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White Paper

Overland REO SERIES™

Implementation Best Practices

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Simply Protected

Using REO to Enhance Your Backup Process

Organizations of all sizes are faced with the challenge of protecting increasing amounts of critical data from loss. Traditional backup methods using tape alone often can no longer meet this challenge, requiring many IT managers to search for new techniques. The search for more capable strategies is primarily due to the risk of unacceptably long periods of down time in cases where individual files and directories need to be quickly restored. Users find that the use of disk devices can significantly speed up and simplify the recovery task.

While disk-based solutions are rapidly emerging as the preferred strategy for backup and recovery, the use of tape for data archiving is also growing rapidly in businesses that need to comply with government regulations that mandate specific data retention requirements.

As a result, industry experts now recommend data protection "best practices" that combine the advantages of disk with those of tape - by using disk as the first stage of data protection and tape for longer term data archiving. This technique has been given the general name of disk-to-disk-to-tape, or D2D2T. Although specific implementations vary widely, there are two basic approaches for implementing the Overland REO SERIES™ Disk-Based Backup and Recovery Appliances with Protection OS™ in a D2D2T environment:

1. Use the REO configured as a virtual tape library (VTL) and/or as standalone virtual tape drives. This enables REO to be easily managed by popular backup software similar to the way physical tape is managed (without changes to existing backup policies), followed by duplication of some virtual tapes to physical tape.

2. Use the REO as a secondary disk device, configured as disk volumes (LUNs). Often referred to as disk staging.

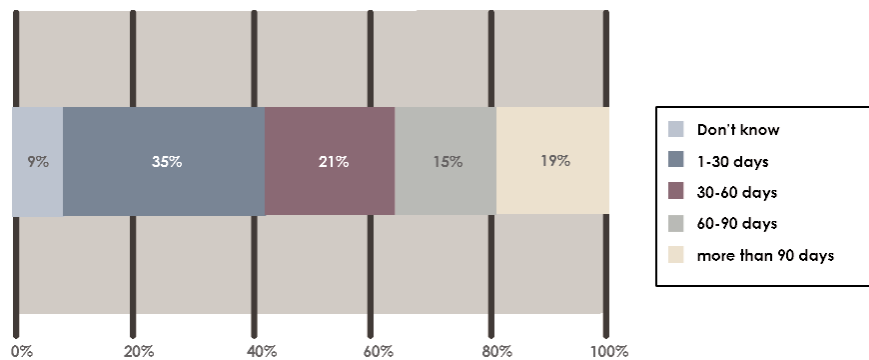### Deploy REO SERIES as Disk, Tape or Both?

A majority of REO users have found that configuring the REO with standalone virtual tape drives and/or as one or more virtual tape libraries is the overall best practice. This is especially true when data is to be retained on REO for an extended period of time in order to take advantage of the fast restore speed offered by disk. Using REO as virtual tape makes it easy to leverage existing backup policies or setup retention cycles that are automatically managed by most popular backup software.
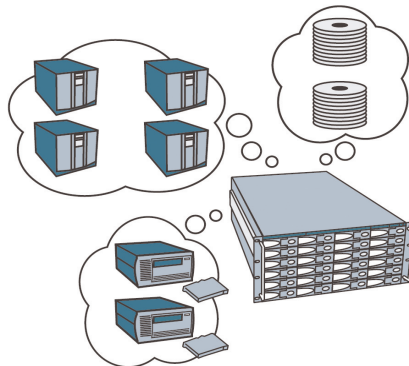
REO SERIES provides configuration flexibility and can be easily configured as a virtual tape library, standalone virtual tape drives, and/or disk volumes (LUNs) to meet changing data protection needs.

Based on research by Enterprise Strategy Group, storage managers who are seeking to optimize data recovery time tend to keep data backed up to disk for longer periods of time than data backed up to tape. For example, 35% of users retain their backup data on disk for up to 30 days; 36% between 30 and 90 days; and 19% for more than 90 days. This is not surprising since it could take hours or days to recover data backed up to tape (especially if the tape is no longer in the library or is off-site) while recovering data stored to disk is typically very fast and more efficient.

