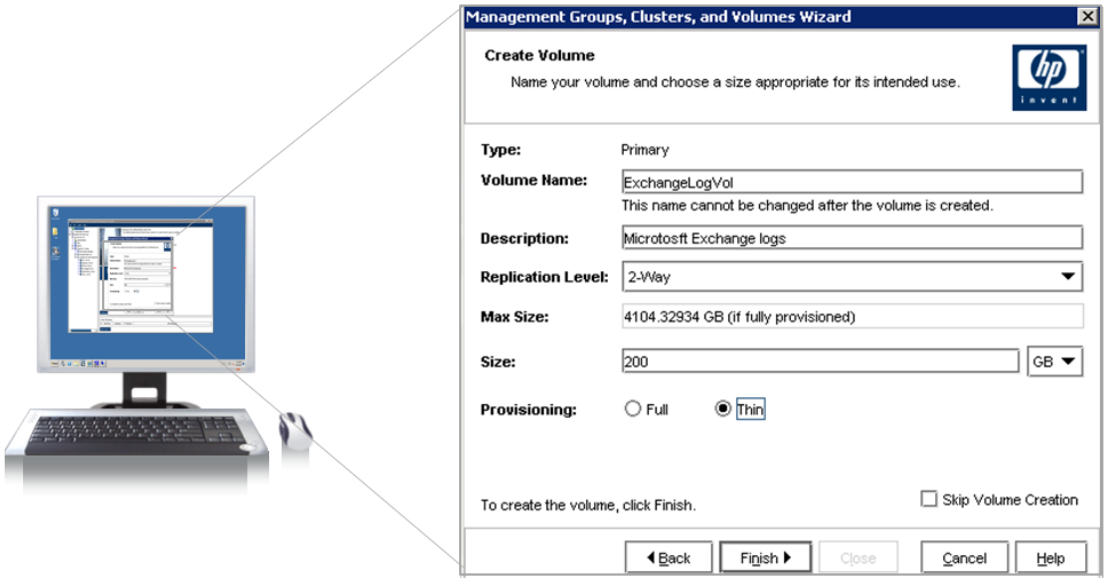
Figure 5. Online Expansion of an Existing Two-node HP StorageWorks P4500 Cluster



Five mouse clicks and one minute later, a third node had been discovered and added to the cluster. SAN/iQ software began a low priority background operation which automatically redistributed existing capacity on the recently expanded cluster. There was no impact to a copy operation running on the existing cluster.

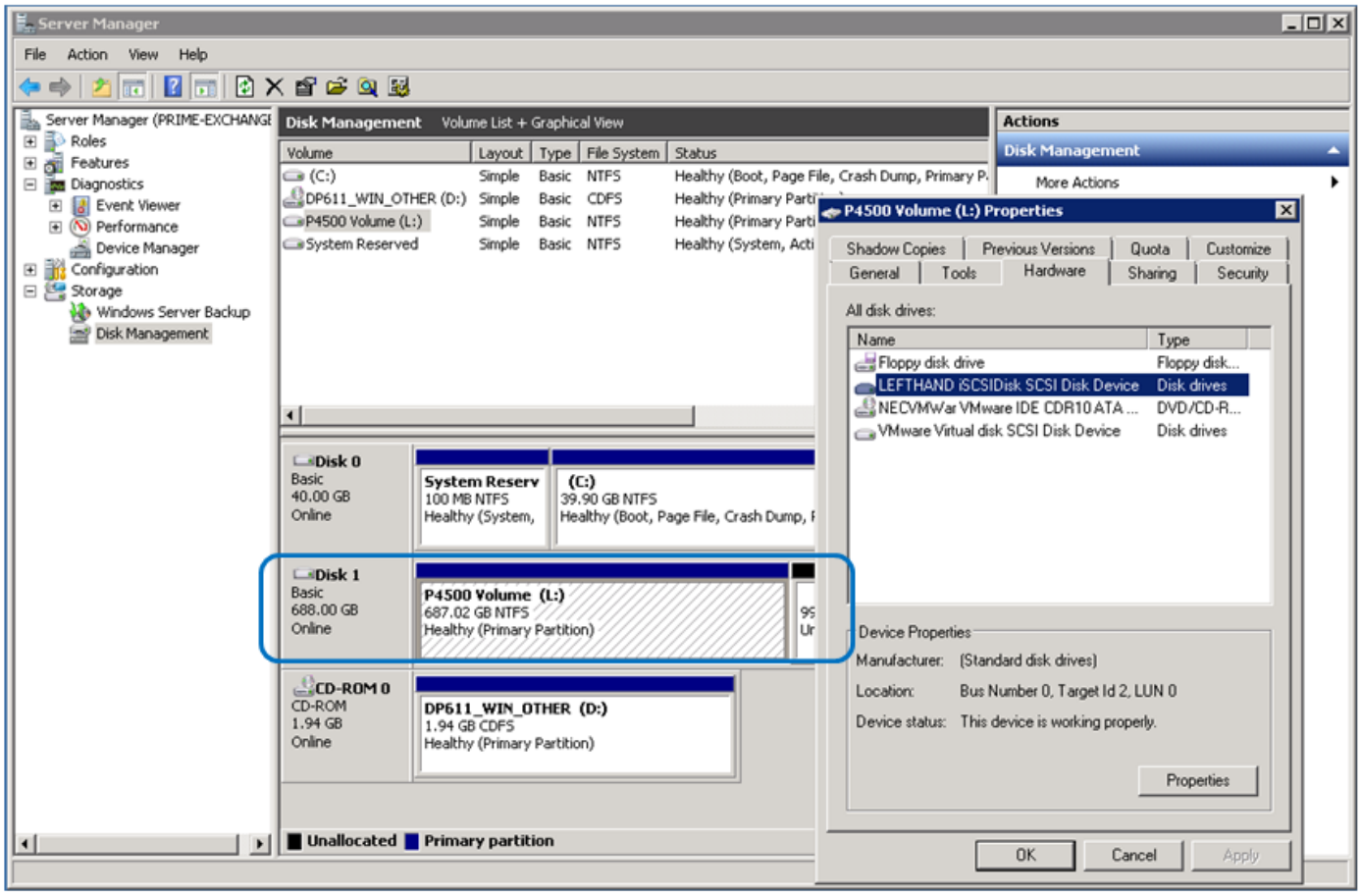
The wizard panel shown in Figure 6 was used to create a new volume for Microsoft Exchange log data. Note that a single mouse click was used to enable thin provisioning. Thin provisioning delivers capacity on demand, which increases efficiency and decreases costs.

