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EMC Corporation
Hopkinton, Massachusetts 01748-9103
1-508-435-1000 In North America 1-866-464-7381
www.EMC.com
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</tbody>
</table>
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Purpose
EMC Disk Library for mainframe (DLM) provides IBM tape drive emulation to the z/OS mainframe using disk storage systems in place of physical tapes. This guide provides information about the features, performance, and capacities of DLM 4.0 and later. It also includes installation and configuration information that is required for ongoing operation.

Audience
This guide is part of the EMC DLM documentation set, and is intended for use by system operators to assist in day-to-day operation. Installation, configuration, and maintenance tasks must be accomplished by qualified EMC service personnel only.

Readers of this document are expected to be familiar with tape library operations and the associated tasks in the mainframe environment.

Related documentation
The following EMC publications provide additional information:

- EMC Disk Library for mainframe Physical Planning Guide
- EMC Disk Library for mainframe Command Processor and Utilities for z/OS Guide
- EMC Disk Library for mainframe Release Notes

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EMC uses the following conventions for special notices:

⚠️ DANGER
Indicates a hazardous situation which, if not avoided, will result in death or serious injury.

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Indicates a hazardous situation which, if not avoided, could result in death or serious injury.
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Indicates a hazardous situation which, if not avoided, could result in minor or moderate injury.

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Addresses practices not related to personal injury.

Note
Presents information that is important, but not hazard-related.

EMC uses the following type style conventions in this document:

Table 1 Typographical conventions

<table>
<thead>
<tr>
<th>Style</th>
<th>Use</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Bold</strong></td>
<td>Use for names of interface elements, such as names of windows, dialog boxes, buttons, fields, tab names, key names, and menu paths (what the user specifically selects or clicks)</td>
</tr>
<tr>
<td><em>Italic</em></td>
<td>Use for full titles of publications referenced in text</td>
</tr>
<tr>
<td><strong>Monospace</strong></td>
<td>Use for:</td>
</tr>
<tr>
<td></td>
<td>• System code</td>
</tr>
<tr>
<td></td>
<td>• System output, such as an error message or script</td>
</tr>
<tr>
<td></td>
<td>• Pathnames, filenames, prompts, and syntax</td>
</tr>
<tr>
<td></td>
<td>• Commands and options</td>
</tr>
<tr>
<td><strong>Monospace italic</strong></td>
<td>Use for variables</td>
</tr>
<tr>
<td><strong>Monospace bold</strong></td>
<td>Use for user input</td>
</tr>
<tr>
<td>[ ]</td>
<td>Square brackets enclose optional values</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>{ }</td>
<td>Braces enclose content that the user must specify, such as x or y or z</td>
</tr>
<tr>
<td>...</td>
<td>Ellipses indicate nonessential information omitted from the example</td>
</tr>
</tbody>
</table>

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Your comments
Your suggestions will help us continue to improve the accuracy, organization, and overall quality of the user publications. Send your opinions of this document to techpubcomments@emc.com.
CHAPTER 1

Overview of Disk Library for mainframe

This chapter provides an overview of Disk Library for mainframe.

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Introduction to Disk Library for mainframe

The EMC® Disk Library for mainframe (DLm) family of products provides IBM System z mainframe customers the ability to replace their physical tape libraries, including traditional virtual tape libraries such as the IBM VTS and Sun/STK VSM, with dynamic tape-less virtual tape solutions, eliminating the challenges tied to traditional tape-based processing.

Some customers have already implemented mainframe host-based tape-emulation solutions such as IBM VTFM (formerly known as CopyCross™) and CA Vtape. However, these solutions utilize expensive host CPU cycles to perform the tape operations, and direct access storage device (DASD) space to store the tape volumes. DLm provides the option for these customers to offload the tape emulation processes from the mainframe host and free up DASD space.

All DLm models are built using a common tape-on-disk software package known as Virtuent. The Virtuent software runs on a base hardware controller which provides one or two FICON connections to the mainframe.

DLm works seamlessly with the mainframe environment, including the major tape management systems, such as DFSMS, DFHSM, and backup applications, such as DFDSS and FDR, and others without the need to change any of the customer’s JCL statements. There is no need to start a task or define a specific subsystem to operate DLm because the mainframe host sees the DLm just as tape devices. DLm tape drives can be shared across LPARs without the need for additional tape sharing software through local device varying or through the implementation of MTL definitions.

DLm provides disaster recovery protection using bidirectional replication between two DLm systems in the same or different sites. It also supports unidirectional replication from one DLm system to up to four DLm systems that could be in different sites.

Since the tape information is kept on disk, DLm enables you to perform disaster recovery tests without compromising your business continuance by having to stop replication during testing.

DLm offers a deduplication feature that delivers the aggregate throughput performance needed for enterprise data centers. This results in lower storage costs and efficient use of replication links as only unique data is transported between the sites.

In summary, the DLm offers you many benefits over traditional tape libraries and virtual tape libraries including high performance, higher reliability, advanced information protection, and overall lower total cost of ownership (TCO).

DLm8100 architecture

The major components of a DLm8100 system are the virtual tape emulation controller (VTEC) and the back-end storage system that can be one of the following or a combination of any two:

- EMC VNX® (VNX5400 or VNX7600) with integrated disk storage arrays

Note

VNX7500 is supported only if the DLm software has been upgraded from an older version. You cannot add a new VNX7500.

- Data Domain® storage system (DD990, DD7200, or DD9500)
• **CloudArray**

DLm8100 provides deduplicated storage using Data Domain systems and traditional disk storage using EMC VNX systems or CloudArray. You can have one of the storage types or a combination of them. For documentation purposes, we will use the following terms:

• Deduplication storage model: DLm8100 with Data Domain storage only
• VNX storage model: DLm8100 with VNX storage only
• CloudArray
• Combination model: DLm8100 with any two of the supported storage types

The following figure shows an overview of how the various components of the DLm8100 system are connected to each other.

**Figure 1 DLm8100 Architecture**

---

**VTEC Overview**

The VTEC is a subsystem that connects to an IBM or IBM-compatible mainframe and provides the emulation of IBM 3480/3490/3590 tape drives. A VTEC contains the following components:

- 1 to 8 virtual tape engines (VTEs)
- A pair of 24-port (1 GbE) switches for the management network
- A pair of 10 GbE switches for data transfer

**VTE**

Each DLm configuration can have from 1 to 8 VTEs. The mainframe virtual tape emulation software, Virtuent, executes on the VTEs. The VTEs emulate IBM tape drives and interface to the mainframe and direct tape data to and from the back-end storage arrays. This data is written to the storage arrays and stored in NFS file systems over a redundant 10G data network.
The following figure shows the VTE buttons and LEDs on its front panel:

**Figure 2** VTE buttons and LEDs — Front panel

The following figure shows the rear view of the VTE:

**Figure 3** VTE — Rear view

DLm8100 management network

The DLm has an internal Gigabit Ethernet network for management purposes. In a DLm8100, the VTEs, VNX, and Data Domain systems management ports are connected to a pair of ATI9924TL switches to protect against a single switch failure.

DLm release 4.1.0 and later provides support for the IPv6 protocol. Each external network interface in the DLm will be configurable for IPv6-only, dual IPv4/IPv6, or
IPv4-only addressing. To configure IPv6 support on your DLm, contact EMC Customer Service.

Figure 4 24-port AT-9924TL switch

DLm8100 data network

In a DLm8100, the data from the mainframe is transferred to the DLm8100 storage systems over 10 Gigabit Ethernet connections.

The 10 GbE DLm data LAN contains two Brocade switches:

- Data switch 1 is the bottom switch in the pair.
- Data switch 2 is the top switch in the pair.

DLm 4.3.0 and earlier use Brocade VDX 6720 switches. DLm 4.4.0 and later use Brocade VDX 6740 switches.

Figure 5 Brocade VDX 6720 switch

Figure 6 Brocade VDX 6740 switch

DLm8100 back-end storage

DLm8100 uses VNX (VNX5400/VNX7600), Data Domain (DD990, DD7200, or DD9500), CloudArray, or a combination of any two of these for storing the data written to the virtual tapes.

In a DLm8100, D990/DD7200/DD9500 is to be used for data that deduplicates well and VNX5400/VNX7600 or CloudArray is used for other data. These systems export NFS file systems and the VTEs then use these NFS file systems to store the data.

Deduplicating storage

The Data Domain system provides DLm's deduplication feature. DLm uses a highly optimized inline data deduplication technology that reduces the footprint by storing only the unique data. This also reduces power consumption and provides a significant
total cost saving. The data is streamed from the mainframe through the VTEs to the back-end Data Domain storage system. Due to the inline implementation, only the deduplicated, unique data gets stored on the drives.

Deduplication back-end storage is best suited for data that is stored long term and is highly redundant.

Each Data Domain system contains:

- A storage controller that executes the Data Domain operating system and supports redundant 12 Gb/s SAS connectivity to the back-end drive enclosures.
- ES30 storage shelves. Each shelf contains fifteen disk drives.

VNX storage

The DLm8100 can be configured with a maximum of two VNX5400/VNX7600 network file servers. Each VNX file server can have 2-8 storage controllers called Data Movers. All DLm8100 systems are configured with a standby Data Mover.

Choose VNX file storage for a large volume of data that does not need to be stored for long periods of time and is not extensively redundant to warrant deduplication.

Cloud storage

The CloudArray appliance attached to a DLm provides a cloud gateway that makes cloud storage look like NAS storage to the DLm VTE.

CloudArray writes to the cloud as a thin or thick provisioned "block device". CloudArray presents cloud storage through standard NFS, making use of large local disk cache(s) to buffer data headed to Public or Private cloud storage.

CloudArray performance depends highly on fast local disk cache. Disk caching maintains frequently accessed data locally while simultaneously replicating it to the cloud. The snapshot scheduler allows users to schedule and maintain pointer-driven,
in-cloud snapshots of their data for greater protection. Bandwidth throttling and scheduling help to minimize WAN network impact, allowing users to set bandwidth limits during peak hours to ensure high network performance.

Mainframe channel interfaces

A VTE contains mainframe channel interfaces. These channel interfaces are two Fibre Connectivity (FICON) interfaces per VTE. The FICON interfaces can be either single mode or multimode.

A DLm8100 system can be configured with 1 to 8 VTEs, providing a maximum of 16 FICON interface connections. The DLm8100 supports only FICON connections.

FICON Channel

You must attach at least one mainframe channel to each VTE you intend to configure to be operational. Any VTE not attached to a mainframe channel will not be operational.

Each DLm VTE FICON interface has a single LC-type fiber-optic connector. The type of cable you must use depends on the following:

- The type of connector on the mainframe (either LC or SC)
- The type of fiber-optic cable (single mode or multimode) supported by the mainframe channel

DLm FICON interfaces are available either with single mode or multimode fiber-optic cable support. The core size micron ratings for the cables are as follows:

- Single mode fiber-optic cable: 9/125
- Multimode fiber-optic cable: either 50/125 or 62.5/125

DLm connection to a FICON channel

DLm can be connected directly to the mainframe FICON channel or it can be connected through a FICON switch. In either case, to properly define a DLm V348x, 3490, 3480, or 3590 device on a z/OS system, the following parameters are required:

- **TYPE** must be FC.
- **UNIT** can be defined as one of the following:
  - One of the virtual device types: V3480, V3481, V3482, or V3483
  - A real 3480, 3490, or 3590
- **CHPID** can be defined as any one of the following:
  - SHARED
  - DED
  - REC

**Note**

V348x should only be used if no other option is available. Use of a V348x device requires installation of the EMC Unit Information Module (UIM). EMC Unit Information Module provides more information.
FICON and Fibre cards status indicators for DLm

Each FICON interface has LED status indicators visible through its backplate. These indicate which speed the link is running 2, 4, and 8 Gbps. When the link is up, the LED remains steadily on and, if there is traffic, it blinks. The numbers stamped into the faceplate correspond to the speed. The following table describes the FICON status indicators for DLm:

**Table 2 Status Indicators**

<table>
<thead>
<tr>
<th>Hardware State</th>
<th>Yellow LED (8G)</th>
<th>Green LED (4G)</th>
<th>Amber LED (2G)</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Power off</td>
<td>Off</td>
<td>Off</td>
<td>Off</td>
<td>Card has no power.</td>
</tr>
<tr>
<td>Power on — before the on-chip firmware initializes</td>
<td>On</td>
<td>On</td>
<td>On</td>
<td>All LEDs are on continuously.</td>
</tr>
<tr>
<td>Power on — after the on-chip firmware initializes</td>
<td>Flash</td>
<td>Flash</td>
<td>Flash</td>
<td>All LEDs flash at the same time.</td>
</tr>
<tr>
<td>Firmware fault</td>
<td>Flash in sequence</td>
<td>Flash in sequence</td>
<td>Flash in sequence</td>
<td>Flashes in the following sequence: Yellow &gt; Green &gt; Amber, then repeating with Yellow.</td>
</tr>
<tr>
<td>2 Gbps link up/activity</td>
<td>Off</td>
<td>Off</td>
<td>On/flash</td>
<td>On for link up. If there is I/O activity, the amber LED flashes several times per second.</td>
</tr>
<tr>
<td>4 Gbps link up/activity</td>
<td>Off</td>
<td>On/flash</td>
<td>Off</td>
<td>On for link up. If there is I/O activity, the green LED flashes several times per second.</td>
</tr>
<tr>
<td>8 Gbps link up/activity</td>
<td>On/flash</td>
<td>Off</td>
<td>Off</td>
<td>On for link up. If there is I/O activity, the yellow LED flashes several times per second.</td>
</tr>
</tbody>
</table>

**DLm capacity**

The following table provides details of the minimum and maximum supported capacity:
Table 3 DLm8100 device details

<table>
<thead>
<tr>
<th>Item</th>
<th>Maximum</th>
<th>Minimum</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of cabinets per system (max. conf.: 1 VTEC, 2 VNX, 10 VNX Storage cabinets, 2 DD990/DD7200/DD9500)</td>
<td>13</td>
<td>2</td>
</tr>
<tr>
<td>Number of virtual tape engines (VTEs)</td>
<td>8 (including 2 Management VTEs - VTE1 and VTE2)</td>
<td>1</td>
</tr>
<tr>
<td>Front-end 8G FICON channels (to the host)</td>
<td>16</td>
<td>2</td>
</tr>
<tr>
<td>Maximum active tape devices</td>
<td>2048</td>
<td>256</td>
</tr>
<tr>
<td>VNX storage systems</td>
<td>2 VNX5400 or 2 VNX7600 systems</td>
<td>Zero$^a$</td>
</tr>
<tr>
<td><strong>Note</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Currently, only one VNX model is allowed in a DLm. You cannot have one of each model in the same DLm.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Data Domain storage systems</td>
<td>2 DD990, DD7200, and DD9500 storage systems</td>
<td>Zero</td>
</tr>
<tr>
<td><strong>Note</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Currently, only one DD model is allowed in a DLm. You cannot have two different models in the same DLm.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Number of VNX Data Movers: VNX7600/VNX5400</td>
<td>8 per VNX7600 (7 active and 1 hot standby)</td>
<td>2 per VNX (1 active and 1 hot standby)</td>
</tr>
<tr>
<td>Number of DD storage controllers: DD990/DD7200/DD9500</td>
<td>1 per DD990/DD7200/DD9500</td>
<td>1 per DD990/DD7200/DD9500</td>
</tr>
<tr>
<td>Number of DAEs supported (dependent on DAE capacity; 2TB, 3TB or 4TB drives)</td>
<td>59 per VNX7600, 118 total 15 per VNX5400, 30 total</td>
<td>1 per VNX</td>
</tr>
<tr>
<td>Usable Storage (TiB) per VNX7600/VNX5400</td>
<td>VNX7600: 1936.79 (with 4TB drives) VNX5400: 493.33 (with 4TB drives)</td>
<td>9.28 (with 2TB drives)</td>
</tr>
<tr>
<td>Number of ES30s supported (dependent on ES30 capacity)</td>
<td>30 per DD9500 24 per DD990 18 per DD7200</td>
<td>1 per DD</td>
</tr>
</tbody>
</table>
Table 3 DLm8100 device details (continued)

<table>
<thead>
<tr>
<th>Item</th>
<th>Maximum</th>
<th>Minimum</th>
</tr>
</thead>
<tbody>
<tr>
<td>Usable storage (TiB) per Data Domain</td>
<td>DD9500: 786 TiB</td>
<td>19 TiB</td>
</tr>
<tr>
<td></td>
<td>DD990: 518 TiB</td>
<td></td>
</tr>
<tr>
<td></td>
<td>DD7200: 389 TiB</td>
<td></td>
</tr>
<tr>
<td>Logical storage per Data Domain at 10:1 total compression</td>
<td>DD9500: 7.86 PiB</td>
<td>190 TiB</td>
</tr>
<tr>
<td></td>
<td>DD990: 5.18 PiB</td>
<td></td>
</tr>
<tr>
<td></td>
<td>DD7200: 3.89 PiB</td>
<td></td>
</tr>
</tbody>
</table>

a. In DLm8100, a minimum of one storage system should be present - either VNX5400/VNX7600 or DD990/DD7200/DD9500 storage system.

The following table provides details of the front-end 8G FICON connections.

Table 4 Mainframe Connectivity Details

<table>
<thead>
<tr>
<th>Item</th>
<th>Supported number</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of unique LPARs</td>
<td>256</td>
</tr>
<tr>
<td>Number of control units</td>
<td>16</td>
</tr>
<tr>
<td>Maximum number of paths supported per VTE</td>
<td>4096</td>
</tr>
</tbody>
</table>

Tape emulation

DLm VTEs emulate the IBM tape drives to the mainframe and direct the tape data to and from the back-end storage arrays. Each VTE, once configured, operates independently of the other VTEs in the VTEC.

A DLm system configured with one VTE can emulate up to 256 virtual tape devices, while one with eight VTEs can emulate up to 2,048.

The virtual tape emulation software performs the following functions:

- Receives and interprets channel command words (CCWs) from the host.
- Sends and receives the tape data records and reads and writes corresponding disk data in response to the CCWs.
- Presents initial, intermediate, and final status to the host commands and asynchronous status as needed.
- Sends and receives control information (such as sense and load display data) to and from the host in response to the CCWs.

Virtual tape drive states

A virtual tape drive is in one of the two basic states at any given time — Not Ready or Ready:

- Not Ready — The virtual tape drive appears online to the host but in an unmounted state. As on a real tape drive, most channel commands are not accepted in this state and receive a Unit Check status with an Intervention Required sense. While in the Not Ready state, no disk file is opened on the disk subsystem.
The Not Ready state is the initial state of all virtual tape drives, and is entered whenever an Unload command is received from the mainframe.

- Ready — The virtual tape drive accepts all data movement, read, and write commands from the host exactly like the emulated tape drive. As the host reads, writes, and otherwise positions the virtual tape, Virtuent, the virtual tape emulation application, maintains synchronization of the associated disk file to exactly match the content and positioning of the virtual tape volume.
  
  A virtual tape drive enters the Ready state when it receives a load-display Mount request from the host. When the Mount message is received, the disk file associated with the volume specified in the Mount message is opened, and the virtual tape drive comes ready to the host. The virtual tape drive remains in the Ready state, with the associated disk file open, until an Unload command is received from the host. On receiving an Unload command, the disk file is closed and the virtual tape drive enters the Not Ready state.

Data formats

The default file format for tape data written to DLm disks is a modified AWSTAPE format. This format keeps track of record lengths as the file is being written so that the variable length records can be read exactly as they were originally written.

Support for physical tape drives

DLm also supports low-volume access to enable the mainframe to read from and write to physical tapes. Each VTE contains a dual port Fibre Card interface to support one physical IBM 3592 tape drive or TS1120 that can be attached by using point-to-point connection (at link speeds of 2, 4, and 8 Gb) The Fibre Channel port provided for this connection uses standard multimode fiber-optic cable with LC-type connectors.

The following figure shows the QLE2562 with the (external tape) at the back of the VTE.

Figure 8 VTE — Rear view

<table>
<thead>
<tr>
<th>Serial port (for modem)</th>
<th>Qlogic QLE2562 (external tape)</th>
<th>Qlogic QLE2562 (mainframe FICON)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dual 750 Watt power supplies</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Channel 2</td>
<td>Channel 1</td>
<td>Channel 2</td>
</tr>
<tr>
<td>Eth 0</td>
<td>Eth 2</td>
<td>Eth 4</td>
</tr>
<tr>
<td>Eth 1</td>
<td>VGA</td>
<td>RMM</td>
</tr>
<tr>
<td>Eth 3</td>
<td>USB ports</td>
<td>Eth 5</td>
</tr>
<tr>
<td>Serial port</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

DLm VTE
Table 5 VTE ports — Rear panel

<table>
<thead>
<tr>
<th>Port</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>Eth0 and Eth1</td>
<td>These ports should be connected to the management switch (management network).</td>
</tr>
<tr>
<td>Eth2 and Eth3</td>
<td>These ports should be connected to the customer network for access for VTE1 and VTE2 only.</td>
</tr>
<tr>
<td>Eth4 and Eth5</td>
<td>These ports should be directly connected to the data switches (data network).</td>
</tr>
<tr>
<td>Serial port</td>
<td>Debugging purpose.</td>
</tr>
<tr>
<td>QLE2562 (external tape) Channel 1 and 2</td>
<td>Connect to an external physical tape drive (link speeds of 2, 4, 8 Gb).</td>
</tr>
<tr>
<td>QLE2562 (mainframe FICON) Channel 1 and 2</td>
<td>Connect the FICON channel cables from the mainframe to these ports (link speeds of 2, 4, 8 Gb).</td>
</tr>
<tr>
<td>RMM</td>
<td>Remote Management Module is connected to management switches for remote management of the VTE.</td>
</tr>
<tr>
<td>USB</td>
<td>Plug in a USB drive to upload or download data from/to the VTE.</td>
</tr>
<tr>
<td>Power Suppliers</td>
<td>Two 750 Watt power supplies. Connect one black cord and one gray cord.</td>
</tr>
</tbody>
</table>

High availability features

DLm includes failure recovery mechanisms in various parts of its architecture to ensure optimum availability.

VTEC

A VTEC delivers enterprise-class availability and scalability through a modular design based on high-performance, highly available VTEs.

- VTEs have redundant power supplies, fans, and RAID-protected internal disks. Emulated tape drives on each VTE can mount any cartridge and any logical partition (LPAR) can access any cartridge, delivering enterprise-class availability.
- DLm8100 configured with two VTEs or more has a shared IP address to ensure high availability for management functions. If the primary Management VTE (VTE1) fails, the secondary Management VTE (VTE2) takes over as the primary, and the shared IP address moves over to that Management VTE (VTE2).
- The configuration files are saved on the Management VTE to allow quick and easy restoration if a VTE is replaced. The files are also copied over to the secondary Management VTE. The redundant copies of the configuration files protect against the single point of failure of a VTE.
- VTEs provide redundant data and control paths. The redundant data path provides failover to protect against link failures, network card failures, and switch failures.
- In DLm8100, two 10 GbE switches provide a redundant data path, and two 1 GbE switches provide a redundant control path.
- The 10 GbE ports on the VNX and Data Domain storage controllers of DLm8100 are bonded together in failover mode also.
VNX server

The VNX server provides the following benefits:

- Storage controller failover
- Fail-Safe Network (FSN)—DLm 4.3.0 and earlier
- Link Aggregation Control Protocol (LACP)—4.4.0 and later
- Control Station failover

Storage controller failover

The VNX server protects against hardware or software failure by providing at least one standby storage controller. A standby storage controller ensures that the VTEs have continuous access to file systems. When a primary storage controller fails, the standby storage controller assumes the identity and functionality of the failed storage controller.

Fail-Safe Network (FSN)

FSN is a high-availability networking feature supported by the VNX storage controllers in DLm 4.3.0 and earlier. An FSN connection may consist of a single or multiple physical links, but only one link is active at a time. VNX defines each set of links to be a single FSN connection with a single hardware (MAC) address.

If the VNX storage controller detects that the active link has failed, the storage controller automatically switches to the standby link in the FSN. The individual links in the FSN connect to different switches so that, if the switch for the active link fails, the FSN fails over to a link using a different switch.

Link Aggregation Control Protocol (LACP)

DLm 4.4.0 and later systems use Brocade VDX 6740 10G switches which are configured for LACP to provide better scalability and increased throughput to utilize the increased performance capabilities of DLm storage options.

LACP scales well as networks grow. It provides the following abilities:

- Detects the availability of individual network ports
- Dynamically adds and removes available network ports to a statically defined network trunk group (called a Link Aggregation Group or LAG) to provide additional bandwidth
- Continuously monitors each individual connection (at a user selectable rate)

All of the ports in the LACP groups are active. A single network transaction on an LACP trunk will not use more than one single network connection within the LACP trunk. The VTE, the 10 GbE switches and the storage controllers employ hashing algorithms to determine which of the available network ports is used for each network transaction. Once the port is selected, the transaction will continue over that port until it is complete.

LACP distributes the workload in such a way that no individual port on the data path becomes a performance bottleneck.

Control Station failover

The VNX server provides a primary and secondary Control Station that ensures uninterrupted file access to users when the primary Control Station is rebooted,
upgraded, or unavailable. The Control Station software, which is used to configure and manage the VNX server, operates independently of the file-access operations and services provided by storage controllers.

The VNX network server uses the ConnectEMC or E-mail Home utility to notify EMC Customer Support (or your service provider) of the failure. After the primary Control Station is repaired or replaced and the Control Stations are rebooted, either directly or as a result of a powerdown and restart cycle, the first Control Station to start is restored as the primary.

VNX network server comes with RAID 6 protection to ensure high availability.

Data Domain

Because the Data Domain operating system (DD OS) is designed for data protection, the goal of its architecture is data invulnerability. Its design includes:

- End-to-end verification
- Fault avoidance and containment
- Continuous fault detection and healing
- File system recovery

End-to-end verification

When the DD OS receives a write request from the backup software, it computes a checksum over the data. After analyzing the data for redundancy, it stores only the new data segments and all of the checksums. After the backup is complete and all the data has been synchronized to disk, the DD OS verifies that it can read the entire file from the disk platter through the Data Domain filesystem, and that the checksums of the data that is read back match the checksums written. This ensures that the data on the disks is readable and correct, can be recovered from every level of the system, and that the filesystem metadata structures used to find the data are also readable and correct.

Fault avoidance and containment

The biggest risk to filesystem integrity is filesystem software errors that occur when writing new data. New data can accidentally write on existing data, and new updates to filesystem metadata can mangle existing structures. Data Domain systems are equipped with a specialized log-structured filesystem that has four important benefits:

- New data never overwrites good data
  Unlike a traditional filesystem, which will often overwrite blocks when data changes, Data Domain systems write only to new blocks. This isolates any incorrect overwrite (for example, a software defect issue) to only the newest backup data. Older versions remain safe.

- Fewer complex data structures
  The Data Domain filesystem was built to protect data in backup applications, where the workload is primarily sequential writes of new data. Because the application is simpler, fewer data structures are required to support it. As long as the system can keep track of the head of the log, new writes will not touch old data. This design simplicity greatly reduces the chances of software errors that could lead to data corruption.

- NVRAM for fast, safe restart
  The system includes a non-volatile RAM write buffer into which it puts all data not yet safely on disk. The filesystem leverages the security of this write buffer to
implement fast and safe restart capability. The filesystem includes many internal
logic and data structure integrity checks. If any problem is found by one of these
checks, the filesystem restarts. The checks and restarts provide early detection
and recovery from the kinds of bugs that can corrupt data.

As it restarts, the Data Domain filesystem verifies the integrity of the data in the
NVRAM buffer before applying it to the filesystem and so ensures that no data is
lost due to the restart. Data Domain systems never update just one block in a
stripe. Following the no-overwrite policy, all new writes go to new RAID stripes
and those new RAID stripes are written in their entirety. The verification after
write ensures that the new stripe is consistent. New writes do not put existing
backups at risk.

Continuous fault detection and healing

As a basis of continuous fault detection and healing, the Data Domain system uses
RAID 6 protection to protect against double disk faults.

On-the-fly error detection and correction

To ensure that all data returned during a restore is correct, the Data Domain file
system stores its on-disk data structures in formatted data blocks that are self-
identifying and verified by a strong checksum. On every read from disk, the system
first verifies that the block read from the disk is the block expected. It then uses the
checksum to verify the integrity of the data. If any issue is found, the system uses
RAID 6 and its extra level of redundancy to correct the data error. Because the RAID
stripes are never partially updated, their consistency is ensured and thus the ability to
heal an error when it is discovered.

Scrub to ensure data does not go bad

Data Domain systems verify the integrity of all data weekly in an ongoing background
process. This scrub process finds and repairs grown defects on the disk before they
can become a problem.

The Data Domain storage array includes various recovery mechanisms to ensure
optimal availability on the storage controller and network. The Data Domain DD OS
Administration Guide contains more information about the various recovery features.

Filesystem recovery

Data Domain systems include features for reconstructing lost or corrupted filesystem
metadata, as well as filesystem check tools that can quickly bring an ailing system
safely back online.

Self-describing data format to ensure metadata recovery

Metadata structures, such as indexes that accelerate access, are rebuildable from the
data on disk. All data is stored along with metadata that describes it. If a metadata
structure is somehow corrupted, there are two levels of recovery. First, a snapshot of
the filesystem metadata is taken every several hours, creating point-in-time copy for
the recovery process to use. Second, the data can be scanned on disk and the
metadata structure can be rebuilt. These features enable recovery even if with a
worst-case corruption of the filesystem or its metadata.

Redundant 10 Gb Ethernet data path

The Data Domain DD990/DD7200/DD9500 communicates with the VTE over DLm's
internal 10 Gb Ethernet (10 GbE) network. The 10 Gb card on the DD990/DD7200/
DD9500 is configured in failover mode to protect against single link and switch
failures.
Redundant 1 Gb Ethernet connectivity for management

The Data Domain in the DLm uses two GbE ports, Eth0 and Eth2, to connect to the management network in the DLm. These ports are configured as a failover pair to protect against single link, switch, and NIC failures.

Redundant 1 GbE ports for replication

Data Domain includes two GbE ports that support replication. These ports can be configured as a Failover pair or in Aggregate Mode (LACP) to protect against single link or switch failures.

Redundant backend/drive connectivity

Each Data Domain in the DLm comes with two quad-ported SAS cards. Each ES30 drive enclosure also has two dual-ported SAS cards that connect to the controller or the adjacent ES30 enclosure in the chain. The eight SAS connections from the controller to the ES30 enclosures are configured as two failover pairs, distributed across the two cards to protect against card failures. The failover pair is active-passive.

Network connectivity failure checks

DLm provides the Data Network Packet Monitor to detect faulty ports or cables in the private network. The monitor is installed on the primary management VTE and runs once every hour. Using this hourly data, it calculates the packet loss percentage for each data network port. If any one of these ports exceeds the packet loss threshold of 5%, a call home will be generated. The call home will have details about the exact port and the component that is affected. This data enables EMC customer Support personnel to troubleshoot the issue and resolve it.

The default threshold is 5%. If your data traffic warrants adjustments to the threshold, contact EMC customer Support.

Benefits

DLm offers many benefits over traditional tape including:

- Faster processing of tape mount requests (translating into shorter overall job step processing)
- No requirement for physical tapes (reducing the cost, storage, and potential for loss of tapes and data).
- Support for data sharing across multiple VTEs (creating a level of data availability not found in previous mainframe virtual tape systems).
- Support for low volume access of external physical tapes that allow the mainframe to write to and read physical tapes.
- Data integrity maintained by storing the tape data on internal storage arrays and using RAID 6 technology to protect the data from physical disk drive failures.
- Built-in monitoring and reporting technologies, such as Simple Network Management Protocol (SNMP) and ConnectEMC, that raise alerts when attention is needed within the DLm environment.
- Support for replication of tape data between DLm systems and up to two local or remote DLm systems.
- No single point of failure of mainframe tape data if the DLm system has more than one VTE.
- Support for two erase policies for space reclamation:
- Space — This is the default policy. When a file system reaches a specified percentage of space usage (Recovery Percent general parameter), DLm begins erasing the oldest scratch tapes in that file system until the amount specified in the Recovery Amount parameter has been recovered.

- Time-to-live (TTL) — This policy specifies a period of time that scratched tapes will be retained after being scratched, before being automatically erased. Once the period expires, the tapes will automatically be erased regardless of current space utilization. The TTL erase options are: Days and Hours.

**Note**

If the VTE has tape libraries with VOLSER that reside on the Data Domain, the erase policy must be configured to the Time-to-live option.

- Support for data deduplication:
  - Support for the best inline data deduplication technology available in the market that reduces the footprint due to deduplication and reduces power consumption.
  - Significant cost savings for replication deployments as only the unique data after deduplication is replicated.

- Support for EMC Secure Remote Support (ESRS) that provides secure, fast, and proactive remote support for maximum information availability. Contact EMC Customer Support to configure ESRS.

- Support for Global Virtual Library (GVL) which provides a common view of the virtual tape library across multiple DLms and/or Data Centers with read and write access to any VOLSER in the library from any tape drive. This feature is a separately licensed and should be ordered with the new DLm.
Overview of Disk Library for mainframe
CHAPTER 2
DLm Operations

This chapter explains the routine DLm operations.

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- License activation ........................................................................ 46
- Powering up and powering down the DLm .................................. 52
- Starting and stopping tape devices ............................................. 61
- Key Management Interoperability Protocol ................................. 62
- Support access to DLm ................................................................. 62
Management access to DLm

The first two VTEs in a multi-VTE DLm (VTE1 and VTE2) provide management and support access to the DLm system. These VTEs are called Management VTEs. If the DLm has only one VTE, that VTE functions as the Management VTE. The Management VTEs also connect to the management LAN of the DLm system. They act as the gateway, providing access to the VNX Control Stations, and Data Domain systems. Management VTEs also function as the firewall isolating the internal DLm networks from your LAN.

The Management VTE provides a user-friendly GUI called DLm Console to execute various setup, monitor, and configuration tasks.

Introduction to the DLm Console

DLm Console is a web-based console that is used to configure and monitor the DLm system. It is the primary interface into the DLm environment and resides on the VTEs. You can use DLm Console to:

- Generate and capture logs.
- View VTE status and DLm statistics.
- Access and configure VTEs.
- Configure drives.

Gathering connection data

To connect to the DLm system, you will need some IP addresses and passwords. You need one IP address for each Management VTE and an additional high availability (HA) IP address that is assigned to the primary Management VTE. Use the HA IP address to access the DLm Console.

The following table lists the details that you will need before you access the DLm system.

<table>
<thead>
<tr>
<th>Item</th>
<th>Default</th>
<th>Actual</th>
</tr>
</thead>
<tbody>
<tr>
<td>DLm Console</td>
<td></td>
<td></td>
</tr>
<tr>
<td>HA IP address</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Username</td>
<td>dlmadmin</td>
<td></td>
</tr>
<tr>
<td>Password</td>
<td>password (first login)</td>
<td></td>
</tr>
<tr>
<td>Note</td>
<td>The system prompts you to change the password at the initial login.</td>
<td></td>
</tr>
<tr>
<td>Management VTE1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>IP address</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Management VTE2</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Table 6 DLm system access details (continued)

<table>
<thead>
<tr>
<th>IP address</th>
<th></th>
</tr>
</thead>
</table>

Accessing the DLm Console

DLm Console is a web-based console that is used to configure and monitor the DLm system. It is the management interface to the DLm system.

To access DLm Console, you need a PC with a Java-capable web browser such as Microsoft Internet Explorer or Mozilla Firefox 3.5 and above.

Note

If you use Internet Explorer, you must configure Trust sites or install the Security certificate.

Connecting to the DLm Console

To connect to the DLm Console:

Note

This procedure assumes that you have access to and are connected to the Data Center LAN to which the VTE is connected to also.

Procedure

1. Open a web browser.
2. Type the Management VTE's HA IP address as follows:
   https://<IP address>
   where the <IP address> is the HA IP address of the Management VTE on the customer LAN.
   For example: https://192.168.1.1
   The login screen opens as shown in the following figure:
3. Type the username and password. For a first time login, type the following user and password:
   - User: dlmadmin
   - Password: password

   **Note**
   At the first login, you are navigated to the External > Authentication page and prompted to change the password. You must remember and use this password for future logins.

Viewing DLm versions

To see the versions of the DLm components, click the Status > Versions tab.

Setting date and time

To adjust the system date or time, use the Time tab on the DLm Console:

**Procedure**

1. Access the DLm Console:
   a. Open a web browser and type the Management VTE's HA IP address as follows:
      
      https://<IP_address>
      
      For example: https://192.168.1.1
   
   b. Type the DLm Console username and password in the login page.

2. Click External.
3. Click the **Time** tab if it is not already displayed.

**Figure 10** DLm date and time

4. Use one of these two methods to set the date and time on a VTEC:
   - Configure the system to use a Network Time Protocol (NTP) server.
   - Manually set a specific date and time, and use the Management VTE as a local NTP server.

   **Note**

   EMC strongly recommends that you use an NTP server.

   If the VTE is connected to the corporate network and one or more NTP servers are accessible, configure the controller to get date and time from an NTP server. Enter either the network name or IP address of up to four NTP servers. When you make this configuration active by installing it, the VTEs in the configuration attempt to query each NTP server that is configured until they successfully get the date and time.

   **Note**

   If you use a network name to identify an NTP server, you will need to configure a Domain Name Server (DNS) as part of the network configuration.

   - Manually set a specific date and time, and use the Management VTE as a local NTP server.

     To manually set the date and time, edit the date and time in the **Current date and time** fields and click **Set**.

     The date and time is set in all the VTEs in the system, and the Management VTE will be used as a local NTP server to keep all the VTEs in sync.

5. Select the time zone applicable to you from the **Time zone** drop-down and click **Set time zone** button.

**Installation history**

To see the history of recent configuration changes, click **Configurations > Installation history** tab.

The following is a sample output:
Configuring user administration

DLm ships with two default user IDs:
- dlmadmin
- dlmuser

The default password for both the usernames is password.

The dlmadmin user has full administrator rights and can create new configurations or modify the existing configurations. This user can monitor and control the operation of the VTE. The dlmadmin user can create new users with the same rights as dlmuser; dlmadmin can also create another user with administrative rights by making sure “Read only” is not checked on the user’s entry on the Authentication page.

The dlmuser user can view the configuration and check the status of the VTEs but does not have the authority to modify configurations or operate the VTEs.

From the Authentication tab of the DLm Console, the dlmadmin user can add, delete, or modify user names recognized by the system.

Procedure

1. Access the DLm Console:
   a. Open a web browser and type the Management VTE’s HA IP address as follows: https://<IP address>
b. Type the DLm Console username and password in the login page.

2. Once connected, click **Configurations**. In the **Configurations operations** screen, make sure the correct configuration is selected in the drop-down list in the upper left corner of the tab.

3. Click **External > Authentication**.

   The **Authentication** tab opens.

4. Select the authentication type:

   - **Native**
     
     Configuring Native authentication type provides instructions to add, modify, or delete users of Native authentication type.
   
   - **LDAP (including Active Directory)**
     
     Configuring LDAP authentication type provides instructions to add, modify, or delete users of LDAP authentication type.

5. In **Logout period (minutes)**, under **Automatic logout**, enter the number of minutes after which the user will automatically be logged out if the session is inactive.

   **Note**

   Leaving this field blank will disable automatic logout.

6. Click **Apply authentication changes** to apply the changes.

**Configuring Native authentication**

Native user administration stores the user names and passwords on the VTE and is the default type.

**Procedure**

1. To modify a user, modify the content of the **Name**, **Password**, or **Readonly?** fields.

2. To add a new user:

   a. Click **Add Next**.

   b. Type the username under **Name**.

   c. Type the password for that user under **Password**.

   d. Select the **Readonly?** option if the user should not make changes to the configuration.

3. To delete a user ID, click the X button corresponding to that user.

   **Note**

   Be careful not to delete all user names with full administrator privileges. If there are no administrators, you will not be able to modify or operate the system.

**Configuring LDAP authentication type**

When you configure DLm user authentication to use an external Lightweight Directory Access Protocol (LDAP), the usernames and passwords will no longer be maintained on the VTE. When a user attempts to log in to DLm Console, DLm sends a message to the LDAP server. The LDAP server searches for the username and password that has
been entered and informs DLm if the user is found and the password is correct. DLm then grants access to the user.

**Procedure**

1. Select the LDAP authentication type if the DLm system is attached to your corporate network, and you already have the appropriate directory server installed and running on the network.
   
   If you select LDAP without the required connectivity, your login fails and you must try again using the Native authentication type.
   
   The LDAP user authentication screen opens as shown in the following figure:

   **Figure 12 LDAP authentication**

   2. For administrative access, enter details under **LDAP parameters for administrative access**:

   ![LDAP parameters for administrative access](image-url)
a. In **LDAP server**, enter the hostname or IP address of the LDAP server.

b. In **Base DN**, enter the Distinguished Name (DN) of the entry at which the server must start the search for authentication credentials.

c. Under **LDAP server bind credentials (optional)**, enter values if you want to use these credentials:
   - In **Bind DN**, enter the DN to bind the server with.
   - In **Bind password**, enter the password for the Bind DN.

3. For read-only access, enter details under **LDAP parameters for readonly access**:
   a. In **LDAP server**, enter the hostname or IP address of the LDAP server.
   b. In **Base DN**, enter the Distinguished Name (DN) of the entry at which the server must start the search for authentication credentials.
      For example, `dc=emc` or `dc=com`.
   c. Under **LDAP server bind credentials (optional)**, enter values if you want to use these credentials:
      - In **Bind DN**, enter the DN to which to bind the server.
      - In **Bind password**, enter the password for the Bind DN.

4. Check the **Use encrypted LDAP access** check-box if you want to use LDAP over SSL/TLS (LDAP/S).

   You can upload and/or delete certificates for using an encrypted channel.

   **Note**
   If LDAP/S is selected but no certificate is uploaded, the public certificate authority certificates included in a standard SuSE LDAP installation will be used for authentication.

5. In the access filter fields, enter LDAP criteria to use to authenticate user access from their LDAP server.

   DLm provides fields for you to enter three access filters:
   - **Administrative access filter**
   - **Service access filter (optional)**
   - **Read-only access filter (optional)**

**Exiting DLm Console**

You should always log out of the DLm Console; do not simply close the browser session. To exit the DLm Console, click **Log out** on the DLm Console menu bar.

**Accessing a VT Console**

You can access the VT Console through the DLm Console.
Note
If you use Internet Explorer, you must configure Trust sites or install the Security certificate to be able to open the VT Console window.

Procedure
1. Access the DLm Console:
   a. Open a web browser and type the management VTE’s HA IP address as follows:
      
      https://<IP address>
   
   b. Type the DLm Console username and password in the login page.
2. Click Status > System status. (The System status page is the default page when you log in to DLm Console.)
   
