Dynamic Multi-Pathing for Windows Administrator's Guide

Windows

7.0

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Contents

Understanding DMPW

This chapter includes the following topics:

- DMPW overview

- Major features of Dynamic Multi-Pathing for Windows

- How DMPW works

- Multiple paths to disk arrays

- Device discovery

DMPW overview

Dynamic Multi-Pathing for Windows (DMPW) adds fault tolerance to disk storage by making use of multiple paths between a server or a host and a disk in a storage array. In previous releases, DMPW was only available as a feature of Storage Foundation.

A path is a connection between a server or a host and the storage array's disks and consists of a host adapter and a SCSI bus connection to one or more SCSI disks or a fiber optic channel connected to a hub, switch, or array. Thus, multiple paths are made possible by connecting two or more host bus adapters with either SCSI or fiber optic cabling to the storage array. DMPW manages the multiple paths so that the data on each of the array's disks is accessible to the host computer. If a path to a disk fails, DMPW automatically transmits data to and from the disk over an alternate path.

The paths on an array are set up to work in two ways—either in Active/Active mode, which provides load balancing of the data between multiple paths, or in Active/Passive mode, in which only one path is active and any remaining paths are backups.

The Dynamic Multi-Pathing for Windows functionality is offered as DMPW device-specific modules (DSMs).

Note: Windows Management Instrumentation (WMI) is a required service for the MPIO feature to work. Without this service, the MPIO Provider will not load and MPIO objects are not displayed on the VEA console or CLI command outputs. MPIO operations too cannot be performed in absence of WMI service.

DMPW DSMs are designed to support a multipath disk storage environment set up with the Microsoft Multipath I/O (Microsoft MPIO) solution. DMPW DSMs work effectively with Windows to provide a fault tolerant multipath disk storage environment. DMPW DSMs have the following benefits:

- Fiber Channel StorPort Miniport HBA Driver support

- iSCSI HBA support

- Microsoft iSCSI Software Initiator support

- Boot from SAN support

- Active/Active Dynamic Multi-Pathing for Windows with clustering support

- DMPW DSMs load balancing support

    Load balancing support includes the following:

    - Round robin load balancing support (Active/Active)

    - Fail Over Only (Active/Passive)

    - Dynamic Least Queue Depth load balancing support

    - Round robin with Subset load balancing support

    - Least Blocks load balancing support

    - Weighted Paths load balancing support

    - Balanced Path load balancing support

For DMPW DSMs, Boot and data volumes are supported on the same bus/HBAs for non-clustered servers if the Boot from SAN recommendations from Microsoft are followed. DMPW DSMs are not supported with fibre channel port drivers, fibre channel SCSI Miniport drivers or boot/cluster disks on the same bus/HBAs.

Major features of Dynamic Multi-Pathing for Windows

The major features of Dynamic Multi-Pathing for Windows (DMPW) are described in this section.

They include the following:

- Fault tolerance
  Provides fault tolerance to a disk system by using multiple paths to each disk. If the primary path fails, either at the card level or in the cabling from the card to the disk, a secondary path is automatically utilized.

- Load balancing in Active/Active configurations
  When a system is configured as Active/Active, Dynamic Multi-Pathing for Windows makes use of all the paths to a disk for the transfer of I/O to and from the disk.

- Support for multiple paths
  With DMPW DSMs, the maximum number of I/O paths you can have is 16 per array LUN.

- Dynamic recovery
  If an active path to a disk fails, Dynamic Multi-Pathing for Windows automatically flags the failed path and no longer attempts to transfer data on it. The failed path is monitored and is automatically restored to service when Dynamic Multi-Pathing for Windows detects that the path is functioning correctly. Dynamic Multi-Pathing for Windows automatically updates path status on the user display when a path fails or is restored to service.

- Dynamic path recognition
  If you add a new path to your Dynamic Multi-Pathing for Windows configuration, running a rescan or rebooting your system causes Dynamic Multi-Pathing for Windows to detect the new path and display its status. If a failed or disabled path is restored to service, Dynamic Multi-Pathing for Windows automatically detects the status change and updates the display.

How DMPW works

DMPW provides greater availability, reliability, and performance by using path failover and load balancing. This feature is available for multiported disk arrays from various vendors.

Multiported disk arrays can be connected to host systems through multiple paths. To detect the various paths to a disk, DMPW uses a mechanism that is specific to

each supported array. DMPW can also differentiate between different enclosures of a supported array that are connected to the same host system.

See "Multiple paths to disk arrays" on page 18.

See "Device discovery" on page 18.

The multi-pathing policy that is used by DMPW depends on the characteristics of the disk array.

DMPW supports the following standard array types:

Active/Active (A/A)	Allows several paths to be used concurrently for I/O. Such arrays allow DMPW 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, DMPW automatically routes I/O over the other available paths.
Asymmetric Active/Active (A/A-A)	All controllers on the array are online and can accept I/O, but one controller is assigned as the preferred (owning) controller of the LUN. The owning controller can issue I/O commands directly to the LUN. The non-owning controller, can accept I/O commands, but cannot communicate with the LUN. If an I/O request reaches the array through the non-owning controller, it will be forwarded to the owning controller of the LUN. A/A-A or Asymmetric Active/Active arrays can be accessed through secondary storage paths with little performance degradation. Usually an A/A-A array behaves like an A/P array rather than an A/A array. However, during failover, an A/A-A array behaves like an A/A array. A/A-A arrays use Asymmetric LUN Access (ALUA) protocol as described in the SCSI protocol specifications.

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

Active/Passive with LUN group failover (A/P-G)	For Active/Passive arrays with LUN group failover (A/PG arrays), a group of LUNs that are connected through a controller is treated as a single failover entity. Unlike A/P arrays, failover occurs at the controller level, and not for individual LUNs. The primary controller and the secondary controller are each connected to a separate group of LUNs. If a single LUN in the primary controller's LUN group fails, all LUNs in that group fail over to the secondary controller.
	This policy 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.

The following figure shows how DMPW sets up a node for a disk in a supported disk array.

Figure 1-1   How DMPW represents multiple physical paths to a disk as one node
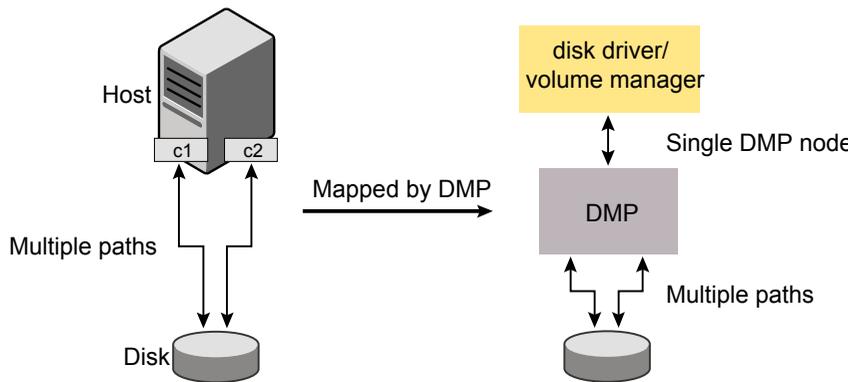
The following figure shows an example where two paths, c1t99d0 and c2t99d0, exist to a single disk in the enclosure, but the single DMPW node, enc0_0, is used to access it.

Figure 1-2   Example of multipathing for a disk enclosure in a SAN
environment
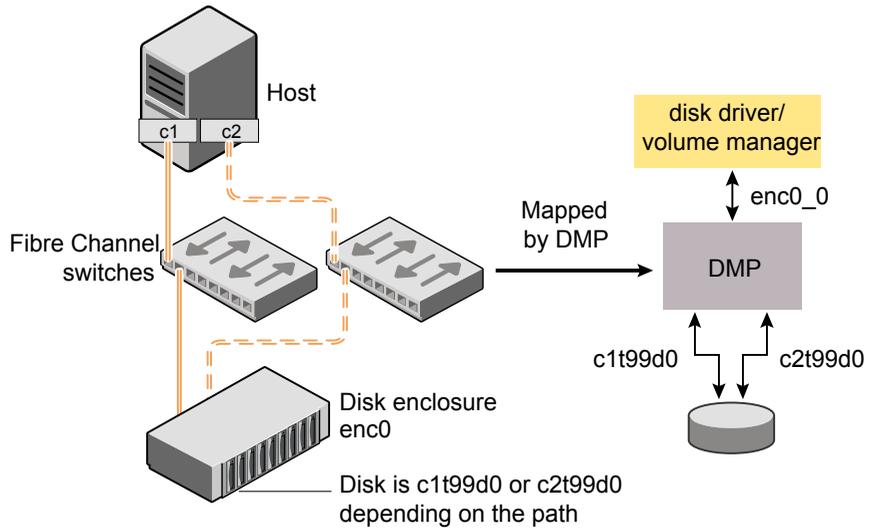
How DMPW monitors I/O on paths

DMPW works in close coordination with the Windows MPIO framework to participate in the I/O processing and monitoring. DMPW performs various operations such as error handling, path verification/failover, SCSI reservation/release, and statistics collection.

In case of an I/O error on a path, DMPW determines if the I/O should be retried after a certain interval on the same path or the path should be invalidated for further I/O processing. It then decides which alternate path should be picked up for I/O in case of a fatal error on the previous path.

DMPW performs path verification every 30 seconds (Default) for all the paths to determine their health for I/O processing and resume I/O on the paths that have been restored. Path verification helps in selecting healthy paths in case a path is reporting intermittent failures.

DMPW gathers I/O statistics on each path. The `vxdmpadm iostat` command can be used to provide information about the I/O statistics for a single disk or for all the disks in an array. The statistics can be displayed after a specified number of seconds and for a specified number of times. Alternately, the VEA GUI also shows the number of Read/Write operations that have occurred through the paths.

