Dynamic Multi-Pathing 8.0 Administrator's Guide - AIX

VERITAS™

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Chapter 1

Understanding DMP

This chapter includes the following topics:

About Dynamic Multi-Pathing (DMP)

Dynamic Multi-Pathing (DMP) provides multi-pathing functionality for the operating system native devices that are configured on the system. DMP creates DMP metadevices (also known as DMP nodes) to represent all the device paths to the same physical LUN.

DMP metadevices support the OS native logical volume manager (LVM). You can create LVM volumes and volume groups on DMP metadevices.

DMP supports the LVM volume devices that are used as the paging devices.

Veritas Volume Manager (VxVM) volumes and disk groups can co-exist with LVM volumes and volume groups. But, each device can only support one of the types. If a disk has a VxVM label, then the disk is not available to LVM. Similarly, if a disk is in use by LVM, then the disk is not available to VxVM.

How DMP works

Dynamic Multi-Pathing (DMP) provides greater availability, reliability, and performance by using the path failover feature and the load balancing feature. These features are available for multiported disk arrays from various vendors.

Disk arrays can be connected to host systems through multiple paths. To detect the various paths to a disk, DMP uses a mechanism that is specific to each supported array. DMP can also differentiate between different enclosures of a supported array that are connected to the same host system.

See “Discovering and configuring newly added disk devices” on page 149.

The multi-pathing policy that DMP uses depends on the characteristics of the disk array.

DMP supports the following standard array types:

Table 1-1

Array type	Description
Active/Active (A/A)	Allows several paths to be used concurrently for I/O. Such arrays allow DMP to provide greater I/O throughput by balancing the I/O load uniformly across the multiple paths to the LUNs. In the event that one path fails, DMP automatically routes I/O over the other available paths.
Asymmetric Active/Active (A/A-A)	A/A-A or Asymmetric Active/Active arrays can be accessed through secondary storage paths with little performance degradation. The behavior is similar to ALUA, except that it does not support the SCSI commands that an ALUA array supports.
Asymmetric Logical Unit Access (ALUA)	DMP supports all variants of ALUA.

Table 1-1 *(continued)*

Array type	Description
Active/Passive (A/P)	Allows access to its LUNs (logical units; real disks or virtual disks created using hardware) via the primary (active) path on a single controller (also known as an access port or a storage processor) during normal operation. In implicit failover mode (or autotrespass mode), an A/P array automatically fails over by scheduling I/O to the secondary (passive) path on a separate controller if the primary path fails. This passive port is not used for I/O until the active port fails. In A/P arrays, path failover can occur for a single LUN if I/O fails on the primary path. This array mode supports concurrent I/O and load balancing by having multiple primary paths into a controller. This functionality is provided by a controller with multiple ports, or by the insertion of a SAN switch between an array and a controller. Failover to the secondary (passive) path occurs only if all the active primary paths fail.
Active/Passive in explicit failover mode or non-autotrespass mode (A/PF)	The appropriate command must be issued to the array to make the LUNs fail over to the secondary path. This array mode supports concurrent I/O and load balancing by having multiple primary paths into a controller. This functionality is provided by a controller with multiple ports, or by the insertion of a SAN switch between an array and a controller. Failover to the secondary (passive) path occurs only if all the active primary paths fail.

Table 1-1 *(continued)*

Array type	Description
Active/Passive with LUN group failover (A/PG)	For Active/Passive arrays with LUN group failover (A/PG arrays), a group of LUNs that are connected through a controller is treated as a single failover entity. Unlike A/P arrays, failover occurs at the controller level, and not for individual LUNs. The primary controller and the secondary controller are each connected to a separate group of LUNs. If a single LUN in the primary controller's LUN group fails, all LUNs in that group fail over to the secondary controller. This array mode supports concurrent I/O and load balancing by having multiple primary paths into a controller. This functionality is provided by a controller with multiple ports, or by the insertion of a SAN switch between an array and a controller. Failover to the secondary (passive) path occurs only if all the active primary paths fail.

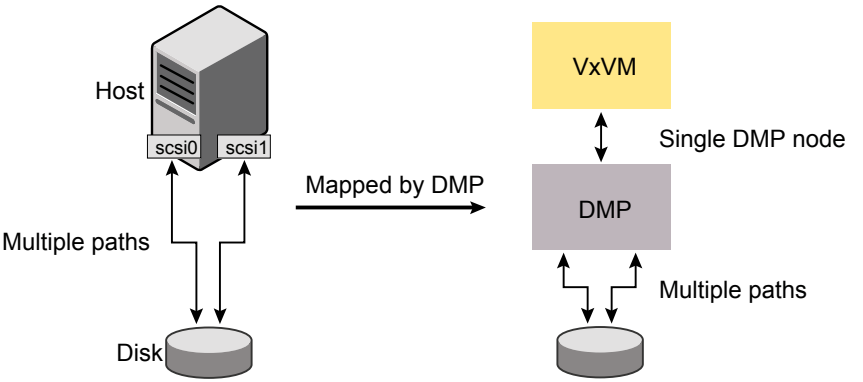
An array policy module (APM) may define array types to DMP in addition to the standard types for the arrays that it supports.

Dynamic Multi-Pathing uses DMP metanodes (DMP nodes) to access disk devices connected to the system. For each disk in a supported array, DMP maps one node to the set of paths that are connected to the disk. Additionally, DMP associates the appropriate multi-pathing policy for the disk array with the node.

For disks in an unsupported array, DMP maps a separate node to each path that is connected to a disk. The raw and block devices for the nodes are created in the directories `/dev/vx/rdmp` and `/dev/vx/dmp` respectively.

Figure 1-1 shows how DMP sets up a node for a disk in a supported disk array.

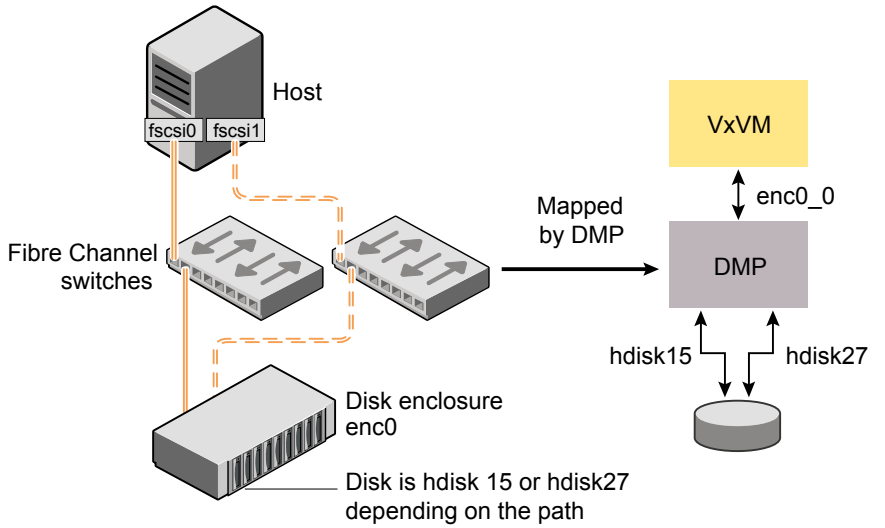
Figure 1-1 How DMP represents multiple physical paths to a disk as one node



DMP implements a disk device naming scheme that allows you to recognize to which array a disk belongs.

Figure 1-2 shows an example where two paths, `hdisk15` and `hdisk27`, exist to a single disk in the enclosure, but VxVM uses the single DMP node, `enc0_0`, to access it.

Figure 1-2 Example of multi-pathing for a disk enclosure in a SAN environment



See “About enclosure-based naming” on page 23.

See "Discovering and configuring newly added disk devices" on page 149.

How DMP monitors I/O on paths

In VxVM prior to release 5.0, DMP had one kernel daemon (`errord`) that performed error processing, and another (`restored`) that performed path restoration activities.

From release 5.0, DMP maintains a pool of kernel threads that are used to perform such tasks as error processing, path restoration, statistics collection, and SCSI request callbacks. The name `restored` has been retained for backward compatibility.

One kernel thread responds to I/O failures on a path by initiating a probe of the host bus adapter (HBA) that corresponds to the path. Another thread then takes the appropriate action according to the response from the HBA. The action taken can be to retry the I/O request on the path, or to fail the path and reschedule the I/O on an alternate path.

The restore kernel task is woken periodically (by default, every 5 minutes) to check the health of the paths, and to resume I/O on paths that have been restored. As some paths may suffer from intermittent failure, I/O is only resumed on a path if the path has remained healthy for a given period of time (by default, 5 minutes). DMP can be configured with different policies for checking the paths.

See "Configuring DMP path restoration policies" on page 145.

The statistics-gathering task records the start and end time of each I/O request, and the number of I/O failures and retries on each path. DMP can be configured to use this information to prevent the SCSI driver being flooded by I/O requests. This feature is known as I/O throttling.

If an I/O request relates to a mirrored volume, VxVM specifies the FAILFAST flag. In such cases, DMP does not retry failed I/O requests on the path, and instead marks the disks on that path as having failed.

See "Path failover mechanism" on page 15.

See "I/O throttling" on page 16.

Path failover mechanism

DMP enhances system availability when used with disk arrays having multiple paths. In the event of the loss of a path to a disk array, DMP automatically selects the next available path for I/O requests without intervention from the administrator.

DMP is also informed when a connection is repaired or restored, and when you add or remove devices after the system has been fully booted (provided that the operating system recognizes the devices correctly).

If required, the response of DMP to I/O failure on a path can be tuned for the paths to individual arrays. DMP can be configured to time out an I/O request either after a given period of time has elapsed without the request succeeding, or after a given number of retries on a path have failed.

See "Configuring the response to I/O failures" on page 140.

Subpaths Failover Group (SFG)

A subpaths failover group (SFG) represents a group of paths which could fail and restore together. When an I/O error is encountered on a path in an SFG, DMP does proactive path probing on the other paths of that SFG as well. This behavior adds greatly to the performance of path failover thus improving I/O performance. Currently the criteria followed by DMP to form the subpaths failover groups is to bundle the paths with the same endpoints from the host to the array into one logical storage failover group.

See "Configuring Subpaths Failover Groups (SFG)" on page 143.

Low Impact Path Probing (LIPP)

The restore daemon in DMP keeps probing the LUN paths periodically. This behavior helps DMP to keep the path states up-to-date even when no I/O occurs on a path. Low Impact Path Probing adds logic to the restore daemon to optimize the number of the probes performed while the path status is being updated by the restore daemon. This optimization is achieved with the help of the logical subpaths failover groups. With LIPP logic in place, DMP probes only a limited number of paths within a subpaths failover group (SFG), instead of probing all the paths in an SFG. Based on these probe results, DMP determines the states of all the paths in that SFG.

See "Configuring Low Impact Path Probing (LIPP)" on page 143.

I/O throttling

If I/O throttling is enabled, and the number of outstanding I/O requests builds up on a path that has become less responsive, DMP can be configured to prevent new I/O requests being sent on the path either when the number of outstanding I/O requests has reached a given value, or a given time has elapsed since the last successful I/O request on the path. While throttling is applied to a path, the new I/O requests on that path are scheduled on other available paths. The throttling is removed from the path if the HBA reports no error on the path, or if an outstanding I/O request on the path succeeds.

See "Configuring the I/O throttling mechanism" on page 142.

Load balancing

By default, DMP uses the Minimum Queue I/O policy for load balancing across paths for all array types. Load balancing maximizes I/O throughput by using the total bandwidth of all available paths. I/O is sent down the path that has the minimum outstanding I/Os.

For Active/Passive (A/P) disk arrays, I/O is sent down the primary paths. If all of the primary paths fail, I/O is switched over to the available secondary paths. As the continuous transfer of ownership of LUNs from one controller to another results in severe I/O slowdown, load balancing across primary and secondary paths is not performed for A/P disk arrays unless they support concurrent I/O.

For other arrays, load balancing is performed across all the currently active paths.

You can change the I/O policy for the paths to an enclosure or disk array. This operation is an online operation that does not impact the server or require any downtime.

Using DMP with LVM boot disks

The Logical Volume Manager (LVM) in AIX is incapable of switching between multiple paths that may exist to the boot disk. If the path that LVM selects becomes unavailable at boot time, the `root` file system is disabled, and the boot fails. DMP can be configured to overcome this problem by ensuring that an alternate path is available at boot time.

Support for LVM bootability over DMP is enabled by running the following command:

```
# /usr/sbin/vxdmpadm native enable vgname=rootvg
```

Individual DMP nodes or subpaths can be added or removed from the rootvg. The following command needs to be executed after adding or removing the DMP node or subpaths:

```
# /usr/sbin/vxdmpadm native enable vgname=rootvg
```

Support for LVM bootability over DMP is disabled by running the following command:

```
# /usr/sbin/vxdmpadm native disable vgname=rootvg
```

LVM bootability over DMP can be verified as being enabled on a system using the following command:

```
# /usr/sbin/vxdmpadm native list vgname=rootvg
```

See the `vxdmpadm`(1M) manual page.

Disabling MPIO

The Multiple Path I/O (MPIO) feature was introduced in AIX 5.2 to manage disks and LUNs with multiple paths. By default, MPIO is enabled on all disks and LUNs that have this capability, which prevents DMP or other third-party multi-pathing drivers (such as EMC PowerPath) from managing the paths to such devices.

To allow DMP or a third-party multi-pathing driver to manage multi-pathing instead of MPIO, you must install suitable Object Data Manager (ODM) definitions for the devices on the host. Without these ODM definitions, MPIO consolidates the paths, and DMP can only see a single path to a given device.

There are several reasons why you might want to configure DMP to manage multi-pathing instead of MPIO:

- Using DMP can enhance array performance if an ODM defines properties such as queue depth, queue type, and timeout for the devices.
- The I/O fencing features of the Storage Foundation HA or Storage Foundation Real Application Cluster software do not work with MPIO devices.
- The Device Discover Layer (DDL) component of DMP provides value-added services including extended attributes like RAID levels, thin provisioning attributes, hardware mirrors, snapshots, transport type, SFGs, array port IDs. These services are not available for MPIO-controlled devices.

Use the following procedure to configure DMP in place of MPIO.

To disable MPIO

1. Obtain the required ODM definitions.

   Contact the array vendor to obtain ODM definitions for the array type and the version of AIX on your system. The ODM definition should permit either DMP or the array vendor's multi-pathing driver to discover the devices in the supported array.

   Some array vendors do not distribute ODM pre-definitions for their arrays for AIX. In this case, you can use the devices as hdisk devices, as long as MPIO does not claim these LUNs.

2. Unmount any file systems and stop all applications such as databases that are configured on VxVM volumes.

3. Stop all I/O to the VxVM volumes by entering the following command for each disk group:

   ```
   # vxvol -g diskgroup stopall
   ```

4. Use the `vxprint` command to verify that no volumes remain open:

   ```
   # vxprint -Aht -e v_open
   ```

5. Deport each disk group in turn:

   ```
   # vxdg deport diskgroup
   ```

6. Use the following command to remove each `hdisk` device that MPIO has configured to the arrays:

   ```
   # rmdev -dl hdisk_device
   ```

   Alternatively, use the `smitty rmdev` command.

7. Use the `installp` command to install the replacement ODM filesets:

   ```
   # installp -agXd ODM_fileset ...
   ```

   Alternately, you can use the `smitty installp` command.

8. Reboot the system so that the new ODM definitions are used to perform device discovery.

9. Use the `vxdmpadm` command to check that DMP now has access to all the paths to the devices. The following command displays a list of HBA controllers that are configured on a system:

   ```
   # vxdmpadm listctlr all
   ```

   The next command displays information about all the paths that are connected to a particular HBA controller:

   ```
   # vxdmpadm getsubpaths ctlr=controller_name
   ```

   For example to display the paths that are connected to the `fscsi2` controller:

   ```
   # vxdmpadm getsubpaths ctlr=fscsi2
   ```

DMP in a clustered environment

In a clustered environment where Active/Passive (A/P) type disk arrays are shared by multiple hosts, all nodes in the cluster must access the disk through the same physical storage controller port. Accessing a disk through multiple paths simultaneously can severely degrade I/O performance (sometimes referred to as the ping-pong effect). Path failover on a single cluster node is also coordinated across the cluster so that all the nodes continue to share the same physical path.

Prior to release 4.1 of VxVM, the clustering and DMP features could not handle automatic failback in A/P arrays when a path was restored, and did not support failback for explicit failover mode arrays. Failback could only be implemented manually by running the `vxdctl enable` command on each cluster node after the path failure had been corrected. From release 4.1, failback is now an automatic cluster-wide operation that is coordinated by the master node. Automatic failback in explicit failover mode arrays is also handled by issuing the appropriate low-level command.

Note: Support for automatic failback of an A/P array requires that an appropriate Array Support Library (ASL) is installed on the system. An Array Policy Module (APM) may also be required.

See "About discovering disks and dynamically adding disk arrays" on page 151.

For Active/Active type disk arrays, any disk can be simultaneously accessed through all available physical paths to it. In a clustered environment, the nodes do not need to access a disk through the same physical path.

See "How to administer the Device Discovery Layer" on page 155.

See "Configuring Array Policy Modules" on page 147.

About enabling or disabling controllers with shared disk groups

Prior to release 5.0, Veritas Volume Manager (VxVM) did not allow enabling or disabling of paths or controllers connected to a disk that is part of a shared Veritas Volume Manager disk group. From VxVM 5.0 onward, such operations are supported on shared DMP nodes in a cluster.

Multi-controller ALUA support

Multi-controller ALUA support enables:

- ALUA arrays with multiple storage controllers. DMP already supported storage arrays conforming to the ALUA standard, but the support was based on the traditional dual storage controller model.
- User-friendly CLI outputs which displays ALUA Asymmetric Access State (AAS) instead of legacy PRIMARY or SECONDARY states in the PATH-TYPE[M] column. For ALUA arrays, the DMP management interface displays the following ALUA states like:
  - Active/Optimized

- Active/Non-optimized
- Standby
- Unavailable
- TransitionInProgress
- Offline

Note: The default value of the `dmp_display_alua_states` tunable is **on**. You can change the display mode to show legacy PRIMARY or SECONDARY path type by turning off the `dmp_display_alua_states` tunable.

Multiple paths to disk arrays

Some disk arrays provide multiple ports to access their disk devices. These ports, coupled with the host bus adaptor (HBA) controller and any data bus or I/O processor local to the array, make up multiple hardware paths to access the disk devices. Such disk arrays are called multipathed disk arrays. This type of disk array can be connected to host systems in many different configurations, (such as multiple ports connected to different controllers on a single host, chaining of the ports through a single controller on a host, or ports connected to different hosts simultaneously).

See “How DMP works” on page 11.

Device discovery

Device discovery is the term used to describe the process of discovering the disks that are attached to a host. This feature is important for DMP because it needs to support a growing number of disk arrays from a number of vendors. In conjunction with the ability to discover the devices attached to a host, the Device Discovery service enables you to add support for new disk arrays. The Device Discovery uses a facility called the Device Discovery Layer (DDL).

The DDL enables you to add support for new disk arrays without the need for a reboot.

This means that you can dynamically add a new disk array to a host, and run a command which scans the operating system’s device tree for all the attached disk devices, and reconfigures DMP with the new device database.

Disk devices

The device name (sometimes referred to as devname or disk access name) defines the name of a disk device as it is known to the operating system.

Such devices are usually, but not always, located in the `/dev` directory. Devices that are specific to hardware from certain vendors may use their own path name conventions.

Dynamic Multi-Pathing (DMP) uses the device name to create metadevices in the `/dev/vx/[r]dmp` directories. DMP uses the metadevices (or DMP nodes) to represent disks that can be accessed by one or more physical paths, perhaps via different controllers. The number of access paths that are available depends on whether the disk is a single disk, or is part of a multiported disk array that is connected to a system.

You can use the `vxdisk` utility to display the paths that are subsumed by a DMP metadevice, and to display the status of each path (for example, whether it is enabled or disabled).

See "How DMP works" on page 11.

Device names may also be remapped as enclosure-based names.

See "Disk device naming in DMP" on page 22.

Disk device naming in DMP

Device names for disks are assigned according to the naming scheme which you specify to DMP. The format of the device name may vary for different categories of disks.

See "Disk categories" on page 152.

Device names can use one of the following naming schemes:

- operating system-based naming.
  See "About operating system-based naming" on page 23.
- enclosure-based naming.
  See "About enclosure-based naming" on page 23.

Devices with device names longer than 31 characters always use enclosure-based names.

By default, DMP uses enclosure-based naming. You can change the disk device naming scheme if required.

See "Changing the disk device naming scheme" on page 167.

About operating system-based naming

In the OS-based naming scheme, all disk devices are named using the `hdisk#` format, where # is a series number.

DMP assigns the name of the DMP meta-device (disk access name) from the multiple paths to the disk. DMP sorts the names by hdisk number, and selects the smallest number. For example, hdisk1 rather than hdisk2.This behavior make it easier to correlate devices with the underlying storage.

If a CVM cluster is symmetric, each node in the cluster accesses the same set of disks. This naming scheme makes the naming consistent across nodes in a symmetric cluster.

By default, OS-based names are not persistent, and are regenerated if the system configuration changes the device name as recognized by the operating system. If you do not want the OS-based names to change after reboot, set the persistence attribute for the naming scheme.

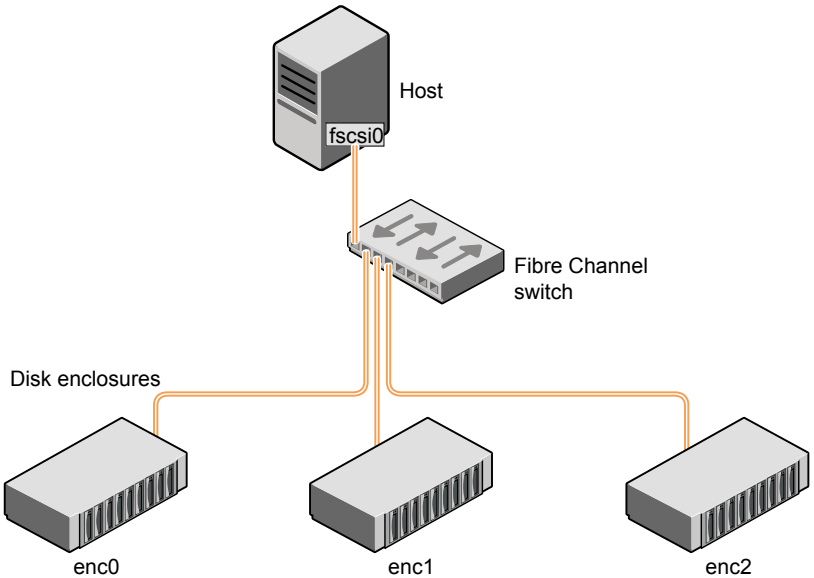
See “Changing the disk device naming scheme” on page 167.

About enclosure-based naming

In a Storage Area Network (SAN) that uses Fibre Channel switches, information about disk location provided by the operating system may not correctly indicate the physical location of the disks. Enclosure-based naming allows DMP to access enclosures as separate physical entities. By configuring redundant copies of your data on separate enclosures, you can safeguard against failure of one or more enclosures.

Figure 1-3 shows a typical SAN environment where host controllers are connected to multiple enclosures through a Fibre Channel switch.

Figure 1-3 Example configuration for disk enclosures connected through a Fibre Channel switch



In such a configuration, enclosure-based naming can be used to refer to each disk within an enclosure. For example, the device names for the disks in enclosure `enc0` are named `enc0_0`, `enc0_1`, and so on. The main benefit of this scheme is that it lets you quickly determine where a disk is physically located in a large SAN configuration.

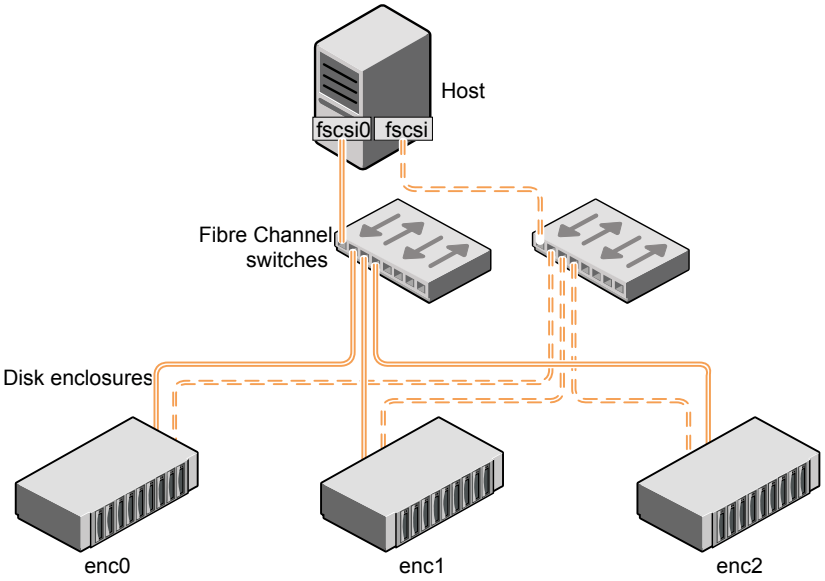
In most disk arrays, you can use hardware-based storage management to represent several physical disks as one LUN to the operating system. In such cases, VxVM also sees a single logical disk device rather than its component disks. For this reason, when reference is made to a disk within an enclosure, this disk may be either a physical disk or a LUN.

Another important benefit of enclosure-based naming is that it enables VxVM to avoid placing redundant copies of data in the same enclosure. This is a good thing to avoid as each enclosure can be considered to be a separate fault domain. For example, if a mirrored volume were configured only on the disks in enclosure `enc1`, the failure of the cable between the switch and the enclosure would make the entire volume unavailable.

If required, you can replace the default name that DMP assigns to an enclosure with one that is more meaningful to your configuration.

Figure 1-4 shows a High Availability (HA) configuration where redundant-loop access to storage is implemented by connecting independent controllers on the host to separate switches with independent paths to the enclosures.

Figure 1-4 Example HA configuration using multiple switches to provide redundant loop access



Such a configuration protects against the failure of one of the host controllers (`fscsi0` and `fscsi1`), or of the cable between the host and one of the switches. In this example, each disk is known by the same name to VxVM for all of the paths over which it can be accessed. For example, the disk device `enc0_0` represents a single disk for which two different paths are known to the operating system, such as `hdisk15` and `hdisk27`.

See "Disk device naming in DMP" on page 22.

See "Changing the disk device naming scheme" on page 167.

To take account of fault domains when configuring data redundancy, you can control how mirrored volumes are laid out across enclosures.

Summary of enclosure-based naming

By default, DMP uses enclosure-based naming.

Enclosure-based naming operates as follows:

- All fabric or non-fabric disks in supported disk arrays are named using the *enclosure_name_#* format. For example, disks in the supported disk array, enggdept are named enggdept_0, enggdept_1, enggdept_2 and so on.
  You can use the vxdmpadm command to administer enclosure names.
  See the vxdmpadm(1M) manual page.
- Disks in the DISKS category (JBOD disks) are named using the Disk_# format.
- Devices in the OTHER_DISKS category are disks that are not multipathed by DMP. Devices in this category have names of the form hdisk#, which are the same as the device names generated by AIX.

By default, enclosure-based names are persistent, so they do not change after a reboot.

If a CVM cluster is symmetric, each node in the cluster accesses the same set of disks. Enclosure-based names provide a consistent naming system so that the device names are the same on each node.

To display the native OS device names of a DMP disk (such as mydg01), use the following command:

```
# vxdisk path | grep diskname
```

See "Disk categories" on page 152.

See "Enclosure based naming with the Array Volume Identifier (AVID) attribute" on page 26.

Enclosure based naming with the Array Volume Identifier (AVID) attribute

By default, Dynamic Multi-Pathing (DMP) assigns enclosure-based names to DMP metadevices using an array-specific attribute called the Array Volume ID (AVID). The AVID provides a unique identifier for the LUN that is provided by the array. The ASL corresponding to the array provides the AVID property. Within an array enclosure, DMP uses the Array Volume Identifier (AVID) as an index in the DMP metanode name. The DMP metanode name is in the format *enclosureID_AVID*.

With the introduction of AVID to the enclosure-based naming (EBN) naming scheme, identifying storage devices becomes much easier. The array volume identifier (AVID) enables you to have consistent device naming across multiple nodes connected to the same storage. The disk access name never changes, because it is based on the name defined by the array itself.

Note: DMP does not support AVID with third party drivers.

If DMP does not have access to a device's AVID, it retrieves another unique LUN identifier called the LUN serial number. DMP sorts the devices based on the LUN Serial Number (LSN), and then assigns the index number. All hosts see the same set of devices, so all hosts will have the same sorted list, leading to consistent device indices across the cluster. In this case, the DMP metanode name is in the format *enclosureID_index*.

DMP also supports a scalable framework, that allows you to fully customize the device names on a host by applying a device naming file that associates custom names with cabinet and LUN serial numbers.

If a Cluster Volume Manager (CVM) cluster is symmetric, each node in the cluster accesses the same set of disks. Enclosure-based names provide a consistent naming system so that the device names are the same on each node.

The Dynamic Multi-Pathing (DMP) utilities such as `vxdisk list` display the DMP metanode name, which includes the AVID property. Use the AVID to correlate the DMP metanode name to the LUN displayed in the array management interface (GUI or CLI) .

For example, on an EMC CX array where the enclosure is emc_clariion0 and the array volume ID provided by the ASL is 91, the DMP metanode name is emc_clariion0_91. The following sample output shows the DMP metanode names:

```
$ vxdisk list
emc_clariion0_91  auto:cdsdisk  emc_clariion0_91   dg1  online shared
emc_clariion0_92  auto:cdsdisk  emc_clariion0_92   dg1  online shared
emc_clariion0_93  auto:cdsdisk  emc_clariion0_93   dg1  online shared
emc_clariion0_282 auto:cdsdisk  emc_clariion0_282  dg1  online shared
emc_clariion0_283 auto:cdsdisk  emc_clariion0_283  dg1  online shared
emc_clariion0_284 auto:cdsdisk  emc_clariion0_284  dg1  online shared

# vxddladm get namingscheme
NAMING_SCHEME       PERSISTENCE    LOWERCASE      USE_AVID
============================================================
Enclosure Based     Yes            Yes            Yes
```

Chapter 2

Setting up DMP to manage native devices

This chapter includes the following topics:

About setting up DMP to manage native devices

You can use DMP instead of third-party drivers for advanced storage management. This section describes how to set up DMP to manage native LVM devices and any logical volume that operates on those devices.

After you install DMP, set up DMP for use with LVM. To set up DMP for use with LVM, turn on the dmp_native_support tunable. When this tunable is turned on, DMP enables support for LVM on any device that does not have a VxVM label and is not

in control of any third party multi-pathing (TPD) software. In addition, turning on the dmp_native_support tunable migrates any LVM volume groups that are not in use onto DMP devices.

The dmp_native_support tunable enables DMP support for LVM, as follows:

LVM volume groups	If the LVM volume groups are not in use, turning on native support migrates the volume groups to DMP devices. If the LVM volume groups are in use, then perform the steps to turn off the volume groups and migrate the volume groups to DMP.
Veritas Volume Manager (VxVM) devices	Native support is not enabled for any device that has a VxVM label. To make the device available for LVM, remove the VxVM label. VxVM devices can coexist with native devices under DMP control.
Devices that are multi-pathed with Third-party drivers (TPD)	If a disk is already multi-pathed with a third-party driver (TPD), DMP does not manage the devices unless you remove TPD support. After removing TPD support, turn on the `dmp_native_support` tunable to migrate the devices. If LVM volume groups are constructed over TPD devices, then perform the steps to migrate the LVM volume groups onto DMP devices. See "Migrating LVM volume groups to DMP" on page 30.

To turn on the dmp_native_support tunable, use the following command:

```
# vxdmpadm settune dmp_native_support=on
```

The first time this operation is performed, the command reports if a volume group is in use, and does not migrate that volume group. To migrate the volume group onto DMP, stop the volume group. Then execute the `vxdmpadm settune` command again to migrate the volume group onto DMP.

To verify the value of the dmp_native_support tunable, use the following command:

```
# vxdmpadm gettune dmp_native_support
Tunable                     Current Value   Default Value
--------------------------  -------------   ---------------
dmp_native_support          on              off
```

Displaying the native multi-pathing configuration

When DMP is enabled for native devices, the dmp_native_support tunable is set to ON. When the tunable is ON, all DMP disks are available for native volumes except:

- Devices that have a VxVM label
  If you initialize a disk for VxVM use, then the native multi-pathing feature is automatically disabled for the disk.
  You can use the disks for native multi-pathing if you remove them from VxVM use.
- Devices that are multi-pathed with Third-party drivers
  If a disk is already multi-pathed with a third-party driver (TPD), DMP does not manage the devices unless TPD support is removed.

To display whether DMP is enabled

1 Display the attribute `dmp_native_support`.

```
# vxdmpadm gettune dmp_native_support

Tunable                Current Value  Default Value
------------------     -------------  -------------
dmp_native_support     on              off
```

2 When the `dmp_native_support` tunable is ON, use the `vxdisk list` command to display available disks. Disks available to LVM display with the TYPE auto:none. Disks that are already in use by LVM display with the TYPE auto:LVM.

Migrating LVM volume groups to DMP

You can use DMP instead of third-party drivers for advanced storage management. This section describes how to set up DMP to manage LVM volume groups and the file systems operating on them.

To set up DMP, migrate the devices from the existing third-party device drivers to DMP.

Table 2-1 shows the supported native solutions and migration paths.

Table 2-1 Supported migration paths

Operating system	Native solution	Migration procedure
AIX	EMC PowerPath	See "Migrating to DMP from EMC PowerPath" on page 31.
AIX	Hitachi Data Link Manager (HDLM)	See "Migrating to DMP from Hitachi Data Link Manager (HDLM)" on page 32.
AIX	IBM Multipath IO (MPIO)	See "Migrating to DMP from IBM Multipath IO (MPIO) or MPIO path control module (PCM)" on page 33.

Migrating to DMP from EMC PowerPath

This procedure describes removing devices from EMC PowerPath control and enabling DMP on the devices.

Make sure that all paths belonging to the migrating PowerPath devices are in healthy state during the migration.

Plan for application downtime for the following procedure.

To remove devices from EMC PowerPath control and enable DMP

1. Stop the applications that use the PowerPath meta-devices.

   In a VCS environment, stop the VCS service group of the application, which will stop the application.

2. Unmount any file systems that use the volume group on the PowerPath device.

3. Stop the LVM volume groups that use the PowerPath device.

   ```
   # varyoffvg vgroupname
   ```

4. If the root volume group (rootvg) is under PowerPath control, migrate the rootvg to DMP.

   See "Migrating a SAN root disk from EMC PowerPath to DMP control" on page 83.

5. Remove the disk access names for the PowerPath devices from VxVM.

   ```
   # vxdisk rm emcpowerXXXX
   ```

   Where *emcpowerXXXX* is the name of the EMC PowerPath device.

6 Take the device out of PowerPath control:

```
# powermt unmanage dev=pp_device_name
or
# powermt unmanage class=array_class
```

7 Verify that the PowerPath device has been removed from PowerPath control.

```
# powermt display dev=all
```

8 Run a device scan to bring the devices under DMP control:

```
# vxdisk scandisks
```

9 Turn on the DMP support for the LVM volume group.

```
# vxdmpadm settune dmp_native_support=on
```

The above command also enables DMP support for LVM root.

10 Mount the file systems.

11 Restart the applications.

Migrating to DMP from Hitachi Data Link Manager (HDLM)

This procedure describes removing devices from HDLM control and enabling DMP on the devices.

Note: DMP cannot co-exist with HDLM; HDLM must be removed from the system.

Plan for application and system downtime for the following procedure.

To remove devices from Hitachi Data Link Manager (HDLM) and enable DMP

1 Stop the applications using the HDLM meta-device

2 Unmount any file systems that use the volume group on the HDLM device.

In a VCS environment, stop the VCS service group of the application, which will stop the application.

3 Stop the LVM volume groups that use the HDLM device.

```
# varyoffvg vgroupname
```

4 Uninstall the HDLM package.

5 Turn on the DMP support for the LVM volume group.

```
# vxdmpadm settune dmp_native_support=on
```

The above command also enables DMP support for LVM root.

6 Reboot the system.

7 After the reboot, DMP controls the devices. If there were any LVM volume groups on HDLM devices they are migrated onto DMP devices.

8 Mount the file systems.

9 Restart the applications.

Migrating to DMP from IBM Multipath IO (MPIO) or MPIO path control module (PCM)

This procedure describes how to migrate to DMP from IBM Multipath IO (MPIO) or an MPIO path control module (PCM). The procedure includes removing the devices from MPIO control and enabling DMP on the devices.

If an MPIO PCM is installed, you need to remove the PCM before you install the ODM packages from the vendor.

Plan for system downtime for the following procedure.

The migration steps involve system downtime on a host due to the following:

- Need to stop applications
- Need to stop the VCS services if using VCS
- The procedure involves one or more host reboots

To take the devices out of MPIO control and enable DMP

1 Obtain the corresponding MPIO-suppression Object Data Manager (ODM) fileset for the array from the array vendor.

If the MPIO suppression ODM fileset is not available, use the `vxmpio` utility to remove the device from MPIO.

