D-Link

D-Link System, Inc.™
xStack Storage DSN-Series SAN Arrays
VMware ESX 3.0.2 & 3.5
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Executive Summary

The xStack Storage Series iSCSI storage arrays from D-Link provide cost-effective, easy-to-deploy shared storage solutions for applications like the VMware Infrastructure 3 server virtualization software. In this document the features and performance of the D-Link xStack Storage™ Series iSCSI storage arrays along with typical server systems are configured, instructions for use with VMware are given, and recommendations are made.

Overview

Server virtualization programs such as VMware run best when the datacenter or enterprise is organized into "farms" of servers that are connected to shared storage. By placing the virtual machines' virtual disks on storage area networks accessible to all the virtualized servers, the virtual machines can be migrated from one server to another within the farm for purposes of load balancing or failover. VMware Infrastructure 3 uses the VMotion live migration facility in its Distributed Resource Scheduling feature and provides a High Availability component which takes advantage of shared storage to quickly boot up a virtual machine on a different ESX server after the original ESX server fails. Shared storage is key to enabling VMotion because, when a virtual machine is migrated from one physical server to another, the virtual machine's virtual disk doesn't actually move. Only the virtual disk's ownership is changed while it continues to reside in the same place.

The xStack Storage iSCSI storage arrays provide excellent performance, reliability and functionality and do not require specialized hardware and skills to set up and maintain. The Fibre Channel storage network starts with the fabric, which involves the use of FC host bus adapters (HBAs) in each server, connected by fiber cables to one or more FC switches, which in turn can network multiple storage arrays, each supporting a scalable number of high speed disk enclosures. An application's request for an input or output (IO) to storage originates as a SCSI (Small Computer System Interface) request, is packed into an FC packet by the FC HBA, and sent down the fiber cable to the FC switch for dispatch to the storage array that contains the requested data, similar to the way Internet Protocol (IP) packets are sent over Ethernet. For smaller IT shops or for those that are just starting out in the virtualization arena, an alternate shared storage paradigm is emerging that employs iSCSI (Internet SCSI) to connect the servers to the storage. In this case the communication between the server and the data storage uses standard Ethernet network interface cards (NICs), switches and cables. SCSI IO requests are packed into standard Internet protocol packets and routed to the iSCSI storage through Ethernet switches and routers. With iSCSI customers can leverage existing networking expertise and equipment to simplify their implementation of a storage network. Like Fibre Channel, iSCSI supports block-level data transmission for all applications, not just VMware. For security iSCSI provides CHAP authentication as well as IPSEC encryption.

Servers can communicate with iSCSI storage using two methods. The first involves the use of an add-in card called an iSCSI hardware initiator or host bus adapter, analogous to the Fibre Channel HBA, which connects directly to the datacenter's Ethernet infrastructure. The second does the iSCSI conversion in software and sends the Ethernet packets through the standard Ethernet NIC.

The xStack Storage Series iSCSI SAN solution is designed for different sized customers and varying environments and is easy to configure to provide storage to VMware hosts.

This document will describe the xStack Storage Series, document how to configure with VMware, and then, using a database workload running on two virtual machines to demonstrate usage.

The configuration shown in this paper represent a single, high-level view of the usage of the xStack Storage array with a simple virtualization workload running on only 5 disks in each array. Typical customer use scenarios will employ larger disk arrays supporting a variety of applications, which may result in varying performance results.

xStack Storage Family

D-Link's virtualized storage technology is revolutionizing the way small and medium enterprises will manage their storage. Our virtualized storage pool eliminates the complexities associated with managing traditional RAID. Best of all, D-Link's iSCSI storage arrays are affordable.

Provision your storage from a single pool of available storage. There is no need to dedicate drive groups or entire arrays to RAID types or manage individual LUNS. Wizard driven provisioning is as simple as selecting a volume size and the appropriate application type from a menu. Seasoned storage administrators have the option of defining volumes with more granularity if desired. The advanced intelligence of the system allows for multiple virtual volumes with mixed RAID types to coexist on the same drives. Each application can have a Quality of Service tailored to the needs of the specific application. Application aware cache algorithms dynamically adjust to each application, further optimizing performance. By eliminating RAID groups, volumes can span across the total quantity of disks in the system, thereby further increasing performance. The benefits of these features become increasingly critical in mixed workload and virtualized server environments where multiple application types concurrently access the system resources.

All xStack Storage family models are comprised of these features. And, all targets work with either VMWare ESX 3.0.2 & 3.5 Server.

The D-Link DSN-1100-10 iSCSI SAN

The D-Link DSN-2100-10 iSCSI SAN

The D-Link DSN-3200-10 & 3400-10 iSCSI SAN

The D-Link DSN-5110-10, & 5210-10 & 5410-10 iSCSI SAN

Figure 1: The xStack Storage family

VMware and iSCSI

This section will describe the steps needed to attach iSCSI storage to a VMware ESX server host. Once attached and formatted, the storage can be provided to guest virtual machines as virtual disks that appear as local storage to the guest. An alternate method, in which the guest is attached directly to iSCSI storage through a software iSCSI initiator supplied with the guest's operating system, is not covered in this document.

ESX 3.0.2 Configuration

Connectivity from a host running VMware's ESX server to iSCSI storage is provided through a built-in software initiator (support for hardware iSCSI initiators will be provided at a later date). The physical network interface cards (NICs) that connect to the Ethernet network in which the iSCSI storage is located must be included within a VMware virtual switch that also includes the ESX Service Console and the VMkernel (which supports VMotion traffic as well as iSCSI packets). For a two-NIC system it is recommended that the NICs be teamed as shown in Figure 2. This provides NIC/cable failover and iSCSI traffic load balancing across the NICs to multiple iSCSI targets with different IP addresses.

Since the VM and iSCSI traffic are mixed in this configuration, CHAP authentication and IPSEC encryption should be employed in the iSCSI connection. (Alternately, in a two- NIC configuration the VM and iSCSI traffic can be each placed on their own non-teamed NICs for total isolation). The network configuration is created in Virtual Center (VC) using the Virtual Infrastructure Client. The ESX server to be connected is highlighted, then the Configuration tab is selected, then Networking.