"If you were to implement a disk-based backup technology, how many days' worth of data would you wish to retain on disk?" -percent of all users, N=222
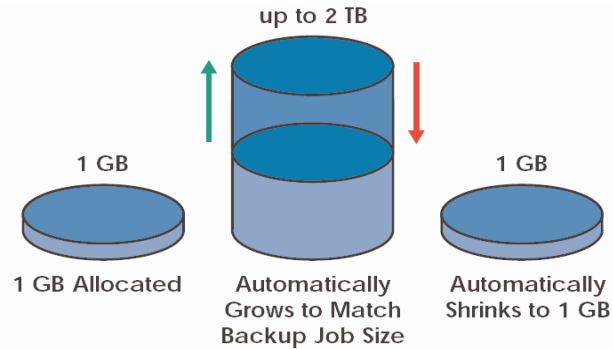
9%	35%	21%	15%	19%	

Legend:
- Don't know
- 1-30 days
- 30-60 days
- 60-90 days
- more than 90 days

0% 20% 40% 60% 80% 100%

Source: ESG Research: Tape Replacement Report, March 2005

The Advantages of REO Virtual Tape

Unlike other disk-based backup systems, only the REO SERIES utilizes embedded Protection OS™ software to deliver a core set of volume and device virtualization, management and connectivity features. This flexible architecture enables storage professionals to easily implement new functionality while retaining a single, stable REO hardware platform. As a result, the REO SERIES can easily meet ever changing data protection needs while preserving the initial hardware investment.

Only REO SERIES disk-based appliances utilize patent-pending Dynamic Virtual Tape™ (DVT). When configured as a virtual tape library or as standalone virtual tape drives, each virtual cartridge utilizes DVT functionality. In both cases, the REO can be easily managed in a similar way to physical tapes with an automated rotation process driven by a retention policy established within the backup software. Thus, users find it quite easy to make the transition from using physical tapes to using REO virtual tapes. And in addition the REO is optimized for use as virtual tape since data is written sequentially and in large blocks for greater performance.

up to 2 TB

1 GB

1 GB

1 GB Allocated

Automatically
Grows to Match
Backup Job Size

Automatically
Shrinks to 1 GB

Dynamic Virtual Tape™ (DVT) is a patent-pending technology that ensures that no storage capacity is wasted while eliminating the manual effort and guesswork of sizing, configuring, provisioning, and deleting virtual tape cartridges. DVTs automatically expand or shrink as needed to match the exact capacity requirements of the backup operation.

Setting up the REO as virtual tape allows the user to retain data on disk for an extended period of time in case it needs to be restored - typically up to 60-days (see ESG user research in previous table), without the need to learn new processes or management interfaces. Additionally this method facilitates a reduction in the number of required full backups. With the REO SERIES, a file system can be easily and quickly restored to its latest state, even if a month's worth of incremental backups on multiple virtual tapes are required. As a result, fewer full backups are needed and daily backups can be incremental rather than differential, which are often used with physical tapes to keep all changes to date on one tape. This also saves storage space.

The use of virtual tape can also enable the user to consolidate backup sessions on virtual tape media to a limited number of physical tapes when disk-to-tape migration is requested. This can be easily accomplished by simply appending backup sessions from virtual tapes to a physical tape until that physical tape cartridge is full. This process is enhanced, however, by special techniques that are available with some backup software packages, such as data consolidation, or what is referred to as virtual full backups or "synthetic full backups," created by the software from a series of incremental backups.

No matter how it is done, an important benefit to be derived from such consolidation is more efficient utilization of physical tape cartridges and tape drives, resulting in less wear and tear on tape drives and on the robotic mechanisms that are used within tape libraries. By utilizing physical tape primarily for archiving, existing tape devices can have an extended useful life since they are utilized less frequently.

