Oracle Linux

SAN hosts and cloud clients

NetApp
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Oracle Linux

Release notes

ASM Mirroring

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

OL 9

Use Oracle Linux 9.2 with ONTAP

You can use the ONTAP SAN host configuration settings to configure Oracle Linux 9.2 with ONTAP as the target.

Install the Linux Unified Host Utilities

The NetApp Linux Unified Host Utilities software package is available on the NetApp Support Site in a 64-bit .rpm file.

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

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

```
# sanlun lun show all
```

Example output:

```
controller(7mode/E-Series)/            device     host                lun
vserver(cDOT/FlashRay)   lun-pathname  filename   adapter  protocol   size
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cDOT
data_vserver          /vol/vol1/lun1   /dev/sdc   host15   FCP        80.0g
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data_vserver          /vol/vol2/lun2   /dev/sdd   host16   FCP        80.0g
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SAN booting

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

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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.

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

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Multipathing

For OL 9.2 the `/etc/multipath.conf` file must exist, but you do not need to make specific changes to the file. OL 9.2 is compiled with all the settings required to recognize and correctly manage ONTAP LUNs.

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

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

All SAN Array configurations

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

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

```
# multipath -ll
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alua' wp=rw
|-+- policy='service-time 0' prio=50 status=active
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  |- 11:0:11:6  sddn 71:80   active ready running
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  |- 12:0:1:6   sdgp 132:80  active ready running
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Do not use an excessive number of paths to a single LUN. No more than four paths should be required. More than eight paths might cause path issues during storage failures.

Non-ASA configurations

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

Example

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

```
# multipath -ll
3600a0980383036347ffb4d59646c4436 dm-28 NETAPP,LUN C-Mode
size=10G features='3 queue_if_no_path pg_init_retries 50' hwhandler='1
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| |- 16:0:6:35 sdwb  69:624  active ready running
| |- 16:0:5:35 sdun  66:752  active ready running
`-+- policy='service-time 0' prio=10 status=enabled
  |- 15:0:0:35 sdaj  66:48   active ready running
  |- 15:0:1:35 sdbx  68:176  active ready running
```

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

Recommended settings

The Oracle Linux 9.2 OS is compiled to recognize ONTAP LUNs and automatically set all configuration parameters correctly for both ASA and non-ASA configurations. You can further optimize performance for your host configuration with the following recommended settings.

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

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

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

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

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

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

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

Example

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

Steps

1. Run the following command to determine the WWID:

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

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

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

```
blacklist {
     wwid   360030057024d0730239134810c0cb833
     devnode "^(ram|raw|loop|fd|md|dm-|sr|scd|st)[0-9]*"
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You should always check your `/etc/multipath.conf` file for legacy settings, especially in the defaults section, that might be overriding the default settings.

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

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

Example

The following example demonstrates 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 other SAN arrays are still attached to the host, these parameters can be

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defaults {
 path_checker readsector0
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To configure Oracle Linux 9.2 RedHat Enterprise Kernel (RHCK), use the recommended settings for Red Hat Enterprise Linux (RHEL) 9.2.

KVM settings

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

Known issues

The Oracle Linux 9.2 with ONTAP release has the following known issues:

NetApp Bug ID	Title	Description	Bugzilla ID

1508554	SAN LUN utility with Emulex HBA needs symbolic links from library packages	When you execute the Linux Unified Host Utilities CLI command - "sanlun fcp show adapter -v" on a SAN host, the command fails with an error message displaying that the library dependencies required for an host bus adapter (HBA) discovery cannot be located:
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detect_prio	yes
dev_loss_tmo	infinity
failback	immediate
fast_io_fail_tmo	5
features	2 pg_init_retries 50
flush_on_last_del	yes
hardware_handler	0
no_path_retry	queue
path_checker	tur
path_grouping_policy	group_by_prio
path_selector	service-time 0
polling_interval	5
prio	ontap
product	LUN.*
retain_attached_hw_handler	yes
rr_weight	uniform
user_friendly_names	no
vendor	NETAPP

Example

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

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

To configure Oracle Linux 9.0 RedHat Enterprise Kernel (RHCK), use the recommended settings for Red Hat Enterprise Linux (RHEL) 9.0.

KVM settings

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

Known issues

The Oracle Linux 9.0 with NetApp ONTAP release has the following known issues:

NetApp Bug ID	Title	Description	Bugzilla ID

1508554	SAN LUN utility with Emulex HBA needs symbolic links from library packages	When you execute the Linux Unified Host Utilities CLI command - "sanlun fcp show adapter -v" on a SAN host, the command fails with an error message displaying that the library dependencies required for a host bus adapter (HBA) discovery cannot be located:
		`[root@hostname ~]# sanlun fcp show adapter -v`
		`Unable to locate /usr/lib64/libHBAAPI.so library`
		`Make sure the package installing the library is installed & loaded`
			Not Applicable

OL 8

Use Oracle Linux 8.8 with ONTAP

You can use the ONTAP SAN host configuration settings to configure Oracle Linux 8.8 with ONTAP as the target.

Install the Linux Unified Host Utilities

The NetApp Linux Unified Host Utilities software package is available on the NetApp Support Site in a 64-bit .rpm file.

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

What you'll need

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

Steps

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

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

SAN toolkit

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

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

```
# sanlun lun show all
```

Example output:

```
controller(7mode/E-Series)/            device     host                lun
vserver(cDOT/FlashRay)   lun-pathname  filename   adapter  protocol   size
Product
------------------------------------------------------------------------
data_vserver          /vol/vol1/lun1   /dev/sdb   host16   FCP        80.0g
cDOT
data_vserver          /vol/vol1/lun1   /dev/sdc   host15   FCP        80.0g
cDOT
data_vserver          /vol/vol2/lun2   /dev/sdd   host16   FCP        80.0g
cDOT
data_vserver          /vol/vol2/lun2   /dev/sde   host15   FCP        80.0g
cDOT
```

SAN booting

What you'll need

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

Steps

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

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

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

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

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

Multipathing

For Oracle Linux (OL) 8.8 the `/etc/multipath.conf` file must exist, but you do not need to make specific changes to the file. OL 8.8 is compiled with all the settings required to recognize and correctly manage ONTAP LUNs.

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

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

All SAN Array configurations

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

Example

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

```
# multipath -ll
3600a098038303634722b4d59646c4436 dm-28 NETAPP,LUN C-Mode
size=10G features='3 queue_if_no_path pg_init_retries 50' hwhandler='1
alua' wp=rw
|-+- policy='service-time 0' prio=50 status=active
  |- 11:0:7:6   sdbz 68:208  active ready running
  |- 11:0:11:6  sddn 71:80   active ready running
  |- 11:0:15:6  sdfb 129:208 active ready running
  |- 12:0:1:6   sdgp 132:80  active ready running
```

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

Non-ASA configurations

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

Example

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

```
# multipath -ll
3600a0980383036347ffb4d59646c4436 dm-28 NETAPP,LUN C-Mode
size=10G features='3 queue_if_no_path pg_init_retries 50' hwhandler='1
alua' wp=rw
|-+- policy='service-time 0' prio=50 status=active
| |- 16:0:6:35 sdwb  69:624  active ready running
| |- 16:0:5:35 sdun  66:752  active ready running
`-+- policy='service-time 0' prio=10 status=enabled
  |- 15:0:0:35 sdaj  66:48   active ready running
  |- 15:0:1:35 sdbx  68:176  active ready running
```

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

Recommended settings

The OL 8.8 OS is compiled to recognize ONTAP LUNs and automatically set all configuration parameters correctly for both ASA and non-ASA configurations. You can further optimize performance for your host configuration with the following recommended settings.

The `multipath.conf` file must exist for the multipath daemon to start, but you can create an empty, zero-

byte file by using the following command:

`touch /etc/multipath.conf`

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

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

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

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

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

Example

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

Steps

1. Run the following command to determine the WWID:

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

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

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

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

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

section, that might be overriding the default settings.

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

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

Example

The following example demonstrates 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 other SAN arrays are 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
 }
}
```

To configure Oracle Linux 8.8 RedHat Enterprise Kernel, use the recommended settings for Red Hat Enterprise Linux (RHEL) 8.8.

KVM settings

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

Known issues

There are no known issues for the Oracle Linux 8.8 with ONTAP release.

Use Oracle Linux 8.7 with ONTAP

You can use the ONTAP SAN host configuration settings to configure Oracle Linux 8.7 with ONTAP as the target.

Install the Linux Unified Host Utilities

The NetApp Linux Unified Host Utilities software package is available on the NetApp Support Site in a 64-bit .rpm file.

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

What you'll need

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

Steps

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

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

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 host bus adapters (HBAs). The `sanlun` command returns information about the LUNs mapped to your host, multipathing, and information necessary to create initiator groups.

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

```
# sanlun lun show all
```

Example output:

```
controller(7mode/E-Series)/            device     host               lun
vserver(cDOT/FlashRay)   lun-pathname  filename   adapter  protocol  size
Product
------------------------------------------------------------------------
data_vserver          /vol/vol1/lun1   /dev/sdb   host16   FCP       80.0g
cDOT
data_vserver          /vol/vol1/lun1   /dev/sdc   host15   FCP       80.0g
cDOT
data_vserver          /vol/vol2/lun2   /dev/sdd   host16   FCP       80.0g
cDOT
data_vserver          /vol/vol2/lun2   /dev/sde   host15   FCP       80.0g
cDOT
```

SAN booting

What you'll need

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

Steps

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

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

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

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

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

Multipathing

For Oracle Linux (OL) 8.7, the `/etc/multipath.conf` file must exist. You do not need to make specific changes to the file because OL 8.7 is compiled with all the settings required to recognize and correctly manage ONTAP LUNs.

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

The following sections provide sample multipath output for a LUN mapped to All SAN Array (ASA) and non-ASA configurations.

All SAN Array configurations

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

Example

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

```
# multipath -ll
3600a098038303634722b4d59646c4436 dm-28 NETAPP,LUN C-Mode
size=80G features='3 queue_if_no_path pg_init_retries 50' hwhandler='1
alua' wp=rw
|-+- policy='service-time 0' prio=50 status=active
  |- 11:0:7:6   sdbz 68:208  active ready running
  |- 11:0:11:6  sddn 71:80   active ready running
  |- 11:0:15:6  sdfb 129:208 active ready running
  |- 12:0:1:6   sdgp 132:80  active ready running
```

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

Non-ASA configurations

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

Example

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

```
# multipath -ll
3600a0980383036347ffb4d59646c4436 dm-28 NETAPP,LUN C-Mode
size=80G features='3 queue_if_no_path pg_init_retries 50' hwhandler='1
alua' wp=rw
|-+- policy='service-time 0' prio=50 status=active
| |- 16:0:6:35 sdwb  69:624  active ready running
| |- 16:0:5:35 sdun  66:752  active ready running
`-+- policy='service-time 0' prio=10 status=enabled
  |- 15:0:0:35 sdaj  66:48   active ready running
  |- 15:0:1:35 sdbx  68:176  active ready running
```

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

Recommended settings

The Oracle Linux 8.7 OS is compiled to recognize ONTAP LUNs and automatically set all configuration parameters correctly for both ASA and non-ASA configurations.

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

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

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

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

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

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

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

Example

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

Steps

1. Run the following command to determine the WWID:

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

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

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

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

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

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

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

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

Example

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

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

To configure Oracle Linux 8.7 RedHat Enterprise Kernel (RHCK), use the recommended settings for Red Hat Enterprise Linux (RHEL) 8.7.

KVM settings

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

Known issues

There are no known issues for the Oracle Linux 8.7 with ONTAP release.

Use Oracle Linux 8.6 with ONTAP

You can use the ONTAP SAN host configuration settings to configure Oracle Linux 8.6 with ONTAP as the target.

Install the Linux Unified Host Utilities

The NetApp Linux Unified Host Utilities software package is available on the NetApp Support Site in a 64-bit .rpm file.

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

What you'll need

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

Steps

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

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

> You can use the configuration settings provided in this document to configure cloud clients connected to Cloud Volumes ONTAP and Amazon FSx for ONTAP.

SAN Toolkit

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

Example

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

```
# sanlun lun show all
```

Example output:

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

SAN Booting

What you'll need

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

Steps

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

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

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

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

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

Multipathing

For Oracle Linux (OL) 8.6 the `/etc/multipath.conf` file must exist, but you do not need to make specific changes to the file. OL 8.6 is compiled with all settings required to recognize and correctly manage ONTAP LUNs.

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

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

Non-ASA configurations

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

Example

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

```
# multipath -ll
3600a098038303634722b4d59646c4436 dm-28 NETAPP,LUN C-Mode
size=80G features='3 queue_if_no_path pg_init_retries 50' hwhandler='1
alua' wp=rw
|-+- policy='service-time 0' prio=50 status=active
| |- 16:0:6:35 sdwb 69:624 active ready running
| |- 16:0:5:35 sdun 66:752 active ready running
|-+- policy='service-time 0' prio=10 status=enabled
|- 15:0:0:35 sdaj 66:48 active ready running
|- 15:0:1:35 sdbx 68:176 active ready running
```

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

All SAN Array configurations

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

Example

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

```
# multipath -ll
3600a098038303634722b4d59646c4436 dm-28 NETAPP,LUN C-Mode
size=80G features='3 queue_if_no_path pg_init_retries 50' hwhandler='1
alua' wp=rw
|-+- policy='service-time 0' prio=50 status=active
  |- 11:0:7:6   sdbz 68:208  active ready running
  |- 11:0:11:6  sddn 71:80   active ready running
  |- 11:0:15:6  sdfb 129:208 active ready running
  |- 12:0:1:6   sdgp 132:80  active ready running
```

Do not use an excessive number of paths to a single LUN. No more than 4 paths should be required. More than 8 paths might cause path issues during storage failures.

