



ESG Lab Validation Report TM



ProtectTIER Data Protection Platform

A validation study
by
ESG Lab
July 2006

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ESG Validation Reports

The goal of the ESG Lab Validation reports is to educate customers about specific storage-related products including storage systems, backup-to-disk solutions, storage management applications, backup/recovery software, storage virtualization platforms, etc. The ESG Lab reports are not meant to replace the necessary evaluation process that end user customers should conduct. The ESG Lab reports are designed to provide insight to what is compelling about various products and how they can solve customer problems. ESG Lab reports also recommend areas we feel the vendor should improve upon. ESG Lab provides third-party expert perspective based on our own hands-on testing in a lab and interviews with customers using these products in production environments.

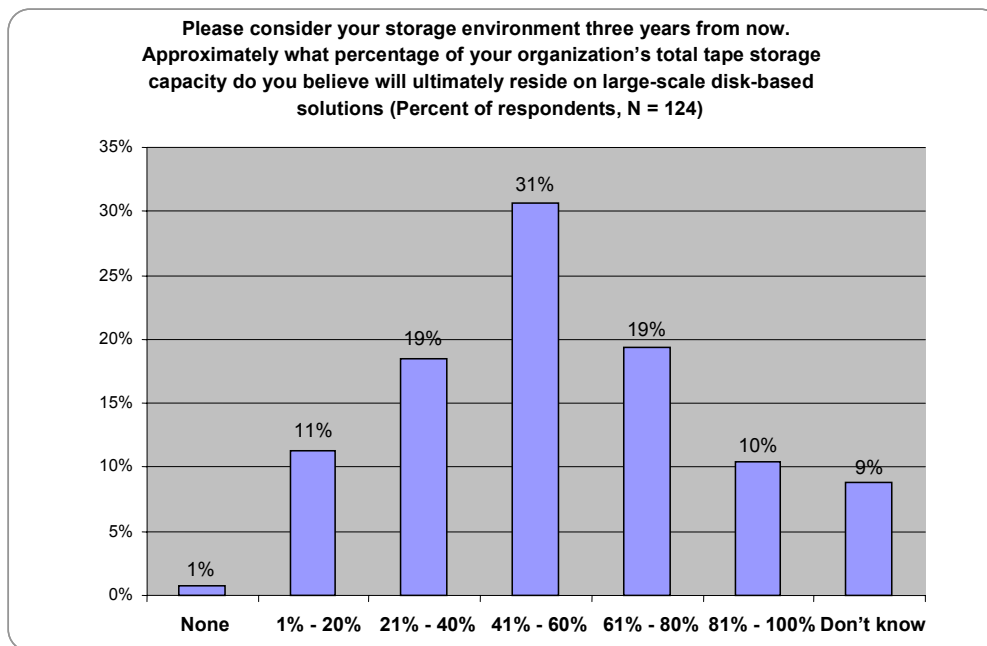
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Introduction

In the last 12 months, Virtual Tape Library (VTL) technology has shed its “emerging technology” status and moved into the “maturing” product category. Having proven itself as a viable alternative to tape for both backup and, importantly, recovery, VTL technology has relegated tape to the important but tertiary role of long-term and off-site archival.

Several factors have contributed to VTL’s early success in the market: its ease of use (it slips easily into existing backup environments, requiring few changes to existing policies and processes and, importantly, preserving end-user investments in backup software), its effect on backup performance (enabling organizations to meet backup window objectives), and, lastly, but perhaps most importantly, its ability to provide both fast and granular data recovery.

Figure One: Percent of Tape Capacity Moving to Disk



From an adoption standpoint, ESG Research¹ indicates that the industry is seeing wide deployment of VTL especially among enterprise-class users (see Figure One). The rate of adoption is expected to accelerate over the coming months as more VTL products come to market and technologies such as data de-duplication, replication and content searching become more widespread. ESG believes these types of technologies will make VTL increasingly attractive from a cost-savings, usability and scalability viewpoint. In particular, we expect data de-duplication technology to really drive VTL adoption going forward because of the potentially huge cost-savings benefits it produces.

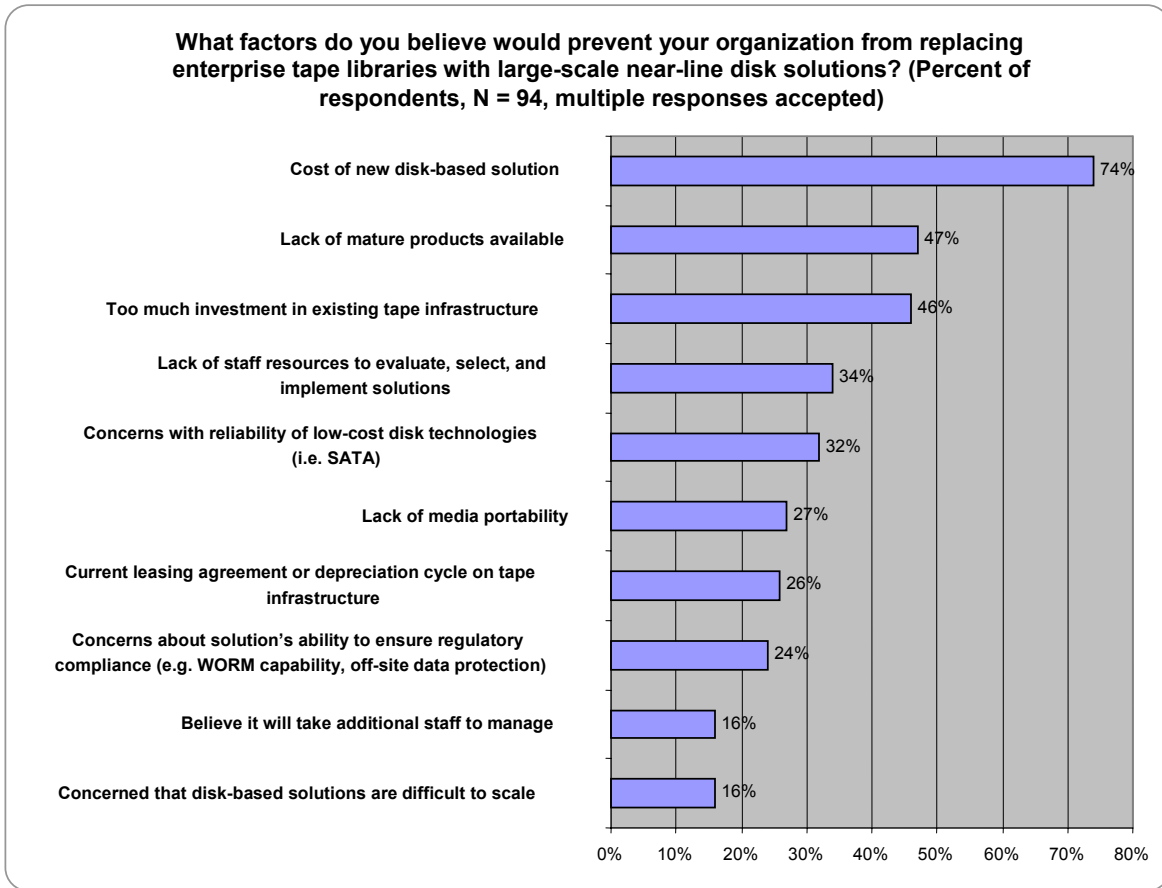
Data De-Duplication

By definition, data de-duplication ensures that only “unique” data is written during the backup process, which means that significantly less disk capacity is needed on the back-end to store changes. The reduction in capacity depends on several factors, including the type of data being backed up (compressed files contain less duplicate data than e-mails) the change rate, or the rate at which data is changing (the slower the change rate, the more duplicates are created), and the backup and retention policies (the more frequently the data is backed up, and the longer it is retained, the greater the amount of duplicate data).

