



ATTO Technology, Inc.

**ATTO MultiPath Director™
Installation and Operation Manual**

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ATTO MultiPath Director™ is available for Windows, Linux and Mac OS X Operating Systems. Please consult your storage vendor for a complete list of supported ATTO HBA's and Operating Systems.

1 ATTO Celerity MultiPath Director™ Overview

Workstation-based applications are evolving and demanding more sophisticated, feature-rich storage solutions. These high-end professional environments require multiple users to share access to large amounts of storage while maintaining the high-throughput performance rates required for the rich media and content applications they serve. The media and entertainment industry is undergoing a transformation to all digital content and accelerated workflow requirements. Digital media professionals are driving the needs for more sophisticated configurations, which require multiple users to share a “pool” of storage for continuous access to large amounts of data. Today, multiple workstations needing access to storage rely on fragmented storage solutions that don't fulfill the high-availability, high-performance demands of rich media applications in shared SAN environments.

When organizations lose access to their storage due to hardware malfunctions, basic maintenance or changes to the storage infrastructure, the cost of storage downtime can add up quickly. Businesses concerned with this kind of downtime are moving to higher-end storage solutions that feature redundant components with multiple connection paths between the workstations and the storage.

Windows and Linux operating systems include general support for redundant storage network infrastructures, or multipathing. The Apple operating system also provides some capabilities for high-availability systems, although they tend to lack management capabilities.

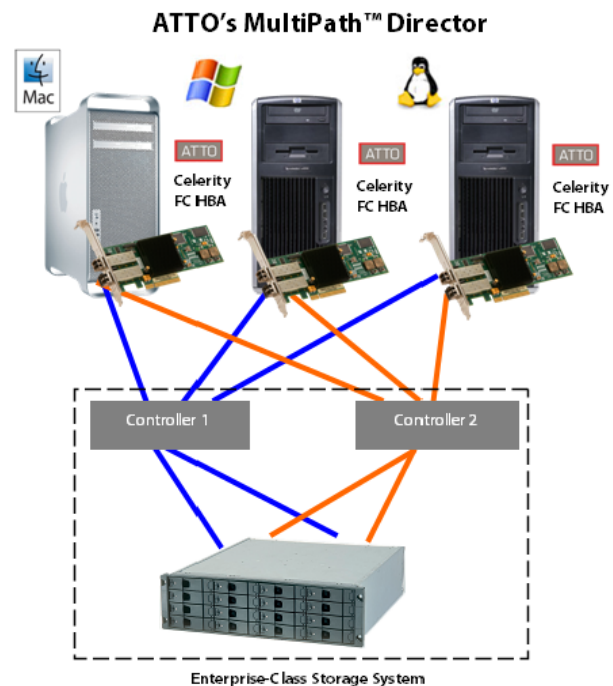
ATTO Technology has developed a feature-rich driver for its Celerity Fibre Channel host bus adapters that, when paired with enterprise-class storage systems, provides a completely redundant, high-performance storage solution for workstation applications in digital video, audio and content-creation environments.

ATTO's MultiPath Director is the ONLY storage connectivity solution that allows you to manage multiple paths between your Windows®, Linux and Mac® workstations, servers and high-end storage systems.

MultiPath Director provides a high-performance collaborative workflow solution that keeps digital media content available in real time for multiple users. This allows for significant gains in productivity, minimal downtime and uninterrupted access to enterprise-

class storage media. Providing multiple redundant paths to storage with load balancing and failover capabilities, ATTO's Fibre Channel host bus adapters with MultiPath Director are the premier choice for reliable and robust SAN connectivity.

Exhibit 1-1 Typical MultiPath Director Configuration.



1.1 MultiPath Director Solution

- RAID protects against a drive failure
- Multiple RAID controllers protect against a controller failure
- Multiple connections to each RAID controller protects against a port, cable or SFP (optical transceiver) failure
- Multiple ATTO Celerity Fibre Channel host adapters protects against a host adapter failure
- Multiple paths to the same target allows I/O to be sent down each of these paths, effectively increasing performance

1.2 MultiPath Director Benefits

High-Availability Connectivity to Storage - Automatic path failover and failback provides uninterrupted access to storage.

Superior Performance - Load balancing increases overall system performance by using more than one Fibre Channel path to transfer data.

Improved Productivity - Workstations can share storage, enabling collaborative workflow and real-time access to content to meet project deadlines.

Flexible Connectivity - Ability to mix Windows, Linux and Mac workstations in heterogeneous environments.

Simplified Management - ATTO ConfigTool simplifies administration, troubleshooting and management of multiple paths to storage.

1.3 Supported ATTO Celerity Fibre Channel Adapters

The list below outlines the ATTO Celerity Fibre Channel Host Adapters that currently support MultiPath Director for various operating systems. Please contact your storage manufacturer for currently supported Celerity Fibre Channel Host Adapters and driver versions. All adapters may not be supported with your particular storage array.

Supported Celerity HBAs include:

- FC-322E
- FC-321E
- FC-164P
- FC-162P
- FC-161P
- FC-164E
- FC-162E
- FC-161E
- FC-84EN
- FC-82EN
- FC-81EN

2 Installing the Celerity HBA Driver

For hardware installation, please see the ATTO Celerity Fibre Channel Host Adapter manual.

2.1 Driver Installation - Mac OS X (Supports 8, 16, and 32Gb)

- 1 Download the appropriate MultiPath Director driver file from www.attotech.com/downloads.html. Make sure it is the version qualified with the storage manufacturer you are connecting to.
- 2 Double-Click the **osx_drv_celerity8_xxxMP.dmg** (8 Gig Fibre Channel), or **osx_drv_celerity16-32_xxxMP.dmg** (16Gb and 32Gb Fibre Channel) file (xxx is the version number of the driver). This will create and launch the disk image.
- 3 Double-click **ATTOCelerityFC_xxxMP.pkg** or **ATTOCelerityFC8_xxxMP.pkg** to begin installation.
- 4 Click **continue** to agree to the “Software License Agreement”.
- 5 Select the “Destination drive (boot drive)” and select **continue**.
- 6 Select **Install**.
- 7 The driver will now automatically install. When complete the following screen will appear, click **restart** to reboot you machine.

2.2 Driver Installation - Windows (Supports 8, 16, and 32Gb)

Driver installation for Windows operating systems is a two step process

2.2.1 Installing Celerity Drivers

- 1 Download the appropriate storport driver package from www.attotech.com/downloads.html. Make sure it is the version qualified with the storage manufacturer you are connecting to.
- 2 Double-click the **win_drv_celerity8_xxx.exe** file for 8Gb, or **win_drv_celerity16-32_xxx.exe** for 16Gb and 32Gb (xxx is the version number of the driver) to extract the driver files.
- 3 When the driver files are extracted, the installer will be launched automatically. Click **Install** to install the driver.

2.2.2 Installing MultiPath Director Drivers

- 1 Download the appropriate MultiPath Director driver file from www.attotech.com/downloads.html. Make sure it is the version qualified with the storage manufacturer you are connecting to.
- 2 Double-click the **win_drv_mpdirector_xxx.exe** file (xxx is the version number of the driver) to extract the driver files.
- 3 When the driver files are extracted, the installer will be launched automatically. Follow the on-screen instructions until the installation completes.

2.3 Driver Installation - Linux (Supports 8, 16, and 32Gb)

- 1 Download the appropriate MultiPath Director driver file from www.attotech.com/downloads.html. Make sure it is the version qualified with the storage manufacturer you are connecting to.
- 2 Copy the `Inx_drv_celerity8mp_xxx.tgz` for 8Gb, or `Inx_drv_celerity16-32mp_xxx.tgz` for 16Gb and 32Gb file (xxx is the version number of the driver) to a temporary folder.
- 3 Open a terminal window and change to the location of the tgz file from step 2.
- 4 Extract the file using the command `tar xzf <filename.tgz>`
- 5 Change to the directory created above, then run the installer script `./install.sh`

3 Installing the ATTO ConfigTool

The ATTO ConfigTool is a utility program that displays information about installed storage adapters, drivers and devices and provides a mechanism to configure installed storage adapters in local and remote hosts. The ATTO ConfigTool is used to manage all ATTO host based products including HBAs, RAID adapters and Thunderbolt Devices.



Note

The ConfigTool service must be running even if the ConfigTool GUI is not installed

The ATTO ConfigTool provides a central interface for managing local and remote hosts with ATTO storage adapters installed. Features include:

- The names of ATTO storage adapters installed in the host
- Information about the devices attached to ATTO storage adapters
- Information about the drivers and firmware controlling the storage adapters, including version information

You may also use the ATTO ConfigTool to:

- Update the flash image when a new version is released by ATTO
- Modify the NVRAM settings (refer to the product-specific NVRAM information sections in this manual)
- Manage RAID groups
- Configure RAID notifications
- Revert to default factory settings

The factory settings should provide excellent performance for a wide range of applications. However, some applications may benefit from modification of the storage adapters NVRAM settings which tune the storage adapters for a specific performance range.

For further information on the use of the ATTO ConfigTool, please see the ATTO Utilities manual (https://www.attotech.com/software/files/manuals/Manual_Software_Uilities.pdf).

Pre-Installation

The ATTO ConfigTool is a free utility available via the ATTO website at www.attotech.com. This application supports a variety of operating systems. Please visit the ATTO website for specific operating system support information and downloads.

Oracle® Java version 1.5, or later, is required to use the ATTO ConfigTool. Visit <http://java.com> for the latest Java updates for Linux and Windows. The latest Java runtime for Mac OS X can be obtained through Software Update.



