■ NetApp

CentOS

ONTAP SAN Host Utilities

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CentOS

CentOS 8

Configure CentOS 8.5 for FCP and iSCSI for ONTAP storage

The Linux Host Utilities software provides management and diagnostic tools for Linux hosts that are connected to ONTAP storage. When you install the Linux Host Utilities on a CentOS 8.5 host, you can use the Host Utilities to help you manage FCP and iSCSI protocol operations with ONTAP LUNs.



You don't need to manually configure Kernel-based Virtual Machine (KVM) settings because ONTAP LUNs are automatically mapped to the hypervisor.

Step 1: Optionally, enable SAN booting

You can configure your host to use SAN booting to simplify deployment and improve scalability.

Before you begin

Use the Interoperability Matrix Tool to verify that your Linux OS, host bus adapter (HBA), HBA firmware, HBA boot BIOS, and ONTAP version support SAN booting.

Steps

- 1. Create a SAN boot LUN and map it to the host.
- 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.

3. Verify that the configuration was successful by rebooting the host and verifying that the OS is up and running.

Step 2: Install the Linux Host Utilities

NetApp strongly recommends installing the Linux Host Utilities to support ONTAP LUN management and assist technical support with gathering configuration data.

Install Linux Host Utilities 8.0.



Installing the Linux Host Utilities doesn't change any host timeout settings on your Linux host.

Step 3: Confirm the multipath configuration for your host

You can use multipathing with CentOS 8.5 to manage ONTAP LUNs.

To ensure that multipathing is configured correctly for your host, verify that the /etc/multipath.conf file is defined and that you have the NetApp recommended settings configured for your ONTAP LUNs.

Steps

1. Verify that the /etc/multipath.conf file exits. If the file doesn't exist, create an empty, zero-byte file:

touch /etc/multipath.conf

2. The first time the multipath.conf file is created, you might need to enable and start the multipath services to load the recommended settings:

chkconfig multipathd on

/etc/init.d/multipathd start

3. Each time you boot the host, the empty /etc/multipath.conf zero-byte file automatically loads the NetApp recommended host multipath parameters as the default settings. You shouldn't need to make changes to the /etc/multipath.conf file for your host because the operating system is compiled with the multipath parameters that recognize and manage ONTAP LUNs correctly.

The following table shows the Linux OS native compiled multipath parameter settings for ONTAP LUNs.

Show parameter settings

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

4. Verify the parameter settings and path status for your ONTAP LUNs:

```
multipath -11
```

The default multipath parameters support ASA, AFF, and FAS configurations. In these configurations, a single ONTAP LUN shouldn't require more than four paths. If there are more than four paths, it might cause issues with the paths during a storage failure.

The following example outputs show the correct parameter settings and path status for ONTAP LUNs in an ASA, AFF, or FAS configuration.

ASA configuration

An ASA configuration optimizes all paths to a given LUN, keeping them active. This improves performance by serving I/O operations through all paths at the same time.

AFF or FAS configuration

An AFF or FAS configuration should have two groups of paths with higher and lower priorities. Higher priority Active/Optimized paths are served by the controller where the aggregate is located. Lower priority paths are active but non-optimized because they are served by a different controller. Non-optimized paths are only used when optimized paths aren't available.

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

Step 4: Optionally, exclude a device from multipathing

If required, you can exclude a device from multipathing by adding the WWID for the unwanted device to the "blacklist" stanza for the multipath.conf file.

Steps

1. Determine the WWID:

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

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

An example WWID is 360030057024d0730239134810c0cb833.

2. Add the WWID to the "blacklist" stanza:

Step 5: Customize multipath parameters for ONTAP LUNs

If your host is connected to LUNs from other vendors and any of the multipath parameter settings are overridden, you need to correct them by adding stanzas later in the multipath.conf file that apply specifically to ONTAP LUNs. If you don't do this, the ONTAP LUNs might not work as expected.

Check your /etc/multipath.conf file, especially in the defaults section, for settings that might be overriding the default settings for multipath parameters.



You shouldn't override the recommended parameter settings for ONTAP LUNs. These settings are required for optimal performance of your host configuration. Contact NetApp support, your OS vendor, or both for more information.

The following example shows how to correct an overridden default. In this example, the multipath.conf file defines values for path_checker and no_path_retry that aren't compatible with ONTAP LUNs, and you can't remove these parameters because ONTAP storage arrays are still attached to the host. Instead, you correct the values for path_checker and no_path_retry by adding a device stanza to the multipath.conf file that applies specifically to the ONTAP LUNs.

Show example

```
defaults {
   path checker
                      readsector0
                      fail
  no path retry
devices {
   device {
      vendor
                       "NETAPP"
      product
                       "LUN"
      no_path_retry
                       queue
      path checker
                       tur
   }
}
```

Step 6: Review the known issues

There are no known issues.

What's next?

- Learn about using the Linux Host Utilities tool.
- Learn about 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 doesn't 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.

Configure CentOS 8.4 for FCP and iSCSI for ONTAP storage

The Linux Host Utilities software provides management and diagnostic tools for Linux hosts that are connected to ONTAP storage. When you install the Linux Host Utilities on a CentOS 8.4 host, you can use the Host Utilities to help you manage FCP and iSCSI protocol operations with ONTAP LUNs.



You don't need to manually configure Kernel-based Virtual Machine (KVM) settings because ONTAP LUNs are automatically mapped to the hypervisor.

Step 1: Optionally, enable SAN booting

You can configure your host to use SAN booting to simplify deployment and improve scalability.

Before you begin

Use the Interoperability Matrix Tool to verify that your Linux OS, host bus adapter (HBA), HBA firmware, HBA boot BIOS, and ONTAP version support SAN booting.

Steps

- 1. Create a SAN boot LUN and map it to the host.
- 2. 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.

3. Verify that the configuration was successful by rebooting the host and verifying that the OS is up and running.

Step 2: Install the Linux Host Utilities

NetApp strongly recommends installing the Linux Host Utilities to support ONTAP LUN management and assist technical support with gathering configuration data.

Install Linux Host Utilities 8.0.



Installing the Linux Host Utilities doesn't change any host timeout settings on your Linux host.

Step 3: Confirm the multipath configuration for your host

You can use multipathing with CentOS 8.4 to manage ONTAP LUNs.

To ensure that multipathing is configured correctly for your host, verify that the /etc/multipath.conf file is defined and that you have the NetApp recommended settings configured for your ONTAP LUNs.

Steps

1. Verify that the /etc/multipath.conf file exits. If the file doesn't exist, create an empty, zero-byte file:

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

2. The first time the multipath.conf file is created, you might need to enable and start the multipath services to load the recommended settings:

chkconfig multipathd on

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

3. Each time you boot the host, the empty /etc/multipath.conf zero-byte file automatically loads the NetApp recommended host multipath parameters as the default settings. You shouldn't need to make changes to the /etc/multipath.conf file for your host because the operating system is compiled with the multipath parameters that recognize and manage ONTAP LUNs correctly.

The following table shows the Linux OS native compiled multipath parameter settings for ONTAP LUNs.

Show parameter settings

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

4. Verify the parameter settings and path status for your ONTAP LUNs:

The default multipath parameters support ASA, AFF, and FAS configurations. In these configurations, a single ONTAP LUN shouldn't require more than four paths. If there are more than four paths, it might cause issues with the paths during a storage failure.

The following example outputs show the correct parameter settings and path status for ONTAP LUNs in an ASA, AFF, or FAS configuration.

ASA configuration

An ASA configuration optimizes all paths to a given LUN, keeping them active. This improves performance by serving I/O operations through all paths at the same time.

AFF or FAS configuration

An AFF or FAS configuration should have two groups of paths with higher and lower priorities. Higher priority Active/Optimized paths are served by the controller where the aggregate is located. Lower priority paths are active but non-optimized because they are served by a different controller. Non-optimized paths are only used when optimized paths aren't available.

The following example displays the 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
```

Step 4: Optionally, exclude a device from multipathing

If required, you can exclude a device from multipathing by adding the WWID for the unwanted device to the "blacklist" stanza for the multipath.conf file.

Steps

1. Determine the WWID:

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

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

An example WWID is 360030057024d0730239134810c0cb833.

2. Add the WWID to the "blacklist" stanza:

Step 5: Customize multipath parameters for ONTAP LUNs

If your host is connected to LUNs from other vendors and any of the multipath parameter settings are overridden, you need to correct them by adding stanzas later in the multipath.conf file that apply specifically to ONTAP LUNs. If you don't do this, the ONTAP LUNs might not work as expected.

Check your /etc/multipath.conf file, especially in the defaults section, for settings that might be overriding the default settings for multipath parameters.



You shouldn't override the recommended parameter settings for ONTAP LUNs. These settings are required for optimal performance of your host configuration. Contact NetApp support, your OS vendor, or both for more information.

The following example shows how to correct an overridden default. In this example, the multipath.conf file defines values for path_checker and no_path_retry that aren't compatible with ONTAP LUNs, and you can't remove these parameters because ONTAP storage arrays are still attached to the host. Instead, you correct the values for path_checker and no_path_retry by adding a device stanza to the multipath.conf file that applies specifically to the ONTAP LUNs.

Show example

```
defaults {
  path checker
                      readsector0
  no path retry
                      fail
devices {
   device {
      vendor
                       "NETAPP"
      product
                       "LUN"
      no_path_retry
                       queue
      path checker
                       tur
   }
}
```

Step 6: Review the known issues

There are no known issues.

What's next?

- Learn about using the Linux Host Utilities tool.
- Learn about 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 doesn't 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.

Configure CentOS 8.3 for FCP and iSCSI for ONTAP storage

The Linux Host Utilities software provides management and diagnostic tools for Linux hosts that are connected to ONTAP storage. When you install the Linux Host Utilities on a CentOS 8.3 host, you can use the Host Utilities to help you manage FCP and iSCSI protocol operations with ONTAP LUNs.



You don't need to manually configure Kernel-based Virtual Machine (KVM) settings because ONTAP LUNs are automatically mapped to the hypervisor.

Step 1: Optionally, enable SAN booting

You can configure your host to use SAN booting to simplify deployment and improve scalability.

Before you begin

Use the Interoperability Matrix Tool to verify that your Linux OS, host bus adapter (HBA), HBA firmware, HBA boot BIOS, and ONTAP version support SAN booting.

Steps

- 1. Create a SAN boot LUN and map it to the host.
- 2. 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.

3. Verify that the configuration was successful by rebooting the host and verifying that the OS is up and running.

Step 2: Install the Linux Host Utilities

NetApp strongly recommends installing the Linux Host Utilities to support ONTAP LUN management and assist technical support with gathering configuration data.

Install Linux Host Utilities 8.0.



Installing the Linux Host Utilities doesn't change any host timeout settings on your Linux host.

Step 3: Confirm the multipath configuration for your host

You can use multipathing with CentOS 8.3 to manage ONTAP LUNs.

To ensure that multipathing is configured correctly for your host, verify that the /etc/multipath.conf file is defined and that you have the NetApp recommended settings configured for your ONTAP LUNs.

Steps

1. Verify that the /etc/multipath.conf file exits. If the file doesn't exist, create an empty, zero-byte file:

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

2. The first time the multipath.conf file is created, you might need to enable and start the multipath services to load the recommended settings:

chkconfig multipathd on

/etc/init.d/multipathd start

3. Each time you boot the host, the empty /etc/multipath.conf zero-byte file automatically loads the NetApp recommended host multipath parameters as the default settings. You shouldn't need to make changes to the /etc/multipath.conf file for your host because the operating system is compiled with the multipath parameters that recognize and manage ONTAP LUNs correctly.

The following table shows the Linux OS native compiled multipath parameter settings for ONTAP LUNs.

Show parameter settings

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

4. Verify the parameter settings and path status for your ONTAP LUNs:

The default multipath parameters support ASA, AFF, and FAS configurations. In these configurations, a single ONTAP LUN shouldn't require more than four paths. If there are more than four paths, it might cause issues with the paths during a storage failure.

The following example outputs show the correct parameter settings and path status for ONTAP LUNs in an ASA, AFF, or FAS configuration.

ASA configuration

An ASA configuration optimizes all paths to a given LUN, keeping them active. This improves performance by serving I/O operations through all paths at the same time.

AFF or FAS configuration

An AFF or FAS configuration should have two groups of paths with higher and lower priorities. Higher priority Active/Optimized paths are served by the controller where the aggregate is located. Lower priority paths are active but non-optimized because they are served by a different controller. Non-optimized paths are only used when optimized paths aren't available.

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

