

# **GRAID SupremeRAID**<sup>™</sup>

# **User Guide for Linux**

Version: 1.2.2

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## **Table of Contents**

Table of Contents	1
Introduction	4
GRAID SupremeRAID™ Specifications	
Supported Operating Systems	4
Installation	5
Prerequisites	5
Installing on Linux using the Pre-installer	5
All supported distro	6
Installing on Linux Manually	9
CentOS, Rocky Linux, AlmaLinux and RHEL	9
Ubuntu	14
openSUSE	18
SLES	22
Upgrading the Software	26
Management	28
Overview of the GRAID SupremeRAID™ Software Module	
RAID Components	28
Physical Drive (PD)	28
Drive Group (DG)	29
Virtual Drive (VD)	29
Overview of graidctl	30
Syntax	30
Managing Licenses	31
Applying the License	31
Checking License Information	31
Managing Remote NVMe-oF Targets	33
Connecting to a Remote NVMe-oF Target	33
Listing Connected Remote NVMe-oF Targets	33
Disconnecting from Remote NVMe-oF Targets	34
Exporting NVMe-oF Target Management	35
Creating the NVMe-oF Target Port Service	35
Exporting NVMe-oF Targets	35
Listing Created NVMe-oF Targets	35
Deleting the NVMe-oF Target Port Service	36



Unexporting NVMe-oF Targets	36
Viewing Host Drive Information	37
Listing the NVMe Drives	37
Listing SAS/SATA Drives	37
Managing Physical Drives	39
Creating a Physical Drive	39
Listing the Physical Drives	39
Deleting a Physical Drive	41
Describing a Physical Drive	41
Locating a Physical Drive	41
Marking a Physical Drive Online or Offline	42
Assigning a Hot Spare Drive	42
Replacing a Nearly Worn-Out or Broken SSD	42
Creating the Physical Drive from the NVMe-oF Drive	43
Managing Drive Groups	45
Creating Drive Groups	45
Listing Drive Groups	46
Deleting Drive Groups	47
Describing a Drive Group	49
Setting the Drive Group Rebuild Speed	49
Locating the Physical Drives in the Drive Group	49
Degradation and Recovery	49
Rescue Mode	49
Managing Virtual Drives	51
Creating a Virtual Drive	51
Listing Virtual Drives	51
Deleting Virtual Drives	53
Describing a Virtual Group	53
About Consistency Check task	54
Consistency Check task	54
The record of the Consistency Check	54
Enable Consistency Check task by manual	54
Stop Consistency Check task	54
Schedule Consistency Check task	55
Describing the Consistency Check task	55
Set the Consistency Check policy	55
Consistency Check exclude certain drive groups.	56
List events	56
Delete Events	56
Creating a RAID-5 Virtual Drive with 5 NVMe SSDs	57
Exporting the Virtual Drive as an NVMe-oF Target Drive using RDMA to the Initiator	58
Setting Up a Stripe Cache to Improve the HDD's RAID 5 and RAID 6 Performance	59



Basic Troubleshooting	60
Sequential Read Performance is not as Expected on a New Drive Group	60
Kernel Log Message "failed to set APST feature (-19)" Appears When Creating Physical Drives	61
Different LED Blink Patterns on the Backplane	62
Appendix	63
Manually Migrating the RAID Configuration Between Hosts	63
Monitoring System Input/Output Statistics for Devices Using iostat	64
sysstat versions v12.3.3 and later	64
sysstat versions prior to v12.3.3	65
Setting Up the Auto-mount File Systems on Linux using the GRAID Driver	67
Enabling Virtual Machines with GPU Passthrough	70
Configuring Hosts for NVIDIA GPU Device Passthrough	70
Configuring Virtual Machines	71
Setting Up a Self-Encrypting Drive (SED)	74
Prerequisites	74
Limitations	74
Importing a Single SED Key using NQN/WWID	74
Importing a Batched SED Key using NQN/WWID	74
Displaying SED Key Information	74
Deleting SED Keys	75
Setting Boot-Drive Devices	76
Prerequisites	76
Limitation	76
Setup by Operating System	76
Importing and Controlling MD Bootable NVMe RAIDs using SupremeRAID™	94



## Introduction

GRAID SupremeRAID<sup>™</sup> is the most powerful, high-speed data protection solution specially designed for NVMe SSDs. GRAID SupremeRAID<sup>™</sup> installs a virtual NVMe controller onto the operating system and integrates a high-performance, AI processor equipped PCIe RAID card into the system to manage the RAID operations of the virtual NVMe controller.

This document explains how to install the SupremeRAID<sup>™</sup> software package for Linux and how to manage the RAID components using the command-line interface.

## **GRAID SupremeRAID™ Specifications**

GRAID SupremeRAID <sup>™</sup> Driver Specifications	
Supported GRAID Models	SR-1000, SR-1010,SR-1001
Supported RAID levels	RAID 0, 1, 5, 6, 10,
Recommended minimum drive number for each RAID level	<pre>RAID 0 : at least two drives RAID 1 : at least two drives RAID 5 : at least three drives RAID 6 : at least four drives RAID 10 : at least four drives</pre>
Maximum number of physical drives	32
Maximum number of drive groups	4
Maximum number of virtual drives per drive group	8
Maximum size of the drive group	Defined by the physical drive sizes

## **Supported Operating Systems**

Linux Distro	x86_64	arm64
CentOS	7.9, 8.3, 8.4, 8.5	Not Supported
RHEL	7.9, 8.3, 8.4, 8.5	Not Supported
Rocky Linux	8.5	Not Supported
AlmaLinux	8.5	Not Supported
Ubuntu	20.04	20.04
openSUSE Leap	15.2, 15.3	Not Supported
SLES	15 SP2, 15 SP3	Not Supported



## Installation

This section describes installing the GRAID SupremeRAID™ software package for Linux.

## **Prerequisites**

Before installing the software package, ensure that the system meets the following requirements:

- 1. Minumum system requirements:
  - CPU: 2 GHz or faster with at least 8 cores
  - RAM: 16 GB
  - An available PCIe Gen3 or Gen4 x16 slot
- 2. The GRAID SupremeRAID™ card is installed into a PCIe x16 slot
- 3. The IOMMU function is disabled in the system BIOS.
- 4. The GRAID SupremeRAID<sup>™</sup> software package is downloaded from the GRAID, or GRAID partner, website.

## Installing on Linux using the Pre-installer

The GRAID pre-installer is an executable file that contains the required dependencies and a setup script that installs the NVIDIA driver. The script makes it easy to prepare the environment and install the GRAID SupremeRAID<sup>™</sup> driver in every supported Linux distribution. Use following steps to prepare the environment and install the GRAID SupremeRAID<sup>™</sup> driver using the pre-installer in supported Linux distributions.



## All supported distro

From a terminal that does not run the GUI console:

1. Download the latest version of the pre-installer and make it to executable.

```
$ wget https://download.graidtech.com/driver/pre-install/<graid-sr-pre-installer-x.x.x-xx.run>
$ chmod +x <graid-sr-pre-installer-x.x.x-xx.run>
```

2. Execute the pre-installer and follow the instructions to complete the pre-installation process as shown below.

• • •		
[root@graid ~]# sudo ./graid-sr-p Extracting installer files, pleas Extracting installer files done.	pre-installer-1.0.0-31. se wait a few seconds .	run 
Starting installer This pre-installer is for CentOS Running service check Service check succeeded.		
Running system check System check succeeded.		
Running install packages and kern Generating grub configuration fil Adding boot menu entry for EFI fi Jone Generating new initramfs Generated new initramfs. Install packages and kernel setti chvt: ioctl VT_ACTIVATE: No such Disabled Xorg instance. Nouveau module has been loaded, p Unload nouveau module successful Running install NVIDIA Driver. (T	nel setting. .e .rmware configuration .ng succeeded. device or address pre-installer will unlow .y. This step will take a wi	ad nouveau for NVIDIA c hile.)
Mon Oct 4 14:30:35 2021 +   NVIDIA-SMI 470.63.01 Driver	Version: 470.63.01	 CUDA Version: 11.4
   GPU Name Persistence-M    Fan Temp Perf Pwr:Usage/Cap 	Bus-Id Disp.A Memory-Usage	+   Volatile Uncorr. ECC   GPU-Util Compute M.   MIG M.
=====================================		+ N/A   0% Default   N/A
Processes:   GPU GI CI PID Tyr   ID ID	be Process name	GPU Memory Usage
No running processes found		
Install NVIDIA Driver succeeded.		
This pre-installer will reboot th Do you want to continue? [Y/n]	e system for apply pre	vious setting!

- 3. The system must be rebooted after running the pre-installation script. When prompted, type Y to reboot the system.
- 4. Download the latest version of the SupremeRAID<sup>™</sup> driver installer from the GRAID website and make it to executable.



- \$ wget https://download.graidtech.com/driver/../.<graid-sr-installer-x.x.x-xx.run>
  \$ chmod +x <graid-sr-installer-x.x.x-xx.run>
- 5. Execute the installer and follow the instructions to complete the installation process as shown below.

```
sudo ./<graid-sr-installer-x.x.x-xx.run>
```

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4. Use the up/down key to switch between the models and click space to select the model you want to install. Once the modal has been selected, you select ok and click enter to proceed

ice installer			
		Colord median	
Please select a package		Select раскаде	
		(*) 5B 1010	
		() SR-1000	
		( ) SR-1001	
	< 0 <mark>K &gt;</mark>	<cancel></cancel>	

6. Apply the SupremeRAID<sup>™</sup> license key.

\$ sudo graidctl apply license <LICENSE\_KEY>



## **Installing on Linux Manually**

If you prefer, you can manually install the dependencies required by the SupremeRAID<sup>™</sup> driver.

#### CentOS, Rocky Linux, AlmaLinux and RHEL

1. Install the package dependencies and build tool for dkms.

For CentOS, Rocky Linux and AlmaLinux

```
$ sudo yum install --enablerepo=extras epel-release
$ sudo yum install vim wget make automake gcc gcc-c++ kernel-devel kernel-headers kernel dkms ipmitool
tar mdadm sg3_utils sqlite-libs automake dialog
```

For RHEL

```
$ sudo yum install https://dl.fedoraproject.org/pub/epel/epel-release-latest-8.noarch.rpm
$ sudo yum install gcc-$(awk -F'=' '/VERSION_ID/{ gsub(/"/,""); print $2}' /etc/os-release) gcc-
c++-$(awk -F'=' '/VERSION_ID/{ gsub(/"/,""); print $2}' /etc/os-release)
$ sudo yum install vim wget make automake kernel-devel-$(uname -r) kernel-headers-$(uname -r) dkms
ipmitool tar mdadm sg3_utils sqlite-libs automake dialog
```

2. Add the kernel option. This step prevents the Nouveau driver from loading during installation and disables IOMMU in the system BIOS.

\$ sudo vim /etc/default/grub

3. Append "iommu=pt" and "nvme\_core.multipath=Y" to GRUB\_CMDLINE\_LINUX then update the grub configuration:

\$ sudo grub2-mkconfig -o /boot/grub2/grub.cfg

4. Append "blacklist nouveau" and "options nouveau modeset=0" to the end of the /etc/modprobe.d/graid-

blacklist.conf file to disable the Nouveau driver and update initramfs.

nouveau" and "options nouveau modeset=0".

```
$ sudo update-initramfs -u
```



For CentOS, Rocky Linux and AlmaLinux

Please find out the latest verion of kernel and assign to --kver

\$ sudo dracut -f --kver `rpm -qa | grep kernel-headers | awk -F'kernel-headers-' {'print \$2'}`

For RHEL

```
$ sudo dracut -f
```

5. Reboot the system and ensure that the grub configuration was applied. You can check **/proc/cmdline** for the grub configuration in use. For example:

[root@graid ~]# cat /proc/cmdline BOOT_IMAGE=(hd3,gpt8)/vmlinuz-4.18.0-305.17.1.el8_4.x86_64 root=UUID=ba33c54d-74c9-409d-ae05-db27cacd68b3 ro crashkernel=auto resume=UUID=ae5b3808-b657- 4593-a598-c5cbc5a87105 rhgb quiet rd.driver.blacklist=nouveau iommu=pt nvme_core.multipath=Y

6. Install the NVIDIA driver.

```
$ wget https://us.download.nvidia.com/XFree86/Linux-x86_64/470.86/NVIDIA-Linux-x86_64-470.86.run
$ chmod +x NVIDIA-Linux-x86_64-470.86.run
```

For CentOS

Use the latest version of kernel-headers to install the NVIDIA driver.

```
$ sudo ./NVIDIA-Linux-x86_64-470.86.run -s --no-systemd --no-opengl-files --no-nvidia-modprobe --dkms -
k `rpm -qa | grep kernel-headers | awk -F'kernel-headers-' {'print $2'}`
```

For RHEL

```
$ sudo ./NVIDIA-Linux-x86_64-470.86.run -s --no-systemd --no-opengl-files --no-nvidia-modprobe --dkms
```

Step 3 disables the Nouveau driver. Using the following command, the NVIDIA driver installer can also disable the Nouveau driver. After disabling the Nouveau driver, you must reboot and re-install the NVIDIA driver.

```
$ sudo ./NVIDIA-Linux-x86_64-470.86.run -s --disable-nouveau
$ sudo reboot
```

Confirm that the NVIDIA GPU is working using the *nvidia-smi* command. Example output of a successful installation is shown below:



root@graid ~]# nvidia-smi ue Sep 21 21:27:37 2021		
NVIDIA-SMI 470.63.01 Driver	Version: 470.63.01 (	CUDA Version: 11.4
GPU Name Persistence-M Fan Temp Perf Pwr:Usage/Cap	Bus-Id Disp.A   Memory-Usage 	Volatile Uncorr. ECC   GPU-Util Compute M.   MIG M.
0 NVIDIA T1000 Off 34% 38C P0 N/A / 50W		
Processes: GPU GI CI PID Type Process name GPU Memory ID ID Usage		
No running processes found		

8. Download the latest version of the SupremeRAID™ driver installer from the GRAID website and make it to executable.

\$ wget https://download.graidtech.com/driver/.././<graid-sr-installer-x.x.x-xx.run>
\$ chmod +x <graid-sr-installer-x.x.x-xx.run>

9. Execute the installer and follow the instructions to complete the installation process as shown below.

```
sudo ./<graid-sr-installer-x.x.x-xx.run>
```

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3. Type accept, click tab, select next and click enter to accept the license agreement

Graid Service Installer	
	Confirm the EULA Do you accept the EULA? (accept/decline/quit):
	< Back > < Next > <cancel></cancel>

4. Use the up/down key to switch between the models and click space to select the model you want to install. Once the modal has been selected, you select ok and click enter to proceed



Graid Service Installer	
	Select-package
	Please select a package
	(*) <u>\$R-1010</u>
	() SR-1000 () SR-1001
	<ul> <li>&lt; (K &gt; <cancel></cancel></li> </ul>

10. Apply the SupremeRAID<sup>™</sup> license key.

\$ sudo graidctl apply license <LICENSE\_KEY>



#### Ubuntu

1. Install the package dependencies and build tool for dkms.

```
$ sudo apt-get update
$ sudo apt-get install make automake gcc g++ linux-headers-$(uname -r) dkms ipmitool initramfs-tools
tar mdadm libsgutils2-2 libudev-dev libpci3 sqlite automake dialog
```

2. Disable Ubuntu daily upgrade.

```
$ sed -i '/Unattended-Upgrade "1"/ s/"1"/"0"/' /etc/apt/apt.conf.d/20auto-upgrades
$ sed -i '/Update-Package-Lists "1"/ s/"1"/"0"/' /etc/apt/apt.conf.d/20auto-upgrades
```

3. Add the kernel option. This step prevents the Nouveau driver from loading during installation and disables IOMMU in the system BIOS.

\$ sudo vim /etc/default/grub

4. Append "iommu=pt" and "nvme\_core.multipath=Y" to GRUB\_CMDLINE\_LINUX then update the grub configuration:

\$ sudo update-grub

5. Append "blacklist nouveau" and "options nouveau modeset=0" to the end of the /etc/modprobe.d/graid-

blacklist.conf file to disable the Nouveau driver and update initramfs.