   The System status page is shown in the following figure:
   
   Figure 13 Accessing a VTE

The Console column contains icons that can open the VT Console of the respective VTEs.

3. In the Console column, click the icon corresponding to the VTE you want to access.
   
   A message pops up prompting you to choose whether you want to open the vtcon or ssh.
   
   If you select ssh, you can access the VTE through the Linux Console. If you select vtcon, the VT Console opens. The VT Console is a console that allows you to monitor and operate Virtuent. Virtuent runs as a started task (daemon) on the VTE. Virtuent attempts to auto-start whenever the VTE is powered on and started.
The title bar displays the selected VTE; for example "Virtuent console on node vte1". The blue bar at the bottom of the screen displays the status of Virtuent. Informational, warning, and error messages from Virtuent scroll on the VT Console window.

**VT Console**

A VT Console does not need to be open for the VTE to be working. You can open a specific VT Console when you want to monitor the status of tape operations on that VTE. You can have all VT Consoles open simultaneously. All VTEs continue to operate normally regardless of which console is open.

The VT Console is divided into three sections:

- The larger, top section displays log messages as they are issued from Virtuent. On startup, the VT Console displays the messages in the log (up to the last 100,000 bytes) since the last startup of the VT Console. The following navigation keys (or commands) can be used to scroll through the messages:
  - Home — Move to the top
  - End — Move to the bottom
  - PgUp — Move up one screen
  - PgDn — Move down one screen
- The smaller, lower section of the VT Console is blue and always shows the current status of Virtuent on this VTE. When Virtuent is not active, the VT status is Not running. When Virtuent is active, the VT status on the VT Console is Running. Starting and stopping tape devices provides more information about starting and stopping Virtuent. DLM system time is displayed in the status line at the bottom of the VT Console.
- Below the VT Status line is a command line where you may enter and edit VT commands.
The following navigation keys can be used on the command line:

- Up Arrow or Ctrl+P — Previous command in history
- Down Arrow or Ctrl+N — Next command in history
- Left Arrow or Ctrl+B — Move to the left in the command line
- Right Arrow or Ctrl+F — Move to the right in the command line
- Ctrl+A — Move to the beginning of the command line
- Del or Ctrl+D — Delete one character
- Ctrl+E — Move to the end of the line
- Backspace or Ctrl+H — Backward delete character
- Ctrl+K — Erase to the end of the line
- Ctrl+T — Transpose characters
- Ctrl+U — Discard the line
- Ctrl+W — Word rubout

To close the VT Console window, type quit. Closing the console does not affect the operation of Virtuent in any way.

Rebooting a VTE

To reboot a VTE:

Note
Before you reboot a VTE, vary offline all DLm devices on that VTE. Otherwise, online mainframe devices are likely to be boxed.

Procedure

1. Access DLm Console:
   a. Open a web browser and type the management VTE’s HA IP address as follows: https://<IP address>
   b. Type the DLm Console username and password in the login page.

   The System status tab of the System menu opens by default.

2. In the Reboot column, click the Reboot button for the VTE you want to reboot.

Note
The average VTE restart time is 8 - 10 minutes. The restart time varies depending on the number of NFS file system mount requests in the /etc/fstab file.

License activation

DLm 4.5.0 and later require license installs for the VTE OS. Each DLm will have its own basic license called VTE OS license, which will cover the generic DLm functionality.
You must activate the license and provide the activated license certificate (eLicense file) to the EMC service personnel during installation.

**Note**

DLm systems acquired at version 4.5.0 or later require license installation. However, systems upgraded from versions prior to 4.5.0 do not require new licenses.

The following table lists the VTE OS licenses for different DLm models.

**Table 7** VTE OS licenses for DLm models

<table>
<thead>
<tr>
<th>DLm Model</th>
<th>Model Number of License</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>DLm8100 with VNX 5400</td>
<td>DLM4-2KVTEOS-CF</td>
<td>DLm8100 – VTE OS License</td>
</tr>
<tr>
<td>DLm8100 with VNX 7600</td>
<td>DLM4-8KVTEOS-CF</td>
<td>DLm8100 – VTE OS License</td>
</tr>
<tr>
<td>DLm8100 with DD9500</td>
<td></td>
<td></td>
</tr>
<tr>
<td>DLm8100 with VMAX</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Overview of the activation procedure**

These are the steps to activate a license and install it on DLm:

**Procedure**

1. Receive the License Authorization Code (LAC) by email.
2. Follow the instructions in the LAC to activate software.
3. Save the license file(s).
4. Provide the license files to the EMC service personnel during installation.

**Receiving the LAC and activating the license**

**Before you begin**

You will receive an email with the LAC and a link that enables you to activate the software.

The following figure shows a sample email.
Figure 15 Sample LAC mail

Dear Dell EMC Customer,

Thank you for choosing EMC software. Your EMC Software License Authorization Code (LAC) is IP010025010049. You must redeem this LAC for license keys to activate your software. Please protect your LAC like you would any other license key to prevent anyone from improperly activating your software.

Activating Your Software
1. Click here or copy and paste the following URL (https://licensing-ssl.emc.com/deeplink/IP010025010049#TARGET_TAG=) into a web browser to activate your entitlements.
2. You will be prompted to log in. (New users should follow the new member registration steps).
3. Follow the on-screen instructions.

Downloading Your Software
1. Click here or copy and paste the following URL (https://stage-c1.emc.com/downloads/) into a web browser to download your software.
2. You will be prompted to log into EMC’s Online Download Service Center (New users should follow the new member registration steps).
3. Enter the product name in the search field to find the software you wish to download.

License Authorization Code: IP010025010049

<table>
<thead>
<tr>
<th>Product #</th>
<th>Title</th>
<th>Quantity</th>
<th>Subscription Start</th>
<th>Subscription End</th>
</tr>
</thead>
<tbody>
<tr>
<td>436-111-005</td>
<td>DLm100 VTE 05 Storage Group 3=IE</td>
<td>2</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

If you have any questions about your sales order, contact your Dell EMC Account Representative or your Authorized Reseller.

If you have any questions about EMC Software Licensing, contact the Dell EMC Worldwide Licensing Support team by completing the following instructions:
1. Visit https://stage-c1.emc.com/servicecenter/to:
   - Use the Live Chat between the hours of 3:00 AM and 7:00 PM Eastern.
   - Open a Service Request.
2. Contact the Dell EMC live support team by calling 1-866-782-4362, option 4, option 4 (24 X 7).

Procedure

1. In the email, click the Click here link under Activating Your Software.
   This takes you to the EMC Software Licensing Central portal.
2. The registered company name and address is listed in the **Step 1: CONFIRM COMPANY & SITE** page.
   - If the details are correct, click NEXT: REVIEW.
   - If the details are not correct, click Change Site, edit the details, and then click NEXT: REVIEW.
In the Step 2: REVIEW YOUR SELECTIONS page, the default email ID to which the license keys should be sent is displayed. Click Email to more people if you want to add more email IDs.

4. Click Add notes to this transaction to enter any remarks pertaining to this activation transaction.

5. Click ACTIVATE.

The license is activated.
6. Save the certificate in your local drive by clicking **SAVE TO FILE**. You will need to upload this certificate in DLm Console later.

7. You can print the certificate by clicking **PRINT CERTIFICATE** or view the certificate by clicking **VIEW CERTIFICATE**.

8. You can also view a copy of the license key by clicking **View license key**.
9. Provide the license file to the EMC service personnel for installation.

**Powering up and powering down the DLm**

**Note**
You must coordinate planned power down and power up events with EMC Customer Support.

Powering up a DLm system is a multi-step process. Power up the following in this order:

1. Each VNX5400/VNX7600 Network Server (including the storage array)
2. Each DD990/DD7200/DD9500
3. CloudArray
4. Each VTE
   - VTE1
   - VTE2
   ...
   - VTEx

Powering down a DLm system is also a multi-step process. Power down the DLm components in this order:

1. Each VTE
   - VTEx
   ...
   - VTE2
VTE1
2. CloudArray
3. Each DD990/DD7200/DD9500
4. Each VNX5400/VNX7600 Network Server (including the storage array)

Powering up the VNX

EMC Customer Service Engineers will have already powered up the DLm, including the VNX. However, the procedure for powering up the VNX is included below.

The cabling for VNX5400 is the standard cabling described in the *VNX5400 Hardware Information Guide* (PN 300-014-324) with only one modification: space is reserved for two Data Mover enclosures (DME) between the DPE and the Control Stations.

The following figure shows the power cabling and power switches in the VNX7600 system.

⚠️ CAUTION

DLm bays and power systems are designed to support DLm equipment only. EMC does not support any other components in these bays, and recommends that you do not install any additional equipment in the DLm bays.
Connect cables and power up the DLm system as follows:

**Procedure**

1. Ensure that the switches for SPS A and SPS B are turned OFF.
2. Verify that the cabinet circuit breakers are in the OFF position. [#1 in the power cabling figure]
3. Connect the power cables as follows:
   a. The standby power supply (SPS) A to power distribution panel (PDU A) [#2 in the power cabling figure]
b. The SPS A to storage processors A & B (Ensure that the retention bails are in place.) [#3 in the power cabling figure]

c. The DAE 0 to SPS A & SPS B [#4 in the power cabling figure]

4. Turn on the circuit breakers using the Master switches.

5. Turn the SPS switches ON. See the following figure.

This powers up the storage subsystem of the VNX. This takes about 10-12 minutes.

**Figure 21 Rear of the SPS**

6. Check the following LEDs on the front and rear of the VNX:
   - Amber warning LEDs flash during the power-on self-test (POST) and then go off.
   - The front fault LED and the SPS recharge LEDs commonly stay on for several minutes while the SPSs are charging.

7. Ensure that the storage array is up and running.

   The storage processors are immediately above the SPS. The physical indication that the storage array is up and running:
   - The Power LED on the storage processors is green.
   - The Fault LED on the storage processor is not lit amber.
   - DAE 0 status is green.
   - The first four drives in the DAE are green.

**Figure 22 Storage processor LEDs**

8. Connect DAE 1-8 to PDUs A & B. [#11 - 18 in the power cabling figure]

9. Power up the DAEs in the DAE-only racks.

   This may require switching on the power at the master switches of these DAE-only racks. It may take some time for all the DAEs to be powered up and available.
The indication that the DAEs have been detected:

- The green seven-segment display indicates the back-end SAS bus the DAE is on.
- The blue seven-segment display indicates the DAE number/ID in a particular SAS chain.
- No amber LEDs are lit on the drives.

10. Connect each side of the Data Mover enclosures to the PDU closest to it. [#5 - 8 in the power cabling figure]

The Data Movers now power up. The LED on the front of the Data Movers are lit when the Data Movers have powered up. Wait for 4-5 minutes, this ensures that the Data Movers are ready.

11. Connect Control Station 0 (CS0) to PDU B. [#9 in the power cabling figure]

Check the power LED on the front of the CS0. If that LED indicates that CS0 has not started to power up, turn on the Control Station by pressing the power button on the front. Wait 5 minutes to make sure that CS0 is powered up before continuing.

12. Connect the Control Station (CS1) to PDU A.

## Powering up the Data Domain

The ES30 shelves of the DD990/DD7200/DD9500 must be powered up before powering up the DD990/DD7200/DD9500 controller. Make sure the SAS cabling to the ES30 drives are connected and plugged in before powering the systems ON.

### Procedure

1. Ensure that the master switch on the DD990/DD7200/DD9500 rack is in the OFF position.
2. Connect power cables to both the power receptacles of the ES30 shelves and make sure the retention clips at both ends are engaged.
3. Power on the expansion shelves. The ES30 shelves take about 3–4 minutes to power ON. (Make sure you power on the ES30 shelves before powering on the DD990/DD7200/DD9500 controller.)
4. Connect both power cables to the DD990/DD7200/DD9500 controller. Ensure that the retention clips are engaged at the PDUs and the cable restraint tie is connected at the controller.

If the DD990/DD7200/DD9500 controller does not automatically power on, push the power button on the front of the controller.

---

### Note

Wait for about 10–15 minutes for the DD990/DD7200/DD9500 system to power up.
The system status LED on the controller should stay green if there are no faults detected. The following table describes the status of this LED.

<table>
<thead>
<tr>
<th>Display</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Steady Green</td>
<td>Normal operation</td>
</tr>
<tr>
<td>Blinking Green</td>
<td>Startup</td>
</tr>
<tr>
<td>Steady Amber</td>
<td>Critical fault. Shut down system for service</td>
</tr>
<tr>
<td>Blinking Amber</td>
<td>Non-fatal fault. Investigate; service the system</td>
</tr>
</tbody>
</table>

**Powering up a CloudArray server**

Pressing the power button on the front of the CloudArray server powers it up. In the following figure, the button beneath the Dell logo is the power button.

![CloudArray server](image)

**Powering up a VTE**

**Note**

Before you power up the VTE, ensure that the storage systems are powered up.

**Procedure**

1. Press the Power/sleep button on the front of the VTE

   **Note**

   You can power up the VTEs in any order as they operate independently of each other.

   You should hear the fans start and then slow down as they adjust for system temperature. Shortly after that, the VTE's disk activity LED begins blinking indicating startup of the VTE.
The VTE front panel contains buttons and LEDs as shown in the following figure:

![Figure 25 VTE buttons and LEDs — Front panel](Image)

The following table shows these controls and indicators on the front of a VTE.

### Table 9 VTE indicators

<table>
<thead>
<tr>
<th>Name</th>
<th>State</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>Power Button with integrated LED</td>
<td>• Press momentary</td>
<td>• Toggles the VTE power on and off.</td>
</tr>
<tr>
<td></td>
<td>• OFF</td>
<td>• Both power supplies are OFF. NO AC power.</td>
</tr>
<tr>
<td></td>
<td>• GREEN</td>
<td>• The power supplies are ON and OK.</td>
</tr>
<tr>
<td>System Identification Button with</td>
<td>• Press momentary</td>
<td>• Toggles the front panel ID LED and the server board ID LED on and off.</td>
</tr>
<tr>
<td>integrated LED</td>
<td></td>
<td>• The server board LED is visible from the rear of the chassis and allows you to locate the server from the rear of a rack of systems.</td>
</tr>
<tr>
<td></td>
<td>• Steady BLUE</td>
<td>Enables you to identify the VTE in a multiple-VTE rack.</td>
</tr>
<tr>
<td></td>
<td>• Rear BLUE LED</td>
<td>• The ID button is pressed.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Lit when the ID button is pressed.</td>
</tr>
<tr>
<td>System Cold Reset Button</td>
<td>Press momentary</td>
<td>Reboots and re-initializes the VTE.</td>
</tr>
<tr>
<td>System Status LED</td>
<td>• OFF</td>
<td>• AC power off.</td>
</tr>
<tr>
<td></td>
<td>• GREEN solid on</td>
<td>• System booted and ready. VTE is operating normally.</td>
</tr>
<tr>
<td></td>
<td>• GREEN blink</td>
<td>• VTE is operating in a degraded condition.</td>
</tr>
<tr>
<td></td>
<td>• AMBER solid on</td>
<td>• Fatal alarm — VTE is in a critical or non-recoverable condition.</td>
</tr>
<tr>
<td></td>
<td>• AMBER blink</td>
<td>• Non-fatal alarm — VTE is likely to fail.</td>
</tr>
<tr>
<td>Hard Drive Activity LED</td>
<td>• Randomly flashing green</td>
<td>Indicates hard disk activity.</td>
</tr>
</tbody>
</table>
### Table 9 VTE indicators (continued)

<table>
<thead>
<tr>
<th>Name</th>
<th>State</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Off</td>
<td>Indicates no hard disk activity is occurring.</td>
</tr>
<tr>
<td>NIC 1 Activity LED (green)</td>
<td>Flashing</td>
<td>Indicates network traffic on NIC 1.</td>
</tr>
<tr>
<td></td>
<td>Lit</td>
<td>Indicates that NIC 1 is linked to the network.</td>
</tr>
<tr>
<td>NIC 2 Activity LED (green)</td>
<td>Flashing</td>
<td>Indicates network traffic on NIC 2.</td>
</tr>
<tr>
<td></td>
<td>Lit</td>
<td>Indicates that NIC 2 is linked to the network.</td>
</tr>
<tr>
<td>NIC 3 Activity LED (green)</td>
<td>Flashing</td>
<td>Indicates network traffic on NIC 3.</td>
</tr>
<tr>
<td></td>
<td>Lit</td>
<td>Indicates that NIC 3 is linked to the network.</td>
</tr>
<tr>
<td>NIC 4 Activity LED (green)</td>
<td>Flashing</td>
<td>Indicates network traffic on NIC 4.</td>
</tr>
<tr>
<td></td>
<td>Lit</td>
<td>Indicates that NIC 4 is linked to the network.</td>
</tr>
<tr>
<td>NMI button</td>
<td>Press momentary</td>
<td>Puts the controller in a halt state for diagnostic purposes.</td>
</tr>
</tbody>
</table>

Normal startup of a VTE takes 8 - 10 minutes. After the VTE starts its network services, you will be able to access the VTE through the DLm Console.

**Note**

If the entire VTEC bay is in the powered down state, some of the LED panel indicators may light when power is applied. This is only an indication that the units have power available; it is not an indication that the VTEs are started. You must press the Power button on each VTE to actually start them when appropriate.

### Powering down the VTE

Always use the Power off button on the DLm Console to shut down a VTE in an orderly manner. If you simply power off the VTE by pressing the Power or Reset buttons, unpredictable errors occur on the host for any active connections, possibly resulting in data loss. Before powering off a VTE, you must stop all host programs using the VTE, and vary off the tape devices from the host.

When powering down a VTEC with more than one VTE, always power down the primary VTE last.

**CAUTION**

Do not power off the VTE when devices are online to the host. Follow the shutdown procedure; do not use the Power button.

To power down a VTE:

**Procedure**

1. Vary all the devices offline to the mainframe.
Vary the tape drives offline from every LPAR and wait for it to go offline. If a job is accessing the drive at that point, the drive does not go offline until the job releases the drive. Depending on the usage, this could take more than an hour.

2. Verify that all the tape drives are offline:
   a. Open a web browser.
   b. In the browser, type the Management VTE's HA IP address:
      \[
      \text{https://<IP address>}
      \]
      where `<IP address>` is the HA IP address of the Management VTE.
      The DLm Console opens displaying the **System status** tab of the **System** menu by default. The console displays icons for each configured VTE.
   c. In the **Console** column, click the icon corresponding to the VTE you want to access.
   d. At the VT Console prompt, type the command:
      \[
      \text{quiesce all}
      \]
      The **quiesce** command prevents new tapes from being mounted on that VTE, but does not affect tapes already mounted.
   e. At the VT Console prompt, type the command:
      \[
      \text{query paths assigned}
      \]
      The desired response is:
      \[
      \text{No paths currently established and assigned.}
      \]
   f. If you do not see this response, refer to EMC Knowledgebase solution **emc280222** "What to do if there are active paths when shutting down or restarting a VTE" for information on how to identify and remove any online devices.
   g. Once the devices are offline, it is still possible that tapes were left mounted. To verify if any tapes are still mounted, at the VT Console prompt, type the command:
      \[
      \text{query mount}
      \]
      That command gives a list of the devices and VOLSERs of any mounted tapes. The heading is always displayed; it is expected to not list any mounted tapes.
   h. If any tapes were listed, follow the instructions provided in the EMC Knowledgebase solution **emc280282** "What to do if there are mounted tapes when shutting down or restarting a VTE".

3. Stop Virtuent. Type:
   \[
   \text{STOPVT}
   \]

---

**Note**

Virtuent automatically restarts the next time you start the system.
4. Quit from the VT Console:

```sh
quit
```

**Note**

Before you do the next step to power off the VTE, remember that you will need physical access to the VTE to power it on again. The VTE cannot be powered on remotely.

5. On the **System status** tab of DLm Console, click the **Power off** button for the VTE in the **Power off** column.

The VTE powers down. Pressing the Power button after a poweroff command will turn the VTE on again.

**Powering down the back-end storage systems**

If you have a DLm8100 with different types of back-end systems, power down the back-end systems in this order: CloudArray, Data Domain, and then VNX.

You need to use the iDRAC port connection to gracefully shut down the CloudArray server. Contact EMC Customer Service for more information.

Follow the procedure in the **EMC Data Domain Operating System 5.5 Administration Guide** to power down the Data Domain system.

Follow the instructions in **VNX5400 Unified Power Off Procedure** to power down VNX5400 and the instructions in **VNX7600 Unified Power Off Procedure** to power down VNX7600. The documents are available on https://support.emc.com

**Starting and stopping tape devices**

To start or stop the virtual tape devices you must start or stop Virtuent. You can control Virtuent through the VT Console. The commands for starting and/or stopping tape emulation on a VTE are:

- **STARTVT** to start Virtuent and activate devices in the installed configuration file.
- **STOPVT** to stop Virtuent. Once Virtuent stops, the channel links are disabled and all virtual drives cease to respond to the host until Virtuent restarts. Any I/O from the host while Virtuent is terminated will receive an I/O error (device not operational). For this reason, you should wait for all host applications using devices to finish, and the virtual tape drives should be varied offline from the host operating system before stopping Virtuent. **STOPVT** will not terminate Virtuent if any virtual drives currently have volumes loaded.
- **STOPVT!** to terminate Virtuent while volumes are loaded. Any virtual tapes currently loaded will be immediately unloaded without any further processing.

**Note**

This may result in an incomplete output tape volume if the host has not yet completed writing and properly closing the tape. For this reason, the **STOPVT!** command should only be used in an emergency situation where VTEs must be brought down immediately. Any virtual tape volumes currently being written should be considered invalid.
When Virtuent is active, the VT Console shows the VT status as "Running."
Informational, warning, and error messages from Virtuent scroll on the console.

To start or stop the virtual tape devices:

Procedure

1. Access the VT Console:
   a. Open a web browser and type the Management VTE's HA IP address as follows: https://<IP address>
   b. Type the DLm Console user name and password in the login page.
2. Open the VT Console from the System status tab for the appropriate VTE.
3. Type the appropriate command: STARTVT, STOPVT, or STOPVT!
   For example, to start Virtuent, type:
   STARTVT
   The blue bar at the bottom of the VT Console displays the changed status of Virtuent.
4. Type quit and press Enter, then click on X to close the VT Console window.

Key Management Interoperability Protocol

Key Management Interoperability Protocol (KMIP) is an industry-standard protocol allowing encryption clients to access any industry key manager which supports the KMIP standard. DLm 4.5.0 and later supports KMIP to enable support for third party key managers for obtaining keys to encrypt and decrypt virtual tape volumes.

EMC customer support personnel configure and initialize KMIP on the VTEs and define channel devices for KMIP encryption.

You must provide the following to enable the support personnel to configure KMIP:

- CA certificate (.pem file)
- KMIP Server certificate (.pem file)
- Client certificate/key (.p12 file)
- Password for the client certificate/key .p12 file
- IP Address and port for the KMIP server

KMIP certificates may have an expiration set on them. New certificates must be uploaded preferably prior to the expiration date.

Note

If you know the expiration dates of any of the certificates, contact EMC customer Support personnel on time to get new certificates installed before the old ones expire.

Support access to DLm

DLm allows remote access to the VTEs for support and diagnostic purposes. DLm supports EMC Secure Remote Support (ESRS) that monitors DLm operation. VTEs are provided with modem support to communicate issues to EMC.
ESRS monitors the operation of DLm for error events and automatically notifies your service provider of error events. It also provides a path for your service provider to use to securely connect to your monitored DLm systems.

**Figure 26 EMC Secure Remote Support**

**Note**

Most DLm systems might not have support for HTTPS connections to the ESRS gateway.

**Modem support**

DLm provides external modems to allow remote access to the VTEs for support and diagnostic purposes. Each management VTE comes with an attached modem. In a single-VTE DLm system, the VTE functions as the management VTE. In a DLm system that has more than one VTE, the first two VTEs (VTE1 and VTE2 at the bottom of the DLm8100 rack) are management VTEs. A telephone line should be connected to the management VTE modem (which in turn should be cabled to the COM1 serial port of the VTE).

The VTE can be configured to send messages to EMC using the VNX ConnectEMC function when problems are detected within the VNX storage systems or the VTEC. The ConnectEMC options include sending the messages via a modem through a customer-supplied analog telephone line. Each of the VNX Control Stations is provided with a modem.
CHAPTER 3

DLm Administration

This chapter explains the common DLm administrative tasks.

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Tape libraries

A virtual tape library is controlled by a top level directory stored on the VTE’s system disks. Each file system to be used as part of the tape library must be mounted as a subdirectory within that top level directory. The VTE automatically uses all file systems mounted under the top level directory to store tape volumes.

For example, /tapelib/CEL1_P1_FS1,

where /tapelib is the top level directory and /CEL1_P1_FS1 is the subdirectory.

DLm stores any number of VOLSERs in the file systems within the library until space within the file systems is depleted. Additional file systems can be added to the library at any time without disrupting the operation of the library. When a new file system is available, DLm automatically begins using it when creating new tape volumes. Each tape volume (VOLSER) is stored as a single file on one file system.

Like real tape volumes, virtual volumes are written, read, and scratched. Once a VOLSER has been scratched within the library, it can be re-used during a future tape allocation process.

Tape libraries allow for multiple storage classes to be defined. Each file system defined to a virtual library is assigned to only one storage class. The storage classes are identified by numbers; for example: 0, 1, 2, etc. If you do not define a class, the file system you define is assigned to the default storage class 0.

Note

Valid storage classes are 0-100.

Initializing DLm scratch volumes

Before any of the VTEs can mount a virtual tape volume and present it to the mainframe host, you must initialize the tape volumes that you use. Execute at least one INITIALIZE command in a VT Console before you start any tape drives on DLm. Otherwise, no scratch tapes will be available for use within the DLm system.

Note

DLm supports a maximum of 275 concurrent NFS file system mounts at startup.

A DLm tape library is made up of one or more file systems and may be sub-divided into storage classes. Since VTEs normally share tape volumes within a tape library, you only need to initialize tape volumes into each storage class to make them available to all VTEs sharing the library. If there are no scratch volumes in a storage class, DLm will not be able to satisfy a mount request for a scratch within that storage class and the mount will remain pending.

If you have not defined storage classes (other than the default class 0), you will only need to initialize a single range of tape volumes to the library. But if you have defined multiple storage classes then you must initialize a range of VOLSERs for each class you have defined.

Use the INITIALIZE command to initialize tapes:

INITIALIZE VOL=volser DEV=devname COUNT=count CLASS=n DIR=dirname

where:

- volser is the starting serial number to initialize.
- `devname` is the device name (address) of any tape drive pointing to the tape library.
- `count` is the number of serial numbers to initialize.
- `n` is the class these volumes are to be added to. `CLASS` is a required parameter.
- `dirname` optionally specifies the subdirectory to create the volumes in. The base tape library directory is derived from the PATH of the `DEV=` parameter. For example, if the tape library is `/tapelib`, specifying `DIR=L2` would initialize the tapes in `/tapelib/L2`.

This parameter is only allowed when the Enhanced File system Architecture option is enabled. Otherwise, the target directory is derived from the first two characters of the VOLSER.

Under the Enhanced File System Architecture, if `DIR` is not specified, `INITIALIZE` spreads the tapes between all the file systems it finds within the storage class. However, if you want to initialize the scratch tapes only in a specific directory, use the `DIR` parameter to specify that directory.

Assuming device E980 is a configured device pointing to your tape library, then the command to initialize 500 serial numbers to the storage class 0 beginning with VOLSER 000000 would be:

```
INITIALIZE VOL=000000 DEV=E980 COUNT=500 CLASS=0
```

This would result with volumes ranging from 000000 to 000499 being created in the file systems in class 0.

If your library has two storage classes defined, class 1 and class 2, the following commands would initialize 1000 VOLSERs per class in the library making both classes ready for use:

```
INITIALIZE VOL=000000 DEV=E980 COUNT=1000 CLASS=1
INITIALIZE VOL=001000 DEV=E980 COUNT=1000 CLASS=2
```

**Note**

Since the `INITIALIZE` program automatically generates VOLSERs starting with the VOLSER specified with `VOL=`, make sure you do not overlap VOLSER ranges when entering these commands.

In the example above, `VOL=000000 COUNT=1000` will result in 1,000 tape volumes being created in the library with serial numbers ranging from 000000 to 000999. `VOL=001000 COUNT=1000` will result in the creation of volumes ranging from 001000 to 001999. The result of these two commands is a virtual library with 2,000 volumes whose serial numbers range from 000000 to 001999.

If the DLm is configured with the GVL feature, the `INITIALIZE` command initializes volumes only in the local file systems, but Virtuent checks for duplicates across the tape library spanning the whole GVL.

If you are initializing tapes on a Unisys mainframe, include the `LABEL` parameter telling DLm the tape volume labels will be ANSI format. For example:

```
INITIALIZE VOL=000000 DEV=E980 COUNT=500 LABEL=A CLASS=0
```
Note
If your tape devices are defined in a Manual Tape Library (MTL), you must also define them in the mainframe's tape configuration database (TCDB). You must run the DLMLIB utility to do this. Instructions for running DLMLIB are provided in DLm z/OS components.

Defining tape libraries

EMC service personnel define tape libraries during initial setup.

Note
At least one file system must be defined for each virtual tape library you intend to define. It is also mandatory to define one small (10 MB) file system to use as a lock directory.

To provide the best overall performance, multiple file systems in each library are desirable. While there is no strict limitation, a minimum of four file systems is recommended to enable the VTE to balance output across all file systems in the library.

Note
DLm does not support a configuration where some VTEs use enhanced file system and the other VTEs in the configuration use a DLm 2.x (legacy) style file system.

EMC service personnel use the following steps to define a tape library:

Procedure
1. Create the file system on back-end storage subsystems like CloudArray, VNX, or DD using DLm tools.
2. Define the lock file system and other file systems in the VTE configuration.
3. Define the libraries to be used by each VTE and configure devices.
4. Install the configuration on all VTEs.
5. Initialize scratch tapes (VOLSERs) into the library.

The list of available libraries can be viewed in the Storage > Available tab of DLm Console.

Note
Make sure you do NOT delete the special purpose file systems, dlmconfig and dlm_lock_fs.

Backward compatibility

If you install a DLm 4.x-based VTE into an existing multiple-VTE environment with an earlier version of software, you can operate the new VTE in compatibility mode.

To operate in compatibility mode using an existing virtual tape library, you simply do not define a lock directory file system in the configuration. When the VOLSERLOCKDIR parameter has not been defined on a VTE, the VTE assumes that the virtual tape library is an existing library created with DLm software older than release 3.1.
Keep in mind that if the VTE is running in backward compatibility mode the restrictions of the previous library architecture are all in force. Specifically, each file system must be defined (mounted) in the library using the first 2 characters of the VOLSERs that will be stored in that file system. File systems are generally restricted to 10,000 VOLSERs per file system and new file systems added to the library must have VOLSERs initialized into them before they can be used.

If you are defining a new DLM virtual tape library, EMC strongly recommends that you define a lock directory file system to take full advantage of the DLM enhanced file system architecture.

**Configuring virtual devices**

You can define up to 256 virtual 3480, 3490, or 3590 tape drives on each DLM VTE. During initial setup, EMC service personnel define your devices based on the details provided by your system administrator.

**Planning considerations**

- For z/OS systems, for each VTE, plan for one virtual device that will always be offline and can be used by DLM utilities to communicate with the VTE.
- If you plan to run the DLM z/OS started task (DLMHOST), this requires a total of three devices offline: one to remain offline and be used by DLMHOST to communicate with the VTE, and two virtual devices if DLMHOST logging is requested.

Refer to the *EMC Disk Library for mainframe Command Processors and Utilities for z/OS Guide* for more details on DLMHOST.

**DLM configuration files**

The DLM Console allows you to configure the VTE and save your configuration as a configuration file. The default configuration file is config. If you simply begin modifying the configuration file, you will be working with this default configuration file. Optionally, you can create and use your own configuration files. DLM allows you to store as many configuration files as you want. However, only one configuration file will be the active configuration at any point in time.

The **Configurations** page allows you to select the configuration file for a VTE. You must save your configuration and install the configuration for it to take effect on the VTE. The current active configuration file is displayed in the **Last installation** field under the **Description** field.

**Configuring global parameters**

The DLM Console allows you to configure the virtual tape drives on a VTE.

**Procedure**

1. Access the DLM Console using the web browser:
   a. Open a web browser and type the Management VTE's HA IP address as follows: `https://<IP address>`
   b. Type the DLM Console username and password in the login page.
2. Once connected, click **Configurations**. In the **Configurations operations** tab, make sure the correct configuration is selected in the drop-down list in the upper left corner of the tab.
3. Click **Devices** to display the **Tape device configuration** panel. This panel contains a tab for each available VTE.

**Figure 27 Global options**

4. Click the tab pertaining to the VTE you want to configure.

5. Enter values in the fields under **Global options** at the top of the **Devices** panel:
   
a. In **Warn at**, select the percentage of disk space usage at which DLm will begin to warn about usage.

   Each time the contents of a file system changes, the VTE checks the space used against this value. If the used space in the file system is at or above this value, a warning will be issued. The valid range is 0 to 100. The default is 88%.

   b. In **Erase policy**, select the erase policy you want the VTE to use when recovering space on scratched tapes: **Space**, **Time-to-Live (TTL)** in days or hours, or **Both**.

   Erase policies cannot be changed by a SET command. This is a global parameter which applies to all tape library directories of a VTE.
Note
If the VTE has tape libraries with VOLSERs that reside on a Data Domain, the erase policy must be configured to TTL.
Tape erase provides more information about DLm’s erase policy.

c. In **Start space recovery at**, select the percentage of disk space usage at which DLm starts to recover disk space by deleting the data from scratch volumes.

Valid values are 0 to 100. The default is 85%. If the recovery percentage is set to 100, DLm will never automatically delete scratch volume data to recover disk space.

Note
This field is visible only if the **Erase policy** option, **Space** or **Both**, is selected.

d. In **Recover amount**, select the percentage of free space to recover.

When DLm starts to recover disk space, it continues erasing data from scratch volumes until this amount of free space has been recovered or until there are no more scratch volumes that can be erased. Valid values are 1 to 100. The default is 5%. Setting recovery amount to 100% causes DLm to erase the data from all scratch volumes on this file system once the **Start space recovery at** value has been reached.

Note
This field is visible only if the **Erase policy** option **Space** or **Both** is selected.

e. In **Erase scratched tapes after**, enter the maximum duration in hours or days for which the data of a scratched tape will be retained before automatic space recovery starts, and select **hours** or **days**.

Note
This field is visible only if the **Erase policy** option **TTL** or **Both** is selected. Stagger the Time-to-Live values across VTEs to ensure that multiple VTEs do not start TTL cleanup at the same time.
**Time-to-Live erase policy** provides more information.

f. Select **Tape import/export enabled** to specify that this VTE must provide export/import utilities.

DLm allows the physical attachment of a real IBM 3592 or TS1120 tape drive. The VTE contains export/import utilities that copy (export) a tape volume (VOLSER) from the library to a physical 3592/TS1120 cartridge or copy (import) a physical 3592/TS1120 cartridge to a tape volume (VOLSER) in the tape library. These utilities are executed on the VTE and are independent of any mainframe security programs (such as RACF and ACF/2). By default, these utilities are disabled. Selecting the **Tape import/export enabled** option enables the VTE’s export/import utilities.
g. Select the **Use default lock FS** check-box to use the default DLm lock directory.

h. In the **GR timeout** field, enter the number of seconds that Virtuent should wait for replication-refresh to complete.

GR timeout (seconds) specifies the number of seconds that the VTE should wait for data to be copied to the replica before assuming a replication failure. If the replication does not complete in the number of seconds specified, a unit check with equipment check sense is returned to the mainframe's WTM or RUN CCW. The default value is 2700 seconds (5 minutes less than the default Missing Interrupt Handler (MIH) value of 50 minutes).

**Note**
The GR Timeout value must be less than the MIH value.

i. Under **Additional parameters**, click on the **Add free-form parameters** link or the parameters next to Additional parameters to specify any global free-form configuration parameters you want.

In addition to the pre-defined global configuration parameters described in the previous steps, you can manually enter global free-form configuration parameters into the configuration. The format is: **PARAMETER<space>VALUE**. For example, **AMDD OFF**.

**Note**
Global additional parameters must be entered using the format: **PARAMETER<space>VALUE**. For example, **AMDD OFF**.

### Adding devices

Each **Devices > VTEx** tab contains **Add devices** and **Current devices** fields.

In the **Add devices** fields, you can define virtual tape devices (drives) to be emulated by this VTE. **Current devices** lists the currently-configured virtual tape devices for the VTE. You can add new devices to the existing tape libraries or create new tape libraries and allocate devices to them.

**Note**
Contact EMC Customer Support to have a file system created for the new tape libraries.

### Adding virtual devices

Define the virtual tape devices (drives) to be emulated to the mainframe by this VTE starting with the **Control Units (CUs)** section.

**Note**
File systems must be created by EMC personnel during initial setup before you add devices.

**Procedure**
1. Add one or more controllers to the configuration by entering a valid control unit number and selecting a device type for the devices to be defined on the VTE:
a. In the **Control Unit** text box, type the hexadecimal control unit number that you are configuring.
   Valid values are 00–FF.

b. Under **Device Type** select the device type to be emulated: 3480, 3490, or 3590.

---

**Note**

All devices on the same Control Unit must be the same type.

---

**Figure 28** Control units

2. Click the + button to complete the addition.
   The Control Unit is added to the list and an **Add devices** configuration section appears below the section.
3. Enter values in the fields of the **Add devices** section to configure the corresponding parameters for each device:

   a. In **Control Unit**, enter the hexadecimal control unit number that you are configuring (from the drop list provided of the **Control Units** section defined).

   b. In **Add address range**, enter the starting and ending hexadecimal device unit addresses you wish to add to the VTE.

      You can define sets of 16 or multiples of 16 (n0—nF).

   c. In **Initial device name**, enter a unique name of 1 to 8 characters for the address.

      Each DLm system must have a unique device name. EMC recommends using the same device name that is defined in the UCB name in the mainframe operating system. The name you type must end in hexadecimal digits, and the configuration program increments the name for the number of devices you are defining. For example, if you are defining 16 devices with an address range of 00 - 0F and you type E900 in this field, the configurator names the 16 devices E900, E901, E902, ... E90F.
d. From the drop-down menu in **Tape Library**, select a tape library to which this device will be connected.

   *For example: /tapelib.*

   To appear in the list of available libraries, the storage must be defined on the **Available** tab of the **Storage** panel and be connected to the VTE on the **VTE** tab of the **Storage** panel.

e. In **IDRC** (Improved Data Recording Capability), specify whether to turn on or off write compression of the data that DLm writes to the library.

   The available values are Yes, No, and Force. The default value is IDRC=Yes. When IDRC is set to Yes, the VTE compresses the data it writes to a virtual tape disk file, but only if the mainframe instructs it to do so. Compression is controlled differently by various host operating systems, but is generally configurable in JCL. DLm only compresses data with a block size of 100 bytes or more.

   When IDRC is set to No, the VTE does not compress the data it writes to a virtual tape disk file, despite instruction from the mainframe. When IDRC is set to No, the VTE still reports to the host that it supports compression but it does not perform any compression on the data it writes to the disk. This is because some host operating systems or tape managers do not use drives that do not support compression.

   For devices attached to tape libraries that are configured for deduplication, select **No** for IDRC during device configuration. When writing to VOLSERs stored on Data Domain, an IDRC setting of YES is ignored. The VTEs do not compress the data before it is written to the deduplicated storage. The deduplication device deduplicates the data and compresses only the unique data before writing to its drives.

   **IDRC=No** affects only the writing of data. When IDRC is set to No, the VTE can still read (decompress) virtual tape volumes that it previously wrote with compression on.

   **IDRC=Force** configures the DLm virtual tape device to compress the data it writes to a virtual tape disk file regardless of the mainframe's instructions to the VTE regarding the tape file and regardless of whether the tape resides on a deduplicating file system.

   Using **Force** with a deduplicating file system can severely limit the ability of the storage system to de-duplicate and will, therefore, use more real disk storage.

f. In the **Encryption key class** field, enter a valid KMIP or RSA key class to enable the drives to do encryption.

   When this is configured, the tape drive makes a call to the KMIP or RSA Key Manager using this key class each time the drive opens a tape volume for output.

   **Note**

   When using KMIP encryption, the 'key class' must be prefixed with 'KMIP_'. For example, if a keyclass name of COMP720 is configured under the KMIP key manager configuration, you must specify 'KMIP_COMP720' in this field. This is required so that Virtuent can distinguish between devices configured for RSA encryption and those configured for KMIP encryption.
g. [For VNX file systems only] From the Guaranteed Replication drop down list, select the type of guaranteed replication you want to enable.

The options listed are:

- **Yes**: This enables GR.
- **No**: This disables GR and RUN.
- **RUN**: This enables Replication on RUN. The mainframe performs a Rewind-Unload (RUN) for a tape on which any writes have been performed since it was mounted.
- **SYNC**: This performs a replication-refresh on all CCWs that invoke an explicit or implicit synchronization of tape data. These CCWs will be blocked while the replication-refresh is performed and their ending status will reflect the replication-refresh results. In addition, if a VTE write-sync interval value is set (SYNC=nnnn, which is 1GB by default), a non-blocking replication-refresh will be started after every successful sync performed at these intervals.

When you select **Yes**, **RUN**, or **SYNC**, the GR timeout field is displayed. Enter the duration (in seconds), for which the VTE should wait for acknowledgment that the replication refresh has been completed before assuming a failure has occurred.

h. [For VNX file systems only] If you want the FLR feature enabled for the devices, select **FLR active**.

**Note**

This field is not displayed if your DLm only has Data Domain back-end storage.

**FLR active** is unchecked by default. Checking **FLR active** opens FLR fields in which you must specify FLR characteristics. **WORM Tapes** provides more information.

- When adding new devices, select **FLR active** in the Add devices section of the tab. Other FLR-related fields appear.
- When adding FLR to existing devices, click the **Off** link in the FLR column under Current devices. A pop-up dialog appears with the **FLR active** check box. Enable **FLR active**. Other FLR-related fields are activated.

i. [For VNX file systems only] If you enabled the FLR feature, specify the following:

- In **FLR retention**, enter the retention period in days, months, or years to be assigned to tape volumes when the mainframe has not indicated an expiration date in the HDR1 record. **FLR retention** provides more information.
- Select **FLR mod** if you want to allow the tape drive to modify (extend) a tape volume that is in the WORM state. It is unchecked by default. **FLR mod** provides more information.
- In **FLR extents**, specify how many times a tape volume in the WORM state can be extended, assuming the **FLR mod** option is selected.
Note

The FLR extents value indicates the total number of files including the base Volser file. For example, if you want to specify 12 extensions to the base Volser, you must enter 13 in this field.