Note

Note: The GNU version of the JVM does not work with the ATTO installer. You must use Oracle Java.

To install the ATTO ConfigTool:

- Windows - run the .exe file
- OS X - mount the .dmg file
- Linux - expand the .tgz file

Installation

The ATTO ConfigTool includes two components: a GUI Application and a system service. Either, or both, of these components can be installed on a host, depending on the functionality desired. This creates several different use cases, described below:

- A host with both the GUI Application and the system service installed will be able to discover and manage local and remote hosts. This is the most comprehensive management capability. During installation of the ATTO ConfigTool select **FULL** installation for this coverage level.
- A host with only the GUI Application installed will be able to discover and manage remote hosts. This host will not be able to discover and manage any ATTO storage adapters installed on the same host. During installation of the ATTO ConfigTool select **APPLICATION ONLY** for this coverage level.
- A host with only the system service installed can be discovered and managed remotely, but it cannot be managed locally (the GUI Application is required for local management). It is common to have multiple hosts with only the system service installed being managed by a single host remotely. To set up a host without any local management capabilities, refer to the OS specific instructions below.

Installing the ATTO ConfigTool



Note

Logging features are only available if the ATTO ConfigTool service is installed. We recommend installing the service as a minimum configuration.

6 Obtain the Installer Package

Download the ConfigTool package from the ATTO website.

Package name is one of the following:

- win_app_configtool_xxx.exe (Windows)
- osx_app_configtool_xxx.dmg (OS X)
- lnx_app_configtool_xxx.tgz (Linux)

7 Windows Instructions:

- 1 Double-click the win_app_configtool_xxx.exe package file
- 2 Click “Unzip” to extract the installer files
- 3 The files are put in “C:\ATTO\ConfigTool\4.xx” directory

To install the **Full Application** or **Application Only**:

- 4 Navigate to the “C:\ATTO\ConfigTool\4.xx” directory
- 5 Double-click on the ConfigTool_xxx.exe installer executable
- 6 Select **Full Installation** or **Application Only** as desired
- 7 Follow the on-screen instructions

To install the **System Service** only:

- 4 Navigate to the “C:\ATTO\ConfigTool\4.xx\Service” directory
- 5 Double-click on the “attocfgd.msi” installer executable
- 6 Follow the on-screen instructions

8 OS X Instructions:

- 1 Double-click on the osx_app_configtool_xxx.dmg package file
- 2 A Finder window appears

To install the **Full Application** or **Application Only**:

- 3 In the Finder window that appears, double-click on the ConfigTool_xxx.app installer executable
- 4 Select **Full Installation** or **Application Only** as desired
- 5 Follow the on-screen instructions

To install the **System Service** only:

- 3 Navigate to the “Service” folder in the Finder window that appears
- 4 Double-click on the “attocfgd.mpkg” installer executable
- 5 Follow the on-screen instructions

9 Linux Instructions:

- 1 Extract the package file by running the following command in a terminal:
`tar -xvzf Inx_app_configtool_xxx.tgz`
- 2 Navigate to the extracted folder
"Inx_app_configtool_xxx"

To install the **Full Application** or **Application Only**:

- 3 Run the ConfigTool_xxx.bin installer executable as root or superuser.
- 4 Select **Full Installation** or **Application Only** as desired
- 5 Follow the on-screen instructions

To install the **System Service** only:

- 3 Navigate to the "Service" directory located inside the
Inx_app_configtool_xxx directory
- 4 Run the "attocfgd.sei" installer executable as root or superuser using the following command line:
`./attocfgd.sei -i`

Uninstalling the ATTO ConfigTool

1 Windows Instructions:

- 1 Navigate to Start->Control Panel
- 2 Select "Programs and Features"
- 3 Select the "ATTO ConfigTool xxx" entry
- 4 Click the "Uninstall/Change" button
- 5 Follow the instructions on the launched uninstaller

2 OS X Instructions:

- 1 Navigate to "/Applications/ATTO\ ConfigTool/uninstall"
- 2 Run "uninstall.app" and follow the instructions on the launched uninstaller

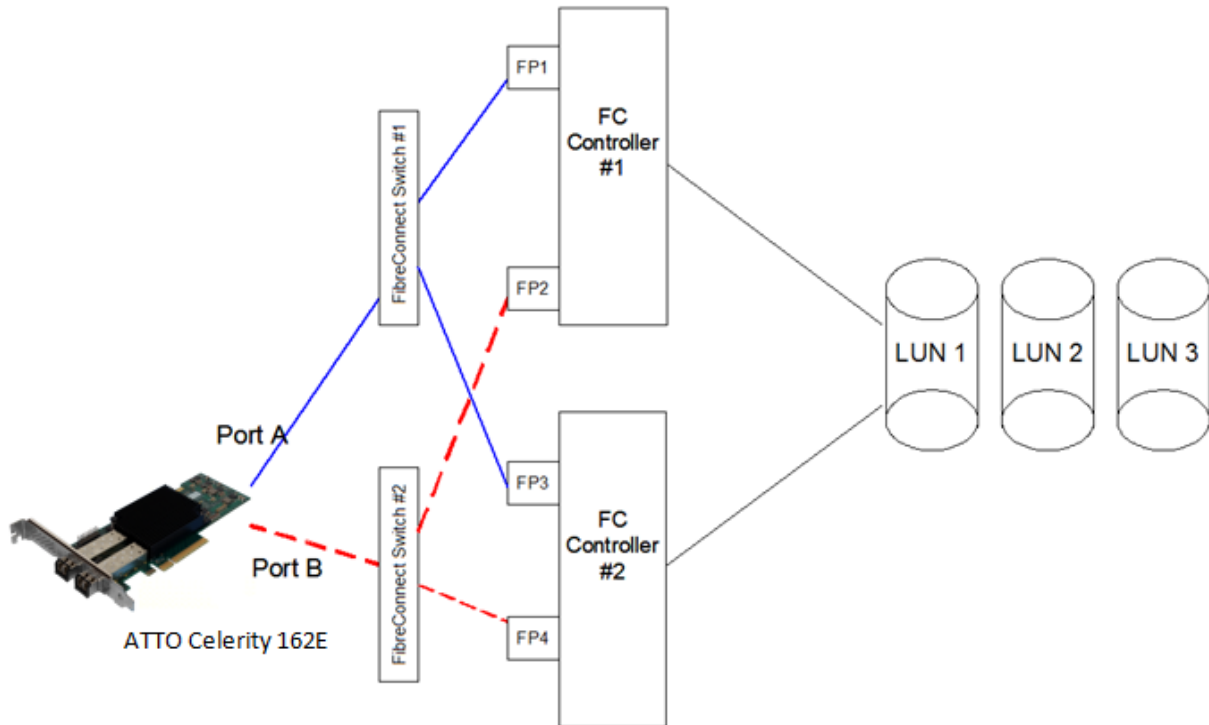
3 Linux Instructions:

- 1 Open a terminal window and navigate to "/usr/bin/attoconfig/uninstall"
- 2 Run the "uninstall" script and follow the instructions on the launched uninstaller

4 Sample MultiPath Director Configuration

The figure below (4-1 Cross Zoned Multipathing Configuration) shows an example of a cross-zoned multipathing configuration.

Exhibit 4-1 Cross Zoned Multipathing Configuration



There are (2) paths from the host, one to each of the switches. Each switch has (2) paths to the target, one to each of the RAID controllers.

This configuration provides (4) paths into the storage from two independent switches and adapter ports. This is one of the most common methods of multipathing in the industry.

- Celerity 82EN/162E Port A ---- Target Port FP1 and Target Port FP3 via Switch #1
- Celerity 82EN/162E Port B ---- Target Port FP2 and Target Port FP4 via Switch #2

If a connection between the host adapter port and either of the switches were to fail (Blue/Port A), all IO would be transferred to the opposite host adapter/switch (Red/Port B) path. Likewise, if a

connection on the back-end (switch to storage) were to fail, IO would be redirected automatically to the available paths. This provides the user simple failover and load balancing.

There are several different ways to configure:

- Automatic (via ALUA / most storage arrays)
- Manual by Target (most simple manual configuration)
- Manual by LUN (greatest level of manual configuration)



Note

Automatic is the recommended mode for reliability and performance.

5 Viewing Multipathing Information - Paths Tab (Status)

One of the strengths of the ATTO MultiPath Director driver is the ability to monitor and manage the multiple connections between the host and the storage. The ATTO Config Tool will show all associated paths to each target or LUN as well as the status of that path. It can also be used to track statistics for data transferred across each path. The **Paths** tab in the multipathing window displays connection path information from the host adapter ports to each individual target port or LUN in the storage system.

5.1 Paths (Target Basis)

Click on the Target in the device tree within the window on the left to display the Target “Paths” multipathing window on the right. In most cases, the Target “Paths” information relates to the connection between the host adapter and the RAID Controller Ports (Target). Most RAID Controllers have more than one port - most storage systems use at least two RAID Controllers. The result is multiple paths to a Target for a typical configuration. The “Paths” window in [5.1-1 Monitoring](#)

[Paths to a LUN](#) below shows four connection paths to the Target. This represents a system with two RAID controllers, each with two input connections (see [Exhibit4-1](#) on page 8). For this storage system, each connection port on the RAID Controllers is identified by a unique World Wide Name. The “Paths” window identifies how each path is configured for read and write operations and the current state of that path.