```
multipath -11
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
```

Step 4: Optionally, exclude a device from multipathing

If required, you can exclude a device from multipathing by adding the WWID for the unwanted device to the "blacklist" stanza for the multipath.conf file.

Steps

1. Determine the WWID:

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

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

An example WWID is 360030057024d0730239134810c0cb833.

2. Add the WWID to the "blacklist" stanza:

Step 5: Customize multipath parameters for ONTAP LUNs

If your host is connected to LUNs from other vendors and any of the multipath parameter settings are overridden, you need to correct them by adding stanzas later in the multipath.conf file that apply specifically to ONTAP LUNs. If you don't do this, the ONTAP LUNs might not work as expected.

Check your /etc/multipath.conf file, especially in the defaults section, for settings that might be overriding the default settings for multipath parameters.



You shouldn't override the recommended parameter settings for ONTAP LUNs. These settings are required for optimal performance of your host configuration. Contact NetApp support, your OS vendor, or both for more information.

The following example shows how to correct an overridden default. In this example, the multipath.conf file defines values for path_checker and no_path_retry that aren't compatible with ONTAP LUNs, and you can't remove these parameters because ONTAP storage arrays are still attached to the host. Instead, you correct the values for path_checker and no_path_retry by adding a device stanza to the multipath.conf file that applies specifically to the ONTAP LUNs.

Show example

```
defaults {
  path checker
                      readsector0
   no path retry
                      fail
devices {
   device {
      vendor
                        "NETAPP"
      product
                        "LUN"
      no_path_retry
                       queue
      path checker
                       tur
   }
}
```

Step 6: Review the known issues

There are no known issues for CentOS 8.3 for FCP and iSCSI with ONTAP storage.

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

What's next?

- · Learn about using the Linux Host Utilities tool.
- · Learn about 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 doesn't 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.

Configure CentOS 8.2 for FCP and iSCSI for ONTAP storage

The Linux Host Utilities software provides management and diagnostic tools for Linux hosts that are connected to ONTAP storage. When you install the Linux Host Utilities on a CentOS 8.2 host, you can use the Host Utilities to help you manage FCP and iSCSI protocol operations with ONTAP LUNs.



You don't need to manually configure Kernel-based Virtual Machine (KVM) settings because ONTAP LUNs are automatically mapped to the hypervisor.

Step 1: Optionally, enable SAN booting

You can configure your host to use SAN booting to simplify deployment and improve scalability.

Before you begin

Use the Interoperability Matrix Tool to verify that your Linux OS, host bus adapter (HBA), HBA firmware, HBA boot BIOS, and ONTAP version support SAN booting.

Steps

- 1. Create a SAN boot LUN and map it to the host.
- 2. 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.

3. Verify that the configuration was successful by rebooting the host and verifying that the OS is up and running.

Step 2: Install the Linux Host Utilities

NetApp strongly recommends installing the Linux Host Utilities to support ONTAP LUN management and assist technical support with gathering configuration data.

Install Linux Host Utilities 8.0.



Installing the Linux Host Utilities doesn't change any host timeout settings on your Linux host.

Step 3: Confirm the multipath configuration for your host

You can use multipathing with CentOS 8.2 to manage ONTAP LUNs.

To ensure that multipathing is configured correctly for your host, verify that the /etc/multipath.conf file is defined and that you have the NetApp recommended settings configured for your ONTAP LUNs.

Steps

1. Verify that the /etc/multipath.conf file exits. If the file doesn't exist, create an empty, zero-byte file:

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

2. The first time the multipath.conf file is created, you might need to enable and start the multipath services to load the recommended settings:

chkconfig multipathd on

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

3. Each time you boot the host, the empty /etc/multipath.conf zero-byte file automatically loads the NetApp recommended host multipath parameters as the default settings. You shouldn't need to make

changes to the /etc/multipath.conf file for your host because the operating system is compiled with the multipath parameters that recognize and manage ONTAP LUNs correctly.

The following table shows the Linux OS native compiled multipath parameter settings for ONTAP LUNs.

Show parameter settings

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

4. Verify the parameter settings and path status for your ONTAP LUNs:

The default multipath parameters support ASA, AFF, and FAS configurations. In these configurations, a single ONTAP LUN shouldn't require more than four paths. If there are more than four paths, it might cause issues with the paths during a storage failure.

The following example outputs show the correct parameter settings and path status for ONTAP LUNs in an ASA, AFF, or FAS configuration.

ASA configuration

An ASA configuration optimizes all paths to a given LUN, keeping them active. This improves performance by serving I/O operations through all paths at the same time.

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An AFF or FAS configuration should have two groups of paths with higher and lower priorities. Higher priority Active/Optimized paths are served by the controller where the aggregate is located. Lower priority paths are active but non-optimized because they are served by a different controller. Non-optimized paths are only used when optimized paths aren't available.

The following example displays the 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
```

Step 4: Optionally, exclude a device from multipathing

If required, you can exclude a device from multipathing by adding the WWID for the unwanted device to the "blacklist" stanza for the multipath.conf file.

Steps

1. Determine the WWID:

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

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

An example WWID is 360030057024d0730239134810c0cb833.

2. Add the WWID to the "blacklist" stanza:

Step 5: Customize multipath parameters for ONTAP LUNs

If your host is connected to LUNs from other vendors and any of the multipath parameter settings are overridden, you need to correct them by adding stanzas later in the multipath.conf file that apply specifically to ONTAP LUNs. If you don't do this, the ONTAP LUNs might not work as expected.

Check your /etc/multipath.conf file, especially in the defaults section, for settings that might be overriding the default settings for multipath parameters.



You shouldn't override the recommended parameter settings for ONTAP LUNs. These settings are required for optimal performance of your host configuration. Contact NetApp support, your OS vendor, or both for more information.

The following example shows how to correct an overridden default. In this example, the multipath.conf file defines values for path_checker and no_path_retry that aren't compatible with ONTAP LUNs, and you can't remove these parameters because ONTAP storage arrays are still attached to the host. Instead, you correct the values for path_checker and no_path_retry by adding a device stanza to the multipath.conf file that applies specifically to the ONTAP LUNs.

Show example

```
defaults {
   path checker
                      readsector0
   no path retry
                       fail
devices {
   device {
      vendor
                        "NETAPP"
      product
                        "LUN"
      no_path_retry
                        queue
      path checker
                        tur
   }
}
```

Step 6: Review the known issues

There are no known issues for CentOS 8.2 for FCP and iSCSI with ONTAP storage.

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

What's next?

- · Learn about using the Linux Host Utilities tool.
- · Learn about 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 doesn't 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.

Configure CentOS 8.1 for FCP and iSCSI for ONTAP storage

The Linux Host Utilities software provides management and diagnostic tools for Linux hosts that are connected to ONTAP storage. When you install the Linux Host Utilities on a CentOS 8.1 host, you can use the Host Utilities to help you manage FCP and iSCSI protocol operations with ONTAP LUNs.



You don't need to manually configure Kernel-based Virtual Machine (KVM) settings because ONTAP LUNs are automatically mapped to the hypervisor.

Step 1: Optionally, enable SAN booting

You can configure your host to use SAN booting to simplify deployment and improve scalability.

Before you begin

Use the Interoperability Matrix Tool to verify that your Linux OS, host bus adapter (HBA), HBA firmware, HBA boot BIOS, and ONTAP version support SAN booting.

Steps

- 1. Create a SAN boot LUN and map it to the host.
- 2. 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.

3. Verify that the configuration was successful by rebooting the host and verifying that the OS is up and running.

Step 2: Install the Linux Host Utilities

NetApp strongly recommends installing the Linux Host Utilities to support ONTAP LUN management and assist technical support with gathering configuration data.

Install Linux Host Utilities 8.0.



Installing the Linux Host Utilities doesn't change any host timeout settings on your Linux host.

Step 3: Confirm the multipath configuration for your host

You can use multipathing with CentOS 8.1 to manage ONTAP LUNs.

To ensure that multipathing is configured correctly for your host, verify that the /etc/multipath.conf file is defined and that you have the NetApp recommended settings configured for your ONTAP LUNs.

Steps

1. Verify that the /etc/multipath.conf file exits. If the file doesn't exist, create an empty, zero-byte file:

touch /etc/multipath.conf

2. The first time the multipath.conf file is created, you might need to enable and start the multipath services to load the recommended settings:

chkconfig multipathd on

/etc/init.d/multipathd start

3. Each time you boot the host, the empty /etc/multipath.conf zero-byte file automatically loads the NetApp recommended host multipath parameters as the default settings. You shouldn't need to make

changes to the /etc/multipath.conf file for your host because the operating system is compiled with the multipath parameters that recognize and manage ONTAP LUNs correctly.

The following table shows the Linux OS native compiled multipath parameter settings for ONTAP LUNs.

Show parameter settings

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

4. Verify the parameter settings and path status for your ONTAP LUNs:

The default multipath parameters support ASA, AFF, and FAS configurations. In these configurations, a single ONTAP LUN shouldn't require more than four paths. If there are more than four paths, it might cause issues with the paths during a storage failure.

The following example outputs show the correct parameter settings and path status for ONTAP LUNs in an ASA, AFF, or FAS configuration.

ASA configuration

An ASA configuration optimizes all paths to a given LUN, keeping them active. This improves performance by serving I/O operations through all paths at the same time.

AFF or FAS configuration

An AFF or FAS configuration should have two groups of paths with higher and lower priorities. Higher priority Active/Optimized paths are served by the controller where the aggregate is located. Lower priority paths are active but non-optimized because they are served by a different controller. Non-optimized paths are only used when optimized paths aren't available.

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

```
multipath -11
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
```

Step 4: Optionally, exclude a device from multipathing

If required, you can exclude a device from multipathing by adding the WWID for the unwanted device to the "blacklist" stanza for the multipath.conf file.

Steps

1. Determine the WWID:

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

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

An example WWID is 360030057024d0730239134810c0cb833.

2. Add the WWID to the "blacklist" stanza:

Step 5: Customize multipath parameters for ONTAP LUNs

If your host is connected to LUNs from other vendors and any of the multipath parameter settings are overridden, you need to correct them by adding stanzas later in the multipath.conf file that apply specifically to ONTAP LUNs. If you don't do this, the ONTAP LUNs might not work as expected.

Check your /etc/multipath.conf file, especially in the defaults section, for settings that might be overriding the default settings for multipath parameters.



You shouldn't override the recommended parameter settings for ONTAP LUNs. These settings are required for optimal performance of your host configuration. Contact NetApp support, your OS vendor, or both for more information.

The following example shows how to correct an overridden default. In this example, the multipath.conf file defines values for path_checker and no_path_retry that aren't compatible with ONTAP LUNs, and you can't remove these parameters because ONTAP storage arrays are still attached to the host. Instead, you correct the values for path_checker and no_path_retry by adding a device stanza to the multipath.conf file that applies specifically to the ONTAP LUNs.