In addition to consolidating backup media and reducing wear on tape and tape libraries, the use of REO disk-based appliances as virtual tape offers significant benefits over generic disk-based systems. For example, REO virtual tape appliances do not suffer from disk fragmentation, which can lead to lower performance. When using traditional file systems on "ordinary disks" (e.g. RAID or NAS systems) users will eventually notice deterioration in performance. This has been shown to be caused by the steady increase in fragmentation of the file system due to constant writing and re-writing of files. Virtual tape cartridges on the REO SERIES are created directly from the logical volume management system and are not presented as a file system to the backup software, minimizing the risk of fragmentation and maintaining the maximum performance of the disk target. In addition, when using REO SERIES as virtual tape the REO is not susceptible to viruses, manual volume management, hackers, ongoing tuning, or file system overhead—all are common problems found with general purpose disk-based backup systems.

The following illustration depicts the use of REO for day-to-day backup and restore while reserving the tape library for archiving.
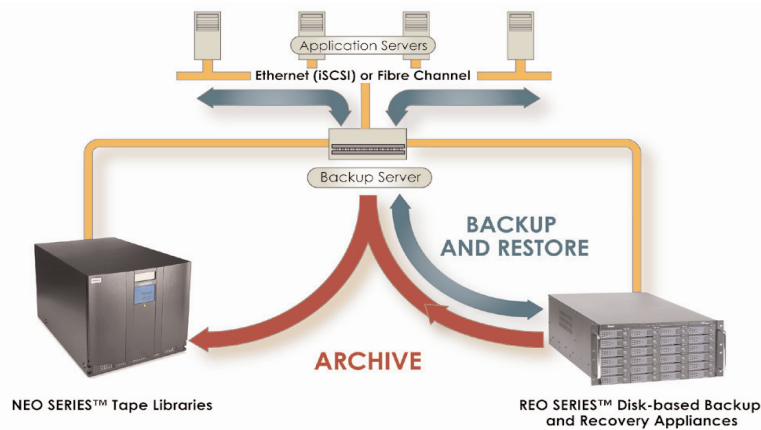
REO SERIES enables fast, reliable backup and recovery and seamlessly integrates into popular backup environments. REO complements existing tape libraries, which can be used for archival storage.

Daily Off-Site Copies Without Tape

If your organization's policies regarding off-site copies will not allow you to follow the above advice to make copies to physical tape from your REO only once a week or once a month, then the REO Multi-SitePAC™ software may be a viable solution. Multi-SitePAC software automates the manual process of protecting remote data without requiring changes to existing backup systems or software. Multi-SitePAC seamlessly transfers back-up data in virtual tape format from a remote REO to a central REO, where it can be con-solidated, managed and archived. Users should determine if they have sufficient Wide Area Network (WAN) bandwidth to transfer a day's worth of incremental backup data across the WAN to another location for off-site archiving or disaster recovery purposes. Incremental data is transferred using Multi-SitePAC software on a pre-determined sched-ule from one REO to another. The receiving REO, at a disaster recovery site for example, then accumulates these incremental sessions and backup software can be used to move data to physical tape as required.

Configuring the REO SERIES as a virtual tape library or standalone virtual tape drives ensures maximum performance over time and minimizes administrative overhead by pro-viding easier manageability, making it a best practice for most backup and recovery environments. One cautionary note to be aware of however: REO users should be sure to create a sufficient number of virtual tape devices to provide multiple concurrent jobs (See Chapter 2) and to implement a sound rotation scheme (i.e. one that allows tapes to be overwritten at the proper time interval). If an insufficient number of virtual tape car-tridges are created, each virtual cartridge could have a wide range of dissimilar retention policies, making it difficult to manage and expire (over-write) the tape cartridges. A single REO can be configured with up to 64 standalone virtual tape drives, or as a virtual tape library with up to 32 virtual drives, 180 virtual tape cartridges, and four partitions giving the user the flexibility that is needed for sound tape rotation schemes.

The Disk Device Alternative

A second common way to quickly convert from a traditional tape-based backup approach to D2D2T is by placing a disk target in the path between primary storage and tape, using it as a type of caching device, then moving data on disk to the appropriate tape media immediately thereafter. This capability is now made available by most back-

up packages, but exact details of the implementations vary considerably among software packages. For example, the "Disk Folders" that can be created in Symantec (VERITAS) Backup Exec, are manageable in a similar way to tape cartridges in that the user can place them in groups and span from one to another. The "Disk Storage Units" and "Disk Staging Storage Units" created by Symantec (VERITAS) NetBackup, on the other hand, are designed as a disk cache, with the primary management decision consisting of how long the data will reside on disk before being copied to tape. Because implementing disk devices as a disk cache varies depending upon the capabilities of the backup software, we are creating Primary Application Notes that describe configuration options to meet your needs. Please refer to these individual documents in the Knowledge Base on the Overland Storage Web site.

