SUSE Linux Enterprise Server

SAN hosts and cloud clients

NetApp
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SUSE Linux Enterprise Server

Release notes

ASM Mirroring

Automatic Storage Management (ASM) mirroring might require changes to the Linux multipath settings to allow ASM to recognize a problem and switch over to an alternate failure group. Most ASM configurations on ONTAP use external redundancy, which means that data protection is provided by the external array and ASM does not mirror data. Some sites use ASM with normal redundancy to provide two-way mirroring, normally across different sites. See Oracle Databases on ONTAP for further information.

SUSE Linux Enterprise Server 15

Use SUSE Linux Enterprise Server 15 SP6 with ONTAP

You can use the ONTAP SAN host configuration settings to configure SUSE Linux Enterprise Server 15 SP6 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 don't 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's not mandatory. The utilities don't change any settings on your Linux host. The utilities improve management and assist NetApp customer support in gathering information about your configuration.

If you have Linux Unified Host Utilities currently installed, you should either upgrade it to the latest version, or remove it and follow these steps to install the latest version.

Steps

1. Download the 32-bit or 64-bit Linux Unified Host Utilities software package from the NetApp Support Site to your host.
2. 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

Your configuration supports SAN booting. See 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 operating system 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 was successful.

Multipathing

For SUSE Linux Enterprise Server 15 SP6, the `/etc/multipath.conf` file must exist. You don't need to make changes to this file because SUSE Linux Enterprise Server 15 SP6 is compiled with all the 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 example multipath outputs for a LUN mapped to ASA and non-ASA personas.

All SAN Array configurations

All SAN Array (ASA) configurations optimize all paths to a given LUN, keeping them active. 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
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
  |- 3:0:7:9    sdco 69:192  active ready running
  |- 3:0:8:9    sddi 71:0    active ready running
  |- 14:0:8:9   sdjq 65:320  active ready running
  `- 14:0:7:9   sdiw 8:256   active ready running
```

A single LUN shouldn’t require more than four paths. Having more than four 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 higher priorities are Active/Optimized, meaning they are serviced by the controller where the aggregate is located. The paths with lower priorities are active but are non-optimized because they are served from a different controller. The non-optimized paths are only used when optimized paths are not 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
| |- 3:0:3:0    sdd  8:48    active ready running
| |- 3:0:4:0    sdx  65:112  active ready running
`-+- policy='service-time 0' prio=10 status=enabled
  |- 14:0:2:0   sdfk 130:96  active ready running
  `- 14:0:5:0   sdgz 132:240 active ready running
```

A single LUN shouldn’t require more than four paths. Having more than four paths might cause path issues during storage failures.

Recommended settings

The SUSE Linux Enterprise Server 15 SP6 OS recognizes ONTAP LUNs and automatically sets all configuration parameters correctly for both ASA and non-ASA configurations. You can further optimize performance for your host configuration with the following recommended settings.

The `multipath.conf` file must exist for the multipath daemon to start. If this file doesn't exist, you can create an empty, zero-byte file by using the `touch /etc/multipath.conf` command.

The first time you create the `multipath.conf` file, you might need to enable and start the multipath services by using the following commands:

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

There is no requirement to add devices directly to the `multipath.conf` file, unless you have devices that you do not want multipath to manage or you have existing settings that override defaults. You can exclude unwanted devices by adding the following syntax to the `multipath.conf` file, replacing <DevId> with the WWID string of the device you want to exclude:

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

In the following example, you determine the WWID of a device and add the device to the `multipath.conf` file.

Steps

1. Determine the WWID:

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

   ```
   360030057024d0730239134810c0cb833
   ```

   `sda` is the local SCSI disk that you want 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, especially in the defaults section, for legacy settings 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. You should only override these defaults 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"
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 15 SP6 with ONTAP release.

Use SUSE Linux Enterprise Server 15 SP5 with ONTAP

You can use the ONTAP SAN host configuration settings to configure SUSE Linux Enterprise Server 15 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 don't 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's not mandatory. The utilities don't change any settings on your Linux host. The utilities improve management and assist NetApp customer support in gathering information about your configuration.

If you have Linux Unified Host Utilities currently installed, you should either upgrade it to the latest version, or remove it and follow these steps to install the latest version.

Steps

1. Download the 32-bit or 64-bit Linux Unified Host Utilities software package from the NetApp Support Site to your host.
2. 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 operating system 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 was successful.

Multipathing

For SUSE Linux Enterprise Server 15 SP5, the `/etc/multipath.conf` file must exist, but you do not need to make specific changes to the file. The SUSE Linux Enterprise Server 15 SP5 is compiled with all the 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 example multipath outputs for a LUN mapped to ASA and non-ASA personas.

All SAN Array configurations

All SAN Array (ASA) configurations optimize all paths to a given LUN, keeping them active. 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
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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
  |- 3:0:7:9    sdco 69:192  active ready running
  |- 3:0:8:9    sddi 71:0    active ready running
  |- 14:0:8:9   sdjq 65:320  active ready running
  `- 14:0:7:9   sdiw 8:256   active ready running
```

> A single LUN shouldn’t require more than four paths. Having more than four 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 higher priorities are Active/Optimized, meaning they are serviced by the controller where the aggregate is located. The paths with lower priorities are active but are non-optimized because they are served from a different controller. The non-optimized paths are only used when optimized paths are not 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
3600a0980383134765724e527766394e dm-5 NETAPP,LUN C-Mode
size=80G features='3 queue_if_no_path pg_init_retries 50' hwhandler='1
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|-+- policy='service-time 0' prio=50 status=active
| |- 3:0:3:0    sdd  8:48    active ready running
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```

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Recommended settings

SUSE Linux Enterprise Server 15 SP5 OS is compiled to recognize ONTAP LUNs and automatically set all configuration parameters correctly for both ASA and non-ASA configurations. You can further optimize performance for your host configuration with the following recommended settings.

The `multipath.conf` file must exist for the multipath daemon to start. If this file doesn't exist, you can create an empty, zero-byte file by using the `touch /etc/multipath.conf` command.

The first time you create the `multipath.conf` file, you might need to enable and start the multipath services by using the following commands:

```
# systemctl enable multipathd
# systemctl start multipathd
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There is no requirement to add devices directly to the `multipath.conf` file, unless you have devices that you do not want multipath to manage or you have existing settings that override defaults. You can exclude unwanted devices by adding the following syntax to the `multipath.conf` file, replacing <DevId> with the WWID string of the device you want to exclude:

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

In the following example, you determine the WWID of a device and add the device to the `multipath.conf` file.

