



## **SLES 12**

### **SAN hosts and cloud clients**

NetApp  
March 29, 2024

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# SLES 12

## Use SUSE Linux Enterprise Server 12 SP5 with ONTAP

You can use the ONTAP SAN host configuration settings to configure SUSE Linux Enterprise Server 12 SP5 with ONTAP as the target.

### Install the Linux Unified Host Utilities

The NetApp Linux Unified Host Utilities software package is available on the [NetApp Support Site](#) in a 32-bit and 64-bit .rpm file. If you do not know which file is right for your configuration, use the [NetApp Interoperability Matrix Tool](#) to verify which one you need.

NetApp strongly recommends installing the Linux Unified Host Utilities, but it is not mandatory. The utilities do not change any settings on your Linux host. The utilities improve management and assist NetApp customer support in gathering information about your configuration.

#### What you'll need

If you have a version of Linux Unified Host Utilities currently installed you should upgrade it or, you should remove it and use the following steps to install the latest version.

1. Download the 32-bit or 64-bit Linux Unified Host Utilities software package from the [NetApp Support Site](#) to your host.
2. Use the following command to install the software package:

```
rpm -ivh netapp_linux_unified_host_utilities-7-1.x86_64
```



You can use the configuration settings provided in this document to configure cloud clients connected to [Cloud Volumes ONTAP](#) and [Amazon FSx for ONTAP](#).

### SAN Toolkit

The toolkit is installed automatically when you install the NetApp Host Utilities package. This kit provides the `sanlun` utility, which helps you manage LUNs and HBAs. The `sanlun` command returns information about the LUNs mapped to your host, multipathing, and information necessary to create initiator groups.

#### Example

In the following example, the `sanlun lun show` command returns LUN information.

```
# sanlun lun show all
```

Example output:

controller (7mode/E-Series) / vserver (cDOT/FlashRay) Product	lun-pathname	device filename	host adapter	protocol	lun size
data_vserver 120.0g cDOT	/vol/vol1/lun1	/dev/sdb	host16	FCP	
data_vserver 120.0g cDOT	/vol/vol1/lun1	/dev/sdc	host15	FCP	
data_vserver 120.0g cDOT	/vol/vol2/lun2	/dev/sdd	host16	FCP	
data_vserver 120.0g cDOT	/vol/vol2/lun2	/dev/sde	host15	FCP	

## SAN Booting

### What you'll need

If you decide to use SAN booting, it must be supported by your configuration. You can use the [NetApp Interoperability Matrix Tool](#) to verify that your OS, HBA, HBA firmware and the HBA boot BIOS, and ONTAP version are supported.

### Steps

1. Map the SAN boot LUN to the host.
2. Verify that multiple paths are available.



Multiple paths become available after the host OS is up and running on the paths.

3. Enable SAN booting in the server BIOS for the ports to which the SAN boot LUN is mapped.

For information on how to enable the HBA BIOS, see your vendor-specific documentation.

4. Reboot the host to verify that the boot is successful.

## Multipathing

For SUSE Linux Enterprise Server 12 SP5 the `/etc/multipath.conf` file must exist, but you do not need to make specific changes to the file. SUSE Linux Enterprise Server 12 SP5 is compiled with all settings required to recognize and correctly manage ONTAP LUNs.

You can use the `multipath -ll` command to verify the settings for your ONTAP LUNs.

The following sections provide sample multipath output for a LUN mapped to ASA and non-ASA personas.

### All SAN Array configurations

In All SAN Array (ASA) configurations, all paths to a given LUN are active and optimized. This improves performance by serving I/O operations through all paths at the same time.

### Example

The following example displays the correct output for an ONTAP LUN:

```
# multipath -ll
3600a0980383034466b2b4a3775474859 dm-3 NETAPP,LUN C-Mode
size=20G 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
| |- 1:0:8:1 sdb 8:16 active ready running
| `-- 2:0:8:1 sdd 8:48 active ready running
`+- policy='round-robin 0' prio=10 status=enabled
  |- 1:0:9:1 sdc 8:32 active ready running
  `-- 2:0:9:1 sde 8:64 active ready running
```



Do not use an excessive number of paths to a single LUN. No more than four paths should be required. More than eight paths might cause path issues during storage failures.

## Non-ASA configurations

For non-ASA configurations, there should be two groups of paths with different priorities. The paths with the higher priorities are Active/Optimized, meaning they are serviced by the controller where the aggregate is located. The paths with the lower priorities are active but are non-optimized because they are served from a different controller. The non-optimized paths are only used when no optimized paths are available.

### Example

The following example displays the correct output for an ONTAP LUN with two Active/Optimized paths and two Active/Non-Optimized paths:

```
#multipath -ll
3600a09803831347657244e527766394e dm-5 NETAPP,LUN C-Mode
size=80G features='3 queue_if_no_path pg_init_retries 50' hwhandler='1
alua' wp=rw
|+- policy='service-time 0' prio=50 status=active
| |- 11:0:1:0 sdj 8:144 active ready running
| |- 11:0:2:0 sdr 65:16 active ready running
`+- policy='service-time 0' prio=10 status=enabled
  |- 11:0:0:0 sdb 8:i6 active ready running
  |- 12:0:0:0 sdz 65:144 active ready running
```



Do not use an excessive number of paths to a single LUN. No more than four paths should be required. More than eight paths might cause path issues during storage failures.

## Recommended Settings

SUSE Linux Enterprise Server 12 SP5 OS is compiled to recognize ONTAP LUNs and automatically set all configuration parameters correctly.

The `multipath.conf` file must exist for the multipath daemon to start, but you can create an empty, zero-byte file by using the following command:

```
touch /etc/multipath.conf
```

The first time you create this file, you might need to enable and start the multipath services:

```
# systemctl enable multipathd
# systemctl start multipathd
```

- There is no requirement to add anything directly to the `multipath.conf` file, unless you have devices that you do not want to be managed by multipath or you have existing settings that override defaults.
- To exclude unwanted devices, add the following syntax to the `multipath.conf` file .

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

Replace the `<DevId>` with the WWID string of the device you want to exclude.

### Example

In this example, we are going to determine the WWID of a device and add to the `multipath.conf` file.

### Steps

1. Run the following command to determine the WWID:

```
# /lib/udev/scsi_id -gud /dev/sda
360030057024d0730239134810c0cb833
```

`sda` is the local SCSI disk that we need to add it to the blacklist.

2. Add the WWID to the blacklist stanza in `/etc/multipath.conf`:

```
blacklist {
    wwid 360030057024d0730239134810c0cb833
    devnode "^(ram|raw|loop|fd|md|dm-|sr|scd|st) [0-9]*"
    devnode "^hd[a-z]"
    devnode "^cciss.*"
}
```

You should always check your `/etc/multipath.conf` file for legacy settings, especially in the defaults section, that might be overriding the default settings.

The following table demonstrates the critical `multipathd` parameters for ONTAP LUNs and the required values. If a host is connected to LUNs from other vendors and any of these parameters are overridden, they will need to be corrected by later stanzas in the `multipath.conf` file that apply specifically to ONTAP LUNs. If this is not done, the ONTAP LUNs might not work as expected. These defaults should only be overridden in consultation with NetApp and/or an OS vendor and only when the impact is fully understood.

