LAB VALIDATION REPORT

Dell PowerVault DL2000

Powered by CommVault

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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 CommVault.

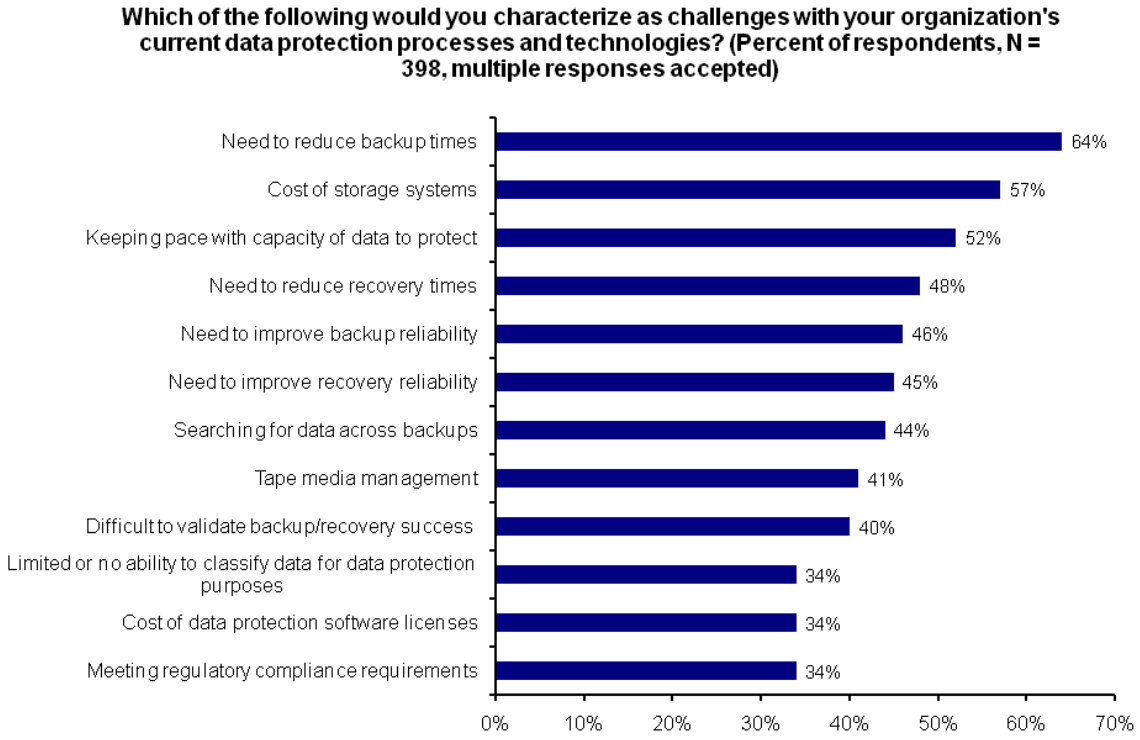
Introduction

The Dell PowerVault DL2000 Powered by CommVault is a customer-installable, fully integrated backup to disk appliance that offers reliable data protection with file level data deduplication and fast, drill-down recovery. With CommVault's Continuous Data Replicator (CDR) agent, companies can protect their remote and branch offices while providing continuous protection of critical servers and applications. This ESG Lab Report presents the results of ESG Lab testing of these capabilities while also exploring integration with Microsoft applications and protection and recovery of VMware virtual servers.

Background

If there is a common theme to be found in end-users' top data protection challenges, it is that they are all generally a result of—and are compounded by—large and growing IT and data storage environments. In fact, ESG recently asked IT decision makers to identify their organization's current data protection challenges and, as shown in Figure 1, respondents clearly identify a wide variety of challenges.[1] Those that rose to the top of the list included the need to reduce backup times; dealing with the cost of storage systems, which affects the ability to keep pace with the capacity of data that needs to be protected; and the need to reduce recovery times.

FIGURE 1. TOP DATA PROTECTION CHALLENGES



ESG research has also found that end-users are solving their data protection technology and process challenges with disk-based solutions. As a matter of fact, two-thirds (67%) of organizations surveyed now use disk-based storage platforms at some point in the backup process, with most of these users employing a mix of disk and tape storage in a disk-to-disk-to-tape architecture. While survey respondents forecast a significant shift in backup capacity to external disk-based storage over the next three years, tape is not going away—a vast majority of early adopters report that tape is augmenting disk for long term archive and offsite data protection.

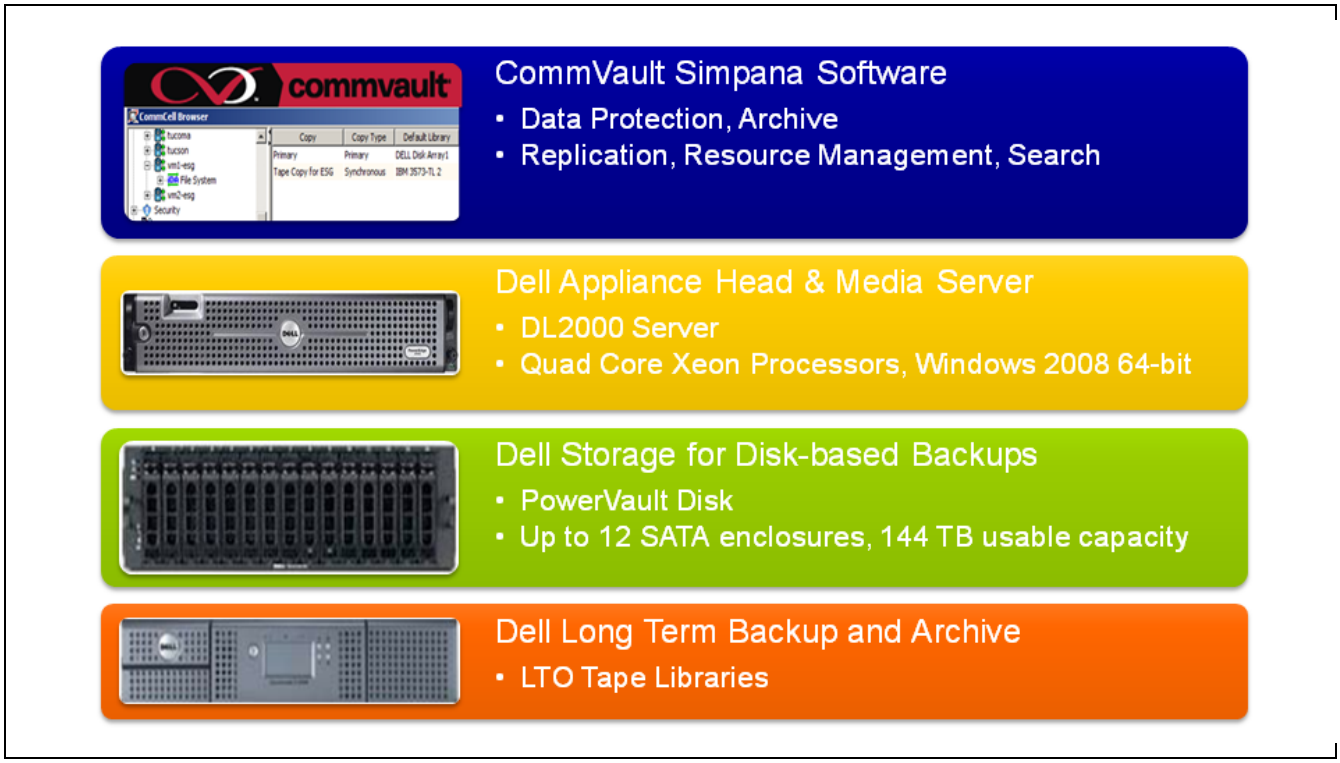
[1] Source: ESG Research Report, *Data Protection Market Trends,* 2008

Dell PowerVault DL2000 Powered by CommVault

Dell and CommVault have created a purpose-built disk-based backup system that combines Dell hardware with CommVault Simpana data protection software. The Dell PowerVault DL2000 Powered by CommVault integrates disk-based backup and recovery with file deduplication technology to help deliver fast, reliable data protection for small to medium-size enterprises. The PowerVault DL2000 comes factory-installed with a wizard-driven set up and management utility that includes an automated dynamic disk provisioning capability that automatically provisions disk for use as a backup target.

As displayed in Figure 2, a PowerVault DL2000 Powered by CommVault consists of CommVault Simpana software which, in turn, consists of CommServe and MediaAgent software pre-installed on a Dell DL2000 server. Up to twelve Dell PowerVault MD1000 disk enclosures may be attached for backup to disk capacity and tape integration with PowerVault TL2000, TL4000, or ML6000 tape libraries to provide long-term disaster recovery.

FIGURE 2. DELL POWERVAULT DL2000 POWERED BY COMMVAULT



CommVault's file level deduplication is available to help eliminate redundant files, attachments, and documents across consolidated backup data sets. By eliminating duplicate files, IT administrators can increase capacity utilization while reducing network bandwidth, reducing footprint, and lowering energy and cooling costs. Simpana can also provide continuous protection of data with its Continuous Data Replicator (CDR) agent. Production servers using the CDR agent can replicate file, Exchange, SQL, and Oracle data securely at the byte level to remote or local sites with point-in-time recovery capability.

This report documents ESG Lab's testing of the Dell PowerVault DL2000 Powered by CommVault with a focus on ease of deployment, management, and the protection of mission critical applications, highlighting integration with Microsoft applications and VMware, file level deduplication, tape integration, and continuous data replication.