Steps

1. Determine the WWID:

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

```
360030057024d0730239134810c0cb833
```

`sda` is the local SCSI disk that you want 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]"
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}
```

You should always check your `/etc/multipath.conf` file, especially in the defaults section, for legacy settings 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. You should only override these defaults 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

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 `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
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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 15 SP5 with ONTAP release.

Use SUSE Linux Enterprise Server 15 SP4 with ONTAP

You can use the ONTAP SAN host configuration settings to configure SUSE Linux Enterprise Server 15 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 don't know which file is right for your configuration, use the NetApp Interoperability Matrix Tool to verify which one you need.

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If you have Linux Unified Host Utilities currently installed, you should either upgrade it to the latest version, or remove it and follow these steps to install the latest version.

Steps

1. Download the 32-bit or 64-bit Linux Unified Host Utilities software package from the NetApp Support Site to your host.
2. Install the software package:

```
rpm -ivh netapp_linux_unified_host_utilities-7-1.x86_64
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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 operating system 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 was successful.

Multipathing

For SUSE Linux Enterprise Server 15 SP4 the `/etc/multipath.conf` file must exist, but you do not need to make specific changes to the file. SUSE Linux Enterprise Server 15 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 example multipath outputs for a LUN mapped to ASA and non-ASA personas.

All SAN Array configurations

All SAN Array (ASA) configurations optimize all paths to a given LUN, keeping them active. 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
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
  |- 3:0:7:9    sdco 69:192  active ready running
  |- 3:0:8:9    sddi 71:0    active ready running
  |- 14:0:8:9   sdjq 65:320  active ready running
  `- 14:0:7:9   sdiw 8:256   active ready running
```

A single LUN shouldn’t require more than four paths. Having more than four 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 higher priorities are Active/Optimized, meaning they are serviced by the controller where the aggregate is located. The paths with lower priorities are active but are non-optimized because they are served from a different

controller. The non-optimized paths are only used when optimized paths are not 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
| |- 3:0:3:0    sdd  8:48    active ready running
| |- 3:0:4:0    sdx  65:112  active ready running
`-+- policy='service-time 0' prio=10 status=enabled
  |- 14:0:2:0   sdfk 130:96  active ready running
  `- 14:0:5:0   sdgz 132:240 active ready running
```

A single LUN shouldn't require more than four paths. Having more than four paths might cause path issues during storage failures.

Recommended settings

SUSE Linux Enterprise Server 15 SP4 OS is compiled to recognize ONTAP LUNs and automatically set all configuration parameters correctly for both ASA and non-ASA configuration. You can further optimize performance for your host configuration with the following recommended settings.

The `multipath.conf` file must exist for the multipath daemon to start. If this file doesn't exist, you can create an empty, zero-byte file by using the `touch /etc/multipath.conf` command.

The first time you create the `multipath.conf` file, you might need to enable and start the multipath services by using the following commands:

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

There is no requirement to add devices directly to the `multipath.conf` file, unless you have devices that you do not want multipath to manage or you have existing settings that override defaults. You can exclude unwanted devices by adding the following syntax to the `multipath.conf` file, replacing <DevId> with the WWID string of the device you want to exclude:

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

In the following example, you determine the WWID of a device and add the device to the `multipath.conf` file.

Steps

1. Determine the WWID:

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

```
360030057024d0730239134810c0cb833
```

`sda` is the local SCSI disk that you want 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]"
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}
```

You should always check your `/etc/multipath.conf` file, especially in the defaults section, for legacy settings 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. You should only override these defaults 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

Parameter	Setting
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"
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 these parameters cannot be removed because other SAN arrays are still attached to the host, they can instead 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 15 SP4 with ONTAP release.

Use SUSE Linux Enterprise Server 15 SP3 with ONTAP

You can use the ONTAP SAN host configuration settings to configure SUSE Linux Enterprise Server 15 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 don't 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's not mandatory. The utilities don't change any settings on your Linux host. The utilities improve management and assist NetApp customer support in gathering information about your configuration.

If you have Linux Unified Host Utilities currently installed, you should either upgrade it to the latest version, or remove it and follow these steps to install the latest version.

Steps

1. Download the 32-bit or 64-bit Linux Unified Host Utilities software package from the NetApp Support Site to your host.
2. 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 operating system 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 was successful.

Multipathing

For SUSE Linux Enterprise Server 15 SP3 the `/etc/multipath.conf` file must exist, but you do not need to make specific changes to the file. SUSE Linux Enterprise Server 15 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 example multipath outputs for a LUN mapped to ASA and non-ASA personas.

All SAN Array configurations

All SAN Array (ASA) configurations optimize all paths to a given LUN, keeping them active. 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
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
  |- 3:0:7:9    sdco 69:192  active ready running
  |- 3:0:8:9    sddi 71:0    active ready running
  |- 14:0:8:9   sdjq 65:320  active ready running
  `- 14:0:7:9   sdiw 8:256   active ready running
```