Show example

```
defaults {
   path checker
                      readsector0
   no path retry
                      fail
devices {
   device {
      vendor
                        "NETAPP"
      product
                        "LUN"
      no_path_retry
                       queue
      path checker
                       tur
   }
}
```

Step 6: Review the known issues

There are no known issues for CentOS 8.1 for FCP and iSCSI with ONTAP storage.

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

What's next?

- · Learn about using the Linux Host Utilities tool.
- · Learn about 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 doesn't 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.

Configure CentOS 8.0 for FCP and iSCSI for ONTAP storage

The Linux Host Utilities software provides management and diagnostic tools for Linux hosts that are connected to ONTAP storage. When you install the Linux Host Utilities on a CentOS 8.0 host, you can use the Host Utilities to help you manage FCP and iSCSI protocol operations with ONTAP LUNs.



You don't need to manually configure Kernel-based Virtual Machine (KVM) settings because ONTAP LUNs are automatically mapped to the hypervisor.

Step 1: Optionally, enable SAN booting

You can configure your host to use SAN booting to simplify deployment and improve scalability.

Before you begin

Use the Interoperability Matrix Tool to verify that your Linux OS, host bus adapter (HBA), HBA firmware, HBA boot BIOS, and ONTAP version support SAN booting.

Steps

- 1. Create a SAN boot LUN and map it to the host.
- 2. 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.

3. Verify that the configuration was successful by rebooting the host and verifying that the OS is up and running.

Step 2: Install the Linux Host Utilities

NetApp strongly recommends installing the Linux Host Utilities to support ONTAP LUN management and assist technical support with gathering configuration data.

Install Linux Host Utilities 8.0.



Installing the Linux Host Utilities doesn't change any host timeout settings on your Linux host.

Step 3: Confirm the multipath configuration for your host

You can use multipathing with CentOS 8.0 to manage ONTAP LUNs.

To ensure that multipathing is configured correctly for your host, verify that the /etc/multipath.conf file is defined and that you have the NetApp recommended settings configured for your ONTAP LUNs.

Steps

1. Verify that the /etc/multipath.conf file exits. If the file doesn't exist, create an empty, zero-byte file:

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

2. The first time the multipath.conf file is created, you might need to enable and start the multipath services to load the recommended settings:

chkconfig multipathd on

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

3. Each time you boot the host, the empty /etc/multipath.conf zero-byte file automatically loads the NetApp recommended host multipath parameters as the default settings. You shouldn't need to make

changes to the /etc/multipath.conf file for your host because the operating system is compiled with the multipath parameters that recognize and manage ONTAP LUNs correctly.

The following table shows the Linux OS native compiled multipath parameter settings for ONTAP LUNs.

Show parameter settings

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

4. Verify the parameter settings and path status for your ONTAP LUNs:

The default multipath parameters support ASA, AFF, and FAS configurations. In these configurations, a single ONTAP LUN shouldn't require more than four paths. If there are more than four paths, it might cause issues with the paths during a storage failure.

The following example outputs show the correct parameter settings and path status for ONTAP LUNs in an ASA, AFF, or FAS configuration.

ASA configuration

An ASA configuration optimizes all paths to a given LUN, keeping them active. This improves performance by serving I/O operations through all paths at the same time.

AFF or FAS configuration

An AFF or FAS configuration should have two groups of paths with higher and lower priorities. Higher priority Active/Optimized paths are served by the controller where the aggregate is located. Lower priority paths are active but non-optimized because they are served by a different controller. Non-optimized paths are only used when optimized paths aren't available.

The following example displays the 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
```

Step 4: Optionally, exclude a device from multipathing

If required, you can exclude a device from multipathing by adding the WWID for the unwanted device to the "blacklist" stanza for the multipath.conf file.

Steps

1. Determine the WWID:

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

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

An example WWID is 360030057024d0730239134810c0cb833.

2. Add the WWID to the "blacklist" stanza:

Step 5: Customize multipath parameters for ONTAP LUNs

If your host is connected to LUNs from other vendors and any of the multipath parameter settings are overridden, you need to correct them by adding stanzas later in the multipath.conf file that apply specifically to ONTAP LUNs. If you don't do this, the ONTAP LUNs might not work as expected.

Check your /etc/multipath.conf file, especially in the defaults section, for settings that might be overriding the default settings for multipath parameters.



You shouldn't override the recommended parameter settings for ONTAP LUNs. These settings are required for optimal performance of your host configuration. Contact NetApp support, your OS vendor, or both for more information.

The following example shows how to correct an overridden default. In this example, the multipath.conf file defines values for path_checker and no_path_retry that aren't compatible with ONTAP LUNs, and you can't remove these parameters because ONTAP storage arrays are still attached to the host. Instead, you correct the values for path_checker and no_path_retry by adding a device stanza to the multipath.conf file that applies specifically to the ONTAP LUNs.

Show example

```
defaults {
   path checker
                      readsector0
   no path retry
                      fail
devices {
   device {
      vendor
                        "NETAPP"
      product
                        "LUN"
      no_path_retry
                       queue
      path checker
                       tur
   }
}
```

Step 6: Review the known issues

There are no known issues for CentOS 8.0 for FCP and iSCSI with ONTAP storage.

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

What's next?

- · Learn about using the Linux Host Utilities tool.
- · Learn about 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 doesn't 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.

CentOS 7

Configure CentOS 7.9 for FCP and iSCSI for ONTAP storage

The Linux Host Utilities software provides management and diagnostic tools for Linux hosts that are connected to ONTAP storage. When you install the Linux Host Utilities on a CentOS 7.9 host, you can use the Host Utilities to help you manage FCP and iSCSI protocol operations with ONTAP LUNs.



You don't need to manually configure Kernel-based Virtual Machine (KVM) settings because ONTAP LUNs are automatically mapped to the hypervisor.

Step 1: Optionally, enable SAN booting

You can configure your host to use SAN booting to simplify deployment and improve scalability.

Before you begin

Use the Interoperability Matrix Tool to verify that your Linux OS, host bus adapter (HBA), HBA firmware, HBA boot BIOS, and ONTAP version support SAN booting.

Steps

- 1. Create a SAN boot LUN and map it to the host.
- 2. 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.

3. Verify that the configuration was successful by rebooting the host and verifying that the OS is up and running.

Step 2: Install the Linux Host Utilities

NetApp strongly recommends installing the Linux Host Utilities to support ONTAP LUN management and assist technical support with gathering configuration data.

Install Linux Host Utilities 7.1.



Installing the Linux Host Utilities doesn't change any host timeout settings on your Linux host.

Step 3: Confirm the multipath configuration for your host

You can use multipathing with CentOS 7.9 to manage ONTAP LUNs.

To ensure that multipathing is configured correctly for your host, verify that the /etc/multipath.conf file is defined and that you have the NetApp recommended settings configured for your ONTAP LUNs.

Steps

1. Verify that the /etc/multipath.conf file exits. If the file doesn't exist, create an empty, zero-byte file:

touch /etc/multipath.conf

2. The first time the multipath.conf file is created, you might need to enable and start the multipath services to load the recommended settings:

chkconfig multipathd on

/etc/init.d/multipathd start

3. Each time you boot the host, the empty /etc/multipath.conf zero-byte file automatically loads the NetApp recommended host multipath parameters as the default settings. You shouldn't need to make

changes to the /etc/multipath.conf file for your host because the operating system is compiled with the multipath parameters that recognize and manage ONTAP LUNs correctly.

The following table shows the Linux OS native compiled multipath parameter settings for ONTAP LUNs.

Show parameter settings

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"
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

4. Verify the parameter settings and path status for your ONTAP LUNs:

The default multipath parameters support ASA, AFF, and FAS configurations. In these configurations, a single ONTAP LUN shouldn't require more than four paths. If there are more than four paths, it might cause issues with the paths during a storage failure.

The following example outputs show the correct parameter settings and path status for ONTAP LUNs in an ASA, AFF, or FAS configuration.

ASA configuration

An ASA configuration optimizes all paths to a given LUN, keeping them active. This improves performance by serving I/O operations through all paths at the same time.

AFF or FAS configuration

An AFF or FAS configuration should have two groups of paths with higher and lower priorities. Higher priority Active/Optimized paths are served by the controller where the aggregate is located. Lower priority paths are active but non-optimized because they are served by a different controller. Non-optimized paths are only used when optimized paths aren't available.

The following example displays the 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
```

Step 4: Optionally, exclude a device from multipathing

If required, you can exclude a device from multipathing by adding the WWID for the unwanted device to the "blacklist" stanza for the multipath.conf file.

Steps

1. Determine the WWID:

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

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

An example WWID is 360030057024d0730239134810c0cb833.

2. Add the WWID to the "blacklist" stanza:

Step 5: Customize multipath parameters for ONTAP LUNs

If your host is connected to LUNs from other vendors and any of the multipath parameter settings are overridden, you need to correct them by adding stanzas later in the multipath.conf file that apply specifically to ONTAP LUNs. If you don't do this, the ONTAP LUNs might not work as expected.

Check your /etc/multipath.conf file, especially in the defaults section, for settings that might be overriding the default settings for multipath parameters.



You shouldn't override the recommended parameter settings for ONTAP LUNs. These settings are required for optimal performance of your host configuration. Contact NetApp support, your OS vendor, or both for more information.

The following example shows how to correct an overridden default. In this example, the multipath.conf file defines values for path_checker and no_path_retry that aren't compatible with ONTAP LUNs, and you can't remove these parameters because ONTAP storage arrays are still attached to the host. Instead, you correct the values for path_checker and no_path_retry by adding a device stanza to the multipath.conf file that applies specifically to the ONTAP LUNs.

```
defaults {
   path checker
                      readsector0
   no path retry
                      fail
devices {
   device {
      vendor
                       "NETAPP"
      product
                       "LUN"
      no_path_retry
                       queue
      path checker
                       tur
   }
}
```

Step 6: Review the known issues

The CentOS 7.9 host with ONTAP storage has the following known issues:

NetApp Bug ID	Title	Description
1440718	If you unmap or map a LUN without performing a SCSI rescan, it might lead to data corruption on the host.	When you set the 'disable_changed_wwids' multipath configuration parameter to YES, it disables access to the path device in the event of a WWID change. Multipath will disable access to the path device until the WWID of the path is restored to the WWID of the multipath device. To learn more, see NetApp Knowledge Base: The filesystem corruption on iSCSI LUN on the Oracle Linux 7.

What's next?

- · Learn about using the Linux Host Utilities tool.
- Learn about 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 doesn't 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.

Configure CentOS 7.8 for FCP and iSCSI for ONTAP storage

The Linux Host Utilities software provides management and diagnostic tools for Linux hosts that are connected to ONTAP storage. When you install the Linux Host Utilities on a CentOS 7.8 host, you can use the Host Utilities to help you manage FCP and iSCSI protocol operations with ONTAP LUNs.



You don't need to manually configure Kernel-based Virtual Machine (KVM) settings because ONTAP LUNs are automatically mapped to the hypervisor.

Step 1: Optionally, enable SAN booting

You can configure your host to use SAN booting to simplify deployment and improve scalability.

Before you begin

Use the Interoperability Matrix Tool to verify that your Linux OS, host bus adapter (HBA), HBA firmware, HBA boot BIOS, and ONTAP version support SAN booting.

Steps

- 1. Create a SAN boot LUN and map it to the host.
- 2. 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.

Verify that the configuration was successful by rebooting the host and verifying that the OS is up and running.

Step 2: Install the Linux Host Utilities

NetApp strongly recommends installing the Linux Host Utilities to support ONTAP LUN management and assist technical support with gathering configuration data.