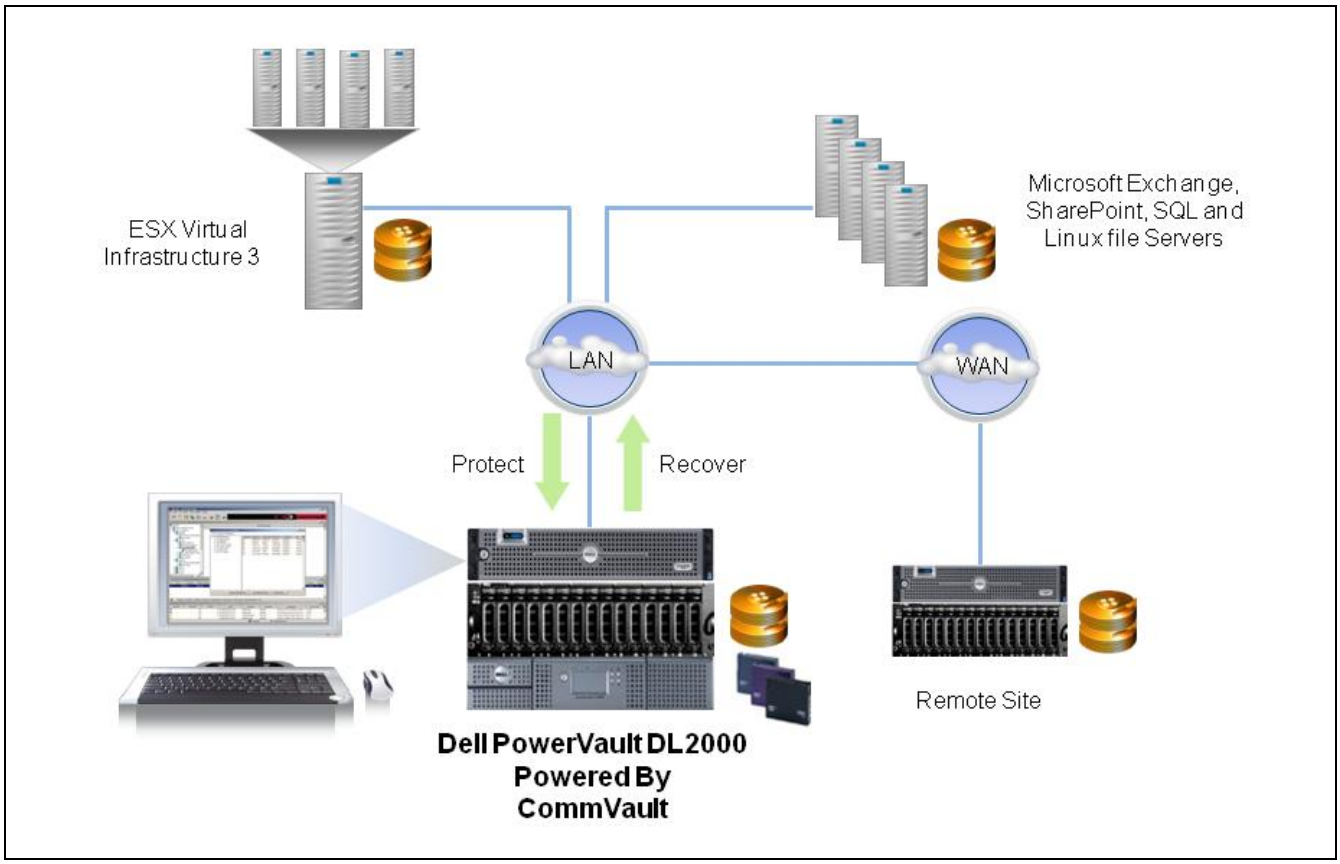
ESG Lab Validation

ESG Lab performed hands-on evaluation and testing of Dell PowerVault DL2000 Powered by CommVault at a CommVault facility located in Oceanport, New Jersey. Testing began with a look at the automated wizard-driven deployment, configuration, and management of the PowerVault DL2000.

Simple, Automated Configuration and Management

In the ESG Lab test bed, four physical servers were installed with Microsoft Windows 2003 and Linux. One server ran VMware ESX. The four physical servers were running Microsoft Exchange, Microsoft SQL Server, Microsoft SharePoint (MOSS), and Linux file services. The VMware ESX server housed two virtual machines running Windows 2003. The physical and virtual servers were connected to the Dell PowerVault DL2000 over a gigabit Ethernet LAN, seen in Figure 3. The remote replication target was connected via a simulated WAN connection utilizing a 100 Mb/sec LAN connection.[2]

FIGURE 3. ESG LAB TEST BED



ESG Lab Testing

ESG Lab began by powering on a pre-wired PowerVault DL2000. Upon Windows startup, the PowerVault Configuration wizard launched and was used to configure basic server settings, including user credentials, network settings, host name, and Active Directory settings. The configuration process continued with ESG Lab

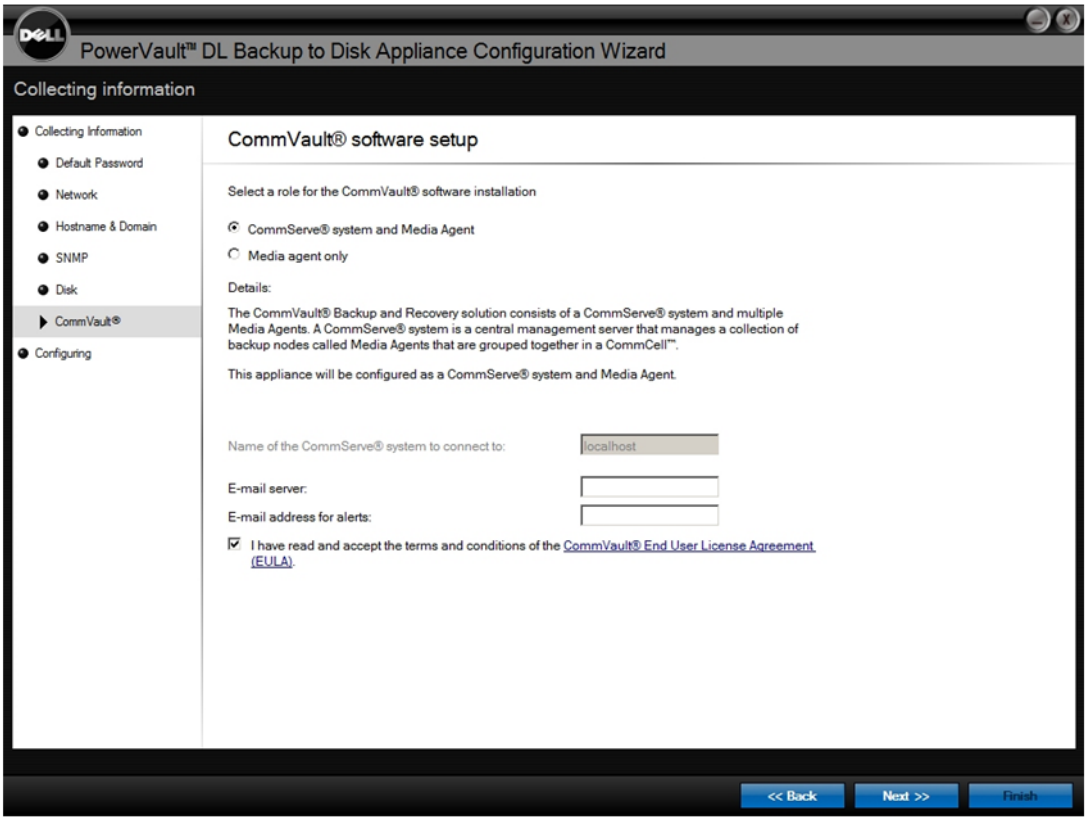
[2] Configuration details can be found in the Appendix.

selecting the 'Automatic' disk configuration policy to allow the CommVault software to configure available physical disks for use by CommVault backup software.

Using the automatic disk configuration policy, the configuration wizard found all un-configured physical disks in the MD1000 enclosure and automatically created disk groups and virtual volumes.[3] ESG Lab noted that it took just seven mouse clicks in less than seven minutes to configure basic appliance settings, establish login credentials, and provision available storage.

Figure 4 shows the DL2000 configuration wizard at the end of the initial setup of the appliance, prior to the automated installation and configuration of CommVault Simpana software.

FIGURE 4. DELL POWERVAULT CONFIGURATION WIZARD



The wizard continued with the installation and configuration of the pre-loaded CommVault backup software and the Dell OpenManage utility used to manage and monitor the appliance. One mouse click and eight minutes later, the wizard automatically installed the CommVault backup software and configured backup storage pools.

[3] Default disk configuration will locate and combine each set of 7 physical disks into a RAID 5 volume.

FIGURE 5. INSTALLING AND CONFIGURING THE POWERVAULT DL2000

Figure 5 depicts the deployment timeline of the PowerVault DL2000 Powered by CommVault. ESG Lab was able to deploy, configure, provision storage, and begin performing backups within twenty minutes.

Why This Matters

When asked by ESG to identify the greatest challenges with respect to their storage environments, survey respondents cited a need to improve backup and recovery processes as their top storage-related issue. ESG research has also indicated that these respondents are turning to disk-based backup appliances to address backups and recoveries that are failing to meet service level agreements, poor backup and recovery reliability, and tape media management issues.

The PowerVault DL2000 Powered by CommVault is a simple, disk-based appliance that ESG Lab was able to deploy, configure, and begin using in less than twenty minutes. The easy wizard-driven setup and management utility required no effort, just basic networking and user credential information to complete the installation process. Integrated dynamic disk provisioning configured and set up pools of storage and automatically configured them for use with CommVault Simpana.

By integrating Dell hardware and automated storage provisioning with CommVault Simpana software, users now have an affordable, customer-installable disk-based backup appliance that can be quickly deployed and easily managed from a single easy to use console.

Protecting Mission Critical Applications

The Dell PowerVault DL2000 Powered by CommVault is specifically designed to protect enterprise-class applications, as well as e-mail, files, and database systems created by applications such as Microsoft Exchange, SharePoint/SQL, and Active Directory. Along with protecting physical systems, CommVault also offers a full range of options for managing and protecting VMware-hosted virtual servers.