¹ ESG Research, Tape Replacement Realities, March 2005

The less disk capacity needed, the lower the overall cost of the VTL solution (in some cases, reducing the cost of the overall solution to less than that of comparably configured tape library solution); the lower the cost, the greater the adoption potential, according to ESG Research. As Figure Two shows, when survey respondents were asked what would keep them from replacing their enterprise-class tape libraries with large-scale near-line disk products, which includes VTL, 74% said the cost of the solution was the main factor.

Figure Two: Factors Preventing Backup to Disk Adoption



ESG believes that data de-duplication addresses the cost issue cited in our research that prevents customers from implementing disk-based backup solutions such as VTL. Diligent Technologies addresses this cost issue head-on with its flagship solution, ProtecTIER. ProtecTIER is an enterprise class VTL solution that supports data de-duplication technology. Together with Hitachi Data Systems, which resells Diligent's ProtecTIER product (and bundles it with their own disk and replication software), Diligent has delivered a cost effective and comprehensive solution that can scale in performance and capacity to meet the demanding requirements of the enterprise data center.

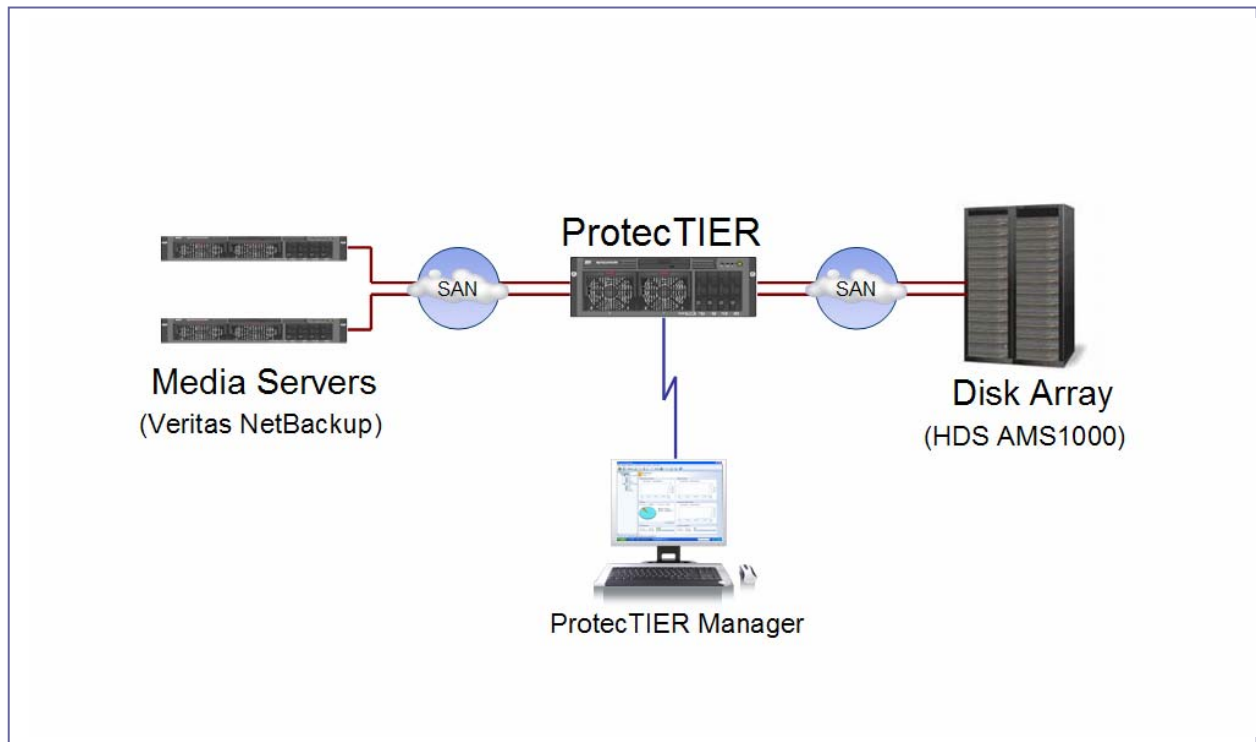
By dramatically reducing secondary disk capacity requirements, ProtecTIER enables organizations to extend retention policies (i.e., keep data on-line on disk longer than they would have if their data weren't "de-duped"). Additionally, because the amount of data to be stored on any given day is reduced to a small fraction of the original load, ProtecTIER, in conjunction with replication solutions such as HDS TrueCopy, allows for the economical electronic transfer of backup data off-site for disaster-recovery purposes.

ESG Lab validation of Diligent ProtecTIER was designed to determine whether the solution can be used to dramatically reduce backup to disk capacity using fast and scalable data de-duplication technology. Ease of use and compatibility with existing backup software and procedures was also examined.

ESG Lab Validation

ESG Lab validation was performed at Hitachi Data Systems headquarters in Santa Clara, California. Backup and restore testing was performed using Veritas NetBackup software running on a pair of media servers as shown in Figure Three and documented in the Appendix. The latest version of ProtecTIER software (v1.2) was run on a powerful quad Opteron server connected to a rack full of modular Fibre Channel (FC) attached storage from HDS. The HDS AMS1000 disk controller was configured with over a hundred FC hard drives spinning at 10,000 RPM². The ProtecTIER appliance was connected to media servers using four FC connections and to the storage system using two FC connections. ProtecTIER Manager was used to configure and manage the archive from a web browser.

Figure Three: The ESG Lab Test Configuration



² A large number of drives (110) were tested to eliminate back end disk as a potential bottleneck while analyzing the performance and scalability of the ProtecTIER appliance and software.

