TECHNICAL WHITE PAPER

INTEL® VIRTUAL RAID ON CPU (VROC) FOR NVM EXPRESS® (NVME™) SSD RAID

Intel® Virtual RAID on CPU (Intel® VROC) provides enterprise RAID solutions on platforms that support Intel® Volume Management Device (Intel® VMD).

INTRODUCTION TO VROC

Intel® VROC software and drivers allow a user to create and manage bootable or data RAID on NVMe SSDs directly attached over PCIe to CPUs in supported Workstations. VROC does not recognize devices on PCIe slots connected to the PCH. VROC is available as an option starting with HP Workstations, Z8 G4, Z6 G4, and Z4 G4. All VROC options except pass-thru require an optional VROC Upgrade Key module be installed on the motherboard. HP systems support the following options:

1. Standard VROC Upgrade SKU: The Standard VROC upgrade key enables RAID 0, 1, & 10.
2. Premium VROC Upgrade SKU: The Premium VROC upgrade key enables RAID 0, 1, & 10 plus RAID 5 with write hole closure options of distributed partial parity logging (distributed among RAID members), or journaling disk (requires a Journaling disk in addition to RAID member drives).
3. Pass-thru mode: No Intel® VROC Upgrade Key installed in the platform. In this case the Intel VROC drivers are used in a pass-thru mode (non-RAID) instead of Microsoft inbox drivers. A user can start a 90-day trial of RAID functionality by creating a RAID using the Intel® RSTe GUI. Trial mode should only be used for evaluation.

Features:

• Each CPU has 3 Volume Management Device (VMD) controllers corresponding to separate PCIe root ports.

• Each VMD controller supports four PCIe x4 NVMe SSDs.

• Each CPU PCIe x16 slot consumes one VMD controller.

• Each CPU PCIe x8 slot consumes one half of a VMD controller that is shared with other slots.

• Each CPU PCIe x4 slot consumes one fourth of a VMD controller that is shared with other slots.

• Bootable RAID must have all NVMe SSDs connected on the same VMD controller.

• Data RAID may span across all VMD controllers.

• The maximum number of NVMe drives supported by VROC in RAID or pass-thru is 48, however the actual number of NVMe drives supported in a system depends on how many CPUs are installed and how many CPU PCIe slots are available.

• A single RAID volume can include up to 48 drives unless limited by the RAID type, number of CPUs, and number of available CPU PCIe slots.

• A maximum of 12 arrays can be created.

• A maximum of 2 RAID volumes can be created per Array.

• RAID 0, 1, and 10 are supported with a standard VROC upgrade key.

• RAID 0, 1, 5, and 10 are supported with a premium VROC upgrade key.

• The RAIDs have the following definition:

  – RAID 0 = Striped array with 2 disk minimum.

  – RAID 1 = Mirrored array with 2 disk minimum and 2 disk maximum.

  – RAID 5 = Striped with parity (3 disk minimum) with 3 write hole closure options.

    • No RAID Write Hole Closure (Default).

    • Distributed write hole closure: distributes recovery info among members.

    • Journaled write hole closure: requires an additional SSD to journal recovery information.

  – RAID 10 = mirror of striped disks with a 4 disk minimum and a 4 disk maximum. The data is striped across a two-disk array forming a RAID 0 component. Each of the drives in the RAID 0 array is mirrored to form a RAID 1 component.

• Supports multiple Z-Turbo Quad Pro Cards.

• Supports multiple Z-Turbo Dual Pro Cards.

• Supports multiple Intel Optane SSDs.

Not Supported:

• Hot Swap is not supported. Systems must be powered down to add or remove NVMe devices.

• HP Z4 G4 systems with I9 and I7 Core X processors and PCH with device ID 0xA2D2. The utility HWKeyCheckRSTeRS.efi available in the tools folder of the driver package posted on hp.com can be used to check the system for compatibility. If the utility reports "HEDT Kaby Lake platform detected, lpcDeviceId = 0xA2D2!", the system is not compatible with VROC.

• Dual port NVMe SSDs.

• Windows 7 is not tested or supported.

• Windows 8 is not tested or supported.

• All Legacy Option ROM Launch Policy.

HOW VROC SHOWS UP IN DEVICE MANAGER

Each NVMe SSD has an integrated controller and shows up as an individual controller under Storage controllers in device manager when VROC is not enabled. Each Intel® VMD Controller will manage up to four x4 NVMe SSDs. When VROC is enabled on a PCIe slot, the NVMe SSD's controllers will be hidden behind the Intel® VMD Controller assigned to the slot.

In the Device Manager image of Storage controllers shown below on the left, VROC is not enabled on any slot. Devices using the Microsoft inbox driver will show up as "Standard NVM Express Controller" unless a vendor specific device is installed. The storage controller name "Intel(R) NVMe Controller" comes from a vendor specific driver.

