



# CentOS 8

## SAN hosts and cloud clients

NetApp  
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# CentOS 8

## Use CentOS 8.5 with ONTAP

You can use the ONTAP SAN host configuration settings to configure CentOS 8.5 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 64-bit .rpm file.

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

#### What you'll need

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

#### Steps

1. Download the 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 OS is up and running on the paths.

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

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

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

## Multipathing

For CentOS 8.5 the `/etc/multipath.conf` file must exist, but you do not need to make specific changes to the file. CentOS 8.5 is compiled with all settings required to recognize and correctly manage ONTAP LUNs.

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

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

### All SAN Array configurations

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

### Example

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

```
# multipath -ll
3600a098038303634722b4d59646c4436 dm-28 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
  |- 11:0:7:1      sdfi   130:64   active ready running
  |- 11:0:9:1      sdiy   8:288    active ready running
  |- 11:0:10:1     sdml   69:464   active ready running
  |- 11:0:11:1     sdpt   131:304  active ready running
```



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

### Non-ASA configurations

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

### Example

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

```
# multipath -ll
3600a098038303634722b4d59646c4436 dm-28 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
| |- 16:0:6:35 sdwb  69:624  active ready running
| |- 16:0:5:35 sdun  66:752  active ready running
`-+- policy='service-time 0' prio=10 status=enabled
  |- 15:0:0:35 sdaj  66:48   active ready running
  |- 15:0:1:35 sdbx  68:176  active ready running
```



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

### Recommended Settings

CentOS 8.5 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, but you can create an empty, zero-byte file by using the following command:

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

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

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

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

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

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

### Example

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

### Steps

1. Run the following command to determine the `WWID`:

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

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

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

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

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

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

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

### KVM settings

You can use the recommended settings to configure Kernel-based Virtual Machine (KVM) as well. There are no changes required to configure KVM as the LUN is mapped to the hypervisor.

### Known issues

There are no known issues for the CentOS 8.5 with ONTAP release.

## Use CentOS 8.4 with ONTAP

You can use the ONTAP SAN host configuration settings to configure CentOS 8.4 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 64-bit .rpm file.

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

#### What you'll need

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

#### Steps

1. Download the 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 OS is up and running on the paths.

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

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

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

## Multipathing

For CentOS 8.4 the `/etc/multipath.conf` file must exist, but you do not need to make specific changes to the file. CentOS 8.4 is compiled with all settings required to recognize and correctly manage ONTAP LUNs.

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

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

### All SAN Array configurations

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

#### Example

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

```
# multipath -ll
3600a098038303634722b4d59646c4436 dm-28 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
  |- 11:0:7:1    sdfi   130:64   active ready running
  |- 11:0:9:1    sdiy   8:288    active ready running
  |- 11:0:10:1   sdml   69:464   active ready running
  |- 11:0:11:1   sdpt   131:304  active ready running
```



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

### Non-ASA configurations

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

#### Example

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

```
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| |- 16:0:6:35 sdwb 69:624 active ready running
| |- 16:0:5:35 sdun 66:752 active ready running
`+- policy='service-time 0' prio=10 status=enabled
|- 15:0:0:35 sdaj 66:48 active ready running
|- 15:0:1:35 sdbx 68:176 active ready running
```



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

## Recommended Settings

CentOS 8.4 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, but you can create an empty, zero-byte file by using the following command:

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

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

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

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

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

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

### Example

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

## Steps

1. Run the following command to determine the WWID:

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

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

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

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

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

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

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

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

### Example

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

```
defaults {
    path_checker      readsector0
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}

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

### KVM settings

You can use the recommended settings to configure Kernel-based Virtual Machine (KVM) as well. There are no changes required to configure KVM as the LUN is mapped to the hypervisor.

### Known issues

There are no known issues for the CentOS 8.4 with ONTAP release.

## Use CentOS 8.3 with ONTAP

You can use the ONTAP SAN host configuration settings to configure CentOS 8.3 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 64-bit .rpm file.

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

### What you'll need

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### Steps

1. Download the 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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data_vserver            /vol/vol1/lun1  /dev/sdc  host15    FCP
120.0g  cDOT
data_vserver            /vol/vol2/lun2  /dev/sdd  host16    FCP
120.0g  cDOT
data_vserver            /vol/vol2/lun2  /dev/sde  host15    FCP
120.0g  cDOT
```

## SAN Booting

### What you'll need

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

### Steps

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



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

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

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

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

## Multipathing

For CentOS 8.3 the `/etc/multipath.conf` file must exist, but you do not need to make specific changes to the file. CentOS 8.3 is compiled with all settings required to recognize and correctly manage ONTAP LUNs.