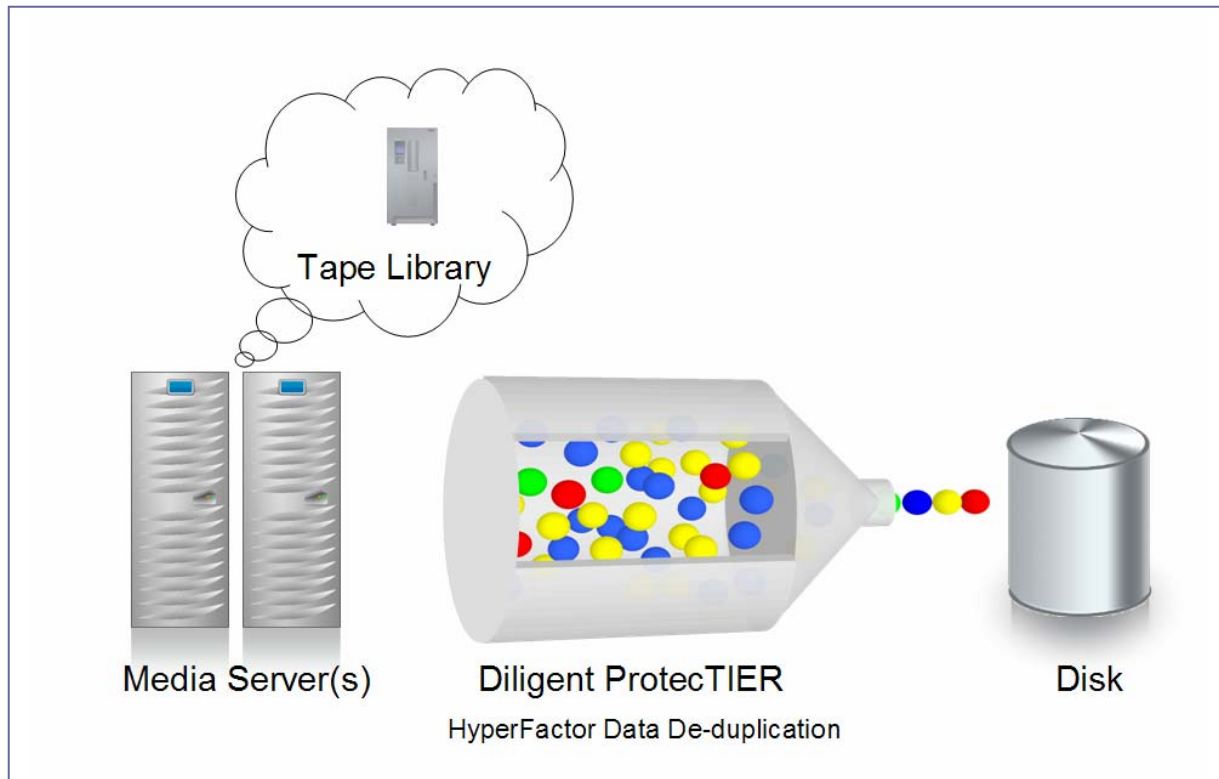
HyperFactor Data De-duplication

Data de-duplication is powerful new technology that is known by a variety of names in the industry. Diligent’s proprietary method of de-duplication, which is at the core of the ProtecTIER platform, is called “HyperFactor.” The concept of data de-duplication is simple - when multiple copies of the same data are sent to a system, the system finds the redundancy and stores only one copy of the data, while maintaining an index to keep track of all data within the system. The motivation for data de-duplication is also simple - storing fewer copies of the same data can significantly reduce disk capacity.

To better understand data de-duplication technology, consider the example of a PowerPoint presentation attached to an e-mail. If the e-mail is sent to multiple recipients and then forwarded to yet another set of recipients, data de-duplication technology can be used to store the presentation only once. This is an example of data de-duplication technology at work at the file level. Next, consider what happens when one of the e-mail recipients modifies a slide in the presentation and again forwards it to a group of colleagues. Advanced data de-duplication algorithms, like that used within ProtecTIER, can be used to store only the data associated with the changed slide.

Figure Four depicts what happens inside a ProtecTIER appliance during a backup. Backup software running on the media server on the left side of the diagram is being sent to the ProtecTIER appliance from a media server over a Fibre Channel interface. The backup software believes it is working with a physical tape library. ProtecTIER software analyzes the backup data, looking for similar data patterns that have previously been backed up to disk. ProtecTIER eliminates duplicate data before it is stored on disk.

Figure Four: ProtecTIER HyperFactor Data De-duplication



ESG Lab Testing

ESG Lab performed a series of tests to validate the data de-duplication capabilities of ProtecTIER. A 120 GB data set composed of Oracle, Exchange and unstructured file data, including a collection of MP3 files, was used during this stage of testing. A full backup policy was created and executed manually three times using Veritas NetBackup. The data set was divided into 20 chunks so that multiple backup jobs could be run in parallel. The amount of disk capacity backed up and consumed due to data de-duplication was observed using the ProtecTIER GUI after each backup job had completed. Daily changes were emulated by a utility that randomly changed 3% of the 120 GB data set after each set of backup jobs had completed.

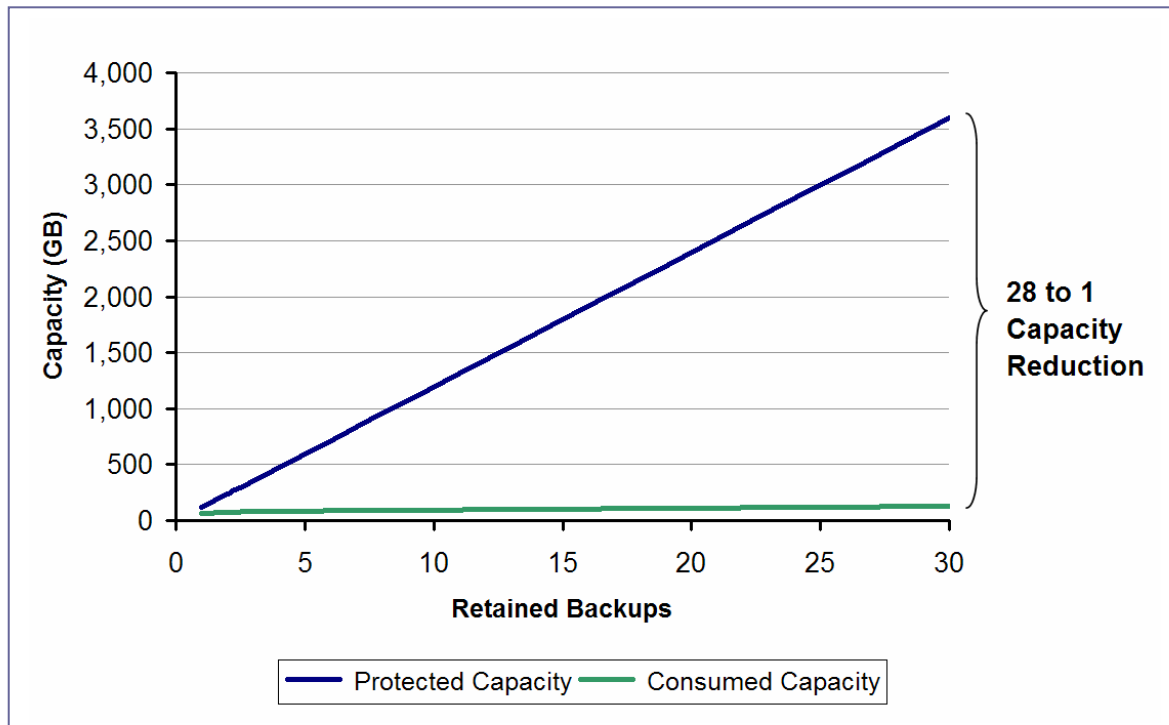
Table One: Data De-duplication Results

Backup Iteration	Capacity Backed Up	Capacity Consumed	De-duplication Ratio
First	120 GB	69 GB	2 to 1
Second	240 GB	78 GB	3 to 1
Third	360 GB	83 GB	4 to 1
Thirtieth ³	3,600 GB	128 GB	28 to 1

What the Numbers Mean

- The first full backup eliminated half the data stored on disk with a 2 to 1 de-duplication ratio.
- Eliminating half the data reduced archive disk capacity requirements by 50%.
- ESG Lab analysis indicates a data de-duplication rate of 28 to 1 would be achieved after 30 days.