If there are more than two NICs available in the ESX server host, it is recommended that two virtual switches be created, one which hosts the Service Console and VMkernel (including iSCSI and VMotion traffic), and one which is dedicated to virtual machine (VM) traffic. The two NICs carrying iSCSI traffic should be cabled to redundant Ethernet switches. An example for four NICs showing two 2-NIC teams is shown in Figure 3.
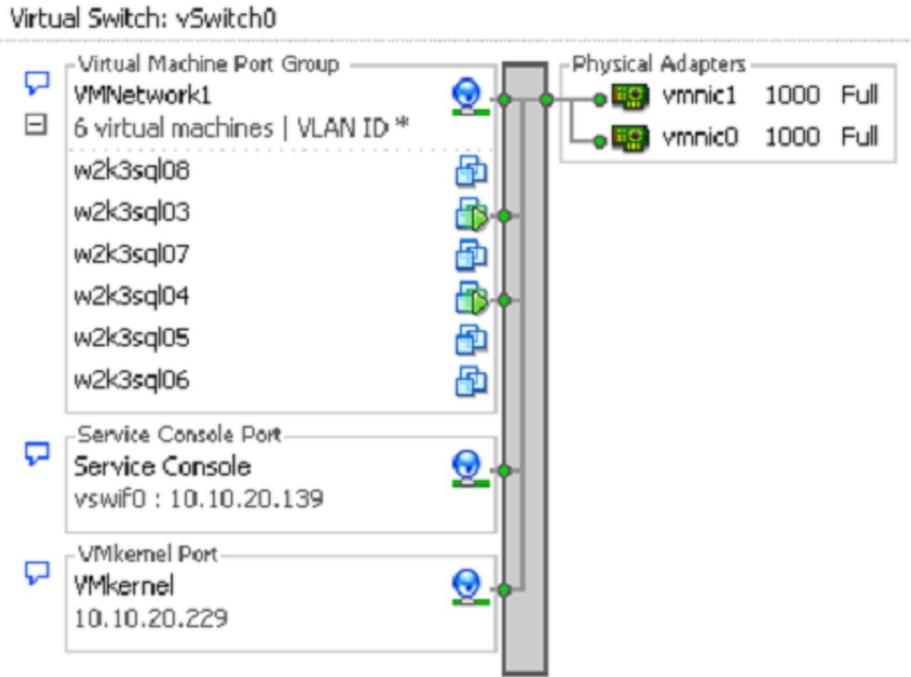
Figure 2: ESX Two NIC Configuration for iSCSI
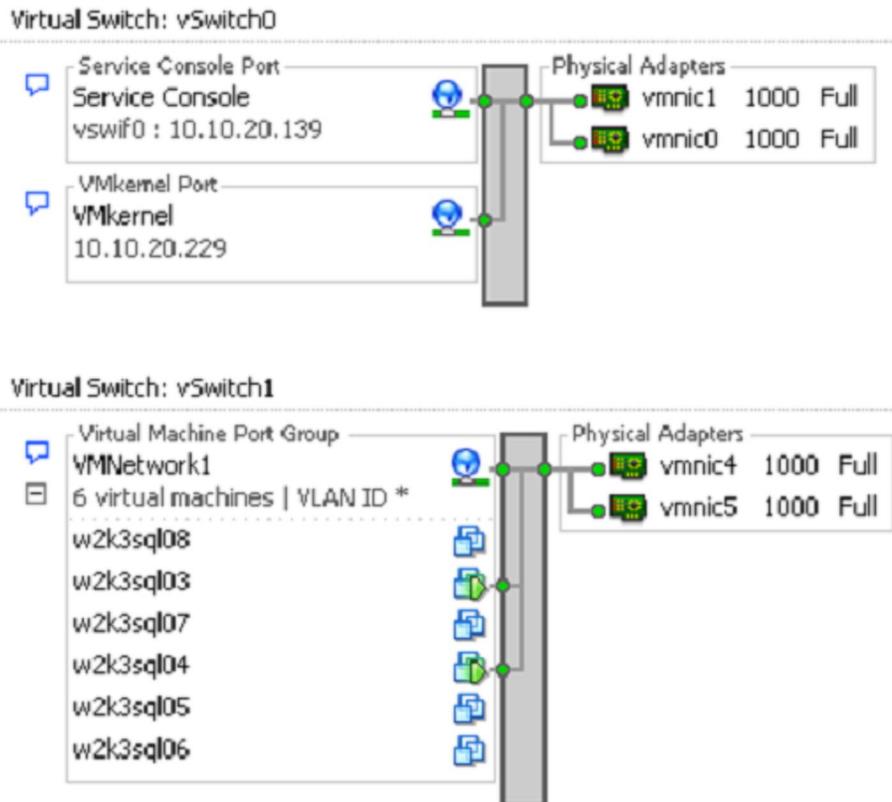
Figure 3: ESX Four NIC Configuration for iSCSI

Connecting the ESX Server Host to the iSCSI Array

The process to connect an ESX Server host to an iSCSI storage array has three steps: First, the iSCSI software initiator in ESX is configured to point to the storage target. Then the target storage array is configured to enable access from the ESX host and the host's disk LUNs (Logical Unit Numbers) are created. Finally it is necessary to format the storage with the VMware File System (VMFS).

Configure iSCSI Software Initiator in ESX

As a security measure iSCSI access is disabled by default in ESX.

To enable it, from the ESX host in VC:

ESX Server → Configuration → Security Profile → Properties → enable Software iSCSI Client

Next, select Configuration → Storage Adapters, and then highlight iSCSI Software Adapter. Notice the SAN Identifier. In this test, for host r3esx1950c, the identifier is iqn.1998-01.com.vmware:r3esx1950c-7b658143. In the Details pane select Properties to bring up the iSCSI Initiator Properties page. Select Configure and then select Status: Enabled if necessary. Finally, select the Dynamic Discovery tab, select Add and on the Add Send Targets Server page enter the IP address of the iSCSI storage array and change the Port from its 3260 default if necessary.

Configure Target Storage Array and Create the LUNs

First, the LUNs that will be assigned to VMware are created on the target storage array. Use the xStack Storage® Management Center.

Format Storage

Back in Virtual Center select ESX Server → Configuration → Storage Adapters and then select Rescan → Scan for New Storage Devices. The LUN(s) defined on the iSCSI storage array should show up.

If this is the first host to access this LUN it is necessary to format the storage with the VMware file system, VMFS3. From the Configuration tab select Storage (SCSI, SAN and NFS) and click on Add Storage. Select Disk/LUN, and then select the LUN to be formatted. Supply a Datastore Name (for example, NX1950-1). For Disk/LUN Formatting accept the default maximum file size (256 GB), block size (1MB), and capacity or change them if desired. The datastore should show up in the list of storage devices. When the next ESX server is connected to the same iSCSI storage array the datastore should show up after the Scan for New Storage step.

Once the storage LUN has been added to an ESX host, VMs can be created on that ESX host with their virtual disks using the LUN storage. Since the LUN is shared between all ESX server hosts connected to the iSCSI storage array the VMs may be live migrated from one host to another using VMotion.

Basic Setup

To provide a basic setup using an xStack Storage iSCSI storage offering, a PowerEdge 2850 ESX host with two Intel® dual-core Xeon® processors running at 2.66GHz and with 4GB memory was connected as described in the previous section to five-disk RAID 5 LUNs on one xStack Storage DSN-3200-10 storage array. We used the two built-in NICs for the ESX Service Console, VMkernel (including iSCSI traffic) and the virtual machine (VM) traffic as shown in Figure 2.

For testing this basic setup, two Windows Server 2003 R2 VMs with Microsoft SQL Server 2005 running a medium size (1 GB) version of the D-Link DVD Store database test application were created with their 10GB virtual disks stored on the five-disk LUN on one array. The VMs were then cloned three times with the copies' virtual disks placed on similar LUNs on each of the other three arrays. The VMs were configured with 4 virtual CPUs and 512MB each so that each virtual CPU roughly had the resources of a single processor core.

The SQL Server database on each VM is created on that VM's local disk so it, too, is stored on the LUN. Since the database size (1 GB) exceeds the memory available to the VM (512 MB), SQL Server will have to access its content from the LUN during the test.

The two VMs attached to a single iSCSI storage array were then stressed using an order entry simulator (included as part of the DVD Store kit) which models users logging into the online DVD Store, browsing for DVDs by title, artist or category, and finally making a DVD purchase. A complete cycle of logging in, browsing, and purchasing counts as one order. The number of users and the amount of time they spend thinking during an order can be controlled by the simulator. In this test, the think time was set to 0 seconds so that each driver thread can be thought of as a super user entering orders without stopping.