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

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```



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

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

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3600a098038303634722b4d59646c4436 dm-28 NETAPP,LUN C-Mode
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| |- 16:0:6:35 sdwb 69:624 active ready running
| |- 16:0:5:35 sdun 66:752 active ready running
`+- policy='service-time 0' prio=10 status=enabled
  |- 15:0:0:35 sdaj 66:48 active ready running
  |- 15:0:1:35 sdbx 68:176 active ready running
```



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touch /etc/multipath.conf
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The first time you create this file, you might need to enable and start the multipath services:

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# systemctl enable multipathd
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- To exclude unwanted devices, add the following syntax to the `multipath.conf` file .

```

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

```

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

### Example

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

### Steps

1. Run the following command to determine the WWID:

```

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

```

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

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

```

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

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

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

| Parameter                     | Setting    |
|-------------------------------|------------|
| <code>detect_prio</code>      | yes        |
| <code>dev_loss_tmo</code>     | "infinity" |
| <code>failback</code>         | immediate  |
| <code>fast_io_fail_tmo</code> | 5          |

| Parameter                  | Setting                |
|----------------------------|------------------------|
| 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
    }
}
```

### KVM settings

You can use the recommended settings to configure Kernel-based Virtual Machine (KVM) as well. There are no changes required to configure KVM as the LUN is mapped to the hypervisor.

## Known issues

For CentOS (Red Hat compatible kernel) known issues, see the [known issues](#) for Red Hat Enterprise Linux (RHEL) 8.3.

## Use CentOS 8.2 with ONTAP

You can use the ONTAP SAN host configuration settings to configure CentOS 8.2 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 64-bit .rpm file.

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

#### What you'll need

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

#### Steps

1. Download the 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) /
vserver (cDOT/FlashRay)   lun-pathname  device      host          lun
Product                  filename      adapter     protocol     size
-----
data_vserver              /vol/vol1/lun1 /dev/sdb    host16        FCP
120.0g cDOT
data_vserver              /vol/vol1/lun1 /dev/sdc    host15        FCP
120.0g cDOT
data_vserver              /vol/vol2/lun2 /dev/sdd    host16        FCP
120.0g cDOT
data_vserver              /vol/vol2/lun2 /dev/sde    host15        FCP
120.0g cDOT

```

## SAN Booting

### What you'll need

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

### Steps

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



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

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

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

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

## Multipathing

For CentOS 8.2 the `/etc/multipath.conf` file must exist, but you do not need to make specific changes to the file. CentOS 8.2 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.

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

### Example

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

```
# multipath -ll
3600a098038303634722b4d59646c4436 dm-28 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
| |- 16:0:6:35 sdwb 69:624 active ready running
| |- 16:0:5:35 sdun 66:752 active ready running
`-- policy='service-time 0' prio=10 status=enabled
|- 15:0:0:35 sdaj 66:48 active ready running
|- 15:0:1:35 sdbx 68:176 active ready running
```



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

## Recommended Settings

The CentOS 8.2 OS is compiled to recognize ONTAP LUNs and automatically set all configuration parameters correctly.

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

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

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

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

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

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

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

### Example

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

## Steps

1. Run the following command to determine the WWID:

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

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

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

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

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

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

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

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

### Example

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

```
defaults {
    path_checker      readsector0
    no_path_retry     fail
}

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

### KVM settings

You can use the recommended settings to configure Kernel-based Virtual Machine (KVM) as well. There are no changes required to configure KVM as the LUN is mapped to the hypervisor.

### Known issues

For CentOS (Red Hat compatible kernel) known issues, see the [known issues](#) for Red Hat Enterprise Linux (RHEL) 8.2.

## Use CentOS 8.1 with ONTAP

You can use the ONTAP SAN host configuration settings to configure CentOS 8.1 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 64-bit

.rpm file.

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

### What you'll need

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

### Steps

1. Download the 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
vservers(cDOT/FlashRay)  lun-pathname filename  adapter  protocol  size
Product
-----
data_vservers              /vol/vol1/lun1  /dev/sdb  host16    FCP
120.0g cDOT
data_vservers              /vol/vol1/lun1  /dev/sdc  host15    FCP
120.0g cDOT
data_vservers              /vol/vol2/lun2  /dev/sdd  host16    FCP
120.0g cDOT
data_vservers              /vol/vol2/lun2  /dev/sde  host15    FCP
120.0g cDOT
```

## SAN Booting

### What you'll need

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

### Steps

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



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

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

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

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

## Multipathing

For CentOS 8.1 the `/etc/multipath.conf` file must exist, but you do not need to make specific changes to the file. CentOS 8.1 is compiled with all settings required to recognize and correctly manage ONTAP LUNs.