A single LUN shouldn't require more than four paths. Having more than four 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 higher priorities are Active/Optimized, meaning they are serviced by the controller where the aggregate is located. The paths with lower priorities are active but are non-optimized because they are served from a different controller. The non-optimized paths are only used when optimized paths are not 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
| |- 3:0:3:0    sdd  8:48    active ready running
| |- 3:0:4:0    sdx  65:112  active ready running
`-+- policy='service-time 0' prio=10 status=enabled
  |- 14:0:2:0   sdfk 130:96  active ready running
  `- 14:0:5:0   sdgz 132:240 active ready running
```

A single LUN shouldn't require more than four paths. Having more than four paths might cause path issues during storage failures.

Recommended Settings

SUSE Linux Enterprise Server 15 SP3 OS is compiled to recognize ONTAP LUNs and automatically set all configuration parameters correctly for both ASA and non-ASA configuration.

The `multipath.conf` file must exist for the multipath daemon to start. If this file doesn't exist, you can create an empty, zero-byte file by using the `touch /etc/multipath.conf` command.

The first time you create the `multipath.conf` file, you might need to enable and start the multipath services by using the following commands:

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

There is no requirement to add devices directly to the `multipath.conf` file, unless you have devices that you do not want multipath to manage or you have existing settings that override defaults. You can exclude unwanted devices by adding the following syntax to the `multipath.conf` file, replacing <DevId> with the WWID string of the device you want to exclude:

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

In the following example, you determine the WWID of a device and add the device to the `multipath.conf` file.

Steps

1. Determine the WWID:

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

   ```
   360030057024d0730239134810c0cb833
   ```

   `sda` is the local SCSI disk that you want 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, especially in the defaults section, for legacy settings 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. You should only override these defaults 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"
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 15 SP3 with ONTAP release.

Use SUSE Linux Enterprise Server 15 SP2 with ONTAP

You can use the ONTAP SAN host configuration settings to configure SUSE Linux Enterprise Server 15 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 don't 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's not mandatory. The utilities don't change any settings on your Linux host. The utilities improve management and assist NetApp customer support in gathering information about your configuration.

If you have Linux Unified Host Utilities currently installed, you should either upgrade it to the latest version, or remove it and follow these steps to install the latest version.

Steps

1. Download the 32-bit or 64-bit Linux Unified Host Utilities software package from the NetApp Support Site to your host.
2. 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 operating system 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 was successful.

Multipathing

For SUSE Linux Enterprise Server 15 SP2 the /etc/multipath.conf file must exist, but you do not need to make

specific changes to the file. SUSE Linux Enterprise Server 15 SP2 is compiled with all settings required to recognize and correctly manage ONTAP LUNs. Use the `multipath -ll` command verify the settings for your ONTAP LUNs.

There should be two groups of paths with different priorities. The paths with higher priorities are Active/Optimized, meaning they are serviced by the controller where the aggregate is located. The paths with lower priorities are active but are non-optimized because they are served from a different controller. The non-optimized paths are only used when optimized paths are not 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=enabled
| |- 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 4 paths should be required. More than 8 paths might cause path issues during storage failures.

Recommended Settings

SUSE Linux Enterprise Server 15 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. If this file doesn't exist, you can create an empty, zero-byte file by using the `touch /etc/multipath.conf` command.

The first time you create the `multipath.conf` file, you might need to enable and start the multipath services by using the following commands:

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

There is no requirement to add devices directly to the `multipath.conf` file, unless you have devices that you do not want multipath to manage or you have existing settings that override defaults. You can exclude unwanted devices by adding the following syntax to the `multipath.conf` file, replacing <DevId> with the WWID string of the device you want to exclude:

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

In the following example, you determine the WWID of a device and add the device to the `multipath.conf` file.

Steps

1. Determine the WWID:

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

```
360030057024d0730239134810c0cb833
```

`sda` is the local SCSI disk that you want 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, especially in the defaults section, for legacy settings 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. You should only override these defaults 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

Parameter	Setting
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"
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 SUSE Linux Enterprise Server 15 SP2 with ONTAP release has the following known issues:

NetApp Bug ID	Title	Description

1308744	iSCSI boot from SAN fails to boot with a static IP configuration after completing an SUSE Linux Enterprise Server 15S P2 OS installation	iSCSI sanbooted LUN failed to boot up after completing an SUSE Linux Enterprise Server 15 SP2 OS installation with a static IP configuration. Bootup failure occurs every time with the static IP configuration. This leads to the server refusing to continue the boot up process with the following error message:
		`dracut-cmdline[241]: warning: Empty autoconf values default to dhcp`
		`dracut: FATAL: FATAL: For argument ip=eth4:static, setting client-ip does not make sense for dhcp`
		`dracut: Refusing to continue`
		`reboot: System halted`

Use SUSE Linux Enterprise Server 15 SP1 with ONTAP

You can use the ONTAP SAN host configuration settings to configure SUSE Linux Enterprise Server 15 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 don't 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's not mandatory. The utilities don't change any settings on your Linux host. The utilities improve management and assist NetApp customer support in gathering information about your configuration.

If you have Linux Unified Host Utilities currently installed, you should either upgrade it to the latest version, or remove it and follow these steps to install the latest version.

Steps

1. Download the 32-bit or 64-bit Linux Unified Host Utilities software package from the NetApp Support Site to your host.
2. 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 operating system 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 was successful.

Multipathing

For SUSE Linux Enterprise Server 15 SP1 the /etc/multipath.conf file must exist, but you do not need to make specific changes to the file. SUSE Linux Enterprise Server 15 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 example multipath outputs for a LUN mapped to ASA and non-ASA personas.

All SAN Array configurations

All SAN Array (ASA) configurations optimize all paths to a given LUN, keeping them active. 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
```

> A single LUN shouldn’t require more than four paths. Having more than four 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 higher priorities are Active/Optimized, meaning they are serviced by the controller where the aggregate is located. The paths with lower priorities are active but are non-optimized because they are served from a different controller. The non-optimized paths are only used when optimized paths are not 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
3600a0980383134765724e527766394e 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
```

A single LUN shouldn't require more than four paths. Having more than four paths might cause path issues during storage failures.

Recommended Settings

SUSE Linux Enterprise Server 15 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. If this file doesn't exist, you can create an empty, zero-byte file by using the `touch /etc/multipath.conf` command.

The first time you create the `multipath.conf` file, you might need to enable and start the multipath services by using the following commands:

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

There is no requirement to add devices directly to the `multipath.conf` file, unless you have devices that you do not want multipath to manage or you have existing settings that override defaults. You can exclude unwanted devices by adding the following syntax to the `multipath.conf` file, replacing <DevId> with the WWID string of the device you want to exclude:

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

In the following example, you determine the WWID of a device and add the device to the `multipath.conf` file.

Steps

1. Determine the WWID:

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

```
360030057024d0730239134810c0cb833
```

`sda` is the local SCSI disk that you want 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, especially in the defaults section, for legacy settings 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. You should only override these defaults 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

The SUSE Linux Enterprise Server 15 SP1 with ONTAP release has the following known issues:

NetApp Bug ID	Title	Description
1246622	Remote ports transit to a blocked state on SLES15SP1 with Emulex LPe12002 8GB FC during storage failover operations.	Remote ports transit to a blocked state on SLES15SP1 with Emulex LPe12002 8GB Fibre Channel (FC) during storage failover operations. When the storage node returns to an optimal state, the LIFs also come up and the remote port state should read "online." Occasionally, the remote port state might continue to read as "blocked" or "not present." This state can lead to a "failed faulty" path to LUNs at the multipath layer as well as an I/O outage for those LUNs. You can check the remoteport's details against the following sample commands: ---- cat/sys/class/fc_host/host*/device/rport*/fc_remote_ports/rport*/port_name cat/sys/class/fc_host/host*/device/rport*/fc_remote_ports/rport*/port_state ----

Use SUSE Linux Enterprise Server 15 with ONTAP

You can use the ONTAP SAN host configuration settings to configure SUSE Linux Enterprise Server 15 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 don't 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's not mandatory. The utilities don't change any settings on your Linux host. The utilities improve management and assist NetApp customer support in gathering information about your configuration.

If you have Linux Unified Host Utilities currently installed, you should either upgrade it to the latest version, or remove it and follow these steps to install the latest version.

Steps

1. Download the 32-bit or 64-bit Linux Unified Host Utilities software package from the NetApp Support Site to your host.
2. 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 operating system 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 was successful.

Multipathing

For SUSE Linux Enterprise Server 15 the /etc/multipath.conf file must exist, but you do not need to make specific changes to the file. SUSE Linux Enterprise Server 15 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 example multipath outputs for a LUN mapped to ASA and non-ASA personas.

All SAN Array configurations

All SAN Array (ASA) configurations optimize all paths to a given LUN, keeping them active. 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
```