One inherent advantage of using the REO is that it can also be configured as up to 64 disk volumes (LUNs) and therefore serve as a disk cache. If the data on the REO is immediately backed up to physical tape, then configuring REO with RAID 0 instead of RAID 5 may be an attractive option. While RAID 0 does not provide redundancy in case of a disk drive failure, it does provide increased performance by as much as 50%. With the flexibility to choose between RAID 0 or RAID 5, and the option to configure REO as disk LUNs or virtual tape, the REO SERIES disk-based backup appliances provide a distinct advantage over an "ordinary disk" system offering general purpose RAID or network attached storage (NAS). The following items should be considered when deciding whether to configure REO as "disk" and/or as a virtual tape library or standalone virtual tape drives:

1.   Use the REO as your primary backup target, moving data to tape no more than once a week for archival purposes. Incremental backups can be mirrored to meet disaster recovery and daily off-site copy requirements (using REO Multi-Site PAC software).

2.   Retain data on REO long enough to cover the majority of your restore needs, perhaps 30-60 days of full and incremental backups.

3.   Set up retention policies in your backup software to automate the rotation of virtual tapes.

4.   Consider using "synthetic full backup" capabilities of your software, if available, to eliminate the need for ongoing full backups. Then, write consolidated synthetic full backups to physical tape periodically.

5.   Determine if your REO appliance should be configured with RAID 0 for high performance - this makes sense if the data will be quickly migrated to physical tape.

The REO and Backup Performance

The REO SERIES product family consists of three models - REO 1000, 4000 and 9000. Each of these models is designed to fit a particular "target market" in terms of capacity, performance, and functionality. The REO 1000 is ideal for backups requiring approximately 1 TB or less capacity, where the tape device is probably an Overland Storage LoaderXpress or equivalent. Thus the REO 1000 is ideal for use with a single backup server sending a single backup stream, which is typically found at small or remote offices.

The REO 4000 and 9000 appliances are designed for more demanding backup environments. For example, the REO 4000 could be easily paired with a dual-drive Overland Storage PowerLoader or NEO 2000 since it can easily move data to its disk array in from two to six simultaneous streams, which matches the NEO characteristics. The REO 9000, with its even higher throughput potential, can easily handle from six to ten simultaneous data streams.

A notable best practice for users with a number of servers to back up is to always perform multiple backup jobs in parallel. And if you currently have only one or two physical tape drives, the addition of a REO 4000 or REO 9000 as your primary backup target will improve backup and recovery performance more than could be attained by simply adding more physical tape drives to the backup environment.

Target Market	REO Model	Recommended Simultaneous Data Streams
Branch / Remote Office	REO 1000	1
Small to Medium Business	REO 4000	Up to 4
Medium Business To Enterprise	REO 9000	8 – 10

Another factor in the performance of a disk array like the REO is the RAID configuration. As noted in the first chapter, the use of RAID 0 can increase performance significantly if data on the REO is being copied to tape soon after backup, making the data protection provided by RAID 5 less important. Also, since the REO 4000 and 9000 include two RAID controllers per array, it is best to ensure that both controllers are in use in order to optimize performance. For example, a REO 9000 with 24 disk drives is setup so that the first array controller accesses the first 12 disks while the second array controller accesses disks 13-24. While advanced load balancing methods are being developed, users can simply create some virtual tape cartridges of pre-determined size in the first 12 disks to ensure that the second array controller is used. Also, standalone dynamic virtual tapes (DVT) can be ideal for use as "overflow" tapes by assigning one DVT to each media group for use in case the statically sized virtual tape cartridges in that group are consumed. Overland Storage Technical Support can assist if you have questions regarding your particular installation.

