



Configuring VMware vSphere Software iSCSI With Dell EqualLogic PS Series Storage

ABSTRACT

This Technical Report will explain how to configure and connect a Dell™ EqualLogic™ PS Series SAN to VMware® vSphere™ using the software iSCSI initiator.

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[Nov 2010]

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Array Software

- PS Series Firmware**
 - Installation and Setup
 - Group Administration
 - CLI Reference
 - Online Help
 - Manual Transfer Utility
 - User Guide
 - Host Scripting Tools

Microsoft

- Remote Setup Wizard**
- Multipath I/O DSM**
 - Host Installation Tools
 - Installation and User Guide
- Auto-Snapshot Manager (ASM/ME)**
 - User Guide
 - Online Help
- SAN HeadQuarters**
 - User Guide

VMware

- Auto-Snapshot Manager (ASM/VE)**
 - User Guide
 - Online Help
- Storage Replication Adapter for Site Recovery Manager**
 - Release Notes
- Multipathing Extension Module (MEM)**
 - Installation and User Guide

Array Hardware

- PS Series Arrays**
 - Setup Poster
 - Installation & Setup
 - Hardware Maintenance

PREFACE

Thank you for your interest in Dell EqualLogic™ PS Series storage products. We hope you will find the PS Series products intuitive and simple to configure and manage.

PS Series arrays optimize resources by automating volume and network load balancing. Additionally, PS Series arrays offer all-inclusive array management software, host software, and free firmware updates. The following value-add features and products integrate with PS Series arrays and are available at no additional cost:

- **PS Series Array Software**
 - **Firmware** – Installed on each array, this software allows you to manage your storage environment and provides capabilities such as volume snapshots, clones, and replicas to ensure data hosted on the arrays can be protected in the event of an error or disaster.
 - **Group Manager GUI:** Provides a graphical user interface for managing your array
 - **Group Manager CLI:** Provides a command line interface for managing your array.
 - **Manual Transfer Utility (MTU):** Runs on Windows and Linux host systems and enables secure transfer of large amounts of data to a replication partner site when configuring disaster tolerance. You use portable media to eliminate network congestion, minimize downtime, and quick-start replication.
- **Host Software for Windows**
 - **Host Integration Tools**
 - **Remote Setup Wizard (RSW):** Initializes new PS Series arrays, configures host connections to PS Series SANs, and configures and manages multipathing.
 - **Multipath I/O Device Specific Module (MPIO DSM):** Includes a connection awareness-module that understands PS Series network load balancing and facilitates host connections to PS Series volumes.
 - **VSS and VDS Provider Services:** Allows 3rd party backup software vendors to perform off-host backups.
 - **Auto-Snapshot Manager/Microsoft Edition (ASM/ME):** Provides point-in-time SAN protection of critical application data using PS Series snapshots, clones, and replicas of supported applications such as SQL Server, Exchange Server, Hyper-V, and NTFS file shares.
 - **SAN HeadQuarters (SANHQ):** Provides centralized monitoring, historical performance trending, and event reporting for multiple PS Series groups.
- **Host Software for VMware**
 - **Storage Adapter for Site Recovery Manager (SRM):** Allows SRM to understand and recognize PS Series replication for full SRM integration.
 - **Auto-Snapshot Manager/VMware Edition (ASM/VE):** Integrates with VMware Virtual Center and PS Series snapshots to allow administrators to enable Smart Copy protection of Virtual Center folders, datastores, and virtual machines.
 - **Multipathing Extension Module for VMware® vSphere:** Provides connection awareness enhancements to the existing VMware multipathing functionality that understands PS Series network load balancing and facilitates host connections to PS Series volumes.

Current Customers Please Note: You may not be running the latest versions of the tools and software listed above. If you are under valid warranty or support agreements for your PS Series array, you are entitled to obtain the latest updates and new releases as they become available.

To learn more about any of these products, contact your local sales representative or visit the Dell EqualLogic™ site at <http://www.equallogic.com>. To set up a Dell EqualLogic support account to download the latest available PS Series firmware and software kits visit: <https://www.equallogic.com/secure/login.aspx>

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Revision Information

The following table describes the release history of this Technical Report.

Report	Date	Document Revision
1.0	June 2009	Initial Release
1.1	October 2009	Update with new 1:1 Example and Clarifications
1.2	November 2010	Removed all non 1:1 configuration references, added installation info for ESXi

The following table shows the software and firmware used for the preparation of this Technical Report.

Vendor	Model	Software Revision
VMware®	vSphere 4.x, ESX v4, ESXi v4	4.0, 4.1
Dell	Dell™ EqualLogic™ PS Series SAN	4.3.7 or Higher

The following table lists the documents referred to in this Technical Report. All PS Series Technical Reports are available on the Customer Support site at: support.dell.com

Vendor	Document Title
VMware	iSCSI SAN Configuration Guide
VMware	vSphere System Administration Guides
Dell	Dell EqualLogic PS Series Array Administration Guide
Dell	Configuring and Installing the EqualLogic Multipathing Extension Module for VMware vSphere 4.1 and PS Series SANs

INTRODUCTION

VMware® vSphere™ offers many new and advanced enhancements to the iSCSI software initiator in conjunction with iSCSI SAN connectivity. Many of these new features require advanced configuration in order to work properly. Administrators who are familiar with ESX 3.5 iSCSI SAN configuration may find that their current configuration steps are not sufficient to enable all of the advanced features offered in vSphere.

This Technical Report will attempt to address some of the new features in vSphere as well as show you how to connect a vSphere environment to a Dell™ EqualLogic™ PS Series iSCSI SAN.

These steps are documented in VMware's iSCSI SAN Configuration Guide which can be found on VMware's website but this Technical Report will go into depth on configuration steps for connecting to a PS Series SAN.

This Technical Report will cover the steps for utilizing the software iSCSI initiator inside the ESX server. Users connecting their vSphere environment using just iSCSI HBAs or users wishing to only assign a single iSCSI NIC with no Jumbo Frame support will not follow these steps and configure their environment in the same manner as ESX 3.x. Users who wish to only enable Jumbo Frame support for their environment will want to take note of steps 1 and 2 but only create a single VMkernel port through the vCenter GUI after that.

NEW FEATURES IN VSPHERE SOFTWARE ISCSI INITIATOR

VMware vSphere ESX 4.X has new support for various new advanced capabilities that were not found in ESX 3.5. This Technical Report will cover the new features in the iSCSI software initiator as well as how to configure them to connect to the SAN.

- **iSCSI Software Initiator** – With ESX 4.X, the iSCSI software initiator was re-written from the ground up for better performance and functionality.
- **Jumbo Frames** – With ESX 4.X and vSphere, Jumbo Frames can be enabled on the iSCSI software initiator. Jumbo Frame support allows for larger packets to be transferred between the ESX 4.X servers and the SAN for increased efficiency and performance. Presently, Jumbo Frame Support can only be enabled via CLI commands with ESX 4.0.

***Note:** Jumbo Frames are not required, they're optional. Your network infrastructure must be able to fully support them to achieve any benefit.*

- **MPIO** – With ESX 4.X and vSphere, customers can benefit from Multi-Path I/O from the ESX 4.X server and the SAN. This allows for multiple connections to be concurrently used to allow for greater bandwidth. This is especially important for the PS Series SAN as each PS Series member has multiple connections and now ESX 4.X can take full advantage of these.
- **Third Party MPIO Support** – With ESX 4.1, VMware has provided an architecture that enables storage vendors to provide new and advanced

intelligent integration. Dell has a new MPIO plug-in that will enhance MPIO with the existing iSCSI software initiator for easier management, better performance and bandwidth.

CONFIGURING VSPHERE ISCSI SOFTWARE INITIATOR WITH PS SERIES STORAGE

Taking advantage of all of these new features requires some new steps to be taken by ESX administrators. Most of the configuration is done via CLI inside the ESX server. At the release of this document there are plans to implement many of these steps into vCenter but currently a majority of the work is done via console commands. The rest of this Technical Report will be focusing on installation and configuration of an iSCSI software initiator connection to a PS Series SAN. Each of these commands can be found inside the VMware iSCSI SAN configuration guide and where names and IP Addresses are used, they will be different for each environment. This is merely an example and demonstration of how to configure a new vSphere ESX 4.X server correctly and connect it to the PS SAN.

The following assumptions are made for this example:

1. Running ESX 4.X
2. Running Dell EqualLogic PS Series SAN Firmware 4.3.7 or later
3. More than one Network Interface Card (NIC) set aside for iSCSI traffic
4. No Distributed Virtual Switch (DVS) nor Cisco Nexus 1000v for iSCSI traffic

Not every environment will require all of the steps detailed in this Technical Report.

Users wishing to only enable Jumbo Frame support for the iSCSI connection need to read and follow steps 1 and steps 2 with the following changes:

Step 1: Configure vSwitch and Enable Jumbo Frames – No changes to the instructions

Step 2: Add iSCSI VMkernel Ports – Instead of assigning multiple VMkernel Ports, administrators will only assign a single VMkernel Port

Once these two steps are done, the rest of the configuration can be accomplished in the vCenter GUI by attaching NICs, assigning storage and then connecting to the storage.

The rest of this document assumes the environment will be using multiple NICs and attaching to a Dell EqualLogic PS Series SAN utilizing Native Multipathing (NMP) from VMware.

DIFFERENT VERSIONS OF VSPHERE REQUIRE DIFFERENT CONFIGURATION OPTIONS

With the release of vSphere 4.1, 3rd party vendors are able to employ Multipathing modules. Dell has released the Multipathing Extension Module (MEM) for vSphere 4.1 but it can only be used in certain environments. Here is a handy reference for which versions of Multipathing steps can be used along with some general minimum requirements.

vSphere 4.0

Patch 5 or Update 2 Required (iSCSI connection drops on same subnet)

Patch ESX400-201009401-SG KB#1023759

1:1 VMkernel to physical nic binding as described in this document

Follow TR1049 (This document) on how to configure MPIO and iSCSI connectivity

vSphere 4.1 with Enterprise or Enterprise Plus License

Dell recommends installing and configuring the Dell EqualLogic Multipathing Extension Module (MEM)

Follow TR1048 Configuring and Installing the EqualLogic Multipathing Extension Module for VMware vSphere 4.1 and PS Series SANs for more information on how to configure the MEM and iSCSI configuration. The MEM also has a convenient setup script that will automate a majority of the CLI command tasks that were needed in vSphere 4.0

vSphere 4.1 without Enterprise or Enterprise Plus License

1:1 VMkernel to physical nic binding as described in this document

Even if you do not have Enterprise or Enterprise Plus license, you can still utilize the setup.pl script found in the EqualLogic Multipathing Extension module to help automate the iSCSI configuration process. This information can be found in TR1048 and even without the installation of the MEM it can assist in helping automate the configuration of iSCSI Multipathing.