A single LUN shouldn’t require more than four paths. Having more than four 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 higher priorities are Active/Optimized, meaning they are serviced by the controller where the aggregate is located. The paths with lower priorities are active but are non-optimized because they are served from a different controller. The non-optimized paths are only used when optimized paths are not 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
3600a0980383134765724e527766394e 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=enabled
| |- 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
```

A single LUN shouldn't require more than four paths. Having more than four paths might cause path issues during storage failures.

Recommended Settings

SUSE Linux Enterprise Server 15 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. If this file doesn't exist, you can create an empty, zero-byte file by using the `touch /etc/multipath.conf` command.

The first time you create the `multipath.conf` file, you might need to enable and start the multipath services by using the following commands:

```
chkconfig multipathd on
/etc/init.d/multipathd start
```

You don't need to add anything directly to the `multipath.conf` file unless you have devices that you don't want multipath to manage or you have existing settings that override defaults. To exclude unwanted devices, add the following syntax to the `multipath.conf` file, replacing <DevId> with the worldwide identifier (WWID) string of the device you want to exclude:

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

The following example determines the WWID of a device and adds it to the `multipath.conf` file.

Steps

1. Determine the WWID:

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

```
3600a098038314c4a433f5774717a3046
/lib/udev/scsi_id -gud /dev/sda
```

360030057024d0730239134810c0cb833

```
+
`sda` is the local SCSI disk that you want to add to the blacklist.

. Add the `WWID` to the blacklist stanza in `/etc/multipath.conf`:
[source,cli]
+
```

blacklist {
wwid 3600a098038314c4a433f5774717a3046
devnode "^(ram|raw|loop|fd|md|dm-|sr|scd|st)"
devnode "^hd[a-z]"
devnode "^cciss."
}

```
Always check your `/etc/multipath.conf` file, especially in the defaults
section, for legacy settings that might be overriding 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 must be
corrected by later stanzas in the `multipath.conf` file that apply
specifically to ONTAP LUNs. Without this correction, the ONTAP LUNs might
not work as expected. You should only override these defaults in
consultation with NetApp, the OS vendor, or both, and only when the impact
is fully understood.

//ONTAPDOC-2578 9-Dec-2024
//ONTAPDOC-2561 25-Nov-202


[cols=2*,options="header"]
|===
| 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"
| 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 SUSE Linux Enterprise Server 15 with ONTAP release has the following
```

```
known issues:

[cols=3*,options="header"]
|===
| NetApp Bug ID
| Title
| Description
| link:https://mysupport.netapp.com/NOW/cgi-
bin/bol?Type=Detail&Display=1154309[1154309^] | SLES 15 host with more
than 20 mapped LUNs might go into maintenance mode after a reboot | SLES
15 host with more than 20 mapped LUNs might go into maintenance mode after
a reboot. The maintenance mode becomes single user mode following the
message:
`Give root password for maintenance (or press Control-D to continue)`
|===

// 2024 SEP 2, ONTAPDOC-2345



:leveloffset: -1


= SUSE Linux Enterprise Server 12

:leveloffset: +1


[[IDf62fe1c232fb0fc2955f3cc841ce25a2]]
= Use SUSE Linux Enterprise Server 12 SP5 with ONTAP
:hardbreaks:
:toclevels: 1
:icons: font
:linkattrs:
:relative_path: ./
:imagesdir: {root_path}{relative_path}./media/

[.lead]
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
link:https://mysupport.netapp.com/site/products/all/details/hostutilities/
downloads-tab/download/61343/7.1/downloads[NetApp Support Site^] in a 32-
```

bit and 64-bit .rpm file. If you don't know which file is right for your configuration, use the link:https://mysupport.netapp.com/matrix/#welcome[NetApp Interoperability Matrix Tool^] to verify which one you need.

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

If you have Linux Unified Host Utilities currently installed, you should either upgrade it to the latest version, or remove it and follow these steps to install the latest version.

.Steps

. Download the 32-bit or 64-bit Linux Unified Host Utilities software package from the link:https://mysupport.netapp.com/site/products/all/details/hostutilities/downloads-tab/download/61343/7.1/downloads[NetApp Support Site^] to your host.
. Install the software package:
+
`rpm -ivh netapp_linux_unified_host_utilities-7-1.x86_64`

NOTE: You can use the configuration settings provided in this document to configure cloud clients connected to link:https://docs.netapp.com/us-en/cloud-manager-cloud-volumes-ontap/index.html[Cloud Volumes ONTAP^] and link:https://docs.netapp.com/us-en/cloud-manager-fsx-ontap/index.html[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.

[source,cli]

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
link:https://mysupport.netapp.com/matrix/imt.jsp?components=91704;&solutio
n=1&isHWU&src=IMT[NetApp Interoperability Matrix Tool^] to verify that
your OS, HBA, HBA firmware and the HBA boot BIOS, and ONTAP version are
supported.

.Steps

. Map the SAN boot LUN to the host.
. Verify that multiple paths are available.
+
[NOTE]
Multiple paths become available after the host operating system is up and
running on the paths.

. 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.

. Reboot the host to verify that the boot was 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 example multipath outputs for a LUN mapped
to ASA and non-ASA personas.

=== All SAN Array configurations

All SAN Array (ASA) configurations optimize all paths to a given LUN,
keeping them active. 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.

//ONTAPDOC-2561 4-Dec-2024

----
# 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
----

NOTE: A single LUN shouldn't require more than four paths. Having more
than four 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 higher priorities are
Active/Optimized, meaning they are serviced by the controller where the
aggregate is located. The paths with lower priorities are active but are
non-optimized because they are served from a different controller. The
non-optimized paths are only used when optimized paths are not available.
```

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

//ONTAPDOC-2561 4-Dec-2024
//ONTAPDOC-2578 9-Dec-2024

----
#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
----

NOTE: A single LUN shouldn't require more than four paths. Having more
than four 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. If
this file doesn't exist, you can create an empty, zero-byte file by using
the `touch /etc/multipath.conf` command.