Recommended Settings

The Oracle Linux 8.6 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, but you can create an empty, zero-byte file by using the following command:

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

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

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

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

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

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

Example

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

Steps

1. Run the following command to determine the WWID:

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

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

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

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

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

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

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

To configure Oracle Linux 8.6 RedHat Enterprise Kernel (RHCK), use the recommended settings for Red Hat Enterprise Linux (RHEL) 8.6.

KVM Settings

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

Known issues

There are no known issues for the Oracle Linux 8.6 with ONTAP release.

For Oracle Linux (Red Hat compatible kernel) known issues, see the known issues section in the corresponding Red Hat Enterprise Linux release documentation.

Use Oracle Linux 8.5 with ONTAP

You can use the ONTAP SAN host configuration settings to configure Oracle Linux 8.5 with ONTAP as the target.

Install the Linux Unified Host Utilities

The NetApp Linux Unified Host Utilities software package is available on the NetApp Support Site in a 64-bit .rpm file.

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

What you'll need

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

Steps

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

host.

2. Install the software package:

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

> You can use the configuration settings provided in this document to configure cloud clients connected to Cloud Volumes ONTAP and Amazon FSx for ONTAP.

SAN Toolkit

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

Example

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

```
# sanlun lun show all
```

Example output:

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

SAN Booting

What you'll need

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

Steps

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

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

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

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

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

Multipathing

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

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

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

Non-ASA configurations

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

Example

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

```
# multipath -ll
3600a098038303634722b4d59646c4436 dm-28 NETAPP,LUN C-Mode
size=80G features='3 queue_if_no_path pg_init_retries 50' hwhandler='1
alua' wp=rw
|-+- policy='service-time 0' prio=50 status=active
| |- 16:0:6:35 sdwb 69:624 active ready running
| |- 16:0:5:35 sdun 66:752 active ready running
|-+- policy='service-time 0' prio=10 status=enabled
|- 15:0:0:35 sdaj 66:48 active ready running
|- 15:0:1:35 sdbx 68:176 active ready running
```

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

All SAN Array configurations

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

Example

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

```
# multipath -ll
3600a098038303634722b4d59646c4436 dm-28 NETAPP,LUN C-Mode
size=80G features='3 queue_if_no_path pg_init_retries 50' hwhandler='1
alua' wp=rw
|-+- policy='service-time 0' prio=50 status=active
  |- 11:0:7:6   sdbz 68:208  active ready running
  |- 11:0:11:6  sddn 71:80   active ready running
  |- 11:0:15:6  sdfb 129:208 active ready running
  |- 12:0:1:6   sdgp 132:80  active ready running
```

Do not use an excessive number of paths to a single LUN. No more than 4 paths should be required. More than 8 paths might cause path issues during storage failures.

Recommended Settings

The Oracle Linux 8.5 OS is compiled to recognize ONTAP LUNs and automatically set all configuration parameters correctly for both ASA and non-ASA configuration.

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

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

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

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

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

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

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

Example

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

Steps

1. Run the following command to determine the WWID:

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

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

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

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

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

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

Parameter	Setting
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.*

Parameter	Setting
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
 }
}
```

To configure Oracle Linux 8.5 RedHat Enterprise Kernel (RHCK), use the recommended settings for Red Hat Enterprise Linux (RHEL) 8.5.

KVM Settings

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

Known issues

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

For Oracle Linux (Red Hat compatible kernel) known issues, see the known issues section in the corresponding Red Hat Enterprise Linux release documentation.

Use Oracle Linux 8.4 with ONTAP

You can use the ONTAP SAN host configuration settings to configure Oracle Linux 8.4 with ONTAP as the target.

Install the Linux Unified Host Utilities

The NetApp Linux Unified Host Utilities software package is available on the NetApp Support Site in a 64-bit .rpm file.

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

What you'll need

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

Steps

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

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

> You can use the configuration settings provided in this document to configure cloud clients connected to Cloud Volumes ONTAP and Amazon FSx for ONTAP.

SAN Toolkit

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

Example

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

```
# sanlun lun show all
```

Example output:

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

SAN Booting

What you'll need

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

Steps

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

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

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

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

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

Multipathing

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

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

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

Non-ASA configurations

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

Example

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

```
# multipath -ll
3600a098038303634722b4d59646c4436 dm-28 NETAPP,LUN C-Mode
size=80G features='3 queue_if_no_path pg_init_retries 50' hwhandler='1
alua' wp=rw
|-+- policy='service-time 0' prio=50 status=active
| |- 16:0:6:35 sdwb 69:624 active ready running
| |- 16:0:5:35 sdun 66:752 active ready running
|-+- policy='service-time 0' prio=10 status=enabled
|- 15:0:0:35 sdaj 66:48 active ready running
|- 15:0:1:35 sdbx 68:176 active ready running
```

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

All SAN Array configurations

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

Example

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

```
# multipath -ll
3600a098038303634722b4d59646c4436 dm-28 NETAPP,LUN C-Mode
size=80G features='3 queue_if_no_path pg_init_retries 50' hwhandler='1
alua' wp=rw
|-+- policy='service-time 0' prio=50 status=active
  |- 11:0:7:6   sdbz 68:208  active ready running
  |- 11:0:11:6  sddn 71:80   active ready running
  |- 11:0:15:6  sdfb 129:208 active ready running
  `- 12:0:1:6   sdgp 132:80  active ready running
```

Do not use an excessive number of paths to a single LUN. No more than 4 paths should be required. More than 8 paths might cause path issues during storage failures.

Recommended Settings

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

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

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

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

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

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

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

Example

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

Steps

1. Run the following command to determine the WWID:

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

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

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

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

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

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

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

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

To configure Oracle Linux 8.4 RedHat Enterprise Kernel (RHCK), use the recommended settings for Red Hat Enterprise Linux (RHEL) 8.4.

KVM Settings

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

Known issues

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

For Oracle Linux (Red Hat compatible kernel) known issues, see the known issues section in the corresponding Red Hat Enterprise Linux release documentation.

Use Oracle Linux 8.3 with ONTAP

You can use the ONTAP SAN host configuration settings to configure Oracle Linux 8.3 with ONTAP as the target.

Install the Linux Unified Host Utilities

The NetApp Linux Unified Host Utilities software package is available on the NetApp Support Site in a 64-bit .rpm file.

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

What you'll need

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

Steps

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

host.

2. Install the software package:

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

> You can use the configuration settings provided in this document to configure cloud clients connected to Cloud Volumes ONTAP and Amazon FSx for ONTAP.

SAN Toolkit

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

Example

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

```
# sanlun lun show all
```

Example output:

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

SAN Booting

What you'll need

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

Steps

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

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

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

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

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

Multipathing

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

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

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

Non-ASA configurations

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

Example

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

```
# multipath -ll
3600a098038303634722b4d59646c4436 dm-28 NETAPP,LUN C-Mode
size=80G features='3 queue_if_no_path pg_init_retries 50' hwhandler='1
alua' wp=rw
|-+- policy='service-time 0' prio=50 status=active
| |- 16:0:6:35 sdwb 69:624 active ready running
| |- 16:0:5:35 sdun 66:752 active ready running
|-+- policy='service-time 0' prio=10 status=enabled
|- 15:0:0:35 sdaj 66:48 active ready running
|- 15:0:1:35 sdbx 68:176 active ready running
```

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

All SAN Array configurations

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

Example

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

```
# multipath -ll
3600a098038303634722b4d59646c4436 dm-28 NETAPP,LUN C-Mode
size=80G features='3 queue_if_no_path pg_init_retries 50' hwhandler='1
alua' wp=rw
|-+- policy='service-time 0' prio=50 status=active
  |- 11:0:7:6   sdbz 68:208  active ready running
  |- 11:0:11:6  sddn 71:80   active ready running
  |- 11:0:15:6  sdfb 129:208 active ready running
  `- 12:0:1:6   sdgp 132:80  active ready running
```

Do not use an excessive number of paths to a single LUN. No more than 4 paths should be required. More than 8 paths might cause path issues during storage failures.

Recommended Settings

The Oracle Linux 8.3 OS is compiled to recognize ONTAP LUNs and automatically set all configuration parameters correctly for both ASA and non-ASA configuration.

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

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

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

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

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

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

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

Example

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

Steps

1. Run the following command to determine the WWID:

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

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

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

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

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

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

Parameter	Setting
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.*

Parameter	Setting
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
 }
}
```

To configure Oracle Linux 8.3 Red Hat Enterprise Kernel (RHCK), use the recommended settings for Red Hat Enterprise Linux (RHEL) 8.3.

Known issues

There are no known issues for the Oracle Linux 8.3 with ONTAP release.

For Oracle Linux (Red Hat compatible kernel) known issues, see the known issues section in the corresponding Red Hat Enterprise Linux release documentation.

Use Oracle Linux 8.2 with ONTAP

You can use the ONTAP SAN host configuration settings to configure Oracle Linux 8.2 with ONTAP as the target.

Install the Linux Unified Host Utilities

The NetApp Linux Unified Host Utilities software package is available on the NetApp Support Site in a 64-bit .rpm file.

NetApp strongly recommends installing the Linux Unified Host Utilities, but it is not mandatory. The utilities do

not change any settings on your Linux host. The utilities improve management and assist NetApp customer support in gathering information about your configuration.

What you'll need

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

Steps

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

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

> You can use the configuration settings provided in this document to configure cloud clients connected to Cloud Volumes ONTAP and Amazon FSx for ONTAP.

SAN Toolkit

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

Example

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

```
# sanlun lun show all
```

Example output:

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

SAN Booting

What you'll need

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

Steps

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

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

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

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

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

Multipathing

For Oracle Linux (OL) 8.2 the /etc/multipath.conf file must exist, but you do not need to make specific changes to the file. OL 8.2 is compiled with all settings required to recognize and correctly manage ONTAP LUNs.

You can use the `multipath -ll` command to verify the settings for your ONTAP LUNs.
The following sections provide sample multipath output for a LUN mapped to ASA and non-ASA personas.

All SAN Array configurations

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

Example

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

```
# multipath -ll
3600a098038303634722b4d59646c4436 dm-28 NETAPP,LUN C-Mode
size=80G features='3 queue_if_no_path pg_init_retries 50' hwhandler='1
alua' wp=rw
`-+- policy='service-time 0' prio=50 status=active
  |- 11:0:7:1    sdfi   130:64   active ready running
  |- 11:0:9:1    sdiy   8:288    active ready running
  |- 11:0:10:1   sdml   69:464   active ready running
  |- 11:0:11:1   sdpt   131:304  active ready running
```

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

Non-ASA configurations

For non-ASA configurations, there should be two groups of paths with different priorities. The paths with the higher priorities are Active/Optimized, meaning they are serviced by the controller where the aggregate is located. The paths with the lower priorities are active but are non-optimized because they are served from a

different controller. The non-optimized paths are only used when no optimized paths are available.

Example

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

```
# multipath -ll
3600a098038303634722b4d59646c4436 dm-28 NETAPP,LUN C-Mode
size=80G features='3 queue_if_no_path pg_init_retries 50' hwhandler='1
alua' wp=rw
|-+- policy='service-time 0' prio=50 status=active
| |- 16:0:6:35 sdwb 69:624 active ready running
| |- 16:0:5:35 sdun 66:752 active ready running
|-+- policy='service-time 0' prio=10 status=enabled
|- 15:0:0:35 sdaj 66:48 active ready running
|- 15:0:1:35 sdbx 68:176 active ready running
```

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

Recommended settings

The Oracle Linux 8.2 OS is compiled to recognize ONTAP LUNs and automatically set all configuration parameters correctly for both ASA and non-ASA configuration.

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

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

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

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

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

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

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

Example

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

Steps

1. Run the following command to determine the WWID:

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

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

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

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

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

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

Parameter	Setting
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

Parameter	Setting
path_selector	service-time 0
polling_interval	5
prio	ontap
product	LUN.*
retain_attached_hw_handler	yes
rr_weight	uniform
user_friendly_names	no
vendor	NETAPP

Example

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

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

To configure Oracle Linux 8.2 RedHat Enterprise Kernel (RHCK), use the recommended settings for Red Hat Enterprise Linux (RHEL) 8.2.

Known issues

There are no known issues for the Oracle Linux 8.2 with ONTAP release.

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

Use Oracle Linux 8.1 with ONTAP

You can use the ONTAP SAN host configuration settings to configure Oracle Linux 8.1 with ONTAP as the target.

Install the Linux Unified Host Utilities

The NetApp Linux Unified Host Utilities software package is available on the NetApp Support Site in a 64-bit .rpm file.

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

What you'll need

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

Steps

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

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

> You can use the configuration settings provided in this document to configure cloud clients connected to Cloud Volumes ONTAP and Amazon FSx for ONTAP.

SAN Toolkit

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

Example

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

```
# sanlun lun show all
```

Example output:

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

SAN Booting

What you'll need

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

Steps

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

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

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

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

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

Multipathing

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

You can use the `multipath -ll` command to verify the settings for your ONTAP LUNs.
There should be two groups of paths with different priorities. The paths with the higher priorities are Active/Optimized, which means they are serviced by the controller where the aggregate is located. The paths with the lower priorities are active but are non-optimized because they are served from a different controller. The non-optimized paths are only used when no optimized paths are available.

Example

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

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

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

Recommended Settings

The Oracle Linux 8.1 OS is compiled to recognize ONTAP LUNs and automatically set all configuration parameters correctly.

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

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

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

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

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

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

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

Example

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

Steps

1. Run the following command to determine the WWID:

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

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

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

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

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

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

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

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

Example

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

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

To configure Oracle Linux 8.1 RedHat Enterprise Kernel (RHCK), use the recommended settings for Red Hat Enterprise Linux (RHEL) 8.1.

Known issues

There are no known issues for the Oracle Linux 8.1 with ONTAP release.

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

Use Oracle Linux 8.0 with ONTAP

You can use the ONTAP SAN host configuration settings to configure Oracle Linux 8.0 with ONTAP as the target.

Install the Linux Unified Host Utilities

The NetApp Linux Unified Host Utilities software package is available on the NetApp Support Site in a 64-bit .rpm file.

