

EMC Disk Library DL4100, DL4200, and DL4400 Version 3.0

Best Practices Planning

Abstract

This white paper details the EMC[®] Disk Library, highlights its advantages, provides an overview of its features and function set, and provides specific best practices and tuning parameters for select backup applications.

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Executive summary

Today's increasing requirements for application availability combined with growth of data volumes dictates a paradigm shift for solutions. IT environments are faced with the combination of this data growth and shrinking backup windows to get their backups completed. Restore time objectives (RTOs) and restore point objectives (RPOs) are also becoming more stringent, increasing the importance of a highly reliable, high-performance backup environment. Adding more tape resources, infrastructure, and cost to the issue may offer incremental gains. Disk-based backup solutions that leverage current environments are the solutions for backup issues.

As a complement to tape for long-term, offsite storage, backup-to-disk and the EMC® Disk Library have emerged as powerful solutions. For users interested in improving the performance and availability of their backup environments without changing their applications or infrastructure, EMC recommends the EMC Disk Library. It provides the service-level benefits of disk while appearing as tape to the existing backup applications, thus requiring minimal changes for such an implementation.

Introduction

This white paper details the EMC Disk Library, highlights its advantages, provides an overview of its features and function set, and provides specific best practices and tuning parameters for select backup applications.

Audience

The intended audience for this paper is members of the EMC field community who interact with customers and need to understand the implementation of the EMC Disk Library backup technology into a customer's backup environment.

Disk libraries

Performance

Customers have to back up more data in less time than ever before. Adding more tape hardware to solve the problem may no longer be an effective solution. On top of that, IT professionals need to be able to restore files and applications more quickly than in the past. The inherent performance limitations of sequential access tape and tape robotics are inhibiting backup administrators from meeting their service level agreements (SLAs).

Disk libraries provide significant performance advantages over tape-based solutions. Backups and restores can now easily be completed within ever-shrinking backup windows.

The EMC Disk Library delivers up to 150 MB/s per individual data stream and up to 2400 MB/s total aggregate performance (model dependent). File restores usually take one-tenth the time using the disk library when compared with tape. Figure 1 provides backup and restore comparisons.

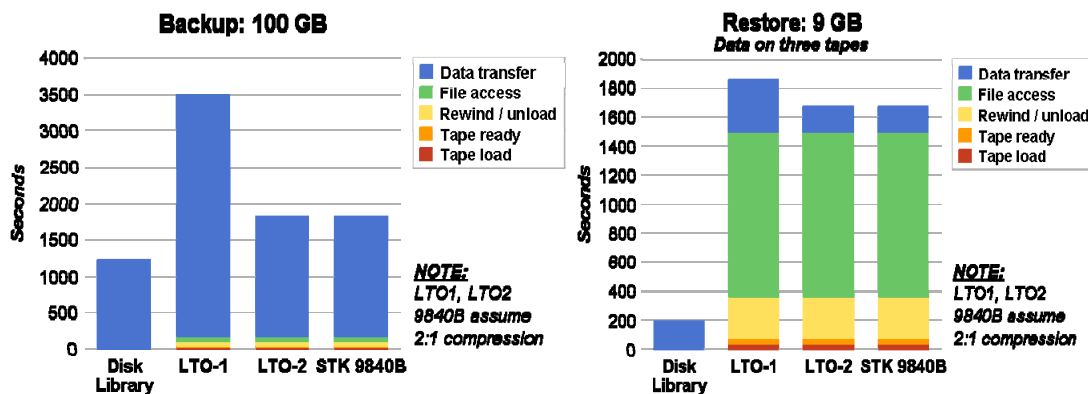


Figure 1. Backup and restore comparison between the EMC Disk Library and physical tape devices

High availability

Tape failures are a major cost for IT customers. When these hardware failures occur, applications are down for extended periods of time and productivity is impacted. When tape failures occur during backup windows, IT professionals spend valuable time diagnosing problems and are not able to provide other benefits to their organizations. Tape libraries, drives, and media do not have high-availability architectures or support for intelligent data protection. Some customers handle this lack of availability and reliability by writing out multiple copies of tape to protect against a media failure. This solution increases the overall cost of the tape infrastructure.

Disk libraries have high availability (HA) designs and are HA solutions. They have redundant components and eliminate all single points of failure for a reliable solution. Disk libraries deploy intelligent data protection, like RAID, to ensure data availability. The EMC Disk Library leverages the proven HA design and RAID protection of industry-leading CLARiiON® storage systems.

Tape emulation

Tape emulation eliminates the need for backup process changes that might be experienced if converting to backup to disk. Tape emulation enables disk libraries to appear to the backup applications as tape libraries and tape drives. In effect, the backup application thinks it is still writing to tape, when it is in fact writing to disk.

The EMC Disk Library provides tape emulation functionality. It presents itself as standard, open-systems tape libraries and tape drives to backup applications. The solution has a broad list of qualified implementations. Leading backup applications have been tested and supported by EMC. The disk library emulates tape libraries from IBM, Sony, ADIC, ATL, and STK. It emulates various tape drives such as DLT, SuperDLT, LTO-I, II and III, STK 9840/9940, Sony AIT, and IBM Magstar 3590Es to name a few. Additional information and updates on emulation types can be found at [EMC Powerlink®](#), EMC's password-protected extranet for customers and partners.

Automated archival process

IT organizations will always have offsite requirements. These requirements are most efficiently handled by ejecting tape cartridges, which can then be shipped offsite. Backup and restore operations should be delivered via disk media; archival operations should be delivered via tape. These tapes should be able to be read directly into a backup application without first being restored to disk-based offerings.

Disk libraries require integrated backup and archival processes. Customers should be able to write the data once, and then move it from the backup media to the archival media without incurring a second write. If

required, this second write adds a second route through the SAN, which is inefficient. Disk libraries without an integrated archival process are incomplete offerings.

The EMC Disk Library has incorporated this offsite archival offering into its solution. Customers can connect a physical tape library to the EMC Disk Library and eject tapes in native tape format for offsite storage. These native tapes can be read directly into the backup application and do not require any interaction with the disk library. Customers archive their data to tape using a policy-based implementation.

EMC Disk Library hardware overview

CLARiiON CX3-80 UltraScale storage systems

The EMC CLARiiON UltraScale™ CX3-80 storage systems, introduced in 2006, are the latest generation CX3 series storage systems following the CX300, CX500 and CX700. Enhancements to the CX3-80 systems include:

- Full 4 Gb/s end-to-end technology
- Quad 3.6-GHz Intel processors per CX3-80 storage system
- 16 GB of total memory per CX3-80 storage system
- Eight 4 Gb/s front-end ports and eight 4 Gb/s back-end ports per CX3-80 storage system
- Scalable to 480 drives

As seen by the enhanced specifications just provided, the CX3-80 storage systems provide an excellent base platform for the DL4100, DL4200, and DL4400 EMC Disk Libraries.

The DL4100, DL4200, and DL4400 Disk Library products are single-purpose disk-based appliances for backup/recovery processing.

The EMC Disk Library appliance will achieve higher backup and restore throughput performance than competing tape library units (TLUs).

Additional shelves of ATA disk drives can be added to the base CLARiiON CX3 series storage systems to increase their overall capacity up to the maximum of the CLARiiON storage system. Performance will also scale up to the maximum rated performance.