2 Stop the applications that use the MPIO devices.

3 Unmount the file systems on the MPIO devices.

4 Vary off the LVM volume groups.

```
# varyoffvg vgroupname
```

5 If an MPIO PCM is present, remove all VxVM devices that the PCM controls.

```
# vxdisk rm dmpnodename
```

6 If the MPIO PCM does not control the `rootvg` devices, then uninstall the PCM.

If a PCM controls the `rootvg` devices, then you must obtain the script from the PCM vendor to uninstall the PCM. For example, if the Subsystem Device Driver Path Control Module (SDDPCM) controls the devices, then contact IBM to obtain the script to remove SDDPCM.

7 Install the MPIO-suppression ODM fileset that you obtained from the array vendor in step 1. Refer to the array vendor documentation for the installation procedure.

Some array vendors do not distribute ODM Pre-defines for their arrays for AIX. In this case, you can use the devices as hdisk devices, as long as MPIO does not claim these LUNs.

8 Turn on the DMP support for the LVM volume groups.

```
# vxdmpadm settune dmp_native_support=on
```

The above command also enables DMP support for LVM root.

9 Reboot the system.

10 After the reboot, DMP controls the devices. Any LVM volume groups on MPIO devices are migrated onto DMP devices.

11 Mount the file systems.

12 Restart the applications.

Using Dynamic Multi-Pathing (DMP) devices with Oracle Automatic Storage Management (ASM)

DMP supports using DMP devices with Oracle Automatic Storage Management (ASM). DMP supports the following operations:

- See “Enabling Dynamic Multi-Pathing (DMP) devices for use with Oracle Automatic Storage Management (ASM)” on page 35.
- See “Removing Dynamic Multi-Pathing (DMP) devices from the listing of Oracle Automatic Storage Management (ASM) disks” on page 36.
- See “Migrating Oracle Automatic Storage Management (ASM) disk groups on operating system devices to Dynamic Multi-Pathing (DMP) devices” on page 36.

Enabling Dynamic Multi-Pathing (DMP) devices for use with Oracle Automatic Storage Management (ASM)

Enable DMP support for Oracle Automatic Storage Management (ASM) to make DMP devices visible to ASM as available disks. DMP support for ASM is available for char devices (`/dev/vx/rdmp/*`).

To make DMP devices visible to ASM

1. From ASM, make sure ASM_DISKSTRING is set to the correct value:

   ```
   /dev/vx/rdmp/*
   ```

   For example:

   ```
   SQL> show parameter ASM_DISKSTRING;
   NAME                 TYPE        VALUE
   -------------------- ----------- ---------------
   asm_diskstring       string      /dev/vx/rdmp/*
   ```

2. As root user, enable DMP devices for use with ASM.

   ```
   # vxdmpraw enable username groupname mode [devicename ...]
   ```

   where *username* represents the ASM user running the ASM instance, *groupname* represents the UNIX/Linux groupname of the specified user-id, and *mode* represents the permissions to set on the device. If you specify one or more *devicenames*, DMP support for ASM is enabled for those devices. If you do not specify a *devicename*, DMP support is enabled for all devices in the system that have an ASM signature.

   For example:

   ```
   # vxdmpraw enable oracle dba 765 eva4k6k0_1
   ```

   ASM support is enabled. The access permissions for the DMP device are set to the permissions specified by *mode*. The changes are persistent across reboots.

3 From ASM, confirm that ASM can see these new devices.

```
SQL> select name,path,header_status from v$asm_disk;

NAME  PATH                       HEADER_STATUS
-----------------------------------------------
...   .......                    ....
      /dev/vx/rdmp/eva4k6k0_1    CANDIDATE
...   .......                    ....
```

4 From ASM, increase the Oracle heartbeat wait time from the default value of 15 seconds. To prevent the Oracle application from marking the disk as offline during the DMP failover, increase the default value for `_asm_hbeatiowait`.

- For example, to set the value to 360 seconds:

```
SQL> alter system set "_asm_hbeatiowait"=360 scope=spfile sid='*';
```

- Restart the ASM instance for the new parameter to take effect.

Removing Dynamic Multi-Pathing (DMP) devices from the listing of Oracle Automatic Storage Management (ASM) disks

To remove DMP devices from the listing of ASM disks, disable DMP support for ASM from the device. You cannot remove DMP support for ASM from a device that is in an ASM disk group.

To remove the DMP device from the listing of ASM disks

1 If the device is part of any ASM disk group, remove the device from the ASM disk group.

2 As root user, disable DMP devices for use with ASM.

```
# vxdmpraw disable diskname
```

For example:

```
# vxdmpraw disable eva4k6k0_1
```

Migrating Oracle Automatic Storage Management (ASM) disk groups on operating system devices to Dynamic Multi-Pathing (DMP) devices

When an existing ASM disk group uses operating system native devices as disks, you can migrate these devices to Dynamic Multi-Pathing control. If the OS devices

are controlled by other multi-pathing drivers, this operation requires system downtime to migrate the devices to DMP control.

Plan for system downtime for the following procedure.

After this procedure, the ASM disk group uses the migrated DMP devices as its disks.

"From ASM" indicates that you perform the step as the user running the ASM instance.

"As root user" indicates that you perform the step as the root user.

To migrate an ASM disk group from operating system devices to DMP devices

1. Stop the applications and shut down the database.
2. From ASM, identify the ASM disk group that you want to migrate, and identify the disks under its control.
3. From ASM, dismount the ASM disk group.
4. If the devices are controlled by other multi-pathing drivers, migrate the devices to DMP control. Perform these steps as root user.

   Migrate from MPIO or PowerPath.

   See "About setting up DMP to manage native devices" on page 28.
5. As root user, enable DMP support for the ASM disk group identified in step 2.

   ```
   # vxdmpraw enable username groupname mode [devicename ...]
   ```

   where *username* represents the ASM user running the ASM instance, *groupname* represents the UNIX/Linux groupname of the specified user-id, and *mode* represents the permissions to set on the device. If you specify one or more *devicenames*, DMP support for ASM is enabled for those devices. If you do not specify a *devicename*, DMP support is enabled for all devices in the system that have an ASM signature.
6. From ASM, set ASM_DISKSTRING as appropriate. The preferred setting is `/dev/vx/rdmp/*`
7. From ASM, confirm that the devices are available to ASM.
8. From ASM, mount the ASM disk groups. The disk groups are mounted on DMP devices.

Example: To migrate an ASM disk group from operating system devices to DMP devices

1 From ASM, identify the ASM disk group that you want to migrate, and identify the disks under its control.

```
SQL> select name, state from v$asm_diskgroup;
NAME                           STATE
------------------------------ -----------
ASM_DG1                        MOUNTED

SQL> select name,path,header_status from v$asm_disk;
NAME         PATH              HEADER_STATUS
-------------------------------------------
ASM_DG1_0000 /dev/rhdisk43     MEMBER
ASM_DG1_0001 /dev/rhdisk51     MEMBER
ASM_DG1_0002 /dev/rhdisk97     MEMBER
```

2 From ASM, dismount the ASM disk group.

```
SQL> alter diskgroup ASM_DG1 dismount;
Diskgroup altered.

SQL> select name , state from v$asm_diskgroup;
NAME                           STATE
------------------------------ -----------
ASM_DG1                        DISMOUNTED
```

3 If the devices are controlled by other multi-pathing drivers, migrate the devices to DMP control. Perform these steps as root user.

See "About setting up DMP to manage native devices" on page 28.

4 As root user, enable DMP support for the ASM disk group identified in step 2, in one of the following ways:

- To migrate selected ASM diskgroups, use the `vxdmpadm` command to determine the DMP nodes that correspond to the OS devices.

```
# vxdmpadm getdmpnode nodename=hdisk4
NAME       STATE   ENCLR-TYPE PATHS ENBL DSBL ENCLR-NAME
=========================================================
EVA4K6K0_0 ENABLED EVA4K6K    4     4    0    EVA4K6K0
```

  Use the device name in the command below:

```
# vxdmpraw enable oracle dba 660 eva4k6k0_0 \
     eva4k6k0_9 emc_clariion0_243
```

- If you do not specify a *devicename*, DMP support is enabled for all devices in the disk group that have an ASM signature. For example:

  ```
  # vxdmpraw enable oracle dba 660
  ```

5 From ASM, set ASM_DISKSTRING.

```
SQL> alter system set ASM_DISKSTRING='/dev/vx/rdmp/*';
System altered.
SQL> show parameter ASM_DISKSTRING;
NAME                         TYPE      VALUE
---------------------------- --------- --------------------
asm_diskstring               string    /dev/vx/rdmp/*
```

6 From ASM, confirm that the devices are available to ASM.

```
SQL> select path , header_status from v$asm_disk where
header_status='MEMBER';

NAME      PATH                                     HEADER_STATUS
-----------------------------------------------------------
          /dev/vx/rdmp/emc_clariion0_243     MEMBER
          /dev/vx/rdmp/eva4k6k0_9            MEMBER
          /dev/vx/rdmp/eva4k6k0_1            MEMBER
```

7 From ASM, mount the ASM disk groups. The disk groups are mounted on DMP devices.

```
SQL> alter diskgroup ASM_DG1 mount;
Diskgroup altered.

SQL> select name, state from v$asm_diskgroup;
NAME                           STATE
------------------------------ -----------
ASM_DG1                        MOUNTED

SQL>  select name,path,header_status from v$asm_disk where
header_status='MEMBER';
NAME          PATH                             HEADER_STATUS
-----------------------------------------------------------
ASM_DG1_0002 /dev/vx/rdmp/emc_clariion0_243  MEMBER
ASM_DG1_0000 /dev/vx/rdmp/eva4k6k0_1         MEMBER
ASM_DG1_0001 /dev/vx/rdmp/eva4k6k0_9         MEMBER
```

Adding DMP devices to an existing LVM volume group or creating a new LVM volume group

When the dmp_native_support is ON, you can create a new LVM volume group on an available DMP device. You can also add an available DMP device to an existing LVM volume group. After the LVM volume groups are on DMP devices, you can use any of the LVM commands to manage the volume groups.

To create a new LVM volume group on a DMP device or add a DMP device to an existing LVM volume group

1 Choose disks that are available for use by LVM.

Use the `vxdisk list` command to identify these types of disks.

- Disks that are not in use by VxVM
  The output of `vxdisk list` shows these disks with the Type auto:none and the Status as online invalid.

The example shows available disks.

```
# vxdisk list

DEVICE            TYPE       DISK    GROUP    STATUS
. . .
emc_clariion0_84  auto:none  -       -        online invalid
emc_clariion0_85  auto:none  -       -        online invalid
```

2 Identify the ODM device name that corresponds to the device. The ODM device name is a truncated form of the DMP device name, since the ODM database requires a shorter name. The dmpname is an attribute of the ODM device name.

In this example, the DMP device name is emc_clariion0_84, and the ODM device name is emc_clari0_84. The enclosure index and the array volume ID (AVID) in the enclosure based name (EBN) are retained from the DMP device name.

```
# lspv | grep emc_clari0
emc_clari0_84       none                        None
emc_clari0_85       none                        None
# lsdev -Cc disk
. . .
emc_clari0_84     Available          Veritas DMP Device
emc_clari0_85     Available          Veritas DMP Device
# lsattr -El emc_clari0_84
dmpname   emc_clariion0_84  DMP Device name            True
pvid      none              Physical volume identifier True
unique_id DGC%5FRAID%200%5FCK200080300687%5F600601601C101F0
0E5CF099D7209DE11 Unique device identifier   True
```

3 Create a new LVM volume group on a DMP device.

Use the ODM device name to specify the DMP device.

```
# mkvg -y newvg emc_clari0_84
0516-1254 mkvg: Changing the PVID in the ODM.
newvg

# lspv
emc_clari0_84       00c95c90837d5ff8      newvg active
emc_clari0_85       none                  None
```

4 Add a DMP device to an existing LVM volume group.

Use the ODM device name to specify the DMP device.

```
# extendvg -f newvg emc_clari0_85
0516-1254 mkvg: Changing the PVID in the ODM.

# lspv
emc_clari0_84       00c95c90837d5ff8      newvg active
emc_clari0_85       00c95c90837d612f      newvg active
```

5 Run the following command to trigger DMP discovery of the devices:

```
# vxdisk scandisks
```

6 After the discovery completes, the disks are shown as in use by LVM:

```
# vxdisk list

. . .
emc_clariion0_84 auto:LVM        -        -    LVM
emc_clariion0_85 auto:LVM        -        -    LVM
```

Removing DMP support for native devices

The dmp_native_support tunable is persistent across reboots and product upgrades. You can disable native support for an individual device if you initialize it for VxVM, or if you set up TPD multi-pathing for that device.

To remove support for native devices from all DMP devices, turn off the dmp_native_support tunable.

This operation also disables DMP support for LVM rootvg, so it requires that you reboot the system. You can enable DMP support for the LVM rootvg separately, if required.

To turn off the dmp_native support tunable:

```
# vxdmpadm settune dmp_native_support=off
```

To view the value of the dmp_native_support tunable:

```
# vxdmpadm gettune dmp_native_support

Tunable                Current Value      Default Value
---------------------- ----------------   --------------
dmp_native_support          off              off
```

To retain DMP support for LVM rootvg after the dmp_native_support tunable is turned off, use the following command:

```
# vxdmpadm native enable vgname=rootvg
Please reboot the system to enable DMP support for LVM bootability
```

Chapter 3

Dynamic Multi-Pathing for the Virtual I/O Server

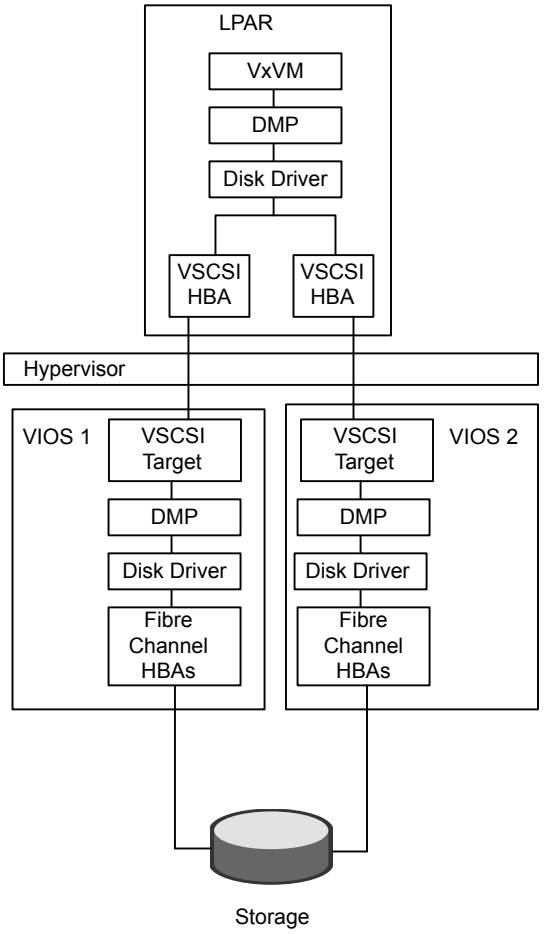
This chapter includes the following topics:

About Dynamic Multi-Pathing in a Virtual I/O server

The Virtual I/O (VIO) server virtualization technology from IBM is a logical partition (LPAR) that runs a trimmed-down version of the AIX operating system. Virtual I/O servers have APV support, which allows sharing of physical I/O resources between virtual I/O clients.

Figure 3-1 illustrates DMP enablement in the Virtual I/O server.

Figure 3-1 Dynamic Multi-Pathing in the Virtual I/O serve



DMP is fully functional in the Virtual I/O server. DMP administration and management commands (`vxdmpadm`, `vxddladm`, `vxdisk`) must be invoked from the non-restricted root shell.

```
$ oem_setup_env
```

Some example commands:

```
dmpvios1$ vxdmpadm getsubpaths dmpnodename=ibm_ds8x000_0337

NAME     STATE[A] PATH-TYPE[M] CTLR-NAME ENCLR-TYPE ENCLR-NAME  ATTRS
================================================================================
hdisk21 ENABLED(A)  -          fscsi0   IBM_DS8x00  ibm_ds8x000  -
```

```
hdisk61 ENABLED(A)  -          fscsi0   IBM_DS8x00  ibm_ds8x000  -
hdisk80 ENABLED(A)  -          fscsi1   IBM_DS8x00  ibm_ds8x000  -
hdisk99 ENABLED(A)  -          fscsi1   IBM_DS8x00  ibm_ds8x000  -

dmpvios1$ vxdmpadm listenclosure all

ENCLR_NAME  ENCLR_TYPE ENCLR_SNO STATUS    ARRAY_TYPE LUN_COUNT FIRMWARE
============================================================================
disk        Disk       DISKS     CONNECTED Disk       1         -
ibm_ds8x000 IBM_DS8x00 75MA641   CONNECTED A/A        6         -
```

See the PowerVM wiki for more in-depth information about VIO server and virtualization:

http://www.ibm.com/developerworks/wikis/display/virtualization/VIO

For more information, see the *PowerVM Virtualization on IBM System p redbook*:

http://www.redbooks.ibm.com/redpieces/abstracts/sg247940.html

About the Volume Manager (VxVM) component in a Virtual I/O server

Volume Manager (VxVM) is a component of Veritas InfoScale whose functionality is disabled in Virtual I/O server (VIOS). VxVM commands that manage volumes or disk groups are disabled in the VIO server.

In the VIOS, VxVM does not detect disk format information, so the disk status for VxVM disks is shown as unknown. For example:

```
dmpvios1$ vxdisk list
DEVICE           TYPE     DISK    GROUP   STATUS
disk_0           auto     -       -       unknown
ibm_ds8x000_02c1 auto     -       -       unknown
ibm_ds8x000_0288 auto     -       -       unknown
ibm_ds8x000_029a auto     -       -       unknown
ibm_ds8x000_0292 auto     -       -       unknown
ibm_ds8x000_0293 auto     -       -       unknown
ibm_ds8x000_0337 auto     -       -       unknown
```

In the VIOS, VxVM displays an error if you run a command that is disabled, as follows:

```
dmpvios1$ vxdisk -f init ibm_ds8x000_0288
VxVM vxdisk ERROR V-5-1-5433 Device ibm_ds8x000_0288: init failed:
Operation not allowed. VxVM is disabled.
```

```
dmpvios1$ vxdg import datadg
VxVM vxdg ERROR V-5-1-10978 Disk group datadg: import failed:
Operation not allowed. VxVM is disabled.
```

Configuring Dynamic Multi-Pathing (DMP) on Virtual I/O server

You can install DMP in the virtual I/O server (VIOS). This enables the VIO server to export dmpnodes to the VIO clients. The VIO clients access the dmpnodes in the same way as any other vSCSI devices. DMP handles the I/O to the disks backed by the dmpnodes.

For support information concerning running Dynamic Multi-Pathing (DMP) in Virtual I/O server (VIOS), see the *Veritas InfoScale Release Notes*.

Dynamic Multi-Pathing (DMP) can operate in the Virtual I/O server. Install DMP on the Virtual I/O server.

To install DMP on the Virtual I/O server

1. Log into the VIO server partition.
2. Use the `oem_setup_env` command to access the non-restricted root shell.
3. Install Dynamic Multi-Pathing on the Virtual I/O server.

   See the *Storage Foundation Configuration and Upgrade Guide*.
4. Installing DMP on the VIO server enables the dmp_native_support tunable. Do not set the dmp_native_support tunable to off.

   ```
   dmpvios1$ vxdmpadm gettune dmp_native_support
   Tunable               Current Value  Default Value
   ------------------  --------------- ------------------
   dmp_native_support       on              off
   ```

Migration options for configuring multi-pathing on a Virtual I/O server:

- Migrate from other multi-pathing solutions to DMP on a Virtual I/O server
- Migrate from MPIO to DMP on a Virtual I/O server for a dual-VIOS configuration
- Migrate from PowerPath to DMP on Virtual I/O server for a dual-VIOS configuration

Virtual I/O Server (VIOS) requirements

To run DMP in VIOS, the minimum VIOS level that is required is 2.2.2.1 or later.

Before installing DMP on VIOS, confirm the following:

If any path to the target disk has `SCSI reserve ODM` attribute set, then change the attributes to release the SCSI reservation from the paths, on a restart.

- If a path has the `reserve_policy` attribute set, change the`reserve_policy` attribute to `no_reserve` for all the paths.

```
# lsattr -E1 hdisk557 | grep res
reserve_policy single_path
Reserve Policy True
# chdev -l hdisk557 -a reserve_policy=no_reserve -P
hdisk557 changed
```

- If a path has the `reserve_lock` attribute set, change the `reserve_lock`attribute to `no`.

```
# lsattr -E1 hdisk558 | grep reserve_lock
reserve_lock yes
Reserve Device on open True
# chdev -l hdisk558 -a reserve_lock=no -P
hdisk558 changed
```

Migrating from other multi-pathing solutions to DMP on Virtual I/O server

DMP supports migrating from AIX MPIO and EMC PowerPath multi-pathing solutions to DMP on Virtual I/O server.

To migrate from other multi-pathing solutions to DMP on a Virtual I/O server

1. Before migrating, back up the Virtual I/O servers to use for reverting the system in case of issues.
2. Shut down all VIO client partitions that are serviced by the VIOS.
3. Log into the VIO server partition. Use the following command to access the non-restricted root shell. All subsequent commands in this procedure must be invoked from the non-restricted shell.

   ```
   $ oem_setup_env
   ```

4. Use commands like `lsdev` and `lsmap` to view the configuration.
5. Unconfigure all VTD devices from all virtual adapters on the system:

   ```
   dmpvios1$ rmdev -p vhost0
   ```

   Repeat this step for all other virtual adapters.

6 Migrate from the third-party device driver to DMP.

Note that you do not need to do turn on the dmp_native_support again, because it is turned on for VIOS by default. You can use the `vxdmpadm gettune dmp_native_support` command to verify that the tunable parameter is turned on.

See "Migrating LVM volume groups to DMP" on page 30.

7 Reboot the VIO Server partition.

8 Use the following command to verify that all Virtual SCSI mappings of TPD multi-pathing solution have been correctly migrated to DMP:

```
dmpvios1$ /usr/ios/cli/ioscli lsmap -all
```

9 Repeat step 1 through step 8 for all of the other VIO server partitions of the managed system.

10 After all of the VIO Server partitions are successfully migrated to DMP, start all of the VIO client partitions.

Migrating from MPIO to DMP on a Virtual I/O server for a dual-VIOS configuration

This following example procedure illustrates a migration from MPIO to DMP on the Virtual I/O server, in a configuration with two VIO Servers.

Example configuration values:

```
Managed System:  dmpviosp6
VIO server1: dmpvios1
VIO server2: dmpvios2
VIO clients: dmpvioc1
SAN LUNs: IBM DS8K array
Current multi-pathing solution on VIO server: IBM MPIO

ODM definition fileset required to disable MPIO support
for IBM DS8K array LUNs:
devices.fcp.disk.ibm.rte
```

To migrate dmpviosp6 from MPIO to DMP

1. Before migrating, back up the Virtual I/O server to use for reverting the system in case of issues.

   See the IBM website for information about backing up Virtual I/O server.

2. Shut down all of the VIO clients that are serviced by the VIO Server.

   ```
   dmpvioc1$ halt
   ```

3. Log into the VIO server partition.Use the following command to access the non-restricted root shell. All subsequent commands in this procedure must be invoked from the non-restricted shell.

   ```
   $ oem_setup_env
   ```

4 The following command shows `lsmap` output before migrating MPIO VTD devices to DMP:

```
dmpvios1$ /usr/ios/cli/ioscli lsmap -all
SVSA            Physloc                      Client Partition ID
--------------- ---------------------------- ------------------
vhost0          U9117.MMA.0686502-V2-C11     0x00000004

VTD                vtscsi0
Status             Available 8100000000000000
Backing device     hdisk21
LUN                0x
Physloc            U789D.001.DQD04AF-P1-C5-T1-W500507630813861A-L4
003403700000000

VTD                vtscsi1
Status             Available
LUN                0x8200000000000000
Backing device     hdisk20
Physloc            U789D.001.DQD04AF-P1-C5-T1-W500507630813861A-L4
00240C100000000

VTD                vtscsi2
Status             Available
LUN                0x8300000000000000
Backing device     hdisk18
Physloc            U789D.001.DQD04AF-P1-C5-T1-W500507630813861A-L4
002409A00000000
```

The VIO Server has MPIO providing multi-pathing to these hdisks. The following commands show the configuration:

```
dmpvios1$ lsdev -Cc disk | egrep "hdisk21|hdisk20|hdisk18"

hdisk18 Available 02-08-02 MPIO Other FC SCSI Disk Drive
hdisk20 Available 02-08-02 MPIO Other FC SCSI Disk Drive
hdisk21 Available 02-08-02 MPIO Other FC SCSI Disk Drive
```

5 Unconfigure all VTD devices from all virtual adapters on the system:

```
dmpvios1 $ rmdev -p vhost0
vtscsi0 Defined
vtscsi1 Defined
vtscsi2 Defined
```

Repeat this step for all other virtual adapters.

6 Migrate the devices from MPIO to DMP.

Unmount the file system and varyoff volume groups residing on the MPIO devices.

Display the volume groups (vgs) in the configuration:

```
dmpvios1$ lsvg
rootvg
brunovg

dmpvios1 lsvg -p brunovg

brunovg:
PV_NAME PV STATE TOTAL PPs FREE PPs FREE DISTRIBUTION
hdisk19 active   511       501      103..92..102..102..102
hdisk22 active   511       501      103..92..102..102..102
```

Use the `varyoffvg` command on all affected vgs:

```
dmpvios1$ varyoffvg brunovg
```

Install the IBMDS8K ODM definition fileset to remove IBM MPIO support for IBM DS8K array LUNs.

```
dmpvios1$ installp -aXd . devices.fcp.disk.ibm.rte


+-----------------------------------------------------+
             Pre-installation Verification...
+-----------------------------------------------------+
Verifying selections...done
Verifying requisites...done
Results...
Installation Summary
--------------------
Name                        Level    Part  Event  Result
-------------------------------------------------------
devices.fcp.disk.ibm.rte  1.0.0.2 USR   APPLY  SUCCESS
devices.fcp.disk.ibm.rte  1.0.0.2 ROOT  APPLY  SUCCESS
```

7 Reboot VIO server1

```
dmpvios1$ reboot
```

8 After the VIO server1 reboots, verify that all of the existing volume groups on the VIO server1 and MPIO VTDs on the VIO server1 are successfully migrated to DMP.

```
dmpvios1 lsvg -p brunovg

brunovg:
PV_NAME          PV STATE TOTAL PPs FREE PPs FREE DISTRIBUTION
ibm_ds8000_0292 active   511       501    103..92..102..102..102
ibm_ds8000_0293 active   511       501    103..92..102..102..102
```

Verify the vSCSI mappings of IBM DS8K LUNs on the migrated volume groups:

```
dmpvios1 lsmap -all

SVSA            Physloc                      Client Partition ID
--------------- ---------------------------- ------------------
vhost0          U9117.MMA.0686502-V2-C11     0x00000000
VTD                   vtscsi0
Status                Available
LUN                   0x8100000000000000
Backing device        ibm_ds8000_0337
Physloc

VTD                   vtscsi1
Status                Available
LUN                   0x8200000000000000
Backing device        ibm_ds8000_02c1
Physloc

VTD                   vtscsi2
Status                Available
LUN                   0x8300000000000000
Backing device        ibm_ds8000_029a
Physloc
```

9 Repeat step 1 through step 8 for VIO server2.

10 Start all of the VIO clients using HMC.

Migrating from PowerPath to DMP on a Virtual I/O server for a dual-VIOS configuration

This following example procedure illustrates a migration from PowerPath to DMP on the Virtual I/O server, in a configuration with two VIO Servers.

Example configuration values:

Managed System: dmpviosp6
VIO server1: dmpvios1
VIO server2: dmpvios2
VIO clients: dmpvioc1
SAN LUNs: EMC Clariion array
Current multi-pathing solution on VIO server: EMC PowerPath

To migrate dmpviosp6 from PowerPath to DMP

1. Before migrating, back up the Virtual I/O server to use for reverting the system in case of issues.

   See the IBM website for information about backing up Virtual I/O server.

2. Shut down all of the VIO clients that are serviced by the VIO Server.

   ```
   dmpvioc1$ halt
   ```

3. Log into the VIO server partition.Use the following command to access the non-restricted root shell. All subsequent commands in this procedure must be invoked from the non-restricted shell.

   ```
   $ oem_setup_env
   ```

4 The following command shows `lsmap` output before migrating PowerPath VTD devices to DMP:

```
dmpvios1$ /usr/ios/cli/ioscli lsmap -all

SVSA            Physloc                      Client Partition ID
--------------- ---------------------------- ------------------
vhost0          U9117.MMA.0686502-V2-C11     0x00000004

VTD              P0
Status           Available
LUN              0x8100000000000000
Backing device   hdiskpower0
Physloc          U789D.001.DQD04AF-P1-C5-T1-W500507630813861A-L4
0034037
00000000

VTD              P1
Status           Available
LUN              0x8200000000000000
Backing device   hdiskpower1
Physloc          U789D.001.DQD04AF-P1-C5-T1-W500507630813861A-L40
0240C10
0000000

VTD              P2
Status           Available
LUN              0x8300000000000000
Backing device   hdiskpower2
Physloc          U789D.001.DQD04AF-P1-C5-T1-W500507630813861A-L40
02409A00000000
```

5 Unconfigure all VTD devices from all virtual adapters on the system:

```
dmpvios1$ rmdev -p vhost0
P0 Defined
P1 Defined
P2 Defined
```

Repeat this step for all other virtual adapters.

6 Migrate the devices from PowerPath to DMP.

Unmount the file system and varyoff volume groups residing on the PowerPath devices.

Display the volume groups (vgs) in the configuration:

```
dmpvios1$ lsvg
rootvg
brunovg

dmpvios1$ lsvg -p brunovg

brunovg:
PV_NAME     PV STATE TOTAL PPs FREE PPs FREE DISTRIBUTION
hdiskpower3 active   511       501    103..92..102..102..102
```

Use the varyoffvg command on all affected vgs:

```
dmpvios1$ varyoffvg brunovg
```

Unmanage the EMC Clariion array from PowerPath control

```
# powermt unmanage class=clariion
hdiskpower0 deleted
hdiskpower1 deleted
hdiskpower2 deleted
hdiskpower3 deleted
```

7 Reboot VIO server1

```
dmpvios1$ reboot
```

8 After the VIO server1 reboots, verify that all of the existing volume groups on the VIO server1 and MPIO VTDs on the VIO server1 are successfully migrated to DMP.

```
dmpvios1$ lsvg -p brunovg

brunovg:
PV_NAME      PV STATE TOTAL PPs FREE PPs FREE DISTRIBUTION
emc_clari0_138 active  511      501    103..92..102..102..102
```

Verify the mappings of the LUNs on the migrated volume groups:

```
dmpvios1$ lsmap -all

SVSA            Physloc                     Client Partition ID
--------------- --------------------------- ------------------
vhost0          U9117.MMA.0686502-V2-C11    0x00000000
VTD               P0
Status            Available
LUN               0x8100000000000000
Backing device    emc_clari0_130
Physloc

VTD               P1
Status            Available
LUN               0x8200000000000000
Backing device    emc_clari0_136
Physloc

VTD               P2
Status            Available
LUN               0x8300000000000000
Backing device    emc_clari0_137
Physloc
```

9 Repeat step 1 to step 8 for VIO server2.

10 Start all of the VIO clients.

Configuring Dynamic Multi-Pathing (DMP) pseudo devices as virtual SCSI devices

DMP in the VIO server supports the following methods to export a device to the VIO client:

- DMP node method
  See “Exporting Dynamic Multi-Pathing (DMP) devices as virtual SCSI disks ” on page 59.
- Logical partition-based method
  See “Exporting a Logical Volume as a virtual SCSI disk” on page 62.
- File-based method
  See “Exporting a file as a virtual SCSI disk” on page 64.

Exporting Dynamic Multi-Pathing (DMP) devices as virtual SCSI disks

DMP supports disks backed by DMP as virtual SCSI disks. Export the DMP device as a vSCSI disk to the VIO client.

To export a DMP device as a vSCSI disk

1. Log into the VIO server partition.
2. Use the following command to access the non-restricted root shell. All subsequent commands in this procedure must be invoked from the non-restricted shell.

   ```
   $ oem_setup_env
   ```

3. The following command displays the DMP devices on the VIO server:

   ```
   dmpvios1$ lsdev -t dmpdisk

   ibm_ds8000_0287 Available  Veritas DMP Device
   ibm_ds8000_0288 Available  Veritas DMP Device
   ibm_ds8000_0292 Available  Veritas DMP Device
   ibm_ds8000_0293 Available  Veritas DMP Device
   ibm_ds8000_029a Available  Veritas DMP Device
   ibm_ds8000_02c1 Available  Veritas DMP Device
   ibm_ds8000_0337 Available  Veritas DMP Device
   ```

4. Assign the DMP device as a backing device. Exit from the non-restricted shell to run this command from the VIOS default shell.

   ```
   dmpvios1$ exit

   $ mkvdev -vdev ibm_ds8000_0288 -vadapter vhost0
   vtscsi3 Available
   ```

5 Use the following command to display the configuration.

```
$ lsmap -all

SVSA            Physloc                      Client Partition ID
--------------- ---------------------------- ------------------
vhost0          U9117.MMA.0686502-V2-C11     0x00000000
VTD               vtscsi0
Status            Available
LUN               0x8100000000000000
Backing device    ibm_ds8000_0337
Physloc

VTD               vtscsi1
Status            Available
LUN               0x8200000000000000
Backing device    ibm_ds8000_02c1
Physloc

VTD               vtscsi2
Status            Available
LUN               0x8300000000000000
Backing device    ibm_ds8000_029a
Physloc V

TD                vtscsi3
Status            Available
LUN               0x8400000000000000
Backing device    ibm_ds8000_0288
Physloc
```

6 For a dual-VIOS configuration, export the DMP device corresponding to the same SAN LUN on the second VIO Server in the configuration. To export the DMP device on the second VIO server, identify the DMP device corresponding to the SAN LUN as on the VIO Server1.

- If the array supports the AVID attribute, the DMP device name is the same as the DMP device name on the VIO Server1.
- Otherwise, use the UDID value of the DMP device on the VIO Server1 to correlate the DMP device name with same UDID on the VIO Server2.
  On VIO Server1:

  ```
  $ oem_setup_env
  ```

```
dmpvios1$ lsattr -El ibm_ds8000_0288

attribute value            description        user_settable
dmpname   ibm_ds8x000_0288 DMP Device name    True
pvid      none             Physical volume identifier True
unique_id IBM%5F2107%5F75MA641%5F6005076308FFC61A000000000
0000288
Unique device identifier   True
```

On VIO Server2:

```
$ oem_setup_env

dmpvios2$ odmget -q "attribute = unique_id and
value = 'IBM%5F2107%5F75MA641%5F6005076308FFC61A000000000
0000288'" CuAt

CuAt:

   name = "ibm_ds8000_0288"
   attribute = "unique_id"
   value = "IBM%5F2107%5F75MA641%5F6005076308FFC61A00
   00000000000288"
   type = "R"
   generic = "DU"
   rep = "s"
   nls_index = 4
```

7 Use the DMP device name identified in step 6 to assign the DMP device as a backing device. Exit from the non-restricted shell to run this command from the VIOS default shell.

```
dmpvios1$ exit

$ mkvdev -vdev ibm_ds8000_0288 -vadapter vhost0
vtscsi3 Available
```

8 Use the following command to display the configuration.

```
$ lsmap -all

SVSA            Physloc                     Client Partition ID
--------------- --------------------------- ------------------
vhost0          U9117.MMA.0686502-V2-C11  0x00000000
VTD               vtscsi0
Status            Available
LUN               0x8100000000000000
Backing device    ibm_ds8000_0337
Physloc

VTD               vtscsi1
Status            Available
LUN               0x8200000000000000
Backing device    ibm_ds8000_02c1
Physloc

VTD               vtscsi2
Status            Available
LUN               0x8300000000000000
Backing device    ibm_ds8000_029a
Physloc V

TD                vtscsi3
Status            Available
LUN               0x8400000000000000
Backing device    ibm_ds8000_0288
Physloc
```

Exporting a Logical Volume as a virtual SCSI disk

Dynamic Multi-Pathing (DMP) supports vSCSI disks backed by a Logical Volume. Export the Logical Volume as a vSCSI disk to the VIO client.