Valid values are from 1 to 10000. 1 indicates just the base Volser file with no extensions. If the FLR extents parameter is omitted, the default is 100 (the base Volser + 99 extensions). FLR extents provides more information.

j. [For Data Domain file systems only] If you want the DDRL feature enabled for the devices, select DDRL active.

Note

This field is not displayed if your DLm only has VNX back-end storage.

DDRL active is unchecked by default. Checking DDRL active opens other DDRL fields in which you must specify DDRL characteristics. WORM Tapes provides more information.

- When adding new devices, select DDRL active in the Add devices section of the tab. Other DDRL-related fields appear.
- When adding on existing devices, click on the Off link in the DDRL column under Current devices. A pop-up dialog appears with the DDRL active check box. Enable DDRL active. Other DDRL-related fields are activated.

k. [For Data Domain file systems only] If you enabled the DDRL feature, specify the following:

- In DDRL retention, enter the retention period in days, months, or years to be assigned to tape volumes when the mainframe has not indicated an expiration date in the HDR1 record. WORM Tapes provides more information.
- Select DDRL mod if you want to allow the tape drive to modify (extend) a tape volume that is in the WORM state. It is unchecked by default. WORM Tapes provides more information.
- In DDRL extents, specify how many times a tape volume in the WORM state can be extended, assuming the DDRL mod option is selected.

Note

The DDRL extents value indicates the total number of files including the base Volser file. For example, if you want to specify 12 extensions to the base Volser, you must enter 13 in this field.

Valid values are from 1 to 10000. 1 indicates just the base Volser file with no extensions. If the DDRL extents parameter is omitted, the default is 100 (the base Volser + 99 extensions). WORM Tapes provides more information.

l. In Additional parameters, code any optional keyword parameters you want assigned to the devices being created:
GROUP=nn — nn is any decimal number. GROUP should be coded whenever DLm is to be used with VSE systems. When the VSE utility DLMMOUNT or a VSE tape manager requests a mount on “any” drive, only virtual drives in the same GROUP as the requesting drive are considered for the mount. All virtual tape drives attached to the same VSE system or guest should have the same GROUP, and each VSE system should use a different GROUP number. When not coded, all drives default to GROUP=0.

LABELS=S/N/A — Most operating system mount requests specify a label type, but for those that do not, the LABELS parameter sets the default label type for the drive. The label types are:

S = IBM standard (EBCDIC) labels (the default)
N = Unlabeled
A = ANSI (ASCII) labels.

The label type affects only the type of scratch tape to select when the host does not specify a label in its mount request. The label type setting has no effect on existing tape volumes. It has no effect when the host requests a specific label type in its mount request.

SIZE=maxvolumesize — This parameter limits the maximum size of an individual tape volume. The maximum volume size can be specified in any of the following:
- bytes (SIZE=nnnnnn)
- kilobytes (SIZE=nnnK)
- megabytes (SIZE=nnnM)
- gigabytes (SIZE=nnnG)
- terabytes (SIZE=nT).

When specifying kilobytes, megabytes, gigabytes, or terabytes the value can contain a decimal point (that is, SIZE= n.nT).

If omitted, the maximum volume size defaults to 2G (2 gigabytes) for 3480 or 3490 tape devices and 40G (40 gigabytes) for 3590 tape devices. The maximum allowable tape size for 3480 or 3490 tape devices is 256 GB. The maximum allowable tape size for 3590 tape devices is 32T but is limited to the amount of available storage in the file system. The minimum tape size is 40M (40 megabytes).

TRACE=n — This parameter allows you to set the trace option for this specific device. Available trace levels are:
0 — No tracing (default)
1 — Trace errors only (default)
2 — Trace errors and status
3 — Trace errors, status, and headers
4 — Trace errors, status, headers, and data
5 — Perform a full packet trace (for customer support only)

VOL=(xx,yy,...) — VOL allows scratch volume allocations to be restricted to a specific range of tape volumes beginning with the prefixes defined in VOL.

xx can be from 1 to 6 characters in length. For example, 00, 001, 0011, 00111, and 001111 are all valid examples of a VOLSER prefix.
VOLSER prefix(es) set with VOL are honored during scratch mounts ONLY. The VOL prefixes filter is applied after all other class, space, age, label-type, penalty, and synonym filters have been applied. VOL prefixes do not affect the determination of which directories are picked or in which sequence directories are picked. VOL prefixes do not affect the sequence that VOLSERs are evaluated in. These prefixes are simply a filter that is applied to the VOLSER candidates being considered. The sequences of the prefixes does not change the evaluation process in any way.

If any one prefix matches a candidate VOLSER, the VOLSER passes the test and is selected for the scratch allocation. For example, if VOL=(01,02) is specified for a range of devices then those devices would only allocate scratch volumes to VOLSERs beginning with '01' or '02'. If no scratch volumes beginning with '01' or '02' are available in the storage class being allocated to them, the allocation will be ignored and the device will remain in a Not Ready state.

4. When the parameters are set to your satisfaction, click Add range to create the new devices.

A Current devices section appears at the bottom of your screen showing the devices that have been created. You can change the configuration of individual devices in the Current devices section.

Deleting a device range

Procedure

1. After connecting, click Configurations. In the Configuration operations tab, make sure the correct configuration is selected in the drop down list in the upper left corner of the tab.
2. Select the Devices menu at the top of the page and select the correct VTE tab.
3. Scroll down to the Current devices section.
4. Scroll to the range of devices that you want to delete and click the X button on the right side of the control unit box.
5. Select the Configurations tab at the top of the screen.
6. On the Configurations panel, click Save Changes to save your configuration to disk.

Scratch synonyms

When the mainframe wants a tape volume (VOLSER) mounted on a tape device, it sends a load display command (CCW) over the channel to the device identifying the VOLSER to be mounted. For example, in z/OS, if a user codes JCL for a tape volume that reads "VOL=SER=000001", z/OS sends Dlm a load display CCW indicating that the tape volume with VOLSER '000001' needs to be mounted on the drive. After sending the load display CCW, z/OS waits for the device to become ready and then reads the VOL1 label to verify the serial number.

z/OS uses the default character strings SCRTCH and PRIVAT to indicate a request for a scratch tape to be mounted for output. By default, Dlm recognizes these two strings as a request for a scratch tape and mounts an available scratch tape on the requested device to be used for output.

Most commercial tape management systems (TMS) support the concept of tape pools, allowing you to define your own scratch pools for use when mounting a scratch
tape. Then, on a mount request the TMS will request a scratch tape by sending its pool name (rather than by requesting `SCRTCH` or `PRIVAT`). In support of scratch tape requests by pool name, DLm allows you to define unique “scratch synonyms” to the VTEs. During installation, you can configure your own sub-pools of scratch tapes to request tape mounts using meaningful names.

The field in the **Scratch Synonyms** section under **Global options** of the device tab lets you include whatever names your installation uses to request scratch tape mounts. DLm recognizes these synonyms, along with `SCRTCH` and `PRIVAT`, as a request for a scratch volume when they are in a load display CCW.

Adding scratch synonyms

To add scratch synonyms (tape pool names):

**Procedure**

1. Define a scratch synonym in the following format in the **Scratch Synonyms** section under **Global Options**:

   ```
   synonym=(prefix1,prefix2,..CLASS=(CLASSn,CLASSn,..))
   ```

   where:

   - `synonym` is the character string to be used as the synonym. Synonyms may be 1 - 8 characters in length and must contain only letters A-Z and numbers 0-9.

   **Note**
   Synonyms are case sensitive in DLm Console and should be entered in upper case.

   - `prefixn` is a set of VOLSER prefixes that may be associated with a scratch synonym. Each prefix can be from 1 to 6 characters in length. `prefixn` defines the prefix characters of the VOLSERs that can be assigned in response to a scratch request made with this synonym. For example, `SCRTCH=(00,01)` would indicate that any load request received for `SCRTCH` must be satisfied with a VOLSER that starts with either "00" or "01". Valid VOLSERs that could be mounted by DLm would include any VOLSER in the range 000000–019999, assuming only numeric VOLSERs are in use. If there are no scratch tapes with VOLSERs beginning with "00" or "01" then DLm does not mount a tape and the mount will remain pending. If a VOLSER prefix is not defined for a specific scratch synonym then any available scratch tape will be used.

   - `CLASSn` defines the storage class or classes associated with this scratch synonym. For example, `PRIVAT=CLASS=CLASS1` would indicate that any load request received for `PRIVAT` must be satisfied by allocating a scratch VOLSER in storage class 1. DLm normally selects which storage from which to allocate a scratch tape based on free space and frequency of file system use. When a synonym specifies a specific class of storage be used, DLm first identifies all file systems assigned to the storage class (or classes) and then selects a file system from those file systems based on free space and frequency of use. If a class is not specified, then the scratch synonym will by default only apply to the default storage class of 0.

2. Click the + button to complete the addition.
Scratch synonyms example

Consider the following definitions of scratch synonyms:

WORK
SCRTCH=(00,01)
PRIVAT=CLASS=CLASS1

In this example any mount requested with the synonym WORK will be assigned any available scratch tape in the default storage class 0.

A request for SCRTCH will also go to default storage (class 0), but will only be assigned a volume with a serial number beginning with 00 or 01. If no scratch tapes with these prefixes are available the mount will not be satisfied and will remain pending.

PRIVAT tapes will be allocated from storage assigned to storage CLASS 1. Any available scratch tape within that class will be used. If there are no available scratch tapes in CLASS 1, the mount will remain pending.

The syntax is very important when coding scratch synonyms. For example, defining:

1. DRTAPE=(00,01),CLASS=(CLASS1,CLASS2) defines two synonyms, DRTAPE and CLASS. DRTAPE will use volume serial numbers beginning with 00 or 01 in Class 0 storage. CLASS will use only VOLSERS of CLASS1 and CLASS2.

2. DRTAPE=(00,01,CLASS=(CLASS1,CLASS2)) establishes the scratch synonym DRTAPE using VOLSERs beginning with 00 or 01 located in either storage class 1 or storage class 2.

Note

It is not necessary to define any scratch synonyms. By default, DLm allocates any request for SCRTCH or PRIVAT to any scratch tape available on the default (class 0) storage class.

DLm Long term retention

DLm 4.5.0 and later provides support for the DLm Long Term Retention (LTR) feature. This feature moves virtual tape files that have not been accessed by the host through Virtuent for a configurable, policy-based period of time from normal tapelib storage to LTR storage. The assumption is that LTR storage will be second-tier, cheaper, possibly “lights out” storage, and could be offsite (for example, in the cloud).

LTR storage will reside outside of “normal” tapelibs; but a tape that resides on LTR storage will be accessible by Virtuent if a migrated tape is requested by the host.

EMC service personnel initialize each of the LTR source tape libraries during initial setup.

Note

Whenever new storage is added after the initial setup, contact EMC Professional Services to initialize tape libraries for LTR.

LTR file systems

LTR storage is defined and created in the same manner that other file systems are defined and created. You must enable LTR for the file systems in DLm Console.
The following are the special characteristics of LTR storage:

- LTR storage will be mounted outside of the normal tapelib mount points. They are not physically a part of any tapelib directory tree, and no devices will be allowed to point to them with a PATH parameter, either in the configuration or with the SET command.

- All LTR file systems will be mounted in subdirectories that reside under a common grandparent directory named /ltr, which resides on the VTE “/” file system.

- To be used for LTR storage, each LTR file system will be associated with a single DLm tape library.

- Virtuent will recognize the association between tape libraries and LTR file systems solely based on LTR mount point naming convention. Under the common /ltr grandparent directory, there will be directories that exactly match (“shadows”) the names of associated tape libraries. For example, the LTR storage /ltr/tapelibPROD would be associated with the tape library /tapelibPROD.

- Once moved to LTR storage, tapes never migrate back to tape library storage until they are scratched.

- Tapes that have been migrated to LTR storage can be accessed (mounted) by Virtuent when requested by explicit VOLSER. They can be read and written to just as if they resided on regular tape library storage (with a possible reduction in throughput, depending on the LTR storage type).

- The Virtuent FIND command does not search LTR storage because it is not part of any active tape library. However, it does indicate that the volume is on LTR storage. No other characteristics will be printed.

- The Virtuent QUERY SPACE command does not see LTR storage because it is not part of any active tape library. A new LTR option can be specified for the QUERY SPACE command that lists information about LTR storage.

- The Guaranteed Replication and Replication on RUN features are not supported on LTR storage.

- Tapes in quiesced tape libraries will not be moved to LTR storage.

- Tapes in FLR and DDRL tape libraries will never be moved to LTR storage.

Defining LTR Filesystems

**Procedure**

1. Log in to DLm Console.

2. Navigate to Storage > Available.

3. To designate a file system as LTR target storage, check the LTR checkbox.

4. Enter the class for the LTR file system in the Storage class field. Storage class becomes a mandatory field when you select LTR.
The Class value must be unique for each LTR file system associated with the same tape library.

DLm Console automatically adds “/ltr” to the front of the Mount Point name when LTR is selected. When a previously checked LTR checkbox is un-checked DLm Console removes “/ltr” from the front of the Mount Point name.

5. Click the VTEn tab.
6. Under Active, select the LTR file systems that you intend to use as LTR target storage. These file systems will be mounted on the VTE.

Policies for migration to LTR storage

You must specify the parameters for migrating tapes from normal tape/lib storage to LTR storage.

Parameters for LTR policies

You must specify the following parameters to define a policy for migration to LTR storage:

- The “from” tape library and class
- The age, specified in number of days, at which time a tape should be migrated to LTR storage
- The minimum file size specified in Kb/Mb/Gb
- Optional limits as to the day(s) of the week and time(s) of day to perform the moves
- Type of modification for moved tape (compressed/uncompressed)
- The length of time, specified in number of hours, between when a tape is migrated to LTR storage and when it is deleted from the tape library storage
- The VTE(s) on which the LTR migration tasks should run
- The Max Tasks number of tasks to be stated on each of the VTEs specified. This is the maximum number of tapes that will be moved concurrently for this policy on each of the specified VTEs.

Configuring LTR policies

The target LTR file system is not explicitly specified in the policy; it is implicitly defined as the LTR file system with the same name as the tape library (for example, /ltr/tapelibPROD for /tapelibPROD) and the same class.

Procedure

1. Log in to DLm Console.
4. Specify valid values in the following fields:

- **Enabled**: Select Enable to switch on LTR policy. If it is unchecked, the policy is disabled but all the parameters of the policy will be saved.

- **Name**: Enter a name for the LTR policy. It can contain any character excluding white spaces, quotes, and apostrophes. It can have a maximum length of 30 characters and cannot be empty. The name value is not case sensitive.

  **Note**
  
  The name of a policy must be unique.

- **Source Tapelib**: Choose one of the tape library names from the drop-down box as a source for moving to LTR storage. Selecting a tape library enables the **Source Storage Class** field.

- **Source Storage Class**: Choose the storage class for which this policy is being defined.

- **Move after**: Enters the age at which tapes under this policy will be moved to LTR storage. This value must be specified in number of days from last access (last Virtuent unload of the tape). Any positive number is valid. The maximum value is 720 days (about 2 years) and the minimum is 1 day (24 hours).

- **Move/Do not move during**: Specify when the filesystems should or should not be moved to LTR storage. **Move** is selected by default.
The first checkbox on each line allows selecting the days where moving will be started if the Move option has been selected or will not be started if the Do not move option has been selected.

- Specify the time periods for each day of the week using the start and end fields.
- The All day checkbox allows you to specify hours from 00:00 to 23:59.

- **Delete after**: Specify the number of hours that Virtuent should leave the original file in the tape library after moving it to LTR.
  The valid values are 0 - 24 hours. The default is 0, which deletes the information immediately after the VOLSER is moved.

- **Minimum tape size**: Specify the minimum size of tape for which moving will be performed. You can specify the size in Kilobytes (Kb), Megabytes (Mb) and Gigabytes (Gb) by choosing appropriate unit from drop-down list. The minimum value is 0 Kb which is the default.

- **Tape modification**: Select the type of tape modification when it is stored in the LTR filesystem: Uncompressed or Compressed. Uncompressed is selected by default.

- **Apply to VTE's**: Select the VTE(s) on which the move policy tasks should run. The number of tasks specified in Max Tasks will be started on each of the VTEs specified. Only the VTE(s) on which filesystems with the particular storage class was marked as active are displayed.

- **Max tasks**: Select the maximum number of concurrent tapes that should be moved at the same time under this policy on each of the specified VTEs. The maximum value is 5 tasks and the minimum is 1 task. The default is 1 task.

**Note**

Specifying too many concurrent moves may impact the overall VTE or DLm performance.

## Managing configuration files

The DLm Console lets you manage configurations in the following ways:

- Activating or installing a configuration on selected VTEs
- Creating a completely new configuration
- Editing a configuration
- Saving a configuration file
- Deleting a configuration

### Activating or installing a configuration on selected VTEs

Saving a configuration does not automatically install it on the VTEs. You must install a configuration for it to be used by a VTE. If you modify the currently installed configuration, the changes will not become active until you re-install the configuration.

Installing a configuration may restart Virtuent, which may result in boxed devices. Beginning with DLm 4.5.0, not all configuration installations require a Virtuent restart. DLm 4.5.0 and later provides fields that enable you to check if a Virtuent restart is required. You can also ensure that Virtuent is not restarted unless you specifically select the option to allow a restart.
Note

If Virtuent must be restarted when the configuration is installed, you must vary all DLm devices offline before installing the configuration.

Ensure that all VTEs that this configuration will be installed on are powered up and running before clicking **Install on nodes**.

To install (and activate) your configuration on selected VTEs:

**Procedure**

1. Click **Configurations > Configuration operations** tab and select the configuration to install.

   The **Configuration** field at the upper right corner of the screen identifies the current selected configuration. If necessary, select the configuration from the drop-down box.

   **Figure 32** Configuration operations — Activating or installing a configuration

2. At the bottom of the page, select the VTEs on which you want to check if installing the configuration will require a Virtuent restart.

3. Click **Check on nodes**.

   This shows you if a Virtuent restart is required for any of the selected VTEs.

4. Save or discard the changes by clicking either **Save changes** or **Discard changes** buttons.

5. Select the **Restart Virtuent if required** check box, if you want to proceed with installing the configuration even if it requires a Virtuent restart. If it does not require a restart, you need not select the check box.

   Leaving it unselected will result in the following:

   - If no restart is required for a particular VTE, the configuration is installed.
   - If a restart is required for a VTE, No changes are applied. The Process stops.
6. Click Install.
   This enables the **Install on nodes** button.

7. Select the VTEs on which to install the configuration file.

8. Click **Install on nodes**.
   The configuration is installed on the selected VTEs.
   The **Apply log** window opens, showing the status and results of the configuration installation.
   On the **Configurations** tab, the **Last Installation** field identifies the active, installed configuration file.

---

**Results**

---

**Note**
In multiple-VTE configurations, all VTEs must be powered on and running when you click **Install**.

---

**CAUTION**

**When you click Install, Virtuent may restart. If your VTE is currently online to the mainframe, EMC strongly recommends that you idle all tape drives and vary them offline before installing a new configuration.**

---

If your DLm system has multiple VTEs, Virtuent on every VTE detects a change to its current configuration and automatically restarts. However, if you are adding a new VTE to an existing system, you can install the configuration while the existing VTEs are active as long as you take care not to modify any of the existing VTE’s configurations.

---

**Creating a new configuration**

You can create a new configuration using one of the following method:

---

**Note**
When naming configurations in DLm Console, use only Latin ASCII characters. Do not use periods (‘.’).

---

- Copy an existing configuration to a new file — Use this method to create a new config file that would need a few changes from the copied one. You can make needed edits to the new file and save the new config file.
  or
- Create a completely new configuration — Use this method to create a completely new file containing only some default values. You may need to edit all of the tabs.

---

**Note**
Make sure you edit the Network address with the correct customer IP network address for the HA, VTE1, and VTE2 (if the DLm has more than one VTE).
Creating a completely new configuration

Procedure
1. Select the Configurations tab in the DLm Console.
2. Enter a configuration name in the text box adjacent to the Create configuration named: button.
3. Click the Create configuration named: button.

Copying a configuration

Procedure
1. Select the Configuration menu in the DLm Console.
2. At the upper left corner of the page, select the configuration you want to copy.
3. From the list box near the Copy to field select the configuration to which the configuration file must be copied.
   You can also copy to a new file by selecting new file from the list and specifying a name.
4. Click Copy to.
5. Make the necessary changes for the configuration.
6. Click Save changes.

Uploading a configuration

You can upload an existing configuration to configure the installation. To upload a configuration:

Procedure
1. Click Configurations > Configuration operations on the DLm Console.
2. Click Upload configuration button.
   A pop-up opens asking you to browse.
3. Click Browse to search for a configuration on your local disk.
4. Click **Upload** to upload the selected configuration.

**Downloading a configuration**

To save a copy of your configuration on your local storage:

**Procedure**

1. Click **Configurations > Configuration operations** on the DLm Console.
2. Select the configuration you want to download from the drop-down box.
3. Click **Download configuration** button.

   A pop-up opens asking you to browse a location where you want to save the file.

**Results**

The configuration file is downloaded in the selected location.

**Editing a configuration**

When you select a specific configuration on the **Configurations** tab, all changes made to that configuration on any tab will apply only to that selected configuration. For example, if you have two configuration, config which is the default and a configuration named config1, and you select config1, all changes that you make on any tab, for example, **Devices**, will apply only to config1.

The name of the configuration that you are currently editing displays in the heading area at the top right corner of the DLm Console window. For example, **Configuration: config1**.

To edit a configuration:

**Procedure**

1. Select the **Configurations** tab at the top of the DLm Console.
2. Select the configuration you wish to modify from the drop down list on the left. Select the Devices tab at the top of the DLm Console and make the required changes.

3. Return to the Configuration menu and click Save changes.

**Saving a configuration file**

**Procedure**

1. Select the Configurations tab at the top of the screen.
2. On the Configurations panel, click Save Changes to save your configuration to disk.
3. To activate the configuration file, select the VTE on which it must be installed at the bottom of the page and click Install on nodes.

**Deleting a configuration**

**Procedure**

1. Select the Configurations tab at the top of the DLm Console.
2. Select the configuration you wish to delete.
3. Click Delete.
4. In a pop up window that appears, verify the deletion.

**Tape erase**

DLm supports a space recovery feature that automatically erases data from scratch tapes on the file system based on an erase policy.

The available erase policies are:

- Space
- Time-To-Live (TTL)
- Both (default)

**Note**

If the VTE has tape libraries with VOLSERs that reside on the Data Domain DD990/DD7200/DD9500, the erase policy must be configured for the Time-to-Live options.

The erase policy is a VTE-wide setting. The erase policy can be different on different VTEs. EMC recommends that the erase policy to be different on each VTE, so that all the VTEs do not contend for the same volume. These erase policies affect only AWS-format scratch tapes (not flat tapes nor physical tape cartridges). They affect only automatic space recovery erasing. Erase policies have no effect on erase actions performed by mainframe programs such as DLMSCR. You can configure the erase policy using the fields described in Configuring global parameters.

**Space erase policy**

When a file system reaches a specified percentage of space usage, DLm begins erasing data in that file system until the amount of space specified in the recovery
amount parameter has been recovered. The threshold value, which triggers DLm to erase data from scratch tapes, is specified using the Start space recovery at field.

This automatic space recovery erases the oldest scratch tapes first (based on the time it was scratched). This method is used so that the most recently scratched tapes can be available for some time before being erased.

Time-to-Live erase policy

The TTL erase policy gives you better control over the length of time that the data on a scratch tape is retained when the tape is in the scratch pool. The data on a particular tape is erased when the amount of time since this tape was moved from the active pool to the scratch pool exceeds the duration specified for TTL in the erase scratched tapes after option. Once the period expires, the tapes will automatically be erased regardless of current space utilization. The default TTL value is 365 days.

You can specify the time in:

- Days
- Hours

**Note**

If the VTE has tape libraries with VOLSERs that reside on the Data Domain, the erase policy must be configured to one of the Time-to-Live options. DLm with integrated Data Domain storage does not immediately return the deleted storage to the free-space pool.

**Note**

Stagger the Time-to-Live values across VTEs to ensure that multiple VTEs do not start TTL cleanup at the same time.

Staggering the Time-to-Live values across VTEs ensures that only the required number of VTEs are engaged in TTL cleanup.

The VTE with the minimum value starts recovering space. If that VTE cannot complete erasing the scratched tapes before the next higher Time-to-Live value, the next VTE joins in and helps to complete the space recovery.

For example, in a four-VTE system, if you set the Time-to-Live value of VTE4 to 48 hours, set that of VTE3 to 36, that of VTE2 to 24 hours, and that of VTE1 to 12 hours.

In the case of this example, VTE1 starts erasing tapes that were scratched 12 hours ago. If it cannot complete the recovery, VTE2 starts at the end of the twenty fourth hour. Both VTEs recover space until all the tapes are cleaned up. If VTE1 and VTE2 cannot complete the space recovery at the end of the thirty sixth hour, VTE3 joins VTE1 and VTE2 in recovering space.

**Both**

DLm starts erasing scratch data if either of the conditions — Space erase or TTL policy is satisfied.
VTE logs and DLm statistics

The DLm Console allows you to view and gather the most recent VTE logs for diagnostic purposes. It also provides statistics such as capacity or performance of the system.

VTE logs

VTEs maintain a log of all messages issued by Virtuent. Log files are automatically rotated each day at midnight. Old log files are compressed to minimize the space they take and then kept for a period of time.

Viewing the latest VTE logs

To view the latest VTE logs:

Procedure

1. Access the DLm Console using the web browser:
   a. Open a web browser and type the Management VTE's HA IP address as follows: https://<IP address>
   b. Type the DLm Console username and password in the login page.
      The System status tab of the Status menu opens by default.

2. Click the VTE log icon in the Logs column corresponding to VTE for which you need the logs.
   The logs appear in a new window or a new tab. Use Previous and Next to navigate through the logs.

3. The Search Logs field enables you to search for the logs containing a particular search string generated during a particular period.
   a. Click on the Since first record link. A calendar widget pops up.
   b. Select the date from which you want to see log details.
   c. Select the time from which you want to see log details.
   d. Click OK to close the widget. The date and time appear as a link.
   e. Enter a search string in the text box. You can use an asterisk as a wildcard in the search string. Search strings are case-sensitive; for example, "Scratch" will only find entries containing the word "Scratch" with a capital ‘S’.
   f. Click Go. Clicking Go without a search string will list all the log entries since the specified date and time.

Support data

To gather VTE details for diagnostic purposes:

Procedure

1. On the Status menu, click the Gather logs menu.
   The VTEs are listed in the Machine name column.
2. In the **Support data** column, click **Gather** in the row corresponding to the system for which you want to gather support data.

   The Last gathered column displays a link with the time stamp of the last gathered data.
   
   A pop-up window confirms the request followed later by another pop-up indicating that the **Gather** is complete.

3. Click the link in the **Last gathered** column to download the support data.

   ![Figure 34 Gather logs](image)

**Results**

The downloaded file is a zip file with the name `<machine-date-time-logs.zip>`; for example, `vte1-2016-12-22_05-49-17_logs.zip`.

**VOLSER Listing**

DLm Console provides a searchable list of tapes. The tapes listed can be filtered by library and VOLSER. You can sort the columns of the table.

The columns are:

- **VOLSER name**
- **Filename**
- **Scratch status**
- **Size**
- **Last modification date/time**
- **Last access date/time**

To view the list of tapes:

**Procedure**

1. Access the DLm Console using a web browser.
2. Select the **Status** menu.
3. Click the **Tape list** tab. Sorted list of tapes and fields for search are displayed as shown in the following figure.

---

**Note**

The VOLSER Listing database is updated on an hourly basis.

---

**Figure 35 VOLSER listing**

Click on an item in the **Directories** field or the **Volser** field. The tapes in the directory are listed. If you select a tape in the list, the details of that tape are displayed on the right.

---

**Capacity statistics**

The DLM Console displays capacity statistics of attached storage. It provides following features:

- The ability to download the graph data in comma separated value (CSV0) format,
- The ability to select a new date and time range,
- A warning indicator indicating that the used storage is close to the maximum for the DLM system, and,
- Indicators on how much storage in each area grew or shrank over the graph period

---

**Procedure**

1. Access the DLM Console:

   a. Open a web browser and type the Management VTE's HA IP address as follows: **https://<IP address>**
b. Type the DLm Console username and password in the login page.

2. Select the Status menu.

3. Click the Space tab.

4. Select the mount points for which you want to see the status.

5. Select specific date and time range by clicking on the Showing from date and time on the screen and select a date and time range from the pop-up box to view the capacity used in that time frame. Alternatively, you can also click and drag a range on the graph to zoom into that selected area.

**Figure 36 Capacity statistics**

6. You can download the statistics in CSV format for use with spreadsheet programs by clicking Download CSV. When prompted, select a location to store the resulting file.

**Results**

The capacity statistics displayed include the following metrics for the selected mount points:

- Capacity used
- Capacity free
- Number of active tapes
- Number of scratch tapes
- Percentage of tapes that is active
- Percentage of tapes that are scratch
- Percentage of capacity used by active tapes
- Percentage of capacity used by scratch tapes.
- Storage Limit Warning Indicator
- Trend Indicator
Performance statistics

DLm Console provides Performance statistics in the form of graphs with parameters like time, channel, VTE, tapeLib, and file system. You can select a date range to view statistics in that time frame.

You can individually enable or disable the following change values:

- throughput
- reads
- writes
- tapes mounted in period
- mount time

Procedure

1. Access the DLm Console using a web browser:
   a. Open a web browser and type the Management VTE's HA IP address as follows: https://<IP address>
   b. Type the DLm Console username and password in the login page.
2. Select the Status menu.
3. Click the Performance tab.

   The Performance statistics are displayed as shown in the following figure. You might only see part of the data on the screen. To zoom into the entire data, hold down the left mouse key and select you area. For example, if the last date on initial display of the chart is 21 April, you can hold down the left mouse key and drag it to see data until the current date.

   ![Figure 37 Performance statistics](image)

4. To download a comma-separated values file (.CSV) for use with spreadsheet programs, click the Download CSV link on the page. A prompt will appear asking you to select a location to store the resulting file.
System health check

DLm Console provides a Health check section under the Status > System status tab which allows you to perform a full DLm health check. Upon clicking, health check initiates immediately, but the results from this may not be available for some time, as health checks on very complex installations can take some time to complete. The DLm system is configured to automatically run health check every hour unless automatic health checks have been disabled. The results shown on the screen are from the most recent health check that was completed, either automatically or through a manual user input.

Note

Health check is only implemented on DLm models that support more than one VTE.

Procedure

1. Access the DLm Console using a web browser.
   a. Open a web browser and type the Management VTE’s HA IP address as follows:
      https://<IP address>
   b. Type the DLm Console username and password in the login page.
2. Select the Status menu.
3. Click System status tab.
4. Click the Run DLm Health Check button to initiate health check.

   You can see the system status for each DLm component in the System status table. The possible states reported after the health check are:
   - OK
   - Warning
   - Check
   - Error

Check and Error are both FAILED health check conditions that will send call home alerts. If the health check summary is not available, DLm Console displays "Health check summary is unavailable:" followed by the specific reason.
Virtuent command interface

The DLm Console provides a menu-type interface to execute Virtuent commands. This interface eliminates the need to remember the command set or refer to related documentation.

Procedure

1. Access the DLm Console:
   a. Open a web browser and type the Management VTE’s HA IP address as follows: https://<IP address>
   b. Type the DLm Console username and password in the login page.
2. Select the Status menu.
3. Click the Command tab.
   The Virtuent Command Interface screen appears as shown in the following figure.
4. From the System drop-down box, select the VTE for which you want to execute the Virtuent command.
5. Select the command from the Command drop-down box.
6. Select an option from the Options drop-down box. The syntax is displayed in the Options Format field.
7. Click Execute to run the command.
Results

The output is displayed in the Command Output box.

Launch storage subsystem interface

DLm Console provides an interface that enables you to launch the VNX storage subsystem interfaces.

DLm Console provides an interface that enables you to launch the DD storage subsystem interfaces.

Note

EMC service personnel configure the storage subsystem network interfaces at initial setup.
In the case of VNX, you would have provided IP addresses for SPA and SPB.

Procedure

1. Access the DLm Console:
   a. Open a web browser and type the Management VTE's HA IP address as follows:
      https://<IP address>
   b. Type the DLm Console username and password in the login page.
2. Select the Storage menu.
3. Once connected, click Configurations. In the Configurations operations tab, make sure the correct configuration is selected in the drop down list in the upper left corner of the tab.
4. Click the **Management** tab. The **Storage Management** page is displayed as shown in the following figure. This page lists buttons for each of the storage subsystems in your DLM.

*Figure 40 Launching storage subsystem interfaces*

5. To access the Unisphere VNX Unisphere Service Manager (USM):
   a. Click **Manage VNX n** to open the VNX USM to manage that particular VNX. When USM launches, a pop up message appears prompting for the IP addresses for SPA and SPB.

   **Note**

   If the DLM has only one VNX, only one button VNX 1 is displayed. If there are two VNX systems, buttons for both VNX 1 and VNX 2 are displayed. The SPA and SPB IP addresses are listed beside the VNXn button.

   b. Enter the user ID and password.

   c. Enter the SPA and SPB IP addresses you provided during initial configuration.

   These IP addresses are listed beside the VNXn button on the **Storage Management** tab.

6. If the DLM has only one DD, only one button **DD 1** is displayed. If there are two DD systems, buttons for both **DD 1** and **DD 2** are displayed.

**Back-end tape support**

The DLM allows the Fibre Channel attachment of IBM 3592, TS1120 or IBM-compatible tape drives at link speeds of 2, 4, and 8 Gb. Each VTE supports one physical IBM 3592 or TS1120 tape drive attached using point-to-point connection. A
Fibre Channel port is provided at the rear of each VTE for physical tape functions. You must provide the IBM 3592 drive and a Fibre Channel cable to connect the drive to a port on the VTE.

Note

DLm supports only point-to-point attachment of a single 3592 or TS1120 tape drive to the VTE. Connection through a Fibre Channel switch is not supported. After the drive is physically attached to a VTE, you have two choices:

- Map a single mainframe tape drive (device address) to the physical tape drive for writing real tape cartridges from the mainframe. This capability is referred to as Direct Tape.
- Use the DLm VTE-based Export and Import utilities to copy individual volumes (VOLSERs) from or to the tape.

Direct tape

While DLm emulates tape drives to the mainframe and stores tape volumes on a back-end disk subsystem, it also allows a tape-drive-to-tape-drive mapping of an emulated 3590 tape drive to a physical IBM tape drive attached to a DLm VTE.

Mapping a device

To map a single mainframe device address through to a Fibre Channel attached IBM 3592 or TS1120 tape drive, modify the virtual device definition to point the device to the physical drive instead of a virtual tape library on disk.

For the device being mapped to the physical drive, you must replace the Tape Library parameter by coding the following parameter:

```
DRIVE-nnnnnnnnnnnn
```

where nnnnnnnnnnnnnnnnnnn is a 12-digit serial number for the tape drive. If your drive serial number is less than 12 characters in length then you must pad the number to the left with zeros. For example, if your serial number is 7818330, then you would enter DRIVE-000007818330 into the Tape Library field for the mapped drive. The emulated tape drive must be configured as Device Type 3590.

Note

This procedure requires restarting Virtuent a minimum of two times. For this reason, you should vary the drives defined on this VTE offline to the mainframe.

To map a device:

**Procedure**

1. Vary the drives defined on this VTE offline to the mainframe.
2. Verify that the external tape drive is powered on.
3. Verify that the external tape drive is connected to the Fibre Channel adapter of the VTE.
4. Access the DLm Console using the web browser:
   a. Open a web browser and type the management VTE’s HA IP address as follows:
      ```
      https://<IP address>
      ```
b. Type the DLm Console username and password in the login page.

The System status tab of the Status menu opens by default.

5. Open the VT Console of the VTE where the tape drive is attached: in the Console column, click the icon corresponding to the VTE you want to access.

The Console column contains icons that can open the VT Console of the respective VTEs.

6. Obtain the drive serial number by typing the following on the VT Console:
   
   query drive list
   
   The response in VT Console should be similar to this:
   
   DLm0409I: Command received: 'QUERY DRIVE LIST'
   
   DRIVE path=DRIVE-<SN>(/dev/nstX)vendor=IBM
   
   product=03592E05
   
   SN=000007882427
   
   7. Write down that tape drive serial number.
   
   8. From a web browser, access the DLm Console.
   
   9. Click the required VTEn tab under the Devices menu.
   
   10. In the Control Units section, specify the device type as 3590.
   
   11. After adding device, change the Tape Library field for the device that will be using the tape drive. Specify the 12 digits of the serial number after selecting the (SCSI drive...) field.
   
   12. Save the configuration as described in Editing a configuration. Then, install it as described in Activating or installing a configuration on selected VTEs.

   At this point, Virtuent should start and verify the external tape drive.

   If you receive an error and Virtuent stops, verify that the tape drive displays "online" and try again.

   13. Vary the drives defined on this VTE online to the mainframe.

Segregating the devices

After mapping a device, you must isolate the mainframe device from other virtual devices in the mainframe configuration to control when a real tape is written versus a virtual tape written to disk. Specifically, if you are using MTLs, you must assign a unique library ID (MTL) to this device address. A physical cartridge is written to only when the system ACS routine determines that a real cartridge is to be written to and assigns the appropriate library ID. Otherwise, when the mainframe allocates to the library IDs (MTL) representing the other drives, a virtual volume is written.

When a mainframe device is mapped to a physical tape drive in this manner, mount requests work just as they would if the drive were directly attached to a mainframe channel. Allocation of the drive results in a mount request being posted to the mainframe operator console and to the physical tape drive's operator display panel. The request remains outstanding until the physical drive becomes ready. Normally, this requires an operator to mount a tape and ready the drive.

The tape cartridge written will be compatible with 3592 cartridges written from any mainframe-attached 3592 tape drive unless the volume has been encrypted by DLm. DLm-created cartridges can be sent to mainframe locations that do not have DLm.
installed as long as those locations have real tape drives capable of reading the 3592 cartridge.

Compression

DLm supports IDRC data compression. If the mainframe requests compression of a block written to a DLm virtual tape device mapped to a physical fibre channel attached drive, the VTE will instruct the drive to compress the data before writing it to tape. The tape drive, rather than DLm, will perform the data compression to ensure compatibility with other IBM drives that may later attempt to read the data.

DLm only compresses data with a block size of 100 bytes or more.

Exporting to and importing from tapes

As an alternative to Direct Tape where a mainframe tape drive is mapped directly to a physical IBM drive, DLm includes two utilities for exporting and importing tape volumes between the DLm disk library and a tape drive attached to a DLm VTE.

These commands are executed within Virtuent running on the VTE, where the drive is attached. You can have either Direct Tape or import/export functionality, not both.

The EXPORT and IMPORT utilities are disabled in the default DLm VTE configuration because:

- The copying of the VOLSER is performed solely within the DLm and outside of any security controls the mainframe may have in place.
- A DLm VTE does not usually have a tape drive physically attached to it.

To enable the Export / Import utilities:

Procedure

1. Access the DLm Console using the web browser:
   a. Open a web browser and type the Management VTE's HA IP address as follows: https://<IP address>
   b. Type the DLm Console username and password in the login page.
2. Once connected, click Configurations. In the Configurations operations tab, make sure the correct configuration is selected in the drop down list in the upper left corner of the tab.
3. Click Devices to display the Tape device configuration panel.
   This panel contains a tab for each configured VTE.
4. Click the tab pertaining to the VTE you want to configure.
5. Select the Tape import/export enabled check box.
   Configuring global parameters provides more information about this field.
6. Save the configuration as described in Saving a configuration file and install it on the VTE as described in Activating or installing a configuration on selected VTEs.

Once Virtuent restarts, the EXPORT and IMPORT utilities are available.

Note

DLm does not support import and export of scratch tapes.

To run these utilities:
a. Open the VT Console of the VTE, where the tape drive is attached.

b. After connecting to the individual VTE, you can type the EXPORT and IMPORT commands in the VT Console.

Note

EXPORT and IMPORT commands have no user interaction. If a command is typed incorrectly, an error message is displayed. Re-type the command.

EXPORT provides details about how to use the EXPORT command. IMPORT provides details about how to use the IMPORT command.

**DLm diagnostic reporting**

The different subsystems of the DLm system generate messages as they operate. The major sources of messages in DLm are:

- VTEC
- ConnectEMC (reports VTEC and VNX issues)
- Data Domain

**VTEC**

The VTEs continually generate informational, warning, and error messages as they operate. These messages are written to the internal system disk so that they can be retrieved as necessary during problem determination. Messages will also be automatically displayed on the VT Console.

Additionally, DLm is capable of sending informational, warning, and error messages to any of the following:

- An SNMP management console
- The z/OS master console via a z/OS started task

You can configure which messages get sent to each destination using the Messages panel of the DLm Console.

**Sending messages to SNMP**

To send messages to SNMP:

**Procedure**

1. Configure the message destinations.
2. Configure which messages to send.

In the Messages menu of DLm Console, under the following tabs, select the SNMP check box for each of the messages you want sent to SNMP:

- Error message routing
- Warning informational message routing
- Informational message routing

Configuring messages and recipients provides more information.
Configuring VTEC to send SNMP alerts

The VTEC contains SNMP MIBs that monitor the system and report events. Once configured, the VTEC can send SNMP alerts to a designated SNMP manager. SNMP alerts are sent as SNMPv2c traps on port 162 using the community name 'public.'

To configure the VTEC to send SNMP alerts:

**Procedure**

1. Access the DLm Console:
   a. Open a web browser and type the Management VTE's HA IP address as follows: https://<IP address>
   b. Type the DLm Console username and password in the login page.
2. Once connected, click **Configurations**. In the **Configurations operations** tab, make sure the correct configuration is selected in the drop down list in the upper left corner of the tab.
3. Click **External**.
4. Click the **Notify** tab.
5. Under **SNMP notifications**, type the host name or IP address of one or two systems to which you want SNMP management messages sent.
   For more information, see Configuring messages and recipients.
   If either of the **SNMP manager host** fields contain a valid host name or IP address, the VTE forwards messages to that host. If both fields are blank, then SNMP messaging is inactive.

Sending messages to z/OS

For z/OS messages, you must install the z/OS started task and then configure which messages you want sent.

In the **Messages** menu of DLm Console, under the following tabs, select the **Mainframe** check box for each of the messages you want sent to the mainframe:

- Error message routing
- Warning informational message routing
- Informational message routing

The next section, Configuring messages and recipients, provides detailed instructions.