Figure Five: Data De-Duplication Analysis



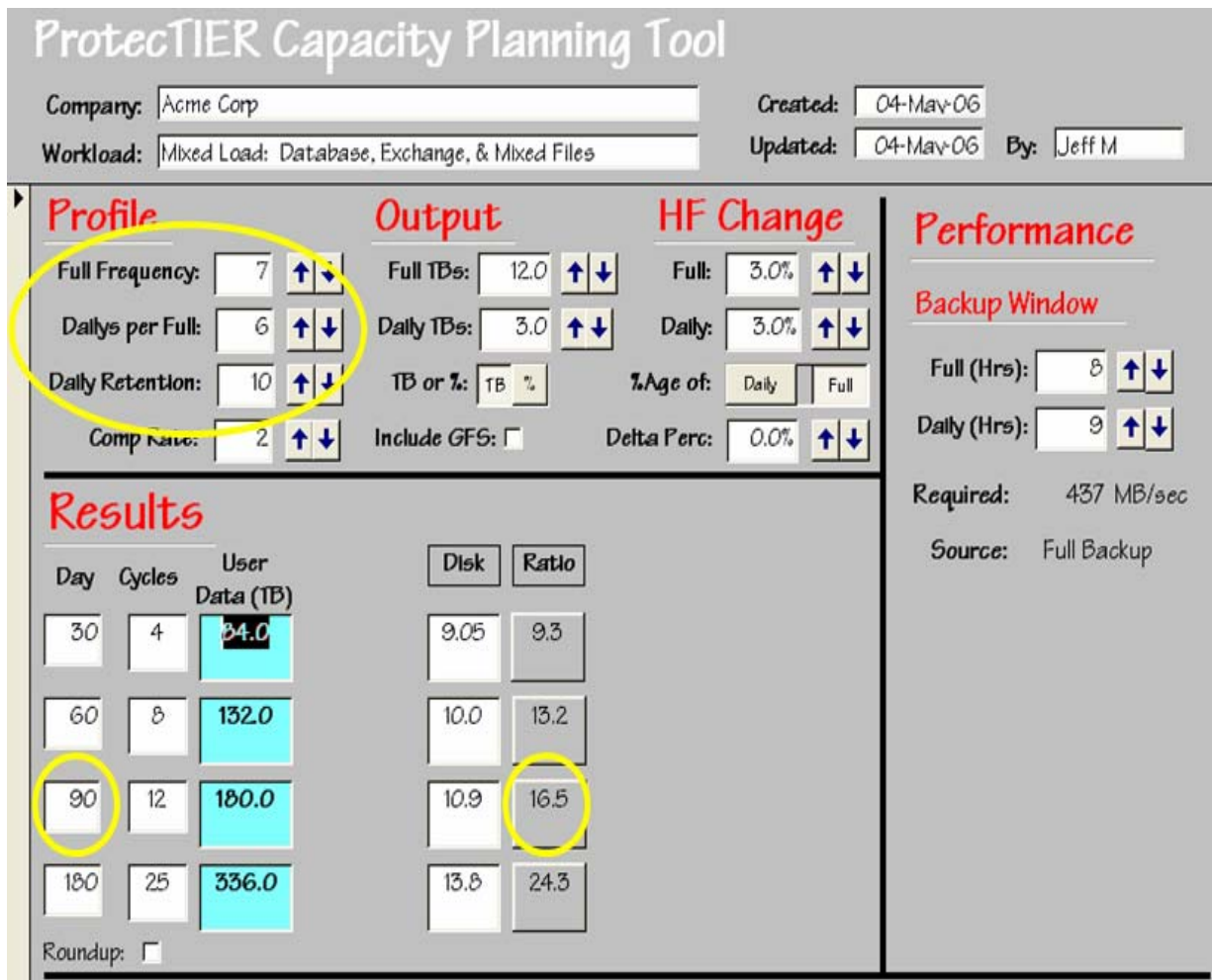
³ ESG projected conclusion based on actual analysis

The amount of disk capacity that can be saved using data de-duplication varies in production environments. Contributing factors include the rate at which data is changing, the data type being backed up and backup/retention policies. Consider, for example, the change rate. ESG Lab recently observed daily change rates as low as 0.1% for shared file systems, between 0.5% and 4% for a Microsoft Exchange e-mail server, and 5% for a file server used for daily engineering software compilations. A full backup of data that is changing at a slow rate has more duplicate data than a backup of data that is changing rapidly⁴.

The type of data being backed up also plays a key role. For example, compressed data types like MP3 files contain less duplicate data than e-mails. And finally, backup and retention policies play a key role. For example, a daily full backup policy with a 30 day retention policy as presented above will generate more duplicate data than a weekly full/daily incremental policy for the same 30 day retention period.

ESG Lab audited the ProtecTIER capacity planning tool which takes each of these factors into account. As shown in Figure Six, a daily full/weekly incremental backup schedule with the last ten incremental backups retained on disk and a 90 day retention policy for full backups will deliver a data de-duplication ratio of 16.5. Note that the tool also indicates that 180 TB of backup data will be generated over 90 days, yet only 10.9 TB of disk capacity will be consumed.

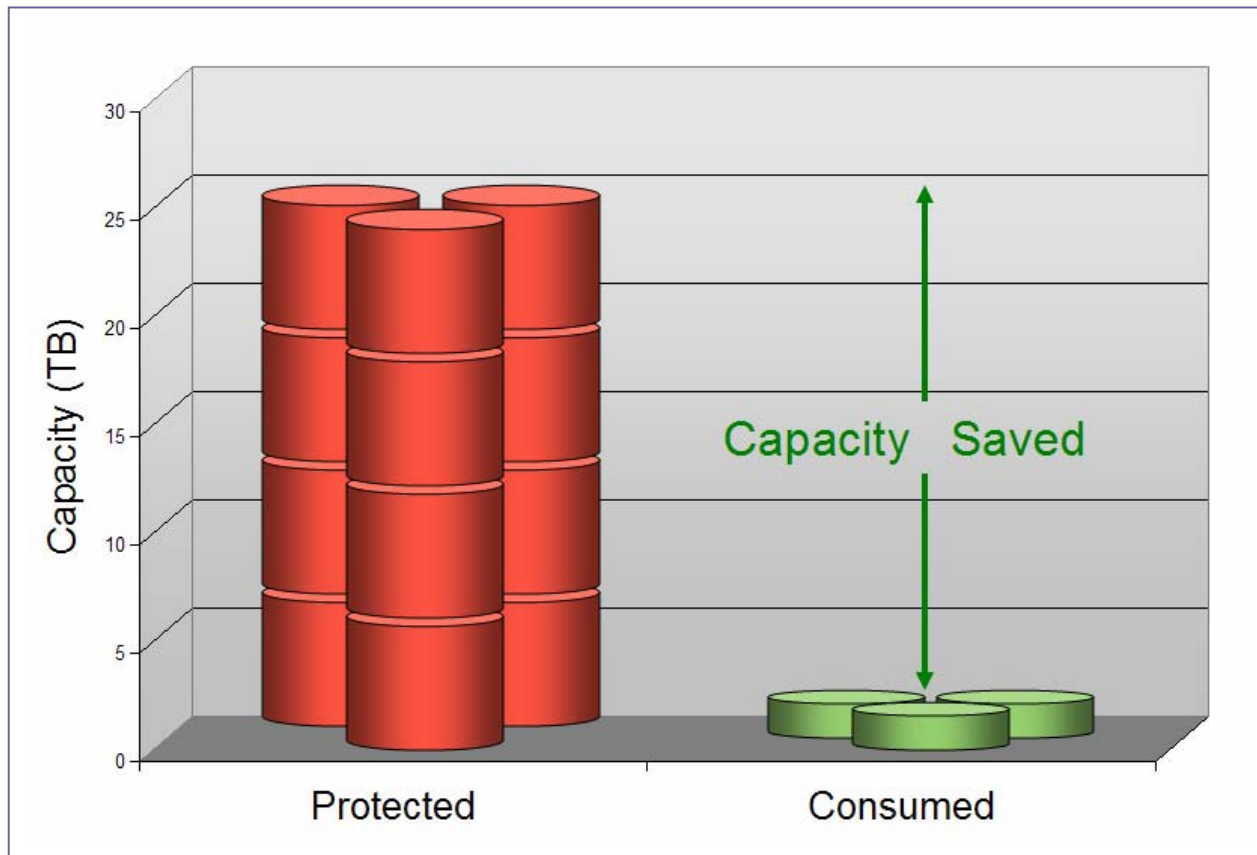
Figure Six: A Weekly Full/Daily Incremental Capacity Planning Example



⁴ Note that a conservative change rate of 3% was used during ESG Lab testing.

The bottom line with ProtecTIER data de-duplication technology is that a drastic reduction in the amount of capacity required to implement a disk-based backup archive can be achieved. Consider, for example, a 25 to 1 data de-duplication rate for a ProtecTIER customer who has retained 25 TB of backup data. In this example, the amount of protected capacity is 25 TB while the amount consumed on disk is only 1 TB.

Figure Seven: Data De-duplication Capacity Savings



Why This Matters

Rapid restores are essential so that IT departments can meet or exceed their service level agreements. Most restores occur when something urgent has happened such as a deleted or corrupted file. Recovery from disk is quicker and less cumbersome than restoring files from tape. Even though the cost of high capacity SATA disk arrays has made restores from disk possible in recent years, ESG research indicates that cost is still the number one barrier to adoption - seventy-four percent of respondents indicated that the cost of new disk-based solutions is preventing their organizations from replacing enterprise-class tape libraries with large-scale near-line disk solutions.

