

# Dynamic Multi-Pathing 8.0.2 Administrator's Guide - Solaris

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# Understanding DMP

This chapter includes the following topics:

- [About Dynamic Multi-Pathing \(DMP\)](#)
- [How DMP works](#)
- [Multi-controller ALUA support](#)
- [Multiple paths to disk arrays](#)
- [Device discovery](#)
- [Disk devices](#)
- [Disk device naming in DMP](#)

## 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 ZFS. You can create ZFS pools on DMP metadevices. DMP supports both root and non-root ZFS pools. For versions prior to Solaris 11 update 1, DMP supports only non-root ZFS file systems.

Veritas Volume Manager (VxVM) volumes and disk groups can co-exist with ZFS pools, but each device can only support one of the types. If a disk has a VxVM label, then the disk is not available to ZFS. Similarly, if a disk is in use by ZFS, 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 101.

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)	<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.</p> <p>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.</p> <p>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.</p>
Active/Passive in explicit failover mode or non-autotrespass mode (A/PF)	<p>The appropriate command must be issued to the array to make the LUNs fail over to the secondary path.</p> <p>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.</p>

**Table 1-1** (continued)

Array type	Description
Active/Passive with LUN group failover (A/PG)	<p data-bbox="749 326 1216 612">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.</p> <p data-bbox="749 635 1216 835">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.</p>

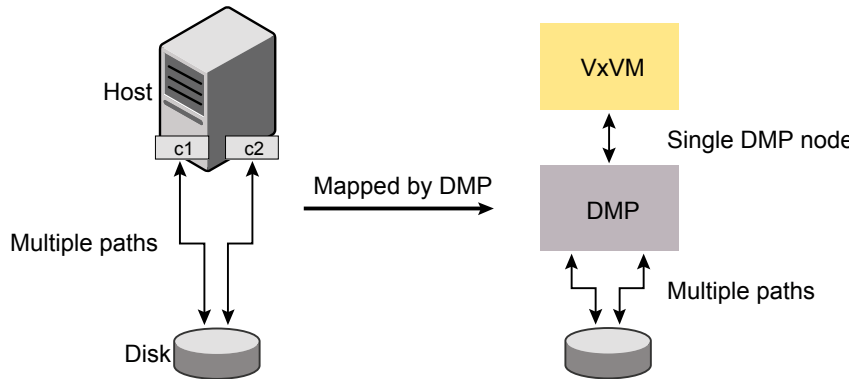
An array policy module (APM) may define array types to DMP in addition to the standard types for the arrays that it supports.

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.

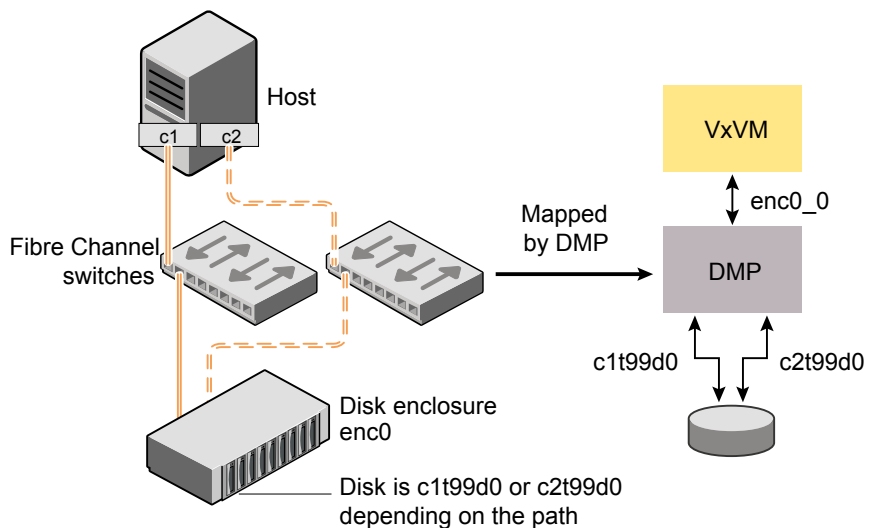
**Figure 1-1** How DMP represents multiple physical paths to a disk as one node



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, `c1t99d0` and `c2t99d0`, 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 21.

See [“Changing the disk device naming scheme”](#) on page 120.

See [“Discovering and configuring newly added disk devices”](#) on page 101.

## How DMP monitors I/O on paths

In VxVM prior to release 5.0, DMP had one kernel daemon (`errorrd`) 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 96.

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 14.

See [“I/O throttling”](#) on page 15.

### 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 91.

## 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 94.

## 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 94.

## 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 93.

## 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.

## Dynamic Reconfiguration

Dynamic Reconfiguration (DR) is a feature that is available on some high-end enterprise systems. It allows some components (such as CPUs, memory, and other controllers or I/O boards) to be reconfigured while the system is still running. The reconfigured component might be handling the disks controlled by VxVM.

See [“About enabling and disabling I/O for controllers and storage processors”](#) on page 44.

## DMP support for the ZFS root pool

Starting with the Solaris 11 update 1 release, DMP supports the ZFS root pool. When you enable native device support for DMP, DMP migrates the ZFS root pool to DMP control. You must reboot the system for the changes to take effect. After the reboot, you can use the DMP devices to create mirrors, snapshots, or clones of the root disks. You can also use raw DMP devices to create swap devices and dump devices.

See [“Managing DMP devices for the ZFS root pool ”](#) on page 49.

## About booting from DMP devices

When the root disk is placed under VxVM control, it is automatically accessed as a DMP device with one path if it is a single disk, or with multiple paths if the disk is part of a multiported disk array. By encapsulating and mirroring the root disk, system

reliability is enhanced against loss of one or more of the existing physical paths to a disk.

---

**Note:** The SAN bootable LUN must be controlled by DMP. PowerPath and MPxIO control of SAN bootable LUNs is not supported.

---

## 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 103.

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 106.

See [“Configuring Array Policy Modules”](#) on page 98.

## 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 10.

## 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/[r]disk` directories. 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 metadvice, and to display the status of each path (for example, whether it is enabled or disabled).

See [“How DMP works”](#) on page 10.

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

See [“Disk device naming in DMP”](#) on page 20.

# 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 104.

Device names can use one of the following naming schemes:

- operating system-based naming.  
See [“About operating system-based naming”](#) on page 20.
- enclosure-based naming.  
See [“About enclosure-based naming”](#) on page 21.

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 120.

## About operating system-based naming

In the OS-based naming scheme, all disk devices are named using the `c#t#d#s#` format.

The syntax of a device name is `c#t#d#s#`, where `c#` represents a controller on a host bus adapter, `t#` is the target controller ID, `d#` identifies a disk on the target controller, and `s#` represents a partition (or slice) on the disk.

---

**Note:** For non-EFI disks, the slice `s2` represents the entire disk. For both EFI and non-EFI disks, the entire disk is implied if the slice is omitted from the device name.

---

DMP assigns the name of the DMP meta-device (disk access name) from the multiple paths to the disk. DMP sorts the names by controller, and selects the smallest controller number. For example, `c1` rather than `c2`. If multiple paths are seen from the same controller, then DMP uses the path with the smallest target name. This behavior makes 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.

The boot disk (which contains the root file system and is used when booting the system) is often identified to VxVM by the device name `c0t0d0`.

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.

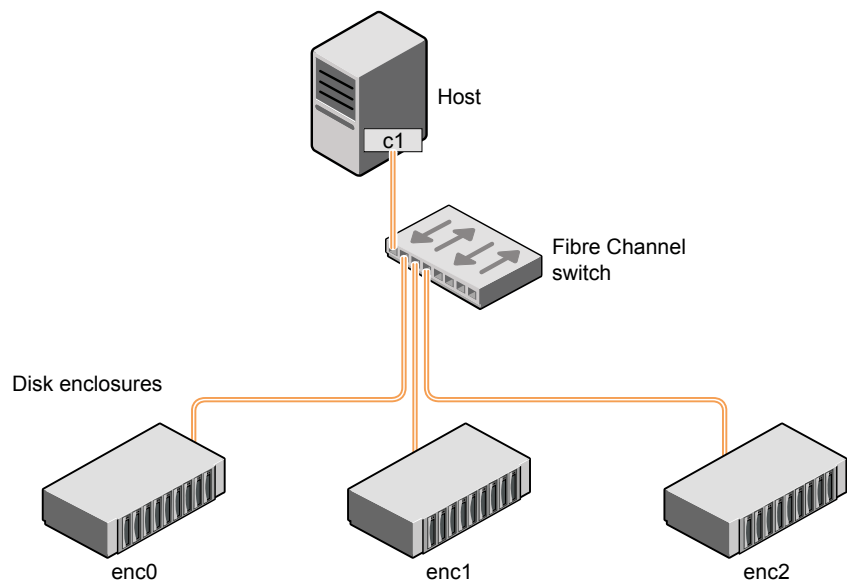
See [“Changing the disk device naming scheme”](#) on page 120.

## About enclosure-based naming

Enclosure-based naming provides an alternative to operating system-based device naming. This allows disk devices to be named for enclosures rather than for the controllers through which they are accessed. 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. For example, `c##d##s##` naming assigns controller-based device names to disks in separate enclosures that are connected to the same host controller. 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.

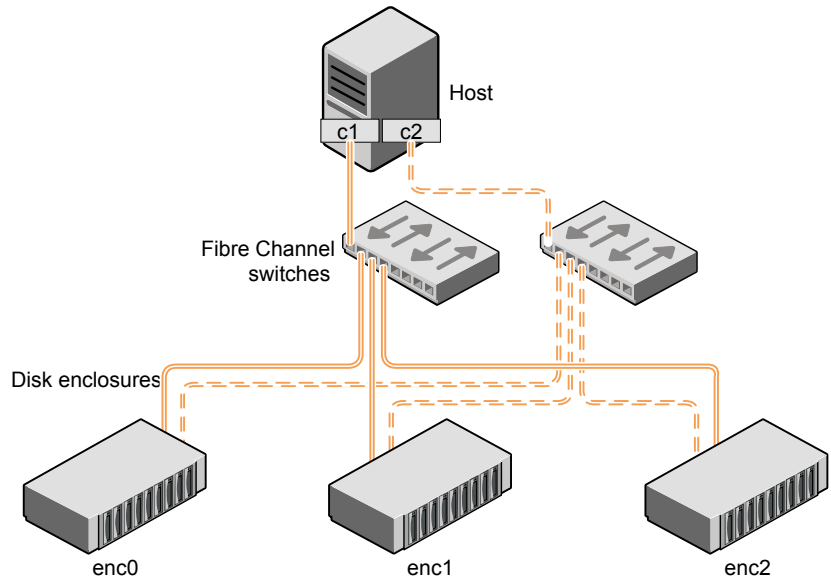
In most disk arrays, you can use hardware-based storage management to represent several physical disks as one LUN to the operating system. In such cases, VxVM also sees a single logical disk device rather than its component disks. For this reason, when reference is made to a disk within an enclosure, 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 (`c1` and `c2`), 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 `c1t99d0` and `c2t99d0`.

See [“Disk device naming in DMP”](#) on page 20.

See [“Changing the disk device naming scheme”](#) on page 120.

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 `vxddmpadm` command to administer enclosure names.

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

- Disks in the `DISKS` category (JBOD disks) are named using the `Disk_#` format.
- Disks in the `OTHER_DISKS` category (disks that are not multipathed by DMP) are named using the `c#t#d#s#` format.

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 104.

See [“Enclosure based naming with the Array Volume Identifier \(AVID\) attribute”](#) on page 24.

## 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
```

# Setting up DMP to manage native devices

This chapter includes the following topics:

- [About setting up DMP to manage native devices](#)
- [Displaying the native multi-pathing configuration](#)
- [Migrating ZFS pools to DMP](#)
- [Migrating to DMP from EMC PowerPath](#)
- [Migrating to DMP from Hitachi Data Link Manager \(HDLM\)](#)
- [Migrating to DMP from Solaris Multiplexed I/O \(MPxIO\)](#)
- [Using Dynamic Multi-Pathing \(DMP\) devices with Oracle Automatic Storage Management \(ASM\)](#)
- [Enabling and disabling DMP support for the ZFS root pool](#)
- [Adding DMP devices to an existing ZFS pool or creating a new ZFS pool](#)
- [Removing DMP support for native devices](#)

## 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 ZFS pools and any ZFS file systems that operate on those pools.

After you install DMP, set up DMP for use with ZFS. To set up DMP for use with ZFS, turn on the `dmp_native_support` tunable. When this tunable is turned on, DMP enables support for ZFS 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 ZFS pools that are not in use onto DMP devices.

The `dmp_native_support` tunable enables DMP support for ZFS, as follows:

ZFS pools	<p>If the ZFS pools are not in use, turning on native support migrates the pools to DMP devices.</p> <p>If the ZFS pools are in use, then perform the steps to turn off the pools and migrate the pools to DMP.</p>
Veritas Volume Manager (VxVM) devices	<p>Native support is not enabled for any device that has a VxVM label. To make the device available for ZFS, remove the VxVM label.</p> <p>VxVM devices can coexist with native devices under DMP control.</p>
Devices that are multi-pathed with Third-party drivers (TPD)	<p>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 <code>dmp_native_support</code> tunable to migrate the devices.</p> <p>If ZFS pools are constructed over TPD devices, then perform the steps to migrate the ZFS pools onto DMP devices.</p> <p>See <a href="#">“Migrating ZFS pools to DMP”</a> on page 28.</p>

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

```
# vxddmpadm settune dmp_native_support=on
```

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

Starting with Solaris 11.1 release, the same procedure also enables DMP support for the ZFS root pool.

Enabling the `dmp_native_support` tunable may take a long time to complete, depending on the number of LUNs and zpools configured on the system. Do not abort the command.

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

```
# vxddmpadm 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`.

```
# vxddmpadm gettune dmp_native_support
```

Tunable	Current Value	Default Value
<code>dmp_native_support</code>	on	off

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

# Migrating ZFS pools 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 ZFS pools 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
Solaris	EMC PowerPath	See <a href="#">“Migrating to DMP from EMC PowerPath”</a> on page 29.
Solaris	Hitachi Data Link Manager (HDLM)	See <a href="#">“Migrating to DMP from Hitachi Data Link Manager (HDLM)”</a> on page 30.
Solaris	Solaris Multiplexed I/O (MPxIO)	See <a href="#">“Migrating to DMP from Solaris Multiplexed I/O (MPxIO)”</a> on page 31.

## 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 pool on the PowerPath device.
- 3 Export the ZFS pools that use the PowerPath device.

```
# zpool export poolname
```

- 4 Remove the disk access names for the PowerPath devices from VxVM.

```
# vxdisk rm emcpowerXXXX
```

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

- 5 Take the device out of PowerPath control:

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

- 6 Verify that the PowerPath device has been removed from PowerPath control.

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

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

```
# vxdisk scandisks
```

- 8 Turn on the DMP support for the ZFS pool.

```
# vxddmpadm settune dmp_native_support=on
```

- 9 Mount the file systems.

- 10 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 pool on the HDLM device.

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

- 3 Export the ZFS pools that use the HDLM device.

```
# zpool export poolname
```

- 4 Uninstall the HDLM package.

- 5 Turn on the DMP support for the ZFS pool.

```
# vxddmpadm settune dmp_native_support=on
```

- 6 Reboot the system.

- 7 After the reboot, DMP controls the devices. If there were any ZFS pools on HDLM devices they are migrated onto DMP devices.
- 8 Mount the file systems.
- 9 Restart the applications.

## Migrating to DMP from Solaris Multiplexed I/O (MPxIO)

This procedure describes removing devices from Solaris Multiplexed I/O (MPxIO) control and enabling DMP on the devices.

Starting with Solaris 11 update 1 release, the same procedure also enables DMP support for the ZFS root pool.

---

**Caution:** The commands should be run in the order below. The system may become unbootable if you do not follow the steps exactly.

---

Plan for application and system downtime for the following procedure.

