NEXSAN

NEXSAN HIGH–DENSITY STORAGE BEAST™ and E–Series™

VMware Best Practices Guide

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Nexsan High Density Storage
VMware Best Practices Guide

About this document

This best practices guide provides high-level information and guidance for setting up Nexsan® E-Series™ and BEAST™ RAID Storage Systems in a VMware environment using vSphere.

Note While Nexsan makes every effort to ensure the accuracy of technical documentation, screen images and procedures may change after publication. In case of discrepancy, please check for the latest updates on the E-Series and BEAST Documents and Downloads page. Also, refer to the latest Release Notes.

Conventions

Here is a list of text conventions used in this document:

Convention	Description
underlined blue	Cross-references, hyperlinks, URLs, and email addresses.
boldface	Text that refers to labels on the physical unit or interactive items in the graphical user interface (GUI).
`monospace`	Text that is displayed in the command-line interface (CLI) or text that refers to file or directory names.
`monospace bold`	Text strings that must be entered by the user in the command-line interface or in text fields in the graphical user interface (GUI).
italics	System messages and non-interactive items in the graphical user interface (GUI) References to Software User Guides

Notes, tips, cautions, and warnings

Note Notes contain important information, present alternative procedures, or call attention to certain items.

Tip Tips contain handy information for end-users, such as other ways to perform an action.

⚠️ **CAUTION:** In hardware manuals, cautions alert the user to items or situations which may cause damage to the unit or result in mild injury to the user, or both. In software manuals, cautions alerts the user to situations which may cause data corruption or data loss.

⚠️ **WARNING: Warnings alert the user to items or situations which may result in severe injury or death to the user.**

Contacting Nexsan

For questions about Nexsan products, please visit the Nexsan support Web page, and the E-Series and BEAST Documents and Downloads page. If you are unable to find the answer to your question there, please see our contact information below.

Service and support

Nexsan's Technical Services Group provides worldwide assistance with installation, configuration, software support, warranty, and repair for all Nexsan products. A variety of service and support programs are available to provide you with the level of coverage and availability your operation requires.

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E-Series/BEAST support:

https://helper.nexsansupport.com/esr_support

Related documents

The following Nexsan product manuals contain related information:

- Nexsan High-Density Storage User Guide
- Nexsan E-Series™ Snapshots and Replication User Guide
- Nexsan Multipathing Best Practices Guide
- Nexsan RAID Storage Plugin for VMware vCenter User Guide
- VMware Best Practices Guide
- Nexsan E32V™ and Nexsan E18™/E18V™ RAID Storage Units Installation Guide
- Nexsan E32V™ and Nexsan E18™/E18V™ RAID Storage Units FRU Removal and Replacement Guide
- Nexsan E32XV™ and Nexsan E18X™/E18XV™ RAID Storage Expansion Units Installation Guide
- Nexsan E32XV™ and Nexsan E18X™/E18XV™ RAID Storage Expansion Units FRU Removal and Replacement Guide
- Nexsan E60™/E60V™/E60VT™/E60P™ and Nexsan E48™/E48V™/E48VT™/E48P™ RAID Storage Units Installation Guide
- Nexsan E60™/E60V™/E60VT™/E60P™ and Nexsan E48™/E48V™/E48VT™/E48P™ RAID Storage Units FRU Removal and Replacement Guide
- Nexsan E60X™/E60XV™ and Nexsan E48X™/E48XV™ RAID Storage Units Installation Guide
- Nexsan E60X™/E60XV™ and Nexsan E48X™/E48XV™ RAID Storage Units FRU Removal and Replacement Guide

Chapter 1

Recommendations and requirements

This chapter contains the following sections:

Introducing the Nexsan VMware plugin

The Nexsan RAID Storage Plugin for VMware vCenter enables monitoring, configuration, provisioning, and maintenance of Nexsan Storage Systems, and integrates Nexsan Storage with VMware vSphere.

The plugin is also intended to enable vCenter administrators to understand relationships between VMware infrastructure – ESXi hosts and clusters, datastores and virtual machines – and Nexsan Storage Systems, Nexsan Volumes, and Storage Pools, particularly where these systems are handled by different teams.

To install and start using the plugin for E-Series and BEAST Storage Systems, go to https://helper.nexsansupport.com/esr_vmware, on the Nexsan Support pages, to download the software, installation guide, and user documentation.