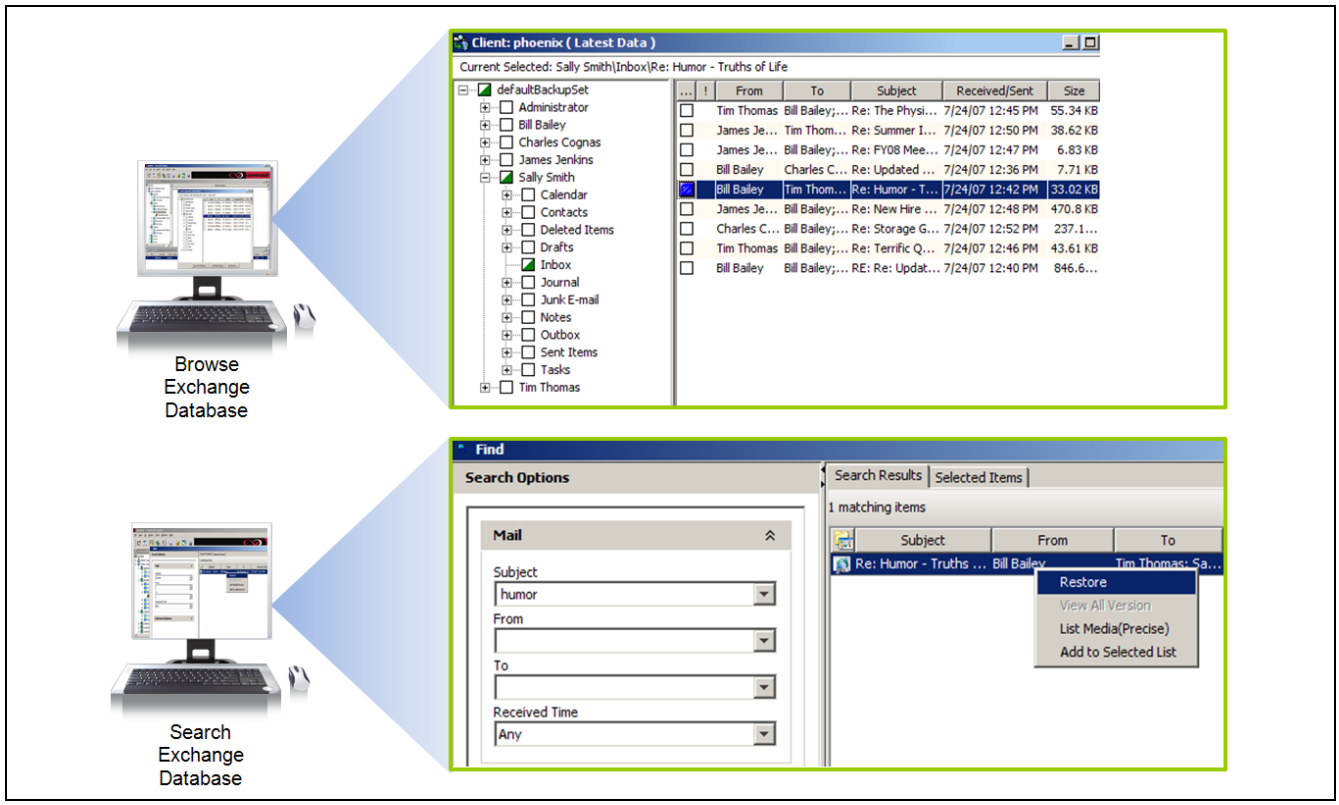
Microsoft Exchange

ESG Lab used the PowerVault DL2000 to restore an individual Outlook message deleted from a user's Inbox after a full backup of the Exchange database. Utilizing CommVault's restore wizard, ESG was able to browse the Exchange database and restore the deleted message from the latest backup copy.

ESG also performed a Find command through the restore wizard to search for all messages that contained the word "Humor" in the message title. From the search results, ESG was able to select a single deleted message and restore the message to the original user's Inbox.

The CommVault Job Controller window was used by ESG to monitor, track, and display all backup and restore jobs from the CommCell GUI interface. The two recovery methods used by ESG Lab to locate and restore deleted e-mail messages are displayed in Figure 6.

FIGURE 6. SINGLE STEP GRANULAR RECOVERY



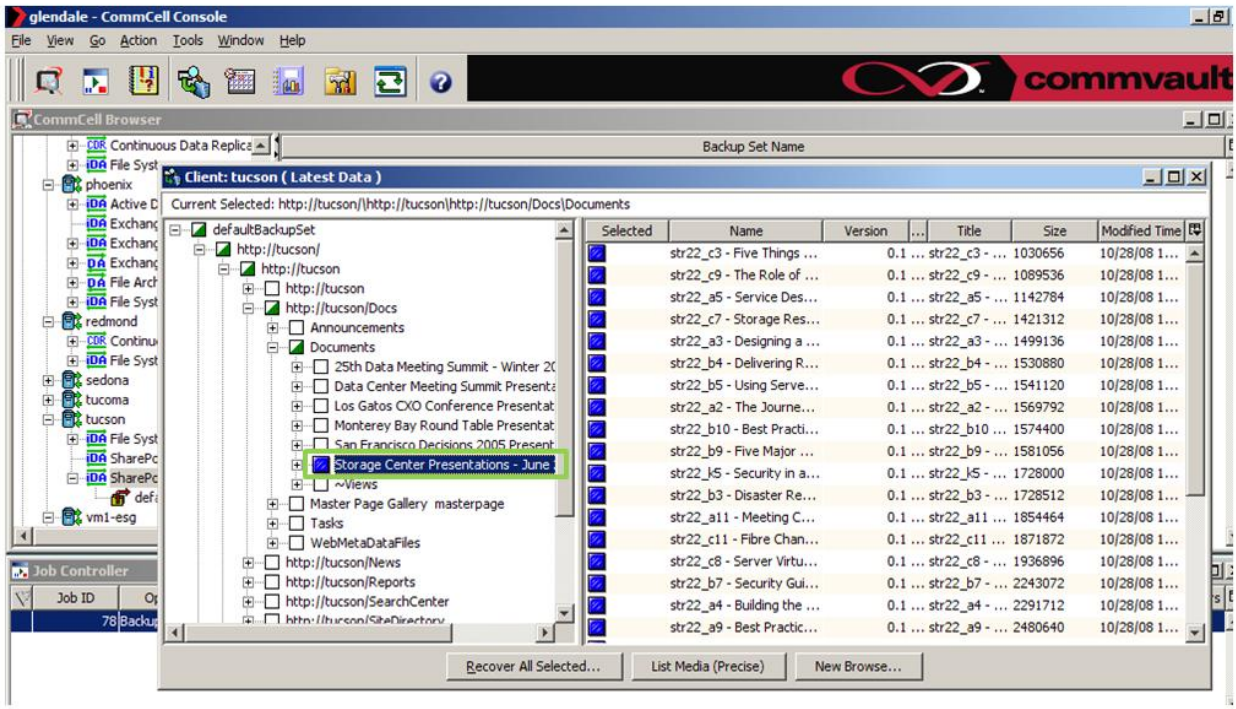
Using an easy to navigate restore wizard, ESG Lab was able to look inside the backed up Exchange database through a simple search interface to locate individual messages, tasks, contacts, calendars, and other Outlook items easily, based on filters such as dataset, date, or user.

Microsoft SharePoint

Microsoft Office SharePoint Server is an integrated suite of server capabilities that provides content management and search using a web frontend and a SQL database backend to manage content. To test the PowerVault DL2000 Powered by CommVault's ability to protect and restore SharePoint items, ESG Lab started with a pre-populated SharePoint Server, with several folders full of presentation materials, running in a virtual machine on a VMware ESX server. CommVault uses the same agents, installation and configuration for virtual servers as for physical servers.

ESG Lab deleted the folder "Storage Center Presentations – June" which contained twenty five files and then emptied the SharePoint recycle bin, ensuring that the files were completely deleted from the system. Utilizing CommVault's restore wizard, ESG was able to search the dataset that had been backed up with a single-pass, full system backup for the individual SharePoint folder that was deleted. ESG selected the folder "Storage Center Presentations – June" from the latest backed up dataset and restored it to its original location as shown in Figure 7.

