ESX Server 3.0 Tips and Tricks

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VMware Product Support Engineering

VMWORLD 2006

Agenda

- Storage Area Network
- VMFS-3
- iSCSI Storage
- NFS

Storage Area Network (SAN)

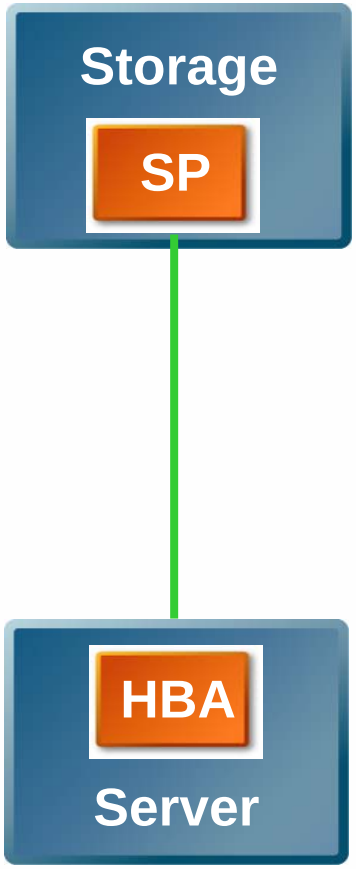
- Components
- Topology
- Identification

SAN Components

- Initiators (host HBAs)
  - QLogic 1/2/4Gb
  - Emulex 1/2/4Gb
  - See HCL for supportability
  - Set HBA's BIOS to "Point-to-Point" or similar to that
- Targets (Storage Processors' Ports)
  - Active/Active Arrays
  - Active/Passive Arrays
  - Check the HCL for supportability
- Fabrics (Switches and Fibre Connections)
  - No specific listing on HCL
  - 1/2/4Gb switches
  - May need to set switch port to "Fx" or equivalent (e.g. F-Port)

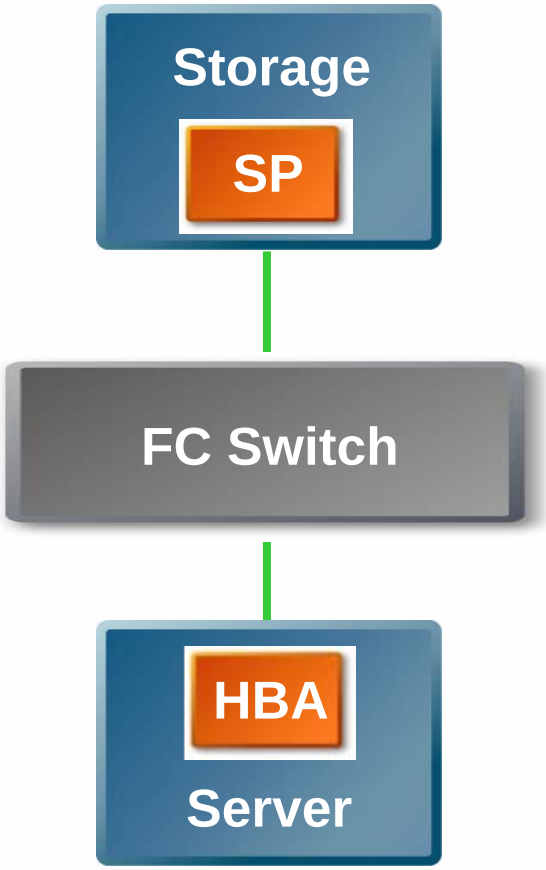
SAN Topology – Point-to-Point

- AKA Direct Connect
- Not supported
- Except CX100



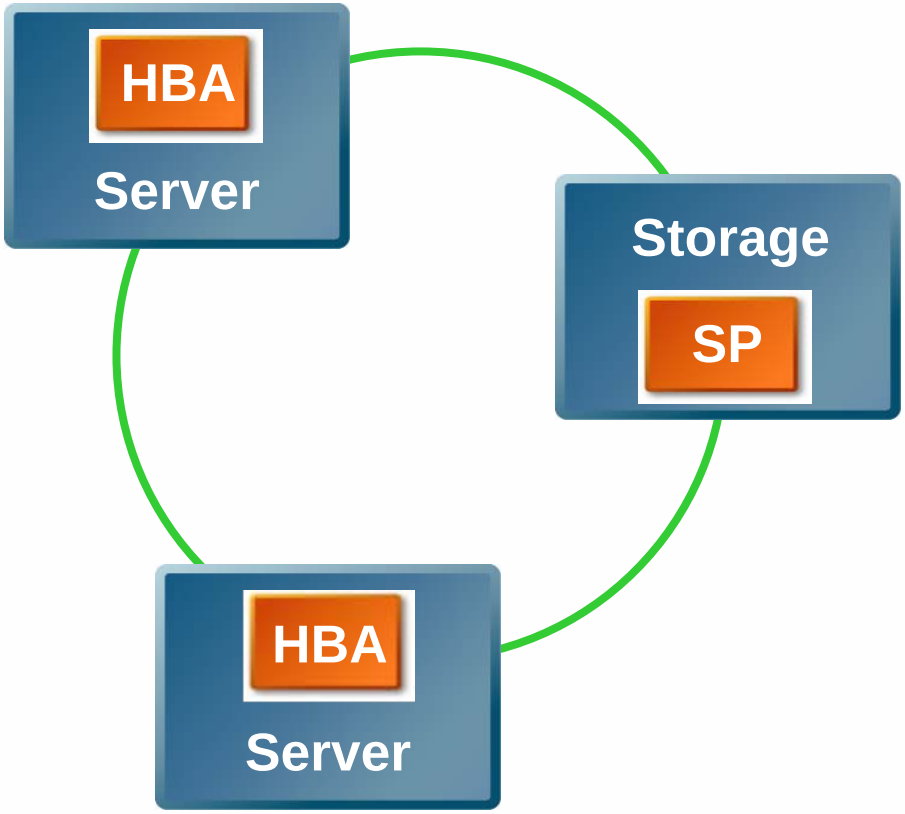
SAN Topology – Absolute Minimum

- Switch allows additional connections of more storage or more servers
- No redundancy
  - Many single points of failure
- Supported by VMware for ESX Server as a bare minimum configuration
  - If the Storage Arrays are not listed on the hardware compatibility list (HCL), VMware only supports them with this simple configuration