In the image on the right, all slots are VROC enabled except one x4 PCIe slot ("Intel(R) NVMe Controller") and one x16 PCIe slot ("Standard NVM Express Controller"). All other NVMe SSDs are now behind "Intel(R) Volume Management Device NVMe RAID Controller".
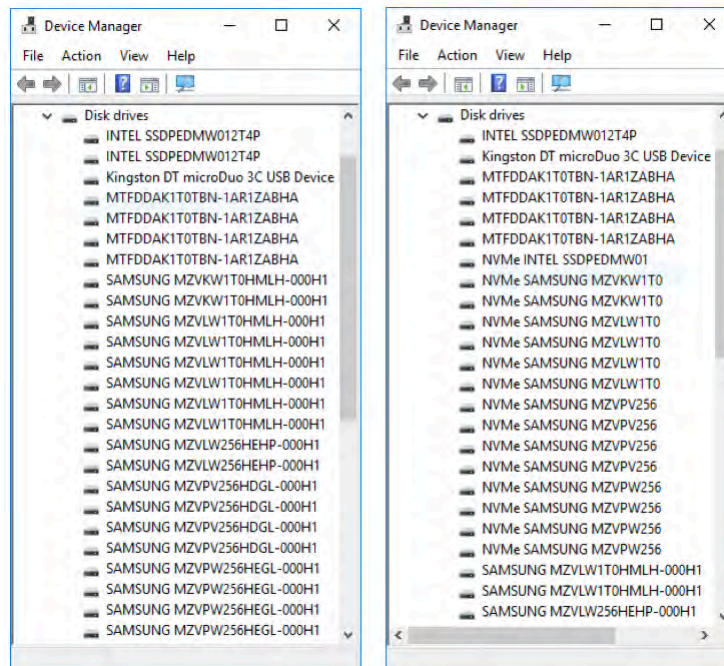
To see the NVMe SSDs under the VMD controllers, change the View in Device Manager to "Devices by Connection". Expand the "PCI Express Root Complex" entries and then expand the "Intel(R) Volume Management Device NVMe RAID Controller" Each VMD controller will show up to 4 SSDs attached.
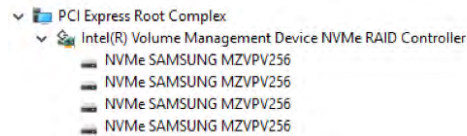
Disk names will also change when a NVMe SSD is managed by VROC. VROC will truncate the SSD manufacturer's string and insert NVMe in front. In the Device Manager images below, the left Image doesn't have any slots enabled for VROC. The image on the right has VROC enabled on most slots.
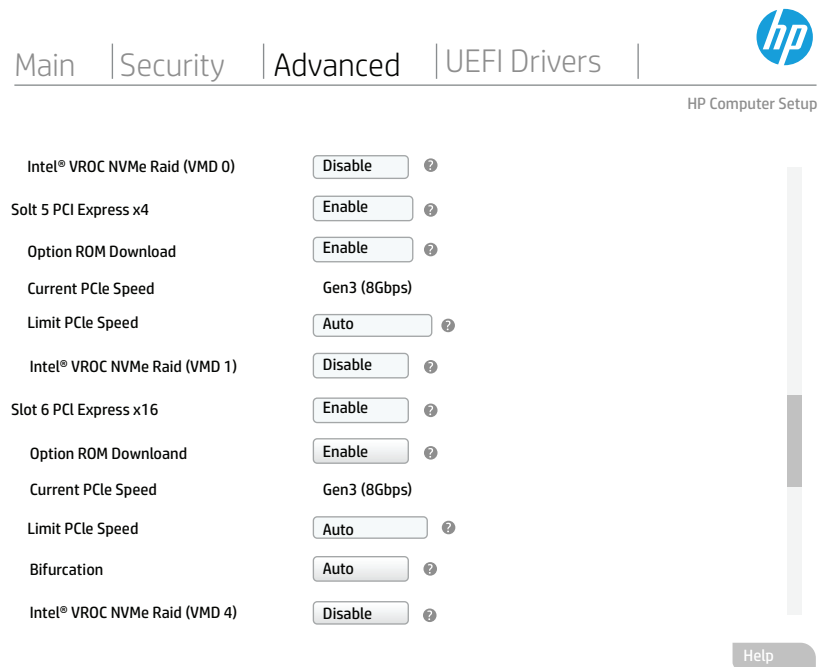
STORAGE ARCHITECTURE CONSIDERATIONS

Windows does not include drivers that support Intel® VROC. This may impact your decision on how initially install your OS.

- To install the OS on NVMe behind a VMD controller you will need to load the drivers manually at install time or inject the drivers using deployment tools.

- Windows does not gracefully handle changing drivers on boot devices. If you intend to use VROC for NVMe RAID in the future you should enable VROC on the slot containing the OS prior to installing the OS.

- Walking the OS across controllers is a technique that may allow you change from a Microsoft driver to the Intel® VROC drivers on the OS disk. This technique consists of installing an additional NVMe data disk in a VMD enabled slot. Then install the VROC drivers using the installer and reboot to verify that the drivers were installed on the NVMe data disk. Reboot the system to the "BIOS Setup (F10)" menu and enable VROC on the slot containing the OS. On reboot, the OS should find the VROC driver and boot properly.

- Bootable RAID member drives must be on a single VMD controller due to current limitations in the Windows OS. Slots with the same VMD controller can be combined in a bootable RAID. Data RAID may span across different VMD controllers. You can view VMD mapping to PCIe slots in "BIOS Setup (F10)" prior to installing drives.