Follow TR1049 (This document) on how to configure MPIO and iSCSI connectivity if you are not using the MEM setup script.

ESTABLISHING SESSIONS TO THE SAN

Before continuing, we first must discuss how VMware ESX establishes its connection to the SAN utilizing the new vSphere iSCSI Software Adapter. VMware uses VMkernel ports as the session initiators so we must configure each port that we want to use as a path to the storage. This configuration will be a one to one relationship. Each session to the SAN will come from one vmkernel port which will go out a single physical nic. Once these sessions to the SAN are initiated, both the VMware NMP and the Dell EqualLogic network load balancer will take care of load balancing and spreading the I/O across all available paths.

Each volume on the PS Series array can be utilized by ESX as either a Datastore or a Raw Device Map (RDM). To do this, the iSCSI software adapter utilizes the VMkernel ports that were created and establishes a session to the SAN and to that volume to communicate. With previous versions of ESX, this session was established using a single NIC path and any additional NICs were there for failover only. With the improvements to vSphere and MPIO, administrators can now take advantage of multiple paths to the SAN for greater bandwidth and performance. This does require some additional configuration which is discussed in detail in this Technical Report.

Each VMkernel is bound to a physical adapter. Depending on the environment this can create a single session to a volume or up to 8 sessions (ESX maximum number of connections per volume). Use a one to one (1:1) ratio of VMkernels to physical network cards. This means if there are 3 physical NICs, you would establish 1 VMkernel per physical NIC and associate a separate NIC with each VMkernel port. This means in this example you would establish 3 sessions to a single volume on the SAN. This trend can be expanded depending on the number of NICs you have in the system.

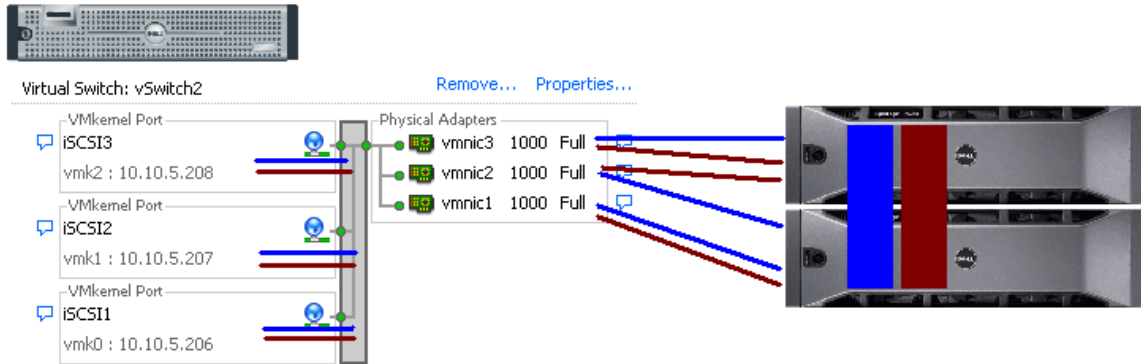


Figure 1: Conceptual Image of iSCSI Sessions using 1:1 VMkernel mapping with physical NICs

EXAMPLE INSTALLATION STEPS

Each environment will be different but the following is a list of example installation steps to configure a new ESX 4.X host to a PS Series SAN. Throughout these examples the names and IP addresses assigned will need to be changed to be relevant in your environment. These examples assume a vSwitch with Jumbo Frame support on the physical hardware. All commands are case sensitive and can be found in their full context in the VMware iSCSI SAN Configuration Guide.

This Technical Report will focus on one to one (1:1) VMkernel mapping with 3 physical NICs and 3 VMkernels. This would be a typical solution for many environments to utilize all of the bandwidth available to the ESX server's network interfaces.

Step 1: Configure vSwitch and Enable Jumbo Frames

This step will create a new vSwitch and enable Jumbo Frame support for this switch. Currently there is no option to enable Jumbo Frames on a vSwitch from VMware vCenter GUI so these commands must be run via CLI. Be sure to check the environment to make sure that Jumbo Frames are supported at the networking layer before enabling it on the ESX host. These commands are run either from the ESX console or if running ESX 4.xi from RCLI or VMA. For more information on using remote configuration calls see Appendix A.

The following command will create a new vSwitch called vSwitch2:

```
#esxcfg-vswitch -a vSwitch2
```

Next, enable Jumbo Frames on the vSwitch:

```
#esxcfg-vswitch -m 9000 vSwitch2
```

To verify that the switch was configured properly run the following command:

```
#esxcfg-vswitch -l
```

Your output will look similar to this:

Switch Name	Num Ports	Used Ports	Configured Ports	MTU
Uplinks				
vSwitch2	64	1	64	9000

PortGroup Name	VLAN ID	Used Ports	Uplinks
----------------	---------	------------	---------

You can note the new vSwitch2 with the MTU of 9000 to verify that the switch was created correctly. You can also see it displayed in the GUI of vCenter. Throughout these procedures some of the verification can be done via command line or seen in the vCenter GUI. The polling rate of vCenter is not instant so changes will not show up immediately after it is typed.

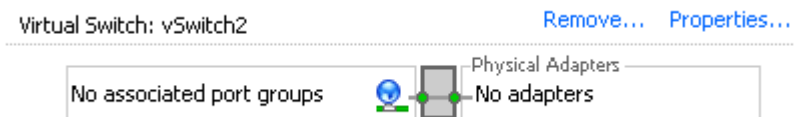


Figure 2: vCenter GUI - New vSwitch2

Step 2: Add iSCSI VMkernel Ports

This next step will assign VMkernel Ports to the new vSwitch2. It will also configure Jumbo Frame support as well as assign the IP Addresses. Administrators familiar with iSCSI connectivity in ESX 3.5 will find that it is no longer required to configure a Service Console port for the iSCSI connection. Another thing to notice is that because the Service Console is not needed, the iSCSI switch environment can be on a different subnet than the public environment or existing service console. Each VMkernel Port will need its own IP Address and they must all be on the same subnet and be on the same subnet as the PS Series Group IP Address.

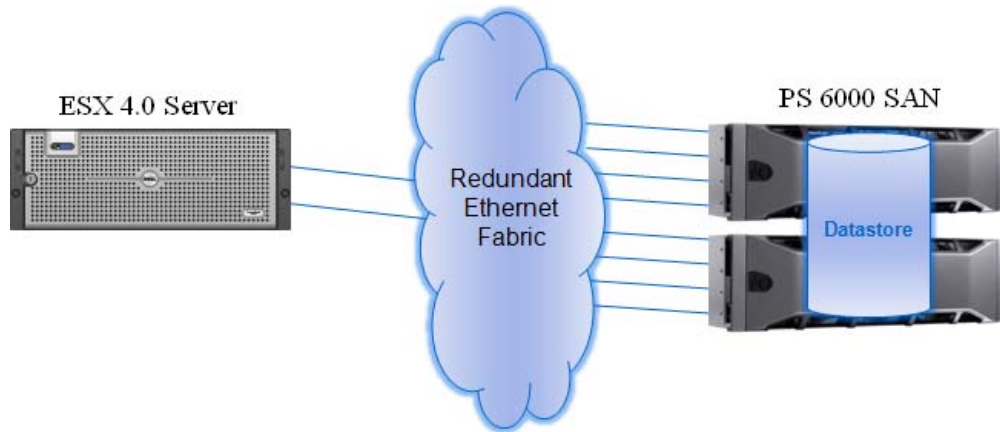


Figure 3: Example Environment

There are some suggested configurations depending on the number of NICs that will be used for iSCSI traffic. Every environment will differ depending on the number of hosts, the number of members, and the number of volumes.

In a default configuration assign one VMkernel port for each physical NIC in the system. So if there are 3 NICs, assign 3 VMkernel Ports. This is referred to in the VMware iSCSI document as 1:1 port binding.

Keep in mind that it is the VMkernel port that establishes the iSCSI session to the volume and the physical NIC is just the means it utilizes to get there.

Due to how the PS Series SAN automatically load balances volumes across multiple members and connections across multiple ports, this configuration can give both redundancy and performance gains when configured properly.

Sample Configurations

2 physical 1Gbe NICs	2 VMkernel Ports (1 per physical NIC)
4 physical 1Gbe NICs	4 VMkernel Ports (1 per physical NIC)
2 physical 10Gbe NICs	2 VMkernel Ports (1 per physical NIC)

VMware vCenter has a maximum of 8 connections to a single volume. In this Technical Report we chose 3 connections in the 1:1 scenario. This provides scalability and performance as the SAN environment grows without having to make changes on each ESX host.

If fewer or more connections are desired follow the above sample configurations to obtain the number of VMkernel Ports that match the environment and the number of paths you need.

Always keep in mind the entire virtual datacenter when deciding on path and volume count. View the Release Notes of the PS Series Firmware for the current connection limits for the Dell EqualLogic PS Series that you are running both for groups and pools.

All of these configurations are done for the vSwitch itself. This means that once it is done, the ESX 4.X host will create multiple connections to the PS Series SAN. Every new volume will have more connections as well. Once this is configured there only need to be changes made if more NICs are being added or if more or less paths are needed.

Note: At the time of this technical report writing, host profiles did not keep information on Jumbo Frames or Port Bindings. See appendix B for more information on configuring iSCSI for multiple new ESX hosts.

For the rest of this technical report the configuration steps and commands will be given for the 1:1 binding.