DL4100, DL4200 and DL4400 EMC Disk Library appliances

The integrated appliance engines of the DL4100, DL4200 and DL4400 have the following features.

The appliance will not include a monitor and will boot directly from the CX3-80 Fibre Channel drives to which it attaches.

Features/specifications

- Up to 150 MB/s in a single backup stream
- More than 2400 MB/s usable throughput (DL4400 model)
- Supports up to eight 4 Gb/s Fibre Channel front-end connections to a customer's SAN
- Integrated Fibre Channel connections for physical tape library connections and exporting
- Availability of an active/active dual-emulation engine configuration for improved reliability
- Auto-archiving features for failure protection and automatic restoration capabilities
- Enhanced IP-based replication for offsite cartridge archival
- Rackmounted in a standard CX3 series CLARiiON 40U cabinet

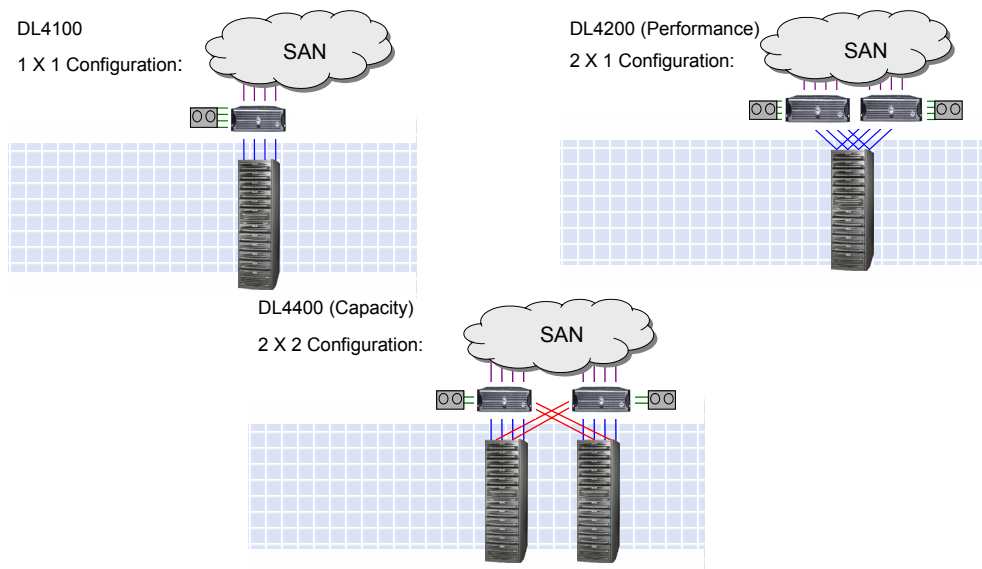


Figure 2. Illustrations of the DL4100, DL4200 and DL4400

Dual active engine front-end design

Active engine failover is a feature that was introduced in version 2.0 of the EMC Disk Library. As illustrated in Figure 2, it is available on two models of the latest DL family, the DL4200 and DL4400. Active engine failover improves availability and recoverability of the DL product in the event of an engine failure.

The DL4200 and DL4400 have two active emulation engines. Each engine is actively working to service the backup requirements of its respective clients. In the event of an engine failure, fail over to the surviving engine occurs. Failure of an engine can be the result of a hardware failure, software crash, loss of SAN connection, or simply a loss of connection to the engine. Active engine failover allows the surviving engine to take over the emulation services that were provided by the failed engine.

Active engine failover should not be confused with similar-sounding functions available for the CLARiiON storage system. CLARiiON failover managed by EMC PowerPath[®] software on the host is designed to deliver transparent application level failover without any loss of data written to the storage system. Active engine failover only fails over the emulation services of the engine. Restarting the failed or suspended backup/restore jobs must be performed by the customer or the backup software.

How active engine failover works

During an active engine failover, the surviving engine takes over the emulation services for the clients of the failed engine, and provides emulation services for its own clients. In order for the surviving engine to take over the emulation services of the failed engine, it assumes the identity of the failed engine by taking ownership of the failed engine's target World Wide Port Names (WWPNs), management IP address, heartbeat address, and repository.

The DL software loads multi-ID firmware for the QLogic HBAs. Multi-ID firmware allows the QLogic HBAs to have multiple WWPNs assigned to an adapter port. When active engine failover occurs, the WWPNs for the DL target ports on the failed engine are transferred to the DL target ports of the surviving engine. The target ports on the surviving engine will now have two WWPNs: their original and the WWPN for the associated target port from the failed engine. Each QLogic adapter has an initiator WWPN, but the ports configured as target ports have an additional target WWPN and a standby target WWPN. The standby WWPN is the WWPN of the port on the other engine that will take over the target WWPN in the event of a failure. The use of multi-ID firmware and moving WWPNs to other ports during failover makes it a

requirement that WWPN zoning, described later in this document, is used when zoning the EDL with clients.

Certain IP addresses assigned to the failed engine will also be moved to the surviving server during a failover. In normal operating conditions, each DL engine will have four IP addresses (two per NIC port) assigned to it. Two of the IP addresses (one per NIC port) are static and the other two are virtual—or sometimes referred to as floating IP addresses. ETH0 is used for the heartbeat between the engines, and its IP addresses are preconfigured during active engine failover setup. ETH2, 3, 4 and 5 are bond ports used for the management IP address and the service IP address of the engine. When a failover between the two engines occurs, the surviving engine will take over the virtual heartbeat IP address and the management IP address of the failed engine. The second heartbeat address and the service IP address do not get failed over to the surviving engine. If the failed engine is not completely down, the CE can use the service IP address to gain access to the failed engine and troubleshoot the failure. If the management IP address is used, the CSE will actually be logging in to the surviving engine since the management IP address of the failed engine is now owned by the surviving engine.

The repository is the last thing that the surviving engine in a failover will gain control of. The surviving engine will access the repository of the failed engine through the Fibre Channel links to the storage arrays that exist between the engine and storage systems.

Software overview

Disk library tape emulation software

Embedded EMC Disk Library tape emulation software makes the CLARiiON Advanced Technology-Attached (ATA) disks appear as tape library units and tape drives to industry-leading backup software applications.

The emulation software has the following features and specifications:

- Windows-based management GUI

As shown in Figure 3, the management GUI is very intuitive and easy to use. The management GUI includes an EMC Navisphere®-type look and feel. The tape emulation software includes a management GUI that runs on a standard Windows 2000, Windows 2003, or Windows XP workstation connected to the appliance via the customer's LAN.