Path failover mechanism

DMPW enhances system reliability when used with multiported disk arrays. In the event of the loss of a path to a disk array, DMPW automatically selects the next available path for I/O requests without intervention from the administrator. DMPW 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). DMPW 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.

Load balancing

DMPW also provides balancing of I/O load traffic, thereby improving system and application performance. Load balancing maximizes I/O throughput by using the total bandwidth of all available paths. Depending on different load balancing policies, appropriate path is selected to send down the I/O to the LUN.

For information on the load balancing policies available under the Active/Active configuration:

See "Active/Active and Active/Passive settings" on page 19.

For information on specifying the load balancing settings for the paths in an array and for individual disks:

See "Specify load balancing settings and the primary path" on page 25.

For Active/Passive disk arrays, I/O is sent down the primary path. If the primary path fails, I/O is switched over to the other available primary paths or secondary paths. As the continuous transfer of ownership of LUNs from one controller to another results in severe I/O slowdown, load balancing across paths is not performed for Active/Passive disk arrays unless they support concurrent I/O. Both paths of an Active/Passive array are not considered to be on different controllers when mirroring across controllers. For A/P, A/PF and A/PG arrays, load balancing is performed across all the currently active paths as is done for Active/Active arrays. You can use the vxdmpadm command or the VEA GUI to change the I/O policy for the paths to an enclosure or disk array.

DMPW in a clustered environment

In a clustered environment, where Active/Passive type disk arrays are shared by multiple hosts, all nodes in the cluster must access the disk by the same physical storage controller port. Accessing a disk by 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. DMPW and the clustering feature can handle automatic failback in A/P arrays when a path is restored, and support failback for explicit failover mode arrays. It is 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. 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 all need to access a disk by the same physical path. In clustered environment, DMPW selects an alternate path without requiring client application reconnection in case of a storage path failure. In case of server failure, the application is failed over to another cluster node which needs client reconnection. During normal operation, multiple data paths may be employed to provide greater aggregate throughput than one path could provide.

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).

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 an important feature because DMPW needs to support a growing number of disk arrays from a number of vendors. With the ability to discover the devices attached to a host, the Device Discovery service enables you to add support dynamically for new disk arrays. This operation, which uses a facility called the device discovery layer (DDL), is achieved by using Windows PnP (plug and play) notifications without the need for any command or user intervention.

Setting up DMPW

This chapter includes the following topics:

- Active/Active and Active/Passive settings

- Active/Active and Active/Passive settings in a cluster environment

- Add and remove paths

- Specify load balancing settings and the primary path

- Configuring DSMs without storage connection

Active/Active and Active/Passive settings

Dynamic Multi-Pathing for Windows has two modes of operation for an array's paths, Active/Active and Active/Passive.

These modes also apply to the array's disks and are defined as follows:

- Active/Active
  The mode in which Dynamic Multi-Pathing for Windows allocates the data transfer across all the possible paths, thus enabling the desirable feature of load balancing. With this mode, Dynamic Multi-Pathing for Windows implements a round-robin algorithm, selecting each path in sequence for each successive data transfer to or from a disk. For example, if you have two paths active, A and B, the first disk transfer occurs on path A, the next on path B, and the next on path A again.

  In addition to the round-robin algorithm, DMPW DSMs offer the following load balancing options:

  - Dynamic Least Queue Depth
    Selects the path with the least number of I/O requests in its queue for the next data transfer.

For example, if you have two active paths, path A with one I/O request and path B with none, DMPW DSMs would select the path with the least number of I/O requests in its queue, path B, for the next data transfer.

- Balanced Path

This policy is designed to optimize the use of caching in disk drives and RAID controllers. The size of the cache depends on the characteristics of the particular hardware. Generally, disks and LUNs are logically divided into a number of regions or partitions. I/O to and from a given region is sent on only one of the active paths. Adjusting the region size to be compatible with the size of the cache is beneficial so that all the contiguous blocks of I/O to that region use the same active path. The value of the partition size can be changed by adjusting the value of the tunable parameter, Block Shift.

Block Shift represents the number of contiguous I/O blocks that are sent along a path to an Active/Active array before switching to the next available path. The Block Shift value is expressed as the integer exponent of a power of 2. For example, the Block Shift value of 11 represents 2^{11} or 2048 contiguous blocks of I/O.

The benefit of this policy is lost if the value is set larger than the cache size. The benefit is also lost when the active path fails. In this situation, the I/O is automatically redistributed across the remaining paths.

The default value of the Block Shift parameter is set to 11 so that 2048 blocks (1MB) of contiguous I/O are sent over a path before switching to a different path. Depending on your hardware, adjusting this parameter may result in better I/O throughput. Refer to your hardware documentation for more information.

Note: Block Shift only affects the behavior of the balanced path policy. A value of 0 disables multi-pathing for the policy unless the vxdmpadm command is used to specify a different partition size for an array.

- Weighted Paths

Uses the path with the lowest numerical weight. Each path is assigned a weight by the user to designate which path is favored for data transfer. If two or more paths have the same weight and are the lowest weight of all paths, then these paths are used each in turn, in round-robin fashion, for the data transfer.

For example, if you have three active paths, path A with weight of 0, path B with weight of 0, and path C with weight of 9, DMPW DSMs would use path A for one data transfer and then use path B for the next. Path C is in standby mode and is used if path A or path B fails.

- Round robin with Subset

Uses a subset of paths, each in turn, in round-robin fashion. The user specifies the paths for data transfer that make up the subset. The remaining paths are in standby mode.

For example, if you have three active paths, path A, path B, and path C and you specify the subset to contain path A and path B, then DMPW DSMs would use path A for one data transfer and then use path B for the next. Path C is in standby mode and is used if path A or path B fails.

- Least Blocks

  Selects the path with the least number of blocks of I/O in its queue for the next data transfer.

  For example, if you have two active paths, path A with one block of I/O and path B with none, DMPW DSMs would select the path with the least number of blocks of I/O in its queue, path B, for the next data transfer.

- Active/Passive

  A mode in which a path designated as the "Preferred Path" or "primary path " is always active and the other path or paths act as backups (standby paths) that are called into service if the current operating path fails.

The modes of operation—Active/Active and Active/Passive—are shown as options in the Load Balancing section of the program's Array Settings and Device Settings windows. The Active/Active mode enables load balancing, but the Active/Passive mode does not provide load balancing except for the Fail Over Only load balancing policy.

Note: If a storage array cannot transfer data on one of the path configurations, the Load Balancing options appear grayed out on the screen and you cannot access these settings.

You configure the load balancing settings for the paths at the array level through the Array Settings screen, or you can accept the default setting. The default setting is dependent on the particular array. Consult the documentation for your storage array to determine the default setting of the array and any additional settings it supports.

After the appropriate array setting is made, all the disks in an array have the same load balancing setting as the array. If the array is set to active/active, you can use the Device Settings screen to change the setting on an individual disk so that it has a different load balancing setting than the array. When an array is set to active/passive, no load balancing is enabled and data transfer is limited to the one preferred or primary path only.

For all Active/Active arrays under control of DMPW DSMs:

- All paths to the disks are current active I/O paths. Each active path is designated by a path icon with a green circle in the VEA GUI.

- For an Active/Passive load balance setting, the primary path is designated by a path icon with a checkmark in a green circle in the GUI.

- The DMPW DSMs are not enabled to indicate which array controller each path is connected to.

For all Active/Passive Concurrent (A/PC) and Asymmetric Logical Unit Access (ALUA) arrays under control of DMPW DSMs, the load balance settings apply only to the current active I/O paths.If all the active I/O paths change or fail, the load balance settings are automatically applied to the new current active I/O paths of the arrays.

In addition, for A/PC and ALUA arrays:

- The current active path is designated by a path icon with a green circle in the VEA GUI.

- For an Active/Passive load balance setting, the primary path is designated by a path icon with a checkmark in a green circle in the VEA GUI.

- DMPW automatically selects the primary path for Active/Passive load balancing.

- Round robin with Subset and Weighted Paths load balance settings are available only at the device level. They are not available at the array level.

- Active paths are connected to the same array controller.

Active/Active and Active/Passive settings in a cluster environment

This section covers information about settings for DMPW DSMs along with information about enabling or disabling SCSI-3 PGR.

DMPW DSMs

For DMPW DSMs in a cluster environment, either Active/Active or Active/Passive load balance settings can be used. DMPW DSMs automatically set the load balancing to active/passive for disks under SCSI-2 reservation. For Active/Active load balancing in a cluster environment, the array must be enabled for SCSI-3 Persistent Group Reservations (SCSI-3 PGR).

Storage arrays may require additional configuration steps or updates to work with Dynamic Multi-Pathing for Windows and MPIO. Contact the manufacturer of the storage array for details.

SCSI-3 PGR technology

SCSI-3 PGR supports multiple nodes accessing a device while at the same time blocking access to other nodes. SCSI-3 PGR supports multiple paths from a host to a disk and SCSI-3 PGR reservations are persistent across SCSI bus resets.

By contrast, SCSI-2 reservations can only be used by one host, with one path. This means if there is a need to block access for data integrity concerns, only one host and one path remain active. This limits access to the device to only one path and prevents the use of multiple paths even if they are available.

SCSI-3 PGR uses a concept of registration and reservation. Systems accessing a device register a key with a SCSI-3 device. Each system registers its own key. Multiple systems registering keys form a membership. Registered systems can then establish a reservation. The reservation type is set to "Exclusive Access - Registrants Only". This means that only some commands are allowed and there is only one persistent reservation holder. With SCSI-3 PGR technology, blocking write access can be done by removing a registration from a device.

In the DMPW implementation, a node registers the same key for all paths to the device.

For DMPW DSMs, the Active/Active setting is implemented by translating SCSI reserve/release commands to SCSI-3 PGR commands.

Enabling SCSI-3 PGR

You must enable SCSI-3 support before using the Active/Active setting for DMPW DSMs. (SCSI-3 support is disabled by default.)