The following command will add a new iSCSI VMkernel Port named iSCSI1 on the vSwitch created in the previous step.

```
#esxcfg-vswitch -A iSCSI1 vSwitch2
```

This next command will configure the IP Address, Subnet Mask and enable Jumbo Frame support for the new VMkernel Port iSCSI1

```
#esxcfg-vmknic -a -i 10.10.5.173 -n 255.255.255.0 -m 9000 iSCSI1
```

For our example with a 1:1 relationship with 3 NICs we need to create 2 more VMkernel Ports named iSCSI2 and iSCSI3

```
#esxcfg-vswitch -A iSCSI2 vSwitch2
#esxcfg-vmknic -a -i 10.10.5.174 -n 255.255.255.0 -m 9000 iSCSI2

#esxcfg-vswitch -A iSCSI3 vSwitch2
#esxcfg-vmknic -a -i 10.10.5.175 -n 255.255.255.0 -m 9000 iSCSI3
```

To verify the configuration enter the following command:

```
#esxcfg-vswitch -l
```

The output will look similar to this:

Switch Name	Num Ports	Used Ports	Configured Ports	MTU
Uplinks				
vSwitch2	64	7	64	9000
PortGroup Name	VLAN ID	Used Ports	Uplinks	
iSCSI3	0	1		
iSCSI2	0	1		
iSCSI1	0	1		

This will show the VMkernel ports that are assigned to the vSwitch. To verify the IP addresses enter the following command:

```
#esxcfg-vmknic -l
```

The output will look similar to this (Note: This example may line wrap depending on the width of your terminal):

Interface	Port Group/DVPort	IP Family	IP Address	MAC Address	MTU	TSO	MSS
vmk0	iSCSI1	IPv4	10.10.5.173	00:50:56:7b:d8:3e	9000		65535
255.255.255.0	10.10.5.255						
true	STATIC						
vmk1	iSCSI2	IPv4	10.10.5.174	00:50:56:7e:ae:80	9000		65535
255.255.255.0	10.10.5.255						
true	STATIC						
vmk2	iSCSI3	IPv4	10.10.5.175	00:50:56:74:a4:e0	9000		65535
255.255.255.0	10.10.5.255						
true	STATIC						

You can also verify the IP Addresses via the vCenter GUI. In vCenter, on the ESX Host, navigate to **Configuration -> Networking**.

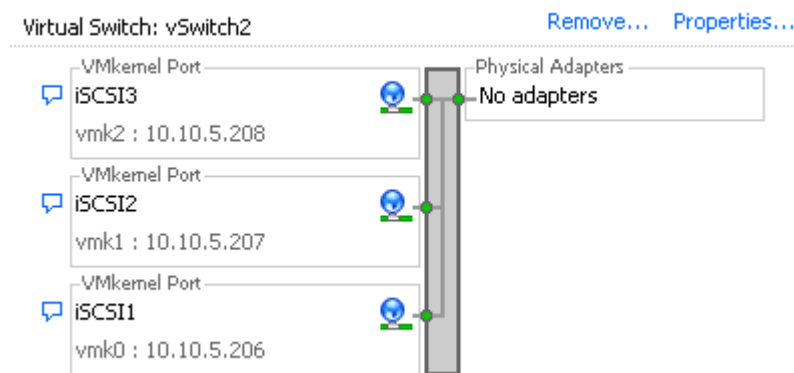


Figure 4: vCenter GUI - VMkernel Ports

Step 3: Assign Network Adapters

The next step in the process is to assign the network adapters (NICs) that will be attached to the iSCSI network and used for iSCSI traffic. These will be attached to the vSwitch2 that we created earlier. This can be done two ways, in the vCenter GUI or by CLI.

To list all of the adapters in the system run the following command:

```
#esxcfg-nics -l
```

The output will look similar to this:

Name	PCI	Driver	Link	Speed	Duplex	MAC Address
vmnic0	03:00.00	bnx2	Up	1000Mbps	Full	00:21:9b:8b:4b:b0
MTU	Description					
1500	Broadcom Corporation					Broadcom NetXtreme II BCM5708 1000Base-T

```

vmnic1 07:00.00 bnx2          Up    1000Mbps Full
00:21:9b:8b:4b:b2 1500    Broadcom Corporation Broadcom NetXtreme
II BCM5708 1000Base-T
vmnic2 0a:00.00 bnx2          Up    1000Mbps Full
00:10:18:4a:79:70 1500    Broadcom Corporation Broadcom NetXtreme
II BCM5709 1000Base-T
vmnic3 0a:00.01 bnx2          Up    1000Mbps Full
00:10:18:4a:79:72 1500    Broadcom Corporation Broadcom NetXtreme
II BCM5709 1000Base-T

```

This will list all of the adapters in the system. Assign the NICs that are physically connected to the SAN infrastructure and to the vSwitch. The following command assumes that we are assigning vmnic1, vmnic2, and vmnic3 to the vSwitch.

```

#esxcfg-vswitch -L vmnic1 vSwitch2
#esxcfg-vswitch -L vmnic2 vSwitch2
#esxcfg-vswitch -L vmnic3 vSwitch2

```

Once again to verify the configuration type the following command to list the vSwitch information:

```
#esxcfg-vswitch -l
```

Your output will look similar to the following. Note the new vmnics that were assigned to the vSwitch under uplinks.

```

Switch Name      Num Ports  Used Ports  Configured Ports  MTU
Uplinks
vSwitch2         64         9           64                9000
vmmnic3,vmnic2,vmnic1

PortGroup Name   VLAN ID  Used Ports  Uplinks
iSCSI3           0        1           vmnic1,vmnic2,vmnic3
iSCSI2           0        1           vmnic1,vmnic2,vmnic3
iSCSI1           0        1           vmnic1,vmnic2,vmnic3

```

Adding a NIC can also be configured and verified in the vCenter GUI. Remember that the polling of vCenter is not instant so a refresh might need to occur to see the latest changes. To configure this same process from the GUI first navigate to the Networking section on the ESX host you are configuring. **Configuration -> Networking**.

From here, click **Properties** on the vSwitch2.

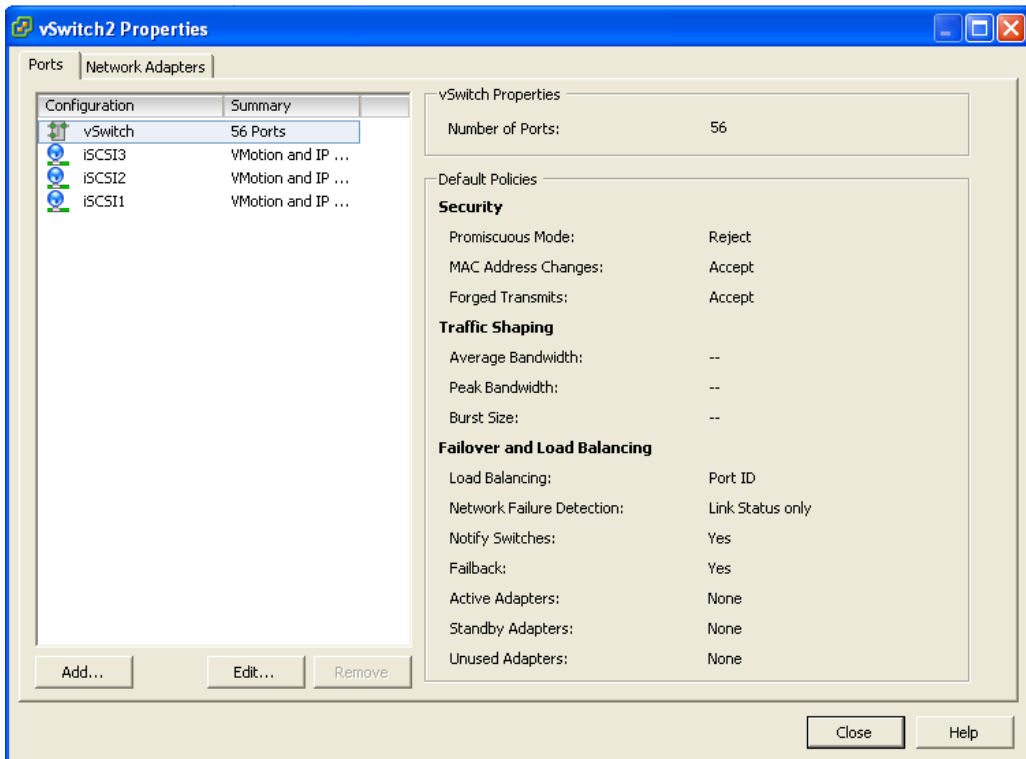


Figure 5: vCenter GUI - vSwitch Properties

Click the **Network Adapters** tab. Then click **Add**. This will open up the Add Adapter Wizard. From here select the vmnics that you want to add to the vSwitch. In our example it will be vmnic1, vmnic2 and vmnic3.