VAAI hardware acceleration

Nexsan E-Series™ Storage Systems include a built-in VAAI (vStorage APIs for Array Integration) plugin to provide hardware acceleration for VMware ESXi environments. VAAI hardware acceleration functionality enables the VMware ESXi host to offload specific virtual machine and storage management operations to E-Series Storage Systems. With storage hardware assistance, the VMware ESXi host performs these operations faster and consumes less CPU, memory, and storage fabric bandwidth.

E-Series systems support these VAAI functions:

- **Full Copy**: This feature enables the storage arrays to make full copies of data within the array without the need for the VMware ESXi server to read and write the data. Rather than reading and writing each block of data, the server sends a single SCSI (Extended Copy) command for a set of contiguous blocks to instruct the storage array to copy the blocks from one location to another. The actual work is performed on the storage array. This enhancement saves time when cloning a virtual machine, performing a Storage Motion, or deploying virtual machines from a template.

- **Block Zero**: This feature enables storage arrays to zero out a large number of blocks to speed up virtual machine provisioning. Instead of sending multiple redundant write commands over the network, the server uses the SCSI Write Same command to instruct the storage device to write the same data to a number of blocks. Instead of having the host wait for the operation to complete, the storage array returns to the requesting service as though the process of writing zeros has been completed. This can be especially helpful when thick-provisioning virtual disks.

- **Hardware Assisted Locking**: This feature provides an alternate means of protecting data in VMware virtual machine file systems (VMFS). When a host accesses a common data store, only block-level data is locked during access, leaving the rest of the logical unit accessible by other hosts. This also improves the scalability of large ESXi servers sharing a VMFS data store.

See also

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Recommended Nexsan storage configurations

To use Nexsan Storage Systems in a VMware environment, make sure to review these requirements and recommendations.

Note Nexsan recommends these default configurations because of their versatility. However, you may get better performance using different settings based on your specific environment and I/O characteristics.

RAID configurations

Depending on your data protection and performance requirements, use RAID 5 or RAID 6, and approximately 10 disks per array.

Use one LUN per array

Given that the VMware datastore size limit is 64 TB, Nexsan recommends using only one LUN per array, and reducing the number of disks per RAID set if necessary to stay below that limit.

⚠️ **CAUTION:** Placing multiple LUNs or datastores on the same disks may severely impact performance.

Load balancing

Distribute arrays evenly between the controllers in dual-controller storage systems.

See also Recommended VMware host and storage configurations below

Recommended VMware host and storage configurations

Nexsan recommends the following for VMware host and storage infrastructure configurations:

- Use one datastore per LUN, and either use VMware Storage Distributed Resource Scheduler (DRS) or manually distribute VMs across them. Datastores spanning multiple LUNs are supported, but not recommended, as ESXi will not automatically load-balance across them.

- If all concurrently-active VMs have similar workloads, distribute them evenly across datastores. If workloads differ, place VMs with similar workloads on the same datastore, and/or place VMs with high random I/O, such as large databases, on a separate datastore if possible.

- Review the planned VMware storage configuration against the VMware configuration maximums here: https://configmax.vmware.com/

- For redundancy, use at least a dual-port HBA in each ESXi host.

- For redundancy, set up each ESXi host with at least one path to each Nexsan E-Series or BEAST controller. To provide maximum redundancy against controller, switch, SFP, or cable failures, if the system is using Fibre Channel or Ethernet switches, use two switches. Then, connect from both switches to one port on each host and to one port on each controller.

- Limit each ESXi host to eight total paths per LUN. You can use switch zoning, LUN mapping, or access controls on the E-Series or BEAST, as necessary. Higher path counts are supported, but may result in increased failover and discovery times.

- Use VMFS6 on ESXi 6.5 or later (minimum VMFS5 otherwise).

VMware and Nexsan provisioning requirements

VMware ESXi supports two models of storage provisioning: thick provisioning and thin provisioning. Please see "Thin Provisioning and Space Reclamation" on the *VMware Docs* Web pages.

Thick provisioning

With thick provisioning, which follows a traditional storage provisioning model, you allocate a large amount of storage space in advance, in anticipation of future storage needs. However, some or all of the allocated space might remain unused, causing under-utilization of storage capacity.

Thick provisioning IS fully supported on Nexsan E-Series and BEAST storage systems.

Thin provisioning

In contrast with thick provisioning, thin provisioning helps to eliminate storage under-utilization problems by allocating storage space in a flexible, on-demand manner. With ESXi, you can use two models of thin provisioning: array-level thin provisioning (NOT supported on Nexsan E-Series and BEAST storage systems - see below), and virtual disk-level thin provisioning.