Install Linux Host Utilities 7.1.



Installing the Linux Host Utilities doesn't change any host timeout settings on your Linux host.

Step 3: Confirm the multipath configuration for your host

You can use multipathing with CentOS 7.8 to manage ONTAP LUNs.

To ensure that multipathing is configured correctly for your host, verify that the /etc/multipath.conf file is defined and that you have the NetApp recommended settings configured for your ONTAP LUNs.

Steps

1. Verify that the /etc/multipath.conf file exits. If the file doesn't exist, create an empty, zero-byte file:

touch /etc/multipath.conf

2. The first time the multipath.conf file is created, you might need to enable and start the multipath services to load the recommended settings:

chkconfig multipathd on

/etc/init.d/multipathd start

3. Each time you boot the host, the empty /etc/multipath.conf zero-byte file automatically loads the NetApp recommended host multipath parameters as the default settings. You shouldn't need to make changes to the /etc/multipath.conf file for your host because the operating system is compiled with the multipath parameters that recognize and manage ONTAP LUNs correctly.

The following table shows the Linux OS native compiled multipath parameter settings for ONTAP LUNs.

Show parameter settings

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"
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

4. Verify the parameter settings and path status for your ONTAP LUNs:

multipath -11

The default multipath parameters support ASA, AFF, and FAS configurations. In these configurations, a single ONTAP LUN shouldn't require more than four paths. If there are more than four paths, it might cause issues with the paths during a storage failure.

The following example outputs show the correct parameter settings and path status for ONTAP LUNs in an ASA, AFF, or FAS configuration.

ASA configuration

An ASA configuration optimizes all paths to a given LUN, keeping them active. This improves performance by serving I/O operations through all paths at the same time.

AFF or FAS configuration

An AFF or FAS configuration should have two groups of paths with higher and lower priorities. Higher priority Active/Optimized paths are served by the controller where the aggregate is located. Lower priority paths are active but non-optimized because they are served by a different controller. Non-optimized paths are only used when optimized paths aren't available.

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

```
multipath -11
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
```

Step 4: Optionally, exclude a device from multipathing

If required, you can exclude a device from multipathing by adding the WWID for the unwanted device to the "blacklist" stanza for the multipath.conf file.

Steps

1. Determine the WWID:

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

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

An example WWID is 360030057024d0730239134810c0cb833.

Add the WWID to the "blacklist" stanza:

Step 5: Customize multipath parameters for ONTAP LUNs

If your host is connected to LUNs from other vendors and any of the multipath parameter settings are overridden, you need to correct them by adding stanzas later in the multipath.conf file that apply specifically to ONTAP LUNs. If you don't do this, the ONTAP LUNs might not work as expected.

Check your /etc/multipath.conf file, especially in the defaults section, for settings that might be overriding the default settings for multipath parameters.



You shouldn't override the recommended parameter settings for ONTAP LUNs. These settings are required for optimal performance of your host configuration. Contact NetApp support, your OS vendor, or both for more information.

The following example shows how to correct an overridden default. In this example, the multipath.conf file defines values for path_checker and no_path_retry that aren't compatible with ONTAP LUNs, and you can't remove these parameters because ONTAP storage arrays are still attached to the host. Instead, you correct the values for path_checker and no_path_retry by adding a device stanza to the multipath.conf file that applies specifically to the ONTAP LUNs.

```
defaults {
   path checker
                      readsector0
   no path retry
                      fail
devices {
   device {
      vendor
                       "NETAPP"
      product
                       "LUN"
      no_path_retry
                       queue
      path checker
                       tur
   }
}
```

Step 6: Review the known issues

The CentOS 7.8 host with ONTAP storage has the following known issues:

NetApp Bug ID	Title	Description
1440718	If you unmap or map a LUN without performing a SCSI rescan, it might lead to data corruption on the host.	When you set the 'disable_changed_wwids' multipath configuration parameter to YES, it disables access to the path device in the event of a WWID change. Multipath will disable access to the path device until the WWID of the path is restored to the WWID of the multipath device. To learn more, see NetApp Knowledge Base: The filesystem corruption on iSCSI LUN on the Oracle Linux 7.

What's next?

- Learn about using the Linux Host Utilities tool.
- Learn about 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 doesn't 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.

Configure CentOS 7.7 for FCP and iSCSI for ONTAP storage

The Linux Host Utilities software provides management and diagnostic tools for Linux hosts that are connected to ONTAP storage. When you install the Linux Host Utilities on a CentOS 7.7 host, you can use the Host Utilities to help you manage FCP and iSCSI protocol operations with ONTAP LUNs.



You don't need to manually configure Kernel-based Virtual Machine (KVM) settings because ONTAP LUNs are automatically mapped to the hypervisor.

Step 1: Optionally, enable SAN booting

You can configure your host to use SAN booting to simplify deployment and improve scalability.

Before you begin

Use the Interoperability Matrix Tool to verify that your Linux OS, host bus adapter (HBA), HBA firmware, HBA boot BIOS, and ONTAP version support SAN booting.

Steps

- 1. Create a SAN boot LUN and map it to the host.
- 2. 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.

Verify that the configuration was successful by rebooting the host and verifying that the OS is up and running.

Step 2: Install the Linux Host Utilities

NetApp strongly recommends installing the Linux Host Utilities to support ONTAP LUN management and assist technical support with gathering configuration data.

Install Linux Host Utilities 7.1.



Installing the Linux Host Utilities doesn't change any host timeout settings on your Linux host.

Step 3: Confirm the multipath configuration for your host

You can use multipathing with CentOS 7.7 to manage ONTAP LUNs.

To ensure that multipathing is configured correctly for your host, verify that the /etc/multipath.conf file is defined and that you have the NetApp recommended settings configured for your ONTAP LUNs.

Steps

1. Verify that the /etc/multipath.conf file exits. If the file doesn't exist, create an empty, zero-byte file:

touch /etc/multipath.conf

2. The first time the multipath.conf file is created, you might need to enable and start the multipath services to load the recommended settings:

chkconfig multipathd on

/etc/init.d/multipathd start

3. Each time you boot the host, the empty /etc/multipath.conf zero-byte file automatically loads the NetApp recommended host multipath parameters as the default settings. You shouldn't need to make changes to the /etc/multipath.conf file for your host because the operating system is compiled with the multipath parameters that recognize and manage ONTAP LUNs correctly.

The following table shows the Linux OS native compiled multipath parameter settings for ONTAP LUNs.

Show parameter settings

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"
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

4. Verify the parameter settings and path status for your ONTAP LUNs:

multipath -11

The default multipath parameters support ASA, AFF, and FAS configurations. In these configurations, a single ONTAP LUN shouldn't require more than four paths. If there are more than four paths, it might cause issues with the paths during a storage failure.

The following example outputs show the correct parameter settings and path status for ONTAP LUNs in an ASA, AFF, or FAS configuration.

ASA configuration

An ASA configuration optimizes all paths to a given LUN, keeping them active. This improves performance by serving I/O operations through all paths at the same time.

AFF or FAS configuration

An AFF or FAS configuration should have two groups of paths with higher and lower priorities. Higher priority Active/Optimized paths are served by the controller where the aggregate is located. Lower priority paths are active but non-optimized because they are served by a different controller. Non-optimized paths are only used when optimized paths aren't available.

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

```
multipath -11
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
```

Step 4: Optionally, exclude a device from multipathing

If required, you can exclude a device from multipathing by adding the WWID for the unwanted device to the "blacklist" stanza for the multipath.conf file.

Steps

1. Determine the WWID:

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

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

An example WWID is 360030057024d0730239134810c0cb833.

2. Add the WWID to the "blacklist" stanza:

Step 5: Customize multipath parameters for ONTAP LUNs

If your host is connected to LUNs from other vendors and any of the multipath parameter settings are overridden, you need to correct them by adding stanzas later in the multipath.conf file that apply specifically to ONTAP LUNs. If you don't do this, the ONTAP LUNs might not work as expected.

Check your /etc/multipath.conf file, especially in the defaults section, for settings that might be overriding the default settings for multipath parameters.



You shouldn't override the recommended parameter settings for ONTAP LUNs. These settings are required for optimal performance of your host configuration. Contact NetApp support, your OS vendor, or both for more information.

The following example shows how to correct an overridden default. In this example, the multipath.conf file defines values for path_checker and no_path_retry that aren't compatible with ONTAP LUNs, and you can't remove these parameters because ONTAP storage arrays are still attached to the host. Instead, you correct the values for path_checker and no_path_retry by adding a device stanza to the multipath.conf file that applies specifically to the ONTAP LUNs.

```
defaults {
   path checker
                      readsector0
   no path retry
                      fail
devices {
   device {
      vendor
                       "NETAPP"
      product
                       "LUN"
      no_path_retry
                       queue
      path checker
                       tur
   }
}
```

Step 6: Review the known issues

The CentOS 7.7 host with ONTAP storage has the following known issues:

NetApp Bug ID	Title	Description
1440718	If you unmap or map a LUN without performing a SCSI rescan, it might lead to data corruption on the host.	When you set the 'disable_changed_wwids' multipath configuration parameter to YES, it disables access to the path device in the event of a WWID change. Multipath will disable access to the path device until the WWID of the path is restored to the WWID of the multipath device. To learn more, see NetApp Knowledge Base: The filesystem corruption on iSCSI LUN on the Oracle Linux 7.

What's next?

- · Learn about using the Linux Host Utilities tool.
- Learn about 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 doesn't 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.

Configure CentOS 7.6 for FCP and iSCSI for ONTAP storage

The Linux Host Utilities software provides management and diagnostic tools for Linux hosts that are connected to ONTAP storage. When you install the Linux Host Utilities on a CentOS 7.6 host, you can use the Host Utilities to help you manage FCP and iSCSI protocol operations with ONTAP LUNs.



You don't need to manually configure Kernel-based Virtual Machine (KVM) settings because ONTAP LUNs are automatically mapped to the hypervisor.

Step 1: Optionally, enable SAN booting

You can configure your host to use SAN booting to simplify deployment and improve scalability.

Before you begin

Use the Interoperability Matrix Tool to verify that your Linux OS, host bus adapter (HBA), HBA firmware, HBA boot BIOS, and ONTAP version support SAN booting.

Steps

- 1. Create a SAN boot LUN and map it to the host.
- 2. 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.

Verify that the configuration was successful by rebooting the host and verifying that the OS is up and running.

Step 2: Install the Linux Host Utilities

NetApp strongly recommends installing the Linux Host Utilities to support ONTAP LUN management and assist technical support with gathering configuration data.

Install Linux Host Utilities 7.1.



Installing the Linux Host Utilities doesn't change any host timeout settings on your Linux host.

Step 3: Confirm the multipath configuration for your host

You can use multipathing with CentOS 7.6 to manage ONTAP LUNs.

To ensure that multipathing is configured correctly for your host, verify that the /etc/multipath.conf file is defined and that you have the NetApp recommended settings configured for your ONTAP LUNs.

Steps

1. Verify that the /etc/multipath.conf file exits. If the file doesn't exist, create an empty, zero-byte file:

touch /etc/multipath.conf

2. The first time the multipath.conf file is created, you might need to enable and start the multipath services to load the recommended settings:

chkconfig multipathd on

/etc/init.d/multipathd start

3. Each time you boot the host, the empty /etc/multipath.conf zero-byte file automatically loads the NetApp recommended host multipath parameters as the default settings. You shouldn't need to make changes to the /etc/multipath.conf file for your host because the operating system is compiled with the multipath parameters that recognize and manage ONTAP LUNs correctly.

The following table shows the Linux OS native compiled multipath parameter settings for ONTAP LUNs.