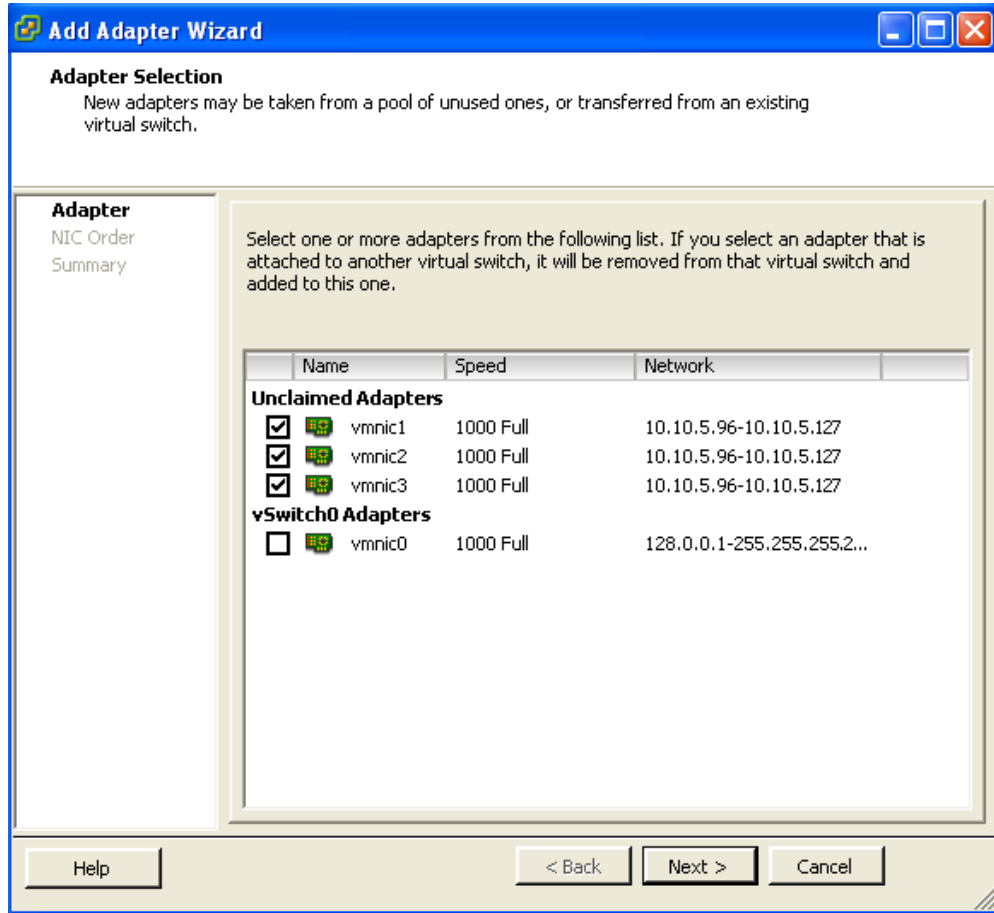


Figure 6: vCenter GUI - Add Adapter Wizard

Click **Next** after you have selected the chosen adapters. For now keep the defaults listed in the Failover Order screen and click **Next**. Review the adapters listed and click **Finish** to complete the process.

These adapters will now show up in the GUI under the Network Adapters tab.

Step 4: Associate VMkernel Ports to Physical Adapters

The next step is used to create the individual path bindings for each VMkernel to a NIC. This is required in order to take advantage of the new advanced features such as Round Robin MPIO or 3rd party MPIO plug-ins that will be available from Dell.

From our previous step there are 3 VMkernel ports and 3 NICs. This means that each NIC will have 1 VMkernel port assigned to it. Again, each environment will differ and these numbers can change based on the number of NICs and the number of paths assigned.

This process can be done either via CLI or through the vCenter GUI.

By default, all the vmnics are assigned to each VMkernel port. We need to remove all but one vnic from each VMkernel port so that each VMkernel port has only one uplink.

Before running these commands the switch information looks like the following (obtained using `#esxcfg-vswitch -l` again):

Switch Name	Num Ports	Used Ports	Configured Ports	MTU
vSwitch2	64	7	64	9000
Uplinks				
vmnic3,vmnic2,vmnic1				

PortGroup Name	VLAN ID	Used Ports	Uplinks
iSCSI3	0	1	vmnic1,vmnic2,vmnic3
iSCSI2	0	1	vmnic1,vmnic2,vmnic3
iSCSI1	0	1	vmnic1,vmnic2,vmnic3

You can see that there are three vmnics in each uplink for each VMkernel Port. This is what we need to change so that only a single vmnic is in each uplink and that we manually load balance them across all available VMkernel Ports.

To configure this process via CLI first note the vmnic number of a NIC you want to remove and type the following command:

```
#esxcfg-vswitch -p iSCSI1 -N vmnic3 vSwitch2
```

What this will do is remove vmnic3 from VMkernel port iSCSI1 so that now vmnic1 and vmnic2 are left on iSCSI1. We then need to remove vmnic2 so that only vmnic1 is associated with the iSCSI1. To do this type the following command:

```
#esxcfg-vswitch -p iSCSI1 -N vmnic2 vSwitch2
```

Now that we have just one vmnic associated with one VMkernel port we need to remove the excess NICs on the other ports.

```
#esxcfg-vswitch -p iSCSI2 -N vmnic1 vSwitch2
#esxcfg-vswitch -p iSCSI2 -N vmnic3 vSwitch2
#esxcfg-vswitch -p iSCSI3 -N vmnic1 vSwitch2
#esxcfg-vswitch -p iSCSI3 -N vmnic2 vSwitch2
```

To verify that this was done correctly type the following command:

```
#esxcfg-vswitch -l
```

The output will look similar to this:

Switch Name	Num Ports	Used Ports	Configured Ports	MTU
vSwitch2	64	7	64	9000
Uplinks				
vmnic3,vmnic2,vmnic1				

PortGroup Name	VLAN ID	Used Ports	Uplinks
iSCSI3	0	1	vmnic3
iSCSI2	0	1	vmnic2
iSCSI1	0	1	vmnic1

The important thing to note is that under the Uplinks section there is only one vmnic assigned to each iSCSI VMkernel port and that they are evenly distributed across them all.

This can also be done through the vCenter GUI. To configure this from the GUI first navigate to the Networking section on the ESX host you are configuring.

Configuration -> Networking.

From here, click **Properties** on the vSwitch2.

Select one of the VMkernel Ports, in this example iSCSI1 and click **Edit**.

From here select the **NIC Teaming** tab.

Here you are going to select the check box for **Override vSwitch Failover Order**.

Just like in the CLI example we will assign vmnic1 to iSCSI1. This is done by selecting the adapters that are not going to be assigned to the VMkernel (vmnic2 and vmnic3 in this case) and clicking the **Move Down** button until it is listed under Unused Adapters. Figure 8 shows the completed result. Click **Ok** to complete the process. Do this same thing for each of the iSCSI VMkernel ports so that each VMkernel port is mapped to only one adapter and they are balanced across them all. In this example we assigned iSCSI1 to vmnic1, iSCSI2 to vmnic2 and iSCSI3 to vmnic3.

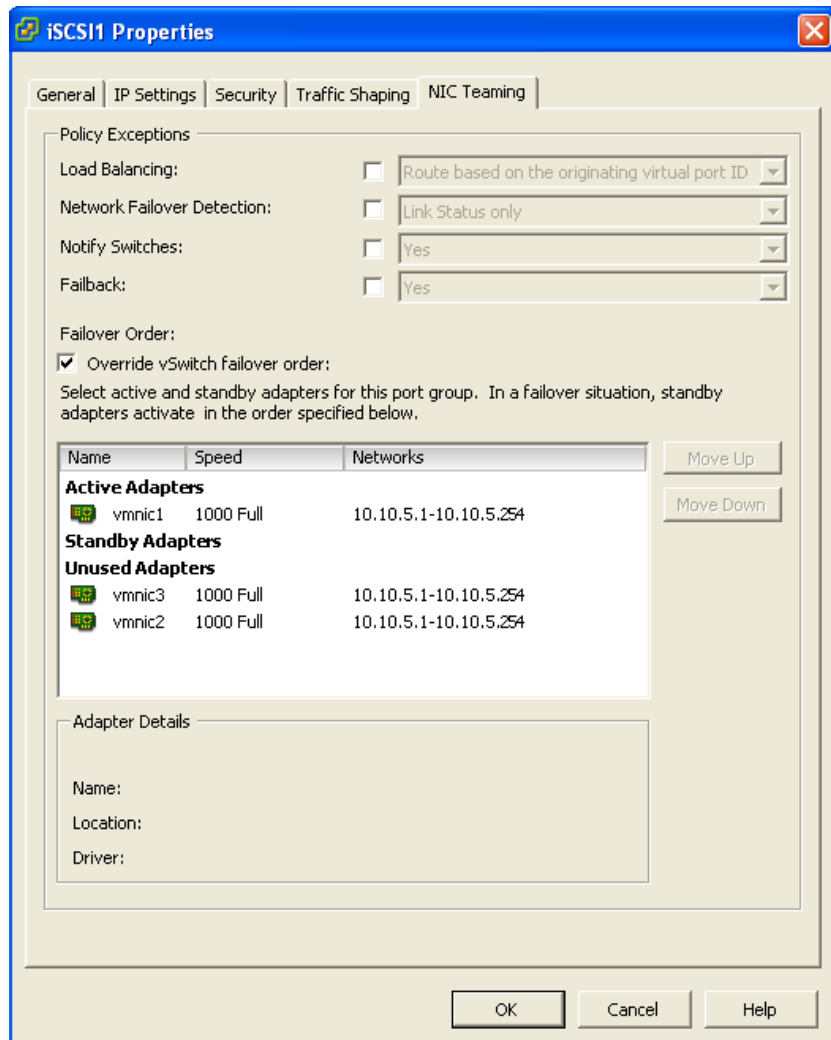


Figure 7: vCenter GUI - Mapping VMkernel Ports to vmnics

Step 5: Enable VMware iSCSI Software Initiator

The next step, if it has not been done already, is to enable the iSCSI initiator to prepare the ESX host to connect to the PS Series SAN. This can be done either through a CLI command or through the vCenter GUI.

To enable the iSCSI initiator through the CLI type the following command:

```
#esxcfg-swiscsi -e
```

This will enable the software iSCSI initiator. To verify that it is enabled type the following command:

```
#esxcfg-swiscsi -q
```

This can also be accomplished by using the vCenter GUI.

From the vCenter GUI on the ESX host navigate to **Configuration -> Storage Adapters**. Select the iSCSI Software Adapter and click **Properties**.

Under the General tab click the **Configure** button. Place a check mark in **Enabled** and hit **Ok**. This will enable the iSCSI initiator and assign a unique iqn to the ESX host. Administrators familiar with enabling iSCSI in ESX 3.5 will notice that the firewall policies are automatically set when you enable it in vSphere.