Exhibit 5.1-1 Monitoring Paths to a Target

The screenshot shows the ATTO ConfigTool interface. On the left is the 'Device Listing' tree with 'ClientPC' expanded to show 'MultiPath Director' and 'X279_HVPBP288F15'. The main window is titled 'Paths' and shows the following information:

Status: Online Load Balance: Pressure Transfer Count: 33.871 KB

| Target Port | Controller Port | Read Mode | Write Mode | Transferred |
|-------------------------|-------------------------|-----------|------------|-------------|
| 21:08:00:0c:ca:2a:15:f8 | 21:00:00:10:86:03:cb:45 | Preferred | Preferred | 30.61 KB |
| 21:08:00:0c:ca:2a:15:f8 | 21:00:00:10:86:03:cb:44 | Preferred | Preferred | 3.26 KB |
| 22:08:00:0c:ca:2a:15:f8 | 21:00:00:10:86:03:cb:45 | Preferred | Preferred | 0.00 bytes |
| 22:08:00:0c:ca:2a:15:f8 | 21:00:00:10:86:03:cb:44 | Preferred | Preferred | 0.00 bytes |





Below the table are tabs for 'Target', 'Adapter', and 'Statistics'. The 'Statistics' tab is active, showing:

| Average | | Total | |
|---------------|---------------|----------------|----------|
| Read Rate: | 0.334 bytes/s | Data Read: | 3.258 KB |
| Write Rate: | 0 bytes/s | Data Written: | 0 bytes |
| Command Rate: | 0 IO/s | Command Count: | 10 |
| Error Rate: | 0 Errs/Cmd | Error Count: | 0 |

At the bottom left is the ATTO logo. At the bottom right, a status bar shows 'X279_HVPBP288F15 information retrieved.'



Overall Status at a Target Level

The icon next to the device in the left hand pane indicates the overall multipathing status for the target (NOT each LUN).

-  A single path is connected to your device
-  Multiple paths are connected to your device
-  Multiple paths were connected to your device, but one or more have failed
NOTE: This will only be visible if a configuration was previously saved (See section 5.4)
-  Multiple paths were connected to your device, but all have failed
NOTE: This will only be visible if a configuration was previously saved. (See section 5.4)

Path Status at Target Level

The icon next to the Target Port in the right hand pane under the “Paths” tab when a target is selected indicates the connection status for the target port.

-  Paths are connected to the target and are functioning normally
-  Paths were connected to the target and are no longer connected
NOTE: This will only be visible if a configuration was previously saved (See Section 5.4)

Additional Management and Monitoring Capabilities at the Target Level

The following additional functions are available within the “Paths” window at a Target level. (Refer to [Exhibit 5.3-1 on page 14](#)).

Status

This represents the status of the sum of all paths connected to the highlighted Target device.

Online – All paths connected to a device are connected and operating properly.

Degraded – One or more paths have failed (if the configuration has been saved).

Changed – One or more paths have been added since the configuration was last saved.

Offline – All paths to a particular Target have failed (if the configuration has been saved) and connectivity has been lost.

Load Balance

The load balancing policy for a Target. See [Chapter 6 page 19](#) for more info.

Transfer Count

The total number of bytes transferred to a target. (You can reset these statistics by going to “Paths” in the Tool Bar and selecting “Reset Statistics”). These stats can be useful in determining if you are properly utilizing the paths.

Target Port

The WWPN (World Wide Port Name; i.e. unique Fibre Channel address) or user assigned alias for each port on the storage controllers

Controller Port

The WWPN (World Wide Port Name; i.e. unique Fibre Channel address) or user assigned alias for each port on the host adapter..

Read Mode

Indicates the selected path's read policy.

Preferred – This will be the first path that the driver will attempt to read IO through.

Alternate – This path will be used for read operations if the preferred path has failed.

Multiple – All LUN paths behind the target are not set the same. Path A (Preferred, Alternate, Disabled) for LUN 0 can be preferred and Path A for LUN 1 could be an alternate; this would result in multiple read mode.

Disabled – The associated path will not be used for read operations.

Write Mode

Indicates the selected path's write policy.

Preferred – This will be the first path that the driver will attempt to write IO through.

Alternate – This path will be used for write operations if the Preferred path has failed.

Multiple – All LUN paths behind the target are not set the same. Path A (Preferred, Alternate, Disabled) for LUN 0 can be preferred and Path A for LUN 1 could be an alternate; this would result in multiple write mode.

Disabled – The associated path will not be used for write operations.

Transferred

The total number of bytes transferred on the associated path.

5.2 Paths (LUN Basis)

The LUN “Paths” display helps to manage and monitor the connections to one or more virtual LUNs created by the RAID Controller. Click on a LUN in the device tree within the window on the left to display the expanded window on the right. Note that the ConfigTool provides three options when viewing LUNs: Basic Info, Flash and Paths. Click on the “Paths” option in the right half window to display the path details for each LUN. With most RAID

Controllers, the same LUN is usually assigned to more than one controller, resulting in multiple paths to each LUN. The display will list out each path, along with its current status for the selected LUN.

[Exhibit 5.2-1 on page 12](#) shows an example of LUN Path information. In this case, there are 4 paths to LUN 1. The WWN for each Target Port on the RAID controllers is listed to show the physical paths to each LUN. Each path can have the following status:

Path Status at LUN Level

The icon next to the Target Port in the right hand pane under Paths when a LUN is selected indicates the connection status for the LUN.





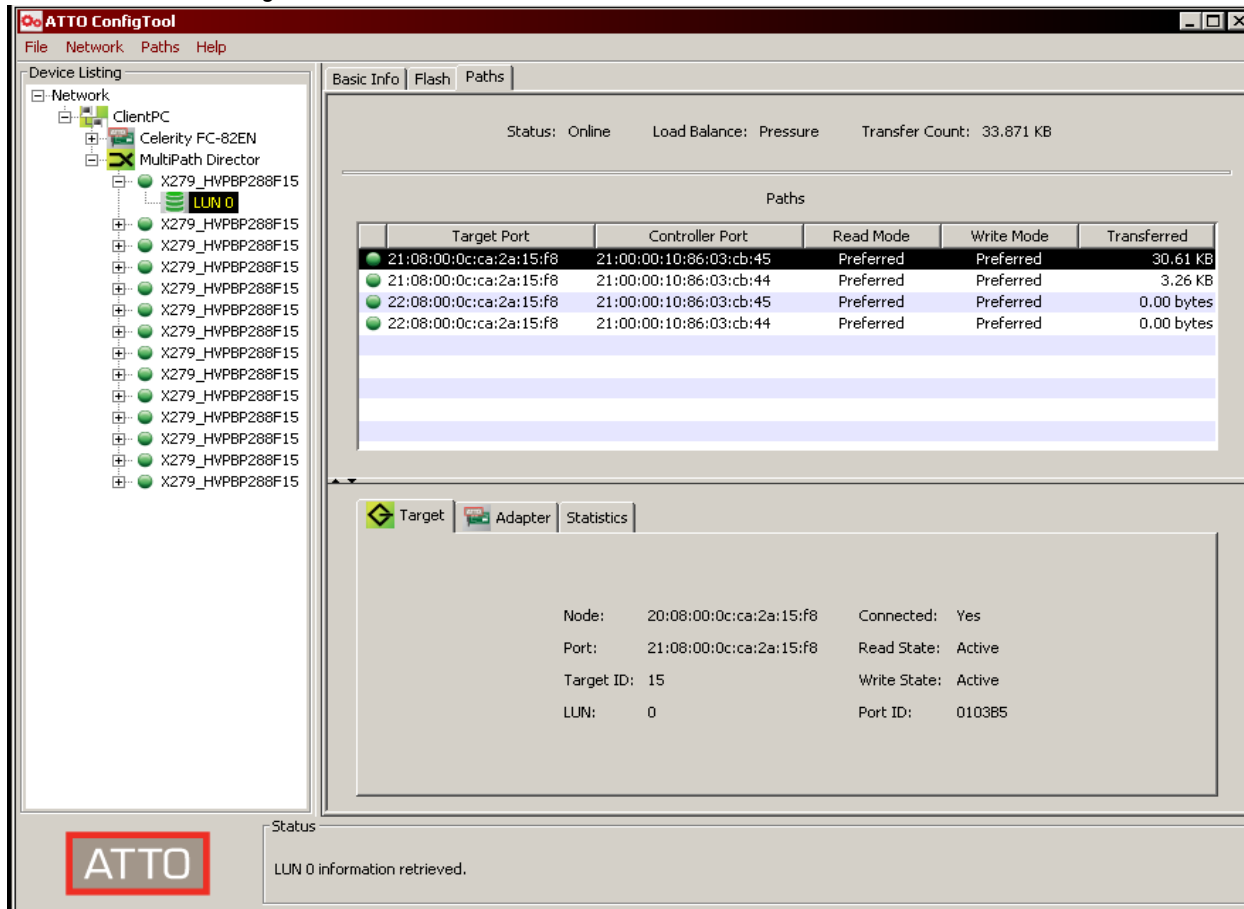
-  Path connected to selected LUN is functioning normally and available for I/O.
-  Path connected to the selected LUN has failed.
NOTE: This will only be visible if a configuration was previously saved. (See section 5.4)
-  Path to the selected LUN is set to Alternate for Read and Write functionality.
-  Path to the selected LUN is Logically DISABLED for Read and Write functionality.

Exhibit 5.2-1 Monitoring Paths to a LUN



Additional Management and Monitoring Capabilities at the LUN Level

The following additional functions are available within the "Paths" window at a LUN level. Refer to [5.2-1 Monitoring Paths to a LUN](#).

Status

This represents the status of the paths connected to the highlighted LUN.

Online - All paths connected to a device are connected and operating properly.

Degraded - One or more paths have failed (if the configuration has been saved).