FIGURE 7. SHAREPOINT RECOVERY



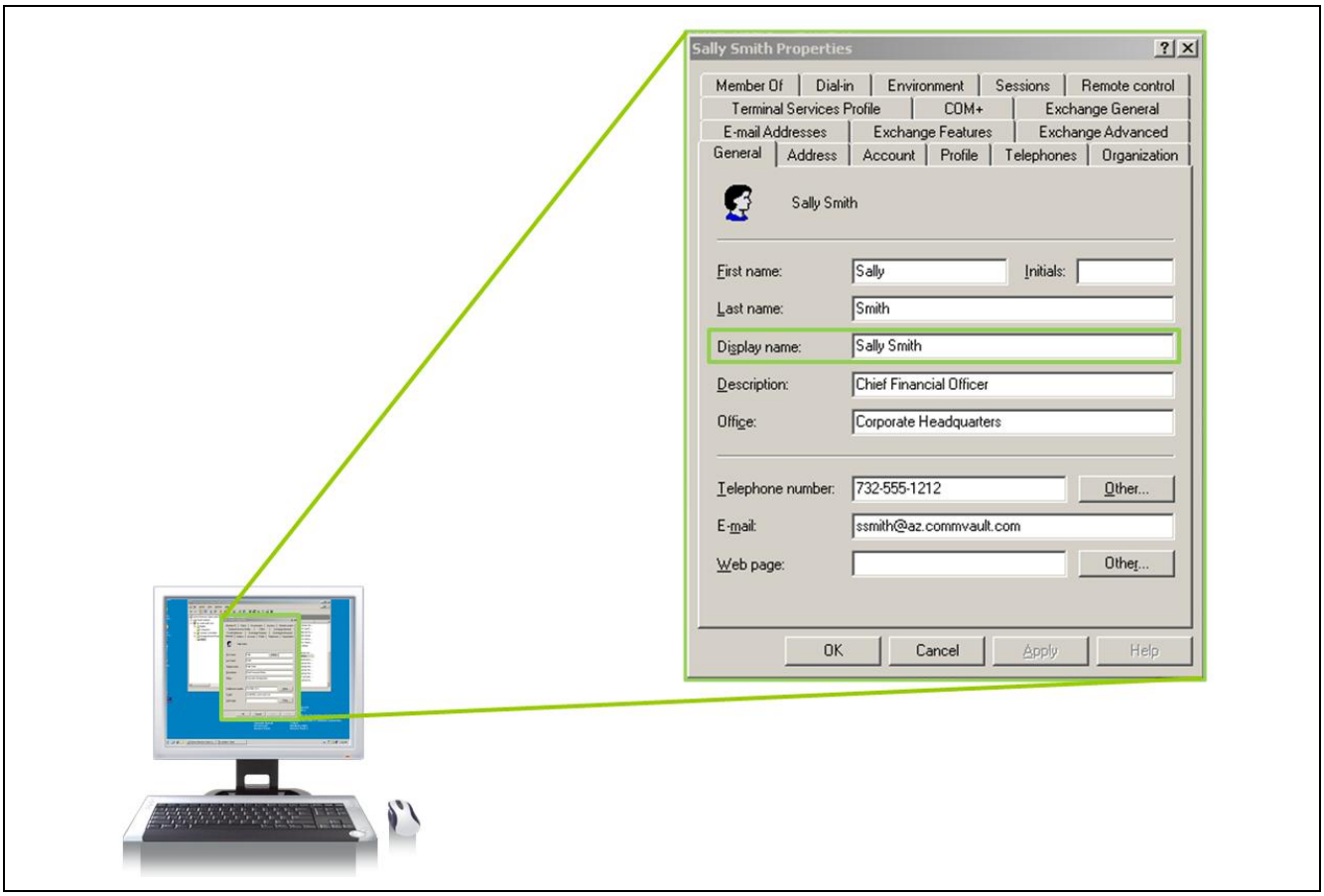
Locating and restoring the files was performed in less than two minutes. ESG Lab was able to verify the restored folder from the SharePoint web interface and open the restored files. ESG Lab found that CommVault can protect SharePoint installation with single-pass backups and recover individual SharePoint items such as sites, documents, lists, folders, and templates with an easy to use restore wizard and search capability.

Microsoft Active Directory

Microsoft Active Directory is a central component of the Windows platform, providing identity and relationship management for the networks that businesses, large and small, rely on. ESG Lab began with a preconfigured Active Directory environment and performed a full, single-pass backup of the active directory server.

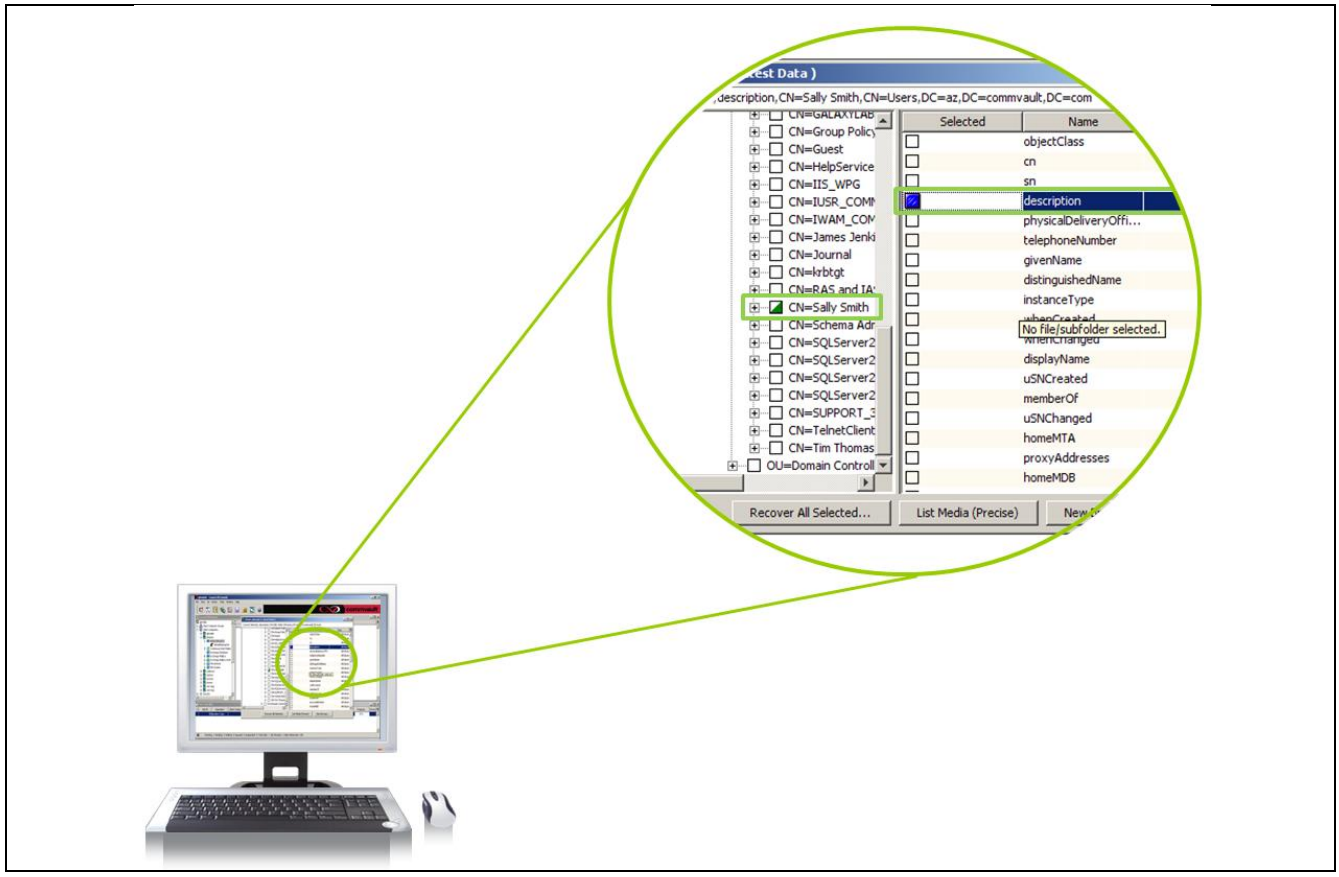
ESG Lab then used the Microsoft Management Console to modify one user's properties in Active Directory as shown in Figure 8. ESG changed the Description property for user Sally Smith from Chief Financial Officer to Human Resources. A second user's entire profile was also deleted.

FIGURE 8. MICROSOFT ACTIVE DIRECTORY USER PROPERTIES



Using the CommVault restore wizard, ESG Lab searched the backed up datasets, selected the individual users' properties, and restored Sally Smith's Description object, as displayed in Figure 9, while also restoring the deleted user's profile.

FIGURE 9. RESTORING A SINGLE ACTIVE DIRECTORY OBJECT



ESG verified that Sally Smith's Active Directory properties were recovered correctly and the deleted user's profile was restored.

Why This Matters

The majority of organizations believe mission-critical data is at risk. In fact, ESG has found that more than 50% of organizations surveyed worry that their backup schedules leave some data exposed to potential loss.[4] The survey also reported that the two application categories with the greatest data protection challenges are databases (46%) and e-mail/messaging (41%). The Dell PowerVault DL2000 Powered by CommVault is specifically designed to protect these and other mission critical applications.

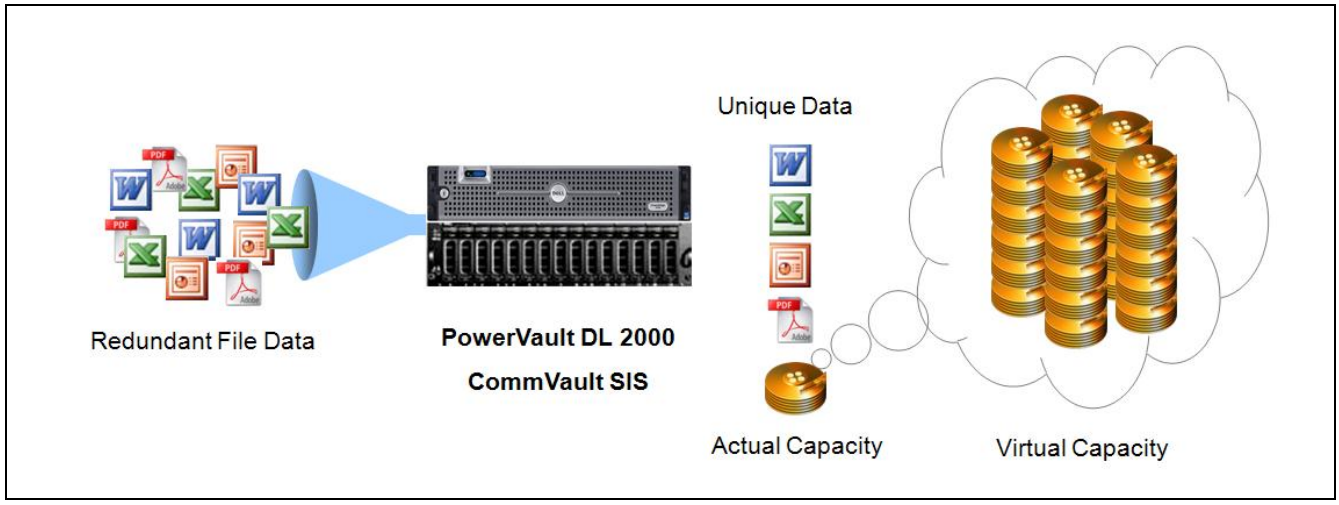
With CommVault's single step object-level recovery, ESG Lab was able to use the DL2000 to recover a message deleted from a user's Inbox, restore a folder from a SharePoint installation, and restore users' Active Directory attributes from single-pass, full database backups. Since CommVault's simple search capability spans applications, searching for and selecting individual files, application items, and database objects for restoration was fast and easy. CommVault's ability to restore only what needed to be recovered from single-pass database level backups is very powerful, yet still fast and easy to perform.