Note: Before enabling SCSI-3 PGR support, move any cluster disk groups to another node or deport the cluster disk groups.

The SCSI-3 PGR support can be enabled for the DMPW DSMs by using the `vxdmpadm` CLI command.

Note: You must ensure that your storage array supports SCSI-3 PGR before using the Active/Active setting for DMPW DSMs. Also check to see if your array manufacturer requires any special settings for a LUN to be enabled for SCSI-3 PGR.

Add and remove paths

After you have been using DMPW DSMs for a while, you might want to add a path to an array if you are adding more disks to the array or if you want additional fault tolerance for the array by having another path. In addition, you may want to remove a path if you are reconfiguring your system.

This section describes how to add and remove paths.

See "Adding a path" on page 24.

See "Removing a path" on page 24.

Adding a path

You might want to add a path when you add more disks to an array or to increase fault tolerance for the array.

To add a path to an array

1 Add the path by physically connecting a new cable.

2 To view the screen changes caused by the additional path, open the Disks folder in the tree view and select a disk. Then select the DMPW DSMs tab in the right-hand pane.

3 Select **Actions** > **Rescan** from VEA.

DMPW DSMs scans for paths and updates the screen, reflecting any changes you have made in the physical installation.

Note: If a disk shares a path with another disk, then it must share all the same paths with the other disk. If a disk in the array is not sharing a path with any other disk in the array, then all the paths of the disk must not be shared with any other disk in the array.

Removing a path

Remove a path by physically disconnecting the cable. The system monitors existing paths and detects that the disconnected path is no longer functioning properly. The display is updated to indicate this, and data transfers fail over to the next path in the sequence.

Note: You may need to perform a rescan to update the screen after removing a path from an array that was under control of DMPW DSMs. Select **Actions** > **Rescan** from VEA to display the change you have made to the configuration.

Specify load balancing settings and the primary path

The primary path setting is only available when you select the Fail Over Only (Active/Passive) load balancing setting for an array or disk.

When you first set up an array under DMPW DSMs, you must make sure you have the load balancing setting you want for the paths in the array. After that is done, all of the disks in the array by default have the same load balancing setting. Then, if desired, you can change this setting for individual disks. The load balancing settings are located in the Load Balance Policy section of the Array Settings wizard and the Device Settings screen.

All of the load balancing settings, except for Fail Over Only (Active/Passive), enable load balancing among the active paths. The Fail Over Only (Active/Passive) setting does not provide load balancing because data transfer only occurs on the one active path, the primary path .

Note: The type of array or disk determines which load balancing settings are available. Load balance settings that are not supported are grayed-out in the VEA GUI. Refer to the documentation for your array or disk for more information about supported load balance settings.

This section gives the step-by-step directions for specifying the load balancing settings for the paths in an array and for individual disks.

See "Specifying load balancing settings for an array" on page 25.

See "Specifying load balancing settings for a disk" on page 28.

See "Specifying the primary path for an array or disk" on page 30.

See "Active/Active and Active/Passive settings" on page 19.

Specifying load balancing settings for an array

The way to specify load balancing settings using the Array Settings wizard follows.

To specify load balancing settings for an array

1   To launch the Array Settings wizard, open the DMPW DSMs folder in the tree view.

2   Right-click the array that you are interested in and the array context menu appears.

3   Select **Array Settings** from the context menu.

4 The Array Settings welcome screen appears. Click **Next** to continue.

5 The Select Array Settings parameters screen appears.

Select the load balancing option by clicking the appropriate radio button.

SCSI-3 reservation support is required for all load balancing settings, except for Fail Over Only (Active/Passive). Refer to your array documentation to determine if your array supports SCSI-3 reservations before selecting any of these load balancing settings.

■ Round robin (Active/Active)

This option ensures that load balancing is used for data transfers to and from an array. With this setting, DMPW DSMs configures all paths in the array as active and I/O transfers occur on the paths each in turn, in a round-robin fashion.

■ Dynamic Least Queue Depth

This option ensures that load balancing is used for data transfers to and from an array. With this setting, DMPW DSMs configures all paths to the array as active and selects the path with the least number of I/O requests in its queue for a data transfer.

■ Balanced Path

This policy is designed to optimize the use of caching in disk drives and RAID controllers. The size of the cache depends on the characteristics of the particular hardware. Generally, disks and LUNs are logically divided into a number of regions or partitions. I/O to and from a given region is sent on only one of the active paths. Adjusting the region size to be compatible with the size of the cache is beneficial so that all the contiguous blocks of I/O to that region use the same active path. The value of the partition size can be changed by adjusting the value of the tunable parameter, Block Shift.

More details about this option are available.

See "Active/Active and Active/Passive settings" on page 19.

■ Weighted Paths

This option ensures that load balancing is used for data transfers to and from an array. With this setting, DMPW DSMs configures all paths to the array as active and selects the path with the lowest weight for data transfer. Weights are assigned by the user to designate which path is favored. If two or more paths have the same weight and are the lowest weight of all paths, then these paths are used each in turn, in round-robin fashion, for the data transfer.

> **Note:** This setting is available for A/PC and ALUA arrays only at the device level. It is not available at the array level.

- Round robin with Subset

    This option ensures that load balancing is used for data transfers to and from an array. With this setting, DMPW DSMs configures all paths to the array as active and uses a subset of paths. These paths are used each in turn, in round-robin fashion, for data transfer. The subset of paths are specified by the user. The remaining paths are in standby mode.

> **Note:** This setting is available for A/PC and ALUA arrays only at the device level. It is not available at the array level.

- Least Blocks

    This option ensures that load balancing is used for data transfers to and from an array. With this setting, DMPW DSMs configures all paths to the array as active and selects the path with the least number of blocks of I/O in its queue for data transfer.

- Fail Over Only (Active/Passive)

    This option has one primary path with the remaining path or paths on standby (backups) in case the primary path fails. The primary path is the only path that is used to transfer data. This option does not provide load balancing among paths. DMPW DSMs sets a path to be the primary path . However, you may choose a specific path to be the primary path .

    See

If you want the selected load balancing setting to be the setting for all the arrays controlled by this specific DMPW DSMs driver, check the checkbox for **All arrays under the DSM**. This option means that the current load balancing setting and the other settings for this array are applied to all the arrays controlled by this specific DMPW DSMs driver.

There are specific DMPW DSMs that work with specific families of hardware arrays. If your environment has more than one family of hardware arrays under control of DMPW DSMs, then each family of hardware arrays would work with specific DMPW DSMs. When you select the option for applying all the settings to all the arrays under control of the DSM, you are applying the settings to only those arrays that work with that specific DMPW DSMs.

See the Symantec Web site for more information about which hardware arrays are supported by specific DMPW DSMs.

http://www.veritas.com/docs/000025353

The default load balancing setting of an array is dependent on the particular array. Consult the documentation for your storage array to determine the default setting and any additional settings it supports.

In the sample screen shown below, the round robin (Active/Active) setting is selected.

Click **Next** to continue.

6 The Array Settings summary screen appears displaying the settings for the array. Review the settings and click **Finish** to apply the settings and exit the wizard.

For some load balance policies, such as round robin with Subset, additional specifications are required. The Array Settings wizard displays a screen before the summary screen to collect these specifications. Click **Next** after setting these specifications to continue to the summary screen.

Specifying load balancing settings for a disk

If a setting has not been specified for an individual disk, the disk assumes the same load balancing setting as the one used by the array. However, by using the Device Settings screen, you can change the load balancing option for an individual disk and make it different than the setting of the array.

DMPW DSMs automatically set the load balancing to Fail Over Only (Active/Passive) for disks under SCSI-2 reservation. The Fail Over Only (Active/Passive) setting is always used on disks under SCSI-2 reservation and the system ignores other load balance settings that may be set.

Disks under SCSI-2 reservation are:

Disks that may be in a clustering environment.

Disks with Private Disk Group Protection.

To specify load balancing settings for a disk

1 Open the DMPW DSMs folder in the VEA console's tree view.

2 Select the disk that has the load balancing settings you want to change.

Note that opening the Disks folder and clicking a disk that is under DMPW DSMs control is an alternate way to select a disk.

3 Make sure the DMPW DSMs tab is selected in the right pane, right-click one of the displayed paths, and then select **Device Settings** from the path context menu.

4 The Device Settings welcome screen appears. Click **Next** to continue.

5 The Select Device Settings parameters screen appears.

Select one of the following load balancing options:

- Round robin (Active/Active)

  This option ensures that load balancing is used for data transfers to and from a disk. With this setting, DMPW DSMs configures all paths to the disk as active and enables paths, each in turn, in a round-robin fashion for data transfer.

- Dynamic Least Queue Depth

  This option ensures that load balancing is used for data transfers to and from an array. With this setting, DMPW DSMs configures all paths to the array as active and selects the path with the least number of I/O requests in its queue for a data transfer.

- Balanced Path

  This policy is designed to optimize the use of caching in disk drives and RAID controllers. The size of the cache depends on the characteristics of the particular hardware. Generally, disks and LUNs are logically divided into a number of regions or partitions. I/O to and from a given region is sent on only one of the active paths. Adjusting the region size to be compatible with the size of the cache is beneficial so that all the contiguous blocks of I/O to that region use the same active path. The value of the partition size can be changed by adjusting the value of the tunable parameter, Block Shift.

  More details about this option are available.

  See "Active/Active and Active/Passive settings" on page 19.

- Weighted Paths

  This option ensures that load balancing is used for data transfers to and from an array. With this setting, DMPW DSMs configures all paths to the array as active and selects the path with the lowest weight for data transfer. Weights are assigned by the user to designate which path is favored. If two or more paths have the same weight and are the lowest weight of all paths, then these paths are used each in turn, in round-robin fashion, for the data transfer.

- Round robin with Subset

  This option ensures that load balancing is used for data transfers to and from an array. With this setting, DMPW DSMs configures all paths to the array as active and uses a subset of paths each in turn, in round-robin fashion, for data transfer. The subset of paths are specified by the user. The remaining paths are in standby mode.