The DLMHOST section in the *EMC Disk Library for mainframe Command Processors and Utilities for z/OS Guide* also provides information.

Configuring messages and recipients

You can configure which message gets sent to an SNMP management console or the z/OS master console.

**Note**

'E' level error messages cannot be configured. They are always selected to be sent to SNMP and the mainframe.

'E' level error message configuration is disabled in the DLm Console by default. If you need to configure a particular 'E' level message, contact Customer Support.
**Procedure**

1. **Access the DLm Console:**
   
   a. Open a web browser and type the Management VTE’s HA IP address as follows: `https://<IP address>`
   
   b. Type the DLm Console username and password in the login page.

2. Once connected, click **Configurations**. In the **Configurations operations** tab, make sure the correct configuration is selected in the drop down list in the upper left corner of the tab.

3. **Click Messages.**

   Three tabs appear representing informational, warning, and error messages:
   
   - **Error message routing**
   - **Warning message routing**
   - **Informational message routing**

   Each tab shows a complete list of all DLm messages in that particular category.

**Figure 41 Configuring messages**

4. Select the tab corresponding to the message type you want to configure.

5. Select the checkboxes in the following columns to send alerts to the corresponding recipient:
   
   - **SNMP**
   - **Mainframe**

6. Select the **toggle all** check boxes to reverse the selection.
Enabling notification for lost VTEs

DLm 4.3.0 and later provides a feature that notifies the mainframe when Virtuent in not active or when a VTE heartbeat is not detected or a Virtuent application transitions from active to inactive (intentionally or unintentionally). This notification instructs mainframe operators to refrain from varying devices offline.

**Note**

This feature is applicable only to DLm systems with more than one VTE.

This feature is disabled by default. You can enable the feature by enabling mainframe notification for the DLm0941W message in DLm Console. When you enable this feature, DLm sends the following message when a VTE heartbeat is not detected or Virtuent application is not active:

```
DLm0941W: DLm <SN> VTE<n> is lost, DO NOT VARY THE DEVICES FOR VTE<n> OFFLINE
```

The following message is sent when the VTE heartbeat returns and the Virtuent application is active again:

```
DLm0941W: DLm <SN> VTE<n> is found, you can vary devices for VTE<n>
```

Follow this procedure to enable the lost VTE notification capability:

**Procedure**

1. Access the DLm Console:
   a. Open a web browser and type the Management VTE's HA IP address as follows:
      ```
      https://<IP address>
      ```
   b. Type the DLm Console username and password in the login page.

2. Click **Messages**.

3. Click the **Warning message routing** tab.

4. Scroll down to the DLm0941W message and click the checkbox in the **Mainframe** column.

**ConnectEMC**

The ConnectEMC function can automatically notify the EMC service center or other service providers if the VTEC or VNX system detects a serious problem. ConnectEMC sends messages using one of the following:

- Email
- FTP
- Modem (through a customer-supplied analog telephone line)

The FTP and email connections require the DLm to have access to your company's LAN.

ConnectEMC is configured by EMC personnel during initial setup. You can have them configure the VTEC to generate ConnectEMC events for error-level SNMP traps.
Data Domain alert notifications

The Data Domain generates e-mail alerts when it identifies a problem with either a software component or a hardware component. Not all events generate an immediate e-mail notification.

Alert e-mail (generated immediately)
All events of CRITICAL or WARNING severity result in immediate notification to the EMC Data Domain support group. For events with a CRITICAL severity level, the Data Domain system can also be configured to forward the e-mail notification to the e-mail address of the system administrator.

Autosupport e-mails (generated once a day)
The Data Domain system generates daily e-mails to the EMC Data Domain support group. These e-mails contain information about all outstanding alerts and the status summary of the general health of the Data Domain. You an also configure Autosupport emails to be sent to the email address of the system administrator.

AWSPRINT library utility

The awspprint utility allows you to produce lists of the tapes in the virtual tape library within the DLm. You must use the command processor CP503 to obtain the awspprint output. The EMC Disk Library for mainframe Command Processors User Guide provides information about CP503.

The FIND VOLUME command function is related to that of awspprint. This command finds a specific volume (VOLSER) in the DLm tape library and reports the current status of that volume. FIND provides the details of the command.
CHAPTER 4

Replication

This chapter explains the replication concepts and features of a DLm system.

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- **Replication terminology** ....................................................................... 111
- **VNX replication** .................................................................................. 112
- **Deduplication storage replication** .......................................................... 116
Overview of DLm replication

DLm offers IP-based remote replication, which leverages your IP network infrastructure, eliminating the need for channel extension hardware. The replication is storage-based and therefore has no impact on mainframe host operations or performance. DLm replication is asynchronous and only the changes are replicated between the remote sites.

DLm supports unidirectional and bidirectional replication, which means that the source system can also be a target system and vice versa. VNX replication supports up to four target sites per source system, which means you can replicate data to four different sites. The source and destination DLm systems do not have to be configured with the same capacity.

DLm replication is a separately licensed feature. In DLm8100, VNX replication and deduplication storage replication are licensed separately. There are some key differences in the way VNX replication and Data Domain replication work.

Note

A separate license is required for each active storage controller.

VNX replication in DLm occurs at the file system level. A continuous range of VOLSERS is defined in each file system. VNX replication on DLm lets you maintain a remote copy of a collection of virtual tape volumes. The following figure depicts DLm replication. However, all the file systems under a tape library should have the same replication state.

VNX replication is based on EMC VNX Replicator. Using VNX Replicator provides more information on VNX replication. This document and the latest documentation for your specific version of the VNX operating environment (OE) for file are available at EMC Online Support website.

Data Domain replication occurs on directories corresponding to a tape library and not at the file system level. A tape library is a collection of file systems. In each file system, a continuous range of VOLSERS is defined. Data Domain replication is based on the EMC Data Domain Replicator. Only unique data with respect to the destination is replicated from the source Data Domain, resulting in large savings in replication bandwidth utilization. The DD OS Administration Guide provides more details.
Replication terminology

The following is some of the terminology used when describing DLm replication:

Table 10 Replication terminology

<table>
<thead>
<tr>
<th>Term</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Replication</td>
<td>The process of sharing information to ensure consistency between redundant resources.</td>
</tr>
<tr>
<td>Source object (SO)</td>
<td>This is the original source collection of data to be replicated. It is also referred to as:</td>
</tr>
<tr>
<td></td>
<td>• The production object (PO)</td>
</tr>
<tr>
<td></td>
<td>• The production file system (PFS)</td>
</tr>
<tr>
<td></td>
<td>• The source file system (SFS)</td>
</tr>
<tr>
<td>Destination object (DO)</td>
<td>This is the replicated copy of the original data. It is also referred to as:</td>
</tr>
<tr>
<td></td>
<td>• The destination file system (DFS)</td>
</tr>
<tr>
<td></td>
<td>• The target file system (TFS)</td>
</tr>
<tr>
<td></td>
<td>• The secondary file system (SDS)</td>
</tr>
<tr>
<td>Replication session</td>
<td>The relationship that enables replication between the SO and the DO, including two internal snapshots for both SO and DO.</td>
</tr>
<tr>
<td>Time-out-of-sync</td>
<td>This defines how closely you want to keep the destination object synchronized with the source object. This is specified in minutes.</td>
</tr>
</tbody>
</table>
## Table 10: Replication terminology (continued)

<table>
<thead>
<tr>
<th>Term</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Full copy</td>
<td>The complete copy of the source object that is sent to the destination when a replication session is first started, or when a common base is not found.</td>
</tr>
<tr>
<td>Differential copy</td>
<td>The changes made to the source object (since the previous replication) that are sent to the destination during replication.</td>
</tr>
<tr>
<td>Snapshot</td>
<td>A point-in-time copy of data. This view of data takes very little space and are just pointers to where the actual files are stored. Snapshots are used when transporting the full copy after first synchronization. Using SnapSure on VNX provides detailed information on snapshots. This document is available on <a href="https://support.emc.com">https://support.emc.com</a>.</td>
</tr>
<tr>
<td>Disaster recovery (DR)</td>
<td>The process, policies, and procedures for restoring operations critical to the resumption of business, including regaining access to data, communications, and other business processes after a natural or human-induced disaster.</td>
</tr>
<tr>
<td>Recovery point objective (RPO)</td>
<td>A description of the amount of data lost, measured in time. For example, if the last available good copy of data was made 18 hours before an outage, then the RPO is 18 hours. You can define different RPO values for different VOLSER ranges or tape libraries based on information criticality.</td>
</tr>
<tr>
<td>Recovery time objective (RTO)</td>
<td>A specified amount of time within which a business process must be restored after a disaster to avoid unacceptable consequences associated with a break in continuity. RPO and RTO form the basis on which a disaster recovery strategy is developed.</td>
</tr>
</tbody>
</table>
| Storage controller interconnect | The storage controller interconnect is a communication path between two VNX storage controllers that is used for all replication sessions between those two storage controllers. This connection defines all interfaces that can be used on each storage controller, and also the bandwidth throttle schedule. This interconnection must be created in both directions. It is also referred to as:  
  - Data Mover interconnect (DMIC)  
  - DART interconnect (DIC) |

## VNX replication

VNX replication is based on EMC VNX Replicator. *Using VNX Replicator* provides more information on VNX replication. This document and the latest documentation for your specific version of VNX operating environment (OE) code are available on the EMC Online Support website.

Prerequisites for VNX replication are:

- The required replication licenses are installed in the source and destination DLM systems.
- The IP addresses that are assigned to the source and destination storage controllers (Data Movers) are available.
- The HTTPS connections between the source and destination storage controllers (port 5085) and between the source and destination Control Stations (port 443) are secure.
- Sufficient storage space is available for the source and destination filesystems.
Supported VNX replication configurations

DLm supports the following configurations for VNX replication:

- Local replication: Between two separate storage controllers located within the same DLm.
- Remote replication: Between two separate DLm systems, typically (but not necessarily) in different geographic locations. This includes replicating from a single source to up to four separate destinations.
- Bi-directional replication: DLm A replicates to DLm B, while DLm B replicates a different file system to DLm A. Currently, these configurations are not supported:
  - Replication to more than four separate destinations.
  - Cascading (for example, DLm A replicates to DLm B which in turn replicates to DLm C).

VNX replication procedure

DLm uses VNX Replicator v2 to replicate VOLSERs stored in file systems on the source VNX. Each file system on the VNX corresponds to a VOLSER range in DLm. Using VNX Replicator, available on the EMC Online Support website, contains more details about the VNX replicator.

The replication environment is initially set up for you at installation by EMC service personnel. They use the DLm tools to create the target file systems and then connect the source to the target file system. The target file system must have the same name and size as the source file system. To make changes or additions to your replication environment, contact EMC Customer Support.

Creating VNX replication sessions

DLm allows many VNX replication sessions to be active simultaneously. (Using VNX Replicator provides more details about VNX replication sessions.) Creating a replication session involves these tasks:

**Procedure**

1. Ensure that the SO already exists.
2. Create and mount (read only) the DO with the same size and properties as the SO (if it does not already exist).
3. Create internal snapshots at both the source and destination ends.

**Note**

Using SnapSure on VNX provides detailed information on snapshots. This document is available on the EMC Online Support website.

4. Configure and start the replication scheduler that drives the time-out-of-sync policy between the two ends.
5. Establish replication between the source and destination ends.
Data replication

The replication of source data occurs in the following way:

- An application running under z/OS writes data to one or more virtual tapes (VOLSERs) within a file system (VOLSER range) set up for replication on DLm.
- Replication creates a checkpoint — a point-in-time, block-level copy of the underlying file system.
- Using intelligent scheduling algorithms, checkpoints are transferred to the remote destination asynchronously.
- Only changed blocks are copied.

VNX RepOutOfSyncHours feature

DLm provides a replication monitoring feature called the RepOutOfSyncHours feature. EMC VNX Replicator monitors the synchronization status of each active replication session.

Every time a session goes out of synchronization, a timer starts tracking the duration of the out-of-sync state. If that session does not get synchronized within a specified time period, DLm generates a ConnectEMC alert for an out-of-sync call-home condition. If the session returns to synchronized state before the specified time period expires, the timer is reset.

The default time period before the generation of an out-of-sync call-home alert is four hours. You can change the default time period in the Storage > Management tab (VNX Replication) in DLm Console.

The latest documentation for your specific level of VNX OE code is available on the EMC Online Support website (support.emc.com).

Recovering from a disaster using DLm VNX replication and disaster recovery

This section explains the role of DLm replication in a disaster recovery (DR) strategy. Replication terminology explains terminology relevant to DLm replication in a disaster recovery strategy.

Replication is not a complete disaster recovery strategy, although it provides an essential enabling technology for accomplishing DR. A DR workflow must take into consideration your environment, potential scenarios, and the desired recovery objectives.

To recover from a disaster in DLm using VNX replication:

Procedure

1. Mount the read only copy of the all the file systems at the target site on the VTEs.
2. Identify the tapes that have been lost due to the disaster event. Identifying lost tapes provides instructions.
3. Perform a failover of the file systems in the VNX.
4. Unmount and remount the file system as read/write.
5. When the source system becomes available, copy the changes made at the target back to the source system.
6. After all the changes have been copied to the source, change the configuration to the original configuration.
Configuring NFS on VNX provides information on working with file systems in VNX.

Results
Replication reduces both RPO and RTO. Each file system (VOLSER range) maintains a unique and independent value for:

- **Time-out-of-sync** — This controls how often the destination site is refreshed. Depending upon your load and bandwidth, this can be nearly synchronous. This value is equivalent to the RPO described in Replication terminology.
- **Quality of service (QoS)** — This controls bandwidth throttling by specifying limits on specific days and hours.

Time-out-of-sync
DLm replication uses an adaptive scheduling algorithm to determine when to refresh replicated storage. RPO is typically set to less than 10 minutes. The replication scheduler uses best effort to maintain the specified RPO for each range of VOLSERs, and automatically works to catch up after any RPO violation. Advanced capacity planning is required to make sure that RPO violations do not occur. However, events (SNMP traps or email) can be configured in case RPO violations do occur.

Quality of service
QoS controls bandwidth throttling by specifying limits on specific days and hours. Interconnect QoS defines up to six bandwidth schedules. These are defined in terms of days, hours, and bandwidth.

Identifying lost tapes
To identify tapes that have been lost due to the disaster event:

**Procedure**

1. Use the `awsprint` utility to identify the list of scratch tapes in the file systems that have been disrupted.
2. Compare the output of the utility with the list of scratch tapes for this VOLSER range according to the Tape Management Catalog.
   
   Some will appear in the `awsprint` output but not in the Tape Management Catalog as they were no longer in scratch state when the disaster event occurred. These tapes might not have completed replicating to the target VNX. The `AWSPRINT library utility` provides information about the utility.
3. Identify the last snapshot that was transferred successfully to the target using the command processor CP504.
   
   The output contains the last successful sync time for a particular file system.
4. Execute `GENSTATS` with the following options:
   
   - `STILLINUSE`
   - `PATHNAME=“name of tape library”`

   The GENSTATS report provides a list of VOLSERs that were being transferred to the destination at the time of the disaster event.
The DATESTART parameter may be used to indicate the start of the search.

An example of param usage in the JCL to generate such a report:

```
STILLINUSE PATHNAME=tapelib/BB
```

Sample output:

```
STILLINUSE PATHNAME=tapelib/BB
--------------------------------------------------------------
VOLSERS STILL MOUNTED    :
NODENAME   DEVICE     VOLSER  LAST MOUNTED         PATH
VTE1       VTE1-01    BB0161  2015/01/29 23:35:14  tapelib/BB
VTE1       VTE1-00    BB0180  2015/01/29 23:35:14  tapelib/BB
VTE1       VTE1-02    BB0160  2015/01/29 23:35:14  tapelib/BB
```

This list indicates the VOLSERs that has been lost due to the disaster event and these jobs will need to be re-run.

*The EMC Disk Library for mainframe Command Processors User Guide* contains more information about GENSTATS and command processor CP504.

DR testing from a copy of production data

DR testing is performed without interrupting data replication between the DR and production sites by using a copy of the production data.

Disk arrays allow the creation of both read-write snaps and instant read-only copies:

**Procedure**

1. For Read-write snaps:
   a. Confirm operation at the DR site.
   b. Require twice the storage capacity of SO.

2. For Read-only copies:
   a. Confirm that the tapes can be mounted and all required data can be accessed.
   b. Require minimal incremental storage capacity.

**Tape catalog considerations**

Tape catalog management is no different for DLm than it is for offsite storage; that is, catalogs can be written to an emulated tape and replicated to allow data to be recovered. However, in environments that replicate the catalogs synchronously with a DASD replication solution, tape catalog management includes some special considerations.

**Deduplication storage replication**

DLm systems attached to Data Domain storage subsystems provide deduplication features.

Replication on deduplication storage is executed by the Data Domain Replicator software available with DD990/DD7200/DD9500.
The replication environment is initially set up for you at installation by EMC service personnel. To make changes or additions to your replication environment, contact EMC Customer Support.

**Note**

Deduplication storage replication applies only to DLm8100 systems equipped with DD990, DD7200, or DD9500 storage system.

The Data Domain Replicator software includes different replication policies that use different logical levels of the system for different effects. In a DLm environment, the Data Domain is configured to use MTrees and directory replication, which offers maximum flexibility in replication implementation. With directory replication, a directory (sub-directory, and all files and directories below it) on a source system is replicated to a destination directory on a different system. Directory replication transfers deduplicated changes of any file or subdirectory within a Data Domain file system directory that has been configured as a replication source to a directory configured as a replication target on a different system.

In DLm, the directory replication context is established at the directory that corresponds to a virtual tape library. Hence, replication cannot be enabled or disabled for individual VOLSER ranges.

DLm supports replication from one source DLm8100 to one target DLm8100 as well as replication between two DLm8100 systems. DLm 4.4.0 and later supports concurrent replication from one source to two destination DLm8100 systems.

Data Domain replication uses a proprietary protocol to transfer only the data that is unique at the destination. Replication transfer for a file is triggered by a file closing. In cases where closes are infrequent, DD Replicator forces data transfer periodically. Once the complete file has been established on the replica, it is made immediately visible to the replica namespace and may be restored or copied at once. The replica at the destination is set to read only. All transfers between the source and the destination use the Diffie-Hellman key exchange. Data Domain Replicator uses its own large checksum to verify the accuracy of all sent data, in addition to the verification that TCP provides.

The two replication ports on the DD990/DD7200/DD9500 are configured in Failover mode to protect against link failures. Failover is the only configuration that DLm supports for the DD990/DD7200/DD9500 replication ports. No other configuration is supported for these replication ports.

**Prerequisites for Data Domain replication**

- Data Domain Replicator licenses are installed in the source and destination DLm systems.
- The software version on the destination VTE must be the same as or higher than the software version on the source VTE.
- You have the IP addresses that are assigned to the source and destination Data Domain systems.
- Cat5 Ethernet cables are available for each Data Domain system and all required WAN switches/ports are configured end-to-end.
- Sufficient storage space is available in the source and destination filesystems. At initial replication setup, EMC recommends that you plan disk capacity based on a deduplication ratio of zero.
• The source and target Data Domains must be running the same version of DDOS or not more than one version difference between them so that replication sessions can be configured and managed within the same Enterprise Manager window.

**Supported replication configurations**

The following configurations are supported:

• Unidirectional from a single source to a single destination
• Unidirectional from a single source to two destination systems
• Bidirectional between a single source and destination pair

**Note**

Data Domain replication is supported only when both the source and target systems are DLM-attached systems. Replication between a Data Domain and a VNX is not supported.

**Requirements for replication session setup**

The requirements for the successful setup of a Data Domain directory replication are:

• The destination system must be large enough to store all the data replicated from the source.
• The network link bandwidth must be large enough to replicate data to the destination.
• The fully qualified domain names FQDN for the source and the destination Data Domain systems must be registered in the DNS servers.

  For example, if the hostname of the Data Domain is DD-1, the FQDN might be "DD-1.customer.com."
• The replication context directory is defined after the directories are created at both the source and the destinations. EMC recommends that you set up replication before the system restores backups to the source directory. Erase all files from the destination directory if it is not empty before the initialization of a directory context.
• Replication initialization must be executed from the source.

**Throttling**

As a basic form of quality of service (QoS), times of day during which data may or may not be sent, along with limits to the amount of bandwidth that can be used.

**Note**

Contact EMC Service if this needs to be configured. By default, no throttling is set.

**Recovery point**

In a Data Domain system, deduplication is fast and inline, and replication can be simultaneous with backup, so it can finish shortly after backup. The restore image is available immediately from the replica. The recovery point is from the current snapshot before the delay represented by the backup window.
Recovery time

The replica contains only deduplicated data. The recovery time is the same as the restore rate from the deduplication pool in the replica. This should be measured carefully with a large dataset to ensure sustained performance characteristics.

The Data Domain Replicator uses the directory replication feature to support replication at the tape library level.

Disaster recovery in Data Domain systems

Disaster recovery for data stored on a Data Domain system is performed on the entire tape library. The Data Domain system reports a parameter called the Sync'd as of time for each tape library being replicated. This Sync'd as of time indicates the timestamp of the most recently replicated data for a replication-enabled tape library. All data that was written to VOLSERs in the source tape library before the Sync'd as of time has been replicated and data received after the Sync'd as of time is in the process of being replicated. For example, if the Sync'd as of time for the replication context /backup/tapelibZZZ is reported as 23:35:00 on 04/29/2013, it indicates that all the data written to the tape library tapelibZZZ, as of this time 23:35:00 on 04/29/2013 at the source, has been replicated. The data written after this time, for example, 23:36:00 on 04/29/2013, is in the process of being replicated.

In the case of a disaster, the VOLSERs in the tape library accessed after the Sync'd as of time reported for that tape library is lost and cannot be recovered. You can use the GENSTAT utility with the SYNTIME, DATESTART, DATEEND, and PATHNAME parameters to identify the data that is not replicated. The EMC Disk Library for mainframe Command Processors User Guide contains more information about GENSTATS.

Identifying unreplicated data on Data Domain

To identify the unreplicated data stored on a Data Domain system:

Procedure

1. Execute the command processor CP603 with the status option for each replication-enabled tape library that stores its data on a Data Domain system.
2. Note the Sync'd as of time for each replication-enabled tape library on the Data Domain system.
3. Execute the command processor 998 to gather statistics.
4. Execute GENSTATS with the following options:
   - STILLINUSE
   - SYNTIME=hr:mm:sec (the Sync'd as of time)
   - DATESTART=yr:mm:dd (the date to start the search)
   - DATEEND=yr:mm:dd (the date of the Sync'd as of time for this context)
   - PATHNAME="name of tapelibrary" (for example, “tapelibZZZ”)

Note

If you run GENSTATS with the PATHNAME option, the report lists VOLSERs in the tape library that correspond to the specified pathname, the updates of which have not been replicated.
DATESTART and DATEEND define the DLm production time period to report in the GENSTATS reports. If you do not specify a time period, you may see extraneous or irrelevant tape mounts in the STILLINUSE report.

Results

The EMC Disk Library for mainframe Command Processors User Guide contains more information about GENSTATS Command Processor 998 and CP603. This GENSTATS report provides a list of VOLSERs that were accessed after the Sync'd as of time and might not have completed replicating the data to the target.

This is an example of how the parameter is used in the JCL:

```
STILLINUSE DATEEND=15/01/29 SYNCTIME=23:36:00 PATHNAME=tapelibZZZ/
```

This is the report generated:

```
VOLSERS MOUNTED AFTER SYNCTIME (15/01/29 23:36:00)
2015/01/29 23:46:36 S10162
2015/01/29 23:46:36 S20181
2015/01/29 23:46:36 S30161
2015/01/29 23:57:59 S10163
2015/01/29 23:57:59 S20182
2015/01/29 23:58:00 S30162
2015/01/30 00:09:25 S10164
2015/01/30 00:09:25 S20183
2015/01/30 00:09:25 S30163
2015/01/30 00:20:49 S10165
2015/01/30 00:20:49 S20184
2015/01/30 00:20:50 S30164
```

The report provides two lists of VOLSERs:

- VOLSERs that were mounted at the Sync'd as of time (23:36:00 on 01/29/15 in this example)
- VOLSERs that were mounted after the Sync'd as of time

Directory replication flow

This is how Data Domain directory replication works:

- The source Data Domain system continuously sends segment references (metadata) to the destination Data Domain system.
- Destination Data Domain replica filters them by looking up its index to check which segments it doesn't already have. This could impact replication performance due to the high restore/backup load.
- The source periodically asks the replica which segments need to be sent.
- The destination responds with list of segment references that it does not have.
- The Source reads the requested segments from its filesystem and sends them.
- Replication code picks up the logged close records from a queue and begins replication. The maximum amount of time between a write and when replication will start is one hour.

Replication logs the close of a modified file based on the following considerations:

- 10 minutes after the last access, NFS closes the file.
- Every hour (by default), all files are closed regardless of how recently they were written.
- If many files are being accessed or written, files may be closed sooner.
Replication
CHAPTER 5

Guaranteed Replication and Replication on RUN

This chapter provides information about the DLm Guaranteed Replication (GR) feature and DLm Replication on Rewind-Unload (RUN) which are enhancement to DLm replication capabilities.

- Overview of Guaranteed Replication and Replication on RUN .........................124
- Configuring GR and Replication on RUN .......................................................128
- Managing GR and Replication on RUN .......................................................131
Overview of Guaranteed Replication and Replication on RUN

The disaster recovery capabilities of DLm include data replication using the VNX Replicator. Replication provides more information on the regular DLm replication feature.

VNX Replicator replicates the data periodically and asynchronously. It is configured to periodically create a snapshot of the local DLm storage/file systems and then asynchronously transfer the data at the time of the snapshot to the remote DLm. The data stored after the last snapshot is not replicated until the next snapshot is taken. A sudden loss of connection to the local DLm leads to the possibility of data loss.

For most situations and applications, this type of periodic and asynchronous replication is adequate. But, for some critical applications where the data is expected on the remote DLm as soon as it is written to local DLm, this type of asynchronous replication is not adequate.

DLm offers the following enhancements to DLm's replication capabilities:

- Guaranteed Replication (GR) on close
  Guaranteed Replication forces a replication refresh whenever a tape file is closed by the host.

- GR on SYNC
  Guaranteed Replication forces a replication refresh on every SYNC command received from the host.

- Replication on RUN
  Replication on RUN forces a replication refresh when the host performs a RUN (Rewind-Unload) command.

Note

On a given device, the Guaranteed Replication feature is mutually exclusive with the Replication on RUN feature. Any device can be configured for either or neither, but not both.

In all three features, the ending status for the host command that triggered the replication refresh is blocked until replication-refresh is complete, and the replication results are reported to the host in the ending status.

Note

GR on close, GR on SYNC, and Replication on RUN are only performed on tapes that reside on VNX file systems with VNX Replicator active.

GR on close, GR on SYNC, and Replication on RUN features do not function with the following:

- SCSI tapes or VTLs
- Virtual tapes on any other type or brand of back-end file system, such as Data Domain or VMAX.

Also, these features are not performed on tapes written to VNX file systems by the Virtuent IMPORT command.
Behavior of replication and non-replication devices

Devices configured for GR on close, GR on SYNC, or Replication on RUN behave differently from devices that are not configured for these replication features, as described in the following table.

**Table 11 Behavior of replication and non-replication devices**

<table>
<thead>
<tr>
<th>Device configuration</th>
<th>Non-replicating file system</th>
<th>Replicating system</th>
</tr>
</thead>
<tbody>
<tr>
<td>Device not configured with any of the guaranteed replication features</td>
<td>Read (from a named VOLSER mount): yes</td>
<td>Read (from a named-VOLSER mount): Yes</td>
</tr>
<tr>
<td></td>
<td>Write (to a named VOLSER mount): yes</td>
<td>Write (to a named-VOLSER mount): Yes</td>
</tr>
<tr>
<td></td>
<td>Mount Scratch: yes</td>
<td>Mount Scratch: Yes</td>
</tr>
<tr>
<td>Device configured with GR on close, GR on SYNC, or Replication on RUN</td>
<td>Read (from a named VOLSER mount): yes</td>
<td>Read (from a named-VOLSER mount): Yes</td>
</tr>
<tr>
<td></td>
<td>Write (to a named VOLSER mount): Yes, with DLm0545W warning message</td>
<td>Write (to a named-VOLSER mount): Yes</td>
</tr>
<tr>
<td></td>
<td>Mount Scratch: No (only replicating file systems are searched)</td>
<td>Mount Scratch: Yes; only replicating file systems are searched</td>
</tr>
</tbody>
</table>

Introduction to GR on close

The GR on close feature is essential for customers and situations where periodic, asynchronous replication is not adequate. For example, if the DLm at the primary site fails and processing needs to relocate to the remote site, the data that was closed on the mainframe but was still being replicated at the time of failure is either completely or partially lost. GR on close helps to avoid the potential loss of data by ensuring that the tape volume is replicated before it closes.

When a tape volume on a replication-enabled file system is written to a DLm tape device configured for GR on close, it is assumed that when a dataset on the VOLSER is successfully closed, it has been fully replicated to the DR site. Assuming the mainframe system log indicates a VOLSER was successfully closed, the dataset at the DR site is a completely replicated copy.

GR on close replication refresh process

When a tape drive is configured for GR, the VTE performs certain replication-related functions after it receives the GR=YES triggering command from the mainframe:

- The mainframe writes two consecutive tapemarks to the tape. The two write tapemark commands do not have to be received as consecutive commands. The replication refresh is triggered when a tapemark is written following an existing tapemark.

- The mainframe writes two tapemarks to the tape while positioned anywhere within the Logical End of Tape (LEOT) area. The two tapemarks do not have to be positioned consecutively on the tape, nor do the two write tapemark commands have to be received as consecutive commands. For example, the sequence write tapemark-write-write-write tapemark (the typical end of volume writes) would result in a replication-refresh on the second write tapemark command.
When GR on close is triggered, the VTE:

- Flushes its cache for the file system where the VOLSER has been written.
- Displays message DLm0543I to document Virtuent’s intent to start a replication refresh.
- Requests the VNX Control Station to perform a replication refresh.
- Waits for the VNX Control Station to complete replication.
- Returns the ending status to the host when the replication refresh completes or fails to complete within the GRTIMEOUT period.

For normal replication completion, the ending status is a normal channel end and device end. For a GR timeout, the ending status is a unit check.

Virtuent sends a replication-refresh request to a VNX file system only when all the following is true:

- The DLm_GR license is installed on the VTE.
- The VTE virtual tape drive is configured with Guaranteed Replication enabled.
- The file system on which the virtual tape file resides is:
  - A configured VNX file system
  - A replication-enabled file system

**Tape requirements for Guaranteed Replication**

Before configuring GR, you must note that not all tapes are supported by GR. Only tapes that use one of the following tape labeling standards are supported by GR:

- IBM Standard Labeled tapes (SL)
- IBM Non-Labeled tapes (NL)
- ANSI Labeled Tapes (AL)

These three standards are implemented in most IBM operating systems as part of the OS data management components (for example, BSAM and QSAM in z/OS). These standards require that tapes must be closed with two consecutive tapemarks. These tapemarks will trigger GR to start a replication refresh.

**Introduction to GR on SYNC**

GR on SYNC forces a replication refresh whenever a SYNC command is received from the host.

Replication is triggered when the mainframe sends any tape synchronizing command. These commands include explicit sync, write tapemark, erase gap, and tape motions commands.

When GR on SYNC is triggered, the VTE:

- Flushes its cache for the file system where the VOLSER has been written.
- Displays message DLm0543I to document Virtuent’s intent to start a replication refresh.
- Requests the VNX Control Station to perform a replication refresh.
- Waits for the VNX Control Station to complete replication.
- Returns ending status to the host when the replication refresh completes or fails to complete within the GRTIMEOUT period.
For normal replication completion, the ending status is normal channel end and device end. For a GR timeout, the ending status is a unit check.

Virtuent sends a (GR) replication-refresh request to a VNX filesystem only when all the following is true:

- The DLm_GR license is installed on the VTE.
- The VTE virtual tape drive is configured with Guaranteed Replication enabled.
- The file system on which the virtual tape file resides is:
  - A configured VNX file system
  - A replication-enabled file system

Introduction to Replication on RUN

Replication on Rewind-Unload (RUN) is an optional VTE feature for VNX file systems with replication enabled. When writing to tapes on VNX file systems with replication enabled, Virtuent devices can be configured to force a replication refresh when the host sends a rewind-unload (RUN) command. The ending status for the RUN command is blocked until the replication-refresh is complete. The replication results are reported to the host in the ending status. This feature is supported only on DLm 4.3.0 and later versions.

It is important to note that, unlike "Guaranteed Replication", Replication on RUN does not provide the "Guaranteed" behavior. The RUN command is performed by the host after the host application completes. Even though Virtuent blocks on the RUN command and returns an equipment check if the replication-refresh fails for any reason, the host application cannot detect whether the replication-refresh completed successfully or with an error because it has already finished. In addition, an error status returned to the RUN command does not cause the host job to abend. It continues as normal and the subsequent job steps will be executed.

Replication on RUN is not performed for a manual unload caused by a Virtuent UNLOAD command, only for RUN commands sent from the host.

Note

On a given device, the Guaranteed Replication feature is mutually exclusive with the Replication on RUN feature. Any device can be configured for either or neither, but not both.

With Replication on RUN, Virtuent sends a replication-refresh request to a VNX file system when all the following is true:

- The DLm_GR license is installed on the VTE.
- The VTE virtual tape drive is configured with Replication on RUN enabled.
- The file system on which the virtual tape file resides is:
  - A configured VNX file system
  - A replication-enabled file system
- The mainframe performs a Rewind-Unload (RUN) command for a tape on which any writes have been performed since it was mounted.

Replication-Refresh Process (Replicate on RUN)

For a tape mounted on a Replication on RUN enabled device on a replication-enabled file system, a replication-refresh is performed when the device receives a Rewind-Unload (RUN) command from the mainframe if any writes have been performed since
the tape was mounted. When it receives a RUN, Virtuent does the following before returning the ending status to the host (thereby blocking on the RUN command):

- Unloads and closes the virtual tape file
- Displays the message DLm0543I to document Virtuent's intent to start a replication refresh
- Requests the VNX Control Station to perform a replication refresh
- Waits for the VNX Control Station to complete replication

If any error occurs during the replication refresh, message DLm0548E is displayed, and a unit check status, with equipment check sense, is returned for the host's RUN command.

If the replication-refresh completes normally, Virtuent displays message DLm0544I and returns normal ending status to the host's RUN command.

If the replication-refresh does not complete normally, before the GRTIMEOUT period expires, message DLm0548E is displayed, and a unit check, with equipment check sense, is returned for the host's RUN command.

### Configuring GR and Replication on RUN

Guaranteed Replication and Replication on RUN work only for the file systems that have replication setup. Contact EMC Professional Services to configure replication for the file systems on which you want to use GR or Replication on RUN.

You can implement these features on either a single tape drive or multiple tape drives. For example, a VTE that emulates 32 tape drives might have only 8 or 16 drives configured for GR or Replication on RUN, while the remaining tape drives can be configured without GR or Replication on RUN.

**Procedure**

1. Install the DLm_GR license.
   
   The DLm_GR license is required for both GR as well as Replication on RUN. Contact EMC Professional Services to install the license.

2. If replication has not been set up for file systems on which you want GR or Replication on RUN, Contact EMC Professional Services.

   **Note**

   EMC recommends that replication be enabled on all the file systems in a tape library even if only one (or few of them) is intended to be used for GR or Replication on RUN. Do not enable replication on a subset of file systems in a tape library intended for GR or Replication on RUN.

3. Configure the global GR timeout value as described in Configuring GR Timeout value.

4. Configure the devices for GR or Replication on RUN as described in Configuring devices for GR or Replication on RUN.

5. Save and install the configuration changes made.
   
   This restarts Virtuent.
Note

Every time you make any change to the device configuration or configure replication on any of the VOLSER range intended for GR or Replication on RUN, you should save and install the configuration for the change to take effect. This must restart Virtuent.

⚠️ CAUTION

Restarting Virtuent will result in a temporary outage of any device emulated by Virtuent. You must coordinate the restart operation with the mainframe operations. You must vary all devices being emulated by a VTE to OFFLINE state before you restart Virtuent.

Configuring GR Timeout value

The GR Timeout parameter is used by both Guaranteed Replication and Replication on RUN and must be configured for either feature. GR Timeout specifies the duration (in seconds), for which the VTE should wait for acknowledgment that the replication refresh has been completed before assuming a failure has occurred. This value prevents the tape drive from remaining in a wait state should replication to the remote DLm fail. The default value for GR Timeout is 2700 seconds or 45 minutes, which is 5 minutes less than the standard mainframe Missing Interrupt Handler time of 50 minutes.

Note

The GR Timeout value must be less than the mainframe MIH value. If the MIH is less than the GR Timeout value, the mainframe will abend the job and take the affected device out of service if it encounters the MIH.

You configure the GR Timeout value in the Global Options section of the DLm configuration file as described in Configuring global parameters.

Configuring devices for GR or Replication on RUN

The GR and Replication on RUN features are implemented on a device-by-device basis. It is not necessary to configure all the devices in your DLm or all the devices within a single VTE for GR or Replication on RUN.

Note

On a given device, the Guaranteed Replication feature is mutually exclusive of the Replication on RUN feature. Any device can be configured for either or neither, but not both.

Contact EMC Professional Services to configure devices.

You can view the device configuration for each VTE by clicking the Devices tab in DLm Console.

Configuring existing devices for GR/Replication on RUN

Procedure

1. Access the DLm Console using the web browser:
a. Open a web browser and type the Management VTE's HA IP address as follows:

   https://<IP address>

b. Type the DLm Console username and password in the login page.

2. Once connected, click Devices to display the Tape device configuration panel. This panel contains a tab for each available VTE.

3. Click the tab pertaining to the VTE you want to configure.

4. Under Global options, select one of the following options from the Guaranteed replication drop down list:

   - Yes: This enables GR.
   - No: This disables GR and RUN.
   - RUN: This enables Replication on RUN. The mainframe performs a Rewind-Unload (RUN) for a tape on which any writes have been performed since it was mounted.
   - SYNC: This performs a replication-refresh on all CCWs that invoke an explicit or implicit synchronization of tape data. These CCWs will be blocked while the replication-refresh is performed and their ending status will reflect the replication-refresh results. In addition, if a VTE write-sync interval value is set (SYNC=nnnn, which is 1GB by default), a non-blocking replication-refresh will be started after every successful sync performed at these intervals.

   When you select Yes, RUN, or SYNC, the GR timeout field is displayed.

5. In GR timeout, enter the number of seconds that Virtuent should wait for replication-refresh to complete.

6. Under Current devices, select Yes, No, RUN, or SYNC from the GR drop down list for each of the listed devices.

Enabling GR when adding devices

Procedure

1. Add devices as described in Adding virtual devices.

2. In the Add devices section of the Device tab in DLm Console, select one of the following options from the Guaranteed replication drop down list:

   - Yes: This enables GR.
   - No: This disables GR and RUN.
   - RUN: This enables Replication on RUN. The mainframe performs a Rewind-Unload (RUN) for a tape on which any writes have been performed since it was mounted.
   - SYNC: This performs a replication-refresh on all CCWs that invoke an explicit or implicit synchronization of tape data. These CCWs will be blocked while the replication-refresh is performed and their ending status will reflect the replication-refresh results. In addition, if a VTE write-sync interval value is set (SYNC=nnnn, which is 1GB by default), a non-blocking replication-refresh will be started after every successful sync performed at these intervals.

3. Click Add range.
Managing GR and Replication on RUN

All output tapes written to a device configured with GR or Replication on RUN trigger replication refresh if the file system to which the tape is written is configured for replication.

During a VNX Control Station failover event, the current GR and new host requests for GR or Replication on RUN are likely to fail. However, as soon as the failover is complete and the secondary Control Station assumes the primary role, the subsequent requests for these features work as expected.

Note

In the event of a Control Station failover, several minutes may be needed to reach the stage where GR or Replication on RUN functions are operational again.

Verifying GR or Replication on RUN configuration

In addition to verifying the VNX configuration, verify the GR or Replication on RUN configuration by using the `QUERY GR` command. You can run the command from the Status > Command tab of DLm Console.

The output of the `QUERY GR` command displays:

- The GR Timeout value
- The tape devices configured with Guaranteed Replication and Replication on RUN
- The file systems on the storage controllers (Data Movers) that have been configured for replication and are eligible for the GR or Replication on RUN

Using best practices for GR and Replication on RUN

As a best practice, the value chosen for GR Timeout should be several minutes less than the host's MIH time. In this way, the DLm's actions, in case of replication issues, occur before the actions associated with MIH, giving the user closer control of managing the consequences of replication issues.

Compare these situations:

- If MIH times out before GR or Replication on RUN is done or times out:
  When replication refresh finishes (either completes or GR Timeout is reached), the VTE will see many attempts from the host to clear the channel and the job will abend.

- If MIH forces cancel:
  The job eventually clears (abend) on the host. The host may have sent a `FORCE` after the initial `CANCEL` accomplished nothing. This is not recommended for the same reasons that a manual `FORCE` is not recommended (see the MVS Commands User's Guide from IBM). The virtual tape drive remains unresponsive until the GR or Replication on RUN finishes (either completes or GR Timeout is reached). Attempts to use the drive during this unresponsive time is likely to result in the drive becoming boxed.

- If the job is manually cancelled:
  When replication refresh is finished or GR Timeout is reached, the VTE will see many attempts from the host to clear the channel and the job will abend.
CANCEL of the mainframe job will NOT occur until GR or Replication on RUN releases the Virtual Tape Drive (either completes or GR Timeout is reached).

- What results from a manual CANCEL and FORCE:
  The job clears (abend) on the host. Use of FORCE is NOT recommended (see the MVS Commands User’s Guide from IBM). The virtual tape drive remains unresponsive until the replication refresh finishes (either completes or GR Timeout is reached). Attempts to use the drive during this unresponsive time is likely to result in the drive becoming boxed.
CHAPTER 6

WORM Tapes

This chapter provides information about defining Write Once Read Many (WORM) file systems in the DLm using the VNX File Level Retention (FLR) and Data Domain Retention Lock (DDRL) capability.

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- Configuring WORM .......................................................................... 137
- Determining if WORM is enabled ...................................................... 142
- WORM extension or modification ...................................................... 143
- Scratch WORM tapes ...................................................................... 144
Overview of WORM tapes

DLm WORM tape is an optional feature which emulates "write-once-read-many" physical tape cartridges. DLm WORM tape allows secure storage of data that is critical for business processes, and for regulatory and legal compliance, by protecting against unintentional or disallowed modification of a virtual tape. You can control the protection status and retention periods at the individual tape level.

Note

The WORM feature is implemented differently for file systems created on VNX file storage and Data Domain.