Figure 6. Wizard-driven HP StorageWorks P4500 Volume Creation



Seven mouse clicks and one minute after getting started, the volume was configured and ready for use. The Microsoft iSCSI initiator was used to discover and connect to the new volume from a Windows 2008 server running within a VMware-enabled virtual machine. The newly created volume was discovered and NTFS quick-formatted as an L: drive using the Microsoft disk administrator utility as shown in Figure 7.

Figure 7. A Virtual Machine's View of an HP P4500 iSCSI Disk Device



In previous reports, ESG Lab has tested the valuable storage software capabilities built into a P4000 SAN at no additional charge, including thin provisioning, snapshots, remote mirroring, high availability, and extreme performance scalability (including a Microsoft-approved test bed supporting 152,000 e-mail users).[3]

Why This Matters

ESG's *2010 IT Spending Intentions Survey* indicates that increasing server virtualization, improving data protection, and managing data growth are top IT priorities. With these priorities in mind, care should be taken when choosing a primary storage solution for virtual server environments.

With a clustered architecture that leverages industry standard server and Ethernet technologies, capacity-optimized thin provisioning, wizard-driven management, and a disruptive pricing model that includes valuable storage software at no additional charge, ESG Lab has confirmed that an HP P4000 SAN is a powerful and cost-effective primary storage solution for growing virtual server environments.

[3] Source: ESG Lab Review, *HP P4000 SAN: Affordable, Scalable, Reliable Storage*, March 2010.

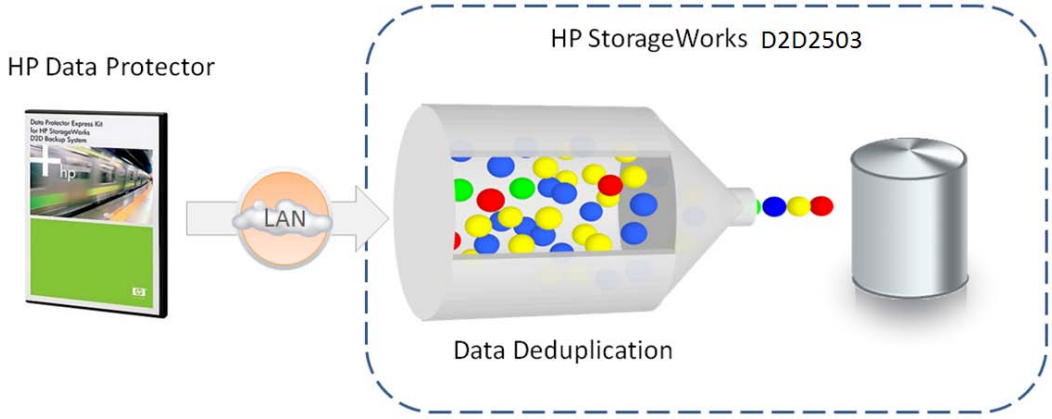
HP Data Protector and HP StorageWorks D2D Deduplication (D2D)

HP Data Protector software and data deduplication algorithms running within an HP StorageWorks D2D appliance reduces the capacity needed to store backups that have already been written to disk. As shown in Figure 8, Data Protector software and D2D hardware work together to create a cost-effective disk-to-disk backup solution. Combining this solution with HP StorageWorks MSL tape library to create end-to-end data protection with a number of key advantages for small businesses:

- Backups and restores are faster and more reliable with disk.
- Data deduplication reduces the capacity required to store backups on disk.
- More backups can be retained on disk for quick and reliable restores.
- Replication to a central location minimizes complexity as it decreases risk.
- Centralized tape archival works with existing processes as it enables cost effective long term archival.

One of the key advantages of HP Data Protector software is its pricing model, in which license price is based on data stored as opposed to data protected. As a result, D2D deduplication not only enables fast and reliable restores from disk, it also reduces licensing costs.

Figure 8. Deduplicating Backups with HP Data Protector and HP StorageWorks D2D2503



HP Data Protector software running on a backup server can be attached to a D2D Backup System through an Ethernet or a Fibre Channel network. D2D capacity can be accessed as a network-attached drive (NAS) or a virtual tape library (VTL).

