



# OL 7

## ONTAP SAN Host

NetApp

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# OL 7

## Using Oracle Linux 7.7 with NetApp ONTAP

### Installing 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.

Installing the Linux Unified Host Utilities is strongly recommended, but 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.

#### *Before you begin*

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

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

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

### 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
controller(7mode/E-Series)/
vserver(cDOT/FlashRay)  lun-pathname  device
                        filename    host
                        adapter      protocol  lun
                        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

### *Before you begin*

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.

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

Remember, multiple paths will only be 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 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, meaning they are serviced by the controller where the aggregate is located. The paths with the lower priorities are active but are non-optimized because they are served from a different controller. The non-optimized paths are only used when no optimized paths are available.

### *Example*

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

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

### Note

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 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 using the command:

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

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

```
[root@jfs0 ~]#systemctl enable multipathd
[root@jfs0 ~]# systemctl start multipathd
```

There is no requirement to add anything directly to `multipath.conf`, unless you have devices that you do not want to be managed by multipath or you have existing settings that override defaults.

You can add the following syntax to the `multipath.conf` file to exclude the unwanted devices.

### Note

Replace the `<DevId>` with the WWID string of the device you want to exclude. Use the following command to determine the WWID:

```
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 blacklist.

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 the `/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 may be overriding default settings.

The table below shows 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 `multipath.conf` that apply specifically to ONTAP LUNs. If this is not done, the ONTAP LUNs may not work as expected. These defaults should only be overridden in consultation with NetApp and/or 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
rr_weight	"uniform"
user_friendly_names	no
vendor	NETAPP

### Example

The following example shows how to correct an overridden default. In this case, the `multipath.conf` file defines values for `path_checker` and `detect_prio` that are not compatible with ONTAP LUNs. If they

cannot be removed because of other SAN arrays still attached to the host, these parameters can be corrected specifically for ONTAP LUNs with a device stanza.

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

## Known Problems and Limitations

There are no known issues for Oracle Linux 7.7.

### *Note*

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

## Release Notes

### ASM Mirroring

ASM mirroring might require changes to the Linux multipath settings to allow ASM to recognize a problem and switch over to an alternate fail 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.

## Using Oracle Linux 7.6 with NetApp ONTAP

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                        size         Product
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data_vserver            /vol/vol1/lun1  /dev/sdb   host16   FCP      120.0g  cDOT
data_vserver            /vol/vol1/lun1  /dev/sdc   host15   FCP      120.0g  cDOT
data_vserver            /vol/vol2/lun2  /dev/sdd   host16   FCP      120.0g  cDOT
data_vserver            /vol/vol2/lun2  /dev/sde   host15   FCP      120.0g  cDOT
```

**SAN Booting**

*Before you begin*

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

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

Remember, multiple paths will only be 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 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.

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hwhandler='1 alua' wp=rw
|-+- policy='service-time 0' prio=50 status=active
|  |- 11:0:1:0 sdj 8:144 active ready running
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|  |- 11:0:0:0 sdb 8:i6 active ready running
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```

### Note

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## Recommended Settings

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#### Note

Replace the `<DevId>` with the WWID string of the device you want to exclude. Use the following command to determine the WWID:

```
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 blacklist.

1. Run the following command to determine the WWID:

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

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

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

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The table below shows 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 `multipath.conf` that apply specifically to ONTAP LUNs. If this is not done, the ONTAP LUNs may not work as expected. These defaults should only be overridden in

consultation with NetApp and/or 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
rr_weight	"uniform"
user_friendly_names	no
vendor	NETAPP

#### *Example*

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

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

## Known Problems and Limitations

NetApp Bug ID	Title	Description	Bugzilla ID
<a href="#">1202736</a>	LUNs might not be available during host discovery due to "Not Present" state of remote ports on a OL7U6 host with QLogic QLE2742 adapter	<p>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:</p> <pre># cat /sys/class/fc_remote_ports/rport-*/port_state</pre> <p>The following is an example of the output that is displayed:</p> <pre>Online Online Not Present Online Online</pre>	<a href="#">16613</a>

NetApp Bug ID	Title	Description	Bugzilla ID
<a href="#">1204078</a>	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.	<a href="#">16606</a>

NetApp Bug ID	Title	Description	Bugzilla ID
<a href="#">1204351</a>	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.	<a href="#">16605</a>

NetApp Bug ID	Title	Description	Bugzilla ID
<a href="#">1204352</a>	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.	<a href="#">16607</a>



NetApp Bug ID	Title	Description	Bugzilla ID
<a href="#">11246134</a>	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.	<a href="#">16852</a>

NetApp Bug ID	Title	Description	Bugzilla ID
<a href="#">1246327</a>	Remote port status on QLogic QLE2672 16G host blocked during storage failover operations	<p>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:</p> <pre># cat /sys/class/fc_remote_ports/rport-*/port_stat</pre> <p>You should see the following output:</p> <pre>Blocked Blocked Blocked</pre>	<a href="#">16853</a>

### *Note*

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

## Release Notes

### ASM Mirroring

ASM mirroring might require changes to the Linux multipath settings to allow ASM to recognize a problem and switch over to an alternate fail 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.

## Using Oracle Linux 7.5 with NetApp ONTAP

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-----
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
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## SAN Booting

### *Before you begin*

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

Remember, multiple paths will only be 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.

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## 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.

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In this example, sda is the local SCSI disk that we need to blacklist.

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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 may be overriding default settings.

The table below shows 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 `multipath.conf` that apply specifically to ONTAP LUNs. If this is not done, the ONTAP LUNs may not work as expected. These defaults should only be overridden in consultation with NetApp and/or 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
  }
}
```