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

What you'll need

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

Steps

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

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

> You can use the configuration settings provided in this document to configure cloud clients connected to Cloud Volumes ONTAP and Amazon FSx for ONTAP.

SAN Toolkit

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

Example

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

```
# sanlun lun show all
```

Example output:

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

SAN Booting

What you'll need

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

Steps

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

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

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

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

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

Multipathing

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

You can use the `multipath -ll` command to verify the settings for your ONTAP LUNs.
There should be two groups of paths with different priorities. The paths with the higher priorities are Active/Optimized, which means they are serviced by the controller where the aggregate is located. The paths with the lower priorities are active but are non-optimized because they are served from a different controller. The non-optimized paths are only used when no optimized paths are available.

Example

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

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

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

Recommended Settings

The Oracle Linux 8.0 OS is compiled to recognize ONTAP LUNs and automatically set all configuration parameters correctly.

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

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

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

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

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

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

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

Example

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

Steps

1. Run the following command to determine the WWID:

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

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

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

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

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

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

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

To configure Oracle Linux 8.0 RedHat Enterprise Kernel (RHCK), use the recommended settings for Red Hat Enterprise Linux (RHEL) 8.0.

Known issues

There are no known issues for the Oracle Linux 8.0 with ONTAP release.

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

OL 7

Use Oracle Linux 7.9 with ONTAP

You can use the ONTAP SAN host configuration settings to configure Oracle Linux 7.9 with ONTAP as the target.

Install the Linux Unified Host Utilities

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

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

What you'll need

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

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

2. Use the following command to install the software package:

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

> You can use the configuration settings provided in this document to configure cloud clients connected to Cloud Volumes ONTAP and Amazon FSx for ONTAP.

SAN Toolkit

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

Example

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

```
# sanlun lun show all
```

Example output:

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

SAN Booting

What you'll need

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

Steps

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

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

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

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

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

Multipathing

For Oracle Linux (OL) 7.9 the /etc/multipath.conf file must exist, but you do not need to make specific changes to the file. OL 7.9 is compiled with all settings required to recognize and correctly manage ONTAP LUNs.

You can use the `multipath -ll` command to verify the settings for your ONTAP LUNs.
The following sections provide sample multipath output for a LUN mapped to ASA and non-ASA personas.

All SAN Array configurations

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

Example

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

```
# multipath -ll
3600a098038303634722b4d59646c4436 dm-28 NETAPP,LUN C-Mode
size=80G features='3 queue_if_no_path pg_init_retries 50' hwhandler='1
alua' wp=rw
`-+- policy='service-time 0' prio=50 status=active
  |- 11:0:7:1    sdfi   130:64   active ready running
  |- 11:0:9:1    sdiy   8:288    active ready running
  |- 11:0:10:1   sdml   69:464   active ready running
  |- 11:0:11:1   sdpt   131:304  active ready running
```

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

Non-ASA configurations

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

Example

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

```
# multipath -ll
3600a0980383034587724507145354l5a dm-15 NETAPP  ,LUN C-Mode
size=40G features='4 queue_if_no_path pg_init_retries 50
retain_attached_hw_handle' hwhandler='1 alua' wp=rw
|-+- policy='service-time 0' prio=50 status=active
| |- 11:0:5:7   sdbg 67:160  active ready running
| `- 12:0:13:7  sdlg 67:480  active ready running
|-+- policy='service-time 0' prio=10 status=enabled
  |- 11:0:8:7   sdck 69:128  active ready running
  |- 11:0:12:7  sddy 128:0   active ready running
```

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

Recommended settings

The Oracle Linux 7.9 OS is compiled to recognize ONTAP LUNs and automatically set all configuration parameters correctly.
The `multipath.conf` file must exist for the multipath daemon to start, but you can create an empty, zero-byte file by using the following command:

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

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

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

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

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

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

Example

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

Steps

1. Run the following command to determine the WWID:

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

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

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

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

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

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

Parameter	Setting
detect_prio	yes
dev_loss_tmo	"infinity"
failback	immediate
fast_io_fail_tmo	5
features	"3 queue_if_no_path pg_init_retries 50"
flush_on_last_del	"yes"
hardware_handler	"0"
path_checker	"tur"
path_grouping_policy	"group_by_prio"
path_selector	"service-time 0"
polling_interval	5
prio	"ontap"
product	LUN.*
retain_attached_hw_handler	yes

Parameter	Setting
rr_weight	"uniform"
user_friendly_names	no
vendor	NETAPP

Example

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

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

To configure Oracle Linux 7.9 RedHat Enterprise Kernel (RHCK), use the recommended settings for Red Hat Enterprise Linux (RHEL) 7.9.

Known issues

The Oracle Linux 7.9 with ONTAP release has the following known issues:

NetApp Bug ID	Title	Description	Bugzilla ID
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 worldwide identifier (WWID) change. Multipath disables access to the path device until the WWID of the path is restored to the WWID of the multipath device. See the NetApp Knowledge Base: The filesystem corruption on iSCSI LUN on the Oracle Linux 7 for more information.	Not applicable

Use Oracle Linux 7.8 with ONTAP

You can use the ONTAP SAN host configuration settings to configure Oracle Linux 7.8 with ONTAP as the target.

Install the Linux Unified Host Utilities

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

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

What you'll need

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

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

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

> You can use the configuration settings provided in this document to configure cloud clients connected to Cloud Volumes ONTAP and Amazon FSx for ONTAP.

SAN Toolkit

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

Example

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

```
# sanlun lun show all
```

Example output:

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

SAN Booting

What you'll need

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

Steps

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

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

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

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

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

Multipathing

For Oracle Linux (OL) 7.8 the /etc/multipath.conf file must exist, but you do not need to make specific changes to the file. OL 7.8 is compiled with all settings required to recognize and correctly manage ONTAP LUNs.

You can use the `multipath -ll` command to verify the settings for your ONTAP LUNs.
The following sections provide sample multipath output for a LUN mapped non-ASA personas.

Non-ASA configurations

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

Example

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

```
# multipath -ll
3600a098038303634722b4d59646c4436 dm-28 NETAPP,LUN C-Mode
size=80G features='4 queue_if_no_path pg_init_retries 50' hwhandler='1
alua' wp=rw
|-+- policy='service-time 0' prio=50 status=active
| |- 16:0:6:35 sdwb 69:624 active ready running
| |- 16:0:5:35 sdun 66:752 active ready running
|-+- policy='service-time 0' prio=10 status=enabled
|- 15:0:0:35 sdaj 66:48 active ready running
|- 15:0:1:35 sdbx 68:176 active ready running
```

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

Recommended Settings

The Oracle Linux 7.8 OS is compiled to recognize ONTAP LUNs and automatically set all configuration parameters correctly.
The `multipath.conf` file must exist for the multipath daemon to start, but you can create an empty, zero-byte file by using the following command:

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

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

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

- There is no requirement to add anything directly to the `multipath.conf` file, unless you have devices

that you do not want to be managed by multipath or you have existing settings that override defaults.

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

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

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

Example

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

Steps

1. Run the following command to determine the WWID:

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

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

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

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

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

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

Parameter	Setting
detect_prio	yes

Parameter	Setting
dev_loss_tmo	"infinity"
failback	immediate
fast_io_fail_tmo	5
features	"3 queue_if_no_path pg_init_retries 50"
flush_on_last_del	"yes"
hardware_handler	"0"
path_checker	"tur"
path_grouping_policy	"group_by_prio"
path_selector	"service-time 0"
polling_interval	5
prio	"ontap"
product	LUN.*
retain_attached_hw_handler	yes
rr_weight	"uniform"
user_friendly_names	no
vendor	NETAPP

Example

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

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

To configure Oracle Linux 7.8 RedHat Enterprise Kernel (RHCK), use the recommended settings for Red Hat Enterprise Linux (RHEL) 7.8.

Known issues

The Oracle Linux 7.8 with ONTAP release has the following known issues:

NetApp Bug ID	Title	Description	Bugzilla ID
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.	N/A
1311575	IO delays observed due to Read/Write operations failed to switch through secondary paths during storage failover with Qlogic QLE2672(16G)	I/O operations might fail to resume through secondary paths during storage failover operations on Oracle Linux 7.7 kernel (5.4.17-2011.0.7.el7uek.x86_6) with QLogic QLE2672 16G HBA. If I/O progress stops due to blocked primary paths during storage failover, the I/O operation might not resume through secondary paths causing an I/O delay. The I/O operation resumes only after primary paths come online after the completion of the storage failover giveback operation.	17171

NetApp Bug ID	Title	Description	Bugzilla ID
1311576	IO delays observed due to Read/Write operation failing to switch through secondary paths during storage failover with Emulex LPe16002(16G)	I/O operations might fail to resume through secondary paths during storage failover operations on Oracle Linux 7.7 kernel (5.4.17-2011.0.7.el7uek.x86_6) with Emulex LPe16002 16G HBA. If I/O progress stops due to blocked primary paths during storage failover, the I/O operation might not resume through secondary paths causing an I/O delay. The I/O operation resumes only after primary paths come online after the completion of the storage failover giveback operation.	17172
1246134	IO delays observed and reports are moving to blocked, NOT PRESENT state during storage failover with Emulex LPe16002(16G)	During storage failover operations on the Oracle Linux 7.6 with the UEK5U2 kernel running with an Emulex LPe16002B-M6 16G Fibre Channel (FC) host bus adapter (HBA), I/O progress might stop due to reports getting blocked. The storage failover operation reports change from "online" state to "blocked" state, causing a delay in read and write operations. After the operation is completed successfully, the reports fail to move back to "online" state and continue to remain in "blocked" state.	16852

NetApp Bug ID	Title	Description	Bugzilla ID
1246327	IO delays observed and Rports are moving to blocked, NOT PRESENT state during storage failover with Qlogic QLE2672(16G) and QLE2742(32G)	Fibre Channel (FC) remote ports might be blocked on Red Hat Enterprise Linux (RHEL) 7.6 with the QLogic QLE2672 16G host during storage failover operations. Because the logical interfaces go down when a storage node is down, the remote ports set the storage node status to blocked. IO progress might stop due to the blocked ports if you are running both a QLogic QLE2672 16G host and a QLE2742 32GB Fibre Channel (FC) host bus adapter (HBA). When the storage node returns to its optimal state, the logical interfaces also come up and the remote ports should be online. However, the remote ports might still be blocked. This blocked state registers as failed faulty to LUNS at the multipath layer. You can verify the state of the remote ports with the following command: # cat /sys/class/fc_remote_ports/rport-*/port_stat You should see the following output: Blocked Blocked Blocked Blocked Online Online	16853

Use Oracle Linux 7.7 with ONTAP

You can use the ONTAP SAN host configuration settings to configure Oracle Linux 7.7 with ONTAP as the target.

Install the Linux Unified Host Utilities

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

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

What you'll need

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

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

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

> You can use the configuration settings provided in this document to configure cloud clients connected to Cloud Volumes ONTAP and Amazon FSx for ONTAP.

SAN Toolkit

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

Example

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

```
# sanlun lun show all
```

Example output:

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

SAN Booting

What you'll need

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

Steps

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

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

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

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

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

Multipathing

For Oracle Linux 7.7 the /etc/multipath.conf file must exist, but you do not need to make specific changes to the file. Oracle Linux 7.7 is compiled with all settings required to recognize and correctly manage ONTAP LUNs.

You can use the `multipath -ll` command to verify the settings for your ONTAP LUNs.
There should be two groups of paths with different priorities. The paths with the higher priorities are Active/Optimized, which means they are serviced by the controller where the aggregate is located. The paths with the lower priorities are active but are non-optimized because they are served from a different controller. The non-optimized paths are only used when no optimized paths are available.

Example

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

```
# multipath -ll
3600a0980383134765724e527766394e dm-5 NETAPP,LUN C-Mode
size=80G features='4 queue_if_no_path pg_init_retries 50
retain_attached_hw_handle' hwhandler='1 alua' wp=rw
|-+- policy='service-time 0' prio=50 status=active
| |- 11:0:1:0 sdj 8:144 active ready running
| |- 11:0:2:0 sdr 65:16 active ready running
|-+- policy='service-time 0' prio=10 status=enabled
|- 11:0:0:0 sdb 8:i6 active ready running
|- 12:0:0:0 sdz 65:144 active ready running
```

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

Recommended Settings

The Oracle Linux 7.7 OS is compiled to recognize ONTAP LUNs and automatically set all configuration parameters correctly.
The `multipath.conf` file must exist for the multipath daemon to start, but you can create an empty, zero-byte file by using the following command:

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

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

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

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

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

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

Example

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

Steps

1. Run the following command to determine the WWID:

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

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

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

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

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

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

Parameter	Setting
detect_prio	yes
dev_loss_tmo	"infinity"
failback	immediate
fast_io_fail_tmo	5
features	"3 queue_if_no_path pg_init_retries 50"
flush_on_last_del	"yes"
hardware_handler	"0"
path_checker	"tur"
path_grouping_policy	"group_by_prio"
path_selector	"service-time 0"
polling_interval	5
prio	"ontap"
product	LUN.*
retain_attached_hw_handler	yes

Parameter	Setting
rr_weight	"uniform"
user_friendly_names	no
vendor	NETAPP

Example

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

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

To configure Oracle Linux 7.7 RedHat Enterprise Kernel (RHCK), use the recommended settings for Red Hat Enterprise Linux (RHEL) 7.7.