\$ sudo update-initramfs -u

6. Reboot the system and ensure that the grub configuguration was applied. You can check **/proc/cmdline** for the grub configuration in use. For example:



7. Install the NVIDIA driver.

\$ wget https://us.download.nvidia.com/XFree86/Linux-x86\_64/470.86/NVIDIA-Linux-x86\_64-470.86.run
\$ chmod +x NVIDIA-Linux-x86\_64-470.86.run
\$ sudo ./NVIDIA-Linux-x86\_64-470.86.run -s --no-systemd --no-opengl-files --no-nvidia-modprobe --dkms

Step 3 disables the Nouveau driver. Using the following command, the NVIDIA driver installer can also disable the Nouveau driver. After disabling the Nouveau driver, you must reboot and re-install the NVIDIA driver.

```
$ sudo ./NVIDIA-Linux-x86_64-470.86.run -s --disable-nouveau
$ reboot
```

 Confirm that the NVIDIA GPU is working using the *nvidia-smi* command. Example output of a successful installation is shown below:

•••						
root@ ue Se	graid ^ p 21 21	/]# nv L:27:3	idia-smi 7 2021			
NVID:	IA-SMI	470.63	3.01 Driver	Version: 470.63.01	CUDA Versio	on: 11.4
GPU Fan	Name Temp	Perf	Persistence-M Pwr:Usage/Cap	Bus-Id Disp.A   Memory-Usage 	Volatile   GPU-Util 	Uncorr. ECC Compute M. MIG M.
0 34%	NVIDIA 38C	A T100( P0	0 Off N/A / 50W	00000000:81:00.0 Off       0MiB /  3911MiB 	   0% 	N/A E. Process N/A
Proce GPU	esses: GI ID	CI ID	PID Tyı	be Process name		GPU Memory Usage
======   No	running	g proc	esses found			
+						

9. Download the latest version of the SupremeRAID<sup>™</sup> driver installer from the GRAID website and make it to executable.

\$ wget https://download.graidtech.com/driver/../~graid-sr-installer-x.x.x-xx.run> \$ chmod +x <graid-sr-installer-x.x.x-xx.run>

10. Execute the installer and follow the instructions to complete the installation process as shown below.

sudo ./<graid-sr-installer-x.x.x-xx.run>

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	2. RESTRICTIONS.	

3. Type **accept**, click tab, select next and click enter to accept the license agreement



er			
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4. Use the up/down key to switch between the models and click space to select the model you want to install. Once the modal has been selected, you select ok and click enter to proceed

	Soloch package		
Please select a package	Serect puckuge		
	(*) SR-1010		
	() SR-1000		
	( ) SR-1001		
< <u>0</u> K	>	<cancel></cancel>	

5. Apply the SupremeRAID<sup>™</sup> license key.

\$ sudo graidctl apply license <LICENSE\_KEY>



#### openSUSE

- 1. Install openSUSE and select all online repositories.
- 2. Install the package dependencies and build tool for dkms.

```
$ sudo zypper addrepo -f https://download.opensuse.org/distribution/leap/15.2/repo/oss/ leap-15.2
$ sudo zypper --gpg-auto-import-keys refresh
$ sudo zypper install sudo vim wget libpci3 dkms ipmitool tar mdadm libsgutils-devel libudev-devel
sqlite3 automake dialog
$ sudo zypper install -C kernel-default-devel=$(uname -r | awk -F"-default" '{print $1}')
```

3. Add the kernel option. This step prevents the Nouveau driver from loading during installation and disables IOMMU in the system BIOS.

\$ sudo vim /etc/default/grub

4. Append "iommu=pt" and "nvme\_core.multipath=Y" to GRUB\_CMDLINE\_LINUX then update the grub configuration:

```
$ sudo update-grub
```

5. Append "blacklist nouveau" to the end of the /etc/modprobe.d/graid-blacklist.conf file to disable the Nouveau driver.

graid@graid-demo:~\$ cat graid-blacklist.conf blacklist nouveau options nouveau modeset=0	

#### Note:

You might need to manually create the /etc/modprobe.d/graid-blacklist.conf file and append "blacklist

nouveau" and "options nouveau modeset=0".

Set the allow\_unsupported\_modules option to 1 in the /etc/modprobe.d/10-unsupported-modules.conf file and update initrd.

\$ sudo mkinitrd

7. Reboot the system and ensure that the grub configuguration was applied. You can check **/proc/cmdline** for the grub configuration in use. For example:

•••
root@graid:~ # cat /proc/cmdline BOOT_IMAGE=/boot/vmlinuz-5.3.18-59.5-default root=UUID=7560fe42-0275-4618-b8a0-0785765610c9 modprobe.blacklist=nouveau iommu=pt splash=silent quiet mitigations=auto nvme_core.multipath=Y

8. Install the NVIDIA driver.

\$ wget https://us.download.nvidia.com/XFree86/Linux-x86\_64/470.86/NVIDIA-Linux-x86\_64-470.86.run
\$ chmod +x NVIDIA-Linux-x86\_64-470.86.run
\$ sudo ./NVIDIA-Linux-x86\_64-470.86.run -s --no-systemd --no-opengl-files --no-nvidia-modprobe --dkms

Step 3 disables the Nouveau driver. Using the following command, the NVIDIA driver installer can also disable the Nouveau driver. After disabling the Nouveau driver, you must reboot and re-install the NVIDIA driver.

```
$ sudo ./NVIDIA-Linux-x86_64-470.86.run -s --disable-nouveau
$ reboot
```

 Confirm that the NVIDIA GPU is working using the *nvidia-smi* command. Example output of a successful installation is shown below:

root@g ue Sep	raid ~ 21 21	-]# nv L:27:3	idia-smi 7 2021					
NVIDI	A-SMI	470.63	3.01	Driver	Version:	470.63.01	CUDA Versio	on: 11.4
GPU Fan	Name Temp	Perf	Persist Pwr:Usa	ence-M ige/Cap	Bus-Id	Disp.A Memory-Usage	Volatile   GPU-Util 	Uncorr. ECC Compute M. MIG M.
0 34%	NVIDIA 38C	A T100( P0	0 N/A /	Off 50W	0000000  0M	0:81:00.0 Off iB / 3911MiB	     0%	N/A E. Process N/A
Proce   GPU	sses: GI ID	CI ID	PI	D Typ	be Proc	ess name		GPU Memory Usage
======   No r	unning	g proc	esses fo	und	=======			

10. Download the latest version of the SupremeRAID<sup>™</sup> driver installer from the GRAID website and make it to executable.

\$ wget https://download.graidtech.com/driver/../~graid-sr-installer-x.x.x-xx.run> \$ chmod +x <graid-sr-installer-x.x.x-xx.run>

11. Execute the installer and follow the instructions to complete the installation process as shown below.

sudo ./<graid-sr-installer-x.x.x-xx.run>

1. Welcome page, please select next and click enter to view the end-user license agreement

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4. Use the up/down key to switch between the models and click space to select the model you want to install. Once the modal has been selected, you select ok and click enter to proceed

Diesse coloct a package	Select package		1
	(*) SR-1010		
	() SR-1000 () SR-1001		
	()		
_			-
K		<cancel></cancel>	

12. Apply the SupremeRAID<sup>™</sup> license key.

\$ sudo graidctl apply license <LICENSE\_KEY>



#### SLES

- 1. Install SLES with the following extensions and modules:
  - 1. SUSE Package Hub 15 SP2 x86\_64
  - 2. Desktop Applications Module 15 SP2 x86\_64
  - 3. Development Tools Module 15 SP2 x86\_64
- 2. Install the package dependencies and build tool for dkms.

```
$ sudo zypper addrepo -f https://download.opensuse.org/distribution/leap/15.2/repo/oss/ leap-15.2
$ sudo zypper --gpg-auto-import-keys refresh
$ sudo zypper install sudo vim wget libpci3 dkms ipmitool tar mdadm libsgutils-devel libudev-devel
sqlite3 automake dialog
$ sudo zypper install -C kernel-default-devel=$(uname -r | awk -F"-default" '{print $1}')
```

3. Add the kernel option. This step prevents the Nouveau driver from loading during installation and disables IOMMU in the system BIOS.

\$ sudo vim /etc/default/grub

4. Append "iommu=pt" and "nvme\_core.multipath=Y" to GRUB\_CMDLINE\_LINUX then update the grub configuration:

\$ sudo update-grub

5. Append "blacklist nouveau" to the end of the /etc/modprobe.d/graid-blacklist.conf file to disable the Nouveau driver.



#### Note:

You might need to manually create the /etc/modprobe.d/graid-blacklist.conf file and append "blacklist nouveau" and "options nouveau modeset=0".

- 6. Set the allow\_unsupported\_modules option to 1 in the /etc/modprobe.d/10-unsupported-modules.conf file.
- 7. Update initrd.

\$ sudo mkinitrd

8. Reboot the system and ensure that the grub configuguration was applied. You can check **/proc/cmdline** for the grub configuration in use. For example:



	root@graid:~ # cat /proc/cmdline BOOT_IMAGE=/boot/vmlinuz-5.3.18-59.5-default root=UUID=7560fe42-0275-4618-b8a0-0785765610c9 modprobe.blacklist=nouveau iommu=pt splash=silent quiet mitigations=auto nvme_core.multipath=Y
9.	Install the NVIDIA driver.
	<pre>\$ wget https://us.download.nvidia.com/XFree86/Linux-x86_64/470.86/NVIDIA-Linux-x86_64-470.86.run \$ chmod +x NVIDIA-Linux-x86_64-470.86.run \$ sudo ./NVIDIA-Linux-x86 64-470.86.run -sno-systemdno-opengl-filesno-nvidia-modprobedkms</pre>

Step 3 disables the Nouveau driver. Using the following command, the NVIDIA driver installer can also disable the Nouveau driver. After disabling the Nouveau driver, you must reboot and re-install the NVIDIA driver.

```
$ sudo ./NVIDIA-Linux-x86_64-470.86.run -s --disable-nouveau
$ reboot
```

10. Confirm that the NVIDIA GPU is working using the *nvidia-smi*command. Example output of a successful installation is shown below:

•••						
[root@	graid ~	~]# nv	idia-smi 7 2021			
	p 21 2.		, 2021 			
NVID	IA-SMI	470.6	3.01 Driver	Version: 470.63.01	CUDA Versio	on: 11.4
   GPU   Fan 	Name Temp	Perf	Persistence-M Pwr:Usage/Cap	Bus-Id Disp.A Memory-Usage	Volatile   GPU-Util 	Uncorr. ECC Compute M. MIG M.
=====   0   34% 	====== NVIDI4 38C	===== A T100 P0	0 Off N/A / 50W		+=====================================	N/A E. Process N/A
+						
I Proc	65565·					
GPU	GI ID	CI ID	PID Typ	be Process name		GPU Memory Usage
=====   No	running	g proc	esses found			
+						

11. Download the latest version of the SupremeRAID<sup>™</sup> driver installer from the GRAID website and make it to executable.

\$ wget https://download.graidtech.com/driver/../.<graid-sr-installer-x.x.x-xx.run>
\$ chmod +x <graid-sr-installer-x.x.x-xx.run>

12. Execute the installer and follow the instructions to complete the installation process as shown below.

```
sudo ./<graid-sr-installer-x.x.x-xx.run>
```

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4. Use the up/down key to switch between the models and click space to select the model you want to install. Once the modal has been selected, you select ok and click enter to proceed

ler			
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	(*) SR-1010		
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	() 5K-1001		
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13. Apply the SupremeRAID<sup>™</sup> license key.

\$ sudo graidctl apply license <LICENSE\_KEY>



## **Upgrading the Software**

#### Note:

You must exactly follow the steps below to upgrade the software.

To upgrade the software:

- 1. Stop all applications running on the virtual drive.
- 2. Stop the management service.

\$ sudo systemctl stop graid

3. Ensure that the GRAID kernel module is unloaded.

```
$ sudo rmmod graid
```

- 4. Check the NVIDIA driver DKMS status.
  - \$ sudo dkms status nvidia

## Note:

The NVIDIA driver version that is installed in the kernel must match the GRAID driver version. Perform step 5, Uninstall the NVIDIA Driver, when the versions do not match.

5. [Optional] Uninstall the NVIDIA Driver

### Note:

This step is only required when the NVIDIA driver version and the GRAID driver version do not match.

• Dracut the initramfs.

\$ dracut --omit-drivers "nvidia graid" -f

• Uninstall the NVIDIA driver.

\$ sudo ./usr/bin/nvidia-uninstall

- Install New Nvidia driver
- Reboot

6. Uninstall the package.

• In Centos, Rocky Linux, AlmaLinux, RHEL, openSUSE and SLES



\$ sudo rpm -e graid-sr

• In Ubuntu

\$ sudo dpkg -r graid-sr

7. Confirm that the GRAID module is unloaded.

```
$ sudo lsmod | grep graid
```

There should not be any ouput.

- 8. Confirm that the GRAID package is uninstalled.
  - In Centos, Rocky Linux, AlmaLinux, RHEL, openSUSE and SLES

\$ sudo rpm -qa | grep graid

• In Ubuntu

\$ sudo dpkg -l | grep graid

There should not be any output.

9. Install the new package.

```
sudo ./<graid-sr-installer-x.x.x-xx.run>
```

10. Start the management service.

\$ sudo systemctl enable graid \$ sudo systemctl start graid



## Management

## Overview of the GRAID SupremeRAID<sup>™</sup> Software Module

There are three major components of the GRAID SupremeRAID<sup>™</sup> Software Module:

- 1. graidctl The command-line management tool.
- 2. graid\_server The management daemon that handles requests from graidctl to control the driver.
- 3. graid.ko The driver kernel module.

## **RAID Components**

There are three major RAID logical components in SupremeRAID<sup>™</sup>, the **Physical Drive (PD)**, the **Drive Group (DG)**, and the **Virtual Drive (VD)**.



## **Physical Drive (PD)**

Since NVMe drives are not directly attached to the SupremeRAID<sup>™</sup> controller, you must tell the controller which SSDs can be managed. Once an SSD has been created as a physical drive, the SupremeRAID<sup>™</sup> driver unbinds the SSD from the operating system, meaning the device node (/dev/nvmeX) will disappear and is no longer accessible. At the same time, a corresponding device node is created (/dev/gpdX) by the SupremeRAID<sup>™</sup> driver. You can check the SSD information, such as SSD model or SMART logs, using this device node. To control and access the SSD using /dev/nvmeXn1, you must first delete the corresponding physical drive.



Currently, SupremeRAID<sup>™</sup> supports a total of **32** physical drives, regardless of whether the physical drives are created from a native NVMe SSD, a drive connected through NVMe-oF, or a SAS/SATA disk.

## **Drive Group (DG)**

The main component of RAID logic is a RAID group. When the drive group is created, the SupremeRAID<sup>™</sup> driver initializes the physical drives with the corresponding RAID mode to ensure that the data and the parity are synchronized. There are two types of the initialization processes.

- Fast Initilization: When all of the physical drives in the drive group (DG) support the deallocate dataset management command, the SupremeRAID<sup>™</sup> driver performs fast initialization by default, meaning the drive group state is optimized immediately.
- Background Initialization: Performance will be slightly affected by the initialization traffic, but you can still create the virtual drive and access the virtual drive during a background initialization.

Currently, SupremeRAID<sup>™</sup> supports a total of 4 drive groups, with a maximum of 32 physical drives in one drive group.

## Virtual Drive (VD)

The virtual drive is equivalent to the RAID volume. You can create multiple virtual drives in the same drive group for multiple applications. The corresponding device node (/dev/nvmeXn1) appears on the operating system when you create a virtual drive, and you can make the file system or running application directly on this device node. Currently, the SupremeRAID<sup>™</sup> driver supports a maximum of **8** virtual drives in each drive group.



## **Overview of graidctl**

## **Syntax**

Use the following syntax to run graidctl commands from the terminal window:

```
graidctl [command] [OBJECT_TYPE] [OBJECT_ID] [flags]
```

where command, OBJECT\_TYPE, OBJECT\_ID, and flags are:

- command: Specifies the operation to perform on one or more resources, for example create, list, describe, and delete.
- OBJECT\_TYPE: Specifies the object type. Object types are case-sensitive, for example license, physical\_drive, and drive\_group.
- OBJECT\_ID: Specifies the object ID. Some commands support simultaneous operations on multiple objects. You can specify the OBJECT\_ID individually, or you can use a dash to describe an OBJECT\_ID range.
   For example, to delete physical drives 1, 3, 4, and 5 simultaneously:

\$ sudo graidctl delete physical\_drive 1 3-5

• flags: Specifies optional flags.

For example:

• --force

Forces the deletion of a physical drive.

```
\ sudo graidctl delete physical_drive 0 --force
```

• --json

Print output in json format. This flag can also assist with API implementation.

\$ sudo graidctl list virtual\_drive --format json

To get help, run graidctl help from the terminal window.



## **Managing Licenses**

You can apply the license and check license information.