Thin provisioning enables you to report more virtual storage space than actual physical capacity. This discrepancy can lead to storage over-subscription, also called over-provisioning. When you use thin provisioning, you must monitor actual storage usage to avoid exceeding physical storage space.

Virtual disk thin provisioning

When you create a virtual machine, a certain amount of storage space on a datastore is provisioned to virtual disk files.For more information, see "Virtual Disk Thin Provisioning" on the *VMware Docs* Web pages.

Virtual disk thin provisioning IS fully supported on Nexsan E-Series and BEAST storage systems.

Array thin provisioning

You can use thin-provisioned storage arrays with ESXi, but it is NOT supported in Nexsan E-Series and BEAST. For more information, see "ESXi and Array Thin Provisioning" on the *VMware Docs* Web pages.

Array Thin Provisioning IS NOT supported on Nexsan E-Series and BEAST storage systems.

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Chapter 2

Setting up VMware

This chapter contains the following sections:

Configuring the vSphere environment

Perform the following steps to configure the vSphere environment for use with Nexsan Storage.

► **To prepare vSphere for hosting Nexsan Storage Systems:**

1. Install the Nexsan RAID Storage Plugin for VMware vCenter. Go to https://helper.nexsansupport.com/esr_vmware, on the Nexsan Support pages, to register and to download the software, installation guide, and user documentation.

2. Configure multipathing on all ESXi hosts using the Nexsan scripts, available from https://helper.nexsansupport.com/esr_downloads, on the Nexsan Support pages. To set up multipathing, see Configuring multipathing for VMware below.

3. Use vCenter Update Manager to update all ESXi hosts to the most recent version and patch level.

   Note You can also manually update the servers by downloading the patches from my.vmware.com.

4. Make sure that all of your host bus adapters (HBAs) are updated to the latest firmware version and patch level.

5. For HBAs and their drivers, ensure that all storage HBAs and driver versions are approved for VMware. See Changing queue depth for HBAs on page 14.

Configuring multipathing for VMware

Use this procedure to configure multipathing for VMware using the Nexsan configuration scripts posted on the Nexsan E-Series/BEAST VMware support pages. Please see https://helper.nexsansupport.com/esr_downloads

You can set up multipathing using scripts for either

- PowerCLI, for Windows users, or
- ESXi shell, logging in via SSH.

Both scripts support options to configure the multipathing behavior for currently connected LUNs and new LUNs, and default to our latest recommendations for our products in general use cases: round-robin across optimized paths, and switching paths for each I/O.

For environments with specific requirements, this can be changed using the options below.

Note If you prefer to configure multipathing manually rather than using the Nexsan scripts, use the settings VMW_PSP_RR and IOs=1. For details, see "Managing Path Policies" in the VMware vSphere 6.5 Documentation Center.

► **To configure multipathing using PowerCLI:**

1. Install PowerCLI for VMware:
   - In Windows PowerShell, enter:

   ```
   Install-Module VMware.PowerCLI

   Set-PowerCLIConfiguration -InvalidCertificateAction Prompt
   ```

2. Connect to either vCenter or an ESXi Server:

   ```
   Connect-VIServer <IP address>
   ```

3. Specify the host:

Host type	Command
One ESXi (single host)	`$hosts = Get-VMHost`
All hosts in all data centers	`$hosts = Get-VMHost`
One specific host	`$hosts = Get-VMHost <host name>`
All hosts in a specific data center	`$hosts = Get-Datacenter <data center>	Get-VMHost`

4. Display the current multipathing policy for current LUNs, and the default policy for new LUNs:

   `.\nexsan-vmw-multipath.ps1 $hosts`

5. Set the multipathing policy:

Policy	Command
Nexsan-recommended default (round-robin, change path every I/O)	`.\nexsan-vmw-multipath.ps1 $hosts -Enable`
Explicitly to MRU	`.\nexsan-vmw-multipath.ps1 $hosts -Enable -MRU`
Round-robin, changing path every <n> I/Os	`.\nexsan-vmw-multipath.ps1 $hosts -Enable -IOPs <n>`
Round-robin, changing path every <n> bytes	`.\nexsan-vmw-multipath.ps1 $hosts -Enable -Bytes <n>`
ESXi default	`.\nexsan-vmw-multipath.ps1 $hosts -Disable`