The first time you create the `multipath.conf` file, you might need to
enable and start the multipath services by using the following commands:

----
chkconfig multipathd on
/etc/init.d/multipathd start
----

You don't need to add anything directly to the `multipath.conf` file
unless you have devices that you don't want multipath to manage or you
have existing settings that override defaults. To exclude unwanted
devices, add the following syntax to the `multipath.conf` file, replacing
<DevId> with the worldwide identifier (WWID) string of the device you want
to exclude:
```

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

The following example determines the WWID of a device and adds it to the
`multipath.conf` file.

.Steps

. Determine the WWID:
+
----
/lib/udev/scsi_id -gud /dev/sda
----
+
----
3600a098038314c4a433f5774717a3046
/lib/udev/scsi_id -gud /dev/sda
----
360030057024d0730239134810c0cb833
----
+
`sda` is the local SCSI disk that you want to add to the blacklist.

. Add the `WWID` to the blacklist stanza in `/etc/multipath.conf`:
[source,cli]
+
----
blacklist {
     wwid   3600a098038314c4a433f5774717a3046
     devnode "^(ram|raw|loop|fd|md|dm-|sr|scd|st)[0-9]*"
     devnode "^hd[a-z]"
     devnode "^cciss.*"
}
----

Always check your `/etc/multipath.conf` file, especially in the defaults
section, for legacy settings that might be overriding 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 must be
corrected by later stanzas in the `multipath.conf` file that apply
specifically to ONTAP LUNs. Without this correction, the ONTAP LUNs might
not work as expected. You should only override these defaults in
consultation with NetApp, the OS vendor, or both, and only when the impact
is fully understood.

//ONTAPDOC-2578 9-Dec-2024
//ONTAPDOC-2561 25-Nov-202


[cols=2*,options="header"]
|===
| 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"
| 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 SUSE Linux Enterprise Server 12 SP5 with ONTAP release has the
following known issues:

[cols=3*,options="header"]
|===
| NetApp Bug ID
| Title
| Description
| link:https://mysupport.netapp.com/NOW/cgi-
bin/bol?Type=Detail&Display=1284293[1284293^] | 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:
ffff8aedf723c2c0" module. Locate this event in the vmcore file by finding
the following string: " [THREAD_INFO: ffff8aedf723c2c0]".
After the kernel disruption, reboot the host OS to enable it to recover.
Then restart the applications.
|===

// 2024 SEP 2, ONTAPDOC-2345



[[IDbf977b53df1f2c3299f1058dd4fb76b2]]
= Use SUSE Linux Enterprise Server 12 SP4 with ONTAP
:hardbreaks:
```

```
:toclevels: 1
:icons: font
:linkattrs:
:relative_path: ./
:imagesdir: {root_path}{relative_path}./media/

[.lead]
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
link:https://mysupport.netapp.com/site/products/all/details/hostutilities/
downloads-tab/download/61343/7.1/downloads[NetApp Support Site^] in a 32-
bit and 64-bit .rpm file. If you don't know which file is right for your
configuration, use the
link:https://mysupport.netapp.com/matrix/#welcome[NetApp Interoperability
Matrix Tool^] to verify which one you need.

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

If you have Linux Unified Host Utilities currently installed, you should
either upgrade it to the latest version, or remove it and follow these
steps to install the latest version.

.Steps

.   Download the 32-bit or 64-bit Linux Unified Host Utilities software
package from the
link:https://mysupport.netapp.com/site/products/all/details/hostutilities/
downloads-tab/download/61343/7.1/downloads[NetApp Support Site^] to your
host.
.   Install the software package:
+
`rpm -ivh netapp_linux_unified_host_utilities-7-1.x86_64`

NOTE: You can use the configuration settings provided in this document to
configure cloud clients connected to link:https://docs.netapp.com/us-
en/cloud-manager-cloud-volumes-ontap/index.html[Cloud Volumes ONTAP^] and
link:https://docs.netapp.com/us-en/cloud-manager-fsx-
ontap/index.html[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.

[source,cli]
----
# 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
link:https://mysupport.netapp.com/matrix/imt.jsp?components=86528;&solutio
n=1&isHWU&src=IMT[NetApp Interoperability Matrix Tool^] to verify that
your OS, HBA, HBA firmware and the HBA boot BIOS, and ONTAP version are
supported.

.Steps

. Map the SAN boot LUN to the host.
. Verify that multiple paths are available.
+
[NOTE]
Multiple paths become available after the host operating system is up and
running on the paths.
```

```
. 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.

. Reboot the host to verify that the boot was 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 example multipath outputs for a LUN mapped
to ASA and non-ASA personas.

=== All SAN Array configurations

All SAN Array (ASA) configurations optimize all paths to a given LUN,
keeping them active. 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.

//ONTAPDOC-2561 4-Dec-2024
```

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

```
NOTE: A single LUN shouldn't require more than four paths. Having more
than four 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 higher priorities are
Active/Optimized, meaning they are serviced by the controller where the
aggregate is located. The paths with lower priorities are active but are
non-optimized because they are served from a different controller. The
non-optimized paths are only used when optimized paths are not available.

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

//ONTAPDOC-2561 4-Dec-2024
//ONTAPDOC-2578 9-Dec-2024
```

#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

```
NOTE: A single LUN shouldn't require more than four paths. Having more
than four 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. If
this file doesn't exist, you can create an empty, zero-byte file by using
the `touch /etc/multipath.conf` command.

The first time you create the `multipath.conf` file, you might need to
enable and start the multipath services by using the following commands:
```

chkconfig multipathd on
/etc/init.d/multipathd start

```
You don't need to add anything directly to the `multipath.conf` file
unless you have devices that you don't want multipath to manage or you
have existing settings that override defaults. To exclude unwanted
devices, add the following syntax to the `multipath.conf` file, replacing
<DevId> with the worldwide identifier (WWID) string of the device you want
to exclude:
```

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

```
The following example determines the WWID of a device and adds it to the
`multipath.conf` file.

.Steps

. Determine the WWID:
+
```

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

```
+
```

3600a098038314c4a433f5774717a3046
/lib/udev/scsi_id -gud /dev/sda

```
360030057024d0730239134810c0cb833
```

+
`sda` is the local SCSI disk that you want to add to the blacklist.