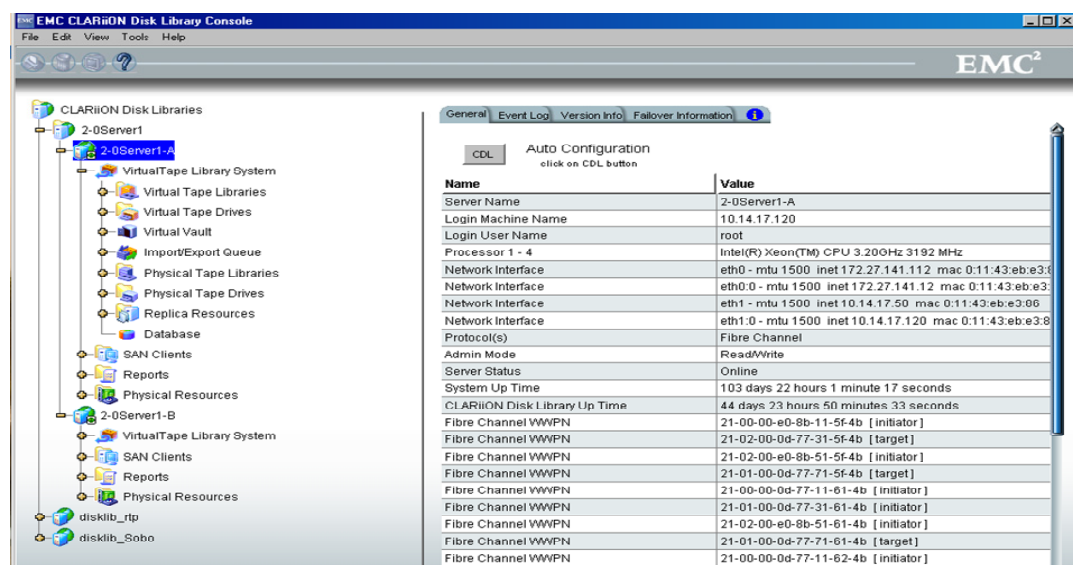


Figure 3. EMC Disk Library management GUI

The management GUI provides the following features:

- EMC Disk Library management functions
- Addition and deletion of libraries and capacities as needed
- Library and storage system error logging and status reporting
- Selectable compression software features
- Physically attached tape library management if required
- Hardware emulation configuration wizards for easy library and drive creation

The tape emulation software emulates market-leading tape libraries and tape technologies. It allows for multiple types and quantities of TLUs and tape drives to be configured into a single EMC Disk Library.

For an up-to-date list of supported tape libraries and drives, consult the *EMC Support Matrix* on [EMC Powerlink](#).

Various emulated libraries include:

- ATL P1000, P3000, P7000, and 7100
- ADIC Scalar 100, 1000, i500, and i2000
- STK L180, L700, 9710, 9714, 9730, and SL500
- IBM 3583, 3584, and 3590
- Sony CSM200BF

Various emulated tape drives/technologies and brands include:

- DLT 7000, DLT 8000, SuperDLT 220/320
- IBM 3580 LTOI, Ultrium LTOII, Ultrium LTOIII, IBM 3590, and IBM 3592
- STK 9840C, 9940B, and T9840B
- Sony S-AIT, and AIT2/3
- HP Ultrium LTOIII

iSeries host support

Version 2.1 of the EDL introduced connectivity to IBM iSeries backup servers. The EDL is qualified with native SAV as well as with Backup Recovery and Media Services for iSeries (BRMS) version 5, which is one of the more commonly used third-party backup applications for the iSeries environment.

The following tape library and drive emulations, as well as physical connections, are supported for iSeries (OS/400 V5R3):

- Tape library — IBM 3584, IBM 3590, and IBM 3583
- Tape drive — IBM 3580 and IBM 3590-E11

For a more thorough understanding of the EDL iSeries integration, please refer to the *iSeries and EMC CLARiiON Disk Library Implementation Guide* on [EMC Powerlink](#).

Integrated storage node cloning of data to physical tape

EDL version 2.2 and later feature integrated EMC NetWorker® storage node cloning capability. With integrated storage node cloning capability, cloning is performed within the EDL, or between two EDLs, under NetWorker control. Use of the storage node cloning requires the installation of one or more of the following licenses:

- NetWorker Storage Node Enabler — Installed via the EDL Console, license enables the NetWorker storage node software inside the EDL.
- NetWorker Storage Node license — Installed via the NetWorker administrator programs at the master server, this license enables the NetWorker storage node to participate in the NetWorker datazone.

In addition, NetWorker currently requires a license for every tape library. Please refer to the latest NetWorker licensing policies to ensure proper licensing.

NetWorker environment

Storage node cloning capability within the EDL supports the NetWorker version 7.3 storage node¹. Therefore, the EDL with the integrated storage node cloning capability must be configured in a NetWorker 7.3 datazone (consisting of a NetWorker 7.3 server, NetWorker clients and, optionally, some number of storage nodes). All standard NetWorker 7.3 configuration rules and restrictions apply.

The integrated storage node software feature is automatically started when you install the EDL NetWorker Storage Node Enabler license. The storage node software is also automatically restarted after a EDL reboot provided that the enabler license remains installed. If the EDL NetWorker Storage Node Enabler license is removed, after an EDL reboot the storage node software is halted and does not restart.

Activating the EDL NetWorker Storage Node Enabler license also enables a menu option within the EDL GUI that checks the status of storage node and enables the starting and stopping of storage node services.

Refer to the *EMC CLARiiON Disk Library Administrator's Guide* and the *EMC Disk Library with NetWorker* white paper on [EMC Powerlink](#) for more information about the Storage Node feature set of the EMC Disk Library.

Integrated NetBackup media server duplication

EDL version 3.0 and later feature an integrated NetBackup media server duplication capability. Under NetBackup control, the integrated media server performs duplication within the DL to physical tape or between two DLs. The NetBackup 5.1 media server is currently integrated within the DL, which means this functionality can be used in NetBackup environments using a NetBackup 5.1 or 6.0 master server. All standard NetBackup 5.1 and 6.0 configuration rules and restrictions apply. Customers should purchase a NetBackup Tier 2 Linux SAN media server license to use the integrated media server within the DL. The SAN media server license can be used because the integrated media server is performing only duplication; it is not backing up other NetBackup clients.

Consolidated media management through integrated NetBackup is for image duplication and data management purposes. Backing up data directly to the integrated media server within the DL via LAN is not supported.

The integrated media server software feature is automatically started when the DL Hosted Backup Enabler license DL-MEDIAMGR (an optional license available from EMC) for NetBackup is installed. The media server software also automatically restarts after a DL reboot as long as the enabler license remains installed. If the Hosted Backup Enabler license for NetBackup license is removed, the media server software is stopped and will remain stopped upon DL reboot.

Activating the DL Hosted Backup Enabler license for NetBackup license also enables a menu option within the DL GUI that checks the status of the media server and enables starting and stopping the media server services.

NetBackup media server

The use of the media server duplication requires the installation of multiple licenses:

- The (DL) Hosted Backup Enabler license for NetBackup license must be installed via the DL Console; this starts the media server software inside the DL.

¹The NetWorker client package is also included for NetWorker intersystem communication

- A unique user/password combination enables root access for properly licensed Disk Libraries; the username is **hbeadmin**, and the password is **backup**. This user will have a group ID of 0 and a unique user ID. This allows the administrator to perform the installation of NetBackup software and to apply the media server license and name. Only DL systems that are properly licensed via the Hosted Bus Enabler license for NetBackup will be able to access the unique user/password access.
- An appropriate NetBackup media server license must be installed by logging in to the DL server using the “hbeadmin” account while installing NetBackup software.
- Stopping, starting, and restarting the NetBackup services can be performed only when the media server license is installed.