### To take devices out of MPxIO control and enable DMP on the devices

- 1 Stop the applications that use MPxIO devices.  
In a VCS environment, stop the VCS service group of the application, which will stop the application.
- 2 Unmount all the file systems that use MPxIO devices.
- 3 Deactivate the ZFS pools operating on MPxIO devices.
- 4 Turn on the DMP support for the ZFS pools.  

```
# vxddmpadm settune dmp_native_support=on
```

If DMP support for ZFS root file system is enabled, you are prompted to reboot the system.

Before you reboot the system, you must disable MPxIO as mentioned in step 5.
- 5 Disable MPxIO using the following command.

```
# stmsboot -d
```

**6** Reboot the system.

After the reboot, DMP controls the ZFS pools. Any ZFS pools are migrated onto DMP devices.

For supported Solaris versions, the ZFS root pool is also migrated to DMP.

**7** Mount the file systems.

**8** Restart the applications and restart the VCS service groups.

## 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 32.
- See [“Removing Dynamic Multi-Pathing \(DMP\) devices from the listing of Oracle Automatic Storage Management \(ASM\) disks”](#) on page 34.
- See [“Migrating Oracle Automatic Storage Management \(ASM\) disk groups on operating system devices to Dynamic Multi-Pathing \(DMP\) devices”](#) on page 34.

## 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/rmp/*`).

## 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.
- 5** To reduce the delay in failing the I/O or the SCSI command from the FC driver, set the following options.

In the `/kernel/drv/fp.conf` file, add the following line:

```
fp_offline_ticker=15;
```

In the `/kernel/drv/fcp.conf` file, add the following line:

```
fcp_offline_delay=10;
```

## 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 MPxIO or PowerPath.

See ["About setting up DMP to manage native devices"](#) on page 26.

- 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 path,header_status from v$asm_disk;
NAME                                PATH                                HEADER_STATUS
-----
ASM_DG1_0001 /dev/rds/c2t5006016130206782d9s6 MEMBER
ASM_DG1_0000 /dev/rds/c2t50001FE1500A8F08d1s6 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 26.

- 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 `vxddmpadm` command to determine the DMP nodes that correspond to the OS devices.

```
# vxddmpadm getdmpnode nodename=c2t5d9
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:

```
# vxddmpraw 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/EVA4K6K0_0s6	MEMBER
	/dev/vx/rdmp/EMC_CLARiion0_208s6	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_0000	/dev/vx/rdmp/EVA4K6K0_0s6	MEMBER
ASM_DG1_0001	/dev/vx/rdmp/EMC_CLARiion0_208s6	MEMBER

## Enabling and disabling DMP support for the ZFS root pool

DMP support for the ZFS root pool is provided as part of DMP support for native devices. DMP support for ZFS root pool requires Solaris 11.1 or later.

The `dmp_native_support` tunable automatically enables or disables support for the ZFS root pool along with other zpools. DMP native support can be enabled for root pools created on EFI or SMI labeled disks.

## To enable the DMP support for ZFS root

- 1 To enable the DMP support for ZFS root, turn on the `dmp_native_support` tunable. The command prompts you to reboot the system if the ZFS root pool has to be migrated to DMP.

```
# zpool status
pool: rpool
state: ONLINE
scan: resilvered 24.6G in 0h4m with 0 errors on Tue Feb 5
      17:56:57 2013
config:
      NAME                                STATE      READ WRITE CKSUM
      rpool                                ONLINE    0    0    0
      c4t50060E8006D43C30d4s0            ONLINE    0    0    0

# vxddmpadm settune dmp_native_support=on
VxVM vxddmpadm INFO V-5-1-0 DMP Native Support is enabled
for root pool. Please reboot the system for changes to
take effect.
```

On system reboot, the ZFS root pool starts using DMP devices.

- 2 To make the system bootable from any of the paths of the DMP devices, set the `eprom boot-device` variable to the paths of the DMP devices.

See [“Updating the boot device settings”](#) on page 52.

### 3 Use ZFS utilities like `zpool` and `zdb` to verify that DMP devices are shown under the root pool.

```
# zpool status rpool
pool: rpool
state: ONLINE
scan: resilvered 24.6G in 0h4m with 0 errors on Tue Feb
      5 17:56:57 2013
config:
      NAME                                STATE      READ WRITE CKSUM
      rpool                                ONLINE    0     0     0
      hitachi_vsp0_00f4s0                 ONLINE    0     0     0

errors: No known data errors

# zdb -C rpool

MOS Configuration:
  version: 34
  name: 'rpool'
  state: 0
  txg: 291980
  pool_guid: 10008700897979933591
  timestamp: 1360279240
  hostid: 2224483892
  hostname: 'sfqasol68'
  vdev_children: 1
  vdev_tree:
    type: 'root'
    id: 0
    guid: 10008700897979933591
    create_txg: 4
    children[0]:
      type: 'disk'
      id: 0
      guid: 2845745816652566832
      path: '/dev/dsk/hitachi_vsp0_00f4s0'
      devid: 'id1,dmp@x001738000e9523e4/x001738000e9523e4-a'
      phys_path: '/pseudo/vxdmp@0:x001738000e9523e4-a'
      whole_disk: 0
      metaslab_array: 27
      metaslab_shift: 28
```

```
ashift: 9
asize: 32195739648
is_log: 0
DTL: 606
create_txdg:
```

### To disable the ZFS root support

- 1 To disable the ZFS root support, turn off the `dmp_native_support` as shown below:

```
# vxddmpadm settune dmp_native_support=off
VxVM vxddmpadm INFO V-5-1-0 DMP Native Support is disabled
for root pool. Please reboot the system for changes to
take effect.
```

- 2 On system reboot, ZFS root pool will show OS devices.

```
# zpool status
pool: rpool
state: ONLINE
scan: resilvered 24.6G in 0h4m with 0 errors on Tue Feb 5
17:56:57 2013
config:
      NAME                                STATE      READ  WRITE CKSUM
      rpool                                ONLINE     0     0     0
      c4t50060E8006D43C30d4s0            ONLINE     0     0     0
```

## Adding DMP devices to an existing ZFS pool or creating a new ZFS pool

When the `dmp_native_support` is ON, you can create a new ZFS pool on an available DMP device. You can also add an available DMP device to an existing ZFS pool. After the ZFS pools are on DMP devices, you can use any of the ZFS commands to manage the pools.

### To create a new ZFS pool on a DMP device or add a DMP device to an existing ZFS pool

- 1 Choose disks that are available for use by ZFS.

Use the `vxddisk 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`.

Do not run `zpool` commands on disks with VxVM labels, as these operations can cause data corruption.

- Disks previously used by a ZFS pool, if the ZFS pool has been destroyed. The output of `vxdisk list` shows these disks with the Type `auto:ZFS` and the Status as `ZFS`.

The example shows available disks.

```
# vxdisk list

DEVICE                TYPE        DISK  GROUP  STATUS
. . .
tagmastore-usp0_0079  auto:none  -    -      online invalid
tagmastore-usp0_0080  auto:none  -    -      online invalid
tagmastore-usp0_0080  auto:ZFS   -    -      ZFS
```

## 2 Create a new ZFS pool on a DMP device.

```
# zpool create newpool tagmastore-usp0_0079s2
# zpool status newpool
pool: newpool
state: ONLINE
scrub: none requested
config:
NAME                STATE        READ WRITE CKSUM
newpool              ONLINE       0    0    0
tagmastore-usp0_0079s2  ONLINE       0    0    0
```

## 3 Add a DMP device to an existing ZFS pool.

```
# zpool add newpool tagmastore-usp0_0080s2
# zpool status newpool
pool: newpool
state: ONLINE
scrub: none requested
config:
NAME                STATE        READ WRITE CKSUM
newpool              ONLINE       0    0    0
tagmastore-usp0_0079s2  ONLINE       0    0    0
tagmastore-usp0_0080s2  ONLINE       0    0    0
errors: No known data errors
```

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

```
# vxdisk scandisks
```

5 After the discovery completes, the disks are shown as in use by ZFS:

```
# vxdisk list

. . .
tagmastore-usp0_0079 auto:ZFS - - ZFS
tagmastore-usp0_0080 auto:ZFS - - ZFS
```

## 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.

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

# Administering DMP

This chapter includes the following topics:

- [About enabling and disabling I/O for controllers and storage processors](#)
- [About displaying DMP database information](#)
- [Displaying the paths to a disk](#)
- [Setting customized names for DMP nodes](#)
- [Managing DMP devices for the ZFS root pool](#)
- [Administering DMP using the `vxdmpadm` utility](#)

## 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 88.

See [“Enabling I/O for paths, controllers, array ports, or DMP nodes”](#) on page 90.

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 57.

## Displaying the paths to a disk

The `vxdisk` command is used to display the multi-pathing information for a particular metadvice. The metadvice 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
c1t0d0s2    c1t0d0s2    mydg01      mydg       ENABLED
c4t0d0s2    c1t0d0s2    mydg01      mydg       ENABLED
c1t1d0s2    c1t1d0s2    mydg02      mydg       ENABLED
c4t1d0s2    c1t1d0s2    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 metadvice

- 1 Use the following command:

```
# vxdisk list devicename
```

For example, to view multi-pathing information for `c2t0d0s2`, use the following command:

```
# vxdisk list c2t0d0s2
```

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

```
Device      c2t0d0
devicetag   c2t0d0
type        sliced
hostid      sys1
.
.
.
Multipathing information:
numpaths:   2
c2t0d0s2    state=enabled   type=primary
c1t0d0s2    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 CLARiON, 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 `eva4k6k0_6`, use the following command:

```
# vxdmpadm getsubpaths dmpnodename=eva4k6k0_6
```

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

NAME	STATE [A]	PATH-TYPE [M]	CTLR-NAME	ENCLR-TYPE	ENCLR-NAME	ATTRS
c0t50001FE1500A8F08d7s2	ENABLED (A)	PRIMARY	c0	EVA4K6K	eva4k6k0	-
c0t50001FE1500A8F09d7s2	ENABLED (A)	PRIMARY	c0	EVA4K6K	eva4k6k0	-
c0t50001FE1500A8F0Cd7s2	ENABLED	SECONDARY	c0	EVA4K6K	eva4k6k0	-
c0t50001FE1500A8F0Dd7s2	ENABLED	SECONDARY	c0	EVA4K6K	eva4k6k0	-

## Setting customized names for DMP nodes

The Dynamic Multi-Pathing (DMP) node name is the metadvice 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 20.

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:

```
# vxddladm 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
```

## Managing DMP devices for the ZFS root pool

When the ZFS root pool is under DMP control, you can use the DMP devices to create mirrors, snapshots, or clones of the root disks. You can also use raw DMP devices to create swap devices and dump devices. The following sections explain the common ZFS root pool operations with DMP.

Mirroring the ZFS root pool.

See [“Configuring a mirror for the ZFS root pool using a DMP device”](#) on page 50.

Creating a snapshot of the ZFS root pool.

See [“Creating a snapshot of an existing boot environment”](#) on page 57.

- Cloning the ZFS root pool. See [“Cloning the boot environment with DMP”](#) on page 55.
- Creating swap devices on raw DMP devices. See [“Using DMP devices as swap devices or dump devices”](#) on page 54.
- Creating dump devices on raw DMP devices. See [“Using DMP devices as swap devices or dump devices”](#) on page 54.

## Configuring a mirror for the ZFS root pool using a DMP device

After the root pool is in DMP control, you can add any DMP device as a mirror to the ZFS root pool. You can attach or detach the DMP device using the `zpool` commands.

To replace a disk of root pool, you can use the following procedure to add the new device as a mirror to the ZFS root pool. After the new device is resilvered, you can detach the original device.

The following examples show attaching and detaching the DMP device `hitachi_vsp0_00f3s0` to the ZFS root pool.

### To configure a mirror for the ZFS root pool using a DMP device.

- 1 Make sure the `dmp_native_support` tunable is set to on.

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

If the `dmp_native_support` tunable is not on, you must enable DMP support for native devices.

See [“About setting up DMP to manage native devices”](#) on page 26.

- 2 View the status of the root pool using the following command:

```
# zpool status rpool
pool: rpool
state: ONLINE
scan: none requested

config:

NAME                                STATE      READ WRITE CKSUM
rpool                                ONLINE    0    0    0
hitachi_vsp0_00f4s0                 ONLINE    0    0    0
```

- 3 Use the `format` command or the `fmthard` command to format the partition table on the DMP device that you want to add to the root pool. Create the partition the same as the partition of the original device. In this example, the new device `hitachi_vsp0_00f3` is formatted to have the similar partitions as the original device `hitachi_vsp0_00f4`.

- 4 Attach the DMP device `hitachi_vsp0_00f3` to the root pool.

```
# zpool attach rpool hitachi_vsp0_00f4s0 hitachi_vsp0_00f3s0
```

- 5 Make sure to wait until the resilvering operation is completed, before you reboot the system.

```
# zpool status rpool
pool: rpool
state: DEGRADED
status: One or more devices is currently being resilvered.
       The pool will continue to function in a degraded
       state.
action: Wait for the resilver to complete.
       Run 'zpool status -v' to see device specific details.
scan: resilver in progress since Fri Feb  8 05:06:26 2013
      10.6G scanned out of 20.0G at 143M/s, 0h1m to go
      10.6G resilvered, 53.04% done
config:

NAME                                STATE      READ WRITE CKSUM
rpool                                DEGRADED   0     0     0
  mirror-0                            DEGRADED   0     0     0
    hitachi_vsp0_00f4s0                ONLINE    0     0     0
    hitachi_vsp0_00f3s0                DEGRADED   0     0     0 (resilvering)
```

For the system to be bootable with the mirror disk, update the `eeeprom` variable `boot-device` with the paths of the mirrored DMP device.

See [“Updating the boot device settings”](#) on page 52.

You can perform these steps while the resilvering is in progress.

**6** If the resilvering operation is completed, then verify booting from mirror disk.

```
# zpool status rpool
pool: rpool
state: ONLINE
scan: resilvered 20.0G in 0h10m with 0 errors on Wed Mar
      6 05:02:36 2013
config:
```

NAME	STATE	READ	WRITE	CKSUM
rpool	ONLINE	0	0	0
mirror-0	ONLINE	0	0	0
hitachi_vsp0_00f4s0	ONLINE	0	0	0
hitachi_vsp0_00f3s0	ONLINE	0	0	0

**7** Update the ZFS bootloader for the new mirror disk.

```
# bootadm install-bootloader hitachi_vsp0_00f3s0

or

# /sbin/installboot -F zfs -f /usr/platform/'uname -m' \
/lib/fs/zfs/bootblk /dev/vx/rmp/hitachi_vsp0_00f3s0
```

## Updating the boot device settings

For the system to be bootable with the mirror disk, update the eeprom variable `boot-device` with the paths of the mirrored DMP device.

The `boot-device` variable has a string limit. To add multiple physical path names without exceeding the string limit, use aliases for the physical paths.

**To configure a mirror for the ZFS root pool using a DMP device.**

**1** Display the subpaths of the DMP device.

```
# vxdmpadm getsubpaths dmpnodename=hitachi_vsp0_00f3
```

NAME	STATE[A]	PATH-TYPE[M]	CTLR-NAME	ENCLR-TYPE	ENCLR-NAME	ATTRS
c3t50060E8006D43C20d3s2	ENABLED(A)	-	c3	Hitachi_VSP	hitachi_vsp0	-
c3t50060E8006D43C30d3s2	ENABLED(A)	-	c3	Hitachi_VSP	hitachi_vsp0	-
c4t50060E8006D43C20d3s2	ENABLED(A)	-	c4	Hitachi_VSP	hitachi_vsp0	-
c4t50060E8006D43C30d3s2	ENABLED(A)	-	c4	Hitachi_VSP	hitachi_vsp0	-

- 2 Obtain the physical path of each of the active enabled paths in step 1.

```
# readlink /dev/dsk/c3t50060E8006D43C20d3s0
../../devices/pci@780/SUNW,qlc@0/fp@0,0/ssd@w5006016141e048ee,2:a
```

- 3 Display the settings for the boot-device variable. The command shows the physical path for the existing boot device.

```
# eeprom boot-device
boot-device=/pci@780/SUNW,qlc@0/fp@0,0/ssd@w5006016941e048ee,4:a
```

- 4 To ensure that the `eeprom boot-device` settings are persistent, disable the `ldmd` services before changing the settings.