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

```
blacklist {
     wwid   3600a098038314c4a433f5774717a3046
     devnode "^(ram|raw|loop|fd|md|dm-|sr|scd|st)[0-9]*"
     devnode "^hd[a-z]"
     devnode "^cciss.*"
}
```

Always check your `/etc/multipath.conf` file, especially in the defaults section, for legacy settings that might be overriding 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 must be corrected by later stanzas in the `multipath.conf` file that apply specifically to ONTAP LUNs. Without this correction, the ONTAP LUNs might not work as expected. You should only override these defaults in consultation with NetApp, the OS vendor, or both, 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"
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 don't 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's not mandatory. The utilities don't change any settings on your Linux host. The utilities improve management and assist NetApp customer support in gathering information about your configuration.

If you have Linux Unified Host Utilities currently installed, you should either upgrade it to the latest version, or remove it and follow these steps to install the latest version.

Steps

1. Download the 32-bit or 64-bit Linux Unified Host Utilities software package from the NetApp Support Site to your host.
2. 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 operating system 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 was 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 example multipath outputs for a LUN mapped to ASA and non-ASA personas.

All SAN Array configurations

All SAN Array (ASA) configurations optimize all paths to a given LUN, keeping them active. 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
```

> A single LUN shouldn’t require more than four paths. Having more than four 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 higher priorities are Active/Optimized, meaning they are serviced by the controller where the aggregate is located. The paths with lower priorities are active but are non-optimized because they are served from a different controller. The non-optimized paths are only used when optimized paths are not 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
3600a0980383134765724e527766394e 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
```

A single LUN shouldn't require more than four paths. Having more than four 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. If this file doesn't exist, you can create an empty, zero-byte file by using the `touch /etc/multipath.conf` command.

The first time you create the `multipath.conf` file, you might need to enable and start the multipath services by using the following commands:

```
chkconfig multipathd on
/etc/init.d/multipathd start
```

You don't need to add anything directly to the `multipath.conf` file unless you have devices that you don't want multipath to manage or you have existing settings that override defaults. To exclude unwanted devices, add the following syntax to the `multipath.conf` file, replacing <DevId> with the worldwide identifier (WWID) string of the device you want to exclude:

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

The following example determines the WWID of a device and adds it to the `multipath.conf` file.

Steps

1. Determine the WWID:

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

```
3600a098038314c4a433f5774717a3046
/lib/udev/scsi_id -gud /dev/sda
```

360030057024d0730239134810c0cb833

```
+
`sda` is the local SCSI disk that you want to add to the blacklist.

. Add the `WWID` to the blacklist stanza in `/etc/multipath.conf`:
[source,cli]
+
```

blacklist {
wwid 3600a098038314c4a433f5774717a3046
devnode "^(ram|raw|loop|fd|md|dm-|sr|scd|st)"
devnode "^hd[a-z]"
devnode "^cciss."
}

```
Always check your `/etc/multipath.conf` file, especially in the defaults
section, for legacy settings that might be overriding 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 must be
corrected by later stanzas in the `multipath.conf` file that apply
specifically to ONTAP LUNs. Without this correction, the ONTAP LUNs might
not work as expected. You should only override these defaults in
consultation with NetApp, the OS vendor, or both, and only when the impact
is fully understood.

//ONTAPDOC-2578 9-Dec-2024
//ONTAPDOC-2561 25-Nov-202


[cols=2*,options="header"]
|===
| 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"
| 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 SUSE Linux Enterprise Server 15 SP3 with ONTAP release has the
following known issues:

[cols=3*,options="header"]
|===
```

```
| NetApp Bug ID
| Title
| Description
| link:https://mysupport.netapp.com/NOW/cgi-
bin/bol?Type=Detail&Display=1089555[1089555^] | Kernel disruption observed
on kernel version SLES12 SP3 with Emulex LPe16002 16GB FC during storage
failover operation | 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.
Example:
In the observed case, the kernel disruption was observed in the module
“lpfc_sli_ringtxcmpl_put+51” and is logged in the vmcore file
- exception RIP: lpfc_sli_ringtxcmpl_put+51.

Recover the operating system after the kernel disruption by rebooting the
host operating system and restarting the application.
| link:https://mysupport.netapp.com/NOW/cgi-
bin/bol?Type=Detail&Display=1089561[1089561^] | Kernel disruption observed
on kernel version SLES12 SP3 with Emulex LPe32002 32GB FC during storage
failover operations | 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.
Example:
In the observed case, the kernel disruption was observed in the module
“lpfc_sli_free_hbq+76” and is logged in the vmcore file
- exception RIP: lpfc_sli_free_hbq+76.

Recover the operating system after the kernel disruption by rebooting the
host operating system and restarting the application.
| link:https://mysupport.netapp.com/NOW/cgi-
bin/bol?Type=Detail&Display=1117248[1117248^] | Kernel disruption observed
on SLES12SP3 with QLogic QLE2562 8GB FC during storage failover operations
|  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.
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"

After the kernel disruption, you can recover the operating system  by
rebooting the Host OS. You can restart the application as required.
| link:https://mysupport.netapp.com/NOW/cgi-
bin/bol?Type=Detail&Display=1117261[1117261^] | Kernel disruption observed
on SLES12SP3 with Qlogic QLE2662 16GB FC during storage failover
operations | 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.
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.

After kernel disruption, the operating system can be recovered by
rebooting the host operating system and restarting the application as
required.
| link:https://mysupport.netapp.com/NOW/cgi-
bin/bol?Type=Detail&Display=1117274[1117274^] | Kernel disruption observed
on SLES12SP3 with Emulex LPe16002 16GB FC during storage failover
operations | 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.
Example:
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:
- exception RIP: _raw_spin_lock_irqsave+30.

After kernel disruption, the operating system can be recovered by
rebooting the host operating system and restarting the application as
required.
|===

// 2024 SEP 2, ONTAPDOC-2345
```

```
[[ID07073b0055641404278c5b325e89698b]]
= Use SUSE Linux Enterprise Server 12 SP2 with ONTAP
:hardbreaks:
:toclevels: 1
:icons: font
:linkattrs:
:relative_path: ./
:imagesdir: {root_path}{relative_path}./media/

[.lead]
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
link:https://mysupport.netapp.com/site/products/all/details/hostutilities/
downloads-tab/download/61343/7.1/downloads[NetApp Support Site^] in a 32-
bit and 64-bit .rpm file. If you don't know which file is right for your
configuration, use the
link:https://mysupport.netapp.com/matrix/#welcome[NetApp Interoperability
Matrix Tool^] to verify which one you need.

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

If you have Linux Unified Host Utilities currently installed, you should
either upgrade it to the latest version, or remove it and follow these
steps to install the latest version.

.Steps

.   Download the 32-bit or 64-bit Linux Unified Host Utilities software
package from the
link:https://mysupport.netapp.com/site/products/all/details/hostutilities/
downloads-tab/download/61343/7.1/downloads[NetApp Support Site^] to your
host.
.   Install the software package:
+
`rpm -ivh netapp_linux_unified_host_utilities-7-1.x86_64`
```

```
NOTE: You can use the configuration settings provided in this document to
configure cloud clients connected to link:https://docs.netapp.com/us-
en/cloud-manager-cloud-volumes-ontap/index.html[Cloud Volumes ONTAP^] and
link:https://docs.netapp.com/us-en/cloud-manager-fsx-
ontap/index.html[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.

[source,cli]
```