  1. Enter "BIOS Setup (F10)".
  2. Select the "Advanced" tab.
  3. Select "Slot Settings".

Look for "Intel® VROC NVMe RAID (VMD n)" where "n" is the VMD controller number.

Main	Security	**Advanced**	UEFI Drivers	*hp*

HP Computer Setup

Intel® VROC NVMe Raid (VMD 0)	Disable
Solt 5 PCI Express x4	Enable
Option ROM Download	Enable
Current PCIe Speed	Gen3 (8Gbps)
Limit PCIe Speed	Auto
Intel® VROC NVMe Raid (VMD 1)	Disable
Slot 6 PCI Express x16	Enable
Option ROM Download	Enable
Current PCIe Speed	Gen3 (8Gbps)
Limit PCIe Speed	Auto
Bifurcation	Auto
Intel® VROC NVMe Raid (VMD 4)	Disable

Help

- Use of the same SSD model numbers for all RAID members is recommended. Using different model numbers may limit the capacity of the RAID, reduce RAID performance, or reduce RAID reliability. The exception is RAID 5 with the Journaling RAID Write Hole (RWH) closure mode. The Journaling disk can be smaller than RAID members, however Intel does not specify a minimum capacity requirement.

PREREQUISITES

A VROC Standard or Premium key module is required for RAID configurations.
A VROC license key module must be installed on the motherboard if you intend to use the RAID capability of VROC. See the side panel of your system for location of the VROC header.


NVMe devices must be connected to PCIe lanes from a CPU.
NVMe devices must be installed in CPU attached PCIe slots and/or in M.2 SSD connectors on systems that have M.2 SSD connectors on the motherboard.

PCIe lanes from the PCH do not support VROC. See the diagram on the inside of the workstations side panel, slot marking on the motherboard, or BIOS Slot Menu to identify CPU attached PCIe slots.

Option ROM Launch Policy must be set use UEFI.
Intel® VMD/VROC requires UEFI drivers. The Option ROM Launch Policy must be set to "All UEFI" or "All UEFI Except Video". The default configuration for HP systems is "Option ROM Launch Policy" set to "All UEFI". This is the recommended setting.
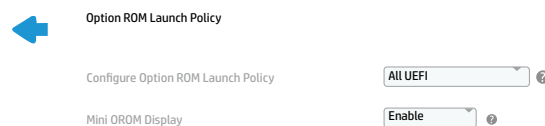
If you have changed "Secure Boot Configuration" to "Legacy Support Enabled and Secure Boot Disabled", you will need to change "Option ROM Launch Policy" from "All Legacy" to "All UEFI Except Video".
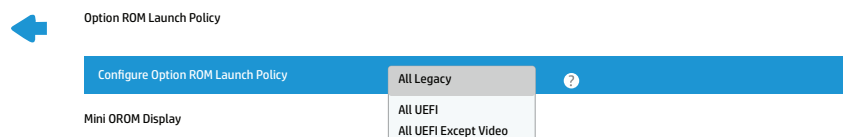
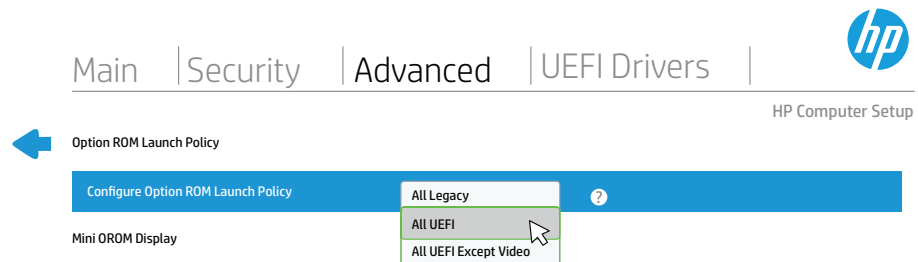A supported Operating Systems must be installed.
Windows 10
Linux (See the Linux VROC Driver package for the latest supported distributions.)

ENABLING VROC IN BIOS

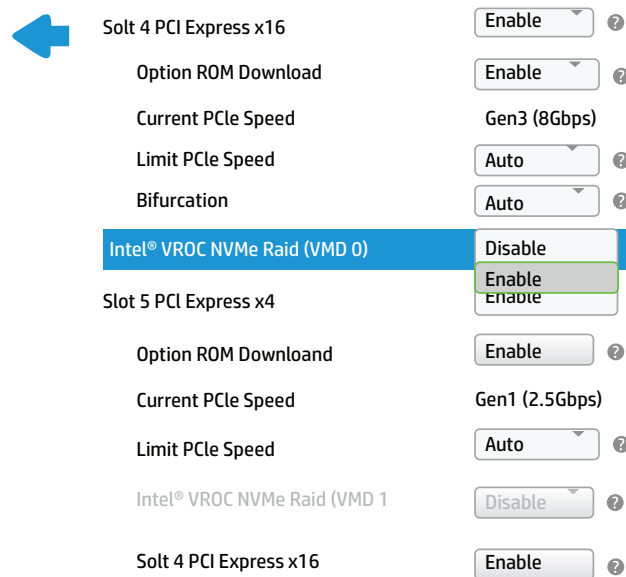**Verify Option ROM Launch Policy is set to UEFI.**
VROC uses UEFI drivers and is not supported in Legacy mode. Verify that the Option ROM Launch Policy in the "Advanced" tab of "BIOS Setup (F10)" is set to "All UEFI" or "All UEFI Except Video". If the Option ROM Launch Policy is set to "All Legacy" you will be able to enable VROC on the slots in BIOS, but the devices attached to those slots will not be visible to the OS.