Starting with 2 such driver threads per VM, a workload was applied to each VM pair for 4 minutes and the average orders per minute and response time recorded. Then the VMs' databases were restored to their original state and a larger workload applied. The workload was increased until the orders per minute rate stopped increasing. At that point the storage array could handle no more IOs per second (IOPS) even as the applied workload increased.
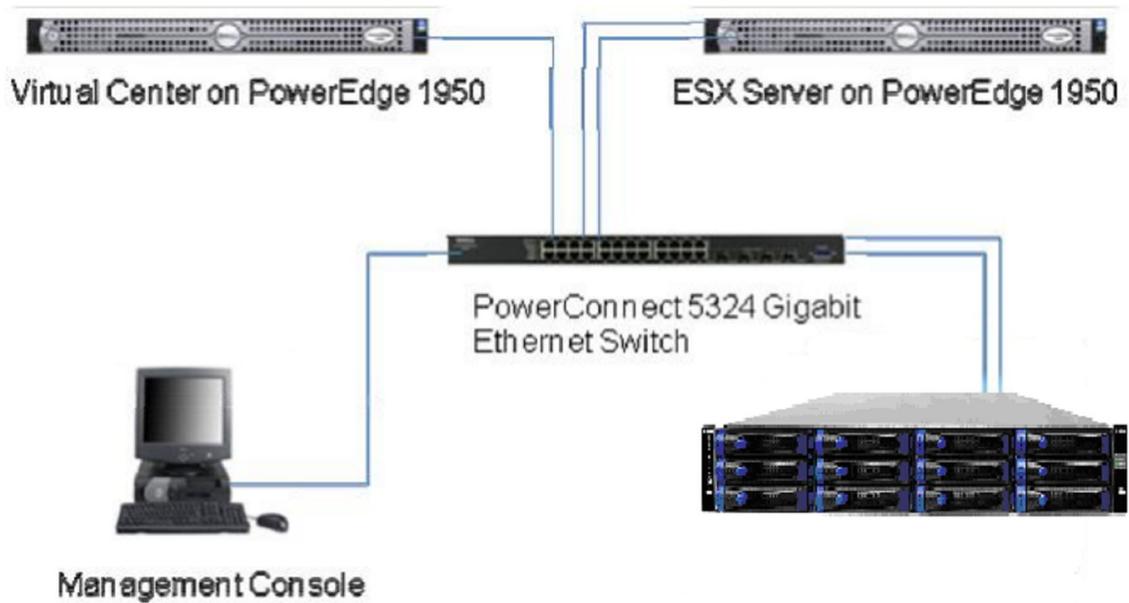
Figure 4: Basic Setup (typical servers, switch and xStack Storage DSN-3200-10 iSCSI SAN Solution)

STORAGE CONNECTIVITY

With the introduction of VMware Virtual Infrastructure 3.0, several new storage connectivity options were introduced. This section covers the available storage options and reviews settings specific to each technology.

To add a LUN as a datastore, follow these steps.

1	Open VirtualCenter.
2	Select an ESX host.
3	In the right pane, select the Configuration tab.
4	In the Hardware box, select the Storage link and then click Add Storage to open the Add Storage Wizard. See Figure 14.
5	Select the Disk/LUN radio button and click Next.
6	Select the LUN you want to use and click Next.
7	Enter a name for the datastore and click Next.
8	Select the block size, click Next, and click Finish.
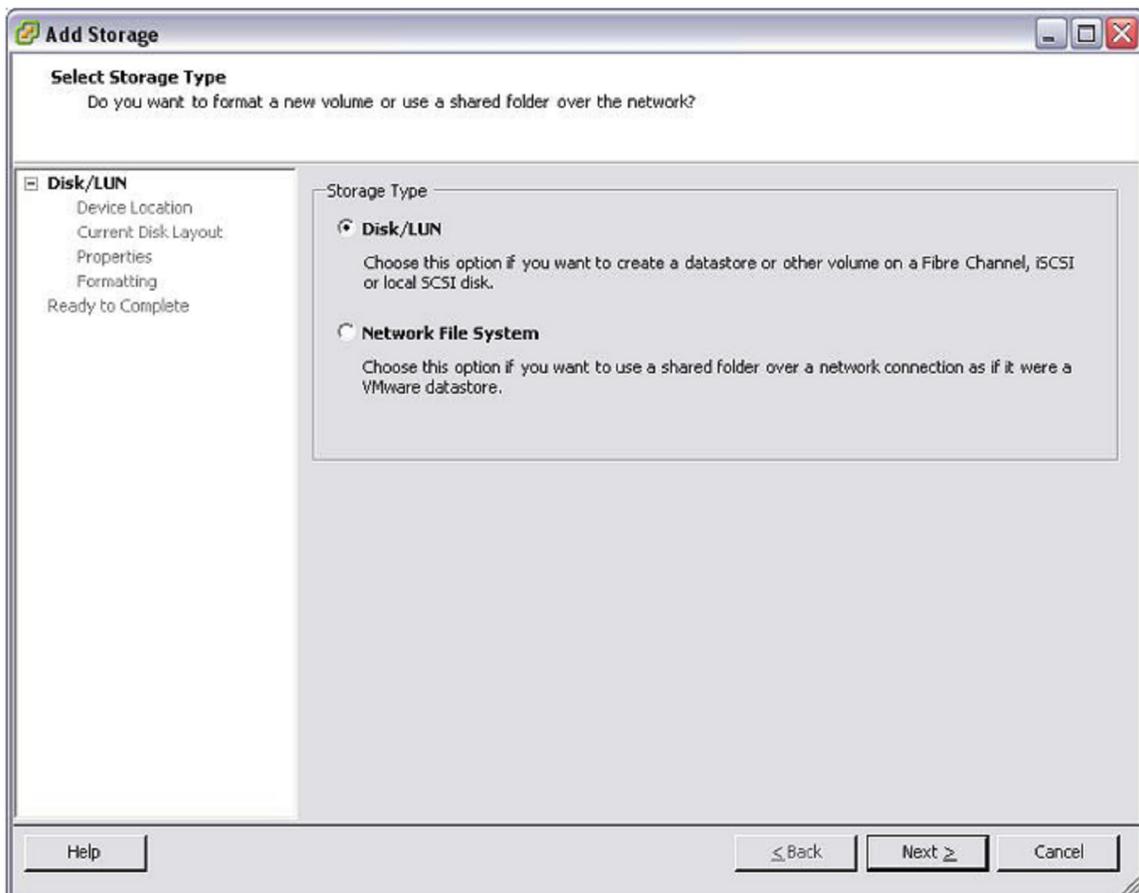
Figure 5: Add Storage