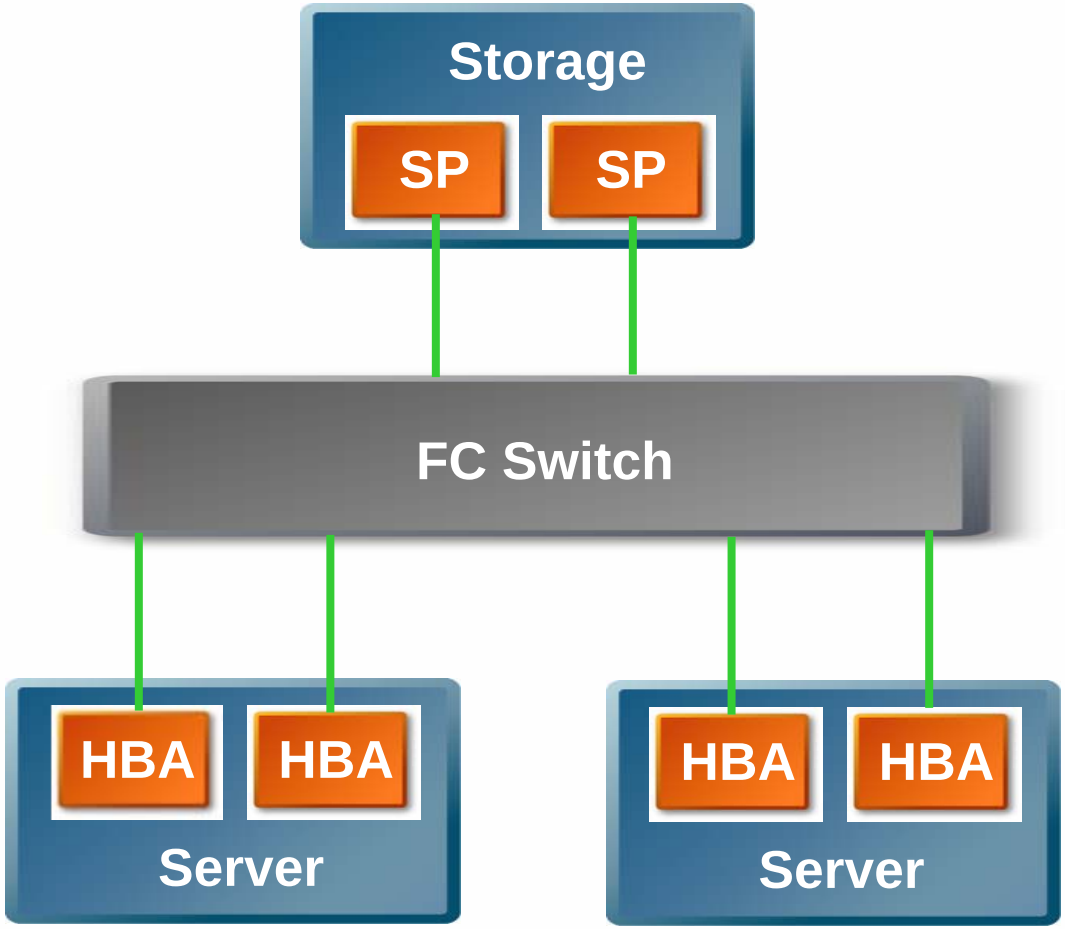


SAN Topology – Arbitrated Loop

- Not Supported

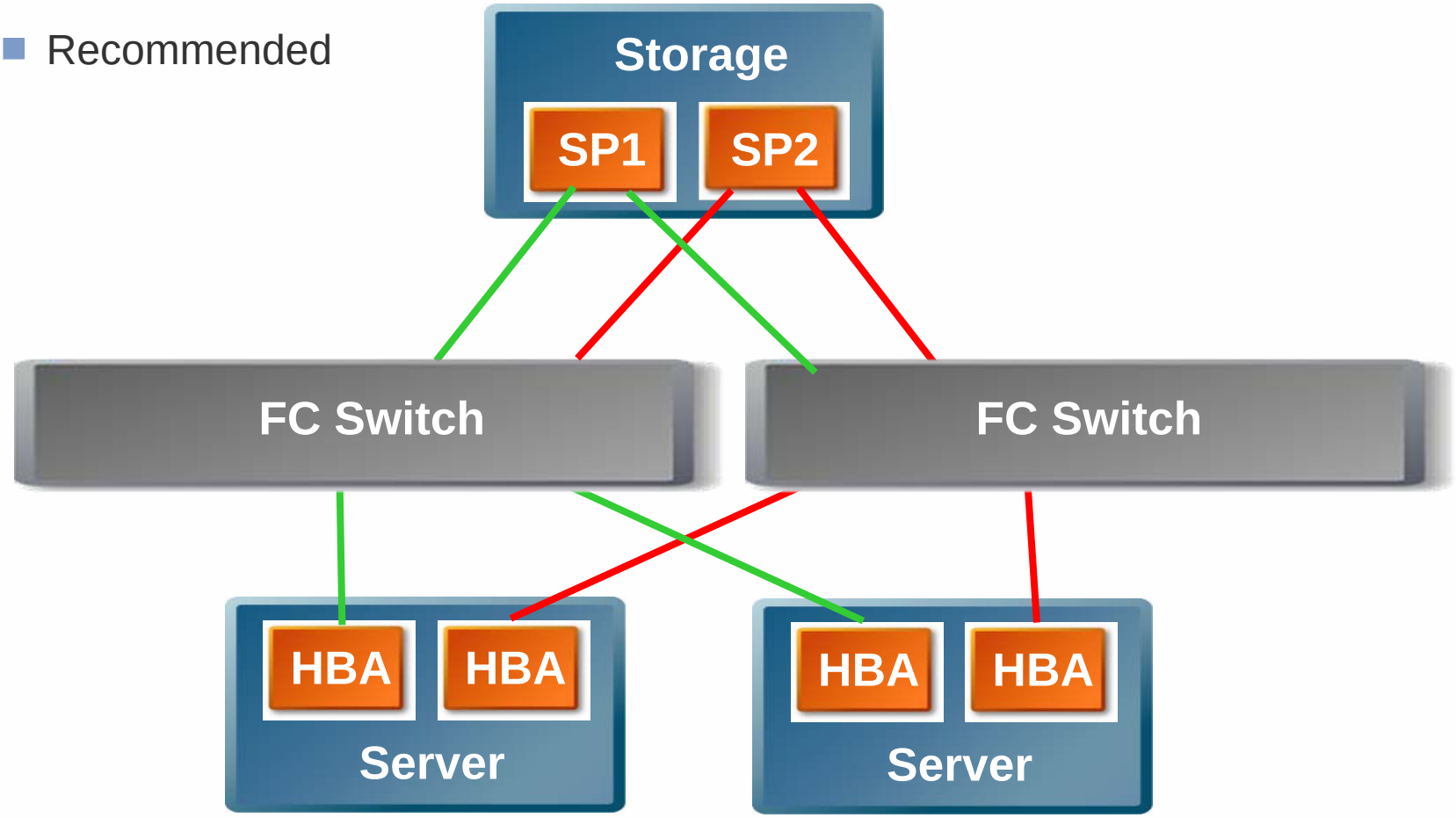


SAN Topology – Multipath Fabric



SAN Topology – Fully Redundant Fabrics

- Recommended

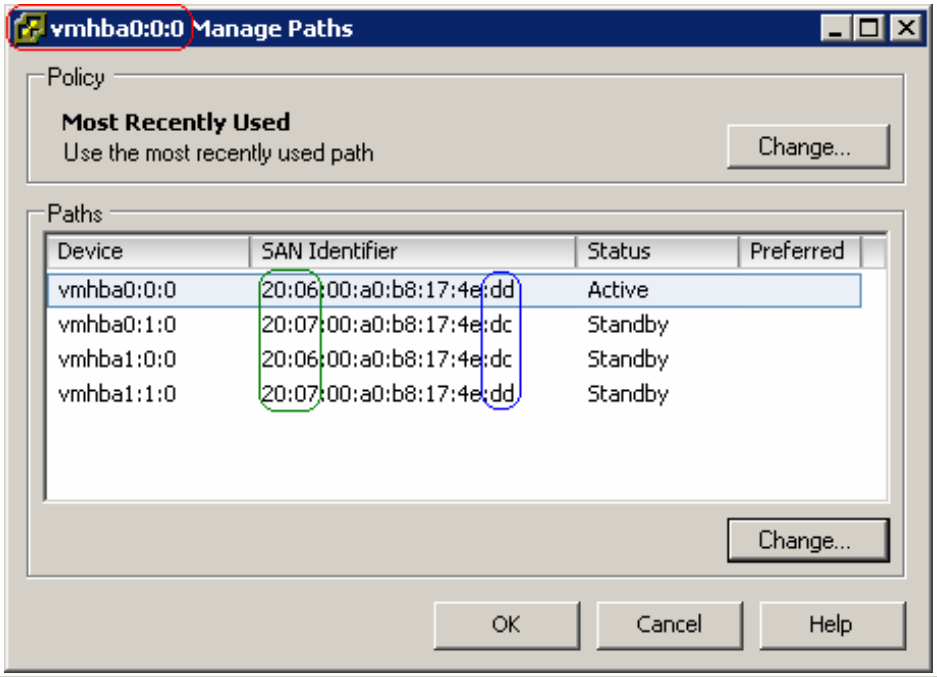


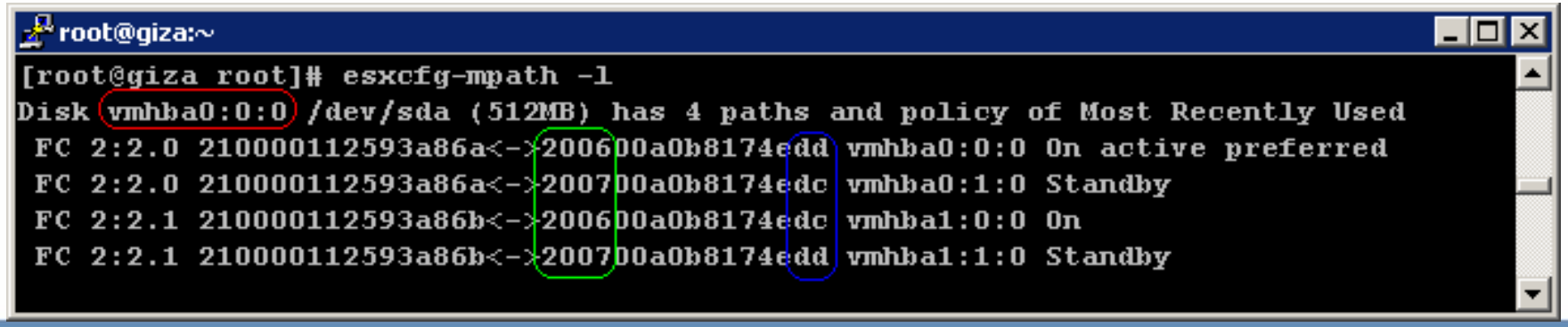
Identifying SAN Configuration

- VI Client
- Console

Multipath Analysis

- Cannonical Name
  - vmhbaC:T:L
- In this example
  - Vmhba0:0:0
- Policy: MRU or Fixed
- In this Example: MRU
- Path States:
  - On
  - Off
  - Standby
  - Dead





Multipath Analysis - Identifying Targets

SAN Type	Port ID	WWN
EMC Clariion	SPA0	xx:xx:xx:60:xx:xx:xx:xx
	SPA1	xx:xx:xx:61:xx:xx:xx:xx
	SPA2	xx:xx:xx:62:xx:xx:xx:xx
	SPA3	xx:xx:xx:63:xx:xx:xx:xx
	SPB0	xx:xx:xx:68:xx:xx:xx:xx
	SPB1	xx:xx:xx:69:xx:xx:xx:xx
	SPB2	xx:xx:xx:6A:xx:xx:xx:xx
	SPB3	xx:xx:xx:6B:xx:xx:xx:xx
HP EVA	SPA1	xx:xx:xx:xx:xx:xx:xx:x9
	SPA2	xx:xx:xx:xx:xx:xx:xx:x8
	SPB1	xx:xx:xx:xx:xx:xx:xx:xD
	SPB2	xx:xx:xx:xx:xx:xx:xx:xC
IBM FAStT	N/A	20:0X:00:00:00:00:xx
	N/A	20:0Z:00:00:00:00:zz

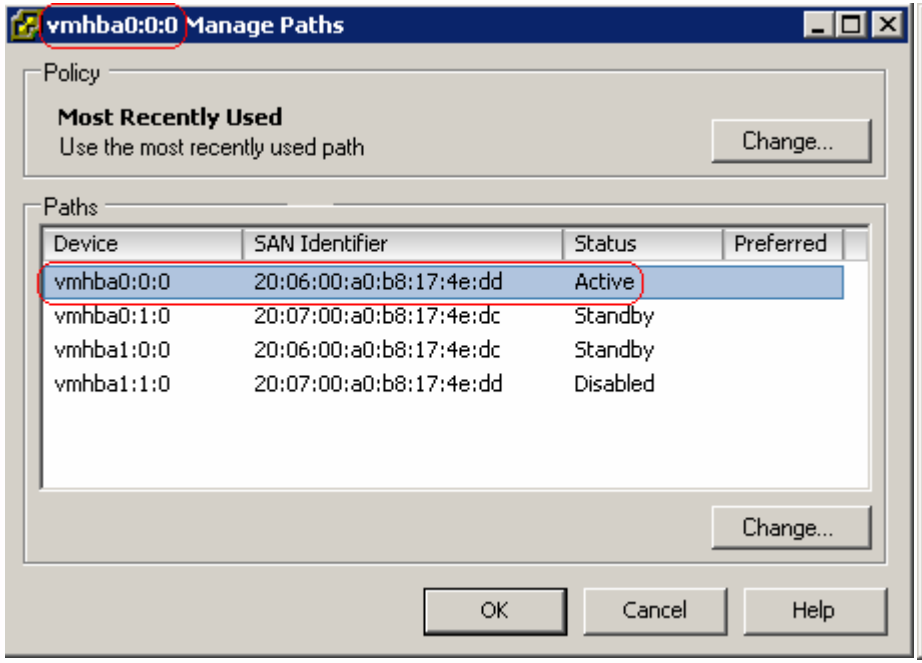
For IBM FAStT:

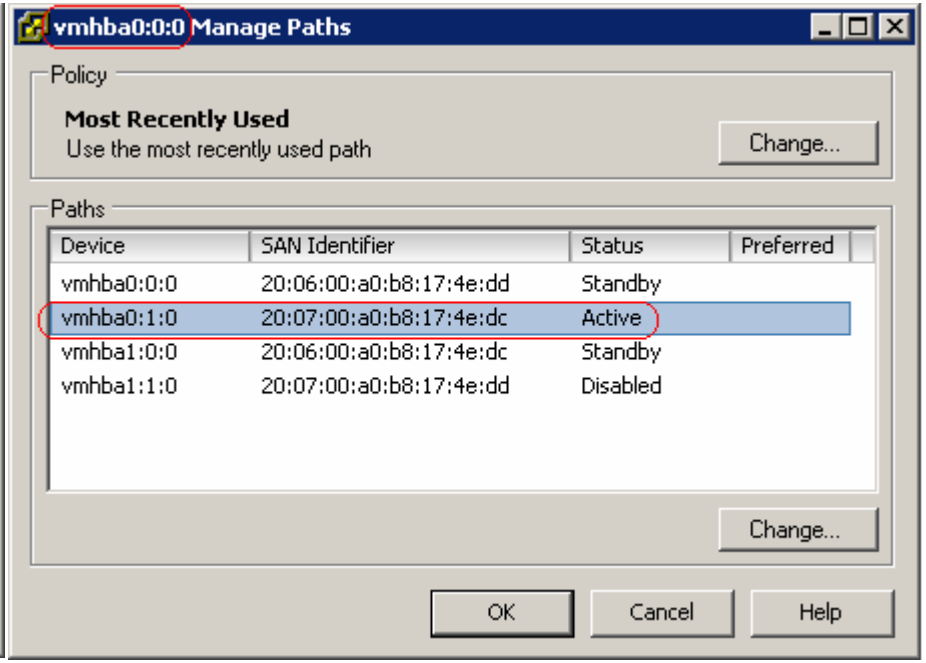
Compare X and Z: Higher number is the secondary processor.

Compare xx and zz: Higher number is the higher number port.