You must save the changes and reboot for Option ROM Launch Policy changes to take place.

Main	Security	Advanced	UEFI Drivers	

HP Computer Setup

Option ROM Launch Policy

Configure Option ROM Launch Policy	All Legacy	?
	All UEFI	
Mini OROM Display	All UEFI Except Video	

Enable Intel® VROC NVM e RAID on PCIe Slots.
VROC is disabled by default to prevent VROC from being enabled on an empty slot and later having a device installed that will not function behind a VMD controller. BIOS will gray out the VROC enablement option and prevent VROC from being enabled on empty slots or slots containing unsupported devices. Graphic cards are an example of a device that will have the VROC enablement option grayed out and disabled. To enable VROC on a slot, go to the "Advanced" tab in "BIOS Setup (F10)" and select "Slot Settings". In the example below, Slot 4 has a valid device installed and VROC can be enabled. Slot 5 is grayed out because no NVMe device is installed. PCIe slots on the PCH do not support VROC and will not have an option to enable VROC.

Solt 4 PCI Express x16	Enable	?
Option ROM Download	Enable	?
Current PCle Speed	Gen3 (8Gbps)	
Limit PCle Speed	Auto	?
Bifurcation	Auto	?
Intel® VROC NVMe Raid (VMD 0)	Disable	?
	Enable	
Slot 5 PCI Express x4	Enable	
Option ROM Download	Enable	?
Current PCle Speed	Gen1 (2.5Gbps)	
Limit PCle Speed	Auto	?
Intel® VROC NVMe Raid (VMD 1	Disable	?
Solt 4 PCI Express x16	Enable	?

After VROC is enabled on all desired slots, press the "F10" key multiple times until you get to the "Exiting…" screen. Select "Save" to save the settings and reboot the system.

CONFIGURING VROC RAID IN BIOS

When navigating in BIOS, Right and Left arrows will switch between BIOS tabs. A selected tab will be in Black text while non-selected tabs will be Gray text. When a menu item is selected under a tab, the tab text will change to Gray. Up and Down arrows can be used to navigate between items in a menu. When an item is highlighted Blue, pressing enter will select the item. The mouse can also be used for navigation. Click on an item to select it. Clicking on the blue arrow ← on menu screens will take you back one level in the menu.

VIEW ALL INTEL® VMD CONTROLLERS

To view configure and manage VROC RAID in BIOS, enter "BIOS Setup (F10)", select the "UEFI Drivers" tab, and select "Intel(R) Virtual RAID on CPU". After a short delay a screen will appear showing the UEFI driver version, Upgrade key type, and RAID volumes currently in the system.

Note: RAID volumes may not get refreshed on this screen if you are navigating backward from the RAID creation screen after creating new RAID volumes. It may be necessary to back out to the "UEFI Drivers" tab and reselect "Intel(R) Virtual RAID on CPU".

Note: There may be a delay of up to 2 minutes for some actions in BIOS. The mouse and arrow keys will be unresponsive during this time.

Intel® VROCwith VMD Technology 5.4.0.1039
Upgrade Key : Premium

Intel VROC Managed Volumes

➡ MyRAID1, RAID1 (Mirror), 226.54GB, Nomal ❓

➡ MyRAID10, RAID10 (RAID0+1), 1800.00GB, Nomal ❓

➡ RAID5 JournSpan, RAID5 (Parity), 4000.00GB Initialize ❓

➡ MyRAID1, RAID (Stripe), 600.00GB, Nomal ❓

Intel® VROC Managed Controllers

➡ All Intel VMD Controllers ❓

If "All Intel VMD Controllers" is not already displayed as blue text, use arrow keys to navigate down to "All Intel VMD Controllers" and press enter to select. There will be a delay while drives in the system are being enumerated. It may take 2 minutes for the driver to discover all devices on a full system. The mouse and arrow keys will be unresponsive during this time.

From the "All Intel VME Controllers" screen you can:

1. Go to the RAID creation screen by selecting "Create RAID Volume".

2. Select a RAID Volume and view the RAID Volume's properties, where you can delete the RAID volume or change some properties depending on the RAID type.
   Note: "RAID volumes:" will not show unless RAID volumes already exist on the system.

3. Scroll through the list Non-RAID drives in your system and see where they are connected.

4. Select a disk to get more information on the disk and "Mark as Spare" or "Mark as Journaling Drive" for RAID 5.
   Note: The "Mark as Spare" and "Mark as Journaling Drive" options are not available on the "Create RAID Volume" screen so disk marking should be done prior to RAID creation. The Journaling option is not supported on Linux platforms.

Note: The VMD numbers shown on this screen will not match the VMD numbers shown in the "BIOS Setup (F10)" "Advanced" tab "Slot Settings". This is due to the way Intel enumerates the drives and assigns VMD controller numbers.