```
# svcs disable svc:/ldoms/ldmd:default
```

- 5 Make sure that the attribute `use-nvramrc?` is set to true.

```
# eeprom use-nvramrc?
use-nvramrc?=true
```

- 6 Create aliases for the physical paths using the `devalias` command. The following command shows creation of aliases `vxdmp1` and `vxdmp2` for two paths of root disk:

```
# eeprom "nvramrc=devalias vxdmp1 /pci@780/SUNW,qlc@0/fp@0,0/disk@w5006016141e048ee,2:a"
vxdmp2 /pci@780/SUNW,qlc@0/fp@0,0/disk@w5006016141e048ee,2:a"
```

- 7 Add the device alias for each physical path to the boot device, to enable booting from the path.

```
# eeprom "boot-device=vxdmp1 vxdmp2"
```

- 8 Verify that the paths are added to the boot-device variable.

```
# eeprom boot-device
boot-device=vxdmp1 vxdmp2
```

- 9 Enable the `ldmd` services as follows:

```
# svcs enable svc:/ldoms/ldmd:default
```

## Using DMP devices as swap devices or dump devices

Oracle recommends that the swap device and the dump device are ZFS volumes. Oracle also recommends that you use the ZFS root pool to create both swap volumes and dump volumes. If both swap and dump devices are ZFS volumes created on the root pool, DMP automatically controls the swap and dump devices when you enable DMP support for native devices. That is, when you turn on the `dmp_native_support` tunable, the swap and dump devices are migrated to DMP control.

You can also add DMP devices as swap and dump devices.

### To add a DMP devices as a swap device

- 1 To add the DMP device `hitachi_vsp0_058as1` as a swap device, run the following command.

```
# swap -a /dev/dsk/hitachi_vsp0_058as1
```

To permanently add the value, update the `/etc/vfstab` file.

```
/dev/dsk/hitachi_vsp0_058as1 - - swap - no -
```

- 2 To verify the status of the swap device, use the following command.

```
# swap -l
swapfile dev          swaplo   blocks      free
/dev/dsk/hitachi_vsp0_058as1 287,169      16 3071984 3071984
```

### To delete the DMP device from swap

- ◆ To delete the DMP device from swap, run the following command.

```
# swap -d /dev/dsk/hitachi_vsp0_058as2
```

### To add a DMP device as a dump device

- ◆ To add the DMP device `hitachi_vsp0_058as2` as a dump device, run the following command.

```
# dumpadm -d /dev/dsk/hitachi_vsp0_058as2
Dump content: all pages
Dump device: /dev/dsk/hitachi_vsp0_058as2 (dedicated)
Savecore directory: /var/crash
Savecore enabled: yes
Save compressed: on
```

## Cloning the boot environment with DMP

When the ZFS root pool is on DMP, you can use the `beadm create` command to create a clone of the boot environment.

See the Oracle website for more details.

If you intend to use multiple boot environments (BEs) in a root pool under DMP control, create the new BEs after you enable the `dmp_native_support` tunable parameter.

If multiple boot environments (BEs) exist in a root pool before you enable the `dmp_native_support` tunable parameter, then only the current BE is bootable after you enable `dmp_native_support` tunable parameter. To boot using another inactive BE, you must disable the `dmp_native_support` tunable parameter.

### To clone the boot environment in the existing root pool

- 1 To clone the boot environment in the existing root pool, run the following command.

```
# beadm create newBE
```

- 2 Activate the new boot environment.

```
# beadm activate newBE
```

- 3 Reboot the system using any of the new paths to boot from the new BE.

### To clone the boot environment in a new pool

- 1 Create the new zpool using a DMP device.

```
# zpool create new_rpool hitachi_vsp0_058s0
```

- 2 Run the following command to apply the DMP-related configuration changes:

```
# bootadm update-archive
```

- 3 Clone the boot environment in the new zpool.

```
# beadm create -p new_rpool newBE
```

- 4 Install the bootblock on the DMP device using one of the following commands:

```
# installboot -F zfs - /platform/`uname -i`/lib/fs/zfs/bootblk \  
/dev/rdisk/hitachi_vsp0_058s0
```

```
# sync
```

OR

```
# bootadm install-bootloader -fv -P new_rpool
```

OR

```
# zpool set bootfs=rpool/ROOT/solaris new_rpool
```

- 5 Activate the new boot environment.

```
# beadm activate newBE
```

- 6 Add the physical names of paths of the DMP device to the `boot-device` variable.

See [“Updating the boot device settings”](#) on page 52.

- 7 Re-create the swap volume.

For example:

```
# zfs create -V 4g new_rpool/swap
```

- 8 Update the `/etc/vfstab` entry for the new swap device with following entry:

```
/dev/dsk/new_rpool/swap - - swap - no - -
```

- 9 Re-create and set the dump volume.

```
# zfs create -V 4g new_rpool/dump
```

```
# dumpadm -d /dev/dsk/new_rpool/dump
```

- 10 Reboot the system using any of the new paths to boot from the new BE.

### To delete the clone of the boot environment

- ◆ To delete the boot environment, run the following command.

```
# beadm delete newBE
```

## Creating a snapshot of an existing boot environment

When the ZFS root pool is on DMP, you can use the `beadm create` command to create a snapshot of an existing boot environment.

See the Oracle website for more details.

### To create a snapshot of an existing boot environment

- ◆ Create a snapshot of an existing boot environment using the following command:

```
# beadm create newBE@snapshotdescription
```

### To recreate the boot environment from an existing snapshot

- ◆ Recreate the boot environment from an existing snapshot using the following command:

```
# beadm create -e newBE@snapshotdescription <bename>
```

## Administering DMP using the vxddmpadm utility

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

You can use the `vxddmpadm` 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 59.
- Display consolidated information about the DMP nodes.  
See [“Displaying consolidated information about the DMP nodes”](#) on page 60.
- Display the members of a LUN group.  
See [“Displaying the members of a LUN group”](#) on page 61.
- 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 62.
- Display information about the HBA controllers on the host.  
See [“Displaying information about controllers”](#) on page 64.
- Display information about enclosures.  
See [“Displaying information about enclosures”](#) on page 65.

- Display information about array ports that are connected to the storage processors of enclosures.  
See [“Displaying information about array ports”](#) on page 66.
- Display asymmetric access state for ALUA arrays.  
See [“User-friendly CLI outputs for ALUA arrays ”](#) on page 67.
- 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 68.
- Display extended devices attributes.  
See [“Displaying extended device attributes”](#) on page 69.
- See [“Suppressing or including devices from VxVM control”](#) on page 71.  
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 72.
- Configure the attributes of the paths to an enclosure.  
See [“Setting the attributes of the paths to an enclosure”](#) on page 79.
- Display the redundancy level of a device or enclosure.  
See [“Displaying the redundancy level of a device or enclosure”](#) on page 80.
- Specify the minimum number of active paths.  
See [“Specifying the minimum number of active paths”](#) on page 81.
- Display or set the I/O policy that is used for the paths to an enclosure.  
See [“Specifying the I/O policy”](#) on page 82.
- 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 88.
- Rename an enclosure.  
See [“Renaming an enclosure”](#) on page 91.
- Configure how DMP responds to I/O request failures.  
See [“Configuring the response to I/O failures”](#) on page 91.
- Configure the I/O throttling mechanism.  
See [“Configuring the I/O throttling mechanism”](#) on page 93.
- Control the operation of the DMP path restoration thread.  
See [“Configuring DMP path restoration policies”](#) on page 96.
- Configure array policy modules.  
See [“Configuring Array Policy Modules”](#) on page 98.

- Get or set the values of various tunables used by DMP.  
 See “[DMP tunable parameters](#)” on page 167.

See the `vxddmpadm(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:

```
# vxddmpadm 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/rdisk` directory.

The command displays output similar to the following example output.

```
# vxddmpadm getdmpnode nodename=c0t5006016041E03B33d0s2
```

NAME	STATE	ENCLR-TYPE	PATHS	ENBL	DSBL	ENCLR-NAME
emc_clariion0_16	ENABLED	EMC_CLARiION	6	6	0	emc_clariion0

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

```
# vxddmpadm -v getdmpnode nodename=c0t5006016041E03B33d0s2
```

NAME	STATE	ENCLR-TYPE	PATHS	ENBL	DSBL	ENCLR-NAME	SERIAL-NO	ARRAY_VOL_ID
emc_clariion0_16	ENABLED	EMC_CLARiION	6	6	0	emc_clariion0	600601606	16

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

```
# vxddmpadm getdmpnode enclosure=enc0
```

NAME	STATE	ENCLR-TYPE	PATHS	ENBL	DSBL	ENCLR-NAME
c2t1d0s2	ENABLED	T300	2	2	0	enc0
c2t1d1s2	ENABLED	T300	2	2	0	enc0
c2t1d2s2	ENABLED	T300	2	2	0	enc0
c2t1d3s2	ENABLED	T300	2	2	0	enc0

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

```
# vxddmpadm 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 `vxddmpadm 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:

```
# vxddmpadm list dmpnode all
```

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

```
# vxddmpadm list dmpnode enclosure=enclosurename
```

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

```
# vxddmpadm 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 `vxddmpadm disable` command is listed as `disabled(m)`.

```
# vxddmpadm list dmpnode dmpnodename=dmpnodename
```

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

```
# vxddmpadm list dmpnode dmpnodename=emc_clariion0_158
```

```
dmpdev      = emc_clariion0_158
state       = enabled
enclosure   = emc_clariion0
```

```

cab-sno      = CK200070400359
asl          = libvxCLARiiON.so
vid          = DGC
pid          = DISK
array-name   = EMC_CLARiiON
array-type   = CLR-A/PF
iopolicy     = MinimumQ
avid         = 158
lun-sno      = 600601606D121B008FB6E0CA8EDBDB11
udid         = DGC%5FDISK%5FCK200070400359%5F600601606D121B008FB6E0CA8EDBDB11
dev-attr     = lun
###path      = name state type transport ctrlr hwpath aprotID aprotWWN attr
path         = c0t5006016141E03B33d1s2 enabled(a) primary FC c0
/pci@1e,600000/SUNW,emlxs@3/fp@0,0 A5 50:06:01:61:41:e0:3b:33 -
path         = c0t5006016041E03B33d1s2 enabled(a) primary FC c0
/pci@1e,600000/SUNW,emlxs@3/fp@0,0 A4 50:06:01:60:41:e0:3b:33 -
path         = c0t5006016841E03B33d1s2 enabled secondary FC c0
/pci@1e,600000/SUNW,emlxs@3/fp@0,0 B4 50:06:01:68:41:e0:3b:33 -
path         = c1t5006016141E03B33d1s2 enabled(a) primary FC c1
/pci@1e,600000/SUNW,emlxs@3,1/fp@0,0 A5 50:06:01:61:41:e0:3b:33 -
path         = c1t5006016841E03B33d1s2 enabled secondary FC c1
/pci@1e,600000/SUNW,emlxs@3,1/fp@0,0 B4 50:06:01:68:41:e0:3b:33 -
path         = c1t5006016041E03B33d1s2 enabled(a) primary FC c1
/pci@1e,600000/SUNW,emlxs@3,1/fp@0,0 A4 50:06:01:60:41:e0:3b:33 -

```

## 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:

```
# vxddmpadm getlungroup dmpnodename=dmpnode
```

For example:

```
# vxddmpadm getlungroup dmpnodename=c11t0d10s2
```

The above command displays output such as the following:

NAME	STATE	ENCLR-TYPE	PATHS	ENBL	DSBL	ENCLR-NAME
c11t0d8s2	ENABLED	ACME	2	2	0	encl
c11t0d9s2	ENABLED	ACME	2	2	0	encl
c11t0d10s2	ENABLED	ACME	2	2	0	encl
c11t0d11s2	ENABLED	ACME	2	2	0	encl

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

The `vxddmpadm getsubpaths` command lists all of the paths known to Dynamic Multi-Pathing (DMP). The `vxddmpadm 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:

```
# vxddmpadm getsubpaths
```

NAME	STATE [A]	PATH-TYPE [M]	DMPNODENAME	ENCLR-NAME	CTLR	ATTRS
c1t65d0s2	ENABLED (A)	-	Disk_1	Disk	c1	-
c1t66d0s2	ENABLED (A)	-	Disk_2	Disk	c1	-
c2t65d0s2	ENABLED (A)	-	Disk_1	Disk	c2	-
c2t66d0s2	ENABLED (A)	-	Disk_2	Disk	c2	-
c3t2d0s2	ENABLED (A)	-	EMC0_1	EMC0	c3	-
c3t2d1s2	ENABLED (A)	-	EMC0_2	EMC0	c3	-
c4t2d0s2	ENABLED (A)	-	EMC0_1	EMC0	c4	-
c4t2d1s2	ENABLED (A)	-	EMC0_2	EMC0	c4	-

The `vxddmpadm 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:

```
# vxddmpadm getsubpaths dmpnodename=c2t66d0s2
```

NAME	STATE [A]	PATH-TYPE [M]	CTLR-NAME	ENCLR-TYPE	ENCLR-NAME	ATTRS
c2t66d0s2	ENABLED (A)	PRIMARY	c2	ACME	enc0	-
c1t66d0s2	ENABLED	PRIMARY	c1	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 82.

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:

```
# vxddmpadm getsubpaths ctrl=c2
```

NAME	STATE [-]	PATH-TYPE [-]	DMPNODENAME	ENCLR-TYPE	ENCLR-NAME	ATTRS
c2t1d0s2	ENABLED (A)	PRIMARY	c2t1d0s2	ACME	enc0	-
c2t2d0s2	ENABLED (A)	PRIMARY	c2t2d0s2	ACME	enc0	-
c2t3d0s2	DISABLED	SECONDARY	c2t3d0s2	ACME	enc0	-
c2t4d0s2	ENABLED	SECONDARY	c2t4d0s2	ACME	enc0	-

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:

```
# vxddmpadm getsubpaths enclosure=enclosure portid=portid
# vxddmpadm getsubpaths pwwn=pwwn
```

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

```
# vxddmpadm getsubpaths enclosure=HDS9500-ALUA0 portid=1A
```

NAME	STATE [A]	PATH-TYPE [M]	DMPNODENAME	ENCLR-NAME	CTLR	ATTRS
c1t65d0s2	ENABLED (A)	PRIMARY	c1t65d0s2	HDS9500-ALUA0	c1	-
c1t66d0s2	ENABLED (A)	PRIMARY	c1t66d0s2	HDS9500-ALUA0	c1	-

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

```
# vxddmpadm getsubpaths pwwn=20:00:00:E0:8B:06:5F:19
```

NAME	STATE [A]	PATH-TYPE [M]	DMPNODENAME	ENCLR-NAME	CTLR	ATTRS
c1t65d0s2	ENABLED (A)	PRIMARY	c1t65d0s2	HDS9500-ALUA0	c1	-
c1t66d0s2	ENABLED (A)	PRIMARY	c1t66d0s2	HDS9500-ALUA0	c1	-

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

```
# vxddmpadm getsubpaths enclosure=enclosure_name [ctrl=ctrlname]
```

To list all subpaths of an enclosure:

```
# vxddmpadm getsubpaths enclosure=Disk
```

NAME	STATE [A]	PATH-TYPE [M]	DMPNODENAME	ENCLR-NAME	CTLR	ATTRS
c1t65d0s2	ENABLED (A)	-	Disk_1	Disk	c1	-
c1t66d0s2	ENABLED (A)	-	Disk_2	Disk	c1	-
c2t65d0s2	ENABLED (A)	-	Disk_1	Disk	c2	-
c2t66d0s2	ENABLED (A)	-	Disk_2	Disk	c2	-

To list all subpaths of a controller on an enclosure:

```
# vxddmpadm getsubpaths enclosure=emc_clariion0
```

NAME	STATE [A]	PATH-TYPE [M]	DMPNODENAME	ENCLR-NAME	CTLR	ATTRS	PRIORITY
sdab	ENABLED	Active/Non-Optimized	emc_clariion0_429	emc_clariion0	c6	-	-
sda1	ENABLED (A)	Active/Optimized (P)	emc_clariion0_429	emc_clariion0	c6	-	-
sdh	ENABLED	Active/Non-Optimized	emc_clariion0_429	emc_clariion0	c1	-	-
sdr	ENABLED (A)	Active/Optimized (P)	emc_clariion0_429	emc_clariion0	c1	-	-

By default, the output of the `vxddmpadm 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:

```
# vxddmpadm -s {path | dmpnode | enclosure | ctlr} getsubpaths \
[all | ctlr=ctlr_name | dmpnodename=dmp_device_name | \
enclosure=enclr_name [ctlr=ctlr_name | portid=array_port_ID] | \
pwnn=port_WWN | tpdnodename=tpd_node_name]
```

See [“Setting customized names for DMP nodes”](#) on page 48.