VI Client – Multipath Analysis (Target Failover)

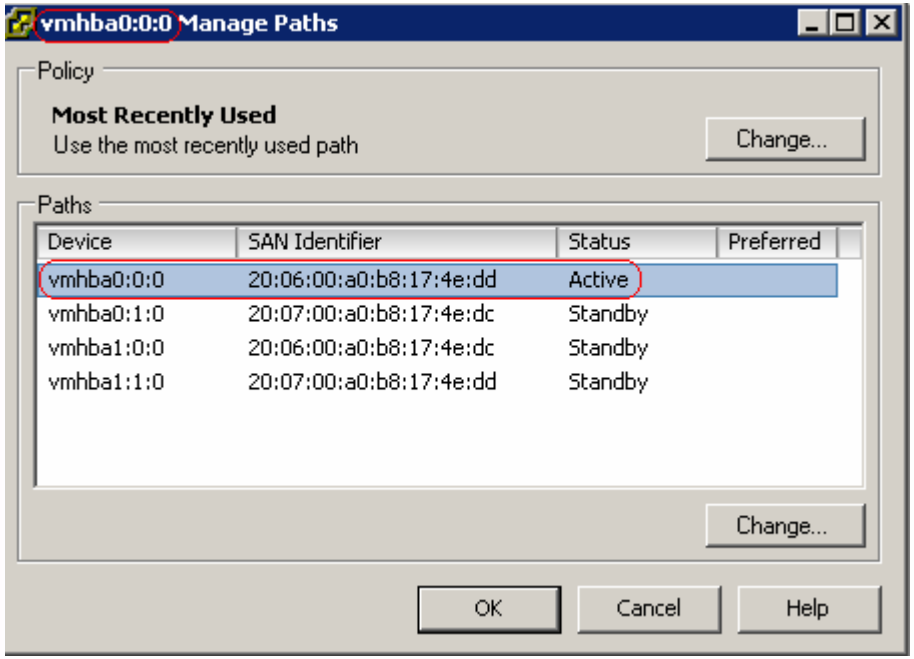
- Cannonical name not equal to active path → Failover
- Target Failover example

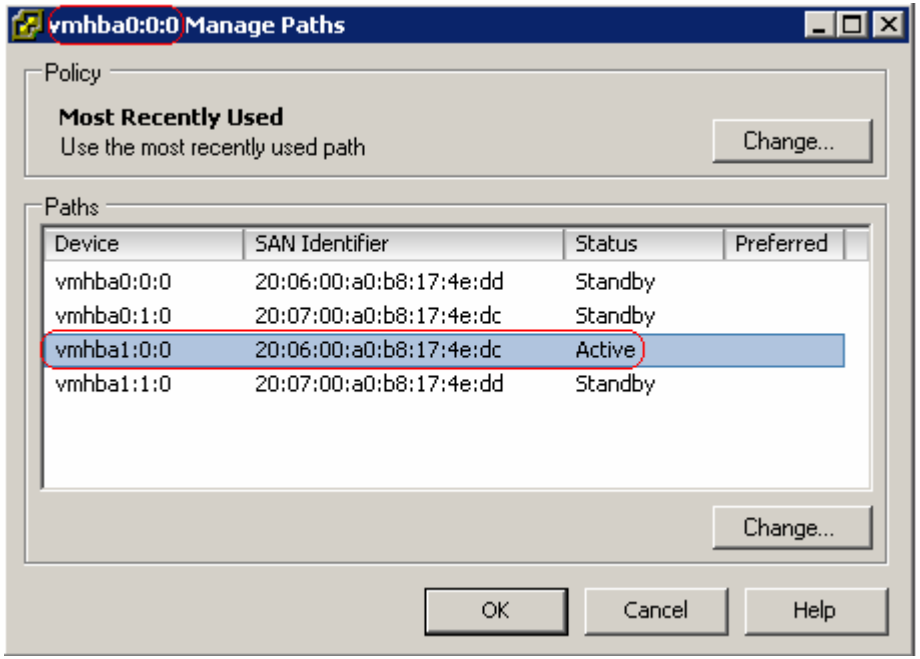




VI Client – Multipath Analysis (HBA Failover)

- Cannonical name not equal to active path -> Failover
- HBA Failover example





Console – Multipath Analysis (Target Failover)

- esxcfg-mpath -l
- Console View of the target failover event

```
root@giza:~
[root@giza root]# esxcfg-mpath -l
Disk vmhba0:0:0 /dev/sda (512MB) has 4 paths and policy of Most Recently Used
 FC 2:2.0 210000112593a86a<->200600a0b8174edd vmhba0:0:0 On active preferred
 FC 2:2.0 210000112593a86a<->200700a0b8174edc vmhba0:1:0 Standby
 FC 2:2.1 210000112593a86b<->200600a0b8174edc vmhba1:0:0 On
 FC 2:2.1 210000112593a86b<->200700a0b8174edd vmhba1:1:0 Standby
```

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 FC 2:2.0 210000112593a86a<->200700a0b8174edc vmhba0:1:0 On active
 FC 2:2.1 210000112593a86b<->200600a0b8174edc vmhba1:0:0 Standby
 FC 2:2.1 210000112593a86b<->200700a0b8174edd vmhba1:1:0 On
```

Console – Multipath Analysis (HBA Failover)

- esxcfg-mpath -l
- Console View of the HBA failover event

```
root@giza:~
[root@giza root]# esxcfg-mpath -l
Disk vmhba0:0:0 /dev/sda (512MB) has 4 paths and policy of Most Recently Used
 FC 2:2.0 210000112593a86a<->200600a0b8174edd vmhba0:0:0 On active preferred
 FC 2:2.0 210000112593a86a<->200700a0b8174edc vmhba0:1:0 Standby
 FC 2:2.1 210000112593a86b<->200600a0b8174edc vmhba1:0:0 On
 FC 2:2.1 210000112593a86b<->200700a0b8174edd vmhba1:1:0 Standby
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 FC 2:2.1 210000112593a86b<->200600a0b8174edc vmhba1:0:0 On active
 FC 2:2.1 210000112593a86b<->200700a0b8174edd vmhba1:1:0 Standby
```

VMFS-3

- Journaling
- Hierarchical
- Metadata
- LVM
- Snapshot handling
- VMotion with Storage Migration
- New Virtual Disk Types

Journaling

- VMFS-3 is now a journal based file system
- Better recovery from crashes
- Online File System Check

Hierarchical Structure

- VMFS-3 volumes support directory structure
- Virtual Machine files stored in the same directory
  - Configuration file (VMX)
  - VM Swap File
  - Virtual Disks
  - Logs
  - Monitor dump

VMFS-3 Metadata

- Copies of metadata stored at the root level of each volume
- Backup these files on a regular basis
- Run vm-support on a regular basis
  - Collects Partition Table info

```
root@giza:/vmfs/volumes/IBM-80-FS3
[root@giza IBM-80-FS3]# ls -a .*.sf
.fbb.sf  .fdc.sf  .pbc.sf  .sbc.sf  .vh.sf
[root@giza IBM-80-FS3]#
```

LVM - VMware Logical Volume Manager

- Spanned VMFS volumes
  - Volume still valid with missing extent(s)
- Snapshot LUN handling
- VMFS file system modules
  - vmfs2
  - vmfs3
  - fsaux

VMFS3 Volume UUID

- A volume UUID looks like this: 42263200-74382e04-b9bf-009c06010000
- Also Known As “Signature”
- Created as a response to non-persistent vmhba names
- Volume names are supposed to be used instead of UUIDs
- Not to be confused with host UUIDs

Snapshot LUN Handling

- Basic rules:
  - A LUN shared by multiple hosts MUST be presented with the SAME LUN ID to all hosts
  - A VMFS volume signature is associated with the LUN ID and the UUID among a few other elements (this may change at a later release)
- AX100 and IBM ESS (Shark) may not meet these rules.
- Symptoms
  - Volume hidden
  - Volume identified as a snapshot

Snapshot LUN Handling

- Sample log entries

Jul 18 10:58:31 ServerB vmkernel: 0:14:17:59.787 cpu13:1046)LVM: 5670: Device vmhba1:0:5:1 is a snapshot:
Jul 18 10:58:31 ServerB vmkernel: 0:14:17:59.787 cpu13:1046)LVM: 5676: disk ID: <type 2, len 22, lun 5, devType 0, scsi 5, h(id) 10179760818951437974>
Jul 18 10:58:31 ServerB vmkernel: 0:14:17:59.787 cpu13:1046)LVM: 5678: m/d disk ID: <type 2, len 22, lun 1, devType 0, scsi 5, h(id) 10179760818951437974>
Jul 18 10:58:31 ServerB vmkernel: 0:14:17:59.790 cpu13:1046)LVM: 5670: Device vmhba1:0:6:1 is a snapshot:
Jul 18 10:58:31 ServerB vmkernel: 0:14:17:59.790 cpu13:1046)LVM: 5676: disk ID: <type 2, len 22, lun 6, devType 0, scsi 5, h(id) 11552037668126695191>
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Jul 18 10:58:31 ServerB vmkernel: 0:14:17:59.794 cpu13:1046)LVM: 5670: Device vmhba1:0:7:1 is a snapshot:
Jul 18 10:58:31 ServerB vmkernel: 0:14:17:59.794 cpu13:1046)LVM: 5676: disk ID: <type 2, len 22, lun 7, devType 0, scsi 5, h(id) 13372428508588014685>
Jul 18 10:58:31 ServerB vmkernel: 0:14:17:59.794 cpu13:1046)LVM: 5678: m/d disk ID: <type 2, len 22, lun 3, devType 0, scsi 5, h(id) 13372428508588014685

Correcting Hidden Volumes

- See KB 6482648 at: http://kb.vmware.com/kb/6482648
- Correct LUN ID so that all hosts “see it” with the same LUN number
  - Symmetrix: Assign the LUNs to the FAs using the same LUN number
  - Clariion: Assign the LUNs to the same Storage Group
  - IBM DS4000/FAStT family: Assign the LUNs to the same Host Group (Logical Partitioning option enabled)
  - Other Arrays: use equivalent features to present the LUN with the same Host LUN ID to all hosts sharing it
- If the above is not possible:
  - Set advanced option LVM.DisallowSnapshotLUN to “0” then rescan
  - DO NOT present actual snapshot LUNs to that server with this option setting in place. Data Corruption may result

AutoResignature

- Auto Resignature feature is disabled by default
- To enable it set advanced option LVM.EnableResignature to “1” then rescan
- This will apply to ALL volumes visible to this host.
- This will affect ALL hosts sharing this volume
- All VMs configurations need to be edited to reflect the new volume ID
- This will be addressed in a future release

VMFS Kernel Modules

- VMFS2
  - Loaded for “Read-Only” by default for all VMFS2 volumes
  - Can be unloaded after all VMFS2 volumes have been upgraded
- VMFS3
  - All operations related to VMFS3 volumes
- FSAUX
  - Auxillary File System functions
  - Upgrading VMFS2 to VMFS3
  - Other functions internal fo VMware

VMFS3 – Virtual Disk Structure Changes

- Virtual machine virtual disk now has a descriptor file which is in ASCII format
- ESX 2.x contained this information in last 512 bytes of vmdk

root@giza:/vmfs/volumes/ax100i-100GB/Windows2000-RDM

```
[root@giza Windows2000-RDM]# cat Windows2000-RDM.vmdk
# Disk DescriptorFile
version=1
CID=877e825d
parentCID=ffffffff
createType="vmfsPassthroughRawDeviceMap"

# Extent description
RW 52428800 VMFSRDM "Windows2000-RDM-rdmp.vmdk"

# The Disk Data Base
#DDB

ddb.virtualHWVersion = "4"
ddb.geometry.cylinders = "3263"
ddb.geometry.heads = "255"
ddb.geometry.sectors = "63"
ddb.adapterType = "buslogic"
ddb.toolsVersion = "7172"
[root@giza Windows2000-RDM]#
```

VMFS3 – Virtual Disk Structure Changes

Format	Example
createType="<type> # Extent description RW <size in 512bytes blocks> <extent>"	createType="vmfsPassthroughRawDeviceMap" # Extent description RW 52428800 VMFSRDM "Win2K-rdmp.vmdk"

Virtual Disk Type	Extent
vmfsPassthroughRawDeviceMap	VMFSRDM "<name>-rdmp.vmdk"
vmfsRawDeviceMap	VMFSRDM "<name>-rdm.vmdk"
vmfs (Thin / Thick)	VMFS "<name>-flat.vmdk"

Sample Virtual Disk

root@giza:/vmfs/volumes/ax100i-100GB/Windows2000-RDM

```
[root@giza Windows2000-RDM]# vmkfstools -c 1g -d thin -a lsilogic thin.vmdk
[root@giza Windows2000-RDM]#
```

root@giza:/vmfs/volumes/ax100i-100GB/Windows2000-RDM

```
[root@giza Windows2000-RDM]# cat thin.vmdk
# Disk DescriptorFile
version=1
CID=4d4662f9
parentCID=ffffffff
createType="vmfs"