- Least Blocks

  This option ensures that load balancing is used for data transfers to and from an array. With this setting, DMPW DSMs configures all paths to the

array as active and selects the path with the least number of blocks of I/O in its queue for data transfer.

- Fail Over Only (Active/Passive)
  This option has one primary path with the remaining path or paths on standby (backups) that are used when the current primary path fails. The primary path is the only path that is used to transfer data. This option does not provide load balancing among paths. DMPW DSMs chooses a path to be the primary path . However, you may choose a specific path to be the primary path .
  See "Specifying the primary path for an array or disk" on page 30.

  Click **Next** to continue.

6 The Device Settings summary screen appears displaying the settings for the array. Review the settings and click **Finish** to apply the settings and exit the wizard.

For some load balance policies, such as round robin with Subset, additional specifications are required. The Array Settings wizard displays a screen before the summary screen to collect these specifications. Click **Next** after setting these specifications to continue to the summary screen.

Specifying the primary path for an array or disk

When an array is configured for Fail Over Only (Active/Passive) operation, you can specify the path that is used for data transfer. The specified path, called the primary path , is the only path used for data transfer.

To specify the primary path for an array or disk

1 Display the Set primary path screen by doing the following:

- Make sure the DMPW DSMs tab is selected in the right pane.
  To display the DMPW DSMs tab, use the tree view in the left pane to select a disk under the DMPW DSMs folder, or a disk under the Disks folder that has DMPW DSMs enabled, and then click the DMPW DSMs tab that appears in the right pane.

- In the DMPW DSMs tab, right-click on the path you want to be the primary path for the array, and select **Set Primary Path** from the path context menu.

The Set primary path screen appears.

2 Select to set the primary path for the device or for the array, as follows:

- Primary path for device

  The primary path for the device is available only when the operational mode for the path to the disk is specified as Fail Over Only (Active/Passive) and the currently selected path is not the primary path . The primary path is the only path that is used to transfer data to and from the disk. Clicking this menu selection makes the selected path the primary path to the disk. The other paths to the disk are placed on standby and available for failover.

- Primary path for array

  This lets you specify the currently selected path as the primary path to the array. The primary path is the only path that is used to transfer data to and from the array.

  The array's primary path can be set regardless of the array's current load balance setting. This means that if the load balance setting for the array is set to round robin (Active/Active) or other Active/Active load balance setting, then the primary path setting for the array is not used. However, if a disk in the array is set to Fail Over Only (Active/Passive), the primary path for the array becomes the primary path for the disk.

  For example, if an array has a load balance setting of round robin (Active/Active) and the primary path for the array is set to path 2-1-1, then any disk in the array that has the load balance setting of Fail Over Only (Active/Passive) will have its primary path set to path 2-1-1.

3 Click **OK** to save your setting and exit the screen.

The primary path is identified by a blue checkmark icon.

Configuring DSMs without storage connection

On Windows Server operating systems, DMPW DSM will enable configuration of some DSM settings without a storage connection. When a storage array is later connected to a host under a MPIO management, the connected storage array will inherit the policy that has been previously set in a DSM.

Support for DSM settings without storage connection applies to operations that are general for storage devices without specific knowledge of a DMPW path of a storage device.

The following are settings you can configure for a DSM without storage connection:

- Load balances: Active/Active, Active/Passive without choosing a primary path, Least Block, Balanced Path and Least Queue. The specific settings for Round Robin with Subset or Weighted Path load balances cannot be configured without a storage connection because the settings require the specific knowledge of a Volume Replicator path of a disk which does not exist yet.

- SCSI-3: Enabling or disabling the setting for SCSI-3 support.

The VEA DSM Configuration command enables viewing a list of installed DSMs on a system and applying load balance settings and SCSI-3 support settings to the selected DSMs. These capabilities are also available through the `vxdmpadm` utility in the command line interface (CLI). In addition, you can use the CLI `vxdmpadm getdsmattrib` command to view existing settings for the installed DSMs.

Specify DSM settings without storage connection

On Windows Server operating systems, you can specify SCSI-3 support and some load balance options for DMPW DSMs without the storage being connected.

See "Configuring DSMs without storage connection" on page 32.

The VEA DSM Configuration command enables you to view and select from a list of installed DSMs and apply selected settings.

Note: The VEA does not show existing or default settings. To view existing settings, you can use the CLI `vxdmpadm getdsmattrib` command.

To specify DSM settings without storage connection

1 In the VEA, right-click DMPW DSM in the tree and select **DSM Configuration**.

The VEA displays a dialog with a list of installed Symantec DSMs.

2 To select the DSMs, use the buttons to move them from the **Available DSMs** list to the **Selected DSMs** list. The options you select will apply to all the selected DSMs.

3 Choose the options that you want to apply to the selected DSMs:

  ■ Load Balance Policy: Fail Over Only (Active/Passive), round robin (Active/Active), Dynamic Least Queue Depth, Least Blocks, and Balanced Path

  ■ If Balanced Path is selected, you can specify the Data Length Block

  ■ Under SCSI Settings, you can specify SCSI-3 support.

More information is available on load balance settings:

See "Active/Active and Active/Passive settings" on page 19.

More information is available on SCSI-3 support.

See "Active/Active and Active/Passive settings in a cluster environment" on page 22.

Administering DMPW

This chapter includes the following topics:

- About administering DMPW

- DMPW DSMs menus

- View array, disk, and path status

- vxdmpadm

About administering DMPW

You can administer Dynamic Multi-Pathing for Windows (DMPW) by using the GUI as well as by using the command line interface.

The support for Microsoft Multipath I/O solution (Microsoft MPIO) is provided by Symantec DMPW DSMs:

See "DMPW DSMs menus" on page 34.

DMPW DSMs provide status information for arrays, disks, and paths to the disks:

See "View array, disk, and path status" on page 39.

You can use the vxdmpadm command to administer DMPW from the CLI:

See "vxdmpadm" on page 41.

DMPW DSMs menus

This section describes DMPW DSMs menus.

They include the following:

- See "Displaying the menu for arrays" on page 35.

- See

- See

- See

Displaying the menu for arrays

There is a context menu for arrays that are under the control of DMPW DSMs that let you access the settings and properties of the array. It is available when you select an array in the VEA GUI.

To display the menu for arrays

1 Open the DMPW DSMs folder in the VEA GUI.

2 Select the array that you are interested in and the array context menu appears.

Commands for arrays

This section describes the DMPW DSMs menu commands.

Array settings

The Array Settings command launches the Array Settings wizard.

It lets you select the setting for the operational modes for the array's paths in the Load Balance Policy section. The Control Timer Settings is a section of tunable parameters for testing the status or health of a path.

At the bottom of the screen there is an option for applying all the settings to all the arrays under control of DMPW DSMs. This option applies all the settings to all arrays under control of a specific DMPW DSMs driver. When you select this option, the current settings for this array are applied to all the arrays controlled by this specific DMPW DSMs driver.

Note: There are specific DMPW DSMs that work with specific families of hardware arrays. If your environment has more than one family of hardware arrays under control of DMPW DSMs, then each family of hardware arrays would work with specific DMPW DSMs. When you select the option for applying all the settings to all the arrays under control of the DSM, you are applying the settings to only those arrays that work with that specific DMPW DSMs.

See the Symantec Web site for more information about which hardware arrays are supported by specific DMPW DSMs.

Additional information about array settings is available.

See

Note: If the Fail Over Only (Active/Passive) array load balancing setting is selected and a primary path has not been set, DMPW DSMs set the primary path . Generally, DMPW DSMs set the primary path to the first path that is able to transfer data. You can manually set the primary path with the Set primary path command.

Properties

The Properties command brings up the Properties screen, which displays information about the selected array, including array name, array type, load balance policy, and a list of the devices contained in the array.

Additional information about the array, disk, and path settings is available.

See

Displaying the menu for disks

The context menu for a disk is available when you highlight a path that is connected to the disk. The menu requires the DMPW DSMs tab to be active.

To display the disk context menu

1 Open the DMPW DSMs folder in the tree view.

2 Select the disk that you are interested in.

Note that opening the Disks folder and clicking a disk that is under DMPW DSMs control is an alternative way to select a disk.

3 Select the DMPW DSMs tab in the right pane. This tab displays the paths to the selected disk.

Each path is displayed with its properties. Some of the attributes displayed are Port, Channel, Target ID, LUN, and Load Balance Policy.

The name of the path is derived from a combination of properties of the path. For example, if the path has properties of Port Number = 2, Channel = 1, and Target ID = 1, then the name of the path is 2-1-1.

4 Right-click on a path and the context menu appears.

Commands for paths of a disk

This section describes the DMPW DSMs menu commands.

The menu commands are the following:

See

Statistics monitoring

The Statistics Monitoring command brings up the Path Statistics screen, which displays the I/O statistics of the selected path.

The I/O statistics for the selected path are the following:

- Number of read operations per second

- Number of write operations per second

- Number of bytes read per second

- Number of bytes written per second

The statistics are updated and displayed at a specified polling interval. The range of values for the polling interval is 2 to 900 seconds. You can set the polling interval by entering the number of seconds in the Polling Interval field and clicking **Set Polling Interval**.

Clear performance statistics

The Clear Performance Statistics command brings up the Clear Performance Statistics screen, which lets you clear the performance statistics that are being monitored for a single device, an array, or for all the arrays under control of a DMPW DSMs. After selecting which performance statistics to clear, click OK to complete the operation.

Device settings

The Device Settings command brings up the Device Settings screen, which displays the DMPW DSMs characteristics of the disk whose path is selected on the DMPW DSMs tab. It has a Load Balance Policy section to set the operational mode that applies to the selected disk.