► **To configure multipathing using ESXi shell:**

1. Enable SSH on the ESXi server and log in as root.

2. Copy the `nexsan-vmw-multipath.sh` script to the ESXi server. See the VMware Knowledge Base article "Using SCP to copy files to or from an ESX host (1918)", at https://kb.vmware.com/s/article/1918

3. Display the multipathing policy for existing LUNs, and the default policy for new LUNs:

```
sh ./nexsan-vmw-multipath.sh
```

4. Set the multipathing policy:

Policy	Command
Nexsan-recommended default (round-robin, change path every I/O)	`sh ./nexsan-vmw-multipath.sh -enable`
Explicitly to MRU	`sh ./nexsan-vmw-multipath.sh -enable -mru`
Round-robin, changing path every <*n*> I/Os	`sh ./nexsan-vmw-multipath.sh -enable -iops <n>`
Round-robin, changing path every <*n*> bytes	`sh ./nexsan-vmw-multipath.sh -enable -bytes <n>`
ESXi default	`sh ./nexsan-vmw-multipath.sh -disable`

Optimizing multipathing

Use this procedure to optimize pathing for both iSCSI and Fibre Channel connections.

Nexsan Storage Systems support all modes of VMware multipathing.

► **To optimize load balancing:**

1. Run the system at full production level for several days to generate performance logs.

2. Use the VMware Performance pages or the Nexsan vCenter Plugin to analyze the host port and disk usage.

3. Adjust array load by moving VMs to less-used datastores.

4. Adjust port load in ESXi Path management.

Changing queue depth for HBAs

If you notice unsatisfactory performance of your HBAs, you can use this procedure to change their maximum queue depths. The maximum value refers to the queue depths reported for various paths to the LUN.

When multiple virtual machines are active on a LUN, the value of *Disk.SchedNumReqOutstanding* is also relevant. In this case, the queue depth value, is equal to whichever value is the lower of the two settings: adapter queue depth or *Disk.SchedNumReqOutstanding*. In that case, set both adapter queue depth and *Disk.SchedNumReqOutstanding* to the same lower setting value.

In general, the following formula applies to each path between the host machine and the array:

[Total number of LUNs] * QDepth < [Array queue depth]

Notes:

● As queue depth increases, so often do IOPS and latency. You should select a QDepth that meets the IOPS and latency requirements of your installation.

● The default queue depth value of **32** is usually satisfactory for Emulex HBA cards.

- For Fibre Channel HBAs under vSphere 6.5, set the QDepth to its maximum setting.

- You only need to set the maximum queue depth when more than one virtual machine is active on a LUN.

► **To change the queue depth for an HBA:**

1. Determine which HBA module is loaded by running the applicable command in the service console.

   If you are using QLogic, run:
   ```
   vmkload_mod -l | grep qla
   ```

   If you are using Emulex, run:
   ```
   vmkload_mod -l | grep lpfc
   ```

2. Run the applicable queue depth command.

   If you are using QLogic, run:
   ```
   esxcfg-module -s ql2xmaxqdepth=16 <HBA module>
   ```
   (where *<HBA module>* is the result of the previous step)
   OR

   If you are using Emulex, run:
   ```
   esxcfg-module -s lpfc0_lun_queue_depth=16 <HBA module>
   ```
   (where *<HBA module>* is the result of the previous step)

   Note These example commands set HBA LUN queue depths to 16.

3. Reboot the ESXi host.

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Chapter 3

Setting up Nexsan Storage

This chapter contains the following sections:

Preparing the system

Nexsan recommends the following preparatory checks prior to configuring Nexsan Systems for use with vSphere:
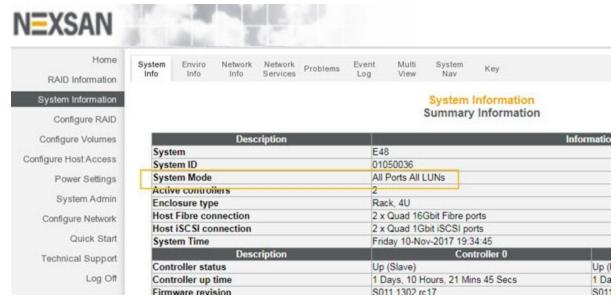
- Wherever possible, update your Nexsan Storage System to the latest available firmware. See Service and support on page vi.

- For dual-controller systems, do the following:

  - Distribute arrays evenly between the controllers.

  - Make sure **System Mode** is set to **All Ports All LUNs (APAL)**.