Parameter	Setting
<code>detect_prio</code>	<code>yes</code>
<code>dev_loss_tmo</code>	<code>"infinity"</code>
<code>failback</code>	<code>immediate</code>
<code>fast_io_fail_tmo</code>	<code>5</code>
<code>features</code>	<code>"2 pg_init_retries 50"</code>
<code>flush_on_last_del</code>	<code>"yes"</code>
<code>hardware_handler</code>	<code>"0"</code>
<code>no_path_retry</code>	<code>queue</code>
<code>path_checker</code>	<code>"tur"</code>
<code>path_grouping_policy</code>	<code>"group_by_prio"</code>
<code>path_selector</code>	<code>"service-time 0"</code>
<code>polling_interval</code>	<code>5</code>
<code>prio</code>	<code>"ontap"</code>
<code>product</code>	<code>LUN.*</code>
<code>retain_attached_hw_handler</code>	<code>yes</code>
<code>rr_weight</code>	<code>"uniform"</code>
<code>user_friendly_names</code>	<code>no</code>
<code>vendor</code>	<code>NETAPP</code>

### Example

The following example shows how to correct an overridden default. In this case, the `multipath.conf` file defines values for `path_checker` and `no_path_retry` that are not compatible with ONTAP LUNs. If they cannot be removed because of other SAN arrays still attached to the host, these parameters can be corrected specifically for ONTAP LUNs with a device stanza.

```
defaults {
  path_checker readsector0
  no_path_retry fail
}
devices {
  device {
    vendor "NETAPP "
    product "LUN.*"
    no_path_retry queue
    path_checker tur
  }
}
```

## Known issues

The SLES 12 SP5 with ONTAP release has the following known issues:



NetApp Bug ID	Title	Description	Bugzilla ID
<a href="#">1284293</a>	Kernel disruption occurs on SLES12 SP5 with QLogic QLE2562 8GB FC HBA during storage failover operations	Kernel disruption occurs during storage failover operations on the SLES12 SP5 kernel with a QLogic QLE2562 Fibre Channel (FC) host bus adapter (HBA). The kernel disruption causes SLES12 SP5 to reboot, leading to application disruption. If the kdump mechanism is enabled, the kernel disruption generates a vmcore file located in the /var/crash/ directory. Check the vmcore file to determine the cause of the disruption. A storage failover with a QLogic QLE2562 HBA event affects the "THREAD_INFO: ffff8aedef723c2c0" module. Locate this event in the vmcore file by finding the following string: "[THREAD_INFO: ffff8aedef723c2c0]". After the kernel disruption, reboot the host OS to enable it to recover. Then restart the applications.	<a href="#">1157966</a>

## Use SUSE Linux Enterprise Server 12 SP4 with ONTAP

You can use the ONTAP SAN host configuration settings to configure SUSE Linux Enterprise Server 12 SP4 with ONTAP as the target.

### Install the Linux Unified Host Utilities

The NetApp Linux Unified Host Utilities software package is available on the [NetApp Support Site](#) in a 32-bit and 64-bit .rpm file. If you do not know which file is right for your configuration, use the [NetApp Interoperability Matrix Tool](#) to verify which one you need.

NetApp strongly recommends installing the Linux Unified Host Utilities, but it is not mandatory. The utilities do not change any settings on your Linux host. The utilities improve management and assist NetApp customer support in gathering information about your configuration.

#### What you'll need

If you have a version of Linux Unified Host Utilities currently installed you should upgrade it or, you should remove it and use the following steps to install the latest version.

1. Download the 32-bit or 64-bit Linux Unified Host Utilities software package from the [NetApp Support Site](#) to your host.
2. Use the following command to install the software package:

```
rpm -ivh netapp_linux_unified_host_utilities-7-1.x86_64
```



You can use the configuration settings provided in this document to configure cloud clients connected to [Cloud Volumes ONTAP](#) and [Amazon FSx for ONTAP](#).

## SAN Toolkit

The toolkit is installed automatically when you install the NetApp Host Utilities package. This kit provides the `sanlun` utility, which helps you manage LUNs and HBAs. The `sanlun` command returns information about the LUNs mapped to your host, multipathing, and information necessary to create initiator groups.

### Example

In the following example, the `sanlun lun show` command returns LUN information.

```
# sanlun lun show all
```

Example output:

controller(7mode/E-Series) / vserver(cDOT/FlashRay)    lun-pathname	device filename	host adapter	lun protocol	size
Product				
-----				
data_vserver                /vol/vol1/lun1	/dev/sdb	host16	FCP	
120.0g   cDOT				
data_vserver                /vol/vol1/lun1	/dev/sdc	host15	FCP	
120.0g   cDOT				
data_vserver                /vol/vol2/lun2	/dev/sdd	host16	FCP	
120.0g   cDOT				
data_vserver                /vol/vol2/lun2	/dev/sde	host15	FCP	
120.0g   cDOT				

## SAN Booting

### What you'll need

If you decide to use SAN booting, it must be supported by your configuration. You can use the [NetApp Interoperability Matrix Tool](#) to verify that your OS, HBA, HBA firmware and the HBA boot BIOS, and ONTAP version are supported.

### Steps

1. Map the SAN boot LUN to the host.
2. Verify that multiple paths are available.



Multiple paths become available after the host OS is up and running on the paths.

3. Enable SAN booting in the server BIOS for the ports to which the SAN boot LUN is mapped.

For information on how to enable the HBA BIOS, see your vendor-specific documentation.

4. Reboot the host to verify that the boot is successful.

## Multipathing

For SUSE Linux Enterprise Server 12 SP4 the `/etc/multipath.conf` file must exist, but you do not need to make specific changes to the file. SUSE Linux Enterprise Server 12 SP4 is compiled with all settings required to recognize and correctly manage ONTAP LUNs.

You can use the `multipath -ll` command to verify the settings for your ONTAP LUNs.

The following sections provide sample multipath output for a LUN mapped to ASA and non-ASA personas.

### All SAN Array configurations

In All SAN Array (ASA) configurations, all paths to a given LUN are active and optimized. This improves performance by serving I/O operations through all paths at the same time.