In addition, NetBackup requires the Virtual Tape Option license, based on the installed usable disk capacity, for every virtual tape library.

Compression

The EMC Disk Library supports software compression at the individual data-stream or emulated tape-drive level. Compression increases the capacity of real tape cartridges. When the EDL compression is turned on, individual data stream performance drops by roughly 40 percent and aggregate performance drops by roughly 50 percent.

The actual data compression rate and therefore storage capacity of the appliance depends on the compressibility of the data itself.

Connections to the tape library

Up to eight integrated 4 Gb/s Fibre ports are front-end ports and are used to implement target-mode SCSI drivers (SCSI over Fibre Channel) that make the EDL look to systems on a SAN as a number of tape libraries with associated tape drives. Up to eight 4 Gb/s Fibre Channel ports are direct-attached back-end ports and are connected to the CLARiiON CX3-80 array. Up to eight 4 Gb/s other Fibre Channel ports can be used for a physical tape attachment to the EMC Disk Library. Figure 4 shows a typical SAN EDL configuration.

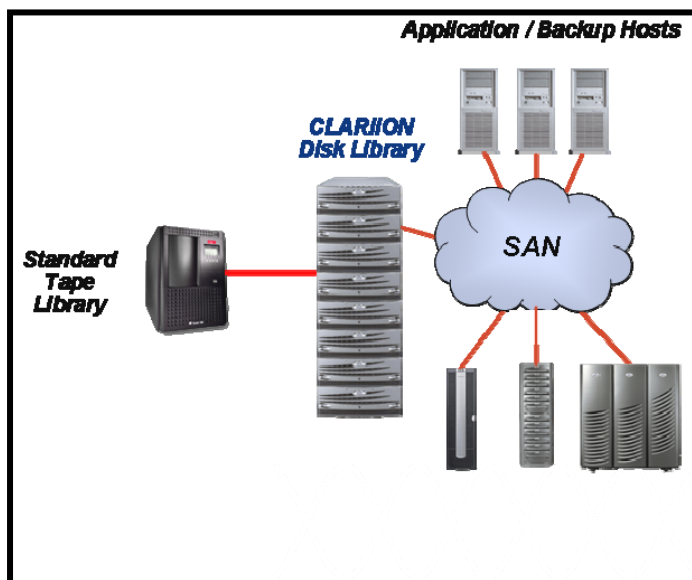


Figure 4. Typical SAN-attached environment using the EMC Disk Library

Typical backup operations

Creating libraries

Creating an emulated tape library and emulated tapes and associating these with physical libraries and SAN clients requires several steps. To simplify the standard configuration process, the EMC Disk Library Console provides a Configuration Wizard. Using the wizard, the user can perform the standard configuration process in four steps. Alternatively, these steps can also be done manually.

For more information on creating emulated tape devices, refer to Chapter 4 in the *EMC CLARiiON Disk Library Administrator's Guide*.

Capacity on demand

The *tape-capacity-on-demand* feature allows you to allocate a small amount of disk storage space when you create your emulated tapes, and later automatically allocate additional space as needed. If this option is not used, the EMC Disk Library engine will pre-allocate each emulated tape at the full size of that tape.

It works as follows:

1. Initially, a 5 GB area is allocated on a LUN.
2. When backup software fills the initial 5 GB area, the disk library software allocates another 5 GB area. The new area might be on a different LUN if the original LUN becomes full.
3. The disk library software will continue allocating 5 GB pieces in this way until the total maximum capacity of the emulated tape has been reached (the last piece being the remainder needed to fill out the max capacity).

The capacity-on-demand feature is enabled by default, meaning that when you create a tape library, tapes will have capacity on demand. You can turn off capacity on demand for a particular tape by changing its properties to disable capacity on demand. This must be done on a per-tape basis. If you want to create a tape library whose tapes are always created without capacity on demand, you must enable the advanced tape creation method, which is done via the Management Console in Tools > Console options.

Exporting-to-tape features

To support a physical tape library connected directly to the EDL, a fibre library may be connected to the flex-Fibre Channel ports on the appliance.

The intent of the back-end library is to create physical tapes as desired. These may be used for offsite storage or to recover data to other systems. A EDL is not required in order to read these tapes. Backup data is restorable on a system that has the backup software installed that was originally used to write the emulated tape. Of course, a physical tape drive capable of reading the tape must also be available on the system.

Two actions can cause EDL to create a physical tape:

- Backup software ejects a tape from the emulated library.
- The user exports a tape from the emulated library via the Management Console GUI.

EMC recommends the first option to maintain cohesive tracking of the backup data. The backup software is responsible for cataloging and maintaining the backup index, which tracks the location and disposition of every cartridge.

Export performance

Export performance is a function of the performance of the physical tape device—whether using a dedicated library or stand-alone tape drive. When the disk library writes data to tape, tape drive compression is enabled. Performance of the physical drive depends on actual compressibility of the data that has been written to virtual tape. It will vary from a low of the native rate to perhaps twice the native rate, assuming the data is rather compressible.

Virtual tape data will always be uncompressed prior to being written to physical tape. This ensures usable physical tapes and allows enabling of physical tape drive compression.

Fibre Channel

Up to eight 4 Gb/s Fibre Channel ports are available from the disk library server to connect to dedicated physical tape drives or library (see Figure 2). The port automatically negotiates to 2 Gb or 4 Gb. Aggregate maximum throughput per port could be up to 360 MB/s, depending on the capability of the physical devices. Actual throughput depends on the tape drives themselves, until reaching the maximum rate of the fibre connection.