To export a Logical Volume as a vSCSI disk

1 Create the volume group.

```
$ mkvg -vg brunovg ibm_ds8000_0292 ibm_ds8000_0293
brunovg
```

The following command displays the new volume group:

```
$ lsvg -pv brunovg
brunovg:
PV_NAME          PV STATE TOTAL PPs FREE PPs FREE DISTRIBUTION
ibm_ds8000_0292 active   494       494      99..99..98..99..99
ibm_ds8000_0293 active   494       494      99..99..98..99..99
```

2 Make a logical volume in the volume group.

```
$ mklv -lv brunovg_lv1 brunovg 1G
brunovg_lv1
```

The following command displays the new logical volume:

```
$ lsvg -lv brunovg
brunovg:
LV NAME       TYPE   LPs   PPs   PVs  LV STATE      MOUNT POINT
brunovg_lv1   jfs    256   256   1    closed/syncd  N/A
```

3 Assign the logical volume as a backing device.

```
$ mkvdev -vdev brunovg_lv1 -vadapter  vhost0
vtscsi4 Available
```

4 Use the following command to display the configuration.

```
$ lsmap -all

SVSA            Physloc                      Client Partition ID
--------------- ---------------------------- ------------------
vhost0          U9117.MMA.0686502-V2-C11  0x00000000
VTD                   vtscsi0
Status                Available
LUN                   0x8100000000000000
Backing device        ibm_ds8000_0337
Physloc

VTD                   vtscsi1
Status                Available
LUN                   0x8200000000000000
Backing device        ibm_ds8000_02c1
Physloc

VTD                   vtscsi2
Status                Available
LUN                   0x8300000000000000
Backing device        ibm_ds8000_029a
Physloc

VTD                   vtscsi3
Status                Available
LUN                   0x8400000000000000
Backing device        ibm_ds8000_0288
Physloc

VTD                   vtscsi4
Status                Available
LUN                   0x8500000000000000
Backing device        brunovg_lv1
Physloc
```

Exporting a file as a virtual SCSI disk

Dynamic Multi-Pathing (DMP) supports vSCSI disks backed by a file. Export the file as a vSCSI disk to the VIO client.

To export a file as a vSCSI disk

1 Create the storage pool.

```
$ mksp brunospool ibm_ds8000_0296
brunospool
0516-1254 mkvg: Changing the PVID in the ODM.
```

2 Create a file system on the pool.

```
$ mksp -fb bruno_fb -sp brunospool -size 500M
bruno_fb
File system created successfully.
507684 kilobytes total disk space.
New File System size is 1024000
```

3 Mount the file system.

```
$ mount


node       mounted   mounted over   vfs    date     options
---------- ----------------------   ----- --------------------
/dev/hd4       /        jfs2      Jul 02 14:47 rw,log=/dev/hd8
/dev/hd2      /usr      jfs2      Jul 02 14:47 rw,log=/dev/hd8
/dev/hd9var   /var      jfs2      Jul 02 14:47 rw,log=/dev/hd8
/dev/hd3      /tmp      jfs2      Jul 02 14:47 rw,log=/dev/hd8
/dev/hd1      /home     jfs2      Jul 02 14:48 rw,log=/dev/hd8
/dev/hd11admin /admin   jfs2      Jul 02 14:48 rw,log=/dev/hd8
/proc         /proc     procfs    Jul 02 14:48 rw
/dev/hd10opt  /opt      jfs2      Jul 02 14:48 rw,log=/dev/hd8
/dev/livedump /var/adm/ras/livedump jfs2 Jul 02 14:48 rw,log=
/dev/hd8
/dev/bruno_fb /var/vio/storagepools/bruno_fb jfs2 Jul 02 15:38
rw,log=INLINE
```

4 Create a file in the storage pool.

```
$ mkbdsp -bd bruno_fbdev -sp bruno_fb 200M
Creating file "bruno_fbdev" in storage pool "bruno_fb".
bruno_fbdev
```

5 Assign the file as a backing device.

```
$ mkbdsp -sp bruno_fb -bd bruno_fbdev -vadapter vhost0
Assigning file "bruno_fbdev" as a backing device.
vtscsi5 Available
bruno_fbdev
```

6 Use the following command to display the configuration.

```
$ lsmap -all

SVSA            Physloc                      Client Partition ID
--------------- ---------------------------- ------------------
vhost0          U9117.MMA.0686502-V2-C11     0x00000000
...
...
VTD                vtscsi5
Status             Available
LUN                0x8600000000000000
Backing device     /var/vio/storagepools/bruno_fb/bruno_fbdev
Physloc
```

Extended attributes in VIO client for a virtual SCSI disk

Using Dynamic Multi-Pathing (DMP) in the a Virtual I/O server enables the DMP in the VIO Client to receive the extended attributes for the LUN. This enables the client LPAR to view back-end LUN attributes such as thin, SSD, and RAID levels associated with the vSCSI devices.

For more information about extended attributes and the prerequisites for supporting them, see the following tech note:

https://www.veritas.com/support/en_US/article.TECH77062.html

Configuration prerequisites for providing extended attributes on VIO client for virtual SCSI disk

Dynamic Multi-Pathing (DMP) in VIO client will provide extended attributes information of backend SAN LUN. The following conditions are prerequisites for using extended attributes on the VIO client:

- VIO client has vSCSI disks backed by SAN LUNs.
- In the VIO Server partition, DMP is controlling those SAN LUNs.
- On VIO client, DMP is controlling the vSCSI disks.

Displaying extended attributes of virtual SCSI disks

When a VIO client accesses a virtual SCSI disk that is backed by a Dynamic Multi-Pathing (DMP) device on the a Virtual I/O server, the VIO client can access the extended attributes associated with the virtual SCSI disk.

The following commands can access and display extended attributes information associated with the vSCSI disk backed by DMP device on a Virtual I/O server.

- `vxdisk -e list`
- `vxdmpadm list dmpnodename=<daname>`
- `vxdmpadm -v getdmpnode dmpnodename=<daname>`
- `vxdisk -p list <daname>`

For example, use the following command on the VIO client dmpvioc1:

```
# vxdisk -e list
```

```
DEVICE           TYPE          DISK   GROUP  STATUS       OS_NATIVE_NAME  ATTR
ibm_ds8x000_114f auto:LVM      -      -      LVM          hdisk83         std
3pardata0_3968   auto:aixdisk  -      -      online thin  hdisk84         tp
```

```
# vxdmpadm list dmpnode dmpnodename=3pardata0_3968
```

```
dmpdev          = 3pardata0_3968
state           = enabled
enclosure       = 3pardata0
cab-sno         = 744
asl             = libvxvscsi.so
vid             = AIX
pid             = VDASD
array-name      = 3PARDATA
array-type      = VSCSI
iopolicy        = Single-Active
avid            = 3968
lun-sno         = 3PARdata%5FVV%5F02E8%5F2AC00F8002E8
udid            = AIX%5FVDASD%5F%5F3PARdata%255FVV%255F02E8%255F2AC00F8002E8
dev-attr        = tp
###path         = name state type transport ctlr hwpath aportID aportWWN attr
path            = hdisk84 enabled(a) - SCSI vscsi1 vscsi1 3 - -
```

Chapter 4

Administering DMP

This chapter includes the following topics:

About enabling and disabling I/O for controllers and storage processors

DMP allows you to turn off I/O through a Host Bus Adapter (HBA) controller or the array port of a storage processor so that you can perform administrative operations. This feature can be used when you perform maintenance on HBA controllers on the host, or array ports that are attached to disk arrays supported by DMP. I/O operations to the HBA controller or the array port can be turned back on after the maintenance task is completed. You can accomplish these operations using the `vxdmpadm` command.

For Active/Active type disk arrays, when you disable the I/O through an HBA controller or array port, the I/O continues on the remaining paths. For Active/Passive

type disk arrays, if disabling I/O through an HBA controller or array port resulted in all primary paths being disabled, DMP will failover to secondary paths and I/O will continue on them.

After the administrative operation is over, use the `vxdmpadm` command to re-enable the paths through the HBA controllers or array ports.

See "Disabling I/O for paths, controllers, array ports, or DMP nodes" on page 137.

See "Enabling I/O for paths, controllers, array ports, or DMP nodes" on page 139.

You can also perform certain reconfiguration operations dynamically online.

About displaying DMP database information

You can use the `vxdmpadm` command to list DMP database information and perform other administrative tasks. This command allows you to list all controllers that are connected to disks, and other related information that is stored in the DMP database. You can use this information to locate system hardware, and to help you decide which controllers need to be enabled or disabled.

The `vxdmpadm` command also provides useful information such as disk array serial numbers, which DMP devices (disks) are connected to the disk array, and which paths are connected to a particular controller, enclosure, or array port.

See "Administering DMP using the vxdmpadm utility" on page 107.

Displaying the paths to a disk

The `vxdisk` command is used to display the multi-pathing information for a particular metadevice. The metadevice is a device representation of a physical disk having multiple physical paths through the system's HBA controllers. In Dynamic Multi-Pathing (DMP,) all the physical disks in the system are represented as metadevices with one or more physical paths.

To display the multi-pathing information on a system

- Use the `vxdisk path` command to display the relationships between the device paths, disk access names, disk media names, and disk groups on a system as shown here:

```
# vxdisk path

SUBPATH      DANAME     DMNAME     GROUP    STATE
hdisk1       hdisk1     mydg01     mydg     ENABLED
hdisk9       hdisk9     mydg01     mydg     ENABLED
hdisk2       hdisk2     mydg02     mydg     ENABLED
hdisk10      hdisk10    mydg02     mydg     ENABLED
   .
   .
   .
```

  This shows that two paths exist to each of the two disks, `mydg01` and `mydg02`, and also indicates that each disk is in the `ENABLED` state.

To view multi-pathing information for a particular metadevice

1 Use the following command:

```
# vxdisk list devicename
```

For example, to view multi-pathing information for `hdisk18`, use the following command:

```
# vxdisk list hdisk18
```

The output from the `vxdisk list` command displays the multi-pathing information, as shown in the following example:

```
Device:    hdisk18
devicetag: hdisk18
type:      simple
hostid:    sys1
.
.
.
Multipathing information:
numpaths:   2
hdisk18 state=enabled  type=primary
hdisk26 state=disabled type=secondary
```

The `numpaths` line shows that there are 2 paths to the device. The next two lines in the "Multipathing information" section of the output show that one path is active (`state=enabled`) and that the other path has failed (`state=disabled`).

The `type` field is shown for disks on Active/Passive type disk arrays such as the EMC CLARiiON, Hitachi HDS 9200 and 9500, Sun StorEdge 6xxx, and Sun StorEdge T3 array. This field indicates the primary and secondary paths to the disk.

The `type` field is not displayed for disks on Active/Active type disk arrays such as the EMC Symmetrix, Hitachi HDS 99xx and Sun StorEdge 99xx Series, and IBM ESS Series. Such arrays have no concept of primary and secondary paths.

2 Alternately, you can use the following command to view multi-pathing information:

```
# vxdmpadm getsubpaths dmpnodename=devicename
```

For example, to view multi-pathing information for `emc_clariion0_17`, use the following command:

```
# vxdmpadm getsubpaths dmpnodename=emc_clariion0_17
```

Typical output from the `vxdmpadm getsubpaths` command is as follows:

```
NAME     STATE[A]   PATH-TYPE[M] CTLR-NAME ENCLR-TYPE   ENCLR-NAME    ATTRS
================================================================================
hdisk107 ENABLED(A) PRIMARY      fscsi1    EMC_CLARiiON emc_clariion0     -
hdisk17  ENABLED    SECONDARY    fscsi0    EMC_CLARiiON emc_clariion0     -
hdisk2   ENABLED    SECONDARY    fscsi0    EMC_CLARiiON emc_clariion0     -
hdisk32  ENABLED(A) PRIMARY      fscsi0    EMC_CLARiiON emc_clariion0     -
```

Setting customized names for DMP nodes

The Dynamic Multi-Pathing (DMP) node name is the metadevice name that represents the multiple paths to a disk. The Device Discovery Layer (DDL) generates the DMP node name from the device name according to the Dynamic Multi-Pathing (DMP) naming scheme.

See "Disk device naming in DMP" on page 22.

You can specify a customized name for a DMP node. User-specified names are persistent even if names persistence is turned off.

You cannot assign a customized name that is already in use by a device. However, if you assign names that follow the same naming conventions as the names that the DDL generates, a name collision can potentially occur when a device is added. If the user-defined name for a DMP device is the same as the DDL-generated name for another DMP device, the `vxdisk list` command output displays one of the devices as 'error'.

To specify a custom name for a DMP node

- Use the following command:

```
# vxdmpadm setattr dmpnode dmpnodename name=name
```

You can also assign names from an input file. This enables you to customize the DMP nodes on the system with meaningful names.

To specify a custom name for an enclosure

- Use the following command:

```
# vxdmpadm setattr enclosure enc_name name=custom_name
```

To assign DMP nodes from a file

1. To obtain a file populated with the names of the devices in your configuration, use the following command:

```
# vxddladm -l assign names  > filename
```

   The sample file shows the format required and serves as a template to specify your customized names.

   You can also use the script `vxgetdmpnames` to get a sample file populated from the devices in your configuration.

2. Modify the file as required. Be sure to maintain the correct format in the file.
3. To assign the names, specify the name and path of the file to the following command:

```
# vxddladm assign names file=pathname
```

To clear custom names

- To clear the names, and use the default operating system-based naming or enclosure-based naming, use the following command:

```
# vxddladm -c assign names
```

Configuring DMP for SAN booting

On AIX, you can configure a SAN disk for booting the operating system. Such a disk, called a SAN boot disk, contains the root volume group (rootvg). In order for the SAN disk to be used for booting (bootable), the SAN disk must be a Logical Volume Manager (LVM) disk. The SAN root disk must be an Active/Active (A/A), A/A-A, or ALUA type array.

You can configure a SAN boot disk so that Dynamic Multi-Pathing (DMP) provides the multi-pathing for this device.

DMP supports LVM root disks in the following ways:

- DMP support for OS native LVM disks

When you enable the support for LVM disks, DMP provides multi-pathing functionality for the operating system native devices configured on the system. When this option is enabled, operations such as `extendvg` and `mirrorvg` can be done online.

DMP native support is controlled by the tunable parameter `dmp_native_support`. Veritas recommends this method.

See "About setting up DMP to manage native devices" on page 28.

- DMP support for LVM root disks

  When you enable the support for LVM root disks only, DMP manages the multi-pathing for the LVM root disk only.

  LVM root disk support is controlled with the command: `vxdmpadm native enable|disable vgname=rootvg`

The procedures in this section describe configuring a SAN root disk under DMP control. Choose the appropriate method based on the existing configuration, as follows:

Configure a new device.	See "Configuring DMP support for booting over a SAN" on page 74.
Migrate an internal root disk.	See "Migrating an internal root disk to a SAN root disk under DMP control " on page 77.
Migrate an existing SAN root disk under MPIO control	See "Migrating a SAN root disk from MPIO to DMP control" on page 82.
Migrate an existing SAN root disk under EMC PowerPath control	See "Migrating a SAN root disk from EMC PowerPath to DMP control" on page 83.

After you configure the root disk as a SAN root disk under DMP control, administer the root volume group.

See "Administering the root volume group (rootvg) under DMP control" on page 83.

Configuring DMP support for booting over a SAN

For DMP to work with an LVM root disk over a SAN, configure the system to use the boot device over all possible paths.

To configure DMP support for booting over a SAN

1. Verify that each path to the root device has the same physical volume identifier (PVID) and the same volume group. Use the `lspv` command for the root volume group to verify that the PVID and volume group entries are set correctly. The PVID and volume group entries in the second and third columns of the output should be identical for all the paths.

   In this example, the LVM root disk is multi-pathed with four paths. The output from the `lspv` command for the root volume group (rootvg) is as follows:

   ```
   # lspv | grep rootvg
   hdisk374 00cbf5ce56def54d rootvg active
   hdisk375 00cbf5ce56def54d rootvg active
   hdisk376 00cbf5ce56def54d rootvg active
   hdisk377 00cbf5ce56def54d rootvg active
   ```

2. If the PVID and volume group entries are not set correctly on any of the paths, use the `chdev` command to set the correct value.

   For example, the following output shows that the `hdisk377` path is not set correctly:

   ```
   # lspv
   hdisk374 00cbf5ce56def54d rootvg active
   hdisk375 00cbf5ce56def54d rootvg active
   hdisk376 00cbf5ce56def54d rootvg active
   hdisk377 none             None
   ```

   To set the PVID for the path, use the following command:

   ```
   # chdev -l hdisk377 -a pv=yes
   hdisk377 changed
   ```

   The output of the `lspv` command now shows the correct values:

   ```
   # lspv | grep rootvg
   hdisk374 00cbf5ce56def54d rootvg active
   hdisk375 00cbf5ce56def54d rootvg active
   hdisk376 00cbf5ce56def54d rootvg active
   hdisk377 00cbf5ce56def54d rootvg active
   ```

3. If any path to the target disk has SCSI reserve ODM attribute set, then change the attributes to release the SCSI reservation from the paths, on a restart.

   - If a path has the `reserve_policy` attribute set, change the`reserve_policy` attribute to `no_reserve` for all the paths.

```
# lsattr -E1 hdisk557 | grep res

reserve_policy single_path
Reserve Policy True

# chdev -l hdisk557 -a reserve_policy=no_reserve -P

hdisk557 changed
```

- If a path has the `reserve_lock` attribute set, change the `reserve_lock`attribute to `no`.

```
#  lsattr -E1 hdisk558 | grep reserve_lock

reserve_lock yes
Reserve Device on open True

# chdev -l hdisk558 -a reserve_lock=no -P

hdisk558 changed
```

4 Set the boot list to include all the paths of current boot disk.

```
# bootlist -m normal hdisk374 hdisk375 hdisk376 hdisk377 blv=hd5
```

Verify that the boot list includes all paths and that each path shows the default boot volume hd5:

```
# bootlist -m normal -o
hdisk374 blv=hd5
hdisk375 blv=hd5
hdisk376 blv=hd5
hdisk377 blv=hd5
```

5 If the `blv` option is not set for a path to the disk, use the `bootlist` command to set it. For example:

```
# bootlist -m normal hdisk374 hdisk375 hdisk376 hdisk377 blv=hd5
```

6 Run one of the following commands to configure DMP on the root disk:

- The recommended method is to turn on DMP support for LVM volumes, including the root volume.

```
# vxdmpadm settune dmp_native_support=on
```

- The following command enables DMP support for LVM volumes only for the root disk.

```
# vxdmpadm native enable vgname=rootvg
```

7 Reboot the system. DMP takes control of the SAN boot device to perform load balancing and failover.

8 Verify whether DMP controls the root disk.

```
# vxdmpadm native list vgname=rootvg
PATH            DMPNODENAME
============================
hdisk374        ams_wms0_491
hdisk375        ams_wms0_491
hdisk376        ams_wms0_491
hdisk377        ams_wms0_491

# lspv | grep rootvg
hdisk374 00cbf5ce56def54d rootvg active
hdisk375 00cbf5ce56def54d rootvg active
hdisk376 00cbf5ce56def54d rootvg active
hdisk377 00cbf5ce56def54d rootvg active
```

Migrating an internal root disk to a SAN root disk under DMP control

If the system has been booted from an internal disk (such as hdisk0), you can configure an alternate root disk on the attached SAN storage before you put it under DMP control.

In this example, a SAN boot disk with multiple paths is created by cloning the existing root disk, and then enabling multi-pathing support by DMP.

To migrate an internal root disk to a SAN root disk under DMP control

1. Choose a disk to use for the SAN root disk. If the disk is under VM control, then remove the disk from VM control before proceeding:.

```
# vxdiskunsetup ams_wms0_1

# vxdisk rm ams_wms0_1
```

2. Clear the PVIDs of all the paths to the SAN boot disk. If the SAN disk is under VM control, then you can get multi-pathing information using the `vxdmpadm` command:

```
# vxdmpadm getsubpaths dmpnodename=ams_wms0_1
NAME    STATE[A]   PATH-TYPE[M] CTLR-NAME ENCLR-TYPE ENCLR-NAME ATTRS
================================================================================
hdisk542 ENABLED(A) PRIMARY     fscsi0    AMS_WMS    ams_wms0   -
hdisk557 ENABLED    SECONDARY   fscsi0    AMS_WMS    ams_wms0   -
hdisk558 ENABLED(A) PRIMARY     fscsi1    AMS_WMS    ams_wms0   -
hdisk559 ENABLED    SECONDARY   fscsi1    AMS_WMS    ams_wms0   -
```

   Clear the PVIDs of all these paths.

```
# chdev -l hdisk542 -a pv=clear
hdisk542 changed
# chdev -l hdisk557 -a pv=clear
hdisk557 changed
# chdev -l hdisk558 -a pv=clear
hdisk558 changed
# chdev -l hdisk559 -a pv=clear
hdisk559 changed
```

   Note that unless the disk is under VM control, the clear command may not work for secondary paths.

3. If any path to the target disk has SCSI reserve ODM attribute set, then change the attributes to release the SCSI reservation from the paths, on a restart.

   - If a path has the `reserve_policy` attribute set, change the `reserve_policy` attribute to `no_reserve` for all the paths.

```
# lsattr -E1 hdisk557 | grep res
reserve_policy single_path
Reserve Policy True
```

```
# chdev -l hdisk557 -a reserve_policy=no_reserve -P
hdisk557 changed
```

- If a path has the `reserve_lock` attribute set, change the `reserve_lock` attribute to `no`.

```
# lsattr -E1 hdisk558 | grep reserve_lock
reserve_lock  yes
Reserve Device on open True

# chdev -l hdisk558 -a reserve_lock=no -P
hdisk558 changed
```

4 Use the `alt_disk_install` command to clone the `rootvg` to the SAN boot disk. You can use any of the paths, but preferably use the primary path.

```
# alt_disk_install -C -P all hdisk542
+-------------------------------------------------------------+
ATTENTION: calling new module /usr/sbin/alt_disk_copy. Please
see the
alt_disk_copy man page and documentation for more details.
Executing command: /usr/sbin/alt_disk_copy -P "all" -d
"hdisk542"
+-------------------------------------------------------------+
Calling mkszfile to create new /image.data file.
Checking disk sizes.
Creating cloned rootvg volume group and associated logical
volumes.
Creating logical volume alt_hd5.
Creating logical volume alt_hd6.
Creating logical volume alt_hd8.
Creating logical volume alt_hd4.
Creating logical volume alt_hd2.
Creating logical volume alt_hd9var.
Creating logical volume alt_hd3.
Creating logical volume alt_hd1.
Creating logical volume alt_hd10opt.
Creating logical volume alt_lg_dumplv.
Creating /alt_inst/ file system.
Creating /alt_inst/home file system.
Creating /alt_inst/opt file system.
Creating /alt_inst/tmp file system.
Creating /alt_inst/usr file system.
Creating /alt_inst/var file system.
Generating a list of files
for backup and restore into the alternate file system...
Backing-up the rootvg files and restoring them to the alternate
file system...
Modifying ODM on cloned disk.
Building boot image on cloned disk.
forced unmount of /alt_inst/var
forced unmount of /alt_inst/usr
forced unmount of /alt_inst/tmp
forced unmount of /alt_inst/opt
forced unmount of /alt_inst/home
forced unmount of /alt_inst
```

```
forced unmount of /alt_inst
Changing logical volume names in volume group descriptor area.
Fixing LV control blocks...
Fixing file system superblocks...
Bootlist is set to the boot disk: hdisk542
```

5 Use the `lspv` command to confirm that the `altinst_rootvg` has been created for one of the paths to the SAN disk:

```
# lspv | grep rootvg
hdisk125 00cdee4fd0e3b3da rootvg active
hdisk542 00cdee4f5b103e98 altinst_rootvg
```

6 Update the remaining paths to the SAN disk to include the correct `altinst_rootvg` information:

```
# chdev -l hdisk557 -a pv=yes
hdisk557 changed
# chdev -l hdisk558 -a pv=yes
hdisk558 changed
# chdev -l hdisk559 -a pv=yes
hdisk559 changed
# lspv | grep rootvg
hdisk125 00cdee4fd0e3b3da rootvg active
hdisk542 00cdee4f5b103e98 altinst_rootvg
hdisk557 00cdee4f5b103e98 altinst_rootvg
hdisk558 00cdee4f5b103e98 altinst_rootvg
hdisk559 00cdee4f5b103e98 altinst_rootvg
```

7 The `bootlist` command verifies that the boot device has been updated for only one of the paths to the SAN disk:

```
# bootlist -m normal -o
hdisk542 blv=hd5
```

8 Use the `bootlist` command to include the other paths to the new boot device:

```
# bootlist -m normal hdisk542 hdisk557 hdisk558 hdisk559 blv=hd5
# bootlist -m normal -o
hdisk542 blv=hd5
hdisk557 blv=hd5
hdisk558 blv=hd5
hdisk559 blv=hd5
```

9 Reboot the system from the SAN disk.

10 Enable DMP on the root disk, using one of the following commands.

- The recommended method is to turn on DMP support for LVM volumes, including the root volume.

```
# vxdmpadm settune dmp_native_support=on
```

- The following command enables DMP support for LVM volumes only for the root disk. This method will be deprecated in a future release.

```
# vxdmpadm native enable vgname=rootvg
```

11 Reboot the system to enable DMP rootability.

12 Confirm that the system is booted from the new multi-pathed SAN disk. Use the following commands:

```
# bootinfo -b
hdisk542
# bootlist -m normal -o
hdisk542 blv=hd5
hdisk557 blv=hd5
hdisk558 blv=hd5
hdisk559 blv=hd5
# lspv | grep rootvg
hdisk125   00cdee4fd0e3b3da old_rootvg
ams_wms0_1 00cdee4f5b103e98 rootvg active
```

13 Verify whether DMP controls the root disk..

```
# vxdmpadm native list vgname=rootvg
PATH        DMPNODENAME
========================
hdisk542    ams_wms0_1
hdisk557    ams_wms0_1
hdisk558    ams_wms0_1
hdisk559    ams_wms0_1
```

Migrating a SAN root disk from MPIO to DMP control

If the system has been booted from a SAN disk under MPIO control, MPIO must be disabled before DMP control can be enabled.

To migrate a SAN root disk from MPIO to DMP control

1. Disable MPIO by installing a device-specific ODM definition fileset as described in the following Technote:

   http://www.veritas.com/docs/000024273

2. Reboot the system. The system is booted without any multi-pathing support.
3. Configure DMP.

   See "Configuring DMP support for booting over a SAN" on page 74.

Migrating a SAN root disk from EMC PowerPath to DMP control

If the system has a root volume group (rootvg) under EMC PowerPath control, use this procedure to migrate the rootvg to DMP control.

To migrate a SAN root disk from EMC PowerPath to DMP control

1. Remove the PowerPath device corresponding to the root disk (rootvg) from VxVM control:

   ```
   # vxdisk rm hdiskpowerX
   ```

2. Issue the following command so that PowerPath returns the pvid to the hdisk device. Otherwise the `bosboot` command does not succeed.

   ```
   # pprootdev fix
   ```

3. Remove the device from PowerPath so that PowerPath releases control of the boot device on the next reboot.

   ```
   # powermt unmanage dev=hdiskpowerX
   ```

4. Enable DMP root support.

   See "Configuring DMP support for booting over a SAN" on page 74.

5. Reboot the system. The system is booted with the rootvg under DMP control.

Administering the root volume group (rootvg) under DMP control

After the root disk is configured for DMP control, the device is visible as the root volume group (rootvg) to the operating system. DMP controls the paths to the device. For certain maintenance tasks, the operating system needs to access the

underlying paths. DMP provides a method to release the paths to the OS during those operations, and resume control of the paths after the operations complete.

The following sections give the procedures for common administrative tasks.

Running the `bosboot` command after installing software.	See "Running the bosboot command when LVM rootvg is enabled for DMP" on page 84.
Extending the root volume group.	See "Extending an LVM rootvg that is enabled for DMP" on page 85.
Reducing the root volume group.	See "Reducing the native rootvg that is enabled for DMP" on page 89.
Mirroring the root volume group.	See "Mirroring the root volume group" on page 91.
Removing the mirror for the root volume group.	See "Removing the mirror for the root volume group (rootvg)" on page 92.
Cloning the root volume group.	See " Cloning a LVM rootvg that is enabled for DMP" on page 94.
Using the `mksysb` command..	See "Using mksysb when the root volume group is under DMP control" on page 99.

Running the bosboot command when LVM rootvg is enabled for DMP

You may want to use the `bosboot` command while performing certain tasks. For example, many software installations require running the `bosboot` command at the end of installation.

To run bosboot command on the rootvg

1 Determine the device paths of the rootvg that are under DMP control.

```
# vxdmpadm native list
PATH                      DMPNODENAME
============================================
hdisk168                  emc0_0039
hdisk172                  emc0_0039
hdisk184                  emc0_0039
hdisk188                  emc0_0039

# lspv | grep -w rootvg
hdisk168   00c398edf9fae077   rootvg  active
hdisk172   00c398edf9fae077   rootvg  active
hdisk184   00c398edf9fae077   rootvg  active
hdisk188   00c398edf9fae077   rootvg  active
```

2 Run the operation that requires the `bosboot` command; for example, install the software. Alternatively, run the `bosboot` command manually.

```
# bosboot -ad /dev/ipldevice
bosboot: Boot image is 56863 512 byte blocks.
```

If the `bosboot` command fails on `/dev/ipldevice`, then retry the command on the paths of current boot disk until it succeeds.

Extending an LVM rootvg that is enabled for DMP

When an LVM root volume group (rootvg) is enabled for DMP, you can add DMP devices to the rootvg.

The procedure differs depending on whether or not DMP support for native devices is enabled; that is, whether the dmp_native_support tunable is set to on.

If dmp_native_support is on, and an LVM root volume group (rootvg) is enabled for DMP	See "Extending an LVM rootvg when dmp_native_support is on " on page 85.
If dmp_native_support is off, and an LVM root volume group (rootvg) is enabled for DMP	See "Extending an LVM rootvg when dmp_native_support is off" on page 87.

Extending an LVM rootvg when dmp_native_support is on

If dmp_native_support is on, and an LVM root volume group (rootvg) is enabled for DMP, you can add DMP devices online to the rootvg, without rebooting the system.

To add a DMP device to a DMP-enabled rootvg

1 List the available physical volumes. The output includes the DMP devices that are available to LVM. For example:

```
# lsdev -c disk
...
ibm_ds8x000_0100   Available      Veritas DMP Device
ibm_ds8x000_017d   Available      Veritas DMP Device
emc0_00a5          Available      Veritas DMP Device
emc0_00a7          Available      Veritas DMP Device
```

2 List the paths that are configured to be managed by DMP as a result of enabling DMP support for the volume group. You can optionally specify the volume group name using the *vgname* parameter.

```
# vxdmpadm native list
NAME        DMPNODENAME
===================================
hdisk21     ibm_ds8x000_0100
hdisk22     ibm_ds8x000_0100
```

3 List the volume groups:

```
# lspv
hdisk1      00f617b700039215   None
hdisk24     00f617b700039215   None
hdisk21     00f617b7ae6f71b3   rootvg   active
hdisk22     00f617b7ae6f71b3   rootvg   active
```

4 Extend the DMP-enabled rootvg to an additional DMP device. For example:

```
# extendvg rootvg ibm_ds8x000_017d
```

5 Verify the subpaths of the DMP device.

```
# vxdmpadm native list
NAME        DMPNODENAME
===================================
hdisk21     ibm_ds8x000_0100
hdisk22     ibm_ds8x000_0100
hdisk1      ibm_ds8x000_017d
hdisk24     ibm_ds8x000_017d
```

6 Release the paths to the operating system.

```
# vxdmpadm native release
```

7 Verify that the DMP device is added to the rootvg. For example:

```
# lsvg -p rootvg
rootvg:
PV_NAME    PV STATE   TOTAL PPs   FREE PPs   FREE DISTRIBUTION
hdisk21    active     73          0          00..00..00..00..00
hdisk1     active     15          15         03..03..03..03..03
```

8 Verify that the subpaths of the DMP device are added to the rootvg.

```
# lspv | grep -w rootvg
hdisk1     00f617b700039215   rootvg   active
hdisk21    00f617b7ae6f71b3   rootvg   active
hdisk22    00f617b7ae6f71b3   rootvg   active
hdisk24    00f617b700039215   rootvg   active
```

Extending an LVM rootvg when dmp_native_support is off

When an LVM root volume group (rootvg) is enabled for DMP, you can extend the rootvg by adding a SAN disk. If the root support is enabled with the `vxdmpadm native enable` command, the system must be rebooted before DMP can manage the new devices added to the LVM rootvg. In this case, the only DMP devices available to LVM are the devices in the rootvg. Therefore, you must extend the rootvg over the OS device paths. After the reboot, DMP can service the I/O to the new devices that were added to the LVM rootvg.

To add a SAN disk to a DMP-enabled rootvg

1. If the disk is under VxVM control, remove the disk from VxVM before you continue.

   ```
   # vxdisk rm emc0_00a7
   ```

2. Clear the physical volume Identifiers (PVIDs) of all the paths to the SAN disk. Perform this step for each of the paths.

```
# vxdmpadm getsubpaths dmpnodename=emc0_00a7
NAME      STATE[A]   PATH-TYPE[M] CTLR-NAME  ENCLR-TYPE  ENCLR-NAME  ATTRS
================================================================================
hdisk32  ENABLED(A)   -          fscsi0     EMC         emc0        -
hdisk6   ENABLED(A)   -          fscsi0     EMC         emc0        -
hdisk88  ENABLED(A)   -          fscsi1     EMC         emc0        -
hdisk99  ENABLED(A)   -          fscsi1     EMC         emc0        -
```

   For example:

   ```
   # chdev -l hdisk32 -a pv=clear
   ```

3. Update the PVID on the remaining paths of the added SAN disk. Perform this step for each of the paths.

   ```
   # chdev -l hdisk6 -a pv=yes

   # chdev -l hdisk88 -a pv=yes

   # chdev -l hdisk99 -a pv=yes
   ```

4. Add the SAN disk to the DMP-enabled rootvg.

   ```
   # extendvg rootvg hdisk32
   ```

5. Reboot the system.

   ```
   # reboot
   ```

6 Verify the DMP rootvg configuration.

```
# vxdmpadm native list
PATH                      DMPNODENAME
============================================
hdisk143                  emc0_0039
hdisk142                  emc0_0039
hdisk141                  emc0_0039
hdisk127                  emc0_0039
hdisk32                   emc0_00a7
hdisk6                    emc0_00a7
hdisk88                   emc0_00a7
hdisk99                   emc0_00a7
```

7 Verify that the DMP device is added to the rootvg. For example:

```
# lsvg -p rootvg
rootvg:
PV_NAME     PV STATE   TOTAL PPs   FREE PPs   FREE DISTRIBUTION
hdisk143    active     73          0          00..00..00..00..00
hdisk88     active     15          15         03..03..03..03..03

# lspv | grep -w rootvg
hdisk143   00c398ed00008e79   rootvg   active
hdisk142   00c398ed00008e79   rootvg   active
hdisk141   00c398ed00008e79   rootvg   active
hdisk127   00c398ed00008e79   rootvg   active
hdisk32    00c398edf9fae077   rootvg   active
hdisk6     00c398edf9fae077   rootvg   active
hdisk88    00c398edf9fae077   rootvg   active
hdisk99    00c398edf9fae077   rootvg   active
```

Reducing the native rootvg that is enabled for DMP

When a native root volume group (rootvg) is enabled for DMP, and contains multiple SAN disks, you can reduce the rootvg. Use this procedure to remove a SAN disk from a rootvg that includes multiple SAN disks. This procedure can be done online, without requiring a reboot.

To remove a SAN disk from a DMP-enabled rootvg

1. View the rootvg configuration. If the configuration contains multiple SAN disks, you can remove one.

```
# lsvg -p rootvg
PV_NAME       PV STATE     TOTAL PPs   FREE PPs   FREE DISTRIBUTION
hdisk1        active       73          8          00..00..00..00..08
hdisk21       active       15          15         03..03..03..03..03

# lspv | grep -w rootvg
hdisk1          00c398edf9fae077      rootvg      active
hdisk21         00c398ed00008e79      rootvg      active
hdisk22         00c398ed00008e79      rootvg      active
hdisk24         00c398edf9fae077      rootvg      active
```

2. Run the following comand to acquire the PVIDs from the operating system:

```
# vxdmpadm native acquire
```

3. The `lspv` output now displays the DMP node names, instead of the device paths:

```
# lspv | grep -w rootvg
emc0_0039       00c398ed00008e79      rootvg      active
emc0_00a7       00c398edf9fae077      rootvg      active
```

4. Remove the SAN disk from the DMP-enabled rootvg. If the physical volume has allocated partitions, you must move or delete the partitions before you remove the SAN disk.

```
# reducevg rootvg emc0_00a7
```

5. Verify that the DMP device is removed from the DMP rootvg configuration. For example:

```
# lsvg -p rootvg
PV_NAME       PV STATE     TOTAL PPs   FREE PPs   FREE DISTRIBUTION
emc0_0039     active       73          8          00..00..00..00..08

# lspv | grep -w rootvg
emc0_0039      00c398ed00008e79      rootvg      active
```

6 Run the following comand to release the PVIDs to the operating system:

```
# vxdmpadm native release
```

7 The `lspv` output now displays the device paths:

```
# lspv | grep -w rootvg
hdisk22      00c398ed00008e79     rootvg     active
hdisk21      00c398ed00008e79     rootvg     active
```

Mirroring the root volume group

You may want to create a mirror of the root volume group to add redundancy. For a root volume group that DMP controls, use the operating system commands to create the mirror.