#### Example

The following example displays the correct output for an ONTAP LUN:

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size=20G 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
|  |- 1:0:8:1   sdb 8:16 active ready running
|  `-- 2:0:8:1   sdd 8:48 active ready running
`--+- policy='round-robin 0' prio=10 status=enabled
    |- 1:0:9:1   sdc 8:32 active ready running
    `-- 2:0:9:1   sde 8:64 active ready running
```



Do not use an excessive number of paths to a single LUN. No more than four paths should be required. More than eight paths might cause path issues during storage failures.

### Non-ASA configurations

For non-ASA configurations, there should be two groups of paths with different priorities. The paths with the higher priorities are Active/Optimized, meaning they are serviced by the controller where the aggregate is located. The paths with the lower priorities are active but are non-optimized because they are served from a different controller. The non-optimized paths are only used when no optimized paths are available.

#### Example

The following example displays the correct output for an ONTAP LUN with two Active/Optimized paths and two Active/Non-Optimized paths:

```
#multipath -ll
3600a09803831347657244e527766394e dm-5 NETAPP,LUN C-Mode
size=80G features='3 queue_if_no_path pg_init_retries 50' hwhandler='1
alua' wp=rw
|+- policy='service-time 0' prio=50 status=active
| |- 11:0:1:0 sdj 8:144 active ready running
| |- 11:0:2:0 sdr 65:16 active ready running
`+- policy='service-time 0' prio=10 status=enabled
|- 11:0:0:0 sdb 8:i6 active ready running
|- 12:0:0:0 sdz 65:144 active ready running
```



Do not use an excessive number of paths to a single LUN. No more than four paths should be required. More than eight paths might cause path issues during storage failures.

## Recommended Settings

SUSE Linux Enterprise Server 12 SP4 OS is compiled to recognize ONTAP LUNs and automatically set all configuration parameters correctly.

The `multipath.conf` file must exist for the multipath daemon to start, but you can create an empty, zero-byte file by using the following command:

```
touch /etc/multipath.conf
```

The first time you create this file, you might need to enable and start the multipath services:

```
# systemctl enable multipathd
# systemctl start multipathd
```

- There is no requirement to add anything directly to the `multipath.conf` file, unless you have devices that you do not want to be managed by multipath or you have existing settings that override defaults.
- To exclude unwanted devices, add the following syntax to the `multipath.conf` file .

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

Replace the `<DevId>` with the WWID string of the device you want to exclude.

### Example

In this example, we are going to determine the WWID of a device and add to the `multipath.conf` file.

## Steps

1. Run the following command to determine the WWID:

```
# /lib/udev/scsi_id -gud /dev/sda
360030057024d0730239134810c0cb833
```

sda is the local SCSI disk that we need to add it to the blacklist.

2. Add the WWID to the blacklist stanza in `/etc/multipath.conf`:

```
blacklist {
    wwid      360030057024d0730239134810c0cb833
    devnode   "(ram|raw|loop|fd|md|dm-|sr|scd|st) [0-9] *"
    devnode   "^hd[a-z] *"
    devnode   "^cciss.*"
}
```

You should always check your `/etc/multipath.conf` file for legacy settings, especially in the defaults section, that might be overriding the default settings.

The following table demonstrates the critical `multipathd` parameters for ONTAP LUNs and the required values. If a host is connected to LUNs from other vendors and any of these parameters are overridden, they will need to be corrected by later stanzas in the `multipath.conf` file that apply specifically to ONTAP LUNs. If this is not done, the ONTAP LUNs might not work as expected. These defaults should only be overridden in consultation with NetApp and/or an OS vendor and only when the impact is fully understood.

Parameter	Setting
detect_prio	yes
dev_loss_tmo	"infinity"
failback	immediate
fast_io_fail_tmo	5
features	"2 pg_init_retries 50"
flush_on_last_del	"yes"
hardware_handler	"0"
no_path_retry	queue
path_checker	"tur"
path_grouping_policy	"group_by_prio"
path_selector	"service-time 0"
polling_interval	5
prio	"ontap"

Parameter	Setting
product	LUN.*
retain_attached_hw_handler	yes
rr_weight	"uniform"
user_friendly_names	no
vendor	NETAPP

### Example

The following example shows how to correct an overridden default. In this case, the `multipath.conf` file defines values for `path_checker` and `no_path_retry` that are not compatible with ONTAP LUNs. If they cannot be removed because of other SAN arrays still attached to the host, these parameters can be corrected specifically for ONTAP LUNs with a device stanza.

```
defaults {
    path_checker readsector0
    no_path_retry fail
}
devices {
    device {
        vendor "NETAPP "
        product "LUN.*"
        no_path_retry queue
        path_checker tur
    }
}
```

### Known issues

There are no known issues for the SUSE Linux Enterprise Server 12 SP4 with ONTAP release.

## Use SUSE Linux Enterprise Server 12 SP3 with ONTAP

You can use the ONTAP SAN host configuration settings to configure SUSE Linux Enterprise Server 12 SP3 with ONTAP as the target.

### Install the Linux Unified Host Utilities

The NetApp Linux Unified Host Utilities software package is available on the [NetApp Support Site](#) in a 32-bit and 64-bit .rpm file. If you do not know which file is right for your configuration, use the [NetApp Interoperability Matrix Tool](#) to verify which one you need.

NetApp strongly recommends installing the Linux Unified Host Utilities, but it is not mandatory. The utilities do not change any settings on your Linux host. The utilities improve management and assist NetApp customer support in gathering information about your configuration.

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1. Download the 32-bit or 64-bit Linux Unified Host Utilities software package from the [NetApp Support Site](#) to your host.
2. Use the following command to install the software package:

```
rpm -ivh netapp_linux_unified_host_utilities-7-1.x86_64
```



You can use the configuration settings provided in this document to configure cloud clients connected to [Cloud Volumes ONTAP](#) and [Amazon FSx for ONTAP](#).

## SAN Toolkit

The toolkit is installed automatically when you install the NetApp Host Utilities package. This kit provides the `sanlun` utility, which helps you manage LUNs and HBAs. The `sanlun` command returns information about the LUNs mapped to your host, multipathing, and information necessary to create initiator groups.

### Example

In the following example, the `sanlun lun show` command returns LUN information.

```
# sanlun lun show all
```

Example output:

controller(7mode/E-Series) / vserver(cDOT/FlashRay)    Product	lun-pathname	device filename	host adapter	protocol	lun size
data_vserver 120.0g   cDOT	/vol/vol1/lun1	/dev/sdb	host16	FCP	
data_vserver 120.0g   cDOT	/vol/vol1/lun1	/dev/sdc	host15	FCP	
data_vserver 120.0g   cDOT	/vol/vol2/lun2	/dev/sdd	host16	FCP	
data_vserver 120.0g   cDOT	/vol/vol2/lun2	/dev/sde	host15	FCP	

## SAN Booting

### What you'll need

If you decide to use SAN booting, it must be supported by your configuration. You can use the [NetApp Interoperability Matrix Tool](#) to verify that your OS, HBA, HBA firmware and the HBA boot BIOS, and ONTAP version are supported.

## Steps

1. Map the SAN boot LUN to the host.
2. Verify that multiple paths are available.



Multiple paths become available after the host OS is up and running on the paths.

3. Enable SAN booting in the server BIOS for the ports to which the SAN boot LUN is mapped.

For information on how to enable the HBA BIOS, see your vendor-specific documentation.

4. Reboot the host to verify that the boot is successful.

## Multipathing

For SUSE Linux Enterprise Server 12 SP3 the `/etc/multipath.conf` file must exist, but you do not need to make specific changes to the file. SUSE Linux Enterprise Server 12 SP3 is compiled with all settings required to recognize and correctly manage ONTAP LUNs.

You can use the `multipath -ll` command to verify the settings for your ONTAP LUNs.

The following sections provide sample multipath output for a LUN mapped to ASA and non-ASA personas.

### All SAN Array configurations

In All SAN Array (ASA) configurations, all paths to a given LUN are active and optimized. This improves performance by serving I/O operations through all paths at the same time.

### Example

The following example displays the correct output for an ONTAP LUN:

```
# multipath -ll
3600a0980383034466b2b4a3775474859 dm-3 NETAPP,LUN C-Mode
size=20G 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
|  |- 1:0:8:1   sdb 8:16 active ready running
|  `-- 2:0:8:1   sdd 8:48 active ready running
`--+- policy='round-robin 0' prio=10 status=enabled
    |- 1:0:9:1   sdc 8:32 active ready running
    `-- 2:0:9:1   sde 8:64 active ready running
```



Do not use an excessive number of paths to a single LUN. No more than four paths should be required. More than eight paths might cause path issues during storage failures.

### Non-ASA configurations

For non-ASA configurations, there should be two groups of paths with different priorities. The paths with the higher priorities are Active/Optimized, meaning they are serviced by the controller where the aggregate is located. The paths with the lower priorities are active but are non-optimized because they are served from a different controller. The non-optimized paths are only used when no optimized paths are available.



## Example

The following example displays the correct output for an ONTAP LUN with two Active/Optimized paths and two Active/Non-Optimized paths:

```
# multipath -ll
3600a09803831347657244e527766394e dm-5 NETAPP,LUN C-Mode
size=80G features='4 queue_if_no_path pg_init_retries 50
retain_attached_hw_handler' hwhandler='1 alua' wp=rw
|+- policy='service-time 0' prio=50 status=active
| |- 11:0:1:0 sdj 8:144 active ready running
| |- 11:0:2:0 sdr 65:16 active ready running
`-+- policy='service-time 0' prio=10 status=enabled
|- 11:0:0:0 sdb 8:i6 active ready running
|- 12:0:0:0 sdz 65:144 active ready running
```



Do not use an excessive number of paths to a single LUN. No more than four paths should be required. More than eight paths might cause path issues during storage failures.

## Recommended Settings

SUSE Linux Enterprise Server 12 SP3 OS is compiled to recognize ONTAP LUNs and automatically set all configuration parameters correctly.

The `multipath.conf` file must exist for the multipath daemon to start, but you can create an empty, zero-byte file by using the following command:

```
touch /etc/multipath.conf
```

The first time you create this file, you might need to enable and start the multipath services:

```
# systemctl enable multipathd
# systemctl start multipathd
```

- There is no requirement to add anything directly to the `multipath.conf` file, unless you have devices that you do not want to be managed by multipath or you have existing settings that override defaults.
- To exclude unwanted devices, add the following syntax to the `multipath.conf` file .

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

Replace the `<DevId>` with the WWID string of the device you want to exclude.

## Example

In this example, we are going to determine the WWID of a device and add to the `multipath.conf` file.

## Steps

1. Run the following command to determine the WWID:

```
# /lib/udev/scsi_id -gud /dev/sda
360030057024d0730239134810c0cb833
```

`sda` is the local SCSI disk that we need to add it to the blacklist.

2. Add the WWID to the blacklist stanza in `/etc/multipath.conf`:

```
blacklist {
    wwid      360030057024d0730239134810c0cb833
    devnode   "(ram|raw|loop|fd|md|dm-|sr|scd|st) [0-9] *"
    devnode   "^hd[a-z] *"
    devnode   "^cciss.*"
}
```

You should always check your `/etc/multipath.conf` file for legacy settings, especially in the defaults section, that might be overriding the default settings.

The following table demonstrates the critical `multipathd` parameters for ONTAP LUNs and the required values. If a host is connected to LUNs from other vendors and any of these parameters are overridden, they will need to be corrected by later stanzas in the `multipath.conf` file that apply specifically to ONTAP LUNs. If this is not done, the ONTAP LUNs might not work as expected. These defaults should only be overridden in consultation with NetApp and/or an OS vendor and only when the impact is fully understood.

Parameter	Setting
<code>detect_prio</code>	<code>yes</code>
<code>dev_loss_tmo</code>	<code>"infinity"</code>
<code>failback</code>	<code>immediate</code>
<code>fast_io_fail_tmo</code>	<code>5</code>
<code>features</code>	<code>"2 pg_init_retries 50"</code>
<code>flush_on_last_del</code>	<code>"yes"</code>
<code>hardware_handler</code>	<code>"0"</code>
<code>no_path_retry</code>	<code>queue</code>
<code>path_checker</code>	<code>"tur"</code>
<code>path_grouping_policy</code>	<code>"group_by_prio"</code>
<code>path_selector</code>	<code>"service-time 0"</code>

Parameter	Setting
polling_interval	5
prio	"ontap"
product	LUN.*
retain_attached_hw_handler	yes
rr_weight	"uniform"
user_friendly_names	no
vendor	NETAPP

### Example

The following example shows how to correct an overridden default. In this case, the `multipath.conf` file defines values for `path_checker` and `no_path_retry` that are not compatible with ONTAP LUNs. If they cannot be removed because of other SAN arrays still attached to the host, these parameters can be corrected specifically for ONTAP LUNs with a device stanza.

