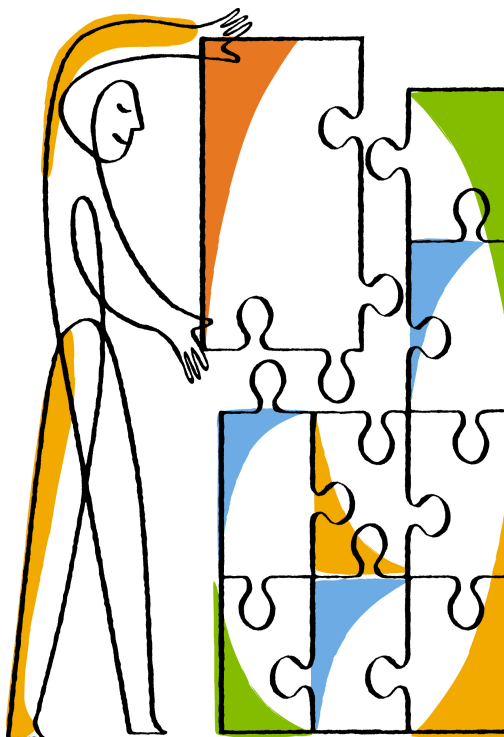




Linux Unified Host Utilities 7.0

Using Linux Hosts with FlashRay™ Systems

Mars™ OS Release 1.0.2



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Linux environments supported on FlashRay

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Overview of supported Linux environments

Linux Unified Host Utilities 7.0 supports all NetApp platforms, as well as several different versions of the Linux operating system on FlashRay. The software ensures proper integration of NetApp storage systems with host hardware, operating systems, and I/O stack components.

You can download the kit from the [Linux Unified Host Utilities download site](#), and the related documentation from the [Linux Host Utilities documentation site](#). For support and the latest configuration information, consult the [NetApp Interoperability Matrix](#).

The following table summarizes key aspects of the Linux environments supported:

Linux environment	Notes
Red Hat Enterprise Linux 5, 6, 7 series	These environments work with following features provided by the Linux operating system. • Multipathing: DM-Multipath • Volume management: Native Linux volume managers • Protocols: FC • ALUA (Asymmetric Logical Unit Access) • SAN booting Setup issues: • Set up host bus adapters (HBAs) before you install the Host Utilities • Set up multipathing with DM-Multipath • Space reclamation requires Red Hat Enterprise Linux 6 update 2 or later.
Oracle Linux 6.5 UEK	
SUSE Linux Enterprise Server 10, 11 series	
Citrix XenServer 6.2	

Oracle Linux setup procedures

This guide provides instructions and examples using Red Hat Enterprise Linux and SUSE Linux Enterprise Server, and in most cases, Oracle Linux uses the same setup procedures as Red Hat

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Enterprise Linux. To simplify this guide, "Red Hat" is used to refer to both Red Hat Enterprise Linux and Oracle Linux systems. If Oracle Linux requires a different procedure, that procedure is included.

NOTE: Ensure that your kernel and DM-Multipath versions are supported in the [NetApp Interoperability Matrix](#). If not, install versions from Oracle ULN (Oracle Unbreakable Linux Network).

Related topics

[Sample configuration file for Red Hat Enterprise Linux 5 on page 30](#)

[Sample configuration file for Red Hat Enterprise Linux 6 on page 33](#)

[Sample configuration file for Red Hat Enterprise Linux 7 on page 36](#)

[Sample configuration file for Oracle Linux on page 40](#)

Configuring FlashRay for Linux hosts

The Linux Unified Host Utilities provide support for Fibre Channel (FC) connections to the FlashRay system using one of two variations of fabric-attached SANs:

- A single FC port can be connected from an HBA to the FlashRay controller through a single switch, which is connected by cable to redundant FC ports.
- A dual-port FC connection from the HBA to the FlashRay controller provides a redundant configuration, avoiding the single point of failure of single-switch configurations.

NOTE: Fibre Channel protocol (FCP) is the only protocol supported to transfer data between the FlashRay system and network hosts.

For details, consult the *FlashRay Installation and Setup Instructions* poster shipped with the FlashRay hardware.

After the hardware setup is completed, you can set up the LUNs that are to be accessed by the host.

How LUNs are accessed by hosts

HBA ports on Linux hosts are identified by worldwide port names (WWPNs) that work as unique addresses to identify a host initiator to a storage system. LUNs are visible to the host only if the HBA's WWPN is known to that system.

Initiator groups (igroups), which are created by using the HBA's WWPNs, control access to the LUNs that are mapped to them. The LUNs on the FlashRay system are recognizable as VHDs (virtual hard disks) to a host because their igroups provide links to the hosts that are allowed to access them.

NOTE: If there is more than a single path to a LUN, multipathing software must be used to ensure that each LUN is displayed as a single disk.

Setting up LUNs and igroups

LUNS must be created and mapped to igroups on the FlashRay controller before hosts can read or write data to them. You can use the FlashRay System Manager or the Mars OS command line to set them up. Consult the *Mars OS System Administration Guide* for detailed instructions.

After you complete the setup, you can use the `sanlun` utility in the Linux Unified Host Utilities kit to help you manage the LUNs and HBAs by displaying the host device names and the LUNs to which they are mapped. For example, you might use the `sanlun fcp show adapter -c` command to display your current configuration.

Related topics

[Configuring Device Mapper Multipath \(DM-Multipath\) on page 11](#)

Setting up optimized paths with ALUA

Asymmetric Logical Unit Access (ALUA) is a method used to determine the optimized and non-optimized paths between the host and LUNs on the FlashRay system. This method defines a standard set of SCSI commands for discovering path priorities to LUNs on SANs.

Optimized paths are the most direct route from your host to the LUN. Non-optimized paths provide additional routes to the LUN if the optimized paths are not available. When you have the host and storage controller configured correctly, ALUA automatically determines which target ports provide optimized and unoptimized access to LUNs.

ALUA is enabled by default on FlashRay systems. The current FlashRay release supports only one node per cluster, so all paths to the cluster are optimized.

Support for ALUA

The Linux Unified Host Utilities support ALUA on hosts running Red Hat Enterprise Linux or SUSE Linux Enterprise Server. The following versions are supported:

Host Utilities Version	Host requirements
Linux Unified Host Utilities 7	Red Hat Enterprise Linux 6 or later Red Hat Enterprise Linux 5 Update 1 or later SUSE Linux Enterprise Server 10 SP2 or later SUSE Linux Enterprise Server 11 or later

NOTE: ALUA is also known as Target Port Group Support (TPGS).