## Displaying information about controllers

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

```
# vxddmpadm listctlr all
```

CTLR-NAME	ENCLR-TYPE	STATE	ENCLR-NAME	PATH_COUNT
c1	OTHER	ENABLED	other0	3
c2	X1	ENABLED	jbod0	10
c3	ACME	ENABLED	enc0	24
c4	ACME	ENABLED	enc0	24

This output shows that the controller `c1` 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 `vxddmpadm disable` command.

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

```
# vxddmpadm listctlr enclosure=emc0
```

or

```
# vxddmpadm listctlr type=EMC
```

```
# vxddmpadm listctlr type=EMC
```

CTLR_NAME	ENCLR_TYPE	STATE	ENCLR_NAME	PATH_COUNT
c1	EMC	ENABLED	emc0	6
c6	EMC	ENABLED	emc0	6

The `vxddmpadm 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.

```
# vxddmpadm getctlr c5
```

LNAME	PNAME	VENDOR	CTLR-ID
c5	c5	qlogic	20:07:00:a0:b8:17:e1:37

## 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:

```
# vxddmpadm 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 attributes for all enclosures in a system, use the following DMP command:

```
# vxddmpadm 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_osp-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 MPxIO, 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 MPxIO 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:

```
# vxddmpadm getportids path=path_name
# vxddmpadm getportids dmpnodename=dmpnode_name
# vxddmpadm getportids ctlr=ctlr_name
```

The following form of the command displays information about all of the array ports within the specified enclosure:

```
# vxddmpadm getportids enclosure=enclr_name
```

The following example shows information about the array port that is accessible through DMP node `c2t66d0s2`:

```
# vxddmpadm getportids dmpnodename=c2t66d0s2
```

```
NAME           ENCLR-NAME  ARRAY-PORT-ID  pWWN
=====
c2t66d0s2     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:

```
# vxddmpadm getsubpaths dmpnodename=dmpnode_name
```

Typical output is as follows:

```
# vxddmpadm 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:

```
# vxdmadm 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:

```
# vxdmadm getsubpaths tpdnodename=TPD_node_name
# vxdmadm gettpdnode nodename=TPD_path_name
```

See [“Changing device naming for enclosures controlled by third-party drivers”](#) on page 124.

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
emcpower10s2	auto:sliced	disk1	ppdg	online
emcpower11s2	auto:sliced	disk2	ppdg	online
emcpower12s2	auto:sliced	disk3	ppdg	online
emcpower13s2	auto:sliced	disk4	ppdg	online
emcpower14s2	auto:sliced	disk5	ppdg	online
emcpower15s2	auto:sliced	disk6	ppdg	online
emcpower16s2	auto:sliced	disk7	ppdg	online
emcpower17s2	auto:sliced	disk8	ppdg	online
emcpower18s2	auto:sliced	disk9	ppdg	online
emcpower19s2	auto:sliced	disk10	ppdg	online

The following command displays the paths that DMP has discovered, and which correspond to the PowerPath-controlled node, `emcpower10s2`:

```
# vxdmadm getsubpaths tpdnodename=emcpower10s2
```

NAME	TPDNODENAME	PATH-TYPE [-] DMP-NODENAME	ENCLR-TYPE	ENCLR-NAME
c7t0d10s2emcpower10s2-		emcpower10s2	EMC	EMC0
c6t0d10s2emcpower10s2-		emcpower10s2	EMC	EMC0

Conversely, the next command displays information about the PowerPath node that corresponds to the path, `c7t0d10s2`, discovered by DMP:

```
# vxddmadm gettpdnode nodename=c7t0d10s2
```

```
NAME           STATE    PATHS  ENCLR-TYPE  ENCLR-NAME
=====
emcpower10s2  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 3-1](#) describes the list of categories.

**Table 3-1** 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 `vxddisk -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 `vxmpadm 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 `vxmpadm 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 encapsulated under VxVM.

---

**Note:** The ! character is a special character in some shells. The following syntax shows how to escape it in a bash shell.

---

```
# vxmpadm exclude { all | product=VID:PID |
ctrlr=[\!]ctrlrname | dmpnodename=diskname [ path=[\!]pathname ] }
```

```
# vxdmpadm include { all | product=VID:PID |
ctrl=[\!]ctrlname | dmpnodename=diskname [ path=[\!]pathname ] }
```

where:

<code>all</code>	all devices
<code>product=VID:PID</code>	all devices with the specified VID:PID
<code>ctrl=ctrlname</code>	all devices through the given controller
<code>dmpnodename=diskname</code>	all paths under the DMP node
<code>dmpnodename=diskname path=!pathname</code>	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`
- `ctrl=ctrl-name`
- `dmpnodename=dmp-node`

- `enclosure=encclr-name [portid=array-portid ] [ctrlr=ctrlr-name]`
- `pathname=path-name`
- `pwwn=array-port-wwn [ctrlr=ctrlr-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 73.

To disable the gathering of statistics, enter this command:

```
# vxddmpadm iostat stop
```

## Displaying cumulative I/O statistics

The `vxddmpadm 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:

```
# vxddmpadm [-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]
```

For example:

```
# vxdmpadm iostat show groupby=dmpnode dmpnodename=c5t0d1s2
```

OPERATIONS	BLOCKS		AVG TIME (ms)			
	READS	WRITES	READS	WRITES	READS	WRITES
DMPNODENAME						
c5t0d1s2	0	0	0	0	0.00	0.00

To group by controller:

```
# vxddmpadm [-u unit] iostat show groupby=ctlr [ all | ctlr=ctlr ]
```

For example:

```
# vxddmpadm iostat show groupby=ctlr ctlr=c5
```

CTLRNAME	OPERATIONS		BLOCKS		AVG TIME (ms)	
	READS	WRITES	READS	WRITES	READS	WRITES
c5	224	14	54	7	4.20	11.10

To group by arrayport:

```
# vxddmpadm [-u unit] iostat show groupby=arrayport [ all \
| pwwn=array_pwwn | enclosure=enclr portid=array-port-id ]
```

For example:

```
# vxddmpadm -u m iostat show groupby=arrayport \
enclosure=HDS9500-ALUA0 portid=1A
```

PORTNAME	OPERATIONS		BYTES		AVG TIME (ms)	
	READS	WRITES	READS	WRITES	READS	WRITES
1A	743	1538	11m	24m	17.13	8.61

To group by enclosure:

```
# vxddmpadm [-u unit] iostat show groupby=enclosure [ all \
| enclosure=enclr ]
```

For example:

```
# vxddmpadm -u h iostat show groupby=enclosure enclosure=EMC_CLARiiON0
```

ENCLOSURENAME	OPERATIONS		BLOCKS		AVG TIME (ms)	
	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:

```
# vxddmpadm [-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:

```
# vxddmpadm -z iostat show dmpnodename=c2t16d4s2
```

PATHNAME	OPERATIONS		BLOCKS		AVG TIME (ms)	
	READS	WRITES	READS	WRITES	READS	WRITES
c3t16d4s2	10	110	2	25	12.00	27.96
c2t17d4s2	20	126	4	29	9.50	19.41

To display average read/write times in microseconds.

```
# vxddmpadm -u us iostat show pathname=c2t17d4s2
```

PATHNAME	OPERATIONS		BLOCKS		AVG TIME (microsec)	
	READS	WRITES	READS	WRITES	READS	WRITES
c2t17d4s2	20	126	4	29	9500.00	19413.79

## Displaying statistics for queued or erroneous I/Os

Use the `vxddmpadm 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 `vxddmpadm(1m)` manual page for more information about the `vxddmpadm iostat` command.

To display queued I/O counts on a DMP node:

```
# vxddmpadm -q iostat show [filter] [interval=n] [count=m]
```

For example:

```
# vxddmpadm -q iostat show dmpnodename=c5t2d1s2
```

DMPNODENAME	QUEUED I/Os		Pending I/Os
	READS	WRITES	
c5t2d1s2	2	15	30

To display the count of I/Os that returned with errors on a DMP node, path, or controller:

```
# vxddmpadm -e iostat show [filter] [interval=n] [count=m]
```

For example, to show the I/O counts that returned errors on a path:

```
# vxddpadm -e iostat show pathname=c1t5006016041E03B33d6s2 interval=1
```

```
cpu usage = 168144us      per cpu memory = 409600b
                        ERROR I/Os
PATHNAME                READS    WRITES
c1t5006016041E03B33d6s2  0        0
c1t5006016041E03B33d6s2  0        0
```

## Examples of using the vxddpadm iostat command

Dynamic Multi-Pathing (DMP) enables you to gather and display I/O statistics with the `vxddpadm iostat` command. This section provides an example session using the `vxddpadm iostat` command.

The first command enables the gathering of I/O statistics:

```
# vxddpadm 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.

```
# vxddpadm -u k iostat show all
```

```
                        cpu usage = 7952us      per cpu memory = 8192b
OPERATIONS              BYTES              AVG TIME (ms)
PATHNAME  READS  WRITES  READS  WRITES  READS  WRITES
c0t0d0    1088    0      557056k  0      0.00  0.00
c2t118d0   87     0      44544k  0      0.00  0.00
c3t118d0   0     0         0  0      0.00  0.00
c2t122d0   87     0      44544k  0      0.00  0.00
c3t122d0   0     0         0  0      0.00  0.00
c2t115d0   87     0      44544k  0      0.00  0.00
c3t115d0   0     0         0  0      0.00  0.00
c2t103d0   87     0      44544k  0      0.00  0.00
c3t103d0   0     0         0  0      0.00  0.00
c2t102d0   87     0      44544k  0      0.00  0.00
c3t102d0   0     0         0  0      0.00  0.00
c2t121d0   87     0      44544k  0      0.00  0.00
c3t121d0   0     0         0  0      0.00  0.00
c2t112d0   87     0      44544k  0      0.00  0.00
c3t112d0   0     0         0  0      0.00  0.00
c2t96d0    87     0      44544k  0      0.00  0.00
c3t96d0    0     0         0  0      0.00  0.00
c2t106d0   87     0      44544k  0      0.00  0.00
c3t106d0   0     0         0  0      0.00  0.00
```

c2t113d0	87	0	44544k	0	0.00	0.00
c3t113d0	0	0	0	0	0.00	0.00
c2t119d0	87	0	44544k	0	0.00	0.00
c3t119d0	0	0	0	0	0.00	0.00

The following command changes the amount of memory that `vxddmpadm` can use to accumulate the statistics:

```
# vxddmpadm 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):

```
# vxddmpadm -u k iostat show pathname=c3t115d0s2
```

```

cpu usage = 8132us      per cpu memory = 4096b
OPERATIONS              BYTES              AVG TIME (ms)
PATHNAME  READS      WRITES      READS      WRITES      READS      WRITES
c3t115d0s2  0          0          0          0          0.00      0.00

```

```
# vxddmpadm -u k iostat show dmpnodename=c0t0d0s2
```

```

cpu usage = 8501us      per cpu memory = 4096b
OPERATIONS              BYTES              AVG TIME (ms)
PATHNAME  READS      WRITES      READS      WRITES      READS      WRITES
c0t0d0s2  1088          0      557056k          0          0.00      0.00

```

```
# vxddmpadm -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
c0t0d0s2  1088          0      57056k          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:

```
# vxddmpadm iostat show dmpnodename=emc_clariion0_342 interval=1 count=2
```

```

cpu usage = 164687us    per cpu memory = 409600b
OPERATIONS              BLOCKS              AVG TIME (ms)
PATHNAME  READS  WRITES  READS  WRITES  READS  WRITES
c0t5006016041E03B33d6s2  3      0      33      0      0.02      0.00
c0t5006016141E03B33d6s2  3      0      3      0      0.16      0.00
c0t5006016841E03B33d6s2  0      0      0      0      0.00      0.00
c1t5006016041E03B33d6s2  1      0      16     0      0.02      0.00
c1t5006016141E03B33d6s2  2      0      2      0      0.18      0.00

```

c1t5006016841E03B33d6s2	0	0	0	0.00	0.00
c0t5006016041E03B33d6s2	0	0	0	0.00	0.00
c0t5006016141E03B33d6s2	0	0	0	0.00	0.00
c0t5006016841E03B33d6s2	0	0	0	0.00	0.00
c1t5006016041E03B33d6s2	0	0	0	0.00	0.00
c1t5006016141E03B33d6s2	0	0	0	0.00	0.00
c1t5006016841E03B33d6s2	0	0	0	0.00	0.00

## Setting the attributes of the paths to an enclosure

You can use the `vxddmpadm 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:

<code>active</code>	Changes a standby (failover) path to an active path. The following example specifies an active path for an array:  <b># vxddmpadm setattr path c2t10d0s2 pathtype=active</b>
<code>nomanual</code>	Restores the original primary or secondary attributes of a path. This example restores the path to a JBOD disk:  <b># vxddmpadm setattr path c3t10d0s2 pathtype=nomanual</b>
<code>nopreferred</code>	Restores the normal priority of a path. The following example restores the default priority to a path:  <b># vxddmpadm setattr path c1t20d0s2 \ pathtype=nopreferred</b>

`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.

See “Specifying the I/O policy” on page 82.

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:

```
# vxddmpadm setattr enclosure enc0 \  
  iopolicy=priority  
# vxddmpadm setattr path c1t20d0s2 \  
  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:

```
# vxddmpadm setattr path c3t10d0s2 \  
  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:

```
# vxddmpadm setattr path c4t10d0s2 \  
  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:

```
# vxddmpadm setattr path c2t10d0s2 \  
  pathtype=standby
```

## Displaying the redundancy level of a device or enclosure

Use the `vxddmpadm 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:

```
# vxddmpadm getdmpnode enclosure=enc1_name redundancy=value
```

For example, to list the devices with fewer than 3 enabled paths, use the following command:

```
# vxddmpadm 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 `vxddmpadm getattr` command, as follows:

```
# vxddmpadm getattr enclosure|arrayname|arraytype \  
component-name redundancy
```

For example, to show the minimum redundancy level for the enclosure HDS9500-ALUA0:

```
# vxddmpadm 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 `vxddmpadm setattr` command to set the minimum redundancy level.

### To specify the minimum number of active paths

- ◆ Use the `vxddmpadm setattr` command with the `redundancy` attribute as follows:

```
# vxddmpadm 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:

```
# vxddmpadm 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 `vxddmpadm getattr` command.

The following example displays the default and current setting of `iopolicy` for JBOD disks:

```
# vxddmpadm 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:

```
# vxddmpadm getattr enclosure enc0 partitionsize
```

ENCLR_NAME	DEFAULT	CURRENT
-----		
enc0	512	4096

## Specifying the I/O policy

You can use the `vxddmpadm 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 3-2 describes the I/O policies that may be set.