It is important to remember that there are many factors that influence backup performance beyond the capabilities and settings of the backup device itself. If your backup performance is slow for structural reasons, for example, adding the REO or any other disk device as the primary target device may not help unless you combine this with other changes. As shown in the graphic below, there are potential impediments to the backup process at every point, from the application servers and their file systems, through the network and the backup server to the connectivity of the backup device(s). Large numbers of small files, for example, can dramatically reduce performance if backup is done file-by-file. Image-type backup methods, available with most backup and restore packages, were created to facilitate efficient backup and restore of large numbers of small files.
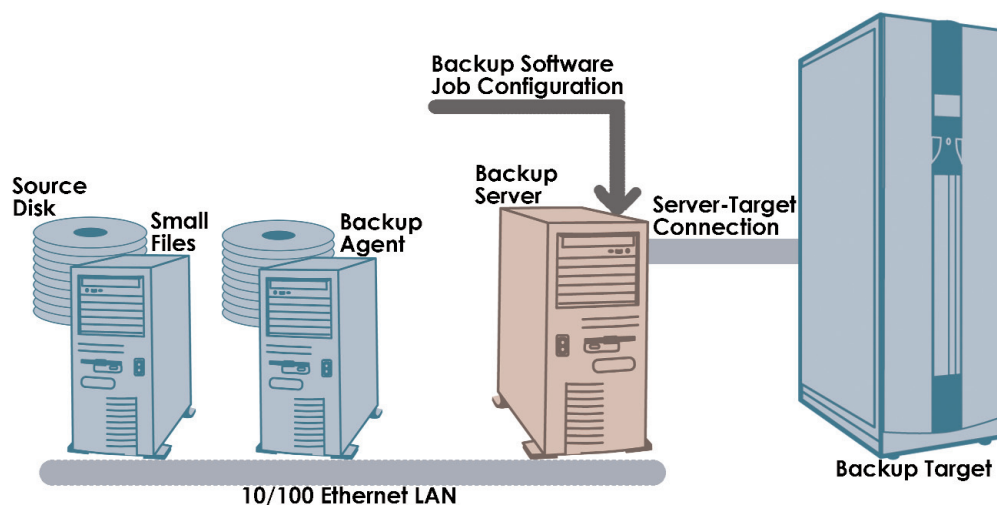

A typical backup environment includes many potential performance bottlenecks. Users should investigate each potential bottleneck to fully understand the performance characteristics of their backup infrastructure.

Improving backup performance requires a commitment to making periodic changes as conditions warrant. Whether you are using tape, disk, or both, you should analyze your backup environment on a regular basis to identify opportunities to improve performance. This includes consulting the manufacturer of your backup software to obtain recommended settings - examples include optimal block and cache sizes, which can significantly impact performance.

You should also consider making use of optional features offered by your software vendor, such as moving data from some of your most heavily loaded backup servers directly to the REO with what is often called dynamic drive sharing among multiple media servers. Whereas this type of operation used to require setting up an expensive Fibre Channel network, costs for Fibre Channel continue to steadily decrease, and users can now take advantage of low cost Gigabit Ethernet networks with iSCSI to direct data streams directly from multiple servers to a REO 4000 or REO 9000. And a SCSI-based tape device can be easily shared in an iSCSI SAN by simply connecting the tape drive or library to the SCSI pass-through port(s) on the REO 4000 or 9000 appliance.

Since REO 4000 and 9000 appliances are designed for backing up multiple simultaneous streams, users should configure them accordingly. With high performance physical tape drives, multiplexing, or interleaving is often used to keep a tape drive streaming during backup operations. However, multiplexing can significantly decrease restore performance since the segments of a file are likely to be spread across a large area of the tape(s). However, REO users do not need to multiplex their data - they can simply allocate one or more virtual drives to each client. And even if data is multiplexed to a REO, it can be quickly and easily de-multiplexed during a copy to physical tape, which makes it easy to restore.
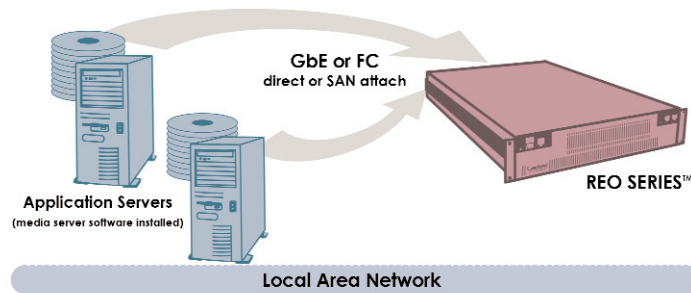
Consider connecting servers with large amounts of data directly to the REO using a Storage Area Network.