## **Applying the License**

To apply the license and complete the installation, run:

```
$ sudo graidctl apply license <LICENSE_KEY>
```

Output example for invalid and valid licenses is shown below:

```
[graid@graid-demo ~]$ sudo graidctl apply license 34B45F67-5694YXQB-I4LHTCAT-VYW6CXWJ
✓Apply license successfully.
[graid@graid-demo ~]$ sudo graidctl apply license 34B45F67-5694YXQB-I4LHTCAT-VYW6CXWI
¥Apply license failed: LicenseApply: Failed to apply license 34B45F67-5694YXQB-I4LHTCAT-VYW6CXWI
```

#### Note:

•••

When applying the license, you might need to provide the serial number of the NVIDIA GPU to GRAID Technical Support.

To obtain NVIDIA GPU serial number, run:

```
$ sudo nvidia-smi --query-gpu=name,index,serial --format=csv
```

This command will list all Nvidia cards in your environment and their serial number.

### **Checking License Information**

To obtain the license information, run:

\$ sudo graidctl describe license

#### Output example:





## Output content:

Field	Description
License State	The license state.
License Key	The applied license key.
Feature	The feature set of the license key.
ExpDays	The expiration date of the license key.

## The license state:

State	Description
UNAPPLIED	The license was not applied.
APPLIED	A valid license was applied.
INVALID	A valid license was applied, but a valid RAID card cannot be detected.



## Managing Remote NVMe-oF Targets

You must connect to the NVMe-oF target before you create physical drives from NVMe-oF devices.

## Connecting to a Remote NVMe-oF Target

To connect to a remote NVMe-oF target, run:

\$ sudo graidctl connect remote\_target <transport type> <addr> <address family> <port service id>

#### Required parameters:

Option	Value	Description
		This field specifies the network fabric being used for a NVMe-over-Fabrics network. Current string values include:
transport	RDMA	The network fabric is an RDMA network (RoCE, iWARP, Infiniband, basic rdma, etc)
type	ТСР	The network fabric is a TCP/IP network.
	FC	The network fabric is a Fibre Channel network.
ip address		This field specifies the network address of the controller.
address family		This field specifies the network address protocol. Current string values include: ipv4/ipv6
port service		This field specifies the transport service ID.

### Output example:

```
    Igraid@graid-demo ~]$ sudo graidctl connect remote_target rdma 192.168.2.10 ipv4 4420
    Connect remote target successfully.
    Connect remote target Target 0 successfully.
```

## Listing Connected Remote NVMe-oF Targets

To list all of the connected remote NVMe-oF targets, run:

```
$ sudo graidctl list remote_target
```



### Output example:

•••					
[graid@graid-demo ~]\$ sudo graidctl list remote_target ⊮List remote target successfully.					
ID	TYPE	ADDRESS	ADDRESS FAMILY	SERVICE ID	
0	rdma	192.168.2.10	ipv4	4420	

## Note:

You can control multiple NVMe-of namespaces using GRAID SupremeRAID™ v1.1.0.

## **Disconnecting from Remote NVMe-oF Targets**

To disconnect from an NVMe-oF target, run:

```
$ sudo graidctl disconnect remote_target <target id>
```

## Output example:

```
● ● ●
[graid@graid-demo ~]$ sudo graidctl disconnect remote_target 0
✓Disconnect remote target successfully.
✓Disconnect remote target Port 0 successfully.
```

#### Note:

You cannot delete the target when there are physical drives created from the target.


# Exporting NVMe-oF Target Management

You can export the virtual drive to other initiators.

#### Creating the NVMe-oF Target Port Service

To create the NVme-oF target port service, run:

\$ sudo graidctl create nvmeof\_target <tcp|rdma> <interface> <address family> <srvcid> [flags]

Output example:

```
[graid@graid-demo ~]$ sudo graidctl create nvmeof_target tcp ens160 ipv4 4420
vCreate nvmeof target successfully.
vCreate nvmeof target Port 0 successfully.
```

#### **Exporting NVMe-oF Targets**

To export NVMe-oF target devices using the service port that you created, run:

```
$ sudo graidctl export virtual_drive <DG_ID> <VD_ID> [flags]
```

Output example:

#### Listing Created NVMe-oF Targets

To list all created NVMe-oF target devices, run:

\$ sudo graidctl list nvmeof\_target

•••								
[graid@gra ✓List nvme	id-demo of targ	~]\$ sudo gra et successfu	aidctl list nvm lly.	eof_target	1	1		
PORT ID	TYPE	INTERFACE	ADDRESS	ADDRESS FAMILY	SERVICE ID	SUBSYSTEMS		
0	tcp	ens160	172.16.11.81	ipv4	4420	   DG0/VD0, DG0/VD1		
1	tcp	ens160	172.16.11.81	ipv4	4421	DG0/VD0, DG0/VD1, DG0/VD3		



#### Deleting the NVMe-oF Target Port Service

To delete the NVMe-oF target port service, run:

```
$ sudo graidctl delete nvmeof_target <PORT_ID> [flags]
```

Output example:

```
● ● ●
[graid@graid-demo ~]$ sudo graidctl delete nvmeof_target 0
✓Delete nvmeof target successfully.
✓Delete nvmeof target Port 0 successfully.
```

#### **Unexporting NVMe-oF Targets**

To unexport an NVMe-of target, run:

```
$ sudo graidctl unexport virtual_drive <DG_ID> <VD_ID> [flags]
```





# **Viewing Host Drive Information**

#### Listing the NVMe Drives

To list all the directly attached NVMe drives, or NVMe-oF target drives, that can be used to create physical drives, run:

\$ sudo graidctl list nvme\_drive

#### Output example:

• • •						
[graid@graid-de ✔List nvme dri	emo ~]\$ sudo gra ve successfully	aidctl list nvme_drive	ı	1		
DEVICE PATH	MODEL	NQN/WWID	NSID	CAPACITY	ADDRESS	
/dev/nvme0	KCM61VUL3T20		1	3.2 TB	0000:1a:00.0	i la
/dev/nvme1	KCM61VUL3T20	ngn.2019-10.com.kioxia:KCM61VUL3T20:Z050A002T1L8	1	3.2 TB	0000:1b:00.0	
/dev/nvme2	KCM61VUL3T20	nqn.2019-10.com.kioxia:KCM61VUL3T20:Z080A05KT1L8	1	3.2 TB	0000:1c:00.0	
/dev/nvme3	KCM61VUL3T20	ngn.2019-10.com.kioxia:KCM61VUL3T20:X0N0A015T1L8	1	3.2 TB	0000:1d:00.0	
/dev/nvme4	KCM61VUL3T20	ngn.2019-10.com.kioxia:KCM61VUL3T20:Z080A06QT1L8	1	3.2 TB	0000:11:00.0	
/dev/nvme5	KCM61VUL3T20	ngn.2019-10.com.kioxia:KCM61VUL3T20:Z0G0A001T1L8	1	3.2 TB	0000:12:00.0	
/dev/nvme6	KCM61VUL3T20	ngn.2019-10.com.kioxia:KCM61VUL3T20:Z060A006T1L8	1	3.2 TB	0000:13:00.0	
/dev/nvme7	KCM61VUL3T20	ngn.2019-10.com.kioxia:KCM61VUL3T20:Z080A04WT1L8	1	3.2 TB	0000:20:00.0	
/dev/nvme8	KCM61VUL3T20	ngn.2019-10.com.kioxia:KCM61VUL3T20:Z010A003T1L8	1	3.2 TB	0000:21:00.0	
/dev/nvme9	KCM61VUL3T20	ngn.2019-10.com.kioxia:KCM61VUL3T20:Z080A04HT1L8	1	3.2 TB	0000:22:00.0	
			<u> </u>			

#### Output content:

Field	Description
DEVICE PATH	This field displays the block device path of the drive.
NQN	This field displays the NVMe Qualified Name of the drive.
MODEL	This field displays the model number of the drive.
CAPACITY	This field displays the capacity of the drive.

#### **Listing SAS/SATA Drives**

To list all SAS/SATA drives that can be used as physical drives, run:

\$ sudo graidctl list scsi\_drive



#### Output content:

Field	Description
DEVICE PATH	This field displays the block device path for the drive.
WWID	This field displays the Worldwide Identification of the drive.
MODEL	This field displays the model number of the drive.
CAPACITY	This field displays the capacity of the drive.



# **Managing Physical Drives**

#### **Creating a Physical Drive**

To create a physical drive, run:

```
$ sudo graidctl create physical_drive <DEVICE_PATH|NQN|WWID>
```

Output example for simultaneously creating multiple physical drives with the device path and NQN:



#### Note:

Ensure that the system or other applications are not on the physical drive before creating or replacing it.

#### **Listing the Physical Drives**

To list all of the physical drives, run:

```
$ sudo graidctl list physical_drive
```

•							
graid@gr 'List ph	aid-demo ysical d	o ~]\$ sudo graido rive successfully	tl list physical_drive /.	1	1	1.	1
PD ID	DG ID	DEVICE PATH	NQN/WWID	MODEL	CAPACITY	SLOT ID	STATE
0	N/A	/dev/qpd0		KCM61VUL3T20	3.2 TB	0	UNCONFIGURED GOOD
1	N/A	/dev/gpd1	ngn.2019-10.com.kioxia:KCM61VUL3T20:Z080A06QT1L8	KCM61VUL3T20	3.2 ТВ	1	UNCONFIGURED_GOOD
2	N/A	/dev/gpd2	nqn.2019-10.com.kioxia:KCM61VUL3T20:Z080A04WT1L8	KCM61VUL3T20	3.2 TB	2	UNCONFIGURED_GOOD
3	N/A	/dev/gpd3	ngn.2019-10.com.kioxia:KCM61VUL3T20:Z050A002T1L8	KCM61VUL3T20	3.2 TB	3	UNCONFIGURED_GOOD
4	N/A	/dev/gpd4	nqn.2019-10.com.kioxia:KCM61VUL3T20:Z010A003T1L8	KCM61VUL3T20	3.2 TB	4	UNCONFIGURED_GOOD
5	N/A	/dev/gpd5	nqn.2019-10.com.kioxia:KCM61VUL3T20:Z060A005T1L8	KCM61VUL3T20	3.2 TB	5	UNCONFIGURED_GOOD
6	N/A	/dev/gpd6	nqn.2019-10.com.kioxia:KCM61VUL3T20:Z0F0A031T1L8	KCM61VUL3T20	3.2 TB	6	UNCONFIGURED_GOOD
7	N/A	/dev/gpd7	nqn.2019-10.com.kioxia:KCM61VUL3T20:Z010A002T1L8	KCM61VUL3T20	3.2 TB	7	UNCONFIGURED_GOOD
32	4	/dev/nvme0n1	nqn.2019-10.com.kioxia:KCM61VUL3T20:Z080A04HT1L8	KCM61VUL3T20	3.2 TB	N/A	ONLINE
	4	/dev/nvme1n1	nap_2010_10_com_kioxia:KCM61\/UU_3T20.70104001T1L8		3 2 TB	N/A	



#### Output content:

Field	Description
SLOT ID	This field displays the slot ID of the corresponding NVMe/SAS/SATA drive. Note that the PD ID is not related to the SLOT ID, and that you must set the physical drives using the PD ID.
DG ID	This field displays the drive group ID of the physical drive.
PD ID	This field displays the PD ID. The PD ID is a unique ID provided by the SupremeRAID driver when the physical drive is created. It is not related to any SSD information such as slot ID or NQN. The PD ID is used for all further operations.
NQN/WWID	This field displays the NQN or WWID of corresponding NVMe/SAS/SATA drive.
MODEL	This field displays the model number of the corresponding NVMe/SAS/SATA drive.
CAPACITY	This field displays the capacity of corresponding NVMe/SAS/SATA drive.
STATE	This field displays the physical drive state.

#### Physical drive STATE:

STATE	Description
ONLINE	The physical drive was added to a drive group and is ready to work.
HOTSPARE	The physical drive is configured as hot spare drive.
FAILED	The physical drive is detected, but it is not functioning normally.
OFFLINE	The physical drive is marked as offline.
REBUILD	The physical drive is being rebuilt.
MISSING	The physical drive cannot be detected.
INCONSISTENT	The data in the physical drive is inconsistent. This condition generally occurs when the physical drive is in the REBUILD state and the system encounters an abnormal crash.
UNCONFIGURED_GOOD	The physical drive did not join a drive group.
UNCONFIGURED_BAD	The physical drive did not join a drive group and it is not functioning normally.



#### **Deleting a Physical Drive**

To delete a physical drive, run:

```
$ sudo graidctl delete physical_drive <PD_ID>
```

Output example for deleting multiple physical drives simultaneously:

[graid@graid-demo ~]\$ sudo graidctl delete physical_drive 2
*Delete physical drive failed: Failed to delete some PDs.
<pre>#Delete physical drive PD2 failed: rpc error: code = NotFound desc = PD2 is still using by DG0</pre>
[graid@graid-demo ~]\$ sudo graidctl delete physical_drive 0 1 5-7
✓Delete physical drive successfully.
✓Delete physical drive PD0 successfully.
✓Delete physical drive PD1 successfully.
✓Delete physical drive PD5 successfully.
✓Delete physical drive PD6 successfully.
✓Delete physical drive PD7 successfully.

The output shows that a physical drive cannot be deleted when it is part of a drive group.

#### **Describing a Physical Drive**

To view detailed information for a physical drive, run:

```
$ sudo graidctl describe physical_drive <PD_ID>
```

Output example:

•••	
[graid@graid-demo ∽ ✔Describe physical	<pre> J\$ sudo graidctl describe physical_drive 5 drive successfully.</pre>
PD ID:	5
DG ID:	-1
Slot ID:	15
GUID:	nqn.2019-10.com.kioxia:KCM61VUL3T20:Z080A038T1L8
Mode:	KCM61VUL3T20
Capacity:	3.2 TB
State:	HOTSPARE
Device Path:	/dev/nvme9n1
Attributes:	
	hotspare = 0, 1
	locating = false

#### Locating a Physical Drive

To locate a physical drive, run:

```
$ sudo graidctl edit physical_drive <PD_ID> locating start
```



To stop locating a physical drive, run:

\$ sudo graidctl edit physical\_drive <PD\_ID> locating stop

#### Marking a Physical Drive Online or Offline

To mark a physical drive as online or offline, run:

\$ sudo graidctl edit physical\_drive <PD\_ID> marker <offline|online>

#### Note:

Marking a physical drive as offline, even briefly, puts the physical drive in the REBUILD state.

#### Assigning a Hot Spare Drive

To assign a physical drive as global hot spare, run:

```
$ sudo graidctl edit physical_drive <PD_ID> hotspare global
```

To assign a physical drive as the hot spare for a specific drive group, run:

\$ sudo graidctl edit physical\_drive <PD\_ID> hotspare <DG\_ID>

To assign a physical drive as a hot spare for multiple drive groups, use a comma (,) to separate the drive group IDs.

#### **Replacing a Nearly Worn-Out or Broken SSD**

To replace a nearly worn-out or broken SSD:

1. Mark the physical drive as bad using the following command. (You can skip this step if the physical drive is in the **MISSING** or other abnormal state.)

\$ sudo graidctl edit pd <OLD\_PD\_ID> marker bad

- 2. Replace the NVMe SSD. The state of the prior physical drive will indicate FAILED.
- 3. Check the NQN of the new SSD.

