

Microsoft Windows Server Best Practices Guide

Version 2.3

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Overview

This guide references the recommended best practices for provisioning and utilizing a Pure Storage FlashArray with the Microsoft Windows Server operating system. It will cover the best practices for the Purity Operating Environment (POE) 3.3.6 and above.

Goals and Objectives

Even though the FlashArray has been designed to be ultra-simplistic and efficient, there are a number of best practices recommendations that should be followed.

The best practices include host multipathing, SAN zoning configurations and policies, and file system recommendations that should be enforced to ensure a highly available and enterprise class implementation.

Audience

The target audience for this document includes storage administrators, server administrators, and consulting data center architects. A working knowledge of servers, server operating systems, storage, and networking is recommended, but is not a prerequisite to read this document.

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Operating System Guidelines

All attached hosts should have a minimum of two paths, connected to different Pure Storage FlashArray controller nodes, to ensure host to storage availability.

Microsoft Windows Server

Supported Versions

The following distributions have been officially tested:

- Windows Server 2012 R2
- Windows Server 2012
- Windows Server 2008 R2 Service Pack 1

Logical Disk Manager and Partition Alignment

Both Windows 2008 R2, 2012 and 2012 R2 automatically use 1024MB offsets. Pure Storage uses a 512-byte geometry on the FlashArray and, as such, there will never be a block alignment issue. To check the StartingOffset of a Windows host use the following Windows PowerShell:

```
Get-WmiObject Win32_DiskPartition -ComputerName $env:COMPUTERNAME | select Name, Index, BlockSize, StartingOffset | Format-Table *
```

Host Connectivity Steps

The following are the high-level steps that outline successful connectivity from a Windows host to the Pure Storage FlashArray:

1. Validate Windows hotfixes
2. Install Multipath I/O (MPIO)
3. Configure New MPIO Device
4. Configuring Disks
5. Setting SAN Policy
6. Configure MPIO Policies
7. Configure HBA settings

Microsoft Windows Hotfixes

Depending on what version of Microsoft Windows Server that is deployed please ensure the below Hotfixes are installed. To check which Hotfixes, also known as Quick Fix Engineering (QFE), are installed the following Windows PowerShell will list out all the details:

```
Get-WmiObject -Class Win32_QuickFixEngineering | Select-Object -Property Description, HotFixID, InstalledOn | Format-Table -Wrap
```

- Windows Server 2008 R2
 - KB979711
 - KB2520235
 - KB2522766
 - KB2528357

- KB2684681
- KB2718576
- KB2754704
- **Windows Server 2008 R2 SP1**
 - KB2528357
 - KB2684681
 - KB2754704
- **Windows Server 2012**
 - KB2796995

Microsoft Multipath I/O (MPIO)

You either have a windows host with MPIO already installed, or this is a new deployment in which you aim to present and attach Pure Storage volumes. Follow the appropriate steps to get MPIO installed and configured.

Install MPIO

You can install the Multipath I/O Windows feature using either Server Manager or Windows PowerShell, both methods are provided below.

Adding MPIO using Server Manager

1. Open up Server Manager select the Local Server
2. Click **Manage** and select **Add Roles and Features**
3. Navigate to the **Features** section in Add Roles and Features Wizard
4. Scroll down in the list of Features and select the **Multipath I/O** feature
5. Click **Next** and choose **Restart the destination server automatically if required**
6. Click **Install**

Adding MPIO using Windows PowerShell

Open up a Windows PowerShell session as an Administrator and run the following command to install Multipath I/O feature: `Add-WindowsFeature -Name "Multipath-IO"`

Configure New MPIO Device

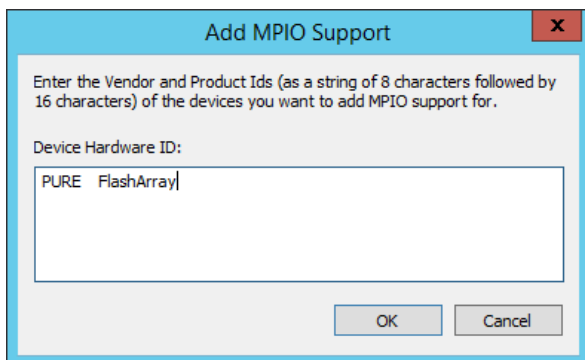
First ensure that the Windows host(s) are zoned to the Pure Storage FlashArray. Next add the Pure FlashArray to the MPIO control panel. Choose how to configure with either the MPIO Control Panel or with Windows PowerShell.

Add New MPIO Device via Control Panel

Open the Windows Start menu or a Run command and type `mpiocpl`. The MPIO Properties dialog will open. The first tab lists the MPIO Devices, a default device is listed as “Vendor 8Product 16”, it is safe to leave this entry. To add the Pure Storage FlashArray click **Add** and enter **PURE FlashArray**, be sure

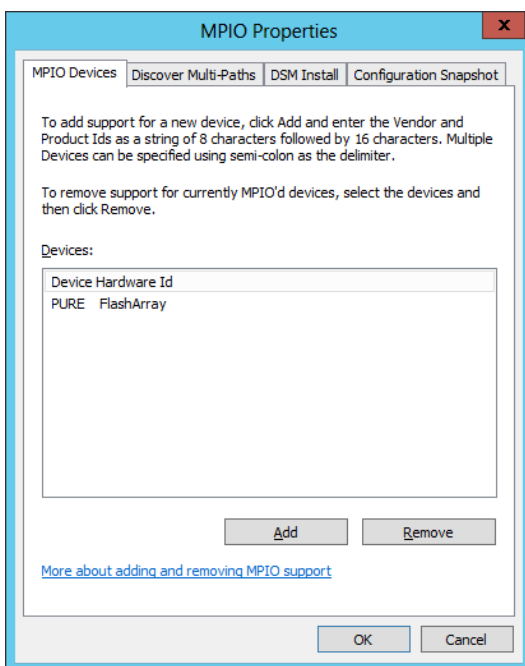
to follow the proper formatting when entering in the Device Hardware ID (see Figure 1). Note the 4 spaces between “PURE” and “FlashArray”.

Figure 1. Add MPIO Support dialog.



You will be prompted to reboot. Upon boot up the Pure Storage FlashArray will be added to MPIO Devices as shown in Figure 2 below.

Figure 2. MPIO Properties



Add New MPIO Device using Windows PowerShell

The following steps walkthrough configuring MPIO with the same details as using the Windows Control Panel applet.

1. Open up an elevated Windows PowerShell session with Run as an Administrator.
2. Run `Get-MSDSMSupportedHW` to list out the existing VendorId and ProductId details.
3. Run `New-MSDSMSupportedHW -ProductId FlashArray -VendorId PURE` to add the PURE FlashArray to the list of MPIO Devices.

4. Prepare to reboot and run [Restart-Computer](#), this will reboot the Windows host.
5. After Windows restarts open up an elevated Windows PowerShell session and run the command from Step 2 above to ensure the PURE FlashArray is now listed.

Configure Disks

Once MPIO has been installed and the proper configurations set any volumes that have been created with a host or host group can be seen from the Windows host.

Note

If no volumes, hosts or host groups have been created please refer to the Pure Storage FlashArray User's Guide, Using Purity GUI to Administer a FlashArray for step-by-step information. This can be accessed by logging into the Pure Storage FlashArray and clicking the **Help** link in the upper right corner of the GUI.

There are two methods that can be used to perform disk management, first is via a GUI uniquely named Disk Management, and second is with Windows PowerShell. Let's first walk through using Disk Management.