Known issues

The Oracle Linux 7.7 with ONTAP release has the following known issues:

NetApp Bug ID	Title	Description	Bugzilla ID
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.	N/A
1311575	IO delays observed due to Read/Write operations failed to switch through secondary paths during storage failover with Qlogic QLE2672(16G)	I/O operations might fail to resume through secondary paths during storage failover operations on Oracle Linux 7.7 kernel (5.4.17-2011.0.7.el7uek.x86_6) with QLogic QLE2672 16G HBA. If I/O progress stops due to blocked primary paths during storage failover, the I/O operation might not resume through secondary paths causing an I/O delay. The I/O operation resumes only after primary paths come online after the completion of the storage failover giveback operation.	17171

NetApp Bug ID	Title	Description	Bugzilla ID
1311576	IO delays observed due to Read/Write operation failing to switch through secondary paths during storage failover with Emulex LPe16002(16G)	I/O operations might fail to resume through secondary paths during storage failover operations on Oracle Linux 7.7 kernel (5.4.17-2011.0.7.el7uek.x86_6) with Emulex LPe16002 16G HBA. If I/O progress stops due to blocked primary paths during storage failover, the I/O operation might not resume through secondary paths causing an I/O delay. The I/O operation resumes only after primary paths come online after the completion of the storage failover giveback operation.	17172
1246134	IO delays observed and reports are moving to blocked, NOT PRESENT state during storage failover with Emulex LPe16002(16G)	During storage failover operations on the Oracle Linux 7.6 with the UEK5U2 kernel running with an Emulex LPe16002B-M6 16G Fibre Channel (FC) host bus adapter (HBA), I/O progress might stop due to reports getting blocked. The storage failover operation reports change from "online" state to "blocked" state, causing a delay in read and write operations. After the operation is completed successfully, the reports fail to move back to "online" state and continue to remain in "blocked" state.	16852

NetApp Bug ID	Title	Description	Bugzilla ID
1246327	IO delays observed and Rports are moving to blocked, NOT PRESENT state during storage failover with Qlogic QLE2672(16G) and QLE2742(32G)	Fibre Channel (FC) remote ports might be blocked on Red Hat Enterprise Linux (RHEL) 7.6 with the QLogic QLE2672 16G host during storage failover operations. Because the logical interfaces go down when a storage node is down, the remote ports set the storage node status to blocked. IO progress might stop due to the blocked ports if you are running both a QLogic QLE2672 16G host and a QLE2742 32GB Fibre Channel (FC) host bus adapter (HBA). When the storage node returns to its optimal state, the logical interfaces also come up and the remote ports should be online. However, the remote ports might still be blocked. This blocked state registers as failed faulty to LUNS at the multipath layer. You can verify the state of the remote ports with the following command: # cat /sys/class/fc_remote_ports/rport-*/port_stat You should see the following output: Blocked Blocked Blocked Blocked Online Online	16853

Use Oracle Linux 7.6 with ONTAP

You can use the ONTAP SAN host configuration settings to configure Oracle Linux 7.6 with ONTAP as the target.

Install the Linux Unified Host Utilities

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

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

What you'll need

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

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

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

> You can use the configuration settings provided in this document to configure cloud clients connected to Cloud Volumes ONTAP and Amazon FSx for ONTAP.

SAN Toolkit

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

Example

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

```
# sanlun lun show all
```

Example output:

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

SAN Booting

What you'll need

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

Steps

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

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

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

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

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

Multipathing

For Oracle Linux 7.6 the /etc/multipath.conf file must exist, but you do not need to make specific changes to the file. Oracle Linux 7.6 is compiled with all settings required to recognize and correctly manage ONTAP LUNs.

You can use the `multipath -ll` command to verify the settings for your ONTAP LUNs.
There should be two groups of paths with different priorities. The paths with the higher priorities are Active/Optimized, which means they are serviced by the controller where the aggregate is located. The paths with the lower priorities are active but are non-optimized because they are served from a different controller. The non-optimized paths are only used when no optimized paths are available.

Example

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

```
# multipath -ll
3600a0980383134765724e527766394e dm-5 NETAPP,LUN C-Mode
size=80G features='4 queue_if_no_path pg_init_retries 50
retain_attached_hw_handle' hwhandler='1 alua' wp=rw
|-+- policy='service-time 0' prio=50 status=active
| |- 11:0:1:0 sdj 8:144 active ready running
| |- 11:0:2:0 sdr 65:16 active ready running
|-+- policy='service-time 0' prio=10 status=enabled
|- 11:0:0:0 sdb 8:i6 active ready running
|- 12:0:0:0 sdz 65:144 active ready running
```

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

Recommended Settings

The Oracle Linux 7.6 OS is compiled to recognize ONTAP LUNs and automatically set all configuration parameters correctly.
The `multipath.conf` file must exist for the multipath daemon to start, but you can create an empty, zero-byte file by using the following command:

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

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

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

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

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

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

Example

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

Steps

1. Run the following command to determine the WWID:

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

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

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

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

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

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

Parameter	Setting
detect_prio	yes
dev_loss_tmo	"infinity"
failback	immediate
fast_io_fail_tmo	5
features	"3 queue_if_no_path pg_init_retries 50"
flush_on_last_del	"yes"
hardware_handler	"0"
path_checker	"tur"
path_grouping_policy	"group_by_prio"
path_selector	"service-time 0"
polling_interval	5
prio	"ontap"
product	LUN.*
retain_attached_hw_handler	yes

Parameter	Setting
rr_weight	"uniform"
user_friendly_names	no
vendor	NETAPP

Example

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

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

To configure Oracle Linux 7.6 RedHat Enterprise Kernel (RHCK), use the recommended settings for Red Hat Enterprise Linux (RHEL) 7.6.

Known issues

The Oracle Linux 7.6 with ONTAP release has the following known issues:

NetApp Bug ID	Title	Description	Bugzilla ID
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.	N/A
1202736	LUNs might not be available during host discovery due to "Not Present" state of remote ports on a OL7U6 host with QLogic QLE2742 adapter	During host discovery, the status of Fibre Channel (FC) remote ports on a OL7U6 host with a QLogic QLE2742 adapter might enter into "Not Present" state. Remote ports with a "Not Present" state might cause paths to LUNs to become unavailable. During storage failover, the path redundancy might be reduced and result in an I/O outage. You can check the remote port status by entering the following command: # cat /sys/class/fc_remote_ports/rport-*/port_state The following is an example of the output that is displayed: Online Online Not Present Online Online	16613

NetApp Bug ID	Title	Description	Bugzilla ID
1204078	Kernel disruption occurs on Oracle Linux 7.6 running with Qlogic(QLE2672) 16GB FC HBA during storage failover operations	During storage failover operations on the Oracle Linux 7.6 with a Qlogic QLE2672 Fibre Channel (FC) host bus adapter (HBA), a kernel disruption occurs due to a panic in the kernel. The kernel panic causes Oracle Linux 7.6 to reboot, which leads to an application disruption. If the kdump mechanism is enabled, the kernel panic generates a vmcore file located in the /var/crash/ directory. You can analyze the vmcore file to determine the cause of the panic. After the kernel disruption, you can reboot the host OS and recover the operating system, and then you can restart any applications as required.	16606
1204351	Kernel disruption might occur on Oracle Linux 7.6 running with Qlogic(QLE2742) 32GB FC HBA during storage failover operations	During storage failover operations on the Oracle Linux 7.6 with a Qlogic QLE2742 Fibre Channel (FC) host bus adapter (HBA), a kernel disruption might occur due to a panic in the kernel. The kernel panic causes Oracle Linux 7.6 to reboot, which leads to an application disruption. If the kdump mechanism is enabled, the kernel panic generates a vmcore file located in the /var/crash/ directory. You can analyze the vmcore file to determine the cause of the panic. After the kernel disruption, you can reboot the host OS and recover the operating system, and then you can restart any applications as required.	16605

NetApp Bug ID	Title	Description	Bugzilla ID
1204352	Kernel disruption might occur on Oracle Linux 7.6 running with Emulex (LPe32002-M2)32GB FC HBA during storage failover operations	During storage failover operations on the Oracle Linux 7.6 with an Emulex LPe32002-M2 Fibre Channel (FC) host bus adapter (HBA), a kernel disruption might occur due to a panic in the kernel. The kernel panic causes Oracle Linux 7.6 to reboot, which leads to an application disruption. If the kdump mechanism is enabled, the kernel panic generates a vmcore file located in the /var/crash/ directory. You can analyze the vmcore file to determine the cause of the panic. After the kernel disruption, you can reboot the host OS and recover the operating system, and then you can restart any applications as required.	16607
11246134	No I/O progress on Oracle Linux 7.6 with UEK5U2 kernel, running with an Emulex LPe16002B-M6 16G FC HBA during storage failover operations	During storage failover operations on the Oracle Linux 7.6 with the UEK5U2 kernel running with an Emulex LPe16002B-M6 16G Fibre Channel (FC) host bus adapter (HBA), I/O progress might stop due to reports getting blocked. The storage failover operation reports change from an "online" state to a "blocked" state, causing a delay in read and write operations. After the operation has completed successfully, the reports fail to move back to an "online" state and continue to remain in a "blocked" state.	16852

NetApp Bug ID	Title	Description	Bugzilla ID
1246327	Remote port status on QLogic QLE2672 16G host blocked during storage failover operations	Fibre Channel (FC) remote ports might be blocked on Red Hat Enterprise Linux (RHEL) 7.6 with the QLogic QLE2672 16G host during storage failover operations. Because the logical interfaces go down when a storage node is down, the remote ports set the storage node status to blocked. IO progress might stop due to the blocked ports if you are running both a QLogic QLE2672 16G host and a QLE2742 32GB Fibre Channel (FC) host bus adapter (HBA). When the storage node returns to its optimal state, the logical interfaces also come up and the remote ports should be online. However, the remote ports might still be blocked. This blocked state registers as failed faulty to LUNS at the multipath layer. You can verify the state of the remote ports with the following command: # cat /sys/class/fc_remote_ports/rport-*/port_stat You should see the following output: Blocked Blocked Blocked Blocked Online Online	16853

Use Oracle Linux 7.5 with ONTAP

You can use the ONTAP SAN host configuration settings to configure Oracle Linux 7.5 with ONTAP as the target.

Install the Linux Unified Host Utilities

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

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

What you'll need

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

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

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

> You can use the configuration settings provided in this document to configure cloud clients connected to Cloud Volumes ONTAP and Amazon FSx for ONTAP.

SAN Toolkit

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

Example

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

```
# sanlun lun show all
```

Example output:

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

SAN Booting

What you'll need

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

Steps

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

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

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

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

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

Multipathing

For Oracle Linux 7.5 the /etc/multipath.conf file must exist, but you do not need to make specific changes to the file. Oracle Linux 7.5 is compiled with all settings required to recognize and correctly manage ONTAP LUNs.

You can use the `multipath -ll` command to verify the settings for your ONTAP LUNs.
There should be two groups of paths with different priorities. The paths with the higher priorities are Active/Optimized, which means they are serviced by the controller where the aggregate is located. The paths with the lower priorities are active but are non-optimized because they are served from a different controller. The non-optimized paths are only used when no optimized paths are available.

Example

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

```
# multipath -ll
3600a0980383134765724e527766394e dm-5 NETAPP,LUN C-Mode
size=80G features='4 queue_if_no_path pg_init_retries 50
retain_attached_hw_handle' hwhandler='1 alua' wp=rw
|-+- policy='service-time 0' prio=50 status=active
| |- 11:0:1:0 sdj 8:144 active ready running
| |- 11:0:2:0 sdr 65:16 active ready running
|-+- policy='service-time 0' prio=10 status=enabled
|- 11:0:0:0 sdb 8:i6 active ready running
|- 12:0:0:0 sdz 65:144 active ready running
```

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

Recommended Settings

The Oracle Linux 7.5 OS is compiled to recognize ONTAP LUNs and automatically set all configuration parameters correctly.
The `multipath.conf` file must exist for the multipath daemon to start, but you can create an empty, zero-byte file by using the following command:

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

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

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

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

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

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

Example

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

Steps

1. Run the following command to determine the WWID:

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

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

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

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

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

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

Parameter	Setting
detect_prio	yes
dev_loss_tmo	"infinity"
failback	immediate
fast_io_fail_tmo	5
features	"3 queue_if_no_path pg_init_retries 50"
flush_on_last_del	"yes"
hardware_handler	"0"
path_checker	"tur"
path_grouping_policy	"group_by_prio"
path_selector	"service-time 0"
polling_interval	5
prio	"ontap"
product	LUN.*
retain_attached_hw_handler	yes

Parameter	Setting
rr_weight	"uniform"
user_friendly_names	no
vendor	NETAPP

Example

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

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

To configure Oracle Linux 7.5 RedHat Enterprise Kernel (RHCK), use the recommended settings for Red Hat Enterprise Linux (RHEL) 7.5.

Known issues

The Oracle Linux 7.5 with ONTAP release has the following known issues:

NetApp Bug ID	Title	Description	Bugzilla ID
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.	N/A
1177239	Kernel disruption observed on OL7.5 with Qlogic QLE2672 16G FC during storage failover operations	During storage failover operations on Oracle Linux 7 (OL7.5) with kernel 4.1.12-112.16.4.el7uek.x86_64 and the Qlogic QLE2672 HBA, you might observe kernel disruption. This prompts a reboot of the operating system which causes an application disruption. If kdump is configured, the kernel disruption creates a vmcore file in the /var/crash/ directory. This disruption can be observed in the module “kmem_cache_alloc+118,” which is logged in the vmcore file and identified with the string "exception RIP: kmem_cache_alloc+118." After a kernel disruption, you can recover by rebooting the host operating system and restarting the application.	

Use Oracle Linux 7.4 with ONTAP

You can use the ONTAP SAN host configuration settings to configure Oracle Linux 7.4 with ONTAP as the target.

Install the Linux Unified Host Utilities

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

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

What you'll need

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

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

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

> You can use the configuration settings provided in this document to configure cloud clients connected to Cloud Volumes ONTAP and Amazon FSx for ONTAP.

SAN Toolkit

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

Example

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

```
# sanlun lun show all
```

Example output:

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

SAN Booting

What you'll need

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

Steps

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

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

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

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

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

Multipathing

For Oracle Linux 7.4 the /etc/multipath.conf file must exist, but you do not need to make specific changes to the file. Oracle Linux 7.4 is compiled with all settings required to recognize and correctly manage ONTAP LUNs.