To mirror a root volume group

1 Extend the DMP-enabled rootvg to a second DMP device.

See "Extending an LVM rootvg that is enabled for DMP" on page 85.

If the rootvg is already extended over DMP device using the recommended steps, then go to step 2.

2 Create the mirror of the root volume group.

```
# mirrorvg rootvg
0516-1734 mklvcopy: Warning, savebase failed.  Please manually
run 'savebase' before rebooting.
....
0516-1804 chvg: The quorum change takes effect immediately.
0516-1126 mirrorvg: rootvg successfully mirrored, user should
     perform bosboot of system to initialize boot records.
     Then, user must modify bootlist to include:  hdisk74 hdisk70.
```

3 As the output of the `mirrorvg` command indicates, run the `savebase` command on `/dev/ipldevice`. If the `savebase` command returns a non-zero value, then retry the command on the paths of current boot disk (hdisk70, hdisk72) until it succeeds.

```
# savebase -d /dev/ipldevice

# echo $?
0
```

4 As the output of the `mirrorvg` command indicates, run the `bosboot` command to initialize the boot records. If the `bosboot` command fails on `/dev/ipldevice`, then retry the command on the paths of current boot disk until it succeeds.

```
# bosboot -ad /dev/ipldevice
A previous bosdebug command has changed characteristics of this
    boot image.  Use bosdebug -L to display what these changes are.

bosboot: Boot image is 56863 512 byte blocks.
```

5 Include the paths corresponding to the mirror device in the boot list. In this example, hdisk70 and hdisk72 are the original boot disk. Add the paths for hdisk73 and hdisk74.

```
# bootlist -m normal -o
hdisk70 blv=hd5
hdisk72 blv=hd5

# bootlist -m normal hdisk70 hdisk72 hdisk73 hdisk74 blv=hd5

# bootlist -m normal -o
hdisk70 blv=hd5
hdisk72 blv=hd5
hdisk73 blv=hd5
hdisk74 blv=hd5
```

6 Verify the rootvg.

```
# lsvg -p rootvg
rootvg:
PV_NAME     PV STATE TOTAL PPs FREE PPs FREE DISTRIBUTION
hdisk70     active    39        361     127..05..00..101..128
hdisk73     active   639        361     127..05..00..101..128
```

Removing the mirror for the root volume group (rootvg)

To remove redundancy to the root volume group, remove the mirror of the root volume group. For a root volume group that is under DMP control, use the operating system commands to remove the mirror.

To unmirror the root volume group

1 View the configuration of the root volume group.

```
# lsvg -p rootvg
rootvg:
PV_NAME    PV STATE  TOTAL PPs FREE PPs FREE DISTRIBUTION
hdisk70    active    639       361      127..05..00..101..128
hdisk73    active    639       639      128..128..127..128..128

# lspv | grep -w rootvg
hdisk70  00f60bfea7406c01  rootvg  active
hdisk72  00f60bfea7406c01  rootvg  active
hdisk73  00f60bfe000d0356  rootvg  active
hdisk74  00f60bfe000d0356  rootvg  active
```

2 Remove the mirror from the root volume group.

```
# unmirrorvg rootvg
0516-1246 rmlvcopy: If hd5 is the boot logical volume,
please run 'chpv -c <diskname>' as root user to
clear the boot record and avoid a potential boot
off an old boot image that may reside on the disk
from which this logical volume is moved/removed.
0516-1804 chvg: The quorum change takes effect
immediately.
0516-1144 unmirrorvg: rootvg successfully unmirrored,
user should perform bosboot of system to reinitialize
boot records.  Then, user must modify bootlist to
just include:  hdisk70.
```

3 As the output of the `unmirrorvg` command in step 2 indicates, run the **`chpv -c`** command on the paths of the device that formerly was the mirror. In this example, the paths are hdisk73 and hdisk74.

```
# chpv -c hdisk74

# chpv -c hdisk73
```

4 Set the boot list to remove the paths for the former mirror. In this example, remove the paths for hdisk73 and hdisk74. The boot list includes the paths hdisk70 and hdisk72.

```
# bootlist -m normal -o
hdisk70 blv=hd5
hdisk72 blv=hd5
hdisk73 blv=hd5
hdisk74 blv=hd5

# bootlist -m normal hdisk70 hdisk72 blv=hd5

# bootlist -m normal -o
hdisk70 blv=hd5
hdisk72 blv=hd5
```

5 As the output of the unmirrorvg command in step 2 indicates, run `bosboot` command to reflect the changes. If the `bosboot` command fails on `/dev/ipldevice`, then retry the command on the paths of current boot disk until it succeeds.

```
# bosboot -ad /dev/ipldevice
A previous bosdebug command has changed characteristics of this
boot image.  Use bosdebug -L to display what these changes are.
bosboot: Boot image is 56863 512 byte blocks.
```

6 Verify that the mirror of the rootvg is removed.

```
# lspv | grep -w rootvg
hdisk70  00f60bfea7406c01  rootvg  active
hdisk72  00f60bfea7406c01  rootvg  active

# lsvg -p rootvg
rootvg:
PV_NAME         PV STATE TOTAL PPs FREE PPs FREE DISTRIBUTION
hdisk70         active   639       361      127..05..00..101..128
```

Cloning a LVM rootvg that is enabled for DMP

Use the `alt_disk_install` command to clone an LVM rootvg that is enabled for DMP.

To clone an LVM rootvg that is enabled for DMP

1 Show the DMP node names.

```
# vxdmpadm native list
PATH                        DMPNODENAME
============================================
hdisk75                     ams_wms0_491
hdisk76                     ams_wms0_491
hdisk80                     ams_wms0_491
hdisk81                     ams_wms0_491
```

2 Verify that the DMP node is the rootvg.

```
# lspv | grep -w rootvg
hdisk75  00c408c4dbd98818  rootvg  active
hdisk76  00c408c4dbd98818  rootvg  active
hdisk80  00c408c4dbd98818  rootvg  active
hdisk81  00c408c4dbd98818  rootvg  active
```

3 Show the DMP paths for the target disk.

```
# vxdmpadm getsubpaths dmpnodename=emc_clariion0_137
NAME     STATE[A]   PATH-TYPE[M] CTLR-NAME ENCLR-TYPE        ENCLR-NAME ATTRS
================================================================================
hdisk59  ENABLED(A) PRIMARY      fscsi0    emc_clariion0_137 emc_clariion0 -
hdisk62  ENABLED    SECONDARY    fscsi0    emc_clariion0_137 emc_clariion0 -
hdisk65  ENABLED(A) PRIMARY      fscsi1    emc_clariion0_137 emc_clariion0 -
hdisk68  ENABLED    SECONDARY    fscsi1    emc_clariion0_137 emc_clariion0 -
```

4 Remove the disk from DMP control.

```
# /etc/vx/bin/vxdiskunsetup -C emc_clariion0_137

# vxdisk rm emc_clariion0_137
```

5 Clone the rootvg.

```
# alt_disk_install -C -P all hdisk59
+-------------------------------------------------------------------------------+
ATTENTION: calling new module /usr/sbin/alt_disk_copy. Please see the
alt_disk_copy man page
and documentation for more details.
Executing command: {/usr/sbin/alt_disk_copy -P "all" -d "hdisk59"}
+-------------------------------------------------------------------------------+
Calling mkszfile to create new /image.data file.
Checking disk sizes.
Creating cloned rootvg volume group and associated logical volumes.
Creating logical volume alt_hd5
Creating logical volume alt_hd6
Creating logical volume alt_hd8
Creating logical volume alt_hd4
Creating logical volume alt_hd2
Creating logical volume alt_hd9var
Creating logical volume alt_hd3
Creating logical volume alt_hd1
Creating logical volume alt_hd10opt
Creating logical volume alt_hd11admin
Creating logical volume alt_livedump
Creating /alt_inst/ file system.
/alt_inst filesystem not converted.
        Small inode extents are already enabled.
Creating /alt_inst/admin file system.
/alt_inst/admin filesystem not converted.
        Small inode extents are already enabled.
Creating /alt_inst/home file system.
/alt_inst/home filesystem not converted.
        Small inode extents are already enabled.
Creating /alt_inst/opt file system.
/alt_inst/opt filesystem not converted.
        Small inode extents are already enabled.
Creating /alt_inst/tmp file system.
/alt_inst/tmp filesystem not converted.
        Small inode extents are already enabled.
Creating /alt_inst/usr file system.
/alt_inst/usr filesystem not converted.
        Small inode extents are already enabled.
Creating /alt_inst/var file system.
/alt_inst/var filesystem not converted.
```

```
        Small inode extents are already enabled.
Creating /alt_inst/var/adm/ras/livedump file system.
/alt_inst/var/adm/ras/livedump filesystem not converted.
        Small inode extents are already enabled.
Generating a list of files
for backup and restore into the alternate file system...
Backing-up the rootvg files and restoring them to the
alternate file system...
Modifying ODM on cloned disk.
Building boot image on cloned disk.
forced unmount of /alt_inst/var/adm/ras/livedump
forced unmount of /alt_inst/var/adm/ras/livedump
forced unmount of /alt_inst/var
forced unmount of /alt_inst/var
forced unmount of /alt_inst/usr
forced unmount of /alt_inst/usr
forced unmount of /alt_inst/tmp
forced unmount of /alt_inst/tmp
forced unmount of /alt_inst/opt
forced unmount of /alt_inst/opt
forced unmount of /alt_inst/home
forced unmount of /alt_inst/home
forced unmount of /alt_inst/admin
forced unmount of /alt_inst/admin
forced unmount of /alt_inst
forced unmount of /alt_inst
Changing logical volume names in volume group descriptor area.
Fixing LV control blocks...
Fixing file system superblocks...
Bootlist is set to the boot disk: hdisk59 blv=hd5
```

6 Set the boot list to include all the paths to emc_clariion0_137.

```
# bootlist -m normal hdisk59 hdisk62 hdisk65 hdisk68 blv=hd5
```

Verify that the boot list includes all paths and that each path shows the default boot volume hd5:

```
# bootlist -m normal -o
hdisk59 blv=hd5
hdisk62 blv=hd5
hdisk65 blv=hd5
hdisk68 blv=hd5
```

7 Reboot the system.

```
# reboot
Rebooting . . .
```

8 Verify the DMP configuration.

```
# vxdmpadm native list
PATH                      DMPNODENAME
============================================
hdisk59                   emc_clariion0_137
hdisk62                   emc_clariion0_137
hdisk65                   emc_clariion0_137
hdisk68                   emc_clariion0_137
```

9 Verify the `lspv` output shows the path names.

```
# lspv | grep -w rootvg
hdisk59  00c408c4cc6f264e    rootvg    active
hdisk62  00c408c4cc6f264e    rootvg    active
hdisk65  00c408c4cc6f264e    rootvg    active
hdisk68  00c408c4cc6f264e    rootvg    active
```

Cleaning up the alternate disk volume group when LVM rootvg is enabled for DMP

When the LVM rootvg is enabled for DMP, use the procedures in this section to clean up the alternate disk volume group. The clean-up process removes the alternate root volume group (altinst_rootvg) from the AIX Object Data Manager (ODM) database. After you clean up the alternate disk volume group, the lspv command output displays 'None' for the altinst_rootvg. The command does not remove any data from the disk.

To clean up the alternate disk volume group when LVM rootvg is enabled for DMP

1. Verify that LVM rootvg is enabled for DMP. The alternate disk volume group to be cleaned up is altinst_rootvg.

```
# lspv | grep rootvg
hdisk59         00c408c4cc6f264e             rootvg active
hdisk62         00c408c4cc6f264e             rootvg active
hdisk65         00c408c4cc6f264e             rootvg active
hdisk68         00c408c4cc6f264e             rootvg active
ams_wms0_491    00c408c4dbd98818             altinst_rootvg
```

2. Show the DMP node names.

```
# vxdmpadm native list
PATH                      DMPNODENAME
============================================
hdisk59                   emc_clariion0_137
hdisk62                   emc_clariion0_137
hdisk65                   emc_clariion0_137
hdisk68                   emc_clariion0_137
```

3. Clean up the alternate disk volume group, altinst_rootvg.

```
# alt_disk_install -X altinst_rootvg
```

4. Display the configuration.

```
# lspv | grep rootvg
hdisk59         00c408c4cc6f264e             rootvg active
hdisk62         00c408c4cc6f264e             rootvg active
hdisk65         00c408c4cc6f264e             rootvg active
hdisk68         00c408c4cc6f264e             rootvg active
```

Using mksysb when the root volume group is under DMP control

You can create a `mksysb` image of the client. You can use the `mksysb` image to restore the root volume group, or to install on another client using NIM.

When the root volume group is under DMP control, use the following procedure to create the `mksysb` image.

To use mksysb when the root volume group is enabled for DMP

1. Show the DMP node names.

```
# vxdmpadm native list
PATH              DMPNODENAME
==================================
hdisk70           ams_wms0_491
hdisk72           ams_wms0_491
hdisk73           ams_wms0_491
hdisk74           ams_wms0_491
```

2. Run the following command:

```
# lspv | grep -w rootvg
hdisk70  00c408c4dbd98818  rootvg  active
hdisk72  00c408c4dbd98818  rootvg  active
hdisk73  00c408c4dbd98818  rootvg  active
hdisk74  00c408c4dbd98818  rootvg  active
```

3. Remove the disk from DMP control.

```
# vxdisk rm ams_wms0_491
```

4. Create the `mksysb` image. Use Network Installation Management (NIM) to install the operating system on the client, using the new image.

   See the operating system documentation for detailed information about `mksysb` and NIM.

5 Verify the status after reinstalling the operating system, using the following command:

```
# vxdmpadm native list
PATH              DMPNODENAME
==================================
hdisk70           ams_wms0_491
hdisk72           ams_wms0_491
hdisk73           ams_wms0_491
hdisk74           ams_wms0_491
```

6 Verify the configuration.

```
# lspv | grep -w rootvg
hdisk70  00c408c4dbd98818  rootvg  active
hdisk72  00c408c4dbd98818  rootvg  active
hdisk73  00c408c4dbd98818  rootvg  active
hdisk74  00c408c4dbd98818  rootvg  active

# lsvg -p rootvg
rootvg:
PV_NAME      PV STATE TOTAL PPs FREE PPs FREE DISTRIBUTION
hdisk70      active    39        361     127..05..00..101..128
```

Upgrading Dynamic Multi-Pathing and AIX on a DMP-enabled rootvg

If the rootvg is enabled for DMP, refer to the *Storage Foundation Configuration and Upgrade Guide* for instructions on how to upgrade Dynamic Multi-Pathing, AIX, or both.

Using Storage Foundation in the logical partition (LPAR) with virtual SCSI devices

Storage Foundation provides support for virtual SCSI (vSCSI) devices on the VIO client. You can create and manage Veritas Volume Manager (VxVM) volumes on vSCSI devices, as on any other devices. Storage Foundation provides Dynamic Multi-Pathing (DMP) for vSCSI devices, by default. Storage Foundation can also co-exist with MPIO for multi-pathing. If you choose to use MPIO to multipath the vSCSI devices, DMP works in pass-through mode.

Use the `vxddladm` utility and the `vxdmpadm` utility to administer DMP for vSCSI devices. The `vxddladm` utility controls enabling and disabling DMP on vSCSI devices,

adding and removing supported arrays, and listing supported arrays. The `vxdmpadm` utility controls the I/O policy and the path policy for vSCSI devices.

Setting up DMP for vSCSI devices in the logical partition (LPAR)

DMP is enabled on LPARs by default. After you install or upgrade Storage Foundation in the LPAR, any vSCSI devices are under DMP control and MPIO is disabled.

If you have already installed or upgraded Storage Foundation in the Virtual I/O client, use the following procedure to enable DMP support for vSCSI devices. This procedure is only required if you have previously disabled DMP support for vSCSI devices.

To enable vSCSI support within DMP and disable MPIO

1 Enable vSCSI support.

```
# vxddladm enablevscsi
```

2 You are prompted to reboot the system, if required.

DMP takes control of the devices, for any array that has DMP support to use the array for vSCSI devices. You can add or remove DMP support for vSCSI for arrays.

See "Adding and removing DMP support for vSCSI devices for an array" on page 104.

About disabling DMP for vSCSI devices in the logical partition (LPAR)

DMP can co-exist with MPIO multi-pathing in the Virtual I/O client or logical partition (LPAR). To use MPIO for multi-pathing, you can override the default behavior which enables Dynamic Multi-Pathing (DMP) in the LPAR.

There are two ways to do this:

- Before you install or upgrade Storage Foundation in the Virtual I/O client
  See "Preparing to install or upgrade Storage Foundation with DMP disabled for vSCSI devices in the logical partition (LPAR)" on page 103.
- After Storage Foundation is installed in the Virtual I/O client
  See "Disabling DMP multi-pathing for vSCSI devices in the logical partition (LPAR) after installation or upgrade" on page 103.

Preparing to install or upgrade Storage Foundation with DMP disabled for vSCSI devices in the logical partition (LPAR)

Before you install or upgrade Storage Foundation, you can set an environment variable to disable DMP use for the vSCSI devices. Storage Foundation is installed with DMP in pass-through mode. MPIO is enabled for multi-pathing.

Note: When you upgrade an existing VxVM installation that has DMP enabled, then DMP remains enabled regardless of whether or not the environment variable __VXVM_DMP_VSCSI_ENABLE is set to no.

To disable DMP before installing or upgrading SF in the LPAR

1. Before you install or upgrade VxVM, set the environment variable __VXVM_DMP_VSCSI_ENABLE to no.

   ```
   # export __VXVM_DMP_VSCSI_ENABLE=no
   ```

   Note: The environment variable name __VXVM_DMP_VSCSI_ENABLE begins with two underscore (_) characters.

2. Install Storage Foundation, as described in the *Veritas InfoScale Installation Guide*.

Disabling DMP multi-pathing for vSCSI devices in the logical partition (LPAR) after installation or upgrade

After VxVM is installed, use the `vxddladm` command to switch vSCSI devices between MPIO control and DMP control.

To return control to MPIO, disable vSCSI support with DMP. After DMP support has been disabled, MPIO takes control of the devices. MPIO implements multi-pathing features such as failover and load balancing; DMP acts in pass-through mode.

To disable vSCSI support within DMP and enable MPIO

1. Disable vSCSI support.

   ```
   # vxddladm disablevscsi
   ```

2. You are prompted to reboot the system, if required.

Adding and removing DMP support for vSCSI devices for an array

Dynamic Multi-Pathing (DMP) controls the devices for any array that has DMP support to use the array for vSCSI devices.

To add or remove DMP support for an array for use with vSCSI devices

1. To determine if DMP support is enabled for an array, list all of the arrays that DMP supports for use with vSCSI devices:

   ```
   # vxddladm listvscsi
   ```

2. If the support is not enabled, add support for using an array as a vSCSI device within DMP:

   ```
   # vxddladm addvscsi array_vid
   ```

3. If the support is enabled, you can remove the support so that the array is not used for vSCSI devices within DMP:

   ```
   # vxddladm rmvscsi array_vid
   ```

4. You are prompted to reboot the system, if required.

How DMP handles I/O for vSCSI devices

On the VIO client, DMP uses the Active/Standby array mode for the vSCSI devices. Each path to the vSCSI device is through a VIO server. One VIO server is Active and the other VIO servers are Standby. An Active/Standby array permits I/O through a single Active path, and keeps the other paths on standby. During failover, I/O is scheduled on one of the standby paths. After failback, I/Os are scheduled back onto the original Active path.

The following command shows the vSCSI enclosure:

```
# vxdmpadm listenclosure all
ENCLR_NAME ENCLR_TYPE ENCLR_SNO STATUS    ARRAY_TYPE LUN_COUNT FIRMWARE
============================================================================
ibm_vscsi0 IBM_VSCSI  VSCSI     CONNECTED VSCSI      9         -
```

The following command shows the I/O policy for the vSCSI enclosure:

```
# vxdmpadm getattr enclosure ibm_vscsi0 iopolicy
ENCLR_NAME     DEFAULT        CURRENT
============================================
ibm_vscsi0     Single-Active  Single-Active
```

For vSCSI devices, DMP balances the load between the VIO servers, instead of balancing the I/O on paths. By default, the `iopolicy` attribute of the vSCSI array is set to `lunbalance`. When `lunbalance` is set, the vSCSI LUNs are distributed so that the I/O load is shared across the VIO servers. For example, if you have 10 LUNs and 2 VIO servers, 5 of them are configured so that VIO Server 1 is Active and VIO Server 2 is Standby. The other 5 are configured so that the VIO Server 2 is Active and VIO Server 1 is Standby. To turn off load sharing across VIO servers, set the `iopolicy` attribute to `nolunbalance`.

DMP dynamically balances the I/O load across LUNs. When you add or remove disks or paths in the VIO client, the load is rebalanced. Temporary failures like enabling or disabling paths or controllers do not cause the I/O load across LUNs to be rebalanced.

Setting the vSCSI I/O policy

By default, DMP balances the I/O load across VIO servers. This behavior sets the I/O policy attribute to `lunbalance`.

To display the current I/O policy attribute for the vSCSI array

- Display the current I/O policy for a vSCSI array:

```
# vxdmpadm getattr vscsi iopolicy
VSCSI      DEFAULT      CURRENT
============================================
IOPolicy  lunbalance   lunbalance
```

To turn off the LUN balancing, set the I/O policy attribute for the vSCSI array to `nolunbalance`.

To set the I/O policy attribute for the vSCSI array

- Set the I/O policy for a vSCSI array:

```
# vxdmpadm setattr vscsi iopolicy={lunbalance|nolunbalance}
```

Note: The DMP I/O policy for each vSCSI device is always Single-Active. You cannot change the DMP I/O policy for the vSCSI enclosure. Only one VIO server can be Active for each vSCSI device.

Running alt_disk_install, alt_disk_copy and related commands on the OS device when DMP native support is enabled

When DMP is enabled for native OS devices, you can use the following procedures to run the `alt_disk_install` command, `alt_disk_copy` command, or related commands on the operating system device.

Running alt_disk_install in the physical environment

1. Find the DMP device corresponding to the OS device path on which you plan to run the `alt_disk_install` command.

```
# vxdmpadm getdmpnode nodename=hdisk13
NAME        STATE    ENCLR-TYPE PATHS ENBL DSBL ENCLR-NAME
============================================================
emc0_0039   ENABLED  EMC        4     4    0    emc0
```

2. Close references to the associated subpaths. Run the following command on the DMP device:

```
# vxdisk rm emc0_0039
```

3. Run the `alt_disk_install` command on the OS device.

   Refer to the OS vendor documentation for the `alt_disk_install` command.

Running alt_disk_install in the VIOS environment

1. Find the DMP device corresponding to the OS device path on which you plan to run the `alt_disk_install` command.

```
# vxdmpadm getdmpnode nodename=hdisk13
NAME        STATE    ENCLR-TYPE PATHS ENBL DSBL ENCLR-NAME
============================================================
emc0_0039   ENABLED  EMC        4     4    0    emc0
```

2. If the DMP device is exported to a VIO client, remove the mapping of the DMP device. From the VIOS, run the following command:

```
# /usr/ios/cli/ioscli rmvdev -vtd VTD_devicename
```

3 Close references to the associated subpaths. Run the following command on the DMP device:

```
# vxdisk rm emc0_0039
```

4 Run the `alt_disk_install` command on the OS device.

Refer to the OS vendor documentation for the `alt_disk_install` command.

Administering DMP using the vxdmpadm utility

The `vxdmpadm` utility is a command-line administrative interface to Dynamic Multi-Pathing (DMP).

You can use the `vxdmpadm` utility to perform the following tasks:

- Retrieve the name of the DMP device corresponding to a particular path.
  See "Retrieving information about a DMP node" on page 108.
- Display consolidated information about the DMP nodes.
  See "Displaying consolidated information about the DMP nodes" on page 109.
- Display the members of a LUN group.
  See "Displaying the members of a LUN group" on page 111.
- List all paths under a DMP device node, HBA controller, enclosure, or array port.
  See "Displaying paths controlled by a DMP node, controller, enclosure, or array port" on page 111.
- Display information about the HBA controllers on the host.
  See "Displaying information about controllers" on page 114.
- Display information about enclosures.
  See "Displaying information about enclosures" on page 115.
- Display information about array ports that are connected to the storage processors of enclosures.
  See "Displaying information about array ports" on page 116.
- Display asymmetric access state for ALUA arrays.
  See "User-friendly CLI outputs for ALUA arrays " on page 116.
- Display information about devices that are controlled by third-party multi-pathing drivers.
  See "Displaying information about devices controlled by third-party drivers" on page 117.
- Display extended devices attributes.

See "Displaying extended device attributes" on page 118.

- See "Suppressing or including devices from VxVM control" on page 121.
  Suppress or include devices from DMP control.
- Gather I/O statistics for a DMP node, enclosure, path, or controller.
  See "Gathering and displaying I/O statistics" on page 121.
- Configure the attributes of the paths to an enclosure.
  See "Setting the attributes of the paths to an enclosure" on page 128.
- Display the redundancy level of a device or enclosure.
  See "Displaying the redundancy level of a device or enclosure" on page 129.
- Specify the minimum number of active paths.
  See "Specifying the minimum number of active paths" on page 130.
- Display or set the I/O policy that is used for the paths to an enclosure.
  See "Specifying the I/O policy" on page 131.
- Enable or disable I/O for a path, HBA controller or array port on the system.
  See "Disabling I/O for paths, controllers, array ports, or DMP nodes" on page 137.
- Rename an enclosure.
  See "Renaming an enclosure" on page 140.
- Configure how DMP responds to I/O request failures.
  See "Configuring the response to I/O failures" on page 140.
- Configure the I/O throttling mechanism.
  See "Configuring the I/O throttling mechanism" on page 142.
- Control the operation of the DMP path restoration thread.
  See "Configuring DMP path restoration policies" on page 145.
- Configure array policy modules.
  See "Configuring Array Policy Modules" on page 147.
- Get or set the values of various tunables used by DMP.
  See "DMP tunable parameters" on page 206.

See the `vxdmpadm`(1M) manual page.

Retrieving information about a DMP node

The following command displays the Dynamic Multi-Pathing (DMP) node that controls a particular physical path:

```
# vxdmpadm getdmpnode nodename=pathname
```

The physical path is specified by argument to the `nodename` attribute, which must be a valid path listed in the device directory.

The device directory is the `/dev` directory.

The command displays output similar to the following example output.

```
# vxdmpadm getdmpnode nodename=hdisk107

NAME              STATE   ENCLR-TYPE   PATHS ENBL DSBL ENCLR-NAME
=============================================================================
emc_clariion0_17 ENABLED EMC_CLARiiON 8     8    0    emc_clariion0
```

Use the `-v` option to display the LUN serial number and the array volume ID.

```
# vxdmpadm -v getdmpnode nodename=hdisk107

NAME              STATE  ENCLR-TYPE  PATHS ENBL DSBL ENCLR-NAME SERIAL-NO ARRAY_VOL_ID
=============================================================================================
emc_clariion0_17 ENABLED EMC_CLARiiON 8   8    0   emc_clariion0 600601601 17
```

Use the `enclosure` attribute with `getdmpnode` to obtain a list of all DMP nodes for the specified enclosure.

```
# vxdmpadm getdmpnode enclosure=enc0

NAME     STATE    ENCLR-TYPE PATHS  ENBL  DSBL ENCLR-NAME
=============================================================
hdisk11  ENABLED  ACME       2      2     0    enc0
hdisk12  ENABLED  ACME       2      2     0    enc0
hdisk13  ENABLED  ACME       2      2     0    enc0
hdisk14  ENABLED  ACME       2      2     0    enc0
```

Use the `dmpnodename` attribute with `getdmpnode` to display the DMP information for a given DMP node.

```
# vxdmpadm getdmpnode dmpnodename=emc_clariion0_158

NAME              STATE   ENCLR-TYPE   PATHS ENBL DSBL ENCLR-NAME
=============================================================================
emc_clariion0_158 ENABLED EMC_CLARiiON 1     1    0    emc_clariion0
```

Displaying consolidated information about the DMP nodes

The `vxdmpadm list dmpnode` command displays the detail information of a Dynamic Multi-Pathing (DMP) node. The information includes the enclosure name, LUN serial number, port id information, device attributes, and so on.

The following command displays the consolidated information for all of the DMP nodes in the system:

```
# vxdmpadm list dmpnode all
```

Use the `enclosure` attribute with `list dmpnode` to obtain a list of all DMP nodes for the specified enclosure.

```
# vxdmpadm list dmpnode enclosure=enclosurename
```

For example, the following command displays the consolidated information for all of the DMP nodes in the `enc0` enclosure.

```
# vxdmpadm list dmpnode enclosure=enc0
```

Use the `dmpnodename` attribute with `list dmpnode` to display the DMP information for a given DMP node. The DMP node can be specified by name or by specifying a path name. The detailed information for the specified DMP node includes path information for each subpath of the listed DMP node.

The path state differentiates between a path that is disabled due to a failure and a path that has been manually disabled for administrative purposes. A path that has been manually disabled using the `vxdmpadm disable` command is listed as `disabled(m)`.

```
# vxdmpadm list dmpnode dmpnodename=dmpnodename
```

For example, the following command displays the consolidated information for the DMP node `emc_clariion0_158`.

```
# vxdmpadm list dmpnode dmpnodename=emc_clariion0_158
```

```
dmpdev      = emc_clariion0_158
state       = enabled
enclosure   = emc_clariion0
cab-sno     = APM00042102192
asl         = libvxCLARiiON.so
vid         = DGC
pid         = CLARiiON
array-name  = EMC_CLARiiON
array-type  = CLR-A/P
iopolicy    = MinimumQ
avid        = -
lun-sno     = 6006016070071100F6BF98A778EDD811
udid        = DGC%5FCLARiiON%5FAPM00042102192%5F6006016070071100F6BF98A778EDD811
dev-attr    = -
```

```
###path     = name state type transport ctlr hwpath aportID aportWWN attr
path        = hdisk11 enabled(a) primary FC fscsi0 07-08-02 B0APM00042102192
50:06:01:68:10:21:26:c1 -
path        = hdisk31 disabled secondary FC fscsi1 08-08-02 A0APM00042102192
50:06:01:60:10:21:26:c1 -
```

Displaying the members of a LUN group

The following command displays the Dynamic Multi-Pathing (DMP) nodes that are in the same LUN group as a specified DMP node:

```
# vxdmpadm getlungroup dmpnodename=dmpnode
```

For example:

```
# vxdmpadm getlungroup dmpnodename=hdisk16

NAME     STATE    ENCLR-TYPE  PATHS     ENBL    DSBL   ENCLR-NAME
=============================================================
hdisk14  ENABLED  ACME        2         2       0       enc1
hdisk15  ENABLED  ACME        2         2       0       enc1
hdisk16  ENABLED  ACME        2         2       0       enc1
hdisk17  ENABLED  ACME        2         2       0       enc1
```

Displaying paths controlled by a DMP node, controller, enclosure, or array port

The `vxdmpadm getsubpaths` command lists all of the paths known to Dynamic Multi-Pathing (DMP). The `vxdmpadm getsubpaths` command also provides options to list the subpaths through a particular DMP node, controller, enclosure, or array port. To list the paths through an array port, specify either a combination of enclosure name and array port id, or array port worldwide name (WWN).

To list all subpaths known to DMP:

```
# vxdmpadm getsubpaths
```

```
NAME      STATE[A]   PATH-TYPE[M] DMPNODENAME  ENCLR-NAME   CTLR   ATTRS
=============================================================================
hdisk1    ENABLED(A)   -          disk_0       disk         scsi0    -
hdisk0    ENABLED(A)   -          disk_1       disk         scsi0    -
hdisk107  ENABLED(A) PRIMARY      emc_clariion0_17 emc_clariion0 fscsi1   -
hdisk17   ENABLED    SECONDARY    emc_clariion0_17 emc_clariion0 fscsi0   -
hdisk108  ENABLED(A) PRIMARY      emc_clariion0_74 emc_clariion0 fscsi1   -
hdisk18   ENABLED    SECONDARY    emc_clariion0_74 emc_clariion0 fscsi0   -
```

```
hdisk109  ENABLED(A) PRIMARY      emc_clariion0_75 emc_clariion0 fscsi1   -
hdisk19   ENABLED    SECONDARY    emc_clariion0_75 emc_clariion0 fscsi0   -
```

The `vxdmpadm getsubpaths` command combined with the `dmpnodename` attribute displays all the paths to a LUN that are controlled by the specified DMP node name from the `/dev/vx/rdmp` directory:

```
# vxdmpadm getsubpaths dmpnodename=hdisk22

NAME    STATE[A]  PATH-TYPE[M] CTLR-NAME ENCLR-TYPE ENCLR-NAME ATTRS
=================================================================
hdisk22 ENABLED(A) PRIMARY     scsi2     ACME       enc0       -
hdisk21 ENABLED    PRIMARY     scsi1     ACME       enc0       -
```

For A/A arrays, all enabled paths that are available for I/O are shown as `ENABLED(A)`.

For A/P arrays in which the I/O policy is set to `singleactive`, only one path is shown as `ENABLED(A)`. The other paths are enabled but not available for I/O. If the I/O policy is not set to `singleactive`, DMP can use a group of paths (all primary or all secondary) for I/O, which are shown as `ENABLED(A)`.

See "Specifying the I/O policy" on page 131.

Paths that are in the DISABLED state are not available for I/O operations.

A path that was manually disabled by the system administrator displays as DISABLED(M). A path that failed displays as DISABLED.

You can use `getsubpaths` to obtain information about all the paths that are connected to a particular HBA controller:

```
# vxdmpadm getsubpaths ctlr=fscsi1

NAME     STATE[A]   PATH-TYPE[M] DMPNODENAME  ENCLR-TYPE   ENCLR-NAME   ATTRS
=============================================================================
hdisk107 ENABLED(A) PRIMARY      emc_clariion0_17 EMC_CLARiiON emc_clariion0 -
hdisk62  ENABLED    SECONDARY    emc_clariion0_17 EMC_CLARiiON emc_clariion0 -
hdisk108 ENABLED(A) PRIMARY      emc_clariion0_74 EMC_CLARiiON emc_clariion0 -
hdisk63  ENABED     SECONDARY    emc_clariion0_74 EMC_CLARiiON emc_clariion0 -
```

You can also use `getsubpaths` to obtain information about all the paths that are connected to a port on an array. The array port can be specified by the name of the enclosure and the array port ID, or by the WWN identifier of the array port:

```
# vxdmpadm getsubpaths enclosure=enclosure portid=portid
# vxdmpadm getsubpaths pwwn=pwwn
```

For example, to list subpaths through an array port through the enclosure and the array port ID:

```
# vxdmpadm getsubpaths enclosure=emc_clariion0 portid=A2

NAME     STATE[A]   PATH-TYPE[M] DMPNODENAME  ENCLR-NAME   CTLR    ATTRS
==========================================================================
hdisk111 ENABLED(A) PRIMARY      emc_clariion0_80 emc_clariion0 fscsi1 -
hdisk51  ENABLED(A) PRIMARY      emc_clariion0_80 emc_clariion0 fscsi0 -
hdisk112 ENABLED(A) PRIMARY      emc_clariion0_81 emc_clariion0 fscsi1 -
hdisk52  ENABLED(A) PRIMARY      emc_clariion0_81 emc_clariion0 fscsi0 -
```

For example, to list subpaths through an array port through the WWN:

```
NAME     STATE[A]   PATH-TYPE[M] DMPNODENAME  ENCLR-NAME   CTLR    ATTRS
==========================================================================
hdisk111 ENABLED(A) PRIMARY      emc_clariion0_80 emc_clariion0 fscsi1 -
hdisk51  ENABLED(A) PRIMARY      emc_clariion0_80 emc_clariion0 fscsi0 -
hdisk112 ENABLED(A) PRIMARY      emc_clariion0_81 emc_clariion0 fscsi1 -
hdisk52  ENABLED(A) PRIMARY      emc_clariion0_81 emc_clariion0 fscsi0 -
```

You can use `getsubpaths` to obtain information about all the subpaths of an enclosure.

```
# vxdmpadm getsubpaths enclosure=enclosure_name [ctlr=ctlrname]
```

To list all subpaths of an enclosure:

```
# vxdmpadm getsubpaths enclosure=emc_clariion0
NAME         STATE[A]   PATH-TYPE[M] DMPNODENAME  ENCLR-NAME   CTLR    ATTRS
================================================================================
hdisk107     ENABLED(A) PRIMARY      emc_clariion0_17 emc_clariion0 fscsi1    -
hdisk17      ENABLED    SECONDARY    emc_clariion0_17 emc_clariion0 fscsi0    -
hdisk110     ENABLED(A) PRIMARY      emc_clariion0_76 emc_clariion0 fscsi1    -
hdisk20      ENABLED    SECONDARY    emc_clariion0_76 emc_clariion0 fscsi0    -
```

To list all subpaths of a controller on an enclosure:

By default, the output of the `vxdmpadm getsubpaths` command is sorted by enclosure name, DMP node name, and within that, path name.