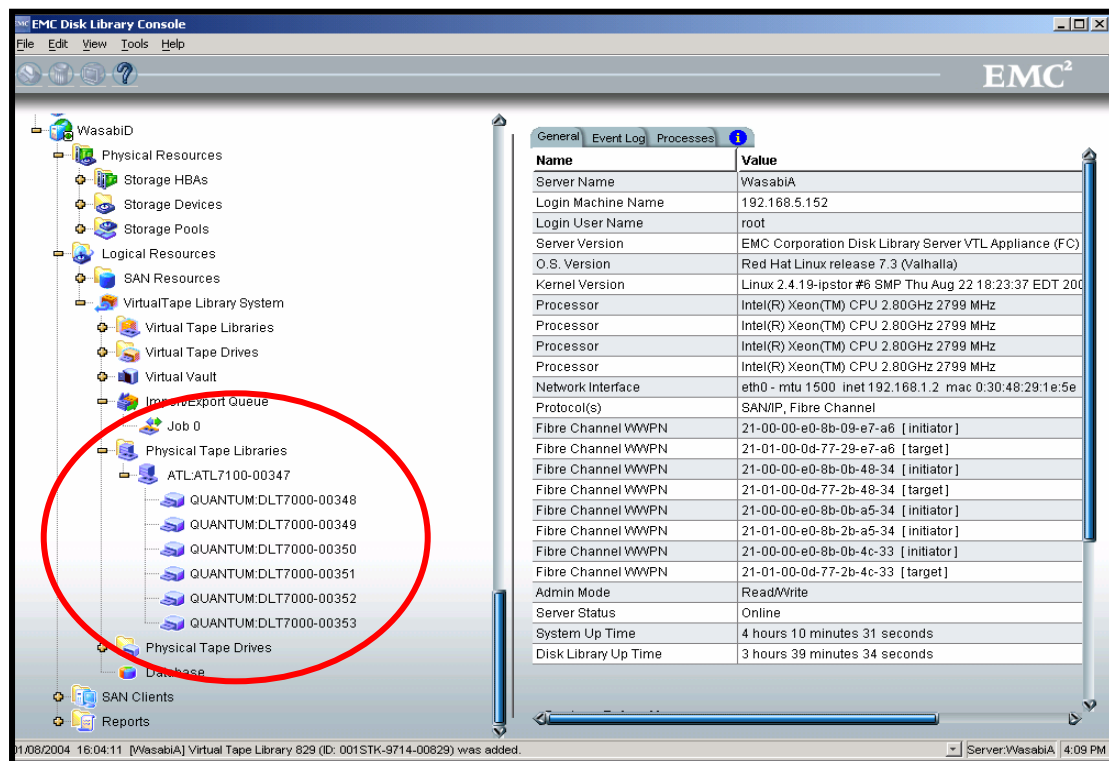


Figure 5. The EDL Management Console showing an attached physical tape library

EMC Disk Library IP remote replication feature

Remote IP replication between two EMC Disk Libraries gives customers the ability to either copy or move an existing emulated tape from a local site to a remote site. A tape “copy” is just that: a one-for-one copy of an emulated tape that exists in two locations. This allows a customer to have a backup copy in two locations for the purpose of restore. Remote replication between EMC Disk Libraries will deliver the highest service levels for backups and restores because the backup is local to the environment.

The EMC Disk Library IP replication feature is an optional utility that enables the end user to copy virtual tapes from a primary virtual tape or virtual tape library on a primary server to a target virtual tape on a remote server over an IP connection. Replication can be done using a set of policies, automatically, or manually.

Policy-triggered replication supports the following features:

- *Watermark Triggered* — If a specified amount of new data is written to a tape, the tape is unloaded from the virtual drive and replicated to the remote virtual tape. The specified amount of new data is called a watermark. When data written to the tape reaches the watermark, the tape is unloaded from the tape drive and the tape is replicated to the remote virtual tape. The maximum watermark size is the size of the source virtual tape.
- *Schedule Based* — Can be triggered by a schedule that you can set. There are two types of schedule settings:
 - Every day at a specific time
 - At a set interval such as every eight hours or every 30 minutes
- *Auto Replication* — If Auto Replication is set up, when a virtual tape is exported out of the virtual tape library, it is replicated to a remote virtual tape (replica). This is similar to the auto-archive feature, where the data is copied or moved to a physical tape. Auto Replication can be set only for a virtual tape library. If this policy is set on a virtual library, all tapes inside the library inherit the policy. Policies set for specific tapes override tape library policies.

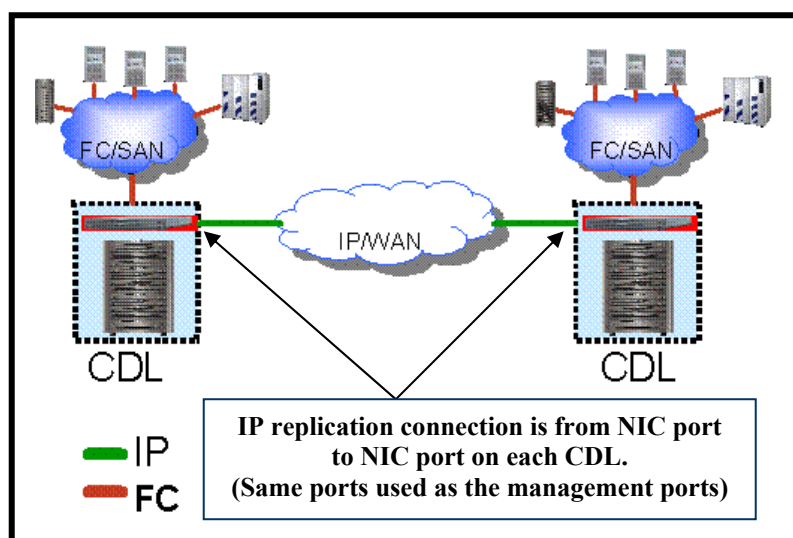


Figure 6. EMC Disk Library IP connections

Remote copy

You can manually replicate (copy) virtual tapes from one EMC Disk Library to another. All used blocks on a virtual tape are copied to a virtual tape on the remote EDL. At the end of the copy operation, the replicated tapes are moved to the vault area of the EDL.

Using compression during a remote copy session

Remote copy compression reduces the size of data transmitted during a remote copy session. Do not use remote copy compression if any of the following is true:

- Virtual library compression is enabled on the EDL.
- The backup application has compression enabled.

- The link can sustain 40 MB/s or greater throughput. The compression algorithm will throttle the data throughput.
- The dataset is known to be incompressible, for example, if it consists of files that are already compressed by another utility.

EDL compression is compatible with remote copy. However, make sure not to use remote copy compression as well; otherwise, performance will be degraded. Replication compression is used only during transmission, and it is decompressed after arriving at the target.

Network performance

This section describes network performance. When performing a remote copy, it is important to consider *link bandwidth*, *latency*, and *packet loss* (if packet loss is regular or predictable). IP networks contain many routers, repeaters, and buffers, all adding their own latencies to the replication process.

Table 1. Maximum speed for common network links

Link type	Transmission speed (Mb/s)	Throughput (GB/hr)
T1	1.544	0.647
10 Mb	10.000	4.191
T3	44.736	18.749
100 Mb	100.000	41.910
OC3	155.520	65.178
OC12	622.080	260.711
1000 Mb (GbE)	1000.000	419.095

These numbers represent the maximum throughput; they do not consider packet loss or network overhead. Transmitting very large tapes over lower-bandwidth links such as T3 might provide unsatisfactory performance, especially when link usage is shared with other network services. For best performance, if replicating large tapes over slower links, perform the remote copies during times of least network demand.

Throughput does not change whether one or many concurrent copies are performed. A single remote copy utilizes as much of the bandwidth as it can. Multiple concurrent copies use the same available bandwidth; aggregate throughput stays about the same because the jobs share the same stream.

Remote copy performance tips and frequently asked questions

Q: What are the key factors to consider before deploying remote copy?

Consider the following:

- Distance
- The amount of data to be replicated via remote copy and the frequency.
- The amount of available storage on remote DL.
- The remote copy window. The tapes will be marked read-only during remote copy and this may delay backups.
- Network utilization. Scheduling remote copy via time-based policy might free up network utilization.

Q: Why is the EDL's Ethernet port set at half-duplex?

This occurs when the EDL is connected to a switch port that is not auto-negotiating. The EDL is set to auto-negotiate the speed. On a GbE infrastructure, this is required and is the norm. Also in some companies, the policy is to force their switch ports to 100 Mb full duplex. The auto-negotiation algorithm

works fine if both ends are using it, but if the switch end is forced, the algorithm can detect only the speed, not the duplex. Therefore, it is recommended to set the switch port to which the EDL server connects to auto-negotiate. If this is absolutely not possible due to strict policies or old switching hardware that is forced only, the EDL server port speed and duplex must be forced.

Q: What happens if my replications take too long and prevent my backups?