Below is a list of helpful performance improvement ideas summarized from the Overland Storage seminar and White Paper "Ten Tips for Faster Backup:"

1. **Check your primary disk systems to make sure they are operating at proper performance; external RAID is usually faster than internal disk.**

2. **Use "image backup" to write large numbers of small files to the REO.**

3. **Use a backup server with plenty of horsepower, minimum 1 GHz CPU speed, and 1 GB of memory.**

4. **Check your backup software's settings such as block sizes and cache sizes for potential performance improvement via "tuning". The REO is optimized for 64KB blocks, a standard used by most backup software packages.**

5. **Use virtual tape instead of "plain disk" with a file system to avoid file system overhead and possible disk fragmentation.**

6. **Use parallel streaming with a REO 4000 or 9000, even if you only have one backup server. If you have large application servers, consider connecting them directly to the REO using a SAN and software with multiple "media servers".**

7. **When using a REO with iSCSI, make SURE that the backup server has one IP port for reading in data from clients and a separate one for writing data to the REO. (See Chapter 3).**

8. **For ultimate performance, consider load balancing the REO using some fixed length virtual tape cartridges along with dynamic virtual tapes as "overflow" for each media group.**

REO Connectivity

Selecting the proper connectivity option can also help to optimize overall REO performance. The REO SERIES comes standard with iSCSI connectivity via Gigabit Ethernet (GbE), and Fibre Channel (2Gb) connectivity is an available option for the REO 4000 and 9000. As the majority of today's server hardware comes standard with multiple GbE ports, and iSCSI initiator software is available for most operating systems at no or minimal cost, iSCSI over GbE is a very cost effective connectivity method. Fibre Channel offers higher throughput for those backup situations that demand the ultimate in performance, but iSCSI over GbE is adequate for most environments. Similar to Fibre Channel, iSCSI eliminates the severe cable-length restrictions of parallel SCSI, and when used with Ethernet switching, iSCSI can also be used to set up a storage area network (SAN). However, if a Fibre Channel SAN is already in use, the REO can easily integrate into your existing environment to preserve your network investment.

As shown in the diagram below, if the REO appliance is connected via iSCSI Ethernet. A best practice is to avoid using the same Ethernet port on your server to connect the REO and application servers. Even with GbE performance, this can create a severe bottleneck. In addition, if you use 10/100 Ethernet as shown below your total performance is restricted to 11 MB/second.
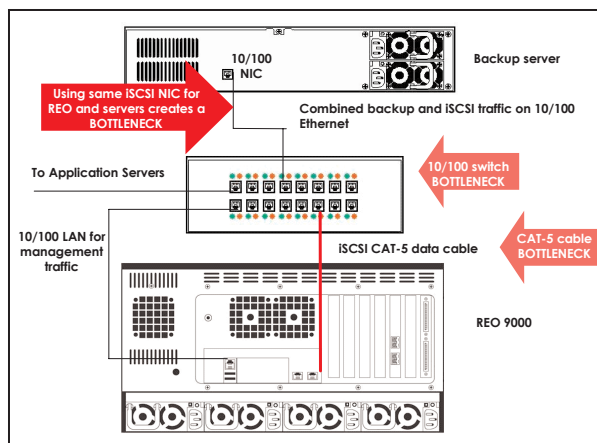
The wrong way: a single iSCSI NIC for both REO and application servers creates several performance bottlenecks