The WORM feature for VNX file systems is called File Level Retention (FLR) and the WORM feature for Data Domain file systems is called Data Domain Retention Lock (DDRL). FLR parameters only affect FLR file systems and DDRL parameters only affect DDRL file systems. The system can be configured to have either, both, or neither.

VNX File Level Retention

In VNX WORM file systems, protection status and retention periods can be controlled at the individual file level.

To set file level retention (FLR) protection on the file, the Last Accessed Time (LAT) of the file is set to specify the desired retention period and the file mode is changed to read-only. VNX FLR also supports a permanent retention period, by setting the LAT to a date/time in the past rather than in the future. A file with permanent retention can never be modified, deleted, or renamed.

Once a file is set to the WORM state, the file’s mode changes to read-only and that file cannot be modified, deleted, or renamed until the WORM retention period has passed. After the WORM retention period has passed, the file is considered expired. Expired WORM files are not automatically deleted, but once a WORM file is expired it can be deleted. An expired WORM file cannot be changed back to writable mode, nor can it be modified or renamed. However, an expired WORM file can be reset to the protected WORM state by changing the FLR retention details.

Two different types of file-level retention are available: enterprise (FLR-E) and compliance (FLR-C).

- FLR-E protects data content from changes made by users, but allows changes to be made by administrators.
- FLR-C protects data content from changes made by users, from changes made by administrators, and also meets the requirements of SEC rule 17a-4(f).

While these two types of the underlying VNX FLR features differ in important ways, management of DLm WORM tapes from the mainframe host is the same in either case.

Note

FLR-enabled file systems or tapes are referred to as "WORM file systems" or "FLR file systems" interchangeably in the following sections.
Data Domain Retention Lock

Data Domain Retention Lock (DDRL) is an optional component of Data Domain which allows a Data Domain MTree to be defined as a WORM file system. Support for DDRL is an optional feature in DLm version 4.3.0 and later.

To set DDRL protection on the file, the last accessed time (LAT) of the file is set to specify the desired retention period. If that LAT is valid for the retention parameters configured on the Data Domain, the file mode is automatically changed to read-only. Unlike FLR, DDRL does not support a permanent retention period. Setting the LAT to a date/time in the past is not allowed on Data Domain. When permanent retention is called for, DLm will set the LAT to the maximum retention time configured on the Data Domain for the MTree that the file resides in.

After the date and time in the LAT has passed, the file is considered expired. Expired DDRL files are never automatically deleted by DDRL. However, when a DDRL file is expired, it can be deleted by an application. An expired DDRL file cannot be changed back to writable mode, nor can it be modified or renamed. However, an expired DDRL file can be reset to the protected DDRL state by changing the LAT to a future date and time.

When enabling DDRL on the Data Domain system for an MTree, you must specify a minimum and maximum retention period. These values will be read when Virtuent starts, and periodically after that, because the value can be changed at any time with the new values effective immediately. DDRL can also be enabled or disabled on a selected MTree at any time.

Data Domain returns an error and leaves the file unlocked if the LAT is set to less than the minimum time allowed or after the maximum time allowed:

- If the error was indicated because the LAT is set to less than the minimum retention period, the file is left unlocked and Virtuent displays a message indicating the retention lock is not set because it is less than the minimum configured value.
- If the error was indicated because the LAT is set after the maximum retention period, DDRL sets the LAT again using the maximum configured value. The DLm0571W message indicates the new value used for the LAT.

File locking criteria

The VTE automatically sets a virtual tape file to the WORM state and locks it at tape unload time if all the following are true:

- The required license is installed and tape drive is configured appropriately:
  - For VNX file systems, the DLm_FLR license is installed and the VTE virtual tape drive on which the tape is written is configured with FLR=yes.
  - For Data Domain file systems, the DLm_DDRL license is installed and the VTE virtual tape drive on which the tape is written is configured with DDRL=yes.
- The file system on which the virtual tape file resides:
  - For VNX file systems:
    - Is on an FLR-configured VNX file system
    - Is an FLR file system
    - Contains a .FLR control file
  - For Data Domain file systems:
    - Is on an configured Data Domain file system
Is a retention lock file system
Contains a .DDRL control file

The tape's HDR1 label specifies a non-zero expiration date, or the virtual drive is configured with a default FLR or DDRL retention period.

WORM control file

The VTE uses a hidden WORM control file to control whether tape volumes written to an FLR- or DDRL-enabled file system are put into the WORM state upon close or whether files are left writable. Files will only be set to the WORM state if this file is present. For VNX file systems, this control file is called .FLR and for Data Domain file systems, the control file is called .DDRL. If the control file is not present, the VTE will not set files to the WORM state. This feature facilitates development and testing of the preparation of DLm WORM tapes without actually committing those tapes to the WORM state.

Once testing is complete, WORM capabilities can be enabled by adding the control file to the file system. Whenever the control file is in place, all future volumes written to the file system from a drive configured for WORM will automatically be locked during tape unload processing by the host.

Note
If the .FLR or .DDRL file is deleted, tape volumes that the host unloads after that time will not be put in a WORM state, but tapes already in WORM state are not affected.

The DLm0594W system message is generated when the host unloads a tape volume written to an FLR- or DDRL-enabled file system but the WORM control file does not exist at that time in that file system.

Retention period

Determining the retention period for tapes depends on whether the tapes are labeled or unlabeled.

Retention period for labeled tapes

Considerations for determining the retention period for labeled tapes:

- For labeled tapes, if the host has specified an expiration date in the HDR1, the retention period is set to 00:00:01 hours on the specified date. For multi-file tapes, only the first HDR1 on the first dataset is used to determine the entire tape's retention period. The WORM retention period depends on the WORMWHICHHDR1 and WORMMODEXPIRATION parameters.

Note

HDR1 dates are specified in the Julian date format YY/DDD or YYYY/DDD.

If the HDR1 does not contain an expiration date or has any of these values: 00/000, 0000/000, 98/000, 1998/000, 97/000, or 1997/0000 (which also mean no retention), the device's default WORM retention period, FLR retention/DDRL retention, is used to determine the action taken:

- If FLR retention/DDRL retention is 0, the tape is not placed in the WORM state (that is, "no retention."potential).
- If FLR retention/DDRL retention is positive, its value is added to the current date and time, and the result is used to set the retention period.
- If FLR retention is negative, permanent retention is set. DDRL retention cannot have a negative value.

Several HDR1 expiration dates have special meaning rather than as a specific date:

- 99/365, 1999/365, 99/366, and 1999/366 all mean permanent retention. For FLR, the VTE sets the file's FLR retention period to 0, which is automatically converted to "infinite retention" by the FLR file system when it locks the file. For DDRL, the LAT is set to the maximum retention period configured on the Data Domain MTree.
- 99/000 and 1999/000 mean today plus 14 days.

- For FLR, if the HDR1 expiration date is greater than 2104/366, the retention period is set to the maximum value, 2104/366. If using DDRL and the HDR1 expiration date is greater than the maximum value configured, the expiration date is set to that maximum retention period configured.

---

**Note**

In DLm release 4.3.0 and later, the maximum expiration date allowed on VNX has changed from 2038/018 (the maximum date supported by VNX prior to 7.1) to 2104/366.

- If the HDR1 expiration date is less than 2003/001, the FLR retention period is set to the minimum value, 2003/001. For DDRL, past retention dates are not allowed. Attempting to set a past date will result in an error message displayed on the VT Console and the file will not be locked.

### Retention period for unlabeled tapes

Considerations for determining the retention period for unlabeled tapes:

- Unlabeled tapes are always treated as if there was a HDR1 containing no expiration date. Therefore, the device's default WORM retention period, if any, is used. (FLR retention and DDRL retention provide information about the default WORM retention period.)
- For FLR, if the default WORM retention period is a negative number, it signifies that the WORM "infinite retention" is desired.
- If no default WORM retention period has been configured for the device, the file is not set to the WORM state.

### Configuring WORM

---

**Note**

Be sure to vary the devices offline to the mainframe before you restart Virtuent.

**Procedure**

1. Access the DLm Console using the web browser:
   a. Open a web browser and type the Management VTE's HA IP address as follows:
      ```
      https://<IP address>
      ```
   b. Type the DLm Console user name and password in the login page.
2. Once connected, click **Configurations**. In the **Configurations operations** tab, make sure the correct configuration is selected in the drop down list in the upper left corner of the tab.

3. Click **Devices** to display the Tape device configuration panel. This panel contains a tab for each available VTE.

4. Click the tab pertaining to the VTE you want to configure.

5. You can enable WORM both in existing devices and when adding new devices:
   a. To enable WORM when adding new devices, select **FLR active** and/or **DDRL active** in the **Add devices** section of the tab. Other WORM-related fields appear.
   b. To enable WORM in existing devices, click on the **Off** link in the **FLR** or **DDRL** column under **Current devices**. A pop-up dialog appears with the **FLR active/DDRL active** check box. Select **FLR active/DDRL active**. Other FLR/DDRL-related fields are activated.

6. Enter values in the following fields:
   - For **VNX**:
     a. **FLR retention** – In **FLR retention**, enter the retention period in days, months, or years to be assigned to tape volumes when the mainframe has not indicated an expiration date in the HDR1 record. **FLR retention** provides more information.
     b. **FLR mod** – Select **FLR mod** if you want to allow the tape drive to modify (extend) a tape volume that is in the WORM state. It is unchecked by default. **FLR mod** provides more information.
     c. **FLR extents** – In **FLR extents**, specify how many times a tape volume in the WORM state can be extended, assuming the **FLR mod** option is selected.

   **Note**
   The **FLR extents** value indicates the total number of files including the base Volser file. For example, if you want to specify 12 extensions to the base Volser, you must enter 13 in this field.

   Valid values are from 1 to 10000. 1 indicates just the base Volser file with no extensions. If the FLR extents parameter is omitted, the default is 100 (the base Volser + 99 extensions). **FLR extents** provides more information.

   - For **Data Domain**:
     a. **DDRL retention** - In **DDRL retention**, enter the retention period in days, months, or years to be assigned to tape volumes when the mainframe has not indicated an expiration date in the HDR1 record. **DDRL retention** provides more information.
     b. **DDRL mod** - Select **DDRL mod** if you want to allow the tape drive to modify (extend) a tape volume that is in the WORM state. It is unchecked by default. **DDRL mod** provides more information.
     c. **DDRL extents** - In **DDRL extents**, specify how many times a tape volume in the WORM state can be extended, assuming the **DDRL mod** option is selected.
Note

The **DDRL extents** value indicates the total number of files including the base Volser file. For example, if you want to specify 12 extensions to the base Volser, you must enter 13 in this field.

Valid values are from 1 to 10000. 1 indicates just the base Volser file with no extensions. If the **DDRL extents** parameter is omitted, the default is 100 (the base Volser + 99 extensions). **DDRL extents** provides more information.

---

**Figure 43** Enabling WORM

7. Save the changes as described in *Editing a Configuration*.
8. To enable changes to the currently running configuration of the VTE, restart Virtuent as described in *Starting and stopping tape devices*.

**FLR**

The **FLR active** field enables or disables WORM on VNX file systems. Selecting **FLR active** enables WORM, and leaving the field unselected disables it. The default value is disabled.

If you disable FLR for a tape drive, the VTE does not attempt to set the WORM state for any volume written on this drive, even when the drive is writing to an FLR-enabled file system. Any new tape volume written by this drive can be deleted, modified, extended, or renamed just as it could be in any non-FLR-enabled file system.

If you enable FLR for a tape drive, tape volumes written to the drive may be set to the WORM state when written, depending on the following conditions:
The file is written to a WORM file system.

The expiration date sent by the mainframe is a date in the future, or if the host does not specify an expiration date, a default retention period is configured for the drive.

A .FLR control file is present in the WORM file system.

**Note**

WORM files can be read by a VTE device even if it does not have FLR configured on it.

### FLR retention

The **FLR retention** field defines a default retention period to be assigned to tape volumes when the mainframe has not indicated an expiration date in the HDR1 record. The FLR retention value has no effect on a tape volume unless the **FLR active** check box is selected for the tape drive.

You can set this period in days, months, or years. Enter a numeric value and then select **Days**, **Months**, or **Years**. The default is 0, which indicates there is no default retention period.

Specifying a negative retention number indicates that the WORM "infinite retention" period should be set if the host does not set an expiration date.

When the mainframe writes a tape volume to an FLR drive with no expiration date in the HDR1 label, the VTE adds the default retention period set in **FLR retention** to the current date to determine the WORM retention period for the tape volume.

If the mainframe does not include an expiration date in the HDR1 and there is no default retention date set then the VTE will leave the volume in a non-WORM state.

### FLR mod

**FLR mod** defines whether a tape drive is allowed to modify (extend) a tape volume that is in the WORM state. If the **FLR mod** field is unselected, tape volumes in the WORM state cannot be modified. By default, the **FLR mod** checkbox is unselected.

By default, WORM tape volumes cannot be extended because this would require a modification of the file. However, selecting the **FLR mod** field for a tape drive causes the VTE to allow WORM tape volumes to be extended by using multiple files in the FLR-enabled file system to hold the modified image of the tape volume.

When you select the **FLR mod** field, tape volumes in WORM mode are mounted in read-write ("ring-in") mode, so that the host will know that it can write to the volume. The **QUERY** command will display the device state as "mod".

When you leave the **FLR mod** field unselected, tape volumes in WORM mode are always mounted in read-only ("ring-out") mode and writes are not allowed.

### FLR extents

The **FLR extents** field controls how many times a tape volume in the WORM state can be extended, assuming **FLR mod** is enabled. The **FLR extents** value indicates the total number of files including the base VOLSER file. For example, if you want to specify 12 extensions to the base Volser, you must enter 13 in this field. Valid values are from 1 to 10000. 1 indicates just the base Volser file with no extensions. The default **FLR extents** value is 100 (the base Volser + 99 extensions).

The number of extents that make up an extended virtual tape volume is transparent to the mainframe. However, having a large number of extents can seriously impact
the amount of time it takes to open and process all the files involved. **FLR extents** can be used to limit the quantity of files to a reasonable number.

After the FLR extents limit is reached, the VTE still makes a new extension file and accepts writes, but it responds to every write and write tapemark command with a Logical End of Volume indication (Unit Exception status). It would be expected that the mainframe would close the tape volume and start a new tape soon after receiving a Logical End of Volume, but it is free to continue writing as much data as it wants past the Logical End of Volume indications (up to the normal size limitation).

**DDRL**

The **DDRL active** field in the Devices tab of DLm Console enables or disables WORM on Data Domain file systems. Selecting **DDRL active** enables WORM and leaving it unselected disables it.

DDRL is disabled by default. If you disable DDRL for a tape drive, the VTE does not attempt to set the WORM state for any volume written on this drive, even when the drive is writing to a DDRL-enabled file system. Any new tape volume written by this drive can be deleted, modified, extended, or renamed just as it could be in any non-DDRL-enabled file system.

If you enable DDRL for a tape drive, tape volumes written to the drive may be set to the WORM state when written, depending on the following conditions:

- The file is written to an WORM file system.
- The expiration date sent by the mainframe is a date in the future, or if the host does not specify an expiration date, a default retention period is configured for the drive.
- A .DDRL control file is present in the WORM file system.

**Note**

WORM files can be read by a VTE device even if it does not have DDRL configured on it.

**DDRL retention**

The **DDRL retention** field defines a default retention period to be assigned to tape volumes when the mainframe has not indicated an expiration date in the HDR1 record. **DDRL retention** has no effect on a tape volume unless the **DDRL active** option is selected for the tape drive.

You can set this period in days, months, or years. Enter a numeric value and then select **Days**, **Months**, or **Years**. The default is 0, which indicates there is no default retention period.

A negative DDRL retention value is not allowed in the configuration.

When the mainframe writes a tape volume to a DDRL drive with no expiration date in the HDR1 label, the VTE adds the default retention period set in the **DDRL retention** field to the current date to determine the WORM retention period for the tape volume. If the mainframe does not include an expiration date in the HDR1 and there is no default retention date set then the VTE will leave the volume in a non-WORM state.
DDRL mod

**DDRL mod** defines whether a tape drive is allowed to modify (extend) a tape volume that is in the WORM state. **DDRL mod** is disabled by default; tape volumes in the WORM state cannot be modified.

By default, WORM tape volumes cannot be extended because this would require a modification of the file. However, selecting the **DDRL mod** field for a tape drive causes the VTE to allow WORM tape volumes to be extended by using multiple files in the DDRL-enabled file system to hold the modified image of the tape volume.

If **DDRL mod** is enabled, tape volumes in WORM mode are mounted in read-write ("ring-in") mode, so that the host will know that it can write to the volume.

The **QUERY** command will display the device state as "mod".

If **DDRL mod** is disabled, tape volumes in WORM mode are always mounted in read-only ("ring-out") mode and writes are not allowed.

DDRL extents

**DDRL extents** controls how many times a tape volume in the WORM state can be extended, assuming **DDRL mod** is enabled. The **DDRL extents** value indicates the total number of files including the base Volser file. For example, if you want to specify 12 extensions to the base Volser, you must enter 13 in this field. Valid values are from 1 to 10000. 1 indicates just the base Volser file with no extensions. The default **DDRL extents** value is 100 (the base Volser + 99 extensions).

The number of extents that make up an extended virtual tape volume is transparent to the mainframe. However, having a large number of extensions can seriously impact the amount of time it takes to open and process all the files involved. **DDRL extents** can be used to limit the quantity of files to a reasonable number.

After the **DDRL extents** limit is reached, the VTE still makes a new extension file and accepts writes, but it responds to every write and write tapemark command with a Logical End of Volume indication (Unit Exception status). It would be expected that the mainframe would close the tape volume and start a new tape soon after receiving a Logical End of Volume, but it is free to continue writing as much data as it wants past the Logical End of Volume indications (up to the normal size limitation).

**Determining if WORM is enabled**

To determine if WORM is enabled, enter one of these commands:

- **QUERY CONFIG**
  - If FLR or DDRL is enabled, the output displays FLR or DDRL details as follows:

<table>
<thead>
<tr>
<th>Index</th>
<th>Devicename</th>
<th>Type</th>
<th>CU</th>
<th>UA</th>
<th>Options</th>
</tr>
</thead>
<tbody>
<tr>
<td>4A</td>
<td>940A</td>
<td>3590</td>
<td>04</td>
<td>0A</td>
<td>PATH=/tapelib/ SIZE=40G FLR=YES FLRRET=1D FLRMODE=YES FLREXTENTS=5</td>
</tr>
<tr>
<td>4B</td>
<td>940B</td>
<td>3590</td>
<td>04</td>
<td>0B</td>
<td>PATH=/tapelibDD/ SIZE=40G DDRL=YES DDRLRET=1D DDRLMOD=YES DDREXTENTS=5</td>
</tr>
</tbody>
</table>

- **QUERY SPACE**
If WORM is enabled, (FLR) or (DDRL) is displayed next to the file system name.

The output displays an ro (read-only) status for a WORM file (unexpired or expired), unless the FLR mod/ DDRL mod option is selected on the device. If the FLR mod/ DDRL mod option is selected, it displays the mod status.

The four columns under VOLSER/L are:
- Volume currently mounted on the drive
- Type of label on the volume
- Drive status
- Volume status

QUERY provides more information.

WORM extension or modification

Normally, a tape in the WORM state is mounted in write-protect ("ring-out") mode. However, a VTE device can be configured to allow appending of data to the last dataset on a WORM-protected tape, or addition of data sets to the tape by setting the FLR mod/ DDRL mod option.

Since a WORM file is in read-only mode and cannot be modified, the appended data is maintained in auxiliary "segment" files while leaving the original files unchanged. Each time a WORM file is modified, a file named VOLSER_nnnnn is created to hold the...
modifications. VOLSER is the original filename and nnnnn is a number that is incremented sequentially each time the file is modified.

For example, if the original volume is VTED00, the first modification will create an additional file named VTED00_00001 to hold the modifications. The next modification, if any, would create an additional file named VTED00_00002, and so on.

When a modified WORM tape is unloaded, the new extension file is set to the WORM state with the same retention period as the original VOLSER file. Whenever an extended file is subsequently mounted, all of the segments are opened, concatenated together, and presented to the host as a single tape volume reflecting all the modifications since file creation.

The host can only write to a modifiable WORM tape at the end of the last dataset (between the last data block and the tapemark preceding the trailer labels), or between two tapemarks at the end of the existing volume. This corresponds to the host appending to a data set (writing with DISP=MOD) or adding a new file to the tape. Attempts to write at any other location will result in a unit check with sense of command reject, ERPA code x'30'.

Any VTE can read segmented FLR/DDRL tapes whether or not the FLR mod/DDRL mod option is selected and whether or not the DLm_FLR/DLm_DDRL license is installed.

By default, an FLR/DDRL tape can only be modified 99 times. This is to restrict the number of files that make up a single tape volume, because a large number of segments would have a performance impact on mounting and reading the tape. The default number of files is 100 (the base Volser + 99 extensions), but it can be configured to a different number with the FLR extents/DDRL extents option.
CHAPTER 7
Mainframe Tasks

This chapter discusses using DLm with z/OS.

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Device configuration

z/OS uses the Hardware Configuration Definition (HCD) utility to define devices on the system. HCD provides an interactive interface that allows you to define the system's hardware configuration to both the channel subsystem and the operating system.

The three alternatives for configuring DLm devices on the mainframe are:

- Configure the devices as real 3480, 3490, or 3590 tape drives.
- Configure the devices as MTL devices.
- Configure the devices with a unique device type using the EMC UIM.

These alternatives are discussed in the following sections. The preferred approach is to configure the devices as MTL devices.

If you are planning to use the DLm with IBM's Object Access Method (OAM), you must configure the devices as MTL devices. OAM needs tape drives to be SMS-managed and treats them on the host as a single tape library. The IBM document, SC35-0427, DFSMS Object Access Method Planning, Installation, and Storage Administration Guide for Tape Libraries, provides more information on using a library for OAM object.

Real 3480, 3490, and 3590

DLm can emulate 3480, 3490, and 3590 tape drives. If your mainframe installation does not have one of these device types installed, you can select the particular device type to be installed. The advantage of using 3480, 3490, or 3590 device types is that some applications or access methods examine device types to make sure that they are writing or reading to a known tape device. These applications typically do not work with the EMC UIM.

However, if you have real 3480, 3490, or 3590 tape drives configured in your system, do not attempt to define DLm devices in this manner. Configuring the devices as a device type that is already present might result in misallocation errors because z/OS might request a real 3480, 3490, or 3590 cartridge on a DLm virtual device or request a DLm virtual tape volume on a real 3480, 3490, or 3590.

If you need to use one of these device types to define DLm devices, make sure that the tape esoterics configured in your installation do not include this device type. For example, if your JCL is using TAPE (UNIT=TAPE), make sure that TAPE does not include the device type (3480, 3490, or 3590) that you are using to define DLm devices.

Manual Tape Library (MTL)

If you have installed 3480, 3490, and 3590 tape drives, and are not using Esoterics to access tape pools or groups, then you cannot define DLm devices as real tape drives. Doing so might result in misallocation errors as described previously. EMC recommends that you use the MTL to define the DLm devices. If you plan to use DLm devices with OAM or any application that verifies device type, you cannot use the EMC UIM. In this case, you must define your DLm devices as real 3490 or 3590 tape drives and include them in an MTL, so that they are not misallocated.

IBM introduced the concept of an MTL with APAR OW45271. This APAR allows stand-alone tape drives and their associated volumes to be SMS-managed by treating a
group of such drives as a logical tape library. SMS manages allocations to such a logical library just as it would any automated tape library dataserver (ATLDS), with the exception that mount messages are routed to a tape operator console rather than the ATLDS robotics. The IBM document *DFSMS Object Access Method Planning, Installation, and Storage Administration Guide for Tape Libraries (SC35-0427)* provides information about MTL support.

### Defining MTL DLM devices with HCD

**Procedure**

1. Configure DLM devices as either 3490 or 3590 tape devices using HCD.

   **Note**

   EMC recommends that you do not use EMC UIM due to cautions and limited function described in [EMC Unit Information Module](#). Use the standard HCD 3490 or 3590 definitions.

2. On the **Device/Parameter Feature definition** screen for each drive, choose **YES** for MTL and supply an artificial LIBRARY-ID and LIBPORT-ID.

   **Note**

   LIBRARY-ID must be hex characters only. You can choose to match it to the first CU name within the library. However, the same name must be used in the LIBRARY ID field when defining the corresponding tape library in SMS. The first LIBPORT-ID should be 01, and subsequently, it should be sequentially incremented by 1, for a maximum of 32.

3. Define the control unit as a 3490 or 3590 with 16 tape drives available.

4. Be sure that all the devices in the same logical library have the same LIBRARY-ID, with each group of 16 devices having a unique LIBPORT-ID.

   IBM requires that there be only 16 tape drives to a LIBPORT-ID. As a result, when you want to configure more than 16 drives, you must configure multiple control units on the same channel using different logical control unit addresses.

5. Make sure that each control unit's devices have the same LIBRARY-ID, but a unique LIBPORT-ID per control unit.

6. If you want more than 512 MTL tape drives, define a second MTL.

   **Note**

   The maximum number of tape drives defined in an MTL is 512.

   The following table contains an example of having the same LIBRARY-ID with its unique LIBPORT-IDs.

   **Table 12** Example of LIBRARY-ID and LIBPORT-ID

<table>
<thead>
<tr>
<th>Dev Add</th>
<th>CU</th>
<th>Log CU</th>
<th>LIBRARY-ID</th>
<th>LIBPORT-ID</th>
</tr>
</thead>
<tbody>
<tr>
<td>E800</td>
<td>CU800</td>
<td>00</td>
<td>12345</td>
<td>01</td>
</tr>
</tbody>
</table>
Table 12 Example of LIBRARY-ID and LIBPORT-ID (continued)

<table>
<thead>
<tr>
<th>Dev Add</th>
<th>CU</th>
<th>Log CU</th>
<th>LIBRARY-ID</th>
<th>LIBPORT-ID</th>
</tr>
</thead>
<tbody>
<tr>
<td>E801</td>
<td>CU800</td>
<td>00</td>
<td>12345</td>
<td>01</td>
</tr>
<tr>
<td>E80F</td>
<td>CU800</td>
<td>00</td>
<td>12345</td>
<td>01</td>
</tr>
<tr>
<td>E810</td>
<td>CU810</td>
<td>01</td>
<td>12345</td>
<td>02</td>
</tr>
<tr>
<td>E811</td>
<td>CU810</td>
<td>01</td>
<td>12345</td>
<td>02</td>
</tr>
<tr>
<td>E81F</td>
<td>CU810</td>
<td>01</td>
<td>12345</td>
<td>02</td>
</tr>
</tbody>
</table>

Defining DLm to SMS

After defining DLm using HCD, it must be defined to SMS using the library management function. Then your ACS routines must be updated to allow jobs to select the new library with appropriate user-defined ACS management, data, and storage classes and groups. For example, if you define a new esoteric called VTAPE, your ACS routines could allocate the dataset to the SMS storage group using the DLm MTL whenever UNIT=VTAPE is specified in JCL.

The characteristics of DLm virtual tape cartridges match the SMS Media Type: MEDIA2 for 3490 or MEDIA4 for 3590. Make sure that you specify the appropriate media type (MEDIA2 or MEDIA4) on the Library Definition screen.

In addition, since SMS requests scratch tapes using media type, you must add MEDIA2 or MEDIA4 to the list of DLm scratch name synonyms as explained in Scratch synonyms. Z/OS might request for mounts by media type based upon the DATACLAS definition. The customer's ACS routines or tape display exits may also change the mount request to use storage group names, LPAR names, pool names, etc. All such names must be entered into the synonym list.

Entering cartridges in the MTL

After you configure the MTL, it is treated as a real library; that is, you must enter cartridges into the library before DLm can use them. Use the DLMLIB utility to enter cartridges into the MTL.

Before using the DLMLIB utility, contact your specific tape management system vendor for their customizations that interface with IBM's MTL.

You must execute DLMLIB out of an authorized library. EMC provides an example of the JCL required for linking DLMLIB. The sample JCL file is found in the LNKLIB member of EMC.DLMS400.SAMPLIBU. EMC Disk Library for mainframe Command Processors and Utilities for z/OS Guide provides download and execution instructions.

EMC also provides an example of the JCL required to run DLMLIB. The sample JCL file is found in the RUNLIB member of EMC.DLMS400.SAMPLIBU. EMC Disk Library for mainframe Command Processors and Utilities for z/OS Guide provides download instructions.

The log file lists the result of each cartridge entry request, including any error codes. The utility invokes IBM's LCS External Services (CBRXLCS) macro.

Return codes and reason codes can be found in the chapter “OAM Diagnostic Aids,” of DFSMSdftp Diagnosis (GY27-7618).
MTL considerations for VTE drive selection

When a request is made for a tape drive defined in an MTL, the ACS routines select the appropriate tape storage group for the library. Allocation subsequently chooses any available drive in that library. This is not a problem if only one VTE is defined as part of the library. However, an MTL can span multiple VTEs for performance and failover considerations. In this case, targeting a specific VTE for batch utilities is required.

---

**Note**

Prior to z/OS 1.11, MTL devices do not support the demand allocation (UNIT=xxxx) method, which selects a specific drive on a particular VTE, thereby enabling a batch utility to communicate with that VTE. In installations running z/OS 1.11 or more recent releases, MTL devices can be specified using the SMSHONOR clause in the UNIT specification. Refer to the *z/OS JCL Reference Manual* for more information.

---

Enabling an EMC batch utility to communicate with a specific VTE

Use one of these methods to enable an EMC batch utility (DLMCMD, DLMSVR, or GENSTATS) to communicate with a specific VTE in an MTL defined with multiple VTEs:

- Omit a single drive from the MTL in each VTE’s device group.
- Define a separate MTL for each VTE to enable VTE selection.

---

Omitting a single drive from the MTL in each VTE’s device group

To enable an EMC batch utility to communicate with a specific VTE in an MTL defined with multiple VTEs, you can omit a single drive from the MTL in each VTE’s device group. EMC recommends that you leave this drive offline to prevent inadvertent allocation by other jobs. One way to accomplish this is to bookend your jobs with steps to vary the device online and offline with an operator command utility program.

As an alternative to varying the device online, executing the utility, and varying the device offline, the DLMCMD, DLMSVR, and GENSTATS batch utility programs support the use of the EXEC statement parameter, **DEV=xxxx**, which allows access to an offline tape device. Installations running z/OS 1.11 or later can also use the **SMSHONOR** parameter in the UNIT specification as an alternative to the use of the DLMCMD PARM **DEV=xxxx** parameter. Refer to the *z/OS JCL Reference Manual* for more information.

Type the code as follows:

```
EXEC PGM=DLMCMD,PARM='DEV=xxxx'
```

where **xxxx** is the offline virtual tape device on the VTE you wish to access.

---

**Note**

Ensure the tape device is offline before you run any utility with the **DEV=** parameter.

The device specified in the **DEV=** parameter must be offline. If the DLMCMD, DLMSVR, or GENSTATS utility is used with the **DEV=** parameter when the specified device is online, DLm displays the corresponding DLm0182I message and terminates the operation.
For DLMCMD and DLMSCR steps, this parameter eliminates the need to code a DLMCTRL DD statement.

For GENSTATS, this parameter eliminates the need to code a GENIN DD statement.

Consider an MTL defined with two VTEs, each configured with 64 devices. To omit a single drive from the MTL in each VTE’s device group:

Procedure

1. In each VTE, define 63 devices as MTL=YES in the HCD. One device would be MTL=NO in the HCD.

2. Subsequently, use demand allocation in JCL to select the specific drive address that is outside the MTL.

Defining an MTL for a device to be used with an EMC batch utility

Procedure

1. Similar to the previous method for omitting a single drive, define only 63 devices on each VTE as part of the same MTL.

2. For each VTE, define a separate MTL (different LIB-ID) for the remaining device, as well as a new esoteric.

3. Use ACS routines to select the appropriate library that limits the available drive selection to that one drive.

MTL-related IBM maintenance

The program temporary fix (PTF) for each of the following APARs must be applied when using DLm in an MTL environment:

- APAR OA03749 — More than one device fails to vary online.
- APAR OA06698 — Replacement tape drives get MSG IEA437I in an MTL environment.
- APAR OA07945 — Mount hangs or times out using MTL with OEM Automated Library.
- APAR OA08963 — Tape volume capacity is incorrect for OAM object support users.
- APAR OA10482 — MTL scratch volume mount error occurs.

EMC Unit Information Module

As an alternative to defining real 3480s, 3490s, or 3590s or using an MTL, EMC provides a user UIM that allows DLm tape devices to be configured to HCD using a unique device type. Using the EMC UIM prevents the operating system from allocating DLm virtual tape drives to jobs requesting a mount of a real tape cartridge. However, using the UIM to define VTE devices is not the recommended choice; EMC recommends that you use OAM or another application that checks device types. OAM and other applications that check device types will fail when allocated to a UIM-defined device. Information regarding user UIM can be found in IBM's document, z/OS MVS Device Validation Support (SA22-7586-0).

You must install the EMC UIM and associated Unit Data Table (UDT) into SYS1.NUCLEUS before you configure DLm devices in HCD. Before you install the UIM,
it is important to back up the SYSRES volume containing the SYS1.NUCLEUS dataset to provide a recovery mechanism if anything fails to operate properly.

Use ISPF function 3.3 (Utilities: Move or Copy) and copy CBDEC255 and CBDUC255 from DLMZOS.PGMS into SYS1.NUCLEUS, as explained in DLm z/OS components.

If CBDEC255 or CBDUC255 already exists in SYS1.NUCLEUS, then another vendor has already supplied a user UIM using the same user device number of 255. Contact EMC Customer Support for a different module name to use.

After installing the UIM, you can configure DLm devices in HCD. The UIM provides the following:

- Four control unit types: V3480, V3481, V3482, and V3483.
- Four supporting device types: V3480, V3481, V3482, and V3483

The generic names for these devices are also V3480, V3481, V3482, and V3483. If you have already defined a generic name of V348x, contact EMC for support. You must define multiple virtual device types to support the multiple DLm systems or a single DLm with multiple virtual tape libraries configured.

You must define a V348x tape drive for each virtual tape device that you have configured in DLm. All virtual tape drives assigned to the default virtual tape library in the DLm (/tapelib) are normally defined with the same generic name (for example, V3480). If you plan to have a drive assigned to a different tape library path in the DLm, you should define that drive with a separate generic name (for example, V3481).

Once DLm device definitions are active, you must either specify UNIT=V348x or hard code the unit address allocated to a device. In this way, regular jobs that call for real tape drives or use tapes previously cataloged on real 3480s are not allocated to DLm devices. After a tape is cataloged as created on a V348x device, it is allocated to that same device type when called again. Conversely, a tape cataloged as created on a real tape drive is not allocated to a device.

Note
Some applications may not work with this device type.

Missing Interrupt Handler

DLm reports a preferred Missing Interrupt Handler (MIH) timer value of 3000 seconds (50 minutes) to the host when it is varied online, and the host should take this value as the DLm devices’ MIH time.

If the MVS, OS/390, or z/OS MIH timer value is set too low for the occasional lengthy operations that can occur on a large tape cartridge and an operation takes longer than the MIH value, the operating system reports I/O errors and often boxes the device, taking it out of service.

For this reason, IBM recommends that you do not set an MIH time value for any device that establishes its own primary or secondary time interval (such as the DLm). Overriding the DLm-supplied primary MIH timeout value might adversely affect MIH recovery processing for the device or device class.

MIH command

To determine the current MIH timer value, you can use the following z/OS operator command:

D  IOS, MIH, DEV=xxxx
where xxxx is any DLm virtual tape drive address.

You can temporarily change the MIH value for DLm devices by typing the following z/OS operator command:

```
SETIOS MIH,DEV=(xxxx-xxxx),TIME=mm:ss
```

where xxxx-xxxx is the range of DLm virtual tape drive addresses.


### Configuring the mainframe for deduplicated virtual tapes

All VOLSERs that reside on the Data Domain are deduplicated. All VOLSERs that reside on the VNX are non-deduplicated.

Isolate the deduplicated virtual tapes/VOLSERs from non-deduplicated virtual tapes:

**Procedure**

1. Define an MTL that contains only deduplicated virtual tapes/VOLSERs.
2. Update your ACS routines so that you can direct specific VOLSERs to the MTL supporting deduplication.

### Dynamic device reconfiguration considerations

The swap function allows you to move volume access from one VTE to another. DLm supports operator-initiated swap functions. This is useful during FRUs or upgrades when the VTE needs to be rebooted. You no longer have to wait for allocated drives on a VTE to be de-allocated and taken offline. Using the `SWAP` command, you can move volume access from the VTE to be serviced to another VTE that has the same attributes as the swapped source device.

DLm only supports operator-initiated swaps. Make sure you follow the considerations under **Critical considerations for operator-initiated swap functions** when you:

- Use the MVS `SWAP (G)` command to move virtual volumes to different VTEs
- Use the operator-initiated MVS (DDR) `SWAP` command to move virtual volumes to drives on different VTEs on the same DLm to permit VTE FRU changes

The system-initiated swap function is not supported. A system-initiated swap indicates a permanent I/O error, and additional recovery attempts are not appropriate.

**Note**

In the case of a system-initiated swap, following a message `IGF500I SWAP xxxx TO xxxx - I/O ERROR` for any device, you must reply `NO` to the subsequent `IGF500D REPLY 'YES', DEVICE, OR 'NO'` message.

If you configured the devices as V348x devices using the UIM, Dynamic Device Reconfiguration (DDR) swap is automatically disabled for those devices, and a swap cannot occur.

### Critical considerations for operator-initiated swap functions

These are the considerations that you must observe before using the operator-initiated `SWAP` command:
Do not attempt to swap between different class tape drives. That is, 3490 to 3590 or 3590 to 3490.

Make sure the drive being swapped from and the drive being swapped to are configured to the same library (for example, /tapelib_ETCxxxx).

Make sure the drive being swapped from and the drive being swapped to have the same attribute (for example, if the 'from' device specifies NO GR the 'to' device cannot specify GR).

When writing to deduplicating storage, the DLm may not perform maximum deduplication optimization on the remainder of the tape after moving to the "to" drive. The DLm deduplication optimization algorithms in some cases recognize data from specific mainframe backup programs based on the first few blocks written to the tape. Since the "to" drive resumes writing in the middle of the tape, it may not recognize and optimally deduplicate in this case.

DFSMShsm considerations

If you plan to use DLm with HSM, the various SETSYS tape parameters do not accept V348x generic names as valid. In that case, it is necessary to define esoteric names that are unique to the various V348x devices.

Identifying esoteric tape unit names to DFSMShsm

Only after they have been successfully specified with the SETSYS USERUNITTABLE command are they recognized and used as valid unit names with subsequent DFSMShsm commands.

Procedure

1. Define these esoteric tape unit names to z/OS during system I/O generation (HCD).
2. Include the esoteric tape unit names in a DFSMShsm SETSYS USERUNITTABLE command.

Specifying tape compaction

Compaction of the virtual tape data under z/OS is initiated like it is initiated for a real compression-capable (IDRC) 3480/3490/3590E. The default is NOCOMP for 3480, and COMP for 3490 and 3590E. You can specify the use of compaction in the JCL by using the DCB=TRTCH=COMP or DCB=TRTCH=NOCOMP parameter on the appropriate DD cards for output tapes. No JCL parameter is required for input tapes. The DLm automatically decompresses the tape data on read requests.

Alternatively, the system programmer can specify the COMPACT=YES parameter in the DEVSVFpxx PARMLIB member. This would result in compaction being the default option for all of the virtual drives. The COMPACT= option on the SMS DATACLAS definition provides another method for activating and disabling compaction.

While the compaction option significantly reduces the amount of storage required on the DLm library, some impact occurs on the data transfer performance compared to uncompressed data. The efficiency of the compaction, as well as the performance impact, varies depending upon the data.

The file-size values reported by the QUERY command and the awsprint utility (using CP503), reflect the compressed data size and not the original uncompressed size.
Note
All data written to the deduplicating storage on the Data Domain should be written without IDRC.

DLm z/OS components
EMC provides a set of utilities and a UIM for the z/OS environments. The utilities are:

- GENSTATS — A utility that generates reports from VTE and VOLSER range statistics.
- DLMSCR — A scratch utility that sends VOLSER scratch requests to DLm.
- DLMCMD — A utility that allows the mainframe to send DLm commands.
- DLMLIB — A utility that is required to define scratch volumes on an MTL.
- DLMVER — A utility that reports the versions of all DLm mainframe utilities on the mainframe and the z/OS release.
- DLMHOST — A host utility that provides z/OS Console Operation support.
- DLMWTOR — A utility allows a WTOR to be issued to the z/OS Console with up to 10 lines of user defined text. This provides a means to require z/OS operator confirmation of a DLm-related change such as halting all DLm Tape activity.

Note
The DLm Command Processors and Utilities for z/OS Guide provides more information about the DLm z/OS utilities.

Initiating an initial program load from a DLm virtual tape
Since the DLm virtual tape drives appear to the host as real tape drives, it is possible to initiate an initial program load (IPL) on a mainframe host from a virtual tape volume on DLm.

Creating a stand-alone IPL tape on DLm
To create a stand-alone IPL tape:

Procedure
1. On the DLm Console, initialize a non-labeled tape on DLm. For example:
   init vol=SAIPL label=nl dev=E980 scratch=no CLASS=0
   OR
   init vol=SAIPL label=nl dev=E980 scratch=no DIR=D0
   The examples create a non-labeled tape called SAIPL in the tape library assigned to the virtual tape drive named E980. You may use any VOLSER of your choice. Replace E980 with the name of a virtual tape drive configured on your DLm. Specify the scratch=no parameter so that NO scratch tape mount request can acquire the volume before you are ready to use it.

2. On the DLm Console, manually mount this tape on any virtual tape drive assigned to the tape library where you initialized your stand-alone IPL tape volume. For example:
load SAIPL E980

This command causes the virtual tape volume SAIPL to be mounted on the DLm virtual tape drive, E980. In your scenario, replace E980 with the name of a virtual tape drive configured on your DLm. It can be any DLm virtual tape drive that is assigned to the tape library where the stand-alone IPL tape volume resides.

3. From the mainframe, write the stand-alone IPL tape to the virtual tape drive where the target tape is mounted, being sure to explicitly specify the VOLSER you mounted in the previous step.

Once the stand-alone IPL tape has been created, it is ready to use.

Note

Follow steps 2 and 3 to mount an existing stand-alone IPL tape and perform the IPL.

IPL considerations for DLm

The considerations for initiating an IPL on a mainframe host from DLm are:

- Stand-alone restore programs might not send a Load Display Mount message, which causes DLm to automatically mount the desired volume. If you use a stand-alone program to restore volumes that reside on the DLm system, you might have to perform a manual Load command on DLm for each of the volumes requested.