    Notes:

    Dual-controller E-Series P Storage Systems always operate in APAL mode.

    For single-controller systems only one RAID Controller is active, and failure of this controller makes all arrays and volumes inaccessible. This is the only possible setting on single-controller units.

Figure 3-1: System Mode page

- Check the VAAI third party copy setting and adjust as required. See VAAI hardware acceleration on page 8.

- For ease of management, assign consistent names to arrays, volumes, and VMware datastore. These names display in vCenter and the Nexsan RAID storage plugin.

- If more than one ESXi host will be accessing the same datastore, AutoMAID should be disabled for the array containing that datastore. ESXi continuously reads and writes heartbeats to on-disk areas to arbitrate access between multiple hosts, and AutoMAID may cause these requests to exceed the VMware-defined timeouts. See the VMware Knowledge Base article "VMFS Heartbeat and usage of ATS (52879)" https://kb.vmware.com/s/article/52879 for more information.

Configuring Nexsan Systems for use with vSphere

Use this procedure for help with setting up Nexsan Systems for use with vSphere.

► **To configure Nexsan Storage Systems for use with vSphere:**

1. When setting up RAID arrays and volumes, follow the recommendations for the storage system you are configuring. See Recommended Nexsan storage configurations on page 9.

2. Do either of the following:

    Use the Nexsan RAID plugin for vCenter:

    a. Create a VMware storage pool (an array), and then create a Nexsan volume and VMware datastore. See the *Nexsan RAID Storage Plugin for VMware vCenter User Guide*.

       If necessary, use the wizard in the Nexsan vCenter Plugin to assign hosts to volumes. See "Assigning a host to a Nexsan Volume" in the *Nexsan RAID Storage Plugin for VMware vCenterUser Guide.*

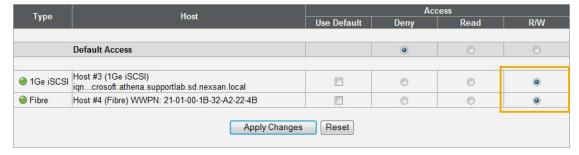   OR

    Use the E-Series Web interface:

    a. Create the arrays and volumes.

    b. Label each volume with a descriptive name.

    c. Map all volumes, starting with **LUN 0**. Make sure that the **Use same LUN for all ports of the same type** check box is checked.

Figure 3-2: LUN mapping

Volume LUN Mapping		Fibre		1Ge iSCSI	
		ⓘ Host 0	ⓘ Host 1	ⓘ 1Ge-iSCSI 0	ⓘ 1Ge-iSCSI 1
3: 'Accounting' (Creating) Array: 'Array #1', Controller 0 Capacity: 50.0 GB (46.5 GiB)	C0	LUN 0 ▾	LUN 0 ▾	LUN 0 ▾	LUN 0 ▾
	C1	LUN 0 ▾	LUN 0 ▾	LUN 0 ▾	LUN 0 ▾
	☑ Use same LUN for all ports of the same type				

3. Give read/write access to all initiators on ESXi hosts that require access to the datastore.

4. To use the Nexsan RAID plugin for vCenter to configure access, open a volume, and then under **Assigned Hosts**, click **Details** > **Assign Hosts**. Then you can select an initiator and click **Assign**.

    If you change HBAs or add new ESXi hosts, repeat this step or complete the task using the Nexsan vCenter Plugin.

Figure 3-3: Host port access

Type	Host	Access			
		Use Default	Deny	Read	R/W
	Default Access		●	○	○
● 1Ge iSCSI	Host #3 (1Ge iSCSI) iqn...crosoft:athena.supportlab.sd.nexsan.local	☐	○	○	●
● Fibre	Host #4 (Fibre) WWPN: 21-01-00-1B-32-A2-22-4B	☐	○	○	●
	Apply Changes Reset				

5. For iSCSI connections, use Jumbo Frames wherever possible. See "Configure 10Ge iSCSI" and "Configure 1Ge iSCSI" in Chapter 3 of the *Nexsan High-Density Storage User Guide*.

Enabling VAAI hardware acceleration

► **To enable VAAI hardware acceleration:**

Note VAAI hardware acceleration is enabled by default. Use this procedure only as needed. A reboot is required to complete this procedure, so advance preparation may be required.

1. Select **System Admin > Cache**.

2. Enable **SCSI third-party copy extensions**.

3. Reboot the Nexsan Storage System.

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Part Number: P0450150 Rev: B