ESG Lab tested a D2D2503 as an iSCSI-attached VTL. This configuration is ideally suited for small to medium-sized businesses as it reduces the cost of backing up to disk in a number of ways:

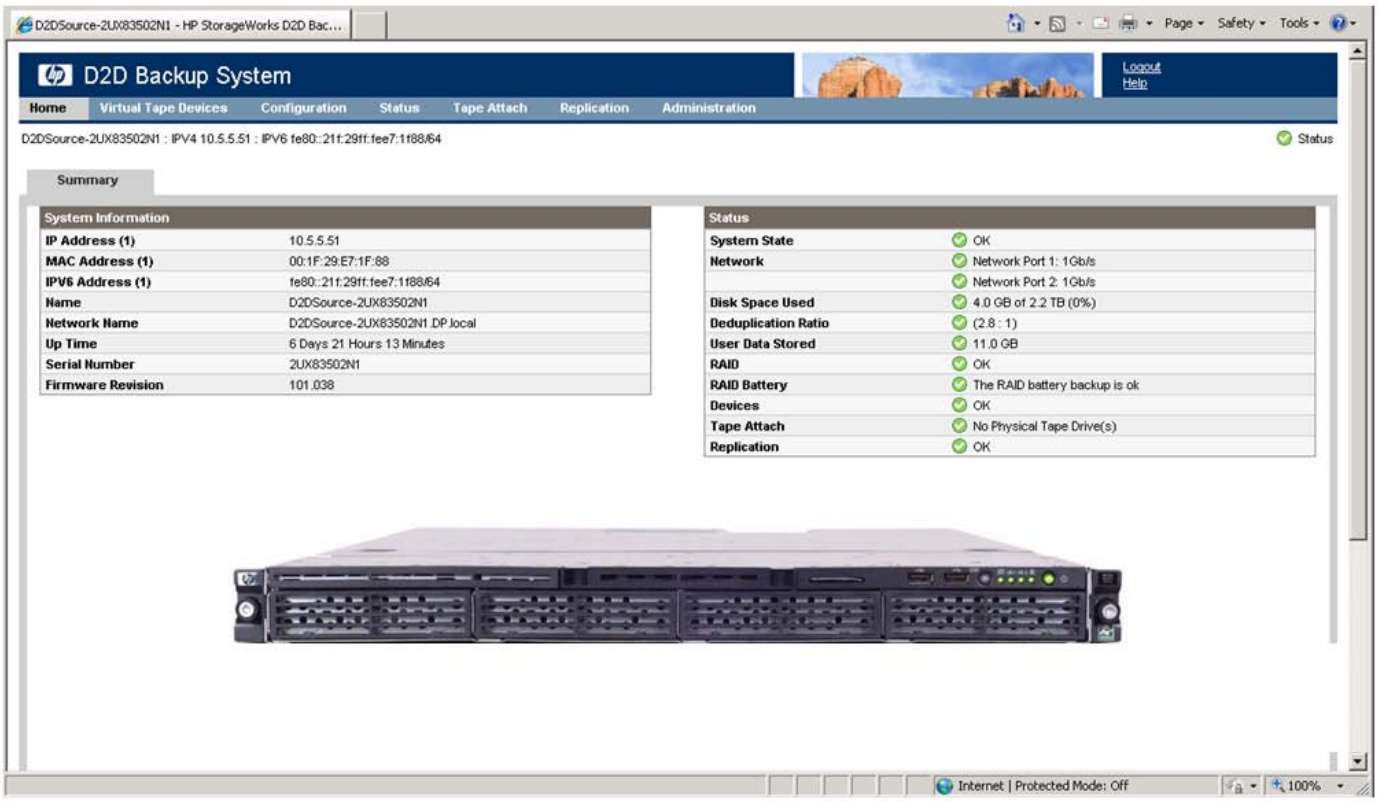
- Data deduplication reduces disk capacity requirements up to 50 times.
- iSCSI eliminates the cost and complexity of Fibre Channel host bus adapters and switches.
- The D2D Backup System performs like multiple tape drives operating in parallel. A single tape drive can only perform one backup at a time. To run more than one, more tape drives must be added and run in parallel. A D2D Backup System can run many backup jobs simultaneously.

While ESG Lab tested HP backup software and hardware, it should be noted that HP Data Protector software can be used with a wide variety of backup hardware from HP and other vendors. Similarly, HP D2D Backup Systems can be used with most popular backup applications.

ESG Lab Testing

ESG Lab used Data Protector software to back up the contents of the program files directory on the C: drive within a virtual machine running Windows Server 2008 as a guest operating system. Data Protector running within a virtual machine was configured to use the iSCSI-attached D2D2503 for disk-based backup and restore operations. The D2D Backup System eliminated duplicate data as backups were ingested and written to disk (a.k.a., inline deduplication). The StorageWorks management console shown in Figure 9 was used to examine the configuration of the D2D Backup System. The management console was also used to monitor the capacity savings that can be achieved with deduplication. In this screenshot, which was taken after the first full backup of the program file directory, an initial deduplication ratio of 2.8 was achieved as 11 GB of backup data consumed only 4 GB of disk capacity.