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Note that the default block size of a Virtual Machine File System is 1MB. This block size supports storing virtual disk files up to a maximum of 256GB in size. If you plan to store virtual disks larger than 256GB in the datastore, you must increase the block size to be greater than the default. See Figure 6.
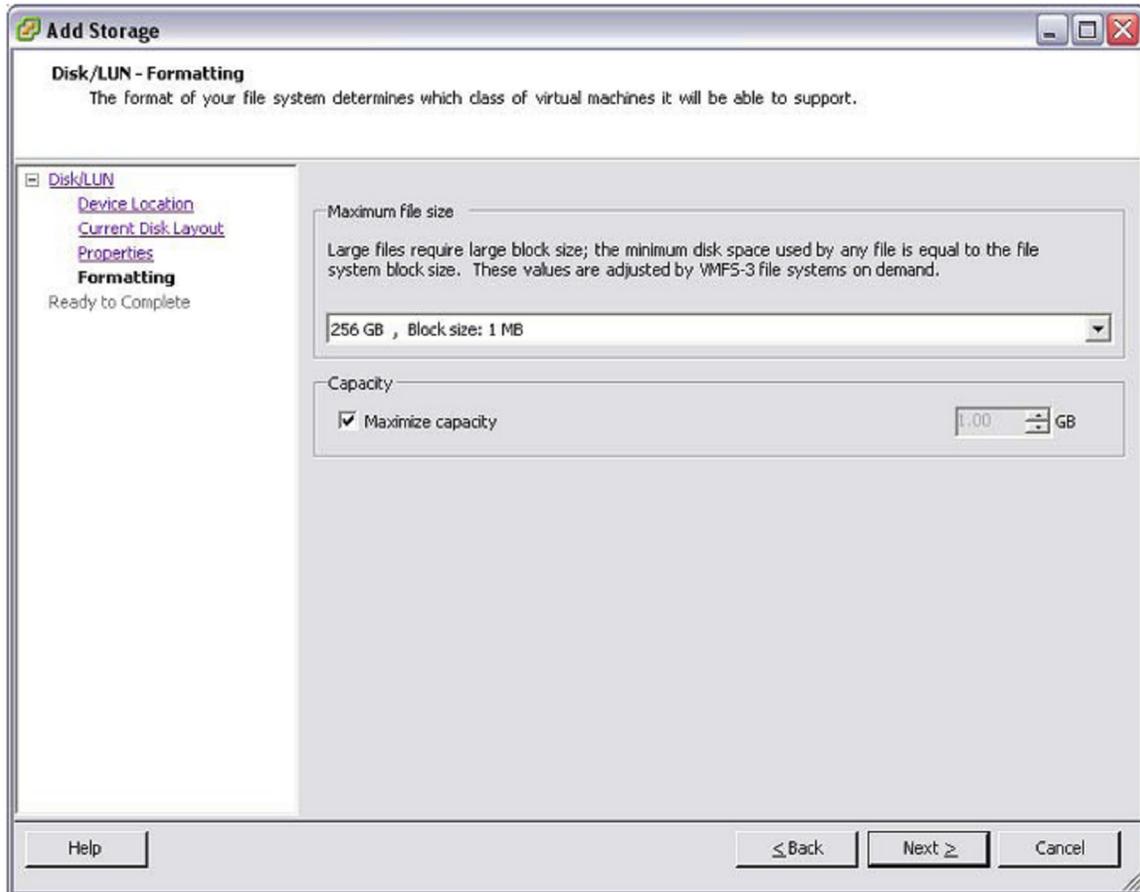
Figure 6: Disk/LUN Formatting

iSCSI/IP SAN Connectivity

As a best practice, D-Link recommends separating iSCSI traffic from other IP network traffic by implementing a separate network or VLAN than the one used for VMotion or virtual machine traffic. To enable ISCSI connectivity, the ESX Server requires a special connection type, referred to as a VMkernel port, along with a service console port. The VMkernel network requires an IP address that is currently not in use on the ESX Server. To configure the iSCSI connectivity, follow these steps.

1	Open VirtualCenter.
2	Select an ESX host.
3	In the right pane, select the Configuration tab.
4	In the Hardware box, select Networking.
5	In the upper right corner, click Add Networking to open the Add Networking Wizard. See Figure 7.
6	Select the VMkernel radio button and click Next.
7	Either select an existing vSwitch or create a new one. **Note:** If a separate iSCSI network does not exist, create a new vSwitch.
8	Click Next.
9	Enter the IP address and subnet mask, click Next, and then click Finish to close the Add Networking Wizard. See Figure 8.
10	In the left pane of the Configuration tab select Security Profile.
11	In the right pane, select the Properties link to open the Firewall Properties window.
12	Select the Software iSCSI Client check box and then click OK to close the Firewall Properties window. See Figure 9.
13	In the right pane, select Storage Adapters in the Hardware box.
14	Highlight the iSCSI Adapter and click the Properties link in the Details box. See Figure 9.
15	Select the Dynamic Discovery tab in the iSCSI Initiator Properties box.
16	Click Add and enter the IP address of the iSCSI-enabled interface for the D-Link system. See Figure 11.
17	For an additional layer of security, select the CHAP tab to configure CHAP authentication. D-Link recommends setting up and verifying iSCSI access before enabling CHAP authentication.
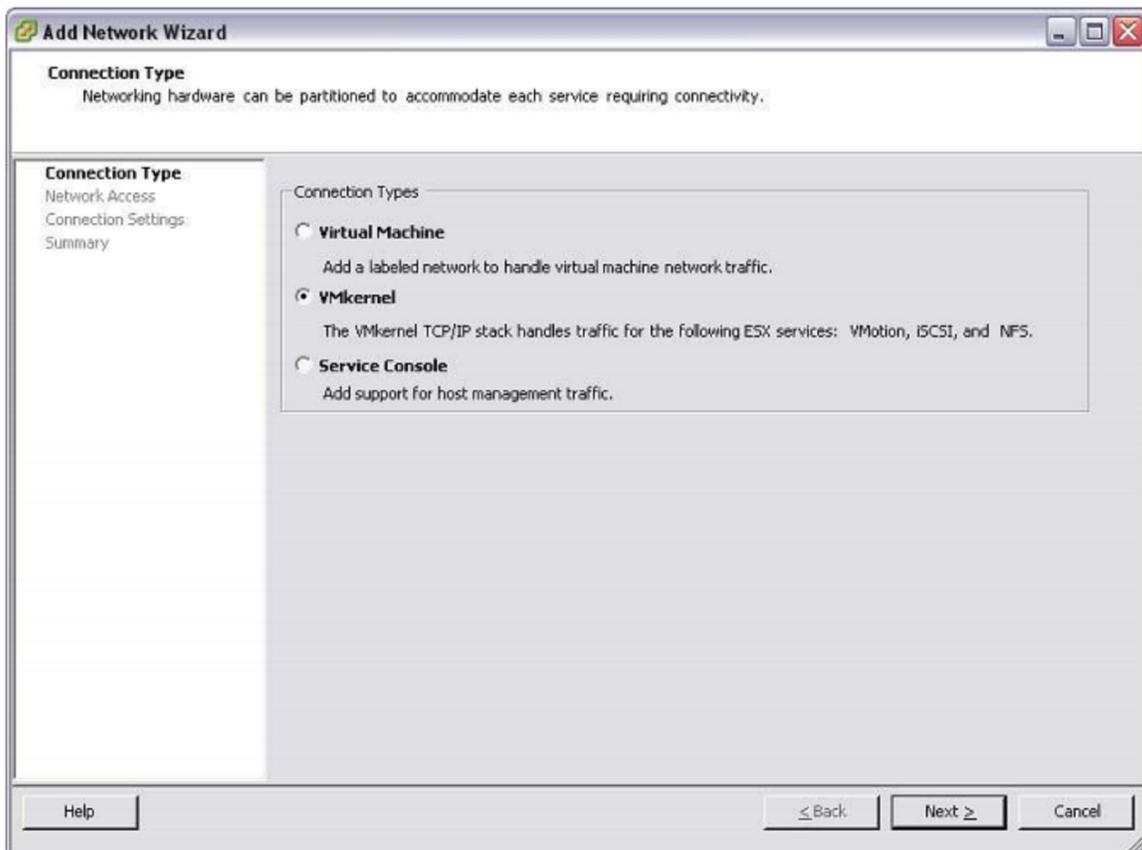
Figure 7: Add Network Wizard | VMKernel for TCP/IP and iSCSI