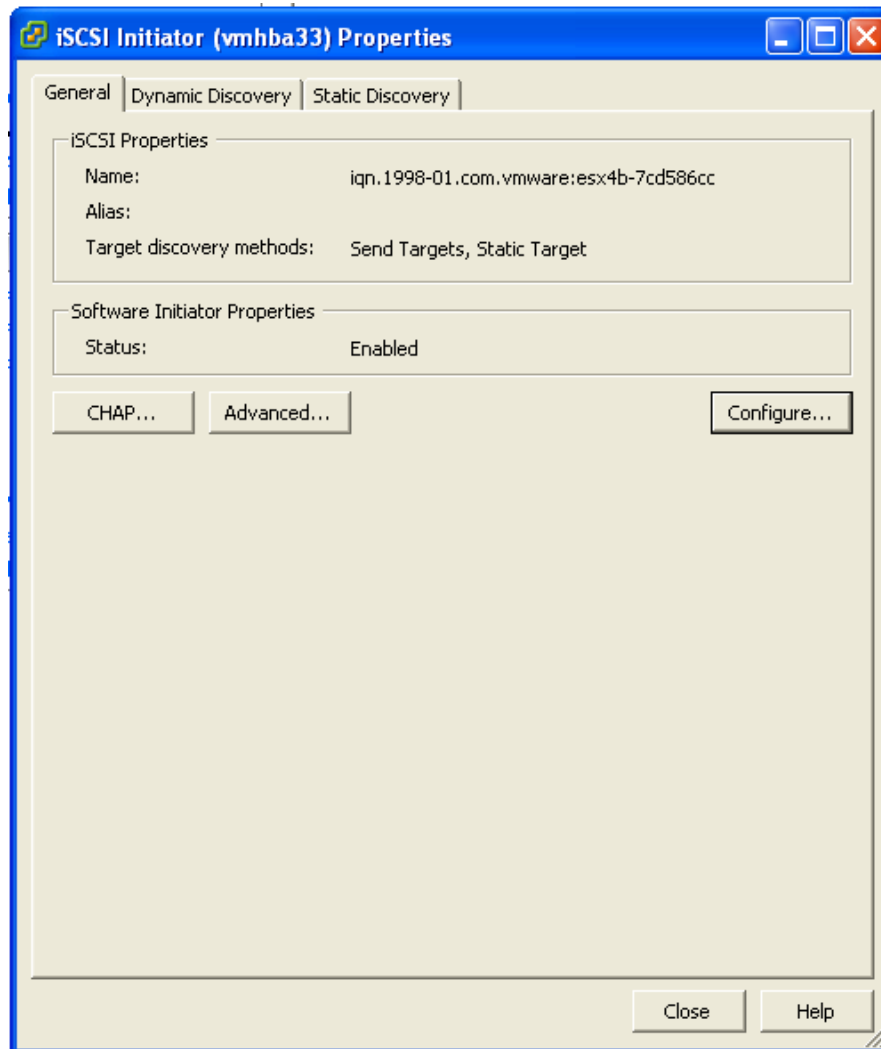


Figure 8: vCenter GUI - Enabling iSCSI Software Initiator

Step 6: Binding VMkernel Ports to iSCSI Software Initiator

This next step will bind the VMkernel ports that were configured in Step 4 earlier, to the iSCSI Software Initiator. If this step is skipped there will only ever be a single connection to the PS Series SAN. This step must be done via CLI.

The first thing to do is to note the vmhba# of the iSCSI Software Initiator. This can be seen in the vCenter GUI on the ESX host under **Configuration -> Storage Adapters**.

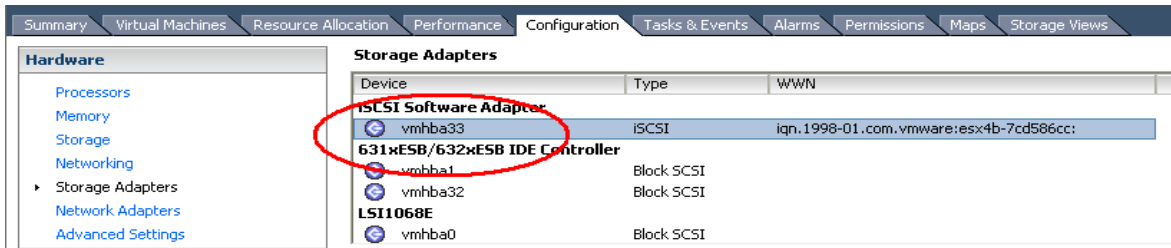


Figure 9: vCenter GUI - vmhba# for iSCSI Software Adapter

This can also be found by running the following CLI command to discover all SCSI devices including the iSCSI software adapter:

```
#esxcfg-scsidevs -a
```

The output will look something like the following:

```
vmhba0 mptsas link-n/a sas.5001ec90e0ba7c00
(1:0.0) LSI Logic / Symbios Logic LSI1068E
vmhba1 ata_piix link-n/a ide.vmhba1
(0:31.1) Intel Corporation 631xESB/632xESB IDE Controller
vmhba32 ata_piix link-n/a ide.vmhba32
(0:31.1) Intel Corporation 631xESB/632xESB IDE Controller
vmhba33 iscsi_vmk link-n/a iscsi.vmhba33
() Software iSCSI
```

In this example from both the GUI and CLI we can determine that the vmhba# for the iSCSI Software Initiator is vmhba33. This will be used in the next part. This will differ on various systems based on the devices installed.

The next piece of information to gather is the vmk# of each of the VMkernel ports. This can be done via the GUI or CLI.

To determine the vmk# of each VMkernel port from the vCenter GUI navigate to **Configuration -> Networking**. From the vSwitch that was created earlier under each VMkernel port, the vmk# will be listed.

NOTE: It is important to recognize that they may not start with vmk0, VMotion ports and other VMkernels will utilize the same numbers based on the order they are created.

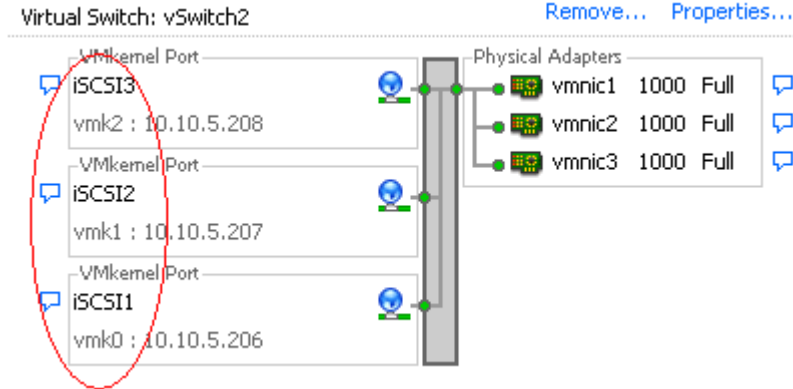


Figure 10: vCenter GUI - Noting the vmk# of the VMkernel Ports

In this example we see that iSCSI1 is vmk0, iSCSI2 is vmk1, and iSCSI3 is vmk2. This is also information that we need to note.

We can also see this in the CLI by using the following command:

```
#esxcfg-vmknic -l
```

The output will look similar to this:

Interface	Port	Group/DVPort	IP Family	IP Address	Netmask	Broadcast	MAC Address	MTU	TSO	MSS
vmk0	iSCSI1		IPv4	10.10.5.173	255.255.255.0	10.10.5.255	00:50:56:7b:d8:3e	9000	65535	
vmk1	iSCSI2		IPv4	10.10.5.174	255.255.255.0	10.10.5.255	00:50:56:7e:ae:80	9000	65535	
vmk2	iSCSI3		IPv4	10.10.5.175	255.255.255.0	10.10.5.255	00:50:56:74:a4:e0	9000	65535	

We can determine the same information as was found from the GUI.

Now that we know the vmhba# and the vmk# we can map each VMkernel Port to the iSCSI Software Initiator. This is done through the CLI by typing the following command:

```
#esxcli swiscsi nic add -n vmk0 -d vmhba33
```

This will bind the vmk0 VMkernel port to the iSCSI Software Adapter vmhba33. We then proceed to bind all of the other vmk# to the same vmhba.

```
#esxcli swiscsi nic add -n vmk1 -d vmhba33
#esxcli swiscsi nic add -n vmk2 -d vmhba33
```

To verify that all of the vmk# are bound properly to the vmhba run the following command:


```
#esxcli swiscsi nic list -d vmhba33
```

This will list all of the information for VMkernel ports that are assigned to the iSCSI Software Adapter.

Step 7: Connect to the Dell EqualLogic PS Series Storage

Now that the advanced configuration for the vSphere iSCSI Software Initiator has been completed, the next stage is to connect to the Dell EqualLogic PS Series SAN and to the volumes it contains.

More information for complete administration of the Dell PS Series SAN can be found in the PS Series Administrators Guide. In this example we will attach the iSCSI Software Initiator to the SAN and to a single volume. We will skip configuring CHAP but both one way and bi-directional CHAP is supported by the PS Series SAN.

The first thing to do is add the PS Series Group IP Address to the dynamic discovery of the ESX Host iSCSI Software Initiator. This is done to enable rescans to find new volumes that can be seen by ESX and used to create Datastores.

To configure this, navigate in the vCenter GUI to **Configuration -> Storage Adapters**.

Click on the iSCSI Software Adapter and click **Properties**.

Click the **Dynamic Discovery** tab.

Click **Add**.

In the iSCSI Server box type in the Group IP Address of the PS Series SAN and hit **Ok**.