Note: If the Fail Over Only (Active/Passive) device load balancing setting is selected and a primary path has not been set, DMPW DSMs set the primary path . Generally, DMPW DSMs set the primary path to the first path that is able to transfer data. You can manually set the primary path with the Set primary path command.

Set primary path

The Set primary path command on the DMPW DSMs menu can be used to specify the currently selected path as the primary path to the disk or the array.

The following options are available:

- Set primary path for device
  This menu option is available only when the operational mode for the path to the disk is specified as Fail Over Only (Active/Passive) and the currently selected path is not the primary path . The primary path is the only path that is used to transfer data to and from the disk. Clicking this menu selection makes the selected path the primary path to the disk.
  See "Specifying the primary path for an array or disk" on page 30.

- Set primary path for array
  This lets you specify the currently selected path as the primary path to the array. The primary path is the only path that is used to transfer data to and from the array.
  The array's primary path can be set regardless of the array's current load balance setting. This means that if a disk in the array is set to Fail Over Only (Active/Passive), the primary path for the array becomes the primary path for the disk. If the setting is set to any other load balance option, then the primary path setting for the array is not used. However, if a disk in the array is set to Fail Over Only (Active/Passive), the primary path for the array becomes the primary path for the disk.
  For example, if an array has a load balance setting of round robin (Active/Active) and the primary path for the array is set to path 2-1-1, then any disk in the array that has the load balance setting of Fail Over Only (Active/Passive) will have its primary path set to path 2-1-1.
  See "Specifying the primary path for an array or disk" on page 30.

Properties

The Properties command brings up the Properties screen, which displays information about the selected path, including path name, status, and SCSI address.

See "Path status" on page 40.

View array, disk, and path status

DMPW DSMs provide status information for arrays, disks, and paths to the disks. Status displays are accessed through the path context menu.

See "Array status" on page 39.

See "Device status" on page 40.

See "Path status" on page 40.

Array status

To view array status with Array Properties, perform the following steps:

To view array status

1 Open the DMPW DSMs folder in the tree view.

2 Right-click the array that you are interested in and the array context menu appears.

3 Select **Properties** from the context menu.

4 The Properties screen appears.

The Properties screen contains the following:

Array Name	Displays the name of the array. The name is fixed by the array and is not user definable.
Array Type	Displays the type of load balance policy in effect for the array.
Control Timer Settings	A set of the following tunable parameters that affect the testing of a path's status or health. ■ Test Path Retry Count — The number of times DMPW DSMs test a path to determine if it has recovered from an error condition. The default value is 0. The maximum value is 50. ■ SCSI Command Timeout — The amount of time a SCSI command waits for a device to respond to it. The default value is 30 seconds. The maximum value is 120 seconds. ■ Kernel Sleep Time — The interval of time the DMPW DSMs kernel waits between attempts to recover a path from an error condition. The default value is 200 milliseconds. The maximum value is 10 seconds. ■ Failover Retry Count — The number of times DMPW DSMs attempt a failover to another path when the current path fails. The default value is 0. The maximum value is 50. Click OK to exit.

Load Balance Policy	Displays the load balancing setting in effect. There is one option, Fail Over Only (Active/Passive), that does not provide load balancing. All other options provide load balancing.
	Option descriptions are available.
	See "Active/Active and Active/Passive settings" on page 19.
	The procedure to specify settings is described also.
	See "Specifying load balancing settings for an array" on page 25.
Devices in the Array	Displays the number of disks in the array and lists them by name.

Device status

The way to view device status is as follows.

To view device status

1   In the tree view under the DMPW DSMs folder, select a disk whose status you want to view.

2   In the right pane, click the DMPW DSMs tab for the disk.

3   Right-click the path and select **Device Settings** from the path context menu that comes up.

4   The Device Settings welcome screen appears. Click **Next** to continue.

The Device Settings screen appears.

The Device Settings screen contains the setting for the **Load Balance Policy** for the disk.

Load Balance Policy — Indicates the setting in effect for the individual disk. The Fail Over Only (Active/Passive) option provides no load balancing. The other options provide load balancing.

Option descriptions are available.

See "Active/Active and Active/Passive settings" on page 19.

The procedure to specify settings is also described.

See "Specifying load balancing settings for a disk" on page 28.

5   Click **Cancel** to exit.

Path status

The way to view path status is as follows.

To view path status

1   Make sure that the path you want to view the status for is displayed in the
DMPW DSMs tab in the right pane of the VEA console.

If the DMPW DSMs tab is not showing, select a disk that uses that path in the
tree view under the Disks folder. Then, in the right pane, click the DMPW DSMs
tab for the disk.

2   Select the path in the DMPW DSMs tab.

Select **Properties** from the path context menu that comes up.

The Path Properties screen appears.

The screen displays the following information for the selected path:

Name	The name of the selected path.
Status	DMPW DSMs have two path state indicators: ■ Healthy — The path is operational. ■ Unhealthy — The path is not operational.
Primary	Whether the path is primary or not.
Port Number	The number of the physical port on the storage array that the selected path is connected to.
Channel	The channel that is associated with the path.
Target ID	The number that, when combined with the LUN, uniquely identifies a disk on the port.
LUN	Logical Unit Number, the number that, when combined with the Target ID, uniquely identifies a disk on the port.

3   Click **OK** to close the screen.

vxdmpadm

The `vxdmpadm` utility provides commands for Dynamic Multi-Pathing for Windows
(DMPW DSMs).

`dsminfo`	Displays information about the DSM.
`arrayinfo`	Displays information about an array.

deviceinfo	Displays information about a device (that is, a hard disk in an array).
pathinfo	Provides information about a path.
arrayperf	Displays performance statistics about an array.
deviceperf	Displays performance statistics about a device.
pathperf	Displays performance statistics about the paths connected to a device.
allperf	Displays performance statistics for all paths for all devices.
iostat	Displays the I/O statistics for a single disk, all disks in an array, or all the disks of all the arrays in the host.
cleardeviceperf	Resets the performance I/O statistics of a device.
cleararrayperf	Resets the performance I/O statistics of an array that contains the specified disk.
clearallperf	Resets the performance I/O statistics of all arrays under the control of the DMPW DSMs that the specified disk belongs to.
setdsmscsi3	Enables or disables SCSI3 support for the DMPW DSMs that controls the specified disk. On Windows Server operating systems, can enable or disable SCSI3 support for Symantec DSMs that are installed but with storage not yet connected.
setarrayscsi3	Enables or disables SCSI3 support in the registry of the array that contains the specified disk.
setattr dsm	Sets DSM attributes.
setattr array	Sets array attributes.
setattr device	Sets device attributes.
setattr path	Sets path attributes.
set isislog	Alters trace level of the VEA/ISIS log dynamically.
rescan	Rescans all the storage system objects on the computer.
disk list	Lists details of all the disks on the managed server.
getdsmattrib	Displays information for installed Symantec DSMs with no storage connection.
getmpioparam	Displays MPIO parameters for installed Symantec DSMs

`setmpioparam`	Sets MPIO parameters for installed Symantec DSMs

A full explanation of the DMPW DSMs software and commands is available.

See "DMPW overview" on page 10.

Each keyword is followed by the volume name or drive letter. Typing the following sequence for each keyword brings up a description of its syntax:

```
vxdmpadm<Keyword> -?
```

vxdmpadm dsminfo

```
vxdmpadm dsminfo <DiskName> | p#c#t#l#>
```

This command displays the DSM name, arrays in the DSM, and the array load balance policy. The *DiskName* parameter can be specified by the device name (such as `Harddisk2`). The `#s` in the `p#c#t#l#` parameter correspond to the port, channel, target, and LUN of a disk.

Example

```
vxdmpadm dsminfo Harddisk5
```

Displays the DSM information in which Harddisk5 participates.

vxdmpadm arrayinfo

```
vxdmpadm arrayinfo <DiskName> | p#c#t#l#>
```

This command displays the array name, the devices in the array, and the array load balance policy. It also displays the tunable parameters (control timer settings) that affect the testing and failover of paths. The *DiskName* parameter can be specified by the device name (such as `Harddisk2`). The `#s` in the `p#c#t#l#` parameter correspond to the port, channel, target, and LUN of a disk.

Example

```
vxdmpadm arrayinfo Harddisk5
```

Displays the array information for the array in which Harddisk5 participates.

vxdmpadm deviceinfo

```
vxdmpadm deviceinfo <DiskName> | p#c#t#l#>...
```

This command displays the device name, the internal disk name, number of paths, status, and load balance policy. The *DiskName* parameter can be specified by the

device name (such as `Harddisk2`). The `p#c#t#l#` parameter corresponds to the port, channel, target, and LUN of a disk.

Example

```
vxdmpadm deviceinfo Harddisk5 Harddisk6
```

Displays DMPW DSMs related information about Harddisk5 and Harddisk 6.

vxdmpadm pathinfo

```
vxdmpadm pathinfo <DiskName> | p#c#t#l#>...
```

This command displays path status, load balance policy, port, target, and LUN along with device name, internal disk name, and number of paths. The *DiskName* parameter can be specified by the device name (such as `Harddisk2`). The `p#c#t#l#` parameter corresponds to the port, channel, target, and LUN of a disk.

Example

```
vxdmpadm pathinfo Harddisk5 Harddisk6
```

Displays path information for Hardisk5 and Harddisk6.

vxdmpadm arrayperf

```
vxdmpadm arrayperf <DiskName> | p#c#t#l#>
```

This command displays the date and time of the performance statistics, the array name, all the devices in the array, the paths for each device, and the performance statistics of all the devices in the array. The statistics are grouped by each path that is connected to a device. The *DiskName* parameter can be specified by the device name (such as `Harddisk2`). The `#`s in the `p#c#t#l#` parameter corresponds to the port, channel, target, and LUN of a disk.

The performance statistics represent the aggregate workload of the array.