# Extent description
RW 2097152 VMFS "thin-flat.vmdk"

# The Disk Data Base
#DDB

ddb.virtualHWVersion = "4"
ddb.geometry.cylinders = "512"
ddb.geometry.heads = "128"
ddb.geometry.sectors = "32"
ddb.adapterType = "lsilogic"
ddb.thinProvisioned = "1"
```

Question?

iSCSI Storage

- Block-level I/O over TCP/IP using SCSI-3 protocols
- Pros
  - Direct access to random blocks on disks or LUNs for performance
  - Block and file traffic on single Ethernet infrastructure
  - Enabled by adoption of Gigabit Ethernet
  - Can use normal IP authentication, encryption, routing features
- Cons
  - Protocol overhead added by TCP/IP
    - Small packets, connection-oriented chatter
    - Gigabit traffic can saturate a 2.4-GHz CPU
  - Slower than Fibre Channel (for now)
- TCP Offload Engines (TOE)
  - Reduce CPU overhead, but expensive
  - Plain Gigabit NICs catching up with better drivers

iSCSI Requirements

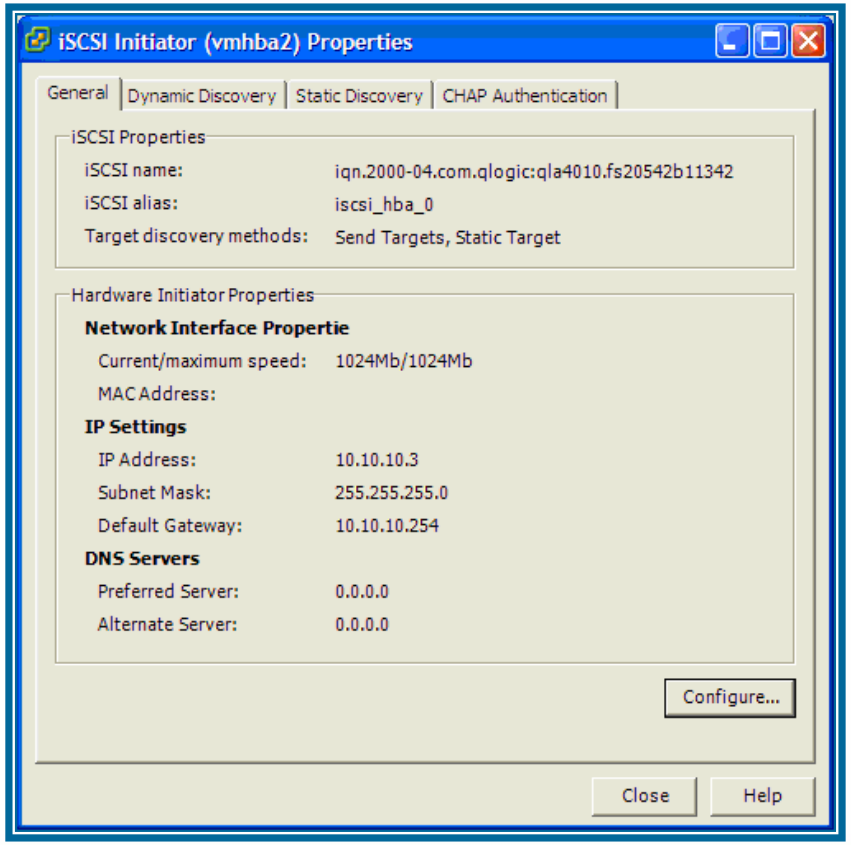
- Install a VMotion and IP Storage licenses on VC
- Host and storage ports on the same subnet
- A supported Ethernet NIC OR
- A QLogic 4050 or other card on the HCL (Experimental)
- A supported iSCSI Storage

iSCSI Configuration

- Authentication
  - CHAP
    - Per HBA or per target
  - None
- Target discovery
  - Static targets
  - SendTargets discovery (Dynamic)
  - No SLP discovery
  - No iSNS discovery
- Administration
  - SNIA-based IMA library
  - Configured through VMware Virtual Infrastructure Client
  - Common approach for all initiators
  - No need for vendor-specific tools

iSCSI – Configuring HW Initiator

- Select: Configuration – Storage Adapters
- Select the HBA and click Properties (in details pane)