**Table 3-2** DMP I/O policies

Policy	Description
adaptive	<p>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.</p> <p>In this example, the adaptive I/O policy is set for the enclosure <code>enc1</code>:</p> <pre># vxddmpadm setattr enclosure enc1 \   iopolicy=adaptive</pre>
adaptiveminq	<p>Similar to the <code>adaptive</code> 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.</p>

**Table 3-2** DMP I/O policies (*continued*)

Policy	Description
balanced [partitionsize=size]	<p>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.</p> <p>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.</p> <p>Specifying a partition size of 0 is equivalent to specifying the default partition size.</p> <p>The default value for the partition size is 512 blocks (256k). Specifying a partition size of 0 is equivalent to the default partition size of 512 blocks (256k).</p> <p>The default value can be changed by adjusting the value of the <code>dmp_pathswitch_blks_shift</code> tunable parameter.</p> <p>See <a href="#">“DMP tunable parameters”</a> on page 167.</p> <p><b>Note:</b> The benefit of this policy is lost if the value is set larger than the cache size.</p> <p>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.</p> <p>The next example sets the balanced I/O policy with a partition size of 4096 blocks (2MB) on the enclosure enc0:</p> <pre># vxddmpadm setattr enclosure enc0 \   iopolicy=balanced partitionsize=4096</pre>
minimumq	<p>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.</p> <p>The following example sets the I/O policy to <code>minimumq</code> for a JBOD:</p> <pre># vxddmpadm setattr enclosure Disk \   iopolicy=minimumq</pre> <p>This is the default I/O policy for all arrays.</p>

**Table 3-2** DMP I/O policies (*continued*)

Policy	Description
priority	<p>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.</p> <p>See <a href="#">“Setting the attributes of the paths to an enclosure”</a> on page 79.</p> <p>In this example, the I/O policy is set to <code>priority</code> for all SENA arrays:</p> <pre># vxddmpadm setattr arrayname SENA \   iopolicy=priority</pre>
round-robin	<p>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.</p> <p>The next example sets the I/O policy to <code>round-robin</code> for all Active/Active arrays:</p> <pre># vxddmpadm setattr arraytype A/A \   iopolicy=round-robin</pre>
singleactive	<p>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.</p> <p>The following example sets the I/O policy to <code>singleactive</code> for JBOD disks:</p> <pre># vxddmpadm setattr arrayname Disk \   iopolicy=singleactive</pre>

## 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:

```
# vxddmpadm 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 `vxddmpadm gettattr` command.

```
# vxddmpadm gettattr 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 `vxddisk list` command, the device `c3t2d15s2` has eight primary paths:

```
# vxddisk list c3t2d15s2
```

```
Device: c3t2d15s2
.
.
.
numpaths: 8
c2t0d15s2 state=enabled type=primary
c2t1d15s2 state=enabled type=primary
c3t1d15s2 state=enabled type=primary
```

```
c3t2d15s2 state=enabled type=primary
c4t2d15s2 state=enabled type=primary
c4t3d15s2 state=enabled type=primary
c5t3d15s2 state=enabled type=primary
c5t4d15s2 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:

```
# vxddmpadm iostat start
```

Next, use the `dd` command to apply an input workload from the volume:

```
# dd if=/dev/vx/rdisk/mydg/myvol1 of=/dev/null &
```

By running the `vxddmpadm iostat` command to display the DMP statistics for the device, it can be seen that all I/O is being directed to one path, `c5t4d15s2`:

```
# vxddmpadm iostat show dmpnodename=c3t2d15s2 interval=5 count=2
```

```
.
.
.
```

```
cpu usage = 11294us per cpu memory = 32768b
```

PATHNAME	OPERATIONS		KBYTES		AVG TIME (ms)	
	READS	WRITES	READS	WRITES	READS	WRITES
c2t0d15s2	0	0	0	0	0.00	0.00
c2t1d15s2	0	0	0	0	0.00	0.00
c3t1d15s2	0	0	0	0	0.00	0.00
c3t2d15s2	0	0	0	0	0.00	0.00
c4t2d15s2	0	0	0	0	0.00	0.00
c4t3d15s2	0	0	0	0	0.00	0.00
c5t3d15s2	0	0	0	0	0.00	0.00
c5t4d15s2	10986	0	5493	0	0.41	0.00

The `vxddmpadm` command is used to display the I/O policy for the enclosure that contains the device:

```
# vxddmpadm 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:

```
# vxddmpadm setattr enclosure ENC0 iopolicy=round-robin
# vxddmpadm getattr enclosure ENC0 iopolicy
```

```
ENCLR_NAME      DEFAULT                CURRENT
=====
ENC0             MinimumQ              Round-Robin
```

The DMP statistics are now reset:

```
# vxddmpadm 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.

```
# vxddmpadm iostat show dmpnodename=c3t2d15s2 interval=5 count=2
```

```
.
.
.
```

```
cpu usage = 14403us per cpu memory = 32768b
```

PATHNAME	OPERATIONS		KBYTES		AVG TIME (ms)	
	READS	WRITES	READS	WRITES	READS	WRITES
c2t0d15s2	2041	0	1021	0	0.39	0.00
c2t1d15s2	1894	0	947	0	0.39	0.00
c3t1d15s2	2008	0	1004	0	0.39	0.00
c3t2d15s2	2054	0	1027	0	0.40	0.00
c4t2d15s2	2171	0	1086	0	0.39	0.00
c4t3d15s2	2095	0	1048	0	0.39	0.00
c5t3d15s2	2073	0	1036	0	0.39	0.00
c5t4d15s2	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:

```
# vxddmpadm 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.

Before detaching a system board, stop all I/O to the HBA controllers that are located on the board. To do this, execute the `vxdmpadm disable` command, and then run the Dynamic Reconfiguration (DR) facility provided by Oracle.

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 ctrl=ctrl_name1[,ctrl_name2,ctrl_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 ctrl=ctrl_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:

```
# vxddmpadm 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:

```
# vxddmpadm enable ctrl=ctrl_name1[,ctrl_name2,ctrl_nameN]
```

To enable I/O for the paths connected to an array port, use one of the following commands:

```
# vxddmpadm enable enclosure=enclr_name portid=array_port_ID
```

```
# vxddmpadm 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:

```
# vxddmpadm enable enclosure=HDS9500V0 portid=1A
```

```
# vxddmpadm 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:

```
# vxddmpadm 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.

```
# vxddmpadm enable dmpnodename=dmpnode
```

## Renaming an enclosure

The `vxddmpadm setattr` command can be used to assign a meaningful name to an existing enclosure, for example:

```
# vxddmpadm 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:

```
# vxddmpadm 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 `vxddmpadm getattr` command.

See [“Displaying recovery option values”](#) on page 95.

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:

```
# vxddmpadm 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:

```
# vxddmpadm 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:

```
# vxddmpadm 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:

```
# vxddmpadm 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:

```
# vxddmpadm 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 93.

---

**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 `vxddmpadm getattr` command.

See “[Displaying recovery option values](#)” on page 95.

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 `vxddmpadm setattr` command:

```
# vxddmpadm 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`:

```
# vxddmpadm setattr enclosure enc0 recoveryoption=nothrottle
```

The `vxddmpadm setattr` command can be used to enable I/O throttling on the paths to a specified enclosure, disk array name, or type of array:

```
# vxddmpadm 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`:

```
# vxddmpadm setattr enclosure enc0 recoveryoption=throttle \  
    iotimeout=60
```

Specify `recoveryoption=default` to reset I/O throttling to the default settings, as follows:

```
# vxddmpadm 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 91.

---

**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:

```
# vxddmpadm 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.

```
# vxddmpadm settune dmp_sfg_threshold=N
```

To see the Subpaths Failover Groups ID, use the following command:

```
# vxddmpadm 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 `vxddmpadm settune` command:

```
# vxddmpadm 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.

```
# vxddmpadm 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:

```
# vxddmpadm getattr \  
  {enclosure enc-name|arrayname name|arraytype type} \  
  recoveryoption
```

The following example shows the `vxddmpadm getattr` command being used to display the `recoveryoption` option values that are set on an enclosure.

```
# vxddmpadm 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 3-3](#) summarizes the possible recovery option settings for retrying I/O after an error.

**Table 3-3** 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 3-4](#) summarizes the possible recovery option settings for throttling I/O.

**Table 3-4** Recovery options for I/O throttling

Recovery option	Possible settings	Description
recoveryoption=nothrottle	None	I/O throttling is not used.
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 `vxddmpadm 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 97.

Use the `vxddmpadm 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 `vxddmpadm 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:

```
# vxddmpadm 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:

```
# vxddmpadm 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:

```
# vxddmpadm 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:

```
# vxddmpadm 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:

```
# vxddmpadm settune dmp_restore_interval=400
```

The settings are immediately applied and are persistent across reboots. Use the `vxddmpadm gettune` command to view the current settings.

See “[DMP tunable parameters](#)” on page 167.

If the `vxddmpadm 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 `vxddmpadm 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:

```
# vxddmpadm 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 `vxddmpadm 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:

```
# vxddmpadm gettune dmp_restore_state
# vxddmpadm gettune dmp_restore_interval
# vxddmpadm 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:

```
# vxddmpadm 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:

```
# vxddmpadm listapm module_name
```

To add and configure an APM, use the following command:

```
# vxddmpadm -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:

```
# vxddmpadm -r cfgapm module_name
```

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

## Configuring latency threshold tunable for metro/geo array

The Metro/Geo cluster system has visibility for both paths, local and remote. Dynamic Multi-Pathing (DMP) A/A array IO policy distributes IO evenly across both of these paths, local and remote. Also, Metro/Geo support serves IO through the local path if the remote paths have higher latency than `latency_threshold_difference`.

Tunable lets you manage the parameter values of `latency_threshold_difference`. The default value of the `latency_threshold_difference` of the tunable parameter is 200  $\mu$ s. The `latency_threshold_difference` tunable is valid only for the METRO type of array.

You can assign a new latency threshold difference value to a specified enclosure. Using tunable option you can increase or decrease the `latency_threshold_difference` value.

The following is the syntax for the tuning `latency_threshold_difference`:

```
# vxddmpadm getattr {enclosure enc-name}  
\ latency_threshold_difference
```

Use the following command `vxddmpadm getattr` that displays the `latency_threshold_difference` value that is set for an enclosure **emc0**:

```
# vxddmpadm getattr enclosure emc0 latency_threshold_difference
ENCLR_NAME  default  CURRENT
=====
emc0         200      200
```

To set new value, you can use the following syntax for the specified enclosure:

```
# vxddmpadm setattr enclosure <enclr-name>
{name=<value> | \ latency_threshold_difference=<value>}
```

The following example shows the `vxddmpadm setattr` command to set the `latency_threshold_difference` value that is set for an enclosure **emc0**:

```
# vxddmpadm setattr enclosure emc0 latency_threshold_difference=300
```

---

**Note:** The `latency_threshold_difference` is applicable for enclosure only.

---

DMP serves IO with local paths only if remote path has higher IO latency, then marks it as STANDBY.

```
#vxddmpadm getsubpaths dmpnodename=emc0_00d2
```

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

```
NAME STATE[A]  PATH-TYPE[M] CLTR-NAME ENCLR-TYPE ENCLR-NAME ATTRS  PRIORITY
=====
Sdar  ENABLED    -           c9         EMC         emc0       STANDBY  -
Sdbj  ENABLED(A) -           c9         EMC         emc0       -        -
Sdh   ENABLED(A) -           c9         EMC         emc0       -        -
Sdz   ENABLED    -           c9         EMC         emc0       STANDBY  -
```

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

# Administering disks

This chapter includes the following topics:

- [About disk management](#)
- [Discovering and configuring newly added disk devices](#)
- [VxVM coexistence with ZFS](#)
- [Changing the disk device naming scheme](#)
- [Discovering the association between enclosure-based disk names and OS-based disk names](#)

## About disk management

Dynamic Multi-Pathing (DMP) is used to administer multiported disk arrays.

See [“How DMP works”](#) on page 10.

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 106.

## Discovering and configuring newly added disk devices

The `vxdiskconfig` utility scans and configures new disk devices attached to the host, disk devices that become online, or Fibre Channel devices that are zoned to host bus adapters connected to this host. The command calls platform-specific interfaces to configure new disk devices and brings them under control of the operating system. It scans for disks that were added since DMP's configuration

daemon was last started. These disks are then dynamically configured and recognized by DMP.

`vxdiskconfig` should be used whenever disks are physically connected to the host or when Fibre Channel devices are zoned to the host.

`vxdiskconfig` calls `vxctl enable` to rebuild volume device node directories and update the Dynamic Multi-Pathing (DMP) internal database to reflect the new state of the system.

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:

```
# vxctl -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 `vxctl(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 above command discovers devices with the characteristic `DDI_NT_FABRIC` property set on them.

The following command scans for the devices `c1t1d0s2` and `c2t2d0s2`:

```
# vxdisk scandisks device=c1t1d0s2,c2t2d0s2
```

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=c1t1d0s2,c2t2d0s2
```

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=c1,c2
```

The next command discovers devices that are connected to the specified physical controller:

```
# vxdisk scandisks pctlr=/pci@1f,4000/scsi@3/
```

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](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 114.

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 114.

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` package. To determine if an updated `VRTSaslapm` package is available for download, refer to the hardware compatibility list (HCL). The hardware compatibility list provides a link to the latest package for download and instructions for installing the `VRTSaslapm` package. You can upgrade the `VRTSaslapm` package 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](https://www.veritas.com/content/support/en_US/doc/infoscale_hcl_8x_unix)

Each `VRTSaslapm` package is specific for the Dynamic Multi-Pathing version. Be sure to install the `VRTSaslapm` package 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` package is installed. If any of the disks in the new disk array are subsequently connected, and if `vxconfigd` is running, `vxconfigd` immediately invokes the DDL device discovery and includes the new disks in the VxVM device list.

If you need to remove the latest `VRTSaslapm` package, 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 `vxdtl 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:

```
# vxdtl enable
```

## 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 [“Changing device naming for enclosures controlled by third-party drivers”](#) on page 124.

See [“Displaying information about devices controlled by third-party drivers”](#) on page 68.

## 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 c2 (20:00:00:E0:8B:19:77:BE)
  Port c2_p0 (50:0A:09:80:85:84:9D:84)
    Target c2_p0_t0 (50:0A:09:81:85:84:9D:84)
      LUN c2t0d0s2
    . . .
HBA c3 (iqn.1986-03.com.sun:01:0003ba8ed1b5.45220f80)
  Port c3_p0 (10.216.130.10:3260)
    Target c3_p0_t0 (iqn.1992-08.com.netapp:sn.84188548)
      LUN c3t0d0s2
      LUN c3t0d1s2
    Target c3_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 4-1](#) shows the HBA information.

**Table 4-1** 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
-----
c2_p0    c2        Online   50:0A:09:80:85:84:9D:84
c3_p0    c3        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 4-2](#) shows the target information.

**Table 4-2**            Target information

Field	Description
Alias	The alias name, if available.
HBA-ID	Parent HBA or port.
State	Whether the device is Online or Offline.

**Table 4-2** Target information (*continued*)

Field	Description
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
-----
c2_p0_t0 - c2 Online 50:0A:09:80:85:84:9D:84
c3_p0_t1 - c3 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=c2
```

```
TARGET-ID ALIAS HBA-ID STATE ADDRESS
-----
c2_p0_t0 - c2 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 4-3](#) shows the device information.

**Table 4-3** Device information

Field	Description
Device	The device name.
Target-ID	The parent target.
State	Whether the device is Online or Offline.

**Table 4-3** Device information (*continued*)

Field	Description
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)
-----
c2t0d2s2   c2_p0_t0   Online    CLAIMED (libvxemc.so)
c3t1d2s2   c3_p0_t1   Online    SKIPPED (libvxemc.so)
c4t1d2s2   c4_p0_t1   Offline   ERROR
c4t1d2s2   c4_p0_t2   Online    EXCLUDED
c4t5d2s2   c4_p0_t5   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 4-4** 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

**Table 4-4** Parameters for iSCSI devices (*continued*)

Parameter	Default value	Minimum value	Maximum value
FirstBurstLength	65535	512	16777215
InitialR2T	yes	no	yes
ImmediateData	yes	no	yes
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=c2_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 10.

---

**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 `vxctl enable` command to bring the array under VxVM control.

```
# vxctl enable
```

See “Enabling discovery of new disk arrays” on page 105.