There are two workarounds for this situation:

- Increase Backup Software Provider's retries if the replication is incremental, or if the replication is on demand, add more media to the backup pool.
- Stop the existing replications in progress. Once the replication is stopped, the session will be marked as *failed*. Any subsequent session won't be incremental.

Q: My BSP won't recognize the replica volume at the remote site, what should I do?

Use auto-replication with the **move** command. **Move** removes the source tape from the source EDL after the replica has been created (whereas **copy** leaves the source tape). Using **move**, the BSP will not be confused with duplicate barcodes at the remote site. Both the source and remote EDL need to be audited (inventory) for tape recognition. So with auto-replication using **move**, the sequence of events from the BSP perspective would be something like this:

1. The BSP exports the tape from source EDL. (This moves the tape to the virtual vault and initiates the replication.)
2. The BSP inventories the source EDL. (Tells BSP the cartridge is gone.)
3. Once the replication is complete and successful, the BSP inventories the remote virtual tape library.

Q: Is there a way to auto-archive at the remote site after the replica is created?

No, remote tape must be placed in the virtual vault and manually exported from there by the SAN administrator.

Q: What type of encryption is available with remote copy?

Encryption is 56-bit RC4.

Best practices and configuration settings

The default virtual library

In version 1.2 and earlier, EMC Disk Library is designed to present a default virtual tape library with virtual tape drives. The library has four tape drives and four tape cartridges. This library is not assigned, which means it is not quite ready to be used by a backup host. The *EMC CLARiiON Disk Library Administrator's Guide* provides details on using the Disk Library Console to manage your disk library.

The library is not ready because it is not *assigned*. This means it has not been enabled for use by backup servers. You could assign the default library to the default Everyone_FC SAN client. In this case, all backup servers will "see" the library. This matches how a real fibre tape library works. The library allows many systems to share the tape drives within the library, but requires an option in your backup software—usually called *shared storage option*, SAN option, or dynamic drive sharing.

Using the Everyone_FC SAN is *not* the recommended practice for systems with multiple backup hosts. SAN clients (backup hosts) should be assigned individual libraries unless library sharing is specifically required.

Virtual libraries and drives

The EMC Disk Library is not subject to the constraints of a real physical library. With the EMC Disk Library, additional libraries can be created to address backup bottlenecks. Libraries can be created and assigned exclusively to back up hosts to ensure best possible performance. This can remove delays inherent in using shared tape drives.

Another possibility is to use a virtual tape library that has many tape drives, but *assign* a few tape drives to each backup server. In some cases, this configuration is the best of both worlds: Tape drives aren't shared,

so backups don't depend on other backups to finish. However, management of the backups is simplified because there is only one library.

The system that controls the library is still a potential single source of failure. For additional availability, consider multiple storage servers (media masters).

Persistent binding

When operating systems scan their fibre (SCSI) buses for devices, they sometimes assign different device special files than were assigned during a previous scan. Since backup software goes through a configuration process and retains information about the various tape drives in its database, this difference can impact the availability of backup devices. For instance, a backup that used to go to `/dev/rmt/2` will not operate if that device becomes `/dev/rmt/4`.

On Windows systems, the filenames might change from `\\.\Tape0` to `\\.\Tape2`.

Persistent binding refers to the ability to fix a particular device to a particular device name. Generally, you associate a WWPN, and possibly LUN, with a SCSI target ID so that the operating system always sets up the same device special files. Methods vary by operating system and by fibre card.

Some backup software products, including VERITAS NetBackup, strongly recommend persistent binding. Consult your backup server's HBA vendor for instructions on how to do this.

Everyone_FC SAN client

You may assign a virtual tape library to the `Everyone_FC` client so that all backup servers (SAN clients) will see the library regardless of the backup host WWPN. This is useful for sharing tapes. However, when a SAN client is created (this is simply a way to create a name that refers to a particular WWPN), that SAN client will no longer see the `Everyone_FC` library. Note that the `Everyone_FC` client is always present.

Assigning and unassigning virtual libraries

You may encounter unexpected behavior when assigning, then unassigning, virtual tape libraries. For example, assume that you have a library with two tape drives and that it is the first library you have assigned to a particular SAN client. The library device will be given LUN 0 and the two drives will be LUNs 1 and 2. Now, let's say that you assign another library of the same type to the same SAN client and you unassign the first library. At this point, your backup server (SAN client) will "see" the second virtual library, but it will occupy LUNs 3 through 5. Because there is a gap in LUN numbering (no LUNs 0, 1, or 2), some operating systems and backup software may become confused.

If you want only the second library assigned to the SAN client, it is recommended to change the LUNs back so they start at 0 (zero). To do this, in the Disk Library Console:

1. Right-click each device under its SAN client (after expanding).
2. Select **Properties**.
3. Choose the desired LUN from the list.

Creating virtual tapes for best performance

It is best to create as many tapes as necessary at one time. When you create tapes, they are allocated to CLARiiON LUNs in a round-robin fashion. Assume for a moment you have 10 LUNs and you need 10 virtual tapes. If you create them all at once, each tape will be on a different LUN. This behavior cannot be guaranteed when manually creating tapes one at a time, possibly resulting in reduced performance.

Archiving tapes

The method you use for creation of offsite tapes depends on the policy in place for long-term data retention and the quantity of backup data that must be saved offsite. Possible methods include:

- Export virtual tapes to physical tape using tape drives or a tape library directly connected to the disk library.
- Use backup software to make a copy of disk library virtual tapes on real tapes.

Use backup software to make a copy of disk library virtual tapes to a different virtual library within the disk library, and then export to physical tape.

- The following sections explore which of these alternative solutions for offsite tape creation might best suit your environment.

Backup software (partial) copy to tape

The backup software (partial) copy-to-tape method makes sense when you archive to offsite storage tapes that have only a subset of the backup save sets. The disk library cannot replicate portions of tapes as it has no catalog knowledge of the data being stored on the tape and no mechanism to communicate this information to the backup software. You can do this with backup software—just as when you copy from one real tape to another. This method requires your backup servers to have SAN connectivity to the disk library, as well as to the real tape library.

Backup software copy to virtual library

The backup software copy-to-virtual-library method is an alternate solution that allows you to copy individual save sets with your backup software. It also reduces management of the physical library attached to the disk library. By exporting from only the one destination virtual library to the physical library, it's easier to keep track of your exported tapes. You can also export individual save sets because backup software made the copy. The disadvantage to this method is that there is an extra step involved, and therefore it takes a longer time until your archived tapes complete.

Performance characteristics

This section provides some general rules concerning performance of the EMC Disk Library compared to real tape drives and libraries.

EMC Disk Library versus tape drives

In most cases, the EMC Disk Library is faster than real tape drives by a wide margin. If your backup infrastructure is robust and can leverage the additional speed of the emulated tapes, the improvement in performance will be noticeable. The greatest potential improvement using the EMC Disk Library is seen during restores. Partial restores where just a few small files are required from many different tapes cause tape library and drive mechanical seek delays, which can add up to several minutes per tape. Most mechanical delays are eliminated by using virtual tape.

Single-stream virtual drive performance

If just one virtual tape stream is being written, the disk library can provide in excess of 150 MB/s performance. Achieving this performance requires a backup host, backup network, and backup client that can meet the performance requirements to drive this performance to the backup target.