The next diagram shows an example of best practices for iSCSI Ethernet connectivity. Note that as an alternative to the private GbE connection from the REO to the backup server (shown below), a virtual LAN or vLAN can be created if supported by your managed GbE switch.
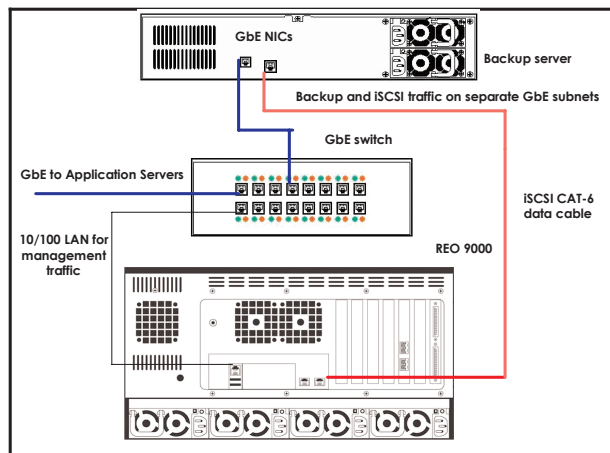
The Right Way: connect the REO via separate iSCSI paths for best performance

Since processing iSCSI and its accompanying Ethernet TCP/IP stack creates CPU over-head when a software iSCSI initiator is used, specialized "Storage NICs" or SNICs can offload the CPU and increase performance. However, if the server has plenty of CPU power, memory, and is only performing backup tasks, the aggregate load of the backup software plus one or two iSCSI data streams typically does not impact performance.

Planning the REO Implementation

In chapter 1 we discussed the criteria associated with using the REO as disk volumes (LUNs) or a virtual tape device. Let's assume that you have decided to use virtual tape—this chapter will address other planning and decision making that will be needed as you implement your REO. Note, however, that although we are discussing virtual tape, similar decisions will be needed to implement the REO as secondary disk volumes.

Virtual Tape Drives Versus Virtual Tape Library

The decision on whether to implement REO SERIES configured as disk volumes (LUNs), standalone virtual tape drives, and/or one or more virtual tape libraries should be based upon your data protection objectives and the characteristics of your backup software. Some backup software packages, particularly enterprise products such as VERITAS NetBackup, EMC Legato NetWorker and CommVault Galaxy, are largely designed around the paradigm of the robotic tape library. Thus, with these packages it may be easier to organize your backup policies and tape rotation system if you use REO config-ured as a virtual tape library. However, some software vendors also charge sizeable licensing fees for additional tape libraries, and sometimes even for tape drives, so this should be explored. As the Primary Application Notes for each major backup software package are developed, where appropriate, there will be notes regarding aspects of the respective package that are known to have an impact on these decisions.

Whether your REO is configured with standalone virtual tape drives or as a virtual tape library, you will want to establish a new set of retention policies in your backup software package based on the length of time you wish to retain data in your REO for immediate restore. And as also noted previously, you will want to set up enough virtual cartridges so that they can be easily expired and re-used when needed. As an example, let's say you decide to limit your virtual tapes to 250 GB each, and you need three virtual tapes to accommodate your monthly full backup (retained for two months) plus two more per

week for daily incremental backups (retained for one month), then you need to set up six monthly tapes on a 7-week cycle (so that they expire on the 8th week) and eight daily tapes on a 3-week cycle (so that they expire on the 4th week), for a total of 14 virtual tapes. By only creating copies of monthly tapes in your tape library, fewer physical tapes are required, which minimizes tape wear and tear and reduces overall media costs.

Keeping Track of Virtual Tapes

Virtual tape cartridges in a virtual tape library will have slot numbers and virtual bar code labels which are tracked in their proper groups by the backup software package, but standalone virtual tape drives (or disk devices) are only given iSCSI names or Fibre Channel LUN numbers. Note that although you can change REO's iSCSI names to something "friendlier", you may not want to do this if you are setting up an iSCSI SAN with devices on the SAN tracked by a name service, or if you might do this in the future. Such a name service generally requires the use of standard iSCSI nomenclature.