Changed - One or more paths have been added since the configuration was last saved.

Offline - All paths to a particular LUN have failed (if the configuration has been saved) and connectivity has been lost.

Load Balance

The load balancing policy for a LUN. See Chapter 8 page 17 for more info.

Transfer Count

The total number of bytes transferred to a LUN. (You can reset these statistics by going to "Paths" in the Tool Bar and selecting "Reset Statistics"). These stats can be useful in determining if you are properly utilizing the paths.

Target Port

The WWPN (World Wide Port Name; i.e. unique Fibre Channel address) or user assigned alias for each port on the storage controllers.

Controller Port

The WWPN (World Wide Port Name; i.e. unique Fibre Channel address) or user assigned alias for each port on the host adapter.

Read Mode

Indicates the selected path's read policy.

Preferred - This will be the first path that the driver will attempt to read IO through.

Alternate - This path will be used for read operations if the Preferred path has failed.

Disabled - The associated path will not be used for read operations.

Write Mode

Indicates the selected path's write policy. Eg. Preferred, Alternate, Multiple (for targets ONLY) or Disabled.

Preferred - This will be the first path that the driver will attempt to write IO through.

Alternate - This path will be used for write operations if the Preferred path has failed.

Disabled - The associated path will not be used for write operations.

Transferred

The total number of bytes transferred on a particular path.

5.3 Path Details

Select a Target or LUN in the left hand pane of the ConfigTool and click on the "Paths" tab in the top of the right hand pane. This will display additional information for the path on a Target or LUN basis in the lower half of the window. The following information is available in three tabs:

1. Target

When a target or LUN is selected, this window will display information for the storage device's target port that is connected to the path. (Refer to [Exhibit 5.3-1 on page 14](#))

Node

World Wide Node Name of the Target Port. This is useful in determining which target Node you are connected to.

Port

World Wide Port Name of the Target Port. This is useful if an alias was assigned to the Target Port.

Target ID

Internal ID used by the ATTO driver

LUN

LUN used to access the device on the Target Port.

Connected

Link Status (Yes, No). Used to identify if the device is logged into the ATTO adapter.

Read State

Status of Read Policy (Active, Alternate, Disabled, Failed, Multiple)

Active - The associated path to the target will be used for read operations.

Alternate - The associated path to the target will only be used as a read alternate in the event there are no active paths.

Disabled - The associated path will not be used for read operations.

Multiple - Special case only available if the target is selected in the left hand pane. The associated paths have several states (active, alternate or disabled) for that target. For example Target 0 could have Path A for LUN 0 as active and Path A for LUN1 as alternate; this would result in a multiple state for that target.

Failed - If the associated path was saved, this path has failed for reads.

Write State

Status of Write Policy (Active, Alternate, Disabled, Failed, Multiple)

Active - The associated path to the target will be used for write operations.

Alternate - The associated path to the target will only be used as a write alternate in the event there are no active paths.

Disabled - The associated path will not be used for write operations.

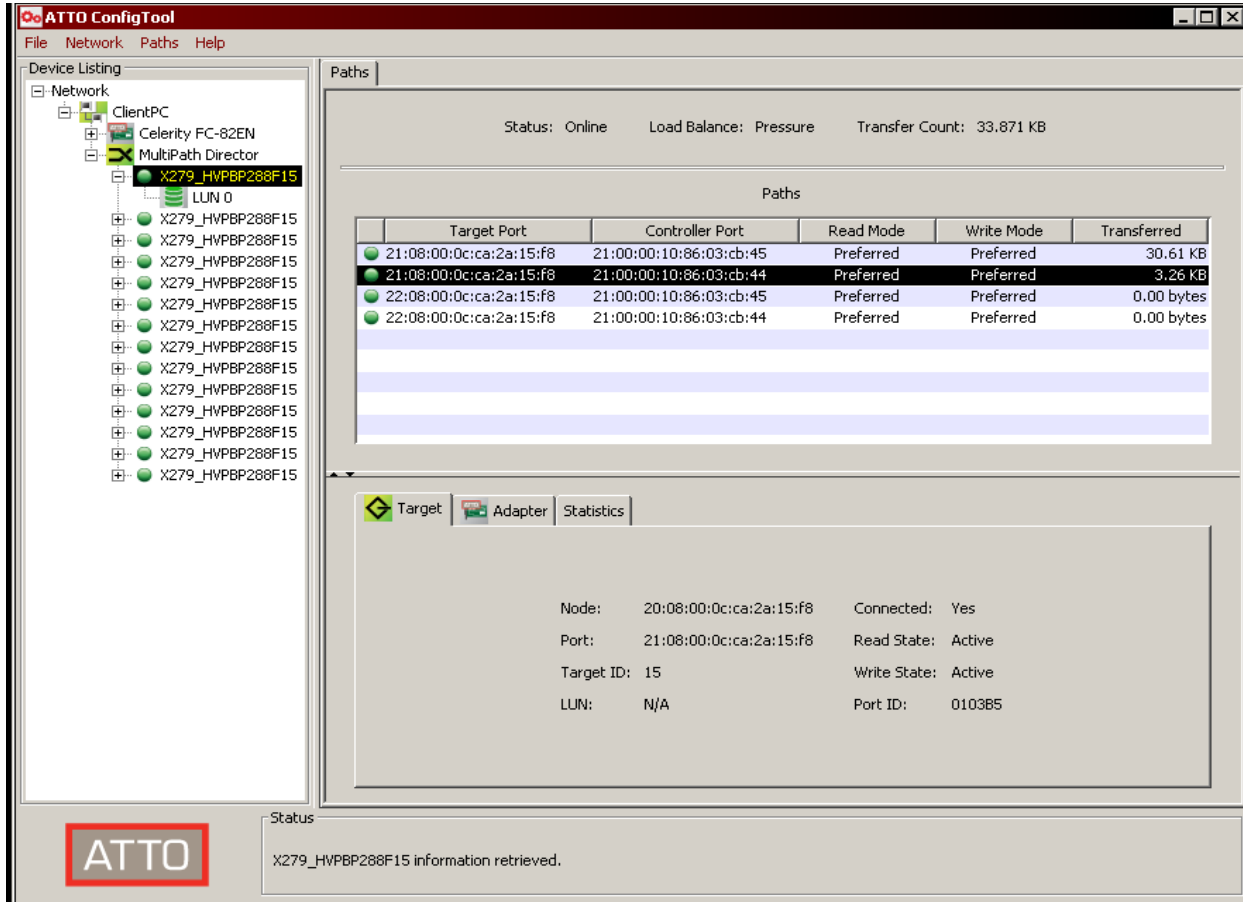
Multiple - Special case only available if the target is selected in the left hand pane. The associated paths have several states (active, alternate or disabled) for that target. For example Target 0 could have Path A for LUN 0 as active and Path A for LUN1 as alternate; this would result in a multiple state for that target.

Failed - If the associated path was saved, this path has failed for writes.

Port ID

Fibre Channel Port ID

Exhibit 5.3-1 Target Information



2. Adapter

When a path is selected it displays information for the Celerity host adapter channel that is connected to that path. (Refer to [Exhibit 5.3-2 on page 15](#))

Node - World Wide Node Name of the Celerity FC Adapter port.

Port - World Wide Port Name of the Celerity FC Adapter port.

Port ID - Fibre Channel Port ID of the Celerity FC Adapter port.

Link - Status of Fibre Channel Link (Up, Down).

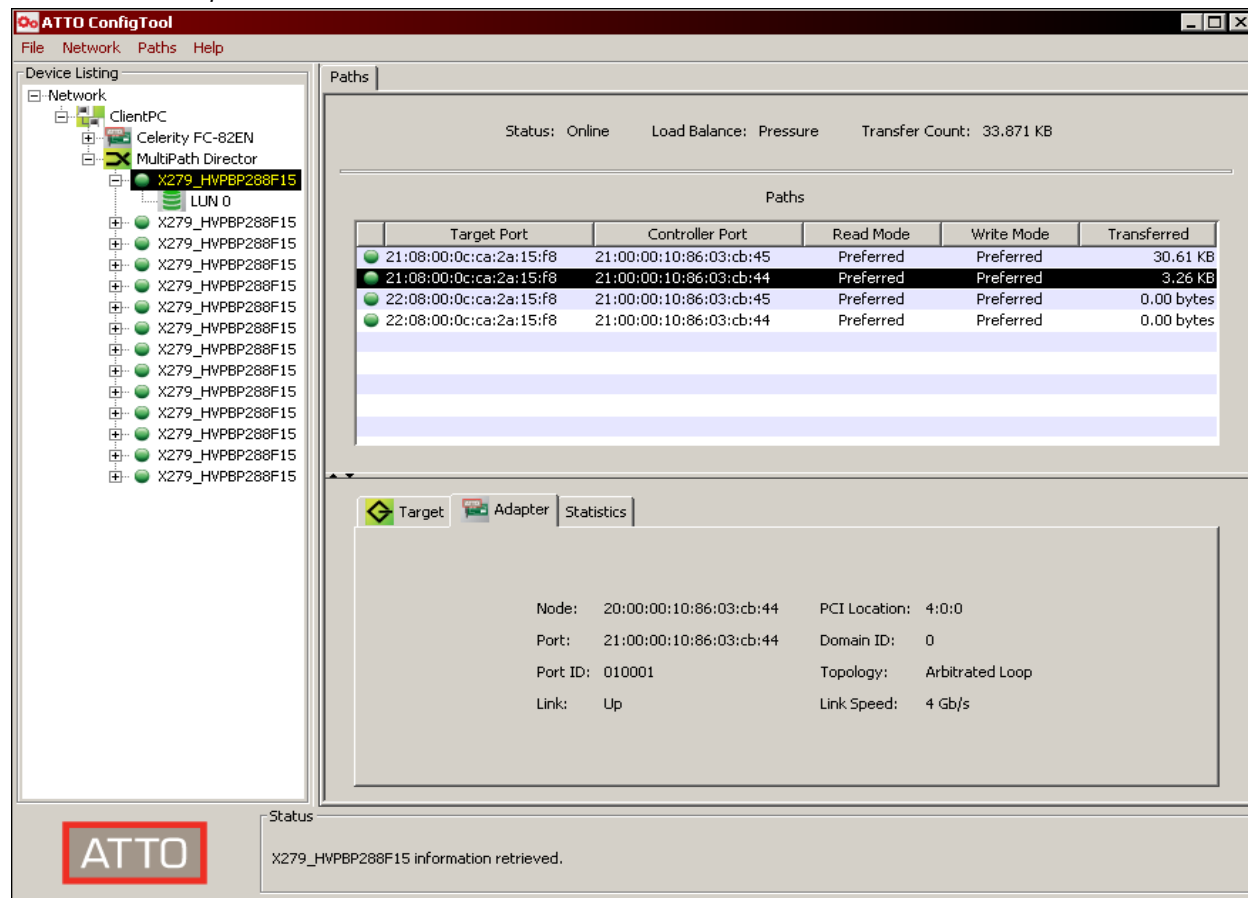
PCI Location - Location of the Fibre Channel Adapter in the PCI bus of the computer.