It includes the following number of:

- Reads
- Writes
- Bytes read
- Bytes written

Example

```
vxdmpadm arrayperf Harddisk5
```

Displays the performance statistics of the devices in the array in which Harddisk5 participates.

vxdmpadm deviceperf

```
vxdmpadm deviceperf <DiskName> | p#c#t#l#>...
```

This command displays the date and time of the performance statistics, the device name, the paths for the device, and the performance statistics of the device. The statistics are grouped by each path connected to the device. The *DiskName* parameter can be specified by the device name (such as Harddisk2). The p#c#t#l# parameter corresponds to the port, channel, target, and LUN of a disk.

The performance statistics represent the aggregate workload of the device.

It includes the following number of:

- Reads

- Writes

- Bytes read

- Bytes written

Example

```
vxdmpadm deviceperf Harddisk6
```

Displays the performance statistics of Harddisk6.

vxdmpadm pathperf

```
vxdmpadm pathperf <DiskName> | p#c#t#l#>...
```

This command displays the date and time of the performance statistics, the device name, and the performance statistics of the device. The statistics are grouped by each path connected to the device. The *DiskName* parameter can be specified by the device name (such as Harddisk2). The p#c#t#l# parameter corresponds to the port, channel, target, and LUN of a disk.

The performance statistics represent the workload of the paths connected to the device.

It includes the following number of:

- Reads

- Writes

- Bytes read

■ Bytes written

Example

```
vxdmpadm pathperf Harddisk6
```

Displays the performance statistics of Harddisk6.

vxdmpadm allperf

```
vxdmpadm allperf
```

This command displays performance information of the paths for all devices.

For devices, this includes the following:

■ Name of the counter

■ Path name

■ Device name

■ Array name

■ Counter value

For path summaries, this includes the following:

■ Name of the counter

■ Path name

■ Array name

■ Counter value

vxdmpadm iostat

This command displays the I/O statistics for a single disk, all disks in an array, or all the disks of all the arrays in the host. The statistics can be grouped by device or array. If no `groupby` is specified, then statistics is shown for all the paths. The statistics can be set to display after a specified number of seconds and for a specified number of times through this CLI option.

```
vxdmpadm iostat vxdmpadm [-g<DynamicDiskGroupName>] iostat
[showdevice|showarray] [interval=#] [count=#] <DiskName> | p#c#t#l#>
vxdmpadm [-g<DynamicDiskGroupName>] iostat [showdevice | showarray
| showall] [groupby=<device | array>] [-u <KB | MB | GB>]
[interval=seconds] [count=N] [<diskname | p#c#t#l#>]
```

The following attributes apply:

`showdevice|showarray`	Display I/O statistics: ■ showdevice specifies paths of the disk. (Default is showdevice.) ■ showarray specifies all the paths of the array that contains the disk.
showall	Displays the I/O statistics for all the paths of all the arrays connected to the host. Diskname should not be specified with this option.
groupby=device	The I/O statistics is shown per device. If no `groupby` is specified, then statistics is shown for all devices.
groupby=array	The I/O statistics is shown per array
KB	Data read or written is shown in KiloBytes/Second
MB	Data read or written is shown in MegaBytes/Second
GB	Data read or written is shown in GigaBytes/Second
`interval=#`	# specifies the amount of time (seconds) between displays of the I/O statistics. (Default value is 5 seconds between displays.)
`count=#`	# specifies the number of times the I/O statistics are displayed. (Default is infinite number of displays.)
<DiskName>	The designated disk, which can be specified by the device name (such as `Harddisk2`) or the internal disk name (such as `Disk2`). The internal disk name must be preceded by the `-g` option (for example, `-gDG2 Disk1`). The designated disk, which can be specified by the device name (such as `Harddisk2`).

p#c#t#l#   The #s correspond to the port, channel,
                                            target, and LUN of a disk.

vxdmpadm cleardeviceperf

vxdmpadm cleardeviceperf

<DiskName> | p#c#t#l#>

This command resets the performance I/O statistics of a device.

The following attributes apply:

<DiskName>   The designated disk, which can be specified by the device name (such
                  as Harddisk2).

p#c#t#l#   The #s correspond to the port, channel, target, and LUN of a disk.

vxdmpadm cleararrayperf

vxdmpadm cleararrayperf*<DiskName>* | p#c#t#l#>

This command resets the performance I/O statistics of an array that contains the
specified disk.

The following attributes apply:

<DiskName>   The designated disk, which can be specified by the device name (such
                  as Harddisk2).

p#c#t#l#   The #s correspond to the port, channel, target, and LUN of a disk.

vxdmpadm clearallperf

vxdmpadm clearallperf*<DiskName>* | p#c#t#l#>

This command resets the performance I/O statistics of all arrays under the control
of the DMPW DSMs that the specified disk belongs to.

The following attributes apply:

<DiskName>   The designated disk, which can be specified by the device name (such
                  as Harddisk2).

p#c#t#l#   The #s correspond to the port, channel, target, and LUN of a disk.

vxdmpadm setdsmscsi3

```
vxdmpadm setdsmscsi3 scsi3support=0|1 <DiskName> | p#c#t#l#> |
[dsmName=ALL | <DsmFileName>]
```

This command enables or disables SCSI3 support in the registry of the DMPW
DSMs that controls the specified disk.

The following attributes apply:

`scsi3support=0|1`	■ 0 disables SCSi3 support in the DMPW DSMs ■ 1 enables SCSi3 support in the DMPW DSMs
<DiskName>	The designated disk, which can be specified by the device name (such as `Harddisk2`).
`p#c#t#l#`	The `#`s correspond to the port, channel, target, and LUN of a disk.
`dsmName=ALL |` *<DsmFileName>*	This attribute applies the scsi3support=0|1 selection to enable or disable SCSI3 on installed DSMs before a connection is configured. You can apply to all installed DSMs or to a particular DSM, specified by file name. You can use the `vxdmpadm getdsmattrib` command to get a list of DSM file names.

vxdmpadm setarrayscsi3

```
vxdmpadm setarrayscsi3 scsi3support=0|1 <DiskName> | p#c#t#l#>
```

This command enables or disables SCSI3 support in the registry of the array that
contains the specified disk.

The following attributes apply:

`scsi3support=0|1`	■ 0 disables SCSi3 support in the DMPW DSMs ■ 1 enables SCSi3 support in the DMPW DSMs
<DiskName>	The designated disk, which can be specified by the device name (such as `Harddisk2`).
`p#c#t#l#`	The `#`s correspond to the port, channel, target, and LUN of a disk.

vxdmpadm setattr dsm

```
vxdmpadm setattr dsm [loadbalancepolicy=FO|RR|LQ|LB|BP [blockshift=#]]
[primarypath=#] [testpathretrycount=# scsicmdtimeout=#
kernalsleeptime=# failoverretrycount=#] <DiskName> | p#c#t#l#>
[dsmName=ALL | <DsmFileName>]
```

This command sets the load balance policy and primary path of the DSM to which
the designated disk belongs. It also lets you set tunable parameters (control timer
settings) that affect the testing and failover of the paths. The following attributes
apply:

`loadbalancepolicy=` `FO|RR|LQ|` `LB|BP`	Specifies the load balance policy for the DSM where: ■ FO specifies Fail Over Only (Active/Passive) ■ RR specifies Round Robin (Active/Active) ■ LQ specifies Dynamic Least Queue Depth ■ LB specifies Least Blocks ■ BP specifies Balanced Path
`blockshift=#`	# specifies the number of contiguous I/O blocks that are sent along a path to an Active/Active array before switching to the next available path. (Default value is 2048 blocks.)
`primarypath=#`	# specifies the primary path of the DSM. For example, primarypath=1-1-1 sets path 1-1-1 as the primary path of the DSM.
`testpathretrycount=#`	Range: 0 ~ 50 times. Default: 0.
`scsicmdtimeout=#`	# specifies the amount of time a SCSI command waits for a device to respond to a SCSI command. Default is 30 seconds. Maximum is 120 seconds.
`kernalsleeptime=#`	# specifies the interval of time the DMPW DSMs kernel waits between attempts to recover a path from an error condition. Default is 200 milliseconds. Maximum is 10000 milliseconds.
`failoverretrycount=#`	# specifies the number of times DMPW DSMs attempts a failover to another path when the current path fails. Default is 0. Maximum is 50 times. **Note:** For DMPW DSMs, Failover Retry Count does not apply to the EMC Symmetrix array.

<DiskName>	The designated disk, which can be specified by the device name (such as `Harddisk2`).
`p#c#t#l#`	The `#s` correspond to the port, channel, target, and LUN of a disk.
dsmName = ALL |*<DsmFileName>*	Specifies whether to apply settings to all installed DSMs or only to the DSM specified by file name. Only the load balance policy settings are applied. If other settings are specified, the command will return an error.
	Note: This parameter can be applied with or without a storage connection. If the array hasn't been configured with load balance settings previously, it inherits the load balance settings specified for the DSM once it is connected. However, if the array was previously connected and has been configured with load balance settings in the registry, the previous settings will be maintained when the array is reconnected.

Example

```
vxdmpadm setattr dsm loadbalancepolicy=FO
primarypath=1-1-0 scsicmdtimout=34 Harddisk6
```

Sets the load balance policy of the DSM to Fail Over Only (Active/Passive), the primary path to path 1-1-0, the scsicmdtimeout to 34 seconds.

vxdmpadm setattr array

```
vxdmpadm setattr array [loadbalancepolicy=FO|RR|RS [path#=state#]
|LQ|WP [path#=weight#]|LB|BP [blockshift=#]] [primarypath=#]
[testpathretrycount=# scsicmdtimeout=# kernalsleeptime=#
failoverretrycount=# ]<DiskName> | p#c#t#l#>
```

This command sets the load balance policy and primary path of the array to which the designated disk belongs. It also lets you set tunable parameters (control timer settings) that affect the testing and failover of the paths. The following attributes apply:

`loadbalancepolicy=`
 	
`FO|RR|RS`
 	
`|LQ|WP`
 	
`|LB|BP`
	Specifies the load balance policy for the array where:
	
	■ FO specifies Fail Over Only (Active/Passive)
	■ RR specifies Round Robin (Active/Active)
	■ RS specifies Round Robin with Subset
	■ LQ specifies Dynamic Least Queue Depth
	■ WP specifies Weighted Paths
	■ LB specifies Least Blocks
	■ BP specifies Balanced Path
	
	Note: Round Robin with Subset and Weighted Paths are available for A/PC and ALUA arrays only at the device level. They are not available at the array level.