- Click “Configure”

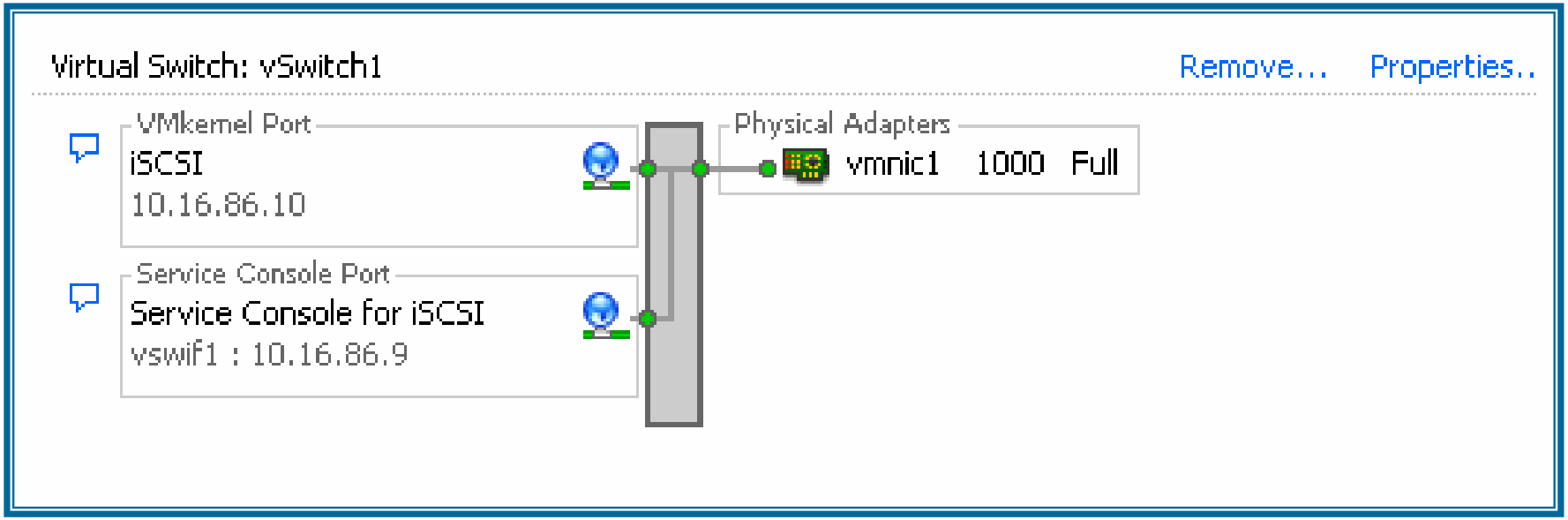


iSCSI – Configuring SW Initiator

- COS port group (for Authentication)
- VMKernel Port Group (for Data Traffic)
- Initiator IQN
- Security
- Discovery
- Multipathing
  - Only with both ports on the same switch and subnet

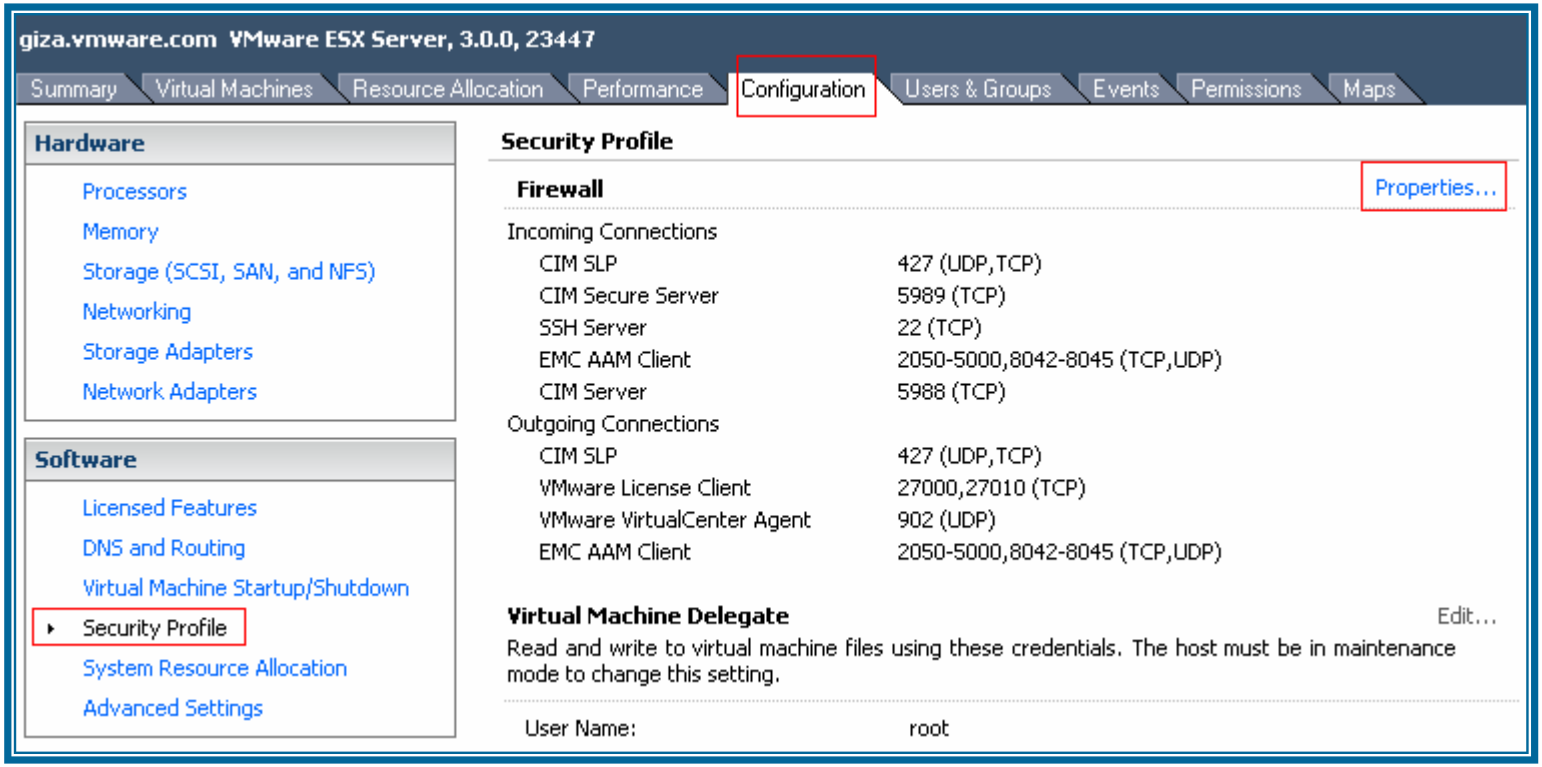
iSCSI – SW Initiator

Configuring Network



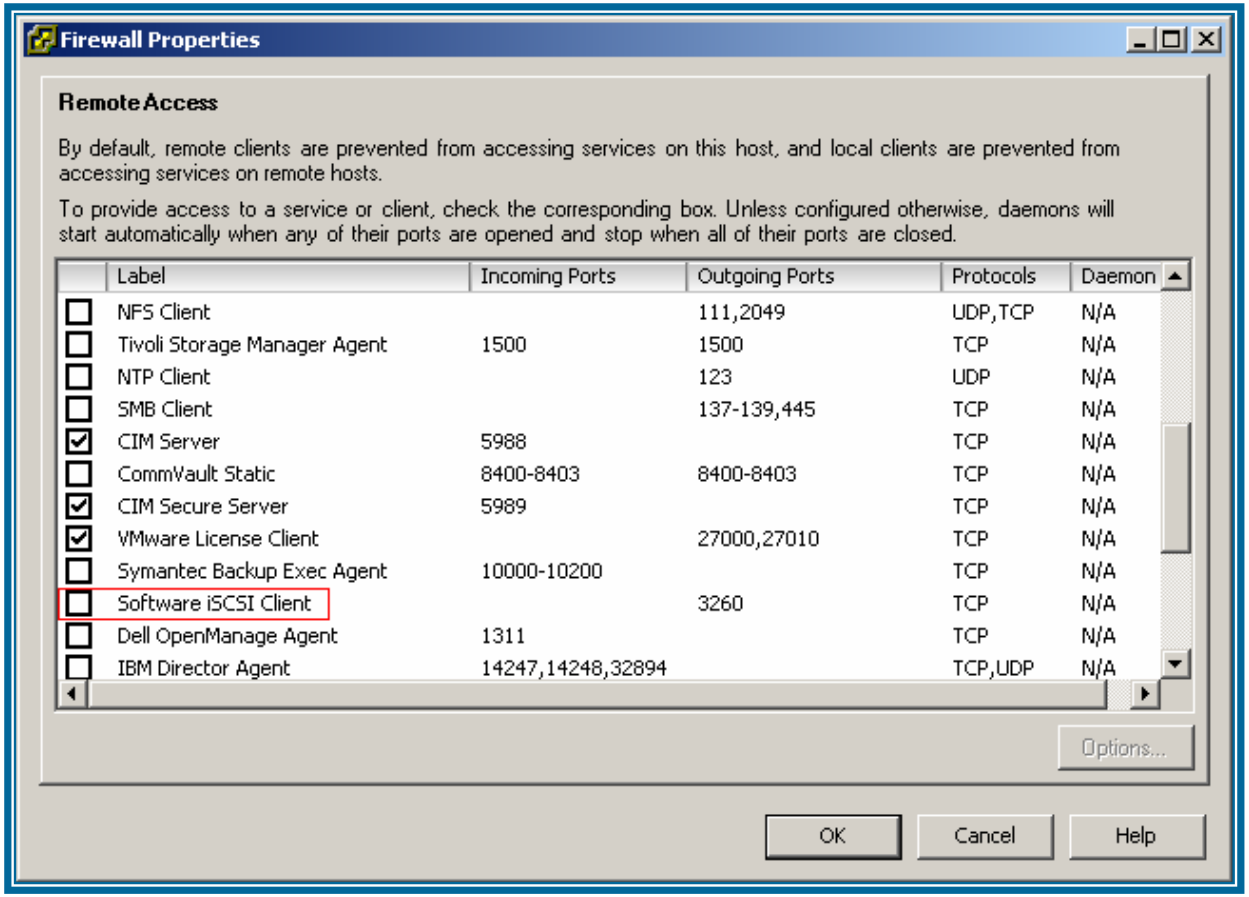
iSCSI – SW Initiator

- Enable software iSCSI client in firewall



iSCSI – SW Initiator

- Enable “Software iSCSI Client” in firewall



Label	Incoming Ports	Outgoing Ports	Protocols	Daemon
NFS Client		111,2049	UDP,TCP	N/A
Tivoli Storage Manager Agent	1500	1500	TCP	N/A
NTP Client		123	UDP	N/A
SMB Client		137-139,445	TCP	N/A
CIM Server	5988		TCP	N/A
CommVault Static	8400-8403	8400-8403	TCP	N/A
CIM Secure Server	5989		TCP	N/A
VMware License Client		27000,27010	TCP	N/A
Symantec Backup Exec Agent	10000-10200		TCP	N/A
Software iSCSI Client		3260	TCP	N/A
Dell OpenManage Agent	1311		TCP	N/A
IBM Director Agent	14247,14248,32894		TCP,UDP	N/A

iSCSI – SW Initiator

- Enable the Software Initiator
  - Storage Adapters – Select "iSCSI" Software Adapter

giza.vmware.com VMware ESX Server, 3.0.0, 23447

Summary | Virtual Machines | Resource Allocation | Performance | Configuration | Tasks & Events | Alarms | Permissions | Maps

Hardware

- Processors
- Memory
- Storage (SCSI, SAN, and NFS)
- Networking
- Storage Adapters
- Network Adapters

Software

- Licensed Features
- DNS and Routing
- Virtual Machine Startup/Shutdown
- Security Profile
- System Resource Allocation
- Advanced Settings