Show parameter settings

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"
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

4. Verify the parameter settings and path status for your ONTAP LUNs:

multipath -11

The default multipath parameters support ASA, AFF, and FAS configurations. In these configurations, a single ONTAP LUN shouldn't require more than four paths. If there are more than four paths, it might cause issues with the paths during a storage failure.

The following example outputs show the correct parameter settings and path status for ONTAP LUNs in an ASA, AFF, or FAS configuration.

ASA configuration

An ASA configuration optimizes all paths to a given LUN, keeping them active. This improves performance by serving I/O operations through all paths at the same time.

AFF or FAS configuration

An AFF or FAS configuration should have two groups of paths with higher and lower priorities. Higher priority Active/Optimized paths are served by the controller where the aggregate is located. Lower priority paths are active but non-optimized because they are served by a different controller. Non-optimized paths are only used when optimized paths aren't available.

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

```
multipath -11
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
```

Step 4: Optionally, exclude a device from multipathing

If required, you can exclude a device from multipathing by adding the WWID for the unwanted device to the "blacklist" stanza for the multipath.conf file.

Steps

1. Determine the WWID:

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

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

An example WWID is 360030057024d0730239134810c0cb833.

2. Add the WWID to the "blacklist" stanza:

Step 5: Customize multipath parameters for ONTAP LUNs

If your host is connected to LUNs from other vendors and any of the multipath parameter settings are overridden, you need to correct them by adding stanzas later in the multipath.conf file that apply specifically to ONTAP LUNs. If you don't do this, the ONTAP LUNs might not work as expected.

Check your /etc/multipath.conf file, especially in the defaults section, for settings that might be overriding the default settings for multipath parameters.



You shouldn't override the recommended parameter settings for ONTAP LUNs. These settings are required for optimal performance of your host configuration. Contact NetApp support, your OS vendor, or both for more information.

The following example shows how to correct an overridden default. In this example, the multipath.conf file defines values for path_checker and no_path_retry that aren't compatible with ONTAP LUNs, and you can't remove these parameters because ONTAP storage arrays are still attached to the host. Instead, you correct the values for path_checker and no_path_retry by adding a device stanza to the multipath.conf file that applies specifically to the ONTAP LUNs.

```
defaults {
   path checker
                      readsector0
   no path retry
                      fail
devices {
   device {
      vendor
                       "NETAPP"
      product
                       "LUN"
      no_path_retry
                       queue
      path checker
                       tur
   }
}
```

Step 6: Review the known issues

The CentOS 7.6 host with ONTAP storage has the following known issues:

NetApp Bug ID	Title	Description
1440718	If you unmap or map a LUN without performing a SCSI rescan, it might lead to data corruption on the host.	When you set the 'disable_changed_wwids' multipath configuration parameter to YES, it disables access to the path device in the event of a WWID change. Multipath will disable access to the path device until the WWID of the path is restored to the WWID of the multipath device. To learn more, see NetApp Knowledge Base: The filesystem corruption on iSCSI LUN on the Oracle Linux 7.

What's next?

- Learn about using the Linux Host Utilities tool.
- Learn about 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 doesn't 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.

Configure CentOS 7.5 for FCP and iSCSI for ONTAP storage

The Linux Host Utilities software provides management and diagnostic tools for Linux hosts that are connected to ONTAP storage. When you install the Linux Host Utilities on a CentOS 7.5 host, you can use the Host Utilities to help you manage FCP and iSCSI protocol operations with ONTAP LUNs.



You don't need to manually configure Kernel-based Virtual Machine (KVM) settings because ONTAP LUNs are automatically mapped to the hypervisor.

Step 1: Optionally, enable SAN booting

You can configure your host to use SAN booting to simplify deployment and improve scalability.

Before you begin

Use the Interoperability Matrix Tool to verify that your Linux OS, host bus adapter (HBA), HBA firmware, HBA boot BIOS, and ONTAP version support SAN booting.

Steps

- 1. Create a SAN boot LUN and map it to the host.
- 2. 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.

Verify that the configuration was successful by rebooting the host and verifying that the OS is up and running.

Step 2: Install the Linux Host Utilities

NetApp strongly recommends installing the Linux Host Utilities to support ONTAP LUN management and assist technical support with gathering configuration data.

Install Linux Host Utilities 7.1.



Installing the Linux Host Utilities doesn't change any host timeout settings on your Linux host.

Step 3: Confirm the multipath configuration for your host

You can use multipathing with CentOS 7.5 to manage ONTAP LUNs.

To ensure that multipathing is configured correctly for your host, verify that the /etc/multipath.conf file is defined and that you have the NetApp recommended settings configured for your ONTAP LUNs.

Steps

1. Verify that the /etc/multipath.conf file exits. If the file doesn't exist, create an empty, zero-byte file:

touch /etc/multipath.conf

2. The first time the multipath.conf file is created, you might need to enable and start the multipath services to load the recommended settings:

chkconfig multipathd on

/etc/init.d/multipathd start

3. Each time you boot the host, the empty /etc/multipath.conf zero-byte file automatically loads the NetApp recommended host multipath parameters as the default settings. You shouldn't need to make changes to the /etc/multipath.conf file for your host because the operating system is compiled with the multipath parameters that recognize and manage ONTAP LUNs correctly.

The following table shows the Linux OS native compiled multipath parameter settings for ONTAP LUNs.

Show parameter settings

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"
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

4. Verify the parameter settings and path status for your ONTAP LUNs:

multipath -11

The default multipath parameters support ASA, AFF, and FAS configurations. In these configurations, a single ONTAP LUN shouldn't require more than four paths. If there are more than four paths, it might cause issues with the paths during a storage failure.

The following example outputs show the correct parameter settings and path status for ONTAP LUNs in an ASA, AFF, or FAS configuration.

ASA configuration

An ASA configuration optimizes all paths to a given LUN, keeping them active. This improves performance by serving I/O operations through all paths at the same time.

AFF or FAS configuration

An AFF or FAS configuration should have two groups of paths with higher and lower priorities. Higher priority Active/Optimized paths are served by the controller where the aggregate is located. Lower priority paths are active but non-optimized because they are served by a different controller. Non-optimized paths are only used when optimized paths aren't available.

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

```
multipath -11
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
```

Step 4: Optionally, exclude a device from multipathing

If required, you can exclude a device from multipathing by adding the WWID for the unwanted device to the "blacklist" stanza for the multipath.conf file.

Steps

1. Determine the WWID:

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

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

An example WWID is 360030057024d0730239134810c0cb833.

2. Add the WWID to the "blacklist" stanza:

Step 5: Customize multipath parameters for ONTAP LUNs

If your host is connected to LUNs from other vendors and any of the multipath parameter settings are overridden, you need to correct them by adding stanzas later in the multipath.conf file that apply specifically to ONTAP LUNs. If you don't do this, the ONTAP LUNs might not work as expected.

Check your /etc/multipath.conf file, especially in the defaults section, for settings that might be overriding the default settings for multipath parameters.



You shouldn't override the recommended parameter settings for ONTAP LUNs. These settings are required for optimal performance of your host configuration. Contact NetApp support, your OS vendor, or both for more information.

The following example shows how to correct an overridden default. In this example, the multipath.conf file defines values for path_checker and no_path_retry that aren't compatible with ONTAP LUNs, and you can't remove these parameters because ONTAP storage arrays are still attached to the host. Instead, you correct the values for path_checker and no_path_retry by adding a device stanza to the multipath.conf file that applies specifically to the ONTAP LUNs.

```
defaults {
   path checker
                      readsector0
   no path retry
                      fail
devices {
   device {
      vendor
                       "NETAPP"
      product
                       "LUN"
      no_path_retry
                       queue
      path checker
                       tur
   }
}
```

Step 6: Review the known issues

The CentOS 7.5 host with ONTAP storage has the following known issues:

NetApp Bug ID	Title	Description
1440718	If you unmap or map a LUN without performing a SCSI rescan, it might lead to data corruption on the host.	When you set the 'disable_changed_wwids' multipath configuration parameter to YES, it disables access to the path device in the event of a WWID change. Multipath will disable access to the path device until the WWID of the path is restored to the WWID of the multipath device. To learn more, see NetApp Knowledge Base: The filesystem corruption on iSCSI LUN on the Oracle Linux 7.

What's next?

- · Learn about using the Linux Host Utilities tool.
- Learn about 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 doesn't 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.

Configure CentOS 7.4 for FCP and iSCSI for ONTAP storage

The Linux Host Utilities software provides management and diagnostic tools for Linux hosts that are connected to ONTAP storage. When you install the Linux Host Utilities on a CentOS 7.4 host, you can use the Host Utilities to help you manage FCP and iSCSI protocol operations with ONTAP LUNs.



You don't need to manually configure Kernel-based Virtual Machine (KVM) settings because ONTAP LUNs are automatically mapped to the hypervisor.

Step 1: Optionally, enable SAN booting

You can configure your host to use SAN booting to simplify deployment and improve scalability.

Before you begin

Use the Interoperability Matrix Tool to verify that your Linux OS, host bus adapter (HBA), HBA firmware, HBA boot BIOS, and ONTAP version support SAN booting.

Steps

- 1. Create a SAN boot LUN and map it to the host.
- 2. 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.

Verify that the configuration was successful by rebooting the host and verifying that the OS is up and running.

Step 2: Install the Linux Host Utilities

NetApp strongly recommends installing the Linux Host Utilities to support ONTAP LUN management and assist technical support with gathering configuration data.

Install Linux Host Utilities 7.1.



Installing the Linux Host Utilities doesn't change any host timeout settings on your Linux host.

Step 3: Confirm the multipath configuration for your host

You can use multipathing with CentOS 7.4 to manage ONTAP LUNs.

To ensure that multipathing is configured correctly for your host, verify that the /etc/multipath.conf file is defined and that you have the NetApp recommended settings configured for your ONTAP LUNs.

Steps

1. Verify that the /etc/multipath.conf file exits. If the file doesn't exist, create an empty, zero-byte file:

touch /etc/multipath.conf

2. The first time the multipath.conf file is created, you might need to enable and start the multipath services to load the recommended settings:

chkconfig multipathd on

/etc/init.d/multipathd start

3. Each time you boot the host, the empty /etc/multipath.conf zero-byte file automatically loads the NetApp recommended host multipath parameters as the default settings. You shouldn't need to make changes to the /etc/multipath.conf file for your host because the operating system is compiled with the multipath parameters that recognize and manage ONTAP LUNs correctly.

The following table shows the Linux OS native compiled multipath parameter settings for ONTAP LUNs.

Show parameter settings

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"
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

4. Verify the parameter settings and path status for your ONTAP LUNs:

multipath -11

The default multipath parameters support ASA, AFF, and FAS configurations. In these configurations, a single ONTAP LUN shouldn't require more than four paths. If there are more than four paths, it might cause issues with the paths during a storage failure.

The following example outputs show the correct parameter settings and path status for ONTAP LUNs in an ASA, AFF, or FAS configuration.

ASA configuration

An ASA configuration optimizes all paths to a given LUN, keeping them active. This improves performance by serving I/O operations through all paths at the same time.

AFF or FAS configuration

An AFF or FAS configuration should have two groups of paths with higher and lower priorities. Higher priority Active/Optimized paths are served by the controller where the aggregate is located. Lower priority paths are active but non-optimized because they are served by a different controller. Non-optimized paths are only used when optimized paths aren't available.