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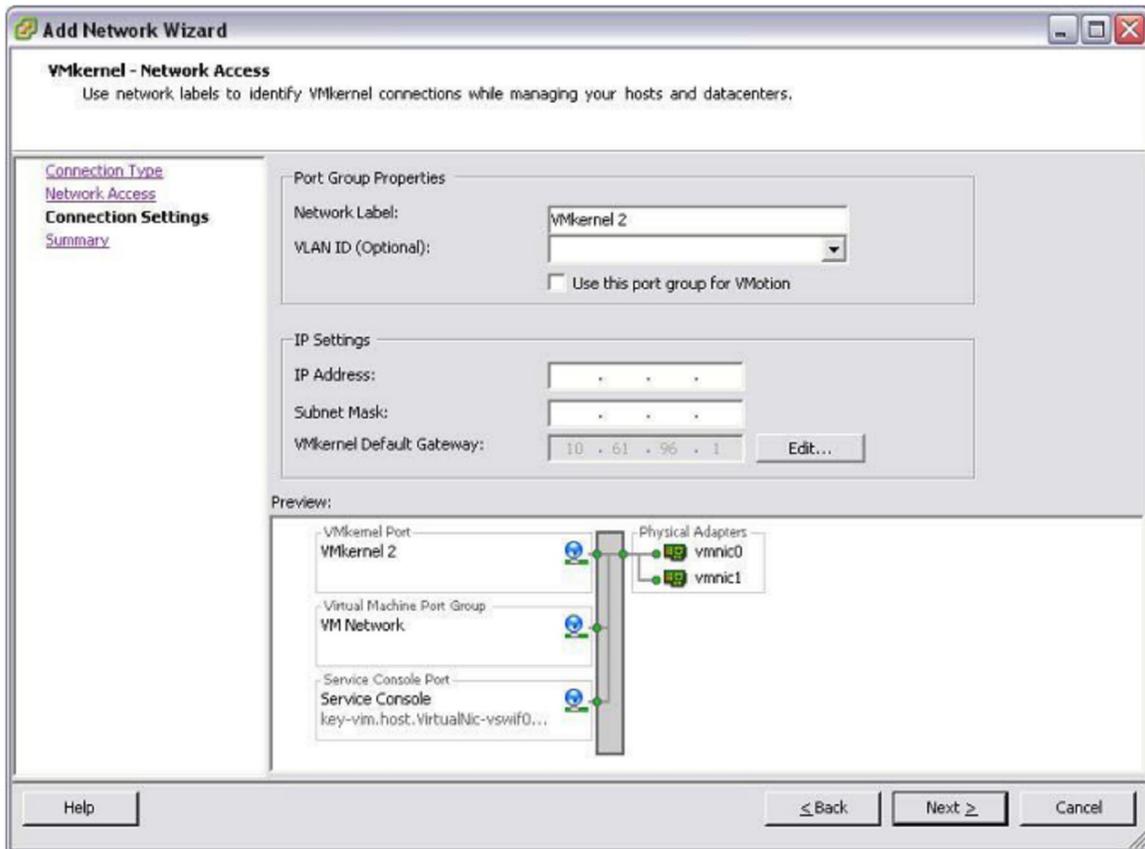
Figure 8: VMKernel | Network Access

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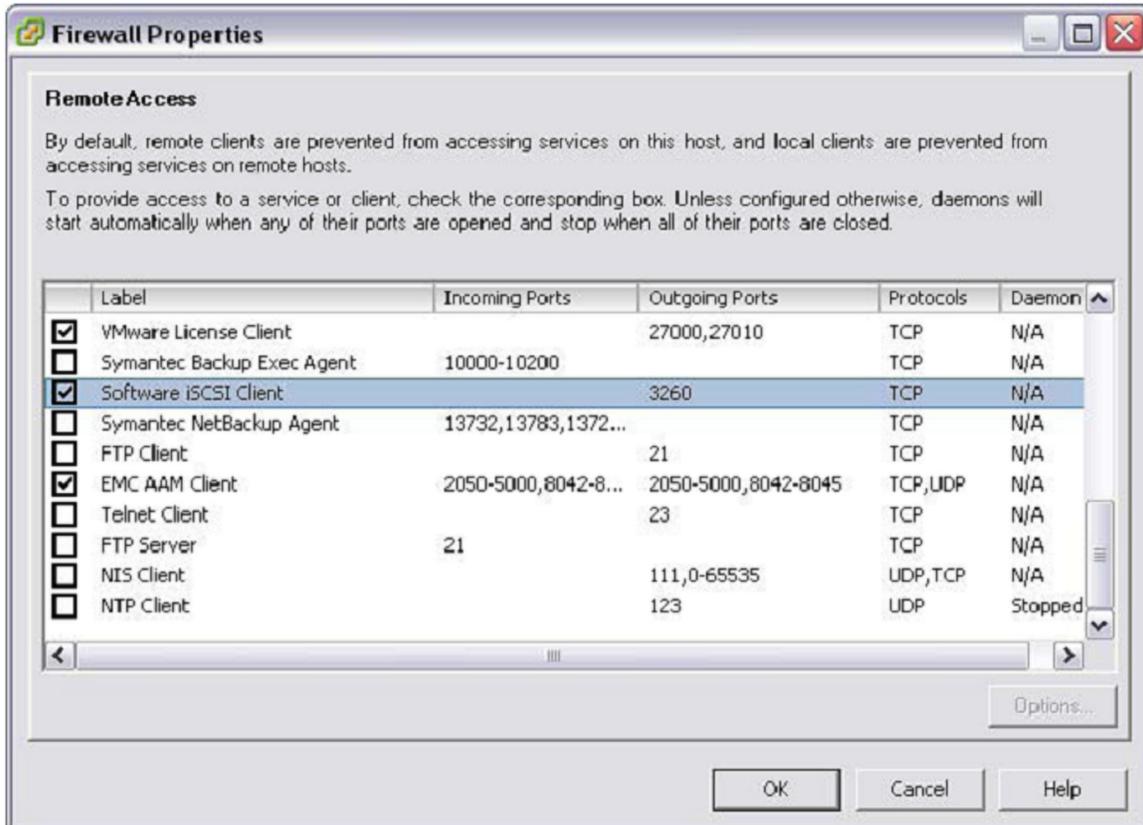
Figure 9: Firewall Properties | Enabling Software iSCSI Client via Port 3260
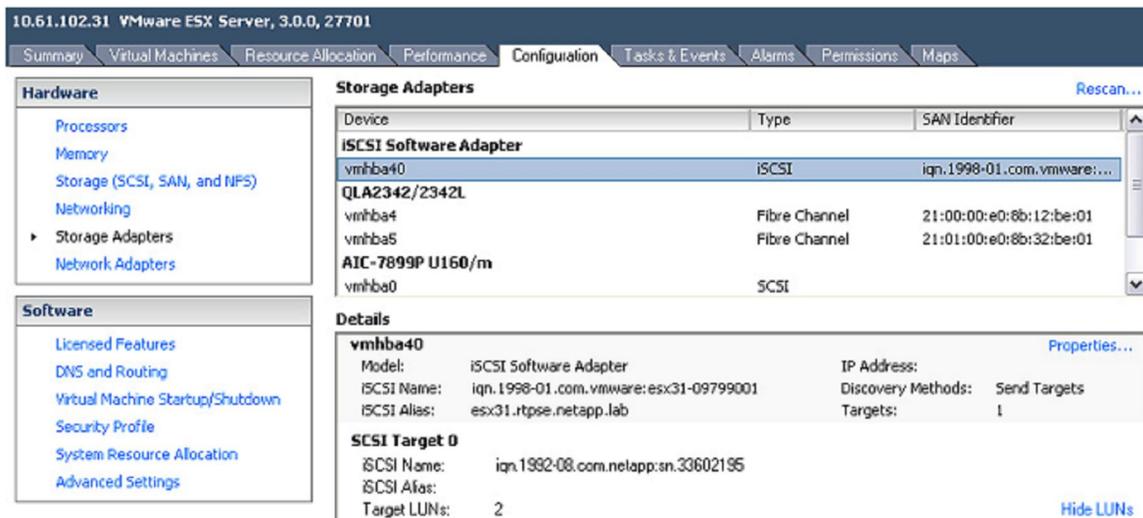
Figure 10: Initial iSCSI Software Adapter Configuration Screen
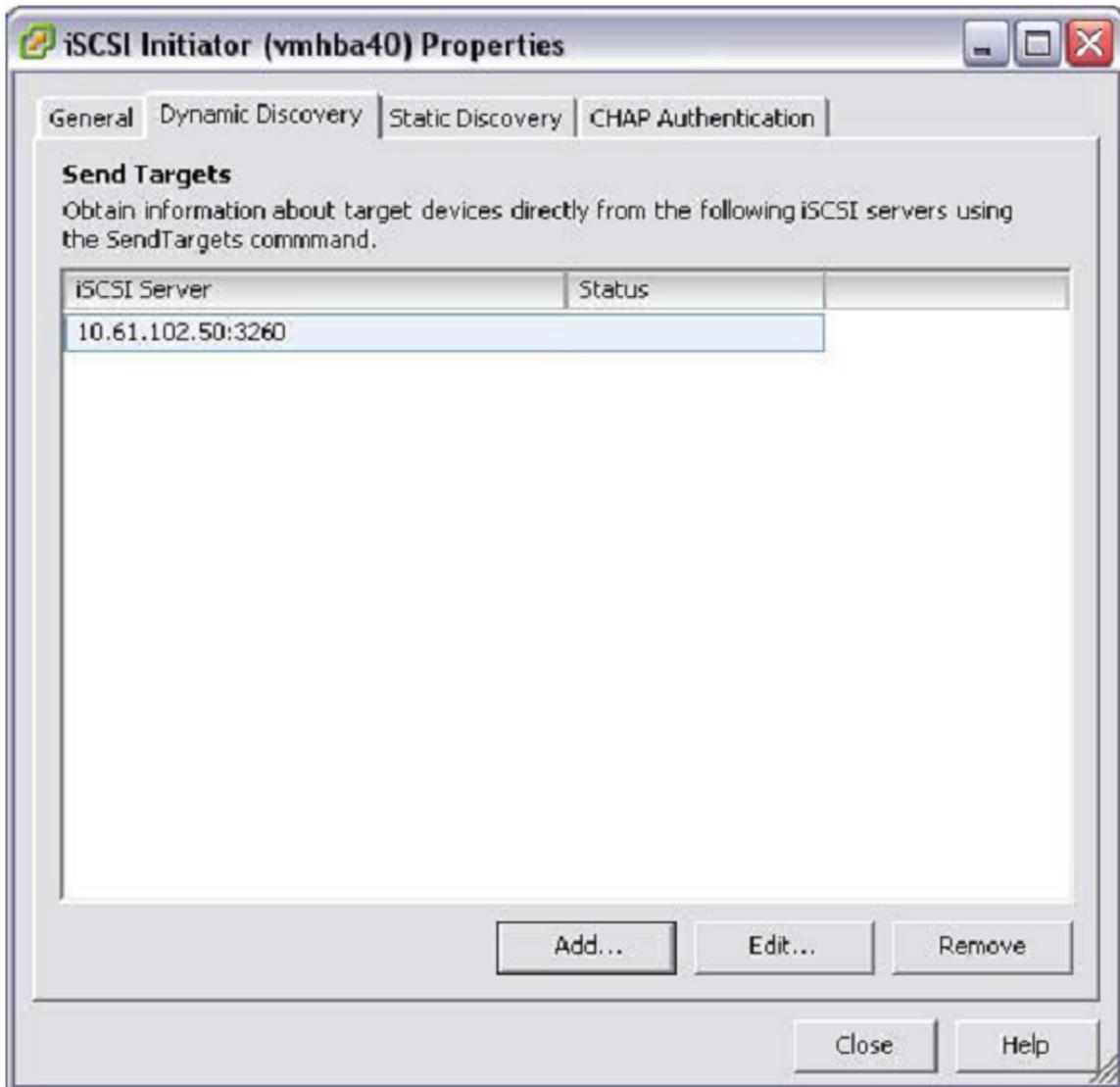
Figure 11: iSCSI Initiator Properties Window