Storage Adapters Rescan

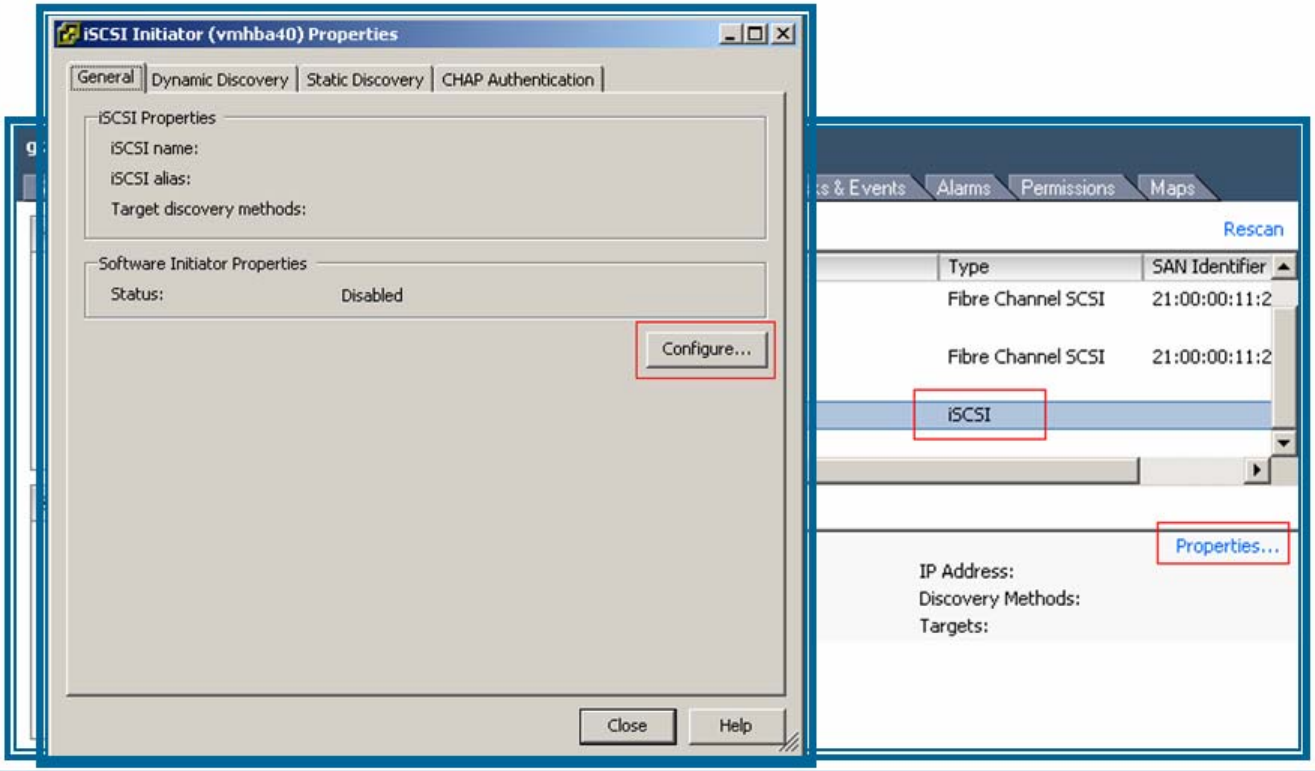
Device	Type	SAN Identifier
vmhba1	Fibre Channel SCSI	21:00:00:11:2
QLA231x/2340		
vmhba0	Fibre Channel SCSI	21:00:00:11:2
iSCSI Software Adapter		
iSCSI Software Adapter	iSCSI	

Details Properties...

Model:
iSCSI Name:
iSCSI Alias:
IP Address:
Discovery Methods:
Targets:

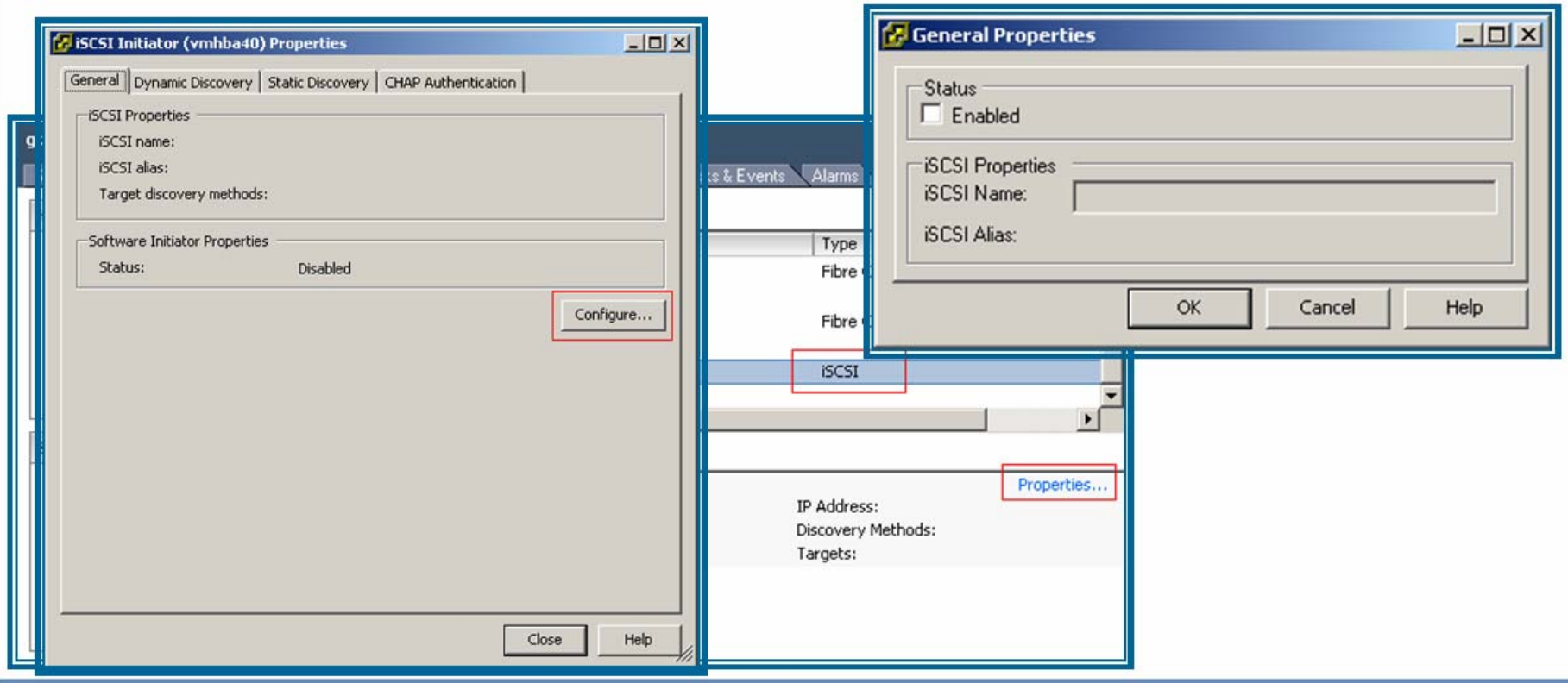
iSCSI – SW Initiator

- Enable the Software Initiator
  - Storage Adapters – Select "iSCSI" Software Adapter
  - Select "properties"



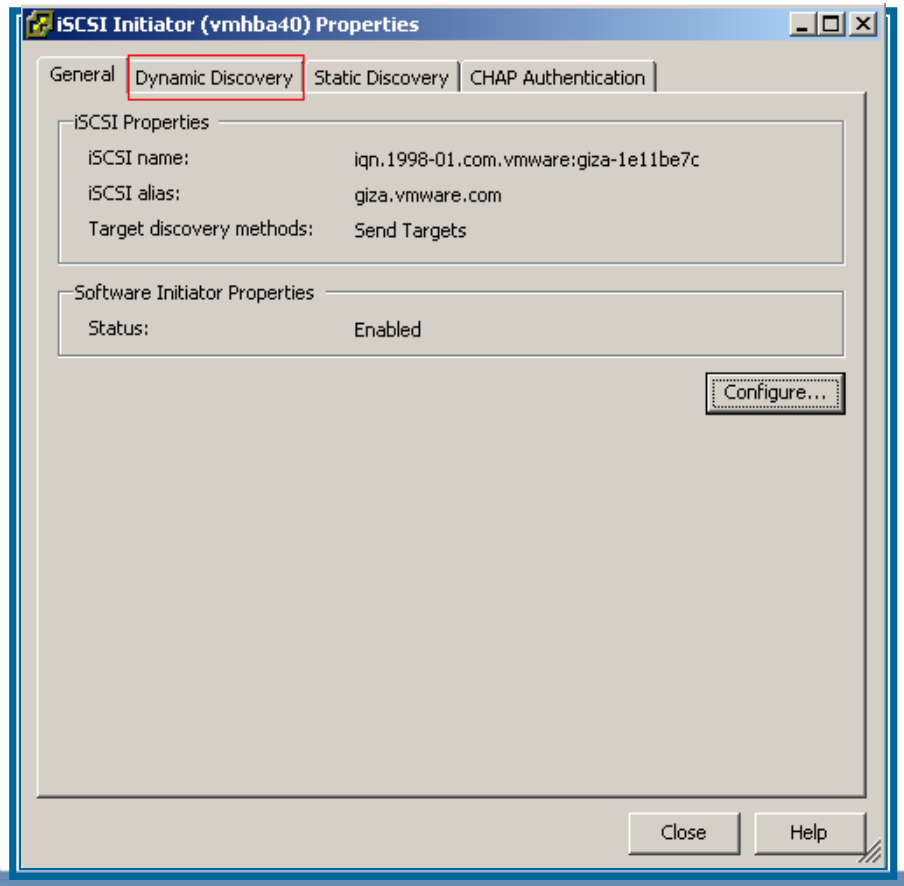
iSCSI – SW Initiator

- Enable the Software Initiator
  - Storage Adapters – Select "iSCSI" Software Adapter
  - Select "properties"
  - Select "Configure"
  - Click "Enabled" then Click "OK"



iSCSI – SW Initiator

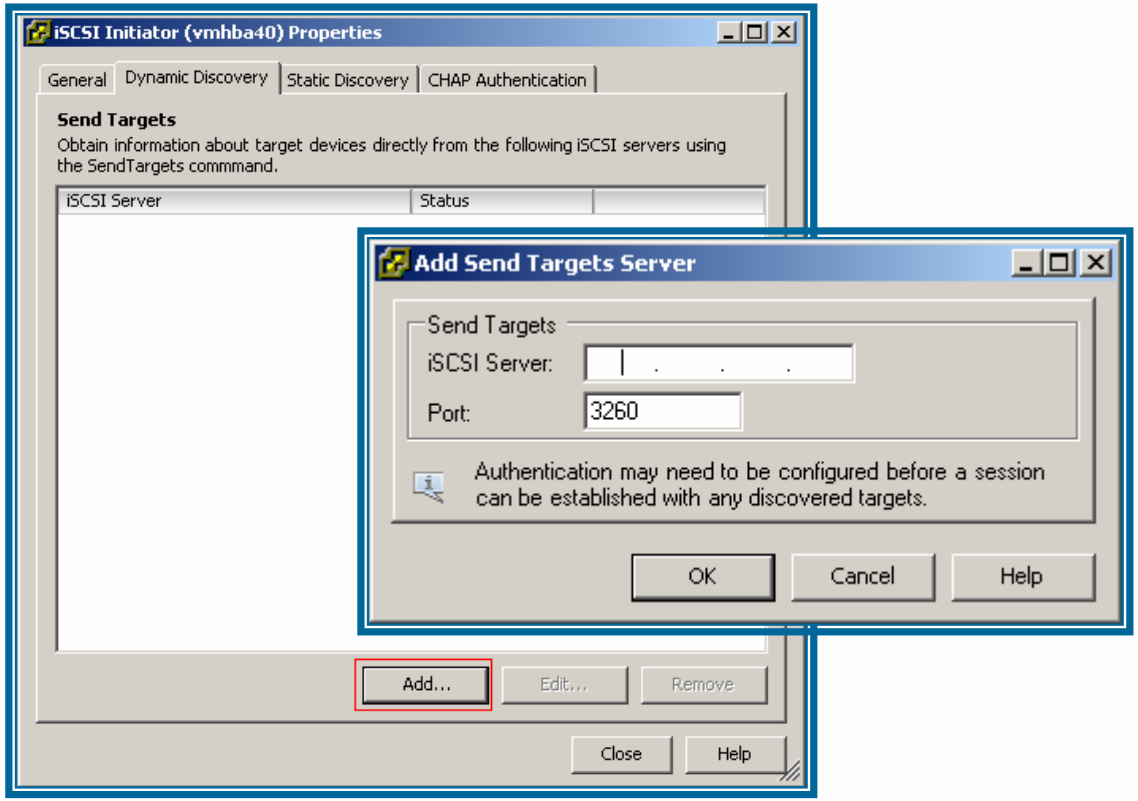
- iSCSI properties get filled automatically



- Select “Dynamic Discovery”

iSCSI – Dynamic Discovery

- Select “Add” then input the iSCSI Server’s IP address
- Repeat for each port on the iSCSI storage



iSCSI – Dynamic Discovery

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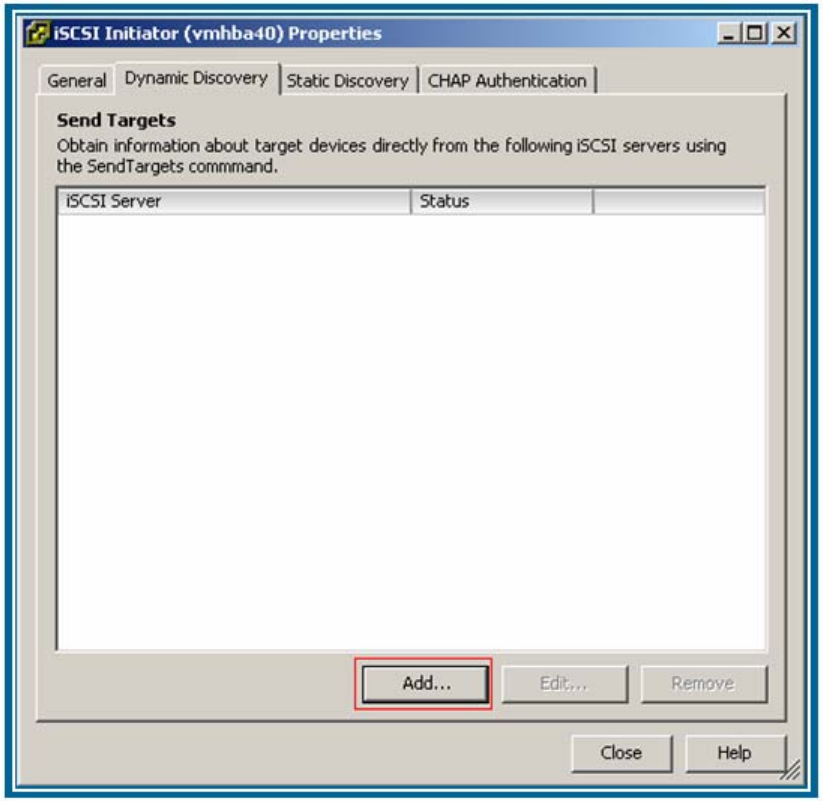
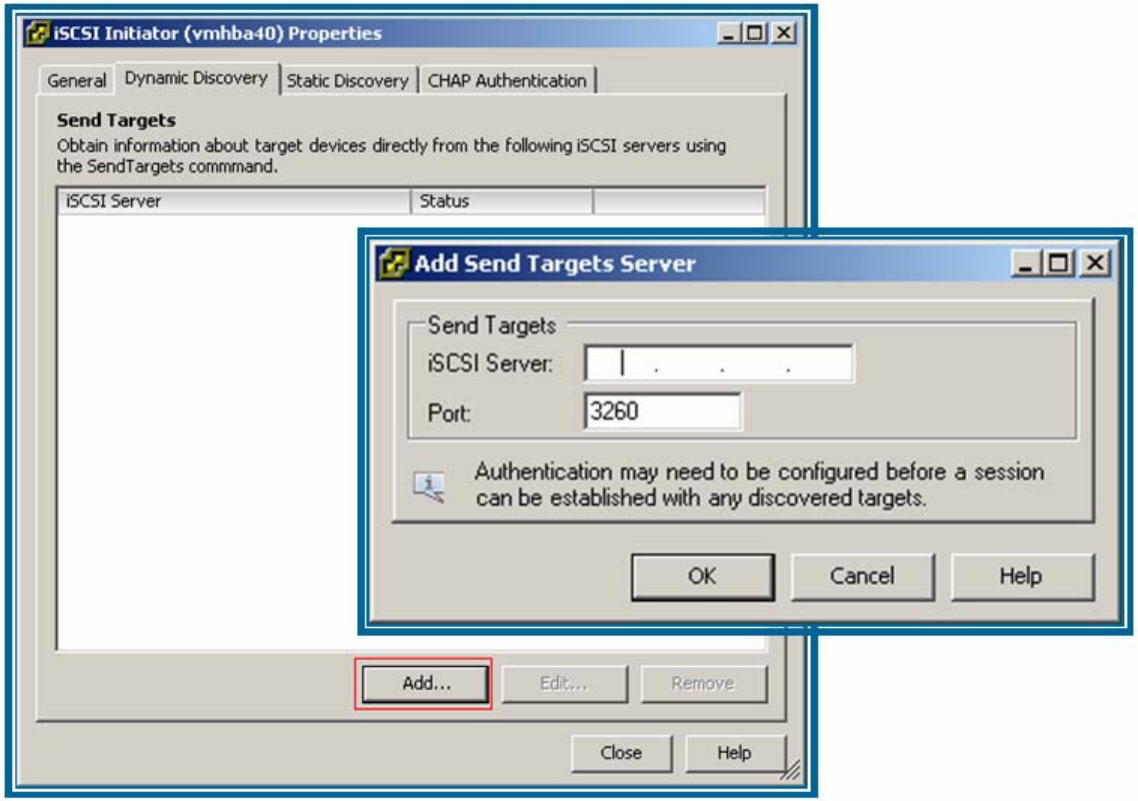


iSCSI – Dynamic Discovery

- Select "Add" then input the iSCSI Server's IP address
- Repeat for each port on the iSCSI storage

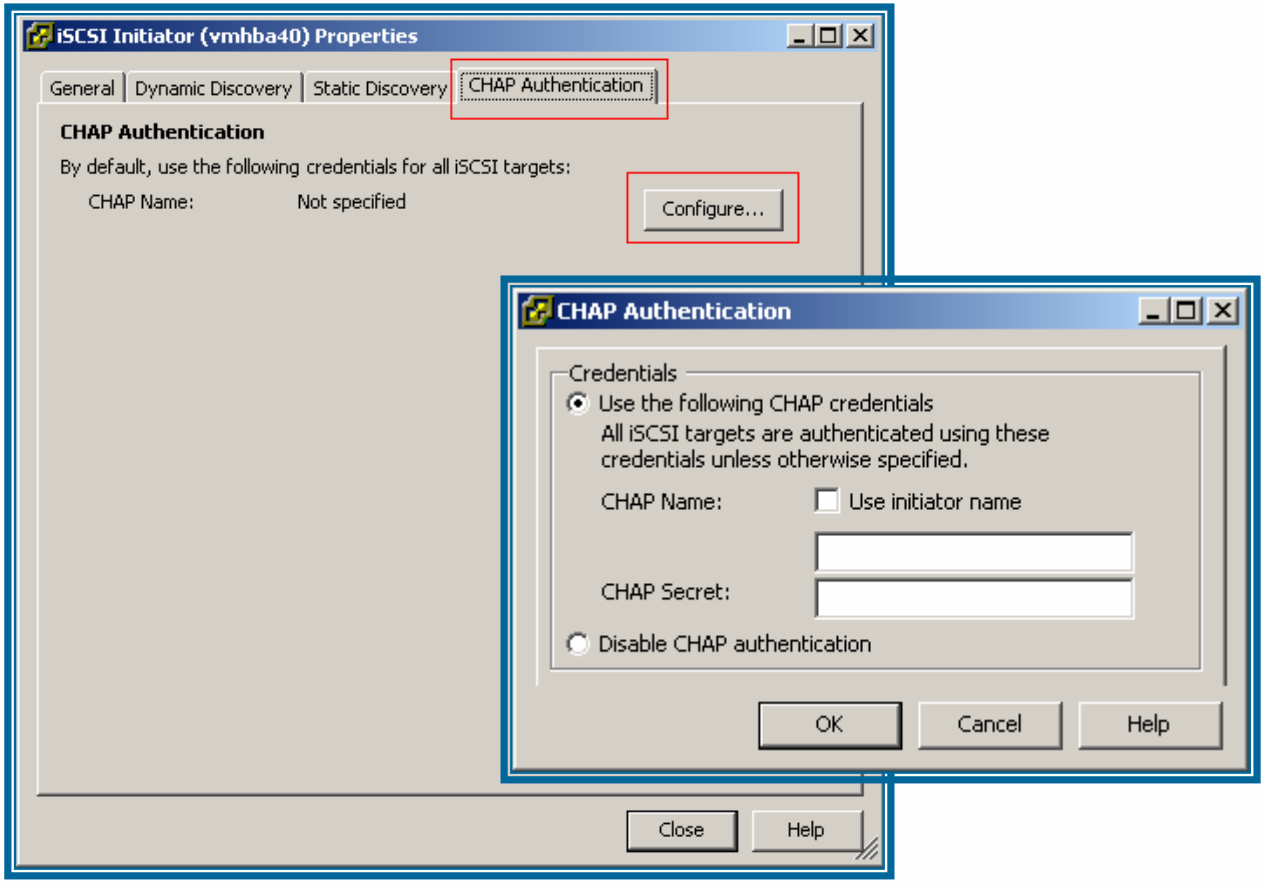


iSCSI – Static Discovery

- Same as Dynamic but select the “Static” tab instead
- Works with HW initiators ONLY

iSCSI – Authentication

- Select the “CHAP Authentication” Tab then “Configure”



iSCSI – Troubleshooting

- vmkiscsi-tool
  - Usage: vmkiscsi-tool <command> <subcommand> adapterName