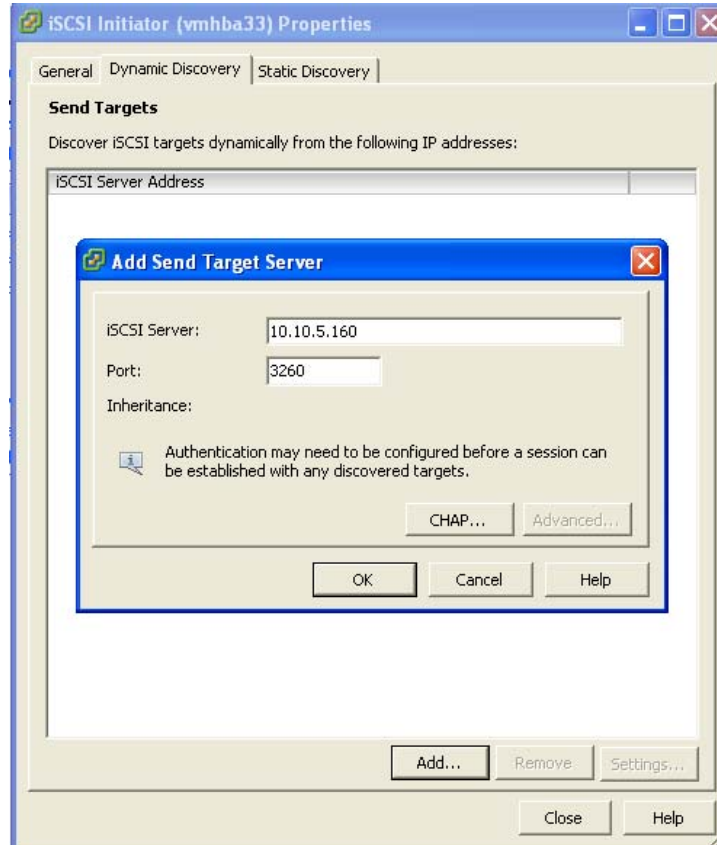


Figure 11: vCenter GUI - Add Group IP Address to Dynamic Discovery

When this is done click **Close** or enter in another Group IP Address if there are multiple SANs in your environment.

You will be prompted for a Rescan of the HBAs but at this time as there are no volumes assigned it is unnecessary.

The next step will be to create a new volume and assign it to the ESX server. This can be done multiple ways so refer to the Group Administrators Guide for more information. In this example we will create a 100GB Volume and assign it to this ESX host via the iqn name.

1. Create a new volume from Group Manager named ESXVOL2 and click **Next**.

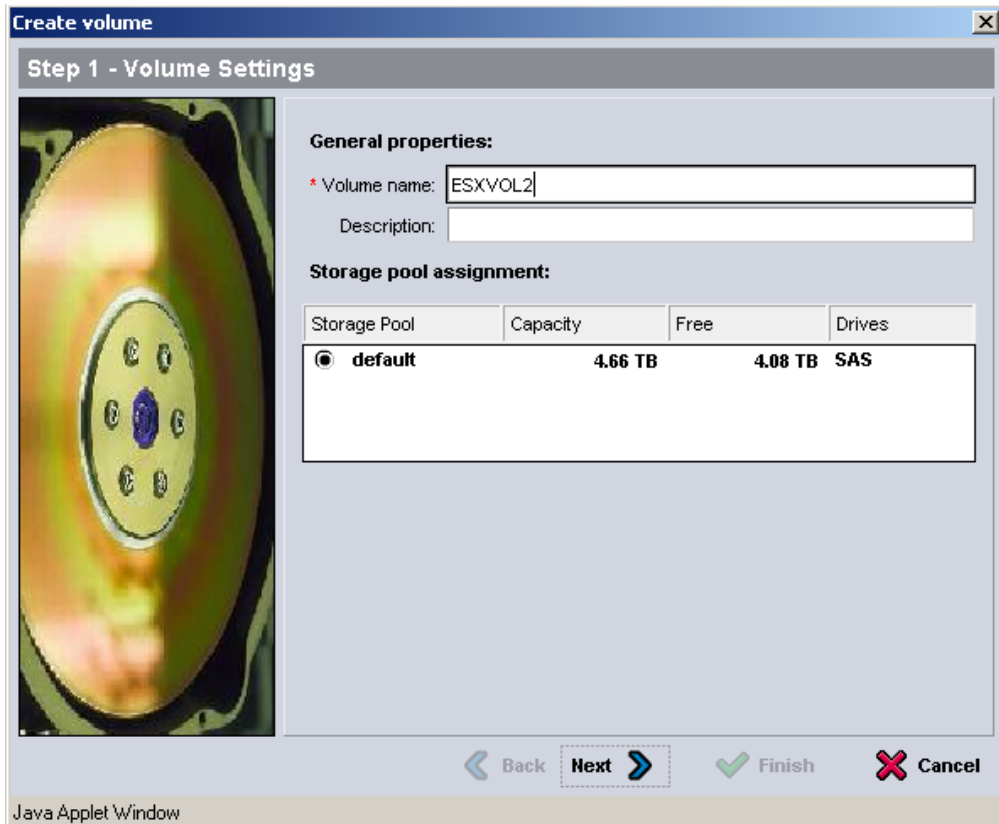


Figure 12: Group Manager GUI - Create Volume – Name

- Set the volume size and keep the rest of the defaults and click **Next**.

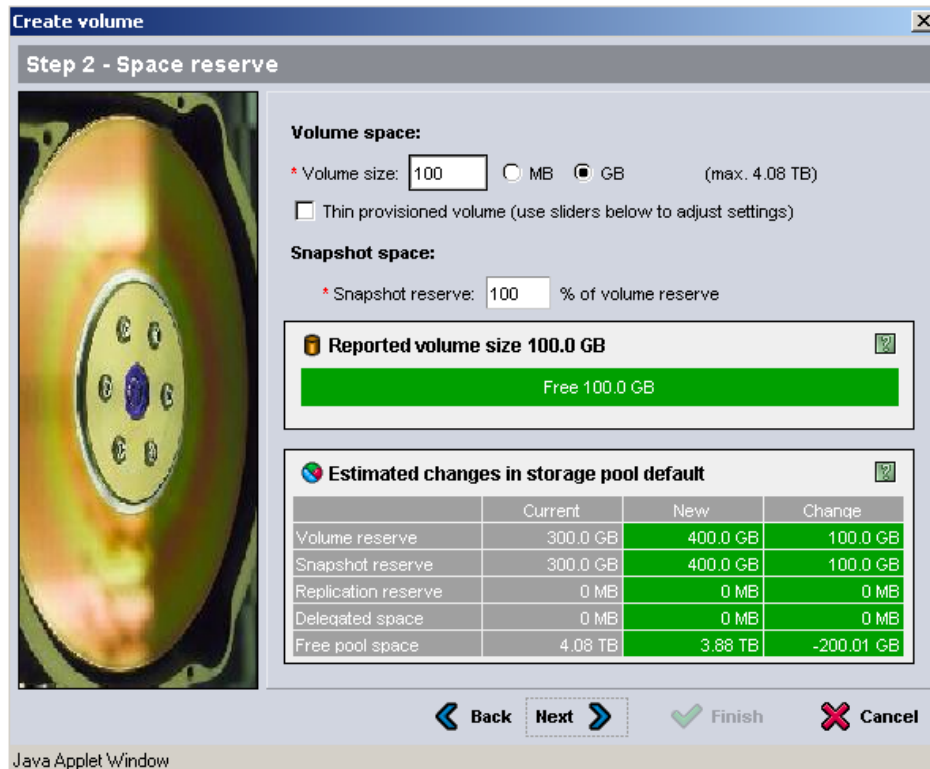


Figure 13: Group Manager GUI - Create Volume – Space Allocation

- Under iSCSI Access you can choose to use CHAP, IP Address, Initiator Name or any combination of the three. Keep in mind that as a vSphere environment grows, being able to scale the number of connections to each volume is important.

To find the iSCSI Initiator Name from the vCenter GUI go to **Configuration -> Storage Adapters**. Click on the iSCSI Software Adapter. The iqn can be copied and pasted into the Group Manager interface for the Initiator Name.

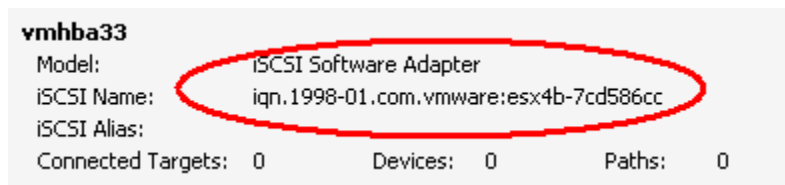


Figure 14: vCenter GUI - Obtaining Initiator Name

If you want to use CHAP you can enable this by pressing the CHAP button in the vmhba adapter properties.

There is another check box option for "Enable shared access to the iSCSI target from multiple initiators". This option is necessary to enable all of the advanced vSphere capabilities that rely on shared storage. This will need to be checked

and more ESX hosts added to the Access tab when configuring access for your remaining ESX hosts.

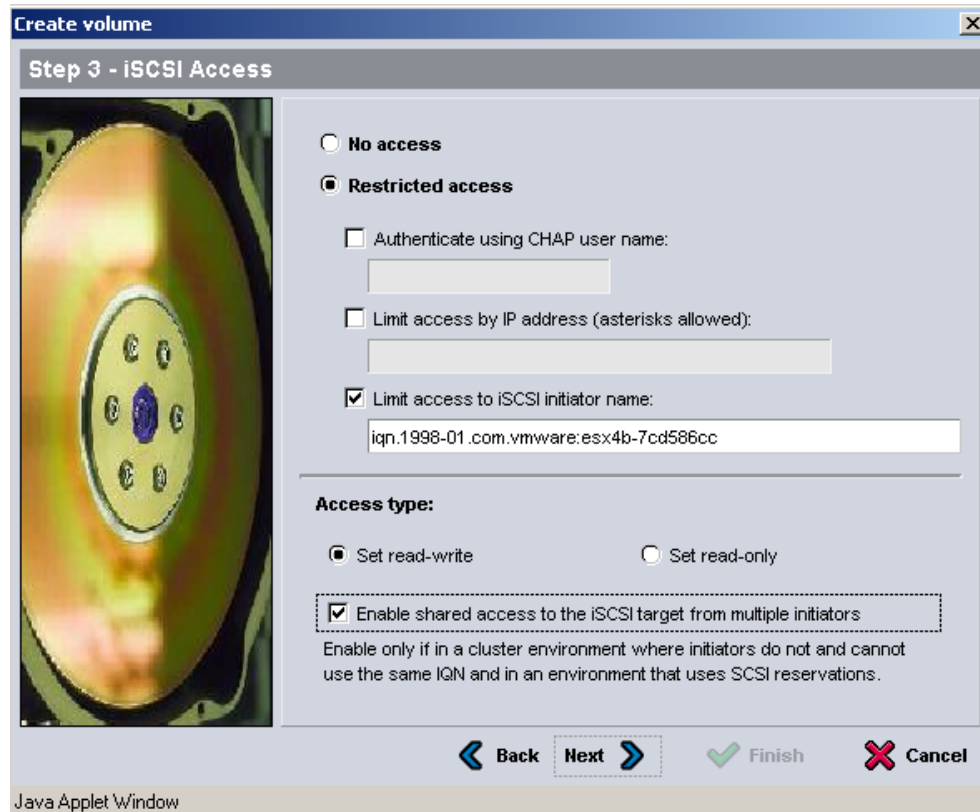


Figure 15: Group Manager GUI - Create Volume – iSCSI Access Control

4. Click **Next** to continue the volume creation.
5. Review the volume creation information on the next screen and click **Finish**.