The following example displays the 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
```

Step 4: Optionally, exclude a device from multipathing

If required, you can exclude a device from multipathing by adding the WWID for the unwanted device to the "blacklist" stanza for the multipath.conf file.

Steps

1. Determine the WWID:

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

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

An example WWID is 360030057024d0730239134810c0cb833.

2. Add the WWID to the "blacklist" stanza:

Step 5: Customize multipath parameters for ONTAP LUNs

If your host is connected to LUNs from other vendors and any of the multipath parameter settings are overridden, you need to correct them by adding stanzas later in the multipath.conf file that apply specifically to ONTAP LUNs. If you don't do this, the ONTAP LUNs might not work as expected.

Check your /etc/multipath.conf file, especially in the defaults section, for settings that might be overriding the default settings for multipath parameters.



You shouldn't override the recommended parameter settings for ONTAP LUNs. These settings are required for optimal performance of your host configuration. Contact NetApp support, your OS vendor, or both for more information.

The following example shows how to correct an overridden default. In this example, the multipath.conf file defines values for path_checker and no_path_retry that aren't compatible with ONTAP LUNs, and you can't remove these parameters because ONTAP storage arrays are still attached to the host. Instead, you correct the values for path_checker and no_path_retry by adding a device stanza to the multipath.conf file that applies specifically to the ONTAP LUNs.

```
defaults {
   path checker
                      readsector0
   no path retry
                      fail
devices {
   device {
      vendor
                       "NETAPP"
      product
                       "LUN"
      no_path_retry
                       queue
      path checker
                       tur
   }
}
```

Step 6: Review the known issues

The CentOS 7.4 host with ONTAP storage has the following known issues:

NetApp Bug ID	Title	Description
1440718	If you unmap or map a LUN without performing a SCSI rescan, it might lead to data corruption on the host.	When you set the 'disable_changed_wwids' multipath configuration parameter to YES, it disables access to the path device in the event of a WWID change. Multipath will disable access to the path device until the WWID of the path is restored to the WWID of the multipath device. To learn more, see NetApp Knowledge Base: The filesystem corruption on iSCSI LUN on the Oracle Linux 7.

What's next?

- Learn about using the Linux Host Utilities tool.
- Learn about 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 doesn't 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.

Configure CentOS 7.3 for FCP and iSCSI for ONTAP storage

The Linux Host Utilities software provides management and diagnostic tools for Linux hosts that are connected to ONTAP storage. When you install the Linux Host Utilities on a CentOS 7.3 host, you can use the Host Utilities to help you manage FCP and iSCSI protocol operations with ONTAP LUNs.



You don't need to manually configure Kernel-based Virtual Machine (KVM) settings because ONTAP LUNs are automatically mapped to the hypervisor.

Step 1: Optionally, enable SAN booting

You can configure your host to use SAN booting to simplify deployment and improve scalability.

Before you begin

Use the Interoperability Matrix Tool to verify that your Linux OS, host bus adapter (HBA), HBA firmware, HBA boot BIOS, and ONTAP version support SAN booting.

Steps

- 1. Create a SAN boot LUN and map it to the host.
- 2. 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.

Verify that the configuration was successful by rebooting the host and verifying that the OS is up and running.

Step 2: Install the Linux Host Utilities

NetApp strongly recommends installing the Linux Host Utilities to support ONTAP LUN management and assist technical support with gathering configuration data.

Install Linux Host Utilities 7.1.



Installing the Linux Host Utilities doesn't change any host timeout settings on your Linux host.

Step 3: Confirm the multipath configuration for your host

You can use multipathing with CentOS 7.3 to manage ONTAP LUNs.

To ensure that multipathing is configured correctly for your host, verify that the /etc/multipath.conf file is defined and that you have the NetApp recommended settings configured for your ONTAP LUNs.

Steps

1. Verify that the /etc/multipath.conf file exits. If the file doesn't exist, create an empty, zero-byte file:

touch /etc/multipath.conf

2. The first time the multipath.conf file is created, you might need to enable and start the multipath services to load the recommended settings:

chkconfig multipathd on

/etc/init.d/multipathd start

3. Each time you boot the host, the empty /etc/multipath.conf zero-byte file automatically loads the NetApp recommended host multipath parameters as the default settings. You shouldn't need to make changes to the /etc/multipath.conf file for your host because the operating system is compiled with the multipath parameters that recognize and manage ONTAP LUNs correctly.

The following table shows the Linux OS native compiled multipath parameter settings for ONTAP LUNs.

Show parameter settings

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"
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

4. Verify the parameter settings and path status for your ONTAP LUNs:

multipath -11

The default multipath parameters support ASA, AFF, and FAS configurations. In these configurations, a single ONTAP LUN shouldn't require more than four paths. If there are more than four paths, it might cause issues with the paths during a storage failure.

The following example outputs show the correct parameter settings and path status for ONTAP LUNs in an ASA, AFF, or FAS configuration.

ASA configuration

An ASA configuration optimizes all paths to a given LUN, keeping them active. This improves performance by serving I/O operations through all paths at the same time.

AFF or FAS configuration

An AFF or FAS configuration should have two groups of paths with higher and lower priorities. Higher priority Active/Optimized paths are served by the controller where the aggregate is located. Lower priority paths are active but non-optimized because they are served by a different controller. Non-optimized paths are only used when optimized paths aren't available.

The following example displays the 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
```

Step 4: Optionally, exclude a device from multipathing

If required, you can exclude a device from multipathing by adding the WWID for the unwanted device to the "blacklist" stanza for the multipath.conf file.

Steps

1. Determine the WWID:

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

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

An example WWID is 360030057024d0730239134810c0cb833.

Add the WWID to the "blacklist" stanza:

Step 5: Customize multipath parameters for ONTAP LUNs

If your host is connected to LUNs from other vendors and any of the multipath parameter settings are overridden, you need to correct them by adding stanzas later in the multipath.conf file that apply specifically to ONTAP LUNs. If you don't do this, the ONTAP LUNs might not work as expected.

Check your /etc/multipath.conf file, especially in the defaults section, for settings that might be overriding the default settings for multipath parameters.



You shouldn't override the recommended parameter settings for ONTAP LUNs. These settings are required for optimal performance of your host configuration. Contact NetApp support, your OS vendor, or both for more information.

The following example shows how to correct an overridden default. In this example, the multipath.conf file defines values for path_checker and no_path_retry that aren't compatible with ONTAP LUNs, and you can't remove these parameters because ONTAP storage arrays are still attached to the host. Instead, you correct the values for path_checker and no_path_retry by adding a device stanza to the multipath.conf file that applies specifically to the ONTAP LUNs.

```
defaults {
   path checker
                      readsector0
                      fail
   no path retry
devices {
   device {
      vendor
                       "NETAPP"
      product
                       "LUN"
      no_path_retry
                       queue
      path checker
                       tur
   }
}
```

Step 6: Review the known issues

There are no known issues.

What's next?

- Learn about using the Linux Host Utilities tool.
- Learn about 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 doesn't 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.

Configure CentOS 7.2 for FCP and iSCSI for ONTAP storage

The Linux Host Utilities software provides management and diagnostic tools for Linux hosts that are connected to ONTAP storage. When you install the Linux Host Utilities on a CentOS 7.2 host, you can use the Host Utilities to help you manage FCP and iSCSI protocol operations with ONTAP LUNs.



You don't need to manually configure Kernel-based Virtual Machine (KVM) settings because ONTAP LUNs are automatically mapped to the hypervisor.

Step 1: Optionally, enable SAN booting

You can configure your host to use SAN booting to simplify deployment and improve scalability.

Before you begin

Use the Interoperability Matrix Tool to verify that your Linux OS, host bus adapter (HBA), HBA firmware, HBA boot BIOS, and ONTAP version support SAN booting.

Steps

- 1. Create a SAN boot LUN and map it to the host.
- 2. 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.

3. Verify that the configuration was successful by rebooting the host and verifying that the OS is up and running.

Step 2: Install the Linux Host Utilities

NetApp strongly recommends installing the Linux Host Utilities to support ONTAP LUN management and assist technical support with gathering configuration data.

Install Linux Host Utilities 7.1.



Installing the Linux Host Utilities doesn't change any host timeout settings on your Linux host.

Step 3: Confirm the multipath configuration for your host

You can use multipathing with CentOS 7.2 to manage ONTAP LUNs.

To ensure that multipathing is configured correctly for your host, verify that the /etc/multipath.conf file is defined and that you have the NetApp recommended settings configured for your ONTAP LUNs.

Steps

1. Verify that the /etc/multipath.conf file exits. If the file doesn't exist, create an empty, zero-byte file:

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

2. The first time the multipath.conf file is created, you might need to enable and start the multipath services to load the recommended settings:

chkconfig multipathd on

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

3. Each time you boot the host, the empty /etc/multipath.conf zero-byte file automatically loads the NetApp recommended host multipath parameters as the default settings. You shouldn't need to make changes to the /etc/multipath.conf file for your host because the operating system is compiled with the multipath parameters that recognize and manage ONTAP LUNs correctly.

The following table shows the Linux OS native compiled multipath parameter settings for ONTAP LUNs.

Show parameter settings

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"
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

4. Verify the parameter settings and path status for your ONTAP LUNs:

The default multipath parameters support ASA, AFF, and FAS configurations. In these configurations, a single ONTAP LUN shouldn't require more than four paths. If there are more than four paths, it might cause issues with the paths during a storage failure.

The following example outputs show the correct parameter settings and path status for ONTAP LUNs in an ASA, AFF, or FAS configuration.

ASA configuration

An ASA configuration optimizes all paths to a given LUN, keeping them active. This improves performance by serving I/O operations through all paths at the same time.

AFF or FAS configuration

An AFF or FAS configuration should have two groups of paths with higher and lower priorities. Higher priority Active/Optimized paths are served by the controller where the aggregate is located. Lower priority paths are active but non-optimized because they are served by a different controller. Non-optimized paths are only used when optimized paths aren't available.

The following example displays the 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
```

Step 4: Optionally, exclude a device from multipathing

If required, you can exclude a device from multipathing by adding the WWID for the unwanted device to the "blacklist" stanza for the multipath.conf file.

Steps

1. Determine the WWID:

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

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

An example WWID is 360030057024d0730239134810c0cb833.

2. Add the WWID to the "blacklist" stanza:

Step 5: Customize multipath parameters for ONTAP LUNs

If your host is connected to LUNs from other vendors and any of the multipath parameter settings are overridden, you need to correct them by adding stanzas later in the multipath.conf file that apply specifically to ONTAP LUNs. If you don't do this, the ONTAP LUNs might not work as expected.

Check your /etc/multipath.conf file, especially in the defaults section, for settings that might be overriding the default settings for multipath parameters.



You shouldn't override the recommended parameter settings for ONTAP LUNs. These settings are required for optimal performance of your host configuration. Contact NetApp support, your OS vendor, or both for more information.

The following example shows how to correct an overridden default. In this example, the multipath.conf file defines values for path_checker and no_path_retry that aren't compatible with ONTAP LUNs, and you can't remove these parameters because ONTAP storage arrays are still attached to the host. Instead, you correct the values for path_checker and no_path_retry by adding a device stanza to the multipath.conf file that applies specifically to the ONTAP LUNs.