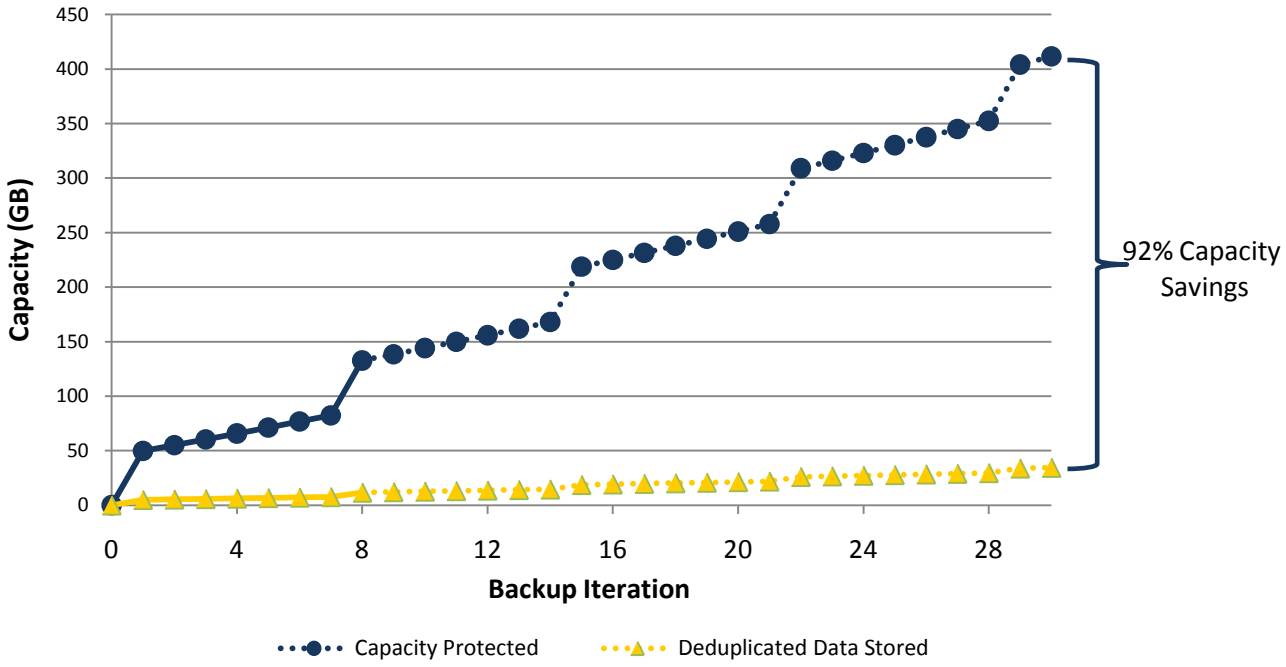
Figure 9. The HP StorageWorks D2D Management Console



The space savings that can be achieved over a month of daily incremental and weekly full backups was documented in a previously published ESG Lab Validation report. [4] As shown in Figure 10, disk capacity was reduced by 92%.

[4] ESG Lab Validation Report, *HP Data Protector and Deduplication Solutions*, June 2010.

Figure 10. Deduplication Capacity Savings Over Time



Why This Matters

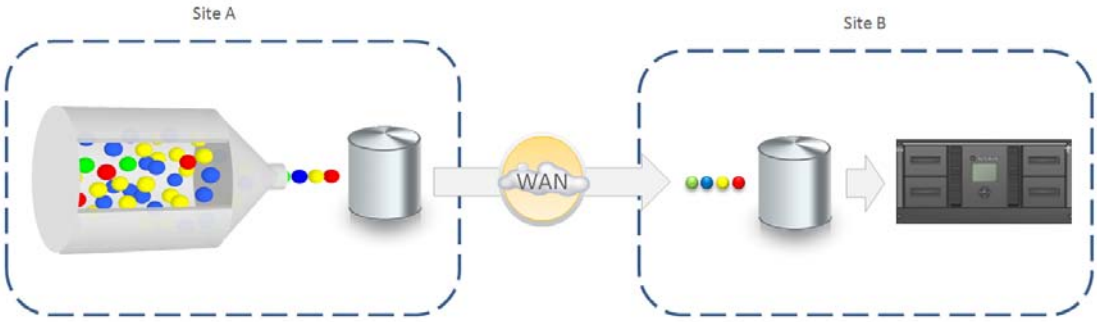
A recent ESG survey indicates that a growing number of mid-sized organizations (100 to 999 employees) are using backup-to-disk and data deduplication technologies to improve the speed and reliability of backup and restore operations. Seventy-five percent are backing up to disk (17% to disk only, 58% to disk and tape). Twenty-nine percent have deployed a data deduplication solution and another 41% plan on doing so within the next 24 months.

ESG Lab has confirmed that Data Protector and StorageWorks D2D Backup Systems are ideal solutions for mid-sized organizations looking to move from traditional tape-based backup and restore methodologies (D2T) to cost-effective disk-based (D2D) data protection strategies that leverage the power and affordability of HP data deduplication technology.

WAN-optimized D2D-Series Replication and Remote Site Tape Archival (D2D2T)

HP backup and tape systems can be used to deploy a WAN-optimized disk-to-disk-to-tape (D2D2T) data protection strategy as shown in Figure 11. Deduplication not only reduces disk capacity requirements in Site A, but also reduces the WAN bandwidth needed to replicate backup data to Site B. With more backups retained safely on disk at Site B, disk-based retention periods can be increased and the amount of tape needed for off-site archival can be decreased.

Figure 11. WAN Efficient D2D2T



While ESG Lab tested a two-site solution, it should be noted that many D2D Backup Systems deployed in remote offices can be configured for WAN-optimized replication to a central site. As documented in a previous lab report,[5] a many to one deployment strategy can be used to eliminate the cost, complexity, and hassle of running backups in remote offices as it provides a centralized platform for tape archival.