Related topics

[Sample configuration file for Red Hat Enterprise Linux 6 on page 33](#)

[Sample configuration file for SUSE Linux Enterprise Server 11 on page 37](#)

Configuring multipathing

This chapter discusses the following topics:

Configuring Device Mapper Multipath (DM-Multipath)	11
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Configuring Device Mapper Multipath (DM-Multipath)

When multipathing is set up, if one path to a device fails, I/O is re-routed to the remaining paths. If you want to provide I/O failover and load sharing for multipathed block devices in Linux environments, you must use Device Mapper Multipathing (DM-Multipath) software. The host cannot distinguish multiple LUNs from multiple paths to the same LUN without multipathing software.

- If you have more than one path from the host to a LUN, use DM-Multipath.
- If you are not using multipathing software, limit each LUN to a single path.

For information about the supported configurations for DM-Multipath, see the [NetApp Interoperability Matrix](#).

How DM-Multipath works

When multiple paths to a LUN are set up, Linux creates a SCSI device for each path. For example, if there are two paths to a single LUN, it might appear to be both `/dev/sdd` and `/dev/sdf`. To make it easy to keep track of the LUNs, DM-Multipath creates a single device in `/dev/mapper/` for each LUN that includes all the paths.

For example, `/dev/mapper/360a9800043346852563444717a513571` might be the multipath device that is created on top of `/dev/sdd` and `/dev/sdf`.

Using DM-Multipath

When you are using DM-Multipath, you should create a file system for each LUN, and then mount the LUN using the device in `/dev/mapper/`. To create a file system on a LUN, use `/dev/mapper/device` on your Linux host console. `device` will be the multipath device name of the LUN in the `/dev/mapper/` directory.

You can also use the DM-Multipath configuration file to determine if ALUA is being used or the hardware handler should be enabled for ALUA.

Verifying the required multipathing package

It is a good practice to verify that you have the correct multipathing packages to enable you to use DM-Multipath. These packages are part of your Linux distribution. Install the appropriate user space package as part of your setup process.

If you are using Red Hat Enterprise Linux or SUSE Linux Enterprise Server, you can determine the name and version of the DM-Multipath package you have installed using the following commands:

If you are using...	Enter the following command...
Red Hat Enterprise Linux	<code>rpm -q device-mapper</code> <code>rpm -q device-mapper-multipath</code>
SUSE Linux Enterprise Server	<code>rpm -q device-mapper</code> <code>rpm -q multipath-tools</code>

If you do not have the required packages, get a copy of your operating system RPM and install the correct multipathing package.

Editing the DM-Multipath configuration file

The `/etc/multipath.conf` configuration file is used to identify the devices you want to exclude (blacklist).

- If the `/etc/multipath.conf` file already exists, edit it to include the sections needed for your system.
- If you do not have the `/etc/multipath.conf` file, copy the appropriate [sample configuration file](#) for your operating system, then edit it.

In this file you should exclude all non-NetApp SCSI devices that do not correspond to LUNs configured on the FlashRay system that is mapped to your Linux host. You can do this by adding their World Wide Identifiers (WWIDs) to the `blacklist` section of the configuration file.

Steps

1. Run the `sanlun lun show` command to determine which devices correspond to LUNs that are mapped to your Linux host. Devices not displayed in output from this command should be excluded.
2. Get the WWIDs of the devices to be excluded by running the `scsi_id` command on each of those devices.
3. In the `blacklist` section of the configuration file, enter the WWID of the devices installed on your host that are to be excluded.

NOTE: You must supply information that is specific to your system, or you will encounter problems.

Example

Assume that `/dev/sda` is a local SCSI drive. If Red Hat Enterprise Linux 6 series or SUSE Linux Enterprise Server 11 is installed, you can get the WWID by running the command

```
/lib/udev/scsi_id -gud /dev/sda.
```

To obtain the WWID on systems running other Linux operating systems, you can get the WWID by using the command `scsi_id -gus /block/sda`.

In both cases, the output looks like the following: `SIBM-ESXSMW3073NC_FDAR9P66067W`

If you wanted to exclude `/dev/sda`, you would enter `SIBM-ESXSMW3073NC_FDAR9P66067W` in the `blacklist` section of the configuration file:

```
blacklist
{
    wwid      IBM-ESXSMW3073NC_FDAR9P66067W
}
```

If you wanted to exclude other devices, you would enter `devnode` lines in the `blacklist` section of the configuration file:

```
blacklist
{
    wwid      IBM-ESXSMW3073NC_FDAR9P66067W
    devnode   "^hd[a-z]"
    devnode   "^(ram|raw|loop|fd|md|dm-|sr|scd|st)[0-9]*"
    devnode   "^cciss.*"
}
```

NOTE: Make sure you use the correct settings for ALUA.

You can find the correct settings in the `multipath.conf` file examples in [Sample configuration files on page 29](#).

Starting DM-Multipath manually

You can start DM-Multipath manually using commands commonly used in Linux distributions. The following example works for Red Hat Enterprise Linux 5 and 6:

Steps

1. To start the multipath daemon, enter the `start` command:

```
# /etc/init.d/multipathd start
```
2. To configure the DM-Multipath devices, enter the following command:
3. `# multipath`

Some Linux environments require different commands to start the multipath daemon, for example:

If you are using...	Enter the following command...
Red Hat Enterprise Linux 7 series	<pre># systemctl start multipathd</pre>
SUSE Linux Enterprise Server	<pre># /etc/init.d/boot.multipath start # /etc/init.d/multipathd start</pre>
Citrix XenCenter or XenServer	1. Enter maintenance mode: <pre>xe host-disable uuid=<host UUID></pre> 2. Enable multipath: <pre>xe host-param-set other-config:multipathing=true uuid=host_uuid xe host-param-set other-config: multipathhandle=dmp uuid=host_uuid</pre> 3. Release maintenance mode: <pre># xe host-enable uuid=<host UUID></pre>

Configuring DM-Multipath to start automatically

You can configure DM-Multipath to start automatically while booting by adding the multipath service to the boot sequence:

If you are using...	Enter the following command...
Red Hat Enterprise Linux 7 series	<pre># systemctl start multipathd # systemctl enable multipathd</pre>
Red Hat Enterprise Linux 5 and 6 series	<pre># chkconfig --add multipathd # chkconfig multipath on</pre> NOTE: If you are configuring a SAN boot LUN on the host, reboot.
SUSE Linux Enterprise Server	<pre># chkconfig --add boot.multipath # chkconfig --add multipathd # chkconfig boot.multipath on # chkconfig multipath on</pre>
Citrix XenServer	The management stack ensures the automatic start of the multipath service.