Drives are sorted by CPU, VMD#, and Port (group of 4 PCIe lanes). The system PCIe slot number corresponding to Port is shown following the Port.

Port 1:3, Slot 3, CPU1, VMD0, BDF 04:00.0

SAMSUNG MZVPW256HEGL-000H1 SN:S34ENY0J302995, 238.47GB

Port 2:0, Slot 6, CPU1, VMD1, BDF 01:00.0

SAMSUNG MZVPW256HEGL-000H1 SN:S34ENY0J302987, 238.47GB

Port 2:1, Slot 6, CPU1, VMD1, BDF 02:00.0

SAMSUNG MZVPW256HEGL-000H1 SN:S34ENY0J302985, 238.47GB

Port 2:2, Slot 6, CPU1, VMD1, BDF 03:00.0

SAMSUNG MZVPW256HEGL-000H1 SN:S34ENY0J302984, 238.47GB

Port 2:3, Slot 6, CPU1, VMD1, BDF 04:00.0

INTEL SSDPEL1D380GA SN:FUKM8083000Q380A, 353.98GB

Port 3:0, Slot 9, CPU1, VMD2, BDF 01:00.0

INTEL SSDPEL1D380GA SN:FUKM8083000J380A, 353.98GB

Port 3:1, Slot 9, CPU1, VMD2, BDF 02:00.0

SAMSUNG MZVKW1T0HMLH-000H1 SN:S34DNYAH500106, 953.87GB

Port 3:2, Slot 1, CPU1, VMD2, BDF 03:00.0

SAMSUNG MZVKW1T0HMLH-000H1 SN:S34DNYAH500125, 953.87GB

Port 3:3, Slot 1, CPU1, VMD2, BDF 04:00.0
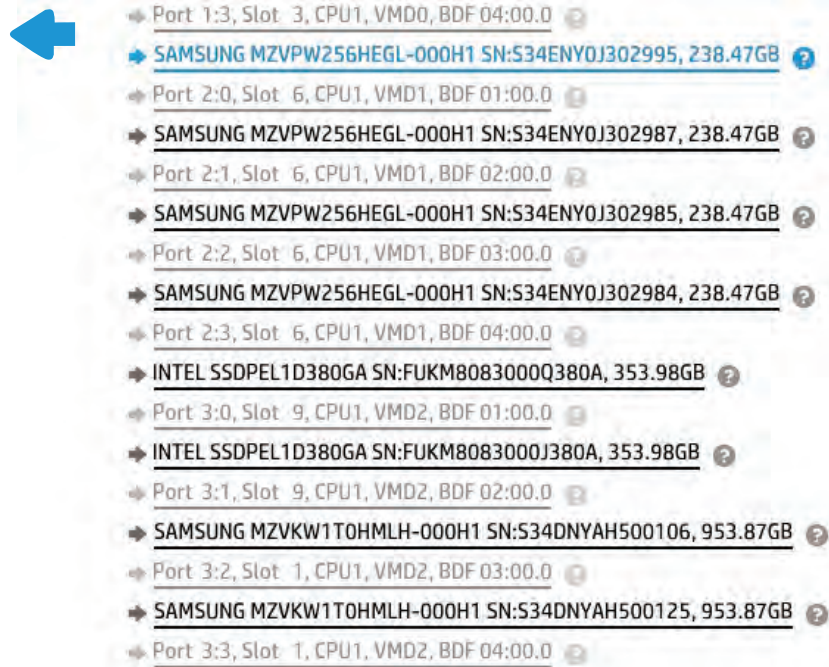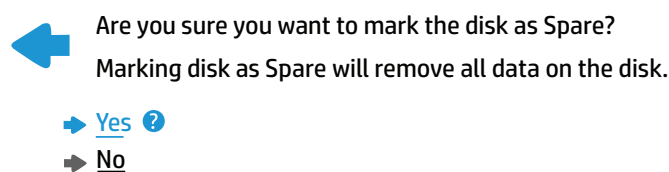
MARK DRIVES AS SPARE

If an impending disk failure condition is detected by Intel® VROC and a compatible spare disk is available, VROC can rebuild the array using the spare disk. All RAID configuration rules still apply to spare drives, for example boot RAID cannot span VMD controllers, so a spare for a boot RAID must be on the same VMD controller as the original boot RAID.

To "Mark as Spare", click on a disk in the list. When the "Disk Actions" screen appears, click "Mark as Spare"

SAMSUNG MZVPV256HDGL-000H1 SN:S27GNYAG702645,238.47GB

Disk Actions:

➡ Mark as Spare

➡ Mark as Journaling Drive

You will be prompted to confirm marking the disk as spare.

Mark as Spare

Are you sure you want to mark the disk as Spare?

Marking disk as Spare will remove all data on the disk.

➡ Yes

➡ No

Select Yes and you will be returned to the disk list.

If you select the disk again, you will see that the "Status" is "Spare".

You can navigate back to the "All VMD Controllers" menu to mark additional drives as spare, mark a Journaling drive, or create a RAID. If you have finished RAID configuration you can reboot the system. There is no need to save BIOS settings unless you have also made BIOS changes in this BIOS setup session.