Disk Management GUI

1. Open Windows Server Manager
2. Click **Tools > Computer Management** to open up the Computer Management application.
3. Click **Storage > Disk Management** to access all of the volumes connected to the Windows host.

Figure 3 provides an example that shows eight volumes connected to the host varying in size from 200GB – 500GB. The volumes shown in Figure 3 have already been initialized and set Online. If the Disk Management view does not show any new volumes connected to the Windows host a rescan should be performed so that Windows can rescan the bus for connected volumes that were setup in the Purity GUI as shown in Figure 5.

Perform a rescan using Disk Management (Computer Management) and select **Action > Rescan Disks**. This will perform a rescan of the bus and display the volumes that are connected to the Windows host. If this is a first time setup of a Pure Storage FlashArray connecting to a Windows host it is most likely that the disks will show Not Initialized and in an Offline state as shown in Figure 4, otherwise it is assumed that the disks were previously setup and should come online and be accessible.

Figure 3. Windows Disk Management

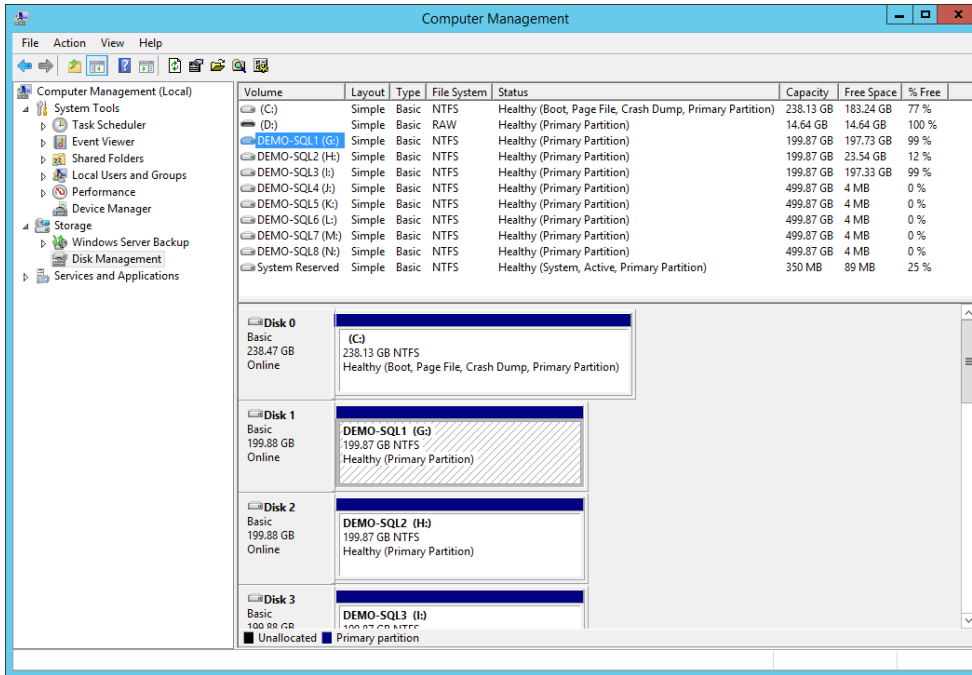


Figure 4. Not Initialized and Offline disk.

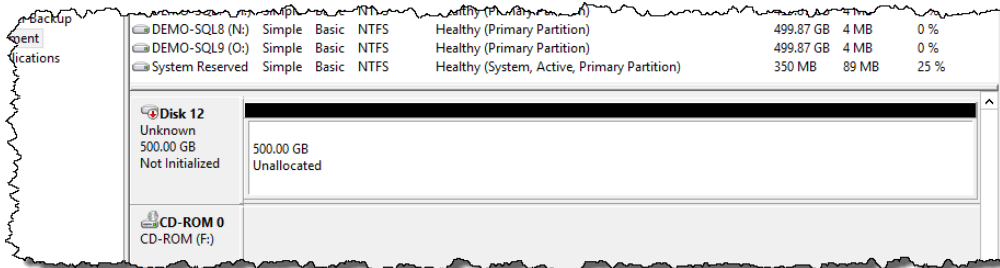
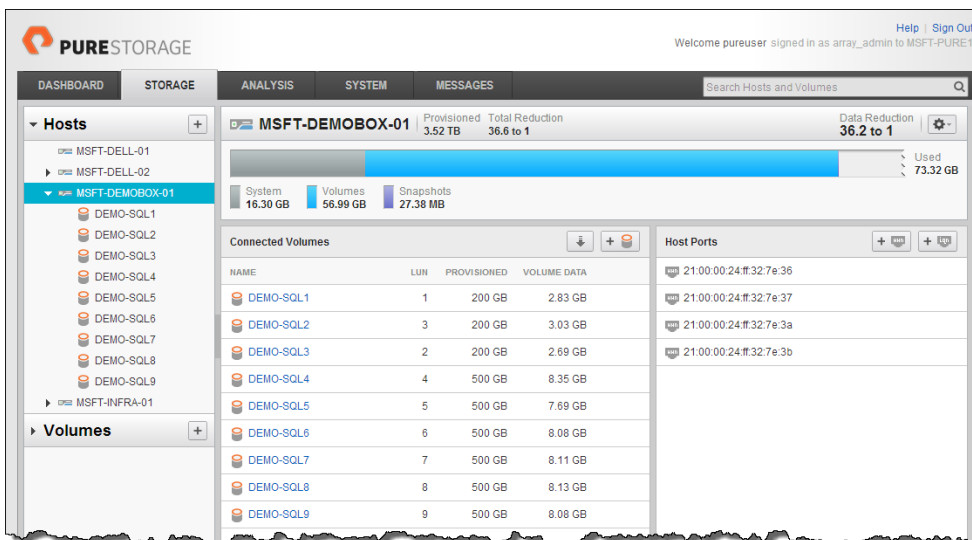


Figure 5. Purity GUI Storage View



Now that there are volumes connected to the Windows host they can be individually accessed to Initialize and Online. To perform this operation right-click the **Disk #** and select **Initialize Disk**, this will open the Initialize Disk dialog select MBR (Master Boot Record) or GPT (GUID Partition Table) as the desired Partition style. Next, select the Volume to create a New Simple Volume based on your business criteria for size, path or drive letter and format. Perform the same steps for however many volumes that are connected to the Windows host.