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
link:https://mysupport.netapp.com/matrix/imt.jsp?components=77284;&solutio
```

```
n=1&isHWU&src=IMT[NetApp Interoperability Matrix Tool^] to verify that
your OS, HBA, HBA firmware and the HBA boot BIOS, and ONTAP version are
supported.

.Steps

. Map the SAN boot LUN to the host.
. Verify that multiple paths are available.
+
[NOTE]
Multiple paths become available after the host operating system is up and
running on the paths.

. 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.

. Reboot the host to verify that the boot was 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 example multipath outputs for a LUN mapped
to ASA and non-ASA personas.

=== All SAN Array configurations

All SAN Array (ASA) configurations optimize all paths to a given LUN,
keeping them active. 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.

//ONTAPDOC-2561 4-Dec-2024

----
# 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
----

NOTE: A single LUN shouldn't require more than four paths. Having more
than four 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 higher priorities are
Active/Optimized, meaning they are serviced by the controller where the
aggregate is located. The paths with lower priorities are active but are
non-optimized because they are served from a different controller. The
non-optimized paths are only used when optimized paths are not available.

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

//ONTAPDOC-2561 4-Dec-2024
//ONTAPDOC-2578 9-Dec-2024

----
# 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
----

NOTE: A single LUN shouldn't require more than four paths. Having more
than four 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. If
this file doesn't exist, you can create an empty, zero-byte file by using
the `touch /etc/multipath.conf` command.

The first time you create the `multipath.conf` file, you might need to
enable and start the multipath services by using the following commands:

----
chkconfig multipathd on
/etc/init.d/multipathd start
----

You don't need to add anything directly to the `multipath.conf` file
unless you have devices that you don't want multipath to manage or you
have existing settings that override defaults. To exclude unwanted
devices, add the following syntax to the `multipath.conf` file, replacing
<DevId> with the worldwide identifier (WWID) string of the device you want
to exclude:

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

The following example determines the WWID of a device and adds it to the
`multipath.conf` file.

.Steps

. Determine the WWID:
+
----
/lib/udev/scsi_id -gud /dev/sda
----
+
----
3600a098038314c4a433f5774717a3046
/lib/udev/scsi_id -gud /dev/sda
```

```
----
360030057024d0730239134810c0cb833
----
+
`sda` is the local SCSI disk that you want to add to the blacklist.

. Add the `WWID` to the blacklist stanza in `/etc/multipath.conf`:
[source,cli]
+
----
blacklist {
     wwid   3600a098038314c4a433f5774717a3046
     devnode "^(ram|raw|loop|fd|md|dm-|sr|scd|st)[0-9]*"
     devnode "^hd[a-z]"
     devnode "^cciss.*"
}
----

Always check your `/etc/multipath.conf` file, especially in the defaults
section, for legacy settings that might be overriding 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 must be
corrected by later stanzas in the `multipath.conf` file that apply
specifically to ONTAP LUNs. Without this correction, the ONTAP LUNs might
not work as expected. You should only override these defaults in
consultation with NetApp, the OS vendor, or both, and only when the impact
is fully understood.

//ONTAPDOC-2578 9-Dec-2024
//ONTAPDOC-2561 25-Nov-202


[cols=2*,options="header"]
|===
| Parameter
| Setting
| detect_prio | yes
| dev_loss_tmo | "infinity"
| failback | immediate
| fast_io_fail_tmo | 5
| features | "3 queue_if_no_path pg_init_retries 50"
| flush_on_last_del | "yes"
| hardware_handler | "0"
| path_checker | "tur"
```

```
| path_grouping_policy | "group_by_prio"
| path_selector | "service-time 0"
| 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
`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.



[[ID5463aeafb7ef8c0c948efe184133d3cb]]
= Use SUSE Linux Enterprise Server 12 SP1 with ONTAP
:hardbreaks:
:toclevels: 1
```

```
:icons: font
:linkattrs:
:relative_path: ./
:imagesdir: {root_path}{relative_path}./media/

[.lead]
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
link:https://mysupport.netapp.com/site/products/all/details/hostutilities/
downloads-tab/download/61343/7.1/downloads[NetApp Support Site^] in a 32-
bit and 64-bit .rpm file. If you don't know which file is right for your
configuration, use the
link:https://mysupport.netapp.com/matrix/#welcome[NetApp Interoperability
Matrix Tool^] to verify which one you need.

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

If you have Linux Unified Host Utilities currently installed, you should
either upgrade it to the latest version, or remove it and follow these
steps to install the latest version.

.Steps

.   Download the 32-bit or 64-bit Linux Unified Host Utilities software
package from the
link:https://mysupport.netapp.com/site/products/all/details/hostutilities/
downloads-tab/download/61343/7.1/downloads[NetApp Support Site^] to your
host.
.   Install the software package:
+
`rpm -ivh netapp_linux_unified_host_utilities-7-1.x86_64`

NOTE: You can use the configuration settings provided in this document to
configure cloud clients connected to link:https://docs.netapp.com/us-
en/cloud-manager-cloud-volumes-ontap/index.html[Cloud Volumes ONTAP^] and
link:https://docs.netapp.com/us-en/cloud-manager-fsx-
ontap/index.html[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.

[source,cli]
----
# 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
link:https://mysupport.netapp.com/matrix/imt.jsp?components=71679;&solutio
n=1&isHWU&src=IMT[NetApp Interoperability Matrix Tool^] to verify that
your OS, HBA, HBA firmware and the HBA boot BIOS, and ONTAP version are
supported.

.Steps

. Map the SAN boot LUN to the host.
. Verify that multiple paths are available.
+
[NOTE]
Multiple paths become available after the host operating system is up and
running on the paths.
```

```
. 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.

. Reboot the host to verify that the boot was 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 example multipath outputs for a LUN mapped
to ASA and non-ASA personas.