You can use the `multipath -ll` command to verify the settings for your ONTAP LUNs.
There should be two groups of paths with different priorities. The paths with the higher priorities are Active/Optimized, which means they are serviced by the controller where the aggregate is located. The paths with the lower priorities are active but are non-optimized because they are served from a different controller. The non-optimized paths are only used when no optimized paths are available.

Example

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

```
# multipath -ll
3600a0980383134765724e527766394e dm-5 NETAPP,LUN C-Mode
size=80G features='4 queue_if_no_path pg_init_retries 50
retain_attached_hw_handle' hwhandler='1 alua' wp=rw
|-+- policy='service-time 0' prio=50 status=active
| |- 11:0:1:0 sdj 8:144 active ready running
| |- 11:0:2:0 sdr 65:16 active ready running
|-+- policy='service-time 0' prio=10 status=enabled
|- 11:0:0:0 sdb 8:i6 active ready running
|- 12:0:0:0 sdz 65:144 active ready running
```

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

Recommended Settings

The Oracle Linux 7.4 OS is compiled to recognize ONTAP LUNs and automatically set all configuration parameters correctly.
The `multipath.conf` file must exist for the multipath daemon to start, but you can create an empty, zero-byte file by using the following command:

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

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

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

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

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

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

Example

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

Steps

1. Run the following command to determine the WWID:

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

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

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

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

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

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

Parameter	Setting
detect_prio	yes
dev_loss_tmo	"infinity"
failback	immediate
fast_io_fail_tmo	5
features	"3 queue_if_no_path pg_init_retries 50"
flush_on_last_del	"yes"
hardware_handler	"0"
path_checker	"tur"
path_grouping_policy	"group_by_prio"
path_selector	"service-time 0"
polling_interval	5
prio	"ontap"
product	LUN.*
retain_attached_hw_handler	yes

Parameter	Setting
rr_weight	"uniform"
user_friendly_names	no
vendor	NETAPP

Example

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

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

To configure Oracle Linux 7.4 RedHat Enterprise Kernel (RHCK), use the recommended settings for Red Hat Enterprise Linux (RHEL) 7.4.

Known issues

The Oracle Linux 7.4 with ONTAP release has the following known issues:

NetApp Bug ID	Title	Description	Bugzilla ID
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.	N/A
1109468	Firmware dumps observed on an OL7.4 Hypervisor with QLE8362 card	During storage failover operations on an OL7.4 Hypervisor with QLE8362 card, the firmware dumps are observed occasionally. The firmware dumps might result in an I/O outage on the host, which might go up to 500 seconds. After the adapter completes the firmware dump, the I/O operation resumes in the normal manner. No further recovery procedure is required on the host. To indicate the firmware dump, the following message is displayed in the /var/log/message file: qla2xxx [0000:0c:00.3]-d001:8: Firmware dump saved to temp buffer (8/ffffc90008901000), dump status flags (0x3f)	16039

Use Oracle Linux 7.3 with ONTAP

You can use the ONTAP SAN host configuration settings to configure Oracle Linux 7.3 with ONTAP as the target.

Install the Linux Unified Host Utilities

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

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

What you'll need

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

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

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

> You can use the configuration settings provided in this document to configure cloud clients connected to Cloud Volumes ONTAP and Amazon FSx for ONTAP.

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

Example

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

```
# sanlun lun show all
```

Example output:

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

SAN Booting

What you'll need

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

Steps

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

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

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

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

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

Multipathing

For Oracle Linux 7.3 the /etc/multipath.conf file must exist, but you do not need to make specific changes to the file. Oracle Linux 7.3 is compiled with all settings required to recognize and correctly manage ONTAP LUNs.

You can use the `multipath -ll` command to verify the settings for your ONTAP LUNs.
There should be two groups of paths with different priorities. The paths with the higher priorities are Active/Optimized, which means they are serviced by the controller where the aggregate is located. The paths with the lower priorities are active but are non-optimized because they are served from a different controller. The non-optimized paths are only used when no optimized paths are available.

Example

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

```
# multipath -ll
3600a0980383134765724e527766394e dm-5 NETAPP,LUN C-Mode
size=80G features='4 queue_if_no_path pg_init_retries 50
retain_attached_hw_handle' hwhandler='1 alua' wp=rw
|-+- policy='service-time 0' prio=50 status=active
| |- 11:0:1:0 sdj 8:144 active ready running
| |- 11:0:2:0 sdr 65:16 active ready running
|-+- policy='service-time 0' prio=10 status=enabled
|- 11:0:0:0 sdb 8:i6 active ready running
|- 12:0:0:0 sdz 65:144 active ready running
```

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

Recommended Settings

The Oracle Linux 7.3 OS is compiled to recognize ONTAP LUNs and automatically set all configuration parameters correctly.
The `multipath.conf` file must exist for the multipath daemon to start, but you can create an empty, zero-byte file by using the following command:

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

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

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

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

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

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

Example

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

Steps

1. Run the following command to determine the WWID:

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

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

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

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

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

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

Parameter	Setting
detect_prio	yes
dev_loss_tmo	"infinity"
failback	immediate
fast_io_fail_tmo	5
features	"3 queue_if_no_path pg_init_retries 50"
flush_on_last_del	"yes"
hardware_handler	"0"
path_checker	"tur"
path_grouping_policy	"group_by_prio"
path_selector	"service-time 0"
polling_interval	5
prio	"ontap"
product	LUN.*
retain_attached_hw_handler	yes

Parameter	Setting
rr_weight	"uniform"
user_friendly_names	no
vendor	NETAPP

Example

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

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

To configure Oracle Linux 7.3 RedHat Enterprise Kernel (RHCK), use the recommended settings for Red Hat Enterprise Linux (RHEL) 7.3.

Known issues

There are no known issues for the Oracle Linux 7.3 with ONTAP release.

Use Oracle Linux 7.2 with ONTAP

You can use the ONTAP SAN host configuration settings to configure Oracle Linux 7.2 with ONTAP as the target.

Install the Linux Unified Host Utilities

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

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What you'll need

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

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

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

> You can use the configuration settings provided in this document to configure cloud clients connected to Cloud Volumes ONTAP and Amazon FSx for ONTAP.

SAN Toolkit

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

Example

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

```
# sanlun lun show all
```

Example output:

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

SAN Booting

What you'll need

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

Steps

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

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

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

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

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

Multipathing

Oracle Linux 7.2 supports Unbreakable Enterprise Kernel (UEK) R3 and UEK R4. The OS boots with UEK R3 kernel by default.

Oracle Linux 7.2 UEK R3 Configuration

For Oracle Linux 7.2 UEK R3, create an empty multipath.conf file. The settings for Oracle Linux 7.2 UEK with and without ALUA update automatically by default. To Enable ALUA Handler, perform the following 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-3.8.13-68.1.2.el6uek.x86_64 ro
   root=/dev/mapper/vg_ibmx3550m421096-lv_root
   rd_NO_LUKSrd_LVM_LV=vg_ibmx3550m421096/lv_root LANG=en_US.UTF-8
   rd_NO_MDSYSFONT=latarcyrheb-sun16 crashkernel=256M KEYBOARDTYPE=pc
   KEYTABLE=us rd_LVM_LV=vg_ibmx3550m421096/lv_swap rd_NO_DM rhgb quiet
   rdloaddriver=scsi_dh_alua
   ```

3. Use the `dracut -f` command to recreate the initrd-image.
4. Reboot the host.
5. Verify the output of the `cat /proc/cmdline` command to ensure that the setting is complete.

Oracle Linux 7.2 UEK R4 Configuration

For Oracle Linux 7.2 UEK R4 the /etc/multipath.conf file must exist, but you do not need to make specific changes to the file. Oracle Linux 7.2 is compiled with all settings required to recognize and correctly manage ONTAP LUNs.

You can use the `multipath -ll` command to verify the settings for your ONTAP LUNs.
There should be two groups of paths with different priorities. The paths with the higher priorities are Active/Optimized, which means they are serviced by the controller where the aggregate is located. The paths with the lower priorities are active but are non-optimized because they are served from a different controller. The non-optimized paths are only used when no optimized paths are available.

Example

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

```
# multipath -ll
3600a0980383134765724e527766394e dm-5 NETAPP,LUN C-Mode
size=80G features='4 queue_if_no_path pg_init_retries 50
retain_attached_hw_handle' hwhandler='1 alua' wp=rw
|-+- policy='service-time 0' prio=50 status=active
| |- 11:0:1:0 sdj 8:144 active ready running
| |- 11:0:2:0 sdr 65:16 active ready running
|-+- policy='service-time 0' prio=10 status=enabled
|- 11:0:0:0 sdb 8:i6 active ready running
|- 12:0:0:0 sdz 65:144 active ready running
```

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

Recommended Settings

The Oracle Linux 7.2 OS is compiled to recognize ONTAP LUNs and automatically set all configuration parameters correctly.
The `multipath.conf` file must exist for the multipath daemon to start, but you can create an empty, zero-byte file by using the following command:

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

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

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

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

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

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

Example

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

Steps

1. Run the following command to determine the WWID:

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

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

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

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

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

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

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

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

Example

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

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

To configure Oracle Linux 7.2 RedHat Enterprise Kernel (RHCK), use the recommended settings for Red Hat Enterprise Linux (RHEL) 7.2.

Known issues

There are no known issues for the Oracle Linux 7.2 with ONTAP release.

Use Oracle Linux 7.1 with ONTAP

You can use the ONTAP SAN host configuration settings to configure Oracle Linux 7.1 with ONTAP as the target.

Install the Linux Unified Host Utilities

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support in gathering information about your configuration.

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2. Use the following command to install the software package:

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

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

Example

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

```
# sanlun lun show all
```

Example output:

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

SAN Booting

What you'll need

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

Steps

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

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

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

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

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

Multipathing

Oracle Linux 7.1 supports Unbreakable Enterprise Kernel (UEK) R3 and UEK R4. The OS boots with UEK R3 kernel by default.

Oracle Linux 7.1 UEK R3 Configuration

For Oracle Linux 7.1 UEK R3, create an empty multipath.conf file. The settings for Oracle Linux 7.1 UEK with and without ALUA update automatically by default. To Enable ALUA Handler, perform the following 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-3.8.13-68.1.2.el6uek.x86_64 ro
   root=/dev/mapper/vg_ibmx3550m421096-lv_root
   rd_NO_LUKSrd_LVM_LV=vg_ibmx3550m421096/lv_root LANG=en_US.UTF-8
   rd_NO_MDSYSFONT=latarcyrheb-sun16 crashkernel=256M KEYBOARDTYPE=pc
   KEYTABLE=us rd_LVM_LV=vg_ibmx3550m421096/lv_swap rd_NO_DM rhgb quiet
   rdloaddriver=scsi_dh_alua
   ```

3. Use the `dracut -f` command to recreate the initrd-image.
4. Reboot the host.
5. Verify the output of the `cat /proc/cmdline` command to ensure that the setting is complete.

Oracle Linux 7.1 UEK R4 Configuration

For Oracle Linux 7.1 UEK R4 the /etc/multipath.conf file must exist, but you do not need to make specific changes to the file. Oracle Linux 7.1 is compiled with all settings required to recognize and correctly manage ONTAP LUNs.
You can use the `multipath -ll` command to verify the settings for your ONTAP LUNs.
There should be two groups of paths with different priorities. The paths with the higher priorities are Active/Optimized, which means they are serviced by the controller where the aggregate is located. The paths with the lower priorities are active but are non-optimized because they are served from a different controller. The non-optimized paths are only used when no optimized paths are available.

Example

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

```
# multipath -ll
3600a0980383134765724e527766394e dm-5 NETAPP,LUN C-Mode
size=80G features='4 queue_if_no_path pg_init_retries 50
retain_attached_hw_handle' hwhandler='1 alua' wp=rw
|-+- policy='service-time 0' prio=50 status=active
| |- 11:0:1:0 sdj 8:144 active ready running
| |- 11:0:2:0 sdr 65:16 active ready running
|-+- policy='service-time 0' prio=10 status=enabled
|- 11:0:0:0 sdb 8:i6 active ready running
|- 12:0:0:0 sdz 65:144 active ready running
```

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

Recommended Settings

The Oracle Linux 7.1 OS is compiled to recognize ONTAP LUNs and automatically set all configuration parameters correctly.

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

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

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

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

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

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

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

Example

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

Steps

1. Run the following command to determine the WWID:

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

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

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

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

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

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

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

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

Example

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

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

To configure Oracle Linux 7.1 RedHat Enterprise Kernel (RHCK), use the recommended settings for Red Hat Enterprise Linux (RHEL) 7.1.

Known issues

There are no known issues for the Oracle Linux 7.1 with ONTAP release.

Use Oracle Linux 7.0 with ONTAP

You can use the ONTAP SAN host configuration settings to configure Oracle Linux 7.0 with ONTAP as the target.

Install the Linux Unified Host Utilities

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

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

What you'll need

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

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

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

> You can use the configuration settings provided in this document to configure cloud clients connected to Cloud Volumes ONTAP and Amazon FSx for ONTAP.

SAN Toolkit

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

Example

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

```
# sanlun lun show all
```

Example output:

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

SAN Booting

What you'll need

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

Interoperability Matrix Tool to verify that your OS, HBA, HBA firmware and the HBA boot BIOS, and ONTAP version are supported.