Verifying the DM-Multipath configuration

Use the `multipath` command on the Linux host to view the DM-Multipath configuration. If you want to display more detail, use the `-v` (verbose) parameter.

Steps

1. Enter the following command on the Linux host:

```
multipath -v3 -d -ll
```

NOTE: The `-d` (dry run) parameter prevents the command from updating the multipath maps.

2. Verify that the `multipathd` is running by entering one of the following commands:

If you are using...	Enter the following command...
Red Hat Enterprise Linux 5 series	# <code>/etc/init.d/multipathd status</code>
Red Hat Enterprise Linux 7 series	# <code>systemctl status multipathd</code>

NOTE: To determine if `multipathd` is working correctly on your system, enter the `multipathd show config` command to display the values currently being used for the `multipath.conf` file. You can then verify that `multipathd` is using the values you specified.

3. To view a list of the multipath devices, including which `/dev/sdx` devices are used, enter the following command:
`multipath -ll`
4. To check which DM-Multipath settings are currently in use on a Linux host, run one of the following commands:

If you are using...	Enter the following command...
Red Hat Enterprise Linux 5 hosts	<code>multipathd -k"show config</code>
Red Hat Enterprise Linux 6 hosts	<code>multipathd show config</code>
SUSE Enterprise Linux 11 hosts	<code>multipathd show config</code>

The output from these commands will return the settings in use. For more details on these commands, refer to the man pages.

5. To view the `/dev/mapper` devices, enter the following command and review the output:
`ls -l /dev/mapper/`

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```
total 0
brw----- 1 root root 253, 1 Sep 20 17:09
360a98000486e5363693444646a2f656c
brw----- 1 root root 253, 0 Sep 20 17:09
360a98000486e5372635a44646a505643
lrwxrwxrwx 1 root root 16 Sep 12 10:16 control -> ../device-mapper
```

Example

FC on Red Hat Enterprise Linux 6, SUSE Linux Enterprise Server 11 SP1/SP2

When you have ALUA enabled and are using either Red Hat Enterprise Linux 6 or SUSE Linux Enterprise Server 11 with SP1/SP2, the output looks like the following:

```
# multipath -ll
3600a0980383034437956314a51617033 dm-0 NETAPP,LUN FlashRay
size=40G features=4 queue_if_no_path pg_init_retries 50 retain_attached_hw_
handle' hwhandler='1 alua' wp=rw
`-+- policy='round-robin 0' prio=50 status=active
   |- 0:0:0:0 sda 8:0 active ready running
   |- 0:0:1:0 sdb 8:16 active ready running
   |- 1:0:0:0 sdc 8:32 active ready running
   `-- 1:0:1:0 sdd 8:48 active ready running
```

Example

FC on Red Hat Enterprise Linux 7, SUSE Linux Enterprise Server 11 SP3

When you have ALUA enabled and are using either Red Hat Enterprise Linux 7 or SUSE Linux Enterprise Server 11 with SP3, the output looks like the following:

```
# multipath -ll
3600a09805176634c48244544306a6e76 dm-0 NETAPP ,LUN FlashRay
size=10G features='4 queue_if_no_path pg_init_retries 50 retain_attached_hw_
handle'hwhandler='1
alua' wp=rw
+-+ policy='service-time 0' prio=50 status=active
|- 8:0:3:0 sda 65:240 active ready running
`- 8:0:2:0 sdb 65:80 active ready running
```

Stopping DM-Multipath

Use the following procedure to stop DM-Multipath on your Linux host.

Steps

1. Unmount all the file systems on the LUNs.
2. Flush the DM-Multipath devices by entering the following command:

```
# multipath -F
```
3. To stop the multipath daemon, use one of the following commands:

If you are using...	Enter the following command...
Red Hat Enterprise Linux 7 series	# systemctl stop multipathd
Red Hat Enterprise Linux 5 and 6 series	# /etc/init.d/multipathd stop
SUSE Linux Enterprise Server	# /etc/init.d/multipathd stop # /etc/init.d/boot.multipathd stop

Related topics

[Overview of supported Linux environments on page 5](#)

[Examples of sanlun output containing DM-Multipath information \(native multipathing\) on page 18](#)

Examples of sanlun output containing DM-Multipath information (native multipathing)

When you use the `sanlun` utility to confirm that DM-Multipath is set up, the command output varies depending on the protocol you are using.

NOTE: Currently, FlashRay supports only Fibre Channel (FC) protocol.

The following example displays the type of output produced when you run the `sanlun host` command on FlashRay.

Using sanlun on Mars OS to display DM-Multipath information

```
# sanlun lun show all

controller (7mode/E-Series) /      device  host
vserver(cDOT/FlashRay) lun name filename adapter protocol  size  product
-----
default vserver      lun1    /dev/sdc host7    FCP      50g    FlashRay
default vserver      lun1    /dev/sdd host7    FCP      50g    FlashRay
default vserver      lun1    /dev/sdb host6    FCP      50g    FlashRay
default vserver      lun1    /dev/sda host6    FCP      50g    FlashRay