## Known Problems and Limitations

NetApp Bug ID	Title	Description	Bugzilla ID
<a href="#">1177239</a>	Kernel disruption observed on OL7.5 with Qlogic QLE2672 16G FC during storage failover operations	<p>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.</p> <p>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."</p> <p>After a kernel disruption, you can recover by rebooting the host operating system and restarting the application.</p>	

#### *Note*

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

## Release Notes

### ASM Mirroring

ASM mirroring might require changes to the Linux multipath settings to allow ASM to recognize a problem and switch over to an alternate fail 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.

## Using Oracle Linux 7.4 with NetApp ONTAP

### Installing 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.

Installing the Linux Unified Host Utilities is strongly recommended, but 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.

#### *Before you begin*

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

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

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

### 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
controller(7mode/E-Series)/
vserver(cDOT/FlashRay)  lun-pathname  device      host      lun
                        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

### *Before you begin*

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.

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

Remember, multiple paths will only be 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 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, meaning they are serviced by the controller where the aggregate is located. The paths with the lower priorities are active but are non-optimized because they are served from a different controller. The non-optimized paths are only used when no optimized paths are available.

### *Example*

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

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

### Note

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 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 using the command:

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

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

```
[root@jfs0 ~]#systemctl enable multipathd
[root@jfs0 ~]# systemctl start multipathd
```

There is no requirement to add anything directly to `multipath.conf`, unless you have devices that you do not want to be managed by multipath or you have existing settings that override defaults.

You can add the following syntax to the `multipath.conf` file to exclude the unwanted devices.

### Note

Replace the `<DevId>` with the WWID string of the device you want to exclude. Use the following command to determine the WWID:

```
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 blacklist.

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 the `/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 may be overriding default settings.

The table below shows 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 `multipath.conf` that apply specifically to ONTAP LUNs. If this is not done, the ONTAP LUNs may not work as expected. These defaults should only be overridden in consultation with NetApp and/or 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
rr_weight	"uniform"
user_friendly_names	no
vendor	NETAPP

### Example

The following example shows how to correct an overridden default. In this case, the `multipath.conf` file defines values for `path_checker` and `detect_prio` that are not compatible with ONTAP LUNs. If they

cannot be removed because of other SAN arrays still attached to the host, these parameters can be corrected specifically for ONTAP LUNs with a device stanza.

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

## Known Problems and Limitations

NetApp Bug ID	Title	Description	Bugzilla ID
<a href="#">1109468</a>	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)	<a href="#">16039</a>

#### Note

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

## Release Notes

### ASM Mirroring

ASM mirroring might require changes to the Linux multipath settings to allow ASM to recognize a problem and switch over to an alternate fail 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.

# Using Oracle Linux 7.3 with NetApp ONTAP

## Installing 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.

Installing the Linux Unified Host Utilities is strongly recommended, but 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.

### *Before you begin*

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

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

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

## 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
controller(7mode/E-Series)/
vserver(cDOT/FlashRay)  lun-pathname  device      host      lun
                        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

### *Before you begin*

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.

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

Remember, multiple paths will only be 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 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, meaning they are serviced by the controller where the aggregate is located. The paths with the lower priorities are active but are non-optimized because they are served from a different controller. The non-optimized paths are only used when no optimized paths are available.

### Example

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

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

### Note

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 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 using the command:

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

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

```
[root@jfs0 ~]#systemctl enable multipathd
[root@jfs0 ~]# systemctl start multipathd
```

There is no requirement to add anything directly to `multipath.conf`, unless you have devices that you do not want to be managed by multipath or you have existing settings that override defaults.

You can add the following syntax to the `multipath.conf` file to exclude the unwanted devices.

### *Note*

Replace the `<DevId>` with the WWID string of the device you want to exclude. Use the following command to determine the WWID:

```
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 blacklist.