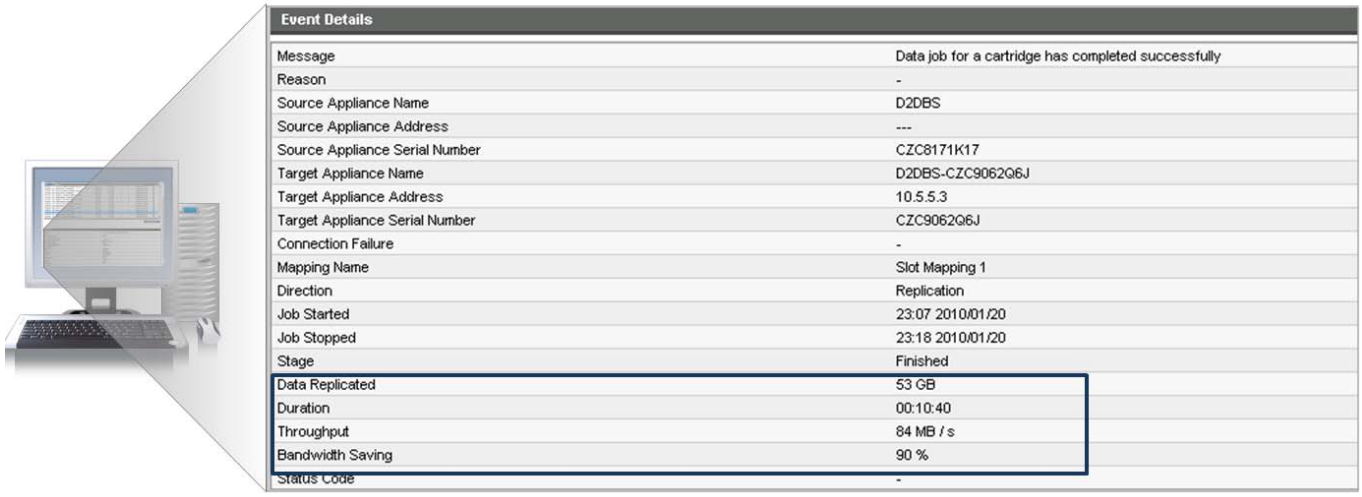
ESG Lab Testing

ESG Lab configured and observed the replication of deduplicated backup data from Site A to Site B and a copy to tape in Site B. Restores were tested using backup data storage on the D2D2503 in Site A, the D2D4112 in Site B, and the MSL4048 tape autoloader in Site B.

The D2D management console was used to configure and monitor replication between Site A and Site B. The screenshot shown in Figure 12 shows the status of a D2D replication job during a previous ESG Lab Validation. [6] In this example, WAN bandwidth requirements were reduced by 90% as 53 GB of Microsoft application data was replicated over an unrestricted Gigabit Ethernet connection in 10 minutes and 40 seconds. Once the first full backup was completely replicated to the target D2D appliance, ESG Lab used a "Network Nightmare" WAN simulator to restrict WAN bandwidth to 2 megabits per second. The first incremental backup was automatically replicated over the 2 Mbit/sec simulated WAN connection. Replication of the incremental backup transferred 5 GB of deduplicated data in 1 hour, 17 minutes, and 49 seconds. As a result, D2D deduplication increased the effective bandwidth of the WAN connection from 2 Mbit/sec to 22.9 Mbit/sec.

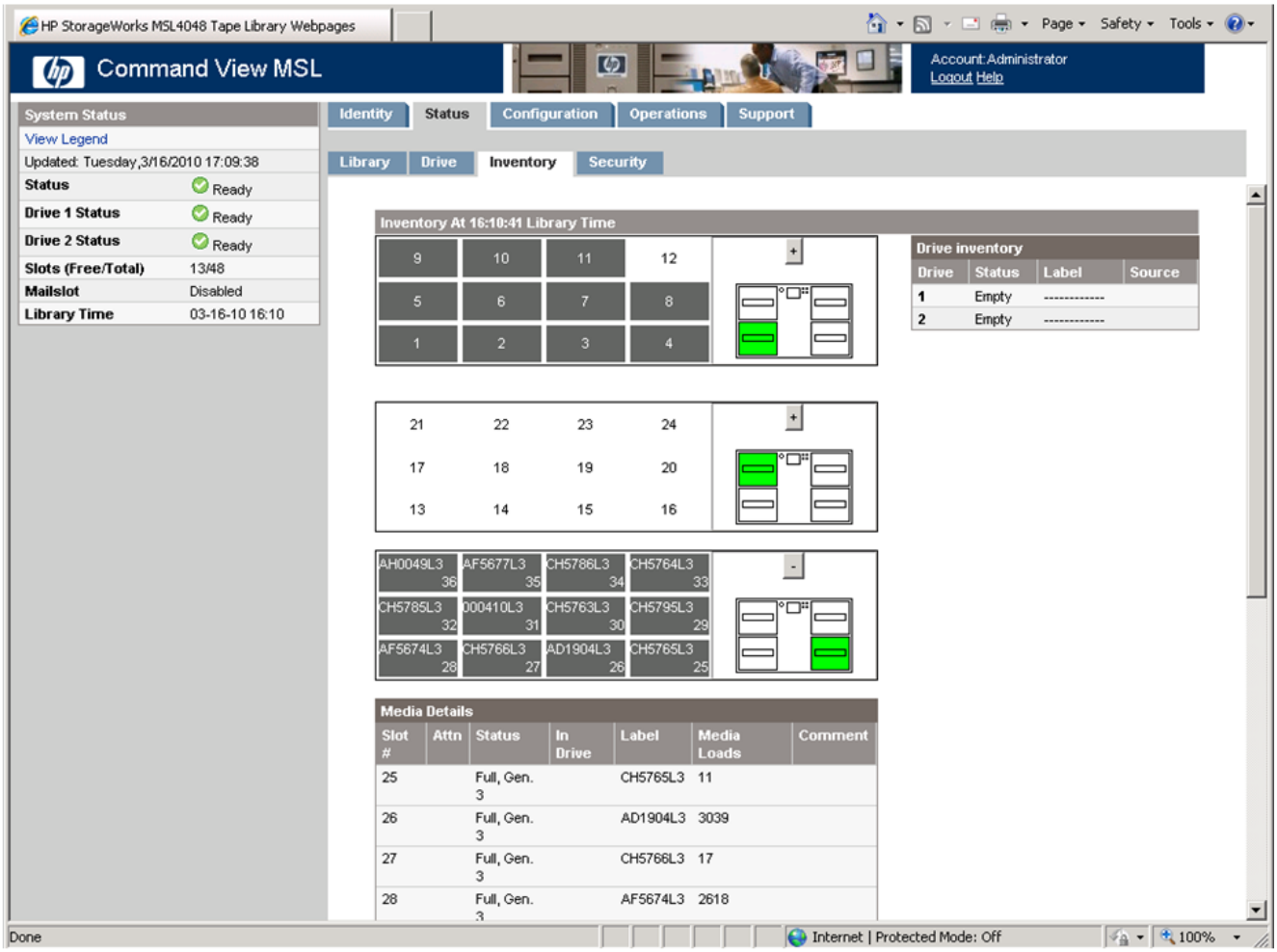
[5] ESG Lab Validation Report, *HP Data Protector and Deduplication Solutions*, June 2010.
[6] IBID.