# sanlun lun show -p

ONTAP Path: NOT APPLICABLE
LUN: 0
LUN Size: 50g
Product: FlashRay
Host Device: 3600a0980383030345556314a4c646a4d
Multipath Policy: service-time 0
Multipath Provider: Native
-----

host      controller
path      path      /dev/      host      controller
state     type      node      adapter   target
-----
up        primary   sda        host6     fc2
up        primary   sdb        host6     fc1
up        primary   sdc        host7     fc3
up        primary   sdd        host7     fc4
```

Related topics

[Overview of supported Linux environments on page 5](#)

[Configuring Device Mapper Multipath \(DM-Multipath\) on page 11](#)

Accessing and using LUNs on hosts

This chapter discusses the following topics.

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Enabling device persistence for newly discovered LUNs	23
SAN booting	25
Setting up a SAN boot LUN on Red Hat Enterprise Linux	26
Setting up a SAN boot LUN on SUSE Enterprise Linux Server	27

Methods for working with LUNs in native Linux environments

The method you use when working with LUNs varies depending on your environment -- which protocol you are using, what kind of host initiator (HBA) is installed, and whether you are using multipathing. In some cases, the method depends on your version of the Linux operating system.

The sections that follow provide information about the tools you need to use to work with LUNs, as well as what actions you should take when working with LUNs in your environment. For example, if you do not have multipathing enabled, it is a good practice to provide persistent identification for the LUNs. See [Enabling device persistence for newly discovered LUNs on page 23](#) for details.

Discovering new LUNs

After you have created and mapped LUNs to your Linux host, you can use the `rescan` script to discover them.

Before you begin

You must have a copy of the `rescan` shell script, which is included in the `sg3_utils` package distributed with Red Hat Enterprise Linux 5 Update 4 or later, or SUSE Linux Enterprise Server 11 or later. (For earlier versions, use `rescan` scripts that are available on the vendors' web sites.)

To discover a new LUN using these Linux distributions, enter the following command:

```
/usr/bin/rescan-scsi-bus.sh
```

Viewing a list of LUNs

You can use the `sanlun lun show all` command to display LUN information.

The example that follows shows the type of output you will see when you run this command in a host utilities environment that is running the FC protocol with DM-Multipath enabled. It displays the host device names and the LUNs to which they are mapped.

FC with DM-Multipath example of using `sanlun` to view LUNs

```
# sanlun lun show all

controller(7mode/E-Series)/ device host lun
vserver(cDOT/FlashRay) lun name filename adapter protocol size product
-----
-
default vserver          lun1      /dev/sdc  host7    FCP      50g     FlashRay
default vserver          lun1      /dev/sdd  host7    FCP      50g     FlashRay
default vserver          lun1      /dev/sdb  host6    FCP      50g     FlashRay
default vserver          lun1      /dev/sda  host6    FCP      50g     FlashRay
```

Related topics

[Enabling device persistence for newly discovered LUNs on page 23](#)

Enabling device persistence for newly discovered LUNs

When you have multiple LUNs, you must be able to persistently identify each LUN across system reboots. But the Linux operating system assigns a unique device name to each LUN as it rediscovers LUNs after rebooting, so the LUN names might change. For example, because the order in which the operating system discovers LUNs cannot be predicted, a device like `/dev/sda` might become `/dev/sdb` after rebooting.

NOTE: When you use multipathing, DM-Multipath automatically creates persistent devices for each LUN in the `/dev/mapper/` directory on the Linux host. You can create a file system directly on a multipath device in `/dev/mapper/`. You do not have to create a partition or label on the multipath device.

To ensure persistence for your LUNs, you can give each of them a unique file system label, then mount the file system automatically by entering them in the `/etc/fstab` file.

Steps

1. Verify your existing LUNs by using the discovery methods described in [Methods for working with LUNs in native Linux environments on page 21](#).
2. Mount the new file systems by adding entries to `/etc/fstab`. Using the following syntax, replace the device, mount point, and file system type values in the `/etc/fstab` file with those that will identify and mount your LUN.

If you are running...	Enter the following line...
DM-Multipath with Red Hat Enterprise Linux	<code>device mount_point type defaults 0 0</code>
DM-Multipath with SUSE Linux Enterprise Server	<code>device mount_point type defaults nofail,rw 0 0</code>

For example, replace `device` with the name of your device in the `/dev/mapper/` directory; replace `mount_point` with the mount point you created for the file system; and replace `type` with the appropriate file system type – for example, `ext2` or `ext3`.

3. Save the `/etc/fstab` file to complete the process.

Removing an unmapped LUN

You can use the `rescan` script to remove an unmapped LUN from the host.

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For more information on `rescan`, see [Methods for working with LUNs in native Linux environments on page 21](#).

Before you begin

Make sure that the LUN is not in use and that it has been unmapped.

Steps

1. Run the rescan script to remove the LUN:
`/usr/bin/rescan-scsi-bus.sh -r`

Related topics

[Methods for working with LUNs in native Linux environments on page 21](#)

SAN booting

SAN booting is the general term for booting a Linux host from a storage system LUN instead of an internal hard disk. SAN booting uses a SAN-attached disk, such as a LUN configured on a storage controller, as a boot device for the host.

A SAN boot LUN provides the following advantages:

- No maintenance and servicing costs for hard drives
You can remove the hard drives from your servers and just use the SAN for booting.
- Consolidated and centralized storage
The host uses only the SAN for storage.
- Lower cost
The hardware and operating costs are lowered.
- Greater reliability
Systems without disks are less prone to failure.
- Quick server swaps
If a server fails, systems without disks can be swapped.
- Better disaster recovery
Site duplication is simplified.

For information about the configurations that are supported for SAN boot LUNs, see the [NetApp Interoperability Matrix](#).

Related topics

[Setting up a SAN boot LUN on Red Hat Enterprise Linux on page 26](#)

[Setting up a SAN boot LUN on SUSE Enterprise Linux Server on page 27](#)

Setting up a SAN boot LUN on Red Hat Enterprise Linux

You can set up a SAN boot LUN to work in a Red Hat Enterprise Linux environment that is using the FC protocol.

Before you begin

Verify that your system setup supports SAN boot LUNs by consulting the [NetApp Interoperability Matrix](#).

Steps

1. Create a LUN on the storage system and map it to the host. This will be the SAN boot LUN. You should ensure the following:
 - The SAN boot LUN is mapped to the host.
 - Multiple paths to the LUN are available.
 - The LUN is visible to the host during the boot process.
2. Enable the BIOS of the HBA port to which the SAN boot LUN is mapped. For information about how to enable the HBA BIOS, see your HBA vendor-specific documentation.
3. Configure the paths to the HBA boot BIOS as primary, secondary, tertiary, etc., on the boot device. For more information, see your vendor-specific documentation.
4. Save and exit.
5. Reboot the host.
6. Install the operating system on the SAN boot LUN.

NOTE: For Red Hat Enterprise Linux 5 series, you must specify Boot Option as `linux mpath` during the operating system installation. When you specify `linux mpath`, you can see the multipath devices (`/dev/mapper/mpathx`) as installation devices.

7. Install the Linux Unified Host Utilities.
8. Configure DM-Multipath.

Related topics

[SAN booting on page 25](#)

[Setting up a SAN boot LUN on SUSE Enterprise Linux Server on page 27](#)

Setting up a SAN boot LUN on SUSE Enterprise Linux Server

You can set up a SAN boot LUN to work in a SUSE Linux Enterprise Server environment that is using the FC protocol.

Before you begin

Verify that your system setup supports SAN boot LUNs by consulting the [NetApp Interoperability Matrix](#).

Steps

1. Create a LUN on the storage system and map it to the host. This will be the SAN boot LUN. You should ensure the following:
 - The SAN boot LUN is mapped to the host.
NOTE: SUSE Linux Enterprise Server 11 SP2 supports multiple paths to the LUN, but if you are running a SAN boot installation using an earlier version, only one primary path to the LUN is available.
 - The LUN is visible to the host during the boot process.
2. Enable the BIOS of the HBA port to which the SAN boot LUN is mapped.
For information on how to enable the HBA BIOS, see your HBA vendor-specific documentation.
3. Install the operating system on the SAN boot LUN.
4. Install the Linux Unified Host Utilities.
5. Configure DM-Multipath.

Configuring the root partition on SUSE Linux Enterprise Server

You can configure the root partition with DM-Multipath on your SUSE Linux Enterprise Server host.

Steps

1. Configure DM-Multipath support.
2. Install the Linux Unified Host Utilities.
3. Enable all paths to the LUN on the storage controller.
4. Recreate the `initrd` by running the following command:

If you are using...	Enter the following command...
SUSE Linux Enterprise Server 11	<code>mkinitrd -f mpath</code>
SUSE Linux Enterprise Server 10 SP2	<code>mkinitrd -f mpath</code>

NOTE: You must keep a backup of the `initrd` image.

- 5. Reboot the host.

NOTE: Because all paths to the SAN boot LUN are now available on the host, you should configure all paths in the HBA boot BIOS as primary boot device, secondary boot device, and so on.

Related topics

[SAN booting on page 25](#)

[Setting up a SAN boot LUN on Red Hat Enterprise Linux on page 26](#)

Sample configuration files

This chapter discusses the following topics:

Sample configuration file for Red Hat Enterprise Linux 5	30
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Sample configuration file for Red Hat Enterprise Linux 5

You can replace your current `multipath.conf` file with a sample Red Hat Enterprise Linux 5 series configuration file and change the values to those that are appropriate for your system. When you do this, keep the following in mind:

Red Hat Enterprise Linux 5 series notes	Explanation
Blacklist section	You must provide information of your system in the blacklist section. Any names shown in the sample files are examples, and will not work with your system.
SAN boot LUNs and the <code>user_friendly_names</code> parameter	It is important to set the <code>user_friendly_names</code> parameter to <code>no</code> . There have been reports of problems when this parameter is set to <code>yes</code> .

NOTE: All versions of Red Hat Enterprise Linux 5 series use a DM-Multipath configuration file, but there might be slight variations in the file depending on which update you have installed.

Red Hat Enterprise Linux 5 series, SAN boot LUNs, and `user_friendly_names` parameter

If you create a SAN boot LUN and the installer sets the `user_friendly_names` parameter to `yes`, you must perform the following steps.

1. Change the `user_friendly_names` parameter to `no`.
2. Make a backup of `initrd-image`.
3. Re-create the `initrd-image` using the command `mkinitrd`. You might use the following command line:
`mkinitrd -f /boot/initrd-`uname -r`.img `uname -r``
4. Change the root DM-Multipath device name to the WWID-based device name in all the locations that refer to the device, such as `/etc/fstab` and `/boot/grub/device.map`.
5. Reboot the host.

For example, suppose the name of the root device is `/dev/mapper/mpatha` and the WWID of the device is `360a98000486e2f66426f583133796572`. You must recreate the `initrd-image`, then change the device name to `/dev/mapper/360a98000486e2f66426f583133796572` in `/etc/fstab` and `/boot/grub/device.map`, and any other place that refers to device `/dev/mapper/mpatha`. After that, reboot the host.

Red Hat Enterprise Linux 5 update 10, 9 or update 8 with ALUA enabled

The following file provides an example of the values you need to supply when your host is running Red Hat Enterprise Linux 5 with update 10, 9, or update 8 with ALUA enabled.

Red Hat Enterprise Linux 5 update 10, 9, and update 8 with ALUA enabled use the same values in the DM-Multipath configuration file, so this file can apply to either version.

NOTE: If you use the blacklist section, you must replace the sample entries with information for your system.