MARK JOURNALING DRIVE (ONLY FOR JOURNALING RAID 5 WRITE HOLE CLOSURE)

RAID 5 Write Hole (RWH) is a potential condition that can occur when power loss is encountered during the time that RAID stripes are being written. A journaling SSD can be used with RAID 5 to preserve the Partial Parity and reduce the potential for data loss.

Note: Linux does not support RWH closure using a journaling drive. RAID 5 shared between Windows and Linux should not use the Journaling option.

To "Mark as Journaling Drive", click on a disk in the list. When the "Disk Actions" screen appears, click "Mark as Journaling Drive".

Disk Actions:
→ Mark as Spare ❔
➡ Mark as Journaling Drive ❔

Controller:	Volume, Management Device Controller
Model Number:	SAMSUNG MZVPV256HDGL-000H1
Serial Number:	S34ENYOJ302984
Size:	238.47GB
Status:	NON-RAID

You will be prompted to confirm marking the disk as a Journaling Drive.

Mark as Journaling Drive

Are you sure you want to mark the disk as Journaling Drive?

Marking disk as Journaling Drive will remove all data on the disk.

→ Yes ❔
→ No

Select Yes and you will be returned to the disk list. If you select the disk again, you will see that the "Status" is "Journaling Drive".

SAMSUNG MZVPV256HDGL-000H1 SN:S27GNYAG702645,238.47GB

Disk Actions:

➡ Reset to non-RAID ❓

Controller:	Volume, Management Device Controller
Model Number:	SAMSUNG MZVPV256HDGL-000H1
Serial Number:	S34ENYOJ302984
Size:	238.47GB
Status:	Journaling Drive

You can navigate back to the "All VMD Controllers" menu to mark additional disks as spare, mark a Journaling drive, or create a RAID. If you have finished RAID configuration you can reboot the system. There is no need to save BIOS settings unless you have also made BIOS changes in this BIOS setup session.

CONFIGURING RAID USING THE UEFI DRIVER INTERFACE IN BIOS

To configure VROC RAID in BIOS, enter "BIOS Setup (F10)", select the "UEFI Drivers" tab, and select "Intel® Virtual RAID on CPU". After a short delay a screen will appear showing the UEFI driver version, Upgrade key type, and RAID volumes in the system.

Note: There may be a delay of up to 2 minutes for some actions in BIOS. The mouse and arrow keys will be unresponsive during this time.

Intel® VROCwith VMD Technology 5.4.0.1039
Upgrade Key : Premium

Intel VROC Managed Volumes

➡ MyRAID1, RAID1 (Mirror), 226.54GB, Nomal ❓

➡ MyRAID10, RAID10 (RAID0+1), 1800.00GB, Nomal ❓

➡ RAID5 JournSpan, RAID5 (Parity), 4000.00GB Initialize

➡ MyRAID1, RAID (Stripe), 600.00GB, Nomal ❓

Intel® VROC Managed Controllers
➡ All Intel VMD Controllers ❓

If "All Intel VMD Controllers" is not already displayed as blue text, use arrow keys to navigate down to "All Intel VMD Controllers" and press enter to select. There will be a delay while disks in the system are being enumerated. It may take 2 minutes for the driver to discover all devices on a full system. The mouse and arrow keys will be unresponsive during this time.

RAID 1 EXAMPLE:

On the "All Intel VMD Controllers" screen, select "Create RAID Volume".

On the "Create RAID Volume" screen, "Name:" should be highlighted in Blue

Name	Volume0

Press enter and backspace to remove the existing name and type a new name.

Name	My RAID1
Type String [ESC = Cancel, ENTER = Accept]	
RAID Level:	RAID0(Stripe)

Press enter to accept the name and use the down arrow to advance to "RAID Level:"

Name: My RAID1

RAID Level:	RAID0(Stripe)

Press enter and use the down arrow to highlight the desired RAID type.

Name:

RAID Level:	RAID0(Stripe)
	RAID01(Mirror)
Enable RAID spanned overVMD Controllers	RAID05(Parity)
	RAID010(RAID0+1)

Press enter to select the highlighted RAID level.

RAID Level:	RAID1(Mirror)

If you are creating a data RAID that needs to span multiple VMD controllers, use the down arrow to highlight "Enable RAID spanned over VMD Controllers:" and press enter.

Note: The OS cannot be installed on a Spanned RAID.

CONTENTS & NAVIGATION

Enable RAID spanned over VMD Controllers:

X

Press the down arrow to highlight the "X".

Enable RAID spanned over VMD Controllers:

X

Press enter to select the "X".

Enable RAID spanned over VMD Controllers: X

Use the down arrow to navigate to the first disk you would like to include in the RAID.

Note: Disks previously marked as Spare or Journaling Drive are grayed out and not available for inclusion in the RAID.

SAMSUNG MZVPV256HDGL-000H1 SN:S27GNYAG603061, 238.47GB Port 1:0 CPU0 VMD0

SAMSUNG MZVPV256HDGL-000H1 SN:S27GNYAG603061, 238.47GB Port 1:1 CPU0 VMD0

SAMSUNG MZVPV256HDGL-000H1 SN:S27GNYAG602674, 238.47GB Port 1:2 CPU0 VMD0

SAMSUNG MZVPV256HDGL-000H1 SN:S27GNYAG602645, 238.47GB Port 1:3 CPU0 VMD0

INTEL SSDPEDMW012T4P SN:CVCQ5162004P1P2BGN,1117.81GB Port 2:0 CPU0 VMD1

Press enter to expose the pull-down options.