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 the `/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 may be overriding default settings.

The table below shows 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 `multipath.conf` that apply specifically to ONTAP LUNs. If this is not done, the ONTAP LUNs may not work as expected. These defaults should only be overridden in consultation with NetApp and/or 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
rr_weight	"uniform"
user_friendly_names	no
vendor	NETAPP

### Example

The following example shows how to correct an overridden default. In this case, the `multipath.conf` file defines values for `path_checker` and `detect_prio` that are not compatible with ONTAP LUNs.

If they cannot be removed because of other SAN arrays still attached to the host, these parameters can be corrected specifically for ONTAP LUNs with a device stanza.

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

## Known Problems and Limitations

There are no known issues for Oracle 7.3.

### *Note*

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

## Release Notes

### ASM Mirroring

ASM mirroring might require changes to the Linux multipath settings to allow ASM to recognize a problem and switch over to an alternate fail 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.

## Using Oracle Linux 7.2 with NetApp ONTAP

### Installing 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.

Installing the Linux Unified Host Utilities is strongly recommended, but 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.

*Before you begin*

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

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

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

**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
controller(7mode/E-Series)/
vserver(cDOT/FlashRay)  lun-pathname  device
                        filename    host
                        adapter      protocol  lun
                        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**

*Before you begin*

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.

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

Remember, multiple paths will only be 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 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=latacyrheb-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, meaning they are serviced by the controller where the aggregate is located. The paths with the lower priorities are active but are non-optimized because they are served from a different controller. The non-optimized paths are only used when no optimized paths are available.

#### *Example*

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

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

#### Note

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 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 using the command:

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

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

```
[root@jfs0 ~]#systemctl enable multipathd
[root@jfs0 ~]# systemctl start multipathd
```

There is no requirement to add anything directly to multipath.conf, unless you have devices that you do not want to be managed by multipath or you have existing settings that override defaults.

You can add the following syntax to the multipath.conf file to exclude the unwanted devices.

#### Note

Replace the <DevId> with the WWID string of the device you want to exclude. Use the following command to determine the WWID:

```
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 blacklist.

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 the `/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 may be overriding default settings.

The table below shows 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 `multipath.conf` that apply specifically to ONTAP LUNs. If this is not done, the ONTAP LUNs may not work as expected. These defaults should only be overridden in consultation with NetApp and/or 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
    }
}
```

## Known Problems and Limitations

There are no known issues for Oracle 7.2.

### Note

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

## Release Notes

### ASM Mirroring

ASM mirroring might require changes to the Linux multipath settings to allow ASM to recognize a problem and switch over to an alternate fail 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.



# Using Oracle Linux 7.1 with NetApp ONTAP

## Installing 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.

Installing the Linux Unified Host Utilities is strongly recommended, but 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.

### *Before you begin*

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

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

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

## 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
controller(7mode/E-Series)/
vserver(cDOT/FlashRay)  lun-pathname  device      host      lun
                        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

### *Before you begin*

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.

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

Remember, multiple paths will only be 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 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=latacyrheb-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, meaning they are serviced by the controller where the aggregate is located. The paths with the lower priorities are active but are non-optimized because they are served from a different controller. The non-optimized paths are only used when no optimized paths are available.

#### *Example*

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

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

#### *Note*

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 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 using the command:

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

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

```
[root@jfs0 ~]#systemctl enable multipathd
[root@jfs0 ~]# systemctl start multipathd
```

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

#### *Note*

Replace the <DevId> with the WWID string of the device you want to exclude. Use the following command to determine the WWID:

```
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 blacklist.

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 the `/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 may be overriding default settings.

The table below shows 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 `multipath.conf` that apply specifically to ONTAP LUNs. If this is not done, the ONTAP LUNs may not work as expected. These defaults should only be overridden in consultation with NetApp and/or 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"
path_checker	"tur"
path_grouping_policy	"group_by_prio"
path_selector	"service-time 0"
polling_interval	5
prio	"ontap"
product	LUN.*
retain_attached_hw_handler	yes
rr_weight	"uniform"
user_friendly_names	no
vendor	NETAPP

### Example

The following example shows how to correct an overridden default. In this case, the `multipath.conf` file defines values for `path_checker` and `detect_prio` that are not compatible with ONTAP LUNs.

If they cannot be removed because of other SAN arrays still attached to the host, these parameters can be corrected specifically for ONTAP LUNs with a device stanza.

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

## Known Problems and Limitations

There are no known issues for Oracle 7.1.

.Note

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

## Release Notes

### ASM Mirroring

ASM mirroring might require changes to the Linux multipath settings to allow ASM to recognize a problem and switch over to an alternate fail 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.

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