```
defaults
{
    user_friendly_names no
    queue_without_daemon no
    flush_on_last_del yes
    max_fds max
    pg_prio_calc avg
}
# All data under blacklist must be specific to your system.

blacklist
{
    devnode "^hd[a-z]"
    devnode "^(ram|raw|loop|fd|md|dm-|sr|scd|st) [0-9]*"
    devnode "^cciss.*"
}

devices
{
    device
    {
        vendor "NETAPP"
        product "LUN"
        path_grouping_policy group_by_prio
        features "3 queue_if_no_path pg_init_retries 50"
        prio_callout "/sbin/mpath_prio_alua /dev/%n"
        path_checker tur
        path_selector "round-robin 0"
        failback immediate
        hardware_handler "1 alua"
        rr_weight uniform
        rr_min_io 128
        getuid_callout "/sbin/scsi_id -g -u -s /block/%n"
    }
}
```

Related topics

[Sample configuration file for Red Hat Enterprise Linux 6 on page 33](#)

[Sample configuration file for Red Hat Enterprise Linux 7 on page 36](#)

Sample configuration file for Red Hat Enterprise Linux 6

You can replace your current `multipath.conf` file with a sample Red Hat Enterprise Linux 6 series configuration file and change the values to those that are appropriate for your system. When you do this, keep the following in mind:

Red Hat Enterprise Linux 6 series notes	Explanation
Blacklist section	You must provide information of your system in the blacklist section. Any names shown in the sample files are examples, and will not work with your system.
Blacklisting the local device	If you want to blacklist the local disk, you must put the WWID of the local disk in the blacklist section. You do not need to add other devnode lines, because DM-Multipath adds them by default.
SAN boot LUNs and the <code>user_friendly_names</code> parameter	It is important to set the <code>user_friendly_names</code> parameter to <code>no</code> . There have been reports of problems when this parameter is set to <code>yes</code> .

NOTE: All versions of Red Hat Enterprise Linux 6 series use a DM-Multipath configuration file, but there might be slight variations in the file depending on which update you have installed.

Red Hat Enterprise Linux 6 series, SAN boot LUNs, and `user_friendly_names` parameter

If you create a SAN boot LUN and the installer sets the `user_friendly_names` parameter to `yes`, you must perform the following steps.

1. Change the `user_friendly_names` parameter to `no`.

NOTE: For Red Hat Enterprise Linux 6.4 series, replace the first step with the following, then continue with Steps 2 to 5.

- Create an empty `multipath.conf` file. All the settings for RHEL 6.4, both with and without ALUA, will be automatically updated by default.

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2. Make a backup of `initrd-image`.
3. Re-create the `initrd-image` using the command `mkinitrd`. For Red Hat Enterprise Linux 6 series and later, use the following command line:

```
mkinitrd -f /boot/ initramfs-"`uname -r`.img `uname -r`
```

or the command

```
dracut -f
```

4. Change the root DM-Multipath device name to the WWID-based device name in all the locations that refer to the device, such as `/etc/fstab` and `/boot/grub/device.map`.

For example, suppose the name of the root device is `/dev/mapper/mpatha` and the WWID of the device is `360a98000486e2f66426f583133796572`. You must recreate the `initrd-image`, then change the device name to `/dev/mapper/360a98000486e2f66426f583133796572` in `/etc/fstab` and `/boot/grub/device.map`, and any other place that refers to device `/dev/mapper/mpatha`. After that, reboot the host.

5. Append the following parameter value to the kernel for ALUA and non-ALUA to work:

```
rdloaddriver=scsi_dh_alua
```

Example

```
kernel /vmlinuz-2.6.32-358.6.1.el6.x86_64 ro root=/dev/mapper/
vg_ibmx355021082-lv_root rd_NO_LUKS rd_LVM_LV=vg_ibmx355021082/
lv_root LANG=en_US.UTF-8 rd_LVM_LV=vg_ibmx355021082/lv_swap rd_NO_MD
SYSFONT=latarcyrheb-sun16 crashkernel=auto KEYBOARDTYPE=pc
KEYTABLE=us rd_NO_DM rhgb quiet rdloaddriver=scsi_dh_alua
```

6. Reboot the host.

Red Hat Enterprise Linux 6 update 4 and 5 with ALUA enabled sample configuration file

Refer to the steps listed in section Red Hat Enterprise Linux 6 series, SAN boot LUNs, and the `user_friendly_names` parameter for setting the parameters, then go to steps 1 and 2.

NOTE: If you use the blacklist section, you must replace the sample entries with information for your system.

```
# All data under blacklist must be specific to your system.

blacklist
{
```

```

    wwid < wwid_of_the_local_disk>
}

```

1. Append the following parameter value to the kernel for ALUA and non-ALUA to work and then reboot: `rdloaddriver=scsi_dh_alua`

Example

```

kernel /vmlinuz-2.6.32-358.6.1.el6.x86_64 ro root=/dev/mapper/
vg_ibmx355021082-lv_root rd_NO_LUKS rd_LVM_LV=vg_ibmx355021082/
lv_root LANG=en_US.UTF-8 rd_LVM_LV=vg_ibmx355021082/lv_swap rd_NO_MD
SYSFONT=latacyrheb-sun16 crashkernel=auto KEYBOARDTYPE=pc
KEYTABLE=us rd_NO_DM rhgb quiet rdloaddriver=scsi_dh_alua

```

2. Verify the output of the `cat /proc/cmdline` command to ensure that the setting is complete.

Related topics

[Sample configuration file for Red Hat Enterprise Linux 5 on page 30](#)

[Sample configuration file for Red Hat Enterprise Linux 7 on page 36](#)

Sample configuration file for Red Hat Enterprise Linux 7

You can replace your current `multipath.conf` file with a sample Red Hat Enterprise Linux 7 series configuration file and change the values to those that are appropriate for your system. When you do this, keep the following in mind:

Red Hat Enterprise Linux 7 series notes	Explanation
Blacklist section	You must provide information of your system in the blacklist section. Any names shown in the sample files are examples and will not work with your system.

NOTE: All versions of Red Hat Enterprise Linux 7 series use a DM-Multipath configuration file, but there might be slight variations in the file based on which update you have installed.

Use an empty `/etc/multipath.conf` file for FC configurations as well as ALUA configurations. Add blacklisting information for the local disks in the file, if required.

Sample configuration file for Red Hat Enterprise Linux 7.0 with and without ALUA enabled

NOTE: If you use the blacklist section, you must replace the sample entries with information for your system.

```
# All data under blacklist must be specific to your system.
blacklist
{
wwid < wwid_of_the_local_disk>
}
```

Related topics

- [Sample configuration file for Red Hat Enterprise Linux 6 on page 33](#)
- [Sample configuration file for Red Hat Enterprise Linux 5 on page 30](#)

Sample configuration file for SUSE Linux Enterprise Server 11

You can replace your current `multipath.conf` file with sample SUSE Linux Enterprise Server 11 series configuration files and change the values to those that are appropriate for your system. When you do this, keep the following in mind:

SUSE Enterprise Linux Server 11 series notes	Explanation
Blacklist section	You must provide information of your system in the blacklist section. Any names shown in the sample files are examples and will not work with your system.

NOTE: All versions of SUSE Linux Enterprise Server use a DM-Multipath configuration file, but there might be slight variations in the file based on which version and update you have installed.

SUSE Linux Enterprise Server 11, SP1 with ALUA enabled sample configuration file

The following file provides an example of the values you need to provide when your host is running either SUSE Linux Enterprise Server 11 or 11 SP1 with ALUA.

NOTE: If you use the blacklist section, you must replace the sample entries with information for your system.