Domain ID - Number of the Fibre Channel Domain.

Topology - Fibre Channel Topology (Point to Point, Arbitrated Loop, Unknown).

Link Speed - Fibre Channel Data Rate (16Gb/s, 8Gb/s, 4Gb/s, 2Gb/s, 1Gb/s).

Exhibit 5.3-2 Adapter Information



3. Statistics

When a Target or LUN path is selected, this window displays information regarding data transferred down that path. (Refer to [Exhibit 5.3-3 on page 16](#))

Average

Read Rate – Number of bytes read per second for a particular path.

Write Rate – Number of bytes written per second for a particular path.

Command Rate – Number of commands sent down a particular path in IO's per second.

Error Rate – Error rate in errors per command for a particular path.

Total

Data Read – Total amount of data in bytes read for a particular path.

Data Written – Total amount of data in bytes written for a particular path.

Command Count – Total number of commands sent down a particular path.

Error Count – Total number of errors for a particular path.

Exhibit 5.3-3 Path Statistics

The screenshot shows the ATTO ConfigTool interface. On the left, the 'Device Listing' pane shows a tree view with 'ClientPC' expanded to 'MultiPath Director' and 'LUN 0' selected. The main area displays 'Paths' with a status of 'Online', 'Load Balance: Pressure', and 'Transfer Count: 33,871 KB'. A table lists paths with columns for Target Port, Controller Port, Read Mode, Write Mode, and Transferred. Below the table, the 'Statistics' tab shows 'Average' and 'Total' performance metrics.

| Target Port | Controller Port | Read Mode | Write Mode | Transferred |
|-------------------------|-------------------------|-----------|------------|-------------|
| 21:08:00:0c:ca:2a:15:f8 | 21:00:00:10:86:03:cb:45 | Preferred | Preferred | 30.61 KB |
| 21:08:00:0c:ca:2a:15:f8 | 21:00:00:10:86:03:cb:44 | Preferred | Preferred | 3.26 KB |
| 22:08:00:0c:ca:2a:15:f8 | 21:00:00:10:86:03:cb:45 | Preferred | Preferred | 0.00 bytes |
| 22:08:00:0c:ca:2a:15:f8 | 21:00:00:10:86:03:cb:44 | Preferred | Preferred | 0.00 bytes |

| Average | | Total | |
|---------------|---------------|----------------|----------|
| Read Rate: | 0.317 bytes/s | Data Read: | 3,258 KB |
| Write Rate: | 0 bytes/s | Data Written: | 0 bytes |
| Command Rate: | 0 IO/s | Command Count: | 10 |
| Error Rate: | 0 Errs/Cmd | Error Count: | 0 |

Status: X279_HVPBP288F15 information retrieved.

5.4 Saving your Configuration



Note

In order to see the associated states of each path (degraded, failed, etc), it is necessary to save your configuration after initial setup. It is also recommended you save your setup after any changes to your SAN.

To save your configuration:

- 1 Highlight the Target in the left pane.
- 2 Select "Paths" from the toolbar.
- 3 Select "Save Configuration" or CTRL + S (or COMMAND + S in Mac OS).
- 4 You will be prompted to save current configuration - select "Yes".

Your multipathing configuration is now saved.



Note

If a LUN is selected in the left pane, only the paths for that particular LUN will be saved.

5.5 Paths Menu

The following functionality can be accessed via the “Paths” menu in the Toolbar, or by right clicking (CTRL + clicking in Mac OS) in the Paths window. Some items also have keyboard shortcuts.

- The “Set Alias” option ([Exhibit 5.5-1 on page 18](#)) will allow you to set a target or controller port alias for the selected path, or set an alias for the selected LUN in the left navigation pane. Target and controller port aliases apply to all paths that contain those ports.
- The “Setup” option in the Paths menu will allow you to configure your paths or load balancing options. The “Setup” option may not appear with some storage systems. In these cases, the optimal path configuration has been predetermined and will automatically be configured (see [Chapter 8 page 21](#)). Users can still select the appropriate “Load Balancing” policy when the paths are automatically configured.
- The “Save Configuration” option will save all paths at any given point in time when the Target is selected. This will allow the user to determine if there has been a link failure or other errors.

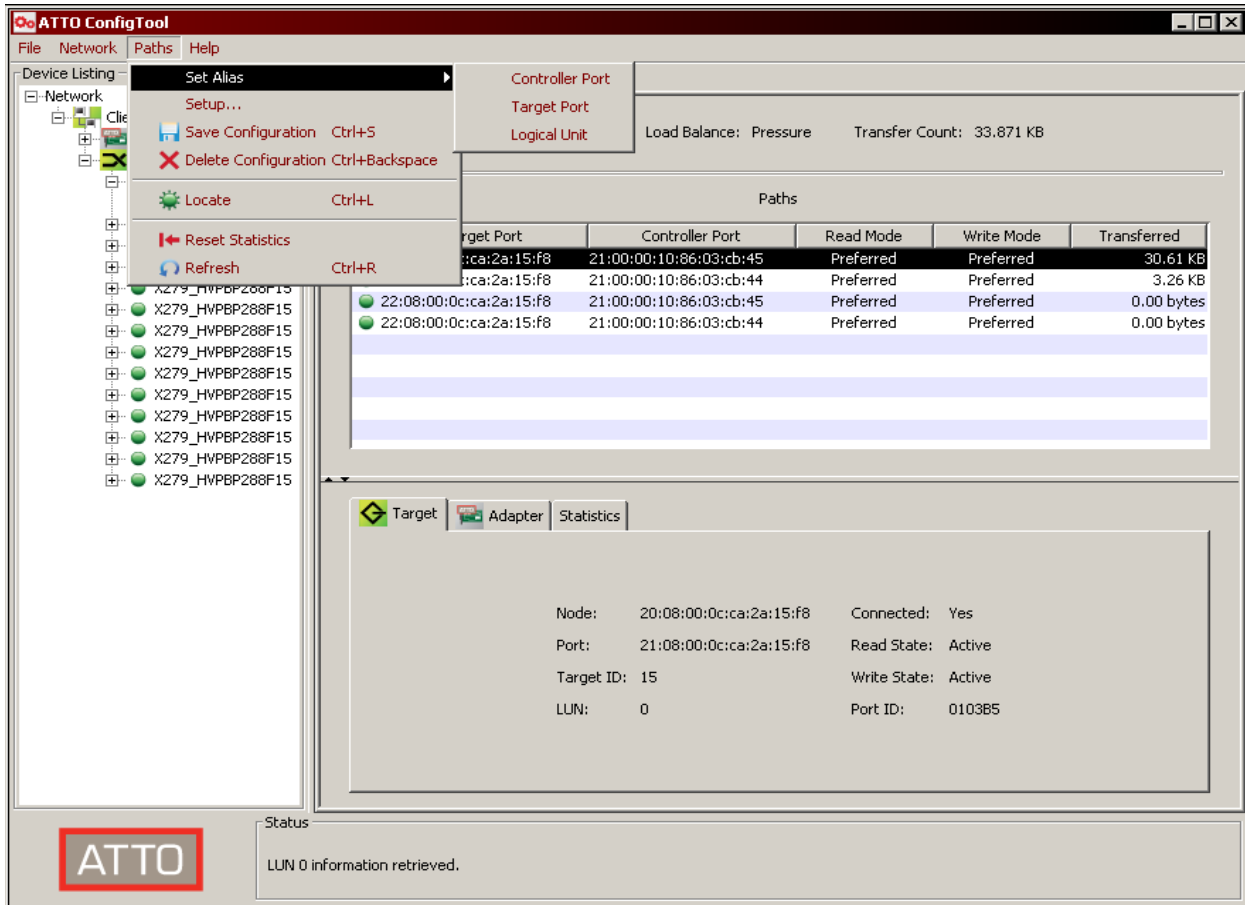


Note

It is recommended that you save your configuration after you verify your multipathing setup is operating properly.