[4] Source: ESG Research Report, *Data Protection Market Trends,* 2008

Deduplication

CommVault deduplication uses Single Instance Store (SIS) to reduce the capacity required to store backed up file data. To illustrate the power of data deduplication technology, consider the example shown in Figure 10. Redundant copies of files (Word, PowerPoint, Excel, and PDF) are included in a backup set. Data deduplication examines the contents of files prior to storing them on disk or tape, recognizes and eliminates redundant copies, and stores only the unique files.

FIGURE 10. COMMVAULT SINGLE INSTANCE STORE IN ACTION



Consider what happens when one copy of a PowerPoint file has been sent via e-mail to a number of team members. Using file deduplication, CommVault recognizes the multiple copies as identical files and saves only one copy. When one of the recipients makes changes and forwards the updated presentation to the team, CommVault recognizes the identical copies of the updated presentation and saves only one additional copy. Pointers are used to recreate the file when restored. The capacity required for many copies of the same PowerPoint file, and the changed version, has been reduced significantly.

ESG Lab Testing

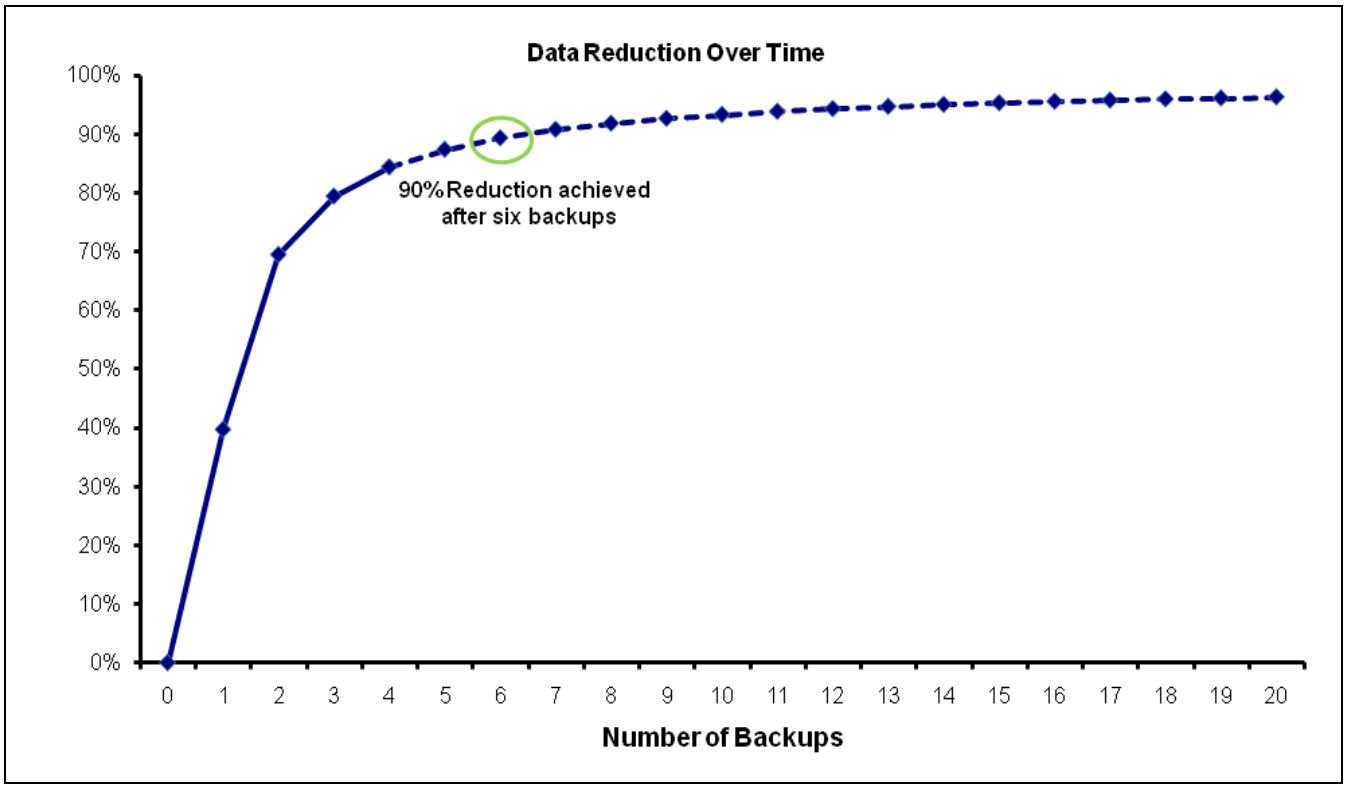
ESG Lab measured the capacity savings that can be achieved over a series of backup operations using the Dell DL2000 Powered by CommVault appliance. The initial data set backed up was composed of 25 GB of randomly generated file data.

A typical backup scenario was simulated using weekly full and daily incremental backups. A file creation utility was used to grow the dataset by 1% daily to simulate changes between each backup. Synthetic full backups were used in combination with CommVault SIS and compression.

ESG Lab measured the capacity consumed before and after running each backup. After four backup jobs had been run, the capacity savings were measured at 85% and the rate for a 30 day retention policy was projected.

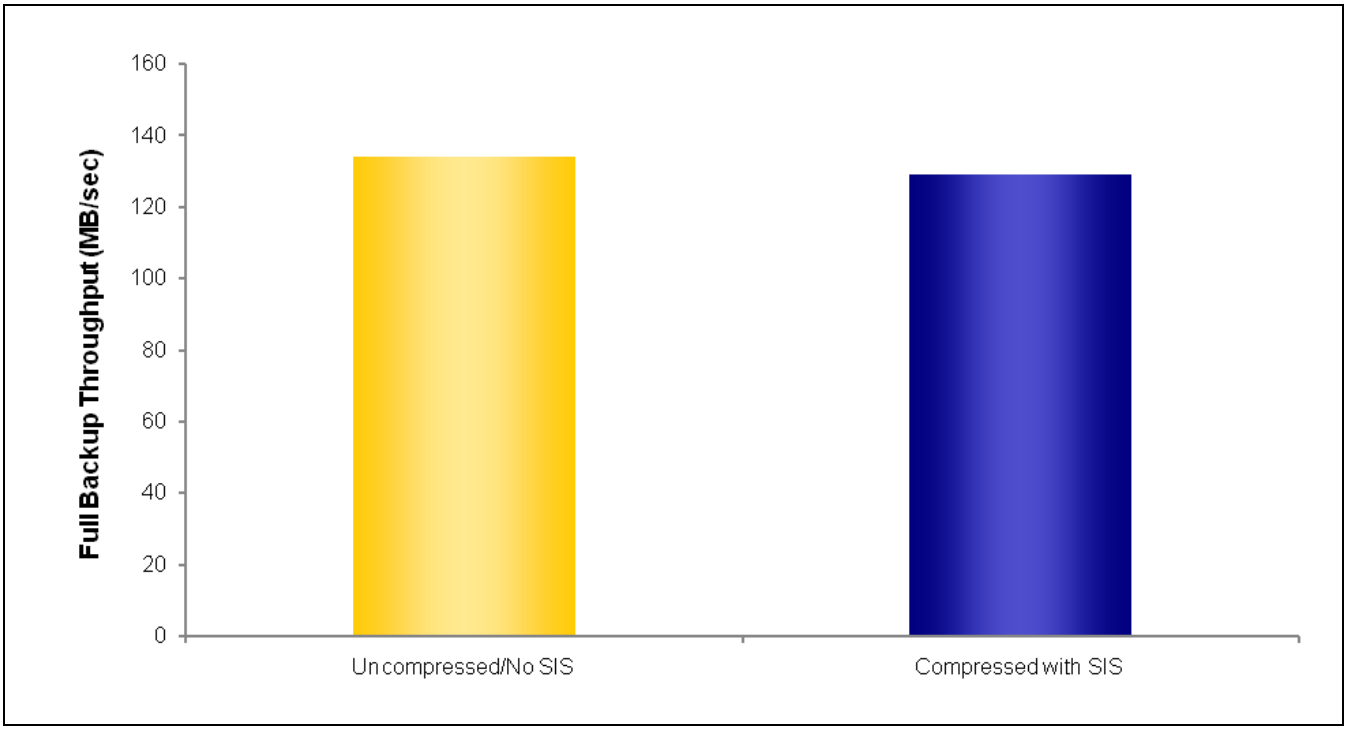
The results are shown in Figure 11, with capacity savings measured for the first four backup jobs shown in a solid line. The projected (dotted line) reduction rate for twenty backups retained on the DL2000 over thirty days is approximately 97%.

FIGURE 11. COMMVAULT SIS DEDUPLICATION SAVINGS



ESG Lab ran backups of the same data sets, this time uncompressed and without using file deduplication. Figure 12 shows a comparison of the system's performance in both modes. Backups running with file deduplication and compression enabled ran at a sustained 129 GB/hour while the same data sets, backed up uncompressed with file deduplication disabled, ran at 134 GB/hour—a difference of 3.8%.

FIGURE 12. POWERVAULT DL2000 PERFORMANCE COMPARISON



What the Numbers Mean

- The total amount of data that CommVault software would have sent to disk over the course of thirty days without using file deduplication and synthetic full backups was calculated to be 613 GB.
- CommVault Simpana file deduplication reduced the disk capacity from 613 GB to only 21 GB.
- The amount of capacity reduction that can be achieved with the DL2000 and CommVault Simpana will vary according to the backup policy in effect, the number of backups retained on disk, and the quantity of file data being stored. In this scenario, capacity was reduced by 97%.
- The DL2000 showed negligible impact when running file deduplication and compression enabled, with a difference of less than 4%.

Why This Matters

ESG research indicates that cost is the leading obstacle to disk-based backup deployment.[5] Data deduplication changes the economics of backup to disk by reducing the amount of data retained. ESG Lab testing confirmed that CommVault Simpana file deduplication was able to reduce disk capacity for user file backups by 85% after just one full and three incremental backups.