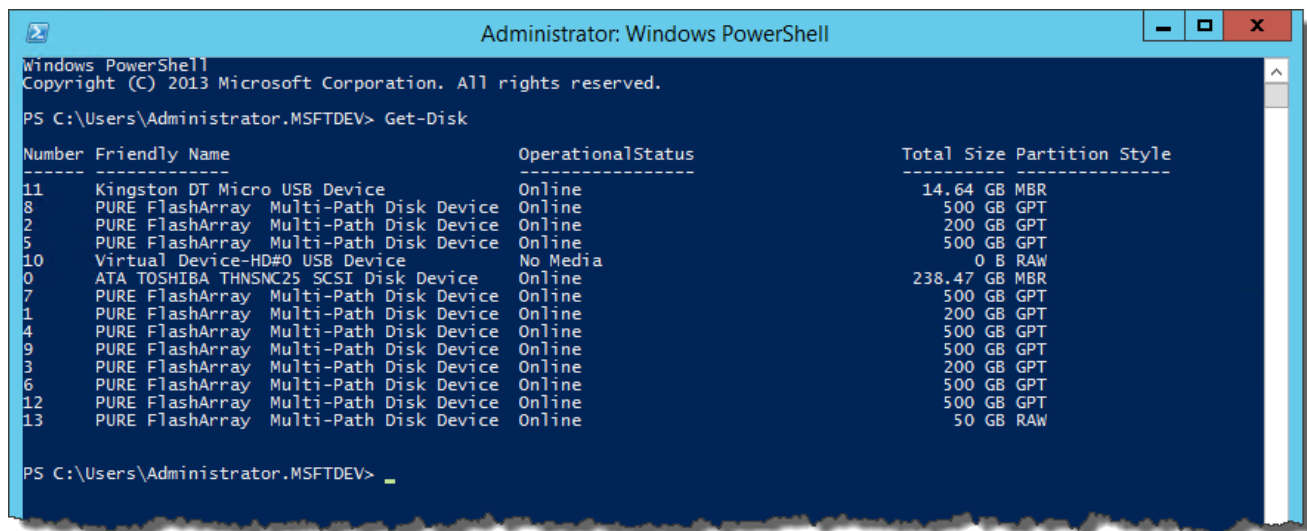
Disk Management via Windows PowerShell

Just as with the GUI management we can see and control all of the details for disks connected to the Windows host. Figure 6 shows the same view of information in Figure 3 using:

`Get-Disk`

The disk management capabilities illustrated here require PowerShell 4.0.

Figure 6. Get-Disk to show all disks connected to the Windows host.



```
Administrator: Windows PowerShell
Windows PowerShell
Copyright (C) 2013 Microsoft Corporation. All rights reserved.

PS C:\Users\Administrator.MSFTDEV> Get-Disk

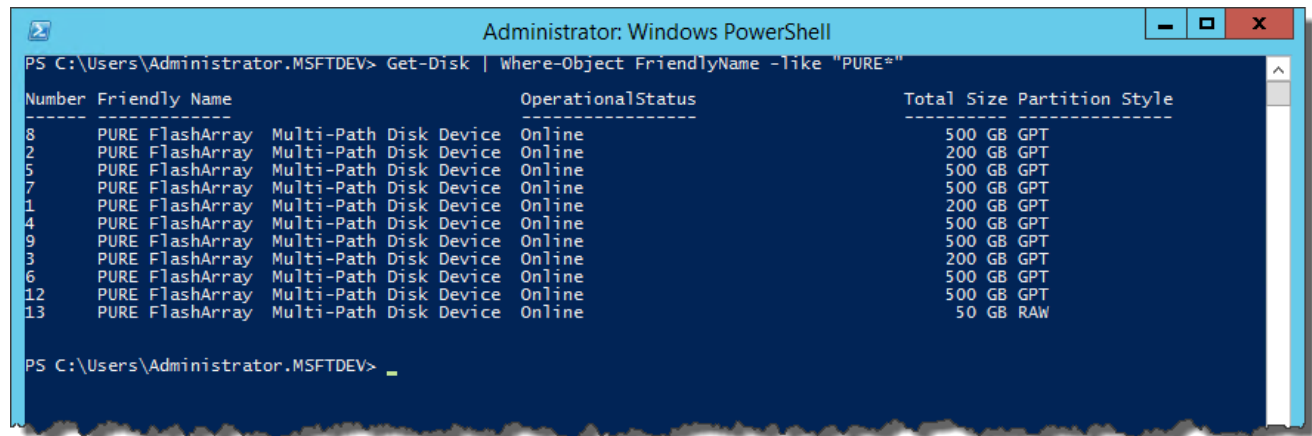
Number Friendly Name OperationalStatus Total Size Partition Style
-----
11 Kingston DT Micro USB Device Online 14.64 GB MBR
8 PURE FlashArray Multi-Path Disk Device Online 500 GB GPT
2 PURE FlashArray Multi-Path Disk Device Online 200 GB GPT
5 PURE FlashArray Multi-Path Disk Device Online 500 GB GPT
10 Virtual Device-HD#0 USB Device No Media 0 B RAW
0 ATA TOSHIBA THNSNC25 SCSI Disk Device Online 238.47 GB MBR
7 PURE FlashArray Multi-Path Disk Device Online 500 GB GPT
1 PURE FlashArray Multi-Path Disk Device Online 200 GB GPT
4 PURE FlashArray Multi-Path Disk Device Online 500 GB GPT
9 PURE FlashArray Multi-Path Disk Device Online 500 GB GPT
3 PURE FlashArray Multi-Path Disk Device Online 200 GB GPT
6 PURE FlashArray Multi-Path Disk Device Online 500 GB GPT
12 PURE FlashArray Multi-Path Disk Device Online 500 GB GPT
13 PURE FlashArray Multi-Path Disk Device Online 50 GB RAW

PS C:\Users\Administrator.MSFTDEV>
```

Now something that can be done with Windows PowerShell that the GUI does not offer is the ability to only view disks that are from Pure Storage using some additional parameters with the same command run previously.

`Get-Disk | Where-Object FriendlyName -like "PURE*"`

Figure 7. Viewing only PURE disks using PowerShell.



The screenshot shows a Windows PowerShell window titled "Administrator: Windows PowerShell". The command entered is `Get-Disk | Where-Object FriendlyName -like "PURE"`. The output is a table with columns: Number, Friendly Name, OperationalStatus, Total Size, and Partition Style. The table lists 13 disks, all of which are PURE FlashArray Multi-Path Disk Devices, all Online, with various sizes and partition styles.

Number	Friendly Name	OperationalStatus	Total Size	Partition Style
8	PURE FlashArray Multi-Path Disk Device	Online	500 GB	GPT
2	PURE FlashArray Multi-Path Disk Device	Online	200 GB	GPT
5	PURE FlashArray Multi-Path Disk Device	Online	500 GB	GPT
7	PURE FlashArray Multi-Path Disk Device	Online	500 GB	GPT
1	PURE FlashArray Multi-Path Disk Device	Online	200 GB	GPT
4	PURE FlashArray Multi-Path Disk Device	Online	500 GB	GPT
9	PURE FlashArray Multi-Path Disk Device	Online	500 GB	GPT
3	PURE FlashArray Multi-Path Disk Device	Online	200 GB	GPT
6	PURE FlashArray Multi-Path Disk Device	Online	500 GB	GPT
12	PURE FlashArray Multi-Path Disk Device	Online	500 GB	GPT
13	PURE FlashArray Multi-Path Disk Device	Online	50 GB	RAW

Just as with Disk Management GUI if there are disks that are not shown a rescan should be performed then the command can be re-run the previous PowerShell command to ensure all of the disks are present.