- The “Delete Configuration” will delete the saved configuration. This can be useful if devices have been removed from your SAN or changed in your SAN.
- The “Locate” button will blink the particular FC adapter’s port LED (very useful troubleshooting tool). You can also locate via CTRL + L (or COMMAND + L in Mac OS).
- Statistics can be reset to ‘0’ by choosing “Reset Statistics”.
- Paths can be manually refreshed by choosing “Refresh” or CTRL + R (or COMMAND + R in Mac OS). The ConfigTool will periodically (every 10 seconds) refresh the path statistics for all devices. If the connection status for a path changes, the ConfigTool will automatically refresh the display.

Exhibit 5.5-1 Paths Menu



6 Load Balancing Policies and Configuration

In addition to failover, the MultiPath Director driver also supports load balancing. This is where the host adapter driver can utilize more than one Fibre Channel link to move data to/from a target or a LUN. The result is a considerable increase in performance. The ATTO Celerity Host Adapter will load balance whenever there are two or more paths to a LUN and at least two of these paths are “preferred”. Load balancing policies (algorithms) can be set on a per Target or a per LUN basis, giving the end user more control of how performance is balanced across RAID controllers and workstations in a SAN environment. ATTO currently supports three load balancing policies (Pressure, Round Robin, and Queue Depth).

Pressure (default)

The path with the least number of bytes currently being transferred is selected for I/O. Pressure based load balancing is domain based. Path selection is based on the domain (adapter channel) with the fewest bytes being transferred. For example, an application sends a 1 MB I/O to LUN 1 that goes down path 1. If the application then issues two 512KB I/Os to LUN 2, they both will be transferred on path 2. If a target based approach was taken, 1.5 MB of data would have been transferred on one path while 512KB would have went on the other – not a good use of available bandwidth. This load balancing algorithm is designed for performance when large blocks are transferred. It usually results in the best performance for most applications.

Queue Depth

The path with the fewest I/Os outstanding will be selected for the next I/O. This policy is strictly target based. Consider an application that simultaneously issues 10 various size I/O's to the target. Assuming there are two paths to the target, 5 I/O's will go down one path and 5 will go down the other. The size of each I/O does not matter in this case. This load balancing policy is designed for those storage devices that have resource

limitations on each target port. If a dual ported device can only handle 10 I/Os on each port, an application can have a queue depth of 20 and be guaranteed the target can process all requests immediately regardless of I/O size.

Round Robin

The least used path is selected for I/O. This policy is also target based. Like Queue Depth, an I/O count is used for path selection; however, the count is cumulative for all I/O in the current configuration (NOT the number of currently queued I/O's). For example, if an I/O operation starts and finishes on one path to a dual ported device, the second path is used when the next I/O operation starts. The round robin policy exercises all paths when the application queue depth to a target is 1. In other words, it ensures that all hardware devices are used evenly. The other policies select the same path repeatedly when the queue depth is 1. The primary reason for using this policy is to exercise all paths when the application queue depth to a target is one. The other policies will always select the same path when the queue depth is one.

6.1 Adjusting Load Balancing Policies

Load Balancing can be configured on a target or LUN basis. If you select the target in the left hand pane, you will set the load balancing policy for all LUNs associated with that target. If you select a LUN you will only set the load balancing policy for that particular LUN. All paths associated with a LUN or target must share the same load balancing policy.

- 1 Select the “Target” or “LUN” in the left hand pane of the ConfigTool.
- 2 Select “Paths” in the toolbar. You can also right click (or CTRL - click in Mac OS) inside the paths window.
- 3 Select “Setup” or “Load Balancing”.
- 4 Select a policy. (Pressure, Round Robin, or Queue Depth)
- 5 Select “Finish”.



Note

It is not necessary to save the configuration to save load balancing settings.

7 ALUA – Asymmetric Logical Unit Access

ALUA is the behavior defined in the SCSI specification that describes how storage devices with multiple ports are to behave. Asymmetrical Logical Unit Access occurs when the access characteristics of one port differ from another. All ports that have the same behavior are referred to as target port groups. Typically, they are referred to as controllers on storage devices. Among other things, each target port group has an asymmetric access state. The MultiPath Director driver will use this state to automatically configure path modes for optimal performance. The ALUA state can be one of the following (with the corresponding path mode in parentheses):

Active/optimized (Preferred)

The path can execute all commands supported by the device with optimal performance.

Active/non-optimized (Alternate)

The path can execute all commands supported by the device with less than optimal performance.

Standby (Alternate)

The path can only execute a subset of commands supported by the device. This typically does not include I/O commands (ex. Reads and Writes). The path can be activated to allow I/O if needed, but usually another active path is reverted to standby at the same time.

Unavailable (Disabled)

The path can only execute a subset of commands supported by the device and it is not available for I/O (ex. Reads and Writes). This state is typically used when a hardware failure has occurred or the device has been placed in a maintenance or service mode.

ALUA allows for target port groups to transition from one state to another. These transitions can be determined by the storage device (implicit transitions) or by the host adapter (explicit transitions). The ATTO MultiPath Director driver supports both of these models.



Note

The preferred mode is reported to the driver from the target array.

Implicit transitions are automatically detected by the driver and the path modes are updated accordingly. The driver will initiate an explicit transition from the standby state to an active state only when no viable active paths to the device exist. During this process,

I/O is suspended and will resume as soon as the transition is complete.

Alternate paths are activated in a tiered approach. Active/non-optimized alternates are immediately activated to take the place of a preferred path. Standby alternates are activated only when there are no remaining active paths.



Note

Saving the configuration does not override ALUA functionality.

Events that result in failover generally fall into two classes:

- 1 Link/protocol events:
 - SFP failure
 - Cable pull
 - Controller power down
 - RSCNs (Registered State Change Notification)
 - LIPs (Loop Initialization Primitive)
 - Other events that result in the target device becoming (temporarily) unavailable for I/O
- 2 When a target is present (logged in), commands are monitored for errors to determine when the path should be logically deactivated. For this reason, all failover is managed at a LUN level.

When a path fails:

- Active/non-optimized alternates are immediately activated to take the place of a preferred path when no preferred paths exist.
- Standby alternates are activated only when there are no remaining active paths.
- Disabled paths will never be activated.

8 Manual Configuration via the Setup Wizard

Every storage device behaves differently in terms of how it handles multiple path configurations to its LUNs. Arrays that support ALUA will most often automatically negotiate path configuration with the ATTO host adapter.

There are a few storage arrays that do not support ALUA. Users will need to manually configure each path to each LUN for these configurations.

An exception to the dynamic path configuration based on ALUA state is when a user needs to manually configure a path mode with the ConfigTool. In this case, the path mode is never changed until the user deletes the original configuration. This is done via the “Setup” Wizard.



CAUTION

Manual Configuration will override the ALUA configuration and is NOT recommended! This is only recommended if your storage does not support ALUA. Please contact your storage manufacturer to determine if an array supports ALUA.

The following settings can be configured on a per LUN or per Target basis (depending on which is highlighted in the left hand pane). If the Target is highlighted, then **ALL** LUN's controlled by it will be configured the same. Users can also customize settings on a per LUN basis.

- Write Mode per Target or LUN (Preferred, Alternate, or Disabled). This allows you to steer writes down a particular path.

- Read Mode per Target or LUN (Preferred, Alternate, or Disabled). This allows you to steer reads down a particular path.
- Load Balancing Policy (see [Chapter 6](#)) per Target or LUN (Pressure, Round Robin, or Queue Depth).

To configure the path:

- 1 Highlight either the Target or LUN to be configured.
- 2 Navigate to the Paths tab in the toolbar.
- 3 Choose “Setup”.
- 4 Notice the configurable options in the lower right pane.
- 5 Select the Load Balancing Policy of choice Target or LUN highlighted.
- 6 Choose “Next”.
- 7 Choose Read policy for the path highlighted
- 8 Choose Write Policy for the path highlighted.
- 9 Select “Next”.
- 10 Choose Load Balancing, Read, and Write Policy for each of the remaining paths.
- 11 When done, select “Finish”. (Clicking “Finish” automatically saves the configuration and overrides any ALUA or previously saved configuration).