**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 (Cmd/PageCode/off/len)	CabinetNum (Cmd/PageCode/off/len)	Policy
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/rdisk
```

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 `vxctl 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.

## VxVM coexistence with ZFS

ZFS is a type of file system presenting a pooled storage model that is provided by Oracle for Solaris. File systems can directly draw from a common storage pool (zpool). Veritas Volume Manager (VxVM) can be used on the same system as ZFS disks.

VxVM protects devices in use by ZFS from any VxVM operations that may overwrite the disk. These operations include initializing the disk for use by VxVM or encapsulating the disk. If you attempt to perform one of these VxVM operations on a device that is in use by ZFS, VxVM displays an error message.

Before you can manage a ZFS disk with VxVM, you must remove it from ZFS control. Similarly, to begin managing a VxVM disk with ZFS, you must remove the disk from VxVM control.

### To determine if a disk is in use by ZFS

- ◆ Use the `vxdisk list` command:

```
# vxdisk list
DEVICE                TYPE           DISK  GROUP  STATUS
c1t0d0s2              auto:none     -    -    online invalid
c1t1d0s2              auto:none     -    -    online invalid
c2t5006016130603AE5d2s2 auto:ZFS      -    -    ZFS
c2t5006016130603AE5d3s2 auto:SVM      -    -    SVM
c2t5006016130603AE5d4s2 auto:cdsdisk  -    -    online
c2t5006016130603AE5d5s2 auto:cdsdisk  -    -    online
```

**To reuse a VxVM disk as a ZFS disk**

- 1 If the disk is in a disk group, remove the disk from the disk group or destroy the disk group.

To remove the disk from the disk group:

```
# vxdg [-g diskgroup] rmdisk diskname
```

To destroy the disk group:

```
# vxdg destroy diskgroup
```

- 2 Remove the disk from VxVM control

```
# /usr/lib/vxvm/bin/vxdiskunsetup diskname
```

- 3 You can now initialize the disk as a ZFS device using ZFS tools.

See the Oracle documentation for details.

You must perform step 1 and step 2 in order for VxVM to recognize a disk as ZFS device.

**To reuse a ZFS disk as a VxVM disk**

- 1 Remove the disk from the zpool, or destroy the zpool.

See the Oracle documentation for details.

- 2 Clear the signature block using the `dd` command:

```
# dd if=/dev/zero of=/dev/rdisk/c##t##s## oseek=16 bs=512 count=1
```

Where `c##t##s##` is the disk slice on which the ZFS device is configured. If the whole disk is used as the ZFS device, clear the signature block on slice 0.

- 3 You can now initialize the disk as a VxVM device using the `vxdiskadm` command or the `vxdisksetup` command.

## 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`.

---

**Note:** Devices with very long device names (longer than 31 characters) are represented by enclosure-based names regardless of the naming scheme. If the OS-based names include WWN identifiers, the device name displays with the WWN identifier as long as the device name is less than 31 characters. If any device name is longer than 31 characters, that device name displays with an enclosure name.

---

### To change the disk-naming scheme

- ◆ Select `Change the disk naming scheme` from the `vxddiskadm` 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 123.

## 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 20.

## 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 122.

### 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 `vxddmpadm` command to switch between these names and the device names that are known to the operating system:

```
# vxddmpadm 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.

```
# vxddisk list
```

DEVICE	TYPE	DISK	GROUP	STATUS
emcpower10s2	auto:sliced	disk1	mydg	online
emcpower11s2	auto:sliced	disk2	mydg	online
emcpower12s2	auto:sliced	disk3	mydg	online
emcpower13s2	auto:sliced	disk4	mydg	online
emcpower14s2	auto:sliced	disk5	mydg	online
emcpower15s2	auto:sliced	disk6	mydg	online
emcpower16s2	auto:sliced	disk7	mydg	online
emcpower17s2	auto:sliced	disk8	mydg	online
emcpower18s2	auto:sliced	disk9	mydg	online
emcpower19s2	auto:sliced	disk10	mydg	online

```
# vxddmpadm setattr enclosure EMC0 tpdmode=native
```

```
# vxddmpadm setattr enclosure pp_emc_clariion0 tpdmode=native
```

```
# vxddisk list
```

DEVICE	TYPE	DISK	GROUP	STATUS
c6t0d10s2	auto:sliced	disk1	mydg	online
c6t0d11s2	auto:sliced	disk2	mydg	online
c6t0d12s2	auto:sliced	disk3	mydg	online
c6t0d13s2	auto:sliced	disk4	mydg	online
c6t0d14s2	auto:sliced	disk5	mydg	online
c6t0d15s2	auto:sliced	disk6	mydg	online
c6t0d16s2	auto:sliced	disk7	mydg	online
c6t0d17s2	auto:sliced	disk8	mydg	online
c6t0d18s2	auto:sliced	disk9	mydg	online
c6t0d19s2	auto:sliced	disk10	mydg	online

If `tpdmode` is set to `native`, the path with the smallest device number is displayed.

## Simple or nopriv disks with enclosure-based naming

If you change from operating system-based naming to enclosure-based naming, simple or nopriv disks may be put in the `error` state and cause Veritas Volume Manager (VxVM) objects on those disks to fail.

You can use the `vxrestore` command to handle simple and nopriv disk failures that arise from changing to the enclosure-based naming scheme. You do not need to use this command if your system does not have any simple or nopriv disks, or if the devices on which any simple or nopriv disks are present are not automatically configured by VxVM (for example, non-standard disk devices such as ramdisks).

---

**Note:** You cannot run `vxrestore` if operating system-based naming is in use. Additionally, `vxrestore` does not handle failures on simple or nopriv disks that are caused by renaming enclosures, by hardware reconfiguration that changes device names, or by changing the naming scheme on a system that includes persistent sliced disk records.

---

See [“Removing the error state for simple or nopriv disks in the boot disk group”](#) on page 126.

See [“Removing the error state for simple or nopriv disks in non-boot disk groups”](#) on page 126.

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

## Removing the error state for simple or nopriv disks in the boot disk group

If the boot disk group (usually aliased as `bootdg`) is comprised of only simple and/or nopriv disks, the `vxconfigd` daemon goes into the disabled state after the naming scheme change.

### To remove the error state for simple or nopriv disks in the boot disk group

- 1 Use `vxdiskadm` to change back to operating system-based (`c##t#d##s#`) naming.
- 2 Enter the following command to restart the Veritas Volume Manager (VxVM) configuration daemon:

```
# vxconfigd -kr reset
```

- 3 If you want to use enclosure-based naming, use `vxdiskadm` to add a sliced disk to the `bootdg` disk group, change back to the enclosure-based naming scheme, and then run the following command:

```
# vxdarestore
```

## Removing the error state for simple or nopriv disks in non-boot disk groups

If an imported disk group, other than `bootdg`, is comprised of only simple and/or nopriv disks, the disk group is in the `online dgdisabled` state after the change to the enclosure-based naming scheme.

### To remove the error state for simple or nopriv disks in non-boot disk groups

- 1 Deport the disk group using the following command:

```
# vxdg deport diskgroup
```

- 2 Use the `vxdarestore` command to restore the failed disks, and to recover the objects on those disks:

```
# vxdarestore
```

- 3 Re-import the disk group using the following command:

```
# vxdg import diskgroup
```

# 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 `ENCO_21`, the appropriate commands would be:

```
# vxdisk list ENCO_21  
# vxdmpadm getsubpaths dmpnodename=ENCO_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/`.

# Dynamic Reconfiguration of devices

This chapter includes the following topics:

- [About online Dynamic Reconfiguration](#)
- [About the DMPDR utility](#)
- [Reconfiguring a LUN online that is under DMP control using the Dynamic Reconfiguration tool](#)
- [Manually reconfiguring a LUN online that is under DMP control](#)
- [Changing the characteristics of a LUN from the array side](#)
- [Upgrading the array controller firmware online](#)

## 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 5-1](#) lists the kinds of online dynamic reconfigurations that you can perform:

Table 5-1

Task	Topic
Reconfigure a LUN online that is under DMP control	<ul style="list-style-type: none"> <li>DR tool—See <a href="#">“Reconfiguring a LUN online that is under DMP control using the Dynamic Reconfiguration tool”</a> on page 131.</li> <li>Manual—See <a href="#">“Manually reconfiguring a LUN online that is under DMP control”</a> on page 137.</li> </ul>
Replace a host bus adapter (HBA) online	<ul style="list-style-type: none"> <li>DR tool—See <a href="#">“Replacing a host bus adapter online”</a> on page 136.</li> <li>Manual—See <a href="#">“Manually replacing a host bus adapter on an M5000 server”</a> on page 147.</li> </ul>
Update the array controller firmware, also known as a nondisruptive upgrade	<ul style="list-style-type: none"> <li>See <a href="#">“Upgrading the array controller firmware online”</a> on page 152.</li> </ul>

## About the DMPDR utility

Adding and removing storage logical unit number (LUNs) on a server is a complex process that involves a series of steps that must be performed in the correct order. Any incorrect step can lead to errors and may require a system restart to recover from that error.

InfoScale provides the Dynamic Multipathing Dynamic Reconfiguration (DMPDR) utility that automates the LUN reconfiguration process. DMPDR provides a non-interactive interface that lets you perform the steps in the correct sequence thereby reducing human error and a need for manual intervention.

DMPDR performs the following tasks:

- Runs the correct sequence of steps to detect any newly added and removed LUNs.
- Updates the underlying OS device handles for the DMP-managed devices and refreshes the VxVM and the DMP structures.
- Creates a log file under `/var/adm/vx/` for each LUN reconfiguration event.

### Considerations for using DMPDR

- The DMPDR utility works only with InfoScale Dynamic Multipathing. Any third-party device drivers (such as MPxIO and EMC PowerPath) are not supported and do not work with the DMPDR interface.

- You must run separate instances or sessions of the DMPDR utility when you physically add or remove LUNs. Do not perform add and remove LUN operations in the same session as it may cause issues with the I/O stack.

## Accessing the DMPDR utility

The DMPDR utility is located at `/usr/lib/vxvm/voladm.d/bin/dmpdr`. After you install InfoScale, a soft link to the utility is created at `/opt/VRTS/bin` for easy access.

Run the DMPDR utility before and after any add or remove LUN operations to ensure that the correct sequence of commands is performed.

Type the following command to run the DMPDR utility:

```
# /usr/lib/vxvm/voladm.d/bin/dmpdr - o refresh
```

## Using the DMPDR utility to reconfigure the LUNs associated with a server

The following procedure describes how to use DMPDR to reconfigure LUNs on a server after they are added or removed from the underlying storage layer.

### Reconfiguring LUN removal

**Perform the following steps:**

- 1 Inform Volume Manager (VxVM) about a change in the disk access name before you remove any LUNs.

Type the following command:

```
# vxdisk rm diskdevicename
```

- 2 Remove the LUNs from the storage array.
- 3 Run the DMPDR utility.

Type the following command:

```
# /usr/lib/vxvm/voladm.d/bin/dmpdr -o refresh
```

The command output displays the progress of the entire process. After the process completes successfully, you can proceed to add or reconfigure new LUNs.

**Reconfiguring a LUN online that is under DMP control using the Dynamic Reconfiguration tool**


---

**Note:** The SCSI Peripheral Qualifier/Device Type (PQ) attribute reports a non-zero value for LUNs that have been removed intentionally from the storage layer.

For example, here's an inquiry for a device named emc0\_00aa:

```
# /etc/vx/diag.d/vxscsiinq -d /dev/vx/dmp/emc0_00aa | head -3
```

The inquiry command output shows the following:

```
Inquiry for /dev/vx/dmp/emc0_00aa, evpd 0x0, page code 0x0 Peripheral
Qualifier/Device Type : 3f
```

The DMPDR tool automatically deletes only the stale OS device handles that show a non-zero value for the Peripheral Qualifier/Device Type (PQ) attribute.

---

## Reconfiguring LUN addition

**Perform the following steps:**

- 1 Add the LUNs from the storage array.
- 2 Run the DMPDR utility.

Type the following command:

```
# /usr/lib/vxvm/voladm.d/bin/dmpdr -o refresh
```

The command output displays the progress of the entire process. The DMPDR utility creates a log file at `/var/adm/vx/` for each LUN reconfiguration operation.

# 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 5-2**

Task	Topic
Removing LUNs dynamically from an existing target ID	See <a href="#">“Removing LUNs dynamically from an existing target ID”</a> on page 132.
Adding LUNs dynamically to a new target ID	See <a href="#">“Adding new LUNs dynamically to a target ID”</a> on page 134.
Replacing a LUN on an existing target ID	See <a href="#">“Replacing LUNs dynamically from an existing target ID”</a> on page 135.

**Table 5-2** (continued)

Task	Topic
Changing the LUN characteristics	See <a href="#">“Changing the characteristics of a LUN from the array side”</a> on page 151.

## Removing LUNs dynamically from an existing target ID

Dynamic Multipathing (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 that are in use by ZFS, export the zpool.

- 2 Start the `vxdiskadm` utility:

```
# vxdiskadm
```

- 3 Select the **Dynamic Reconfiguration operations** option from the `vxdiskadm` menu.
- 4 Select the **Remove LUNs** option.

**Reconfiguring a LUN online that is under DMP control using the Dynamic Reconfiguration tool**

- 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_017e
```

- 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_017e`.

- 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 or the target.

```
Enclosure=emc0 AVID=017E
Device=emc0_017e Serial=830017E000
-----
PATH=c15t0d6 ctlr=c15 port=7e-a [50:01:43:80:12:08:3c:26]
PATH=c17t0d6 ctlr=c17 port=7e-a [50:01:43:80:12:08:3a:76]
-----
Please remove LUNs with above details from array and
press 'y' to continue removal (default:y):
```

- 9** Return to the Dynamic Reconfiguration tool and select `y` to continue the removal process.

DMP completes the removal of the device from VxVM usage. Output similar to the following is displayed:

```
Luns Removed
-----
emc0_017e
```

DMP updates the operating system device tree and the VxVM device tree.

- 10** The following are sample EMC Symmetrix commands:

**Reconfiguring a LUN online that is under DMP control using the Dynamic Reconfiguration tool**

- 11** DMP completes the removal of the device from VxVM usage. Output similar to the following is displayed:
- 12** 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** Select the **Add LUNs** option.
- 4** The following are sample EMC Symmetrix commands:

**Reconfiguring a LUN online that is under DMP control using the Dynamic Reconfiguration tool**

- 5** When the prompt displays, add the LUNs from the array.

Output similar to the following is displayed:

- 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=017E
Device=emc0_017e Serial=830017E000
PATH=c15t0d6 ctrlr=c15 port=7e-a [50:01:43:80:12:08:3c:26]
PATH=c17t0d6 ctrlr=c17 port=7e-a [50:01:43:80:12:08:3a:76]
```

- 7** Select a label to add to the disk.

- 8** 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
```

## Replacing LUNs dynamically from an existing target ID

Dynamic Multipathing (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.