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

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

### All SAN Array configurations

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

### Example

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

```
# multipath -ll
3600a098038303634722b4d59646c4436 dm-28 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
  |- 11:0:7:1    sdfi   130:64   active ready running
  |- 11:0:9:1    sdiy   8:288    active ready running
  |- 11:0:10:1   sdml   69:464   active ready running
  |- 11:0:11:1   sdpt   131:304  active ready running
```



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

## Non-ASA configurations

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

### Example

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

```
# multipath -ll
3600a098038303634722b4d59646c4436 dm-28 NETAPP,LUN C-Mode
size=10G features='3 queue_if_no_path pg_init_retries 50' hwhandler='1
alua' wp=rw
|+- policy='service-time 0' prio=50 status=active
| |- 16:0:6:35 sdwb 69:624 active ready running
| |- 16:0:5:35 sdun 66:752 active ready running
`+- policy='service-time 0' prio=10 status=enabled
  |- 15:0:0:35 sdaj 66:48 active ready running
  |- 15:0:1:35 sdbx 68:176 active ready running
```



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

## Recommended Settings

The CentOS 8.1 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, but you can create an empty, zero-byte file by using the following command:

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

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

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

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

```

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

```

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

### Example

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

### Steps

1. Run the following command to determine the WWID:

```

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

```

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

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

```

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

```

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

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

| Parameter                     | Setting    |
|-------------------------------|------------|
| <code>detect_prio</code>      | yes        |
| <code>dev_loss_tmo</code>     | "infinity" |
| <code>failback</code>         | immediate  |
| <code>fast_io_fail_tmo</code> | 5          |

| Parameter                  | Setting                |
|----------------------------|------------------------|
| 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
    }
}
```

### KVM settings

You can use the recommended settings to configure Kernel-based Virtual Machine (KVM) as well. There are no changes required to configure KVM as the LUN is mapped to the hypervisor.

## Known issues

For CentOS (Red Hat compatible kernel) known issues, see the [known issues](#) for Red Hat Enterprise Linux (RHEL) 8.1.

## Use CentOS 8.0 with ONTAP

You can use the ONTAP SAN host configuration settings to configure CentOS 8.0 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 64-bit .rpm file.

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#### What you'll need

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

#### Steps

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

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

```

## SAN Booting

### What you'll need

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

### Steps

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



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

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

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

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

## Multipathing

For CentOS 8.0 the `/etc/multipath.conf` file must exist, but you do not need to make specific changes to the file. CentOS 8.0 is compiled with all settings required to recognize and correctly manage ONTAP LUNs.

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

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

### All SAN Array configurations

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

### Example

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

```
# multipath -ll
3600a098038303634722b4d59646c4436 dm-28 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
  |- 11:0:7:1      sdfi    130:64   active ready running
  |- 11:0:9:1      sdiy    8:288    active ready running
  |- 11:0:10:1     sdml   69:464   active ready running
  |- 11:0:11:1     sdpt   131:304  active ready running
```



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

## Non-ASA configurations

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

### Example

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

```
# multipath -ll
3600a098038303634722b4d59646c4436 dm-28 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
  |- 11:0:7:1      sdfi    130:64   active ready running
  |- 11:0:9:1      sdiy    8:288    active ready running
  |- 11:0:10:1     sdml   69:464   active ready running
  |- 11:0:11:1     sdpt   131:304  active ready running
```



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

## Recommended Settings

The CentOS 8.0 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, but you can create an empty, zero-byte file by using the following command:

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

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

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

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

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

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

### Example

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

### Steps

1. Run the following command to determine the WWID:

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

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

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

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

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

The following table demonstrates the critical `multipathd` parameters for ONTAP LUNs and the required values. If a host is connected to LUNs from other vendors and any of these parameters are overridden, they

will need to be corrected by later stanzas in the `multipath.conf` file that apply specifically to ONTAP LUNs. If this is not done, the ONTAP LUNs might not work as expected. These defaults should only be overridden in consultation with NetApp and/or an OS vendor and only when the impact is fully understood.

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

### **KVM settings**

You can use the recommended settings to configure Kernel-based Virtual Machine (KVM) as well. There are no changes required to configure KVM as the LUN is mapped to the hypervisor.

### **Known issues**

For CentOS (Red Hat compatible kernel) known issues, see the [known issues](#) for Red Hat Enterprise Linux (RHEL) 8.0.

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