To sort the output based on the pathname, the DMP node name, the enclosure name, or the host controller name, use the `-s` option.

To sort subpaths information, use the following command:

```
# vxdmpadm -s {path | dmpnode | enclosure | ctlr} getsubpaths \
[all | ctlr=ctlr_name | dmpnodename=dmp_device_name | \
```

```
enclosure=enclr_name [ctlr=ctlr_name | portid=array_port_ID] | \
pwwn=port_WWN | tpdnodename=tpd_node_name]
```

See "Setting customized names for DMP nodes" on page 72.

Displaying information about controllers

The following Dynamic Multi-Pathing (DMP) command lists attributes of all HBA controllers on the system:

```
# vxdmpadm listctlr all

CTLR-NAME    ENCLR-TYPE     STATE     ENCLR-NAME       PATH_COUNT
============================================================
scsi1        OTHER          ENABLED   other0           3
scsi2        X1             ENABLED   jbod0            10
scsi3        ACME           ENABLED   enc0             24
scsi4        ACME           ENABLED   enc0             24
```

This output shows that the controller `scsi1` is connected to disks that are not in any recognized DMP category as the enclosure type is `OTHER`.

The other controllers are connected to disks that are in recognized DMP categories.

All the controllers are in the ENABLED state, which indicates that they are available for I/O operations.

The state DISABLED is used to indicate that controllers are unavailable for I/O operations. The unavailability can be due to a hardware failure or due to I/O operations being disabled on that controller by using the `vxdmpadm disable` command.

The following forms of the command lists controllers belonging to a specified enclosure or enclosure type:

```
# vxdmpadm listctlr enclosure=emc0
```

or

```
# vxdmpadm listctlr type=EMC

CTLR-NAME    ENCLR-TYPE     STATE     ENCLR-NAME        PATH_COUNT
============================================================
scsi2        EMC           ENABLED   emc0              10
scsi3        EMC           ENABLED   emc0              24
```

The `vxdmpadm getctlr` command displays HBA vendor details and the Controller ID. For iSCSI devices, the Controller ID is the IQN or IEEE-format based name.

For FC devices, the Controller ID is the WWN. Because the WWN is obtained from ESD, this field is blank if ESD is not running. ESD is a daemon process used to notify DDL about occurrence of events. The WWN shown as 'Controller ID' maps to the WWN of the HBA port associated with the host controller.

```
# vxdmpadm getctlr fscsi2

LNAME     PNAME       VENDOR    CTLR-ID
============================================================
fscsi2    20-60-01    IBM       10:00:00:00:c9:2d:26:11
```

Displaying information about enclosures

Dynamic Multi-Pathing (DMP) can display the attributes of the enclosures, including the enclosure type, enclosure serial number, status, array type, number of LUNs, and the firmware version, if available.

To display the attributes of a specified enclosure, use the following DMP command:

```
# vxdmpadm listenclosure emc0
ENCLR_NAME ENCLR_TYPE ENCLR_SNO            STATUS    ARRAY_TYPE LUN_COUNT FIRMWARE
================================================================================
emc0       EMC        000292601383         CONNECTED A/A        30        5875
```

To display the attrtibutes for all enclosures in a system, use the following DMP command:

```
# vxdmpadm listenclosure all

ENCLR_NAME      ENCLR_TYPE     ENCLR_SNO     STATUS    ARRAY_TYPE LUN_COUNT FIRMWARE
================================================================================
Disk            Disk           DISKS         CONNECTED Disk       6         -
emc0            EMC            000292601383  CONNECTED A/A        1         5875
hitachi_usp-vm0 Hitachi_USP-VM 25847         CONNECTED A/A        1         6008
emc_clariion0   EMC_CLARiiON   CK20007040035 CONNECTED CLR-A/PF   2         0324
```

If an A/P or ALUA array is under the control of MPIO, then DMP claims the devices in A/A mode. The output of the above commands shows the ARRAY_TYPE as A/A. For arrays under MPIO control, DMP does not store A/P-specific attributes or ALUA-specific attributes. These attributes include primary/secondary paths, port serial number, and the array controller ID.

Displaying information about array ports

Use the Dynamic Multi-Pathing (DMP) commands in this section to display information about array ports. The information displayed for an array port includes the name of its enclosure, its ID, and its worldwide name (WWN) identifier.

Note: DMP does not report information about array ports for LUNs that are controlled by the native multi-pathing driver. DMP reports pWWN information only if the dmp_monitor_fabric tunable is on, and the event source daemon (esd) is running.

To display the attributes of an array port that is accessible through a path, DMP node or HBA controller, use one of the following commands:

```
# vxdmpadm getportids path=path_name
# vxdmpadm getportids dmpnodename=dmpnode_name
# vxdmpadm getportids ctlr=ctlr_name
```

The following form of the command displays information about all of the array ports within the specified enclosure:

```
# vxdmpadm getportids enclosure=enclr_name
```

The following example shows information about the array port that is accessible through DMP node `hdisk12`:

```
# vxdmpadm getportids dmpnodename=hdisk12

NAME        ENCLR-NAME   ARRAY-PORT-ID pWWN
============================================================
hdisk12     HDS9500V0    1A            20:00:00:E0:8B:06:5F:19
```

User-friendly CLI outputs for ALUA arrays

DMP supports storage arrays using ALUA standard. From Veritas InfoScale 7.1 onwards, DMP supports multi-controller (more than 2 controllers) ALUA compliant arrays.

For ALUA arrays, the `dmp_display_alua_states` tunable parameter displays the asymmetric access state of the Logical Unit (LUN) instead of PRIMARY or SECONDARY in the PATH-TYPE[M] column.

Note: The default tunable value is **on**.

To view asymmetric access states of an ALUA LUN, enter:

```
# vxdmpadm getsubpaths dmpnodename=dmpnode_name
```

Typical output is as follows:

```
# vxdmpadm getsubpaths dmpnodename=emc_clariion0_786

NAME      STATE[A]    PATH-TYPE[M]         CTLR-NAME ENCLR-TYPE    ENCLR-NAME    ATTRS
==========================================================================================
hdisk40   ENABLED     Active/Non-Optimized fscsi0    EMC_CLARiiON  emc_clariion0     -
hdisk58   ENABLED     Active/Non-Optimized fscsi1    EMC_CLARiiON  emc_clariion0     -
hdisk67   ENABLED(A)  Active/Optimized(P)  fscsi1    EMC_CLARiiON  emc_clariion0     -
hdisk77   ENABLED(A)  Active/Optimized(P)  fscsi0    EMC_CLARiiON  emc_clariion0     -
```

Note: In the output, (P) signifies that the path is connected to the target port group marked as preferred by the device server.

All VxVM/DMP outputs which earlier displayed PRIMARY or SECONDARY in the PATH-TYPE[M] column will now display the asymmetric access state.

If you want to go back to the previous version of the CLI output which displays PRIMARY or SECONDARY in the PATH-TYPE[M] column, enter the following command to disable the `dmp_display_alua_states` tunable parameter:

```
# vxdmpadm settune dmp_display_alua_states=off
```

The tunable value changes immediately.

Displaying information about devices controlled by third-party drivers

The third-party driver (TPD) coexistence feature allows I/O that is controlled by third-party multi-pathing drivers to bypass Dynamic Multi-Pathing (DMP) while retaining the monitoring capabilities of DMP. The following commands allow you to display the paths that DMP has discovered for a given TPD device, and the TPD device that corresponds to a given TPD-controlled node discovered by DMP:

```
# vxdmpadm getsubpaths tpdnodename=TPD_node_name
# vxdmpadm gettpdnode nodename=TPD_path_name
```

See “Changing device naming for enclosures controlled by third-party drivers” on page 170.

For example, consider the following disks in an EMC Symmetrix array controlled by PowerPath, which are known to DMP:

```
# vxdisk list
```

```
DEVICE          TYPE            DISK        GROUP     STATUS
hdiskpower10    auto:cdsdisk    disk1       ppdg      online
hdiskpower11    auto:cdsdisk    disk2       ppdg      online
hdiskpower12    auto:cdsdisk    disk3       ppdg      online
hdiskpower13    auto:cdsdisk    disk4       ppdg      online
hdiskpower14    auto:cdsdisk    disk5       ppdg      online
hdiskpower15    auto:cdsdisk    disk6       ppdg      online
hdiskpower16    auto:cdsdisk    disk7       ppdg      online
hdiskpower17    auto:cdsdisk    disk8       ppdg      online
hdiskpower18    auto:cdsdisk    disk9       ppdg      online
hdiskpower19    auto:cdsdisk   disk10      ppdg      online
```

The following command displays the paths that DMP has discovered, and which correspond to the PowerPath-controlled node, `emcpower10`:

```
# vxdmpadm getsubpaths tpdnodename=hdiskpower10

NAME     TPDNODENAME   PATH-TYPE[-]DMP-NODENAME   ENCLR-TYPE ENCLR-NAME
=================================================================
hdisk10 hdiskpower10s2 -           hdiskpower10    EMC        EMC0
hdisk20 hdiskpower10s2 -           hdiskpower10    EMC        EMC0
```

Conversely, the next command displays information about the PowerPath node that corresponds to the path, `hdisk10`, discovered by DMP:

```
# vxdmpadm gettpdnode nodename=hdiskpower10

NAME          STATE     PATHS   ENCLR-TYPE     ENCLR-NAME
=================================================================
hdiskpower10s2 ENABLED  2       EMC            EMC0
```

Displaying extended device attributes

Device Discovery Layer (DDL) extended attributes are attributes or flags corresponding to a Veritas Volume Manager (VxVM) or Dynamic Multi-Pathing (DMP) LUN or disk and that are discovered by DDL. These attributes identify a LUN to a specific hardware category.

Table 4-1 describes the list of categories.

Table 4-1 Categories for extended attributes

Category	Description
Hardware RAID types	Displays what kind of Storage RAID Group the LUN belongs to
Thin Provisioning Discovery and Reclamation	Displays the LUN's thin reclamation abilities
Device Media Type	Displays the type of media –whether SSD (Solid State Drive)
Storage-based Snapshot/Clone	Displays whether the LUN is a SNAPSHOT or a CLONE of a PRIMARY LUN
Storage-based replication	Displays if the LUN is part of a replicated group across a remote site
Transport	Displays what kind of HBA is used to connect to this LUN (FC, SATA, iSCSI)

Each LUN can have one or more of these extended attributes. DDL discovers the extended attributes during device discovery from the Array Support Library (ASL). If Veritas Operations Manager (VOM) is present, DDL can also obtain extended attributes from the VOM Management Server for hosts that are configured as managed hosts.

The `vxdisk -p list` command displays DDL extended attributes. For example, the following command shows attributes of `std`, `fc`, and `RAID_5` for this LUN:

```
# vxdisk -p list
DISK           : tagmastore-usp0_0e18
DISKID         : 1253585985.692.rx2600h11
VID            : HITACHI
UDID           : HITACHI%5FOPEN-V%5F02742%5F0E18
REVISION       : 5001
PID            : OPEN-V
PHYS_CTLR_NAME : 0/4/1/1.0x50060e8005274246
LUN_SNO_ORDER  : 411
LUN_SERIAL_NO  : 0E18
LIBNAME        : libvxhdsusp.sl
HARDWARE_MIRROR: no
DMP_DEVICE     : tagmastore-usp0_0e18
DDL_THIN_DISK  : thick
DDL_DEVICE_ATTR: std fc RAID_5
CAB_SERIAL_NO  : 02742
```

```
ATYPE          : A/A
ARRAY_VOLUME_ID: 0E18
ARRAY_PORT_PWWN: 50:06:0e:80:05:27:42:46
ANAME          : TagmaStore-USP
TRANSPORT      : FC
```

The `vxdisk -x attribute -p list` command displays the one-line listing for the property list and the attributes. The following example shows two Hitachi LUNs that support Thin Reclamation through the attribute `hdprclm`:

```
# vxdisk -x DDL_DEVICE_ATTR -p list
DEVICE                  DDL_DEVICE_ATTR
tagmastore-usp0_0a7a    std fc RAID_5
tagmastore-usp0_065a    hdprclm fc
tagmastore-usp0_065b    hdprclm fc
```

User can specify multiple -x options in the same command to display multiple entries. For example:

```
# vxdisk -x DDL_DEVICE_ATTR -x VID -p list

DEVICE               DDL_DEVICE_ATTR  VID
tagmastore-usp0_0a7a std fc RAID_5    HITACHI
tagmastore-usp0_0a7b std fc RAID_5    HITACHI
tagmastore-usp0_0a78 std fc RAID_5    HITACHI
tagmastore-usp0_0a79 std fc RAID_5    HITACHI
tagmastore-usp0_065a hdprclm fc       HITACHI
tagmastore-usp0_065b hdprclm fc       HITACHI
tagmastore-usp0_065c hdprclm fc       HITACHI
tagmastore-usp0_065d hdprclm fc       HITACHI
```

Use the `vxdisk -e list` command to show the DLL_DEVICE_ATTR property in the last column named ATTR.

```
# vxdisk -e list
DEVICE               TYPE  DISK  GROUP  STATUS  OS_NATIVE_NAME  ATTR
tagmastore-usp0_0a7a auto  -     -      online  c10t0d2         std fc RAID_5
tagmastore-usp0_0a7b auto  -     -      online  c10t0d3         std fc RAID_5
tagmastore-usp0_0a78 auto  -     -      online  c10t0d0         std fc RAID_5
tagmastore-usp0_0655 auto  -     -      online  c13t2d7         hdprclm fc
tagmastore-usp0_0656 auto  -     -      online  c13t3d0         hdprclm fc
tagmastore-usp0_0657 auto  -     -      online  c13t3d1         hdprclm fc
```

For a list of ASLs that supports Extended Attributes, and descriptions of these attributes, refer to the hardware compatibility list (HCL).

Note: DMP does not support Extended Attributes for LUNs that are controlled by the native multi-pathing driver.

Suppressing or including devices from VxVM control

The `vxdmpadm exclude` command suppresses devices from Veritas Volume Manager (VxVM) based on the criteria that you specify. When a device is suppressed, Dynamic Multi-Pathing (DMP) does not claim the device so that the device is not available for VxVM to use. You can add the devices back into VxVM control with the `vxdmpadm include` command. The devices can be included or excluded based on VID:PID combination, paths, controllers, or disks. You can use the bang symbol (!) to exclude or include any paths or controllers except the one specified.

The root disk cannot be suppressed. The operation fails if the VID:PID of an external disk is the same VID:PID as the root disk and the root disk is under DMP rootability control.

Note: The ! character is a special character in some shells. The following syntax shows how to escape it in a bash shell.

```
# vxdmpadm exclude { all | product=VID:PID |
ctlr=[\!]ctlrname | dmpnodename=diskname [ path=[\!]pathname] }

# vxdmpadm include { all | product=VID:PID |
ctlr=[\!]ctlrname | dmpnodename=diskname [ path=[\!]pathname] }
```

where:

all	all devices
product=*VID:PID*	all devices with the specified VID:PID
ctlr=*ctlrname*	all devices through the given controller
dmpnodename=*diskname*	all paths under the DMP node
dmpnodename=*diskname* path=\!*pathname*	all paths under the DMP node except the one specified

Gathering and displaying I/O statistics

You can use the `vxdmpadm iostat` command to gather and display I/O statistics for a specified DMP node, enclosure, path, port, or controller.

The statistics displayed are the CPU usage and amount of memory per CPU used to accumulate statistics, the number of read and write operations, the number of kilobytes read and written, and the average time in milliseconds per kilobyte that is read or written.

To enable the gathering of statistics, enter this command:

```
# vxdmpadm iostat start [memory=size]
```

The `memory` attribute limits the maximum amount of memory that is used to record I/O statistics for each CPU. The default limit is `32k` (32 kilobytes) per CPU.

To reset the I/O counters to zero, use this command:

```
# vxdmpadm iostat reset
```

To display the accumulated statistics at regular intervals, use the following command:

```
# vxdmpadm iostat show {filter} [interval=seconds [count=N]]
```

The above command displays I/O statistics for the devices specified by the *filter*. The *filter* is one of the following:

- `all`
- `ctlr=`*`ctlr-name`*
- `dmpnodename=`*`dmp-node`*
- `enclosure=`*`enclr-name`* `[portid=`*`array-portid`* `] [ctlr=`*`ctlr-name`*`]`
- `pathname=`*`path-name`*
- `pwwn=`*`array-port-wwn`* `[ctlr=`*`ctlr-name`*`]`

Use the `interval` and `count` attributes to specify the interval in seconds between displaying the I/O statistics, and the number of lines to be displayed. The actual interval may be smaller than the value specified if insufficient memory is available to record the statistics.

DMP also provides a *groupby* option to display cumulative I/O statistics, aggregated by the specified criteria.

See "Displaying cumulative I/O statistics" on page 123.

To disable the gathering of statistics, enter this command:

```
# vxdmpadm iostat stop
```

Displaying cumulative I/O statistics

The `vxdmpadm iostat` command provides the ability to analyze the I/O load distribution across various I/O channels or parts of I/O channels. Select the appropriate *filter* to display the I/O statistics for the DMP node, controller, array enclosure, path, port, or virtual machine. Then, use the *groupby* clause to display cumulative statistics according to the criteria that you want to analyze. If the `groupby` clause is not specified, then the statistics are displayed per path.

When you combine the *filter* and the *groupby* clause, you can analyze the I/O load for the required use case scenario. For example:

- To compare I/O load across HBAs, enclosures, or array ports, use the *groupby* clause with the specified attribute.
- To analyze I/O load across a given I/O channel (HBA to array port link), use *filter* by HBA and PWWN or enclosure and array port.
- To analyze I/O load distribution across links to an HBA, use *filter* by HBA and *groupby* array port.

Use the following format of the `iostat` command to analyze the I/O loads:

```
# vxdmpadm [-u unit] iostat show [groupby=criteria] {filter}  \
  [interval=seconds [count=N]]
```

The above command displays I/O statistics for the devices specified by the *filter*. The *filter* is one of the following:

- `all`
- `ctlr=ctlr-name`
- `dmpnodename=dmp-node`
- `enclosure=enclr-name [portid=array-portid ] [ctlr=ctlr-name]`
- `pathname=path-name`
- `pwwn=array-port-wwn[ctlr=ctlr-name]`

You can aggregate the statistics by the following `groupby` criteria:

- `arrayport`
- `ctlr`
- `dmpnode`
- `enclosure`

By default, the read/write times are displayed in milliseconds up to 2 decimal places. The throughput data is displayed in terms of BLOCKS, and the output is scaled,

meaning that the small values are displayed in small units and the larger values are displayed in bigger units, keeping significant digits constant. You can specify the units in which the statistics data is displayed. The `-u` option accepts the following options:

`h or H`	Displays throughput in the highest possible unit.
`k`	Displays throughput in kilobytes.
`m`	Displays throughput in megabytes.
`g`	Displays throughput in gigabytes.
`bytes| b`	Displays throughput in exact number of bytes.
`us`	Displays average read/write time in microseconds.

To group by DMP node:

```
# vxdmpadm [-u unit] iostat show groupby=dmpnode \
[all | dmpnodename=dmpnodename | enclosure=enclr-name]
```

To group by controller:

```
# vxdmpadm [-u unit] iostat show groupby=ctlr [ all | ctlr=ctlr ]
```

For example:

```
# vxdmpadm iostat show groupby=ctlr ctlr=fscsi0

cpu usage = 843us    per cpu memory = 49152b
              OPERATIONS       BLOCKS          AVG TIME(ms)
CTLRNAME   READS  WRITES   READS   WRITES   READS   WRITES
fscsi0     276    0        2205    0         0.03     0.00
```

To group by arrayport:

```
# vxdmpadm [-u unit] iostat show groupby=arrayport [ all \
| pwwn=array_pwwn | enclosure=enclr portid=array-port-id ]
```

For example:

```
# vxdmpadm -u m iostat show groupby=arrayport \
enclosure=HDS9500-ALUA0 portid=1A

             OPERATIONS         BYTES        AVG TIME(ms)
PORTNAME   READS    WRITES   READS  WRITES   READS    WRITES
1A         743      1538     11m    24m      17.13    8.61
```

To group by enclosure:

```
# vxdmpadm [-u unit] iostat show groupby=enclosure [ all \
| enclosure=enclr ]
```

For example:

```
# vxdmpadm -u h iostat show groupby=enclosure enclosure=EMC_CLARiiON0

OPERATIONS        BLOCKS        AVG TIME(ms)
ENCLOSURENAME   READS  WRITES  READS  WRITES  READS   WRITES
EMC_CLARiiON0   743    1538    11392k  24176k 17.13   8.61
```

You can also filter out entities for which all data entries are zero. This option is especially useful in a cluster environment that contains many failover devices. You can display only the statistics for the active paths.

To filter all zero entries from the output of the `iostat show` command:

```
# vxdmpadm [-u unit] -z iostat show [all|ctlr=ctlr_name |
dmpnodename=dmp_device_name | enclosure=enclr_name [portid=portid] |
pathname=path_name|pwwn=port_WWN][interval=seconds [count=N]]
```

For example:

```
# vxdmpadm -z iostat show dmpnodename=hdisk40

cpu usage = 906us    per cpu memory = 49152b
             OPERATIONS      BLOCKS          AVG TIME(ms)
PATHNAME  READS  WRITES   READS   WRITES   READS    WRITES
hdisk100  7      0        70      0         0.02      0.00
hdisk115  12     0        58      0         0.03      0.00
hdisk40   10     0        101     0         0.02      0.00
hdisk55   5      0        21      0         0.04      0.00
```

To display average read/write times in microseconds.

```
# vxdmpadm -u us iostat show pathname=hdisk115

cpu usage = 1030us    per cpu memory = 49152b
              OPERATIONS       BLOCKS           AVG TIME(us)
PATHNAME   READS    WRITES  READS    WRITES   READS    WRITES
hdisk115   12       0       58       0        32.00      0.00
```

Displaying statistics for queued or erroneous I/Os

Use the `vxdmpadm iostat show` command with the `-q` option to display the I/Os queued in Dynamic Multi-Pathing (DMP) for a specified DMP node, or for a specified

path or controller. For a DMP node, the `-q` option displays the I/Os on the specified DMP node that were sent to underlying layers. If a path or controller is specified, the `-q` option displays I/Os that were sent to the given path or controller and not yet returned to DMP.

See the `vxdmpadm`(1m) manual page for more information about the `vxdmpadm iostat` command.

To display queued I/O counts on a DMP node:

```
# vxdmpadm -q iostat show [filter] [interval=n [count=m]]
```

For example:

```
# vxdmpadm -q iostat show dmpnodename=hdisk10

cpu usage = 529us    per cpu memory = 49152b
                        QUEUED I/Os     PENDING I/Os
DMPNODENAME          READS    WRITES
hdisk10              0        0         0
```

To display the count of I/Os that returned with errors on a DMP node, path, or controller:

```
# vxdmpadm -e iostat show [filter] [interval=n [count=m]]
```

For example, to show the I/O counts that returned errors on a path:

```
# vxdmpadm -e iostat show pathname=hdisk55

cpu usage = 656us    per cpu memory = 49152b
                        ERROR I/Os
PATHNAME             READS    WRITES
hdisk55                  0         0
```

Examples of using the vxdmpadm iostat command

Dynamic Multi-Pathing (DMP) enables you to gather and display I/O statistics with the `vxdmpadm iostat` command. This section provides an example session using the `vxdmpadm iostat` command.

The first command enables the gathering of I/O statistics:

```
# vxdmpadm iostat start
```

The next command displays the current statistics including the accumulated total numbers of read and write operations, and the kilobytes read and written, on all paths.

```
# vxdmpadm -u k iostat show all
                    cpu usage = 7952us    per cpu memory = 8192b
              OPERATIONS           BYTES             AVG TIME(ms)
PATHNAME   READS     WRITES     READS     WRITES     READS    WRITES
hdisk10       87          0     44544k         0      0.00      0.00
hdisk16        0          0         0          0      0.00      0.00
hdisk11       87          0     44544k         0      0.00      0.00
hdisk17        0          0         0          0      0.00      0.00
hdisk12       87          0     44544k         0      0.00      0.00
hdisk18        0          0         0          0      0.00      0.00
hdisk13       87          0     44544k         0      0.00      0.00
hdisk19        0          0         0          0      0.00      0.00
hdisk14       87          0     44544k         0      0.00      0.00
hdisk20        0          0         0          0      0.00      0.00
hdisk15       87          0     44544k         0      0.00      0.00
hdisk21        0          0         0          0      0.00      0.00
```

The following command changes the amount of memory that `vxdmpadm` can use to accumulate the statistics:

```
# vxdmpadm iostat start memory=4096
```

The displayed statistics can be filtered by path name, DMP node name, and enclosure name (note that the per-CPU memory has changed following the previous command):

```
# vxdmpadm -u k iostat show pathname=hdisk17
                     cpu usage = 8132us    per cpu memory = 4096b
               OPERATIONS             BYTES           AVG TIME(ms)
PATHNAME    READS     WRITES      READS     WRITES     READS    WRITES
hdisk17         0          0          0          0      0.00      0.00

# vxdmpadm -u k iostat show dmpnodename=hdisk10
                    cpu usage = 8501us    per cpu memory = 4096b
               OPERATIONS             BYTES            AVG  TIME(ms)
PATHNAME   READS     WRITES      READS     WRITES     READS    WRITES
hdisk10     1088          0    557056k          0      0.00      0.00

# vxdmpadm -u k iostat show enclosure=Disk
                    cpu usage = 8626us    per cpu memory = 4096b
               OPERATIONS            BYTES            AVG TIME(ms)
PATHNAME   READS     WRITES      READS     WRITES     READS    WRITES
hdisk10     1088          0    557056k          0      0.00      0.00
```

You can also specify the number of times to display the statistics and the time interval. Here the incremental statistics for a path are displayed twice with a 2-second interval:

```
# vxdmpadm iostat show pathname=hdisk17 interval=2 count=2
                    cpu usage = 719us    per cpu memory = 49152b
               OPERATIONS            BLOCKS          AVG TIME(ms)
PATHNAME    READS     WRITES     READS     WRITES     READS     WRITES
hdisk17     0         0          0         0          0.00      0.00

hdisk17     0         0          0         0          0.00      0.00
```

Setting the attributes of the paths to an enclosure

You can use the `vxdmpadm setattr` command to set the attributes of the paths to an enclosure or disk array.

The attributes set for the paths are persistent across reboots or product upgrades.

You can set the following attributes:

`active` Changes a standby (failover) path to an active path. The following example specifies an active path for an array:

```
# vxdmpadm setattr path hdisk10 pathtype=active
```

`nomanual` Restores the original primary or secondary attributes of a path. This example restores the path to a JBOD disk:

```
# vxdmpadm setattr path hdisk20 pathtype=nomanual
```

`nopreferred` Restores the normal priority of a path. The following example restores the default priority to a path:

```
# vxdmpadm setattr path hdisk16 pathtype=nopreferred
```

`preferred [priority=N]`

Specifies a path as preferred, and optionally assigns a priority number to it. If specified, the priority number must be an integer that is greater than or equal to one. Higher priority numbers indicate that a path is able to carry a greater I/O load.

Note: Setting a priority for path does not change the I/O policy. The I/O policy must be set independently.

See "Specifying the I/O policy" on page 131.

This example first sets the I/O policy to `priority` for an Active/Active disk array, and then specifies a preferred path with an assigned priority of 2:

```
# vxdmpadm setattr enclosure enc0 \
  iopolicy=priority
# vxdmpadm setattr path hdisk16 pathtype=preferred \
  priority=2
```

`primary`

Defines a path as being the primary path for a JBOD disk array. The following example specifies a primary path for a JBOD disk array:

```
# vxdmpadm setattr path hdisk20 pathtype=primary
```

`secondary`

Defines a path as being the secondary path for a JBOD disk array. The following example specifies a secondary path for a JBOD disk array:

```
# vxdmpadm setattr path hdisk22 \
  pathtype=secondary
```

`standby`

Marks a standby (failover) path that it is not used for normal I/O scheduling. This path is used if there are no active paths available for I/O. The next example specifies a standby path for an A/P-C disk array:

```
# vxdmpadm setattr path hdisk10 \
  pathtype=standby
```

Displaying the redundancy level of a device or enclosure

Use the `vxdmpadm getdmpnode` command to list the devices with less than the required redundancy level.

To list the devices on a specified enclosure with fewer than a given number of enabled paths, use the following command:

```
# vxdmpadm getdmpnode enclosure=encl_name redundancy=value
```

For example, to list the devices with fewer than 3 enabled paths, use the following command:

```
# vxdmpadm getdmpnode enclosure=EMC_CLARiiON0 redundancy=3

NAME               STATE    ENCLR-TYPE   PATHS ENBL DSBL ENCLR-NAME
=============================================================================
emc_clariion0_162 ENABLED  EMC_CLARiiON 3     2    1    emc_clariion0
emc_clariion0_182 ENABLED  EMC_CLARiiON 2     2    0    emc_clariion0
emc_clariion0_184 ENABLED  EMC_CLARiiON 3     2    1    emc_clariion0
emc_clariion0_186 ENABLED  EMC_CLARiiON 2     2    0    emc_clariion0
```

To display the minimum redundancy level for a particular device, use the `vxdmpadm getattr` command, as follows:

```
# vxdmpadm getattr enclosure|arrayname|arraytype \
 component-name redundancy
```

For example, to show the minimum redundancy level for the enclosure HDS9500-ALUA0:

```
# vxdmpadm getattr enclosure HDS9500-ALUA0 redundancy

ENCLR_NAME  DEFAULT  CURRENT
============================================
 HDS9500-ALUA0    0      4
```

Specifying the minimum number of active paths

You can set the minimum redundancy level for a device or an enclosure. The minimum redundancy level is the minimum number of paths that should be active for the device or the enclosure. If the number of paths falls below the minimum redundancy level for the enclosure, a message is sent to the system console and also logged to the Dynamic Multi-Pathing (DMP) log file. Also, notification is sent to `vxnotify` clients.

The value set for minimum redundancy level is persistent across reboots and product upgrades. If no minimum redundancy level is set, the default value is 0.

You can use the `vxdmpadm setattr` command to set the minimum redundancy level.

To specify the minimum number of active paths

- Use the `vxdmpadm setattr` command with the redundancy attribute as follows:

  ```
  # vxdmpadm setattr enclosure|arrayname|arraytype component-name
   redundancy=value
  ```

  where *value* is the number of active paths.

  For example, to set the minimum redundancy level for the enclosure HDS9500-ALUA0:

  ```
  # vxdmpadm setattr enclosure HDS9500-ALUA0 redundancy=2
  ```

Displaying the I/O policy

To display the current and default settings of the I/O policy for an enclosure, array, or array type, use the `vxdmpadm getattr` command.

The following example displays the default and current setting of `iopolicy` for JBOD disks:

```
# vxdmpadm getattr enclosure Disk iopolicy

ENCLR_NAME        DEFAULT         CURRENT
---------------------------------------
Disk              MinimumQ        Balanced
```

The next example displays the setting of `partitionsize` for the enclosure `enc0`, on which the `balanced` I/O policy with a partition size of 2MB has been set:

```
# vxdmpadm getattr enclosure enc0 partitionsize

ENCLR_NAME      DEFAULT         CURRENT
---------------------------------------
enc0            2048          4096
```

Specifying the I/O policy

You can use the `vxdmpadm setattr` command to change the Dynamic Multi-Pathing (DMP) I/O policy for distributing I/O load across multiple paths to a disk array or enclosure. You can set policies for an enclosure (for example, `HDS01`), for all enclosures of a particular type (such as `HDS`), or for all enclosures of a particular array type (such as `A/A` for Active/Active, or `A/P` for Active/Passive).

Note: I/O policies are persistent across reboots of the system.

Table 4-2 describes the I/O policies that may be set.

Table 4-2 DMP I/O policies

Policy	Description

`adaptive`	This policy attempts to maximize overall I/O throughput from/to the disks by dynamically scheduling I/O on the paths. It is suggested for use where I/O loads can vary over time. For example, I/O from/to a database may exhibit both long transfers (table scans) and short transfers (random look ups). The policy is also useful for a SAN environment where different paths may have different number of hops. No further configuration is possible as this policy is automatically managed by DMP.
	In this example, the adaptive I/O policy is set for the enclosure `enc1`:
	`# vxdmpadm setattr enclosure enc1 \`
	`iopolicy=adaptive`

`adaptiveminq`	Similar to the `adaptive` policy, except that I/O is scheduled according to the length of the I/O queue on each path. The path with the shortest queue is assigned the highest priority.

Table 4-2 DMP I/O policies *(continued)*

Policy	Description

`balanced [partitionsize=size]`	This policy is designed to optimize the use of caching in disk drives and RAID controllers. The size of the cache typically ranges from 120KB to 500KB or more, depending on the characteristics of the particular hardware. During normal operation, the disks (or LUNs) are logically divided into a number of regions (or partitions), and I/O from/to a given region is sent on only one of the active paths. Should that path fail, the workload is automatically redistributed across the remaining paths.
	
	You can use the partitionsize attribute to specify the size for the partition. The partition size in blocks is adjustable in powers of 2 from 2 up to 231. A value that is not a power of 2 is silently rounded down to the nearest acceptable value.
	
	Specifying a partition size of 0 is equivalent to specifying the default partition size.
	
	The default value for the partition size is 2048 blocks (1024k). Specifying a partition size of 0 is equivalent to the default partition size of 2048 blocks (1024k).
	
	The default value can be changed by adjusting the value of the `dmp_pathswitch_blks_shift` tunable parameter.
	
	See "DMP tunable parameters" on page 206.
	
	Note: The benefit of this policy is lost if the value is set larger than the cache size.
	
	For example, the suggested partition size for an Hitachi HDS 9960 A/A array is from 32,768 to 131,072 blocks (16MB to 64MB) for an I/O activity pattern that consists mostly of sequential reads or writes.
	
	The next example sets the balanced I/O policy with a partition size of 4096 blocks (2MB) on the enclosure enc0:
	
	`# vxdmpadm setattr enclosure enc0 \`
	`  iopolicy=balanced partitionsize=4096`

`minimumq`	This policy sends I/O on paths that have the minimum number of outstanding I/O requests in the queue for a LUN. No further configuration is possible as DMP automatically determines the path with the shortest queue.
	
	The following example sets the I/O policy to `minimumq` for a JBOD:
	
	`# vxdmpadm setattr enclosure Disk \`
	`  iopolicy=minimumq`
	
	This is the default I/O policy for all arrays.

Table 4-2 DMP I/O policies *(continued)*

Policy	Description

`priority`	This policy is useful when the paths in a SAN have unequal performance, and you want to enforce load balancing manually. You can assign priorities to each path based on your knowledge of the configuration and performance characteristics of the available paths, and of other aspects of your system.
	See "Setting the attributes of the paths to an enclosure" on page 128.
	In this example, the I/O policy is set to `priority` for all SENA arrays:
	`# vxdmpadm setattr arrayname SENA \`
	`  iopolicy=priority`

`round-robin`	This policy shares I/O equally between the paths in a round-robin sequence. For example, if there are three paths, the first I/O request would use one path, the second would use a different path, the third would be sent down the remaining path, the fourth would go down the first path, and so on. No further configuration is possible as this policy is automatically managed by DMP.
	The next example sets the I/O policy to `round-robin` for all Active/Active arrays:
	`# vxdmpadm setattr arraytype A/A \`
	`  iopolicy=round-robin`

`singleactive`	This policy routes I/O down the single active path. This policy can be configured for A/P arrays with one active path per controller, where the other paths are used in case of failover. If configured for A/A arrays, there is no load balancing across the paths, and the alternate paths are only used to provide high availability (HA). If the current active path fails, I/O is switched to an alternate active path. No further configuration is possible as the single active path is selected by DMP.
	The following example sets the I/O policy to `singleactive` for JBOD disks:
	`# vxdmpadm setattr arrayname Disk \`
	`  iopolicy=singleactive`

Scheduling I/O on the paths of an Asymmetric Active/Active or an ALUA array

You can specify the `use_all_paths` attribute in conjunction with the `adaptive`, `balanced`, `minimumq`, `priority`, and `round-robin` I/O policies to specify whether I/O requests are to be scheduled on the secondary paths in addition to the primary paths of an Asymmetric Active/Active (A/A-A) array or an ALUA array. Depending on the characteristics of the array, the consequent improved load balancing can

increase the total I/O throughput. However, this feature should only be enabled if recommended by the array vendor. It has no effect for array types other than A/A-A or ALUA.

For example, the following command sets the `balanced` I/O policy with a partition size of 4096 blocks (2MB) on the enclosure `enc0`, and allows scheduling of I/O requests on the secondary paths:

```
# vxdmpadm setattr enclosure enc0 iopolicy=balanced \
      partitionsize=4096 use_all_paths=yes
```

The default setting for this attribute is `use_all_paths=no`.