```
defaults {
    path_checker readsector0
    no_path_retry fail
}
devices {
    device {
        vendor "NETAPP "
        product "LUN.*"
        no_path_retry queue
        path_checker tur
    }
}
```

### Known issues

The SLES 15 SP3 with ONTAP release has the following known issues:

NetApp Bug ID	Title	Description	Bugzilla ID
<a href="#">1089555</a>	Kernel disruption observed on kernel version SLES12 SP3 with Emulex LPe16002 16GB FC during storage failover operation	<p>A kernel disruption might occur during storage failover operations on kernel version SLES12 SP3 with Emulex LPe16002 HBA. The kernel disruption prompts a reboot of the operating system, which in turn causes an application disruption. If the kdump is configured, the kernel disruption generates a vmcore file under /var/crash/directory. You can investigate the cause of the failure in the vmcore file.</p> <p>Example:</p> <p>In the observed case, the kernel disruption was observed in the module "lpfc_sli_ringtxcmpl_put+51" and is logged in the vmcore file</p> <p>– exception RIP: lpfc_sli_ringtxcmpl_put+51.</p> <p>Recover the operating system after the kernel disruption by rebooting the host operating system and restarting the application.</p>	<a href="#">1042847</a>

NetApp Bug ID	Title	Description	Bugzilla ID
<a href="#">1089561</a>	Kernel disruption observed on kernel version SLES12 SP3 with Emulex LPe32002 32GB FC during storage failover operations	<p>A kernel disruption might occur during storage failover operations on kernel version SLES12 SP3 with Emulex LPe32002 HBA. The kernel disruption prompts a reboot of the operating system, which in turn causes an application disruption. If the kdump is configured, the kernel disruption generates a vmcore file under /var/crash/directory. You can investigate the cause of the failure in the vmcore file.</p> <p>Example:</p> <p>In the observed case, the kernel disruption was observed in the module "lpfc_sli_free_hbq+76" and is logged in the vmcore file</p> <p>– exception RIP: lpfc_sli_free_hbq+76.</p> <p>Recover the operating system after the kernel disruption by rebooting the host operating system and restarting the application.</p>	<a href="#">1042807</a>

NetApp Bug ID	Title	Description	Bugzilla ID
<a href="#">1117248</a>	Kernel disruption observed on SLES12SP3 with QLogic QLE2562 8GB FC during storage failover operations	<p>During storage failover operations on the Sles12sp3 kernel (kernel-default-4.4.82-6.3.1) with QLogic QLE2562 HBA, the kernel disruption was observed due to a panic in the kernel. The kernel panic leads to a reboot of the operating system, causing an application disruption. The kernel panic generates the vmcore file under the /var/crash/ directory if kdump is configured. Upon the kernel panic, the vmcore file can be used to understand the cause of the failure.</p> <p>Example: In this case, the panic was observed in the "blk_finish_request+289" module. It is logged in the vmcore file with the following string: "exception RIP: blk_finish_request+289"</p> <p>After the kernel disruption, you can recover the operating system by rebooting the Host OS. You can restart the application as required.</p>	<a href="#">1062496</a>

NetApp Bug ID	Title	Description	Bugzilla ID
<a href="#">1117261</a>	Kernel disruption observed on SLES12SP3 with Qlogic QLE2662 16GB FC during storage failover operations	<p>During storage failover operations on Sles12sp3 kernel (kernel-default-4.4.82-6.3.1) with Qlogic QLE2662 HBA, you might observe kernel disruption. This prompts a reboot of the operating system causing application disruption. The kernel disruption generates a vmcore file under /var/crash/ directory if kdump is configured. The vmcore file can be used to understand the cause of the failure.</p> <p>Example: In this case the Kernel disruption was observed in the module "unknown or invalid address" and is logged in vmcore file with the following string - exception RIP: unknown or invalid address.</p> <p>After kernel disruption, the operating system can be recovered by rebooting the host operating system and restarting the application as required.</p>	<a href="#">1062508</a>

NetApp Bug ID	Title	Description	Bugzilla ID
<a href="#">1117274</a>	Kernel disruption observed on SLES12SP3 with Emulex LPe16002 16GB FC during storage failover operations	<p>During storage failover operations on Sles12sp3 kernel (kernel-default-4.4.87-3.1) with Emulex LPe16002 HBA, you might observe kernel disruption. This prompts a reboot of the operating system causing application disruption. The kernel disruption generates a vmcore file under the /var/crash/ directory if kdump is configured. The vmcore file can be used to understand the cause of the failure.</p> <p>Example:</p> <p>In this case kernel disruption was observed in the module “raw_spin_lock_irqsave+30” and is logged in the vmcore file with the following string:</p> <ul style="list-style-type: none"> <li>– exception RIP: _raw_spin_lock_irqsave+30.</li> </ul> <p>After kernel disruption, the operating system can be recovered by rebooting the host operating system and restarting the application as required.</p>	<a href="#">1062514</a>

## Use SUSE Linux Enterprise Server 12 SP2 with ONTAP

You can use the ONTAP SAN host configuration settings to configure SUSE Linux Enterprise Server 12 SP2 with ONTAP as the target.

### Install the Linux Unified Host Utilities

The NetApp Linux Unified Host Utilities software package is available on the [NetApp Support Site](#) in a 32-bit and 64-bit .rpm file. If you do not know which file is right for your configuration, use the [NetApp Interoperability Matrix Tool](#) to verify which one you need.

NetApp strongly recommends installing the Linux Unified Host Utilities, but it is not mandatory. The utilities do not change any settings on your Linux host. The utilities improve management and assist NetApp customer support in gathering information about your configuration.



## What you'll need

If you have a version of Linux Unified Host Utilities currently installed you should upgrade it or, you should remove it and use the following steps to install the latest version.

1. Download the 32-bit or 64-bit Linux Unified Host Utilities software package from the [NetApp Support Site](#) to your host.
2. Use the following command to install the software package:

```
rpm -ivh netapp_linux_unified_host_utilities-7-1.x86_64
```



You can use the configuration settings provided in this document to configure cloud clients connected to [Cloud Volumes ONTAP](#) and [Amazon FSx for ONTAP](#).

## SAN Toolkit

The toolkit is installed automatically when you install the NetApp Host Utilities package. This kit provides the `sanlun` utility, which helps you manage LUNs and HBAs. The `sanlun` command returns information about the LUNs mapped to your host, multipathing, and information necessary to create initiator groups.

### Example

In the following example, the `sanlun lun show` command returns LUN information.

```
# sanlun lun show all
```

Example output:

controller(7mode/E-Series) / vserver(cDOT/FlashRay) Product	lun-pathname	device filename	host adapter	lun protocol	size
data_vserver 120.0g cDOT	/vol/vol1/lun1	/dev/sdb	host16	FCP	
data_vserver 120.0g cDOT	/vol/vol1/lun1	/dev/sdc	host15	FCP	
data_vserver 120.0g cDOT	/vol/vol2/lun2	/dev/sdd	host16	FCP	
data_vserver 120.0g cDOT	/vol/vol2/lun2	/dev/sde	host15	FCP	

## SAN Booting

### What you'll need

If you decide to use SAN booting, it must be supported by your configuration. You can use the [NetApp Interoperability Matrix Tool](#) to verify that your OS, HBA, HBA firmware and the HBA boot BIOS, and ONTAP version are supported.

## Steps

1. Map the SAN boot LUN to the host.
2. Verify that multiple paths are available.



Multiple paths become available after the host OS is up and running on the paths.

3. Enable SAN booting in the server BIOS for the ports to which the SAN boot LUN is mapped.

For information on how to enable the HBA BIOS, see your vendor-specific documentation.

4. Reboot the host to verify that the boot is successful.

## Multipathing

For SUSE Linux Enterprise Server 12 SP2 the `/etc/multipath.conf` file must exist, but you do not need to make specific changes to the file. SUSE Linux Enterprise Server 12 SP2 is compiled with all settings required to recognize and correctly manage ONTAP LUNs.

You can use the `multipath -ll` command to verify the settings for your ONTAP LUNs.

The following sections provide sample multipath output for a LUN mapped to ASA and non-ASA personas.

### All SAN Array configurations

In All SAN Array (ASA) configurations, all paths to a given LUN are active and optimized. This improves performance by serving I/O operations through all paths at the same time.

### Example

The following example displays the correct output for an ONTAP LUN:

```
# multipath -ll
3600a0980383034466b2b4a3775474859 dm-3 NETAPP,LUN C-Mode
size=20G 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
|  |- 1:0:8:1   sdb 8:16 active ready running
|  `-- 2:0:8:1   sdd 8:48 active ready running
`--+- policy='round-robin 0' prio=10 status=enabled
    |- 1:0:9:1   sdc 8:32 active ready running
    `-- 2:0:9:1   sde 8:64 active ready running
```



Do not use an excessive number of paths to a single LUN. No more than four paths should be required. More than eight paths might cause path issues during storage failures.

### Non-ASA configurations

For non-ASA configurations, there should be two groups of paths with different priorities. The paths with the higher priorities are Active/Optimized, meaning they are serviced by the controller where the aggregate is located. The paths with the lower priorities are active but are non-optimized because they are served from a different controller. The non-optimized paths are only used when no optimized paths are available.

## Example

The following example displays the correct output for an ONTAP LUN with two Active/Optimized paths and two Active/Non-Optimized paths:

```
# multipath -ll
3600a09803831347657244e527766394e dm-5 NETAPP,LUN C-Mode
size=80G 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
| |- 11:0:1:0 sdj 8:144 active ready running
| |- 11:0:2:0 sdr 65:16 active ready running
`-+- policy='service-time 0' prio=10 status=enabled
|- 11:0:0:0 sdb 8:i6 active ready running
|- 12:0:0:0 sdz 65:144 active ready running
```



Do not use an excessive number of paths to a single LUN. No more than four paths should be required. More than eight paths might cause path issues during storage failures.

## Recommended Settings

SUSE Linux Enterprise Server 12 SP2 OS is compiled to recognize ONTAP LUNs and automatically set all configuration parameters correctly.

The `multipath.conf` file must exist for the multipath daemon to start, but you can create an empty, zero-byte file by using the following command:

```
touch /etc/multipath.conf
```

The first time you create this file, you might need to enable and start the multipath services:

```
# systemctl enable multipathd
# systemctl start multipathd
```

- There is no requirement to add anything directly to the `multipath.conf` file, unless you have devices that you do not want to be managed by multipath or you have existing settings that override defaults.
- To exclude unwanted devices, add the following syntax to the `multipath.conf` file .

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

Replace the `<DevId>` with the WWID string of the device you want to exclude.

## Example

In this example, we are going to determine the WWID of a device and add to the `multipath.conf` file.

## Steps

1. Run the following command to determine the WWID:

```
# /lib/udev/scsi_id -gud /dev/sda
360030057024d0730239134810c0cb833
```

`sda` is the local SCSI disk that we need to add it to the blacklist.

2. Add the WWID to the blacklist stanza in `/etc/multipath.conf`:

```
blacklist {
    wwid      360030057024d0730239134810c0cb833
    devnode   "^(ram|raw|loop|fd|md|dm-|sr|scd|st) [0-9] *"
    devnode   "^hd[a-z] *"
    devnode   "^cciss.*"
}
```

You should always check your `/etc/multipath.conf` file for legacy settings, especially in the defaults section, that might be overriding the default settings.

The following table demonstrates the critical `multipathd` parameters for ONTAP LUNs and the required values. If a host is connected to LUNs from other vendors and any of these parameters are overridden, they will need to be corrected by later stanzas in the `multipath.conf` file that apply specifically to ONTAP LUNs. If this is not done, the ONTAP LUNs might not work as expected. These defaults should only be overridden in consultation with NetApp and/or an OS vendor and only when the impact is fully understood.

Parameter	Setting
<code>detect_prio</code>	<code>yes</code>
<code>dev_loss_tmo</code>	<code>"infinity"</code>
<code>failback</code>	<code>immediate</code>
<code>fast_io_fail_tmo</code>	<code>5</code>
<code>features</code>	<code>"3 queue_if_no_path pg_init_retries 50"</code>
<code>flush_on_last_del</code>	<code>"yes"</code>
<code>hardware_handler</code>	<code>"0"</code>
<code>path_checker</code>	<code>"tur"</code>
<code>path_grouping_policy</code>	<code>"group_by_prio"</code>
<code>path_selector</code>	<code>"service-time 0"</code>
<code>polling_interval</code>	<code>5</code>

Parameter	Setting
prio	"ontap"
product	LUN.*
retain_attached_hw_handler	yes
rr_weight	"uniform"
user_friendly_names	no
vendor	NETAPP

### Example

The following example shows how to correct an overridden default. In this case, the `multipath.conf` file defines values for `path_checker` and `detect_prio` that are not compatible with ONTAP LUNs. If they cannot be removed because of other SAN arrays still attached to the host, these parameters can be corrected specifically for ONTAP LUNs with a device stanza.

```
defaults {
    path_checker readsector0
    detect_prio no
}
devices {
    device {
        vendor "NETAPP "
        product "LUN.*"
        path_checker tur
        detect_prio yes
    }
}
```

### Known issues

There are no known issues for the SUSE Linux Enterprise Server 12 SP2 with ONTAP release.

## Use SUSE Linux Enterprise Server 12 SP1 with ONTAP

You can use the ONTAP SAN host configuration settings to configure SUSE Linux Enterprise Server 12 SP1 with ONTAP as the target.

### Install the Linux Unified Host Utilities

The NetApp Linux Unified Host Utilities software package is available on the [NetApp Support Site](#) in a 32-bit and 64-bit .rpm file. If you do not know which file is right for your configuration, use the [NetApp Interoperability Matrix Tool](#) to verify which one you need.

NetApp strongly recommends installing the Linux Unified Host Utilities, but it is not mandatory. The utilities do not change any settings on your Linux host. The utilities improve management and assist NetApp customer support in gathering information about your configuration.

## What you'll need

If you have a version of Linux Unified Host Utilities currently installed you should upgrade it or, you should remove it and use the following steps to install the latest version.

1. Download the 32-bit or 64-bit Linux Unified Host Utilities software package from the [NetApp Support Site](#) to your host.
2. Use the following command to install the software package:

```
rpm -ivh netapp_linux_unified_host_utilities-7-1.x86_64
```



You can use the configuration settings provided in this document to configure cloud clients connected to [Cloud Volumes ONTAP](#) and [Amazon FSx for ONTAP](#).

## SAN Toolkit

The toolkit is installed automatically when you install the NetApp Host Utilities package. This kit provides the `sanlun` utility, which helps you manage LUNs and HBAs. The `sanlun` command returns information about the LUNs mapped to your host, multipathing, and information necessary to create initiator groups.

### Example

In the following example, the `sanlun lun show` command returns LUN information.

```
# sanlun lun show all
```

Example output:

```
controller(7mode/E-Series)/          device      host          lun
vserver(cDOT/FlashRay)   lun-pathname filename  adapter  protocol  size
Product
-----
data_vserver              /vol/vol1/lun1  /dev/sdb   host16    FCP
120.0g  cDOT
data_vserver              /vol/vol1/lun1  /dev/sdc   host15    FCP
120.0g  cDOT
data_vserver              /vol/vol2/lun2  /dev/sdd   host16    FCP
120.0g  cDOT
data_vserver              /vol/vol2/lun2  /dev/sde   host15    FCP
120.0g  cDOT
```

## SAN Booting

### What you'll need

If you decide to use SAN booting, it must be supported by your configuration. You can use the [NetApp Interoperability Matrix Tool](#) to verify that your OS, HBA, HBA firmware and the HBA boot BIOS, and ONTAP version are supported.

## Steps

1. Map the SAN boot LUN to the host.
2. Verify that multiple paths are available.



Multiple paths become available after the host OS is up and running on the paths.

3. Enable SAN booting in the server BIOS for the ports to which the SAN boot LUN is mapped.

For information on how to enable the HBA BIOS, see your vendor-specific documentation.

4. Reboot the host to verify that the boot is successful.

## Multipathing

For SUSE Linux Enterprise Server 12 SP1 the `/etc/multipath.conf` file must exist, but you do not need to make specific changes to the file. SUSE Linux Enterprise Server 12 SP1 is compiled with all settings required to recognize and correctly manage ONTAP LUNs.

You can use the `multipath -ll` command to verify the settings for your ONTAP LUNs.

The following sections provide sample multipath output for a LUN mapped to ASA and non-ASA personas.

### All SAN Array configurations

In All SAN Array (ASA) configurations, all paths to a given LUN are active and optimized. This improves performance by serving I/O operations through all paths at the same time.

### Example

The following example displays the correct output for an ONTAP LUN:

```
# multipath -ll
3600a0980383034466b2b4a3775474859 dm-3 NETAPP,LUN C-Mode
size=20G 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
|  |- 1:0:8:1   sdb 8:16 active ready running
|  `-- 2:0:8:1   sdd 8:48 active ready running
`--+- policy='round-robin 0' prio=10 status=enabled
    |- 1:0:9:1   sdc 8:32 active ready running
    `-- 2:0:9:1   sde 8:64 active ready running
```



Do not use an excessive number of paths to a single LUN. No more than four paths should be required. More than eight paths might cause path issues during storage failures.

### Non-ASA configurations

For non-ASA configurations, there should be two groups of paths with different priorities. The paths with the higher priorities are Active/Optimized, meaning they are serviced by the controller where the aggregate is located. The paths with the lower priorities are active but are non-optimized because they are served from a different controller. The non-optimized paths are only used when no optimized paths are available.

## Example

The following example displays the correct output for an ONTAP LUN with two Active/Optimized paths and two Active/Non-Optimized paths:

```
# multipath -ll
3600a09803831347657244e527766394e dm-5 NETAPP,LUN C-Mode
size=80G 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
| |- 11:0:1:0 sdj 8:144 active ready running
| |- 11:0:2:0 sdr 65:16 active ready running
`-+- policy='service-time 0' prio=10 status=enabled
|- 11:0:0:0 sdb 8:i6 active ready running
|- 12:0:0:0 sdz 65:144 active ready running
```



Do not use an excessive number of paths to a single LUN. No more than four paths should be required. More than eight paths might cause path issues during storage failures.

## Recommended Settings

SUSE Linux Enterprise Server 12 SP1 OS is compiled to recognize ONTAP LUNs and automatically set all configuration parameters correctly.

The `multipath.conf` file must exist for the multipath daemon to start, but you can create an empty, zero-byte file by using the following command:

```
touch /etc/multipath.conf
```

The first time you create this file, you might need to enable and start the multipath services:

```
# systemctl enable multipathd
# systemctl start multipathd
```

- There is no requirement to add anything directly to the `multipath.conf` file, unless you have devices that you do not want to be managed by multipath or you have existing settings that override defaults.
- To exclude unwanted devices, add the following syntax to the `multipath.conf` file .

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

Replace the `<DevId>` with the WWID string of the device you want to exclude.



## Example

In this example, we are going to determine the WWID of a device and add to the `multipath.conf` file.

## Steps

1. Run the following command to determine the WWID:

```
# /lib/udev/scsi_id -gud /dev/sda
360030057024d0730239134810c0cb833
```

`sda` is the local SCSI disk that we need to add it to the blacklist.

2. Add the WWID to the blacklist stanza in `/etc/multipath.conf`:

```
blacklist {
    wwid      360030057024d0730239134810c0cb833
    devnode   "^(ram|raw|loop|fd|md|dm-|sr|scd|st) [0-9] *"
    devnode   "^hd[a-z] *"
    devnode   "^cciss.*"
}
```

You should always check your `/etc/multipath.conf` file for legacy settings, especially in the defaults section, that might be overriding the default settings.

The following table demonstrates the critical `multipathd` parameters for ONTAP LUNs and the required values. If a host is connected to LUNs from other vendors and any of these parameters are overridden, they will need to be corrected by later stanzas in the `multipath.conf` file that apply specifically to ONTAP LUNs. If this is not done, the ONTAP LUNs might not work as expected. These defaults should only be overridden in consultation with NetApp and/or an OS vendor and only when the impact is fully understood.

Parameter	Setting
<code>detect_prio</code>	<code>yes</code>
<code>dev_loss_tmo</code>	<code>"infinity"</code>
<code>failback</code>	<code>immediate</code>
<code>fast_io_fail_tmo</code>	<code>5</code>
<code>features</code>	<code>"3 queue_if_no_path pg_init_retries 50"</code>
<code>flush_on_last_del</code>	<code>"yes"</code>
<code>hardware_handler</code>	<code>"0"</code>
<code>path_checker</code>	<code>"tur"</code>
<code>path_grouping_policy</code>	<code>"group_by_prio"</code>
<code>path_selector</code>	<code>"service-time 0"</code>
<code>polling_interval</code>	<code>5</code>

Parameter	Setting
prio	"ontap"
product	LUN.*
retain_attached_hw_handler	yes
rr_weight	"uniform"
user_friendly_names	no
vendor	NETAPP

### Example

The following example shows how to correct an overridden default. In this case, the `multipath.conf` file defines values for `path_checker` and `detect_prio` that are not compatible with ONTAP LUNs. If they cannot be removed because of other SAN arrays still attached to the host, these parameters can be corrected specifically for ONTAP LUNs with a device stanza.

```
defaults {
    path_checker readsector0
    detect_prio no
}
devices {
    device {
        vendor "NETAPP "
        product "LUN.*"
        path_checker tur
        detect_prio yes
    }
}
```

### Known issues

There are no known issues for the SUSE Linux Enterprise Server 12 SP1 with ONTAP release.

## Use SUSE Linux Enterprise Server 12 with ONTAP

You can use the ONTAP SAN host configuration settings to configure SUSE Linux Enterprise Server 12 with ONTAP as the target.

### Install the Linux Unified Host Utilities

The NetApp Linux Unified Host Utilities software package is available on the [NetApp Support Site](#) in a 32-bit and 64-bit .rpm file. If you do not know which file is right for your configuration, use the [NetApp Interoperability Matrix Tool](#) to verify which one you need.

NetApp strongly recommends installing the Linux Unified Host Utilities, but it is not mandatory. The utilities do not change any settings on your Linux host. The utilities improve management and assist NetApp customer support in gathering information about your configuration.

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If you have a version of Linux Unified Host Utilities currently installed you should upgrade it or, you should remove it and use the following steps to install the latest version.

1. Download the 32-bit or 64-bit Linux Unified Host Utilities software package from the [NetApp Support Site](#) to your host.
2. Use the following command to install the software package:

```
rpm -ivh netapp_linux_unified_host_utilities-7-1.x86_64
```



You can use the configuration settings provided in this document to configure cloud clients connected to [Cloud Volumes ONTAP](#) and [Amazon FSx for ONTAP](#).

## SAN Toolkit

The toolkit is installed automatically when you install the NetApp Host Utilities package. This kit provides the `sanlun` utility, which helps you manage LUNs and HBAs. The `sanlun` command returns information about the LUNs mapped to your host, multipathing, and information necessary to create initiator groups.

### Example

In the following example, the `sanlun lun show` command returns LUN information.