Steps

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

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

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

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

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

Multipathing

For Oracle Linux 7.0 the /etc/multipath.conf file must exist, but you do not need to make specific changes to the file. Oracle Linux 7.0 is compiled with all settings required to recognize and correctly manage ONTAP LUNs. To Enable ALUA Handler, perform the following 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-3.8.13-68.1.2.el6uek.x86_64 ro
   root=/dev/mapper/vg_ibmx3550m421096-lv_root
   rd_NO_LUKSrd_LVM_LV=vg_ibmx3550m421096/lv_root LANG=en_US.UTF-8
   rd_NO_MDSYSFONT=latarcyrheb-sun16 crashkernel=256M KEYBOARDTYPE=pc
   KEYTABLE=us rd_LVM_LV=vg_ibmx3550m421096/lv_swap rd_NO_DM rhgb quiet
   rdloaddriver=scsi_dh_alua
   ```

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

Example

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

```
# multipath -ll
3600a0980383134765724e527766394e dm-5 NETAPP,LUN C-Mode
size=80G features='4 queue_if_no_path pg_init_retries 50
retain_attached_hw_handle' hwhandler='1 alua' wp=rw
|-+- policy='service-time 0' prio=50 status=active
| |- 11:0:1:0 sdj 8:144 active ready running
| |- 11:0:2:0 sdr 65:16 active ready running
|-+- policy='service-time 0' prio=10 status=enabled
|- 11:0:0:0 sdb 8:i6 active ready running
|- 12:0:0:0 sdz 65:144 active ready running
```

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

Recommended Settings

The Oracle Linux 7.0 OS is compiled to recognize ONTAP LUNs and automatically set all configuration parameters correctly.

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

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

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

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

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

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

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

Example

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

Steps

1. Run the following command to determine the WWID:

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

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

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

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

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

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

Parameter	Setting
detect_prio	yes
dev_loss_tmo	"infinity"
failback	immediate
fast_io_fail_tmo	5
features	"3 queue_if_no_path pg_init_retries 50"
flush_on_last_del	"yes"
hardware_handler	"0"
path_checker	"tur"
path_grouping_policy	"group_by_prio"
path_selector	"service-time 0"
polling_interval	5
prio	"ontap"
product	LUN.*

Parameter	Setting
retain_attached_hw_handler	yes
rr_weight	"uniform"
user_friendly_names	no
vendor	NETAPP

Example

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

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

To configure Oracle Linux 7.0 RedHat Enterprise Kernel (RHCK), use the recommended settings for Red Hat Enterprise Linux (RHEL) 7.0.

Known issues

The Oracle Linux 7.0 with ONTAP release has the following known issues:

NetApp Bug ID	Title	Description	Bugzilla ID
901558	OL7.0 : Host loses all paths to the lun and hangs due to "RSCN timeout" error on OL 7.0 UEK r3U5 Beta on Emulex 8G(LPe12002) host	You might observe that the Emulex 8G(LPe12002) host hangs and there is a high I/O outage during storage failover operations with I/O. You might observe paths not recovering, which is a result of the RSCN timeout, due to which the host loses all the paths and hangs. Probability of hitting this issue is high.	14898
901557	OL 7.0: High IO outage observed on QLogic 8G FC (QLE2562) SAN host during storage failover operations with IO	You might observe high IO outage on QLogic 8G FC (QLE2562) host during storage failover operations with IO. Aborts and Device resets manifests as IO outage on the host. Probability of hitting this IO outage is high.	14894
894766	OL7.0: Dracut fails to include scsi_dh_alua.ko module in initramfs on UEKR3U5 alpha	The scsi_dh_alua module might not load even after adding the parameter "rdloaddriver=scsi_dh_alua" in the kernel command line and creating Dracut. As a result, ALUA is not enabled for NetApp LUNs as recommended.	14860

NetApp Bug ID	Title	Description	Bugzilla ID
894796	Anaconda displays an iSCSI login failure message although logins are successful during OL 7.0 OS installation	When you are installing OL 7.0, the anaconda installation screen displays that iSCSI login to multiple target IPs have failed though the iSCSI logins are successful. Anaconda displays following error message: "Node Login Failed" You will observe this error only when you select multiple target IPs for iSCSI login. You can continue the OS installation by clicking the "ok" button. This bug does not hamper either the iSCSI or the OL 7.0 OS installation.	14870
894771	OL7.0 : Anaconda does not add bootdev argument in kernel cmd line to set IP address for iSCSI SANboot OS install	Anaconda does not add a bootdev argument in the kernel command line where you set the IPv4 address during the OL 7.0 OS installation on an iSCSI multipath'd LUN. Owing to this, you cannot assign IP addresses to any of the Ethernet interfaces that were configured to establish iSCSI sessions with the storage subsystem during the OL 7.0 boot. Since iSCSI sessions are not established, the root LUN is not discovered when the OS boots and hence the OS boot fails.	14871
916501	Qlogic 10G FCoE (QLE8152) host kernel crash observed during storage failover operations with IO	You may observe a kernel crash in Qlogic driver module on 10G FCoE Qlogic (QLE8152) host. The crash occurs during storage failover operations with IO. Probability of hitting this crash is high which leads to longer IO outage on the host.	15019

OL 6

Use Oracle Linux 6.10 with ONTAP

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

Install the Linux Unified Host Utilities

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

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

What you'll need

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

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

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

> You can use the configuration settings provided in this document to configure cloud clients connected to Cloud Volumes ONTAP and Amazon FSx for ONTAP.

SAN Toolkit

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

Example

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

```
# sanlun lun show all
```

Example output:

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

SAN Booting

What you'll need

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

Steps

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

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

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

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

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

Multipathing

For Oracle Linux 6.10 the /etc/multipath.conf file must exist, but you do not need to make specific changes to the file. Oracle Linux 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.
2. Append the following parameter value to the kernel for ALUA and non-ALUA to work:
   `rdloaddriver=scsi_dh_alua`

Example

```
kernel /vmlinuz-3.8.13-68.1.2.el6uek.x86_64 ro
root=/dev/mapper/vg_ibmx3550m421096-lv_root
rd_NO_LUKSrd_LVM_LV=vg_ibmx3550m421096/lv_root LANG=en_US.UTF-8
rd_NO_MDSYSFONT=latarcyrheb-sun16 crashkernel=256M KEYBOARDTYPE=pc
KEYTABLE=us rd_LVM_LV=vg_ibmx3550m421096/lv_swap rd_NO_DM rhgb quiet
rdloaddriver=scsi_dh_alua
```

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

Example

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

```
# multipath -ll
3600a09803831347657244e527766394e dm-5 NETAPP,LUN C-Mode
size=80G features='4 queue_if_no_path pg_init_retries 50
retain_attached_hw_handle' hwhandler='1 alua' wp=rw
|-+- policy='round-robin 0' prio=50 status=active
| |- 0:0:26:37 sdje 8:384   active ready running
| |- 0:0:25:37 sdik 135:64  active ready running
`-+- policy='round-robin 0' prio=10 status=enabled
  |- 0:0:18:37 sdda 70:128  active ready running
  |- 0:0:19:37 sddu 71:192  active ready running
```

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

Recommended Settings

The Oracle Linux 6.10 OS is compiled to recognize ONTAP LUNs and automatically set all configuration parameters correctly.

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

`touch /etc/multipath.conf`.

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

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

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

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

Example

In this example, `sda` is the local SCSI disk that we need to add to the blacklist.

Steps

1. Run the following command to determine the WWID:

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

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

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

You should always check your `/etc/multipath.conf` file for legacy settings, especially in the defaults section, that might be overriding 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. If this is not done, the ONTAP LUNs might not work as expected. You should only override these defaults in consultation with NetApp and/or the OS vendor and only when the impact is fully understood.

Parameter	Setting
detect_prio	yes
dev_loss_tmo	"infinity"
failback	immediate
fast_io_fail_tmo	5
features	"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 `detect_prio` that are not compatible with ONTAP LUNs.
If they cannot be removed because of other SAN arrays still attached to the host, these parameters can be corrected specifically for ONTAP LUNs with a device stanza.

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

To configure Oracle Linux 6.10 RedHat Enterprise Kernel (RHCK), use the recommended settings for Red Hat Enterprise Linux (RHEL) 6.10.

Known issues

There are no known issues for the Oracle Linux 6.10 with ONTAP release.

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

Use Oracle Linux 6.9 with ONTAP

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

Install the Linux Unified Host Utilities

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

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

What you'll need

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

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

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

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

SAN Toolkit

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

Example

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

```
# sanlun lun show all
```

Example output:

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

SAN Booting

What you'll need

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

Steps

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

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

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

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

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

Multipathing

For Oracle Linux 6.9 the /etc/multipath.conf file must exist, but you do not need to make specific changes to the file. Oracle Linux 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-3.8.13-68.1.2.el6uek.x86_64 ro
   root=/dev/mapper/vg_ibmx3550m421096-lv_root
   rd_NO_LUKSrd_LVM_LV=vg_ibmx3550m421096/lv_root LANG=en_US.UTF-8
   rd_NO_MDSYSFONT=latarcyrheb-sun16 crashkernel=256M KEYBOARDTYPE=pc
   KEYTABLE=us rd_LVM_LV=vg_ibmx3550m421096/lv_swap rd_NO_DM rhgb quiet
   rdloaddriver=scsi_dh_alua
   ```

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

Example

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

```
# multipath -ll
3600a0980383134765724e527766394e dm-5 NETAPP,LUN C-Mode
size=80G features='4 queue_if_no_path pg_init_retries 50
retain_attached_hw_handle' hwhandler='1 alua' wp=rw
|-+- policy='round-robin 0' prio=50 status=active
| |- 0:0:26:37 sdje 8:384   active ready running
| |- 0:0:25:37 sdik 135:64  active ready running
|-+- policy='round-robin 0' prio=10 status=enabled
  |- 0:0:18:37 sdda 70:128  active ready running
  |- 0:0:19:37 sddu 71:192  active ready running
```

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

Recommended Settings

The Oracle Linux 6.9 OS is compiled to recognize ONTAP LUNs and automatically set all configuration parameters correctly.

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

`touch /etc/multipath.conf.`

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

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

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

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

Example

In this example, `sda` is the local SCSI disk that we need to add to the blacklist.

Steps

1. Run the following command to determine the WWID:

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

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

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

You should always check your `/etc/multipath.conf` file for legacy settings, especially in the defaults section, that might be overriding 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. If this is not done, the ONTAP LUNs might not work as expected. You should only override these defaults in consultation with NetApp and/or the OS vendor and only when the impact is fully understood.

Parameter	Setting
detect_prio	yes
dev_loss_tmo	"infinity"
failback	immediate
fast_io_fail_tmo	5
features	"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

Parameter	Setting
rr_weight	"uniform"
user_friendly_names	no
vendor	NETAPP

Example

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

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

To configure Oracle Linux 6.9 RedHat Enterprise Kernel (RHCK), use the recommended settings for Red Hat Enterprise Linux (RHEL) 6.9.

Known issues

The Oracle Linux 6.9 with ONTAP release has the following known issues:

NetApp Bug ID	Title	Description	Bugzilla ID
1082780	Firmware dumps are observed occasionally on OL6.9 hypervisor with the QLE8362 card	During storage failover operations on OL6.9 hypervisor with QLE8362 card, the firmware dumps are observed occasionally. The firmware dumps might result in an I/O outage on the host which might go up to a thousand seconds. After the adapter completes the firmware dump, the I/O operation resumes in the normal manner. No further recovery procedure is required on the host. To indicate the firmware dump, the following message is displayed in the /var/log/message file: qla2xxx [0000:0c:00.3]-d001:3: Firmware dump saved to temp buffer (3/ffffc90008901000), dump status flags (0x3f).	16039

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

Use Oracle Linux 6.8 with ONTAP

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

Install the Linux Unified Host Utilities

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

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

What you'll need

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

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

2. Use the following command to install the software package:

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

> You can use the configuration settings provided in this document to configure cloud clients connected to Cloud Volumes ONTAP and Amazon FSx for ONTAP.

SAN Toolkit

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

Example

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

```
# sanlun lun show all
```

Example output:

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

SAN Booting

What you'll need

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

Steps

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

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

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

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

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

Multipathing

For Oracle Linux 6.8 the /etc/multipath.conf file must exist, but you do not need to make specific changes to the file. Oracle Linux 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-3.8.13-68.1.2.el6uek.x86_64 ro
   root=/dev/mapper/vg_ibmx3550m421096-lv_root
   rd_NO_LUKSrd_LVM_LV=vg_ibmx3550m421096/lv_root LANG=en_US.UTF-8
   rd_NO_MDSYSFONT=latarcyrheb-sun16 crashkernel=256M KEYBOARDTYPE=pc
   KEYTABLE=us rd_LVM_LV=vg_ibmx3550m421096/lv_swap rd_NO_DM rhgb quiet
   rdloaddriver=scsi_dh_alua
   ```

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

Example

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

```
# multipath -ll
3600a0980383134765724e527766394e dm-5 NETAPP,LUN C-Mode
size=80G features='4 queue_if_no_path pg_init_retries 50
retain_attached_hw_handle' hwhandler='1 alua' wp=rw
|-+- policy='round-robin 0' prio=50 status=active
| |- 0:0:26:37 sdje 8:384   active ready running
| |- 0:0:25:37 sdik 135:64  active ready running
|-+- policy='round-robin 0' prio=10 status=enabled
  |- 0:0:18:37 sdda 70:128  active ready running
  |- 0:0:19:37 sddu 71:192  active ready running
```

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

Recommended Settings

The Oracle Linux 6.8 OS is compiled to recognize ONTAP LUNs and automatically set all configuration parameters correctly.

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

`touch /etc/multipath.conf.`

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

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

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

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

Example

In this example, `sda` is the local SCSI disk that we need to add to the blacklist.

Steps

1. Run the following command to determine the WWID:

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

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

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

You should always check your `/etc/multipath.conf` file for legacy settings, especially in the defaults section, that might be overriding 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. If this is not done, the ONTAP LUNs might not work as expected. You should only override these defaults in consultation with NetApp and/or the OS vendor and only when the impact is fully understood.

Parameter	Setting
detect_prio	yes
dev_loss_tmo	"infinity"
failback	immediate
fast_io_fail_tmo	5
features	"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

Parameter	Setting
rr_weight	"uniform"
user_friendly_names	no
vendor	NETAPP

Example

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

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

To configure Oracle Linux 6.8 RedHat Enterprise Kernel (RHCK), use the recommended settings for Red Hat Enterprise Linux (RHEL) 6.8.

Known issues

There are no known issues for the Oracle Linux 6.8 with ONTAP release.

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

Use Oracle Linux 6.7 with ONTAP

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

Install the Linux Unified Host Utilities

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

NetApp strongly recommends installing the Linux Unified Host Utilities, but it is not mandatory. The utilities do

not change any settings on your Linux host. The utilities improve management and assist NetApp customer support in gathering information about your configuration.

What you'll need

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

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

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

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

SAN Toolkit

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

Example

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