- If you need to initiate IPL a second time from the stand-alone IPL tape, first make sure that the tape is rewound to loadpoint. To do this, enter the Unready, Rewind, and Ready commands at the VT Console.

- Tapes on which stand-alone programs exist typically are not automatically unloaded. You may need to manually execute the Unready and Unload commands using DLm Console to unload the stand-alone IPL tape when you are done.

DR logging

Introduction to DR logging

In z/OS environments, DLm controllers provide a service referred to as “DR Logging”, which logs tape volume mounts and un-mounts to a log file on the virtual tape library. When DR Logging is enabled, each DLm controller defined as part of the virtual tape library creates a log file on each of the file systems. The controller writes a single record to the log file for each tape volume (VOLSER) it mounts and un-mounts from the file system.
These log files are hidden from view so that they cannot be mistaken for tape volume (VOLSER) files.

If a controller outage should occur, a DLm “Still in Use” report can be generated using the GENSTATS utility. This report will read all the log files in the virtual tape library and report those tape volumes which were mounted and never unmounted.

The purpose of this report is to help determine which tape volumes may be incomplete following a controller failure.

By placing the DR log files in the virtual tape library rather than writing them on the controller’s internal storage, the log files can be replicated to a secondary disaster recovery site along with the tape volumes. Then, in the unlikely event there is a complete loss of the primary processing facility, the DLm "Still in Use" report can be used to help identify all tape volumes that were in use at the primary site at the time of the failure.

Enabling DR logging
The DR logging feature is not enabled by default in DLm. To enable DR logging, a hidden control file named “.vstats”, must be present in each file system where logging is to be performed.

The .vstats file may be empty. DLm does not look at the contents of the file. It only uses the presence of the file to determine whether or not to perform DR logging for that file system.

The procedure to create the .vstats file in a file system varies depending on the DLm controller model. Please refer to the hardware installation guide that accompanied your system for information on how to create this control file.

Retrieving the Still In Use Report
The "Still In Use" report is part of the standard DLm general statistics report program, GENSTATS.
First, execute Command Processors CP998 or CP999. Then run GENSTATS with the STILLINUSE parameter to produce the Still In Use report from available DR Logs. DLm Command Processors also provide the GENSTATW PROC to perform the CP998 and CP999 Command Processors.

Preparing z/OS for IPv6

IPv6 is supported by the z/OS Communications Server. In DLm 4.1.0 and later, you have the option to use either IPv6 or IPv4 addresses. The default is IPv4. If you want to use IPv6 addresses, and your z/OS system does not currently support IPv6, then z/OS installation changes are required.

Enabling IPv6

Enable IPv6 by performing the following procedure:

Procedure

1. Uncomment and activate an IPv6 NETWORK statement in SYS1.PARMLIB(BPXPRMxx). There are two of these: one for INET, one for CINET. Uncomment the one you're already using for IPv4. The following is a commented CINET statement:

/*NETWORK DOMAINNAME(AF_INET6) DOMAINNUMBER(19) */ /* For IPv6 */
/* TYPE(CINET) */

2. Test the activated change by entering the following commands on ISPF Command Shell:

netstat up
ping ::1

For example:

```plaintext
MVS TCP/IP NETSTAT CS V1R12 TCPIP Name: TCPIP
Tcpip started at 14:52:42 on 04/29/2014 with IPv6 enabled
***
```

```plaintext
CS V1R12: Pinging host ::1
Ping #1 response took 0.000 seconds.
***
```

Configuring IPv6

Configure IPv6 by performing the following procedure:

Procedure

1. Add an IPCONFIG6 statement to your TCPIP profile. This example includes the optional SOURCEVIPA parameter:

IPCONFIG6 SOURCEVIPA
2. Add an INTERFACE statement to your TCPIP profile that is appropriate to your environment for an IPv6 interface. INTERFACE is used for IPv6 in place of the DEVICE, LINK, and HOME statements.

The following example is an INTERFACE — IPAQENET6 OSA-Express QDIO interfaces statement:

```
INTERFACE OSAQDIO15 DEFINE IPAQENET6 PORTNAME OSAQDIO1
```

where:

- OSAQDIO15 is an interface name of your choice.
- OSAQDIO1 is a port name of your choice.

3. Add a START statement for your new interface:

```
START OSAQDIO15
```

4. If you are not already doing so, convert the GATEWAY statement in your TCPIP profile to a BEGINRoutes statement. The GATEWAY statement is not supported for IPv6 and will eventually be dropped for IPv4. GATEWAY and BEGINRoutes statements may not co-exist, so, to combine the two in a single stack, IPv4 must be converted to BEGINRoutes and IPv6 added to it. See “Steps for converting from IPv4 IPAQENET DEVICE, LINK, and HOME definitions to the IPv4 IPAQENET INTERFACE statement” in the z/OS Communications Server IP Configuration Guide.

- Sample GATEWAY statement for IPv4:

```
GATEWAY
;
; Direct Routes - Routes that are directly connected to my interfaces.
;
; Network  First Hop  Link Name Packet Size  Subnet Mask  Subnet Value
;
10 =                     OSA01Al 1500    0.255.255.0 0.242.29.0
DEFAULTNET 10.242.29.1    OSA01Al 1500         0
```

- Corresponding BEGINRoutes statement:

```
BEGINRoutes
ROUTE 10.242.29.0 255.255.255.0    = OSA01AL   MTU 1418
    MAXImumretransmittime 120 MINImumretransmittime 0.5
    ROUNDTRIPGain 0.125 VARIANCEGain 0.25 VARIANCEMultiplier 2
    DELAYAcks NOREPLaceable
ROUTE DEFAULT     10.242.29.1        OSA01AL   MTU 1418
    MAXImumretransmittime 120 MINImumretransmittime 0.5
    ROUNDTRIPGain 0.125 VARIANCEGain 0.25 VARIANCEMultiplier 2
    DELAYAcks NOREPLaceable
ENDRoutes
```

- To this, add the second and fourth ROUTE statements as follows for IPv6:

```
BEGINRoutes
ROUTE 10.242.29.0 255.255.255.0    = OSA01AL   MTU 1418
    MAXImumretransmittime 120 MINImumretransmittime 0.5
    ROUNDTRIPGain 0.125 VARIANCEGain 0.25 VARIANCEMultiplier 2
    DELAYAcks NOREPLaceable
ROUTE 2001:DB8:0:0:10:0:0:1/32        = OSAQDIO15 MTU 1418
    MAXImumretransmittime 120 MINImumretransmittime 0.5
    ROUNDTRIPGain 0.125 VARIANCEGain 0.25 VARIANCEMultiplier 2
    DELAYAcks NOREPLaceable
ENDRoutes
```
where:

- OSAQDIO15 matches the interface name designated on the INTERFACE statement.
- 2001:DB8:0:0:10:0:0:1/32 is the IPv6 address for the desired VLAN interface at your installation.
- 2001:DB8:0:0:10:0:0:1 is the gateway address for the desired VLAN interface at your installation.

5. Activate the above changes.

### Configuring Virtual Telecommunications Access Method (VTAM)

Configure VTAM by performing the following procedure:

**Procedure**

1. Add and activate a TRLE statement to VTAMLST using available OSA device numbers.

```plaintext
TRLOSA  VBUILD TYPE=TRL
TRL01   TRLE  LNCTL=MPC,READ=0004,WRITE=0005,DATAPATH=(0006), PORTNAME=OSAQDIO1, MPCLEVEL=QDIO
TRL01B  TRLE  LNCTL=MPC,READ=0008,WRITE=0009,DATAPATH=(000A), PORTNAME=OSA01A, MPCLEVEL=QDIO
```

where:

PORTNAME is the one designated on the INTERFACE statement.

2. Test the activated changes by pinging a host with a known IPv6 address:

For example:

```plaintext
--- ISPF Command Shell
Enter TSO or Workstation commands below:

--- ping 2001:DB8:0:0:10:0:0:1
CS V1R12: Pinging host 2001:DB8:0:0:10:0:0:1
Ping #1 response took 0.001 seconds.
***
```
CHAPTER 8
GDDR and DLMAUT

This chapter introduces GDDR and provides information about the DLm disaster recovery and testing automation (DLMAUT) feature for VNX and DD back-end storage systems.

Topics include

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- DLMAUT.................................................................................................................. 162
- DLMAUT Configurations....................................................................................... 163
- Enabling DLMAUT ............................................................................................... 165
- DLMAUTC ............................................................................................................. 166
Introduction to DLMAUT/GDDR Tape Solution

The GDDR Tape solution makes the DLm disaster recovery operations more reliable and also greatly reduces RTO and chances of error. In addition to the DR operations, it provides several monitoring facilities to monitor the DLm health and replication status from the mainframe.

The GDDR Tape solution provides quicker DR using well-defined DR procedures and brings consistency among different DLm installations. It alleviates the need for custom DR procedures and automation development.

The GDDR Tape solution has two components:

- **GDDR ISPF Panels and Scripts**
  
  GDDR is the mainframe component of the GDDR Tape solution. It provides mainframe interfaces (ISPF Panels) to gather environment specific information and scripts to perform DLm disaster recovery and test operations. GDDR leverages DLMAUT to run specific DR operations on the DLm.

- **DLMAUT**
  
  DLMAUT is the DLm component of the GDDR Tape solution. It is installed and run on each DLm separately. It is used by GDDR to run DR operations such as replication failover and snapshot on the DLm. DLMAUT provides a common interface to perform DR operations on all storage systems supported by DLm and abstracts the storage system internal commands and procedures from the user and GDDR Tape.

The GDDR Tape solution allows:

- Planned and unplanned failover for VNX and DD
- DR testing using VNX Snapshots and DD Fast copy
- Switching over workload from one site to other
- DLm health monitoring from the mainframe and alerting mechanisms
- Support for DLm GVL environment

DLMAUT

DLMAUT is a TCP/IP-based software module which runs on the DLm Management VTEs (VTE1 and VTE2). It interfaces with EMC GDDR to perform DLm disaster recovery and DR test operations for DLm from the mainframe with minimal or no direct user intervention.

DLMAUT is supported on DLm systems with VNX and/or Data Domain back-ends and running DLm version 4.5.0 and later.

DLMAUT provides several commands which are used for DLm disaster recovery or DR testing operations. It also provides a mechanism for communication between the customer's mainframe LPAR and the DLm so that the DR operations can be initiated and controlled by GDDR.

The communication between DLMAUT and the mainframe LPAR where GDDR runs is based on a propriety protocol using the TCP/IP protocol. DLMAUT also communicates to the DLMAUT instance running on the remote DLm in order to remotely run commands on the other DLm. The supported DLm models have the DLMAUT software running on the Management VTEs at all times.
DLMAUT Architecture

The following diagram depicts the internal working of DLMAUT.

**Figure 45 DLMAUT architecture**

---

**DLMAUT Configurations**

Depending on your environment and requirements, you can create many Regular or DR configurations. These configurations can have overlapping tape libraries/devices or have different tape libraries/devices. During a DR event (DR Test or Planned/Unplanned DR), GDDR installs a configuration on the DLm using DLMAUT.

When a DLm is installed for the very first time, a regular configuration is created as the initial configuration during the installation process. This configuration can be used as a base configuration to create more regular configurations. You can make a copy of this config with another name and modify it's storage, tape library and device configuration to suit your need. This type of configuration is used during a Planned or unplanned DR event and contains all configuration parameters.

A disaster recovery configuration is only used during a DR Test event. Unlike regular configuration, it only contains tape library and device configuration. It does not contain any other DLm configuration parameters.
You can associate up to five configurations of type Production to the DLMAUT configuration. Similarly you can associate up to five configurations of type DR to the DRTEST configuration in DLMAUT configuration. In addition, you can also define a configuration with no tape library or devices. This configuration is referred to as a Dummy configuration and associated to Dummy Config in the DLMAUT configuration. It is generally installed to change a role of a site to standby during the site failover operation.

Creating a regular configuration

One or more regular configuration are created for you during initial installation. Make a copy of this configuration with another name and modify it's storage, tape library, and device configuration to suit your requirement.

Creating disaster recovery configuration

The DR configuration is only used during a DR Test event. It only contains tape library and device configuration.

Procedure

1. Log in to the DLm Console.
2. Navigate to the Configurations page.
3. Enter a name in the Create Configuration named text box and click Create Configuration named.
4. Select the Disaster Recovery type of the configuration.
   This creates an empty configuration of type DR.
5. Navigate to Storage > Available.
6. Click Detect additional storage.
   This populates the available file systems.
   If you are defining a DR configuration and there are no DR test (snap shot) filesystems as yet, you must enter the name of the snapshot filesystem and their mount point manually.
7. Navigate to the Storage > VTE{x} tab for each VTE and select file systems that you want to mount on the particular VTE.
8. Click the Devices tab and configure devices for each VTE.
9. Return to the Configuration page and save the configuration.

Creating a dummy configuration

Procedure

1. Log in to DLm Console.
2. Go to the Configurations page and copy the production configuration as Dummy configuration.
3. Select your new Dummy configuration from the drop down box.
4. Go to the Devices page:
   a. Remove all defined devices (if any).
   b. Uncheck the Use default lock FS check-box (if available).
c. Repeat steps a and b for configuring each VTE.

5. Go to the Storage page and remove all file systems (if any) from each VTE by clicking the Delete button.

6. Go to the Storage tab. Enter /dummy in the Mount point field.

7. Enter /dummy in the Storage Location field.

8. You need not input the storage class. The system takes the default values for the Options and Filesystem fields.

9. Click each VTE tab and check the Active checkbox.

10. Go to the Devices tab.

11. Click to the right of the Additional parameter area and enter:

sendGoLive no

12. Click OK.

13. Go to the Configuration page and update or modify Descriptions and click Save changes to save the configuration.

14. Add a virtual 3480 Control unit using FF.

15. Scroll down and select FF from the Control unit drop-down.

16. Select 00-0F for the Add address range field.

17. Enter VTE00 in the Initial device name field.

18. Select /dummy from the Tape Library drop-down.

19. Click Add Range to add virtual devices.

20. Repeat steps 11-20 for each VTE.

21. Click on the Configuration tab and save your updated Dummy configuration.

Enabling DLMAUT

To enable DLMAUT in DLm Console:

Procedure

1. Log in to DLm Console providing the required user name and password.

2. Select External > DLMAUT.

3. In the DLMAUT Configuration panel, select Enable DLMAUT.

4. Enter the TCP/IP Port that DLMAUT will listen on. The default port 9060.

5. Enter Site ID in the Site ID field.

6. If the SNMP service is configured in DLm Console, DLMAUT generates SNMP alerts. You can enable SNMP alerting for DLMAUT by selecting the Enable SNMP check box.

7. If you want DLMAUT to send messages to the HOST using DLMHOST, select the Enable DLMHOST check box.

8. In the Configuration selection panel, selecting the configurations you want to use:

   - Production configuration
   - DR Test configuration
   - Dummy configuration name
9. In **Current site role** in the **Site configuration** panel, select the role of the current site.

10. Enter the appropriate external IP addresses and ports in:

   - **DC1 external IP address** and **Port**
     The default port is 9060.
   - **DC2 external IP address** and **Port**
     The default port is 9060.

**DLMAUTC**

DLMAUTC is a mainframe TCP/IP client program for DLMAUT. It provides an interface to issue DLMAUT commands to DLm from the Customer Mainframe LPAR and read replies.

DLMAUTC can be used to:

- Test DLMAUT in the absence of GDDR or for troubleshooting
- Manually perform individual step in the DR process without GDDR
- Manually complete a DR activity if one of the DLMAUT commands fails and GDDR skips the rest of the DLm steps
- Support both IPv4 and IPv6

**Usage**

DLMAUTC can be invoked using the following batch job:

```plaintext
//JOBNME JOB (MYJOB)
//      JCLLIB ORDER=USER.SAMPLIB
//RUND EXEC DLMAUTC,
//       PORT=9060,
//       IP=10.246.168.20,
//       CMD=DLMDEVINFO,
//       DEBUG=Y,
//       WAITSECS=1200,
//       REXXLIB=USER.REXXLIB
//DLMCCFG DD *
PARMS(SYS=VTE)
PARMS(TAPELIB=tapelibT1)
PARMS(TAPELIB=tapelibT2)
/*
```

Where:

- **IP** - VTE IP address
- **PORT** - VTE port for DLMAUT
- **CMD** - command to execute
- **PARMS** - Command specific parameters
- **Syntax**: `PARMS(name=value)`
  - The PARMS parameter can be specified in the DLMCCFG DD.
  - A PARMS parameter with the same `<name>` will override the previous value.
- The exception is <name> = TAPELIB. For TAPELIB, <name> values will be concatenated.

Example 1:

PARMS(TAPELIB=<tapelib1>)
PARMS(TAPELIB=<tapelib2>)

Example 2 (equivalent to 1):

PARMS(TAPELIB=<tapelib1>,<tapelib2>)

- DEBUG - enable debug trace, optional, values: Y/N
- WAITSECS - timeout in seconds, optional, default value is 1200

List of files

The following table lists the DLMAUTC files:

<table>
<thead>
<tr>
<th>File</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>SAMPLIBA(DLMAUTC)</td>
<td>JCL procedure for DLMAUTC.</td>
</tr>
<tr>
<td>SAMPLIBA(...)</td>
<td>Sample jobs to run DLMAUT commands using procedure DLMAUTC</td>
</tr>
<tr>
<td>REXXAUTC(DLMAUTCM)</td>
<td>The main REXX exec itself DLMAUTCM)</td>
</tr>
<tr>
<td>REXXAUTC(DLMXLAT)</td>
<td>ASCII to EBCDIC or EBCDIC to ASCII conversion (used by DLMAUTCM)</td>
</tr>
</tbody>
</table>
CHAPTER 9
Using DLm with Unisys

This chapter describes how to use DLm with Unisys.

- Unique DLm operations for Unisys mainframes .................................................. 170
- Configuration for Unisys .................................................................................... 171
- Initializing tapes for Unisys ............................................................................... 171
- Configuring the Unisys mainframe for DLm ...................................................... 172
Unique DLm operations for Unisys mainframes

This section describes the unique DLm operations required for Unisys mainframe systems.

Autodetection

DLm automatically detects that it is attached to a Unisys host when it receives a Load Display command containing data that is unique to a Unisys mainframe. When this occurs, a message is displayed on the DLm Console (DLm0080I: Device <devicename> UNISYS detected). You can confirm that DLm has recognized that a drive is attached to a Unisys mainframe by reviewing the messages displayed on the DLm Console or by running a QUERY CONFIG command.

Load displays

Unisys does not send the M mount message sent by the z/OS mainframe systems. DLm determines a Unisys mount request by the FCB byte containing x'48', and then moves the VOLSER from the 1st position into the 2nd position of the mount message and inserts an M into the 1st position to form a standard mount message.

Mount "Ready" interrupt

The Unisys mainframe does not expect a Not-Ready-to-Ready interrupt when the DLm device comes ready. After sending the Load Display, the Unisys mainframe performs repetitive senses to detect when the device is ready. To accommodate the way Unisys mainframe works, DLm does not send an interrupt when a mount is initiated by a Load Display like it normally does. However, it sends an interrupt when a manual mount is performed at the DLm Console, and when a manual Not-Ready-to-Ready transition is performed.

Query Config command

The DLm QUERY CONFIG command displays an additional parameter, HOST=UNISYS, for a device that has been determined to be attached to a Unisys mainframe.

Ring-Out Mount request

The Unisys Load Display mount request uses the 8th position of the mount message as a file protect indicator. If that position contains the character 'F', the Unisys mainframe expects to have the tape mounted "ring-out" (read-only). DLm honors the 'F' indicator and mounts the requested volume in read-only mode.

Scratch request

When a Unisys host asks for a scratch tape, DLm ignores the label type (either explicitly requested in the mount request or implied by the LABEL=x configuration parameter) and picks any available scratch tape. This behavior is applicable only to...
Unisys-attached devices. All non-Unisys devices will continue to honor label type for scratch mount requests.

**Configuration for Unisys**

This section describes what you need to consider about device type, labels, and scratch tapes when you configure DLm for Unisys.

**Device type**

When configuring devices for use by a Unisys mainframe the Device Type should be set to 3490.

**Labels**

When the Unisys operating system sends a Load Display mount message, it does not specify a label type. Unisys always expects an ANSI label by default. To accommodate this, you must configure each Unisys-attached device with the \texttt{LABEL=A} parameter. This will change the DLm default for this device to ANSI labels instead of IBM standard labels.

**Scratch tapes**

The Unisys operating system does not send the MSCRTCH message to request a scratch tape as an IBM mainframe would. Instead it sends an \texttt{L-BLNK} message. To accommodate the \texttt{L-BLNK} message, you must specify a scratch synonym equal to \texttt{L-BLNK}. The following figure shows a scratch synonym configured for Unisys mainframes.

![Scratch synonym for Unisys](image)

**Initializing tapes for Unisys**

When initializing tape volumes to be used with Unisys, include the \texttt{LABEL=A} option on the initialize command to tell the system that the tape labels will follow the ANSI standard.

For example, to initialize 100 tapes beginning with VOLSER B00000 using tape drive E980, you would enter the following initialize command:

\texttt{INITIALIZE VOL=B00000 DEV=E980 COUNT=100 LABEL=A CLASS=0}
Configuring the Unisys mainframe for DLm

Configure DLm devices in OS2200 using SCMS / SCMS-II as one or more CTS5136-VSM (non-library) subsystems of 1 to 16 units. The resulting ODB or .PTN file must be installed and the OS rebooted with the proper definitions.

The Unisys equipment code for DLm devices is U47M.
APPENDIX A

Virtual tape operator command reference

This appendix provides details about the DLm virtual tape operator commands.

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- CLOSE VSTATS PATH .................................................................................... 174
- DETAIL MOUNT ............................................................................................. 174
- EXPORT ........................................................................................................... 175
- FIND ............................................................................................................... 176
- HELP .............................................................................................................. 177
- IMPORT .......................................................................................................... 178
- INITIALIZE ...................................................................................................... 178
- KMRESTART .................................................................................................. 180
- LOAD ............................................................................................................. 180
- LTR ................................................................................................................ 181
- QUERY .......................................................................................................... 181
- QUIESCE ........................................................................................................ 188
- READY .......................................................................................................... 189
- REWIND ......................................................................................................... 190
- ROTATE .......................................................................................................... 190
- SAVE TRACE ................................................................................................. 190
- SCRATCHNAME ............................................................................................. 191
- SET ............................................................................................................... 192
- SNMP ............................................................................................................. 200
- STARTVT ....................................................................................................... 200
- STOPVT ......................................................................................................... 201
- UNLOAD ......................................................................................................... 201
- UNQUIESCE ................................................................................................... 202
- UNREADY ....................................................................................................... 202
Virtual tape operator commands use the following syntax rules:

- **Note**
The commands and associated syntax listed in this appendix refer to the full set of commands available through the VT Console. If you are viewing or executing commands in the DLm Console's Command tab (on the Status page), the available commands are only a subset of the full commands available through the VT Console.

- UPPERCASE words are keywords and must be spelled as shown. You can type the keywords in either uppercase or lowercase.
- Lowercase words in italics are values that you supply. Generally, you can type these values in either uppercase or lowercase. The exceptions are noted in the command description.
- Values in square brackets [ ] are optional.
- When multiple values are separated by a pipe symbol (|), enter only one of the choices.

### CLOSE VSTATS PATH

#### Syntax

```
CLOSE VSTATS PATH=xxx
```

#### Description

The `CLOSE VSTATS PATH=xxx` command closes the DR logging vstats file in the path specified to allow a mount point to be unmounted.

- **Note**
  A closed vstats file will automatically re-open if a tape is mounted in or moved to a directory with a closed vstats file, or if the `ROTATE DRLOG` command is executed. To prevent a vstats file from automatically reopening, take the directory out of service with the `QUIESCE TAPELIB` command before closing its vstats file.

- **Example**
  ```
  close vstats path=/tapelib/DT
  ```

### DETAIL MOUNT

#### Syntax

```
DETAIL MOUNT
```

#### Description

The `DETAIL MOUNT` command returns detailed information about currently mounted tapes.
Example

DETAIL MOUNT

Sample Output

<table>
<thead>
<tr>
<th>Devicename</th>
<th>VOLSER</th>
<th>Load Time</th>
<th>Duration</th>
<th>Requestor</th>
<th>Path</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Requestor</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Tape Library</td>
<td></td>
<td></td>
</tr>
<tr>
<td>------------</td>
<td>---------</td>
<td>-----------------</td>
<td>-----------</td>
<td>--------------------</td>
<td>------------------------------------------------</td>
</tr>
<tr>
<td>F401</td>
<td>D10322</td>
<td>2016/04/24 09:52:03</td>
<td>45.0 s</td>
<td>[intfc 1/#1001100:link 100:1par 11]</td>
<td>/tapelib/DD1_BPOOL_FS4/</td>
</tr>
<tr>
<td>F402</td>
<td>D40324</td>
<td>2016/04/24 09:52:38</td>
<td>10.0 s</td>
<td>[intfc 1/#1001100:link 100:1par 11]</td>
<td>/tapelib/DD1_BPOOL_FS1/</td>
</tr>
<tr>
<td>F403</td>
<td>D10318</td>
<td>2016/04/24 09:50:42</td>
<td>2.1 m</td>
<td>[intfc 1/#1001100:link 100:1par 11]</td>
<td>/tapelib/DD1_BPOOL_FS1/</td>
</tr>
<tr>
<td>7C0C</td>
<td>LMA100</td>
<td>2016/05/05 09:27:23</td>
<td>21.0 m</td>
<td>[Manual Mount]</td>
<td>/ltr/tapelibA/FS1/</td>
</tr>
</tbody>
</table>

EXPORT

Syntax

```
EXPORT from to [NORUN] [COMPRESS] [KEYCLASS=key_class]
```

Description

Copies a tape volume (VOLSER) from the tape library to a physical tape cartridge.
`from` is the full path of the tape volume (VOLSER) to be copied and `to` is the tape drive serial number that the volume must be written to in the format DRIVE-nnnnnnnnnnnnn.

Note

Make sure that the volume does not exceed the physical capacity of the cartridge being written to. If you attempt to write a volume that cannot fit on the cartridge, the export fails and invalidates the data on the tape by rewinding and writing a tapemark in the front of the tape.

Options

The following table provides the descriptions for the command options.

**Table 14 Export command — option description**

<table>
<thead>
<tr>
<th>Value</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>NORUN</td>
<td>Instructs Virtuent not to unload the tape when the export is complete.</td>
</tr>
<tr>
<td>COMPRESS</td>
<td>Indicates whether Virtuent should compress the tape volume when it is written to the drive. The default is to write the data without compression. If you include this option in the command, Virtuent instructs the tape drive to compress the data before writing it to the media. If the virtual tape volume is already compressed and unencrypted on the tape library, Virtuent decompresses the data before writing it to the physical tape. Then, if the COMPRESS option is specified, Virtuent instructs the drive to compress the data. If the virtual tape volume is already encrypted on the</td>
</tr>
</tbody>
</table>
Table 14 Export command — option description (continued)

<table>
<thead>
<tr>
<th>Value</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>tape library, the COMPRESS option has no effect on the data. Virtuent copies the encrypted volume as is to the physical tape.</td>
<td></td>
</tr>
<tr>
<td>KEYCLASS=key_class</td>
<td>Tells Virtuent whether or not the data should be encrypted before it is written to tape. The encryption key class specified must be defined in the RSA or KMIP Key Manager. When the KEYCLASS option specifies a valid encryption key class Virtuent calls the RSA or KMIP Key Manager in order to get an encryption key and will then encrypt the data before sending it to the tape drive. If the compress option is also specified, Virtuent will compress the data before encrypting it and the drive will not be asked to do compression. If the data in the disk file is already encrypted, Virtuent will copy the existing encrypted data from the disk to the tape as is. The export utility will not decrypt data which is already encrypted on the tape library. In this case, it is not necessary to specify the encryption key class on the export command. Tape volumes written by Virtuent using the EXPORT command which are encrypted (either during the EXPORT or were already encrypted on disk) can only be processed by the Virtuent IMPORT command or Direct Tape. They cannot be processed without using a Virtuent controller. Tape volumes written to an IBM 3592 drive by EXPORT which are not encrypted are compatible with other 3592 drives and can be processed by systems other than Virtuent. For example, a compressed volume written by EXPORT to an IBM 3592 drive could be mounted on a mainframe channel attached 3592 drive and read directly by a mainframe application.</td>
</tr>
</tbody>
</table>

Example
EXPORT /tapelib/B0/B00104 DRIVE-000007818330

This example copies tape volume (VOLSER) B00104 from the back-end tape library to the tape drive DRIVE-000007818330, where 000007818330 is a 12-character serial number of the fibre channel attached tape drive.

FIND

Syntax

FIND VOL=volser [DEV=devicename][LOCAL]

Description
The FIND command finds a specific volume (VOLSER) in the DLm tape library and reports the current status of that volume.

If the [LOCAL] parameter is specified, Virtuent displays only volumes found in the local file systems in a GVL and not the remote file systems.

If the DEV= parameter is specified, the search is limited to the PATH set for that device.

Note
For compatibility, this syntax is allowed:
FIND VOLUME volser [DEV=devicename]
Example
FIND VOL=000001

The example returns the current status of the tape volume with the serial number 0000001.

Sample Output
DLm0409I: Command received: 'FIND VOL=D40316 DEV=F400'
find volume(s) 'D40316' Fri Apr 24 10:02:50 2015 (Julian 114)
Volume Type  DSN          Size  Modified       Mounted  St Class  Path
====================================================================================
D40316 S VTC01263.M5120B32 5.3G  114/2015  9:57          [0] /tapelib/DD1_BPOOL_FS4
find volume(s) 'D40316' -- command complete

HELP

Syntax

HELP [command|message number|ABOUT]

Description
The HELP command displays the following information about Virtuent commands and messages:

Options
The following table provides the descriptions for the command options.

Table 15 Help command — option description

<table>
<thead>
<tr>
<th>Value</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>HELP or ?</td>
<td>Displays summary of all commands. HELP and ? are synonymous.</td>
</tr>
<tr>
<td>HELP [command]</td>
<td>Displays a detailed description of the specified command.</td>
</tr>
<tr>
<td>HELP [message number]</td>
<td>Displays an explanation of the message. HELP 0489 displays information about message DLm0489E. (Typing the message number as DLm0489E, DLm0489, or 0489 gives the same result.)</td>
</tr>
<tr>
<td>HELP [About]</td>
<td>Displays information about Virtuent.</td>
</tr>
</tbody>
</table>

Note
The Help information pertains to Virtuent only.

Example
HELP DLm0489
HELP SET
**IMPORT**

**Syntax**

```
IMPORT from to [NORUN] [COMPRESS] [KEYCLASS=key_class]
```

**Description**
Copies a tape volume from a physical tape cartridge to the tape library. `from` parameter is the tape drive serial number of the tape drive to be read, in the format: `DRIVE-nnnnnnnnnnnn

to is the complete path of the tape volume (VOLSER) being imported.

**Options**
The following table provides the descriptions for the command options.

<table>
<thead>
<tr>
<th>Value</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>NORUN</td>
<td>NORUN instructs Virtuent not to unload the tape when the import is complete.</td>
</tr>
<tr>
<td>COMPRESS</td>
<td>COMPRESS indicates that Virtuent should compress the tape volume when it is written to the tape library. Virtuent assumes that if the tape is compressed on the cartridge, the drive will automatically decompress it as it is being read from tape. If you include this option in the command, Virtuent compresses the data before writing it to the tape library. If you do not include this option, Virtuent stores the uncompressed volume in the library.</td>
</tr>
<tr>
<td>KEYCLASS=key_class</td>
<td>Tells Virtuent whether or not to encrypt the data as it is writing it to the library. The encryption key class you specify must be a valid key class in the RSA or KMIP Key Manager. The default is no encryption indicating Virtuent will not do encryption as it is writing the data to the library. If the volume was previously encrypted by Virtuent then the volume is imported as is onto the tape library. The Virtuent IMPORT command does not decrypt data. Virtuent encrypted tape volumes can only be decrypted by being mounted and read from the mainframe.</td>
</tr>
</tbody>
</table>

**Example**

```
IMPORT DRIVE-000007818330 /tapelib/B0/B00104
```

The example imports the tape-on-drive `DRIVE-000007818330` (where `000007818330` is a 12-character serial number of the fibre channel attached tape drive) and writes it to `/tapelib/B0/B00104`.

**INITIALIZE**

**Syntax**

```
INITIALIZE VOL=volser DEVICE=devname
[COUNT=count] [CLASS=n] [DIR=subdirectory] [LABEL=S|A|N]
```
Description
Creates and initializes one or more AWS-format virtual tape volumes in the tape library.

Note
In DLm command syntax, you can use DEVICE and DEV interchangeably.

Options
The following table provides the descriptions for the command options.

<table>
<thead>
<tr>
<th>Value</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>VOL=volser</td>
<td>It is the starting serial number to initialize. If VOLSER is specified without a count, only the volume specified is created.</td>
</tr>
<tr>
<td>COUNT=count</td>
<td>It is the number of serial numbers to initialized. If count is not specified, only the single VOLSER specified will be initialized. If count is specified, volser becomes a template for creating a number of sequential VOLSERs. volser must end with numeric digits that start with a value that is low enough and has sufficient digits to contain the number of volumes specified in count. For example, VOL=BT0000 COUNT=1000 would create volumes BT0000 through BT0999. Similarly, VOL=XXX100 COUNT=500 would create volumes XXX100 through XXX599. However, VOL=BTA100 COUNT=1000 would be illegal, as would VOL=ABCDE0 COUNT=11 or VOL=ABCDEF COUNT=2.</td>
</tr>
<tr>
<td>ERRORS=nnnnn</td>
<td>If ERRORS=nnnnn is specified, up to nnnnn errors are tolerated and initializations continue until &lt;nnnnn&gt; have occurred. If the ERRORS parameter is not specified, initializations terminate after encountering five errors (such as volser already exists). Any existing volume in the range is skipped. It will not be altered in any way.</td>
</tr>
<tr>
<td>DEVICE=devname</td>
<td>Instructs the INITIALIZE function to use the tape library pointed by devname to determine where to create the new scratch tapes. For example, if device E980 points to /tapelib, the following command causes 100 scratch tapes to be created in the default storage class (CLASS0) of the library /tapelib when using EFS: INIT VOL=B00000 DEVICE=E980 COUNT=100 CLASS=0</td>
</tr>
<tr>
<td>CLASS=n</td>
<td>The CLASS parameter directs the new volumes being initialized to a specific storage class within the library. You must initialize scratch tapes into any new storage class before you attempt to allocate a new scratch volume from that class. CLASS is a required parameter when using Enhanced File System (EFS), and is not valid when EFS is not being used. Unless DIR is also specified, the new tapes will be spread across all subdirectories of the specified CLASS.</td>
</tr>
<tr>
<td>DIR=subdirectory</td>
<td>The DIR parameter is always optional and allows you to direct the new volumes being initialized to a specific file system (directory) within the library. When not specified, INITIALIZE will spread the new tapes across all subdirectories of the specified CLASS. During operation, Virtuent automatically moves scratch volumes between file systems in the same class as needed. Therefore it is not necessary to initialize tape volumes into all file systems. You only need to make sure that each storage class has scratch tapes. Specify only the subdirectory name; the base tape library directory is derived from the PATH= parameter defined for the devname</td>
</tr>
</tbody>
</table>
Table 17 Initialize command — option description (continued)

<table>
<thead>
<tr>
<th>Value</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>specified. For example, if the tape library is /tapelib, specifying DIR=L2 initializes the tapes in /tapelib/L2.</td>
<td>Note</td>
</tr>
<tr>
<td>This parameter is only allowed when the Enhanced File System (EFS) architecture option is enabled.</td>
<td></td>
</tr>
<tr>
<td>LABEL=[S/A/N]</td>
<td>The LABEL parameter specifies whether the new volumes are created with Standard IBM (EBCDIC) labels (S), ANSI (ASCII) labels (A), or no labels (N). The default is Standard IBM labels.</td>
</tr>
<tr>
<td>SCRATCH=[Y/N]</td>
<td>Volumes are initialized as scratch volumes by default and are immediately available for allocation in response to a mount scratch tape request from any VTE in the system. If you want to initialize a volume and do not want it to assume the default scratch status, specify SCRATCH=N.</td>
</tr>
<tr>
<td>EPIC=[N/Y]</td>
<td>Specifying EPIC=Y places an identifier on the VOL1 label signifying that the volume is owned by BIM-EPIC tape manager causing BIM-EPIC to accept the new volume without requiring any host operator intervention. The default is EPIC=N.</td>
</tr>
</tbody>
</table>

Example

INITIALIZE VOL=S20000 DEV=3800 COUNT=100 CLASS=2

KMRESTART

Syntax

KMRESTART

Description

This command restarts the keymanager daemon. It is used to reinitialize new certificates and parameters.

LOAD

Syntax

LOAD [VOL=volser] [ON] [DEVICE=devicename|*] [UNLABELED|LABELED|NL|SL|AL] [PROTECTED]

Description

Use the LOAD command to perform a manual load of a virtual tape volume.

Use a manual load to load a volume for a host system that does not send Load Display Mount messages, or in a situation where you want to mount a tape other than the one the host is requesting.

Note

The label option applies only to scratch mount requests. Virtuent ignores the label specification when a specific VOLSER is specified.
Options
The following table provides the descriptions for the command options.

Table 18 Load command — option description

<table>
<thead>
<tr>
<th>Value</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>VOL=volser</td>
<td>Specifies the VOLSER to be loaded.</td>
</tr>
<tr>
<td>DEVICE=devicename</td>
<td>Specifies the virtual tape drive to be loaded. * loads the first available device.</td>
</tr>
<tr>
<td>[UNLABELED</td>
<td>LABELED</td>
</tr>
<tr>
<td></td>
<td>UNLABELED/NL specifies that the scratch volume must be initialized as an unlabeled tape. The UNLABELED and NL options are synonymous. This option has no effect when a specific VOLSER is requested.</td>
</tr>
<tr>
<td></td>
<td>AL specifies that the scratch volume must be initialized with standard ANSI (ASCII) labels. This option has no effect when a specific VOLSER is requested.</td>
</tr>
<tr>
<td>PROTECTED</td>
<td>The PROTECTED option loads the tape as read-only. Otherwise, the volume is loaded in normal read-write mode.</td>
</tr>
</tbody>
</table>

Example
LOAD VOL=S20000 DEV=3800

LTR

Syntax
LTR [ ENABLE | DISABLE ] policyname | *

Description
Enables or disables the specified LTR policy. Wildcards are allowed in the policy name parameter.

QUERY

Syntax
QUERY [[DEV=]devicename[+]|ALL|MOUNTED] [CONFIG] | [CRITICAL] | [PATHS [ASSIGNED]] | [EFS] | [GVL] | [LABELS] [[DEV=]devicename] [VERSION] | [SPACE [BYCLASS|BYDLM] [LTR] [WIDEFORMAT] [LOCAL]] | [SCRATCHNAMES] | [COMPRESSION] | [encryption] | [GR] [STATISTICS|STATS] [STCLASS] [WARNING|RECOVER|RECOVERAMT] [WORM] [CHANNEL ADAPTERS] [DRIVE LIST] [REJECTED PATHS] [LOCKS] [LTR]
**Description**
Use the **QUERY** command to display the system information. The following is a description of the values within the command:

**Options**
The following table provides the descriptions for the command options.

<table>
<thead>
<tr>
<th>Value</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>QUERY [] [DEV=] device name</strong></td>
<td>With no operands, displays the current status of all virtual tape drives, while DEVICE=device name displays a single drive or range of drives. Use * as a wildcard character to display a range of drives. For example, *<em>Q E98</em> displays all the devices E980–E98F.</td>
</tr>
<tr>
<td><strong>QUERY ALL</strong></td>
<td>Displays information about Virtuent, the channel interface cards, and all virtual tape devices.</td>
</tr>
<tr>
<td><strong>QUERY MOUNTED</strong></td>
<td>Displays information only about the drives that currently have virtual tape volumes mounted.</td>
</tr>
<tr>
<td><strong>QUERY CONFIG</strong></td>
<td>Shows detailed configuration information for all devices, or a single device if <strong>DEV=</strong> is specified.</td>
</tr>
<tr>
<td><strong>QUERY CRITICAL</strong></td>
<td>Shows information about the critical usage thresholds and behaviors.</td>
</tr>
<tr>
<td><strong>QUERY PATHS[ASSIGNED]</strong></td>
<td>Shows all the channel paths established for the VTE devices, or a single device if <strong>DEV=</strong> is specified. If <strong>ASSIGNED</strong> is specified, only channel paths with a current host assignment (typically those varied online) are displayed.</td>
</tr>
<tr>
<td><strong>QUERY EFS</strong></td>
<td>Displays information about the Enhanced File System (EFS) states.</td>
</tr>
<tr>
<td><strong>QUERY GVL</strong></td>
<td>Displays the DLm ID and the number of DLms in the GVL. For non-GVL systems, the command displays the DLm ID as zero and states that it is not part of a GVL.</td>
</tr>
<tr>
<td><strong>QUERY LABELS</strong></td>
<td>Shows the header labels, if any, for all mounted tapes.</td>
</tr>
<tr>
<td><strong>QUERY VERSION</strong></td>
<td>Displays Virtuent release number.</td>
</tr>
</tbody>
</table>
| **QUERY SPACE [BYCLASS|BYDLM] [LTR] [WIDEFORMAT] [LOCAL]** | Shows a summary of the disk space used and available in all the tape libraries. **Note**

You can enter additional commands while the **QUERY SPACE** command is being processed.

- If FLR is enabled, "(FLR)" is displayed next to the file system name.
- If DDRL is enabled, "(DDRL)" is displayed next to the file system name.
- If the **BYCLASS** option is used, the subdirectories are listed and totaled for each class.
- The **BYDLM** option is only applicable to DLm systems with the GVL feature. The **BYDLM** option sorts the storage for each device group by the DLm in the GVL that it is associated with.