**Reconfiguring a LUN online that is under DMP control using the Dynamic Reconfiguration tool**


---

**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 that are in use by ZFS, export the zpool.

- 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 or the 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 or the 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:

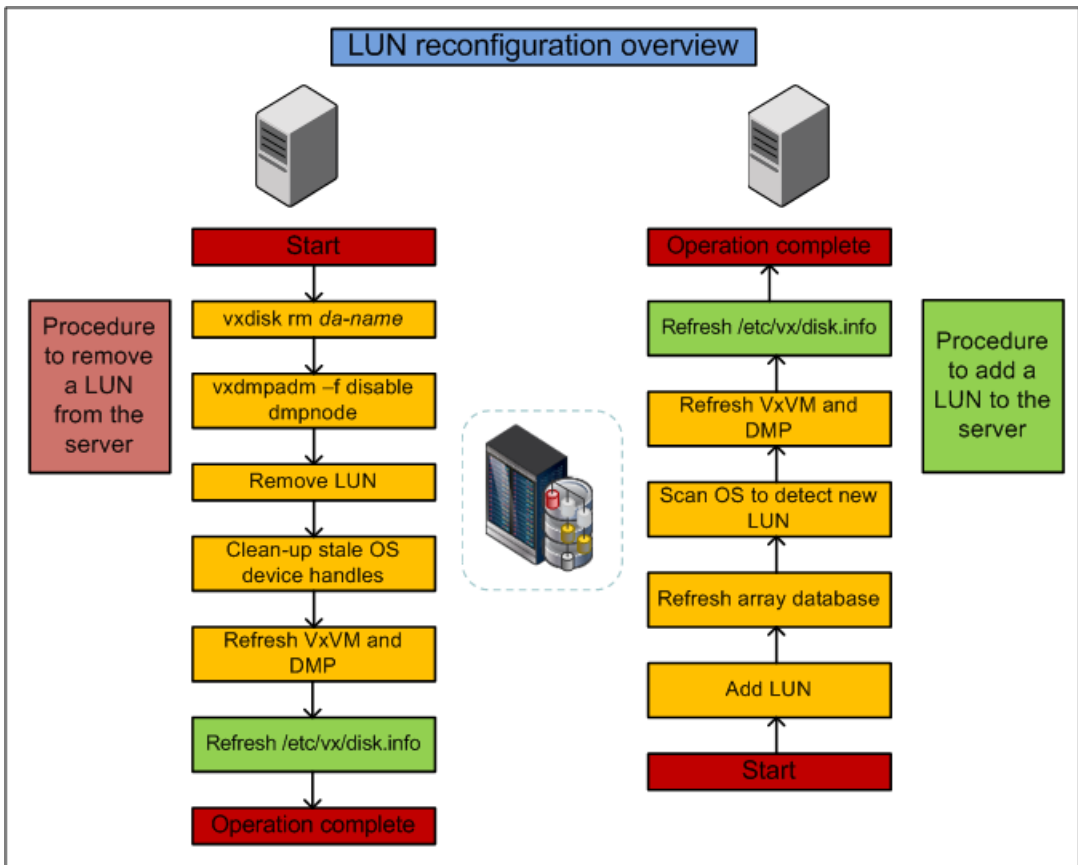
**Table 5-3**

| Task                                                             | Topic                                                                                                        |
|------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------|
| Removing LUN dynamically from an existing target ID              | See <a href="#">“Manually removing LUNs dynamically from an existing target ID”</a> on page 140.             |
| Cleaning up the operating system device tree after removing LUNs | See <a href="#">“Manually cleaning up the operating system device tree after removing LUNs”</a> on page 145. |

**Table 5-3** (continued)

| Task                                                                   | Topic                                                                                                     |
|------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------|
| Scanning an operating system device tree after adding or removing LUNs | See <a href="#">“Scanning an operating system device tree after adding or removing LUNs”</a> on page 145. |
| Adding LUN dynamically to a new target ID                              | See <a href="#">“Manually adding new LUNs dynamically to a new target ID”</a> on page 143.                |
| Changing the LUN characteristics                                       | See <a href="#">“Changing the characteristics of a LUN from the array side”</a> on page 151.              |

**Figure 5-1** LUN reconfiguration overview



## Prechecks

Perform the following prechecks before manually reconfiguring a LUN:

**Table 5-4** Prechecks

| Task                                          | Command                                        |
|-----------------------------------------------|------------------------------------------------|
| Check the <code>/etc/vx/disk.info</code> file | <code># grep "0xffff" /etc/vx/disk.info</code> |
| Check leadville stack                         | <code># cfgadm -alo show_FCP_dev</code>        |
| Clean-up OS device handles                    | <code># devfsadm -Cvc disk</code>              |
| Refresh VxVM and DMP                          | <code># vxdisk scandisks</code>                |
| Refresh DDL layer/dev_t (device number) list  | <code># vxddladm assign names</code>           |

**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 5-5** LUN removal steps

| Task                                                                             | Validation                                                                                                       |
|----------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------|
| Unmount file system (s)                                                          | Confirm whether the disk has been removed from the disk group.                                                   |
| Close the VxVM device:<br><code># vxdisk rm da-name</code>                       | Confirm whether the VxVM device has been closed:<br><code># vxdisk list</code>                                   |
| Disable DMP paths:<br><code># vxdmpadm -f disable<br/>dmpnodename=da-name</code> | Confirm whether the DMP paths have been disabled:<br><code># vxdmpadm getsubpaths<br/>dmpnodename=da-name</code> |
| Mask LUN from the server                                                         | Confirm whether the LUN has been removed at the array level.                                                     |

**Table 5-5** LUN removal steps (*continued*)

| Task                                                                                              | Validation                                                                                                                                       |
|---------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------|
| Unconfigure cfgadm access paths:<br><pre># cfgadm -o unusable_FCP_dev -c unconfigure c#:wwn</pre> | Confirm whether the cfgadm access paths have been deleted:<br><pre># cfgadm -alo show_FCP_dev</pre> Or<br><pre># cfgadm -alo show_SCSI_LUN</pre> |
| Refresh VxVM and DMP:<br><pre># vxdisk scandisks</pre>                                            |                                                                                                                                                  |
| Delete OS device handles:<br><pre># devfsadm -Cvc disk</pre>                                      |                                                                                                                                                  |
| Refresh DDL layer/dev_t (device number) list:<br><pre># vxddladm assign names</pre>               |                                                                                                                                                  |

## 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. However, the operating system commands may vary depending on the Solaris version. For example, the following procedure uses Solaris 11 with the Leadville stack.

**To remove LUNs dynamically from an existing target ID**

- 1 Before any dynamic reconfiguration, ensure that the `dmp_cache_open` tunable is set to `on`. This setting is the default.

```
# vxddmpadm gettune dmp_cache_open
```

If the tunable is set to `off`, set the `dmp_cache_open` tunable to `on`.

```
# vxddmpadm settune dmp_cache_open=on
```

- 2 Identify which LUNs to remove from the host. Do one of the following:
  - Use the 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 a disk group, remove the LUNs from the disk group using the following command. 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 that are in use by ZFS, either export or destroy the zpool.
  - 5 Using the AVID or the LUN index, use the 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 step is required. If you do not perform this step, the DMP device tree shows ghost paths.

- 7 Clean up the Solaris 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 145.

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 145.

- 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?  
Verify that the operating system metanodes are removed from the `/dev` directory.
- 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. However, the operating system commands may vary depending on the Solaris version. For example, the following procedure uses Solaris 11 with the Leadville stack.

### 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.

```
# vxddmpadm gettune dmp_cache_open
```

If the tunable is set to `off`, set the `dmp_cache_open` tunable to `on`.

```
# vxddmpadm settune dmp_cache_open=on
```

- 2 If DMP co-exists with EMC PowerPath, make sure the `dmp_monitor_osevent` parameter is set to `off`. The `vxesd` daemon will not monitor operating system events.

If you install DMP on a system that already has PowerPath installed, DMP sets the `dmp_monitor_osevent` to `off` by default.

```
# vxddmpadm gettune dmp_monitor_osevent
```

If required, turn off the `dmp_monitor_osevent` parameter explicitly:

```
# vxddmpadm settune dmp_monitor_osevent=off
```

- 3 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.
- 4 Map/mask the LUNs to the new target IDs on multiple hosts.
- 5 Scan the operating system device.

See [“Scanning an operating system device tree after adding or removing LUNs”](#) on page 145.

Repeat step 3 and step 4 until you see that all the LUNs have been added.

- 6 Use DMP to perform a device scan. You must perform this operation on all nodes in a cluster. Enter one of the following commands:
  - # `vxctl enable`
  - # `vxdisk scandisks`
- 7 Refresh the DMP device name database using the following command:
  - # `vxddladm assign names`
- 8 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 3 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 ZFS.

## About detecting target ID reuse if the operating system device tree is not cleaned up

If you try to reprovision a LUN or set of LUNs whose previously-valid operating system device entries are not cleaned up, the following messages are displayed. Also, DMP reconfiguration during the DMP device scan and DMP reconfiguration are temporarily inhibited.

See [“Manually cleaning up the operating system device tree after removing LUNs”](#) on page 145.

```
VxVM vxdisk ERROR V-5-1-14519 Data Corruption Protection Activated
- User Corrective Action Needed
```

```
VxVM vxdisk INFO V-5-1-14521 To recover, first ensure that the OS
device tree is up to date (requires OS specific commands).
```

```
VxVM vxdisk INFO V-5-1-14520 Then, execute 'vxdisk rm' on the
following devices before reinitiating device discovery. <DA names>
```

The message above indicates that a new LUN is trying to reuse the target ID of an older LUN. The device entries have not been cleaned, so the new LUN cannot use the target ID. Until the operating system device tree is cleaned up, DMP prevents this operation.

## 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.

The operating system commands may vary, depending on the Solaris version. The following procedure uses Solaris 11 with the Leadville stack.

### Adding

#### To scan an operating system device tree after adding or removing LUNs

- 1 Enter the following command:

```
# cfgadm -alo show_FCP_dev
```

Or

```
# cfgadm -alo show_SCSI_LUN
```

- 2 To configure new devices not detected by the previous command:

```
# cfgadm -c configure c#
```

- 3 To configure the OS device handles for the newly presented devices, enter:

```
# devfsadm -vc disk
```

### Removing

#### To remove `cfgadm` access paths for paths intentionally removed at the storage layer, the state must be reported as unusable:

- 1 Enter the following command:

```
# cfgadm -o unusable_FCP_Dev -c unconfigure c#:wwn
```

- 2 To delete the OS device handles for the intentionally removed paths:

```
# devfsadm -Cvc disk
```

## Manually cleaning up the operating system device tree after removing LUNs

After you remove LUNs, you must clean up the operating system device tree.

The operating system commands may vary, depending on the Solaris version. The following procedure uses Solaris 11 with the Leadville stack. If any of these steps do not produce the desired result, contact Oracle support.

### To clean up the operating system device tree after removing LUNs

- 1 Run the `format` command. In the command output, a device that has been removed includes the text `<drive not available>`.

```
413. c3t5006048ACAFE4A7Cd252 <drive not available>
/pci@1d,700000/SUNW,qlc@1,1/fp@0,0/ssd@w5006048acafe4a7c,fc
```

- 2 Use Storage Array Management or the command line to unmap the LUNs. After they are unmapped, Solaris indicates the devices are either `unusable` or `failing`.

```
# cfgadm -al -o show_SCSI_LUN | grep -i unusable
c2::5006048acafe4a73,256 disk connected configured unusable
c3::5006048acafe4a7c,255 disk connected configured unusable
# cfgadm -al -o show_SCSI_LUN | grep -i failing
c2::5006048acafe4a73,71 disk connected configured failing
c3::5006048acafe4a7c,252 disk connected configured failing
```

See [“Manually reconfiguring a LUN online that is under DMP control”](#) on page 137.

- 3 If the output indicates the LUNs are `failing`, you must force an LIP on the HBA.

```
# luxadm -e forcelip /devices/pci@1d,700000/SUNW,qlc@1,1/fp
@0,0:devctl
```

This operation probes the targets again, so that output indicates the devices are `unusable`. To remove a device from the operating system device tree, it must be `unusable`.

- 4 Remove the device from the `cfgadm` database. On the HBA, enter the following commands:

```
# cfgadm -c unconfigure -o unusable_SCSI_LUN c2::5006048acafe4a73
# cfgadm -c unconfigure -o unusable_SCSI_LUN c3::5006048acafe4a7c
```

- 5 To verify that the LUNs have been removed, repeat step 2.
- 6 Clean up the device tree. The following command removes the `/dev/dsk` links to `/devices`.

```
# devfsadm -Cv
```

## Manually replacing a host bus adapter on an M5000 server

This section contains the procedure to replace an online host bus adapter (HBA) when DMP is managing multi-pathing in a Cluster File System (CFS) cluster. The HBA World Wide Port Name (WWPN) changes when the HBA is replaced. Following are the prerequisites to replace an online host bus adapter:

- A single node or two or more node CFS or RAC cluster.
- I/O running on CFS file system.
- An M5000 server with at least two HBAs in separate PCIe slots and recommended Solaris patch level for HBA replacement.

**To replace an online host bus adapter on an M5000 server**

- 1 Identify the HBAs on the M5000 server. For example, to identify Emulex HBAs, enter the following command:

```
/usr/platform/sun4u/sbin/prtdiag -v | grep emlx  
00 PCIe 0 2, fc20, 10df 119, 0, 0 okay 4,  
4 SUNW,emlxs-pci10df,fc20 LPe 11002-S  
/pci@0,600000/pci@0/pci@9/SUNW,emlxs@0  
00 PCIe 0 2, fc20, 10df 119, 0, 1 okay 4,  
4 SUNW,emlxs-pci10df,fc20 LPe 11002-S  
/pci@0,600000/pci@0/pci@9/SUNW,emlxs@0,1  
00 PCIe 3 2, fc20, 10df 2, 0, 0 okay 4,  
4 SUNW,emlxs-pci10df,fc20 LPe 11002-S  
/pci@3,700000/SUNW,emlxs@0  
00 PCIe 3 2, fc20, 10df 2, 0, 1 okay 4,  
4 SUNW,emlxs-pci10df,fc20 LPe 11002-S  
/pci@3,700000/SUNW,emlxs@0,1
```

- 2 Identify the HBA and its WWPN(s), which you want to replace using the `cfgadm` command.

To identify the HBA, enter the following:

```
# cfgadm -al | grep -i fibre
iou#0-pci#1 fibre/hp connected configured ok
iou#0-pci#4 fibre/hp connected configured ok
```

To list all HBAs, enter the following:

```
# luxadm -e port
/devices/pci@0,600000/pci@0/pci@9/SUNW,emlxs@0/fp@0,0:devctl
NOT CONNECTED
/devices/pci@0,600000/pci@0/pci@9/SUNW,emlxs@0,1/fp@0,0:devctl
CONNECTED
/devices/pci@3,700000/SUNW,emlxs@0/fp@0,0:devctl
NOT CONNECTED
/devices/pci@3,700000/SUNW,emlxs@0,1/fp@0,0:devctl
CONNECTED
```

To select the HBA to dump the portap and get the WWPN, enter the following:

```
# luxadm -e dump_map /devices/pci@0,600000/pci@0/pci@9/SUNW,emlxs@0,1/
  fp@0,0:devctl
0      304700  0          203600a0b84790c 200600a0b84790c 0x0
(Disk device)
1      30a800  0          20220002ac00065f 2ff70002ac00065f 0x0
(Disk device)
2      30a900  0          21220002ac00065f 2ff70002ac00065f 0x0
(Disk device)
3      560500  0          10000000c97c3c2f 20000000c97c3c2f 0x1f
(Unknown Type)
4      560700  0          10000000c97c9557 20000000c97c9557 0x1f
(Unknown Type)
5      560b00  0          10000000c97c34b5 20000000c97c34b5 0x1f
(Unknown Type)
6      560900  0          10000000c973149f 20000000c973149f 0x1f
(Unknown Type,Host Bus Adapter)
```

Alternately, you can run the `fcinfo hba-port` Solaris command to get the WWPN(s) for the HBA ports.

- 3 Ensure you have a compatible spare HBA for hot-swap.

- 4 Stop the I/O operations on the HBA port(s) and disable the DMP subpath(s) for the HBA that you want to replace.

```
# vxddmpadm disable ctrl=ctrl#
```

- 5 Dynamically unconfigure the HBA in the PCIe slot using the `cfgadm` command.

```
# cfgadm -c unconfigure iou#0-pci#1
```

Look for console messages to check if the `cfgadm` command is unsuccessful. If the `cfgadm` command is unsuccessful, proceed to troubleshooting using the server hardware documentation. Check the Solaris 11 patch level recommended for dynamic reconfiguration operations and contact SUN support for further assistance.

```
console messages
```

```
Oct 24 16:21:44 m5000sb0 pcihp: NOTICE: pcihp (pxb_plx2):  
card is removed from the slot iou 0-pci 1
```

- 6 Verify that the HBA card that is being replaced in step 5 is not in the configuration. Enter the following command:

```
# cfgadm -al | grep -i fibre
```

```
iou 0-pci 4 fibre/hp connected configured ok
```

- 7 Mark the fiber cable(s).

- 8 Remove the fiber cable(s) and the HBA that you must replace.

For more information, see the HBA replacement procedures in *SPARC Enterprise M4000/M5000/M8000/M9000 Servers Dynamic Reconfiguration (DR) User's Guide*.