The economics of ProtecTIER data de-duplication (a.k.a. HyperFactor) technology drastically reduces the cost of disk capacity - in some cases making it more affordable than tape capacity. Customers can back up 25 TB of data using only 1 TB of disk capacity. Since customers can cost effectively store large amounts of data on disk using ProtecTIER, they can retain backup data longer. This results in lowering the cost per GB for backup data and enables companies to retain data longer for recovery purposes.

Performance

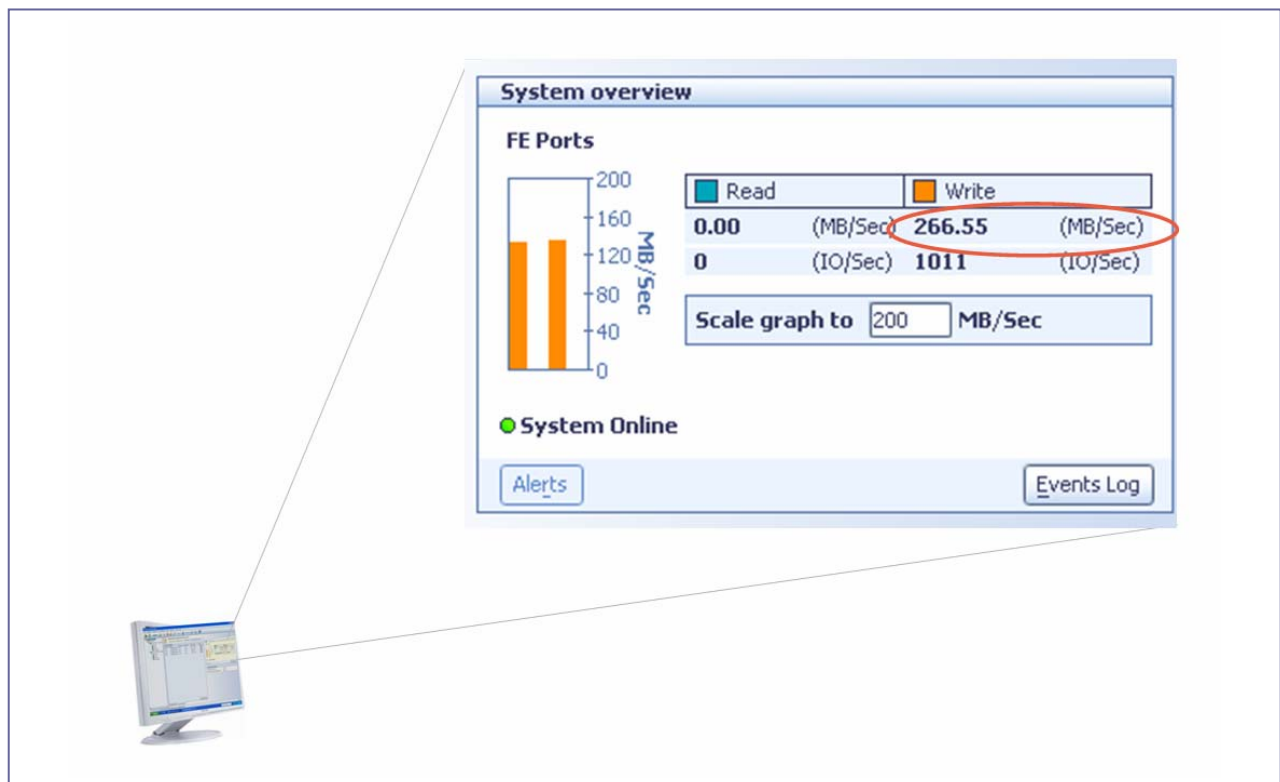
Traditional data de-duplication algorithms use a method called hashing to recognize duplicates. Hashing uses a mathematical algorithm to create a large number (20 digits or more). Duplicate data patterns are recognized by running a data stream through the algorithm and comparing the result to a list of previously calculated hash values. Instead of using hashing, ProtecTIER uses an advanced pattern matching and differencing algorithm to find and keep track of duplicates. In this section, ESG Lab validates Diligent's claim that the ProtecTIER data de-duplication method is faster than traditional hashing methods because it is less CPU- and memory-intensive.

ESG Lab Testing

ESG Lab recorded peak backup throughput rates as 20 backup streams were sent from two media servers through a ProtecTIER appliance over a pair of 2 Gbps FC interfaces to an HDS AMS1000 disk array⁵. 120 GB of Oracle, Exchange and unstructured file data was backed up using Veritas NetBackup.

The aggregate throughput rate was recorded, as shown in Figure Eight. Aggregate throughput rose as the backup jobs started and trailed off as each of the jobs ended. A peak backup rate of 250 MB/sec was recorded for the first and third set of full backup jobs. A peak rate of 266 MB/sec was observed during the second set of full backup jobs.

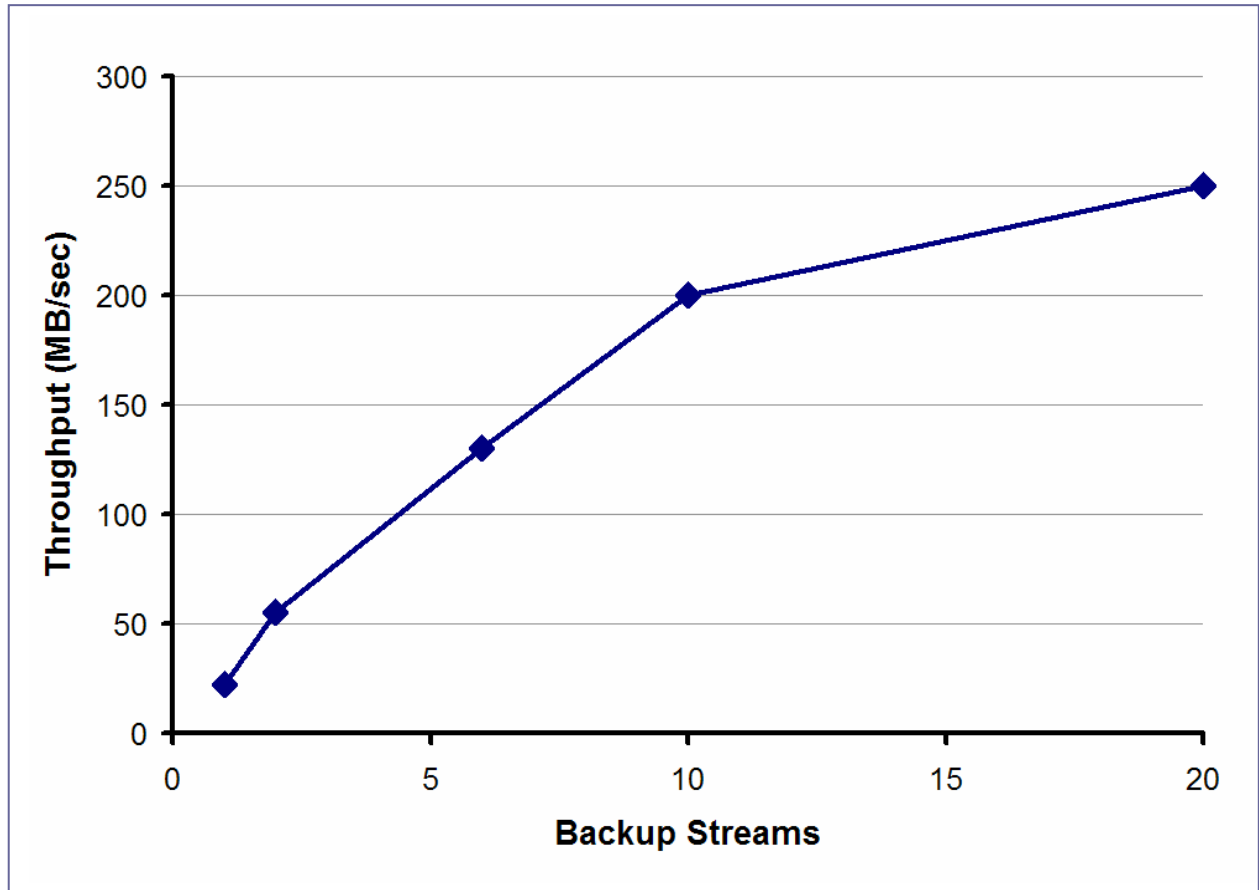
Figure Eight: Peak Multi-Stream Performance



Multi-stream performance scalability was analyzed by recording aggregate throughput rates as backup jobs ended during the third set of full backup jobs. A peak performance of 250 MB/sec was recorded when all 20 jobs were running in parallel. A throughput rate of 200 MB/sec was observed after half of the jobs had ended (10 jobs active). As jobs continued to end, the throughput rates were recorded, as shown in Figure Nine.