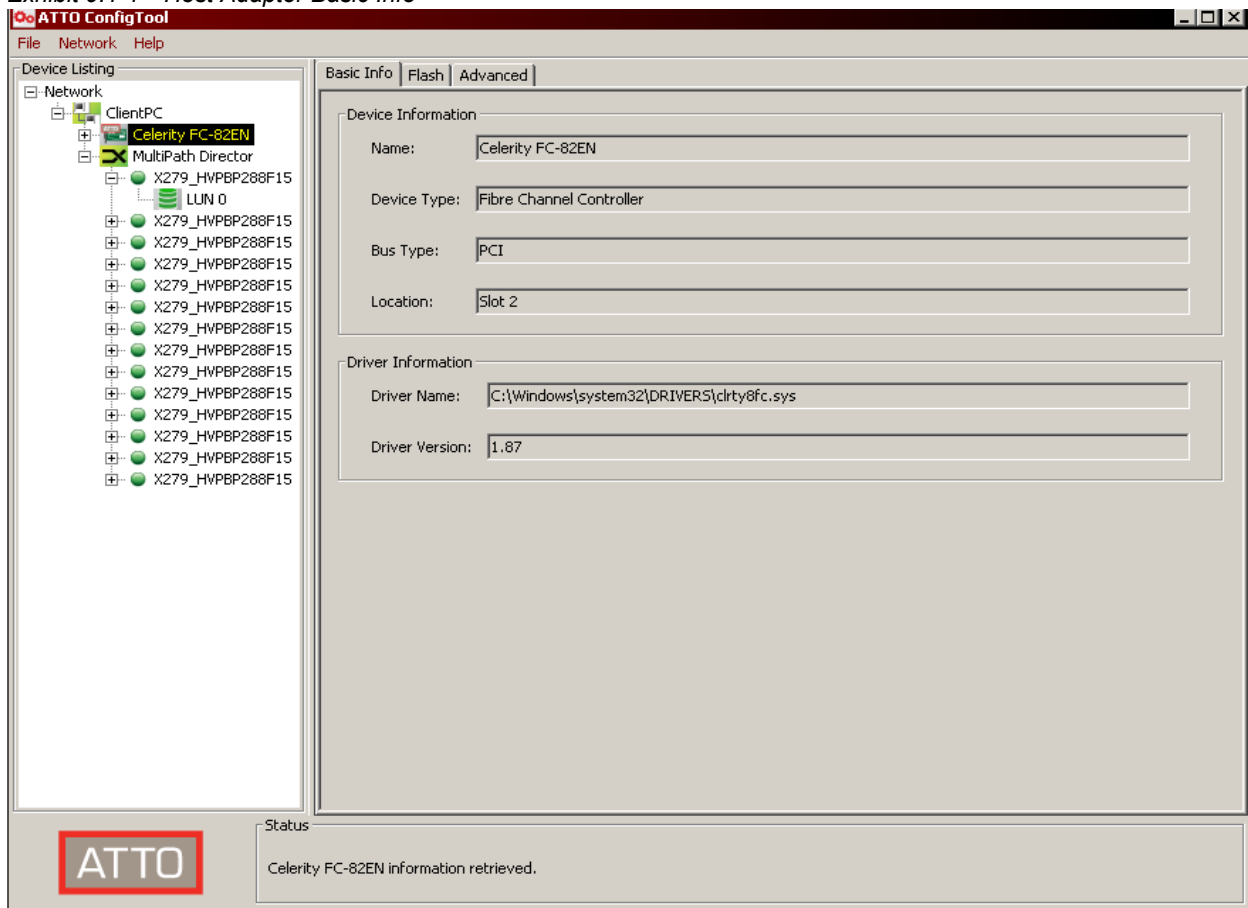
9 Support Information and NVRAM Settings

9.1 Verifying and Collecting Celerity Host Adapter Info

The ATTO ConfigTool will display “Basic” information on the ATTO Celerity Host Adapter(s) installed in the host when it is selected in the device tree within the window on the left. Once the appropriate host adapter is selected, click on the “Basic Info” tab at the top of the window on the right (See 9.1-1). The following host adapter information will be displayed:

- HBA model number
- Device Type
- Bus Type
- PCI slot number the adapter is located in
- Location and name of the Celerity driver installed
- HBA driver version

Exhibit 9.1-1 Host Adapter Basic Info

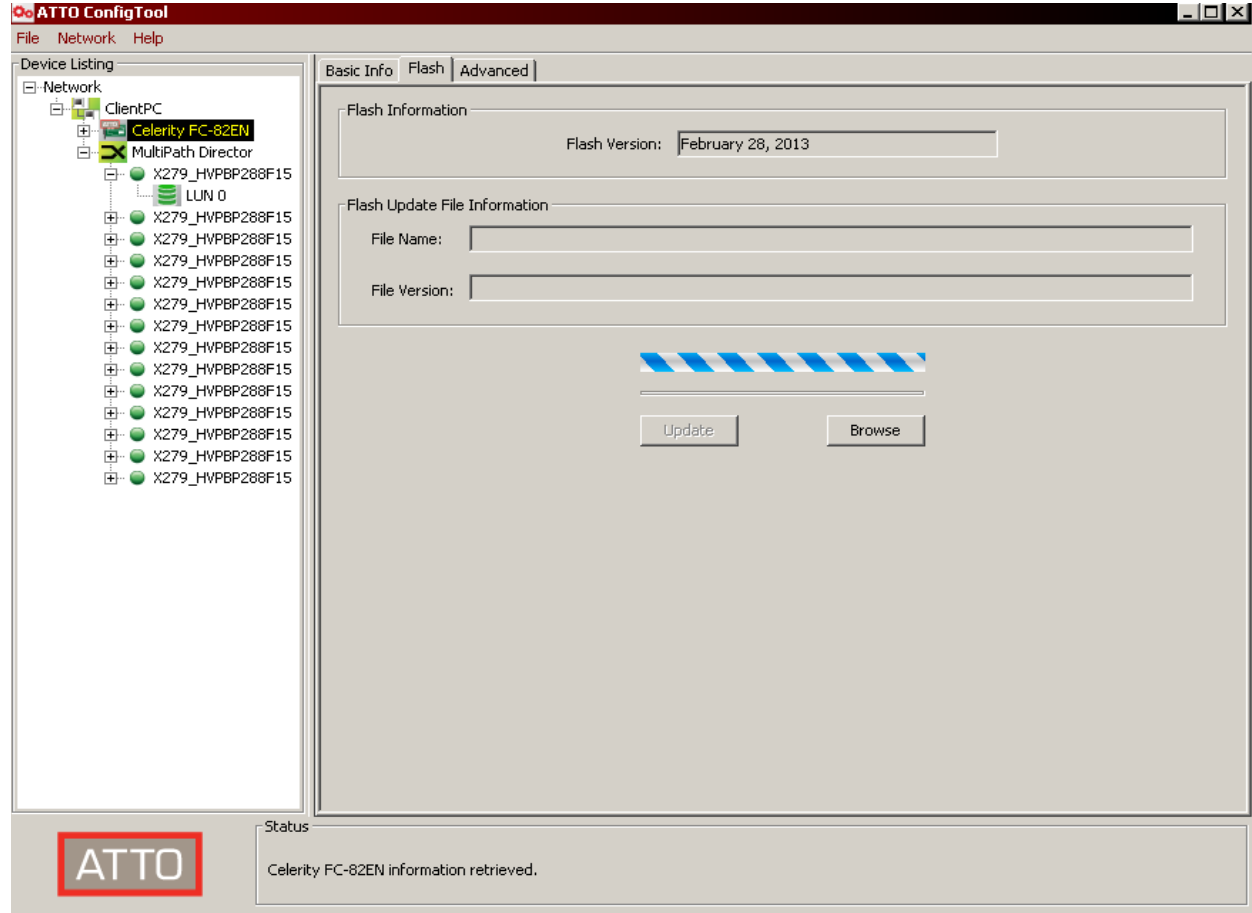


9.2 Verifying and Updating the Flash for the Celerity Host Adapter

The ATTO ConfigTool will display the current version of the Flash installed on the ATTO host adapter(s) as well as provide a method for updating the Flash. Select the appropriate host adapter from the device tree within the window on the left. Click on the “Flash” tab at the top of the window on the right (See 9.2-1). The following flash information will be displayed:

- HBA Flash version
- Flash update information
- Flash update progress bar

Exhibit 9.2-1 Host Adapter Flash Info



To update the Flash version of the HBA from this pane.

- 1 Select “Browse”
- 2 Locate the proper flash bundle available at the ATTO website (www.attotech.com)
- 3 Select “Update”
- 4 Reboot when the update has completed

9.3 Verifying and Modifying NVRAM for the Celerity Host Adapter

The ATTO ConfigTool will display the current parameters in NVRAM for each ATTO host adapter channel. Select the appropriate host adapter channel from the device tree on the left. This will display all available NVRAM parameters for that channel. You can change these settings and there are several options to save.



Note

The adapter settings are on a per channel basis and should only be changed by advanced users

Below are the available NVRAM parameters:

Node Name

The Node WWN (World Wide Name) assigned to this channel of the adapter.

Port Name

The Node WWN (World Wide Name) assigned to this channel of the adapter.

Boot Driver

Choices: enabled, scan only, disabled

Default: disabled

If enabled you will be able to boot off the Celerity Fibre Channel adapter.



Note

Scan Only has no effect in Mac OS X.

Hard Address Enable

Choices: enabled, disabled

Default: disabled

When a fibre channel loop is initialized, each device selects and configures itself to an available ID. Hard Address Enable permits the host to select a value entered in the Hard Address field.



Note

It is recommended to leave this disabled.

Hard Address (Not supported for Gen 6 16Gb/32Gb)

Choices: None, 0-125

Default: 0

The value used as the FC-AL hard address.



Note

It is recommended not to change this setting.

Execution Throttle (8Gb, 16Gb or 32Gb)

Choices: 1- 255

Default: 255 (Disabled)

Specifies the maximum number of concurrent commands which can be achieved per port or per SCSI Target.

Higher numbers or disabling the feature may increase performance, but some storage controllers react poorly when flooded with too many commands at a time, ultimately decreasing performance. Note that the setting applies to the aggregate of all LUNs controlled by the SCSI Target.

Frame Size

Choices: 512, 1024, 2048

Default: 2048

Changes the size of the FC packet of information being sent.



Note

It is not recommended to change this setting.

Device Discovery (8Gb)

Choices: Node WWN, Port WWN

Default: Port WWN

Specifies the type of device discovery the adapter performs.



Note

This should not be changed in a multipathing environment.

Connection Mode Options (Not supported for Gen 6 16Gb/32Gb)

Choices: AL, PTP, AL Preferred, PTP Preferred

Default: PTP Preferred

- **Arbitrated Loop (AL):** Connects to either an Arbitrated Loop or a Fabric Loop Port (FL Port) on a switch.
- **Point-to-Point (PTP):** Connects to a direct Fabric connection, such as an F port on a switch or directly to another device that is capable of running in PTP mode.
- **AL Preferred:** Allows the card to determine what kind of connection to use, but tries to connect in Loop mode first, then Point-to-Point mode.