You can display the current setting for `use_all_paths` for an enclosure, arrayname, or arraytype. To do this, specify the `use_all_paths` option to the `vxdmpadm gettattr` command.

```
# vxdmpadm getattr enclosure HDS9500-ALUA0 use_all_paths

ENCLR_NAME    ATTR_NAME     DEFAULT CURRENT
============================================
HDS9500-ALUA0 use_all_paths no      yes
```

The `use_all_paths` attribute only applies to A/A-A arrays and ALUA arrays. For other arrays, the above command displays the message:

```
Attribute is not applicable for this array.
```

Example of applying load balancing in a SAN

This example describes how to use Dynamic Multi-Pathing (DMP) to configure load balancing in a SAN environment where there are multiple primary paths to an Active/Passive device through several SAN switches.

As shown in this sample output from the `vxdisk list` command, the device `hdisk18` has eight primary paths:

```
# vxdisk list hdisk18

Device: hdisk18
  .
  .
  .
numpaths: 8
hdisk11 state=enabled type=primary
hdisk12 state=enabled type=primary
hdisk13 state=enabled type=primary
```

```
hdisk14 state=enabled type=primary
hdisk15 state=enabled type=primary
hdisk16 state=enabled type=primary
hdisk17 state=enabled type=primary
hdisk18 state=enabled type=primary
```

In addition, the device is in the enclosure `ENC0`, belongs to the disk group `mydg`, and contains a simple concatenated volume `myvol1`.

The first step is to enable the gathering of DMP statistics:

```
# vxdmpadm iostat start
```

Next, use the `dd` command to apply an input workload from the volume:

```
# dd if=/dev/vx/rdsk/mydg/myvol1 of=/dev/null &
```

By running the `vxdmpadm iostat` command to display the DMP statistics for the device, it can be seen that all I/O is being directed to one path, `hdisk18`:

```
# vxdmpadm iostat show dmpnodename=hdisk18 interval=5 count=2
    .
    .
    .
cpu usage = 11294us per cpu memory = 32768b
             OPERATIONS           KBYTES          AVG TIME(ms)
PATHNAME   READS    WRITES    READS    WRITES    READS       WRITES
hdisk11    0        0         0        0          0.00         0.00
hdisk12    0        0         0        0          0.00         0.00
hdisk13    0        0         0        0          0.00         0.00
hdisk14    0        0         0        0          0.00         0.00
hdisk15    0        0         0        0          0.00         0.00
hdisk16    0        0         0        0          0.00         0.00
hdisk17    0        0         0        0          0.00         0.00
hdisk18    10986    0         5493     0          0.41         0.00
```

The `vxdmpadm` command is used to display the I/O policy for the enclosure that contains the device:

```
# vxdmpadm getattr enclosure ENC0 iopolicy

ENCLR_NAME      DEFAULT           CURRENT
============================================
ENC0            MinimumQ      Single-Active
```

This shows that the policy for the enclosure is set to `singleactive`, which explains why all the I/O is taking place on one path.

To balance the I/O load across the multiple primary paths, the policy is set to `round-robin` as shown here:

```
# vxdmpadm setattr enclosure ENC0 iopolicy=round-robin
# vxdmpadm getattr enclosure ENC0 iopolicy

ENCLR_NAME    DEFAULT            CURRENT
============================================
ENC0          MinimumQ           Round-Robin
```

The DMP statistics are now reset:

```
# vxdmpadm iostat reset
```

With the workload still running, the effect of changing the I/O policy to balance the load across the primary paths can now be seen.

```
# vxdmpadm iostat show dmpnodename=hdisk18 interval=5 count=2
    .
    .
    .
cpu usage = 14403us per cpu memory = 32768b
               OPERATIONS           KBYTES          AVG TIME(ms)
PATHNAME     READS    WRITES    READS     WRITES    READS      WRITES
hdisk11      2041     0         1021      0          0.39        0.00
hdisk12      1894     0         947       0          0.39        0.00
hdisk13      2008     0         1004      0          0.39        0.00
hdisk14      2054     0         1027      0          0.40        0.00
hdisk15      2171     0         1086      0          0.39        0.00
hdisk16      2095     0         1048      0          0.39        0.00
hdisk17      2073     0         1036      0          0.39        0.00
hdisk18      2042     0         1021      0          0.39        0.00
```

The enclosure can be returned to the single active I/O policy by entering the following command:

```
# vxdmpadm setattr enclosure ENC0 iopolicy=singleactive
```

Disabling I/O for paths, controllers, array ports, or DMP nodes

Disabling I/O through a path, HBA controller, array port, or Dynamic Multi-Pathing (DMP) node prevents DMP from issuing I/O requests through the specified path, or the paths that are connected to the specified controller, array port, or DMP node.

If the specified paths have pending I/Os, the `vxdmpadm disable` command waits until the I/Os are completed before disabling the paths.

DMP does not support the operation to disable I/O for the controllers that use Third-Party Drivers (TPD) for multi-pathing.

To disable I/O for one or more paths, use the following command:

```
# vxdmpadm [-c|-f] disable path=path_name1[,path_name2,path_nameN]
```

To disable I/O for the paths connected to one or more HBA controllers, use the following command:

```
# vxdmpadm [-c|-f] disable ctlr=ctlr_name1[,ctlr_name2,ctlr_nameN]
```

To disable I/O for the paths connected to an array port, use one of the following commands:

```
# vxdmpadm [-c|-f] disable enclosure=enclr_name portid=array_port_ID
# vxdmpadm [-c|-f] disable pwwn=array_port_WWN
```

where the array port is specified either by the enclosure name and the array port ID, or by the array port's worldwide name (WWN) identifier.

The following examples show how to disable I/O on an array port:

```
# vxdmpadm disable enclosure=HDS9500V0 portid=1A
# vxdmpadm disable pwwn=20:00:00:E0:8B:06:5F:19
```

To disable I/O for a particular path, specify both the controller and the portID, which represent the two ends of the fabric:

```
# vxdmpadm [-c|-f] disable ctlr=ctlr_name enclosure=enclr_name \
portid=array_port_ID
```

To disable I/O for a particular DMP node, specify the DMP node name.

```
# vxdmpadm [-c|-f] disable dmpnodename=dmpnode
```

You can use the `-c` option to check if there is only a single active path to the disk.

Use the **-f** option to disable the last path, irrespective of whether the device is in use or not.

The `disable` operation fails if it is issued to a controller that is connected to the root disk through a single path, and there are no root disk mirrors configured on alternate paths. If such mirrors exist, the command succeeds. The `disable` operation fails if it is issued to a controller that is connected to the swap device through a single path.

Enabling I/O for paths, controllers, array ports, or DMP nodes

Enabling a controller allows a previously disabled path, HBA controller, array port, or Dynamic Multi-Pathing (DMP) node to accept I/O again. This operation succeeds only if the path, controller, array port, or DMP node is accessible to the host, and I/O can be performed on it. When connecting Active/Passive disk arrays, the `enable` operation results in failback of I/O to the primary path. The `enable` operation can also be used to allow I/O to the controllers on a system board that was previously detached.

Note: This operation is supported for controllers that are used to access disk arrays on which cluster-shareable disk groups are configured.

DMP does not support the operation to enable I/O for the controllers that use Third-Party Drivers (TPD) for multi-pathing.

To enable I/O for one or more paths, use the following command:

```
# vxdmpadm enable path=path_name1[,path_name2,path_nameN]
```

To enable I/O for the paths connected to one or more HBA controllers, use the following command:

```
# vxdmpadm enable ctlr=ctlr_name1[,ctlr_name2,ctlr_nameN]
```

To enable I/O for the paths connected to an array port, use one of the following commands:

```
# vxdmpadm enable enclosure=enclr_name portid=array_port_ID
# vxdmpadm enable pwwn=array_port_WWN
```

where the array port is specified either by the enclosure name and the array port ID, or by the array port's worldwide name (WWN) identifier.

The following are examples of using the command to enable I/O on an array port:

```
# vxdmpadm enable enclosure=HDS9500V0 portid=1A
# vxdmpadm enable pwwn=20:00:00:E0:8B:06:5F:19
```

To enable I/O for a particular path, specify both the controller and the portID, which represent the two ends of the fabric:

```
# vxdmpadm enable ctlr=ctlr_name enclosure=enclr_name \
  portid=array_port_ID
```

To enable I/O for a particular DMP node, specify the DMP node name.

```
# vxdmpadm enable dmpnodename=dmpnode
```

Renaming an enclosure

The `vxdmpadm setattr` command can be used to assign a meaningful name to an existing enclosure, for example:

```
# vxdmpadm setattr enclosure emc0 name=GRP1
```

This example changes the name of an enclosure from `emc0` to `GRP1`.

Note: The maximum length of the enclosure name prefix is 23 characters.

The following command shows the changed name:

```
# vxdmpadm listenclosure all

ENCLR_NAME       ENCLR_TYPE     ENCLR_SNO      STATUS    ARRAY_TYPE LUN_COUNT F
==========================================================================
Disk             Disk           DISKS          CONNECTED Disk       6         -
GRP1             EMC            000292601383   CONNECTED A/A        1         5
hitachi_usp-vm0 Hitachi_USP-VM 25847          CONNECTED A/A        1         6
emc_clariion0    EMC_CLARiiON   CK20007040035 CONNECTED CLR-A/PF   2         0
```

Configuring the response to I/O failures

You can configure how Dynamic Multi-Pathing (DMP) responds to failed I/O requests on the paths to a specified enclosure, disk array name, or type of array. By default, DMP is configured to retry a failed I/O request up to five minutes on various active paths.

To display the current settings for handling I/O request failures that are applied to the paths to an enclosure, array name, or array type, use the `vxdmpadm getattr` command.

See "Displaying recovery option values" on page 144.

To set a limit for the number of times that DMP attempts to retry sending an I/O request on a path, use the following command:

```
# vxdmpadm setattr \
  {enclosure enc-name|arrayname name|arraytype type} \
  recoveryoption=fixedretry retrycount=n
```

The value of the argument to `retrycount` specifies the number of retries to be attempted before DMP reschedules the I/O request on another available path, or fails the request altogether.

As an alternative to specifying a fixed number of retries, you can specify the amount of time DMP allows for handling an I/O request. If the I/O request does not succeed within that time, DMP fails the I/O request. To specify an `iotimeout` value, use the following command:

```
# vxdmpadm setattr \
  {enclosure enc-name|arrayname name|arraytype type} \
  recoveryoption=timebound iotimeout=seconds
```

The default value of `iotimeout` is 300 seconds. For some applications such as Oracle, it may be desirable to set `iotimeout` to a larger value. The `iotimeout` value for DMP should be greater than the I/O service time of the underlying operating system layers.

Note: The `fixedretry` and `timebound` settings are mutually exclusive.

The following example configures time-bound recovery for the enclosure `enc0`, and sets the value of `iotimeout` to 360 seconds:

```
# vxdmpadm setattr enclosure enc0 recoveryoption=timebound \
  iotimeout=360
```

The next example sets a fixed-retry limit of 10 for the paths to all Active/Active arrays:

```
# vxdmpadm setattr arraytype A/A recoveryoption=fixedretry \
  retrycount=10
```

Specifying `recoveryoption=default` resets DMP to the default settings for recovery.

For example, the following command sets the default settings:

```
# vxdmpadm setattr arraytype A/A recoveryoption=default
```

For PCI devices, the default settings are `recoveryoption=fixedretry retrycount=5`.

For all other devices, the default settings are `recoveryoption=timebound iotimeout=300`

Specifying `recoveryoption=default`also has the effect of configuring I/O throttling with the default settings.

See "Configuring the I/O throttling mechanism" on page 142.

Note: The response to I/O failure settings is persistent across reboots of the system.

Configuring the I/O throttling mechanism

By default, Dynamic Multi-Pathing (DMP) is configured with I/O throttling turned off for all paths. To display the current settings for I/O throttling that are applied to the paths to an enclosure, array name, or array type, use the `vxdmpadm getattr` command.

See "Displaying recovery option values" on page 144.

If enabled, I/O throttling imposes a small overhead on CPU and memory usage because of the activity of the statistics-gathering daemon. If I/O throttling is disabled, the daemon no longer collects statistics, and remains inactive until I/O throttling is re-enabled.

To turn off I/O throttling, use the following form of the `vxdmpadm setattr` command:

```
# vxdmpadm setattr \
  {enclosure enc-name|arrayname name|arraytype type} \
  recoveryoption=nothrottle
```

The following example shows how to disable I/O throttling for the paths to the enclosure `enc0`:

```
# vxdmpadm setattr enclosure enc0 recoveryoption=nothrottle
```

The `vxdmpadm setattr` command can be used to enable I/O throttling on the paths to a specified enclosure, disk array name, or type of array:

```
# vxdmpadm setattr \
  {enclosure enc-name|arrayname name|arraytype type}\
  recoveryoption=throttle [iotimeout=seconds]
```

If the `iotimeout` attribute is specified, its argument specifies the time in seconds that DMP waits for an outstanding I/O request to succeed before invoking I/O throttling on the path. The default value of `iotimeout` is 10 seconds. Setting `iotimeout` to a larger value potentially causes more I/O requests to become queued up in the SCSI driver before I/O throttling is invoked.

The following example sets the value of `iotimeout` to 60 seconds for the enclosure `enc0`:

```
# vxdmpadm setattr enclosure enc0 recoveryoption=throttle \
  iotimeout=60
```

Specify `recoveryoption=default` to reset I/O throttling to the default settings, as follows:

```
# vxdmpadm setattr arraytype A/A recoveryoption=default
```

The above command configures the default behavior, corresponding to `recoveryoption=nothrottle`. The above command also configures the default behavior for the response to I/O failures.

See "Configuring the response to I/O failures" on page 140.

Note: The I/O throttling settings are persistent across reboots of the system.

Configuring Subpaths Failover Groups (SFG)

The Subpaths Failover Groups (SFG) feature can be turned on or off using the tunable `dmp_sfg_threshold`. The default value of the tunable is `1`, which represents that the feature is on.

To turn off the feature, set the tunable `dmp_sfg_threshold` value to 0:

```
# vxdmpadm settune dmp_sfg_threshold=0
```

To turn on the feature, set the `dmp_sfg_threshold` value to the required number of path failures that triggers SFG.

```
# vxdmpadm settune dmp_sfg_threshold=N
```

To see the Subpaths Failover Groups ID, use the following command:

```
# vxdmpadm getportids {ctlr=ctlr_name | dmpnodename=dmp_device_name \
    | enclosure=enclr_name | path=path_name}
```

Configuring Low Impact Path Probing (LIPP)

The Low Impact Path Probing (LIPP) feature can be turned on or off using the `vxdmpadm settune` command:

```
# vxdmpadm settune dmp_low_impact_probe=[on|off]
```

Path probing will be optimized by probing a subset of paths connected to the same HBA and array port. The size of the subset of paths can be controlled by the `dmp_probe_threshold` tunable. The default value is set to 5.

```
# vxdmpadm settune dmp_probe_threshold=N
```

Displaying recovery option values

To display the current settings for handling I/O request failures that are applied to the paths to an enclosure, array name, or array type, use the following Dynamic Multi-Pathing (DMP) command:

```
# vxdmpadm getattr \
  {enclosure enc-name|arrayname name|arraytype type} \
  recoveryoption
```

The following example shows the `vxdmpadm getattr` command being used to display the `recoveryoption` option values that are set on an enclosure.

```
# vxdmpadm getattr enclosure HDS9500-ALUA0 recoveryoption
ENCLR-NAME      RECOVERY-OPTION  DEFAULT[VAL]    CURRENT[VAL]
================================================================
HDS9500-ALUA0   Throttle         Nothrottle[0]   Nothrottle[0]
HDS9500-ALUA0   Error-Retry      Timebound[300]  Timebound[300]
```

The command output shows the default and current policy options and their values.

Table 4-3 summarizes the possible recovery option settings for retrying I/O after an error.

Table 4-3 Recovery options for retrying I/O after an error

Recovery option	Possible settings	Description
recoveryoption=fixedretry	Fixed-Retry (retrycount)	DMP retries a failed I/O request for the specified number of times if I/O fails.
recoveryoption=timebound	Timebound (iotimeout)	DMP retries a failed I/O request for the specified time in seconds if I/O fails.

Table 4-4 summarizes the possible recovery option settings for throttling I/O.

Table 4-4 Recovery options for I/O throttling

Recovery option	Possible settings	Description
recoveryoption=nothrottle	None	I/O throttling is not used.

Table 4-4 Recovery options for I/O throttling *(continued)*

Recovery option	Possible settings	Description
recoveryoption=throttle	Timebound (iotimeout)	DMP throttles the path if an I/O request does not return within the specified time in seconds.

Configuring DMP path restoration policies

Dynamic Multi-Pathing (DMP) maintains a kernel task that re-examines the condition of paths at a specified interval. The type of analysis that is performed on the paths depends on the checking policy that is configured.

Note: The DMP path restoration task does not change the disabled state of the path through a controller that you have disabled using `vxdmpadm disable`.

When configuring DMP path restoration policies, you must stop the path restoration thread, and then restart it with new attributes.

See "Stopping the DMP path restoration thread" on page 146.

Use the `vxdmpadm settune dmp_restore_policy` command to configure one of the following restore policies. The policy remains in effect until the restore thread is stopped or the values are changed using the `vxdmpadm settune` command.

- `check_all`

  The path restoration thread analyzes all paths in the system and revives the paths that are back online, as well as disabling the paths that are inaccessible. The command to configure this policy is:

  ```
  # vxdmpadm settune dmp_restore_policy=check_all
  ```

- `check_alternate`

  The path restoration thread checks that at least one alternate path is healthy. It generates a notification if this condition is not met. This policy avoids inquiry commands on all healthy paths, and is less costly than `check_all` in cases where a large number of paths are available. This policy is the same as `check_all` if there are only two paths per DMP node. The command to configure this policy is:

  ```
  # vxdmpadm settune dmp_restore_policy=check_alternate
  ```

- `check_disabled`

This is the default path restoration policy. The path restoration thread checks the condition of paths that were previously disabled due to hardware failures, and revives them if they are back online. The command to configure this policy is:

```
# vxdmpadm settune dmp_restore_policy=check_disabled
```

- `check_periodic`
  The path restoration thread performs `check_all` once in a given number of cycles, and `check_disabled` in the remainder of the cycles. This policy may lead to periodic slowing down (due to `check_all`) if a large number of paths are available. The command to configure this policy is:

  ```
  # vxdmpadm settune dmp_restore_policy=check_periodic
  ```

  The default number of cycles between running the `check_all` policy is 10.

The `dmp_restore_interval` tunable parameter specifies how often the path restoration thread examines the paths. For example, the following command sets the polling interval to 400 seconds:

```
# vxdmpadm settune dmp_restore_interval=400
```

The settings are immediately applied and are persistent across reboots. Use the `vxdmpadm gettune` command to view the current settings.

See "DMP tunable parameters" on page 206.

If the `vxdmpadm start restore` command is given without specifying a policy or interval, the path restoration thread is started with the persistent policy and interval settings previously set by the administrator with the `vxdmpadm settune` command. If the administrator has not set a policy or interval, the system defaults are used. The system default restore policy is `check_disabled`. The system default interval is 300 seconds.

Warning: Decreasing the interval below the system default can adversely affect system performance.

Stopping the DMP path restoration thread

Use the following command to stop the Dynamic Multi-Pathing (DMP) path restoration thread:

```
# vxdmpadm stop restore
```

Warning: Automatic path failback stops if the path restoration thread is stopped.

Displaying the status of the DMP path restoration thread

Use the `vxdmpadm gettune` command to display the tunable parameter values that show the status of the Dynamic Multi-Pathing (DMP) path restoration thread. These tunables include:

dmp_restore_state the status of the automatic path restoration kernel thread.

dmp_restore_interval the polling interval for the DMP path restoration thread.

dmp_restore_policy the policy that DMP uses to check the condition of paths.

To display the status of the DMP path restoration thread

- Use the following commands:

```
# vxdmpadm gettune dmp_restore_state

# vxdmpadm gettune dmp_restore_interval

# vxdmpadm gettune dmp_restore_policy
```

Configuring Array Policy Modules

Dynamic Multi-Pathing (DMP) provides Array Policy Modules (APMs) for use with an array. An APM is a dynamically loadable kernel module (or plug-in) that defines array-specific procedures and commands to:

- Select an I/O path when multiple paths to a disk within the array are available.
- Select the path failover mechanism.
- Select the alternate path in the case of a path failure.
- Put a path change into effect.
- Respond to SCSI reservation or release requests.

DMP supplies default procedures for these functions when an array is registered. An APM may modify some or all of the existing procedures that DMP provides, or that another version of the APM provides.

You can use the following command to display all the APMs that are configured for a system:

```
# vxdmpadm listapm all
```

The output from this command includes the file name of each module, the supported array type, the APM name, the APM version, and whether the module is currently loaded and in use.

To see detailed information for an individual module, specify the module name as the argument to the command:

```
# vxdmpadm listapm module_name
```

To add and configure an APM, use the following command:

```
# vxdmpadm -a cfgapm module_name [attr1=value1 \
      [attr2=value2 ...]]
```

The optional configuration attributes and their values are specific to the APM for an array. Consult the documentation from the array vendor for details.

Note: By default, DMP uses the most recent APM that is available. Specify the `-u` option instead of the `-a` option if you want to force DMP to use an earlier version of the APM. The current version of an APM is replaced only if it is not in use.

Specify the `-r` option to remove an APM that is not currently loaded:

```
# vxdmpadm -r cfgapm module_name
```

See the `vxdmpadm`(1M) manual page.

Chapter 5

Administering disks

This chapter includes the following topics:

About disk management

Dynamic Multi-Pathing (DMP) is used to administer multiported disk arrays.

See "How DMP works" on page 11.

DMP uses the Device Discovery Layer (DDL) to handle device discovery and configuration of disk arrays. DDL discovers disks and their attributes that are required for DMP operations. Use the `vxddladm` utility to administer the DDL.

See "How to administer the Device Discovery Layer" on page 155.

Discovering and configuring newly added disk devices

When you physically connect new disks to a host or when you zone new Fibre Channel devices to a host, you can use the `vxdctl enable` command to rebuild the volume device node directories and to update the Dynamic Multi-Pathing (DMP) internal database to reflect the new state of the system.

To reconfigure the DMP database, first run `cfgmgr` to make the operating system recognize the new disks, and then invoke the `vxdctl enable` command.

You can also use the `vxdisk scandisks` command to scan devices in the operating system device tree, and to initiate dynamic reconfiguration of multipathed disks.

If you want DMP to scan only for new devices that have been added to the system, and not for devices that have been enabled or disabled, specify the `-f` option to either of the commands, as shown here:

```
# vxdctl -f enable
# vxdisk -f scandisks
```

However, a complete scan is initiated if the system configuration has been modified by changes to:

- Installed array support libraries.
- The list of devices that are excluded from use by VxVM.
- DISKS (JBOD), SCSI3, or foreign device definitions.

See the `vxdctl`(1M) manual page.

See the `vxdisk`(1M) manual page.

Partial device discovery

Dynamic Multi-Pathing (DMP) supports partial device discovery where you can include or exclude paths to a physical disk from the discovery process.

The `vxdisk scandisks` command rescans the devices in the OS device tree and triggers a DMP reconfiguration. You can specify parameters to `vxdisk scandisks` to implement partial device discovery. For example, this command makes DMP discover newly added devices that were unknown to it earlier:

```
# vxdisk scandisks new
```

The next example discovers fabric devices:

```
# vxdisk scandisks fabric
```

The following command scans for the devices `hdisk10` and `hdisk11`:

```
# vxdisk scandisks device=hdisk10,hdisk11
```

Alternatively, you can specify a ! prefix character to indicate that you want to scan for all devices except those that are listed.

Note: The ! character is a special character in some shells. The following examples show how to escape it in a bash shell.

```
# vxdisk scandisks \!device=hdisk10,hdisk11
```

You can also scan for devices that are connected (or not connected) to a list of logical or physical controllers. For example, this command discovers and configures all devices except those that are connected to the specified logical controllers:

```
# vxdisk scandisks \!ctlr=scsi1,scsi2
```

The next command discovers devices that are connected to the specified physical controller:

```
# vxdisk scandisks pctlr=10-60
```

The items in a list of physical controllers are separated by + characters.

You can use the command `vxdmpadm getctlr all` to obtain a list of physical controllers.

You should specify only one selection argument to the `vxdisk scandisks` command. Specifying multiple options results in an error.

See the `vxdisk`(1M) manual page.

About discovering disks and dynamically adding disk arrays

Dynamic Multi-Pathing (DMP) uses array support libraries (ASLs) to provide array-specific support for multi-pathing. An array support library (ASL) is a dynamically loadable shared library (plug-in for DDL). The ASL implements hardware-specific logic to discover device attributes during device discovery. DMP provides the device discovery layer (DDL) to determine which ASLs should be associated to each disk array.

In some cases, DMP can also provide basic multi-pathing and failover functionality by treating LUNs as disks (JBODs).

How DMP claims devices

For fully optimized support of any array and for support of more complicated array types, Dynamic Multi-Pathing (DMP) requires the use of array-specific array support libraries (ASLs), possibly coupled with array policy modules (APMs). ASLs and APMs effectively are array-specific plug-ins that allow close tie-in of DMP with any specific array model.

Refer to the Hardware Compatibility List at:

https://www.veritas.com/content/support/en_US/doc/infoscale_hcl_8x_win

During device discovery, the DDL checks the installed ASL for each device to find which ASL claims the device.

If no ASL is found to claim the device, the DDL checks for a corresponding JBOD definition. You can add JBOD definitions for unsupported arrays to enable DMP to provide multi-pathing for the array. If a JBOD definition is found, the DDL claims the devices in the DISKS category, which adds the LUNs to the list of JBOD (physical disk) devices used by DMP. If the JBOD definition includes a cabinet number, DDL uses the cabinet number to group the LUNs into enclosures.

See "Adding unsupported disk arrays to the DISKS category" on page 163.

DMP can provide basic multi-pathing to arrays that comply with the Asymmetric Logical Unit Access (ALUA) standard, even if there is no ASL or JBOD definition. DDL claims the LUNs as part of the aluadisk enclosure. The array type is shown as ALUA. Adding a JBOD definition also enables you to group the LUNs into enclosures.

Disk categories

Disk arrays that have been certified for use with Dynamic Multi-Pathing (DMP) are supported by an array support library (ASL), and are categorized by the vendor ID string that is returned by the disks (for example, "HITACHI").

Disks in JBODs that are capable of being multi-pathed by DMP, are placed in the DISKS category. Disks in unsupported arrays can also be placed in the DISKS category.

See "Adding unsupported disk arrays to the DISKS category" on page 163.

Disks in JBODs that do not fall into any supported category, and which are not capable of being multi-pathed by DMP are placed in the OTHER_DISKS category.

Adding DMP support for a new disk array

You can dynamically add support for a new type of disk array. The support comes in the form of Array Support Libraries (ASLs) that are developed by Veritas. Veritas provides support for new disk arrays through updates to the VRTSaslapm fileset. To determine if an updated VRTSaslapm fileset is available for download, refer to the hardware compatibility list (HCL). The hardware compatibility list provides a link to the latest fileset for download and instructions for installing the VRTSaslapm fileset. You can upgrade the VRTSaslapm fileset while the system is online; you do not need to stop the applications.

Refer to the hardware compatibility list at:

https://www.veritas.com/content/support/en_US/doc/infoscale_hcl_8x_unix

Each VRTSaslapm fileset is specific for the Dynamic Multi-Pathing version. Be sure to install the VRTSaslapm fileset that supports the installed version of Dynamic Multi-Pathing.

The new disk array does not need to be already connected to the system when the `VRTSaslapm` fileset is installed. If any of the disks in the new disk array are subsequently connected, you need to trigger OS device discovery using the `cfgmgr` command and then trigger DDL device discovery using the `vxdctl enable` command.

If you need to remove the latest `VRTSaslapm` fileset, you can revert to the previously installed version. For the detailed procedure, refer to the *Veritas InfoScale Troubleshooting Guide*.

Enabling discovery of new disk arrays

The `vxdctl enable` command scans all of the disk devices and their attributes, updates the DMP device list, and reconfigures DMP with the new device database. There is no need to reboot the host.

Warning: This command ensures that Dynamic Multi-Pathing is set up correctly for the array. Otherwise, VxVM treats the independent paths to the disks as separate devices, which can result in data corruption.

To enable discovery of a new disk array

- Type the following command:

```
# vxdctl enable
```

Discovering renamed devices on AIX

Starting with AIX 6.1TL6, AIX provides a feature to rename a device using the `rendev` command. You can now specify user-defined names instead of the traditional hdisk name.

Dynamic Multi-Pathing (DMP) now can discover the renamed devices. DMP supports device renaming for both enclosure-based naming (EBN) and operating system naming (OSN). Before renaming a device, remove the DMP node from VxVM/DMP control.

You can use the `vxdmpadm` command to enable and disable the renamed path.

The following features are not supported with renamed devices:

- Enabling rootability
- Migrating LVM to VxVM using the `vxconvert` command
- Hot relocation

To rename a device and bring it back to VxVM/DMP control

1 Remove the DMP node from VxVM/DMP control. For example, the following output shows that the DMP node name ds4100-0_9 refers to the device hdisk1.

```
# vxdmpadm getsubpaths dmpnodename=ds4100-0_9
NAME    STATE[A] PATH-TYPE[M] CTLR-NAME ENCLR-TYPE ENCLR-NAME ATTRS
=============================================================================
hdisk1 ENABLED(A) -           fscsi1    DS4100-    ds4100-0     -
```

Remove hdisk1 from VxVM/DMP control:

```
# vxdisk rm ds4100-0_9
```

2 Rename the device.

```
# rendev -l hdisk1 -n myhdisk1
```

3 Scan the devices.

```
# vxdisk scandisks
```

4 Verify that the DMP node now refers to the new device name.

```
# vxdmpadm getsubpaths dmpnodename=ds4100-0_9
NAME    STATE[A] PATH-TYPE[M] CTLR-NAME ENCLR-TYPE ENCLR-NAME ATTRS
=============================================================================
myhdisk1 ENABLED(A)  -       fscsi1    DS4100-    ds4100-0     -
```

About third-party driver coexistence

The third-party driver (TPD) coexistence feature of Dynamic Multi-Pathing (DMP) allows I/O that is controlled by some third-party multi-pathing drivers to bypass Dynamic Multi-Pathing (DMP) while retaining the monitoring capabilities of DMP. If a suitable Array Support Library (ASL) is available and installed, devices that use TPDs can be discovered without requiring you to set up a specification file, or to run a special command. The TPD coexistence feature of DMP permits coexistence without requiring any change in a third-party multi-pathing driver.

See “Displaying information about devices controlled by third-party drivers” on page 117.

How to administer the Device Discovery Layer

The Device Discovery Layer (DDL) allows dynamic addition of disk arrays. DDL discovers disks and their attributes that are required for Dynamic Multi-Pathing (DMP) operations.

The DDL is administered using the `vxddladm` utility to perform the following tasks:

- List the hierarchy of all the devices discovered by DDL including iSCSI devices.
- List all the Host Bus Adapters including iSCSI.
- List the ports configured on a Host Bus Adapter.
- List the targets configured from a Host Bus Adapter.
- List the devices configured from a Host Bus Adapter.
- Get or set the iSCSI operational parameters.
- List the types of arrays that are supported.
- Add support for an array to DDL.
- Remove support for an array from DDL.
- List information about excluded disk arrays.
- List disks that are claimed in the `DISKS` (JBOD) category.
- Add disks from different vendors to the `DISKS` category.
- Remove disks from the `DISKS` category.
- Add disks as foreign devices.

The following sections explain these tasks in more detail.

See the `vxddladm`(1M) manual page.

Listing all the devices including iSCSI

You can display the hierarchy of all the devices discovered by DDL, including iSCSI devices.

To list all the devices including iSCSI

- Type the following command:

```
# vxddladm list
```

The following is a sample output:

```
HBA fscsi0 (20:00:00:E0:8B:19:77:BE)
    Port fscsi0_p0 (50:0A:09:80:85:84:9D:84)
       Target fscsi0_p0_t0 (50:0A:09:81:85:84:9D:84)
            LUN hdisk1
. . .
HBA iscsi0 (iqn.1986-03.com.sun:01:0003ba8ed1b5.45220f80)
    Port  iscsi0_p0 (10.216.130.10:3260)
       Target  iscsi0_p0_t0 (iqn.1992-08.com.netapp:sn.84188548)
            LUN hdisk2
            LUN hdisk3
       Target  iscsi0_p0_t1 (iqn.1992-08.com.netapp:sn.84190939)
. . .
```

Listing all the Host Bus Adapters including iSCSI

You can obtain information about all the Host Bus Adapters (HBAs) configured on the system, including iSCSI adapters.

Table 5-1 shows the HBA information.

Table 5-1 HBA information

Field	Description
Driver	Driver controlling the HBA.
Firmware	Firmware version.
Discovery	The discovery method employed for the targets.
State	Whether the device is Online or Offline.
Address	The hardware address.

To list all the Host Bus Adapters including iSCSI

- Use the following command to list all of the HBAs, including iSCSI devices, configured on the system:

```
# vxddladm list hbas
```

Listing the ports configured on a Host Bus Adapter

You can obtain information about all the ports configured on an HBA. The display includes the following information:

HBA-ID	The parent HBA.
State	Whether the device is Online or Offline.
Address	The hardware address.

To list the ports configured on a Host Bus Adapter

- Use the following command to obtain the ports configured on an HBA:

```
# vxddladm list ports

PORT-ID    HBA-ID  STATE      ADDRESS
-----------------------------------------------------------
fscsi0_p0  fscsi0  Online     50:0A:09:80:85:84:9D:84
iscsi0_p0  iscsi0  Online     10.216.130.10:3260
```

Listing the targets configured from a Host Bus Adapter or a port

You can obtain information about all the targets configured from a Host Bus Adapter or a port.

Table 5-2 shows the target information.

Table 5-2 Target information

Field	Description
Alias	The alias name, if available.
HBA-ID	Parent HBA or port.
State	Whether the device is Online or Offline.
Address	The hardware address.

To list the targets

- To list all of the targets, use the following command:

```
# vxddladm list targets
```

The following is a sample output:

```
TARGET-ID    ALIAS HBA-ID STATE  ADDRESS
-----------------------------------------------------------------
fscsi0_p0_t0 -     fscsi0 Online 50:0A:09:80:85:84:9D:84
iscsi0_p0_t1 -     iscsi0 Online iqn.1992-08.com.netapp:sn.84190939
```

To list the targets configured from a Host Bus Adapter or port

- You can filter based on a HBA or port, using the following command:

```
# vxddladm list targets [hba=hba_name|port=port_name]
```

For example, to obtain the targets configured from the specified HBA:

```
# vxddladm list targets hba=fscsi0

TARGET-ID     ALIAS  HBA-ID   STATE   ADDRES
-----------------------------------------------------------------
fscsi0_p0_t0  -      fscsi0   Online  50:0A:09:80:85:84:9D:84
```

Listing the devices configured from a Host Bus Adapter and target

You can obtain information about all the devices configured from a Host Bus Adapter.

Table 5-3 shows the device information.

Table 5-3 Device information

Field	Description
Device	The device name.
Target-ID	The parent target.
State	Whether the device is Online or Offline.
DDL status	Whether the device is claimed by DDL. If claimed, the output also displays the ASL name.

To list the devices configured from a Host Bus Adapter

- To obtain the devices configured, use the following command:

```
# vxddladm list devices

Device    Target-ID    State    DDL status (ASL)
-------------------------------------------------------
hdisk1    fscsi0_p0_t0 Online   CLAIMED (libvxemc.so)
hdisk2    fscsi0_p0_t0 Online   SKIPPED (libvxemc.so)
hdisk3    fscsi0_p0_t0 Offline  ERROR
hdisk4    fscsi0_p0_t0 Online   EXCLUDED
hdisk5    fscsi0_p0_t0 Offline  MASKED
```

To list the devices configured from a Host Bus Adapter and target

- To obtain the devices configured from a particular HBA and target, use the following command:

```
# vxddladm list devices target=target_name
```

Getting or setting the iSCSI operational parameters

DDL provides an interface to set and display certain parameters that affect the performance of the iSCSI device path. However, the underlying OS framework must support the ability to set these values. The `vxddladm set` command returns an error if the OS support is not available.