⁵ Complete configuration details are available in the Appendix.

Figure Nine: Multi-Stream Performance Scalability



Backup verification and a single file restore were also tested. The ProtectTIER GUI reported that a Veritas NetBackup verification job reached a peak internal read transfer rate of 370 MB/sec. A single file restore of an MP3 file took only 20 seconds to complete. These results indicate that ProtectTIER can not only perform backups while de-duplicating in real-time, but that restore performance is not impacted as the de-duplication algorithm is run in reverse.

Why This Matters

Backup administrators have been struggling for years to get nightly backups done before business resumes in the morning. Globalization and the increasing need for 24x7 application availability exacerbates the problem. As backup windows continue to shrink, IT managers are increasingly adopting backup to disk and virtual tape technologies to get nightly backups done quicker.

ESG Lab recorded an aggregate multi-stream backup throughput rate of 266 MB/sec. A throughput rate of 266 MB/sec means that a single ProtectTIER appliance has the horsepower needed to back up data at nearly 1 TB/hour (957 MB/sec) – even as duplicate data is being eliminated in real-time. Based on ESG Lab’s experience, this is an impressive throughput rate.

Scalability

ProtectTIER maintains an index in high speed memory for optimal performance during backups and restores. The index is used to keep track of duplicate data. In this section, ESG Lab validates Diligent's claim that the space efficiency of the memory resident index enables ProtectTIER to scale better than traditional hashing methods.

ESG Lab Testing

ESG Lab audited ProtectTIER index overhead during the validation. An index of approximately 300 KB was recorded after the first set of full backups of Oracle, Exchange and unstructured file data was completed. The amount of data backed up to that point was 120 GB and it consumed 68.5 GB of physical disk storage. ESG Lab used this data to compare the index overhead of ProtectTIER to that of a traditional de-duplication hashing algorithm for a theoretical customer.

Customer Profile

- ☑ 8 TB of Oracle, Exchange and unstructured data
- ☑ 30 TB disk-based near-line archive that supports data de-duplication
- ☑ 90 day retention period
- ☑ A data de-duplication rate of 25 to 1

ProtectTIER Index Overhead

- ☑ ESG observed a 300 KB index for 68.5 GB of physical storage.
- ☑ Analysis indicates that an index of 4.4 MB is needed for each TB of physical storage.
- ☑ Calculations indicate that a 115 MB index could be used to track 90 days of retained backup data.

Hashing Index Overhead

- ☑ To estimate index overhead, ESG Lab made two assumptions:
 - The size of the data chunk that each index entry tracks is 64 KB⁶
 - Each index is 32 Bytes in length to accommodate a hash value and addressing.
- ☑ Based on these conservative assumptions, a 360 GB (360,000 MB) index would be required.

What the Numbers Mean

- An index of 115 MB fits in the high speed memory of a single ProtectTIER appliance.
- The 360 GB hashing index is 3,130 times bigger and won't fit in high speed memory.

Why This Matters

Disk based backup systems are increasingly being deployed within the data center to improve backup performance and to provide quick and reliable restores. Large organizations which drove the initial adoption of disk-based backup technologies need systems that support massive amounts of cost effective capacity to store multiple versions of critical application data. A critical application with a Terabyte of information can require tens, or even hundreds, of Terabytes of near-line capacity.

Until now, systems that reduce the cost of near-line capacity using data de-duplication technology could not scale to meet the needs of large enterprises. Hash index overhead and lookup performance limited the amount of storage that can be contained in a single system. ESG Lab verified that ProtectTIER is thousands of times more efficient than other systems that use hash based indexing. Using a 4 GB memory resident index that supports up to 25,000 terabytes of usable storage in a single system, ProtectTIER provides the scalability needed to meet the needs of large enterprise-class deployments.

⁶ A smaller chunk size would eliminate more duplicates, but the index size would be bigger. For example, an 8 KB chunk size would create 8 times more index entries than the 64 KB index chosen for analysis.

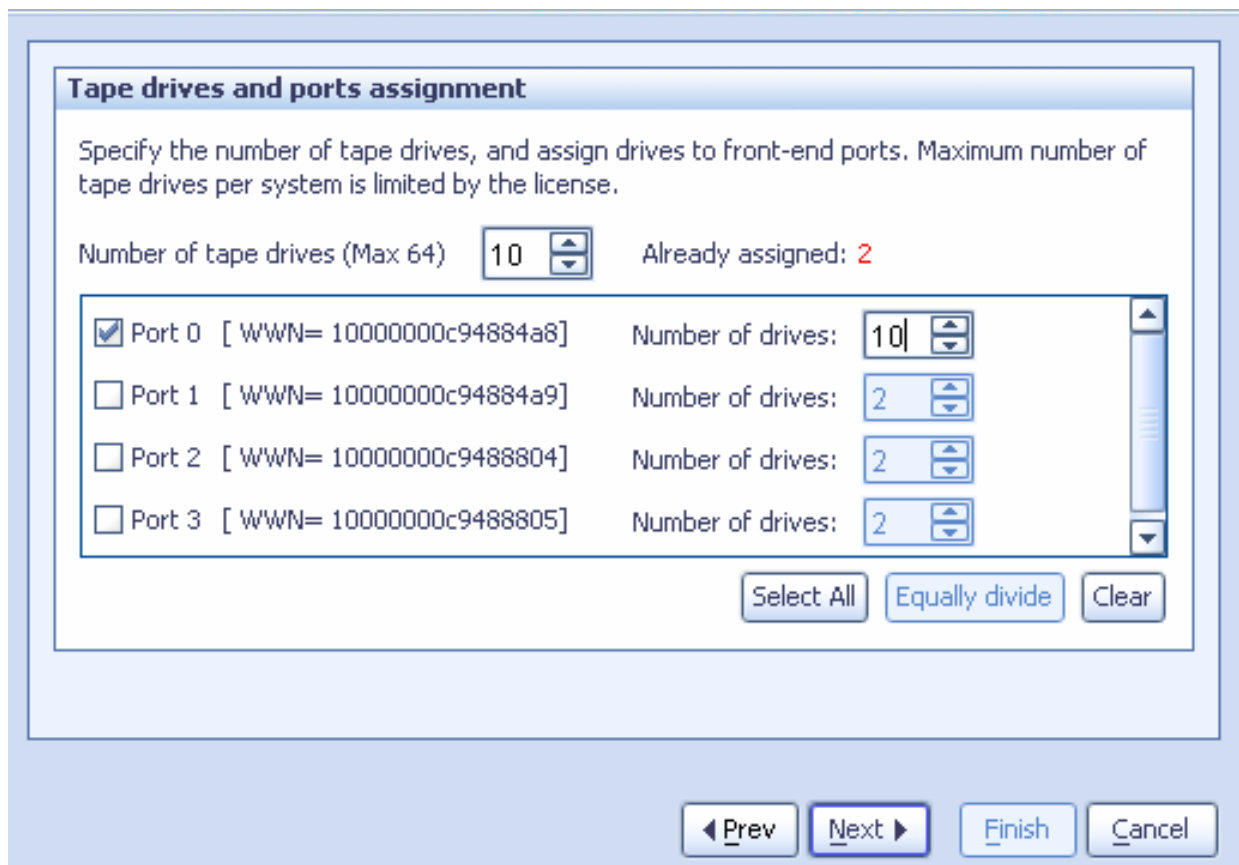
Ease of Use

A ProtecTIER appliance is a Virtual Tape Library (VTL) that appears to backup software as a physical tape library. Once configured, a VTL solution works with existing backup software and procedures.