D-Link offers iSCSI HBAs for use with iSCSI implementations. For larger deployments, scalability benefits may be realized in storage performance by implementing iSCSI HBAs. Note that this statement is not a requirement or a recommendation, but rather a consideration when designing dense storage solutions. The benefits of iSCSI HBAs are best realized because the storage arrays will have a higher aggregated I/O load than that of any individual VI3 Server.

iSCSI offers several options for addressing storage. If you are not ready to use iSCSI for your primary data access, you may consider iSCSI for several other uses. iSCSI could be used to connect to data stores that store CD-ROM ISO images. Also, iSCSI can be used as a redundant or failover path for a primary Fibre Channel path.

ESX 3.5 Configuration

Connectivity from a host running VMware's ESX 3.5 server to iSCSI storage is much similar to ESX 3.0.2 Server in the above configuration. However, there are some basic differences noted in this section.

This section lists the steps required to configure the software initiator on the VMware ESX 3.5 Server. Connect to the ESX server/VirtualCenter using VI Client, and follow the below steps:

1. Select *Configuration->Security Profile* on the ESX server.
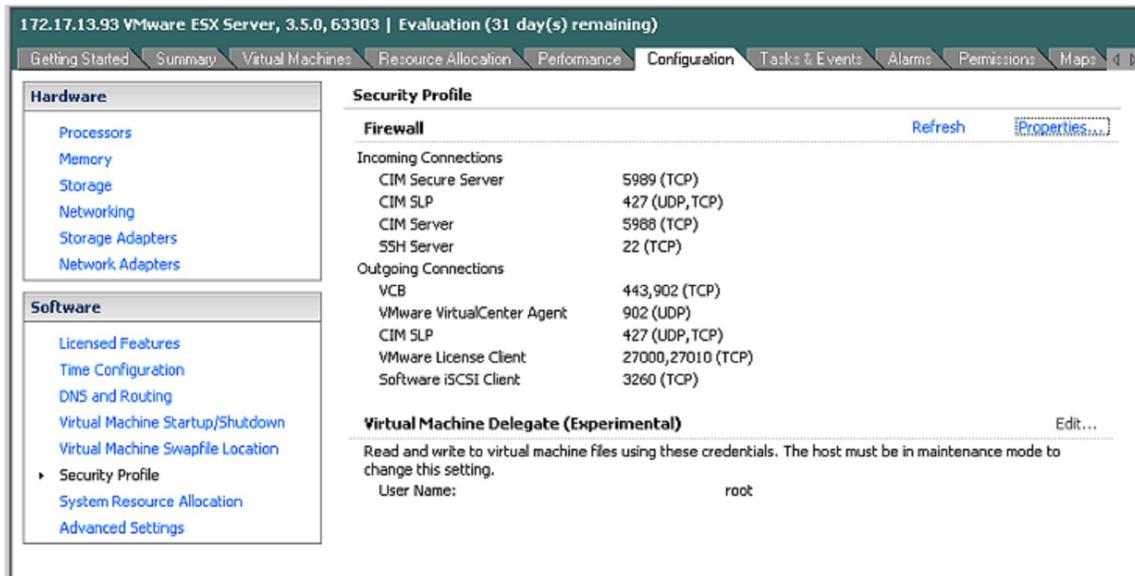
Figure 12: Security Profile Configuration Tab