`"rescan" | diskpart`

Figure 8. Rescan for new disks.

```

Administrator: Windows PowerShell

11 Kingston DT Micro USB Device Online 14.64 GB MBR
8 PURE FlashArray Multi-Path Disk Device Online 500 GB GPT
2 PURE FlashArray Multi-Path Disk Device Online 200 GB GPT
5 PURE FlashArray Multi-Path Disk Device Online 500 GB GPT
10 Virtual Device-HD#0 USB Device No Media 0 B RAW
0 ATA TOSHIBA THNSNC25 SCSI Disk Device Online 238.47 GB MBR
7 PURE FlashArray Multi-Path Disk Device Online 500 GB GPT
1 PURE FlashArray Multi-Path Disk Device Online 200 GB GPT
4 PURE FlashArray Multi-Path Disk Device Online 500 GB GPT
9 PURE FlashArray Multi-Path Disk Device Online 500 GB GPT
3 PURE FlashArray Multi-Path Disk Device Online 200 GB GPT
6 PURE FlashArray Multi-Path Disk Device Online 500 GB GPT
12 PURE FlashArray Multi-Path Disk Device Online 500 GB GPT
13 PURE FlashArray Multi-Path Disk Device Online 50 GB RAW
14 PURE FlashArray Multi-Path Disk Device Online 50 GB RAW

PS C:\Users\Administrator.MSFTDEV> "rescan" | diskpart

Microsoft DiskPart version 6.3.9600

Copyright (C) 1999-2013 Microsoft Corporation.
On computer: MSFT-DEMOBOX-01

DISKPART>
Please wait while DiskPart scans your configuration...

DiskPart has finished scanning your configuration.

DISKPART> PS C:\Users\Administrator.MSFTDEV> Get-Disk

Number Friendly Name OperationalStatus Total Size Partition Style
-----
11 Kingston DT Micro USB Device Online 14.64 GB MBR
8 PURE FlashArray Multi-Path Disk Device Online 500 GB GPT
2 PURE FlashArray Multi-Path Disk Device Online 200 GB GPT
5 PURE FlashArray Multi-Path Disk Device Online 500 GB GPT
10 Virtual Device-HD#0 USB Device No Media 0 B RAW
0 ATA TOSHIBA THNSNC25 SCSI Disk Device Online 238.47 GB MBR
7 PURE FlashArray Multi-Path Disk Device Online 500 GB GPT
1 PURE FlashArray Multi-Path Disk Device Online 200 GB GPT
4 PURE FlashArray Multi-Path Disk Device Online 500 GB GPT
9 PURE FlashArray Multi-Path Disk Device Online 500 GB GPT
3 PURE FlashArray Multi-Path Disk Device Online 200 GB GPT
6 PURE FlashArray Multi-Path Disk Device Online 500 GB GPT
12 PURE FlashArray Multi-Path Disk Device Online 500 GB GPT
13 PURE FlashArray Multi-Path Disk Device Online 50 GB RAW
14 PURE FlashArray Multi-Path Disk Device Online 50 GB RAW

PS C:\Users\Administrator.MSFTDEV>
  
```

Figure 8 shows that doing a rescan the Windows host now has a new Disk 14 that was connected and it is in RAW Partition Style.

With Windows Server 2012 and PowerShell it is possible to initialize the newly added disk(s) using `Initialize-Disk <DiskNumber>`, this will initialize the disk then based on the current SAN Policy have the corresponding effect. Using `Initialize-Disk` by default set the PartitionStyle to GPT unless specified using the `-PartitionStyle` parameter to MBR or Unknown.

If the current SAN Policy is set to the default of OfflineShared the newly initialized disk will need to be brought online manually. Run the following PowerShell commands to determine which disks are Offline then set them all Online. The next section on SAN Policy goes into more detail.

```
Get-Disk | Where-Object IsOffline -eq $True | Set-Disk -IsOffline $False
```

Next is to create a partition with the newly initialized disk using maximum size. Using the Disk Management GUI it is possible to assign a drive letter or mount point using the Initialize Disk dialog. When creating a new partition with Windows PowerShell you can use the `-AssignDriveLetter` option and also use `Add-PartitionAccessPath` to set a mount point location (eg. C:\MyMountPoint). Note that the mount point location needs to exist prior. Finally using the `Format-Volume` command will create a

newly formatted NTFS volume, or whatever FileSystem you choose.

```
New-Partition -DiskNumber <DiskNumber> -UseMaximumSize -AssignDriveLetter
Add-PartitionAccessPath -DiskNumber <#> -PartitionNumber <#> -AccessPath C:\MyMountPoint
Format-Volume -DriveLetter <DriveLetter> -FileSystem NTFS
```

SAN Policy

One final settings not to overlook is the SAN Policy which defines how disks are mounted.

If you are running Windows Server 2012 this is accessible (Get/Set) from PowerShell using **Get-StorageSetting** to find out the current disk policy. If this has not been changed it will have defaulted to OfflineShared for Windows Server 2012 editions. This should be changed to **OnlineAll**. To change this to the recommended setting run the following:

```
Set-StorageSetting -NewDiskPolicy OnlineAll
```

Policy Setting	Effect
OfflineAll	All new disks are left offline by default.
OfflineInternal	All disks on busses that are detected as internal are left offline as default.
OfflineShared	All Disks on sharable busses, such as iSCSI, FC, or SAS are left offline by default
OnlineAll (Recommended)	All disks are automatically brought online.

On Windows 2008 / 2008 R2 the SAN Policy can also be changed using Windows PowerShell with the following command:

```
"SAN Policy=OnlineAll" | diskpart
```

Note

If for whatever reason working in the Windows Disk Management tool or using Windows PowerShell is not for you, all of the aforementioned tasks can be performed using a command line utility included in Windows called DiskPart. DiskPart provides the ability to manage disks, volumes and partitions. Please refer to the following link for full details <http://technet.microsoft.com/en-us/library/bb490893.aspx>.

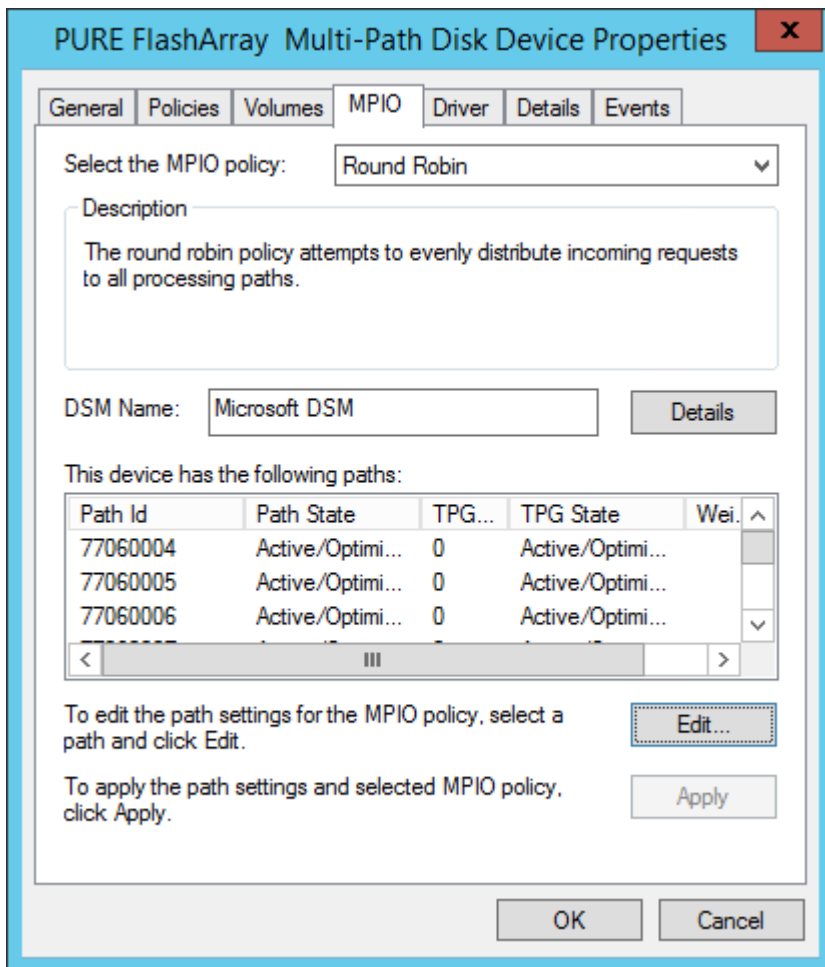
Configure MPIO Policies

Now that the Windows host has the disks connected, initialized and online the MPIO device properties can now be verified. To access the Multi-Path Disk Device Properties perform the following steps:

1. Open Windows Server Manager
2. Click **Tools > Computer Management** to open up the Computer Management application.
3. Click **Storage > Disk Management** to access all of the volumes connected to the Windows host.
4. Right-click on one of the new **Disk #** from the Pure Storage FlashArray
5. Click **Properties**
6. Click the **MPIO** tab

The dropdown menu **Select the MPIO Policy**, shown in Figure 9, can be used to select a desired policy, but as mentioned earlier the default policy of **Round Robin** is recommended. An equivalent number of paths that have been setup from the host to the Pure Storage FlashArray will be listed with their Path Id, Path State, etc. All of these should read **Active/Optimized**, shown in Figure 9. It is important to note that Pure Storage leverages the Microsoft Device Specific Module (DSM) as you will see that listed as the DSM Name, this can also be seen in Figure 9.