ESG Lab is confident that for a backup policy in which data is retained for 30 days with a 1% daily change rate, the Dell PowerVault DL2000 Powered by CommVault can achieve data reduction rates of up to 97% for file-based data.

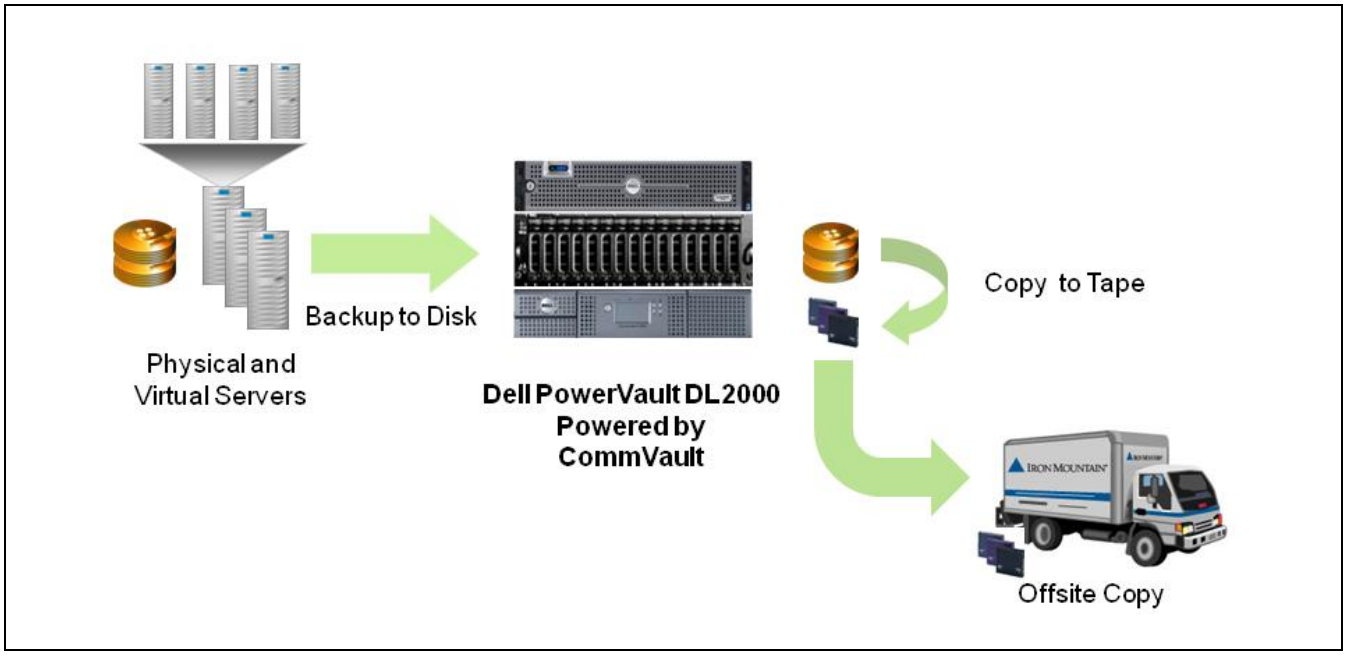
[5] Source: ESG Research Report, *Data Protection Market Trends,* 2008

Integration with Physical Tape

In most backup environments, physical tape is still used for long-term storage and offsite archiving. Backup to disk users need to export backups to physical tapes for archiving with the knowledge that they will be able to recover that data if necessary. With that need in mind, the Dell PowerVault DL2000 powered by CommVault is available integrated with a Dell PowerVault TL2000, TL4000, or ML6000 tape library.

The PowerVault DL2000 manages tape as an integral part of the backup infrastructure. Physical tapes created by the PowerVault DL2000 are managed natively by CommVault software. This allows administrators to restore tapes without conversion. It also means that in a disaster situation, the tapes can be restored directly by the backup application in an alternate location.

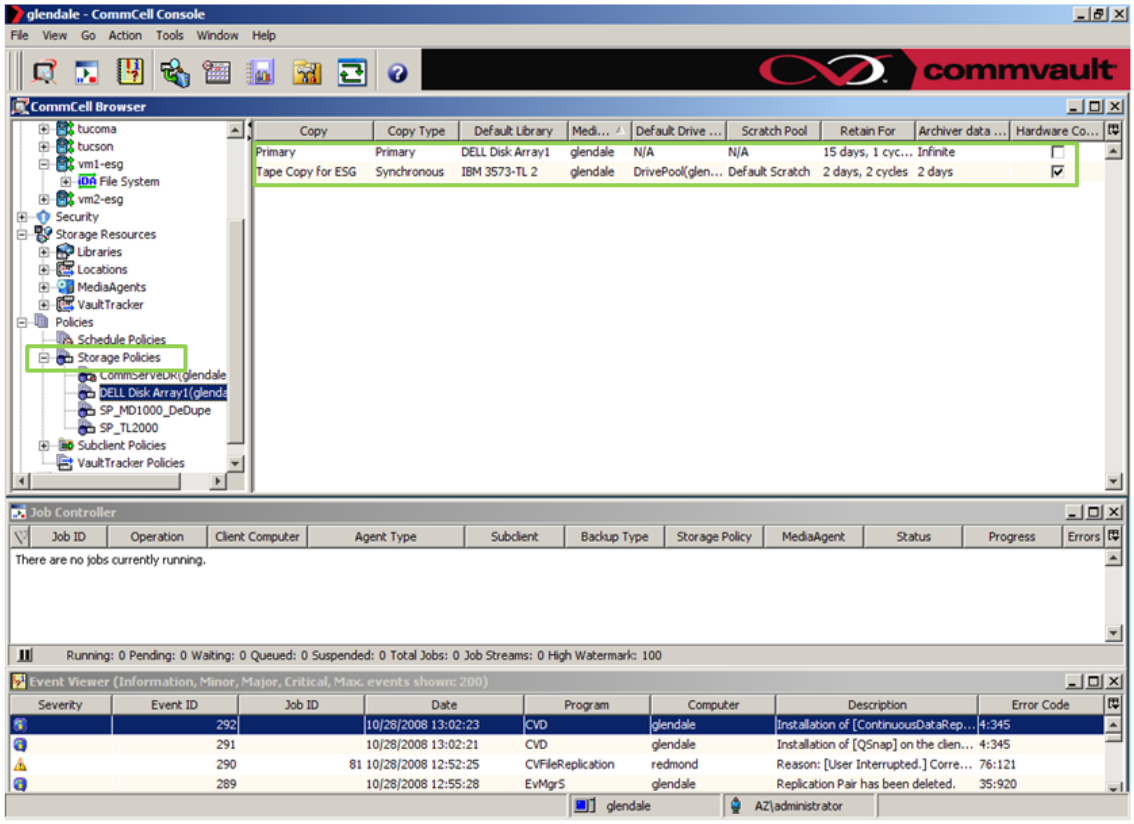
FIGURE 13. DISK TO DISK TO TAPE DATA PROTECTION



ESG Lab Testing

ESG Lab first looked at tape creation procedures. Figure 14 shows an example of disk to tape configuration in operation. First, a retention policy was created to automatically move backups from disk to tape after 15 days and then a policy was created to make second tape copy after 2 days for offsite use.

FIGURE 14. DATA RETENTION POLICIES



ESG Lab next used the Auxiliary Copy function to manually create a tape copy of an existing disk backup of a Microsoft file server. Once the copy was complete, the backup set was browsed from the tape and individual files were selected and restored to an alternate location. ESG Lab then verified the validity of the files by performing a 'compare' and determined that the restored files were identical to the original source files.

Why This Matters

ESG research shows that 87% of organizations integrating disk-based systems into their backup strategy still incorporate physical tape in their backup policies.[6] Tape copies are made for offsite DR, archival, and compliance requirements. A disk-based backup solution's integration with physical tape enables IT managers to meet these requirements as they move an increasing amount of operational backup and restore operations onto disk-based systems.

ESG Lab validated that the Dell PowerVault DL2000 Powered by CommVault integrates tape seamlessly using Simpana's built-in media management functions. ESG Lab controlled the process using the Simpana GUI, which provided fully independent control of disk and tape tiers. This allowed different expiration policies for the same data in different locations, all under the same single point of management. These capabilities provide offsite and archive capability to small and medium-size enterprises at low cost and minimal management overhead.

[6] Source: ESG Research Report, *Data Protection Market Trends,* 2008

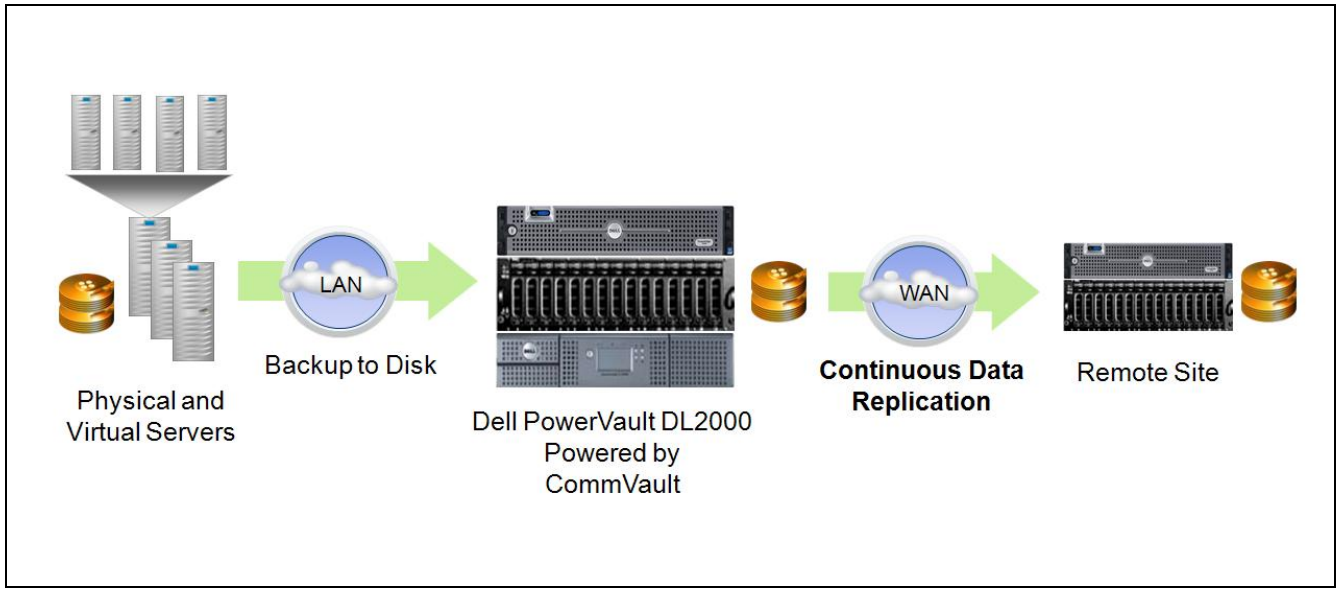
Remote/Branch Office Protection

Remote and branch offices (ROBOs) house a large portion of enterprise data, yet most still rely upon tape-based backup methods managed by non-IT staff. Non-IT staff performing backups and handling tapes increases both the risk of data loss and the cost of data protection, while backups, snapshots, staging, and archiving all significantly increase the amount of storage under management.