Aggregate performance

When many virtual tape drives simultaneously receive backup streams, the EMC Disk Library models DL4100, DL4200, and DL4400 can provide in excess of 2400 MB/s aggregate throughput (the DL4400 is greater than 2400 MB/s). However, you must take certain steps to achieve these performance levels:

-
1. Use all front-end target ports. Zone some backup servers to each port. Make sure that your backups use servers zoned to multiple ports. If you use only one 4 Gb/s Fibre Channel port, your maximum performance will be 400 MB/s—or 200 MB/s if using one 2 Gb/s Fibre Channel port.
 2. Virtual tapes are assigned to CLARiiON LUNs when they are created. To ensure that each tape library has virtual tapes located on many LUNs, create as many virtual tapes at once as possible. Allocation of the tape cartridges to separate CLARiiON LUNs helps to enforce the predictable performance characteristic of the appliance. By choosing LUNs on a round-robin basis, the appliance helps to ensure that backup data is distributed across the back-end storage systems in such a way as to support maximum performance.

Exact performance cannot be *guaranteed*. Performance of backups may be affected by multiple sources of performance delay. It is possible but not likely that backups will target specific “hot” LUNs, which may negatively impact the aggregate performance.

Configuring your backup server

The EMC Disk Library emulates standard tape drives and libraries. You set up your backup server to access disk library virtual devices the same way you set up for a real tape library. Some specific performance and ease-of-use suggestions are included in the next section, as well as in the various configuration sections. Most of these suggestions are not specific to the disk library. They apply to any tape library—especially those that employ multiple LUNs.

Device drivers

In a backup environment using the EMC Disk Library or any typical backup devices, several different driver types are involved, depending on the backup server hardware and software platform. Following are recommendations on how to set up those drivers for best results with the disk library.

These suggestions are still relevant if you use real tape libraries.

Fibre Channel port drivers

As noted previously, persistent binding is a best practice. Persistent binding is performed at the Fibre Channel HBA driver level. Procedures are vendor-specific and also vary among operating systems. Refer to your Fibre Channel card vendor’s documentation for instructions on how to do this.

If persistent binding is improperly configured, it may result in the operating system providing a device with multiple names: giving a device one device name after boot, but giving it a different name on subsequent boot. In the case of non-persistent binding, the backup software must be reconfigured to use the new device special filenames.

Tape drivers

The device driver for the tape drives that are within the virtual library is usually the first software set up on a backup server. The device driver you use depends on backup software and the operating system. Some products, such as the CA products BrightStor EB and BrightStor ARCserve, do not require a driver in Windows environments. Other products, such as IBM Tivoli Storage Manager, use their own drivers and replace regular operating-system drivers. A middle ground is offered with other backup software packages—notably VERITAS Backup Exec—that come with their own drivers. You may choose to use the special driver or standard Windows drivers.

If you create disk library virtual libraries that have the same type of tape drives as you’ve been using in your backup environment, you will likely continue using the same driver. This is preferable since the customer has verified its proper operation. However, one could decide to use a different type of tape drive

or, if implementing a different backup scheme than before, the user may have to set up device drivers for the virtual tape drives.

Windows drivers

If the user chooses a backup software product that has its own drivers (such as Backup Exec), they may want to load that driver. At the appropriate point during installation of the backup software, select the option to load drivers. Alternatively, one may load or reload the drivers after installation. Another alternative is using drivers from the vendor of the “real” tape drive. The user should download the latest and appropriate driver from the vendor’s website.

Select **System Management > Device Manager** to verify that the device drivers have been installed. If tape drives are in the Other Devices category, the user must update the driver by following instructions provided in the driver download.

Solaris drivers

Solaris’ tape driver is **st**. To get it to properly support the type of tape drive (real or virtual), the users must edit **st.conf**. Two types of edits must be made to this file:

- Type of tape drive and low-level characteristics
- Tape drive target ID and LUN

The tape drive type is specified by a string of characters, which is the drive’s SCSI Inquiry information. A second line must be edited that tells the tape driver the characteristics of the tape drive. Before editing, the user should consult the backup software vendor’s literature to see if specific settings are recommended. If no recommendations exist in the backup literature, consult the drive vendor documentation. As an example, to add proper support for LTO tape drives to a Solaris 8 system, add the following lines to **st.conf** (note that the user must add them in the correct place; this is not a complete how-to guide):

```
"IBM", "IBM Ultrium", "CLASS_LTO1",  
...  
CLASS_LTO1      = 1, 0x24, 0, 0x45863d, 2, 0x00, 0x01, 0;
```

You must also specify the tape drive target ID and LUN.

You often don’t know what target ID Solaris will assign to a particular tape drive.

The LUNs can be determined by checking the Disk Library Console. Expand the library under SAN clients to find the LUNs the disk library has given to each of the virtual devices. You must ensure that **st.conf** contains an entry for each of the LUNs. It may also be necessary to hunt for the target ID that Solaris gives the tape device. It may simply be easier to put a line in **st.conf** for several target IDs. As an example, here are the lines you would add to **st.conf** to allow LUNs up to eight on IDs 0, 1, 2, and 3:

```
name="st" class="scsi"  
    target=0 lun=0;  
  
name="st" class="scsi"  
    target=0 lun=1;  
  
name="st" class="scsi"  
    target=0 lun=2;  
  
name="st" class="scsi"  
    target=0 lun=3;
```

```
name="st" class="scsi"
    target=0 lun=4;

name="st" class="scsi"
    target=0 lun=5;

name="st" class="scsi"
    target=0 lun=6;

name="st" class="scsi"
    target=0 lun=7;

name="st" class="scsi"
    target=0 lun=8;

name="st" class="scsi"
    target=1 lun=0;

name="st" class="scsi"
    target=1 lun=1;

name="st" class="scsi"
    target=1 lun=2;

name="st" class="scsi"
    target=1 lun=3;

name="st" class="scsi"
    target=1 lun=4;

name="st" class="scsi"
    target=1 lun=5;

name="st" class="scsi"
    target=1 lun=6;

name="st" class="scsi"
    target=1 lun=7;

name="st" class="scsi"
    target=1 lun=8;

name="st" class="scsi"
    target=2 lun=0;

name="st" class="scsi"
    target=2 lun=1;

name="st" class="scsi"
    target=2 lun=2;

name="st" class="scsi"
    target=2 lun=3;

name="st" class="scsi"
    target=2 lun=4;
```

```
name="st" class="scsi"
    target=2 lun=5;

name="st" class="scsi"
    target=2 lun=6;

name="st" class="scsi"
    target=2 lun=7;

name="st" class="scsi"
    target=2 lun=8;

name="st" class="scsi"
    target=2 lun=9;

name="st" class="scsi"
    target=2 lun=0;

name="st" class="scsi"
    target=3 lun=0;

name="st" class="scsi"
    target=3 lun=1;

name="st" class="scsi"
    target=3 lun=2;

name="st" class="scsi"
    target=3 lun=3;

name="st" class="scsi"
    target=3 lun=4;

name="st" class="scsi"
    target=3 lun=5;

name="st" class="scsi"
    target=3 lun=6;

name="st" class="scsi"
    target=3 lun=7;

name="st" class="scsi"
    target=3 lun=8;
```

Once the correct ID has been found, remove the others. Solaris takes longer to boot if it has to check for more devices.