Figure 9. Select the MPIO Policy.



By selecting the individual Path Id and clicking Edit it is possible to see all of the details for the given path as seen in Figure 10.

Figure 10. MPIO Path Details.

MPIO Path Details

Path Information

Path ID:

77040007

Path State:

Active/Optimized

Weight:

☐ Preferred

☐ Failed

Scsi Address:

Port: 4 Bus: 0 Target: 7 Lun: 10

Path Component Information

Adapter Name:

QLogic Fibre Channel Adapter

Controller ID:

46616B65436F6E74726F6C6C

State:

Active

Target Port Group Information

Identifier:

0

☐ Preferred

Target Port Identifier:

3

Basic Statistics

Number Of Reads:

146

Bytes Read:

6296576

Number Of Writes:

312


Bytes Written:

19456000

Clear

OK

Cancel

 PURE STORAGE

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Set Disk and MPIO Recommendations

Configure the Pure Storage recommended settings using the below Windows PowerShell. The PowerShell commands will do the following:

1. Display the current MPIO settings of the Windows host
2. Set all four of recommended MPIO settings

```
Get-MPIOSetting
Set-MPIOSetting -NewPathRecoveryInterval 20
Set-MPIOSetting -CustomPathRecovery Enabled
Set-MPIOSetting -NewPDORemovePeriod 30
Set-MPIOSetting -NewDiskTimeout 20
```

Registry Key	Windows Default (Decimal)	Recommended (Decimal)
HKLM\System\CurrentControlSet\Services\Disk\TimeoutValue	60 seconds	60 seconds
HKLM\System\CurrentControlSet\Services\MPIO\Parameters\PDORemovePeriod	20 seconds	30 seconds
HKLM\System\CurrentControlSet\Services\MPIO\Parameters\UseCustomPathRecoveryInterval	0 = disabled	1 = enabled
HKLM\System\CurrentControlSet\Services\MPIO\Parameters\PathRecoveryInterval	55 seconds	20 seconds

HBA Settings

Pure recommends the using the following HBA settings. The can be modified via the following tools:

- Emulex OneCommand Manager (OCManager) or HBAnyware (GUI/CLI)
- QLogic QConvergeConsole or SANsurfer (GUI/CLI)
- Brocade Host Connectivity Manager (HCM) or Brocade Command Line Utility (BCU)

Setting	HBA	Default	Recommended
Execution Throttle	QLogic	32	32

Queue Depth	Emulex	32	32
NodeTimeOut	Emulex	30	0
Queue Depth (qdepth)	Brocade	32	32

Additional Tools

Windows allows administrators to see some of the additional Fibre Channel information. One tool that can be used is 'fcinfo' which can be downloaded from the Microsoft download site. It allows you access to most of the older Host Bus Adapter API functions. The fcinfo tool can be downloaded from <http://www.microsoft.com/en-us/download/details.aspx?id=17530>.

Figure 11. fcinfo Example.

```

Administrator: C:\Windows\system32\cmd.exe
C:\Users\Administrator.MSFTDEV>fcinfo

There are 6 adapters:
com.qlogic-QLE2562-0: PortWWN: 21:00:00:24:ff:57:41:80    \\.\Scsi1:
com.qlogic-QLE2562-1: PortWWN: 21:00:00:24:ff:57:41:81    \\.\Scsi2:
com.qlogic-QLE2562-2: PortWWN: 21:00:00:24:ff:57:41:3e    \\.\Scsi3:
com.qlogic-QLE2562-3: PortWWN: 21:00:00:24:ff:57:41:3f    \\.\Scsi4:
com.qlogic-QLE2562-4: PortWWN: 21:00:00:24:ff:57:41:24    \\.\Scsi5:
com.qlogic-QLE2562-5: PortWWN: 21:00:00:24:ff:57:41:25    \\.\Scsi6:

C:\Users\Administrator.MSFTDEV>_

```

Yet another helpful tool is 'mpclaim', which is actually a built-in tool. When using the tool an administrator will be able to see which device targets actually attached.

Figure 12. mpclaim Example.

```

Administrator: C:\Windows\system32\cmd.exe

C:\Users\Administrator.MSFTDEV>mpclaim -s -d

For more information about a particular disk, use 'mpclaim -s -d #' where # is the
the MPIO disk number.

MPIO Disk    System Disk  LB Policy    DSM Name
-----
MPIO Disk3   Disk 3         RR           Microsoft DSM
MPIO Disk1   Disk 2         RR           Microsoft DSM
MPIO Disk0   Disk 1         RR           Microsoft DSM

C:\Users\Administrator.MSFTDEV>mpclaim -s -d 3

MPIO Disk3: 12 Paths, Round Robin, Symmetric Access
Controlling DSM: Microsoft DSM
SN: 624A9370EE2020FA26F4371401B56
Supported Load Balance Policies: FOO RR RRWS LQD WP LB

Path ID      State          SCSI Address    Weight
-----
0000000077050003 Active/Optimized 005:000:003:001 0
TPG_State : Active/Optimized , TPG_Id: 0, : 3
0000000077050002 Active/Optimized 005:000:002:001 0
TPG_State : Active/Optimized , TPG_Id: 0, : 17
0000000077050001 Active/Optimized 005:000:001:001 0
TPG_State : Active/Optimized , TPG_Id: 0, : 1
0000000077050000 Active/Optimized 005:000:000:001 0
TPG_State : Active/Optimized , TPG_Id: 0, : 19
0000000077030003 Active/Optimized 003:000:003:001 0
TPG_State : Active/Optimized , TPG_Id: 0, : 3
0000000077030002 Active/Optimized 003:000:002:001 0
TPG_State : Active/Optimized , TPG_Id: 0, : 17
0000000077030001 Active/Optimized 003:000:001:001 0
TPG_State : Active/Optimized , TPG_Id: 0, : 1
0000000077030000 Active/Optimized 003:000:000:001 0
TPG_State : Active/Optimized , TPG_Id: 0, : 19
0000000077010003 Active/Optimized 001:000:003:001 0
TPG_State : Active/Optimized , TPG_Id: 0, : 3
0000000077010002 Active/Optimized 001:000:002:001 0
TPG_State : Active/Optimized , TPG_Id: 0, : 17
0000000077010001 Active/Optimized 001:000:001:001 0
TPG_State : Active/Optimized , TPG_Id: 0, : 1
0000000077010000 Active/Optimized 001:000:000:001 0
TPG_State : Active/Optimized , TPG_Id: 0, : 19

C:\Users\Administrator.MSFTDEV>_

```

3rd Party MPIO DSM Interoperability

3rd party DSMs will not claim pure Storage LUNs. At this time, Pure LUNs are not supported by 3rd party DSM modules, such as: EMC PowerPath, NetApp ONTAP DSM, HP 3PAR DSM, etc.