- *PTP Preferred: Allows the card to determine what kind of connection is to use, but tries to connect in Point-to-Point mode first, then Loop mode.*



Note

Sometimes it is necessary to force a given connect mode because there is no industry standard for the topology detection protocol and some devices may not connect when set to one of the automatic modes.

Data Rate

Choices for 32 Gig: 8Gb/sec., 16Gb/sec., 32Gb/sec., Auto
 Choices for 16 Gig: 4Gb/sec., 8Gb/sec., 16Gb/sec., Auto
 Choices for 8 Gig: 2Gb/sec., 4Gb/sec., 8Gb/sec., Auto
 Default: Auto

*Selects the Fibre Channel transmission rate. **Auto** indicates that the storage controller determines the rate based upon the devices connected.*



Note

16 Gig and Loop Only are incompatible choices and will not be allowed.

Interrupt Coalesce

Choices: None, Low, Medium, High
 Default: None

Specifies the time period a storage controller chip delays an interrupt. This allows the storage controller chip to queue up more than one interrupt before interrupting the CPU. When this methodology is chosen there is less overhead to service the interrupts. However, the coalescing time may delay the delivery of the completion for a single interrupt.



Note

Setting this value to high may be helpful when doing small IOs.

Port Down Retry Count (8Gb)

Choices: 0-255
 Default: 8

The number of times the driver retries a command to a port which is currently logged out.

Example 1: Port Down Retry Count = 3

- A command is sent out on the physical link..
- The target port logs out for 500msec.

- The target port logs back in. The command is retried (count is now 2).
- The target port logs out for 500msec.
- The target port logs back in. The command is retried (count is now 1)
- The target port logs out for 500msec.
- The target port logs back in. The command is retried (count is now 0)
- The target port logs out for 500msec.
- The error is now passed to the OS layer

Example 2: Port Down Retry Count = 3; Link Down Timeout = 10

- Same scenario as above. The Link Down Timeout does not matter since all retries will be exhausted before the 10 second Link Down Timeout expires.

Link Down Timeout

Choices: 0-255
 Default: 0

The number of seconds the driver waits for a link that is down to come up before reporting it to the operating system.

This only comes into effect when there is one path left to a Target/LUN. The following conditions:

- The link from the HBA to the target or switch could go down.
- The target could also explicitly logout.
- The controller can fail or be taken offline for maintenance.

Example: Link Down Timeout = 0 (special case = 1 second)

- If the adapter port senses that the link has gone down to the device, the driver will wait 1 second and then report an error to the OS.

Spinup Delay

Choices: 0-255
 Default: 0

Specifies number of seconds the driver waits for the first device to be logged in and become ready.



Note

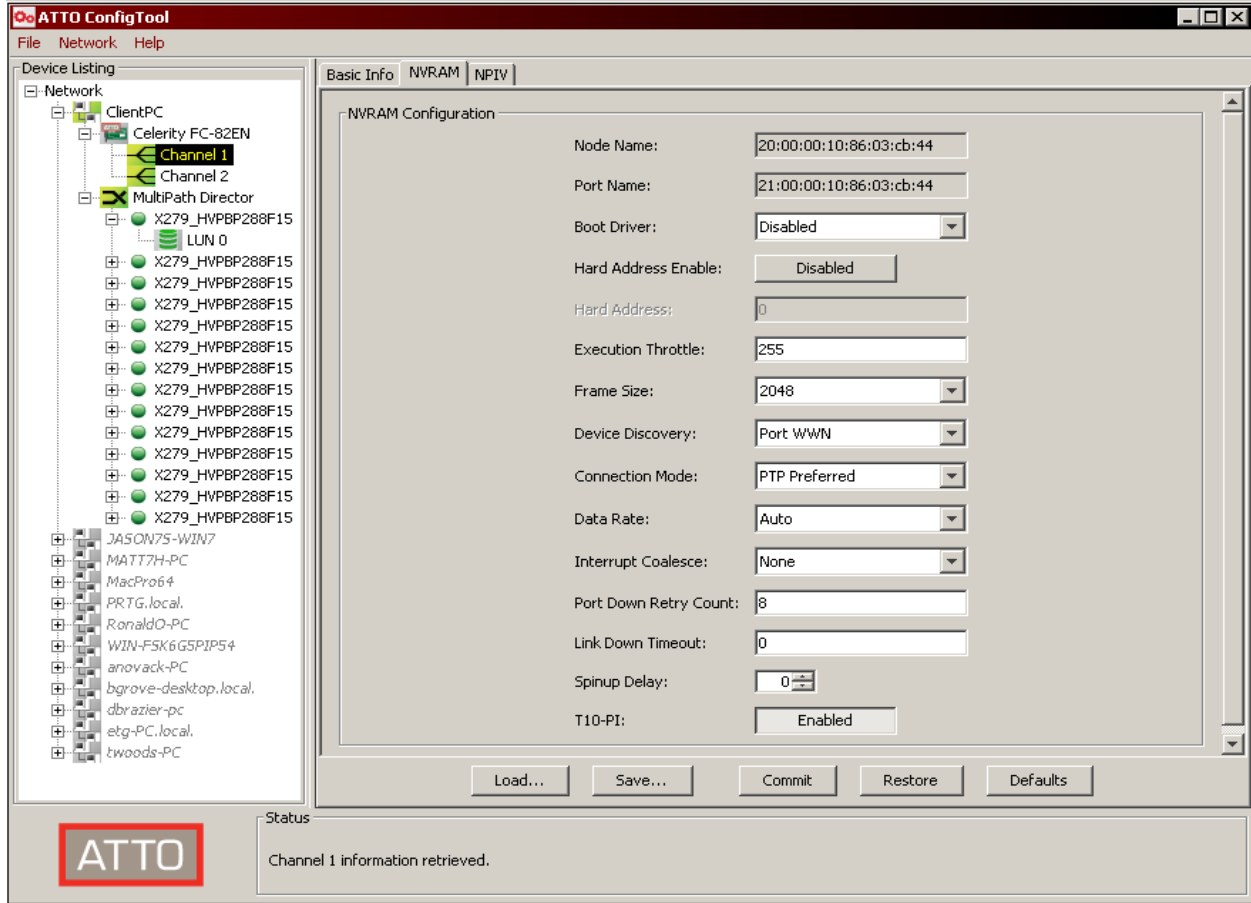
This is only honored by the Celerity BIOS driver in 3.20 and later and all 16Gb and 32Gb BIOS drivers.

T10-PI

This option enables or disables support for drives formatted with T10 protection information.

Valid settings = (Enabled, Disabled) Default = Enabled

Exhibit 9.3-1 NVRAM Settings



10 CLI Applications with Help and Usage Example

Atpmcfg.exe

This tool can be used to save the configuration settings for Celerity HBA's MultiPath Director.

Options:

-b {bus}

Select a bus number for the operation, starts at 0, default is all busses.

-c {channel}

Select a specific multipathing director for the operation, starts at 1, default is all channels.

-h

Display extended help.

-j

Reset path statistics.

-k

Locate a path (toggle on/off).

-l

List the multipathing directors in the system.

-m {pathMode}

Set the specified path mode. Modes are preferred, alternate, or disabled.

-n {policy}

Set the specified load balancing policy. Policies are pressure, roundrobin, or queuedepth.

-o {failoverMode}

Set the specified failover mode. Modes are: default
Default mode fbdisabled Failback disabled

-p {path}

Select a path for the operation, starts at 1, default is all paths. Use 0 to omit path information.

-q

Rescan devices to discover new LUNs.

-r

Delete the saved multipathing configuration.

-s

Save the current multipathing configuration.

-t {id}

Select a device (target) ID for the operation, starts at 0, default is all devices.

-u {lun}

Select a logical unit for the operation, starts at 0, default is all logical units.

-v

Display non-error messages.

Example: atpmcfg -o fbdisabled

-x {alias}

Set an alias for a logical unit.

-y {alias}

Set an alias for a path's controller port.

-z {alias}

Set an alias for a path's target port.

Atmpinfo.exe

This tool can be used to display information for the Celerity HBA's multiple paths to the storage.

Options:

-b {bus}

Select a bus number for the operation, starts at 0, default is all busses.

-c {channel}

Select a specific multipathing director for the operation, starts at 1, default is all channels.

-h

Display extended help.

-i {infotype}

Print multipathing information. Information types are:

all All information

device All device (target) information

lun All logical unit information

diag

-l

List the multipathing directors in the system.

-p {path}

Select a path for the operation, starts at 1, default is all paths. Use 0 to omit path information.

-t {id}

Select a device (target) ID for the operation, starts at 0, default is all devices.

-u {lun}

Select a logical unit for the operation, starts at 0, default is all logical units.

-v

Display non-error messages.

Example: `atmpinfo -i diag`

Atreset.exe

This tool can be used to view and manage resets for test environments for the ATTO Celerity adapters.

-c {channel}

Select a specific controller channel for the operation, starts at 1, all channels are selected by default.

-h

Display extended help.

-l

List the controllers in the system.

-m {taskType}

Send a task management command to a device. Types are:

devreset Device (target) reset

lunreset Logical unit reset

cts Clear task set (all initiators)

ats Abort task set (single initiator)

-q

Reset the bus.

-r

Reset the controller.

-s

Get the controller state.

-t {id}

Select a device (target) ID for the operation, starts at 0.

-u {lun}

Select a logical unit for the operation, starts at 0.

-v

Display non-error messages.

Example: `atreset -t 1 -u 0 -m lunreset`