SAMSUNG MZVPV256HDGL-000H1 SN:S27GNYAG603061, 238.47GB Port 1:0 CPU0 VMD0

X

SAMSUNG MZVPV256HDGL-000H1 SN:S27GNYAG603061, 238.47GB Port 1:1 CPU0 VMD0

Press the down arrow key to highlight the "X".

SAMSUNG MZVPV256HDGL-000H1 SN:S27GNYAG603061, 238.47GB Port 1:0 CPU0 VMD0 ?

X

SAMSUNG MZVPV256HDGL-000H1 SN:S27GNYAG603061, 238.47GB Port 1:1 CPU0 VMD0 ?

Press enter to select the "X".

SAMSUNG MZVPV256HDGL-000H1 SN:S27GNYAG603061, 238.47GB Port 1:0 CPU0 VMD0 ?

X

SAMSUNG MZVPV256HDGL-000H1 SN:S27GNYAG603068, 238.47GB Port 1:1 CPU0 VMD0 ?

Continue selecting disks following the above steps until all desired RAID members have been selected.

SAMSUNG MZVPV256HDGL-000H1 SN:S27GNYAG603061, 238.47GB Port 1:0 CPU0 VMD0 ?

X

SAMSUNG MZVPV256HDGL-000H1 SN:S27GNYAG603068, 238.47GB Port 1:1 CPU0 VMD0 ?

X

SAMSUNG MZVPV256HDGL-000H1 SN:S27GNYAG602674, 238.47GB Port 1:2 CPU0 VMD0 ?

SAMSUNG MZVPV256HDGL-000H1 SN:S27GNYAG602645, 238.47GB Port 1:3 CPU0 VMD0 ?

INTEL SSDPEDMW012T4P SN:CVCQ5162004P1P2BGN,1117.81GB Port 2:0 CPU0 VMD1 ?

Note: The above disks were selected while "Enable RAID spanned over VMD Controllers:" was selected. When spanning is not enabled, disks will be grayed out if they are not on the same VMD controller as the first disk selected.

Use arrow keys to scroll down to the bottom of the disk list. If you want to reduce the size of the RAID for overprovisioning, you can stop when the "Capacity (GB):" line is highlighted and press enter to change the capacity.

Capacity   226.54

When you are satisfied with the RAID settings, use the down arrow to highlight ➔ Create Volume ? and press enter to create the volume.
Note: If you have selected disks from multiple VMD controllers you will receive a message asking you to confirm creation because spanned volumes cannot be used for boot.
When the RAID volume has been created you will be returned to the top of the "All Intel VMD Controllers" where you will see your newly created RAID volume.

⬅ All Intel VMD Controllers

➡ Create Volume ❓

RAID Volumes
➡ MyRAID1, RAID1 (Mirror), 226.54GB, Nomal ❓
➡ MyRAID10, RAID10 (RAID0+1), 1800.00GB, Nomal ❓
➡ RAID5 JournSpan, RAID5 (Parity), 4000.00GB Initialize ❓
➡ MyRAID1, RAID (Stripe), 600.00GB, Nomal ❓

Non-RAID Physical Disks
➡ SAMSUNG MZVPV256HDGL-000H1 SN:S27GNYAG702674,238,47GB ❓
➡ Port 1:2, Slot 4, CPU0, VMD0,BDF 03:00,0 ❓
➡ SAMSUNG MZVPV256HDGL-000H1 SN:S27GNYAG702645,238,47GB ❓
➡ Port 1:3, Slot 4, CPU0, VMD0,BDF 04:00,0 ❓
➡ SAMSUNG MZVPV256HDGL-000H1 SN:S340NX0J213614,238,47GB ❓

RAID 0 EXAMPLE:

The process of creating RAID 0; specifying a volume name, selecting the RAID level, specifying spanning and selecting disks is the same as it is for other RAID volumes.

When you are finished selecting disks, use the arrow keys to scroll down to highlight "Strip Size:"

Note: 128KB is the default recommended strip size for RAID 0 and should only be changed if your applications work better with a different strip size.

Strip Size	128KB ▾	❓

Capacity (GB):   679.65

➡ Create Volume ❓

Press enter to show the options.

4KB
8KB
16KB
32KB
64KB
128KB

SAMSUNG MZVPV256HDGL-000H1 SN:S27GN...8.47GB

▾

Strip Size	❓

Capacity (GB):   679.65

➡ Create Volume ❓

➡ Create Volume ❓

Use up and down arrows to highlight the desired strip size and press enter to select.

Strip Size	64KB ▼
Capacity (GB):	679.65

➡ **Create Volume**

Press the down arrow to advance to "Capacity (GB):"

Strip Size	64KB ▼
Capacity (GB):	**679.65**

➡ **Create Volume**

Press enter to edit the capacity.