```
root@giza:~
[root@giza root]# vmkiscsi-tool -P -l vmhba40

=========PHBA Properties for Adapter vmhba40=========
VENDOR                          : VMware
MODEL                           : VMware-Isoft
DESCRIPTION                     : VMware Software Initiator
SERIAL NUMBER                   :

=========Node Properties for Adapter vmhba40=========
NODE NAME VALID                 : 1
NODE NAME                       : iqn.1998-01.com.vmware:giza-611765c3
NODE ALIAS VALID                : 1
NODE ALIAS                      : giza.vmware.com
NODE NAME AND ALIAS SETTABLE: 1
[root@giza root]#
```

shows the Initiators properties

iSCSI – Troubleshooting

```
root@giza:~
[root@giza root]# vmkiscsi-tool -D -l vmhba40

=========Discovery Properties for Adapter vmhba40=========
iSnsDiscoverySettable     : 0
iSnsDiscoveryEnabled      : 0
staticDiscoverySettable   : 0
staticDiscoveryEnabled    : 0
sendTargetsDiscoverySettable  : 0
sendTargetsDiscoveryEnabled   : 1
slpDiscoverySettable  : 0

Discovery Status: Timed out. Displayed information may be incomplete.
DISCOVERY ADDRESS          : 10.16.92.36:3260
DISCOVERY ADDRESS          : 10.16.112.76:3260
DISCOVERY ADDRESS          : 10.16.92.40:3260

Static Discovery not supported for this adapter
[root@giza root]#
```

- Shows Discovery Properties
- If this were a Hardware Initiator, Static Targets would have been listed

iSCSI – Troubleshooting

```
root@giza:~
[root@giza root]# vmkiscsi-tool -I -l vmhba40
iSCSI Node Name: iqn.1998-01.com.vmware:giza-611765c3
[root@giza root]#
```

- Shows iSCSI Node Name (IQN)

iSCSI – Troubleshooting

```
root@giza:~

-----------------------------------------
[root@giza root]#
[root@giza root]# vmkiscsi-tool -T -l vmhba40

-----------------------------------------
```

- Lists Targets

iSCSI – Troubleshooting

```
root@giza:~
root@giza:~
--------------------------------------------
NAME                                : iqn.1992-04.com.emc:ax.apm00054207419.b0
ALIAS                               : 7419.b0
DISCOVERY METHOD FLAGS              : 0
SEND TARGETS DISCOVERY SETTABLE     : 0
SEND TARGETS DISCOVERY ENABLED      : 0
Portal 0                            : 10.16.92.37:3260

--------------------------------------------

--------------------------------------------
NAME                                : iqn.1992-04.com.emc:ax.apm00054207419.a0
ALIAS                               : 7419.a0
DISCOVERY METHOD FLAGS              : 0
SEND TARGETS DISCOVERY SETTABLE     : 0
SEND TARGETS DISCOVERY ENABLED      : 0
Portal 0                            : 10.16.92.36:3260

--------------------------------------------
[root@giza root]#
```

- Lists Targets

iSCSI – Troubleshooting

```
root@giza:~
-----------------------------------------
[root@giza root]#
[root@giza root]# vmkiscsi-tool -L -l vmhba40
```

- Lists LUNs

iSCSI – Troubleshooting

```
root@giza:~
-------------------------------------------

Target iqn.1992-04.com.emc:ax.apm00054207419.b0:
-------------------------------------------
OS DEVICE NAME     : vmhba40:3:0
BUS NUMBER         : 0
TARGET ID          : 3
LUN ID             : 0

-------------------------------------------

Target iqn.1992-04.com.emc:ax.apm00054207419.a0:
-------------------------------------------
OS DEVICE NAME     : vmhba40:4:0
BUS NUMBER         : 0
TARGET ID          : 4
LUN ID             : 0

-------------------------------------------
OS DEVICE NAME     : vmhba40:4:1
BUS NUMBER         : 0
TARGET ID          : 4
LUN ID             : 1
```

- Lists LUNs

iSCSI – Troubleshooting

```
root@giza:~
[root@giza root]# vmkiscsi-tool -k -l vmhba40
iSCSI Node Alias: giza.vmware.com
[root@giza root]# vmkiscsi-tool -A -l vmhba40