```
# sanlun lun show all
```

Example output:

controller(7mode/E-Series) / vserver(cDOT/FlashRay) Product	lun-pathname	device filename	host adapter	lun protocol	size
data_vserver 120.0g cDOT	/vol/vol1/lun1	/dev/sdb	host16	FCP	
data_vserver 120.0g cDOT	/vol/vol1/lun1	/dev/sdc	host15	FCP	
data_vserver 120.0g cDOT	/vol/vol2/lun2	/dev/sdd	host16	FCP	
data_vserver 120.0g cDOT	/vol/vol2/lun2	/dev/sde	host15	FCP	

## SAN Booting

### What you'll need

If you decide to use SAN booting, it must be supported by your configuration. You can use the [NetApp Interoperability Matrix Tool](#) to verify that your OS, HBA, HBA firmware and the HBA boot BIOS, and ONTAP version are supported.

## Steps

1. Map the SAN boot LUN to the host.
2. Verify that multiple paths are available.



Multiple paths become available after the host OS is up and running on the paths.

3. Enable SAN booting in the server BIOS for the ports to which the SAN boot LUN is mapped.

For information on how to enable the HBA BIOS, see your vendor-specific documentation.

4. Reboot the host to verify that the boot is successful.

## Multipathing

For SUSE Linux Enterprise Server 12 the `/etc/multipath.conf` file must exist, but you do not need to make specific changes to the file. SUSE Linux Enterprise Server 12 is compiled with all settings required to recognize and correctly manage ONTAP LUNs.

You can use the `multipath -ll` command to verify the settings for your ONTAP LUNs.

The following sections provide sample multipath output for a LUN mapped to ASA and non-ASA personas.

### All SAN Array configurations

In All SAN Array (ASA) configurations, all paths to a given LUN are active and optimized. This improves performance by serving I/O operations through all paths at the same time.

#### Example

The following example displays the correct output for an ONTAP LUN:

```
# multipath -ll
3600a0980383034466b2b4a3775474859 dm-3 NETAPP,LUN C-Mode
size=20G 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
|  |- 1:0:8:1   sdb 8:16 active ready running
|  `-- 2:0:8:1   sdd 8:48 active ready running
`--+- policy='round-robin 0' prio=10 status=enabled
    |- 1:0:9:1   sdc 8:32 active ready running
    `-- 2:0:9:1   sde 8:64 active ready running
```



Do not use an excessive number of paths to a single LUN. No more than four paths should be required. More than eight paths might cause path issues during storage failures.

### Non-ASA configurations

For non-ASA configurations, there should be two groups of paths with different priorities. The paths with the higher priorities are Active/Optimized, meaning they are serviced by the controller where the aggregate is located. The paths with the lower priorities are active but are non-optimized because they are served from a different controller. The non-optimized paths are only used when no optimized paths are available.

## Example

The following example displays the correct output for an ONTAP LUN with two Active/Optimized paths and two Active/Non-Optimized paths:

```
# multipath -ll
3600a09803831347657244e527766394e dm-5 NETAPP,LUN C-Mode
size=80G 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
| |- 11:0:1:0 sdj 8:144 active ready running
| |- 11:0:2:0 sdr 65:16 active ready running
`-+- policy='service-time 0' prio=10 status=enabled
|- 11:0:0:0 sdb 8:i6 active ready running
|- 12:0:0:0 sdz 65:144 active ready running
```



Do not use an excessive number of paths to a single LUN. No more than four paths should be required. More than eight paths might cause path issues during storage failures.

## Recommended Settings

SUSE Linux Enterprise Server 12 OS is compiled to recognize ONTAP LUNs and automatically set all configuration parameters correctly.

The `multipath.conf` file must exist for the multipath daemon to start, but you can create an empty, zero-byte file by using the following command:

```
touch /etc/multipath.conf
```

The first time you create this file, you might need to enable and start the multipath services:

```
# systemctl enable multipathd
# systemctl start multipathd
```

- There is no requirement to add anything directly to the `multipath.conf` file, unless you have devices that you do not want to be managed by multipath or you have existing settings that override defaults.
- To exclude unwanted devices, add the following syntax to the `multipath.conf` file .

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

Replace the `<DevId>` with the WWID string of the device you want to exclude.

## Example

In this example, we are going to determine the WWID of a device and add to the `multipath.conf` file.

## Steps

1. Run the following command to determine the WWID:

```
# /lib/udev/scsi_id -gud /dev/sda
360030057024d0730239134810c0cb833
```

`sda` is the local SCSI disk that we need to add it to the blacklist.

2. Add the WWID to the blacklist stanza in `/etc/multipath.conf`:

```
blacklist {
    wwid      360030057024d0730239134810c0cb833
    devnode   "(ram|raw|loop|fd|md|dm-|sr|scd|st) [0-9] *"
    devnode   "^hd[a-z] *"
    devnode   "^cciss.*"
}
```

You should always check your `/etc/multipath.conf` file for legacy settings, especially in the defaults section, that might be overriding the default settings.

The following table demonstrates the critical `multipathd` parameters for ONTAP LUNs and the required values. If a host is connected to LUNs from other vendors and any of these parameters are overridden, they will need to be corrected by later stanzas in the `multipath.conf` file that apply specifically to ONTAP LUNs. If this is not done, the ONTAP LUNs might not work as expected. These defaults should only be overridden in consultation with NetApp and/or an OS vendor and only when the impact is fully understood.

Parameter	Setting
<code>detect_prio</code>	<code>yes</code>
<code>dev_loss_tmo</code>	<code>"infinity"</code>
<code>failback</code>	<code>immediate</code>
<code>fast_io_fail_tmo</code>	<code>5</code>
<code>features</code>	<code>"3 queue_if_no_path pg_init_retries 50"</code>
<code>flush_on_last_del</code>	<code>"yes"</code>
<code>hardware_handler</code>	<code>"0"</code>
<code>path_checker</code>	<code>"tur"</code>
<code>path_grouping_policy</code>	<code>"group_by_prio"</code>
<code>path_selector</code>	<code>"service-time 0"</code>
<code>polling_interval</code>	<code>5</code>

Parameter	Setting
prio	"ontap"
product	LUN.*
retain_attached_hw_handler	yes
rr_weight	"uniform"
user_friendly_names	no
vendor	NETAPP

## Example

The following example shows how to correct an overridden default. In this case, the `multipath.conf` file defines values for `path_checker` and `detect_prio` that are not compatible with ONTAP LUNs. If they cannot be removed because of other SAN arrays still attached to the host, these parameters can be corrected specifically for ONTAP LUNs with a device stanza.

```
defaults {
    path_checker readsector0
    detect_prio no
}
devices {
    device {
        vendor "NETAPP "
        product "LUN.*"
        path_checker tur
        detect_prio yes
    }
}
```

## Known issues

The SLES 12 with ONTAP release has the following known issues:

NetApp Bug ID	Title	Description	Bugzilla ID
<a href="#">873555</a>	scsi_dh_alua module is not loaded during multipathd startup on local boot	scsi_dh_alua is a Linux ALUA device handler module. This is is not loaded during multipathd startup on local boot. Due to this device handler will not be loaded though ALUA is enabled on target side.	<a href="#">908529</a>

NetApp Bug ID	Title	Description	Bugzilla ID
<a href="#">863584</a>	The message "conflicting device node '/dev/mapper/360xx' found" appears on the screen when you create a DM device on SLES12	You might observe a failure in creating a link to DM devices under /dev/mapper dir in SLES 12 and see the messages "conflicting device node '/dev/mapper/360xx' found".	<a href="#">903001</a>
<a href="#">847490</a>	Multipath daemon shows path failures on SLES 12	You might observe path failures on the SLES12 multipath daemon during I/O with storage or fabric faults.	<a href="#">890854</a>



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