Figure 12. WAN-optimized HP StorageWorks D2D Replication



The object copy capabilities of HP Data Protector software were used to archive a full backup image to a removable tape cartridge in a SAS-attached HP StorageWorks MSL tape autoloader in Site B. The Command View MSL console shown in Figure 13 was used to monitor the status of two LTO3 tape drives in the MSL4048.

Figure 13. HP StorageWorks Command View MSL



Data Protector was used to recover a single file from the D2D Backup System in Site A. Browsing the backup history and finding the file to restore was intuitive and easy. Restoring from disk using the D2D virtual tape interface felt the same as a restore from a real tape library, but completed quicker due to the random access of a disk-based backup.

Restores from the D2D Backup System at the remote site in Site B were tested next. A Windows iSCSI initiator rescan and login were used to present the remote D2D appliance to the destination Data Protector cell. After the Data Protector cell had discovered the remote virtual tape device, the restore operation felt the same as the restore from Site B.

The server and D2D Backup System in Site A was powered down to simulate a disaster. A recovery from tape in Site B began with a login to the active directory virtual machine at the remote site. Data Protector was used to perform a barcode scan and an import of backup data on tape. A restore from tape of the program file directory completed without error in just under 10 minutes.

Why This Matters

As disk-based backup becomes more pervasive in data protection strategies, it increasingly does so at the expense of tape. Yet many organizations moving away from a tape-only approach would prefer a more gradual transition in which both media types are used. In fact, ESG research indicates that the number of organizations using only tape to support backup operations dropped from 33% in 2008 to 20% in 2010, though there is only a 4% increase in those exclusively using disk-based systems. This can be attributed to a number of concerns, most notably comfort levels with a new technology, the financial considerations of the existing tape infrastructure, and the feasibility of long-term retention.

ESG Lab has confirmed that the HP StorageWorks division has created a cost-effective data protection solution for mid-sized organizations that leverages the WAN efficient replication of disk-based backup data and the portability of industry standard LTO tape cartridges.

Cost-Efficient

Organizations of all sizes are struggling to meet the conflicting challenges associated with macro-level global financial uncertainty and micro-level information storage growth and complexity. A growing number of IT managers are turning to virtualization and consolidation technologies to meet these challenges. With a focus on scalability, automated management, and capacity-efficient pricing, the HP StorageWorks-enabled solution tested by ESG Lab is an excellent example of an end-to-end solution that is purpose-built to address these issues.

ESG Lab created a total cost of ownership (TCO) model which compares the cost of a traditional physical server environment protected with tape to a virtual server environment protected with an HP StorageWorks-enabled D2D2T data protection strategy. Costs were broken down into categories including capital expenditures, administrative costs, tape costs, maintenance costs, power and cooling costs, and total floor space costs. The five year cost of ownership was compared. A number of assumptions were made based on the type of equipment, WAN connectivity, backup and restore policies, and capacity and performance requirements a typical mid-sized organization might have in place. [7] The results are shown in Figure 14.

[7] TCO assumptions are documented in the Appendix.