In a distributed environment typical of small to medium-size enterprises, limited network capacity makes it impractical to centralize backup operations with traditional backup architectures over the WAN. Moving even daily incremental backup data sets across the WAN requires so much bandwidth and time that even this simple process can quickly become prohibitively expensive and inefficient.

The Dell PowerVault DL2000 Powered by CommVault addresses these issues using the Continuous Data Replicator agent (CDR) to protect critical applications by moving data across the WAN as it is written to the local DL2000 Appliance as seen in Figure 15.

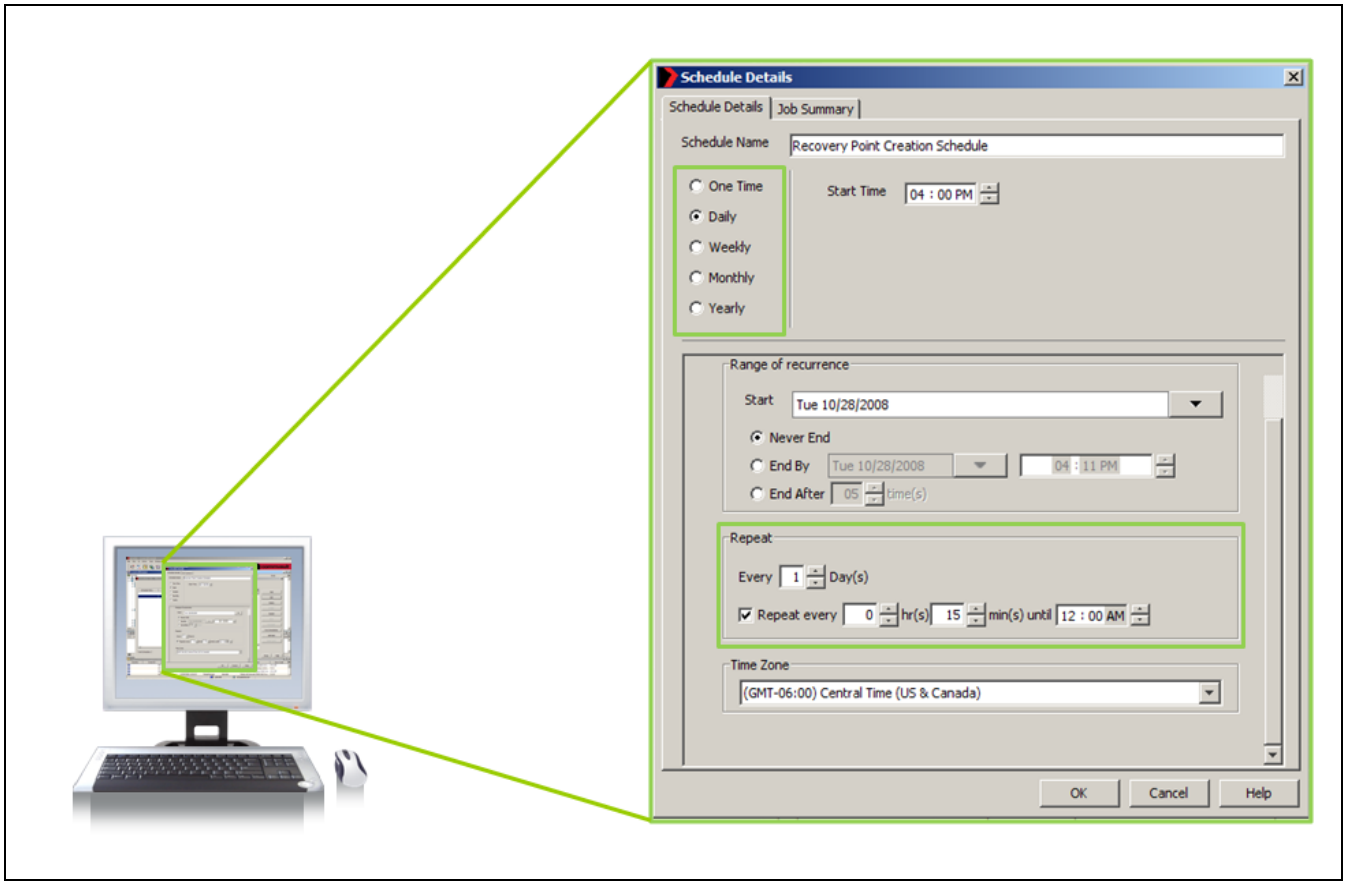
FIGURE 15. CONTINUOUS DATA REPLICATION



ESG Lab Testing

A remote office was simulated locally to test the CommVault CDR agent with the DL2000 appliance. A second DL2000 was configured as the remote replication target and a 100 Mbps LAN connection linked the two systems together. In this test, ESG Lab used continuous data replication (CDR) to protect a virtualized Microsoft Windows file server running under VMware ESX. As seen in Figure 16, ESG Lab set a daily replication schedule to send all changes across the link to the remote system and create a restorable snapshot every 15 minutes.

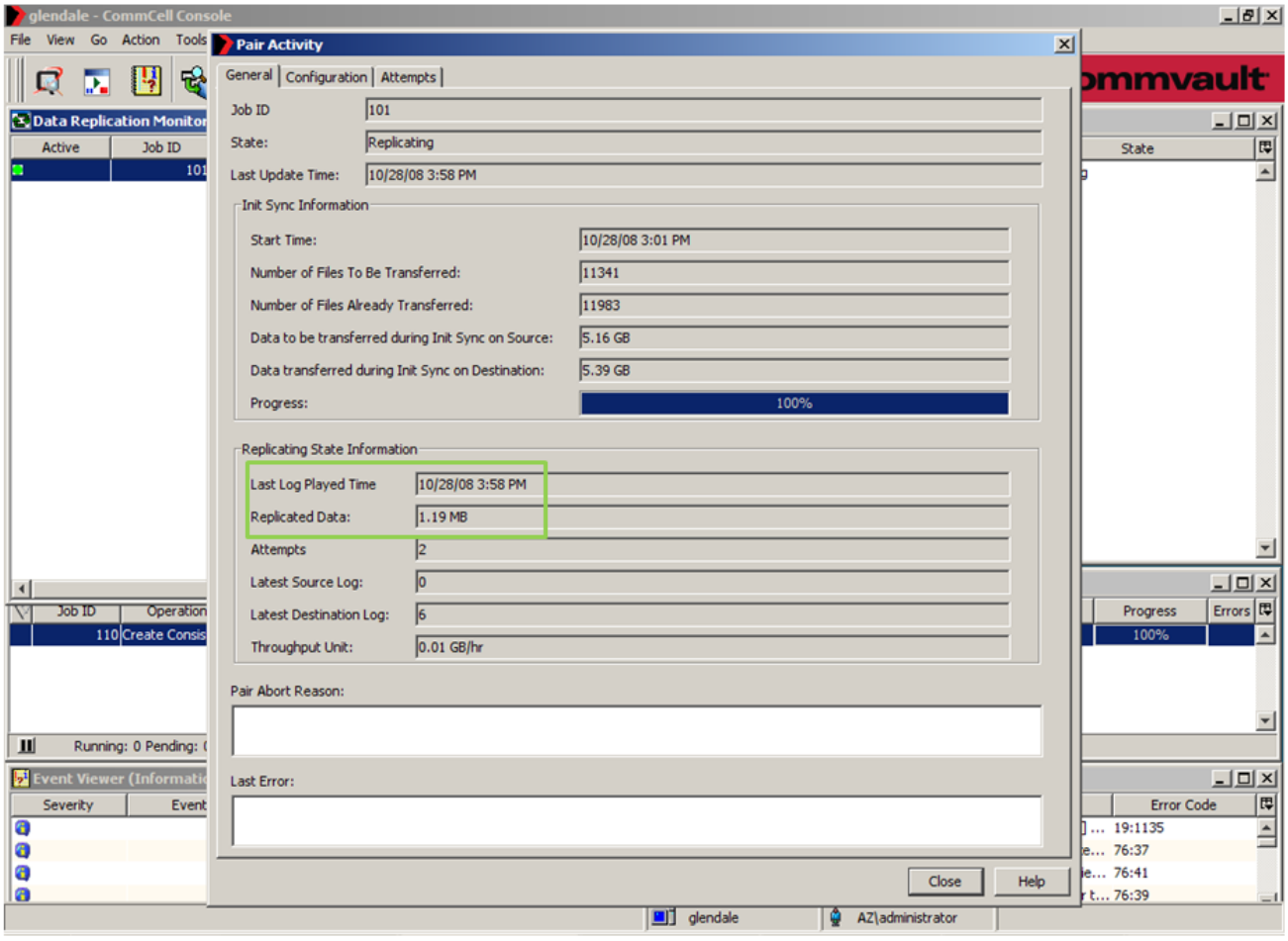
FIGURE 16. SCHEDULING REPLICATION



ESG Lab next kicked off the initial data synchronization to make the first baseline copy of the file system on the target appliance. For larger datasets, CommVault Simpana supports making the baseline copy to tape to minimize the amount of data required sent across the WAN for the initial sync.