```
defaults {
  path checker
                      readsector0
  no path retry
                      fail
devices {
   device {
      vendor
                       "NETAPP"
      product
                       "LUN"
      no_path_retry
                       queue
      path checker
                       tur
   }
}
```

Step 6: Review the known issues

There are no known issues.

What's next?

- · Learn about using the Linux Host Utilities tool.
- Learn about 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 doesn't 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.

Configure CentOS 7.1 for FCP and iSCSI for ONTAP storage

The Linux Host Utilities software provides management and diagnostic tools for Linux hosts that are connected to ONTAP storage. When you install the Linux Host Utilities on a CentOS 7.1 host, you can use the Host Utilities to help you manage FCP and iSCSI protocol operations with ONTAP LUNs.



You don't need to manually configure Kernel-based Virtual Machine (KVM) settings because ONTAP LUNs are automatically mapped to the hypervisor.

Step 1: Optionally, enable SAN booting

You can configure your host to use SAN booting to simplify deployment and improve scalability.

Before you begin

Use the Interoperability Matrix Tool to verify that your Linux OS, host bus adapter (HBA), HBA firmware, HBA boot BIOS, and ONTAP version support SAN booting.

Steps

- 1. Create a SAN boot LUN and map it to the host.
- 2. 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.

3. Verify that the configuration was successful by rebooting the host and verifying that the OS is up and running.

Step 2: Install the Linux Host Utilities

NetApp strongly recommends installing the Linux Host Utilities to support ONTAP LUN management and assist technical support with gathering configuration data.

Install Linux Host Utilities 7.1.



Installing the Linux Host Utilities doesn't change any host timeout settings on your Linux host.

Step 3: Confirm the multipath configuration for your host

You can use multipathing with CentOS 7.1 to manage ONTAP LUNs.

To ensure that multipathing is configured correctly for your host, verify that the /etc/multipath.conf file is defined and that you have the NetApp recommended settings configured for your ONTAP LUNs.

Steps

1. Verify that the /etc/multipath.conf file exits. If the file doesn't exist, create an empty, zero-byte file:

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

2. The first time the multipath.conf file is created, you might need to enable and start the multipath services to load the recommended settings:

chkconfig multipathd on

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

3. Each time you boot the host, the empty /etc/multipath.conf zero-byte file automatically loads the NetApp recommended host multipath parameters as the default settings. You shouldn't need to make changes to the /etc/multipath.conf file for your host because the operating system is compiled with the multipath parameters that recognize and manage ONTAP LUNs correctly.

The following table shows the Linux OS native compiled multipath parameter settings for ONTAP LUNs.

Show parameter settings

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"
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

4. Verify the parameter settings and path status for your ONTAP LUNs:

The default multipath parameters support ASA, AFF, and FAS configurations. In these configurations, a single ONTAP LUN shouldn't require more than four paths. If there are more than four paths, it might cause issues with the paths during a storage failure.

The following example outputs show the correct parameter settings and path status for ONTAP LUNs in an ASA, AFF, or FAS configuration.

ASA configuration

An ASA configuration optimizes all paths to a given LUN, keeping them active. This improves performance by serving I/O operations through all paths at the same time.

AFF or FAS configuration

An AFF or FAS configuration should have two groups of paths with higher and lower priorities. Higher priority Active/Optimized paths are served by the controller where the aggregate is located. Lower priority paths are active but non-optimized because they are served by a different controller. Non-optimized paths are only used when optimized paths aren't available.

The following example displays the 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
```

Step 4: Optionally, exclude a device from multipathing

If required, you can exclude a device from multipathing by adding the WWID for the unwanted device to the "blacklist" stanza for the multipath.conf file.

Steps

1. Determine the WWID:

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

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

An example WWID is 360030057024d0730239134810c0cb833.

2. Add the WWID to the "blacklist" stanza:

Step 5: Customize multipath parameters for ONTAP LUNs

If your host is connected to LUNs from other vendors and any of the multipath parameter settings are overridden, you need to correct them by adding stanzas later in the multipath.conf file that apply specifically to ONTAP LUNs. If you don't do this, the ONTAP LUNs might not work as expected.

Check your /etc/multipath.conf file, especially in the defaults section, for settings that might be overriding the default settings for multipath parameters.



You shouldn't override the recommended parameter settings for ONTAP LUNs. These settings are required for optimal performance of your host configuration. Contact NetApp support, your OS vendor, or both for more information.

The following example shows how to correct an overridden default. In this example, the multipath.conf file defines values for path_checker and no_path_retry that aren't compatible with ONTAP LUNs, and you can't remove these parameters because ONTAP storage arrays are still attached to the host. Instead, you correct the values for path_checker and no_path_retry by adding a device stanza to the multipath.conf file that applies specifically to the ONTAP LUNs.

Show example

```
defaults {
   path checker
                      readsector0
                      fail
   no path retry
devices {
   device {
      vendor
                       "NETAPP"
      product
                       "LUN"
      no_path_retry
                       queue
      path checker
                       tur
   }
}
```

Step 6: Review the known issues

There are no known issues.

What's next?

- · Learn about using the Linux Host Utilities tool.
- Learn about 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 doesn't 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.

Configure CentOS 7.0 for FCP and iSCSI for ONTAP storage

The Linux Host Utilities software provides management and diagnostic tools for Linux hosts that are connected to ONTAP storage. When you install the Linux Host Utilities on a CentOS 7.0 host, you can use the Host Utilities to help you manage FCP and iSCSI protocol operations with ONTAP LUNs.



You don't need to manually configure Kernel-based Virtual Machine (KVM) settings because ONTAP LUNs are automatically mapped to the hypervisor.

Step 1: Optionally, enable SAN booting

You can configure your host to use SAN booting to simplify deployment and improve scalability.

Before you begin

Use the Interoperability Matrix Tool to verify that your Linux OS, host bus adapter (HBA), HBA firmware, HBA boot BIOS, and ONTAP version support SAN booting.

Steps

- 1. Create a SAN boot LUN and map it to the host.
- 2. 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.

3. Verify that the configuration was successful by rebooting the host and verifying that the OS is up and running.

Step 2: Install the Linux Host Utilities

NetApp strongly recommends installing the Linux Host Utilities to support ONTAP LUN management and assist technical support with gathering configuration data.

Install Linux Host Utilities 7.1.



Installing the Linux Host Utilities doesn't change any host timeout settings on your Linux host.

Step 3: Confirm the multipath configuration for your host

You can use multipathing with CentOS 7.0 to manage ONTAP LUNs.

To ensure that multipathing is configured correctly for your host, verify that the /etc/multipath.conf file is defined and that you have the NetApp recommended settings configured for your ONTAP LUNs.

Steps

1. Verify that the /etc/multipath.conf file exits. If the file doesn't exist, create an empty, zero-byte file:

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

2. The first time the multipath.conf file is created, you might need to enable and start the multipath services to load the recommended settings:

chkconfig multipathd on

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

3. Each time you boot the host, the empty /etc/multipath.conf zero-byte file automatically loads the NetApp recommended host multipath parameters as the default settings. You shouldn't need to make changes to the /etc/multipath.conf file for your host because the operating system is compiled with the multipath parameters that recognize and manage ONTAP LUNs correctly.

The following table shows the Linux OS native compiled multipath parameter settings for ONTAP LUNs.

Show parameter settings

D	0.44
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"
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

4. Verify the parameter settings and path status for your ONTAP LUNs:

The default multipath parameters support ASA, AFF, and FAS configurations. In these configurations, a single ONTAP LUN shouldn't require more than four paths. If there are more than four paths, it might cause issues with the paths during a storage failure.

The following example outputs show the correct parameter settings and path status for ONTAP LUNs in an ASA, AFF, or FAS configuration.

ASA configuration

An ASA configuration optimizes all paths to a given LUN, keeping them active. This improves performance by serving I/O operations through all paths at the same time.

AFF or FAS configuration

An AFF or FAS configuration should have two groups of paths with higher and lower priorities. Higher priority Active/Optimized paths are served by the controller where the aggregate is located. Lower priority paths are active but non-optimized because they are served by a different controller. Non-optimized paths are only used when optimized paths aren't available.

The following example displays the 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
```

Step 4: Optionally, exclude a device from multipathing

If required, you can exclude a device from multipathing by adding the WWID for the unwanted device to the "blacklist" stanza for the multipath.conf file.

Steps

1. Determine the WWID:

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

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

An example WWID is 360030057024d0730239134810c0cb833.

2. Add the WWID to the "blacklist" stanza:

Step 5: Customize multipath parameters for ONTAP LUNs

If your host is connected to LUNs from other vendors and any of the multipath parameter settings are overridden, you need to correct them by adding stanzas later in the multipath.conf file that apply specifically to ONTAP LUNs. If you don't do this, the ONTAP LUNs might not work as expected.

Check your /etc/multipath.conf file, especially in the defaults section, for settings that might be overriding the default settings for multipath parameters.



You shouldn't override the recommended parameter settings for ONTAP LUNs. These settings are required for optimal performance of your host configuration. Contact NetApp support, your OS vendor, or both for more information.

The following example shows how to correct an overridden default. In this example, the multipath.conf file defines values for path_checker and no_path_retry that aren't compatible with ONTAP LUNs, and you can't remove these parameters because ONTAP storage arrays are still attached to the host. Instead, you correct the values for path_checker and no_path_retry by adding a device stanza to the multipath.conf file that applies specifically to the ONTAP LUNs.

Show example

```
defaults {
   path checker
                      readsector0
                      fail
   no path retry
devices {
   device {
      vendor
                        "NETAPP"
      product
                        "LUN"
      no_path_retry
                       queue
      path checker
                       tur
   }
}
```

Step 6: Review the known issues

There are no known issues.

What's next?

- · Learn about using the Linux Host Utilities tool.
- Learn about 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 doesn't 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.

CentOS 6

Use CentOS 6.10 with ONTAP

You can use the ONTAP SAN host configuration settings to configure CentOS 6.10 with ONTAP as the target.

Install the Linux Host Utilities

The NetApp Linux 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 Interoperability Matrix Tool to verify which one you need.

NetApp strongly recommends installing the Linux 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 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 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 procedure 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:

<pre>/server(cDOT/FlashRay) Product</pre>	lun-pathname	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					
120.09					
	/vol/vol2/lun2	/dev/sdd	host16	FCP	
<u> </u>	/vol/vol2/lun2	/dev/sdd	host16	FCP	

SAN Booting

Before you begin

If you decide to use SAN booting, it must be supported by your configuration. You can use the 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 was successful.

Multipathing

For CentOS 6.10 the /etc/multipath.conf file must exist, but you do not need to make specific changes to the file. CentOS 6.10 is compiled with all settings required to recognize and correctly manage ONTAP LUNs.

To Enable ALUA Handler, perform the following steps:

Steps

- 1. Create a backup of the initrd-image.
- Append the following parameter value to the kernel for ALUA and non-ALUA to work: rdloaddriver=scsi_dh_alua

Example

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

Use the mkinitrd command to recreate the initrd-image.

CentOS 6x and later versions use either:

```
The command: mkinitrd -f /boot/ initrd-"uname -r".img uname -r
Or
```

The command: dracut -f

- 4. Reboot the host.
- 5. Verify the output of the cat /proc/cmdline command to ensure that the setting is complete.

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 -11
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
|- 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. This means they are serviced by the controller where the aggregate is located. The paths with lower priorities are active but 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 -11
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.

Recommended Settings

The CentOS 6.10 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:

```
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
```

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

2. Add the wwild 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"
no_path_retry	queue
path_checker	"tur"
path_grouping_policy	"group_by_prio"
path_selector	"round-robin 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
                       "LUN.*"
      product
      no path retry
                         queue
      path checker
                         tur
}
```

Configure KVM settings

You don't need to configure settings for a Kernel-based Virtual Machine because the LUN is mapped to the hypervisor.

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 doesn't 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.

Known issues

For CentOS (Red Hat compatible kernel) known issues, see the known issues for Red Hat Enterprise Linux (RHEL) 6.10.

Use CentOS 6.9 with ONTAP

You can use the ONTAP SAN host configuration settings to configure CentOS 6.9 with ONTAP as the target.

Install the Linux Host Utilities

The NetApp Linux 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 Interoperability Matrix Tool to verify which one you need.