Figure 14. The HP StorageWorks-enabled Cost Advantage

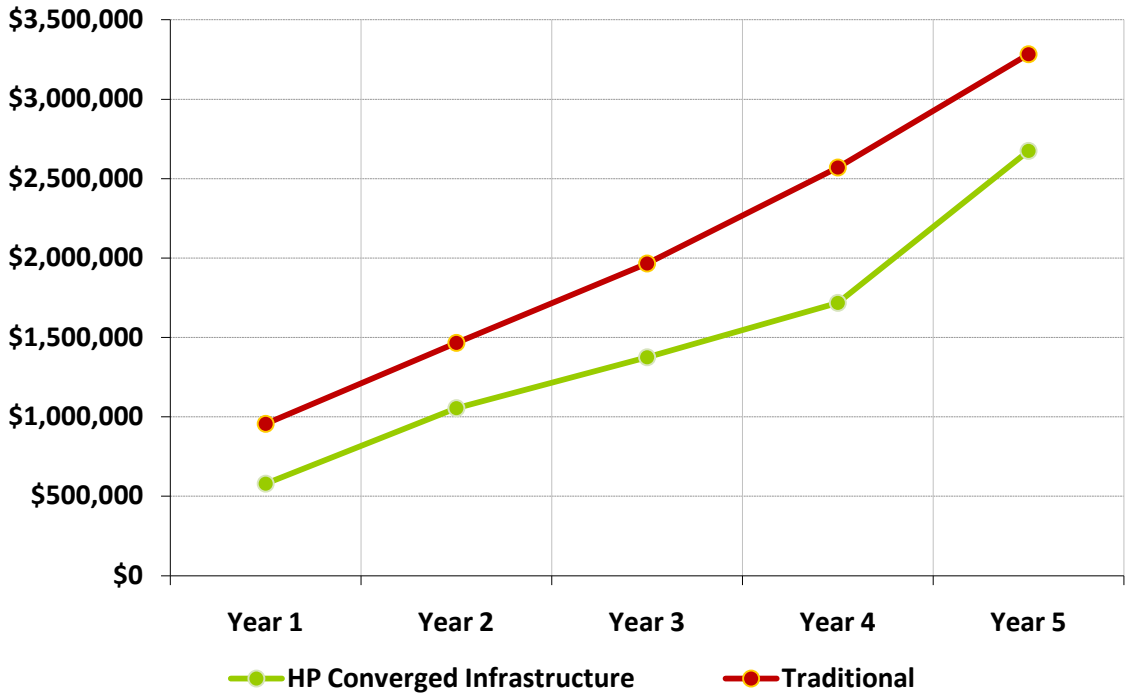


Table 1: Five Year Cost Breakdown by Category

	Acquisition	Maintenance	Administration	Power/Cooling/ Footprint	Total
Traditional	$2,346,651	$480,000	$382,046	$75,003	$3,283,700
HP Converged Infrastructure	$1,994,831	$241,882	$209,128	$228,199	$2,674,040

What the Numbers Mean

- The total cost of ownership of traditional physical servers protected with tape is 23% higher than the HP Converged Infrastructure.
- The bulk of the savings were realized with an iSCSI-attached clustered storage system (HP StorageWorks P4500), backup to disk with data deduplication (HP StorageWorks D2D Backup Systems), and the HP Data Protector licensing model which is based on capacity stored as opposed to data protected.

Why This Matters

Mid-sized organizations often lack the manpower needed to effectively manage growing information assets residing on disk and tape. Until recently, extending the benefits of a D2D2T protection strategy to a remote site has been impractical. The cost of disk and WAN bandwidth often can't be justified. If a disk-based storage system is used for replication, the backup software can't keep track of where the copies reside.

With D2D Backup Systems that reduce the cost of disk capacity and WAN bandwidth and HP Data Protector software that manages the data protection environment, ESG Lab has confirmed that the HP StorageWorks division has created a cost-effective, end-to-end data protection solution for mid-sized organizations.

ESG Lab Validation Highlights

- ☑ VMware vSphere was used to simulate a consolidated mix of common business applications running on an HP ProLiant DL380 server (Microsoft Active Directory, Apache Web Server, Microsoft Exchange Server, Microsoft SharePoint Server, and Microsoft SQL Server).
- ☑ An HP P4500 SAS Virtualization SAN solution was attached via iSCSI to the HP ProLiant server. In less than ten minutes, the two-node storage cluster was upgraded online to three nodes and a new volume was created and accessed by a virtual machine.
- ☑ HP Data Protector software and a pair of HP StorageWorks D2D Backup Systems were used to provide deduplicated backup-to-disk in one site and WAN-optimized replication of backup data to a second site.
- ☑ HP Data Protector software was used to make copies of backup data on portable LTO3 tape cartridges within an HP StorageWorks MSL4048 autoloader.
- ☑ The HP StorageWorks converged infrastructure was used to test backup and restore operations within a D2D2T data protection strategy.
- ☑ A five year TCO analysis indicates that an HP StorageWorks enabled converged infrastructure is 23% more cost-effective than a traditional physical server infrastructure attached to a legacy modular FC disk array and a tape-only data protection strategy.

Issues to Consider

- ☑ ESG Lab tested an end-to-end HP solution in a controlled lab setting. Due to the many variables in each production data center environment, capacity planning and application-level testing are recommended to ensure that the solution meets the performance and recovery objectives for your organization.
- ☑ While the HP DL380, P4500, D2D, and MSL systems all have easy-to-use management interfaces, a single "manager of managers" that provides an overall view of an entire environment would be of great value to administrators.
- ☑ While ESG is confident that one or more HP StorageWorks D2D Backup Systems can be used to meet the performance needs of a mid-sized organization, D2D systems with more capacity and horsepower could reduce cost and complexity within larger mid-sized organizations. HP has advised ESG that the new line of D2D Backup Systems, released in June 2010, has been designed with these considerations in mind.

The Bigger Truth

As the global economy provides a constant reminder that costs have to be contained, a number of factors must be considered as IT managers examine the benefits of emerging technologies; specifically, data growth, consolidation initiatives, server virtualization, new application deployments, compliance mandates, and business requirements that necessitate more stringent SLAs make it difficult for IT organizations to keep up with growing demands. IT managers within mid-sized organizations are especially challenged as they look for ways to consolidate, optimize, and automate the delivery of IT services.