Table 5-4 Parameters for iSCSI devices

Parameter	Default value	Minimum value	Maximum value
DataPDUInOrder	yes	no	yes
DataSequenceInOrder	yes	no	yes
DefaultTime2Retain	20	0	3600
DefaultTime2Wait	2	0	3600
ErrorRecoveryLevel	0	0	2
FirstBurstLength	65535	512	16777215
InitialR2T	yes	no	yes
ImmediateData	yes	no	yes

Table 5-4 Parameters for iSCSI devices *(continued)*

Parameter	Default value	Minimum value	Maximum value
MaxBurstLength	262144	512	16777215
MaxConnections	1	1	65535
MaxOutStandingR2T	1	1	65535
MaxRecvDataSegmentLength	8182	512	16777215

To get the iSCSI operational parameters on the initiator for a specific iSCSI target

- Type the following commands:

  ```
  # vxddladm getiscsi target=tgt-id {all | parameter}
  ```

  You can use this command to obtain all the iSCSI operational parameters.

  ```
  # vxddladm getiscsi target=iscsi0_p2_t0
  ```

  The following is a sample output:

  ```
  PARAMETER               CURRENT  DEFAULT    MIN      MAX
  ------------------------------------------------------------
  DataPDUInOrder              yes      yes      no      yes
  DataSequenceInOrder         yes      yes      no      yes
  DefaultTime2Retain           20       20       0     3600
  DefaultTime2Wait              2        2       0     3600
  ErrorRecoveryLevel            0        0       0        2
  FirstBurstLength          65535    65535     512 16777215
  InitialR2T                  yes      yes      no      yes
  ImmediateData               yes      yes      no      yes
  MaxBurstLength           262144   262144     512 16777215
  MaxConnections                1        1       1    65535
  MaxOutStandingR2T             1        1       1    65535
  MaxRecvDataSegmentLength   8192     8182     512 16777215
  ```

To set the iSCSI operational parameters on the initiator for a specific iSCSI target

- Type the following command:

  ```
  # vxddladm setiscsi target=tgt-id parameter=value
  ```

Listing all supported disk arrays

Use this procedure to obtain values for the `vid` and `pid` attributes that are used with other forms of the `vxddladm` command.

To list all supported disk arrays

- Use the following command:

```
# vxddladm listsupport all
```

Excluding support for a disk array library

You can exclude support for disk arrays that depends on a particular disk array library. You can also exclude support for disk arrays from a particular vendor.

To exclude support for a disk array library

- To exclude support for a disk array library, specify the array library to the following command.

```
# vxddladm excludearray libname=libname
```

You can also exclude support for disk arrays from a particular vendor, as shown in this example:

```
# vxddladm excludearray vid=ACME pid=X1

# vxdisk scandisks
```

Re-including support for an excluded disk array library

If you previously excluded support for all arrays that depend on a particular disk array library, use this procedure to include the support for those arrays. This procedure removes the library from the exclude list.

To re-include support for an excluded disk array library

- If you have excluded support for all arrays that depend on a particular disk array library, you can use the `includearray` keyword to remove the entry from the exclude list.

```
# vxddladm includearray libname=libname
```

This command adds the array library to the database so that the library can once again be used in device discovery.

```
# vxdisk scandisks
```

Listing excluded disk arrays

To list all disk arrays that are currently excluded from use by Veritas Volume Manager (VxVM)

- Type the following command:

```
# vxddladm listexclude
```

Listing disks claimed in the DISKS category

To list disks that are claimed in the `DISKS` (JBOD) category

- Type the following command:

```
# vxddladm listjbod
```

Displaying details about an Array Support Library

Dynamic Multi-Pathing (DMP) enables you to display details about the Array Support Libraries (ASL).

To display details about an Array Support Library

- Type the following command:

```
# vxddladm listsupport libname=library_name.so
```

This command displays the vendor IDs (`VIDs`), product IDs (`PIDs`) for the arrays, array types (for example, A/A or A/P), and array names. The following is sample output.

```
# vxddladm listsupport libname=libvxfujitsu.so
ATTR_NAME            ATTR_VALUE
==============================================
LIBNAME              libvxfujitsu.so
VID                  vendor
PID                  GR710, GR720, GR730
                     GR740, GR820, GR840
ARRAY_TYPE           A/A, A/P
ARRAY_NAME           FJ_GR710, FJ_GR720, FJ_GR730
                     FJ_GR740, FJ_GR820, FJ_GR840
```

Adding unsupported disk arrays to the DISKS category

Disk arrays should be added as JBOD devices if no Array Support Library (ASL) is available for the array.

JBODs are assumed to be Active/Active (A/A) unless otherwise specified. If a suitable ASL is not available, an A/A-A, A/P, or A/PF array must be claimed as an Active/Passive (A/P) JBOD to prevent path delays and I/O failures. If a JBOD is ALUA-compliant, it is added as an ALUA array.

See "How DMP works" on page 11.

Warning: This procedure ensures that Dynamic Multi-Pathing (DMP) is set up correctly on an array that is not supported by Veritas Volume Manager (VxVM). Otherwise, VxVM treats the independent paths to the disks as separate devices, which can result in data corruption.

To add an unsupported disk array to the DISKS category

1. Use the following command to identify the vendor ID and product ID of the disks in the array:

   ```
   # /etc/vx/diag.d/vxscsiinq device_name
   ```

   where *device_name* is the device name of one of the disks in the array. Note the values of the vendor ID (`VID`) and product ID (`PID`) in the output from this command. For Fujitsu disks, also note the number of characters in the serial number that is displayed.

   The following example output shows that the vendor ID is `SEAGATE` and the product ID is `ST318404LSUN18G`.

   ```
   Vendor id (VID)      : SEAGATE
   Product id (PID)     : ST318404LSUN18G
   Revision             : 8507
   Serial Number        : 0025T0LA3H
   ```

2. Stop all applications, such as databases, from accessing VxVM volumes that are configured on the array, and unmount all file systems and Storage Checkpoints that are configured on the array.

3. If the array is of type A/A-A, A/P, or A/PF, configure it in autotrespass mode.

4 Enter the following command to add a new JBOD category:

```
# vxddladm addjbod vid=vendorid [pid=productid] \
[serialnum=opcode/pagecode/offset/length] \
[cabinetnum=opcode/pagecode/offset/length] policy={aa|ap}]
```

where *vendorid* and *productid* are the VID and PID values that you found from the previous step. For example, *vendorid* might be `FUJITSU`, `IBM`, or `SEAGATE`. For Fujitsu devices, you must also specify the number of characters in the serial number as the `length` argument (for example, 10). If the array is of type A/A-A, A/P, or A/PF, you must also specify the `policy=ap` attribute.

Continuing the previous example, the command to define an array of disks of this type as a JBOD would be:

```
# vxddladm addjbod vid=SEAGATE pid=ST318404LSUN18G
```

5 Use the `vxdctl enable` command to bring the array under VxVM control.

```
# vxdctl enable
```

See "Enabling discovery of new disk arrays" on page 153.

6 To verify that the array is now supported, enter the following command:

```
# vxddladm listjbod
```

The following is sample output from this command for the example array:

```
VID      PID          SerialNum            CabinetNum    Policy
                  (Cmd/PageCode/off/len) (Cmd/PageCode/off/len)
==============================================================
SEAGATE ALL PIDs  18/-1/36/12          18/-1/10/11    Disk
SUN      SESS01    18/-1/36/12          18/-1/12/11    Disk
```

7 To verify that the array is recognized, use the `vxdmpadm listenclosure` command as shown in the following sample output for the example array:

```
# vxdmpadm listenclosure
```

```
ENCLR_NAME ENCLR_TYPE ENCLR_SNO STATUS    ARRAY_TYPE LUN_COUNT FIRMWARE
============================================================================
Disk       Disk       DISKS     CONNECTED Disk       2         -
```

The enclosure name and type for the array are both shown as being set to `Disk`. You can use the `vxdisk list` command to display the disks in the array:

```
# vxdisk list
DEVICE       TYPE            DISK         GROUP        STATUS
punr710vm04_disk_1 auto:none       -            -            online invalid
punr710vm04_disk_2 auto:none       -            -            online invalid
punr710vm04_disk_3 auto:none       -            -            online invalid
punr710vm04_disk_4 auto:none       -            -            online invalid
sda                auto:none       -            -            online invalid
xiv0_9148          auto:none       -            -            online invalid thinrclm
...
```

8 To verify that the DMP paths are recognized, use the `vxdmpadm getdmpnode` command as shown in the following sample output for the example array:

```
# vxdmpadm getdmpnode enclosure=Disk
NAME                STATE        ENCLR-TYPE   PATHS  ENBL  DSBL  ENCLR-NAME
============================================================================
punr710vm04_disk_1   ENABLED      Disk         1      1     0     disk
punr710vm04_disk_2   ENABLED      Disk         1      1     0     disk
punr710vm04_disk_3   ENABLED      Disk         1      1     0     disk
punr710vm04_disk_4   ENABLED      Disk         1      1     0     disk
sda                  ENABLED      Disk         1      1     0     disk
...
```

The output in this example shows that there are two paths to the disks in the array.

For more information, enter the command `vxddladm help addjbod`.

See the `vxddladm`(1M) manual page.

See the `vxdmpadm`(1M) manual page.

Removing disks from the DISKS category

Use the procedure in this section to remove disks from the DISKS category.

To remove disks from the `DISKS` category

- Use the `vxddladm` command with the `rmjbod` keyword. The following example illustrates the command for removing disks that have the vendor id of `SEAGATE`:

```
# vxddladm rmjbod vid=SEAGATE
```

Foreign devices

The Device Discovery Layer (DDL) may not be able to discover some devices that are not auto-discoverable, such as RAM disks. Such foreign devices can be made available as simple disks to Veritas Volume Manager (VxVM) by using the `vxddladm addforeign` command. This also has the effect of bypassing DMP for handling I/O. The following example shows how to add entries for block and character devices in the specified directories:

```
# vxddladm addforeign blockdir=/dev/foo/dsk chardir=/dev/foo/rdsk
```

By default, this command suppresses any entries for matching devices in the OS-maintained device tree that are found by the autodiscovery mechanism. You can override this behavior by using the `-f` and `-n` options as described on the `vxddladm`(1M) manual page.

After adding entries for the foreign devices, use either the `vxdisk scandisks` or the `vxdctl enable` command to discover the devices as simple disks. These disks then behave in the same way as autoconfigured disks.

Foreign device support has the following limitations:

- A foreign device is always considered as a disk with a single path. Unlike an autodiscovered disk, it does not have a DMP node.
- It is not supported for shared disk groups in a clustered environment. Only standalone host systems are supported.
- It is not supported for Persistent Group Reservation (PGR) operations.
- It is not under the control of DMP, so enabling of a failed disk cannot be automatic, and DMP administrative commands are not applicable.
- Enclosure information is not available to VxVM. This can reduce the availability of any disk groups that are created using such devices.
- The I/O fencing and Cluster File System features are not supported for foreign devices.

Changing the disk device naming scheme

You can either use enclosure-based naming for disks or the operating system's naming scheme. DMP commands display device names according to the current naming scheme.

The default naming scheme is enclosure-based naming (EBN).

When you use Dynamic Multi-Pathing (DMP) with native volumes, the disk naming scheme must be EBN, the `use_avid` attribute must be `yes`, and the persistence attribute must be set to `yes`.

To change the disk-naming scheme

- Select `Change the disk naming scheme` from the `vxdiskadm` main menu to change the disk-naming scheme that you want DMP to use. When prompted, enter `y` to change the naming scheme.

  OR

  Change the naming scheme from the command line. Use the following command to select enclosure-based naming:

  ```
  # vxddladm set namingscheme=ebn [persistence={yes|no}] \
  [use_avid={yes|no}] [lowercase={yes|no}]
  ```

  Use the following command to select operating system-based naming:

  ```
  # vxddladm set namingscheme=osn [persistence={yes|no}] \
  [lowercase=yes|no]
  ```

  The optional `persistence` argument allows you to select whether the names of disk devices that are displayed by DMP remain unchanged after disk hardware has been reconfigured and the system rebooted. By default, enclosure-based naming is persistent. Operating system-based naming is not persistent by default.

  To change only the naming persistence without changing the naming scheme, run the `vxddladm set namingscheme` command for the current naming scheme, and specify the persistence attribute.

  By default, the names of the enclosure are converted to lowercase, regardless of the case of the name specified by the ASL. The enclosure-based device names are therefore in lowercase. Set the `lowercase=no` option to suppress the conversion to lowercase.

  For enclosure-based naming, the `use_avid` option specifies whether the Array Volume ID is used for the index number in the device name. By default, `use_avid=yes`, indicating the devices are named as *enclosure_avid.* If `use_avid` is set to `no`, DMP devices are named as *enclosure_index.* The index number is assigned after the devices are sorted by LUN serial number.

  The change is immediate whichever method you use.

  See "Regenerating persistent device names" on page 169.

Displaying the disk-naming scheme

In Dynamic Multi-Pathing (DMP), disk naming can be operating system-based naming or enclosure-based naming.

The following command displays whether the DMP disk-naming scheme is currently set. It also displays the attributes for the disk naming scheme, such as whether persistence is enabled.

To display the current disk-naming scheme and its mode of operations, use the following command:

```
# vxddladm get namingscheme
NAMING_SCHEME    PERSISTENCE LOWERCASE USE_AVID
=============================================
Enclosure Based  Yes         Yes       Yes
```

See "Disk device naming in DMP" on page 22.

Regenerating persistent device names

The persistent device naming feature makes the names of disk devices persistent across system reboots. The Device Discovery Layer (DDL) assigns device names according to the persistent device name database.

If operating system-based naming is selected, each disk name is usually set to the name of one of the paths to the disk. After hardware reconfiguration and a subsequent reboot, the operating system may generate different names for the paths to the disks. Therefore, the persistent device names may no longer correspond to the actual paths. This does not prevent the disks from being used, but the association between the disk name and one of its paths is lost.

Similarly, if enclosure-based naming is selected, the device name depends on the name of the enclosure and an index number. If a hardware configuration changes the order of the LUNs exposed by the array, the persistent device name may not reflect the current index.

To regenerate persistent device names

- To regenerate the persistent names repository, use the following command:

  ```
  # vxddladm [-c] assign names
  ```

  The `-c` option clears all user-specified names and replaces them with autogenerated names.

  If the `-c` option is not specified, existing user-specified names are maintained, but operating system-based and enclosure-based names are regenerated.

Changing device naming for enclosures controlled by third-party drivers

By default, enclosures controlled by third-party drivers (TPD) use pseudo device names based on the TPD-assigned node names. If you change the device naming to native, the devices are named in the same format as other Dynamic Multi-Pathing (DMP) devices. The devices use either operating system names (OSN) or enclosure-based names (EBN), depending on which naming scheme is set.

See "Displaying the disk-naming scheme" on page 168.

To change device naming for TPD-controlled enclosures

- For disk enclosures that are controlled by third-party drivers (TPD) whose coexistence is supported by an appropriate Array Support Library (ASL), the default behavior is to assign device names that are based on the TPD-assigned node names. You can use the `vxdmpadm` command to switch between these names and the device names that are known to the operating system:

  ```
  # vxdmpadm setattr enclosure enclosure_name tpdmode=native|pseudo
  ```

  The argument to the `tpdmode` attribute selects names that are based on those used by the operating system (`native`), or TPD-assigned node names (`pseudo`).

  The use of this command to change between TPD and operating system-based naming is illustrated in the following example for the enclosure named `EMC0`. In this example, the device-naming scheme is set to OSN.

  ```
  # vxdisk list

  DEVICE          TYPE             DISK       GROUP      STATUS
  emcpower10      auto:sliced      disk1      mydg       online
  emcpower11      auto:sliced      disk2      mydg       online
  emcpower12      auto:sliced      disk3      mydg       online
  emcpower13      auto:sliced      disk4      mydg       online
  emcpower14      auto:sliced      disk5      mydg       online
  emcpower15      auto:sliced      disk6      mydg       online
  emcpower16      auto:sliced      disk7      mydg       online
  emcpower17      auto:sliced      disk8      mydg       online
  emcpower18      auto:sliced      disk9      mydg       online
  emcpower19      auto:sliced      disk10     mydg       online

  # vxdmpadm setattr enclosure EMC0 tpdmode=native

  # vxdmpadm setattr enclosure pp_emc_clariion0 tpdmode=native

  # vxdisk list
  ```

```
DEVICE          TYPE            DISK        GROUP       STATUS
hdisk1          auto:sliced     disk1       mydg        online
hdisk2          auto:sliced     disk2       mydg        online
hdisk3          auto:sliced     disk3       mydg        online
hdisk4          auto:sliced     disk4       mydg        online
hdisk5          auto:sliced     disk5       mydg        online
hdisk6          auto:sliced     disk6       mydg        online
hdisk7          auto:sliced     disk7       mydg        online
hdisk8          auto:sliced     disk8       mydg        online
hdisk9          auto:sliced     disk9       mydg        online
hdisk10         auto:sliced     disk10      mydg        online
```

If `tpdmode` is set to `native`, the path with the smallest device number is displayed.

Discovering the association between enclosure-based disk names and OS-based disk names

If you enable enclosure-based naming, the `vxprint` command displays the structure of a volume using enclosure-based disk device names (disk access names) rather than OS-based names.

To discover the association between enclosure-based disk names and OS-based disk names

- To discover the operating system-based names that are associated with a given enclosure-based disk name, use either of the following commands:

```
# vxdisk list enclosure-based_name
# vxdmpadm getsubpaths dmpnodename=enclosure-based_name
```

For example, to find the physical device that is associated with disk `ENC0_21`, the appropriate commands would be:

```
# vxdisk list ENC0_21
# vxdmpadm getsubpaths dmpnodename=ENC0_21
```

To obtain the full pathname for the block disk device and the character disk device from these commands, append the displayed device name to `/dev/vx/dmp/` or `/dev/vx/rdmp/`.

Chapter 6

Dynamic Reconfiguration of devices

This chapter includes the following topics:

About online Dynamic Reconfiguration

System administrators and storage administrators may need to modify the set of LUNs provisioned to a server. You can change the LUN configuration dynamically, without performing a reconfiguration reboot on the host.

Note: You can change the LUN configuration dynamically either using the Dynamic Reconfiguration (DR) tool or manually. Veritas recommends using the Dynamic Reconfiguration tool.

Table 6-1 lists the kinds of online dynamic reconfigurations that you can perform:

Table 6-1

Task	Topic
Reconfigure a LUN online that is under DMP control	■ DR tool—See "Reconfiguring a LUN online that is under DMP control using the Dynamic Reconfiguration tool" on page 173. ■ Manual—See "Manually reconfiguring a LUN online that is under DMP control" on page 182.
Replace a host bus adapter (HBA) online	■ DR tool—See "Replacing a host bus adapter online" on page 181. ■ Manual—See "Manually replacing a host bus adapter online" on page 190.
Update the array controller firmware, also known as a nondisruptive upgrade	■ See "Upgrading the array controller firmware online" on page 192.

Reconfiguring a LUN online that is under DMP control using the Dynamic Reconfiguration tool

Perform the following tasks to reconfigure a LUN online that is under DMP control using the Dynamic Reconfiguration tool:

Table 6-2

Task	Topic
Removing LUNs dynamically from an existing target ID	See "Removing LUNs dynamically from an existing target ID" on page 173.
Adding LUNs dynamically to a new target ID	See "Adding new LUNs dynamically to a target ID" on page 176.
Replacing a LUN on an existing target ID	See "Replacing LUNs dynamically from an existing target ID" on page 180.
Changing the LUN characteristics	See "Changing the characteristics of a LUN from the array side" on page 191.

Removing LUNs dynamically from an existing target ID

Dynamic Multi-Pathing (DMP) provides a Dynamic Reconfiguration tool to simplify the removal of LUNs from an existing target ID. Each LUN is unmapped from the

host. DMP issues an operating system device scan and cleans up the operating system device tree.

Warning: Do not run any device discovery operations outside of the Dynamic Reconfiguration tool until the device operation is completed.

In a cluster, perform the steps on all nodes in the cluster.

To remove LUNs dynamically from an existing target ID

1. Stop all applications and volumes that are hosted on the LUNs that are to be removed.

   For LUNs using AIX LVM over DMP devices, remove the device from the LVM volume group.

   ```
   # reducevg vgname
         pvname
   ```

2. Start the `vxdiskadm` utility:

   ```
   # vxdiskadm
   ```

3. Select the **Dynamic Reconfiguration operations** option from the `vxdiskadm` menu.
4. Select the **Remove LUNs** option.
5. Type **list** or press **Return** to display a list of LUNs that are available for removal. A LUN is available for removal if it is not in use.

   The following shows an example output:

   ```
   Select disk devices to remove: [<pattern-list>,all,list]: list
   LUN(s) available for removal:
   eva4k6k0_0
   eva4k6k0_1
   eva4k6k0_2
   eva4k6k0_3
   eva4k6k0_4
   emc0_02b8
   ```

6 Enter the name of a LUN, a comma-separated list of LUNs, or a regular expression to specify the LUNs to remove.

For example, enter `emc0_02b8`.

```
Select disk devices to Remove: [<pattern-list>,all,list,
file=<filename>,q] (default:list): emc0_02b8
```

7 At the prompt, confirm the LUN selection.

DMP removes the LUN from VxVM usage.

8 At the following prompt, remove the LUN from the array/target.

```
Remove Luns
Menu: VolumeManager/Disk/DynamicReconfigurationOperations/RemoveLuns

INFO: Removing Lun [emc0_02b8] from VxVM
INFO: LUN [emc0_02b8] removed successfully from VxVM.
-----------------------------------------------------
Enclosure=emc0 AVID=02B8
Device=emc0_02b8 Serial=22002B8000
PATH=hdisk12 ctlr=fscsi0 port=16c-0 [-]
PATH=hdisk14 ctlr=fscsi0 port=16c-1 [-]
-----------------------------------------------------
Please remove LUNs with Above details from array and press 'y' to
continue removal or 'q' to quit :
```

9 The following are sample EMC Symmetrix commands:

```
# symmask -sid 822 -wwn 10000000c989e032 -dir 16c -p 0 remove devs 02b8
# symmask -sid 822 -wwn 10000000c989e032 -dir 16c -p 1 remove devs 02b8
# symmask -sid 822 refresh -nopr

Symmetrix FA/SE directors updated with contents of SymMask
Database 000290300822

When complete, enter “y” to continue now the storage activity
is complete

Please remove LUNs with Above details from array and
press 'y' to continue removal or 'q' to quit : y
```

10 DMP completes the removal of the device from VxVM usage. Output similar to the following is displayed:

```
Remove Luns
Menu: VolumeManager/Disk/DynamicReconfigurationOperations/RemoveLuns

INFO: [emc0_02b8] removed Successfully from OS device Tree.
INFO: Refreshing OS device Tree
INFO: Updating VxVM device tree
------------------------------------------------------------
Luns Removed
------------------------------------------------------------
emc0_02b8
------------------------------------------------------------

Press <Enter> or <Return> to continue:
```

11 Specify the dynamic reconfiguration operation to be done:

```
Specify Dynamic Reconfiguration Operation to be done:
Menu: VolumeManager/Disk/DynamicReconfigurationOperations

 1 Add Luns
 2 Remove Luns
 3 Replace Luns
 4 Replace HBA


 ? Display help about menu
 ?? Display help about the menuing system
 q Exit
```

To exit the Dynamic Reconfiguration tool, enter: `q`

Adding new LUNs dynamically to a target ID

Dynamic Multi-Pathing (DMP) provides a Dynamic Reconfiguration tool to simplify the addition of new LUNs to a new or existing target ID. One or more new LUNs are mapped to the host by way of multiple HBA ports. An operating system device scan is issued for the LUNs to be recognized and added to DMP control.

Warning: Do not run any device discovery operations outside of the Dynamic Reconfiguration tool until the device operation is completed.

In a cluster, perform the steps on all the nodes in the cluster.

To add new LUNs dynamically to a target ID

1. Start the `vxdiskadm` utility:

```
# vxdiskadm
```

2. Select the **Dynamic Reconfiguration operations** option from the `vxdiskadm` menu.

3. Specify the Dynamic Reconfiguration operation to be done. Output similar to the following is displayed:

```
Specify Dynamic Reconfiguration Operation to be done:
Menu: VolumeManager/Disk/DynamicReconfigurationOperations

 1      Add Luns
 2      Remove Luns
 3      Replace Luns
 4      Replace HBA


 ?      Display help about menu
 ??     Display help about the menuing system
 q      Exit
```

   To add a LUN, enter **1**. Output similar to the following is displayed:

```
Add Luns
Menu: VolumeManager/Disk/DynamicReconfigurationOperations/AddLuns

INFO: Refreshing OS device Tree
INFO: Updating VxVM device tree
Add LUNs from array, once done then press 'y' to continue
or 'q' to quit. :
```

4 The following are sample EMC Symmetrix commands:

```
# symmask -sid 822 -wwn 10000000c989e032 -dir 1c -p 0 add devs
02b8 -nopr
# symmask -sid 822 -wwn 10000000c989e032 -dir 1c -p 1 add devs
02b8 -nopr
# symmask -sid 822 -wwn 10000000c989e032 -dir 16c -p 0 add devs
02b8 -nopr
# symmask -sid 822 -wwn 10000000c989e032 -dir 16c -p 1 add devs
02b8 -nopr
# symmask -sid 822 refresh -nopr

Symmetrix FA/SE directors updated with contents of SymMask
Database 000290300822
```

5 When the prompt displays, add the LUNs from the array.

Output similar to the following is displayed:

```
Add LUNs from array, once done then press 'y' to continue
or 'q' to quit. : y
Add Luns
Menu: VolumeManager/Disk/DynamicReconfigurationOperations/AddLuns

INFO: Refreshing OS device Tree
INFO: Updating VxVM device tree
INFO: Number of Paths for Lun [emc0_02b8] presented=4
INFO: Updating VxVM device tree
```

6 Select **y** to continue to add the LUNs to DMP.

DMP updates the operating system device tree and the VxVM device tree. The newly-discovered devices are now visible.

```
-----------------------------------------------------
Luns Added
-----------------------------------------------------
Enclosure=emc0 AVID=02B8
Device=emc0_02b8 Serial=22002B8000
PATH=hdisk49 ctlr=fscsi0 port=1c-0 [-]
PATH=hdisk11 ctlr=fscsi0 port=16c-0 [-]
PATH=hdisk12 ctlr=fscsi0 port=16c-1 [-]
PATH=hdisk14 ctlr=fscsi0 port=1c-1 [-]
-----------------------------------------------------

Press <Enter> or <Return> to continue:
```

7 Specify the dynamic reconfiguration operation to be done:

```
Specify Dynamic Reconfiguration Operation to be done:
Menu: VolumeManager/Disk/DynamicReconfigurationOperations

 1 Add Luns
 2 Remove Luns
 3 Replace Luns
 4 Replace HBA


 ? Display help about menu
 ?? Display help about the menuing system
 q Exit

Select an operation to perform : q
```

To exit the Dynamic Reconfiguration tool, enter: `q`

8 Initialize the disk.

```
# vxdisk -eo alldgs list | grep -w emc0_02b8
emc0_02b8    auto:none      -            -           online invalid
hdisk49          Mirror lun

If to be used by VxVM and not already initialised,
run /etc/vx/bin/vxdisksetup -i <da-name>

# /etc/vx/bin/vxdisksetup -i emc0_02b8

# vxdisk -eo alldgs list | grep -w emc0_02b8
emc0_02b8    auto:cdsdisk   -            -           online
hdisk49          Mirror lun
```

Replacing LUNs dynamically from an existing target ID

Dynamic Multi-Pathing (DMP) provides a Dynamic Reconfiguration tool to simplify the replacement of new LUNs from an existing target ID. Each LUN is unmapped from the host. DMP issues an operating system device scan and cleans up the operating system device tree.

Warning: Do not run any device discovery operations outside of the Dynamic Reconfiguration tool until the device operation is completed.

In a cluster, perform the steps on all the nodes in the cluster.

To replace LUNs dynamically from an existing target ID

1. Stop all applications and volumes that are hosted on the LUNs that are to be removed.

   For LUNs using AIX LVM over DMP devices, remove the device from the LVM volume group.

   ```
   # reducevg vgname
         pvname
   ```

2. Start the `vxdiskadm` utility:

   ```
   # vxdiskadm
   ```

3. Select the **Dynamic Reconfiguration operations** option from the `vxdiskadm` menu.
4. Select the **Replace LUNs** option.

   The output displays a list of LUNs that are available for replacement. A LUN is available for replacement if there is no open on the LUN, and the state is online or nolabel.
5. Select one or more LUNs to replace.
6. At the prompt, confirm the LUN selection.
7. Remove the LUN from the array/target.
8. Return to the Dynamic Reconfiguration tool and select `y` to continue the removal.

   After the removal completes successfully, the Dynamic Reconfiguration tool prompts you to add a LUN.
9. When the prompt displays, add the LUNs from the array/target.
10. Select **y** to continue to add the LUNs.

    DMP updates the operating system device tree and the VxVM device tree. The newly-discovered devices are now visible.

Replacing a host bus adapter online

Dynamic Multi-Pathing (DMP) provides a Dynamic Reconfiguration tool to simplify the removal of host bus adapters from an existing system.

To replace a host bus adapter online

1 Start the `vxdiskadm` utility:

```
# vxdiskadm
```

2 Select the **Dynamic Reconfiguration operations** option from the `vxdiskadm` menu.

3 Select the **Replace HBAs** option.

The output displays a list of HBAs that are available to DMP.

4 Select one or more HBAs to replace.

5 At the prompt, confirm the HBA selection.

6 Replace the host bus adapter.

7 Return to the Dynamic Reconfiguration tool and select `y` to continue the replacement process.

DMP updates the operating system device tree.

Manually reconfiguring a LUN online that is under DMP control

Dynamic LUN reconfigurations require array configuration commands, operating system commands, and Veritas Volume manager commands. To complete the operations correctly, you must issue the commands in the proper sequence on the host.

Overview of manually reconfiguring a LUN

This section only provides an overview of the prechecks and the procedure to manually add or remove a LUN. The procedures have been elaborately documented in the topics listed in the following table:

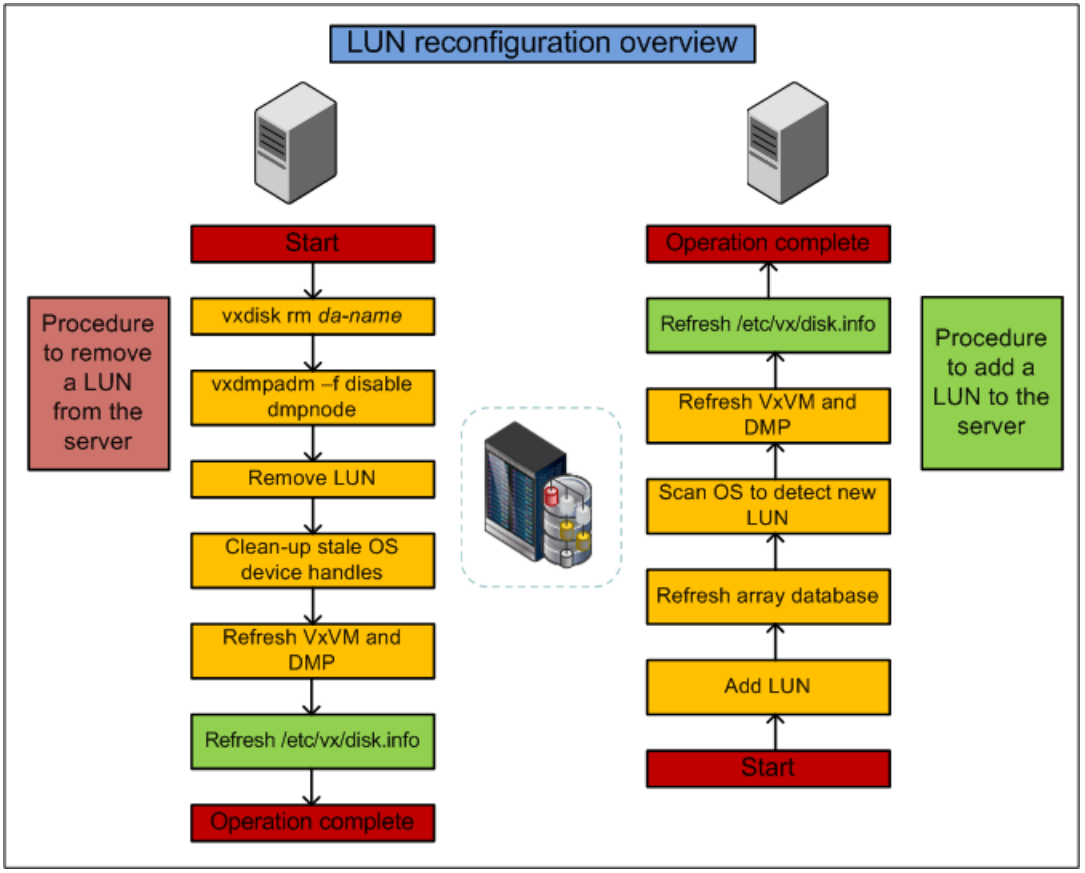
Table 6-3

Task	Topic
Removing LUN dynamically from an existing target ID	See "Manually removing LUNs dynamically from an existing target ID" on page 185.
Cleaning up the operating system device tree after removing LUNs	See "Manually cleaning up the operating system device tree after removing LUNs" on page 189.

Table 6-3 *(continued)*

Task	Topic
Scanning an operating system device tree after adding or removing LUNs	See "Scanning an operating system device tree after adding or removing LUNs" on page 189.
Adding LUN dynamically to a new target ID	See "Manually adding new LUNs dynamically to a new target ID" on page 187.
Changing the LUN characteristics	See "Changing the characteristics of a LUN from the array side" on page 191.

Figure 6-1 LUN reconfiguration overview



Prechecks

Perform the following prechecks before manually reconfiguring a LUN:

Table 6-4 Prechecks

Task	Command
Check the `/etc/vx/disk.info` file	`# grep "0xffff" /etc/vx/disk.info`
Refresh the OS layer	`# cfgmgr [-v]`
List OS device handles	`# lsdev -Cc disk`
Refresh VxVM and DMP	`# vxdisk scandisks`
Refresh DDL layer/dev_t (device number) list	`# vxddladm assign names`

Note: Ensure that the OS and VxVM are both clean prior to provisioning any new LUNs.

Manually removing a LUN

Perform the following steps to manually remove a LUN:

Table 6-5 LUN removal steps

Task	Validation
Unmount file system (s)	Confirm whether the disk has been removed from the disk group.
Close the VxVM device: `# vxdisk rm da-name`	Confirm whether the VxVM device has been closed: `# vxdisk list`
Disable DMP paths: `# vxdmpadm -f disable dmpnodename=da-name`	Confirm whether the DMP paths have been disabled: `# vxdmpadm getsubpaths dmpnodename=da-name`
Mask LUN from the server	Confirm whether the LUN has been removed at the array level.
Clean-up OS device handles: `# rmdev -dl hdisk#`	Confirm whether OS device handles are clean: `# lsdev -Cc disk`

Table 6-5 LUN removal steps *(continued)*

Task	Validation
Refresh VxVM and DMP: `# vxdisk scandisks`	
Refresh DDL layer/dev_t (device number) list: `# vxddladm assign names`	

Manually adding a LUN

To manually add a LUN

1. Mask LUN to HBA worldwide name (WWN) in the server.
2. Refresh the array database.
3. Refresh OS device handles.
4. Refresh VxVM and DMP.
5. Refresh the `/etc/vx/disk.info` file.

Manually removing LUNs dynamically from an existing target ID

In this case, a group of LUNs is unmapped from the host HBA ports and an operating system device scan is issued. To add subsequent LUNs seamlessly, perform additional steps to clean up the operating system device tree.

The high-level procedure and the DMP commands are generic.

To remove LUNs dynamically from an existing target ID

1. Prior to any dynamic reconfiguration, ensure that the `dmp_cache_open` tunable is set to `on`. This setting is the default.

   ```
   # vxdmpadm gettune dmp_cache_open
   ```

   If the tunable is set to `off`, set the `dmp_cache_open` tunable to `on`.

   ```
   # vxdmpadm settune dmp_cache_open=on
   ```

2. Identify which LUNs to remove from the host. Do one of the following:
   - Use Storage Array Management to identify the Array Volume ID (AVID) for the LUNs.
   - If the array does not report the AVID, use the LUN index.
3. For LUNs under VxVM, perform the following steps:

- Evacuate the data from the LUNs using the `vxevac` command.

  See the `vxevac`(1M) online manual page.

  After the data has been evacuated, enter the following command to remove the LUNs from the disk group:

  ```
  # vxdg -g diskgroup rmdisk da-name
  ```

- If the data has not been evacuated and the LUN is part of a subdisk or disk group, enter the following command to remove the LUNs from the disk group. If the disk is part of a shared disk group, you must use the `-k` option to force the removal.

  ```
  # vxdg -g diskgroup -k rmdisk da-name
  ```

4 For LUNs using AIX LVM over DMP devices, remove the device from the LVM volume group.

```
# reducevg vgname
      pvname
```

5 Using the AVID or LUN index, use Storage Array Management to unmap or unmask the LUNs you identified in step 2.

6 Remove the LUNs from the `vxdisk` list. Enter the following command on all nodes in a cluster:

```
# vxdisk rm da-name
```

This is a required step. If you do not perform this step, the DMP device tree shows ghost paths.

7 Clean up the AIX SCSI device tree for the devices that you removed in step 6.

See "Manually cleaning up the operating system device tree after removing LUNs" on page 189.

This step is required. You must clean up the operating system SCSI device tree to release the SCSI target ID for reuse if a new LUN is added to the host later.

8 Scan the operating system device tree.

See "Scanning an operating system device tree after adding or removing LUNs" on page 189.