```
defaults
{
    user_friendly_names    no
    max_fds                max
    flush_on_last_del      yes
}
# All data under blacklist must be specific to your system.
blacklist
{
    devnode                "^hd[a-z]"
    wwid                   "<wwid_of_the_local_disk>"
    devnode                "^(ram|raw|loop|fd|md|dm-|sr|scd|st) [0-9]*"
    devnode                "^cciss.*"
}
devices
{
    device
```

```

{
    vendor                "NETAPP"
    product                "LUN"
    getuid_callout         "/lib/udev/scsi_id -g -u -d /dev/%n"
    prio "alua"
    features               "1 queue_if_no_path"
    hardware_handler       "1 alua"
    path_grouping_policy   group_by_prio
    path_selector           "round-robin 0"
    failback               immediate
    rr_weight              uniform
    rr_min_io              128
    path_checker            tur
}

```

SUSE Linux Enterprise Server 11 SP2 with ALUA enabled sample configuration file

The following file provides an example of the values you need to supply when your host is running SUSE Linux Enterprise Server 11 SP2 with ALUA.

NOTE: If you use the blacklist section, you must replace the sample entries with information for your system.

```

defaults
{
    user_friendly_names    no
    max_fds                 max
    queue_without_daemon    no
    flush_on_last_del       yes
}
# All data under blacklist must be specific to your system.
blacklist
{
    devnode                 "^hd[a-z]"
    wwid                    "<wwid_of_the_local_disk>"
    devnode                 "^ (ram|raw|loop|fd|md|dm-|sr|scd|st) [0-9] *"
    devnode                 "^cciss.*"
}
devices
{
    device
    {
        vendor              "NETAPP"
        product              "LUN"
        getuid_callout       "/lib/udev/scsi_id -g -u -d /dev/%n"
    }
}

```

```

        prio                "alua"
        features             "3 queue_if_no_path pg_init_retries 50"
        hardware_handler     "1 alua"
        path_grouping_policy group_by_prio
        failback             immediate
        rr_weight            uniform
        rr_min_io            128
        path_checker         tur
    }
}

```

Sample configuration file for SUSE Linux Enterprise 11 SP3 with and without ALUA enabled

With SUSE Linux Enterprise 11 SP3, you do not need the `/etc/multipath.conf` file to configure DM-Multipath on NetApp LUNs.

NOTE: To blacklist a device, you must add the following sample information into your `/etc/multipath.conf` file.

```

# All data under blacklist must be specific to your system.
blacklist
{
wwid < wwid_of_the_local_disk>
}

```

Related topics

[Sample configuration file for Red Hat Enterprise Linux 6 on page 33](#)

[Sample configuration file for Oracle Linux on page 40](#)

Sample configuration file for Oracle Linux

You can replace your current file with a sample file, then change the values to those that are appropriate for your system.

In most cases, Oracle Linux uses the same setup procedures as Red Hat and SUSE Enterprise Linux. To simplify this guide, we use "Red Hat" to refer to systems using Red Hat Enterprise Linux and Oracle Linux. If Oracle Linux requires a different procedure, that procedure is included.

NOTE: All versions of Oracle Linux 5 use a DM-Multipath configuration file, but there might be slight variations in the file based on the update you have installed.

Consult the [NetApp Interoperability Matrix](#) to ensure that the kernel and DM-Multipath versions are supported. If not, install the versions from Oracle ULN (Oracle Unbreakable Linux Network).

NOTE: Use RHEL-based settings when using Red Hat Compatible Kernel and multipath packages.

Related topics

[Sample configuration file for Red Hat Enterprise Linux 6 on page 33](#)

[Sample configuration file for Red Hat Enterprise Linux 6 on page 33](#)

Sample configuration file for Citrix XenServer

You can replace your current `multipath.conf` file with the sample Citrix XenServer configuration files and change the values to those that are appropriate for your system. When you do this, keep the following in mind:

Citrix XenServer 6 series	Parameter notes
Blacklist section	You must provide information of your system in the blacklist section. Any names shown in the sample files are examples and will not work with your system.
<code>wwid <Dev ID></code>	Use the actual device ID. Run the <code>/sbin/ scsi_id -g -u -s /block/%n</code> command to get the WWID for the SCSI drive to be blacklisted.
SAN boot support	SAN booting is supported only with Citrix XenServer 6 series and the FC protocol.
SAN boot LUNs and the <code>user_friendly_names</code> parameter	Set the <code>user_friendly_names</code> parameter to <code>no</code> . There have been reports of problems when this parameter is set to <code>yes</code> .

NOTE: All versions of Citrix XenServer use a DM-Multipath configuration file, but there might be slight variations in the file based on which Citrix update you have installed.

Citrix XenServer, SAN boot LUNs, and `user_friendly_names` parameter

If you create a SAN boot LUN and the installer sets the `user_friendly_names` parameter to `yes`, you must perform the following steps.

1. Change the `user_friendly_names` parameter to `no`.
2. Make a backup of `initrd-image`.
3. Place the `multipath.conf` file in the `/etc` directory.
4. Run the following commands:

```
service multipathd reload
multipath -v3.
```

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NOTE: `multipath -ll` should reflect the changes on the SAN Boot LUN made in the `multipath.conf` file.

5. Re-create the `initrd-image` using the command `mkinitrd`. You could use the following command line:

```
mkinitrd -f /boot/initrd-"`uname -r`".img `uname -r`
```

6. Reboot the host.

NOTE: Currently SAN Boot LUN does not support the `queue_if_no_path` feature. To overcome this limitation, run the `multipath` command after booting.

To avoid running the `multipath` command after every boot, add `/sbin/multipath` to the `/etc/rc.d/rc.local` file.

- Running `multipath` forces the unused LUNs (on which there is no storage repository) to be added to the XAPI Layer.
- To remove the `scsi_device` ID of those unused LUNs from `mpathutil` use the following command:

```
# /opt/xensource/sm/mpathutil.py remove <scsi_device-id>.
```

Skip this step if you have no unused LUNs (where no SR is created).

Citrix XenServer 6.2 with ALUA enabled sample configuration file

The following file provides an example of the values you need to supply when your host is running Citrix XenServer 6.2 with ALUA enabled.

NOTE: If you use the blacklist section, you must replace the sample entries with information for your system.