Step 8: Connect to a Volume on PS Series SAN

The next step is to connect to the volume on the SAN and verify the connection status. Since the iSCSI access and configuration was configured in the last step, the only thing to do now is to rescan the HBAs and make sure the volume appears correctly.

In the vSphere GUI click on **Configuration -> Storage Adapters** and select the iSCSI Software Adapter.

Click **Rescan** and choose to Scan for New Storage Devices and select **Ok**.

When this is done, if everything has been configured properly under Devices there will be a new EQLOGIC iSCSI Disk with the correct size shown.

vmhba33 Properties...					
Model:		iSCSI Software Adapter			
iSCSI Name:		iqn.1998-01.com.vmware:esx4b-7cd586cc			
iSCSI Alias:					
Connected Targets:		1	Devices:	1	Paths:
				6	
View: Devices Paths					
Name	Identifier	Runtime Name	LUN	Type	Transport
EQLOGIC iSCSI Disk (naa.6090a03810f2b61b6fa3c4f3c49cc91e)	naa.60...	vmhba33:C0:T1:L0	0	disk	iSCSI

Figure 16: vCenter GUI - Verification of Volume in vCenter GUI

Step 9: Enabling VMware Native Multipathing - Round Robin

One of the new advanced features that is enabled by configuring the iSCSI Software Initiator the way we have is that now we can take advantage of MPIO by using Round Robin. This combined with the fan out intelligent design of the PS Series group allows for greater and better bandwidth utilization than in previous versions of ESX.

To configure Round Robin Multipathing on a volume, select the volume from the vCenter GUI. **Configure -> Storage**. Right click and select **Manage Paths**. This will display the path information with the default of fixed path.

To enable Round Robin select the drop down next to Path Selection and choose Round Robin (VMware). This will reconfigure the volume to utilize a load balancing policy going across all available paths.

NOTE: This needs to be done for every existing and new volumes that you want the Round Robin policy for.

NOTE: Some administrators want to set the default policy for all new volumes added to Round Robin. To do this, from CLI type the following:

```
esxcli nmp satp setdefaultpsp --satp VMW_SATP_EQL --psp VMW_PSP_RR
esxcli corestorage claimrule load
esxcli corestorage claimrule run
```

For more information on the setdefaultpsp command see the VMware CLI administration guide.

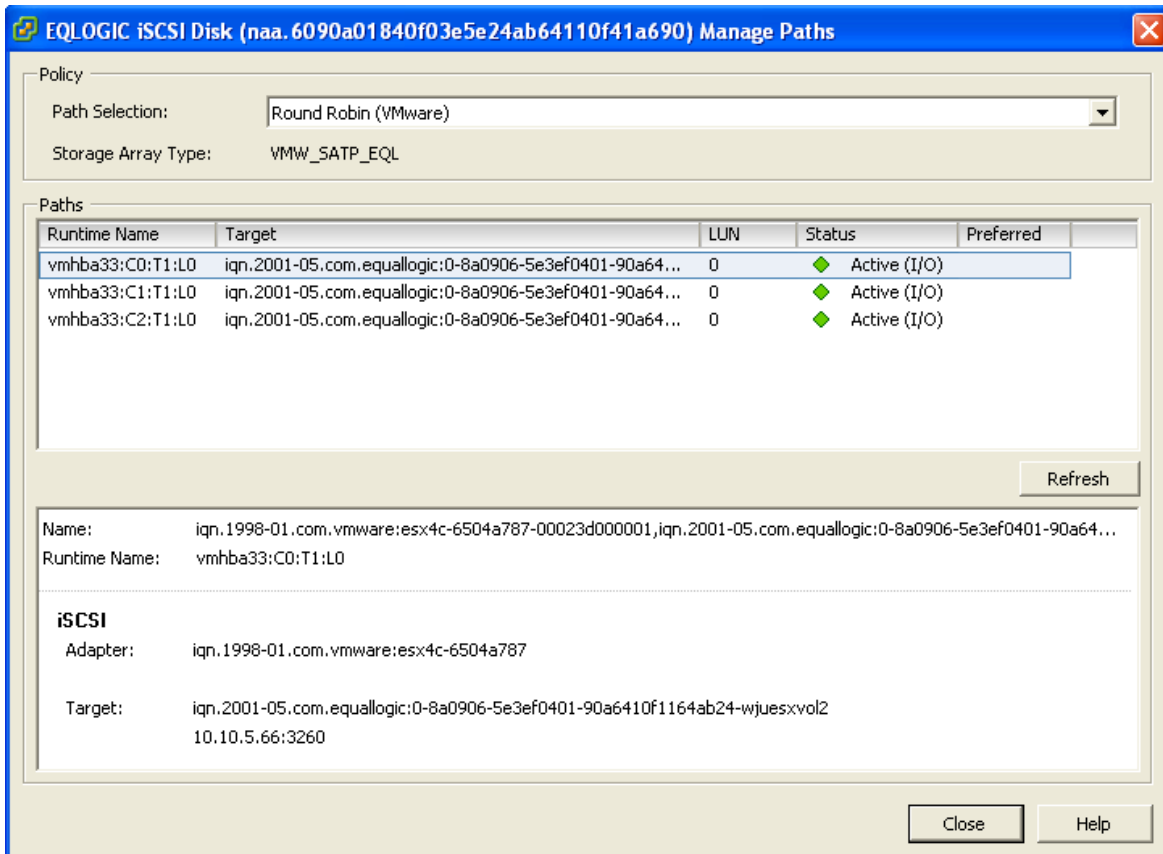


Figure 17: vCenter GUI - Round Robin MPIO Policy for New Volume

To verify that all of the configuration settings were made correctly, in the PS Series Group Manager, select the Volume and then click the **Connections** tab.

As shown here you will see 3 paths from each of the VMkernel IP Addresses that were assigned at the beginning.

iSCSI Connections			
Total iSCSI connections to the volume: 3			
Initiator address ▲	Connection time	MB read	MB written
10.10.5.206	6 d 32 min	1 MB	6 MB
10.10.5.207	2 d 1 hr 52 min	0 MB	9 MB
10.10.5.208	2 d 1 hr 48 min	442 MB	2.7 GB
Total read 37.67 GB, written 91.61 GB			

Figure 18: Group Manager GUI - Multiple Connections in Group Manager

Step 10: Create VMFS Datastores and Connect More Volumes

Now that the iSCSI Software vSwitch is set up and configured, follow steps 8-9 for each additional new Volume that is created. Each Volume can also be formatted VMFS and utilized as normal.

Each existing Volume can be modified to allow multiple ESX servers to attach to it by adding the Initiator Name in the Access Tab inside the Group Manager. See the PS Series Group Administration Guide for more information on adding more access control connections to a volume.

SUMMARY

This Technical Report is intended to guide new vSphere administrators in the proper configuration of the VMware iSCSI Software Initiator and connect it to the Dell EqualLogic PS Series SAN. With all of the advanced features that vSphere has it is important to follow these steps to enable them in the vSphere environment. This was just an example and not the only way to configure this although some of the CLI commands will be the same. Always consult the VMware iSCSI Configuration Guide for the latest full documentation for configuring vSphere environments.

TECHNICAL SUPPORT AND CUSTOMER SERVICE

Dell's support service is available to answer your questions about PS Series SAN arrays. If you have an Express Service Code, have it ready when you call. The code helps Dell's automated-support telephone system direct your call more efficiently.

Contacting Dell

Dell provides several online and telephone-based support and service options. Availability varies by country and product, and some services might not be available in your area.

For customers in the United States, call 800-945-3355.

Note: If you do not have access to an Internet connection, contact information is printed on your invoice, packing slip, bill, or Dell product catalog.

Use the following procedure to contact Dell for sales, technical support, or customer service issues:

1. Visit support.dell.com or the Dell support URL specified in information provided with the Dell product.
2. Select your locale. Use the locale menu or click on the link that specifies your country or region.
3. Select the required service. Click the "Contact Us" link, or select the Dell support service from the list of services provided.
4. Choose your preferred method of contacting Dell support, such as e-mail or telephone.

Online Services

You can learn about Dell products and services using the following procedure:

1. Visit www.dell.com (or the URL specified in any Dell product information).
2. Use the locale menu or click on the link that specifies your country or region.

Appendix A – Configure MPIO for ESX4i

The steps for ESX and ESXi are basically identical. However, the way to perform the "esxcli" commands is different, since ESXi does not have an internal service console. Instead, the commands need to be run from a remote CLI perl script program which can be run from a physical Windows server or a Windows virtual machine. VMware also provides the vSphere Management Assistant (vMA) virtual appliance which you can use to run all of these commands. The installation and configuration of the vMA is beyond the scope of this document.

To perform the necessary steps in ESXi, first download and install the Remote CLI package for ESXi. Go to vmware.com, click Support & Downloads, VMware ESXi, Download ESXi. Click on the Drivers and Tools tab and expand the Automation Tools and SDKs. Download and install "VMware vSphere CLI 4.x".

Then for each command listed in the Tech Report, use the analogous command from the Remote CLI package. When you start the Remote CLI, it puts you in the CLI directory. You can see the commands available by looking in the "bin" directory. You will need to specify the server IP address to communicate with.