`path#=state#`	`state#` specifies either standby (0) or active (1) state of the specified `path#`. For example, 1-1-1=0 means that path 1-1-1 is assigned a state of standby. (Default state of a path is active (1).)
`path#=weight#`	`weight#` specifies the weight assigned to the specified `path#`. For example, 1-1-1=10 means that path 1-1-1 is assigned a weight of 10. The path with the lowest weight indicates the most-favored path for I/O. (Range of values for `weight#`: `0 - 255`.)
`blockshift=#`	# specifies the number of contiguous I/O blocks that are sent along a path to an Active/Active array before switching to the next available path. (Default value is 2048 blocks.)
`primarypath=#`	# specifies the primary path of the array. For example, primarypath=1-1-1 sets path 1-1-1 as the primary path of the array.
`testpathretrycount=#`	# specifies the number of times the testpath routine will retry to test the health of the path. Range: 0 ~ 50 times. Default: 0.
`scsicmdtimeout=#`	# specifies the amount of time a SCSI command waits for a device to respond to a SCSI command. Range: 30 ~ 120 seconds. Default is 30 seconds.
`kernalsleeptime=#`	# specifies the interval of time the DMPW DSMs kernel waits between attempts to recover a path from an error condition. Range: 200 ~ 10000 milliseconds. Default is 200 milliseconds.

`failoverretrycount=#`	**#** specifies the number of times the failover routine will retry to failover the path. Range: 0 ~ 50 times. Default: 0.
	Note: For DMPW DSMs, Failover Retry Count does not apply to the EMC Symmetrix array.
<DiskName>	The designated disk, which can be specified by the device name (such as `Harddisk2`).
`p#c#t#l#`	The `#s` correspond to the port, channel, target, and LUN of a disk.

Examples

```
vxdmpadm setattr array loadbalancepolicy=FO primarypath=2-1-0
testpathretrycount=4 Harddisk6
```

Sets the load balance policy of the array to Fail Over Only (Active/Passive), the primary path to path 2-1-0, the testpathretrycount to 4 times.

```
vxdmpadm setattr array loadbalancepolicy=RR Harddisk6
```

Sets the load balance policy of the array to Round Robin (Active/Active).

vxdmpadm setattr device

```
vxdmpadm setattr device [loadbalancepolicy=FO|RR|RS [path#=state#]
|LQ|WP [path#=weight#]|LB|BP [blockshift=#]] [primarypath=#]
<DiskName> | p#c#t#l#>
```

This command sets the load balance policy and primary path of the device to which the designated disk belongs. The following attributes apply:

`loadbalancepolicy=`	Specifies the load balance policy for the device where:
`FO|RR|RS|`	■ FO specifies Fail Over Only (Active/Passive)
`LQ| WP|LB`	■ RR specifies Round Robin (Active/Active)
	■ RS specifies Round Robin with Subset
	■ LQ specifies Dynamic Least Queue Depth
	■ WP specifies Weighted Paths
	■ LB specifies Least Blocks
	■ BP specifies Balanced Path

path#=state#   state# specifies either standby (0) or active (1) state of
                                the specified path#. For example, 1-1-1=0 means that
                                path 1-1-1 is assigned a state of standby.

                                (Default state of a path is active (1).)

path#=weight#   weight# specifies the weight assigned to the specified
                                path#. For example, 1-1-1=10 means that path 1-1-1 is
                                assigned a weight of 10. The path with the lowest weight
                                indicates the most-favored path for I/O.

                                (Range of values for weight#: 0 - 255.)

blockshift=#   # specifies the number of contiguous I/O blocks that are
                                sent along a path to an Active/Active array before
                                switching to the next available path.

                                (Default value is 2048 blocks.)

primarypath=#   # specifies the primary path of the device. For example,
                                primarypath=1-1-1 sets path 1-1-1 as the primary path of
                                the device.

<DiskName>   The designated disk, which can be specified by the device
                                name (such as Harddisk2).

p#c#t#l#   The #s correspond to the port, channel, target, and LUN
                                of a disk.

Example

```
vxdmpadm setattr device loadbalancepolicy=FO primarypath=1-1-0
Harddisk6
```

Sets the load balance policy of the device to Fail Over Only (Active/Passive) and
the primary path to path 1-1-0 for Harddiskd6.

vxdmpadm setattr path

```
vxdmpadm setattr path [loadbalancepolicy=FO|RR|RS [path#=state#]
|LQ|WP [path#=weight#]|LB|BP [blockshift=#]] [primarypath=#]
<DiskName> | p#c#t#l#>...
```

This command sets the load balance policy and primary path of the designated
disk. The following attributes apply:

`loadbalancepolicy=` `FO|RR|RS|` `LQ|WP|LB`	Specifies the load balance policy for the device where: ■ FO specifies Fail Over Only (Active/Passive) ■ RR specifies Round Robin (Active/Active) ■ RS specifies Round Robin with Subset ■ LQ specifies Dynamic Least Queue Depth ■ WP specifies Weighted Paths ■ LB specifies Least Blocks ■ BP specifies Balanced Path
`path#=state#`	`state#` specifies either standby (0) or active (1) state of the specified `path#`. For example, 1-1-1=0 means that path 1-1-1 is assigned a state of standby. (Default state of a path is active (1).)
`path#=weight#`	`weight#` specifies the weight assigned to the specified `path#`. For example, 1-1-1=10 means that path 1-1-1 is assigned a weight of 10. The path with the lowest weight indicates the most-favored path for I/O. (Range of values for `weight#`: 0 - 255.)
`blockshift=#`	# specifies the number of contiguous I/O blocks that are sent along a path to an Active/Active array before switching to the next available path. (Default value is 2048 blocks.)
`primarypath=#`	# specifies the primary path of the device. For example, primarypath=1-1-1 sets path 1-1-1 as the primary path of the device.
<DiskName>	The designated disk, which can be specified by the device name (such as `Harddisk2`).
`p#c#t#l#`	The #s correspond to the port, channel, target, and LUN of a disk.

Example

```
vxdmpadm setattr path loadbalancepolicy=FOprimarypath=1-1-0
Harddisk6
```

Sets the load balance policy of the device to Fail Over Only (Active/Passive) and the primary path to path 1-1-0 for Harddiskd6.

vxdmpadm set isislog

```
vxdmpadm set isislog level=<#|default> [reg=<y|n>]
```

This command alters trace level of the VEA/ISIS log dynamically. The following attributes apply:

`level=#`	Specifies the trace level to be set as current trace level, where #can be:

- 1 specifies the trace level Info1
- 2 specifies the trace level Info2
- 3 specifies the trace level Info3
- 4 specifies the trace level Info
- 5 specifies the trace level Warning
- 6 specifies the trace level Error (default)

`reg=y|n`	Specifies whether to update the trace level in the registry or not.

- Specify reg=y to update the trace level in the registry.
- Specify reg=n to not update the trace level in the registry.

By default, the trace level is not updated in the registry if this attribute is not specified.

Example

```
vxdmpadm set isislog level=default
```

Sets the trace level to 'Error'(6) and does not update the trace level in the registry.

```
vxdmpadm set isislog level=4 reg=y
```

Sets the trace level to 'Info'(4) and updates the trace level in the registry.

vxdmpadm rescan

```
vxdmpadm [-b] rescan
```

Rescans all the storage system objects on the computer, including disks, volumes, and file systems. The `-b` option runs the command in the background.

vxdmpadm disk list

```
vxdmpadm disk list
```

Lists the device name and PCTL (Port, Channel, Target, LUN) information for all the disks on the managed server.

vxdmpadm getdsmattrib

```
vxdmpadm getdsmattrib [dsmName=ALL | <DsmFileName>]
```

`ALL` is the default; it gets the information for all installed Symantec DSMs.

`<DsmFileName>`: gets the information only for the DSM with that file name.

This command displays information for Symantec DSMs that have been installed in the system, with no storage connection required, as follows:

- The Symantec DSM file name

- The Symantec DSM full name which has been registered with MPIO

- The current load balance of the Symantec DSM

- The SCSI3 support setting of the Symantec DSM

vxdmpadm getmpioparam

```
vxdmpadm getmpioparam [dsmName=ALL | <DsmFileName>]
```

If a DSM file name is specified, the command will display MPIO parameter settings for the specified DSM. Otherwise, the command will display MPIO parameter settings for all Symantec DSMs that have been installed on a system.

vxdmpadm setmpioparam

```
vxdmpadm setmpioparam [default] |[PathVerifyEnabled=0|1]
[PathVerificationPeriod=#][PDORemovePeriod=#] [RetryCount=#]
[RetryInterval=#] [dsmName=ALL | <DsmFileName>]
```

This command enables changing MPIO timer parameters or restoring default MPIO timer parameters.

Warning: Symantec DSMs always use the default MPIO timer parameters. Therefore, this command should not be used unless a customer has been advised by Microsoft to change the settings for debugging purposes. Attempting to change these MPIO parameters would affect the behavior of a DSM for I/O error, path failover, and DSM performance.

---

default	Restores the default settings of these MPIO parameters
PathVerifyEnabled=0|1	Default: 0 (not enabled)
	If enabled (value 1) MPIO will perform path verification every *N* seconds where *N* is the value set in PathVerificationPeriod.