\$ sudo graidctl list nvme\_drive

4. Replace the physical drive.

\$ sudo graidctl replace physical\_drive <OLD\_PD\_ID> <DEVICE\_PATH|NQN|WWID>



#### Output example:

•														
graid@gr ⁄Edit pl graid@gr ⁄List pl	raid de hysical raid de hysical	mo ~]\$ . drive mo ~]\$ . drive	sudo PD0 s sudo succe	graidctl successful graidctl essfully.	edit phys ly. list phys	sical_dri sical_dri	ve 0 marker ve	bad		1				
PD ID (	) (5) DG ID DEVICE PATH NQN/WWID								MODEL	CAPACITY	SLOT ID	STATE		
0 1 2 3 4		0 0 0 0 0	   /dev/gpd0   nqn.2019-10.com.kioxia:KCM61VUL3T2   /dev/gpd1   nqn.2019-10.com.kioxia:KCM61VUL3T2   /dev/gpd2   nqn.2019-10.com.kioxia:KCM61VUL3T2   /dev/gpd3   nqn.2019-10.com.kioxia:KCM61VUL3T2   /dev/gpd4   nqn.2019-10.com.kioxia:KCM61VUL3T2				0:Z010A004T1L8 0:Z060A006T1L8 0:Z010A001T1L8 0:Z080A04HT1L8 0:Z080A05KT1L8	KCM61VUL3T. KCM61VUL3T. KCM61VUL3T. KCM61VUL3T. KCM61VUL3T.	20   3.2 TB 20   3.2 TB 20   3.2 TB 20   3.2 TB 20   3.2 TB 20   3.2 TB	15   9   8   11   3	FAILED ONLINE ONLINE ONLINE ONLINE			
graid@gr ⁄ List nv	raid de vme dri	mo ~]\$ Lve suc	sudo cessfi	graidctl ully.	list nvme	e_drive				I				
DEVICE	PATH (	1)	NQN						MODEL	CAPACITY				
/dev/nvme5   ngn 2019-		019-10.co	om.kioxia:KCM61VUL3T20:Z050A002T1L8			2T1L8		3.2 TB						
/dev/nv graid@gr / Replace graid@gr / List pl	vme5 raid de e physi raid de hysical	mo ~]\$ Lcal dr mo ~]\$ . drive	sudo ive su sudo succe	graidctl uccessfull graidctl essfully.	replace p y. list phys	ohysical_ sical_dri	drive 0 /dev ve	/nvme5						
/dev/nv graid@gr / Replace graid@gr / List pl	vme5 raid de re physi raid de hysical	mo ~]\$ Lcal dr mo ~]\$ . drive	sudo ive su sudo succe	graidctl uccessfull graidctl essfully.	replace p .y. list phys	ohysical_ sical_dri	drive 0 /dev ve	/nvme5		 		-	.[	I
/dev/nv graid@gr / Replace graid@gr / List pl PD ID ( 0 1 2 3	vme5 raid de e physi raid de hysical (5)   (5)     	 mo ~]\$ ccal dr mo ~]\$ . drive DG ID 0 0 0 0 0	sudo ive su sudo succe DEVI /dev /dev /dev /dev /dev	graidctl graidctl essfully. //gpd5 //gpd1 //gpd2 //gpd3	replace p .y. list phys NQN/WWII nqn.2019 nqn.2019 nqn.2019		drive 0 /dev ve kioxia:KCM61 kioxia:KCM61 kioxia:KCM61 kioxia:KCM61	//nvme5 //nvme5 .vuL3T2 .vuL3T2 .vuL3T2 .vuL3T2	0:Z050A002T1L8 0:Z050A000T1L8 0:Z010A000T1L8 0:Z010A001T1L8 0:Z080A04HT1L8		CAPACITY 20 3.2 TB 20 3.2 TB 20 3.2 TB 20 3.2 TB 20 3.2 TB	-		(0.16%)
/dev/nv graid@gr / Replace graid@gr / List pl PD ID ( 0 1 2 3 4	vme5 raid de e physi raid de hysical (5)   (5)             	<pre> </pre>	sudo ive su sudo succe DEVI /dev /dev /dev /dev /dev	graidctl graidctl graidctl essfully. //gpd5 //gpd1 //gpd2 //gpd3 //gpd4 //gpd4	replace p .y. list phys NQN/WWII nqn.2019 nqn.2019 nqn.2019 nqn.2019	<pre>&gt;&gt;hysical_ sical_dri &gt;&gt;-10.com. &gt;&gt;-10.com. &gt;&gt;-10.com. &gt;&gt;-10.com. &gt;&gt;-10.com. &gt;&gt;-10.com.</pre>	drive 0 /dev ve kioxia:KCM61 kioxia:KCM61 kioxia:KCM61 kioxia:KCM61	/nvme5 //nvme5 .VUL3T20 .VUL3T20 .VUL3T20 .VUL3T20 .VUL3T20	0:2050A002T1L8 0:2060A006T1L8 0:2010A001T1L8 0:2080A04HT1L8 0:2080A04HT1L8	MODEL KCM61VUL3T: KCM61VUL3T: KCM61VUL3T: KCM61VUL3T:	CAPACITY 20 3.2 TB 20 3.2 TB 20 3.2 TB 20 3.2 TB 20 3.2 TB 20 3.2 TB	SLOT ID   SLOT ID   6   9   8   11   3 	STATE REBUILD ONLINE ONLINE ONLINE	(0.16%)
/dev/nv graid@gr / Replace graid@gr / List pl PD ID ( 0 1 2 3 4 graid@gr / List du	vme5 raid de e physic hysical (5)   (5)   raid de raid de	 mo ~]\$ .cal dr mo ~]\$ . drive DG ID 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	sudo ive su sudo succe DEVI /dev /dev /dev /dev /dev sudo	graidctl graidctl essfully. / /(gpd5   //gpd5   //gpd3   //gpd3   //gpd4   graidctl fully.	replace p y. list phys NQN/W/II nqn.2019 nqn.2019 nqn.2019 list driv		drive 0 /dev ve kioxia:KCM61 kioxia:KCM61 kioxia:KCM61 kioxia:KCM61	//nvme5 .v/uL3T2/ .vuL3T2/ .vuL3T2/ .vuL3T2/ .vuL3T2/	 0:2050A002T1L8 0:2050A006T1L8 0:2010A001T1L8 0:2080A40T1L8 0:2080A405KT1L8	MODEL KCM61VUL3T KCM61VUL3T KCM61VUL3T KCM61VUL3T	CAPACITY 20 3.2 TB 20 3.2 TB 20 3.2 TB 20 3.2 TB 20 3.2 TB 20 3.2 TB	SLOT ID   6   9   8   11   3 	STATE   SEBUILD   REBUILD   ONLINE   ONLINE   ONLINE   ONLINE	(0.16%)
/dev/nv graid@gr / Replace graid@gr / List pl PD ID ( 0 1 2 3 4 graid@gr / List d 	vme5 raid de raid de hysical (5)   (5)   raid de raid de rive gr MODE	<pre></pre>	sudo succe DEVI /dev /dev /dev /dev /dev /dev /dev /dev	graidctl graidctl graidctl essfully. /gpd5 / /gpd1 / /gpd2 / /gpd3 / /gpd4 / graidctl fully. CAPACITY	replace f .y. list phys NQN/WWII nqn.2019 nqn.2019 nqn.2019 list driv FREE		drive 0 /dev ve kioxia:KCM61 kioxta:KCM61 kioxta:KCM61 kioxia:KCM61 state	VUL3T24 VUL3T24 VUL3T2 VUL3T2 VUL3T2 VUL3T24 VUL3T24	0:2050A002T1L8 0:2060A006T1L8 0:2010A001T1L8 0:2080A04HT1L8 0:2080A05KT1L8	MODEL KCM61VUL3T: KCM61VUL3T KCM61VUL3T KCM61VUL3T KCM61VUL3T	CAPACITY 20 3.2 TB 20 3.2 TB 20 3.2 TB 20 3.2 TB 20 3.2 TB 20 3.2 TB	SLOT ID   6   9   8   11   3   -	STATE REBUILD ONLINE ONLINE ONLINE	(0.16%)   
/dev/nv graid@gr / Replace graid@gr / List pl PD ID ( 0 1 2 3 4 graid@gr / List du DG ID 0 0 0	vme5 raid de e physi raid de hysical (5) (5) raid de rive gr   maid de rive gr   MODE   RAID5		sudo ive su sudo succe DEVI /dev /dev /dev /dev /dev /dev /dev /dev	graidctl gcaidctl graidctl sssfully. (CE PATH / /gpd5 / /gpd5 / /gpd2 / /gpd4 / graidctl fully. CAPACITY 13 TB	replace ; .y. list phys NQN/WWII nqn.2019 nqn.2019 nqn.2019 list driv FREE FREE 12 TB	) ) ) ) ) ) ) ) ) ) ) ) ) )	drive 0 /dev ve kioxia:KCM61 kioxia:KCM61 kioxia:KCM61 kioxia:KCM61 sTATE STATE RECOVERY	.VUL3T21 .VUL3T21 .VUL3T21 .VUL3T21 .VUL3T21	0:2050A002T1L8 0:2060A006T1L8 0:2060A006T1L8 0:2080A4HT1L8 0:2080A4HT1L8	MODEL KCM61VUL3T KCM61VUL3T KCM61VUL3T KCM61VUL3T	20 3.2 TB 20 3.2 TB 20 3.2 TB 20 3.2 TB 20 3.2 TB 20 3.2 TB 20 3.2 TB	SLOT ID   6   9   8   11   3	STATE REBUILD ONLINE ONLINE ONLINE ONLINE	(0.16%)     
/dev/nv graid@gr / Replace graid@gr / List pl PD ID ( 0 1 2 3 4 graid@gr / List dl DG ID   0   0 graid@gr	vme5 raid de e physi raid de hysical (5)	mo ~]\$ .cal dr mo ~]\$ . drive DG ID 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	sudo success DEVI /dev /dev /dev /dev /dev /dev /dev /dev	graidctl graidctl graidctl escessfully. (CE PATH   //gpd5   //gpd2   //gpd2   //gpd3   //gpd4   //gpd5   //gpd5   //gpd5   //gpd5   //gpd5   //gpd4   //gpd4	replace p y.y. list phys nqn.2019 nqn.2019 nqn.2019 list driv FREE 12 TB		drive 0 /dev ve kioxia:KCM61 ki	//nvme5	0:2050A002T1L8 0:2060A006T1L8 0:2010A001T1L8 0:2080A04HT1L8 0:2080A04HT1L8 0:2080A05KT1L8	MODEL KCM61VUL3T KCM61VUL3T KCM61VUL3T KCM61VUL3T	CAPACITY 20 3.2 TB 20 3.2 TB 20 3.2 TB 20 3.2 TB 20 3.2 TB 20 3.2 TB 20 3.2 TB	SLOT ID   6   9   8   11   3   -	STATE REBUILD ONLINE ONLINE ONLINE ONLINE	(0.16%)       
/dev/nv graid@gr / Replace graid@gr / List pl PD ID ( 0 1 2 3 4 graid@gr / List d 0 ] graid@gr / List v 0 ] yraid@gr	raid de e physi raid de hysical (5)   	mo         -]\$           mo         -]\$           mo         -]\$           DG         D           0         0           0 <td< td=""><td>sudo sudo sudo DEVI /dev /dev /dev /dev /dev /dev /dev /dev</td><td>graidctl graidctl graidctl essfully. /gpd5   /gpd5   /gpd3   /gpd4   graidctl fully. cAPACITY 13 TB graidctl graidctl s5tully.</td><td>replace f y. list phys nqn.2019 nqn.2019 nqn.2019 nqn.2019 list driv   FREE   12 TB list vird</td><td></td><td>drive 0 /dev ve kioxia:KCM61 ki</td><td>//nvme5 //UL3T2i /VUL3T2i /VUL3T2i /VUL3T2i /VUL3T2i</td><td> </td><td>MODEL KCM61VUL3T KCM61VUL3T KCM61VUL3T KCM61VUL3T</td><td>CAPACITY 20 3.2 TB 20 3.2 TB 20 3.2 TB 20 3.2 TB 20 3.2 TB 20 3.2 TB</td><td>SLOT ID 6 9 8 11 3</td><td>STATE REBUILD ONLINE ONLINE ONLINE ONLINE</td><td>(0.16%)</td></td<>	sudo sudo sudo DEVI /dev /dev /dev /dev /dev /dev /dev /dev	graidctl graidctl graidctl essfully. /gpd5   /gpd5   /gpd3   /gpd4   graidctl fully. cAPACITY 13 TB graidctl graidctl s5tully.	replace f y. list phys nqn.2019 nqn.2019 nqn.2019 nqn.2019 list driv   FREE   12 TB list vird		drive 0 /dev ve kioxia:KCM61 ki	//nvme5 //UL3T2i /VUL3T2i /VUL3T2i /VUL3T2i /VUL3T2i		MODEL KCM61VUL3T KCM61VUL3T KCM61VUL3T KCM61VUL3T	CAPACITY 20 3.2 TB 20 3.2 TB 20 3.2 TB 20 3.2 TB 20 3.2 TB 20 3.2 TB	SLOT ID 6 9 8 11 3	STATE REBUILD ONLINE ONLINE ONLINE ONLINE	(0.16%)

#### Note:

Ensure that the system or other applications are not on the physical drive before creating or replacing it.

#### Creating the Physical Drive from the NVMe-oF Drive

To create the physical drive from the NVMe-oF drive:

1. Connect to the remote NVMe-oF target.

\$ sudo graidctl connect remote\_target <tcp|rdma|fc> <addr> <address family> <service id>

2. Check the NVMe drives from the remote NVMe-oF target.

\$ sudo graidctl list nvme\_drive

3. Create the physical drives.

\$ sudo graidctl create physical\_drive <nqn or devpath>...

4. Create a RAID5 drive group with 4 physical drives.



\$ sudo graidctl create drive\_group <Mode> <PD\_ID>... [flags]

#### Output example:

•••						
[graid@graid demo~ Connect remote ta Connect remote ta [graid@graid demo~] List nvme drive s	]\$ \$ sudd rget suc rget Tar ]\$ sudo g uccessfu	o graidctl connect remote_target tcp 172.16. cessfully. get 0 successfully. graidctl list nvme_drive lly.	11.81 i	pv4 4420		
DEVICE PATH (4)	MODEL	NQN/WWID	NSID	CAPACITY	ADDRESS	
/dev/nvme0n1 /dev/nvme1n1 /dev/nvme2n1 /dev/nvme3n1	Linux Linux Linux Linux	uuid.b951d877-76af-4dfe-84ee-a45164554fe2 uuid.6f21ec8f-00ee-4a30-a9b8-413447b8f138 uuid.34d1d6aa-41fc-4c02-a660-f75429d7d74b uuid.0846f451-31af-49ae-b3db-8ca90f454c3b	1 1 1 1	22 GB 22 GB 22 GB 22 GB 22 GB	traddr=172.16.11.81,trsvcid=4420 traddr=172.16.11.81,trsvcid=4420 traddr=172.16.11.81,trsvcid=4420 traddr=172.16.11.81,trsvcid=4420	
[graid@graid demo~] f75429d7d74b	\$ sudo q	graidctl create physical_drive uuid.b951d877-	-76af-4	dfe-84ee-a4	 5164554fe2 /dev/nvme1 /dev/nvme3 uu <sup>.</sup>	id.34d1d6aa-41fc-4c02-a660-

/ Create physical drive successfully. //Create physical drive PD0 (uutd.b951d877-76af-4dfe-84ee-a45164554fe2) successfully. //Create physical drive PD1 (/dev/nvme1: uuid.6f21ec8f-00ee-4a30-a9b8-413447b8f138) successfully. //Create physical drive PD2 (/dev/nvme3: uuid.d846f451-31af-49ae-b3db-8ca30f454c3b) successfully. //Create physical drive PD3 (uuid.34d1d6aa-41fc-4c02-a660-f75429d7d74b) successfully. [graid@graid demo-]\$ sudo graidctl create drive\_group raid5 0-3 // Create drive group DG0 successfully.



# **Managing Drive Groups**

#### **Creating Drive Groups**

To create a drive group or groups, run:

```
$ sudo graidctl create drive_group <RAID_MODE> (PD_IDs) [--background-init]
```

#### •••

```
[graid@graid-demo ~]$ sudo graidctl create drive_group raid1 0-1

✓Create drive group DG0 successfully.
[graid@graid-demo ~]$ sudo graidctl create drive_group raid5 2-4

✓Create drive group DG1 successfully.
[graid@graid-demo ~]$ sudo graidctl create drive_group raid6 5-9

✓Create drive group DG2 successfully.
```

#### Required parameters:

Option	Description
RAID_MODE	This field specifies the RAID mode of the drive group. Entries must be all uppercase or all lowercase. (For example, RAID6 or raid6 are both correct)
PD_IDs	This field specifies the ID of the physical drive joining the drive group.

#### Optional parameters:

Option	Description	Behavior
 backgroud- init, -b	Default option. Use standard methods to initialize the drive group. When all the physical drives in the drive group support the deallocate dataset management command, it is used to synchronize the data, or parity, between the physical drives during the creation of the drive group.	An I/O capable device path similar to /dev/gvd0n1 is created.
		The virtual drive

\_\_\_

foreground-Initialzing foreground. init,

-z

appears in the system after initialization is

\$ sudo graidctl list

initialization progress.

complete.

drive\_group
to check the

Use:



<b>Option</b>	Description	Behavior
force,	Force to initialize. Assumes	The drive group STATE immediately becomes OPTIMAL indicating that
-f	that the drive is free.	the drive group is available for use.

#### Important Note:

Wait for the drive group initialization to complete. DO NOT power-off or reboot the system when the drive\_group state is INIT/RESYNC/RECOVERY.