```
# sanlun lun show all
```

Example output:

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

SAN Booting

What you'll need

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

version are supported.

Steps

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

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

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

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

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

Multipathing

For Oracle Linux 6.7 the /etc/multipath.conf file must exist, but you do not need to make specific changes to the file. Oracle Linux 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-3.8.13-68.1.2.el6uek.x86_64 ro
   root=/dev/mapper/vg_ibmx3550m421096-lv_root
   rd_NO_LUKSrd_LVM_LV=vg_ibmx3550m421096/lv_root LANG=en_US.UTF-8
   rd_NO_MDSYSFONT=latarcyrheb-sun16 crashkernel=256M KEYBOARDTYPE=pc
   KEYTABLE=us rd_LVM_LV=vg_ibmx3550m421096/lv_swap rd_NO_DM rhgb quiet
   rdloaddriver=scsi_dh_alua
   ```

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

Example

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

Active/non-Optimized paths:

```
# multipath -ll
3600a0980383134765724e527766394e dm-5 NETAPP,LUN C-Mode
size=80G features='4 queue_if_no_path pg_init_retries 50
retain_attached_hw_handle' hwhandler='1 alua' wp=rw
|-+- policy='round-robin 0' prio=50 status=active
| |- 0:0:26:37 sdje 8:384   active ready running
| |- 0:0:25:37 sdik 135:64  active ready running
|-+- policy='round-robin 0' prio=10 status=enabled
  |- 0:0:18:37 sdda 70:128  active ready running
  |- 0:0:19:37 sddu 71:192  active ready running
```

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

Recommended Settings

The Oracle Linux 6.7 OS is compiled to recognize ONTAP LUNs and automatically set all configuration parameters correctly.

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

`touch /etc/multipath.conf`.

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

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

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

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

Example

In this example, `sda` is the local SCSI disk that we need to add to the blacklist.

Steps

1. Run the following command to determine the WWID:

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

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

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

You should always check your `/etc/multipath.conf` file for legacy settings, especially in the defaults section, that might be overriding 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. If this is not done, the ONTAP LUNs might not work as expected. You should only override these defaults in consultation with NetApp and/or the OS vendor and only when the impact is fully understood.

Parameter	Setting
detect_prio	yes
dev_loss_tmo	"infinity"
failback	immediate
fast_io_fail_tmo	5
features	"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"

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

Example

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

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

To configure Oracle Linux 6.7 RedHat Enterprise Kernel (RHCK), use the recommended settings for Red Hat Enterprise Linux (RHEL) 6.7.

Known issues

There are no known issues for the Oracle Linux 6.7 with ONTAP release.

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

Use Oracle Linux 6.6 with ONTAP

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

Install the Linux Unified Host Utilities

The NetApp Linux Unified Host Utilities software package is available on the NetApp Support Site in a 32-bit and 64-bit .rpm file. If you do not know which file is right for your configuration, use the NetApp Interoperability

Matrix Tool to verify which one you need.

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

What you'll need

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

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

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

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

SAN Toolkit

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

Example

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

```
# sanlun lun show all
```

Example output:

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

SAN Booting

What you'll need

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

Steps

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

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

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

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

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

Multipathing

For Oracle Linux 6.6 the /etc/multipath.conf file must exist, but you do not need to make specific changes to the file. Oracle Linux 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-3.8.13-68.1.2.el6uek.x86_64 ro
   root=/dev/mapper/vg_ibmx3550m421096-lv_root
   rd_NO_LUKSrd_LVM_LV=vg_ibmx3550m421096/lv_root LANG=en_US.UTF-8
   rd_NO_MDSYSFONT=latarcyrheb-sun16 crashkernel=256M KEYBOARDTYPE=pc
   KEYTABLE=us rd_LVM_LV=vg_ibmx3550m421096/lv_swap rd_NO_DM rhgb quiet
   rdloaddriver=scsi_dh_alua
   ```

3. Use the `mkinitrd` command to recreate the initrd-image.
   Oracle 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.
   There should be two groups of paths with different priorities. The paths with the higher priorities are Active/Optimized, which means they are serviced by the controller where the aggregate is located. The

paths with the lower priorities are active but are non-optimized because they are served from a different controller. The non-optimized paths are only used when no optimized paths are available.

Example

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

```
# multipath -ll
3600a09803831347657244e527766394e dm-5 NETAPP,LUN C-Mode
size=80G features='4 queue_if_no_path pg_init_retries 50
retain_attached_hw_handle' hwhandler='1 alua' wp=rw
|-+- policy='round-robin 0' prio=50 status=active
| |- 0:0:26:37 sdje 8:384   active ready running
| |- 0:0:25:37 sdik 135:64  active ready running
|-+- policy='round-robin 0' prio=10 status=enabled
  |- 0:0:18:37 sdda 70:128  active ready running
  |- 0:0:19:37 sddu 71:192  active ready running
```

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

Recommended Settings

The Oracle Linux 6.6 OS is compiled to recognize ONTAP LUNs and automatically set all configuration parameters correctly.

The `multipath.conf` file must exist for the multipath daemon to start, but you can create an empty, zero-byte file by using the following command:

`touch /etc/multipath.conf.`

The first time you create this file, you might need to enable and start the multipath services.

```
# chkconfig multipathd on
# /etc/init.d/multipathd start
```

- There is no requirement to add anything directly to the `multipath.conf` file unless you have devices that you do not want multipath to manage or you have existing settings that override defaults.
- You can add the following syntax to the `multipath.conf` file to exclude the unwanted devices:
  - Replace the <DevId> with the WWID string of the device you want to exclude:

```
blacklist {
        wwid <DevId>
        devnode "^(ram|raw|loop|fd|md|dm-|sr|scd|st)[0-9]*"
        devnode "^hd[a-z]"
        devnode "^cciss.*"
}
```

Example

In this example, `sda` is the local SCSI disk that we need to add to the blacklist.

Steps

1. Run the following command to determine the WWID:

```
# /lib/udev/scsi_id -gud /dev/sda
360030057024d0730239134810c0cb833
```

2. Add this WWID to the "blacklist" stanza in `/etc/multipath.conf`:

```
blacklist {
     wwid   360030057024d0730239134810c0cb833
     devnode "^(ram|raw|loop|fd|md|dm-|sr|scd|st)[0-9]*"
     devnode "^hd[a-z]"
     devnode "^cciss.*"
}
```

You should always check your `/etc/multipath.conf` file for legacy settings, especially in the defaults section, that might be overriding 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. If this is not done, the ONTAP LUNs might not work as expected. You should only override these defaults in consultation with NetApp and/or the OS vendor and only when the impact is fully understood.

Parameter	Setting
detect_prio	yes
dev_loss_tmo	"infinity"
failback	immediate
fast_io_fail_tmo	5
features	"3 queue_if_no_path pg_init_retries 50"
flush_on_last_del	"yes"

Parameter	Setting
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 `detect_prio` that are not compatible with ONTAP LUNs. If they cannot be removed because of other SAN arrays still attached to the host, these parameters can be corrected specifically for ONTAP LUNs with a device stanza.

```
defaults {
 path_checker readsector0
 detect_prio no
 }
devices {
 device {
 vendor "NETAPP "
 product "LUN.*"
 path_checker tur
 detect_prio yes
 }
}
```

To configure Oracle Linux 6.6 RedHat Enterprise Kernel (RHCK), use the recommended settings for Red Hat Enterprise Linux (RHEL) 6.6.

Known issues

There are no known issues for the Oracle Linux 6.6 with ONTAP release.

For Oracle Linux (Red Hat compatible kernel) known issues, see the known issues for Red Hat Enterprise Linux (RHEL) 6.6.

Use Oracle Linux 6.5 with ONTAP

You can use the ONTAP SAN host configuration settings to configure Oracle Linux 6.5 with ONTAP as the target.

Install the Linux Unified Host Utilities

The NetApp Linux Unified Host Utilities software package is available on the NetApp Support Site in a 32-bit and 64-bit .rpm file. If you do not know which file is right for your configuration, use the NetApp Interoperability Matrix Tool to verify which one you need.

NetApp strongly recommends installing the Linux Unified Host Utilities, but it is not mandatory. The utilities do not change any settings on your Linux host. The utilities improve management and assist NetApp customer support in gathering information about your configuration.

What you'll need

If you have a version of Linux Unified Host Utilities currently installed you should upgrade it or, you should remove it and use the following steps to install the latest version.

1. Download the 32-bit or 64-bit Linux Unified Host Utilities software package from the NetApp Support Site Site to your host.
2. Use the following command to install the software package:

```
rpm -ivh netapp_linux_unified_host_utilities-7-1.x86_64
```

You can use the configuration settings provided in this document to configure cloud clients connected to Cloud Volumes ONTAP and Amazon FSx for ONTAP.

SAN Toolkit

The toolkit is installed automatically when you install the NetApp Host Utilities package. This kit provides the `sanlun` utility, which helps you manage LUNs and HBAs. The `sanlun` command returns information about the LUNs mapped to your host, multipathing, and information necessary to create initiator groups.

Example

In the following example, the `sanlun lun show` command returns LUN information.

```
# sanlun lun show all
```

Example output:

```
controller(7mode/E-Series)/            device     host                lun
vserver(cDOT/FlashRay)   lun-pathname  filename   adapter  protocol   size
Product
------------------------------------------------------------------------
data_vserver          /vol/vol1/lun1   /dev/sdb   host16   FCP
120.0g  cDOT
data_vserver          /vol/vol1/lun1   /dev/sdc   host15   FCP
120.0g  cDOT
data_vserver          /vol/vol2/lun2   /dev/sdd   host16   FCP
120.0g  cDOT
data_vserver          /vol/vol2/lun2   /dev/sde   host15   FCP
120.0g  cDOT
```

SAN Booting

What you'll need

If you decide to use SAN booting, it must be supported by your configuration. You can use the NetApp Interoperability Matrix Tool to verify that your OS, HBA, HBA firmware and the HBA boot BIOS, and ONTAP version are supported.

Steps

1. Map the SAN boot LUN to the host.
2. Verify that multiple paths are available.

   Multiple paths become available after the host OS is up and running on the paths.

3. Enable SAN booting in the server BIOS for the ports to which the SAN boot LUN is mapped.

   For information on how to enable the HBA BIOS, see your vendor-specific documentation.

4. Reboot the host to verify that the boot is successful.

Multipathing

For Oracle Linux 6.5 the /etc/multipath.conf file must exist, but you do not need to make specific changes to the file. Oracle Linux 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.
2. Append the following parameter value to the kernel for ALUA and non-ALUA to work:
   `rdloaddriver=scsi_dh_alua`

Example

```
kernel /vmlinuz-3.8.13-68.1.2.el6uek.x86_64 ro
root=/dev/mapper/vg_ibmx3550m421096-lv_root
rd_NO_LUKSrd_LVM_LV=vg_ibmx3550m421096/lv_root LANG=en_US.UTF-8
rd_NO_MDSYSFONT=latarcyrheb-sun16 crashkernel=256M KEYBOARDTYPE=pc
KEYTABLE=us rd_LVM_LV=vg_ibmx3550m421096/lv_swap rd_NO_DM rhgb quiet
rdloaddriver=scsi_dh_alua
```

3. Use the `mkinitrd` command to recreate the initrd-image.
   Oracle 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.
   There should be two groups of paths with different priorities. The paths with the higher priorities are Active/Optimized, which means they are serviced by the controller where the aggregate is located. The paths with the lower priorities are active but are non-optimized because they are served from a different controller. The non-optimized paths are only used when no optimized paths are available.

Example

The following example displays the correct output for an ONTAP LUN with two Active/Optimized paths and two Active/non-Optimized paths:

```
# multipath -ll
3600a0980383134765724e527766394e dm-5 NETAPP,LUN C-Mode
size=80G features='4 queue_if_no_path pg_init_retries 50
retain_attached_hw_handle' hwhandler='1 alua' wp=rw
|-+- policy='round-robin 0' prio=50 status=active
| |- 0:0:26:37 sdje 8:384   active ready running
| |- 0:0:25:37 sdik 135:64  active ready running
|-+- policy='round-robin 0' prio=10 status=enabled
  |- 0:0:18:37 sdda 70:128  active ready running
  |- 0:0:19:37 sddu 71:192  active ready running
```

Do not use an excessive number of paths to a single LUN. No more than four paths should be required. More than eight paths might cause path issues during storage failures.

Recommended Settings

The Oracle Linux 6.5 OS is compiled to recognize ONTAP LUNs and automatically set all configuration parameters correctly.

The `multipath.conf` file must exist for the multipath daemon to start, but you can create an empty, zero-byte file by using the following command:

`touch /etc/multipath.conf`.

The first time you create this file, you might need to enable and start the multipath services.