If you set up persistent binding, you will know the target ID.

EMC NetWorker

Each backup application has its own configuration requirements. Following are recommendations on how to get best results with specific backup software.

Device drivers

EMC NetWorker does not require special drivers or driver settings. The user sets up tape drivers directly in the operating system for the virtual tape drives within the virtual libraries.

Scanning devices

Use NetWorker's **inquire** command to make sure that virtual tape libraries and their drives are visible to the operating system.

If there is a gap in LUNs, run **inquire -l** to force LUN detection across gaps in LUN numbering.

jbconfig

This is similar to **inquire**. If there is a gap in LUNs, run **jbconfig -l**.

VERITAS NetBackup

Device drivers

Consult VERITAS NetBackup documentation for special driver considerations. Generally, the tape vendor's drivers are required for Windows. However, for UNIX systems, refer to the *NetBackup Media Manager Device Configuration Guide for UNIX*.

Scanning devices

Run **sgscan** to verify that the operating system and NetBackup can see all the virtual tape devices. Usually on UNIX systems, you must properly install and configure an **sg** driver. It is not sufficient for the UNIX system to have properly configured tape devices (such as `/dev/rmt/0`, `/dev/rmt/1`, and so on); you must also ensure the **sg** driver has been configured to handle the highest target ID and LUN. Otherwise, **sgscan** won't list the devices. NetBackup documentation describes how to set up the **sg** driver using scripts **sg.build** and **sg.install**.

NetBackup settings for best performance

The user must change the default NetBackup settings to obtain best performance—especially on UNIX systems. Increasing the size of backup buffers and their quantity has a profound effect on performance. The greatest improvement is obtained by setting `SIZE_DATA_BUFFERS` to 128 KB (131072) and `NUMBER_DATA_BUFFERS` to 16 KB. Defaults are 64 KB and 8 KB, respectively.

Refer to VERITAS NetBackup documentation on Symantec's website (<http://www.symantec.com>) for precise details. There are different documents for UNIX and Windows systems.

On Solaris systems, it may be necessary to add a line to the `/etc/system` file similar to:

```
set shmsys:shminfo_shmmax=XXXXXXXX
```

where `XXXXXXXX` is the maximum amount of memory to allocate to shared memory. This will eliminate potential system call errors.

It is not always possible to change these settings in all environments. These are global settings and affect all tape drives — not just virtual tape drives. The user cannot implement a tape drive type-specific setting. It is not advisable to change the block size when using the Shared Storage option. To do so, one must be very careful to ensure the same changes are implemented on all systems running NetBackup to eliminate possible system restore errors across systems. Otherwise, restores across systems may fail. Increasing the size of the buffers increases the amount of memory NetBackup reserves which, in turn, reduces the amount of memory available for other processes. This may negatively impact the performance of other applications run at the same time as backups.

Tivoli Storage Manager

Device drivers

Tivoli Storage Manager (TSM) uses its own tape drivers. Refer to TSM documentation for details.

Other recommendations

- To take full advantage of the device-configuration facilities of TSM, it may be necessary to install the latest version of TSM. Use the TSM device configuration and media-labeling wizards. You can also use the TSM console administration interface to accomplish configuration manually.
- When a virtual library is first assigned to an AIX-based TSM installation, the user may need to reboot the system in order for it to recognize the autochanger.
- Consult the *EMC CLARiiON Disk Library Release Notes* for specific information.

Creating physical tapes

Users can create physical tapes directly with the disk library or can use the standard method of copying or *cloning* with backup software. Virtual tapes look just like real tapes and can be the source tape when copying.

Export

If a physical tape drive or library is used on the SCSI or fibre bus of the disk library, users can *export* to tape. This process, while initiated by the backup software issuing an eject, does not require the data to traverse the SAN. Advantages of this method are:

- No CPU cycles and no I/O bandwidth resources are consumed on the backup server.
- The backup server does not need to retain connectivity to both the disk library and a real tape library.

Disadvantages of this method are:

- Bandwidth is limited by the throughput of the single 2 Gb FC port or the SCSI bus.
- There is a small risk that the entire contents of the virtual tape *may not* fit on the physical tape. The disk library default cartridge size accounts for usable tape capacity, which may vary from manufacturer specification.
- The dedicated tape library must match the format of the virtual library. It is not possible to copy to a different physical tape type.
- The user must select to move cartridges. Use of the copy alternatives is reserved for full parallel backup environments where a complete disaster recovery copy of the backup indexes and catalogs is required.
- An export can be directed to any tape in a library. This is similar to a stand-alone physical tape drive being used for export: Manual record keeping is involved unless the backup software contains some type of vaulting software to track offsite cartridges.

When a disk library virtual tape is exported to a physical tape, the physical tape is identical to a tape that was written directly by the backup software and can be used to restore files directly on a system (without the disk library). The restore environment must conform to certain rules:

- The same backup software must be used as that which wrote the virtual tape.
- The same type of tape drive must be used as that which wrote the physical tape.

When creating physical tapes on the disk library itself, there are two options:

- Set up the disk library for auto-archive, in which case the backup software triggers an export.
- Explicitly export to tape using the Disk Library Console. (This method requires manual cataloging of cartridges.)

Export via backup software

To export via backup software, you enable the auto-archive feature when you create a virtual tape library. When a virtual tape is ejected from its virtual library with the backup software, it triggers the disk library to automatically export to physical tape.

The requirements for this method to work are:

- You must use a back-end tape library (will not support stand-alone physical drives).
- Barcodes of tapes in the physical library must match those of the virtual library. (When auto-export is enabled for a virtual library, automation of the tape creation process creates matching tapes.)
- Tapes can be ejected from virtual libraries using the backup software's GUI. For a more automated approach, scripts to eject tapes can be called when backups finish.

Export via Disk Library Console

While you may explicitly export tapes using the Disk Library Console, this method will cause confusion with most backup software. Manual export works with both stand-alone physical tape drives and with physical tape libraries. It allows export to any tape (does not require matching barcodes), but the user must keep track of the tape(s).

Exporting to physical tape

There must remain a one-to-one correspondence when using export to move data from emulated tape to physical tape. For this reason, some precautions are taken when creating virtual tapes:

- The default emulated tape cartridge size is slightly less than the quoted maximum from the drive vendors. On rare occasions, the compression algorithm used by disk library could be more efficient than that used by the physical tape drive. If no precautions were taken, it's possible the data might not fit on the physical tape.
- Utilization of the physical tape drive capacity may not be ideal. This is especially the case when the emulated tape drive does not enable compression.

Conclusion

EMC Disk Libraries provide significant performance advantages over tape-based solutions. Backups and restores can now easily be completed within ever-shrinking backup windows.

References

- *NetBackup Media Manager Device Configuration Guide for UNIX*
- *EMC CLARiiON Disk Library Release Notes*
- *EMC CLARiiON Disk Library Administrator's Guide*

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- *iSeries and EMC CLARiiON Disk Library Implementation Guide*

The following white paper can be found on [EMC.com](#) and [Powerlink](#):

- *EMC Disk Library with NetWorker*