9 Use DMP to perform a device scan. You must perform this operation on all nodes in a cluster. Enter one of the following commands:

- `# vxdctl enable`
- `# vxdisk scandisks`

10 Refresh the DMP device name database using the following command:

```
# vxddladm assign names
```

11 Verify that the LUNs were removed cleanly by answering the following questions:

- Is the device tree clean?
  After the LUN is removed cleanly, there should be no `hdisk` entries in the "Defined" state.
- Were all the appropriate LUNs removed?
  Use the DMP disk reporting tools such as the `vxdisk list` command output to determine if the LUNs have been cleaned up successfully.
- Is the `vxdisk list` output correct?
  Verify that the `vxdisk list` output shows the correct number of paths and does not include any ghost disks.

If the answer to any of these questions is "No," return to step 5 and perform the required steps.

If the answer to all of the questions is "Yes," the LUN remove operation is successful.

Manually adding new LUNs dynamically to a new target ID

In this case, a new group of LUNs is mapped to the host via multiple HBA ports. An operating system device scan is issued for the LUNs to be recognized and added to DMP control.

The high-level procedure and the DMP commands are generic.

To add new LUNs dynamically to a new target ID

1. Prior to any dynamic reconfiguration, ensure that the `dmp_cache_open` tunable is set to `on`. This setting is the default.

   ```
   # vxdmpadm gettune dmp_cache_open
   ```

   If the tunable is set to `off`, set the `dmp_cache_open` tunable to `on`.

   ```
   # vxdmpadm settune dmp_cache_open=on
   ```

2. Identify which LUNs to add to the host. Do one of the following:
   - Use Storage Array Management to identify the Array Volume ID (AVID) for the LUNs.
   - If the array does not report the AVID, use the LUN index.
3. Map/mask the LUNs to the new target IDs on multiple hosts.
4. Scan the operating system device.

   See "Scanning an operating system device tree after adding or removing LUNs" on page 189.

   Repeat step 2 and step 3 until you see that all the LUNs have been added.
5. Use DMP to perform a device scan. You must perform this operation on all nodes in a cluster. Enter one of the following commands:
   - `# vxdctl enable`
   - `# vxdisk scandisks`
6. Refresh the DMP device name database using the following command:

   ```
   # vxddladm assign names
   ```

7. Verify that the LUNs were added correctly by answering the following questions:
   - Do the newly provisioned LUNs appear in the `vxdisk list` output?
   - Are the configured paths present for each LUN?

   If the answer to any of these questions is "No," return to step 2 and begin the procedure again.

   If the answer to all of the questions is "Yes," the LUNs have been successfully added. You can now add the LUNs to a disk group, create new volumes, or grow existing volumes.

If the dmp_native_support tunable is set to ON and the new LUN does not have a VxVM label or is not claimed by a TPD driver then the LUN is available for use by LVM.

About detecting target ID reuse if the operating system device tree is not cleaned up

When the target ID is reused and the operating system device tree is not cleaned up, the `vxdisk scandisks` and `vxdctl enable` commands hang. To correct this situation, you must clean up the operating system device tree.

See "Manually cleaning up the operating system device tree after removing LUNs" on page 189.

Scanning an operating system device tree after adding or removing LUNs

After you add or remove LUNs, scan the operating system device tree to verify that the operation completed successfully.

To scan an operating system device tree after adding or removing LUNs

- Enter the following command:

```
# cfgmgr
```

Manually cleaning up the operating system device tree after removing LUNs

After you remove LUNs, you must clean up the operating system device tree.

To clean up the operating system device tree after removing LUNs

1. Enter the following command. Devices that have been removed will have `Defined` after the disk name.

```
# lsdev -Cc disk
hdisk431 Defined  09-08-02 IBM 2810XIV Non-MPIO Fibre Channel Disk
hdisk432 Defined  0A-08-02 IBM 2810XIV Non-MPIO Fibre Channel Disk
```

2. For each disk name, run the following command to remove it from the operating system database:

```
# rmdev -dl hdisk-name
```

   In this example, the commands would be the following:

```
# rmdev -dl hdisk431

# rmdev -dl hdisk432
```

3. Repeat step 1 and verify that no devices are shown as `Defined`.

Manually replacing a host bus adapter online

Before you replace a host bus adapter (HBA) online, you must disable the I/O paths to the controller. After you replace the HBA, you enable the I/O paths.

To replace a host bus adapter online

1. Disable the paths to the controller by removing the reference from DMP. Enter the following. In this example, the controller name is `fscsi`.

```
# vxdmpadm -f disable ctlr=fscsi
```

2. Remove the device references from the operating system. Enter the following:

```
# rmdev -Rdl fscsi
```

3. Rescan the device tree and rebuild the DMP database. Enter the following:

```
# vxdctl enable
```

4. Replace the host bus adapter.
5. Reconfigure the devices in the operating system. Enter the following:

```
# cfgmgr
```

6 Verify that new devices appear at the operating system level.

```
# lsdev -Cc disk
```

7 Enable the controller. In this example, the controller name is `fscsi`.

```
# vxdmpadm enable ctlr=fscsi
```

8 Rescan the device tree and rebuild the DMP database.

```
# vxdctl enable
```

Changing the characteristics of a LUN from the array side

Some arrays provide a way to change the properties of LUNs. In most cases, you must completely stop usage of the device before the device shows the changed characteristics. We recommend taking the device offline before changing the LUN properties, and bringing the device back online again afterwards.

In certain cases, such as EMC BCV and SRDF operations, the device can remain online during this procedure.

In a cluster, perform the steps on all the nodes in the cluster.

To change the properties of a LUN

1 Stop all applications and volumes that are hosted on the device.

If the device is in use by Veritas Volume Manager (VxVM), perform the following steps:

For LUNs using AIX LVM over DMP devices, remove the device from the LVM volume group or varyoff the volume group.

```
# varyoffvg vgname
```

2 Change the LUN characteristics.

3 Bring the device online.

For a Veritas Volume Manager disk:

For LUNs using AIX LVM over DMP devices, add the device back into the LVM volume group or varyon the volume group.

```
# varyonvg vgname
```

4 Use DMP to perform a device scan.

In a cluster, perform this command on all the nodes.

```
# vxdisk scandisks
```

Upgrading the array controller firmware online

Storage array subsystems need code upgrades as fixes, patches, or feature upgrades. You can perform these upgrades online when the file system is mounted and I/Os are being served to the storage.

Storage subsystems contain multiple controllers for redundancy. An online upgrade is done one controller at a time. Dynamic Multi-Pathing (DMP) fails over all I/O to an alternate controller while one of the controllers is undergoing an Online Controller Upgrade. After the controller has completely staged the code, it reboots, resets, and comes online with the new version of the code. The other controller goes through the same process, and I/O fails over to the alternate controller.

Note: Throughout this process, application I/O is not affected.

Array vendors have different names for this process. For example, EMC calls it a nondisruptive upgrade (NDU) for CLARiiON arrays.

A/A type arrays require no special handling during this online upgrade process. For A/P, A/PF, and ALUA type arrays, DMP performs array-specific handling through vendor-specific array policy modules (APMs) during an online controller code upgrade.

When a controller resets and reboots during a code upgrade, DMP detects this state through the SCSI status. DMP immediately fails over all I/O to the next controller.

If the array does not fully support NDU, all paths to the controllers may be unavailable for I/O for a short period of time. Before beginning the upgrade, set the `dmp_lun_retry_timeout` tunable to a period greater than the time that you expect the controllers to be unavailable for I/O. DMP does not fail the I/Os until the end of

the `dmp_lun_retry_timeout` period, or until the I/O succeeds, whichever happens first. Therefore, you can perform the firmware upgrade without interrupting the application I/Os.

For example, if you expect the paths to be unavailable for I/O for 300 seconds, use the following command:

```
# vxdmpadm settune dmp_lun_retry_timeout=300
```

DMP does not fail the I/Os for 300 seconds, or until the I/O succeeds.

To verify which arrays support Online Controller Upgrade or NDU, refer to the hardware compatibility list (HCL).

Chapter 7

Event monitoring

This chapter includes the following topics:

About the Dynamic Multi-Pathing (DMP) event source daemon (vxesd)

The event source daemon (`vxesd`) is a Dynamic Multi-Pathing (DMP) component process that receives notifications of any device-related events that are used to take appropriate actions. The benefits of `vxesd` include:

- Monitoring of SAN fabric events and proactive error detection (SAN event)
  See "Fabric Monitoring and proactive error detection" on page 195.
- Logging of DMP events for troubleshooting (DMP event)
  See "DMP event logging" on page 196.
- Discovery of SAN components and HBA-array port connectivity (Fibre Channel and iSCSI)
  See "Dynamic Multi-Pathing (DMP) discovery of iSCSI and SAN Fibre Channel topology" on page 196.

See "Starting and stopping the Dynamic Multi-Pathing (DMP) event source daemon" on page 197.

Fabric Monitoring and proactive error detection

DMP takes a proactive role in detecting errors on paths.

The DMP event source daemon `vxesd` uses the Storage Networking Industry Association (SNIA) HBA API library to receive SAN fabric events from the HBA.

DMP checks devices that are suspect based on the information from the SAN events, even if there is no active I/O. New I/O is directed to healthy paths while DMP verifies the suspect devices.

During startup, `vxesd` queries the HBA (by way of the SNIA library) to obtain the SAN topology. The `vxesd` daemon determines the Port World Wide Names (PWWN) that correspond to each of the device paths that are visible to the operating system. After the `vxesd` daemon obtains the topology, `vxesd` registers with the HBA for SAN event notification. If LUNs are disconnected from a SAN, the HBA notifies `vxesd` of the SAN event, specifying the PWWNs that are affected. The `vxesd` daemon uses this event information and correlates it with the previous topology information to determine which set of device paths have been affected.

The `vxesd` daemon sends the affected set to the `vxconfigd` daemon (DDL) so that the device paths can be marked as suspect.

When the path is marked as suspect, DMP does not send new I/O to the path unless it is the last path to the device. In the background, the DMP restore task checks the accessibility of the paths on its next periodic cycle using a SCSI inquiry probe. If the SCSI inquiry fails, DMP disables the path to the affected LUNs, which is also logged in the event log.

If the LUNs are reconnected at a later time, the HBA informs `vxesd` of the SAN event. When the DMP restore task runs its next test cycle, the disabled paths are checked with the SCSI probe and re-enabled if successful.

Note: If `vxesd` receives an HBA LINK UP event, the DMP restore task is restarted and the SCSI probes run immediately, without waiting for the next periodic cycle. When the DMP restore task is restarted, it starts a new periodic cycle. If the disabled paths are not accessible by the time of the first SCSI probe, they are re-tested on the next cycle (300s by default).

The fabric monitor functionality is disabled by default. The value of the `dmp_monitor_fabric` tunable is persistent across restarts.

To display the current value of the `dmp_monitor_fabric` tunable, use the following command:

```
# vxdmpadm gettune dmp_monitor_fabric
```

To disable the Fabric Monitoring functionality, use the following command:

```
# vxdmpadm settune dmp_monitor_fabric=off
```

To enable the Fabric Monitoring functionality, use the following command:

```
# vxdmpadm settune dmp_monitor_fabric=on
```

Dynamic Multi-Pathing (DMP) discovery of iSCSI and SAN Fibre Channel topology

The `vxesd` builds a topology of iSCSI and Fibre Channel (FC) devices that are visible to the host. The `vxesd` daemon uses the SNIA Fibre Channel HBA API to obtain the SAN topology. If IMA is not available, then the iSCSI management CLI is used to obtain the iSCSI SAN topology.

To display the hierarchical listing of Fibre Channel and iSCSI devices, use the following command:

```
# vxddladm list
```

See the `vxddladm(1M)` manual page.

DMP event logging

See “About the Dynamic Multi-Pathing (DMP) event source daemon (vxesd)” on page 194.

The event source daemon (`vxesd`) is a Dynamic Multi-Pathing (DMP) component process that receives notifications of any device-related events that are used to take appropriate actions.

DMP notifies `vxesd` of major events, and `vxesd` logs the event in a log file. These events include:

- Marking paths or dmpnodes enabled
- Marking paths or dmpnodes disabled
- Throttling of paths
- I/O error analysis
- HBA and SAN events

You can change the level of detail that is displayed in the system or console log about the DMP events. Use the tunable `dmp_log_level`. Valid values are 1 through 9. The default level is 1.

```
# vxdmpadm settune dmp_log_level=X
```

The current value of `dmp_log_level` can be displayed with:

```
# vxdmpadm gettune dmp_log_level
```

For details on the various log levels, see the `vxdmpadm`(1M) manual page.

Starting and stopping the Dynamic Multi-Pathing (DMP) event source daemon

By default, Dynamic Multi-Pathing (DMP) starts the event source daemon, `vxesd`, at boot time.

To stop the `vxesd` daemon, use the `vxddladm` utility:

```
# vxddladm stop eventsource
```

To start the `vxesd` daemon, use the `vxddladm` utility:

```
# vxddladm start eventsource [logfile=logfilename]
```

To view the status of the `vxesd` daemon, use the `vxddladm` utility:

```
# vxddladm status eventsource
```

Chapter 8

Performance monitoring and tuning

This chapter includes the following topics:

About tuning Dynamic Multi-Pathing (DMP) with templates

Dynamic Multi-Pathing has multiple tunable parameters and attributes that you can configure for optimal performance. DMP provides a template method to update several tunable parameters and attributes with a single operation. The template represents a full or partial DMP configuration, showing the values of the parameters and attributes of the host.

To view and work with the tunable parameters, you can dump the configuration values of the DMP tunable parameters to a file. Edit the parameters and attributes,

if required. Then, load the template file to a host to update all of the values in a single operation.

You can load the configuration file to the same host, or to another similar host. The template method is useful for the following scenarios:

- Configure multiple similar hosts with the optimal performance tuning values. Configure one host for optimal performance. After you have configured the host, dump the tunable parameters and attributes to a template file. You can then load the template file to another host with similar requirements. Veritas recommends that the hosts that use the same configuration template have the same operating system and similar I/O requirements.
- Define multiple specialized templates to handle different I/O load requirements. When the load changes on a host, you can load a different template for the best performance. This strategy is appropriate for predictable, temporary changes in the I/O load. As the system administrator, after you define the system's I/O load behavior, you can customize tuning templates for particular loads. You can then automate the tuning, since there is a single load command that you can use in scripts or cron jobs.

At any time, you can reset the configuration, which reverts the values of the tunable parameters and attributes to the DMP default values.

You can manage the DMP configuration file with the `vxdmpadm config` commands.

See the `vxdmpadm`(1m) man page.

DMP tuning templates

The template mechanism enables you to tune DMP parameters and attributes by dumping the configuration values to a file, or to standard output.

DMP supports tuning the following types of information with template files:

- DMP tunable parameters.
- DMP attributes defined for an enclosure, array name, or array type.
- Veritas naming scheme parameters.

The template file is divided into sections, as follows:

DMP Tunables	Applied to all enclosures and arrays.
Namingscheme	Applied to all enclosures and arrays.
Arraytype	Use to customize array types. Applied to all of the enclosures of the specified array type.

Arrayname	Use if particular arrays need customization; that is, if the tunables vary from those applied for the array type. Attributes in this section are applied to all of the enclosures of the specified array name.
Enclosurename	Applied to the enclosures of the specified Cab serial number and array name. Use if particular enclosures need customization; that is, if the tunables vary from those applied for the array type and array name.

Loading is atomic for the section. DMP loads each section only if all of the attributes in the section are valid. When all sections have been processed, DMP reports the list of errors and warns the user. DMP does not support a partial rollback. DMP verifies the tunables and attributes during the load process. However, Veritas recommends that you check the configuration template file before you attempt to load the file. Make any required corrections until the configuration file validates correctly.

The attributes are given priority in the following order when a template is loaded:

Enclosure Section > Array Name Section > Array Type Section

If all enclosures of the same array type need the same settings, then remove the corresponding array name and enclosure name sections from the template. Define the settings only in the array type section. If some of the enclosures or array names need customized settings, retain the attribute sections for the array names or enclosures. You can remove the entries for the enclosures or the array names if they use the same settings that are defined for the array type.

When you dump a configuration file from a host, that host may contain some arrays which are not visible on the other hosts. When you load the template to a target host that does not include the enclosure, array type, or array name, DMP ignores the sections.

You may not want to apply settings to non-shared arrays or some host-specific arrays on the target hosts. Be sure to define an enclosure section for each of those arrays in the template. When you load the template file to the target host, the enclosure section determines the settings. Otherwise, DMP applies the settings from the respective array name or array type sections.

Example DMP tuning template

This section shows an example of a DMP tuning template.

```
DMP Tunables
        dmp_cache_open=on
        dmp_daemon_count=10
        dmp_delayq_interval=15
        dmp_restore_state=enabled
        dmp_fast_recovery=on
        dmp_health_time=60
        dmp_log_level=1
        dmp_low_impact_probe=on
        dmp_lun_retry_timeout=30
        dmp_path_age=300
        dmp_pathswitch_blks_shift=9
        dmp_probe_idle_lun=on
        dmp_probe_threshold=5
        dmp_restore_cycles=10
        dmp_restore_interval=300
        dmp_restore_policy=check_disabled
        dmp_retry_count=5
        dmp_scsi_timeout=30
        dmp_sfg_threshold=1
        dmp_stat_interval=1
        dmp_monitor_ownership=on
        dmp_monitor_fabric=on
        dmp_native_support=off
Namingscheme
        namingscheme=ebn
        persistence=yes
        lowercase=yes
        use_avid=yes
Arraytype
        arraytype=CLR-A/PF
        iopolicy=minimumq
        partitionsize=512
        recoveryoption=nothrottle
        recoveryoption=timebound iotimeout=300
        redundancy=0
Arraytype
        arraytype=ALUA
        iopolicy=adaptive
```

```
        partitionsize=512
        use_all_paths=no
        recoveryoption=nothrottle
        recoveryoption=timebound iotimeout=300
        redundancy=0
Arraytype
        arraytype=Disk
        iopolicy=minimumq
        partitionsize=512
        recoveryoption=nothrottle
        recoveryoption=timebound iotimeout=300
        redundancy=0
Arrayname
        arrayname=EMC_CLARiiON
        iopolicy=minimumq
        partitionsize=512
        recoveryoption=nothrottle
        recoveryoption=timebound iotimeout=300
        redundancy=0
Arrayname
        arrayname=EVA4K6K
        iopolicy=adaptive
        partitionsize=512
        use_all_paths=no
        recoveryoption=nothrottle
        recoveryoption=timebound iotimeout=300
        redundancy=0
Arrayname
        arrayname=Disk
        iopolicy=minimumq
        partitionsize=512
        recoveryoption=nothrottle
        recoveryoption=timebound iotimeout=300
        redundancy=0
Enclosure
        serial=CK200051900278
        arrayname=EMC_CLARiiON
        arraytype=CLR-A/PF
        iopolicy=minimumq
        partitionsize=512
        recoveryoption=nothrottle
        recoveryoption=timebound iotimeout=300
        redundancy=0
```

```
        dmp_lun_retry_timeout=30
Enclosure
        serial=50001FE1500A8F00
        arrayname=EVA4K6K
        arraytype=ALUA
        iopolicy=adaptive
        partitionsize=512
        use_all_paths=no
        recoveryoption=nothrottle
        recoveryoption=timebound iotimeout=300
        redundancy=0
        dmp_lun_retry_timeout=30
Enclosure
        serial=50001FE1500BB690
        arrayname=EVA4K6K
        arraytype=ALUA
        iopolicy=adaptive
        partitionsize=512
        use_all_paths=no
        recoveryoption=nothrottle
        recoveryoption=timebound iotimeout=300
        redundancy=0
        dmp_lun_retry_timeout=30
Enclosure
        serial=DISKS
        arrayname=Disk
        arraytype=Disk
        iopolicy=minimumq
        partitionsize=512
        recoveryoption=nothrottle
        recoveryoption=timebound iotimeout=300
        redundancy=0
        dmp_lun_retry_timeout=30
```

Tuning a DMP host with a configuration attribute template

You can use a template file to upload a series of changes to the DMP configuration to the same host or to another similar host.

Veritas recommends that you load the DMP template to a host that is similar to the host that was the source of the tunable values.

To configure DMP on a host with a template

1. Dump the contents of the current host configuration to a file.

   ```
   # vxdmpadm config dump file=filename
   ```

2. Edit the file to make any required changes to the tunable parameters in the template.

   The target host may include non-shared arrays or host-specific arrays. To avoid updating these with settings from the array name or array type, define an enclosure section for each of those arrays in the template. When you load the template file to the target host, the enclosure section determines the settings. Otherwise, DMP applies the settings from the respective array name or array type sections.

3. Validate the values of the DMP tunable parameters.

   ```
   # vxdmpadm config check file=filename
   ```

   DMP displays no output if the configuration check is successful. If the file contains errors, DMP displays the errors. Make any required corrections until the configuration file is valid. For example, you may see errors such as the following:

   ```
   VxVM vxdmpadm ERROR V-5-1-0 Template file 'error.file' contains
   following errors:

   Line No: 22  'dmp_daemon_count' can not be set to 0 or less
   Line No: 44  Specified value for 'dmp_health_time' contains
   non-digits
   Line No: 64  Specified value for 'dmp_path_age' is beyond
   the limit of its value
   Line No: 76  'dmp_probe_idle_lun' can be set to either on or off
   Line No: 281 Unknown arraytype
   ```

4. Load the file to the target host.

   ```
   # vxdmpadm config load file=filename
   ```

   During the loading process, DMP validates each section of the template. DMP loads all valid sections. DMP does not load any section that contains errors.

Managing the DMP configuration files

You can display the name of the template file most recently loaded to the host. The information includes the date and time when DMP loaded the template file.

To display the name of the template file that the host currently uses

- `# vxdmpadm config show`

```
TEMPLATE_FILE      DATE              TIME
=============================================
/tmp/myconfig      Feb 09, 2011      11:28:59
```

Resetting the DMP tunable parameters and attributes to the default values

DMP maintains the default values for the DMP tunable parameters and attributes. At any time, you can restore the default values to the host. Any changes that you applied to the host with template files are discarded.

To reset the DMP tunables to the default values

- Use the following command:

```
# vxdmpadm config reset
```

DMP tunable parameters and attributes that are supported for templates

DMP supports tuning the following tunable parameters and attributes with a configuration template.

DMP tunable parameters	See "DMP tunable parameters" on page 206.
DMP attributes defined for an enclosure, array name, or array type.	■ iopolicy ■ partitionsize ■ use_all_paths ■ recoveryoption attributes (retrycount or iotimeout) ■ redundancy ■ dmp_lun_retry_timeout

Naming scheme attributes:

- naming scheme
- persistence
- lowercase
- use_avid

The following tunable parameters are NOT supported with templates:

- OS tunables
- TPD mode
- Failover attributes of enclosures (failovermode)

DMP tunable parameters

DMP provides various parameters that you can use to tune your environment.

Table 8-1 shows the DMP parameters that can be tuned. You can set a tunable parameter online, without a reboot.

Table 8-1 DMP parameters that are tunable

Parameter	Description
`dmp_cache_open`	If this parameter is set to `on`, the first open of a device is cached. This caching enhances the performance of device discovery by minimizing the overhead that is caused by subsequent opens on the device. If this parameter is set to `off`, caching is not performed. The default value is `on`.
`dmp_daemon_count`	The number of kernel threads that are available for servicing path error handling, path restoration, and other DMP administrative tasks. The default number of threads is 10.
`dmp_delayq_interval`	How long DMP should wait before retrying I/O after an array fails over to a standby path. Some disk arrays are not capable of accepting I/O requests immediately after failover. The default value is 15 seconds.

Table 8-1 DMP parameters that are tunable *(continued)*

Parameter	Description
`dmp_display_alua_states`	For ALUA arrays, this tunable displays the asymmetric access state instead of PRIMARY or SECONDARY state in the PATH-TYPE[M] column. The asymmetric access state can be: ■ Active/Optimized ■ Active/Non-optimized ■ Standby ■ Unavailable ■ TransitionInProgress ■ Offline The default tunable value is on.
`dmp_fast_recovery`	Whether DMP should try to obtain SCSI error information directly from the HBA interface. Setting the value to `on` can potentially provide faster error recovery, if the HBA interface supports the error enquiry feature. If this parameter is set to `off`, the HBA interface is not used. The default setting is `on`.
`dmp_health_time`	DMP detects intermittently failing paths, and prevents I/O requests from being sent on them. The value of `dmp_health_time` represents the time in seconds for which a path must stay healthy. If a path's state changes back from enabled to disabled within this time period, DMP marks the path as intermittently failing, and does not re-enable the path for I/O until `dmp_path_age` seconds elapse. The default value is 60 seconds. A value of 0 prevents DMP from detecting intermittently failing paths.

Table 8-1 DMP parameters that are tunable *(continued)*

Parameter	Description
`dmp_log_level`	The level of detail that is displayed for DMP console messages. The following level values are defined: 1 — Displays all DMP log messages that are critical. 2 — Displays level 1 messages plus messages that relate to path or disk addition or removal, SCSI errors, IO errors and DMP node migration. 3 — Displays level 1 and 2 messages plus messages that relate to path throttling, suspect path, idle path and insane path logic. 4 — Displays level 1, 2 and 3 messages plus messages that relate to setting or changing attributes on a path and tunable related changes. 5 or higher — Displays level 1, 2, 3 and 4 messages plus more verbose messages. The default value is 1.
`dmp_low_impact_probe`	Determines if the path probing by restore daemon is optimized or not. Set it to `on` to enable optimization and `off` to disable. Path probing is optimized only when restore policy is check_disabled or during check_disabled phase of check_periodic policy. The default value is `on`.

Table 8-1 DMP parameters that are tunable *(continued)*

Parameter	Description
dmp_lun_retry_timeout	Specifies a retry period for handling transient errors that are not handled by the HBA and the SCSI driver. Specify the time in seconds. In general, no such special handling is required. Therefore, the default value of the dmp_lun_retry_timeout tunable parameter is 30. When all paths to a disk fail, DMP fails the I/Os to the application. The paths are checked for connectivity only once. In special cases when DMP needs to handle the transient errors, configure DMP to delay failing the I/Os to the application for a short interval. Set the dmp_lun_retry_timeout tunable parameter to a non-zero value to specify the interval. If all of the paths to the LUN fail and I/Os need to be serviced, then DMP probes the paths every five seconds for the specified interval. If the paths are restored within the interval, DMP detects this and retries the I/Os. DMP does not fail I/Os to a disk with all failed paths until the specified dmp_lun_retry_timeout interval or until the I/O succeeds on one of the paths, whichever happens first.
dmp_monitor_fabric	Determines if DMP should register for HBA events from SNIA HAB APIs. These events improve the failover performance by proactively avoiding the I/O paths that have impending failure. The default setting is off. Veritas recommends that this setting remain off to avoid performance issues on the AIX platform.
dmp_monitor_ownership	Determines whether the ownership monitoring is enabled for ALUA arrays. When this tunable is set to on, DMP polls the devices for LUN ownership changes. The polling interval is specified by the dmp_restore_interval tunable. The default value is on. When the dmp_monitor_ownership tunable is off, DMP does not poll the devices for LUN ownership changes.

Table 8-1 DMP parameters that are tunable *(continued)*

Parameter	Description
`dmp_native_support`	Determines whether DMP will do multi-pathing for native devices. Set the tunable to `on` to have DMP do multi-pathing for native devices. When Dynamic Multi-Pathing is installed as a component of another Veritas InfoScale product, the default value is `off`. When Dynamic Multi-Pathing is installed as a stand-alone product, the default value is `on`.
`dmp_path_age`	The time for which an intermittently failing path needs to be monitored as healthy before DMP again tries to schedule I/O requests on it. The default value is 300 seconds. A value of 0 prevents DMP from detecting intermittently failing paths.
`dmp_pathswitch_blks_shift`	The default number of contiguous I/O blocks that are sent along a DMP path to an array before switching to the next available path. The value is expressed as the integer exponent of a power of 2; for example 9 represents 512 blocks. The default value is 9. In this case, 512 blocks (256k) of contiguous I/O are sent over a DMP path before switching. For intelligent disk arrays with internal data caches, better throughput may be obtained by increasing the value of this tunable. For example, for the HDS 9960 A/A array, the optimal value is between 15 and 17 for an I/O activity pattern that consists mostly of sequential reads or writes. This parameter only affects the behavior of the `balanced` I/O policy. A value of 0 disables multi-pathing for the policy unless the `vxdmpadm` command is used to specify a different partition size for an array. See "Specifying the I/O policy" on page 131.

Table 8-1 DMP parameters that are tunable *(continued)*

Parameter	Description
dmp_probe_idle_lun	If DMP statistics gathering is enabled, set this tunable to on (default) to have the DMP path restoration thread probe idle LUNs. Set this tunable to off to turn off this feature. (Idle LUNs are VM disks on which no I/O requests are scheduled.) The value of this tunable is only interpreted when DMP statistics gathering is enabled. Turning off statistics gathering also disables idle LUN probing. The default value is on.
dmp_probe_threshold	If the dmp_low_impact_probe is turned on, dmp_probe_threshold determines the number of paths to probe before deciding on changing the state of other paths in the same subpath failover group. The default value is 5.
dmp_restore_cycles	If the DMP restore policy is check_periodic, the number of cycles after which the check_all policy is called. The default value is 10. See "Configuring DMP path restoration policies" on page 145.
dmp_restore_interval	The interval attribute specifies how often the path restoration thread examines the paths. Specify the time in seconds. The default value is 300. The value of this tunable can also be set using the vxdmpadm start restore command. See "Configuring DMP path restoration policies" on page 145.

Table 8-1 DMP parameters that are tunable *(continued)*

Parameter	Description
`dmp_restore_policy`	The DMP restore policy, which can be set to one of the following values: ■ `check_all` ■ `check_alternate` ■ `check_disabled` ■ `check_periodic` The default value is `check_disabled` The value of this tunable can also be set using the `vxdmpadm start restore` command. See "Configuring DMP path restoration policies" on page 145.
`dmp_restore_state`	If this parameter is set to `enabled`, it enables the path restoration thread to be started. See "Configuring DMP path restoration policies" on page 145. If this parameter is set to `disabled`, it stops and disables the path restoration thread. If this parameter is set to `stopped`, it stops the path restoration thread until the next device discovery cycle. The default is `enabled`. See "Stopping the DMP path restoration thread" on page 146.
`dmp_scsi_timeout`	Determines the timeout value to be set for any SCSI command that is sent via DMP. If the HBA does not receive a response for a SCSI command that it has sent to the device within the timeout period, the SCSI command is returned with a failure error code. The default value is 30 seconds.
`dmp_sfg_threshold`	Determines the minimum number of paths that should be failed in a failover group before DMP starts suspecting other paths in the same failover group. The value of 0 disables the failover logic based on subpath failover groups. The default value is 1.

Table 8-1 DMP parameters that are tunable *(continued)*

Parameter	Description
dmp_stat_interval	The time interval between gathering DMP statistics. The default and minimum value are 1 second.

DMP driver tunables

DMP uses a slab allocator to service I/Os. DMP uses the DMP driver tunables dmpslab_minsz and dmpslab_maxsz to control the memory allocated for this slab allocator. These tunables are defined as follows:

dmpslab_maxsz — Maximum size of the slab. The size is specified in pages, where 1 page equals 4096 bytes.

The default value for dmpslab_maxsz is 5% of the physical memory.

dmpslab_minsz — The minimum memory size that should be allocated to the slab during the driver load time. The size is specified in pages, where 1 page equals 4096 bytes.

The default value for dmpslab_minsz is 48 pages.

To display the tunables, use the following command:

```
# lsattr -El vxdmp
dmpslab_maxsz   101580 N/A True
dmpslab_minsz   48     N/A True
```

Note: If the errpt displays ENOMEM error code, you might need to change the dmpslab_minsz and dmpslab_maxsz to suit the load on the system.

Changing the value of the DMP driver tunables

1. Specify a new size in pages. You must increase the size in multiples of 8.

   To change the dmpslab_minsz tunable:

   ```
   # chdev -P -l vxdmp -a dmpslab_minsz=newsize
   ```

   To change the dmpslab_maxsz tunable:

   ```
   # chdev -P -l vxdmp -a dmpslab_maxsz=newsize
   ```

2. Reboot the system for the new values to take effect.

Appendix A

DMP troubleshooting

This appendix includes the following topics:

Displaying extended attributes after upgrading to DMP 8.0

You may see the following changes in functionality when you upgrade to DMP 8.0 from the Storage Foundation 5.1 release:

- The device names that are listed in the `vxdisk list` output do not display the Array Volume IDs (AVIDs).
- The `vxdisk -e list` output does not display extended attributes.
- An Active/Passive (A/P) or ALUA array is claimed as Active/Active (A/A).

This behavior may be because the LUNs are controlled by the native multi-pathing driver, MPIO. When a LUN is controlled by TPD drivers like MPIO, then in DMP those enclosures are claimed as A/A (irrespective of what array mode LUN has at array). This is because multi-pathing is done from the TPD driver and DMP only sees oruses the TPD metanode to route commands. For TPD, DMP also suppresses the value-add extended attributes like AVID, media_type, and so on. If you migrate LUN multi-pathing to DMP, those extended attributes start showing with the actual LUN array mode as per the Array Support Library (ASL).

To check whether LUNs are controlled by native multi-pathing driver

- Check the output of the following command to see if the LUN is an MPIO device:

```
# lsdev -Cc disk
```

You can migrate the LUNs from the control of the native multi-pathing driver to DMP control.

- To migrate to DMP with Veritas Volume Manager, refer to the section on disabling MPIO in the *Storage Foundation Administrator's Guide*.
- To migrate to DMP with OS native volume support, refer to the section on migrating to DMP from MPIO in the *Dynamic Multi-Pathing Adminstrator's Guide*.

Recovering from errors when you exclude or include paths to DMP

You can exclude a path from DMP with the `vxdmpadm exclude` command. You can return a previously excluded path to DMP control with the `vxdmpadm include` command. These commands use the `vxvm.exclude` file to store the excluded paths. The include path and exclude path operations cannot complete successfully if the `vxvm.exclude` file is corrupted.

The following error displays if the `vxvm.exclude` file is corrupted:

```
# vxdmpadm exclude ctlr=fscsi3
VxVM vxdmpadm ERROR V-5-1-3996  File not in correct format
```

DMP saves the corrupted file with the name `vxvm.exclude.corrupt`. DMP creates a new `vxvm.exclude` file. You must manually recover from this situation.

To recover from a corrupted exclude file

1. Reissue the `vxdmpadm include` command or the `vxdmpadm exclude` command that displayed the error.

   ```
   # vxdmpadm exclude ctlr=fscsi3
   ```

2. View the saved `vxvm.exclude.corrupt` file to find any entries for the excluded paths that are relevant.

   ```
   # cat /etc/vx/vxvm.exclude

   exclude_all 0
   paths
   #
   controllers
   fscsi3 46-T1-01_3
   #
   product
   #
   pathgroups
   #
   ```

3. Reissue the `vxdmpadm exclude` command for the paths that you noted in step 2.

   ```
   # vxdmpadm exclude ctlr=c4
   ```

4. Verify that the excluded paths are in the `vxvm.exclude` file.

   ```
   # cat /etc/vx/vxvm.exclude

   exclude_all 0
   paths
   #
   controllers
   fscsi3 46-T1-01_3
   #
   product
   #
   ```

Downgrading the array support

The array support is available in a single fileset, `VRTSaslapm`, that includes Array Support Libraries (ASLs) and Array Policy Modules (APMs). Each major release of Dynamic Multi-Pathing includes the supported `VRTSaslapm` fileset, which is installed as part of the product installation. Between major releases, Veritas may provide additional array support through updates to the `VRTSaslapm` fileset.

If you have issues with an updated `VRTSaslapm` fileset, Veritas may recommend that you downgrade to a previous version of the ASL/APM fileset. You can only revert to a fileset that is supported for the installed release of Dynamic Multi-Pathing. To perform the downgrade while the system is online, do not remove the installed fileset. Instead, you can install the previous version of the fileset over the new fileset. This method prevents multiple instances of the `VRTSaslapm` fileset from being installed.

Use the following method to downgrade the `VRTSaslapm` fileset.

To downgrade the ASL/APM fileset while online

- Specify the previous version of the `VRTSaslapm` fileset to the following command:

```
# installp -F -ad ./VRTSaslapm.bff VRTSaslapm
```

Appendix B

Reference

This appendix includes the following topics:

Command completion for Veritas commands

Dynamic Multi-Pathing supports command completion for Dynamic Multi-Pathing (DMP) commands.

In this release, command completion is supported only on the bash shell. The shell must be bash version 2.4 or later.

To use this feature, press **Tab** while entering a supported VxVM or DMP command. The command is completed as far as possible. When there is a choice, the command completion displays the next valid options for the command. Enter one of the displayed values. A value in brackets indicates a user-specified value.

Note: Platform-specific options are not supported with command completion.

By default, you can use the command completion feature by invoking the bash shell on every log in. If you want to permanently enable the command completion, use the following command:

```
# vxdctl cmdcompletion enable
```

The enable command completion creates the `.bash_profile` file, if it is not present.

To permanently disable the command completion, use the following command:

```
# vxdctl cmdcompletion disable
```

See the `vxdctl`(1M) manual page.

The following commands support command completion:

- vxddladm
- vxdisk
- vxdmpadm