2. Click on *Properties*. The *Firewall Properties* box appears.
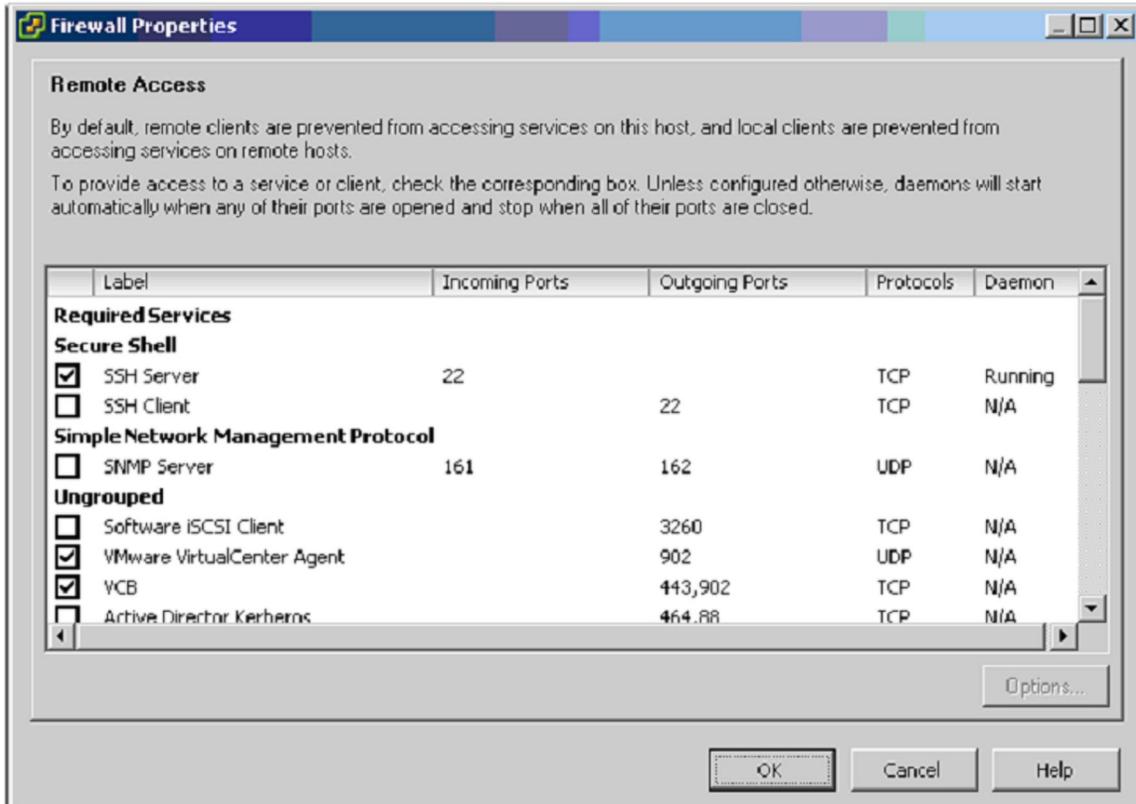
Figure 13: Firewall Properties Window

3. Check *Software iSCSI Client*.
4. Select *Configuration->Storage Adapters* on the ESX server.
5. Select iSCSI software adapter and click on *Properties.*
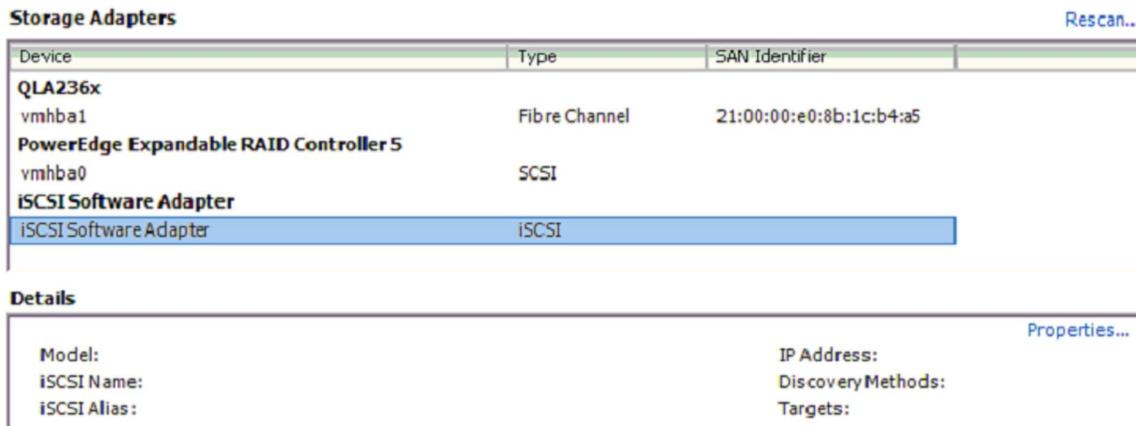
Figure 14: iSCSI software adapter under Storage Adapters on VI client

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6. The iSCSI initiator Properties window appears.
7. Under the general tab select Configure tab. Select the *Enabled* checkbox and click *OK*. Select Close.
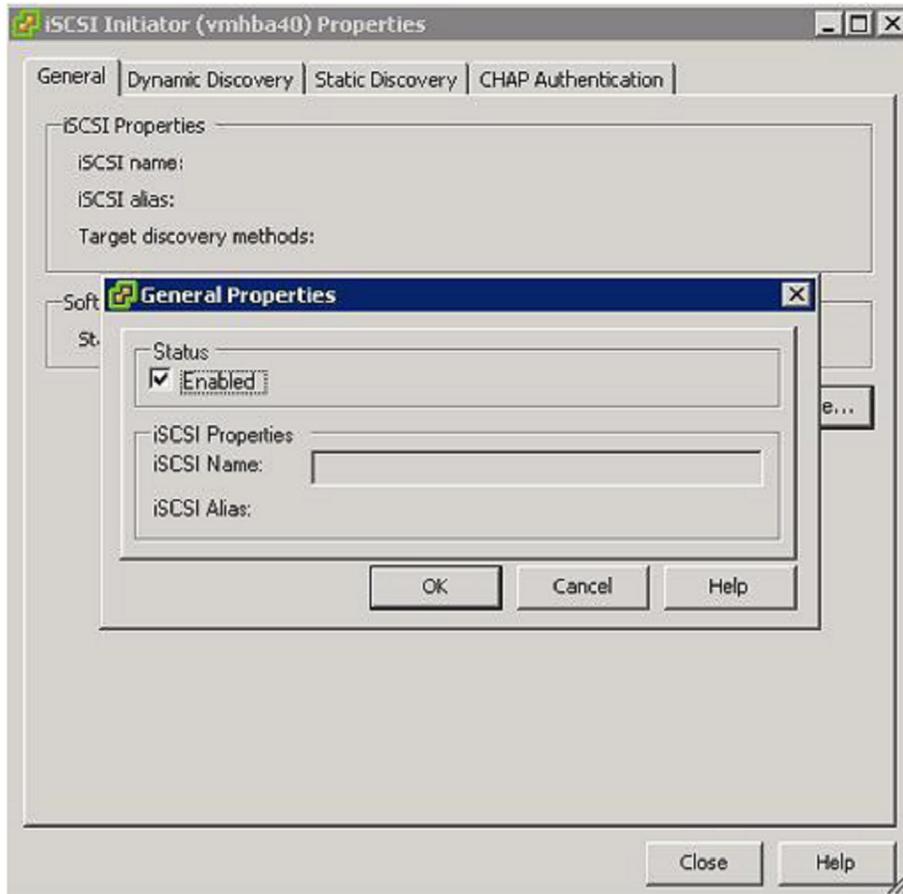
Figure 15: iSCSI software initiator properties window