Data protection is an integral part of IT operations—maintaining one or more local and/or remote copies of primary data provides an insurance policy for minimizing data loss and downtime. Data growth is wreaking havoc on data protection, making it difficult for IT organizations to keep pace with the capacity of data to protect, to meet backup windows and recovery objectives, and to manage spending.

Backup modernization has been underway over the last few years, with disk-based backup and recovery as a top initiative. ESG's research shows that organizations are more often leveraging disk and the increased adoption of deduplication is a contributing factor to the rise in the use of disk in backup. Regardless, organizations are not releasing their grip on tape. Tape remains an integral part of data protection strategies, especially as the go-to media of choice for long-term retention.

ESG Lab has validated that HP has created a converged infrastructure for mid-sized organizations. ESG Lab tested HP ProLiant servers with HP Data Protector software running within VMware-enabled virtual machines. An iSCSI-attached HP P4000 SAN that uses intelligent software running on a cluster of industry standard servers was used to create a primary storage solution that's scalable, fast, and extremely easy to manage. The data deduplication that's built into HP StorageWorks D2D Backup Systems reduced disk capacity and WAN bandwidth requirements as a multi-site D2D2T strategy was implemented.

The deduplication technology at the core of a disk-based StorageWorks D2D Backup System was developed by HP Labs researchers working with engineers in the HP StorageWorks division. This valuable technology can be deployed in concert with HP Data Protector software and an HP StorageWorks MSL tape autoloader to create an end-to-end data protection solution that is ideally suited for mid-sized organizations.

The bigger truth of this ESG Lab validation can be summed up in two words: trust and affordability. HP has been a trusted supplier of IT infrastructure for decades. The solution tested by ESG Lab is a converged infrastructure with all of the hardware and all of the storage software supplied by HP. An end-to-end solution from a single vendor that has earned your trust avoids the complexity and risk of building a solution on your own. A five-year cost analysis indicates that the solution presented in this report reduces costs by 23% over five years compared to a legacy solution that relies on physical servers attached to a Fibre Channel disk array and backed up with a traditional tape library. ESG Lab believes that IT managers in mid-sized organizations would be wise to consider the affordability of converged infrastructure powered by HP StorageWorks technology.

Appendix

Table 2. ESG Lab Test Bed

Hardware	
Servers	HP ProLiant DL380 G5 Eight 2.33 GHz Intel Xeon CPU cores, 24 GB RAM HP ProLiant DL360 G5 Two 2.33 GHz Intel Xeon CPU cores, 24 GB RAM
Primary Storage	Three node HP P4500 SAN Two nodes: 10.8 TB SAS Virtualization SAN Solution Third node: P4500 5.4 TB SAS Virtualization SAN Expansion
Backup-to-Disk Storage (Site A)	HP StorageWorks D2D2503, 3 TB, v101.038
Backup-to-Disk Storage (Site B)	HP StorageWorks D2D4112, 12 TB, v101.037 EH995A (D2D4112 Backup System upgrade kit) EH994A (HP StorageWorks D2D4112 Replication License)
Tape Autoloader (Site B)	HP StorageWorks MSL4048 with 2 Ultrium 920 SAS drives
Ethernet Switching	HP ProCurve 2824 LAN switch
Software	
HP Data Protector	Version: 6.1.1
Hypervisor	VMware 4 Enterprise Plus
Guest Operating Systems	Windows Server 2008 R2 Enterprise Red Hat Enterprise Linux Server, v5.4, Kernel 2.6.18-8.e15
Total Cost of Ownership Assumptions	
Power	$.0937/kW-hr
Data center floor space	$40.00/sq. ft.
Hourly loaded labor rate for a backup admin	$45/hour
Total working hours per year per backup admin	2,000 hours
Annual growth rate in required labor cost	10%
Traditional	
Physical Servers	Eight with 4 GB or RAM each
Storage Network	Fibre Channel
Primary Storage	Dual controller FC disk array
Usable Primary Disk Capacity	25 TB
Backup Method	Tape only
Backup hardware	Ultrium 920 LTO3 tape drives in an MSL 2024 tape library
Backup policy	Weekly Full, Daily Incremental
Retention	30 days on site, 1 year off-site
Backup window	8 hours for a full backup
Compressibility of data	2:1 compression
Incremental backup size	10% of production capacity
Data set growth rate	40% Annually
Full restores required annually	Two (25 TB)
Partial restores required weekly	Five (>2.5 GB)

HP Converged Infrastructure	
Physical Servers	Five with 16 GB of RAM each (three in Site A, two in Site B)
Storage Network	iSCSI
Primary Storage	HP StorageWorks P4500 SAS Virtualization SAN Solution
Usable Primary Disk Capacity	25 TB
Backup Method	D2D2T over two sites
Backup hardware	HP StorageWorks D2D2503 (Site A) HP StorageWorks D2D4112 (Site B) HP StorageWorks MSL4048 (Site B)
Backup policy	Weekly full, daily incremental
Retention policy (disk)	90 Days on-site, 1 year off-site
Retention policy (tape)	7 days on-site, 1 year off-site
Backup window	2 hours for a full backup
Compressibility of data	2:1 compression, 10:1 deduplication over time
Incremental backup size	10% of production capacity
Data set growth rate	40% Annually
Full restores required annually	Two (25 TB)
Partial restores required weekly	Five (>5 GB)

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