Supported Authentication Methods for Adapter vmhba40:
 AUTHMETHOD_NONE
 AUTHMETHOD_CHAP
[root@giza root]#
```

- Shows Node Alias then shows Authentication Method

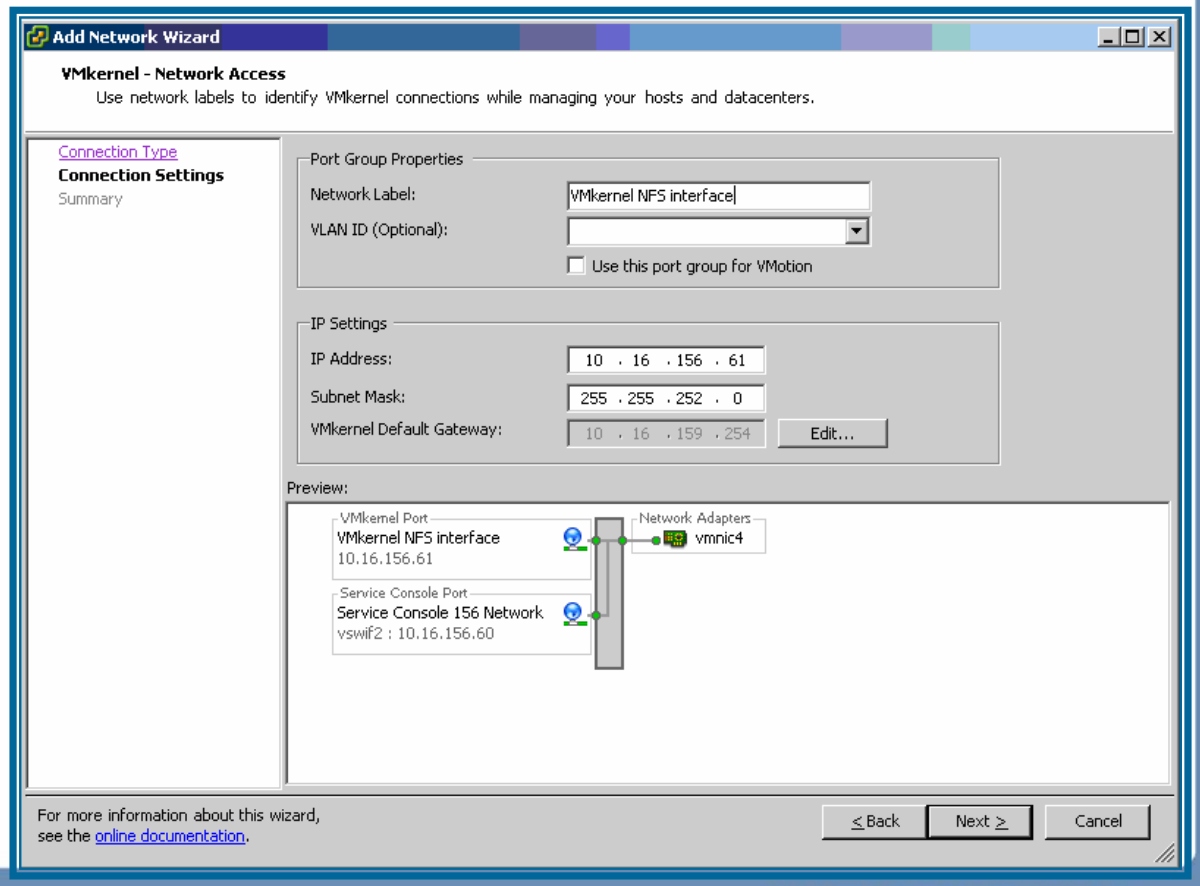
Q&A

NAS and NFS – Overview

- Use Network FileSystem Protocol
- NFS 3 TCP only (no UDP)
- Supported NAS filers only but also works with Linux NFS 3.x
- No CIFS/SMB yet
- NFS Naming Convention
  - **nfs.remote.com:/remote/filesystem**
- Locking Handled by VMkernel
- Lease-based locks
- 8 NFS mounts by default. Can be increased to 32

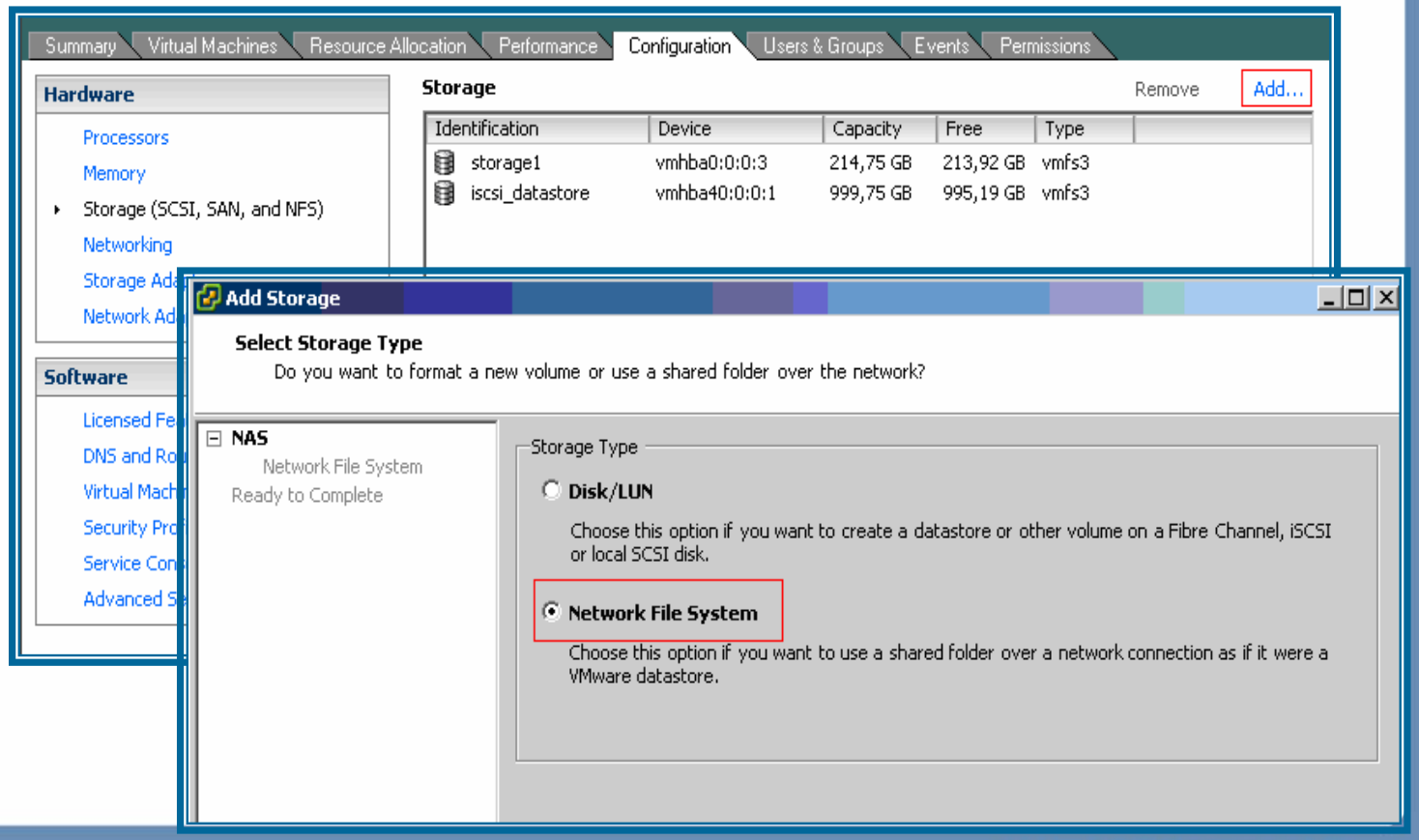
NFS
Configuring datastore

- Configure the network



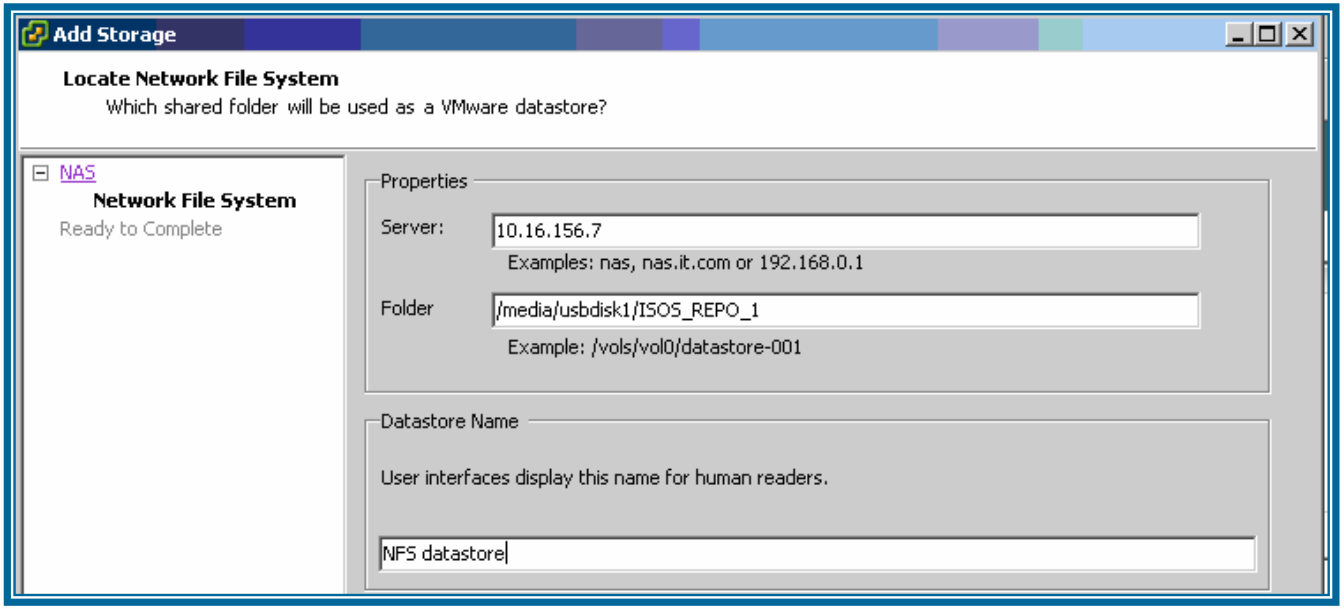
NFS
Configuring datastore (cont.)

- In “Storage” pane select “add” then “Network File System”



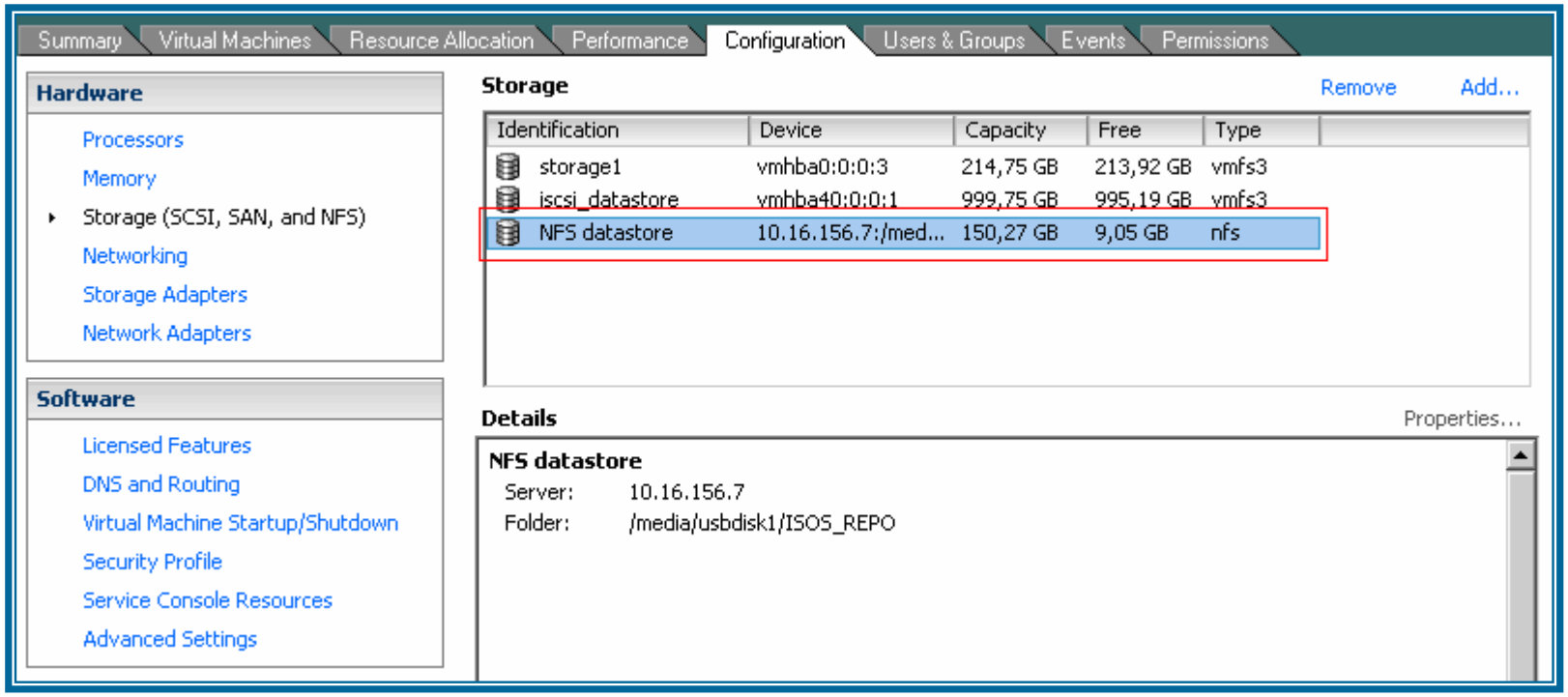
NFS
Configuring datastore (cont.)

- Fill in the NFS info



NFS
Configuring datastore (cont.)

- Now the storage shows the new DataStore



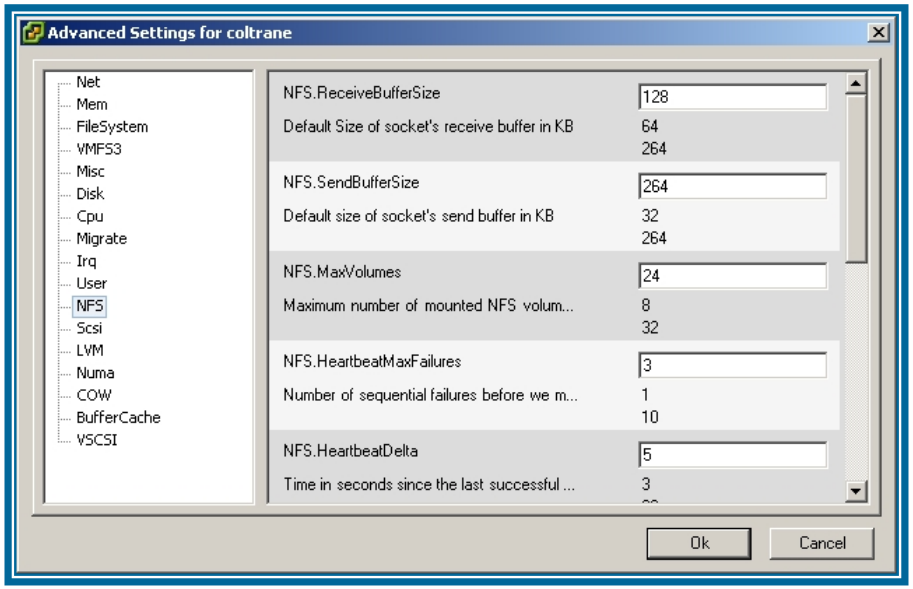
NFS – Console View

```
root@giza:~
[root@giza root]# vmkfstools -P /vmfs/volumes/NetApp-Home
NFS-1.00 file system spanning 1 partitions.
File system label (if any): NetApp-Home
Mode: public
Capacity 97430245376 (23786681 file blocks * 4096), 41162186752 (10049362 blocks) avail
UUID: 325cd719-166b8372-0000-000000000000
Partitions spanned:
        nfs:NetApp-Home
[root@giza root]#
```

- Mounted in the VMkernel NOT on the Service Console
- No need to modify /etc/fstab
- Recognized by vmkfstools as an NFS volume
- Virtual Machines can be stored there

NAS Tips and Tricks

- ESX Server needs full access to NFS datastores to create directories, set permissions
  - turn off **`root squash`**
- 8 NFS mounts per ESX Server allowed by default. To increase
  - Select host from inventory, right-click "Advanced Settings" and select "NFS"
  - Adjust "NFS.MaxVolumes"



- Avoid VM swapping to NFS volumes
  - Edit VM config file to add:
  - **`sched.swap.dir = /vmfs/volumes/<volume_name>/<dir_name>"`**
  - Where <volume_name> is a VMFS3 volume

Troubleshooting NAS

- Verify NAS filer/host configuration
- Make sure ESX Server is on the (Read/Write) host list on the filer
- Use ethereal to monitor NFS traffic
- On ESX Server use tcpdump to get a trace
- Verify the NFS connection properties on ESX Server
- To list Linux NFS host throughput, use:
  - **hdparm –tT /dev/sd<x>**

Questions?

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