For instance, for the command "#esxcfg-nics -l", your remote CLI command would be changed to this (where 192.168.1.28 is the IP address of your ESXi server):

```
bin\esxcfg-nics.pl -l --server 192.168.1.28
```

```
Name PCI Driver Link Speed Duplex MAC Address MTU
Description
vmnic0 03:00:00 bnx2 Up 1000Mbps Full 00:21:9b:8b:4b:b0 1500
Broadcom Corporation Broadcom NetXtreme II BCM5708 1000Base-T
vmnic1 07:00:00 bnx2 Up 1000Mbps Full 00:21:9b:8b:4b:b2 1500
Broadcom Corporation Broadcom NetXtreme II BCM5708 1000Base-T
vmnic2 0a:00:00 bnx2 Up 1000Mbps Full 00:10:18:4a:79:70 1500
Broadcom Corporation Broadcom NetXtreme II BCM5709 1000Base-T
vmnic3 0a:00:01 bnx2 Up 1000Mbps Full 00:10:18:4a:79:72 1500
Broadcom Corporation Broadcom NetXtreme II BCM5709 1000Base-T
```

Note: Most of the commands are Perl files (command-name.pl), but "esxcli" by itself is a .EXE. So the command "#esxcli swiscsi nic add -n vmk0 -d vmhba33" becomes:

```
bin\esxcli --server 192.168.1.28 swiscsi nic add -n vmk0 -d vmhba33
```

A full description of all the Remote CLI commands and how to use them, including how to set up a default ESX server and/or login credentials, is beyond the scope of this document. Check with VMware for more guidance about these commands.

Appendix B – Scalability and Scripting

VMware vSphere 4.0 introduced a number of advanced integration techniques to help administrators quickly scale out their environment. One of these new tools is called Host Profiling. The idea behind Host Profiles is to make a single ESX 4.X server a “gold master” and any new ESX servers that join the Datacenter can inherit all of the configuration settings of the gold master.

As of the writing of this Technical Report, Host Profiles did not propagate all of the correct vSwitch settings that this article describes. By using Host Profiles it will create the vSwitch and the VMkernel ports but Jumbo Frames are not enabled by default and the uplinks still have to be configured.

Because of this, it is recommended that instead of using Host Profiles, administrators can take advantage of simple shell scripting commands to automate the instructions detailed here. With 4.1 Administrators can take advantage of the automated setup script provided by Dell in the Multipathing Extension Module.

Below is a shell script that will automatically create the entire environment detailed in the example of this Technical Report. There are some assumptions that the information is the same from ESX host to ESX host and that there is no error checking in such a simple script but it can be used to help automate new ESX servers being added to the environment. Even more advanced scripting can be utilized to the effect of actually inputting values during run time but that is beyond the scope of this appendix.

This script can be created on a standalone server and the values inputted before being moved to the ESX server in question.

To create a new shell script in ESX run:

```
vi MPIO_Config.sh
```

This will create a new shell script file that can be modified to automate the entire process. Or this can be created on another system and moved to the ESX server.

Once it is created or moved, proper permissions need to be assigned so that it can be run. To do this, navigate to the directory where you uploaded the file and type in the following commands:

```
chmod 777 MPIO_Config.sh
```

This will change the permissions on the file to allow anyone to run it. For more information on the chmod command, its usage, and implications see the man pages on the command.

To run the shell script, navigate to the directory in which you uploaded it and run:

```
./MPIO_Config.sh
```

Example Shell Script

This is an example shell script that details all of the configuration settings performed in this document. The administrator can change the VMkernel IP Addresses and run this on each new system as long as they are all identically configured to help save some time on configuration. Then once this is done, the administrator can follow the steps from Step 7 to completion for each new ESX host. In order to get the iSCSI Software Adapter vmhba#, follow the procedure in step 5 prior to running the shell script in order to be able to assign the values to the script. There are advanced mechanisms to actually obtain it real time but they are outside the scope of this simple script.

```
#!/bin/bash
#MPIO_Config.sh

echo "MPIO_Config Script"

echo "Creating new vSwitch and Enabling Jumbo Frames"
esxcfg-vswitch -a vSwitch2
esxcfg-vswitch -m 9000 vSwitch2

echo "Creating VMkernel Ports"
esxcfg-vswitch -A iSCSI1 vSwitch2
esxcfg-vmknic -a -i 10.10.5.173 -n 255.255.255.0 -m 9000 iSCSI1
esxcfg-vswitch -A iSCSI2 vSwitch2
esxcfg-vmknic -a -i 10.10.5.174 -n 255.255.255.0 -m 9000 iSCSI2
esxcfg-vswitch -A iSCSI3 vSwitch2
esxcfg-vmknic -a -i 10.10.5.175 -n 255.255.255.0 -m 9000 iSCSI3

echo "Attaching NICs to vSwitch"
esxcfg-vswitch -L vmnic1 vSwitch2
esxcfg-vswitch -L vmnic2 vSwitch2
esxcfg-vswitch -L vmnic3 vSwitch2

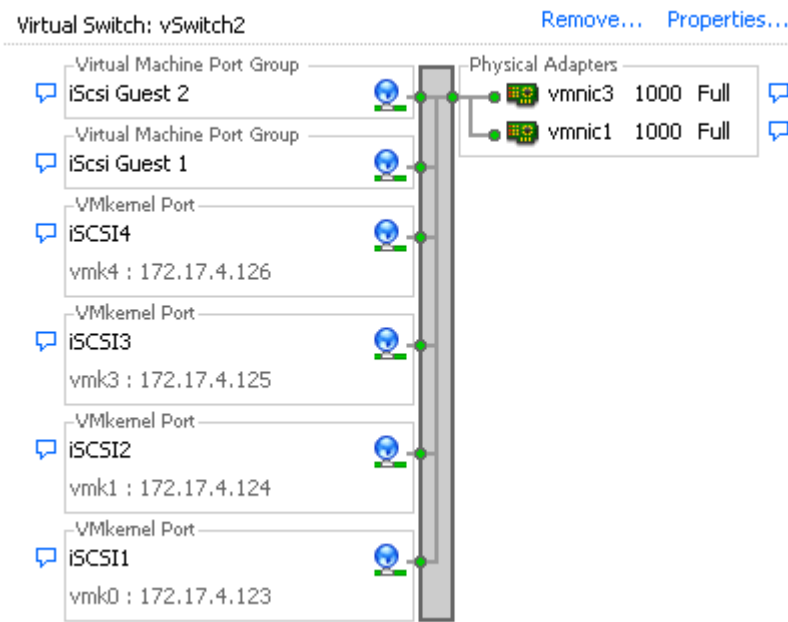
echo "Binding vmnics to VMkernel Ports"
esxcfg-vswitch -p iSCSI1 -N vmnic2 vSwitch3
esxcfg-vswitch -p iSCSI2 -N vmnic1 vSwitch3
esxcfg-vswitch -p iSCSI3 -N vmnic1 vSwitch2

echo "Binding VMkernel Ports to iSCSI Software Adapter"
esxcli swiscsi nic add -n vmk0 -d vmhba33
esxcli swiscsi nic add -n vmk1 -d vmhba33
esxcli swiscsi nic add -n vmk2 -d vmhba33
```

Appendix C - Removing Extra VMkernel Ports

In previous editions of this document it was possible to assign multiple VMkernel ports to physical nics. This was called over subscribing and was done to attempt to obtain more bandwidth for the environment especially when the ESX server had 10Gb nics and the SAN was running multiple 1Gb ports. Dell and VMware have changed the support for this practice and now only recommend using a 1:1 VMkernel binding process as described in this updated technical report. If you are running an environment that has VMkernel oversubscriptions it is advised that you follow the below steps and configure the server as recommended.

In the following example we have a 2:1 oversubscribed VMkernel vSwitch and we are going to remove the additional ports to create a 1:1 binding.



Switch Name	Num Ports	Used Ports	Configured Ports	MTU
vSwitch2	64	7	64	9000

Uplinks
vmnic1,vmnic3

PortGroup Name	VLAN ID	Used Ports	Uplinks
iScsi Guest 2	0	0	vmnic3,vmnic1
iScsi Guest 1	0	0	vmnic1,vmnic3
iSCSI4	0	1	vmnic3
iSCSI3	0	1	vmnic1
iSCSI2	0	1	vmnic3
iSCSI1	0	1	vmnic1

Step 1: Enter Maintenance Mode

VMotion all of the active VMs off the server and place the server into maintenance mode. Because the following steps will be removing VMkernel ports and possibly iSCSI connections you do not want this impacting current running Virtual Machines.

Step 2: Remove VMkernel Binding from Software Initiator

The first thing to do is to remove the VMkernel Binding from the software initiator adapter. This is done so that later VMkernels are not automatically assigned to the software adapter by accident.

Since we are moving to a 1:1 VMkernel binding, remove all VMkernels in excess of this. In this example you can see vmk3 and vmk4 are in excess of the 1:1 binding. To see which VMkernels we have bound to the software adapter use the following command:

```
esxcli swiscsi nic list -d vmhba33
```

To remove excess vmk ports type the following:

```
esxcli swiscsi nic remove -n vmk3 -d vmhba33
```

```
esxcli swiscsi nic remove -n vmk4 -d vmhba33
```

This removes vmk3 and vmk4 from the vmhba it is assigned to since in this example these are the two oversubscribed ports we want to remove. Re-verify that they are now gone.

Step 3: Remove Excess VMkernels

Now that the VMkernel ports have been removed from the software adapter, we want to remove them from the vSwitch. This can be done either through the GUI by selecting the vSwitch and clicking **Properties**. Select the VMkernel Port you want to remove and click **Remove**. Do this for all extra VMkernel ports.

Step 4: Rebalance VMkernel port to Physical nic relationship

Once the excess VMkernel ports are removed, you need to double check that each of the remaining VMkernel ports are correctly bound to a unique physical nic. This can be done through the GUI or via CLI using the instructions in Part 4 of this technical document. Verify that each VMkernel is now only bound 1:1 to a physical nic.

Step 5: Reboot and Verify

After these steps have been done, reboot the server, verify that all the configuration changes you made have been applied, verify the correct path connectivity and exit the host from maintenance mode. Do this for all servers until they have the recommended 1:1 binding.