ESG Lab Testing

ESG Lab configured a pre-wired ProtecTIER appliance and had backups running from Veritas NetBackup media software in just under 15 minutes. Ten virtual tape drives and 50 virtual tape cartridges were configured for testing. ESG Lab found that the wizard-driven configuration process and the ProtecTIER GUI are intuitively easy to use.

Figure Ten: Wizard Driven Configuration

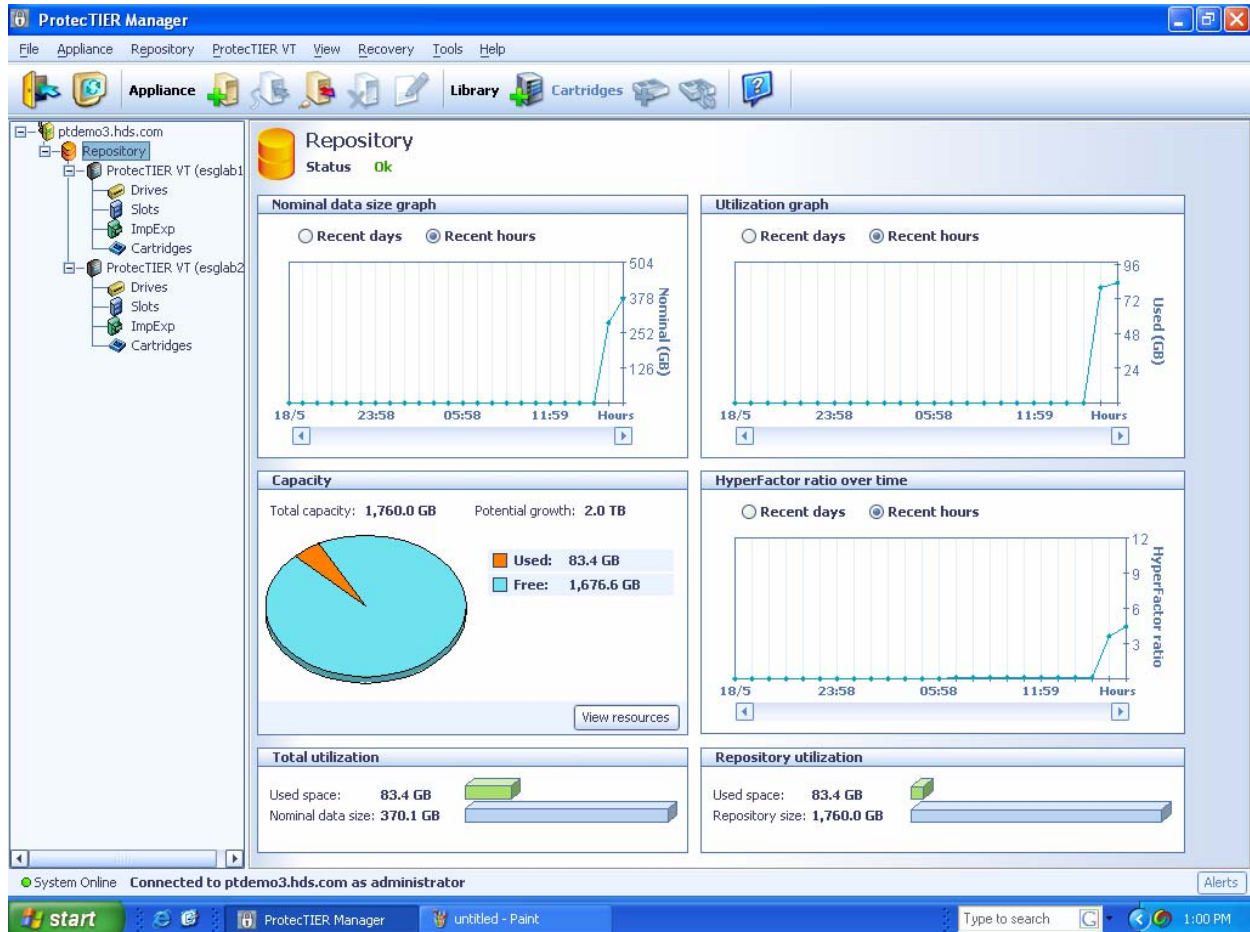


ProtecTIER Manager is a thin Java application that can be run from a browser anywhere on the network. ProtecTIER Manager was used during the validation to monitor the performance, capacity and health of the backup archive. ESG Lab found the user interface visually attractive and very intuitive as shown in Figure Eleven, which was captured after the third set of full backups.

The nominal data graph on the top left shows the amount of backup data that had been written by NetBackup in the last couple of hours (370 GB). The utilization graph to the right shows the amount of physical capacity consumed by those backups (83.1 GB). The graph on the bottom right depicts the ratio

of duplicate data that had been eliminated by ProtecTIER recently. A recent ratio of 4 to 1 indicates that ProtecTIER eliminated 75% of the capacity required to store a series of three full backups.

Figure Eleven: the ProtecTIER Manager User Interface



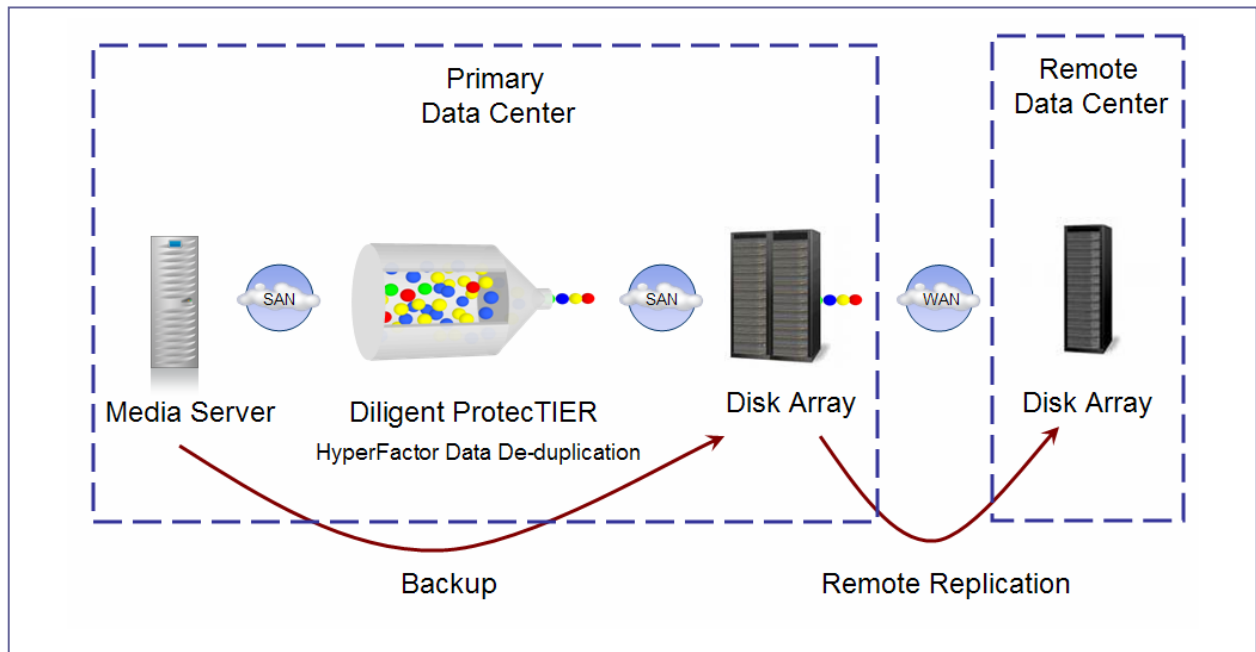
Why This Matters

Two of the main reasons customers implement VTL solutions are ease of use and transparency. ESG Lab found that ProtecTIER fit into an existing Veritas NetBackup environment seamlessly in less than 15 minutes. Customers prefer a VTL solution like ProtecTIER over a home-grown backup to disk solution because it is a purpose-built appliance that is optimized for backup and recovery from disk. Once configured, there is nothing to manage. In other words, with VTL, you can set it and forget it.