Use the command below to check drive\_group state:

\$ sudo graidctl list drive\_group

#### **Listing Drive Groups**

To list all drive groups, run:

\$ sudo graidctl list drive\_group

Output example:

[graid@gr ✔List dri	aid-demo ive grou	o ~]\$ sudo p success	o graidctl fully.	list drive	e_group	
DG ID	MODE	VD NUM	CAPACITY	FREE	USED	STATE
0	RAID1	0	3.2 TB	3.2 TB	0 B   0 B	OPTIMAL
2	RAID6	0	9.6 TB	9.6 TB	ов   ов	OPTIMAL

#### Output content:

Field	Description
DG ID	This field displays the drive group ID.
MODE	This field displays the drive group RAID mode.
VD NUM	This field displays the number of virtual drives in the drive group.
CAPACITY	This field displays the total usable capacity of the drive group.
FREE	This field displays the unused space of the drive group.
USED	This field displays the used space of the drive group.
STATE	This field displays the drive group state.



S GRAI	D
--------	---

STATE	Description
OFFLINE	The drive group does not function normally. This condition is usually caused when the number of damaged physical drives exceeds the limit.
OPTIMAL	The drive group is in optimal state.
OPTIMAL(!)	The drive group is in optimal state but found inconsistency data.
OPTIMAL(cc)	The drive group is in optimal state and the consistency check task is ongoing.
OPTIMAL(cc!)	The drive group is in optimal state and the consistency check task is ongoing but found inconsistent data.
DEGRADED	The drive group is available and ready, but the number of missing or failed physical drives has reached the limit.
PARTIALLY_DEGRADED	The drive group is available and ready for use, but some physical drives are missing or failed.
RECOVERY	The drive group is recovering.
FAILED	The drive group does not function normally.
INIT	The drive group is initializing.
RESYNC	The drive group is re-synchronizing. This condition usually occurs when the system encounters an abnormal crash. Do not replace the physical drive in this state until the re-synchronization process is complete.
RESCUE	The drive group is in rescue mode.
INIT	The drive group is initializing.
RESYNC	The drive group is re-synchronizing. This condition usually occurs when the system encounters an abnormal crash. Do not replace the physical drive in this state until the re-synchronization process is complete.
RESCUE	The drive group is in rescue mode.

### **Deleting Drive Groups**

To delete drive groups, run:

\$ sudo graidctl delete drive\_group <DG\_ID>



# [graid@graid-demo ~]\$ sudo graidctl delete drive\_group 1 \*Delete drive group failed: Failed to delete some DGs. \*Delete drive group DG1 failed: rpc error: code = FailedPrecondition desc = DG1 still has 1VD(s) [graid@graid-demo ~]\$ sudo graidctl delete drive\_group 0 2 \*Delete drive group DG0 successfully. \*Delete drive group DG2 successfully.

You cannot delete a drive group that contains a virtual drive.

In this example, drive group 1 was not deleted because it contains a virtual drive. Drive groups 0 and 2 were deleted successfully.



#### **Describing a Drive Group**

To display detailed information for a drive group, run:

```
$ sudo graidctl describe drive_group <DG_ID>
```

Output example:

•••	
[graid@graid-demo	~]\$ sudo graidctl describe drive_group 0
✓Describe drive g	group successfully.
DG ID:	0
Mode:	RAID5
Capacity:	11 GB
Free Space:	1.4 GB
Used Space:	9.2 GB
State:	OPTIMAL
PD IDs:	[0 1 2]
Number of VDs:	3
Attributes:	
	rebuild_speed = high

#### Setting the Drive Group Rebuild Speed

To set the rebuild speed for a drive group, run:

```
$ sudo graidctl edit drive_group <DG_ID> rebuild_speed {low|normal|high}
```

#### Locating the Physical Drives in the Drive Group

To locate all the physical drives in the drive group, run:

\$ sudo graidctl edit drive\_group <DG\_ID> locating start

To stop locating all the physical drives in drive group, run:

\$ sudo graidctl edit drive\_group <DG\_ID> locating stop

#### **Degradation and Recovery**

- When multiple drive groups require simultaneous recovery, the drive groups recover individually.
- When multiple physical drives in the same drive group require rebuilding, the physical drives are rebuilt simultaneously.

#### **Rescue Mode**

When a damaged drive group is initialized, or when a recovering drive group encounters an abnormal system crash, the data integrity of the drive group is affected. In this event, the drive group is forced offline to prevent data from being written to the drive group. To read the data for the drive group, force the drive group to go online using Rescue mode.



#### Note:

A drive group in Rescue mode is read-only. Rescue mode cannot be disabled.

To enter the rescue mode, run:

\$ sudo graidctl edit drive\_group <DG\_ID> rescue\_mode on



# **Managing Virtual Drives**

#### **Creating a Virtual Drive**

To create a virtual drive, run:

```
$ sudo graidctl create virtual_drive <DG_ID> [<VD_SIZE>]
```

Output example:



#### **Listing Virtual Drives**

To list virtual drives, run:

```
$ sudo graidctl list virtual_drive [--dg-id=<DG_ID>] [--vd-id=<VD_ID>]
```

#### Output example:

[graid@graid-de ✔List virtual	emo ~]\$ s drive su	udo graio ccessfull	dctl list virtual_driv y.	ve	
VD ID (12)	DG ID	SIZE	DEVICE PATH	STATE	EXPORTED
0	0	4.3 GB	= Stripe Cache =	OPTIMAL	No
1	0	4.3 GB	/dev/mapper/dg0vd1	OPTIMAL	No
2	0	105 GB	/dev/gvd2n1	OPTIMAL	Yes
3	0	105 GB	/dev/gvd3n1	OPTIMAL	Yes
0	4	14 GB	/dev/md125	OPTIMAL	No
1	4	1.1 GB	/dev/md126	OPTIMAL	No
2	4	629 MB	/dev/md124	OPTIMAL	No
3	4	1.7 GB	/dev/md127	OPTIMAL	No

Output content:

Field	Description
DG ID	This field displays the drive group ID.
VD ID	This field displays the virtual drive ID.
SIZE	This field displays the usable size of the virtual drive.
DEVICE PATH	This field displays the device path of the virtual drive.



Field	Description
NQN	This field displays the NQN of the virtual drive.
STATE	This field displays the virtual drive state. It is identical to the drive group state.
EXPORTED	This field displays whether the virtual drive was exported using NVMe-oF or iSCSI.

#### Note:

Do not perform I/O before the virtual drive is initialized and the device path (for example, /dev/gvd0n) is created.

#### Virtual Drive STATE:

Identical to the drive group state.

STATE	Description
OFFLINE	The drive group does not function normally. This condition is usually caused when the number of damaged physical drives exceeds the limit.
OPTIMAL	The drive group is in the optimal state.
DEGRADED	The drive group is available and ready, but the number of missing or failed physical drives has reached the limit.
PARTIALLY_DEGRADED	The drive group is available and ready for use, but some physical drives are missing or failed.
RECOVERY	The drive group is recovering.
FAILED	The drive group does not function normally.
INIT	The drive group is initializing.
RESYNC	The drive group is re-synchronizing. This condition usually occurs when the system encounters an abnormal crash. Do not replace the physical drive in this state until the re-synchronization process is complete.
RESCUE	The drive group is in rescue mode.



#### **Deleting Virtual Drives**

To delete virtual drives, run:

```
$ sudo graidctl delete virtual_drive <DG_ID> <VD_ID> [--force]
```

Output example:

The example shows that a virtual drive being used by the application cannot be deleted without adding the force flag.

#### **Describing a Virtual Group**

To check the detailed information for a virtual group, run:

```
$ sudo graidctl describe virtual_drive <DG_ID> <VD_ID>
```

•••					
[graid@g ✓Descri DG ID: VD ID: Model: NQN: DevicePa Size: State:	graid-demo ~]\$ s be virtual driva 0 SER ngn ath: /de 4.3 0PT	udo graidctl des successfully. 2001 .2020-05.com.gra v/gvd4n1 GB IMAL	cribe virtua idtech:SER000	L_drive 0 4 013DBDD6BD73EF89C	9
Descript Exported	tion: 1:		1	1	1
PORT	TRANSPORT TYPE	ADDRESS	INTERFACE	ADDRESS FAMILY	SERVICE ID
0	tcp	172.16.11.64	ens192	ipv4	4420



#### **About Consistency Check task**

#### **Consistency Check task**

The consistency check operation verifies the data is correct in DGs that use RAID levels 1, 5, 6, and 10. For example, in a system with parity, checking consistency means calculating the data on one drive and comparing the results to the contents of the parity drive. The consistency check cannot be performed on RAID 0 because it does not provide data redundancy. Besides, a consistency check can only run when the DG is in OPTIMAL or PARTIALLY\_DEGRADED state.

#### The record of the Consistency Check

The consistency check function will record all events to the event database, and graidctl provides commands to retrieve the events. The maximum number of event entries is limited to 1000. The event entries will be periodically deleted by the system or manually deleted by the user's command.

#### Enable Consistency Check task by manual

To start consistency check manual, run:

\$ sudo graidctl start consistency\_check manual\_task [DG\_IDs][--policy|-p <stop\_on\_error|auto\_fix>]

Enable consistency check task would add annotations beside the output string of DG state as follows:

DG state	Description
OPTIMAL	Normal state without enable consistency check
OPTIMAL (!)	Inconsistency found
OPTIMAL (cc)	Consistency check ongoing
OPTIMAL (cc!)	Consistency check ongoing and Inconsistency found

#### Output example:



#### Stop Consistency Check task

To stop the consistency check task, run:

```
$ sudo graidctl stop consistency_check current_task
```





#### •••

[graid@graid-demo ~]\$ sudo graidctl stop consistency\_check current\_task Stop consistency check successfully.

#### Schedule Consistency Check task

To schedule the consistency check task, run:

\$ sudo graidctl set consistency\_check schedule\_mode <off|ontinuously|hourly|daily|weekly|monthly>
<yyyy/mm/dd> <hh>

Enable consistency check task would add annotations beside the output string of DG state as follows:

DG state	Description
OPTIMAL	Normal state without enable consistency check
OPTIMAL (!)	Inconsistency found
OPTIMAL (cc)	Consistency check ongoing
OPTIMAL (cc!)	Consistency check ongoing and Inconsistency found

#### Output example:

[graid@graid-demo ~]\$ sudo graidctl set consistency_check schedule_mode daily 2022/06/25 10 ✔Set consistency check successfully.	

#### **Describing the Consistency Check task**

To check the detailed information for the consistency check task, run:

\$ sudo graidctl describe consistency\_check

#### Output example:



#### Set the Consistency Check policy



To set consistency check policy, run:

\$ sudo graidctl set consistency\_check policy <auto\_fix|stop\_on\_error>

**Note:** The consistency check would runs on all drive\_group by defalt, if user wants to exclude some drive group user needs to run "excluded\_dgs" command.

Output example:



#### Consistency Check exclude certain drive groups.

To exclude some drive groups, run:

\$ sudo graidctl set consistency\_check excluded\_dgs <DG\_IDs>

Output example:



#### List events

To check the detailed information from record, run:

```
$ sudo graidctl list event [-n <max_entries>] [-s <severity>] [-c <component>]
```

Output example:

#### **Delete Events**

To delete old events, run:

\$ sudo graidctl delete event [-d yyyy/mm/dd] [-e <num\_entries>]



Output example:



#### Creating a RAID-5 Virtual Drive with 5 NVMe SSDs

To create a RAID-5 virtual drive with 5 NVMe SSDs:

1. Create a physical drive.

\$ sudo graidctl create physical\_drive /dev/nvme0-4

2. Create a drive group.

\$ sudo graidctl create drive\_group raid5 0-4

3. Create a virtual drive.

\$ sudo graidctl create virtual\_drive 0

4. Check the device path of the new virtual drive.

\$ sudo graidctl list virtual\_drive --dg-id=0





#### Exporting the Virtual Drive as an NVMe-oF Target Drive using RDMA to the Initiator

To export the virtual drive as an NVMe-oF target drive using RDMA to the initiator:

1. Create the RDMA/TCP NVMe-of target port services.

\$ sudo graidctl create nvmeof\_target <tcp|rdma> <interface> <address family> <srvcid> [flags]

2. Export a virtual drive as an NVMe-of target.

\$ sudo graidctl export virtual\_drive <DG\_ID> <VD\_ID>... [flags]

3. List all NVMe-of targets.

\$ sudo graidctl list nvmeof\_target [flags]

- 4. Describe the detail information for an NVMe-of target.
  - \$ sudo graidctl describe nvmeof\_target <PORT\_ID> [flags]

•••									
[graid@graid ✔List virtu	d demo nal dr	o~]\$ : ive s	sudo grai uccessful	dctl list virtu .ly.	ual_drive	2			
VD ID (1)	D	G ID	SIZE	DEVICE PATH	STATE	EXP	ORTED		
-	0	0	10.0 GB	/dev/gvd0n1	OPTIM/	AL No			
∣ [graid@graid ✔Create nvm ✔Create nvm	d dem neof t neof t	o~]\$ : arget arget	sudo grai success Port 0 s	dctl create nvr ully. successfully.	neof_taro	get tcp	ens160'i	pv4 4420	
[graid@graid ✓Export vir ✓Export vir	d demo tual tual	D∼]\$ : drive drive	sudo grai successi VD0 into	dctl export vi Fully. • Port 0 succes	rtual_dri sfully.	lve 0 0	-p 0		
[graid@graid ✓List nvmeo	d demo of tar	o~]\$ : get s	sudo grai uccessful	dctl list nvmed .ly.	of_target				
PORT ID	TYPE	IN.	TERFACE	ADDRESS	ADDRESS	5 FAMILY	SERVI	CE ID	SUBSYSTEMS
0	tcp	en:	s160	172.16.11.81	ipv4		4420		DG0/VD0
l [graid@graid pDescribe n Port: TransportTy Address: Interface: AddressFami ServiceId: Subsystems:	d demo ovmeof pe: ly:	י targ 0 נו 1 נו 4	sudo grai let succes cp 72.16.11. ns160 pv4 420	dctl describe n ssfully. 81	nvmeof_ta	arget 0	' 		
TARGET NA	ME					DG ID	VD ID	ENABLE	DEVICE P
nqn.2020-	05.co	n.gra	idtech:SE	R0001763D84DEEF	30A1F15	0	0 	Yes	/dev/gvd _



#### Setting Up a Stripe Cache to Improve the HDD's RAID 5 and RAID 6 Performance

To set up a stripe cache to improve an HDD's RAID 5 and RAID 6 performance:

1. Create a stripe cache with a 4GB virtual drive.

```
$ sudo graidctl create virtual_drive 0 4GB
```

#### Note:

A 4GB stripe cache is considered the best practice.

Use this configuration whenever possible.

2. Assign a 4GB virtual disk as the stripe cache.

\$ sudo graidctl edit virtual\_drive 1 0 stripecache /dev/gvd0n1

3. Check the stripe cache:

```
$ sudo graidctl list virtual_drive
```

The assigned virtual drive is listed as '= Stripe Cache =' in DEVICE PATH column.

Output example:

•••					
[graid@graid-	sake ~]\$ sud al drive suc al drive DGG sake ~]\$ sud al drive suc sake ~]\$ sud drive succe sake ~]\$ sud drive succe	o graidctl create vir ccessfully. /VD0 successfully. o graidctl create vir ccessfully. /VD0 successfully. o graidctl edit virtu: cssfully. o graidctl list virtu: csfully.	tual_drive tual_drive al_drive 1 al_drive	0 4GB 1 0 stripeca	che ∕dev/gvd0n1
VD ID DG	D SIZE 0 4.0 GB 1 5.0 TB	DEVICE PATH = Stripe Cache = /dev/mapper/dglvd0	STATE OPTIMAL OPTIMAL	EXPORTED No No	

To flush the stipe cache:

```
$ sudo graidctl edit vd 0 0 stripecache none
```



# **Basic Troubleshooting**

# Sequential Read Performance is not as Expected on a New Drive Group

Unlike SAS/SATA hard drives, many NVMe SSDs support the deallocate dataset management command. Using this command, you can reset all data in the NVMe SSD immediately, eliminationg the need to synchronize data between physical drives when creating a drive group.

But for other SSDs, the performance is not as expected when reading unwritten sectors after issuing the deallocate dataset management command. While this behavior also impacts the performance of the new drive group, it does not affect the applications because they do not read sectors that do not contain data.

To test GRAID perfomance, write the entire virtual drive sequentially using a large block size.



# Kernel Log Message "failed to set APST feature (-19)" Appears When Creating Physical Drives

Some NVMe SSD models might display a "failed to set APST feature (-19)" message in the kernel log when creating the physical drive.

When SupremeRAID<sup>™</sup> creates the physical drive, the SSD is unbound from the operating system so that SupremeRAID<sup>™</sup> can control the SSD. During the unbinding process, when the APST feature is enabled, the NVMe driver attempts and fails to set the APST state to SSD, and the error message is issued.

This message is expected and can be ignored. SupremeRAID™ is functioning normally.