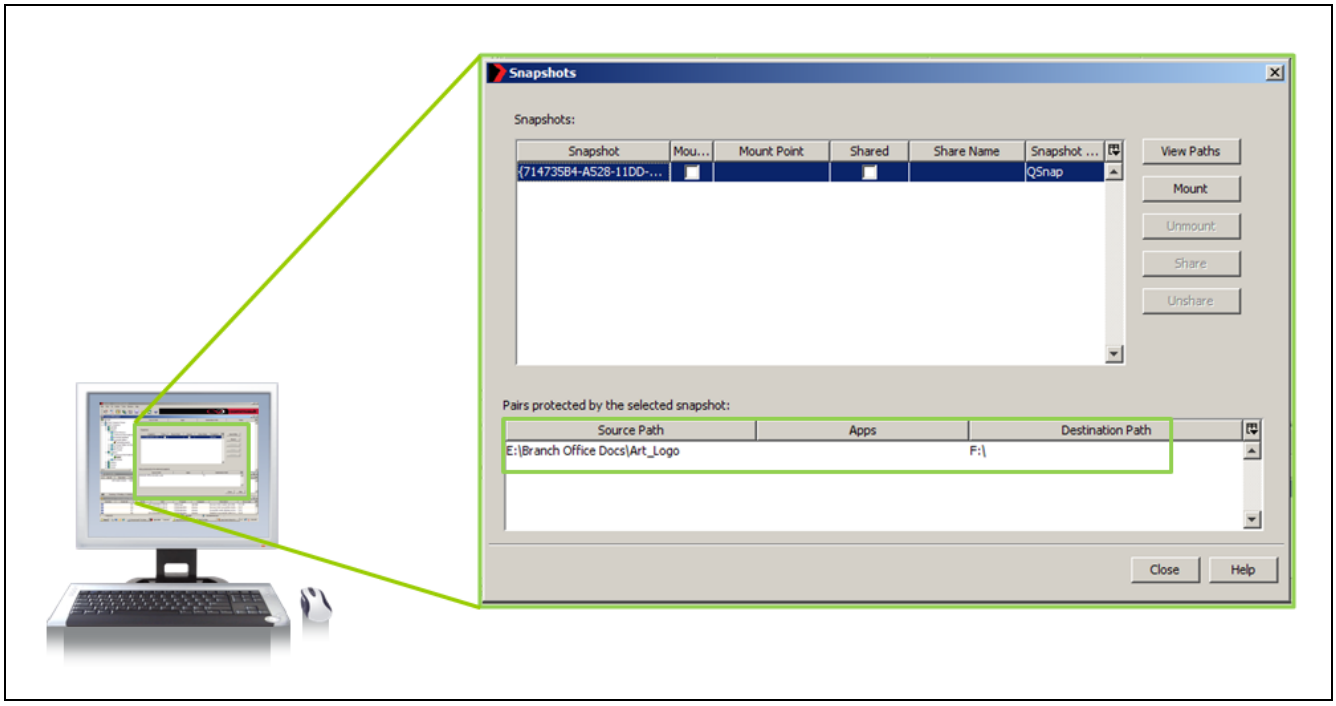
Once the initial sync completed, ESG Lab copied a 1 MB presentation file to a shared folder on the file server. Figure 17 shows the CommVault Simpana Pair Activity screen after the initial synchronization and the first snapshot completed.

FIGURE 17. PAIR ACTIVITY SCREEN



Once the snapshot on the remote side was verified, as seen in Figure 18, ESG Lab deleted the presentation file copied in the last step.

FIGURE 18. RESTORING FROM A SNAPSHOT



Finally, the file was restored from the snapshot stored at the remote site. Once the file was restored, ESG Lab validated the contents by visual inspection; the restored file was identical to the backed up file in every way.

Why This Matters

Much of the information critical to the success and efficiency of an organization resides in remote and branch offices. For example, ESG research found that 61% of remote and branch offices house e-mail servers and data requiring protection.[7] Protecting remote offices using traditional backup methods is often costly and risky, especially when performed by non-technical local staff. Replicating data over a WAN instead of shipping tapes reduces the risk of human error, but can be cost prohibitive because of the significant amount of data that needs to be transferred across the network.

ESG Lab has confirmed that the Dell PowerVault DL2000 Powered by CommVault can use Continuous Data Replication to protect critical servers and applications while significantly reducing the amount of data sent over the WAN—enabling fast, continuous protection. Protection is centrally managed using the CommVault Simpana GUI and can be used to protect targeted individual folders or entire systems continuously with user-definable consistency points.

[7] Source: ESG Research Report, *Branch Office Optimization,* January, 2007

ESG Lab Validation Highlights

- ☑ The PowerVault DL2000 was shipped factory-installed with Microsoft Windows 2008 and CommVault Simpana software.
- ☑ Twenty minutes after starting the configuration process, ESG was performing backup operations to the PowerVault DL2000.
- ☑ ESG was able to search and recover individual files, e-mail messages, and database objects using the intuitive wizard-driven user interface.
- ☑ CommVault SIS data deduplication achieved a reduction rate of 85% after just four backups as measured by ESG Lab. Up to 97% reduction for file-based data was projected for data retained for just 30 days.
- ☑ CommVault enables the ability to browse virtual machines' backup sets and restore them to the source virtual machines as if the backups were created locally, eliminating the burden of manually tracking the location of backup sets as they relate to specific virtual machines.
- ☑ Long term data protection, archival, and recovery was easily accomplished via simple integration with Dell's PowerVault TL2000 tape library.
- ☑ Continuous data replication was able to protect a live file server using minimal bandwidth. Restores were fast and intuitive.

Issues to Consider

- ☑ Automatic storage provisioning is only supported with the factory installed and add-on MD1000 disk shelves populated with factory SATA drives. If a user wants to provision any other storage for use with the DL2000, it must be done manually.
- ☑ While the installation process will enable the software to provide basic functionality, there are some common custom configurations that should be enabled. For example, the DL2000's Windows 2008 firewall must be disabled and File and Print Services should be enabled on the management network interface for web-based remote CommCell console access.
- ☑ CommVault SIS deduplication is an advanced storage feature for the DL2000 appliance that must be licensed for the Media Agent and configured on the CommCell Console.
- ☑ By default, each backup cycle (full plus any dependent incremental backups) is retained for 15 days on disk. By enabling "managed data," users can increase disk retention and keep their data on disk longer. If free disk space falls below the minimum, data eligible for pruning will automatically be erased (oldest first) by CommVault.

ESG Lab's View

Organizations are struggling to keep up with the challenges associated with protecting growing volumes of digital information. Faced with a number of seemingly unrelated challenges, disparate software and processes are often deployed to meet growing backup, archive, disaster recovery, and search challenges. This can result in a maze of solutions, requiring separate GUI consoles, training, licenses, and maintenance. Adding to the potential complexity is the growing use of disk-based solutions for faster backup, restore and discovery operations.

The Dell DL2000 Powered by CommVault is a customer-installable, fully integrated appliance that offers reliable data protection to meet all of an organization's data protection challenges. Combining Dell hardware with a pre-installed suite of CommVault software with a single management interface, the Dell PowerVault DL2000 Powered by CommVault combines data protection and single step granular recovery with data deduplication and continuous data replication to create a single solution that redefines the way companies can store, manage, and recover their mission critical data.

ESG Lab testing has confirmed that the Dell PowerVault DL2000 Powered by CommVault can be deployed, configured, and performing backups in less than twenty minutes. Single step granular recovery and simple search capabilities were used to find and recover individual files and application-specific objects (e.g., an Exchange mailbox), including items located on virtual servers. The capacity savings of CommVault SIS deduplication were used to change the economics of data protection—making backups more cost-effective as more data is stored for longer periods of time on fast and reliable built-in disk. Continuous data replication was used to demonstrate cost-effective, tape-less recovery of data at a simulated remote site.

Considering the hefty financial commitment required to modify, upgrade, or replace most backup environments, users now have an affordable, customer-installable disk-based backup appliance to turn to. Leveraging the reliability of affordable hardware from Dell and a fully integrated suite of software services from CommVault including disk-based backup and recovery, space-saving data deduplication and cost-efficient remote replication, ESG Lab believes that the Dell PowerVault DL2000 Powered by CommVault is ideally suited to meet the challenges of small to medium-size enterprises looking to eliminate costly downtime as they optimize the protection of precious digital assets.

Appendix

TABLE 1. TEST CONFIGURATION

Hardware	Software
Dell PowerVault DL2000	
Dell PowerVault DL2000 • Server – DL2000 • 2 X Quad Core Intel Xeon E5410 CPUs 2.33GHz • 16 GB RAM • Storage – MD1000 • 8 – 500 GB SATA drives • 3 TB usable capacity OS – Windows 2008 Standard Edition	CommVault Simpana Version: 7.0 (SP-4A)
Dell TL2000 One LTO-4 tape drive	
Application Servers	
Physical Servers – PE2950 - 2 X Dual Core Intel Xeon E5205 CPUs 1.86GHz - 16 GB RAM OS - Windows 2003	• Microsoft Exchange • Active Directory/DNS • File Services • Red Hat Linux • Windows 2003 64-bit 25 GB dataset (deduplication) • Windows 2003 - Branch Office 5 GB dataset
Virtual Infrastructure Server – PE2950 - 2 X Dual Core Intel Xeon E5205 CPUs 1.86GHz - 16 GB RAM OS – VMware ESX Server 3.0	Virtual Machines: SharePoint (MOSS) Windows File Services OS – Windows 2003 Standard Edition

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