Configuring iSCSI

Usually the iSCSI initiator client is built-in. If it is not present, download and install the latest version (2.08) of the Microsoft iSCSI initiator that is relevant for your operating system. Pure Storage does not support port aggregation or VLAN's per iSCSI port.

Pure Storage provides high availability through the use of Multipath I/O. MCS or Link Aggregation (NIC teaming) is not supported.

Configure the IP networking settings on the Pure Storage iSCSI 10Gbe ports. If this task has not been performed the IP settings can be configured via the Pure Storage GUI or CLI interfaces.

From the Pure Storage GUI

- Select the System tab
- Select the Networking Option.
- Select the relevant iSCSI interface and select the 'Edit' option

Once the changes are completed the interface can be enabled. Pure Storage iSCSI interfaces support jumbo frames so an MTU of 9000 can be selected if the intervening network supports jumbo frames without fragmentation.

DASHBOARD

STORAGE

ANALYSIS

SYSTEM

MESSAGES

Search Hosts and Volumes

System Health

Connections

Configuration

Array Information

Networking

Support Connectivity

Alerts

SNMP

System Time

Users

Networking

Ethernet Ports

PORT NAME	STATUS	ADDRESS	NETMASK	GATEWAY	MTU	MAC
ct0.eth0	enabled	10.124.151.11	255.255.0.0	10.124.0.1	1500	00:50:cc:69:27:bb
ct0.eth1	disabled				1500	00:50:cc:69:27:bc
ct0.eth4	enabled	192.10.10.1	255.255.255.0	192.10.10.255	9000	90:e2:ba:2c:7f:c4
ct0.eth5	enabled	192.10.20.1	255.255.255.0	192.10.20.255	9000	90:e2:ba:2c:7f:c5
ct1.eth0	enabled	10.124.151.12	255.255.0.0	10.124.0.1	1500	00:50:cc:69:26:fd
ct1.eth1	disabled				1500	00:50:cc:69:26:fe
ct1.eth4	enabled	192.10.10.2	255.255.255.0	192.10.10.255	9000	90:e2:ba:2c:94:5c
ct1.eth5	enabled	192.10.20.2	255.255.255.0	192.10.20.255	9000	90:e2:ba:2c:94:5d
vir0	enabled	10.124.151.10	255.255.0.0	10.124.0.1	1500	24:a9:37:2e:3a:e0
vir1	disabled				1500	24:a9:37:2e:3a:e1
DNS						

From the Pure Storage CLI

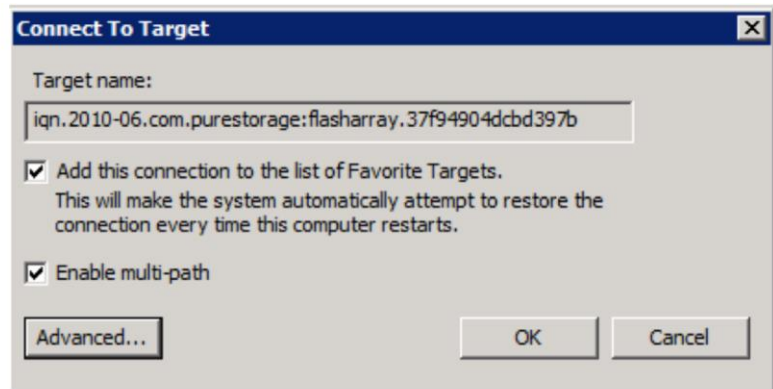
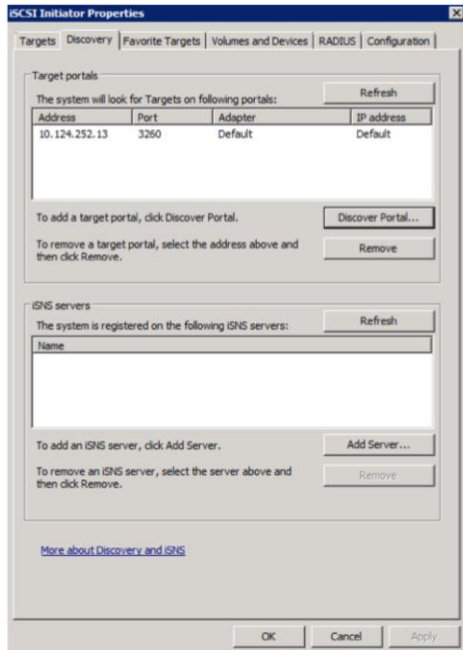
Use the purenetwork command to set the required attributes

```
pureuser@purestorage> purenetwork setattr -address xxx.xxx.xxx.xxx -netmask
xxx.xxx.xxx.xxx --gateway xxx.xxx.xxx.xxx --mtu 9000 <Ethernet interface>
```

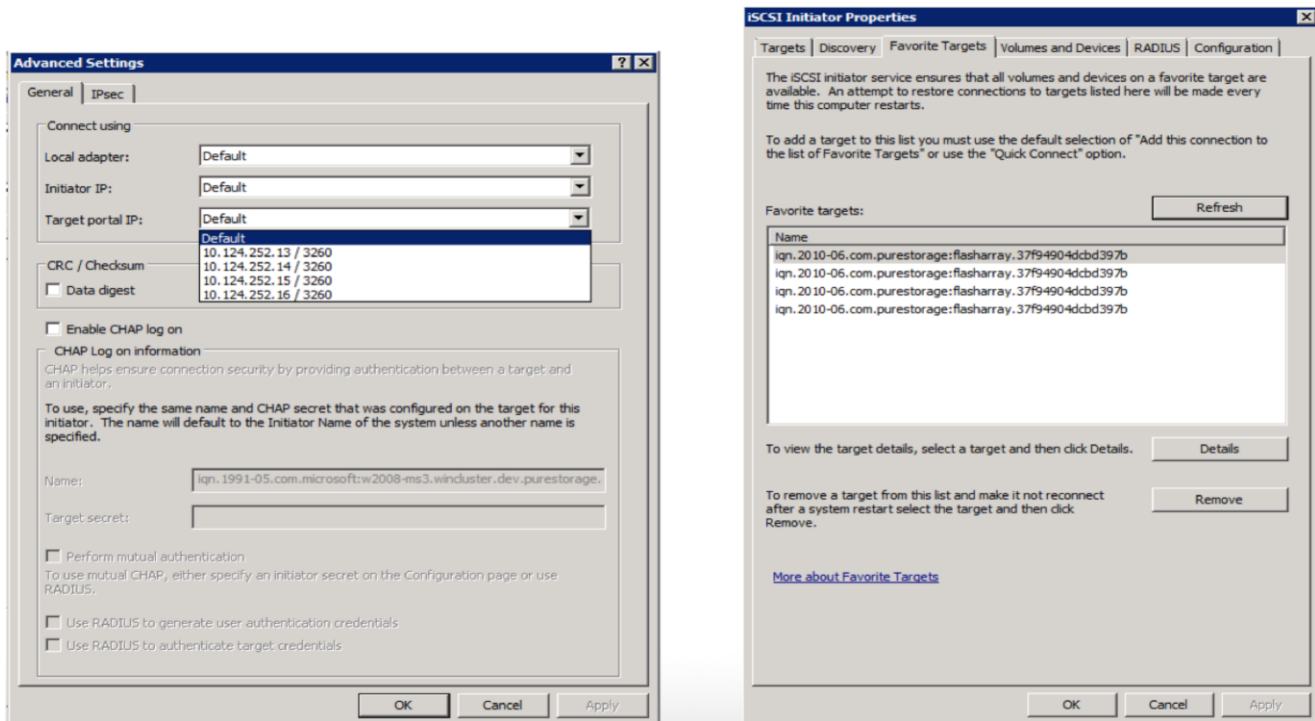
```
pureuser@purestorage> purenetwork enable <Ethernet interface>
```

Once configured setup and discovery of the Pure Storage FlashArray and relevant targets can be completed.