Remote Replication

Backup data managed by ProtecTIER and stored on a disk array from HDS can be replicated to a remote site for disaster recovery. Only the unique data stored on ProtecTIER is replicated, as shown in the diagram in Figure Twelve.

Figure Twelve: Replicating a ProtecTIER Archive



Why This Matters

Adoption of disk-based data recovery does not eliminate the need for off-site backup data to recover from a disaster. Because ProtecTIER works with existing backup software, copies of virtual tape images can be made onto physical tape cartridges and transported off-site. As an alternative to using trucks to move tapes to remote sites, the remote replication capabilities of the connected storage arrays (e.g., HDS TrueCopy) can be used to replicate virtual tape images over a WAN.

Data de-duplication brings the same level of compelling economic value to WAN bandwidth optimization as it does to disk capacity. Bandwidth is the most expensive element of a remote replication environment, and with ProtecTIER, customers can dramatically reduce their bandwidth requirements. Reducing bandwidth requirements to this degree not only reduces cost but actually can enable customers to protect enormous amounts of data over long distances that otherwise may have been impossible. Because of the large capacity of backup archives, traditional methods of backup to disk prevent customers from replicating the data to a remote site, forcing them to rely on tape-based data transport.

ESG Lab Validation Highlights

- ☑ ESG Lab found the web-enabled ProtecTIER user interface visually appealing and easy to use. A wizard-driven configuration on a pre-wired test bed was completed in just under fifteen minutes.
- ☑ Once Veritas NetBackup had recognized ProtecTIER as a group of fast and reliable tape drives, existing backup policies and procedures worked just like those for physical tape library drives, only faster.
- ☑ Full backups of 120 GB of Oracle, Exchange and MP3 data were performed using Veritas NetBackup. Three percent of the data was changed after each backup. After three full backups, ProtecTIER stored 360 GB of backup data on only 83 GB of physical storage. Results indicate that a data de-duplication rate of 28 to 1 over a 30 day period can be achieved.
- ☑ Performance scaled up to 266 MB/sec as multiple Veritas NetBackup streams were executed in parallel over two Fibre Channel interfaces.
- ☑ Verification of the integrity of backups using Veritas NetBackup software drove a ProtecTIER internal read transfer rate of 370 MB/sec.
- ☑ A single MP3 file restore was completed in 20 seconds.
- ☑ ProtecTIER index overhead of 300 KB was measured after a first full backup that consumed 69 GB of physical storage. ESG Lab analysis indicates that this low level of index overhead exceeds the efficiency of the hashing approaches used by competitive data de-duplication technologies by more than 3,000 times.
- ☑ ESG Lab analysis indicates that ProtecTIER can not only be used to reduce disk capacity, but can also be used to reduce the capacity of backup data replicated to another data center using the native disk replication capabilities of HDS disk arrays.

Roadmap Recommendations

The following recommendations were made by ESG Lab:

- The ProtecTIER GUI provides an instantaneous view of performance statistics. Recording and presenting performance statistics over time for trending analysis and problem isolation is recommended. Diligent states that these additional statistics will be available in ProtecTIER by the end of 2006.
- Clustering support is recommended for improved performance scalability and fault tolerance. Multiple ProtecTIER appliances working together in an active-active cluster could be used to increase the aggregate backup performance of a singly managed archive. Cold stand-by server support could be used to automatically fail over in the event of a ProtecTIER appliance failure. Cold stand-by support is recommended by ESG Lab with the understanding that automatic on-line failover for a backup and recovery device is a feature that customers often ask for, but can seldom cost-justify. Diligent states that it will introduce ProtecTIER clustering for both increased throughput and high-availability in Q1 2007.

ESG Lab's View

Data duplication is one of the most powerful new technologies to come out of the storage industry in several years. The implications of this technology for the data protection market in particular are potentially huge. ESG Research shows that the leading obstacle to disk-based backup deployment (and this includes VTL) among enterprise-class end-users has been cost. We believe this to be true of smaller companies too.

By reducing the disk capacity footprint necessary for these systems by up to 25x (or more in some cases), vendors are effectively eliminating cost as a barrier of entry for these types of systems. In fact, in some cases, the acquisition cost of a disk-based system like VTL with data de-duplication may actually be lower than that of a similarly sized tape library.

ESG believes Diligent has a compelling story to tell about their ProtecTIER technology from a cost, as well as a performance and scalability, standpoint. Hands on testing by ESG Lab proved that the ProtecTIER appliance, via its HyperFactor de-duplication technology, can be used to reduce backup to disk capacity requirements by a factor of 25 to 1, or more. In capacity terms, that means ProtecTIER can reduce the disk capacity required for a 25 TB archive to only 1 TB.

With a throughput rate in excess of 250 MB/sec, ESG Lab verified that ProtecTIER can de-duplicate and back up data at the same time with minimal performance degradation. ESG Lab also validated that the ProtecTIER indexing process is extremely efficient and makes the product extremely scalable, more so than using hashing techniques. ESG Lab believes that cluster support for ProtecTIER appliances, which will be available in Q1 2007, will provide even greater levels of performance, scalability and fault tolerance.

By reducing the capacity footprint needed by up to 25 times or more, ProtecTIER also opens up new opportunities for end-users from both a replication (less backup data to replicate reduces WAN bandwidth requirements) and a retention (backup data can be kept on-line on disk longer) standpoint. And, finally, not to ignore the recovery side of the equation, which, of course, is one of the key benefits of implementing disk- versus tape-based data protection solutions, ProtecTIER provides both fast (we were able to restore a single MP3 file in 20 seconds) and granular recovery.

It is also important to point out that Diligent has a reseller relationship with Hitachi Data Systems. Hitachi is one of the leading storage system vendors in the market and has an excellent reputation. Additionally, since the core of Hitachi's customers are the largest enterprises, they have a great need for VTL solutions as well as an enormous amount of data that they can now back up cost effectively using ProtecTIER.

ESG Lab has validated that ProtecTIER dramatically reduces backup to disk capacity using fast and scalable data de-duplication technology that works seamlessly with existing backup infrastructure.

Appendix

ESG Lab Test Configuration Details

ProtectTier Software	Version 1.2.1.1
ProtectTier Server	880 quad Opteron 3U server 2.4 GHz CPUs, 16 GB RAM Two QLA2342 2 Gbps FC HBA's
ProtectTier Storage	HDS AMS1000 disk controller 110 10K 300 GB FC drives, 4+1 RAID5
Fibre Channel Switch	Brocade Silkworm 3850
Number of Media Servers	Two
Media server hardware	Dell PowerEdge 2850 with two dual core 2.8 GHz Xeon processors, 4 GB of RAM, and a QLA2342 2 Gbps FC HBA
Media Server operating system	Red Hat Linux 3.0, update 5
Backup Software	Veritas NetBackup, Version 5