PathVerificationPeriod=#	# specifies the amount of time MPIO will perform the path verification, if path verification is enabled. Default: 30 seconds. Maximum value: MAXULONG.
PDORemovePeriod=#	# specifies the amount of time an MPIO pseudo LUN, which represents a disk under MPIO control, will stay in memory after all paths of a disk have been removed from the system. It also specifies how long the pending I/O should fail after all paths have been removed from a disk. Default: 20 seconds. Maximum value: MAXULONG.
RetryCount=#	# specifies the number of times DSM will ask MPIO to retry the I/O when an I/O error occurs. Default: 3. There is no maximum value.
RetryInterval=#	# specifies the amount of time MPIO should retry a failed I/O. Default: 1 second.
dsmName = ALL |<*DsmFileName*>	Specifies whether to apply these settings to all installed DSMs or only to the DSM specified by file name. **Note:** You can use the `vxdmpadm getdsmattrib` command if you want to find out the file names of installed DSMs.

Performance tuning

This chapter includes the following topics:

- Specifying control timer settings for an array

Specifying control timer settings for an array

Control Timer Settings for an array are a set of tunable parameters that affect the testing of a path's status or health.

To specify control timer settings for an array

1 To launch the Array Settings wizard, open the DMPW DSMs folder in the tree view.

2 Right-click the array that you are interested in and the array context menu appears.

3 Select **Array Settings** from the path context menu.

4 The Array Settings welcome screen appears. Click **Next** to continue.

5   The Select Array Settings parameters screen appears.

Edit the values for the parameters.

Click **Next** to continue.

The Control Timer Settings parameters are as follows:

Test Path Retry Count	The number of times DMPW DSMs test a path to determine if it has recovered from an error condition. The default value is 0. The maximum value is 50.
SCSI Command Timeout	The amount of time a SCSI command waits for a device to respond to it. The default value is 30 seconds. The maximum value is 120 seconds.
Kernel Sleep Time	The interval of time the DMPW DSMs kernel waits between attempts to recover a path from an error condition. The default value is 200 milliseconds. The maximum value is 10000 milliseconds.
Failover Retry Count	The number of times DMPW DSMs attempt a failover to another path when the current path fails. The default value is 0. The maximum value is 50.

6   The Array Settings summary screen appears displaying the settings for the array. Review the settings and click Finish to apply the settings and exit the wizard.

For some load balance policies, such as round robin with Subset, additional specifications are required. The Array Settings wizard displays a screen before the summary screen to collect these specifications. Click **Next** after setting these specifications to continue to the summary screen.

Troubleshooting

This chapter includes the following topics:

- Resolving DMPW issues

- Using status information

Resolving DMPW issues

Refer to *Veritas InfoScale Release Notes* for information on the known issues in this release.

Refer to the hardware compatibility list (HCL) on the Symantec Support Web site for the list of equipment that has been tested to work with DMPW:

http://www.veritas.com/docs/000025353

Refer to the software compatibility list (SCL) on the Symantec Support Web site for the list of supported software:

http://www.veritas.com/docs/000025350

When a DMPW license is no longer valid

If you have a demo license and have DMPW installed on an array and your demo license expires or you replace the demo license key with a permanent license key that does not include DMPW, the program will not let you make changes to your settings. However, all of your current settings will remain in effect. You need to purchase a license that enables DMPW to make any additional changes to your settings.

When an unknown disk group appears in a DMPW environment

When an unknown disk group appears in a DMPW environment, it is likely that there is a problem with a path to a storage array or that a storage array was not placed under the control of DMPW. Make sure that all paths are healthy and perform a rescan of all the disks and recheck the status of the disk groups.

Using status information

If a disk or a path fails, it is important to repair the disk or the path as quickly as possible to avoid data loss. Because time is critical, Dynamic Multi-Pathing for Windows (DMPW) makes it easy for you to locate problems quickly. In the **Status** column under the **DMP DSMs** tab, you can view the status of a path.

Path status

The following table lists the descriptions that appear in the **Status** column of the path in the right pane of the console window. Use this table to understand the meaning of each status and to identify the action that you need to take.

Table 5-1   Path status descriptions

Status	Meaning	Action Required
Healthy	The path is operational and has no known problems.	No user action is required.
Unhealthy	The path is not operational.	No user action is required. DMPW removes the unhealthy paths from the view.

See "View array, disk, and path status" on page 39.

Path states

The following table lists the icons that appear in the **Name** column of the path in the right pane of the console window. Use this table to understand the meaning of each icon.

Table 5-2   DMPW path states

Symbol	Meaning
	The path is active and it is designated as the primary path.

Table 5-2   DMPW path states *(continued)*

Symbol	Meaning
	The path is active.
	The path is passive.

Glossary

This chapter includes the following topics:

- Dynamic Multi-Pathing for Windows glossary

Dynamic Multi-Pathing for Windows glossary

Active/Active disk arrays	This type of multipathed disk array lets you access a disk in the disk array through all the paths to the disk simultaneously, without any performance degradation.
Active/Passive disk arrays	This type of multipathed disk array allows one path to a disk to be designated as primary and used to access the disk at any time. Using a path other than the designated active path results in severe performance degradation in some disk arrays.
ALUA	Asymmetric Logical Unit Access. A protocol specified in the SCSI-3 standard that is used by Asymmetric Active/Active (A/A-A) arrays.
block	The minimum unit of data transfer to or from a disk or array.
cluster	A set of hosts (each termed a node) that share a set of disks.

device name	The device name or address used to access a physical disk, such as hdisk3, which indicates the whole of disk 3.
	The device name or address used to access a physical disk, such as c0t0d0. The c#t#d# syntax identifies the controller, target address, and disk.
	The device name or address used to access a physical disk, such as sda or sda3, where sda indicates the whole device, and sda3 refers to the third partition on sda.
	The device name or address used to access a physical disk, such as c0t0d0s2. The c#t#d#s# syntax identifies the controller, target address, disk, and slice (or partition).
	In a SAN environment, it is more convenient to use enclosure-based naming, which forms the device name by concatenating the name of the enclosure (such as enc0) with the disk's number within the enclosure, separated by an underscore (for example, enc0_2). The term disk access name can also be used to refer to a device name.
disabled path	A path to a disk that is not available for I/O. A path can be disabled due to real hardware failures or if the user has used the `vxdmpadm disable` command on that controller.
disk	A collection of read/write data blocks that are indexed and can be accessed fairly quickly. Each disk has a universally unique identifier.
disk access name	An alternative term for a device name.
disk array	A collection of disks logically arranged into an object. Arrays tend to provide benefits such as redundancy or improved performance.
disk array serial number	This is the serial number of the disk array. It is usually printed on the disk array cabinet or can be obtained by issuing a vendor- specific SCSI command to the disks on the disk array. This number is used by the DMPW subsystem to uniquely identify a disk array.
disk controller	In the multi-pathing subsystem, the controller (host bus adapter or HBA) or disk array connected to the host.
disk enclosure	An intelligent disk array that usually has a backplane with a built-in Fibre Channel loop, and which permits hot-swapping of disks.
disk ID	A universally unique identifier that is given to each disk and can be used to identify the disk, even if it is moved.
disk media name	An alternative term for a disk name.
disk name	A logical or administrative name chosen for a disk that is under the control of DMPW DSM, such as disk03. The term disk media name is also used to refer to a disk name.

DMPW DSMs   Dynamic Multi-Pathing for Windows device-specific modules. DMPW DSMs are designed to support a multipath disk storage environment setup with the Microsoft Multipath I/O (Microsoft MPIO) solution. DMPW DSMs work effectively with Windows to provide a fault tolerant multipath disk storage environment. DMPW DSMs provide Windows Storport driver support.

DMPW   A short name for the product Dynamic Multi-Pathing for Windows.

enabled path   A path to a disk that is available for I/O.

enclosure   See disk enclosure.

enclosure-based naming   See device name.

failover   An automatic process where an alternative path to data on a storage array is activated when the current data path fails.

fault tolerance   The characteristic of ensuring data integrity and system functionality when hardware failures occur.

Fibre Channel   A collective name for the fiber optic technology that is commonly used to set up a storage area network (SAN).

JBOD (just a bunch of disks)   The common name for an unintelligent disk array which may, or may not, support the hot-swapping of disks.

load balancing   The process of balancing the data load between disks so that I/O demands are spread as evenly as possible across an I/O subsystem's resources. With DMPW, load balancing is achieved either by moving subdisks between disks or by using the Active/Active path configuration with DMPW to distribute the data load across multiple disks.

LUN   Logical unit number . The number that, when combined with the Target ID, uniquely identifies a disk on the port.

MPIO   Microsoft Multipath I/O. A Windows-based multi-pathing framework that interacts with DMPW DSMs.

multi-pathing   Where there are multiple physical access paths to a disk connected to a system, the disk is called multi-pathed. Any software residing on the host, (for example, the DMPW driver) that hides this fact from the user is said to provide multi-pathing functionality.

node   One of the hosts in a cluster.

path   When a disk is connected to a host, the path to the disk consists of the HBA (host bus adapter) on the host, the SCSI or fibre cable connector and the controller on the disk or disk array. These components constitute a path to a disk. A failure on any of these results in DMPW trying to shift all I/O for that disk onto the remaining (alternate) paths.

primary path	In Active/Passive disk arrays, a disk can be bound to one particular controller on the disk array or owned by a controller. The disk can then be accessed using the path through this particular controller.
RAID (redundant array of independent disks)	A disk array set up with part of the combined storage capacity used for storing duplicate information about the data stored in that array. This makes it possible to regenerate the data if a disk failure occurs.
secondary path	In Active/Passive disk arrays, the paths to a disk other than the primary path are called secondary paths. A disk is supposed to be accessed only through the primary path until it fails, after which ownership of the disk is transferred to one of the secondary paths.
SAN (storage area network)	A networking paradigm that provides easily reconfigurable connectivity between any subset of computers, disk storage and interconnecting hardware such as switches, hubs and bridges.
target ID	The number that, when combined with the LUN, uniquely identifies a disk on the port.