NetApp strongly recommends installing the Linux 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 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 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 procedure 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 vserver(cDOT/Flash Product	•	device filename	host adapter	protocol	lun 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

Before you begin

If you decide to use SAN booting, it must be supported by your configuration. You can use the 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 was successful.

Multipathing

For CentOS 6.9 the /etc/multipath.conf file must exist, but you do not need to make specific changes to the file. CentOS 6.9 is compiled with all settings required to recognize and correctly manage ONTAP LUNs.

To Enable ALUA Handler, perform the following steps:

Steps

- 1. Create a backup of the initrd-image.
- 2. Append the following parameter value to the kernel for ALUA and non-ALUA to work: rdloaddriver=scsi_dh_alua

Example

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

3. Use the mkinitrd command to recreate the initrd-image.

CentOS 6x and later versions use either:

```
The command: mkinitrd -f /boot/ initrd-"uname -r".img uname -r Or
```

The command: dracut -f

- Reboot the host.
- 5. Verify the output of the cat /proc/cmdline command to ensure that the setting is complete.

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 -11
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
|- 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. This means they are serviced by the controller where the aggregate is located. The paths with lower priorities are active but 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 -11
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.

Recommended Settings

The CentOS 6.9 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:

```
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
```

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

2. 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"
no_path_retry	queue
path_checker	"tur"
path_grouping_policy	"group_by_prio"
path_selector	"round-robin 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
                       "LUN.*"
      product
      no path retry
                         queue
      path checker
                         tur
}
```

Configure KVM settings

You don't need to configure settings for a Kernel-based Virtual Machine because the LUN is mapped to the hypervisor.

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 doesn't 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.

Known issues

For CentOS (Red Hat compatible kernel) known issues, see the known issues for Red Hat Enterprise Linux (RHEL) 6.9.

Use CentOS 6.8 with ONTAP

You can use the ONTAP SAN host configuration settings to configure CentOS 6.8 with ONTAP as the target.

Install the Linux Host Utilities

The NetApp Linux 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 Interoperability Matrix Tool to verify which one you need.

NetApp strongly recommends installing the Linux 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 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 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 procedure 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:

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

SAN Booting

Before you begin

If you decide to use SAN booting, it must be supported by your configuration. You can use the 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 was successful.

Multipathing

For CentOS 6.8 the /etc/multipath.conf file must exist, but you do not need to make specific changes to the file. CentOS 6.8 is compiled with all settings required to recognize and correctly manage ONTAP LUNs.

To Enable ALUA Handler, perform the following steps:

Steps

- 1. Create a backup of the initrd-image.
- 2. Append the following parameter value to the kernel for ALUA and non-ALUA to work: rdloaddriver=scsi_dh_alua

Example

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

3. Use the mkinitrd command to recreate the initrd-image.

CentOS 6x and later versions use either:

```
The command: mkinitrd -f /boot/ initrd-"uname -r".img uname -r Or
```

The command: dracut -f

- Reboot the host.
- 5. Verify the output of the cat /proc/cmdline command to ensure that the setting is complete.

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 -11
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
|- 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. This means they are serviced by the controller where the aggregate is located. The paths with lower priorities are active but 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 -11
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.

Recommended Settings

The CentOS 6.8 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:

```
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
```

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

2. 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"
no_path_retry	queue
path_checker	"tur"
path_grouping_policy	"group_by_prio"
path_selector	"round-robin 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
                       "LUN.*"
      product
      no path retry
                         queue
      path checker
                         tur
}
```

Configure KVM settings

You don't need to configure settings for a Kernel-based Virtual Machine because the LUN is mapped to the hypervisor.

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 doesn't 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.

Known issues

For CentOS (Red Hat compatible kernel) known issues, see the known issues for Red Hat Enterprise Linux (RHEL) 6.8.

Use CentOS 6.7 with ONTAP

You can use the ONTAP SAN host configuration settings to configure CentOS 6.7 with ONTAP as the target.

Install the Linux Host Utilities

The NetApp Linux 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 Interoperability Matrix Tool to verify which one you need.

NetApp strongly recommends installing the Linux 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 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 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 procedure 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-vserver(cDOT/FlashRefroduct	, .	device filename	host adapter	protocol	lun 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

Before you begin

If you decide to use SAN booting, it must be supported by your configuration. You can use the 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 was successful.

Multipathing

For CentOS 6.7 the /etc/multipath.conf file must exist, but you do not need to make specific changes to the file. CentOS 6.7 is compiled with all settings required to recognize and correctly manage ONTAP LUNs. To Enable ALUA Handler, perform the following steps:

Steps

- 1. Create a backup of the initrd-image.
- 2. Append the following parameter value to the kernel for ALUA and non-ALUA to work: rdloaddriver=scsi dh alua

Example

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

3. Use the mkinitrd command to recreate the initrd-image.

CentOS 6x and later versions use either:

```
The command: mkinitrd -f /boot/ initrd-"uname -r".img uname -r Or
```

The command: dracut -f

- 4. Reboot the host.
- 5. Verify the output of the cat /proc/cmdline command to ensure that the setting is complete.

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 -11
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
|- 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. This means they are serviced by the controller where the aggregate is located. The paths with lower priorities are active but 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
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.

Recommended Settings

The CentOS 6.7 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:

```
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
```

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

2. 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"
no_path_retry	queue
path_checker	"tur"
path_grouping_policy	"group_by_prio"
path_selector	"round-robin 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
                       "LUN.*"
      product
      no path retry
                         queue
      path checker
                         tur
}
```

Configure KVM settings

You don't need to configure settings for a Kernel-based Virtual Machine because the LUN is mapped to the hypervisor.

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 doesn't 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.

Known issues

For CentOS (Red Hat compatible kernel) known issues, see the known issues for Red Hat Enterprise Linux (RHEL) 6.7.

Use CentOS 6.6 with ONTAP

You can use the ONTAP SAN host configuration settings to configure CentOS 6.6 with ONTAP as the target.

Install the Linux Host Utilities

The NetApp Linux 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 Interoperability Matrix Tool to verify which one you need.

NetApp strongly recommends installing the Linux 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 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 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 procedure 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:

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

SAN Booting

Before you begin

If you decide to use SAN booting, it must be supported by your configuration. You can use the 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 was successful.

Multipathing

For CentOS 6.6 the /etc/multipath.conf file must exist, but you do not need to make specific changes to the file. CentOS 6.6 is compiled with all settings required to recognize and correctly manage ONTAP LUNs. To Enable ALUA Handler, perform the following steps:

Steps

- 1. Create a backup of the initrd-image.
- 2. Append the following parameter value to the kernel for ALUA and non-ALUA to work: rdloaddriver=scsi dh alua

Example

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

3. Use the mkinitrd command to recreate the initrd-image.

CentOS 6x and later versions use either:

```
The command: mkinitrd -f /boot/ initrd-"uname -r".img uname -r Or
```

The command: dracut -f

- 4. Reboot the host.
- 5. Verify the output of the cat /proc/cmdline command to ensure that the setting is complete.

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 -11
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
|- 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. This means they are serviced by the controller where the aggregate is located. The paths with lower priorities are active but 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 -11
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.

Recommended Settings

The CentOS 6.6 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:

```
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
```

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

2. 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"
no_path_retry	queue
path_checker	"tur"
path_grouping_policy	"group_by_prio"
path_selector	"round-robin 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
                       "LUN.*"
      product
      no path retry
                         queue
      path checker
                         tur
}
```

Configure KVM settings

You don't need to configure settings for a Kernel-based Virtual Machine because the LUN is mapped to the hypervisor.

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 doesn't 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.

Known issues

For CentOS (Red Hat compatible kernel) known issues, see the known issues for Red Hat Enterprise Linux (RHEL) 6.6.

Use CentOS 6.5 with ONTAP

You can use the ONTAP SAN host configuration settings to configure CentOS 6.5 with ONTAP as the target.

Install the Linux Host Utilities

The NetApp Linux 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 Interoperability Matrix Tool to verify which one you need.

NetApp strongly recommends installing the Linux 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 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 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 procedure 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 vserver(cDOT/Flash Product	G-Series)/ NRay) lun-pathname	device filename	host adapter	protocol	lun 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

Before you begin

If you decide to use SAN booting, it must be supported by your configuration. You can use the 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 was successful.

Multipathing

For CentOS 6.5 the /etc/multipath.conf file must exist, but you do not need to make specific changes to the file. CentOS 6.5 is compiled with all settings required to recognize and correctly manage ONTAP LUNs.

To Enable ALUA Handler, perform the following steps:

Steps

- 1. Create a backup of the initrd-image.
- Append the following parameter value to the kernel for ALUA and non-ALUA to work: rdloaddriver=scsi_dh_alua

Example

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

3. Use the mkinitrd command to recreate the initrd-image.

CentOS 6x and later versions use either:

```
The command: mkinitrd -f /boot/ initrd-"uname -r".img uname -r Or
```

The command: dracut -f

- 4. Reboot the host.
- 5. Verify the output of the cat /proc/cmdline command to ensure that the setting is complete.

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 -11
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
|- 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. This means they are serviced by the controller where the aggregate is located. The paths with lower priorities are active but 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 -11
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.

Recommended Settings

The CentOS 6.5 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. 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
```

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

2. 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"
no_path_retry	queue
path_checker	"tur"
path_grouping_policy	"group_by_prio"
path_selector	"round-robin 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
                       "LUN.*"
      product
      no path retry
                         queue
      path checker
                         tur
}
```

Configure KVM settings

You don't need to configure settings for a Kernel-based Virtual Machine because the LUN is mapped to the hypervisor.

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 doesn't 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.

Known issues

For CentOS (Red Hat compatible kernel) known issues, see the known issues for Red Hat Enterprise Linux (RHEL) 6.5.

Use CentOS 6.4 with ONTAP

You can use the ONTAP SAN host configuration settings to configure CentOS 6.4 with ONTAP as the target.

Install the Linux Host Utilities

The NetApp Linux 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 Interoperability Matrix Tool to verify which one you need.

NetApp strongly recommends installing the Linux 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 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 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 procedure 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 vserver(cDOT/Flash Product	G-Series)/ NRay) lun-pathname	device filename	host adapter	protocol	lun 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

Before you begin

If you decide to use SAN booting, it must be supported by your configuration. You can use the 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 was successful.

Multipathing

For CentOS 6.4 the /etc/multipath.conf file must exist, but you do not need to make specific changes to the file. CentOS 6.4 is compiled with all settings required to recognize and correctly manage ONTAP LUNs.

To Enable ALUA Handler, perform the following steps:

Steps

- 1. Create a backup of the initrd-image.
- Append the following parameter value to the kernel for ALUA and non-ALUA to work: rdloaddriver=scsi_dh_alua

Example

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

3. Use the mkinitrd command to recreate the initrd-image.

CentOS 6x and later versions use either:

```
The command: mkinitrd -f /boot/ initrd-"uname -r".img uname -r Or
```

The command: dracut -f

- Reboot the host.
- 5. Verify the output of the cat /proc/cmdline command to ensure that the setting is complete.

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 -11
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
|- 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. This means they are serviced by the controller where the aggregate is located. The paths with lower priorities are active but 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 -11
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
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| `- 2:0:8:1 sdd 8:48 active ready running
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```



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 CentOS 6.4 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:

```
chkconfig multipathd on
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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
```

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

2. 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"
no_path_retry	queue
path_checker	"tur"
path_grouping_policy	"group_by_prio"
path_selector	"round-robin 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
}
```

Configure KVM settings

You don't need to configure settings for a Kernel-based Virtual Machine because the LUN is mapped to the hypervisor.

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 doesn't 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.

Known issues

For CentOS (Red Hat compatible kernel) known issues, see the known issues for Red Hat Enterprise Linux (RHEL) 6.4.

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