**Note**

**BYDLM cannot be used in conjunction with BYCLASS.**

The **LTR** option displays information only about LTR storage.
<table>
<thead>
<tr>
<th>Value</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Value</td>
<td>Description</td>
</tr>
<tr>
<td>The <strong>WIDEFORMAT</strong> option prints all the information on one line for each tape library directory, regardless of the length of the tape library path names. The column positioning will be adjusted to accommodate the longest path name.</td>
<td></td>
</tr>
<tr>
<td>The <strong>LOCAL</strong> option is only applicable to DLm systems with the GVL feature. If the <strong>LOCAL</strong> option is used only the local storage information for the DLm in the GVL is displayed.</td>
<td></td>
</tr>
<tr>
<td>QUERY SCRATCHNAMES</td>
<td>Displays all the scratch VOLSER synonyms currently in effect.</td>
</tr>
<tr>
<td>QUERY COMPRESSION</td>
<td>Lists the status of a VTE's AHA compression adapters.</td>
</tr>
<tr>
<td>QUERY ENCRYPTION</td>
<td>Shows the status of the DLm encryption keys.</td>
</tr>
<tr>
<td>QUERY GR</td>
<td>Displays the tape library directories configured for replication and are eligible for GR or Replication on RUN. It also displays the GR timeout value.</td>
</tr>
<tr>
<td>QUERY WARNING</td>
<td>WARNING, RECOVER, and RECOVERAMT are effectively the same, and display the space usage warning percent, space recovery percent, space recover amount, recovery update time, and erase policy TTL time. File-size values reported by the QUERY command reflect the compressed data size, not the original uncompressed size.</td>
</tr>
<tr>
<td>QUERY RECOVER</td>
<td></td>
</tr>
<tr>
<td>QUERY RECOVERAMT</td>
<td></td>
</tr>
<tr>
<td>QUERY STATISTICS or QUERY STATS</td>
<td>Displays the current state of the Virtuent statistics collection system.</td>
</tr>
<tr>
<td>QUERY STCLASS</td>
<td>Displays the storage classes of the tape libraries.</td>
</tr>
<tr>
<td>QUERY CHANNEL ADAPTERS</td>
<td>Displays information about all channel adapters in the VTE.</td>
</tr>
<tr>
<td>QUERY REJECTED PATHS</td>
<td>Displays connections that the host has attempted to establish with the VTE, but which are not configured.</td>
</tr>
<tr>
<td>QUERY DRIVE LIST</td>
<td>Displays the current SCSI tape drives attached to this node.</td>
</tr>
<tr>
<td>QUERY LOCKS</td>
<td>Displays two kinds of VOLSER locks currently set:</td>
</tr>
<tr>
<td></td>
<td>- Short term locks set by Enhanced File System (EFS) when searching for or moving files between file systems.</td>
</tr>
<tr>
<td></td>
<td>- Long term locks set by Virtuent to reserve a VOLSER for the duration it is used.</td>
</tr>
<tr>
<td>QUERY LTR</td>
<td>Displays information about the Long Term Retention feature and policies configured on this VTE.</td>
</tr>
</tbody>
</table>

**QUERY sample output**

DLm0409I: Command received: 'query'
Devicename  VOLSER/L
----------  --------
1D00          NR-UA
1D01          NR-UA
1D02          NR-UA
1D03          NR-UA
9200        AA2222 S  R-A2  aws/rw  LP
The four columns under VOLSER/L are:

- Volume currently mounted on the drive.
- Type of label on the volume:
  - S = Standard IBM
  - A = ANSI
  - N = Unlabeled
- Drive status:
  - Q = Quiesced
  - R = Ready
  - NR = Not ready
  - NA = Not accessible
  - UA = Not currently allocated by a Host
  - An = Allocated on n logical channel paths: A1 = allocated on one logical channel path, A2 = allocated on two paths, A3 = allocated to three paths, etc.
    (For a non-auto-switched device, An means one host has varied online n paths and the device; for an auto-switched device, or in a JES3 environment, An means the host has reserved the device for use on n logical channel paths.)
- Volume status:
  - aws or flat is the virtual tape file format.
  - scsi for a SCSI or Fibre-Channel-attached tape drive.
  - rw is read-write.
  - ro is read-only.
  - Ifp is logical file protect set by the host.
  - If FLRMODE=YES or DDLRMODE=YES is set, the status will be “mod”, indicating the tape is modifiable.
  - If a volume is mounted, the current block position or LP (for loadpoint) is displayed, and whether the last operation was a read or write.
  - Other notations might also be displayed when a volume is being written:
    - h-compr or s-compr signifies that the most recent write was compressed by hardware or software, respectively. The total volume size shown is after the compression notation, if any.
    - crypt signifies that the most recent write was encrypted.
    - AMDD signifies that the AMDD feature has modified one or more blocks being written to this volume.
  - The notation “GR” is displayed for any device that is configured for Guaranteed Replication or Replication on RUN and is writing to a replication-enabled file system. When a replication-refresh is in progress, “(replicating)” is displayed.
**QUERY COMPRESSION sample output**

DLM0409I: Command received: 'q compression'
DLM0010I: Compression hardware available
DLM0011I: Compression driver version: 1.4.1
DLM0012I: Compression card #0: id=0x193F0367 (AHA367) version=0x30300 state=00000000
DLM0013I: Hardware compression set ON
DLM0013I: Hardware decompression set ON
DLM0931I: HW Compression Adapter Watchdog timer set to 120 seconds

**QUERY CONFIG sample output**

DLM0409I: Command received: 'query config'
DLM0102I: Configuration file is /etc/bti/xmap0
Current Values Are:
<table>
<thead>
<tr>
<th>Index</th>
<th>Devicename</th>
<th>Type</th>
<th>CU</th>
<th>UA</th>
<th>Options</th>
</tr>
</thead>
<tbody>
<tr>
<td>00</td>
<td>1D00</td>
<td>3490</td>
<td>00</td>
<td>00</td>
<td>PATH=/tapelib/ SIZE=2G</td>
</tr>
<tr>
<td>01</td>
<td>1D01</td>
<td>3490</td>
<td>00</td>
<td>01</td>
<td>PATH=/tapelib/ SIZE=2G</td>
</tr>
<tr>
<td>02</td>
<td>1D02</td>
<td>3490</td>
<td>00</td>
<td>02</td>
<td>PATH=/tapelib/ SIZE=2G</td>
</tr>
<tr>
<td>03</td>
<td>1D03</td>
<td>3490</td>
<td>00</td>
<td>03</td>
<td>PATH=/tapelib/ SIZE=2G</td>
</tr>
<tr>
<td>04</td>
<td>1D04</td>
<td>3490</td>
<td>00</td>
<td>04</td>
<td>PATH=/tapelib/ SIZE=2G</td>
</tr>
<tr>
<td>05</td>
<td>1D80</td>
<td>3490</td>
<td>08</td>
<td>00</td>
<td>PATH=/tapelibGRS2/ SIZE=2G GR=YES</td>
</tr>
<tr>
<td>06</td>
<td>1D90</td>
<td>3490</td>
<td>08</td>
<td>00</td>
<td>PATH=/tapelibGRS2/ SIZE=2G GR=RUN</td>
</tr>
<tr>
<td>07</td>
<td>6302</td>
<td>3490</td>
<td>00</td>
<td>02</td>
<td>PATH=/tapelib/ SIZE=40G GR=SYNC</td>
</tr>
<tr>
<td>08</td>
<td>940A</td>
<td>3590</td>
<td>04</td>
<td>0A</td>
<td>PATH=/tapelibFLR/ SIZE=40G FLR=YES FLRRET=1D FLRMODE=YES FLREXTENTS=5</td>
</tr>
<tr>
<td>09</td>
<td>940B</td>
<td>3590</td>
<td>04</td>
<td>0B</td>
<td>PATH=/tapelibDD/ SIZE=40G DDRL=YES DDRLRET=1D DDRLMO=YES DDRLEXTENTS=5</td>
</tr>
</tbody>
</table>

**QUERY GR sample output**

DLM0409I: Command received: 'q gr'
DLM0108I: Guaranteed Replication Timeout set to 2700 seconds
DLM0160I: Device 6300 configured GR=RUN
DLM0160I: Device 6301 configured GR=RUN
DLM0160I: Device 6302 configured GR=SYNC
DLM0160I: Device 6303 configured GR=YES
DLM0160I: Device 6304 configured GR=YES
DLM0161I: Tape library '/tapelib/DD' enabled for replication
DLM0161I: Tape library '/tapelib/BB' enabled for replication

**QUERY GVL sample output**

DLM3110I: This is DLM #2 of 2 in the GVL

**QUERY LABELS sample output**

DLM0409I: Command received: 'query labels'
1D00 S VOL1JJ0031 HDR1LL6.DEMO.BACKUP02JJ00310010000 0101520000000000000IBM OS/VS 370
HDR2U000000000DDPHILL6D/DUMP 00000 0000065520

**QUERY LOCKS sample output**

DLM0409I: Command received: 'query locks'
DLM0256I: EFS Short Term Lock Directory set to: /lockfs/LOCK/
DLM0953I: Locking with .lk lock files turned ON
DLM0957I: Locking with NLM Locks turned OFF

====================================================================
### .lk long term lock files

<table>
<thead>
<tr>
<th>owner</th>
<th>lock file name</th>
</tr>
</thead>
<tbody>
<tr>
<td>------</td>
<td>---------------</td>
</tr>
</tbody>
</table>

lk lock file count: 0

### EFS short term lock files (dir: /lockfs/LOCK/)

<table>
<thead>
<tr>
<th>owner</th>
<th>volser</th>
</tr>
</thead>
<tbody>
<tr>
<td>------</td>
<td>-----</td>
</tr>
</tbody>
</table>

EFS lock count: 0

### QUERY MOUNTED sample output

Dlm0409I: Command received: 'query mounted'

Devicename VOLSER/L

---

1D00       JJ0031 S   R-A2  aws/rw   block 2514 (writing 135.6M)

### QUERY PATHS sample output

Dlm0409I: Command received: 'q paths'

<table>
<thead>
<tr>
<th>Device</th>
<th>Interface/Path#</th>
<th>Port</th>
<th>LPAR</th>
<th>CU</th>
<th>Device</th>
<th>PathGroup ID</th>
</tr>
</thead>
<tbody>
<tr>
<td>1D00</td>
<td></td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>1D01</td>
<td></td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>1D02</td>
<td></td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

### QUERY SCRATCHNAMES sample output

Dlm0409I: Command received: 'query scratchnames'

Dlm0856I: 6 scratch synonyms:

- PRIVAT=(CLASS=CLASS0)
- SCRTCH=(CLASS=CLASS0)
- POOLFOUR=(D0,D1,D2,D3,D4,CLASS=CLASS0)
- SCRTCH1=(CLASS=CLASS1)
- SCRTCH3=(M0,CLASS=CLASS3)
- SCRTCH4=(ABA,ABB,ABC,CLASS=CLASS4)

### QUERY SPACE sample output

The QUERY SPACE output for VNX back-end systems is similar to:

Dlm0409I: Command received: 'q space'

<table>
<thead>
<tr>
<th>Path</th>
<th>Size</th>
<th>Active</th>
<th>Scratch/</th>
<th>Qty</th>
<th>Free</th>
<th>Filesystem</th>
</tr>
</thead>
<tbody>
<tr>
<td>/tapelib/</td>
<td>28G</td>
<td>0%</td>
<td>736 0%</td>
<td>04</td>
<td>25G</td>
<td>99% /dev/sda2</td>
</tr>
<tr>
<td>/tapelib/F0</td>
<td>48G</td>
<td>25%</td>
<td>329M 0%</td>
<td>1832</td>
<td>23G</td>
<td>48% celldm2:/tapelibCEL1/FS0</td>
</tr>
<tr>
<td>/tapelib/N0</td>
<td>877G</td>
<td>22G  2%</td>
<td>15K  0%</td>
<td>83</td>
<td>855G</td>
<td>97% celldm2:/tapelibCEL1/FS2</td>
</tr>
<tr>
<td>/tapelib/FE</td>
<td>99G</td>
<td>1G  1%</td>
<td>1K  0%</td>
<td>07</td>
<td>98G</td>
<td>98% celldm2:/tapelibCEL1/C1_FS1 (FLR)</td>
</tr>
<tr>
<td>/tapelib/DD</td>
<td>492.4G</td>
<td>3G  0%</td>
<td>15.1K 0%</td>
<td>84</td>
<td>489.4G</td>
<td>99% celldm2:/tapelibCEL2/C2_FS1 (Repl)</td>
</tr>
</tbody>
</table>

Totals: 1544.4G 51G  5%  329M 1%  2010  1001G  95%
The QUERY SPACE output for Data Domain back-end systems is similar to:

```
Dlm0409I: Command received: 'q space'

Tape library space for drives: 7700-773B

Path                      Size    Active     Scratch / Qty     Free     Filesystem
----------------         -------   --------   ----------------  ---------  ----------
/tapelibVTE3            393.7G   0 0%       0 0%        0 367.6G  93% /dev/sda2
/tapelibVTE3/D0         DD1      962M 0%     558.2K      1374 DD1 99% ddls-alias0:/data/backup/
/tapelib_96/D0          DD1      1.3G 0%     557K        1371 DD1 99% ddls-alias0:/data/backup/
/tapelibVTE3/D1         DD1      1.4G 0%     549.7K      1353 DD1 99% ddls-alias0:/data/backup/
/tapelib_96/D1          DD1      525.8M 0%   546.4K      1345 DD1 99% ddls-alias0:/data/backup/
/tapelibVTE3/D2         DD1      652.4M 0%   549.7K      1353 DD1 99% ddls-alias0:/data/backup/
/tapelib_96/D2          DD1      966.8M 0%   545.6K      1343 DD1 99% ddls-alias0:/data/backup/
/tapelibVTE3/D3         DD1      3.2G 0%     118.2K      291 DD1 99% ddls-alias0:/data/backup/
/tapelib_96/D3          DD1      427.6M 0%   547.2K      1347 DD1 99% ddls-alias0:/data/backup/
/tapelibVTE3/D4         DD1      966.8M 0%   545.6K      1343 DD1 99% ddls-alias0:/data/backup/
/tapelib_96/D4          DD1      525.8M 0%   546.4K      1345 DD1 99% ddls-alias0:/data/backup/
/tapelibVTE3/D5         DD1      1.3G 0%     557K        1371 DD1 99% ddls-alias0:/data/backup/
/tapelib_96/D5          DD1      1.4G 0%     549.7K      1353 DD1 99% ddls-alias0:/data/backup/
/tapelibVTE3/D6         DD1      652.4M 0%   549.7K      1353 DD1 99% ddls-alias0:/data/backup/
/tapelib_96/D6          DD1      3.2G 0%     118.2K      291 DD1 99% ddls-alias0:/data/backup/
/tapelibVTE3/D7         DD1      427.6M 0%   547.2K      1347 DD1 99% ddls-alias0:/data/backup/
/tapelib_96/D7          DD1      966.8M 0%   545.6K      1343 DD1 99% ddls-alias0:/data/backup/

 Totals:  10T 9.4G 0% 3.9M 0% 9777 9.9T 99%

DD1 Total: 10T  9.9T
```

---

- **Tape library space for drives** — All devices sharing the same tape library are grouped together.
- **Path** — The first (or only) entry is the tape library base directory. If the base tape library contains subdirectories, they are listed separately and a total is printed.
- **Size** — This is the size of the entire file system.
- **Active** — This is the amount of space being used by non-scratch tape volumes.
- **Scratch** — This is the amount of space that scratch tape volumes use. The system can reclaim scratch tape space at any time as needed.
- **Qty** — This is the number of scratch tape volumes in this directory.
- **Free** — This is the amount of free space currently available on the entire file system. Note that if the file system holds files in directories other than the tape library directory, the space of all other files will reduce the free space. For this reason (Size - Active - Scratch) it may not add up (Unused), as seen in the first example.
- **Filesystem** — The file system device name, typically a hard drive partition name or an NFS or SMB mount point. For VNX file systems that are recognized as FLR file systems, the output displays *(FLR)* next to the file system device name.

The notation "*(Repl)*" is displayed for each file system that is recognized as a replication-enabled file system.

When a Data Domain is integrated with the DLm system, the following differences appear:

- For all tape libraries on DD back ends, the Size and Free space will be displayed as DD1 or DD2 based on the DD of the attached space.
- The totals will be calculated based on the actual numbers. After the totals the ‘size’ and ‘free’ space for each DD will be listed.
Active, Scratch, and Qty remain the same.

**QUERY STCLASS sample output**

```
DLm0409I: Command received: 'query stclass'
Class     Path
----------------------
0         /tapelibSP/S5
0         /tapelibSP
0         /tapelib/D1
2         /tapelib/D6
0         /tapelib/D0
0         /tapelib
```

**QUERY TAPELIBS sample output**

```
DLm0409I: Command received: 'QUERY TAPELIBS'
/tapelib/T2 (dev 11)
Warn/Warned 75% / 0% checked 01/30/2015 21:52:52 to 01/30/2015 21:52:52
Recover/Recovered 95% / 0% recovered never to never
Highest Usage 29% at 01/30/2015 20:16:35
Current Penalty 0%
Last Picked Time at 12/31/1969 19:00:00.000000
```

**QUERY VERSION sample output**

```
DLm0409I: Command received: 'query version'
Model Family: dlm8100v
Licensed Features Enabled:
   EMC FLR Support
   EMC DDLR Support
   SCSI Tape Support
   Import-Export Support
   EMC Dlm Support
   EMC GR Support
   DR Logging Support
   AMDD Support for EMC
   RSA Encryption Support
Program started at Tue Feb 7 09:23:01 2017
DLm1000I: Dlm PSNT S/N: APM1024230180
DLm1001I: VTE node number: 1
```

**QUIESCE**

**Syntax**

```
QUIESCE [[DEVICE=?]device|ALL|*] [SCRATCH PATH=path] [TAPELIB PATH=path]
```

**Description**

The QUIESCE command sets one or all of the virtual devices, or a tape library directory, into the 'quiesced' state. Quiesced drives will not accept any future Load requests until UNQUIESCE'd (or until the system is restarted). Other than not accepting new loads, quiesced drives remain On-Line, Ready and fully functional; any volume already loaded on the drive can be accessed normally until it is unloaded.

Mount requests issued by the host while a drive is quiesced remain pending and will be performed when the drive is unquiesced.
Options
The following table provides the descriptions for the command options:

### Table 20 QUIESCE option description

<table>
<thead>
<tr>
<th>Value</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>ALL or *</td>
<td>Are synonymous and quiences all drives</td>
</tr>
<tr>
<td>QUIESCE SCRATCH PATH=path</td>
<td>Quiesced SCRATCH tape library directories will be bypassed when searching for or mounting a scratch tape. In addition, a quiesced directory will not be eligible to move scratch volumes into. Usage of the directory will return to normal once it is UNQUIESCE'd.</td>
</tr>
<tr>
<td>QUIESCE TAPELIB PATH=path</td>
<td>Quiesced TAPELIB tape library directories will be bypassed when searching for or mounting a virtual tape. In addition, a quiesced directory will not be checked for free space or have space recovery performed on it. Any tape already in use in a quiesced directory will continue to be accessed normally until it is unloaded. Usage of the directory will return to normal once it is UNQUIESCE'd.</td>
</tr>
</tbody>
</table>

**Example**

QUIESCE TAPELIB PATH=/tapelib/FS1
QUIESCE DEVICE=4000

---

### READY

**Syntax**

```
READY [DEVICE=]devicename
```

**Description**

Use the **READY** command to change a virtual drive from the Not Ready to the Ready state.

Typing the **READY** command for a virtual tape drive is equivalent to pressing the Ready button on a physical tape drive.

To make a virtual drive ready, it must already have a volume mounted and be in the Not Ready (Intervention Required) state. If the specified drive does not have a volume mounted, or is already in the Ready state, the **READY** command is ignored.

The **READY** command is not needed during normal processing to make a drive Ready. Normally, a drive automatically becomes Ready whenever a volume is mounted and stays Ready until the volume is unloaded.

The Not Ready condition, while a volume is mounted, is an exceptional condition that occurs only when the **UNREADY** command was entered.

**Example**

READY DEVICE=9200
**REWIN D**

**Syntax**

```
REWIND [DEVICE=devicename]
```

**Description**

Use the `REWIND` command to manually rewind the specified virtual tape drive.

Using the `REWIND` command for a virtual tape drive is equivalent to pressing the Rewind button on a physical tape drive. Like a physical tape drive, the specified virtual tape drive must be in the Not Ready state for the `REWIND` command to be accepted.

The VTE immediately executes the `REWIND` command regardless of whether the host might currently be using the tape.

---

**Note**

If the host is still processing the volume and has not yet closed the tape, manual repositioning may make the host read from or write to an incorrect location of the virtual tape volume. For this reason, use the `REWIND` command only in an emergency situation when a tape volume is known and to not be in use by a host application, but needs to be rewound to load point immediately.

**Example**

```
REWIND DEVICE=940A
```

---

**RO TA TE**

**Syntax**

```
ROTATE [LOCAL|DRLOG]
```

**Description**

The `ROTATE` command rotates the local statistics file (`LOCAL`) or the DR Logging files (`DRLOG`) in each of the tape library directories.

The current data will be zipped and the specified log will be cleared.

---

**SAVE TRACE**

**Syntax**

```
SAVE [TRACE]
```

**Description**

Use the `SAVE TRACE` command to write all trace buffers to disk immediately.

Normally, the traces are buffered in memory and only written to disk periodically for performance reasons. Before examining or copying the trace files, you must perform
the SAVE TRACE command to make sure that all currently buffered trace data is written to disk. It also saves channel adapter trace files to disk.

**SCRATCHNAME**

**Syntax**

```
SCRATCHNAMES [ADD synonym=(prefix,prefix,...,CLASS=CLASSn)]
[DELETE synonym]
```

**Description**

The SCRATCHNAMES ADD command adds a new scratch synonym. The SCRATCHNAMES DELETE command deletes an existing synonym. synonym is a 1-8 character scratch synonym (poolname). SCRATCH is the minimum abbreviation for the SCRATCHNAMES command.

**Options**

**Table 21** SCRATCHNAME command - option description

<table>
<thead>
<tr>
<th>Value</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>ADD synonym=(prefix,prefix,...,CLASS=CLASSn)</td>
<td>Adds a new scratch synonym. For ADD, synonym must not already exist as a current scratch synonym. Otherwise, the command is rejected. Prefix(es) and class are optional (default is no VOLSER prefix, class 0). Valid prefixes are 1-6 valid VOLSER values. Any number of prefixes may be specified, separated by commas, and must precede any optional CLASS parameter.</td>
</tr>
<tr>
<td>DELETE synonym</td>
<td>Deletes a scratch synonym. For DELETE, synonym must exist as a current scratch synonym. Otherwise, the command is rejected. DEL is the minimum abbreviation for DELETE.</td>
</tr>
</tbody>
</table>

**Example**

The following are examples of valid SCRATCH ADD commands:

- SCRATCH ADD POOLFOUR=(D0,D1,D2,D3,D4)
  
The synonym POOLFOUR is added. POOLFOUR allocates scratch tapes with the VOLSER prefixes “D0”, “D1”, “D2”, “D3”, and “D4” from CLASS 0 directories.

- SCRATCH ADD SCRTCH1=(CLASS=CLASS1)
  
The synonym SCRTCH1 is added. SCRTCH1 allocates scratch tapes with any VOLSER prefix from CLASS 1 directories.

- SCRATCH ADD SCRTCH3=(M0,CLASS=CLASS3)
  
The synonym SCRTCH3 is added. SCRTCH3 allocates scratch tapes with the VOLSER prefix “M0” from CLASS 3 directories.
The synonym SCRTCH4 is added. SCRTCH4 allocates scratch tapes with the VOLSER prefixes “ABA”, “ABB”, and “ABC” from CLASS 4 directories.

The following is an example of a valid SCRATCH DELETE command:

```
SCRATCH_DEL SCRTCH4
```

**SET**

**Syntax**

```
SET [AMDD=ON|OFF]
[CriticalPercent=nn]
[CriticalScratch=YES|NO]
[CriticalEFSMove=YES|NO]
[CriticalRo=YES|NO]
[CriticalLEOT=YES|NO]
[DdWriteVerify=ON|OFF|CRC|DATA|HEADERS]
[Device=device|ALL]
[EFSMove=SPACE|RANDOM|NEVER]
[EFSMoveFlr=ON|OFF]
[EFSMoveDdlr=ON|OFF]
[EFSMoveCr=ON|OFF]
[EncryptKey=[n|KEYn|NONE]
[EraseMove=SPACE|COUNT|RANDOM|NEVER]
[ErasePolicyTtl=nn|nnnH|nnnD|OFF]
[FileListRefreshIntervalDdRemote=OFF|nnn|nnnM|nnnH]
[FileListRefreshIntervalVnxRemote=OFF|nnn|nnnM|nnnH]
[FlrLockIfExpired=YES|NO]
[PsAllocation=PR|SPACE]
[Gr=YES | NO | SYNC | RUN [DEVICE=devname]]
[GRReportInterval=n]
[HwComp=ON|OFF|FORCE]
[HwDecomp=ON|OFF|FORCE]
[IDRC=ON|OFF|FORCE]
[InjectGrtTimeout=ON|OFF]
[KeyClass=key_class|NONE]
[LEOT=xxx]
[NonTruncateWrite=YES|NO]
[Path=pathname [NOCHECK]]
[ProtectVol1=ON|OFF]
[QSpaceTimeout=nn]
[RDC256K=ON|OFF]
[Recover=nn]
[RecoverAmt=nn]
[RecoverUpdate=nn]
[RescratchFread=NO|YES]
[Size=xxx]
[TestCompressedData=TRUE|FALSE|CRYPT]
[TimeStamps=NO|YES]
[Trace=n]
[Vol=prefix]
[Warning=nn]
[WriteVerify=ON|OFF|CRC|DATA|HEADERS]
[WormWhichHdr1=FIRST|HDR1|ALL|HDR1]
[WormModeExpiration=ADDTOTOYDAY|ABSOLUTE]
```

**Description**

Use the **SET** command to set various options for the virtual tape devices. Any option set by the **SET** command is a temporary change, and the setting reverts to the configuration file or default value the next time Virtuent is started. To make permanent changes, make the changes in the VTE configuration file.
### Options
The following table provides the descriptions for the command options:

#### Table 22 Set command — option description

<table>
<thead>
<tr>
<th>Value</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>AMDD=[ON/OFF]</td>
<td>Turns on or off the Assisted Mainframe De-Duplication (AMDD) feature that modifies data written by the host for more efficient de-duplication. AMDD is on by default for all Data Domain storage, and has no effect on non-Data Domain storage. EMC recommends that the AMDD feature be left on, for improved de-duplication of data written by the host to a Data Domain. This is a global parameter and it affects all virtual devices on this VTE. Setting the AMDD feature on or off only affects writing of data; data previously written with AMDD can be read even if AMDD=OFF.</td>
</tr>
<tr>
<td>CRITICALSCRATCH=[YES</td>
<td>NO]</td>
</tr>
<tr>
<td>CRITICALPERCENT=nn</td>
<td>- CRITICALPERCENT is the percentage threshold at which the critical space behaviors are invoked. The default is 97%. Valid values are 0 through 100, inclusive.</td>
</tr>
<tr>
<td>CRITICALEFSMOVE=[YES</td>
<td>NO]</td>
</tr>
<tr>
<td>CRITICALRO=[YES</td>
<td>NO]</td>
</tr>
<tr>
<td>CRITICALLEOT=[YES</td>
<td>NO]</td>
</tr>
<tr>
<td>CRITICALLEOT=[YES</td>
<td>NO]</td>
</tr>
<tr>
<td>DDWRITEVERIFY=[ON</td>
<td>OFF</td>
</tr>
<tr>
<td></td>
<td>- CRC reads the data from the disk, checks the disk CRC, but doesn't decrypt or decompress the data. This is the default option when ON is selected.</td>
</tr>
<tr>
<td></td>
<td>- ON is synonymous with CRC. After writes, the data will be read back and checked against the CRC generated when it was written.</td>
</tr>
<tr>
<td></td>
<td>- OFF turns off all read-back verification of data written to the tape library. It is the default value.</td>
</tr>
<tr>
<td></td>
<td>- DATA configures the write verification feature to perform full verification of the data blocks. Full verification entails reading, checking the data against the CRC generated when it was written, decrypting, decompressing and checking the CRC of the block against the original CRC written by the host.</td>
</tr>
</tbody>
</table>
### Table 22 Set command — option description (continued)

<table>
<thead>
<tr>
<th>Value</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>HEADERS</strong></td>
<td>configures the write verification feature to only check the AWS headers of each block. When HEADERS is set, the full data blocks are not read or checked.</td>
</tr>
<tr>
<td>**DEVICE=[devname</td>
<td>ALL]**</td>
</tr>
<tr>
<td>**EFSMOVE=[SPACE</td>
<td>RANDOM</td>
</tr>
</tbody>
</table>
| **EFSMOVEFLR=OFF/ON** | Indicates whether a scratch volume in an FLR file system can be moved to another file system.  
The default is OFF: not allowing a tape to move from an FLR file system, regardless of the target file system type. If EFSMOVEFLR is set to ON, a scratch volume can move from an FLR file system to any other non-FLR file system of the same class. It will never move to an FLR file system, regardless of the setting. |
| **EFSMOVEDDRL=OFF/ON** | Indicates whether a scratch volume in a DDRL file system can be moved to another file system.  
The default is OFF: not allowing a tape to move from a DDRL file system, regardless of the target file system type. If EFSMOVEDDRL is set to ON, a scratch volume can move from a DDRL file system to any other non-DDRL file system of the same class. It will never move to a DDRL file system, regardless of the setting. |
| **EFSMOVEGR=OFF/ON** | Indicates if a GR-enabled device can move a scratch volume from a replicating file system to a non-replicating file system.  
The default is OFF: not allowing such a move. If EFSMOVEGR is set to ON, a GR device can move a scratch volume from a replicating file system into a non-replicating file system of the same class. |
| **ENCRYPTKEY=[n|KEYn|NONE]**  
**DEV=devicename** | Sets the encryption key for the specified device to the key number (1-9) or to no key (and thus no encryption).  
This option requires a specific DEVICE parameter, and the specified device must not have a tape mounted for the command to be accepted. ’n’ and ’KEYn’ are equivalent. |
| **ERASEMOVE=SPACE|COUNT|RANDOM|NEVER** | Indicates whether erased scratch files will be moved based on free space, scratch count, random or never. |
| **ERASEPOLICYTTL=[nnn|nnnH|nnnD|OFF]** | Sets the Erase Policy TTL value to OFF or sets the Erase Policy TTL to a value in days (default) or hours. For example, the SET ERASEPOLICYTTL=10D command results in setting the TTL ERASEPOLICY to 10 days. SET ERASEPOLICYTTL=OFF turns off TTL ERASEPOLICY. |
| **FILELISTREFRESHINTERVALDDREMOTE=[OFF|nnn|nnnM|nnnH]** | Sets the interval at which the file list for each remote Data Domain file system is refreshed. The default is OFF. You can set the value in minutes or hours. |

**Note**  
This parameter is only applicable to systems configured for GVL.
### Table 22 Set command — option description (continued)

<table>
<thead>
<tr>
<th>Value</th>
<th>Description</th>
</tr>
</thead>
</table>
| FILELISTREFRESHINTERVALVNXREMOTE = [OFF|nnn|nnnM|nnnH] | Sets the interval at which the file list for each remote VNX file system is refreshed. The default is OFF. You can set the value in minutes or hours.  
**Note**  
This parameter is only applicable to systems configured for GVL. |
<p>| FLRLOCKIFEXPIRED=YES|NO | Controls whether the tape is locked when unloading if the determined retention period is a past date (meaning the tape would already be expired). The default for this parameter is YES, which will set the retention period to the date specified. This will result in a past date and FLR will set permanent retention on the tape. If the value is NO, Virtuent will not lock the file. This parameter only affects the initial writing of the tape, not when extending (modifying). FLRLOCKIFEXPIRED=NO has an effect if HDR1 includes a past date. This is a global parameter; it affects all virtual devices on the VTE. |
| FSALLOCATION=[RR|SPACE] | Sets the method for choosing a file system for a scratch tape mount. The default is RR (Round Robin); Virtuent cycles to the least-frequently used eligible file system to fulfill a scratch tape mount request. RR is the recommended setting as it tends to allocate scratch tapes evenly from all the file systems over time. The SPACE setting instructs Virtuent to use the file system with the most available free space, and is not recommended as it will tend to allocate scratch tapes from a limited number of file systems rather than spreading them out more evenly. |
| GR=YES|NO|SYNC|RUN [DEVICE=devname] | Enables or disables the Guaranteed Replication or Replication on RUN for one or more devices. If no device is specified, the option is changed for every device. |
| GRREPORTINTERVAL=n | Specifies the frequency in seconds at which Virtuent checks if the Celerra report written by the Control Station in /opt/DLm/VNX-n/dlmconfig/ has been updated, and reloads the report if it has changed. Any positive number, including 0, is valid. The default is 15 seconds. |
| GRTIMEOUT=n | Sets the number of seconds that Virtuent will wait for a replication refresh to complete before sending an error to the host. Any positive number, including 0, is valid. Changing the GRTIMEOUT value will affect any replication refreshes that are already in progress. GRTIMEOUT is a global option, and cannot be set by individual device. |
| HWCOMP=[ON|OFF|FORCE] | Indicates whether the VTE will use the hardware compression adapter to perform data compression. By default, the VTE uses hardware data compression (HWCOMP=ON) if the compression hardware is present and the mainframe has requested IDRC. If you set HWCOMP=OFF, the VTE does not use the compression hardware to do data compression; it performs software compression when IDRC is requested by the mainframe. If you set HWCOMP=FORCE, Virtuent will always try hardware compression first and then drop to software compression if necessary. DLm only compresses data with a block size of 100 bytes or more. |
| HWDECOMP=[ON|OFF|FORCE] | Indicates whether the VTE will use the hardware compression adapter to perform data decompression. By default, the VTE uses hardware decompression (HWDECOMP=ON) whenever the compression hardware is present and decompression is required. If you set HWDECOMP=OFF, the VTE... |</p>
<table>
<thead>
<tr>
<th>Value</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>HWDECOMP=FORCE</td>
<td>Uses software decompression when decompression is needed. If you set HWDECOMP=FORCE, Virtuent will always try hardware decompression first and then try software decompression if necessary.</td>
</tr>
<tr>
<td>IDRC=[ON</td>
<td>OFF</td>
</tr>
<tr>
<td>KEYCLASS=[key_class</td>
<td>NONE]</td>
</tr>
<tr>
<td>LEOT=xxx</td>
<td>Sets the distance from Physical End of Tape (PEOT) at which Virtuent starts returning Logical End of Tape (LEOT) signals to the host. LEOT is a global value; all tape devices use the same value. LEOT can be specified in bytes (&quot;SIZE=1234500000&quot;) kilobytes (&quot;SIZE=1234500K&quot;), megabytes (&quot;SIZE=1234.5M&quot;), gigabytes (&quot;SIZE=1.2345G&quot;), or terabytes (&quot;SIZE=2T&quot;). Valid values are 0 (bytes) to 32T. The new size value takes effect immediately. The default value is 10M.</td>
</tr>
<tr>
<td>NONTRUNCATEWRITE=[YES</td>
<td>NO]</td>
</tr>
<tr>
<td>PATH=pathname[NOCHECK]</td>
<td>Sets the path for the virtual tape library for a specific device. This option requires a specific DEVICE specification. If a tape volume is not currently loaded on the drive, the new pathname specification takes effect immediately. Otherwise, the change takes effect immediately after the current volume is unloaded. The pathname is case-sensitive and must exactly match the disk directory name in DLm. Always specify the tape library base directory, that is, /tapelib, not a subdirectory of the tape library (such as /tapelib/BA). Virtuent checks the specified tape library and any subdirectories for logical errors, such as a tape VOLSER being in the wrong subdirectory, and if it finds any error, it leaves the path unchanged. If you absolutely must set the path to a directory which cannot pass validation, you can specify the NOCHECK parameter to accept the path even if it fails validation.</td>
</tr>
</tbody>
</table>
### Table 22 Set command — option description (continued)

<table>
<thead>
<tr>
<th>Value</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td><strong>SET PATH</strong> can also be used to assign a virtual device to a Fibre Channel tape drive to use the Direct Tape feature. To use SET PATH in this manner, specify the tape drive serial number. For example: <strong>SET PATH=DRIVE-nnnnnnnnnnn DEV=xxxx</strong> where <em>nnnnnnnnnnn</em> is the 12 digit tape drive serial number and <em>xxxx</em> is the name of the device that is being set to access the tape drive.</td>
</tr>
<tr>
<td>PROTECTVOL1=[ON</td>
<td>OFF]</td>
</tr>
<tr>
<td></td>
<td>• Data</td>
</tr>
<tr>
<td></td>
<td>• A tapemark after data has been written elsewhere on the tape during the same usage</td>
</tr>
<tr>
<td>Message DLm0921I will also be displayed each time, as a reminder that the feature can be turned off if required. This feature is ON by default.</td>
<td></td>
</tr>
<tr>
<td></td>
<td><strong>Note</strong></td>
</tr>
<tr>
<td></td>
<td><strong>ON</strong> does not protect the VOL1 label against intentional overwrites by utilities like IEHINITT.</td>
</tr>
<tr>
<td>QSPACETIMEOUT=nn</td>
<td>Sets the number of minutes that QUERY SPACE can run before it is automatically cancelled.</td>
</tr>
<tr>
<td>RDC256K=[ON</td>
<td>OFF]</td>
</tr>
<tr>
<td>RECOVER=nnn</td>
<td>Sets the percentage of disk space at which Virtuent starts to recover disk space by deleting the data from scratch volumes. Valid values are from 0 to 100.</td>
</tr>
<tr>
<td></td>
<td><strong>Note</strong></td>
</tr>
<tr>
<td></td>
<td>If the recovery percentage is set to 100, the Virtuent never automatically deletes scratch volume data to recover disk space.</td>
</tr>
<tr>
<td>RECOVERAMT=nn</td>
<td>Sets the maximum amount of space (in percentage of disk space) that Virtuent attempts to recover once the recovery threshold is reached. Valid values are from 1 to 100.</td>
</tr>
<tr>
<td>RECOVERUPDATE=nn</td>
<td>Sets a forced space recovery attempt to occur every nn hours when the amount of space used in a given tape library directory is above the RECOVER threshold, but hasn’t changed in percentage value since the last space recovery attempt ended. The valid range is 1 hour to 8760 hours (365 days). The default is 24 hours.</td>
</tr>
<tr>
<td>RESCRATCHIFREAD=[NO</td>
<td>YES]</td>
</tr>
</tbody>
</table>
### Table 22 Set command — option description (continued)

<table>
<thead>
<tr>
<th>Value</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>SIZE=xxx</strong></td>
<td>Sets the maximum volume size for virtual tape volumes. The valid range is 40M (40 megabytes) to 256G (256 gigabytes) for 3480 or 3490 tape devices and 40M (40 megabytes) to 32T (32 terabytes) for 3590 tape devices. The maximum allowable tape size for 3480 or 3490 tape devices is 256G. The maximum allowable tape size for 3590 tape devices is 32T but is limited to the amount of available storage in the file system. Since the maximum file system size in a DLm is 16 TiB, a tape volume cannot be more than 16 TiB. You can specify a single <code>DEVICE</code>, or <code>ALL</code> devices at the same time (the default). You can specify the size in bytes, kilobytes (K), megabytes (M), gigabytes (G), or terabytes (T). For example: &quot;SIZE=1500000&quot;, &quot;SIZE=500000K&quot;, &quot;SIZE=500M&quot;, &quot;SIZE=1.5G&quot;, &quot;SIZE=1T&quot;. The new size specification takes effect immediately. If a tape is being written at the time SIZE is changed and the position on the tape is already past the new SIZE value, Virtuent sends logical end-of-volume warnings on all subsequent write/write tapemark commands. Virtuent signals the physical end of the volume approximately LEOT bytes past the current position. Note: The <code>SIZE=</code> option is not allowed for SCSI tape devices.</td>
</tr>
<tr>
<td>**TESTCOMPRESSEDDATA=[ON</td>
<td>OFF</td>
</tr>
<tr>
<td>**TIMESTAMPS=[NO</td>
<td>YES]**</td>
</tr>
<tr>
<td><strong>TRACE=n</strong></td>
<td>Sets the trace level for a specific device if you specify a <code>DEVICE=devicename</code>. If <code>ALL</code> is specified, the trace level is set for all devices plus the general system trace at the same time. The default is <code>ALL</code> if no <code>DEVICE</code> is specified. This option affects only Virtuent traces.</td>
</tr>
<tr>
<td><strong>VOL=prefix</strong></td>
<td>Sets an additional filter for scratch volume selection for a given device. After meeting all other scratch selection criteria, the candidate VOLSER is checked against this VOL parameter and is used only if it matches this prefix.</td>
</tr>
</tbody>
</table>
**Table 22** Set command — option description (continued)

<table>
<thead>
<tr>
<th>Value</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>WARNING=nnn</td>
<td>Sets the percentage of disk space usage at which Virtuent begins to warn about usage. The valid range is 0 to 100.</td>
</tr>
<tr>
<td>WORMMODEXPIRATION=ADDTOTODAY</td>
<td>With the ADDTOTODAY (default) setting, when a modified FLR/DDRL tape is unloaded, the FLR/DDRL retention period of the extension and all previous file segments is pushed forward from the date of the modification by the same amount as the original first write. The new FLR/DDRL retention date is determined by first calculating the original retention period by subtracting the modify-date from last-access-date of the original file, VOLSER. After determining the original retention period in this manner, the retention period is added to the current modification time to derive the new FLR/DDRL retention period. The new file segment is set to read-only with this new retention period, and all existing file segments are changed to the same retention period by modifying their last-access date.</td>
</tr>
<tr>
<td></td>
<td>With the ABSOLUTE setting, when a modified FLR/DDRL tape is unloaded, the FLR/DDRL retention period of the extension and all previous file segments is set to whichever is higher of the following:</td>
</tr>
<tr>
<td></td>
<td>- The original retention period</td>
</tr>
<tr>
<td></td>
<td>- The HDR1 retention date used during the modification</td>
</tr>
<tr>
<td></td>
<td>The new file segment is set to the FLR/DDRL protected mode with this new retention period, and all existing file segments are changed to the same period by modifying their last-access date.</td>
</tr>
<tr>
<td></td>
<td>This is a global parameter and it affects all the virtual devices on the VTE.</td>
</tr>
<tr>
<td>WORMWHICHDR1=FIRSTHDR1</td>
<td>FIRSTHDR1 (default) uses the expiration date in the first HDR1 label on the tape when determining the retention period for the entire tape volume or the FLRRET/DDRLRET value if no expiration date is specified.</td>
</tr>
<tr>
<td></td>
<td>ALLHDR1 parses all HDR1 labels and uses the highest expiration date found in determining the retention period. A value of 'Permanent' will be considered the highest. When this option is enabled, FLRRET/DDRLRET is used only when setting the retention period during the initial writing of the tape. FLRRET/DDRLRET is not used when determining the retention period on extensions.</td>
</tr>
<tr>
<td></td>
<td>This is a global parameter and it affects all the virtual devices on the VTE.</td>
</tr>
<tr>
<td>WRITEVERIFY=[ON</td>
<td>OFF</td>
</tr>
<tr>
<td></td>
<td>- CRC reads the data from the disk, checks the disk CRC, but doesn't decrypt or decompress the data. This is the default option when ON is selected.</td>
</tr>
<tr>
<td></td>
<td>- ON is synonymous with CRC. After writes, the data will be read back and checked against the CRC generated when it was written.</td>
</tr>
<tr>
<td></td>
<td>- OFF turns off all read-back verification of data written to the tape library.</td>
</tr>
<tr>
<td></td>
<td>- DATA configures the write verification feature to perform full verification of the data blocks. Full verification entails reading, checking the data against the CRC generated when it was written, decrypting, decompressing and checking the CRC of the block against the original CRC written by the host.</td>
</tr>
</tbody>
</table>
Table 22 Set command — option description (continued)

<table>
<thead>
<tr>
<th>Value</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>l HEADERS</td>
<td>configures the write verification feature to only check the AWS headers if each block. When HEADERS is set, the full data blocks are not read or checked</td>
</tr>
</tbody>
</table>

Example

SET HWDECOMP=OFF
SET HWCOMP=OFF
SET ERASEPOLICYTTL=1D

SNMP

Syntax

SNMP [SHOW STATUS] [ACKNOWLEDGE FAILURE]

Description

Table 23 SNMP command — option description

<table>
<thead>
<tr>
<th>Value</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>SHOW STATUS</td>
<td>Shows the current SNMP settings</td>
</tr>
<tr>
<td>ACKNOWLEDGE FAILURE</td>
<td>Enables users to acknowledge that they are aware of the lost message(s). To acknowledge that you are aware of the lost messages, enter this command immediately after the error that indicated message loss. This command stops the periodic warnings generated as a result of the error.</td>
</tr>
</tbody>
</table>

STARTVT

Syntax

STARTVT

Description

This command starts Virtuent on the VTE.