=== All SAN Array configurations

All SAN Array (ASA) configurations optimize all paths to a given LUN,
keeping them active. 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.

//ONTAPDOC-2561 4-Dec-2024
```

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

```
NOTE: A single LUN shouldn't require more than four paths. Having more
than four 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 higher priorities are
Active/Optimized, meaning they are serviced by the controller where the
aggregate is located. The paths with lower priorities are active but are
non-optimized because they are served from a different controller. The
non-optimized paths are only used when optimized paths are not available.

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

//ONTAPDOC-2561 4-Dec-2024
//ONTAPDOC-2578 9-Dec-2024
```

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

```
NOTE: A single LUN shouldn't require more than four paths. Having more
than four 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. If
this file doesn't exist, you can create an empty, zero-byte file by using
the `touch /etc/multipath.conf` command.

The first time you create the `multipath.conf` file, you might need to
enable and start the multipath services by using the following commands:
```

chkconfig multipathd on
/etc/init.d/multipathd start

```
You don't need to add anything directly to the `multipath.conf` file
unless you have devices that you don't want multipath to manage or you
have existing settings that override defaults. To exclude unwanted
devices, add the following syntax to the `multipath.conf` file, replacing
<DevId> with the worldwide identifier (WWID) string of the device you want
to exclude:
```

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

```
The following example determines the WWID of a device and adds it to the
`multipath.conf` file.

.Steps

. Determine the WWID:
+
```

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

```
+
```

3600a098038314c4a433f5774717a3046
/lib/udev/scsi_id -gud /dev/sda

```
360030057024d0730239134810c0cb833
```

+
`sda` is the local SCSI disk that you want to add to the blacklist.

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

```
blacklist {
     wwid   3600a098038314c4a433f5774717a3046
     devnode "^(ram|raw|loop|fd|md|dm-|sr|scd|st)[0-9]*"
     devnode "^hd[a-z]"
     devnode "^cciss.*"
}
```

Always check your `/etc/multipath.conf` file, especially in the defaults section, for legacy settings that might be overriding 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 must be corrected by later stanzas in the `multipath.conf` file that apply specifically to ONTAP LUNs. Without this correction, the ONTAP LUNs might not work as expected. You should only override these defaults in consultation with NetApp, the OS vendor, or both, 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	"3 queue_if_no_path pg_init_retries 50"
flush_on_last_del	"yes"
hardware_handler	"0"
path_checker	"tur"
path_grouping_policy	"group_by_prio"
path_selector	"service-time 0"
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 `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 don't 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's not mandatory. The utilities don't change any settings on your Linux host. The utilities improve management and assist NetApp customer support in gathering information about your configuration.

If you have Linux Unified Host Utilities currently installed, you should either upgrade it to the latest version, or remove it and follow these steps to install the latest version.

Steps

1. Download the 32-bit or 64-bit Linux Unified Host Utilities software package from the NetApp Support Site to your host.
2. 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 operating system 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 was 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 example multipath outputs for a LUN mapped to ASA and non-ASA personas.

All SAN Array configurations

All SAN Array (ASA) configurations optimize all paths to a given LUN, keeping them active. 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
```

> A single LUN shouldn’t require more than four paths. Having more than four 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 higher priorities are Active/Optimized, meaning they are serviced by the controller where the aggregate is located. The paths with lower priorities are active but are non-optimized because they are served from a different controller. The non-optimized paths are only used when optimized paths are not 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
3600a0980383134765724e527766394e 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
```

A single LUN shouldn't require more than four paths. Having more than four 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. If this file doesn't exist, you can create an empty, zero-byte file by using the `touch /etc/multipath.conf` command.

The first time you create the `multipath.conf` file, you might need to enable and start the multipath services by using the following commands:

```
chkconfig multipathd on
/etc/init.d/multipathd start
```

You don't need to add anything directly to the `multipath.conf` file unless you have devices that you don't want multipath to manage or you have existing settings that override defaults. To exclude unwanted devices, add the following syntax to the `multipath.conf` file, replacing <DevId> with the worldwide identifier (WWID) string of the device you want to exclude:

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

The following example determines the WWID of a device and adds it to the `multipath.conf` file.

Steps

1. Determine the WWID:

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

```
3600a098038314c4a433f5774717a3046
/lib/udev/scsi_id -gud /dev/sda
```

360030057024d0730239134810c0cb833

```
+
`sda` is the local SCSI disk that you want to add to the blacklist.

. Add the `WWID` to the blacklist stanza in `/etc/multipath.conf`:
[source,cli]
+
```

blacklist {
wwid 3600a098038314c4a433f5774717a3046
devnode "^(ram|raw|loop|fd|md|dm-|sr|scd|st)"
devnode "^hd[a-z]"
devnode "^cciss."
}

```
Always check your `/etc/multipath.conf` file, especially in the defaults
section, for legacy settings that might be overriding 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 must be
corrected by later stanzas in the `multipath.conf` file that apply
specifically to ONTAP LUNs. Without this correction, the ONTAP LUNs might
not work as expected. You should only override these defaults in
consultation with NetApp, the OS vendor, or both, and only when the impact
is fully understood.

//ONTAPDOC-2578 9-Dec-2024
//ONTAPDOC-2561 25-Nov-202


[cols=2*,options="header"]
|===
| Parameter
| Setting
| detect_prio | yes
| dev_loss_tmo | "infinity"
```

```
| failback | immediate
| fast_io_fail_tmo | 5
| features | "3 queue_if_no_path pg_init_retries 50"
| flush_on_last_del | "yes"
| hardware_handler | "0"
| path_checker | "tur"
| path_grouping_policy | "group_by_prio"
| path_selector | "service-time 0"
| 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
`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 SUSE Linux Enterprise Server 12 with ONTAP release has the following
known issues:

[cols=3*,options="header"]
|===
| NetApp Bug ID
```

```
| Title
| Description
| link:https://mysupport.netapp.com/NOW/cgi-
bin/bol?Type=Detail&Display=873555[873555^] | 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.
| link:https://mysupport.netapp.com/NOW/cgi-
bin/bol?Type=Detail&Display=863584[863584^] | 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".
| link:https://mysupport.netapp.com/NOW/cgi-
bin/bol?Type=Detail&Display=847490[847490^] | 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.
|===

// 2024 SEP 2, ONTAPDOC-2345



:leveloffset: -1


:leveloffset: -1


:leveloffset: -1

<<<
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IMPLIED WARRANTIES, INCLUDING, BUT NOT LIMITED TO, THE IMPLIED WARRANTIES
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```

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