```
# chkconfig multipathd on
# /etc/init.d/multipathd start
```

- There is no requirement to add anything directly to the `multipath.conf` file unless you have devices that you do not want multipath to manage or you have existing settings that override defaults.
- You can add the following syntax to the `multipath.conf` file to exclude the unwanted devices:
  - Replace the <DevId> with the WWID string of the device you want to exclude:

```
blacklist {
        wwid <DevId>
        devnode "^(ram|raw|loop|fd|md|dm-|sr|scd|st)[0-9]*"
        devnode "^hd[a-z]"
        devnode "^cciss.*"
}
```

Example

In this example, `sda` is the local SCSI disk that we need to add to the blacklist.

Steps

1. Run the following command to determine the WWID:

```
# /lib/udev/scsi_id -gud /dev/sda
360030057024d0730239134810c0cb833
```

2. Add this WWID to the "blacklist" stanza in `/etc/multipath.conf`:

```
blacklist {
     wwid   360030057024d0730239134810c0cb833
     devnode "^(ram|raw|loop|fd|md|dm-|sr|scd|st)[0-9]*"
     devnode "^hd[a-z]"
     devnode "^cciss.*"
}
```

You should always check your `/etc/multipath.conf` file for legacy settings, especially in the defaults section, that might be overriding 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. If this is not done, the ONTAP LUNs might not work as expected. You should only override these defaults in consultation with NetApp and/or the OS vendor and only when the impact is fully understood.

Parameter	Setting
detect_prio	yes
dev_loss_tmo	"infinity"
failback	immediate
fast_io_fail_tmo	5
features	"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 `detect_prio` that are not compatible with ONTAP LUNs.
If they cannot be removed because of other SAN arrays still attached to the host, these parameters can be corrected specifically for ONTAP LUNs with a device stanza.

```
defaults {
 path_checker readsector0
 detect_prio no
 }
devices {
 device {
 vendor "NETAPP "
 product "LUN.*"
 path_checker tur
 detect_prio yes
 }
}
```

To configure Oracle Linux 6.5 RedHat Enterprise Kernel (RHCK), use the recommended settings for Red Hat Enterprise Linux (RHEL) 6.5.

Known issues

There are no known issues for the Oracle Linux 6.5 with ONTAP release.

For Oracle Linux (Red Hat compatible kernel) known issues, see the known issues for Red Hat Enterprise Linux (RHEL) 6.5.

Use Oracle Linux 6.4 with ONTAP

You can use the ONTAP SAN host configuration settings to configure Oracle Linux 6.4 with ONTAP as the target.

Install the Linux Unified Host Utilities

The NetApp Linux Unified Host Utilities software package is available on the NetApp Support Site in a 32-bit and 64-bit .rpm file. If you do not know which file is right for your configuration, use the NetApp Interoperability Matrix Tool to verify which one you need.

NetApp strongly recommends installing the Linux Unified Host Utilities, but it is not mandatory. The utilities do not change any settings on your Linux host. The utilities improve management and assist NetApp customer support in gathering information about your configuration.

What you'll need

If you have a version of Linux Unified Host Utilities currently installed you should upgrade it or, you should remove it and use the following steps to install the latest version.

1. Download the 32-bit or 64-bit Linux Unified Host Utilities software package from the NetApp Support Site Site to your host.
2. Use the following command to install the software package:

```
rpm -ivh netapp_linux_unified_host_utilities-7-1.x86_64
```

You can use the configuration settings provided in this document to configure cloud clients connected to Cloud Volumes ONTAP and Amazon FSx for ONTAP.

SAN Toolkit

The toolkit is installed automatically when you install the NetApp Host Utilities package. This kit provides the `sanlun` utility, which helps you manage LUNs and HBAs. The `sanlun` command returns information about the LUNs mapped to your host, multipathing, and information necessary to create initiator groups.

Example

In the following example, the `sanlun lun show` command returns LUN information.

```
# sanlun lun show all
```

Example output:

```
controller(7mode/E-Series)/            device     host               lun
vserver(cDOT/FlashRay)   lun-pathname  filename   adapter  protocol  size
Product
------------------------------------------------------------------------
data_vserver          /vol/vol1/lun1   /dev/sdb   host16   FCP
120.0g  cDOT
data_vserver          /vol/vol1/lun1   /dev/sdc   host15   FCP
120.0g  cDOT
data_vserver          /vol/vol2/lun2   /dev/sdd   host16   FCP
120.0g  cDOT
data_vserver          /vol/vol2/lun2   /dev/sde   host15   FCP
120.0g  cDOT
```

SAN Booting

What you'll need

If you decide to use SAN booting, it must be supported by your configuration. You can use the NetApp Interoperability Matrix Tool to verify that your OS, HBA, HBA firmware and the HBA boot BIOS, and ONTAP version are supported.

Steps

1. Map the SAN boot LUN to the host.
2. Verify that multiple paths are available.

   Multiple paths become available after the host OS is up and running on the paths.

3. Enable SAN booting in the server BIOS for the ports to which the SAN boot LUN is mapped.

   For information on how to enable the HBA BIOS, see your vendor-specific documentation.

4. Reboot the host to verify that the boot is successful.

Multipathing

For Oracle Linux 6.4 the /etc/multipath.conf file must exist, but you do not need to make specific changes to the file. Oracle Linux 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.
2. Append the following parameter value to the kernel for ALUA and non-ALUA to work: `rdloaddriver=scsi_dh_alua`

   Example

   ```
   kernel /vmlinuz-3.8.13-68.1.2.el6uek.x86_64 ro
   root=/dev/mapper/vg_ibmx3550m421096-lv_root
   rd_NO_LUKSrd_LVM_LV=vg_ibmx3550m421096/lv_root LANG=en_US.UTF-8
   rd_NO_MDSYSFONT=latarcyrheb-sun16 crashkernel=256M KEYBOARDTYPE=pc
   KEYTABLE=us rd_LVM_LV=vg_ibmx3550m421096/lv_swap rd_NO_DM rhgb quiet
   rdloaddriver=scsi_dh_alua
   ```

3. Use the `mkinitrd` command to recreate the initrd-image.
   Oracle 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.
   There should be two groups of paths with different priorities. The paths with the higher priorities are Active/Optimized, which means they are serviced by the controller where the aggregate is located. The paths with the lower priorities are active but are non-optimized because they are served from a different controller. The non-optimized paths are only used when no optimized paths are available.

Example

The following example displays the correct output for an ONTAP LUN with two Active/Optimized paths and two Active/non-Optimized paths:

```
# multipath -ll
3600a0980383134765724e527766394e dm-5 NETAPP,LUN C-Mode
size=80G features='4 queue_if_no_path pg_init_retries 50
retain_attached_hw_handle' hwhandler='1 alua' wp=rw
|-+- policy='round-robin 0' prio=50 status=active
| |- 0:0:26:37 sdje 8:384   active ready running
| |- 0:0:25:37 sdik 135:64  active ready running
|-+- policy='round-robin 0' prio=10 status=enabled
  |- 0:0:18:37 sdda 70:128  active ready running
  |- 0:0:19:37 sddu 71:192  active ready running
```

Do not use an excessive number of paths to a single LUN. No more than four paths should be required. More than eight paths might cause path issues during storage failures.

Recommended Settings

The Oracle Linux 6.4 OS is compiled to recognize ONTAP LUNs and automatically set all configuration parameters correctly.

The `multipath.conf` file must exist for the multipath daemon to start, but you can create an empty, zero-byte file by using the following command:

`touch /etc/multipath.conf.`

The first time you create this file, you might need to enable and start the multipath services.

```
# chkconfig multipathd on
# /etc/init.d/multipathd start
```

- There is no requirement to add anything directly to the `multipath.conf` file unless you have devices that you do not want multipath to manage or you have existing settings that override defaults.
- You can add the following syntax to the `multipath.conf` file to exclude the unwanted devices:
  - Replace the <DevId> with the WWID string of the device you want to exclude:

```
blacklist {
        wwid <DevId>
        devnode "^(ram|raw|loop|fd|md|dm-|sr|scd|st)[0-9]*"
        devnode "^hd[a-z]"
        devnode "^cciss.*"
}
```

Example

In this example, `sda` is the local SCSI disk that we need to add to the blacklist.

Steps

1. Run the following command to determine the WWID:

```
# /lib/udev/scsi_id -gud /dev/sda
360030057024d0730239134810c0cb833
```

2. Add this WWID to the "blacklist" stanza in `/etc/multipath.conf`:

```
blacklist {
     wwid   360030057024d0730239134810c0cb833
     devnode "^(ram|raw|loop|fd|md|dm-|sr|scd|st)[0-9]*"
     devnode "^hd[a-z]"
     devnode "^cciss.*"
}
```

You should always check your `/etc/multipath.conf` file for legacy settings, especially in the defaults section, that might be overriding 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. If this is not done, the ONTAP LUNs might not work as expected. You should only override these defaults in consultation with NetApp and/or the OS vendor and only when the impact is fully understood.

Parameter	Setting
detect_prio	yes
dev_loss_tmo	"infinity"
failback	immediate
fast_io_fail_tmo	5
features	"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

Parameter	Setting
rr_weight	"uniform"
user_friendly_names	no
vendor	NETAPP

Example

The following example shows how to correct an overridden default. In this case, the `multipath.conf` file defines values for `path_checker` and `detect_prio` that are not compatible with ONTAP LUNs. If they cannot be removed because of other SAN arrays still attached to the host, these parameters can be corrected specifically for ONTAP LUNs with a device stanza.

```
defaults {
 path_checker readsector0
 detect_prio no
 }
devices {
 device {
 vendor "NETAPP "
 product "LUN.*"
 path_checker tur
 detect_prio yes
 }
}
```

To configure Oracle Linux 6.4 RedHat Enterprise Kernel (RHCK), use the recommended settings for Red Hat Enterprise Linux (RHEL) 6.4.

Known issues

The Oracle Linux 6.4 with ONTAP release has the following known issues:

NetApp Bug ID	Title	Description	Bugzilla ID
713555	QLogic adapter resets are seen on OL6.4 and OL5.9 with UEK2 on controller faults such as takeover/giveback, and reboot	QLogic adapter resets are seen on OL6.4 hosts with UEK2 (kernel-uek-2.6.39-400.17.1.el6uek) or OL5.9 hosts with UEK2 (kernel-uek-2.6.39 400.17.1.el5uek) when controller faults happen (such as takeover, giveback, and reboots). These resets are intermittent. When these adapter resets happen, a prolonged I/O outage (sometimes, more than 10 minutes) might occur until the adapter resets succeed and the paths' status are updated by dm-multipath. In /var/log/messages, messages similar to the following are seen when this bug is hit: kernel: qla2xxx [0000:11:00.0]-8018:0: ADAPTER RESET ISSUED nexus=0:2:13. This is observed with the kernel version: On OL6.4: kernel-uek-2.6.39-400.17.1.el6uek On OL5.9: kernel-uek-2.6.39-400.17.1.el5uek	13999

NetApp Bug ID	Title	Description	Bugzilla ID
715217	Delay in path recovery on OL6.4 or OL5.9 hosts with UEK2 may result in delayed I/O resumption on controller or fabric faults	When a controller fault (storage failover or giveback, reboots and so on) or a fabric fault (FC port disable or enable) occurs with I/O on Oracle Linux 6.4 or Oracle Linux 5.9 hosts with UEK2 Kernel, the path recovery by DM-Multipath takes a long time (4mins. to 10 mins). Sometimes, during the paths recovering to active state, the following lpfc driver errors are also seen: kernel: sd 0:0:8:3: [sdlt] Result: hostbyte=DID_ERROR driverbyte=DRIVER_OK Due to this delay in path recovery during fault events, the I/O resumption also delays. OL 6.4 Versions: device-mapper-1.02.77-9.el6 device-mapper-multipath-0.4.9-64.0.1.el6 kernel-uek-2.6.39-400.17.1.el6uek OL 5.9 Versions: device-mapper-1.02.77-9.el5 device-mapper-multipath-0.4.9-64.0.1.el5 kernel-uek-2.6.39-400.17.1.el5uek	14001

NetApp Bug ID	Title	Description	Bugzilla ID
709911	DM Multipath on OL6.4 & OL5.9 iSCSI with UEK2 kernel takes long time to update LUN path status after storage faults	On systems running Oracle Linux 6 Update4 and Oracle Linux 5 Update9 iSCSI with Unbreakable Enterprise Kernel Release 2 (UEK2), a problem has been seen during storage fault events where DM Multipath (DMMP) takes around 15 minutes to update the path status of Device Mapper (DM) devices (LUNs). If you run the "multipath -ll" command during this interval, the path status is shown as "failed ready running" for that DM device (LUN). The path status is eventually updated as "active ready running." This issue is seen with following version: Oracle Linux 6 Update 4: UEK2 Kernel: 2.6.39-400.17.1.el6uek.x86_64 Multipath: device-mapper-multipath-0.4.9-64.0.1.el6.x86_64 iSCSI: iscsi-initiator-utils-6.2.0.873-2.0.1.el6.x86_64 Oracle Linux 5 Update 9: UEK2 Kernel: 2.6.39-400.17.1.el5uek Multipath: device-mapper-multipath-0.4.9-64.0.1.el5.x86_64 iSCSI: iscsi-initiator-utils-6.2.0.872-16.0.1.el5.x86_64	13984

NetApp Bug ID	Title	Description	Bugzilla ID
739909	The SG_IO ioctl system call fails on dm-multipath devices after an FC fault on OL6.x and OL5.x hosts with UEK2	A problem is seen on Oracle Linux 6.x hosts with UEK2 kernel and Oracle Linux 5.x hosts with UEK2 kernel. The sg_* commands on a multipath device fail with EAGAIN error code (errno) after a fabric fault that makes all the paths in the active path group go down. This problem is seen only when there is no I/O occurring to the multipath devices. The following is an example: # sg_inq -v /dev/mapper/3600a09804 1764937303f436c753243 70 inquiry cdb: 12 00 00 00 24 00 ioctl(SG_IO v3) failed with os_err (errno) = 11 inquiry: pass through os error: Resource temporarily unavailable HDIO_GET_IDENTITY ioctl failed: Resource temporarily unavailable [11] Both SCSI INQUIRY and fetching ATA information failed on /dev/mapper/3600a09804 1764937303f436c753243 70 # This problem occurs because the path group switchover to other active groups is not activated during ioctl() calls when no I/O is occurring on the DM-Multipath device. The problem has been observed on the following versions of the kernel-uek and device-mapper-multipath packages: OL6.4 versions:	14082

For Oracle Linux (Red Hat compatible kernel) known issues, see the known issues for Red Hat Enterprise Linux (RHEL) 6.4.

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