Launch the iSCSI initiator, discover the target IP address and connect to the Pure Storage FlashArray. Add the discovered target or targets to the list of favorite targets and enable the multipath option.



Connect to all the discovered iSCSI interfaces on the Pure Storage FlashArray and add them to favorite targets



Performance Tuning - iSCSI

In order to get the best performance out of a single host, 8 iSCSI sessions to a Pure Storage FlashArray are recommended. A session is normally created for every target port where a host is connected. If this host is connected to less than 8 paths, additional sessions can be configured going to the same target ports. To add more iSCSI sessions, repeat the steps above for the same target portal IP address.

Space Reclamation

One challenge inherent in storage arrays that present Thin Provisioned volumes is how the various operating systems that use those volumes indicate that data has been deleted.

This is referred to as Dead Space Reclamation and is provided by one of two techniques: **SSD Trim** or **SCSI Unmap**.

This process enables you to reclaim blocks of thin-provisioned LUNs by telling the array that specific blocks are obsolete. Most legacy operating systems inherently do not provide this capability, so special attention needs to be paid if a Host performs large delete operations without rewriting new data into the deleted space. Most current operating environments, such as ESX 5.x, Windows 2012 / 2012 R2 and RedHat Enterprise Linux 6 provide this functionality.

SSD Trim

TRIM is not a command that forces the SSD to immediately erase data. The TRIM command simply notifies the SSD which LBAs (Logical Block Addresses) are no longer needed.

The SSD takes those addresses and updates its own internal map in order to mark those locations as invalid. With this information, the SSD will no longer move that marked invalid block during garbage collection (GC); thus eliminating the time wasted in order to rewrite invalid data to new flash pages.

Benefits of TRIM

- Lower write amplification: Less data is rewritten and more free space is available during GC
- Higher throughput: Less data to move during GC
- Improved flash endurance: The drive is writing less to the flash by not rewriting invalid data during GC
- Keeps SSDs “Trim”: As an SSD comes close to full, there is a substantial slowdown in write performance as more flash cells must undergo write erase cycles before data can be rewritten
- Reduce flash controller (processor) time: A lot of resources are used for wear levelling, so more free blocks can help dynamic wear levelling algorithms

SCSI UNMAP

SCSI UNMAP is the full equivalent of TRIM, but for SCSI disks. UNMAP is a SCSI command that a host can issue to a storage array to free blocks (LBAs) that no longer need to be allocated.

Benefits of SCSI UNMAP

- Beneficial to thinly provisioned storage pools as reclaimed blocks will be put back into the unused pool
- Avoid out of space condition for thinly provisioned pools of storage
- Automatic operation that no longer needs to be run manually on host
- No longer need to run backend array tools to perform thin reclamation (zero page reclaim) that consumed valuable array cycles and potentially slowed down host performance

Operating Systems and SCSI UNMAP

The following is the currently known list of operating systems that either support or don't support the SCSI UNMAP command.

Host Operating System	File System Support	T10 UNMAP
Windows Server 2012	NTFS supported; Resilient File System (ReFS) does not support TRIM/UNMAP	Yes ⁽¹⁾
Windows Server 2003/2008 ⁽⁴⁾	No native OS support, must use SDelete ⁽²⁾ Fsutil ⁽³⁾	No
Windows Hyper-V 2012	VHDX ⁽⁵⁾ supported; VHD not supported	Yes

1. While Server 2012 supports SSD TRIM (ATA), Pure LUNs are discovered as SCSI devices so UNMAP will be used to reclaim space
2. Secure Delete (SDelete) <http://technet.microsoft.com/en-us/sysinternals/bb897443.aspx>
3. Fsutil with can be used to create a balloon file that consumes a portion of the free space and then the balloon file can be deleted <http://technet.microsoft.com/en-us/library/cc788058.aspx>
4. Windows 2008 R2 supports SSD TRIM (ATA), however TRIM is not used for Pure Storage LUNs (SCSI)
5. The virtual hard disk must be formatted as a .VHDX file (dynamic or fixed). SCSI UNMAP is not supported with the .VHD virtual hard disk format. The guest VM must also support SCSI UNMAP.

Microsoft Windows Server 2008 R2

Windows 2003, 2008 and 2008 R2 do not natively provide the capability to reclaim space. Microsoft has provided an alternative through a tool called sDelete. This tool can be downloaded through TechNet at: <http://technet.microsoft.com/en-us/sysinternals/bb897443.aspx>

sDelete is a command line utility that allows you to delete one or more files and/or directories, or to cleanse free space on a logical disk. sDelete accepts wild card characters as part of the directory or file specifier.

```
usage: sdelete [-p passes] [-s] [-q] <file or directory> ... sdelete [-p
passes] [-z|-c] [drive letter] ...
-a Remove Read-Only attribute
-c Clean free space
-p passes Specifies number of overwrite passes (default is 1)
-q Don't print errors (Quiet)
-s or -r Recurse subdirectories
-z Zero free space (good for virtual disk optimization)
```

Note

When utilizing the -z option, a balloon file is generated. Please evaluate the space available before performing this option. If utilization is high (80-90%), Garbage Collection (GC) will take care of the space clean-up after host side deletion. Garbage Collection may take some time and the reader should be aware of this.

Microsoft Windows Server 2012 / 2012 R2

Windows 2012 natively supports the capability to reclaim space and will do so by default. If you wish to disable automatic reclamation, then run the following Windows PowerShell as appropriate:

Disable Delete Notification

```
Set-ItemProperty -Path "HKLM:\System\CurrentControlSet\Control\FileSystem" -Name  
DisableDeleteNotification -Value 1
```

Enable Delete Notification

```
Set-ItemProperty -Path "HKLM:\System\CurrentControlSet\Control\FileSystem" -Name  
DisableDeleteNotification -Value 0
```

If space reclamation is disabled, then you can use **Defragment and Optimize Drives** to manually perform space reclamation. To start the tool, on the **Server Manager > Tools > Defragment and Optimize Drives**.

Microsoft Hyper-V

Deleting a file from the file system of an UNMAP capable guest operating system sends UNMAP requests to the Hyper-V host.

For this to work successfully, the virtual hard disk must be formatted as a [VHDX](#) file; either dynamic or fixed. This feature does not work with the older Virtual Hard Disk (VHD) format. Also, the guest OS must support SCSI UNMAP (see chart under **Operating Systems that support SCSI UNMAP**).

Hyper-V pass-through disks and Virtual Fibre-Channel (NPIV), which will show up as physical disks to the Guest VM, are also supported.

SAN Zoning Recommendations

Pure Storage supports enterprise class single host initiator zoning configurations. It is recommended, whenever possible and to aid in troubleshooting, that the zoning practices advised by the switch vendors be implemented.