# **Different LED Blink Patterns on the Backplane**

You might notice that the HDD/SSD activity indicator blink pattern is different on GRAID SupremeRAID<sup>™</sup> than on traditional RAID cards.

GRAID SupremeRAID<sup>™</sup> does not require a buffering or caching mechanism to improve read/write performance like traditional RAID cards. This feature causes GRAID SupremeRAID<sup>™</sup> indicators to blink differently than traditional RAID cards.



# Appendix

# Manually Migrating the RAID Configuration Between Hosts

To manually migrate the RAID configuration between hosts:

- 1. Periodically backup the configuration file */etc/graid.conf* from the original host. Use cp or scp to move the configuration file to another system.
- 2. Setup the target host and ensure that the GRAID service is stopped.

#### Note

When the target host already contains an installed and running SupremeRAID<sup>™</sup> card, stop and restart the service using the **graid.conf** file from the original system.

- 3. Move all the SSDs from the original host to the new host.
- 4. Copy the configuration backup file to the new host using the same path.
- 5. Start the GRAID service directly if the original card also moved to the new host.

\$ sudo systemctl start graid

Otherwise, you must apply the new license.

\$ sudo graidctl apply license <LICENSE\_KEY>



# Monitoring System Input/Output Statistics for Devices Using iostat

The sysstat package contains the tools most commonly used to monitor I/O statistics in Linux systems. The sysstat package includes the iostat tool, which monitors system I/O device loading by observing the time the devices are active relative to their average transfer rates. The iostat command generates reports that enable you to fine tune the system configuration to better balance the I/O load between physical disks.

For example, to monitor specific devices and display statistics in megabytes per second (MBps):

\$ iostat -m md124 sda nvme0n1

Output example:

•••								
[graid@gr Linux 4.1	aid-demo 8.0-348.	~]\$ io 7.1.el8	stat -m md124 _5.x86_64 (gr	sda nvme3nl aid-demo) 01	/06/2022 _x8	6_64_ (1	L6 CPU)	
avg-cpu:	%user 0.01	%nice 0.00	%system %iowa 0.15 0.	it %steal 00 0.00	%idle 99.84			
Device		tps	MB_read/s	MB_wrtn/s	MB_dscd/s	MB_read	MB_wrtn	MB_dscd
md124								
nvme3n1								
				0.05		80843	5208	

#### sysstat versions v12.3.3 and later

For sysstat versions v12.3.3 and later, the iostat tool includes an "alternative directory" feature that enables you to specify the directory from which to read device statistics.

- Add a "+f" parameter to the tool and use the "/sys/devices/virtual/graid/graid" sysfs device path to read device statistics from both the standard kernel files and from the files in the alternative directory.
- Add a "-f" parameter to the tool and use the "/sys/devices/virtual/graid/graid" sysfs device path to only read device statistics from the files in the alternative directory.

Alternative directory description from the iostat manual page.





To check the iostat version:

\$ iostat -V

Output example:

•••	
[graid@graid-demo ~]\$ iostat -V sysstat version 12.5.5 (C) Sebastien Godard (sysstat <at> orange.fr)</at>	

The gpd# statistics are not displayed in the iostat report without appending the "+f" and defining the sysfs path.

```
$ iostat -m +f /sys/devices/virtual/graid/graid gvd0nl md124 sda nvme0n1 gpd3
```

Output example:

•••							
[graid@graid-demo Linux 4.18.0-348.	~]\$ ios 7.1.el8_	tat -m gvd0n <sup>-</sup> 5.x86_64 (gra	l md124 sda n aid-demo) 01	vme0n1 gpd3 ./06/2022 _x8	6_64_ (1	LG CPU)	
avg-cpu: %user 0.01	%nice % 0.00	system %iowa 0.14 0.(	it %steal 00 0.00	%idle 99.84			
Device	tps	MB_read/s	MB_wrtn/s	MB_dscd/s	MB_read	MB_wrtn	MB_dscd
gvd0n1	0.68						
md124							
nvme0n1							
	5.62	0.66	0.03		118093	5468	

The gpd# statistics are displayed when "+f" is appended and the sysfs path is defined.

```
$ iostat -m +f /sys/devices/virtual/graid/graid gvd0nl md124 sda nvme0n1 gpd3
```

Output example:

•••								
[graid@gra Linux 4.18	id-demo .0-348.7	~]\$ io: 7.1.el8	stat -m +f /s _5.x86_64 (gra	ys/devices/vi aid-demo) 01	rtual/graid/g /06/2022 _x8	raid gvd0n1 6_64_ (1	. md124 sda .6 CPU)	n∨me0n1 gpc
avg-cpu:	%user 0.01	%nice 9 0.00	system %iowa 0.15 0.0	it %steal 00 0.00	%idle 99.84			
Device		tps	MB_read/s	MB_wrtn/s	MB_dscd/s	MB_read	MB_wrtn	MB_dscd
gpd3								
gvd0n1								
md124								
nvme0n1								
sda		6.22	0.72	0.05		80853	5208	

#### sysstat versions prior to v12.3.3

For operating systems with sysstat versions prior to v12.3.3 (CentOS for example), GRAID provides an alternate tool called "giostat" to display device statistics.

In the following example, the operating system version of iostat is prior to v12.3.3.



\$ sudo yum list --installed |grep sysstat

#### Output example:

•••			
[graid@graid-demo ~]\$ sudo yum listinstalle	ed  grep sysstat		
sysstat.x86_64	11.7.3-6.el8	@appstream	

The giostat and iostat tools are very similar and their usage is the same. Set the parameter preferences using giostat.

graid@gr ′List ph	aid-d ysical	emo ~]: L drive	\$ sud succ	o graidctl essfully.	list phys	ical_dri	ve;sudo gra	aidctl list	drive_group	;sudo graidctl	list virtu	al_drive	1
PD ID (	5)	DG ID	DE	VICE PATH	NQN/WWIE	)				MODEL	CAPACITY	SLOT ID	STATE
0 1 2 3 4	Image: constraint of the state of				nqn.2019-10.com.kioxia:KCM61VUL3T20:Z060A001T1L8 nqn.2019-10.com.kioxia:KCM61VUL3T20:Z010A004T1L8 nqn.2019-10.com.kioxia:KCM61VUL3T20:X0X0A01ET1L8 nqn.2019-10.com.kioxia:KCM61VUL3T20:Z080A04HT1L8 nqn.2019-10.com.kioxia:KCM61VUL3T20:Z080A038T1L8					KCM61VUL3T20 KCM61VUL3T20 KCM61VUL3T20 KCM61VUL3T20 KCM61VUL3T20 KCM61VUL3T20	3.2 TB 3.2 TB 3.2 TB 3.2 TB 3.2 TB 3.2 TB	12   19   18   8   0	ONLINE ONLINE ONLINE ONLINE UNCONFIGURED_GOOD
/List dr	ive gr	oup su	ccess	fully.						1			
DG ID	MODE	VD	NUM	CAPACITY	FREE	USED	STATE						
0	RAID	6	4	6.4 TB	6.4 TB	25 GB	OPTIMAL						
List vi	rtual	drive	succe	essfully.	-	-1							
VD ID (	4)	DG ID	SI	ZE DEV	ICE PATH	STATE	EXPORTED	-					
	0 1 2 3	0 0 0	10   5.   5.	GB /de 0 GB / /de 0 GB / /de 0 GB / /de	v/gvd0n1 v/gvd1n1 v/gvd2n1 v/gvd3n1	RESYNC RESYNC RESYNC RESYNC	No   No   No   No						
graid@gr _inux 4.1	-aid-d 18.0-3	emo ~]: 48.2.1	-	 stat -m gv 5.x86_64 (	d0n1 gpd3 graid-demo	nvme10n1 ) 01/06		-  5_64_ (1	28 CPU)				
avg-cpu:	%use 0.0	r %n 2 0	ice % .00	system %io 0.04	wait %ste 0.00 0.	al %id 00 99.	lle 93						
Device gpd3 gvd0n1		t; 1449.9 0.0	os 98 95	MB_read/s 3.79 0.01	MB_wrt 2	:n/s M .19 .00	IB_dscd/s 0.00 0.00	MB_read 3355542 9530	MB_wrtn 3707736 0	MB_dscd 0 0			
ivme10n1 sda													



# Setting Up the Auto-mount File Systems on Linux using the GRAID Driver

To set up the auto-mount file systems on Linux using the GRAID driver:

1. Create a virtual drive.

\$ sudo graidctl create virtual\_drive <DG\_ID> [size] [flags]

2. Format the virtual drive and create a mount point for it.

```
$ sudo mkdir /mnt/<name-of-the-drive>
$ sudo mkfs.<file-system-type> /dev/gvd#n1
$ sudo mount /dev/gvd#n1 /mnt/<name-of-the-drive>/
```

3. Obtain the Name, UUID, and file system type.

\$ sudo blkid

- 4. Edit the /etc/fstab file.
  - 1. Edit the /etc/fstab file.

\$ sudo vim /etc/fstab

2. Append one line of code to the end of the file. Use the following format:

```
UUID=<uuid-of-the-drive> <mount-point> <file-system-type> <mount-option> <dump> <pass>
```

5. Update the mount dependency.

```
$ sudo graidctl update mount_dependency
```

#### Note

The mount point will auto-mount even after a system reboot.





• • • [graid@graid-demo ~]\$ sudo graidctl create virtual\_drive 0 Allocating group tables: done Writing inode tables: done Creating journal (16384 blocks): done Writing superblocks and filesystem accounting information: done [graid@graid-demo ~]\$ sudo mount /dev/gvd4n1 /mnt/auto mount/ [graid@graid-demo ~]\$ sudo blkid /dev/nvmeln1p1: UUID="cf83c157-7e54-c01c-a145-8c965a6eaaa9" UUID\_SUB="7d80b309-0dec-bcd5-a722-6dd5df348f8c" LABEL="localhost:root". /dev/nymeinipi: 0010= C105C157-7634-C01C-4145-6395a648443 0010\_505-7600505-0000-0005-4722-00050134616C LABEL= 10Cathost:Foot /dev/nymeinip2: UUID="6795ce8e-8975-9a61-a597-4b5b40976113" UUID\_SUB="7b04beee-9b0d-eded-24dc-66c7d77f770f" LABEL="localhost:boot" TYPE="linux\_raid\_member" PARTUUID="5c915506-43be-4add-829d-320bb3508eea" /dev/nymeinip3: UUID="cd36b754-8fb7-636f-7077-8ce6c1172b76" UUID\_SUB="009a90e9-03d7-6fa8-6efd-ca2388f631af" LABEL="localhost:boot\_efi" TYPE="linux\_raid\_member" PARTUUID="1723a6eb-bfdb-4b3f-bb73-616c24692162" /dev/nymeinip4: UUID="a946683c-eec8-6ca9-2a90-db1fc7350ad6" UUID\_SUB="df470c-ff13-e0f3-086d-5202da944391" LABEL="localhost:swap" TVPE="linux\_raid\_member" PARTUUID="1723a6eb-bfdb-4b3f-bb73-616c24692162" TYPE="linux\_raid\_member" PARTUUID="8feefc8a-2045-4268-bdfd-ff546111ce4e" /dev/nvme0n1p1: UUID="cf83c157-7e54-c01c-a145-8c965a6eaaa9" UUID\_SUB="2bde7b08-6d5b-8a99-3236-3ccb16fd7a4d" LABEL="localhost:root" /dev/nyme@nlp2: UUID="6795ce8e-8975-9a61-a597-4b5b40976113" UUID\_SUB="3a2afb38-4d29-b31b-1f7e-66abdfa85227" LABEL="localhost:boot" /dev/numeonlp3: UUID="d12aefb3-e844-40b7-8a78-f59a7e3e5bdf" /dev/nvme0nlp3: UUID="cd36b754-8fb7-636f-7077-8ce6c1172b76" UUID\_SUB="70ee39ac-b9ac-5876-ac2b-1d35149958e1" LABEL="localhost:boot\_efi" TYPE="linux\_raid\_member" PARTUUID="e65af2b7-4a14-4adb-86fa-e97a5c029618" /dev/nyme@nlp4: UUID="a946683c-eec8-6ca9-2a90-db1fc7350ad6" UUID\_SUB="98fc65ee-be6e-425c-cff2-943660d40f9b" LABEL="localhost:swap" /dev/nvme@n1p4: UUID="a946683c-eec8-6ca9-2a90-db1fc7350ad6" UUID\_SUB='98fc65ee-be6e-42' TYPE="linux\_raid\_member" PARTUUID="dd656e5f-a46b-4647-b034-c853e94c6abe" /dev/md127: UUID="a069e3d2-04c8-4576-a6d9-af0e06495985" TYPE="swap" /dev/md126: UUID="1c807345-02fd-49b0-a4ee-444d5beca6c9" BLOCK\_SIZE="512" TYPE="xfs" /dev/md125: UUID="6828ce26-088e-4d72-ae95-89b68b3fd17d" BLOCK\_SIZE="512" TYPE="xfs" /dev/md124: UUID="6828ce26-088e-4d72-ae95-89b68b3fd17d" BLOCK\_SIZE="512" TYPE="xfs" /dev/md124: UUID="6828ce26-088e-4d72-ae95-89b68b3fd17d" BLOCK\_SIZE="512" TYPE="xfs" /dev/gd3n1: UUID="6428ce26-088e-4d72-ae95-89b68b3fd17d" BLOCK\_SIZE="512" TYPE="xfs" /dev/nyme11: PTUUID="6310375f-ea2c-4df0-af40-59c7726e0736" PTTYPE="gpt" /dev/nyme0n1: PTUUID="e2fdfb97-da06-44dc-864e-f6bf5a1c4062" PTTYPE="gpt" /dev/nyme11: UUID="63a98h2-4d72-ae95-49b6e-3d675a0e9736" PTTYPE="gpt" BL OCK 096" TYPE="ext4" [graid@graid-demo ~]\$ sudo vim /etc/fstab [graid@graid-demo ~]\$ sudo cat /etc/fstab # /etc/fstab
# Created by anaconda on Mon Nov 15 04:51:50 2021 # Accessible filesystems, by reference, are maintained under '/dev/disk/'. # See man pages fstab(5), findfs(8), mount(8) and/or blkid(8) for more info. # After editing this file, run 'systemctl daemon-reload' to update systemd # units generated from this file. UUID=6828ce26-088e-4d72-ae95-89b68b3fd17d / defaults 0 0 UUID=1c807345-02fd-49b0-a4ee-444d5beca6c9 /boot 0 0 defaults 
 UUID=7520-A102
 /boot/efi
 vfat
 umask=0077,shortname=winnt 0 2

 UUID=a069e3d2-04c8-4576-a6d9-af0e06495985
 none
 swap
 defaults
 swap defaults ext4 defaults 0 0 defaults 0 0 [graid@graid-demo ~]\$ sudo graidctl update mount\_dependency vUpdate mount dependency successfully. vUpdate mount dependency Added mount point: /mnt/auto\_mount successfully.

6. Remove the mount dependency.





•••				
[graid@graid-demo ~]\$ sudo cat /etc/fstab				
<pre># # /etc/fstab # Created by anaconda on Mon Nov 15 04:51:50 2021 # # Accessible filesystems, by reference, are maintained under '/dev/d' # See man pages fstab(5), findfs(8), mount(8) and/or blkid(8) for mou # # After editing this file, run 'systemctl daemon-reload' to update sy # units generated from this file. #</pre>	isk∕'. re info. ystemd			
UUID=6828ce26-088e-4d72-ae95-89b68b3fd17d / xfs	s defaults	0 0		
UUID=1c807345-02fd-49b0-a4ee-444d5beca6c9 /boot xfs	s defaults	0 0		
UUID=7520-A102 /boot/efi vfat umask=0077,shortname=winnt 0 2				
UUID=a069e3d2-04c8-4576-a6d9-af0e06495985 none swa	ap defaults	0 0		
<pre>#UUID=b7aa98b4-d8b7-4123-bbee-e3d0752de973 /mnt/auto_mount [graid@graid-demo ~]\$ sudo graidctl update mount_dependency /Update mount dependency successfully. /Update mount dependency Removed mount point: /mnt/auto_mount succes</pre>	ext4 defaults ssfully.	0 0		

#### Note

To disable the automount point or delete the virtual drive, edit the /etc/fstab file and delete/comment that entry.

Then, execute update mount\_dependency to unmount the virtual drive.



# **Enabling Virtual Machines with GPU Passthrough**

You can create virtual machines with GRAID SupremeRAID™ support to maximize performance.