This command is only valid when the VT Console window indicates that the VT status is Not Running.

Once the VT status is Running, tape devices on this VTE may be varied online on the mainframe.
STOPVT

Syntax

```plaintext
STOPVT [!]  
```

Description
This command stops Virtuent on the VTE.
This command is only valid when the VT Console window indicates that the VT status is Running.
This command causes all tape emulation to stop. To prevent input / output errors from occurring on the mainframe, all tape devices on this VTE should be varied offline before issuing the STOPVT command.

STOPVT does not cause emulation to stop if any tape device on the VTE is active. However, `STOPVT!` forces termination of all tape emulation regardless of the status of the tape devices. Stopping tape emulation results in I/O errors and job termination on the mainframe when tapes are actively being used when `STOPVT!` is issued.

Note
The `STOPVT` and `STOPVT!` commands work only when entered directly through the VT Console. They do not work when sent from the mainframe through the DLMHOST or when used with CP501.

UNLOAD

Syntax

```plaintext
UNLOAD [[DEVICE=]devicename]  
```

Description
Use the UNLOAD command to perform a manual unload of the specified virtual tape drive.

Entering the `UNLOAD` command for a virtual tape drive is equivalent to pressing the Unload button on a physical tape drive. Like a physical tape drive, the specified virtual tape drive must be in the Not Ready state in order for the `UNLOAD` command to be accepted as explained in `UNREADY`.

The `UNLOAD` command is executed immediately regardless of whether the host might currently be using the tape.
Unloading the tape results in an I/O error (Intervention Required) if the host tries to read from or write to the drive after it is unloaded. For this reason, use the `UNLOAD` command only in an emergency situation when a tape volume is known to not be in use by a host application, but needs to be unloaded immediately.

**Example**

```
UNLOAD DEVICE=9200
```

## UNQUIESCE

### Syntax

```
UNQUIESCE [[DEV=]devicename|ALL|*] [SCRATCH PATH=path] [TAPELIB PATH=path]
```

### Description

The `UNQUIESCE` command removes one or all of the virtual devices, or a tape library directory, or a scratch tape library directory from the quiesced state. After being unquiesced, drives once again accept mount requests. Pending load requests issued by the host while a drive was quiesced will be automatically retried and performed when the drive is unquiesced. Once unquiesced, the tape library directory becomes eligible for searches and mounting scratch volumes.

Unquiescing a drive does not send any signal to the host.

### Options

The following table provides the descriptions for the command options:

<table>
<thead>
<tr>
<th>Value</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>ALL or *</td>
<td>Unquiesces all drives at once</td>
</tr>
<tr>
<td>UNQUIESCE SCRATCH PATH=path</td>
<td>Unquiesces quiesced scratch tape library directories</td>
</tr>
<tr>
<td>UNQUIESCE TAPELIB PATH=path</td>
<td>Unquiesces quiesced tape library directories</td>
</tr>
</tbody>
</table>

**Example**

```
UNQUIESCE DEVICE=4000
UNQUIESCE TAPELIB PATH=/tapelib/FS1
```

## UNREADY

### Syntax

```
UNREADY [DEVICE=]devicename
```
Description
Use the UNREADY command to change a virtual drive from the Ready to the Not Ready (Intervention Required) state.

Using the UNREADY command for a virtual tape drive is equivalent to pressing the Not Ready button on a physical tape drive.

The UNREADY command is executed immediately regardless of whether the host might currently be using the tape.

Note
An I/O error (Intervention Required) occurs if the host tries to read from or write to the drive when it is not ready. For this reason, use the UNREADY command only in an emergency situation when no host application is using it.

Example
UNREADY DEVICE=9200

UNREADY CD05
This appendix provides the procedure for SMP/E installation. The topics include:

- Introduction to SMP/E Installation ................................................................. 206
- Loading DLMSxyz.XMITLIB to disk................................................................. 206
- Preparing DLMSxyz.XMITLIB(#EXTRACT)..................................................... 208
- Customizing the RIMLIB JCL ...........................................................................210
- Running the installation jobs ............................................................................212
- Performing a cleanup........................................................................................213
- Applying maintenance ......................................................................................213
- Authorizing DIm LINKLIB and Recycle DLMHOST ...........................................214
- Shutting down and restarting DLMHOST ........................................................214
Introduction to SMP/E Installation

DLm 3.4.1 and later supports SMP/E-based installation procedures for DLm Utilities and JCL for z/OS.

Note

In this chapter, x.y.z is used to denote the release number. For example, for DLm release 4.3.0, x.y.z refers to 4.3.0 and xyz refers to 430.

The DLm kit consists of a flattened file (DLMSxyz.XMITFILE) that contains a PDS of TSO TRANSMIT images of files, and the JCL needed to perform an SMP/E indirect-library installation on the product. The PDS is packaged as a TSO TRANSMIT file on a CD or in an open systems zip file, DLMSxyz.zip, for an electronic download from EMC's Online Support Downloads section. Also included on the CD, or within the zip file, is a ReadMe_DLMSxyz.txt text file which contains installation instructions.

The steps for installation are:

Procedure

1. Load DLMSxyz.XMITLIB to disk.
2. Prepare DLMSxyz.XMITLIB(#EXTRACT).
3. Customize the RIMLIB JCL
4. Run the installation jobs.
5. Perform cleanup.
6. Apply maintenance.
7. Shut down and restart DLMHOST.

Loading DLMSxyz.XMITLIB to disk

You can choose to load the software in one of two ways:

- Installing DLm from a CD
- Installing DLm from the online EMC Support web page

To install DLm from a CD:

Procedure

1. If you are installing DLm from a CD:
   a. Mount the CD on an open systems host. The host must have FTP installed.
   b. Allocate a working directory on the open system for the installation.
   c. Copy the contents of the CD to that working directory.
2. If you are installing DLm from the online EMC Support web page, perform the following steps:
   a. Log in to a privileged account on an open systems host (root on UNIX or administrator on Windows).
   b. Allocate a working directory on the open system for the installation.
   c. Log on to the EMC Support home page: https://support.emc.com.
d. Click on **Downloads**. In the **Type a Product Name** field, type **Disk Library for mainframe** immediately followed by the applicable DLM model (for example, "DLm8100") for which you are searching. Select the text that automatically displays for the appropriate DLM model and click the **Search** button.

e. Click on **DLm 4.5.x SMP/E z/OS base pkg (450)** to download. This zip file contains the installation kit and the installation instructions.

f. Download the installation kit into the working directory you selected above.

g. If your current host is a Windows system, unzip the file in the working directory. If your current host is a UNIX system, unzip and untar the file in the working directory.

h. Locate the **DLMSxyz.XMITFILE**. This file is in the TSO TRANSMIT format and contains a flattened copy of **DLMSxyz.XMITLIB**, a PDS that holds other TRANSMIT images, the JCL to extract them, and necessary SMP/E installation files.

i. On the target mainframe, allocate a file to which you can FTP the **DLMSxyz.XMITFILE**. Use the Data Set name prefix you intend to use for product installation. For example, if you intend to install the product with the recommended Data Set name prefix of **EMC.DLMSxyz**, name the file **EMC.DLMSxyz.XMITFILE**.

j. Allocate the Data Set with the following characteristics:

   - LRECL=80
   - BLKSIZE=3120 (This value is required)
   - DSORG=PS
   - SPACE=(CYL,(5,2)) (Assumes 3390 devices)
   - RECFM=FB

   **Note**
   The **SPACE** parameter here and elsewhere assumes that you are allocating the dataset on a 3390 device.

k. FTP the **DLMSxyz.XMITFILE** to the mainframe in binary format (as-is without translation or encoding).

   Your FTP session may look similar to:

   ```
   ftp> binary
   200 Representation type is Image
   ftp> put DLMS450.xmitfile 'emc.dlms450.xmitfile'
   200 Port request OK.
   125 Storing data set EMC.DLMS450.XMITFILE
   250 Transfer completed successfully.
   ftp: 1401360 bytes sent in 2.70Seconds 519.21Kbytes/sec.
   ftp>
   ```

   **Note**
   If you use another method, such as IND$FILE, ensure that you use the equivalent of the ftp binary format.
I. Use TSO RECEIVE to receive the file into a PDS. The PDS is created by the RECEIVE command and does not have to be pre-allocated. However, you must specify a Data Set name using the DA[set] parameter; otherwise the file is allocated using your TSO prefix (usually your logon id). Use the Data Set prefix that you intend to use for the product libraries.

For example:

```
Menu  List  Mode  Functions  Utilities  Help
-----------------------------------------------
ISPF Command Shell
Enter TSO or Workstation commands below:

====> receive INDA('EMC.DLMS450.XMITFILE')
```

Note
If you did not specify "DA(...)" as above, the Data Set would be allocated as user ID.XMITLIB.

**Preparing DLMSxyz.XMITLIB(#EXTRACT)**

Prepare DLMSxyz.XMITLIB(#EXTRACT) to extract ds-prefix.RIMLIB and the SMP/E indirect libraries by completing the following steps:
Procedure

1. Edit the #EXTRACT member of the newly RECEIVED library. You can edit the #EXTRACT job by running the SETUP REXX program in the XMITLIB Data Set. The SETUP REXX program prompts you for all of the information needed to edit the JOB. For example:

<table>
<thead>
<tr>
<th>Menu</th>
<th>Functions</th>
<th>Confirm</th>
<th>Utilities</th>
<th>Help</th>
</tr>
</thead>
<tbody>
<tr>
<td>DLIST</td>
<td>EMC.DLMS450.XMITLIB</td>
<td>Row 00001 of 00013</td>
<td>Scroll ==&gt; CSR</td>
<td></td>
</tr>
</tbody>
</table>

   **End**

In the above example, the received dataset is listed in an ISPF 3.4 member list, EX has been entered next to the SETUP member, and Enter is pressed.

The following is a sample of the SETUP Customization panel:

```
+---------------------- EMC JCL Customization Utility ----------------------+
| COMMAND ==> _____________________________________________________________ |
|                                                                           |
| Type EXEC on the command line and press ENTER to proceed, or PF3 to exit. |
|                                                                           |
| CLIST library         ==> 'EMC.DLMS450.XMITLIB'                           |
| Edit macro name       ==> XMIT                                            |
| XMITLIB dsname prefix ==> EMC.DLMS450                                     |
|                                                                           |
| Install-to disk volser==> ______       Disk unit name ==> SYSDA           |
|                                                                           |
| Enter your job card below ('%MEMBER%' will be replaced by member name):   |
| => //RGREEN7X JOB MSGCLASS=A,CLASS=A,MSGLEVEL=(1,1)                       |
+---------------------------------------------------------------------------+
```

2. Specify the job card and install-to VOLSER and change any defaults as required. Then press Enter to update the #EXTRACT member with the correct JCL customization.

3. If you wish to edit the #EXTRACT manually, make the following changes:
   a. Change the job card to one that conforms to your standards.
   b. Globally change ds-prefix to the Data Set prefix of this library (to be the Data Set prefix for the product libraries).
   c. Globally change DVOL to a disk VOLSER that can be used to hold the extracted libraries.
   d. Globally change DISK-UNIT to a site-appropriate unit name.
4. Submit #EXTRACT. All step completion codes must be 0, except for the DELETE step, which has a step completion code of 8, unless the job is a rerun. The #EXTRACT JOB creates all the data sets needed to do an SMP/E install.

**Customizing the RIMLIB JCL**

Continue the installation process by editing the JCL in the RIMLIB created by the #EXTRACT JOB.

**Table 25 RIMLIB File Contents**

<table>
<thead>
<tr>
<th>Contents</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>#U1ALLOC</td>
<td>Allocate product and SMP/E datasets (Upgrade install only)</td>
</tr>
<tr>
<td>#U4DDDEF</td>
<td>Adds required DDDEF and other required UCLIN to SMP/E CSI (Upgrade install only)</td>
</tr>
<tr>
<td>#01ALLOC</td>
<td>Allocate product and SMP/E datasets</td>
</tr>
<tr>
<td>#02DFZON</td>
<td>Defines SMP/E CSI cluster</td>
</tr>
<tr>
<td>#03REPRO</td>
<td>Initializes SMP/E CSI cluster with SYS1.SAMPLIB(GIMZPOOL)</td>
</tr>
<tr>
<td>#04DDDEF</td>
<td>Adds required DDDEF and other required UCLIN to SMP/E CSI</td>
</tr>
<tr>
<td>#05RECEV</td>
<td>Receives DLM V4.5.0 functions</td>
</tr>
<tr>
<td>#06APPLY</td>
<td>Applies DLM V4.5.0 functions</td>
</tr>
<tr>
<td>#07ACCP</td>
<td>Accepts DLM V4.5.0 functions</td>
</tr>
<tr>
<td>#08CLEAN</td>
<td>Removes unneeded DDDEF entries and deletes unneeded datasets.</td>
</tr>
<tr>
<td>#99MAINT</td>
<td>Boilerplate JCL to receive and apply maintenance</td>
</tr>
<tr>
<td>DLMJCL</td>
<td>Recommended optional JCL customization REXX exec.</td>
</tr>
<tr>
<td>DLMWIN1</td>
<td>ISPF panel definition used by DLMJCL exec.</td>
</tr>
<tr>
<td>SETUP</td>
<td>REXX program to run DLMJCL directly from the RIMLIB</td>
</tr>
</tbody>
</table>

The RIMLIB library (ds-prefix.RIMLIB) is a PDS containing JCL to install the product. After you have extracted the RIMLIB PDS, RIMLIB has the contents shown in the table above.

**Note**

The RIMLIB dataset also includes a $$README member with includes installation instructions.

**Note**

EMC strongly suggests that you use the DLMJCL utility, contained in the RIMLIB dataset to perform this task. However, if you prefer to do it manually, refer to the $$README member for manual editing instructions.

To customize the installation JCL using the DLMJCL utility with SETUP REXX:
Procedure

1. While in the EDIT or BROWSE member list, use the EX command on the SETUP member and press <Enter>. A panel similar to the following is displayed:

```
+---------------------- EMC JCL Customization Utility ----------------------+
| COMMAND ==> _____________________________________________________________ |
|                                                                           |
| Type EXEC on the command line and press ENTER to proceed, or PF3 to exit. |
|                                                                           |
| CLIST library         ==> 'EMC.DLM450.RIMLIB'                             |
| Edit macro name       ==> DLM                                             |
| Product dsname prefix ==> EMC.DLM450                                      |
| SMP/E dsname prefix   ==> EMC.SMPE                                        |
| SMP/E datasets volser ==> ______                                          |
| Install-to disk volser ==> ______       Disk unit name ==> SYSDA           |
|                                                                           |
| Enter your job card below ('%MEMBER%' will be replaced by member name):   |
| => //RGREEN7X JOB MSGCLASS=A,CLASS=A,MSGLEVEL=(1,1)                       |
|                                                                           |
| +---------------------------------------------------------------------------+
```

2. Customize the JCL:

   a. The **CLIST library** field is set by default to the name of the RIMLIB library. This field must contain the name of a library in which you want the edit macro created by this dialog to be stored. The default value is fine for most users and need not be changed.

   b. In the **Edit macro name** field, perform one of the following:

      - Accept the default name displayed.
      - If necessary, change the name of the edit macro.

      **Note**

      Normally, you should not have to change the name.

   c. In the **Product dsname prefix** field, enter the Data Set name prefix you want to use for the DLm target data sets. EMC suggests `EMC.fmid`.

   d. In the **SMP/E dsname prefix** field, enter the Data Set name prefix of the SMP/E data sets into which you installed Mainframe Enablers (EMCSCF).

   e. In the **SMP/E data sets volser** field, enter the six-character volume serial number of the disk volume on which you want to allocate the SMP/E distribution libraries for DLm.

      This volume may be the same as the volume you specify in the SMP/E dsname prefix field, or you may elect to keep these data sets on a separate volume.

   f. In the **Install-to disk volser** field, enter the six-character volume serial number of the disk volume to which you want to install the DLm libraries.

   g. In the **Disk unit name** field, you can specify an esoteric disk name that is appropriate to your site. SYSDA is the default, but you can overtype it with another esoteric disk name.

   h. Enter a site-appropriate job card.

      The job card is initially set to a value that may be suitable to many users. The first seven characters of the job name is set to your TSO user ID, plus X.

      You can set the job name to %MEMBER%. This causes the edit macro to set each job name equal to the JCL member name (that is, #01ALLOC, #02DDDEF, and so forth).
Note
Do not use any parameter that contains an ampersand (&), such as NOTIFY=&SYSUID. An ampersand in the job card can cause edit-macro errors.

3. Enter the following information in the EMC JCL Customization Utility panel to customize your installation:

```
+---------------------- EMC JCL Customization Utility ----------------------+
| COMMAND ==> _____________________________________________________________ |
| Type EXEC on the command line and press ENTER to proceed, or PF3 to exit. |
| CLIST library         ==> 'EMC.DLM450.RIMLIB'                             |
| Edit macro name       ==> DLM                                             |
| Product dsname prefix ==> EMC.DLM450                                      |
| SMP/E dsname prefix   ==> EMC.SMPE                                        |
| SMP/E datasets volser ==> DV0L01                                         |
| Install-to disk volser==> DV0L02       Disk unit name ==> SYSDA           |
| Enter your job card below ('%MEMBER%' will be replaced by member name): |
| => //RGREEN7X JOB MSGCLASS=A,CLASS=A,MSGLEVEL=(1,1)                       |
+---------------------------------------------------------------------------+
```

4. Type EXEC on the Command line and press Enter. You will see an output similar to the following:

```
BUILDING AN EDIT MACRO(DLM) IN 'EMC.DLMS450.RIMLIB'
Processing Member: #U1ALLOC
Processing Member: #U2DFZON
Processing Member: #U3REPRO
Processing Member: #U4DDDEF
Processing Member: #01ALLOC
Processing Member: #02DFZON
Processing Member: #03REPRO
Processing Member: #04DDDEF
Processing Member: #05RECEV
Processing Member: #06APPLY
Processing Member: #07ACCEPT
Processing Member: #08CLEAN
Processing Member: #99MAINT
***
```

Running the installation jobs

Carefully examine each job before you submit it to make sure that it was customized the way you intended. Submit the customized jobs in the following order, making sure that each job completes successfully before submitting the next one:

Procedure

1. Installing into a new SMP/E CSI:
   a. #01ALLOC
   b. #02DFZON
   c. #03REPRO
   d. #04DDDEF
   e. #05RECEV
Performing a cleanup

After you are satisfied that DLm is correctly installed and functioning properly, run the #08CLEAN job to delete data sets and DDDEFS used during the installation process that are no longer needed.

Applying maintenance

You must install any available maintenance for DLm before you start running. (If there is no current maintenance, keep these instructions for future maintenance downloads.) You can obtain the latest maintenance updates and current release or service notes (identical to release notes) from the Downloads section on the Support menu in the EMC Online Support website. Refer to the “Loading DLMSxyz.XMITLIB to disk” section using DLMSxyz for the search. Any and all maintenance that must be applied to this release will be in an item called DLMSxyz_Fixes.zip.

Note

If this file does not exist, there is no current maintenance to be applied.

This zip file contains the following:

- ReadMe_DLMSxyz_Fixes.txt: lists the fixes included in the release.
- Service_Notes_DLMSxyz.txt: updates the release notes with information discovered after initial product release.
- DLMSxyz_Fixes.zip: contains the two previous files, as well as a software patch file (DLMSxyzFix.bin), and a sample job (smpjob.txt) with instructions about how to apply the maintenance.

To download maintenance from EMC online support:

Procedure

1. Click Downloads, type DLMSxyz in the Search for Product text box, and press Enter.
2. Click the zip file, DLMSxyz Fixes.zip. Download the zip file to your home system, unpack the zip file, and follow the instructions it contains.

3. When you are finished reading or copying from EMC online support, return to the previous pages to view other products and services, or choose Logout from the menu bar at the top of any page.

**Authorizing DLm LINKLIB and Recycle DLMHOST**

The installed Linklib must be APF-Authorized. Add it to your existing authorized dataset list and/or enter a SETPROG z/OS Console command to mark it as authorized until the next IPL for your LPAR.

```
SETPROG APF,ADD,DSNAME=EMC.DLMSxyz.LINKLIB,SMS
```

**Shutting down and restarting DLMHOST**

After you install this release of DLm and performed the above authorization, you must recycle DLMHOST, (if it is currently running). Ensure that your DLMHOST JCL points to the installed LINKLIB.
APPENDIX C

AWSTAPE Information

This appendix provides information about AWSTAPE.

- AWSTAPE format ........................................................................................................... 216
**AWSTAPE format**

DLm stores virtual tape volumes on disk in the AWSTAPE format. The AWS format allows DLm to maintain an exact representation of a physical tape, including variable block sizes, tapemarks, labels, and so on.

Each AWSTAPE disk file emulates one physical tape volume.

Each emulated physical record in the emulated tape volume is represented by one or more pairs of block headers followed by data. An emulated tapemark is represented only by a block header.

The following figure illustrates an AWSTAPE disk file:

*Figure 47 AWSTAPE single disk file*

Mainframe data is usually in the EBCDIC format. However, if the mainframe application writes the data in ASCII mode, then the AWSTAPE data block will contain ASCII data. In general, DLm handles ASCII data in the same way it handles EBCDIC data or binary data. The host software can write and read the data in the desired format.
This appendix describes volume handling in DLm. Major topics are:

- Volume serial numbers .......................................................... 218
- Scratch volumes ................................................................. 218
- Mount volumes ...................................................................... 220
Volume serial numbers

DLm supports those VOLSERs that conform to the IBM standard VOLSER naming convention. IBM standard VOLSERs contain one to six alphanumeric EBCDIC characters of uppercase A through Z, 0 through 9, and hyphen. VOLSERs are left-justified and padded with spaces on the right.

The disk filename of a virtual tape volume matches the VOLSER converted from EBCDIC to ASCII and holds the virtual tape volume.

The virtual volume's disk filename is equivalent to a physical tape's external label. It is important for a physical tape's external label to always match the VOLSER recorded on the tape's VOL1 label to identify, store, and retrieve it, and it is vital that a virtual volume's disk filename matches the recorded VOLSER for the same reason.

As long as the host does not write a different VOLSER to the virtual volume, the disk filename and the VOLSER recorded in the volume remain the same.

Under some circumstances, the host writes a new VOL1 label containing a VOLSER different from the original that is associated with the mounted volume. This occurs when the host uses a program such as Ditto to perform a physical tape copy that copies the original volume's labels and also its data to the new tape.

Whenever the host writes a VOL1 label, Virtuent checks whether the VOLSER being written differs from the original VOLSER under which the volume was mounted. This maintains the association between a virtual volume's disk filename and the actual VOLSER recorded in the volume.

If the new VOLSER is different, Virtuent tries to rename the volume's disk filename to match the new VOLSER in the VOL1 label being written. If the new VOLSER does not already exist in the virtual tape library, Virtuent allows the VOL1 write and renames the disk file to the new VOLSER.

If the new disk filename (that is, the new VOLSER) already exists, Virtuent does not rename the mounted volume and does not allow writing of the new VOL1 label. This returns an error (Unit Check status with Command Reject sense) to the host's write command.

If the host changes a labeled volume to an unlabeled volume by writing over the standard labels with data or a tapemark, Virtuent accepts the change but does not change the volume's filename.

Scratch volumes

Virtual volumes in a tape library exist in one of the three states:

- **Active**
  
  Any volume that is not currently a scratch tape. A scratch volume becomes active whenever it is mounted in response to a request from the host (or by a manual mount), whether by explicit VOLSER or to fulfill a scratch tape request. Once a volume is active it is no longer a scratch tape, so you can mount it again only by explicitly requesting it by specific VOLSER, not by a scratch tape request.

  You can recognize an active volume by its filename, which is exactly the same as its VOLSER. Once a volume is active, it remains active in the virtual tape library until it is explicitly scratched by the host.

- **Scratched**
Volumes created by Virtuent `INITIALIZE` command and available to be mounted in response to a scratch tape request.

You can recognize a scratch volume by the fact that its filename is preceded by a tilde (~), for example, ~BT0040.

When the host requests a scratch volume, Virtuent selects the oldest scratch volume from the tape library directory that has the most free space, but only after any erased scratch volumes have been used. You can also mount a scratch volume by explicitly requesting it by `VOLSER`. In either case, whenever a scratch volume is mounted, it is changed to active status by renaming the file from ~VOLSER back to VOLSER (without the ~) and is no longer a scratch tape.

You can move volumes from active to scratched state by using the `DLMSCR` utility running on the host. The *EMC Disk Library for mainframe Command Processors and Utilities for z/OS Guide* provides more information on the `DLMSCR` utility. `DLMSCR` processes a host-generated scratch report and sends scratch volume requests over the channel to Virtuent. When Virtuent receives a request to scratch an active volume, the disk file for that volume is renamed from VOLSER to ~VOLSER. For example, scratching B00004 would rename the file to ~B00004. All of the data in the scratched volume is retained at this time, although it may be deleted ("erased") later if DLm needs the disk space.

- **Erased**

  A scratch volume that has had its data deleted to recover disk space. Scratched tapes retain their data as long as possible until Virtuent needs to reclaim disk space to write new data. When DLm starts running out of disk space, it selects the oldest scratched volume from the tape library and deletes its data. Virtuent will also erase scratched tapes when their "Time-To-Live" (TTL) value has been exceeded.

  When a scratch tape is "erased," all of the data in the volume past the standard header labels is deleted. Only the VOL1 and HDR labels are retained (these are retained as some host tape management systems verify the labels and previous dataset name (DSN) on a tape before allowing a previously scratched tape to be reused). The disk filename remains ~VOLSER.

  **Note**

  After a scratch volume has been erased, the data cannot be recovered.

  Virtuent selects an erased scratch tape in response to a scratch tape request from the host, before selecting an unerased scratch tape. As with any scratch tape, whenever an erased scratch volume is mounted, it is moved back to active status by renaming the file from ~VOLSER to VOLSER (without the ~).

**Delete (erase) scratch volume data**

When a virtual volume is scratched, the data in the volume remains intact for some period of time. This provides some time to unscratch a tape that was accidentally scratched.

Eventually, as the library fills up, space must be recovered from scratched tapes to write new data. By default, when the usage in any tape library directory within a tape library reaches 85 percent, Virtuent starts recovering the disk space from scratch volumes in that library. The oldest scratch volumes are moved to erased status and the data is deleted. Virtuent continues to erase scratched volumes until the disk usage drops below 85 percent (or the value specified by the `SET RECOVER` option) by an amount equal to five percent of the available disk space (or the percentage specified by the `SET RECOVERAMT` option).
If the recovery percentage is set to 100 percent, Virtuent never automatically erases data from scratch volumes to recover disk space.

In addition to the automatic space recovery based on disk usage described above, Virtuent will also erase tapes when they reach the optional, configurable “Time-to-Live” (TTL) time. The TTL time is interval starts from the time when a tape is scratched.

Virtuent never automatically moves an active tape to scratch status, nor does it ever erase data from an active tape.

**Mount volumes**

This section describes how to:

- Mount a specific volume by VOLSER
- Mount a scratch volume

---

**Note**

DLM supports a maximum of 275 concurrent NFS file system mounts at startup.

If you exceed this concurrent mounts threshold at startup, you might see errors during VTD start that indicate problems while attempting to verify all the tapelib directories.

If all of the VTEs have the same /etc/fstab (in exactly the same order), they may all fail to mount the same file systems. You will not have access to tapes in file systems that failed to mount to the VTEs.

**Mount a specific volume by VOLSER**

This section describes how VTEs handle requests to mount a specific volume by VOLSER, when:

- The requested VOLSER exists
- The requested VOLSER does not exist
- The volumes are write-protected

**Requested VOLSER exists**

When the host requests a specific VOLSER, the VTE receiving the Load Display command first searches for the requested VOLSER as an active volume in the tape library. If not found, the VTE searches for it as a scratch volume. If the VTE finds the specified VOLSER, it opens the file and positions the file at the beginning of the volume (load point). The virtual tape drive presents a Not-Ready-to-Ready interrupt to the host and enters the Ready state, ready for I/O from the host.

If the volume is a scratch volume, it is changed to active status by renaming the file VOLSER (without the ~) before it mounts it.

If the volume is a scratch volume and its data has been deleted (it is in the erased state), the volume is still mounted as requested. If the host attempts to read past the standard labels into the non-existent data, it receives an I/O error (Unit Check status, Tape Void sense).

**Requested VOLSER does not exist**

If the host requests a VOLSER that does not exist as either an active or scratched volume in the tape library assigned to this device, the virtual tape drive remains in a...
"mount-pending" state; the drive will continue to search for the specified tape either until it finds it, or until the host cancels the mount request.

**Write-protected volumes**

If a tape volume’s disk file can only be opened in Read-Only mode (for example, it resides on a read-only medium, in a directory with read-only access, or the file itself is read-only), the Write Protect bit is set on the virtual tape drive while this volume is mounted. You can only read the volume but you cannot write to it, in this situation. Any attempt to write (Write, Write Tapemark, or Erase) to the volume results in a Unit Check error being presented to the host.

**Mount a scratch volume**

This section describes how VTEs handle requests to mount a scratch volume. z/OS uses some character strings to indicate a request for a scratch tape to be mounted for output. These strings are called scratch synonyms. By default, Virtuent recognizes SCRTCH and PRIVAT as a request for a scratch tape and mounts an available scratch tape on the requested device to be used for output. Virtuent allows you to define your own scratch synonyms. Do not use the names "SCRTCH" or "PRIVAT" for the scratch synonyms you create.

**Unlabeled scratch request**

If the host requests an unlabeled scratch volume (determined by an N in the eighth position of the mount message), Virtuent displays an error message and ignores the mount request, and the virtual tape drive remains in the Not Ready state. This is because an unlabeled scratch tape cannot be subsequently tracked or retrieved as no permanent VOLSER is associated with the volume.

**Labeled scratch request**

If the host requests a scratch volume with standard labels (anything other than N in the eighth position of the Load Display Mount message), Virtuent checks any scratch synonym definitions that might exist to identify which file systems in the tape library are eligible to receive the new tape based on CLASS definition (if any). Virtuent checks those eligible file systems to determine which has the most free space. After identifying the file system, Virtuent searches that file system for a scratched, erased volume. If it finds a scratched, erased volume, it changes the volume status to active by renaming the file from ~VOLSER to VOLSER (without the ~).

Virtuent allows scratch volume allocations to be restricted to a specific range of tape volumes beginning with the prefixes defined in the VOL parameter. VOLSER prefix(es) set with VOL are honored during scratch mounts ONLY. The VOL prefixes filter is applied after all other class, space, age, label-type, penalty, and synonym filters have been applied.

---

**Note**

In an erased volume, no data follows the standard labels. Any attempt by the host to read past the labels results in an I/O error (Unit Check status with Data Check and Tape Void sense).

If Virtuent does not find a scratched, erased volume, it searches the selected file system for the oldest scratch volume. If it finds a scratch volume, it changes the volume status to active by renaming the file from ~VOLSER to VOLSER (without the ~). The existing data in the scratch volume is not erased before mounting the tape.
Virtuent allows you to select one of two methods for choosing a file system for a scratch tape mount:

- **Round Robin (RR):** Virtuent cycles to the least-frequently used eligible file system to fulfill a scratch tape mount request. RR is the recommended setting as it tends to allocate scratch tapes evenly from all the file systems over time.

- **Space:** The SPACE setting instructs Virtuent to use the file system with the most available free space.

  If DLm does not find a scratch volume on the tape library file system with the maximum free space, it searches the next eligible file system with the next most free space, and so on until it finds a scratch tape or until it has searched all file systems.

If DLm does not find a scratch volume to fulfill the mount request, it displays a message on the VT Console and enters a "mount-pending" state. The drive continues to search for the specified tape either until it finds it, or until the host cancels the mount request.

After Virtuent allocates a volume for the mount request, it opens the file and places it at the beginning of the volume (load point). The virtual tape drive presents a Not-Ready-to-Ready interrupt to the host and enters the Ready state, ready for I/O from the host.
This appendix describes load display data and load display messages. The topics include:

- **Load display messages** ................................................................. 224
- **Load display data** ................................................................. 226
Load display messages

IBM-compatible 3480/3490/3590E tape drives support a Load Display command (CCW Opcode x’9F’) that is used to display messages on the tape drive's LED display. The mainframe operating system or the tape management system typically sends these messages to request the operator to mount a specific volume.

Virtuent depends on the Load Display messages to determine when virtual tape volumes should be mounted on its virtual tape drives. When Virtuent sees a Load Display message that it interprets as a mount request of a specific VOLSER, it opens the volume's disk file and makes the drive ready for the host, that is, it acts like a tape has been mounted. If Virtuent determines that the Load Display is requesting a scratch volume, it identifies a suitable VOLSER and opens the volume's disk file. The drive comes ready to the host. Virtuent ignores any Load Display messages not determined to be a mount message.

Since the Load Display messages are intended to be human readable, they can possibly vary from mainframe system to system. Virtuent requires a specific Load Display message format to determine that the host is requesting a volume mount. Specifically, Virtuent has been designed to recognize the Load Display Mount messages issued by z/OS.

The format of the mount messages that Virtuent recognizes follows. “Format Control Byte” provides detailed information about the Load Display messages format.

Format Control Byte
Virtuent recognizes Function Select (bits 0–2) values of 000, 010, and 111 as potential mount messages.

Messages 0 and 1
If the Format Control Byte (FCB) Alternating Message bit (bit 3) is on, 0 is checked for a first mount message, then message 1.
If the FCB Alternating Message bit (bit 3) is off, the FCB Display Low/High Message bit (bit 5) is checked to determine which message (0 or 1) is to be checked for a mount message. If bit 5 is on, only message 0 is checked for a mount message. If bit 5 is off, only message 1 is checked for a mount message.

Virtuent recognizes a mount request by the Load Display message format.
If the Load Display message does not pass all the tests to determine a mount request, the message is simply ignored.

Load Display message formats
Virtuent recognizes a mount request by the Load Display message format.

The following formats are valid irrespective of the HOST type:

- 'M'+volser+label
  where volser is a 1 to 6-character VOLSER or a scratch synonym, left justified, with trailing spaces.

  **Note**

  This format invokes a scratch synonym search.

  Examples: "MAA1234S", "MPRIVATS", "MPRIVS"

- 'M'+volser+


where volser is a 1 to 6-character VOLSER or a scratch synonym, left justified, with trailing spaces.

---

**Note**

This format invokes a scratch synonym search.

Examples: "MAA1234", "MPRIVAT", "MPRIV"

- volser[+spaces]
  
  where volser is a 1 to 8-character scratch synonym starting in the first position, left justified, with trailing spaces.

---

**Note**

It must be a synonym. It cannot be an explicit VOLSER. This format invokes a scratch synonym search.

Examples: "POOLNAME", "APRIVT1", "SYN"

- 'M'+volser
  
  where volser is a 1 to 6-character VOLSER, left justified, with trailing spaces.

---

**Note**

Note the space between the 'M' and the VOLSER. This is an unusual format; Fujitsu and Hitachi are known to use this format for SL tapes, but it is recognized for all host types. This option DOES invoke scratch synonym search but only for devices defined as FUJITSU or HITACHI drives. It does NOT invoke scratch synonym search in any other case.

Examples: "M AA1234", "M RWVOL"

- 'M'+volser+s', 'M'+volser+a', 'M'+volser+n'
  
  These are equivalent to 'MvolserS', 'MvolserA', and 'MvolserN', respectively, except that the lower case label-type means mount read-only. Example: "MAA1234s".

---

**Note**

To avoid possible confusion, do NOT use MTL names in the following formats:

- M<6-characters VOLSER >S
- M<6-characters VOLSER>N
- M<6-characters VOLSER>A

The following are supported only for devices defined as HITACHI drives:

- 'M*'+volser
where `volser` is a 1 to 6-character VOLSER, left justified, with trailing spaces.

**Note**

This is an unusual request and does NOT invoke a scratch synonym search. Hitachi is known to use this format, only for NL tapes.

Example: "M*AA1234"

- 'M-`volser`
  
  where `volser` is a 1 to 6-character VOLSER, left justified, with trailing spaces.

**Note**

This is a JL label request and is handled just like the "M" request. This option DOES invoke a scratch synonym search.

Examples: "M-AA1234", "M-PRIVAT"

### Load display data

The table in this section provides information about load display.

**Table 26** Load display data

<table>
<thead>
<tr>
<th>Bits</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>Format Control Byte</td>
</tr>
<tr>
<td>1–8</td>
<td>Message 0</td>
</tr>
<tr>
<td>9–16</td>
<td>Message 1</td>
</tr>
</tbody>
</table>

**Format Control Byte**

The table in this section describes the FCB.

**Table 27** Format Control Byte

<table>
<thead>
<tr>
<th>Bits</th>
<th>Value</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>0–2</td>
<td></td>
<td><strong>Function select</strong></td>
</tr>
<tr>
<td></td>
<td>000</td>
<td>The message specified in bytes 1–8 and 9–16 is maintained until the tape drive next starts tape motion or the message is updated.</td>
</tr>
<tr>
<td></td>
<td>001</td>
<td>The message specified in bytes 1–8 is maintained until the tape cartridge is physically removed from the tape drive or the next unload or load cycle.</td>
</tr>
<tr>
<td></td>
<td>010</td>
<td>The message specified in bytes 1–8 is maintained until the drive is next loaded.</td>
</tr>
<tr>
<td></td>
<td>011</td>
<td>This value is used to physically access a drive without changing the message display. This option can be used to test whether a control unit can physically communicate with a drive.</td>
</tr>
<tr>
<td></td>
<td>100 to 110</td>
<td>Reserved.</td>
</tr>
</tbody>
</table>
|      | 111   | The message specified in bytes 1–8 and 9–16 is displayed. The message in bytes 1–8 is displayed until a tape cartridge is physically removed from the tape drive, or until the drive is next loaded. The message in bytes 9–16 is displayed until the drive is next loaded (not including the loading of the cleaning cartridge). If no cartridge
### Table 27 Format Control Byte (continued)

<table>
<thead>
<tr>
<th>Bits</th>
<th>Value</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>is present in the drive, the first message is ignored and only the second message is displayed until the drive is next loaded (not including the loading of the cleaning cartridge).</td>
</tr>
<tr>
<td>3</td>
<td></td>
<td><strong>Alternate messages</strong></td>
</tr>
<tr>
<td></td>
<td>0</td>
<td>The tape drive displays only the message that is specified in bit 5.</td>
</tr>
<tr>
<td></td>
<td>1</td>
<td>The tape drive displays both messages specified in bytes 1–8 and 9–6, respectively, alternating them on the message displays. The sequence repeats until the message is replaced on the display. When bit 3 is set to 1, bits 4 and 5 are ignored.</td>
</tr>
<tr>
<td>4</td>
<td></td>
<td><strong>Blink message</strong></td>
</tr>
<tr>
<td></td>
<td>0</td>
<td>The message specified by setting bit 5 does not blink.</td>
</tr>
<tr>
<td></td>
<td>1</td>
<td>The message specified by setting bit 5 blinks repeatedly. When bit 3 is set to 1, bit 4 is ignored.</td>
</tr>
<tr>
<td>5</td>
<td></td>
<td><strong>Display low/high message</strong></td>
</tr>
<tr>
<td></td>
<td>0</td>
<td>The message specified in bytes 1–8 is displayed. This bit is ignored if bit 3 is set to 1.</td>
</tr>
<tr>
<td></td>
<td>1</td>
<td>The message specified in bytes 9–16 is displayed. This bit is ignored if bit 3 is set to 1.</td>
</tr>
<tr>
<td>6</td>
<td>0</td>
<td><strong>Reserved</strong></td>
</tr>
<tr>
<td>7</td>
<td>0</td>
<td><strong>Index automatic load (reserved)</strong></td>
</tr>
</tbody>
</table>

### Sample Load Display messages

The following are some sample Load Display messages. The hex values are in EBCDIC:

- **48D4C2E3 F0F0F0F1 E2000000 00000000 00**
  - Interpretation:
    - Display message 0 (bytes 1–8) MBT0001S, blink, and retain until loaded. In other words, mount volume BT0001. Volume BT0001 is expected to be a standard labeled volume.
    - Virtuent would interpret this as a valid mount request for standard labeled volume BT0001.
- **28D9C2E3 F4F44040 40000000 00000000 00**
  - Interpretation:
    - Display message 0 (bytes 1–8) RBT44, blink it, and retain until the tape is removed from the drive. In other words, Remove volume BT44.
    - Virtuent would ignore this message because it is not a mount request.
- **F0D9C2E3 F0F0F2F2 40D4C2E3 F2F7F2F7 E2**
  - Interpretation:
    - Display in an alternating fashion message 0 (bytes 1–8) “RBT0022” and message 1 (bytes 9–16) MBT2727S. Stop displaying (or never display) message 0 when the tape is removed from the drive. Stop displaying (or never display) message 1 when the tape drive is next loaded. In other words, remove volume BT0022, then mount volume BT2727.
    - Virtuent would interpret this as a valid mount request for standard labeled volume BT2727.
Load Display Command — CCW Opcode x'9F'