Figure 1: Current Pure Storage port connectivity

Help | Sign Out
Welcome pureuser (signed in to r15se-pure1c1)

DASHBOARD
STORAGE
ANALYSIS
SYSTEM
MESSAGES
Search Hosts and Volumes

System Health
Connections
Configuration
Users

Host Port Connectivity		CT0						CT1					
HOST / PORT	CONNECTION STATUS	ETH4	ETH5	FC0	FC1	FC2	FC3	ETH4	ETH5	FC0	FC1	FC2	FC3
SVARhost	No Connectivity												
r15se-esx1	Redundant Connections			2	2	2	2			2	2	2	2
10:00:00:00:c9:a1:9b:42				1	1	1	1			1	1	1	1
10:00:00:00:c9:a1:9b:43				1	1	1	1			1	1	1	1
r15se-esx1-iscsi	Redundant Connections	1	1					1	1				
iqn.1998-01.com.vmware:r15se-esx1-6cc53818													
r15se-esx2	Redundant Connections			1	1	1	1			1	1	1	1
10:00:00:00:c9:a1:92:4a													
10:00:00:00:c9:a1:92:4b													

Offset host connections to the Pure Storage FlashArray so as to optimize fibre channel or iSCSI HBA load. A fair balance can be obtained by alternating connectivity from the fabric between odd and even host ports on the relevant storage controller node.

For example in a highly available 2-node storage controller configuration:

```
pureuser@purestorage> purereport list --initiator
```

Initiator WWN	Target	Target WWN
21:00:00:24:FF:23:23:F4	CT0.FC1	52:4A:93:70:00:00:86:01
21:00:00:24:FF:23:23:F4	CT1.FC1	52:4A:93:70:00:00:86:11
21:00:00:24:FF:27:29:D6	CT0.FC2	52:4A:93:70:00:00:86:02
21:00:00:24:FF:27:29:D6	CT1.FC2	52:4A:93:70:00:00:86:12

Troubleshooting

Brocade Fill Words

Brocade FC switches and their OEMs have been known to have some performance and connectivity deficiencies when used with QLogic HBA's that are operating at 8Gb. The Pure Storage FlashArray uses the QLogic 2642 Dual-Port FC HBA and is thus susceptible to this deficiency.

This section outlines how to properly configure and tune a Brocade switch in order to avoid excessive CRC and Decode errors.

IDLE Fill Word

Prior to FOS version 7.0, Brocade FC switches and their derivatives used IDLE primitives for both link initialization and for fill words. This ensured successful link initialization between Brocade switch ports and end devices operating at 1G/2G/4G speeds.

However, some 8G devices, such as QLogic HBA's, are not capable of properly establishing links with Brocade 8G FC switches when ARB/ARB or IDLE/ARB primitives are used.

For these devices, a new mode is available that provides a hybrid for both link initialization and the fill word.

Problem Symptoms

Excessive errors can prevent servers from connecting properly or performing with optimum efficiency with the Pure FlashArray. Decode errors indicate failure on an HBA. Failure on a Brocade switch may be indicated by "er_enc_out" and/or a large number of "er_bad_os" errors.

```
swd77:root> portstatsshow 6
```

> stat_wtx	547107199	4-byte words transmitted
> stat_wrx	785641731	4-byte words received
> stat_ftx	1082261	Frames transmitted
> stat_frx	1528326	Frames received
> stat_c2_frx	0	Class 2 frames received
> stat_c3_frx	1528326	Class 3 frames received
> stat_lc_rx	0	Link control frames received
> stat_mc_rx	0	Multicast frames received
> stat_mc_to	0	Multicast timeouts
> stat_mc_tx	0	Multicast frames transmitted
> tim_rdy_pri	0	Time R_RDY high priority
> tim_txcrd_z	0	Time TX Credit Zero (2.5Us ticks)
> tim_txcrd_z_vc 0- 3:	0	0 0 0
> tim_txcrd_z_vc 4- 7:	0	0 0 0
> tim_txcrd_z_vc 8-11:	0	0 0 0
> tim_txcrd_z_vc 12-15:	0	0 0 0
> er_enc_in	0	Encoding errors inside of frames
> er_crc	0	Frames with CRC errors
> er_trunc	0	Frames shorter than minimum
> er_toolong	0	Frames longer than maximum
> er_bad_eof	0	Frames with bad end-of-frame
> er_enc_out	318	Encoding error outside of frames
> er_bad_os	2016423236	Invalid ordered set
> er_rx_c3_timeout	0	Class 3 receive frames discarded due to timeout
> er_tx_c3_timeout	0	Class 3 transmit frames discarded due to timeout

> er_c3_dest_unreach	0	Class 3 frames discarded due to destination unreachable
> er_other_discard	0	Other discards
> er_type1_miss	0	frames with FTB type 1 miss
> er_type2_miss	0	frames with FTB type 2 miss
> er_type6_miss	0	frames with FTB type 6 miss
> er_zone_miss	0	frames with hard zoning miss
> er_lun_zone_miss	0	frames with LUN zoning miss
> er_crc_good_eof	0	Crc error with good eof
> er_inv_arb	0	Invalid ARB
> open	0	loop_open
> transfer	0	loop_transfer
> opened	0	FL_Port opened
> starve_stop	0	tenancies stopped due to starvation
> fl_tenancy	0	number of times FL has the tenancy
> nl_tenancy	0	number of times NL has the tenancy
> zero_tenancy	0	zero tenancy

Problem Resolution

In order to ensure correct interoperability between a Brocade FC and the Pure FlashArray, use the “portCfgFillWord” command to set the fill word of the connecting port to option3 (aa-then-ia).

```
Brocade5100:admin> portcfgfillword 0 3
```

Usage: portCfgFillWord PortNumber Mode

Mode: 0/-idle-idle - IDLE in Link Init, IDLE as fill word (default)
 1/-arbfff-arbfff - ARBFF in Link Init, ARBFF as fill word
 2/-idle-arbfff - IDLE in Link Init, ARBFF as fill word (SW)
 3/-aa-then-ia - If ARBFF/ARBFF failed, then do IDLE/ARBFF

References

The following links were used during the research for this Best Practices document.

CRC and Decode Errors on 8-Gbps Fibre Channel Ports connected to Brocade Switches

https://support.qlogic.com/app/answers/detail/a_id/564/~/_/crc-and-decode-errors-on-8-gbps-fibre-channel-ports-connected-to-brocade

Brocade 8 Gbps Fibre Channel Switches and Fill Words

https://www.ibm.com/developerworks/mydeveloperworks/blogs/anthonyv/entry/brocade_8_gbps_fibre_channel_switches_and_fill_words?lang=en

Windows Sysinternals – SDelete

<http://technet.microsoft.com/en-us/sysinternals/bb897443.aspx>

Windows Storage Team Blog: Updated Guidance on Microsoft MPIO Settings

<http://blogs.msdn.com/b/san/archive/2011/12/02/updated-guidance-on-microsoft-mpio-settings.aspx>

Windows Storage Team Blog: The Windows Disk timeout value: Less is better

<http://blogs.msdn.com/b/san/archive/2011/09/01/the-windows-disk-timeout-value-understanding-why-this-should-be-set-to-a-small-value.aspx>

Microsoft Multipath I/O Step-by-Step Guide

[http://technet.microsoft.com/en-us/library/ee619778\(WS.10\).aspx](http://technet.microsoft.com/en-us/library/ee619778(WS.10).aspx)



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