So, the best practice for setting up logical device groupings of standalone virtual tape drives in your backup software, whether you are using iSCSI or Fibre Channel, is to create one device at a time on the REO, and log that device into the proper host (backup server) if iSCSI, and identify that new device in your backup package, assigning it to the proper group. Device or media groups, in turn should be set up according to a well thought out plan. Many users organize their tapes by application since applications typically determine quality-of-service factors such as retention periods. The above procedure may seem to be a bit tedious, but remember that you only have to do it once. You should then document all of your device names as used in the REO and in your backup software for ready reference.

Finally, after all of your new devices are created, be sure to backup your REO System Configuration File, using the Create System Configuration File option in the Maintenance Menu.

Overland REO Case Study

A medium sized medical equipment manufacturer had a problem: rapid growth of their data had outstripped the ability of their LTO-1-based tape library system to handle the backup load. Daily differential backups were taking most of the night and, and the full backups on the weekend took so long that they spilled into business hours every Monday. Tape drives in the library had failed twice in the last several months and the IT staff lived in fear of having to do a full restore, knowing it would take over 24 hours just to restore the contents of their 1 TB external RAID system.

The IT director and his manager began looking at what it would take to replace their tape library with a larger LTO-3-based model, while also examining some of the new D2D2T alternatives. They discussed their needs with two value-added resellers (VARs), one of whom suggested that by investing in a REO 9000 instead of in a new tape library they could continue to use their current tape library as an archival device while keeping 30-days' worth of backup data on disk for quick restore.

In discussion with their VAR, they designed a D2D2T solution that included keeping four weeks of full and incremental data on disk. The decision was made to purchase a Fibre Channel attached REO 9000 with 8TB capacity in order to accommodate that volume of data, keeping their existing tape library as strictly an archival device. When the REO was installed, the VAR helped the IT manager design a tape rotation scheme for the REO that included tapes for full and incremental backups as shown in the following chart. It was decided to use standalone REO virtual tape drives rather than VTL to avoid having to purchase a new license for a tape library from their backup software vendor.

Since the full backups were the most critical in terms of performance, four 250GB virtual tape cartridges were created on the REO for each weekly full (two per RAID array controller). This helped to leverage the full performance of the REO 9000 by using multiple

streams and load balancing. And they also created a standalone Dynamic Virtual Tape cartridge for each weekly media group, to provide extra backup capacity when needed.

For the daily backups, it was decided to replace differential backups with incrementals to reduce the required capacity and time. Daily backup tapes were created for each of the four weeks in the cycle, using REO Dynamic Virtual Tape (DVT) cartridges that automatically grow as needed since the size of daily incremental backups varies considerably from day to day.

VIRTUAL TAPE ROTATION SCHEME
Media Groups for Full Backups, 4-week retention cycles:
Week 1 = 4 Virtual Tapes + 1 DVT
Week 2 = 4 Virtual Tapes + 1 DVT
Week 3 = 4 Virtual Tapes + 1 DVT
Week 4 = 4 Virtual Tapes + 1 DVT
Media Groups for Daily Incremental Backups, 4-week retention cycles:
1 DVT for each group

After the new backup scheme was put into production, the IT staff breathed a sigh of relief since backup jobs now completed within the backup window and user productivity was no longer impacted. And recovering data when needed is now fast and easy. Weekend full backups now finish in little more than three hours, leaving plenty of time to do duplication to physical tape for the rest of the weekend. And the duplication process runs faster than the backups ever did even to the older LTO-1 tape drives. And the users can't believe how quickly their data can be recovered when requested!

We're With You All the Way

Based on the experience of literally thousands of users, the REO makes it easy to implement disk into your backup environment. But like any new system, REO integration requires careful planning and installation. After setting up the REO appliance, the product is designed to require very little management or maintenance. By setting up the Email Notification System, or SNMP traps found in the System Configuration Menu, users will receive an email or SNMP trap if any critical condition occurs that requires immediate attention.

Since 1980, Overland Storage has provided industry leading data protection solutions. As mentioned earlier, you should also consult the Primary Application Note for your particular backup software if available, as well as other related documents that can be obtained at www.overlandstorage.com under the Service & Support section. If you have questions that are not addressed in your REO SERIES documentation, please contact your Overland Storage reseller or the Overland Storage Technical Support team for assistance. Contact information can be found in your REO SERIES User's Guide or online at the Overland Storage Web site.

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