```
defaults {
    flush_on_last_del    no
    dev_loss_tmo         30
    fast_io_fail_tmo     off
}
blacklist
{
    wwid                device_id_of_the_device_to_be_blacklisted
    devnode              "(ram|raw|loop|fd|md|dm-|sr|scd|st) [0-9] *"
    devnode              "^hd[a-z]"
    devnode              "^cciss.*"
}
devices
{
    device
```

```
{  
    vendor          "NETAPP"  
    product         "LUN.*"  
    prio            "alua"  
    hardware_handler "1 alua"  
}  
}
```

Related topics

[Sample configuration file for Red Hat Enterprise Linux 6 on page 33](#)

Troubleshooting Linux hosting

This chapter discusses the following topics:

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Installing the nSANity data collection program	49

Troubleshooting

The following sections provide resolutions for some common problems.

LUNs not recognized by DM-Multipath

If LUNs are mapped to the Linux host and correctly reported by the `sanlun lun show all` command, but not be reported by the `multipath -ll` command, make sure the LUNs are not blacklisted (excluded) from the DM-Multipath support configuration in the `/etc/multipath.conf` file.

Start by entering the following command on the Linux host to display the devices that are blacklisted:

```
multipath -v3 -d | grep blacklist
```

If any devices show up as being blacklisted, check the `devnode_blacklist` or `blacklist` section of the `/etc/multipath.conf` file and verify that all the entries are correctly specified.

If the devices are not blacklisted, but are still not recognized by the `multipath` command, regenerate the multipath maps by entering the following command:

```
multipath -v3
```

For more information, see bug number 228744 on Bugs Online, which is available on the NetApp Support Site.

LUNs not visible on the Linux host

If LUNs do not appear as local disks to the host, try rescanning the HBAs by reloading the drivers.

If the LUNs still do not appear, verify the configuration settings:

Configuration settings	What you should do
Driver version	Verify that the version of the external HBA driver you are running is supported. You can check the latest system requirements in the NetApp Interoperability Matrix .
Cabling	Verify that the cables between the host and the storage system are properly connected.

Configuration settings	What you should do
Zoning	Verify that the zoning is correct.
HBA Settings	Verify the recommended HBA settings.
HBA World Wide Port Names	Verify that you are using the correct initiator WWPNs in the igroup configuration. Use the <code>igroup show</code> command to display the WWPNs of the initiators in the storage system's igroups. On the host, use the HBA tools to display the initiator WWPN. The initiator WWPNs configured in the igroup and on the host should match.
Initiator login	Verify that the initiator is logged in to the storage system by entering the <code>fcpl initiator show</code> command on the storage system console. If the initiator is configured and logged in to the storage system, the storage system console displays the initiator WWPN.
LUN mappings	Verify that the LUNs are mapped to an igroup by issuing the following commands on the Mars OS command line: • <code>lun mapping show</code> displays all the LUNs and the igroups to which they are mapped. • <code>lun mapping show igroups</code> displays the LUNs mapped to a specific igroup.
System requirements	Verify that the components of your configuration are supported. Verify that you have the correct host Operating System (OS) Service Pack level, initiator version, and other system requirements. You can find the latest requirements in the NetApp Interoperability Matrix .

Warnings displayed during Host Utilities installation

Occasionally, you might see warnings during the installation of Linux Unified Host Utilities. These warnings might be like the following:

```
Warning: libnl.so (32-bit) library not found, some sanlun commands may
not work. Refer Linux Host Utilities Installation and Setup Guide for
more details
```

```
Warning: libHBAAPI.so (32-bit) library not found, some sanlun commands
```

```
may not work. Refer Linux Host Utilities Installation and Setup Guide
for more details
```

```
Warning: libdevmapper.so (32-bit) library not found, some sanlun
commands may not work. Refer Linux Host Utilities Installation and Setup
Guide for more details
```

To prevent these warnings, make sure you install the packages that provide the libraries before you install the Host Utilities software. For more information, see the vendor information on installing and configuring QLogic and Emulex HBAs.

Warnings displayed when using LVM with multipathing software

When you use Logical Volume Manager (LVM) in a multipathing environment, a warning message is displayed.

In a default configuration, LVM scans all attached disks and identifies the disks that contain physical volumes. In environments that use multipathing software, each path to a particular LUN is registered as a different SCSI device. LVM detects this and chooses one of the devices, then displays a warning message.

To resolve this problem, modify the paths to the `preferred_names` parameter in the `/etc/lvm/lvm.conf` file. The following is an example of how the `preferred_names` parameter line should look:

```
preferred_names = [ "^/dev/mapper/*" ]
```

After you make the change, perform a rescan (`pvscan` and `vgscan`) to ensure all devices are properly displayed.

sanlun command displays error when HBA libHBAAPI.so is missing

The `sanlun` command uses the HBAAPI software provided by both the host operating system and the HBA vendor's API plugins to gather information about the HBAs, including their WWPNs. If this software is not available, the `sanlun` command returns an error message.

Error messages like the following indicate that the operating system's libHBAAPI library is not installed:

```
Unable to locate /usr/lib/libHBAAPI.so library
```

```
Unable to locate /usr/lib64/libHBAAPI.so library
```

Error messages like the following indicate that the HBA vendor API plug-in is not installed:

```
No supported adapters are present
```

```
Unable to load HBA control library
```

To resolve this problem, make sure you have the correct management software package for your HBAs and host architecture installed:

- For QLogic HBAs, install the QLogic QConvergeConsole CLI package.
- For Emulex HBAs, install the Emulex OneCommand Manager core application (CLI) package.

NOTE: If you are using a different HBA than those supported by the Host Utilities, you must install the management software for that HBA. Those packages are available from the HBA vendor.

Related topics

[Configuring FlashRay for Linux hosts on page 7](#)

[Configuring Device Mapper Multipath \(DM-Multipath\) on page 11](#)

Installing the nSANity data collection program

Download and install the nSANity Diagnostic and Configuration Data Collector program when instructed to do so by your technical support representative.

About this task

The nSANity program replaces the diagnostic programs included in previous versions of the Host Utilities. It runs on a Windows or Linux system with network connectivity to the component from which you want to collect data.

Steps

1. Log in to the [NetApp Support Site](#) and search for "nSANity".
2. Follow the instructions to download the Windows .zip or Linux .tgz version of the nSANity program, depending on the workstation or server you want to run it on.
3. Change to the directory to which you downloaded the .zip or .tgz file.
4. Extract all of the files and follow the instructions in the `README.txt` file, and be sure to review the `RELEASE_NOTES.txt` file for any warnings and notices.

After you finish

Run the nSANity commands specified by your technical support representative.

Related topics

[Troubleshooting on page 45](#)

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