#### Hypervisor support:

• VMWare ESXi 7.0U3

Configuring Hosts for NVIDIA GPU Device Passthrough

#### Put the ESXi host into maintenance mode

1. From the **Navigator** menu, select **Host** > **Enter maintenance mode**.

Carigator		twice.office.gra
▼		
Manage	🗐 Host	
Monitor	1 Create/Regis	ster VM
	o Shut down	
	💽 Reboot	
	💼 Services	•
	🛃 Enter mainte	nance mode
	Locke Put th	is host into maintenan
	Permissions	
and the second se	🛟 Generate su	oport bundle
	SSH Consol	e


#### Manage PCI Device Passthrough

- 1. From the **Navigator** menu, select **Manage** > **Hardware** > **PCI Devices**. The **Passthrough Configuration** page appears listing all of the available pass-through devices.
- 2. Select the NVIDIA T1000 (Quadro T1000 Mobile) and its audio device.
- 3. Click Toggle passthrough.
- 4. Check the Passthrough status. It should be Active.

System Hardware	Licensing	Packages	Services Security & users			
PCI Devices	<b>\$</b>	Toggle passthrough	🥒 Configure SR-IOV 🧳 Hardware label 🛛 👔 Reboot host 🕴 😋 Refresh		QS	earch
Power Management		Address 🗸	Description	, SR-IOV 🗸	Passthrough 🗸	Hardware Label $\checkmark$
		0000:40:03.1	Advanced Micro Devices, Inc. [AMD] Starship/Matisse GPP Bridge	Not capable	Not capable	
0000:42:00.1		0000:42:00.1	nVidia Corporation Audio device	Not capable	Active	
		0000:42:00.0	NVIDIA Corporation TU117GLM [Quadro T1000 Mobile]	Not capable	Active	
		0000:40:04.0	Advanced Micro Devices, Inc. [AMD] Starship/Matisse PCIe Dummy Host Bridge	Not capable	Not capable	
		0000:40:05.0	Advanced Micro Devices, Inc. [AMD] Starship/Matisse PCIe Dummy Host Bridge	Not capable	Not capable	
		0000:40:07.0	Advanced Micro Devices, Inc. [AMD] Starship/Matisse PCIe Dummy Host Bridge	Not capable	Not capable	
		0000:40:07.1	Advanced Micro Devices, Inc. [AMD] Starship/Matisse Internal PCIe GPP Bridg	Not capable	Not capable	
						123 items

# **Configuring Virtual Machines**

#### Attach PCI devices to the virtual machine.

- 1. From the Edit VM setting page, choose Virtual Hardware > Add other device > PCI device.
- 2. Choose Quadro T1000 and its Audio device as the two PCI devices.

PCI device 1	TU117GLM [Quadro T1000 Mobile] - 0000:42:00.0	~	8
PCI device 2	<class> Audio device - 0000:42:00.1</class>	~	8

#### Note:

When the T1000 PCI device is assigned to the virtual machine, you must set the memory reservation to accomodate the fully configured memory size.

- 3. Choose Virtual Hardware > Memory.
- 4. Check Reserve all guest memory (All locked).



Virtual Hardware VM Options	
🔜 Add hard disk 🛛 🎫 Add network ad	lapter 🛛 🔚 Add other device
▶ 🛄 CPU	8 ~ 1
- Memory	
RAM	16 GB ~
Reservation	16384 ~ MB ~
	Reserve all guest memory (All locked)

# Enabling Point-to-Point (P2P) on the Virtual Machine for Best Performance

1. From the Edit VM setting page, choose VM Options > Advanced > Configuration Parameters > Edit Configuration....

Virtual Hardware VM Options	
<ul> <li>General Options</li> </ul>	VM Name: tiff-Ubuntu
VMware Remote Console Options	Lock the guest operating system when the last remote user disconnects
▶ VMware Tools	Expand for VMware Tools settings
Power management	Expand for power management settings
<ul> <li>Boot Options</li> </ul>	Expand for boot options
- Advanced	
Settings	Disable acceleration
	C Enable logging
Debugging and statistics	Run normally ~
Swap file location	<ul> <li>Default         Use the settings of the cluster or host containing the virtual machine.</li> <li>Virtual machine directory         Store the swap file in the same directory as the virtual machine.</li> <li>Datastore specified by host         Store the swap files in the datastore specified by the host to be used for swap files. If not         possible, store the swap files in the same directory as the virtual machine. Using a datastore         that is not visible to both hosts during vMotion might affect the vMotion performance for the         affected virtual machines.</li> </ul>
Configuration Parameters	Edit Configuration

2. Add the following two parameters:



hypervisor.cpuid.v0 = "FALSE"
pciPassthru.allowP2P = "TRUE"

3. From the Edit VM setting page, choose VM Options > Boot Options > Firmware > EFI.

4. Uncheck Whether or not to enable UEFI secure boot for this VM.

Virtual Hardware VM Options	
<ul> <li>General Options</li> </ul>	VM Name: GRAID
VMware Remote Console Options	Lock the guest operating system when the last remote user disconnects
▶ VMware Tools	Expand for VMware Tools settings
Power management	Expand for power management settings
- Boot Options	
Firmware	Choose which firmware should be used to boot the virtual machine:
Enable UEFI secure boot	Whether or not to enable UEFI secure boot for this VM k UEFI secure boot
Boot Delay	Whenever the virtual machine is powered on or reset, delay boot by           0         Image: Comparison of the second s
Force BIOS setup	The next time the virtual machine boots, force entry into the BIOS setup screen.
Failed Boot Recovery	When the virtual machine fails to find a boot device, automatically retry boot after
► Advanced	Expand for advanced settings
Fiber Channel NPIV	Expand for fiber channel NPIV



# Setting Up a Self-Encrypting Drive (SED)

A SED utilizes native full-disk encryption. GRAID SupremeRAID<sup>™</sup> supports SEDs and SED key management. When the SED key is configured, GRAID SupremeRAID<sup>™</sup> uses the imported key to unlock the SED.

#### Note:

You must configure the SED key using the graidctl tool before creating the physical drives.

#### **Prerequisites**

- Collect the NQN/WWID of the NVMe disks. (They are required to import the SED key.)
- Prepare the SED key for each disk.

#### Limitations

- Only NVMe devices are supported.
- Only the "global" range parameter is supported.

# Importing a Single SED Key using NQN/WWID

\$ sudo graidctl edit config sed <NQN/WWID>

# •••

graid@graid:~\$ sudo graidctl edit config sed nqn.2014-08.org.nvmexpress:uuid:52bbdb40-c5bf-f92d-9961-a6368e845bfd
Enter Key:

Edit config sed successfully.

# Importing a Batched SED Key using NQN/WWID

```
$ sudo graidctl edit config sed file <filename>
file content format:
<NQN1/WWID1>, <KEY1>
<NQN1/WWID1>, <KEY2>
...
<NQNn/WWIDn>, <KEYn>
```

# **Displaying SED Key Information**

\$ sudo graidctl describe config sed

. . .

graid@graid:~\$ sudo graidctl describe config sed Totally 1 GUIDs have SED key: nqn.2014-08.org.nvmexpress:uuid:52bbdb40-c5bf-f92d-9961-a6368e845bfd



# **Deleting SED Keys**

\$ graidctl delete config sed <GUID>

graid@graid:~\$ sudo graidctl delete config sed nqn.2014-08.org.nvmexpress:uuid:52bbdb40-c5bf-f92d-9961a6368e845bfd ✓ Delete config sed successfully.

To delete all keys:

\$ graidctl delete config sed all

#### •••

graid@graid:~\$ sudo graidctl delete config sed all
Do you really want to delete all SED key?
Repeat IMEANTODELETEALL to continue: IMEANTODELETEALL
✓ Delete config sed successfully.



# **Setting Boot-Drive Devices**

You can set two NVMe SSDs as RAID1 boot devices and control them using GRAID SupremeRAID<sup>™</sup>. The methods used to set NVMe SSDs as RAID1 boot devices depend upon the operating system in use.

#### **Prerequisites**

• Two NVMe SSDs to set as RAID1 boot devices.

#### Limitation

• Installation on multiple operating systems is not supported.

#### Setup by Operating System

#### CentOS

#### Assigning RAID1 Boot Devices Manually

You assign RAID1 boot devices when you install CentOS. If you are not prompted by the CentOS GUI to assign the boot devices, you can assign them manually.

To manually assign the RAID 1 boot devices:

#### 1. From the INSTALLATION SUMMARY page, choose SYSTEM > Installation Destination.





2. From the INSTALLATION DESTINATION page, select the two NVMe SSDs that you want to set as RAID1 boot devices.

Tip: Use the "Ctrl" key to select multiple devices.

INSTALLATION DESTINATION Done	CENTOS LINUX 8 INSTALLATION
Device Selection	
Select the device(s) you'd like to install to. They will be left untouch	ed until you click on the main menu's "Begin Installation" button.
Local Standard Disks	
10 GiB	10 GiB
	<b></b>
re Virtual NVMe Disk i.6b4f27116183325d000c296a891bb4a3 nvme0n1 / 10 GiB free	VMware Virtual NVMe Disk i.1c65d3900abf288f000c296788e2902a nvme0n2 / 10 GiB free
	Disks left unselected here will not be touched.
Specialized & Network Disks	
Add a disk	
	Disks left unselected here will not be touched.
Storage Configuration	
Automatic     Custom	
Encontion	
Encrypt my data. You'll set a passphrase next.	
Full disk summary and boot loader	2 disks selected; 20 GiB capacity; 20 GiB free Refresh

- 3. Choose **Custom** for the **Storage Configuration**.
- 4. Click **Done** to continue.



INSTALLATION DESTINATION				CENTOS	INUX 8 INSTALLATION
Done				🕮 us	Help!
Device Selection					
Select the device(s) you'd like t	o install to.	They will be left untouched unti	l you click on the main menu's "I	Begin Install	ation" button.
Local Standard Disks					
	10 GiB			10 GiB	
VMware Virtual NVMe Disk i	.6b4f27116	5183325d000c296a891bb4a3	VMware Virtual NVMe Disk	i.1c65d390	0abf288f000c296788
nvme0n1	1	10 GiB free	nvme0n2	/	10 GiB free
Consisting of P. Naturada Disks			Dis	ks left unselect	ted here will not be touched.
Specialized & Network Disks					
Add a disk					
			Disi	ks left unselect	ted here will not be touched.
Storage Configuration	-				
Automatic     Ocustom					

# **Creating Storage Partitions Manually**

You manually create the storage partitions on CentOS systems.

To manually create partitions:

- 1. From the MANUAL PARTITIONING page, choose New CentOS Linux 8 Installation.
- 2. Click Click here to create them automatically to create the mount points.





MANUAL PARTITIONING Done	CENTOS LINUX 8 INSTALLATION
+       -       C	When you create mount points for your CentOS Linux 8 installation, you'll be able to view their details here.

- 3. Set the Device Type to RAID and set the RAID LEVEL to RAID 1.
- 4. Click Update Settings.



MANUAL PARTITIONING			CENTOS LINUX 8 INSTALLATION
<pre> • New CentOS Linux 8 Installation SYSTEM / cl-root /boot/efi nvme0n1p1 /boot nvme0n1p2 swap cl-swap</pre>	16.41 GiB > 600 MiB 1024 MiB 2 GiB	cl-root Mount Point: / Desired Capacity: 16.41 GiB Device Type: RAID TIME Encrypt File System:	Device(s): VMware Virtual NVMe Disk I. 6b4f27116183325d000c296a891bb4a 3 (nvme0n1) and 1 other Modify RAID Level:
+ - C		xfs       Reformat         Label:       Note:         be ap       Description	Name: root Update Settings The settings you make on this screen will not oplied until you click on the main menu's 'Begin Installation' button.

#### Ubuntu Server 20.04

# **Creating and Configuring Storage Partitions**

Storage partitions must be created and configured during Ubuntu Server 20.04 installations. The partitions are required for mounting /boot, swap, and root/. Each partition functions as a soft RAID.

To create the storage partitions:

1. From the Guided storage configuration page, select Custom storage layout.



Guided storage configuration	[Help]
Configure a guided storage layout, or create a custom one:	
( ) Use an entire disk	
[ VMware Virtual NVMe Disk_VMware NVME_0000 local disk 10.000G ▼ ]	
[X] Set up this disk as an LVM group	
Passphrase:	
Confirm passphrase:	
( <u>Χ</u> ) Custom storage layout	

2. From the **Storage configuration** page, select the first disk as the boot disk.



Storage configuration			[Help]
To continue you need to: Mount a filesystem at /			
FILE SYSTEM SUMMARY			Â.
MOUNT POINT SIZE TYPE DEVICE TYPE [/boot/efi 512.000M new fat32 new partition of local dis	sk 🕨 ]		
AVAILABLE DEVICES			
DEVICE [ md2 (new) unused	TYPE software RAID 1	SIZE 20.481G ►	1
[ md1 (new) unused	software RAID 1	7.991G ►	1
[ md0 (new) unused	software RAID 1	1022.000M ►	1
[ VMware Virtual NVMe Disk_VMware NVME_0000 partition 1 new, unused	local disk	30.000G ► 512.000M ►	1
[ VMware Virtual NVMe Disk_VMware NVME_0001 unused	local disk	16.000G 🕨	1
[ VMware Virtual NVMe Disk_VMware NVME_0001 unused	local disk	16.000G 🕨	1
[ VMware Virtual NVMe Disk_VMware NVME_0001 unused	local disk	16.000G 🕨	1
[ VMware Virtual NVMe Disk_VMware NVME_0001 unused	local disk	16.000G 🕨	]
[ Create software RAID (md) ▶ ] [ Create volume group (LVM) ▶ ]			
USED DEVICES			
[ Done ] [ Reset ] [ Back ]			

- 3. From the second **Disk** menu, choose **Add GPT partition** > **Create a partition**.
- 4. Set the Size of the new partition. Use the same size as the boot disk so that the first and second partitions align.
- 5. For the Format, select [Leave unformatted].

#### Note:

# You must use [Leave unformatted].

DO NOT mount the partition. Setting RAID1 and mounting partitions on multiple drives (MD) occurs later in the process.

6. Select [Create] to create the storage partition.



Storage configu	uration				[ Help ]
	SIZE TYPE DEVICE T 512.000M new fat32 new part				
DEVICE [ VMware Virtua free space					
	Adding GPT partition to VM	ware Virtual NVMe Disk_V	/Mware NVME_0000	, ,	
	Size (max 29.998G): <mark>512M</mark>				
	Format: [ Leave	unformatted 🔻 ]			
	Mount: [/			•	
	ľ	<u>C</u> reate] Cancel]		•	
USED DEVICES					
DEVICE [ VMware Virtua partition 1					
	[ [ [	Done ] Reset ] Back ]			

# **Configuring the Boot Partitions**

This process configures the /boot, swap, and root/ partitions on both disks.

To configure the partitions:

1. From the Storage configuration page Disk menu, select Add GPT Partition.



Storage configuration			[ Help ]
To continue you need to: Mount a filesystem Select a boot disk	at /		
FILE SYSTEM SUMMARY			
AVAILABLE DEVICES			
DEVICE	TYPE	SIZE	
[ VMware Virtual NVMe Disk_VMware NVME_0000 unused	local disk	30.000G ► < (close) Info Reformat	•
[ VMware Virtual NVMe Disk_VMware NVME_0000 unused	local disk	30.000G  Add GPT Pa Format	artition •
[ VMware Virtual NVMe Disk_VMware NVME_0001 unused	local disk	16.000G ► Use As Boo	m RAID/LVM ot Device
[ VMware Virtual NVMe Disk_VMware NVME_0001 unused	local disk	16.000G ► ]	
[ VMware Virtual NVMe Disk_VMware NVME_0001 unused	local disk	16.000G ► ]	
[ VMware Virtual NVMe Disk_VMware NVME_0001 unused	local disk	16.000G ►]	
[ Create software RAID (md) ► ] [ Create volume group (LVM) ► ]			
USED DEVICES			

- 2. Set the Size of the partitions. Use 1G for /boot, the memory size for swap, and the remaining size for root/.
- 3. For the Format, select [Leave unformatted].