- 9 Replace the HBA with a new compatible HBA of similar type in the same slot. The reinserted card shows up as follows:

```
console messages
```

```
iou 0-pci 1 unknown disconnected unconfigured unknown
```

- 10 Bring the replaced HBA back into the configuration. Enter the following:

```
# cfgadm -c configure iou 0-pci 1
```

```
console messages
```

```
Oct 24 16:21:57 m5000sb0 pcihp: NOTICE: pcihp (pxb_plx2):  
card is inserted in the slot iou#0-pci#1 (pci dev 0)
```

- 11 Verify that the reinserted HBA is in the configuration. Enter the following:

```
# cfgadm -al | grep -i fibre
iou#0-pci 1 fibre/hp connected configured ok <====
iou#0-pci 4 fibre/hp connected configured ok
```

- 12 Modify fabric zoning to include the replaced HBA WWPN(s).
- 13 Enable LUN security on storage for the new WWPN(s).
- 14 Perform an operating system device scan to re-discover the LUNs. Enter the following:

```
# cfgadm -c configure c3
```

- 15 Clean up the device tree for old LUNs. Enter the following:

```
# devfsadm -Cv
```

---

**Note:** Sometimes replacing an HBA creates new devices. Perform cleanup operations for the LUN only when new devices are created.

---

- 16 If DMP does not show a ghost path for the removed HBA path, enable the path using the `vxdmpadm` command. This performs the device scan for that particular HBA subpath(s). Enter the following:

```
# vxdmpadm enable ctrl=ctrl#
```

- 17 Verify if I/O operations are scheduled on that path. If I/O operations are running correctly on all paths, the dynamic HBA replacement operation is complete.

## 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 that you first take the device offline, change the LUN properties, and then bring back the device online again.

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 that are in use by ZFS, remove the device from the zpool or export the zpool.
- 2 Change the LUN characteristics.
- 3 Bring the device online.  
For a Veritas Volume Manager disk:  
For a ZFS device, add the device back into the zpool or import the zpool.
- 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:

```
# vxddmpadm 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).

# Event monitoring

This chapter includes the following topics:

- [About the Dynamic Multi-Pathing \(DMP\) event source daemon \(vxesd\)](#)
- [Fabric Monitoring and proactive error detection](#)
- [Dynamic Multi-Pathing \(DMP\) automated device discovery](#)
- [Dynamic Multi-Pathing \(DMP\) discovery of iSCSI and SAN Fibre Channel topology](#)
- [DMP event logging](#)
- [Starting and stopping the Dynamic Multi-Pathing \(DMP\) event source daemon](#)

## 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 155.
- Logging of DMP events for troubleshooting (DMP event)  
See [“DMP event logging”](#) on page 157.
- Automated device discovery (OS event)
- 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 157.

See [“Starting and stopping the Dynamic Multi-Pathing \(DMP\) event source daemon”](#) on page 158.

## 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 enabled 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:

```
# vxddmpadm gettune dmp_monitor_fabric
```

To disable the Fabric Monitoring functionality, use the following command:

```
# vxddmpadm settune dmp_monitor_fabric=off
```

To enable the Fabric Monitoring functionality, use the following command:

```
# vxddmpadm settune dmp_monitor_fabric=on
```

## Dynamic Multi-Pathing (DMP) automated device discovery

In releases before Veritas Volume Manager (VxVM) 4.0, VxVM device discovery required manual invocation of commands such as `vxdisk scandisks` or `vxctl enable.vxesd` automates the discovery process by interfacing with the Reconfiguration Coordination Manager (RCM) framework.

The `vxesd` daemon registers the script `es_devfs.pl` with the Solaris `syseventd` daemon for device arrival events. In the event that `cfgadm` is invoked to attach a new device to the system, the `syseventd` daemon executes the scripts that are registered for device arrival events, including `es_devfs.pl`. The `es_devfs.pl` script establishes a socket with `vxesd` and transfers the event parameter (physical path of device) to the daemon. The `vxesd` daemon in turn connects to the `vxconfigd` daemon to initiate device discovery with the Device Discovery Layer (DDL) for the device that had arrived. The whole operation takes place asynchronously so that the `cfgadm` command returns after the event has been added to the `syseventd` queue.

In the event that a device is removed with `cfgadm`, a similar process exists that uses the `es_rcm.pl` script to disable the relevant DMP paths. The removal operation is synchronous so that the `cfgadm` command waits until all the registered detach scripts have completed execution.

---

**Note:** On systems with EMC PowerPath, a slow PowerPath discovery process may lead to a device being automatically claimed and controlled by DMP control. In such scenarios, the `vxesd` daemon may be stopped before the addition of the disk and restart after PowerPath has claimed control of the device.

---

# 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. On Solaris, the `vxesd` daemon uses the iSCSI management API (IMA) to build the 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 154.

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
```

# Performance monitoring and tuning

This chapter includes the following topics:

- [About tuning Dynamic Multi-Pathing \(DMP\) with templates](#)
- [DMP tuning templates](#)
- [Example DMP tuning template](#)
- [Tuning a DMP host with a configuration attribute template](#)
- [Managing the DMP configuration files](#)
- [Resetting the DMP tunable parameters and attributes to the default values](#)
- [DMP tunable parameters and attributes that are supported for templates](#)
- [DMP tunable parameters](#)

## 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	<p>Use if particular arrays need customization; that is, if the tunables vary from those applied for the array type.</p> <p>Attributes in this section are applied to all of the enclosures of the specified array name.</p>
Enclosurename	<p>Applied to the enclosures of the specified Cab serial number and array name.</p> <p>Use if particular enclosures need customization; that is, if the tunables vary from those applied for the array type and array name.</p>

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_CLARiON
    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_CLARiON
    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**

```
◆ # vxddmpadm 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:

```
# vxddmpadm 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 167.

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 7-1](#) shows the DMP parameters that can be tuned. You can set a tunable parameter online, without a reboot.

**Table 7-1** DMP parameters that are tunable

Parameter	Description
<code>dmp_cache_open</code>	If this parameter is set to <code>on</code> , 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 <code>off</code> , caching is not performed.  The default value is <code>on</code> .
<code>dmp_daemon_count</code>	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.
<code>dmp_delayq_interval</code>	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 7-1** DMP parameters that are tunable (*continued*)

Parameter	Description
<code>dmp_display_alua_states</code>	<p>For ALUA arrays, this tunable displays the asymmetric access state instead of PRIMARY or SECONDARY state in the PATH-TYPE[M] column.</p> <p>The asymmetric access state can be:</p> <ul style="list-style-type: none"> <li>■ Active/Optimized</li> <li>■ Active/Non-optimized</li> <li>■ Standby</li> <li>■ Unavailable</li> <li>■ TransitionInProgress</li> <li>■ Offline</li> </ul> <p>The default tunable value is <code>on</code>.</p>
<code>dmp_fast_recovery</code>	<p>Whether DMP should try to obtain SCSI error information directly from the HBA interface. Setting the value to <code>on</code> can potentially provide faster error recovery, if the HBA interface supports the error enquiry feature. If this parameter is set to <code>off</code>, the HBA interface is not used.</p> <p>The default setting is <code>on</code>.</p>
<code>dmp_health_time</code>	<p>DMP detects intermittently failing paths, and prevents I/O requests from being sent on them. The value of <code>dmp_health_time</code> 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 <code>dmp_path_age</code> seconds elapse.</p> <p>The default value is 60 seconds.</p> <p>A value of 0 prevents DMP from detecting intermittently failing paths.</p>

**Table 7-1** DMP parameters that are tunable (*continued*)

Parameter	Description
<code>dmp_log_level</code>	<p>The level of detail that is displayed for DMP console messages. The following level values are defined:</p> <ul style="list-style-type: none"><li>1 — Displays all DMP log messages that are critical.</li><li>2 — Displays level 1 messages plus messages that relate to path or disk addition or removal, SCSI errors, IO errors and DMP node migration.</li><li>3 — Displays level 1 and 2 messages plus messages that relate to path throttling, suspect path, idle path and insane path logic.</li><li>4 — Displays level 1, 2 and 3 messages plus messages that relate to setting or changing attributes on a path and tunable related changes.</li><li>5 or higher — Displays level 1, 2, 3 and 4 messages plus more verbose messages.</li></ul> <p>The default value is 1.</p>
<code>dmp_low_impact_probe</code>	<p>Determines if the path probing by restore daemon is optimized or not. Set it to <code>on</code> to enable optimization and <code>off</code> to disable. Path probing is optimized only when restore policy is <code>check_disabled</code> or during <code>check_disabled</code> phase of <code>check_periodic</code> policy.</p> <p>The default value is <code>on</code>.</p>

**Table 7-1** DMP parameters that are tunable (*continued*)

Parameter	Description
<code>dmp_lun_retry_timeout</code>	<p>Specifies a retry period for handling transient errors that are not handled by the HBA and the SCSI driver. Specify the time in seconds.</p> <p>In general, no such special handling is required. Therefore, the default value of the <code>dmp_lun_retry_timeout</code> 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.</p> <p>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 <code>dmp_lun_retry_timeout</code> 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 <code>dmp_lun_retry_timeout</code> interval or until the I/O succeeds on one of the paths, whichever happens first.</p>
<code>dmp_monitor_fabric</code>	<p>The default setting is <code>off</code> for releases before 5.0 that have been patched to support this DDL feature. The default setting is <code>on</code> for 5.0 and later releases.</p>
<code>dmp_monitor_ownership</code>	<p>Determines whether the ownership monitoring is enabled for ALUA arrays. When this tunable is set to <code>on</code>, DMP polls the devices for LUN ownership changes. The polling interval is specified by the <code>dmp_restore_interval</code> tunable. The default value is <code>on</code>.</p> <p>When the <code>dmp_monitor_ownership</code> tunable is <code>off</code>, DMP does not poll the devices for LUN ownership changes.</p>

**Table 7-1** DMP parameters that are tunable (*continued*)

Parameter	Description
<code>dmp_native_support</code>	<p>Determines whether DMP will do multi-pathing for native devices.</p> <p>Set the tunable to <code>on</code> to have DMP do multi-pathing for native devices.</p> <p>When Dynamic Multi-Pathing is installed as a component of another Veritas InfoScale product, the default value is <code>off</code>.</p> <p>When Dynamic Multi-Pathing is installed as a stand-alone product, the default value is <code>on</code>.</p>
<code>dmp_path_age</code>	<p>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.</p> <p>The default value is 300 seconds.</p> <p>A value of 0 prevents DMP from detecting intermittently failing paths.</p>
<code>dmp_pathswitch_blks_shift</code>	<p>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.</p> <p>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.</p> <p>This parameter only affects the behavior of the <code>balanced</code> I/O policy. A value of 0 disables multi-pathing for the policy unless the <code>vxddmpadm</code> command is used to specify a different partition size for an array.</p> <p>See <a href="#">“Specifying the I/O policy”</a> on page 82.</p>

**Table 7-1** DMP parameters that are tunable (*continued*)

Parameter	Description
<code>dmp_probe_idle_lun</code>	<p>If DMP statistics gathering is enabled, set this tunable to <code>on</code> (default) to have the DMP path restoration thread probe idle LUNs. Set this tunable to <code>off</code> 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.</p> <p>The default value is <code>on</code>.</p>
<code>dmp_probe_threshold</code>	<p>If the <code>dmp_low_impact_probe</code> is turned <code>on</code>, <code>dmp_probe_threshold</code> determines the number of paths to probe before deciding on changing the state of other paths in the same subpath failover group.</p> <p>The default value is 5.</p>
<code>dmp_restore_cycles</code>	<p>If the DMP restore policy is <code>check_periodic</code>, the number of cycles after which the <code>check_all</code> policy is called.</p> <p>The default value is 10.</p> <p>See <a href="#">“Configuring DMP path restoration policies”</a> on page 96.</p>
<code>dmp_restore_interval</code>	<p>The interval attribute specifies how often the path restoration thread examines the paths. Specify the time in seconds.</p> <p>The default value is 300.</p> <p>The value of this tunable can also be set using the <code>vxdmpadm start restore</code> command.</p> <p>See <a href="#">“Configuring DMP path restoration policies”</a> on page 96.</p>

**Table 7-1** DMP parameters that are tunable (*continued*)

Parameter	Description
dmp_restore_policy	<p>The DMP restore policy, which can be set to one of the following values:</p> <ul style="list-style-type: none"> <li>■ check_all</li> <li>■ check_alterate</li> <li>■ check_disabled</li> <li>■ check_periodic</li> </ul> <p>The default value is <code>check_disabled</code>.</p> <p>The value of this tunable can also be set using the <code>vxmpadm start restore</code> command.</p> <p>See <a href="#">“Configuring DMP path restoration policies”</a> on page 96.</p>
dmp_restore_state	<p>If this parameter is set to <code>enabled</code>, it enables the path restoration thread to be started.</p> <p>See <a href="#">“Configuring DMP path restoration policies”</a> on page 96.</p> <p>If this parameter is set to <code>disabled</code>, it stops and disables the path restoration thread.</p> <p>If this parameter is set to <code>stopped</code>, it stops the path restoration thread until the next device discovery cycle.</p> <p>The default is <code>enabled</code>.</p> <p>See <a href="#">“Stopping the DMP path restoration thread”</a> on page 97.</p>
dmp_scsi_timeout	<p>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.</p> <p>The default value is 30 seconds.</p>
dmp_sfg_threshold	<p>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.</p> <p>The default value is 1.</p>

**Table 7-1** 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 troubleshooting

This appendix includes the following topics:

- [Displaying extended attributes after upgrading to DMP 8.0.2](#)
- [Recovering from errors when you exclude or include paths to DMP](#)
- [Downgrading the array support](#)

## Displaying extended attributes after upgrading to DMP 8.0.2

You may see the following changes in functionality when you upgrade to DMP 8.0.2 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, MPxIO. When a LUN is controlled by TPD drivers like MPxIO, 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 or uses 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 the native multi-pathing driver**

- ◆ Check the output of the following command. The LUN is controlled by MPxIO if the controller of the affected LUN has the physical name (PNAME) as `/scsi_vhci`:

```
# vxddmpadm getctlr all
```

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 MPxIO 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 MPxIO in the *Dynamic Multi-Pathing Administrator's Guide*.

## Recovering from errors when you exclude or include paths to DMP

You can exclude a path from DMP with the `vxddmpadm exclude` command. You can return a previously excluded path to DMP control with the `vxddmpadm 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:

```
# vxddmpadm exclude ctrl=c0  
VxVM vxddmpadm 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 `vxddmpadm include` command or the `vxddmpadm exclude` command that displayed the error.

```
# vxddmpadm exclude ctlr=c0
```

- 2 View the saved `vxvm.exclude.corrupt` file to find any entries for the excluded paths that are relevant.

```
# cat /etc/vx/vxvm.exclude.corrupt
exclude_all 0
paths
controllers
c4 /pci@1f,4000/pci@4/scsi@4/fp@0,0
```

- 3 Reissue the `vxddmpadm exclude` command for the paths that you noted in step 2.

```
# vxddmpadm 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
c0 /pci@1f,4000/scsi@3
c4 /pci@1f,4000/pci@4/scsi@4/fp@0,0
#
product
#
```

## Downgrading the array support

The array support is available in a single package, `VRTSaslapm`, that includes Array Support Libraries (ASLs) and Array Policy Modules (APMs). Each major release of Dynamic Multi-Pathing includes the supported `VRTSaslapm` package, which is installed as part of the product installation. Between major releases, Veritas may provide additional array support through updates to the `VRTSaslapm` package.

If you have issues with an updated `VRTSaslapm` package, Veritas may recommend that you downgrade to a previous version of the ASL/APM package. You can only revert to a package 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 package. Instead, you can install the previous version of the package over the new package. This method prevents multiple instances of the `VRTSaslapm` package from being installed.

Use the following method to downgrade the `VRTSaslapm` package.

#### **To downgrade the ASL/APM package for Solaris 11**

- ◆ To downgrade the package, use the following command:

```
# pkg update -g ./VRTSaslapm.p5p VRTSaslapm
```

# Reference

This appendix includes the following topics:

- [Command completion for Veritas commands](#)

## 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:

```
# vxctl 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:

```
# vxctl cmdcompletion disable
```

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

The following commands support command completion:

- vxddladm
- vxdisk
- vxdumpadm