8. Select iSCSI software adapter under storage. You should now see your iSCSI Target name listed.

Figure 16: iSCSI software initiator properties window

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9. Select Properties under storage adapters. Select Dynamic Discovery. Select *Add*. Provide the IP address of the xStack Storage iSCSI Data Port and click OK. There may be a slight delay before the process completes.
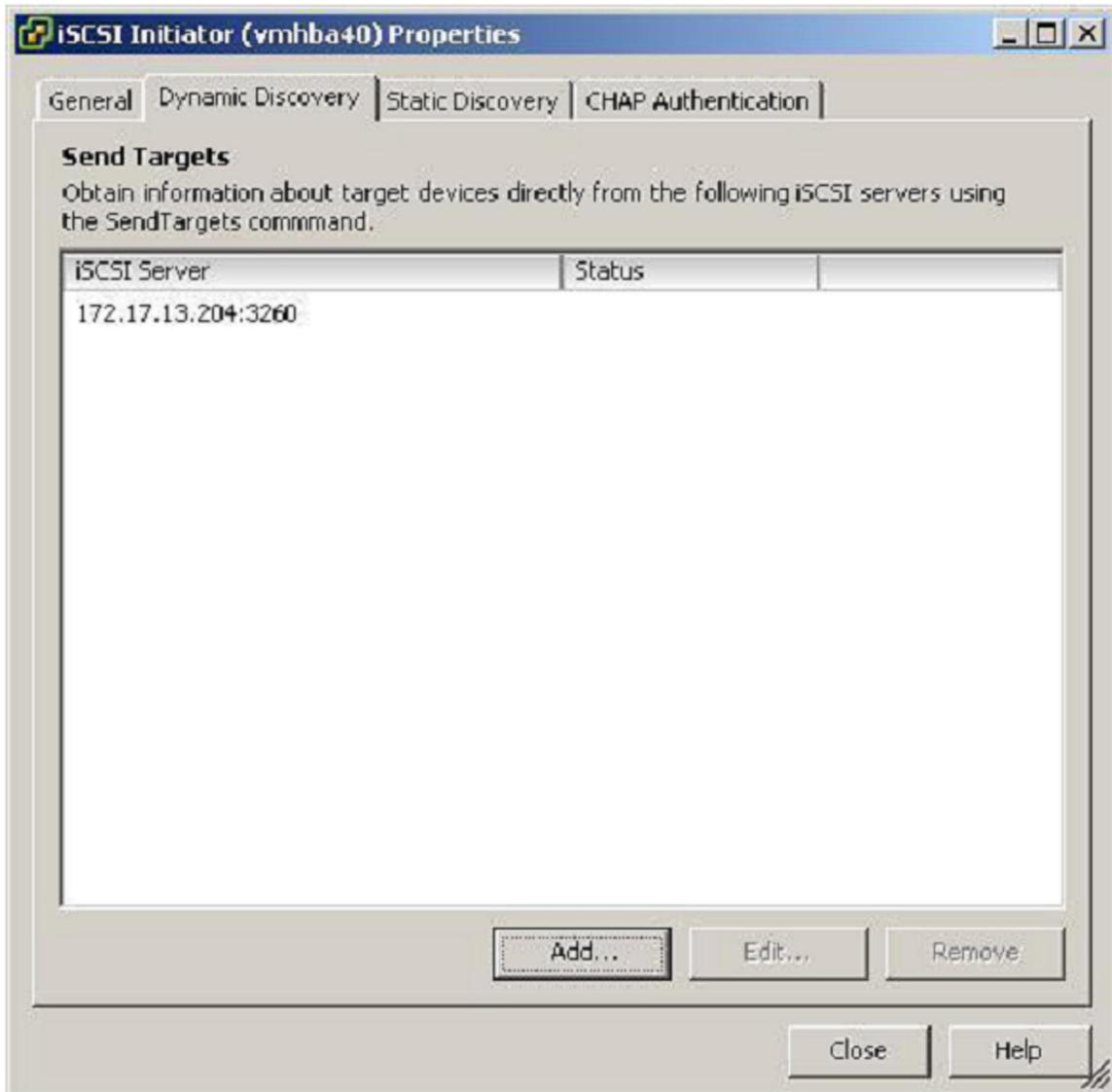
Figure 17: iSCSI software initiator properties window

10. Click *Close*.

Configure iSCSI storage on ESX 3.5 Server

Connect to the ESX server/Virtual Center using VI Client and follow the steps below. 1. Go to the configuration tab and select *Storage Adapters*. Select the iSCSI Software Adapter and click *Rescan*. The newly created iSCSI target and LUN should be visible from the ESX server.

```
Details
  vmhba40                                                                    Properties...
    Model:        iSCSI Software Adapter                   IP Address:
    iSCSI Name:   iqn.1998-01.com.vmware:sec141-55167817   Discovery Methods: Send Targets
    iSCSI Alias:  sec141.vmware.vse.lab                     Targets:          1

  SCSI Target 6
    iSCSI Name:   iqn.1991-05.com.microsoft:nx1950-target1-target
    iSCSI Alias:
    Target LUNs:  1                                                          Hide LUNs

    Path              Canonical Path       Capacity        LUN ID
    vmhba40:6:0       vmhba40:6:0          20.00 GB        0
```

Figure 18: iSCSI target and LUNs as visible through VI client

2. Go to the configuration tab and select *Storage*. Click on *Add Storage*, select *Disk/Lun* and click *Next*. Select the newly added storage and click *Next*.

3. Select the newly created iSCSI LUN and click *Next*.

4. Review the disk layout and click *Next*

5. Provide a name for the VMFS datastore and click *Next*.

6. Select the appropriate block size and capacity for the VMFS datastore and click *Next*.

7. Review the disk layout and click *Finish* to create the VMFS datastore. The new datastore is now ready to be used for storing virtual machine images.

Performance Tuning

Tuning your environment is very important. ALWAYS update the BIOS, firmware, drivers, and patches to the latest and greatest version. By doing so, you may circumvent a problem before you even get to it. Test your design in the lab before you put it into production. You can design the best system on paper, but due to issues that you might not be aware of, your design may not deliver optimal performance.

If you are looking to squeeze every ounce of speed out of your SAN environment, you will want to create multiple RAID arrays and deliver each array to a separate server. This way the IO of one server and the spindles it uses will not affect the others but if you are planning to do this, you will need to plan carefully how you plan on using your SAN. If you need to reconfigure your SAN at a later time, you may need to delete one or more arrays and start again.

If at all possible, you should build a separate iSCSI network for your SAN environment. Yes, you can connect your SAN to the existing gig-e network and mount its drives from another building but you may pay a performance penalty by doing so plus you are competing with normal network traffic. As applications begin using more and more of a gigabyte connection or others begin using the bandwidth for video streaming, MP3 downloading, or whatever, if you elect to put your SAN on a normal communications network, be prepared for the day when you will need to move it. One case in which you may wish to put one leg of your SAN on a corporate network is when you are conducting SAN to SAN replication. With the D-Link xStack Storage series SAN, you can limit the amount of bandwidth you allocate for replication.

SUMMARY

VMware Virtual Infrastructure gives customers several methods of providing storage to virtual machines. Each of these storage methods enables customers to have flexibility in their infrastructure design, which in turn provides cost savings, increased storage utilization, and enhanced data recovery. This technical report is not intended to be a definitive implementation or solutions guide. Expertise may be required to solve user-specific deployments.

Conclusions and Recommendations

In conclusion, the D-Link xStack Storage series SAN is an excellent value for the money and offers high end features with a reasonable price tag. Combine it with VMWare ESX (or other virtual) server, and you have the major tools you need to build a state-of-the-art server environment without breaking your budget.

The xStack Storage Series provides a range of performance and functionality that match the various levels of iSCSI storage applications and user environments.

For those datacenters and businesses requiring fast and robust storage, especially those who already have made investments in elaborate hardware and expertise, the xStack Storage Series iSCSI provides a ready means to deploy large iSCSI SANs either standalone or in conjunction with existing (Fibre Channel) SANs.

The D-Link xStack Storage Series is a good entry level iSCSI solution and is ideal for customers who have file-intensive environments and are looking to deploy virtualization for a small subset of application data. As proven in various implementations, the xStack Storage Series iSCSI provides customers a compelling value proposition offering versatility, ease of use and expandability at an affordable price.