Stora	age configuration	[ Help ]
To co FILE MOU [/bo	ontinue you need to: Mount a filesystem at / SYSTEM SUMMARY UNT POINT SIZE TYPE DEVICE TYPE oot/efi 512.000M new fat32 new partition of local disk ▶]	
AVAI DE' [ VMu fre	LABLE DEVICES VICE TYPE SIZE ware Virtual NVMe Disk_VMware NVME_0000 local disk 30.000G e space 29.498G	
[ VMu par fre [ VMu unu [ VMu unu [ VMu unu [ VMu unu unu [ VMu unu unu [ VMu unu unu	ware Vi rtition ee spac ware Vi used ware Vi used Ware Vi used Ware Vi used Ware Vi used Ware Vi used Ware Vi used Wount: Leave unformatted Ware Vi used	
[Cre [Cre USED DE [VMI par	eate so eate volume group (LVM) ▶] DEVICES VICE TYPE SIZE ware Virtual NVMe Disk_VMware NVME_0000 local disk 30.000G ▶ rtition 1 new, primary ESP, to be formatted as fat32, mounted at /boot/efi 512.000M ▶ [Done ] [Reset ] [Back ]	

# Creating a Software RAID for Multiple Devices (MD)

To create the software RAID on multiple devices:

1. From the Storage configuration page, select Create software RAID (md).



Storage configuratio	n			[ Help	]
To continue you need	∣to: Mount a filesystem at /				
AVAILABLE DEVICES					
DEVICE [VMware Virtual NVM partition 2 new, partition 3 new, partition 4 new,	le Disk_VMware NVME_0000 unused unused unused		TYPE local disk	SIZE 30.000G ►] 1.000G ► 8.000G ► 20.498G ►	
[ VMware Virtual NVM partition 1 new, partition 2 new, partition 3 new, partition 4 new,	le Disk_VMware NVME_0000 unused unused unused unused		local disk	30.000G • ] 512.000M • 1.000G • 8.000G • 20.498G •	
[ VMware Virtual NVM unused	∣e Disk_VMware NVME_0001		local disk	16.000G ►]	1
[ VMware Virtual NVM unused	∣e Disk_VMware NVME_0001		local disk	16.000G ►]	1
[ VMware Virtual NV№ unused	le Disk_VMware NVME_0001		local disk	16.000G ►]	1
[ VMware Virtual NVM unused	le Disk_VMware NVME_0001		local disk	16.000G ►]	1
[ Create software Rf [ Create volume grou	ID (md) ▶ ] µp (LVM) ▶ ]				
USED DEVICES					
DEVICE [ VMware Virtual NVM partition 1 new,	e Disk_VMware NVME_0000 primary ESP, to be formatted	l as fat32, mounte	TYPE local disk d at ∕boot∕efi	SIZE 30.000G ►] 512.000M ►	
	[ Dor [ Res [ Bac	ne ] set ] sk ]			

# Setting MD as the Mounting Point

To set MD as the mounting point:

1. From the Storage configuration page Disk menu, set md0 as the /boot mounting point.



Storage config	uration			[Help]
	MMARY			
MOUNT POINT [ /	SIZE TYPE DEVICE T 9.991G new ext4 new soft			
	CES			
DEVICE [ VMware Virtu: unused				
[ VMware Vi	Form	nat and∕or mount mdO		
	Format: [ext4	• ]		
	Mount: [/boot	▼ ]		
		[ Done ] [ Cancel ]		
USED DEVICE				
DEVICE [ md0 (new) to be format			SIZE 9.991G ►]	
	al NVMe Disk_VMware NVME_0000 software RAID 1 md0			
	al NVMe Disk_VMware NVME_0000 software RAID 1 md0			
		[ Done ] [ Reset ] [ Back ]		

2. From the **Disk** menu, select **Add GPT Partition**, set md1 as the swap mounting point.





3. From the Disk menu, select Add GPT Partition, set md2 as the root / mounting point.





4. Click **Done** when you finish setting the mount points.



Storage configuration			[Help]	
[ VMware Virtual NVMe Disk_VMware NVME_0001 unused	local disk	16.000G	•]	
[ VMware Virtual NVMe Disk_VMware NVME_0001 unused	local disk	16.000G	• ]	
[ VMware Virtual NVMe Disk_VMware NVME_0001 unused	local disk	16.000G	• ]	
[ VMware Virtual NVMe Disk_VMware NVME_0001 unused	local disk	16.000G	• 1	
[ Create software RAID (md) ► ] [ Create volume group (LVM) ► ]				
USED DEVICES				
DEVICE [ md2 (new) partition 1 new, to be formatted as ext4, mounted at /	TYPE software RAID 1	SIZE 20.481G 20.477G	;1	
[ md1 (new) partition 1 new, to be formatted as swap	software RAID 1	7.991G 7.987G	<b>;</b> 1	
[ md0 (new) partition 1 new, to be formatted as ext4, mounted at /boot	software RAID 1	1022.000M 1018.000M	<b>;</b> 1	
[ VMware Virtual NVMe Disk_VMware NVME_0000 partition 1 new, primary ESP, to be formatted as fat32, mour partition 2 new, component of software RAID 1 md0 partition 3 new, component of software RAID 1 md1 partition 4 new, component of software RAID 1 md2	local disk ∩ted at ∕boot/efi	30.000G 512.000M 1.000G 8.000G 20.498G	• 1	
[ VMware Virtual NVMe Disk_VMware NVME_0000 partition 2 new, component of software RAID 1 md0 partition 3 new, component of software RAID 1 md1 partition 4 new, component of software RAID 1 md2	local disk	30.000G 1.000G 8.000G 20.498G	▶ ] ▶ ▶	
[ <u>D</u> one ] [ Reset ] [ Back ]				

5. From the Confirm destructive action  $\ensuremath{\mathsf{popup}}$  , select Continue.

The partition settings are now in effect.





Storage configu	uration		[Help]
			16.000G ►]
[ Create softwa [ Create vo			
	Confirm destructive	action ————	
USED DEVICE	Selecting Continue below will begin the result in the loss of data on the disks	installation process and selected to be formatted	d d.
DEVICE [ md2 (new) partition	You will not be able to return to this o installation has started.	r a previous screen onc	e the   ▶ ] ▶
	Are you sure you want to continue?		÷1
	[ No [ Continue	] ]	* 1 *
	new, primary ESP, to be formatted as fat32 new, component of software RAID 1 md0 new, component of software RAID 1 md1 new, component of software RAID 1 md2		► ] 512.000M ► 1.000G ► 8.000G ► 20.498G ►
	al NVMe Disk_VMware NVME_0000 new, component of software RAID 1 md0 new, component of software RAID 1 md1 new, component of software RAID 1 md2		30.000G ► ] 1.000G ► 8.000G ► 20.498G ►

# SLES 15 SP2, and SP3

When installing SLES 15 SP2 or SP3, you must manually create RAID1 and configure the partitions.

To manually create RAID1 and configure the partitions:

1. From the SUSE Suggested Partitioning page, select Expert Partitioner > Next.





2. From the SUSE Add menu, select Add > RAID.

or SUSE								
System Add Device Yiew RAID RAID Brand Burds Partition Cogical Volume Rains Subvolume B Bcache Devices Bitris wrme0n1p2 Timpis NFS	Device	Size 16.00 GiB 8.00 MiB 14.72 GiB 10.00 GiB 10.00 GiB 16.00 GiB 16.00 GiB 16.00 GiB	Enc	Type  Type Type	Label	Mount Point / /boot/grub2//386-pc /boot/grub2/x86_64-efi /opt /root /srv /tmp /usr/local /var swap		
Help Release Notes						Cancel	Back	Acc <u>e</u> pt

3. From the SUSE Add RAID page, select RAID 1 (Mirroring) for the RAID Type.



# SUSE 🔊

Add RAID /d	ev/ı	md0								
ACCC KAID /CC RAID Type O RAID 0 (Striping) O RAID 1 (Mirroring) O RAID 5 (Redundant St O RAID 6 (Dual Redunda O RAID 10 (Mirroring an Available Devices: Device Size /dev/nvme0n2 10.00 GiB /dev/nvme0n3 10.00 GiB /dev/nvme11 1600 GiB	riping) Int Stripin d Stripin Enc	Rajd Name (optional)         GRAID_BOOT_DEVICE         ing)         g)         Type         Spci 0x15ad VMware, IncVMware Disk         Spci 0x15ad VMware, IncVMware Disk		Selected De Device	vices: Size	Enc	Туре			
/dev/nwie1m1 16.00 GiB /dev/nvme1n3 16.00 GiB /dev/nvme1n4 16.00 GiB		© pic tot Isad VMware, IncVMware Disk ⓒ pic tot Sad VMware, IncVMware Disk ⓒ pic tot Sad VMware, IncVMware Disk ⓒ pic tot Isad VMware, IncVMware Disk	Add → Add All → ← Remove ← Remove All							Iop       Up       Down       Bottom
Total size: 84.00 GiB				Resulting si	ze: 0.00 B					
Help Release No	tes								Cancel	Back Next

- 4. From the Selected Devices list, choose two NVMe disks and click Add.
- 5. Click **Next** to continue with the installation.

GRE SUSE		
Add RAID /dev/md0		
RAID Type     Rajd Name (optional)       O RAID 0 (Striping)		
Available Devices:	Selected Devices:	
Device Size Enc Type	Device Size Enc Type	
/dev/nvme0n2 16.00 GiB S pci 0x15ad VMware, IncVMware Disk /dev/nvme0n3 16.00 GiB S pci 0x15ad VMware, IncVMware Disk	/dev/nvme1n1 10.00 GiB S Part of md0 /dev/nvme1n2 10.00 GiB S Part of md0	
	<u>A</u> dd →	Тор
	A <u>d</u> d All →	<u>U</u> p
	← R <u>e</u> move	D <u>o</u> wn
	Remoye All	Botto <u>m</u>
Total size: 32.00 GiB	Resulting size: 9.87 GiB	
Help Release Notes		<u>N</u> ext



#### Importing and Controlling MD Bootable NVMe RAIDs using SupremeRAID™

After installing the SupremeRAID<sup>™</sup> driver and the graidctl utility, SupremeRAID<sup>™</sup> can import and control an MD bootable NVMe RAID. This feature makes it easier to swap drives when a bootable drive malfunctions.

#### Importing an MD Bootable NVMe RAID

#### Note:

Only MD bootable NVMe RAID1 can be imported.

To import MD bootable NVMe RAID1 and control it using the GRAID driver:

\$ sudo graidctl import md\_drive <DEVICE\_PATH\_0> <DEVICE\_PATH\_1>

#### Output example:

•											
[graid@gı ✓ Import [graid@gı ✓ List p	raid ~]\$ md driv raid ~]\$ hysical	sudo gra e Import sudo gra drive suc	idctl impor MD drives / idctl ls pd cessfully.	t md_dr dev/nvm	ive /de e0n1 /c	ev/nvme0n1 /c dev/nvme1n1 :	ev/nvmelnl successfully.				
PD ID	DG ID	NQN/WWI	D					MODEL	CAPACITY	SLOT ID	STATE
32 33	4	nqn.2014 nqn.2014	4-08.org.nv 4-08.org.nv	nexpres nexpres	s:uuid: s:uuid:	527970f1-8f0 5218a65c-e25	f-27b3-fb2f-8462d3c8f972 9-6392-ff5c-35759b31b537	VMware Virtual NVMe Disk VMware Virtual NVMe Disk	27 GB 27 GB	N/A N/A	ONLINE ONLINE
[graid@gı ∕ List d	raid ~]\$ rive gro	sudo gra up succes	idctl ls dg sfully.								1
DG ID	MODE	VD NUM	CAPACITY	FREE	USED	STATE					
4	RAID1	3	27 GB	0 B	27 GB	OPTIMAL					
[graid@gı ⁄ List v	raid ~]\$ irtual d	sudo gra rive succ	 idctl ls vd essfully. 	ı——	·	-11					
VD ID	DG ID	SIZE	DEVICE PA	TH ST.	ATE						
0	4	11 GB	/dev/md12	7   0P	TIMAL						
2	4	5.4 GB	/dev/md12	6   OP	TIMAL						

#### Replacing an MD Bootable NVMe RAID1

#### Note:

Only MD bootable NVMe RAID1 can be replaced.

To replace an MD bootable NVMe RAID1:

1. Replace the old NVMe SSD with the new one. The old physical drive state should indicate **MISSING**.

\$ sudo graidctl replace md\_drive <OLD\_MD)PD\_ID> <NEW\_DEVICE\_PATH>

Output example MD missing:





[graid@grai ✔ List phy  ─── ──   PD ID   [	id ~]\$ sical c 	sudo grai drive suc	idctl ls pd								
PD ID [			cessfacty.				1				
	DG ID	NQN/WWID	D					MODEL	CAPACITY	SLOT ID	STATE
32 4 33 4	4	nqn.2014 nqn.2014	4-08.org.nvn 4-08.org.nvn	mexpres mexpres	s:uuid:5 s:uuid:5	27970f1-8f0 218a65c-e25	-27b3-fb2f-8462d3c8f972 -6392-ff5c-35759b31b537	VMware Virtual NVMe Disk VMware Virtual NVMe Disk	27 GB 27 GB	N/A N/A	ONLINE MISSING
[graid@grai ✔ List dri	id ~]\$ .ve grou	sudo grai up succes	idctl ls dg sfully.	1	ı	1			1		
DG ID M	MODE	VD NUM	CAPACITY	FREE	USED	STATE					
4 F	RAID1	3	27 GB	0 B	27 GB	DEGRADED					
graid@grai	id ~]\$ tual dr	sudo grai rive succ	 idctl ls vd essfully. 	ı——	ıı						
VD ID [	DG ID	SIZE	DEVICE PA	TH ST.	ATE						
0	4	11 GB	/dev/md12	7 DE	GRADED						
1 2	4	5.4 GB 5.4 GB	/dev/md125 /dev/md126	5   DE 6   DE	GRADED   GRADED						

# Output example replace drive:

PD ID	DG ID	NQN/WWI	D					MODEL	CAPACITY	SLOT ID	STATE
32 33	4	nqn.201 nqn.201	4-08.org.nvn 4-08.org.nvn	mexpres mexpres	s:uuid:5 s:uuid:5	27970f1-8f 2524729-5a	b3-fb2f-8462d3c8f972 e7-a316-f6e765e16ec8	VMware Virtual NVMe Disk   VMware Virtual NVMe Disk	27 GB 27 GB 27 GB	N/A N/A	ONLINE REBUILD
[graid@g ✔ List	graid ~]\$ drive gro	sudo gra	idctl ls dg sfully. 								
4	RAID1	3	   27 GB	0 B	27 GB	REBUILD					
∥────	-		idctl ls vd								

The bootable RAID group rebuilds immediately after replacing the drive.

# Dismissing an Imported MD Bootable NVMe RAID1

#### Note:

Only MD bootable NVMe RAID1 can be dismissed.

To dismiss an Imported MD Bootable NVMe RAID1:

\$ sudo graidctl delete dg <DG\_ID>

[graid@g ✔ List d	raid ~]\$ rive gro	sudo gra up succes	idctl ls dg sfully. '								
DG ID	MODE	VD NUM	CAPACITY	FREE	USED	STATE					
4	RAID1	3	27 GB	0 B	27 GB	OPTIMAL					
─── [graid@g ✔ Delete	 raid ~]\$ drive g	sudo gra roup succ	 idctl delet essfully.	 e dg 4							



# **Compatible NVMe Drives List**

The following NVMe drives passed GRAID qualification and can be used with GRAID SupremeRAID™.

GRAID updates this list when new NVMe drives pass the qualification process.

Manufacturer	Series	Interface	FormFactor
Dapustor	H3200	PCIe Gen3 x 4	2.5 inch U.2
Intel	DC P4510	PCIe Gen3 x 4	2.5 inch U.2
Intel	DC P4610	PCIe Gen3 x 4	2.5 inch U.2
Intel	D7-P5316	PCIe Gen4 x 4	2.5 inch U.2
Intel	D7-P5510	PCIe Gen4 x 4	2.5 inch U.2
Intel	Optane™ P5800X	PCIe Gen4 x 4	2.5 inch U.2
Kioxia	CD5	PCIe Gen3 x 4	2.5 inch U.2
Kioxia	CD6	PCIe Gen4 x 4	2.5 inch U.3
Kioxia	CM6	PCIe Gen4 x 4	2.5 inch U.3
Memblaze	P6536	PCIe Gen4 x 4	2.5 inch U.2
Micron	9300	PCIe Gen3 x 4	2.5 inch U.2
Micron	7300	PCIe Gen4 x 4	2.5 inch U.2
Micron	7400	PCIe Gen4 x 4	2.5 inch U.3
Netlist	N1951	PCIe Gen3 x 4	2.5 inch U.2
Samsung	PM963	PCIe Gen3 x 4	2.5 inch U.2
Samsung	PM983	PCIe Gen3 x 4	2.5 inch U.2
Samsung	РМ9АЗ	PCIe Gen4 x 4	2.5 inch U.2
Samsung	PM1733	PCIe Gen4 x 4	2.5 inch U.2
Western Digital Technologies	SN640	PCIe Gen3 x 4	2.5 inch U.2

For the latest information, see the Compatible NVMe Drives List on the GRAID website.