Strip Size	64KB ▼
Capacity (GB):	**600**
Type String [ESC = Cancel, ENTER 0 Accept]	

➡ **Create Volume**

Press enter to accept the capacity.

Strip Size	64KB ▼
Capacity (GB):	**600**

➡ **Create Volume**

When you are satisfied with the RAID settings, use the down arrow to highlight ➡ Create Volume and press enter to create the volume.

Note: If you have selected disks from multiple VMD controllers you will receive a message asking you to confirm creation because spanned volumes cannot be used for boot.

When the RAID volume has been created you will be returned to the top of the "All Intel VMD Controllers" where you will see your newly created RAID volume.

RAID 5 EXAMPLE:

The process of creating RAID 5; specifying a volume name, selecting the RAID level, specifying spanning and selecting disks is the same as it is for other RAID volumes.

When you are finished selecting disks, use the arrow keys to scroll down to highlight "Strip Size:"

Strip Size	64KB

Press enter to show the options.

| X |
| SAMSUNG MZVPV256HDGL-000H1 SN:S27GN | 3.47GB |
| X |

4KB
8KB
16KB
32KB
64KB
128KB

| Strip Size |

Use up and down arrows to highlight the desired strip size.
Note: The default of 64KB is best for most applications. Only change the strip size if your applications work better with another strip size.

| X |
| SAMSUNG MZVPV256HDGL-000H1 SN:S27GN | 3.47GB |
| X |

4KB
8KB
16KB
32KB
64KB
128KB

| Strip Size |

Press enter to select the strip size.

Strip Size	32KB

Press the down arrow to advance to "Capacity (GB):"

Strip Size	32KB
Capacity (GB):	4530.86
RWH Policy	Disable

➡ **Create Volume**

Press enter to edit the capacity.

CONTENTS & NAVIGATION

Strip Size: 64KB ▾ ❷

Capacity (GB): 4000
Type String [ESC = Cancel, ENTER = Accept]
RWH Policy Disable ❷

➡ Create Volume ❷

Press enter to accept the capacity.

Strip Size: 64KB ▾ ❷

Capacity (GB): 4000

RWH Policy Disable ▾ ❷

➡ Create Volume ❷

Use the down arrow to highlight "RWH Policy".

Strip Size: 64KB ▾ ❷

Capacity (GB): 4000

RWH Policy Disable ▾ ❷

➡ Create Volume ❷

Press enter to display the RWH options and use the arrow keys to highlight the desired option.

Strip Size: 64KB ▾ ❷

Capacity (GB): 4000

RWH Policy Distributed PPL ▾ ❷
Journaling Drive
Disable

➡ Create Volume ❷

Press enter to accept the option. Any disks previously marked as a Journaling Drive will now be listed.

Strip Size: 64KB ▾ ❷

Capacity (GB): 4000.00

RWH Policy Journaling Drive ▾ ❷

Select RWH Journaling Drive

SAMSUNG MZVPV256HDGL-000H1 SN:S34ENY0J302984, 238.47GB Port 2:3 CPU0 VMD1 ▾

➡ Create Volume ❷

If more than one disk was previously specified for Journaling, use the down arrow to key to advance to the "Select RWH Journaling Drive", press enter, use arrow keys to select the desired disk, and press enter to accept the selection.

When you are satisfied with the RAID settings, use the down arrow to highlight ➡ Create Volume ❷ and press enter to create the volume.

Note: If you have selected disks from multiple VMD controllers you will receive a message asking you to confirm creation because spanned volumes cannot be used for boot.

When the RAID volume has been created you will be returned to the top of the "All Intel VMD Controllers" where you will see your newly created RAID volume.

RAID 10 EXAMPLE:

The process of creating RAID 10; specifying a volume name, selecting the RAID level, specifying spanning and selecting disks is the same as it is for other RAID volumes.

When you are finished selecting disks, use the arrow keys to scroll down to highlight "Strip Size:"

Note: 64B is the default recommended strip size for RAID 10 and should only be changed if your applications work better with a different strip size.

Strip Size:	64KB ▾	❷
Capacity (GB):	1812.34	

➡ **Create Volume** ❷

Press enter to show the options.

- 4KB
- 8KB

SAMSUNG MZVPV256HDGL-000H1 SN:S27GN ▾

- 16KB
- 32KB
- 64KB
- 128KB

Strip Size	❷
Capacity (GB):	1812.34

➡ **Create Volume** ❷

Use up and down arrows to highlight the desired strip size and press enter to select.

Strip Size	128KB ▾	❷
Capacity (GB):	1812.34	

➡ **Create Volume** ❷

Press the down arrow to advance to "Capacity (GB):"

Strip Size	128KB ▾	❷
Capacity (GB):	1812.34	

➡ **Create Volume** ❷

Press enter to edit the capacity.

Strip Size	128KB ▼	❓

Capacity (GB): 1800
Type String [ESC = Cancel, ENTER = Accept]

Press enter to accept the capacity.

Strip Size	128KB ▼	❓

Capacity (GB): 1800

➡ **Create Volume** ❓

When you are satisfied with the RAID settings, use the down arrow to highlight ➡ Create Volume ❓ and press enter to create the volume.

Note: If you have selected disks from multiple VMD controllers you will receive a message asking you to confirm creation because spanned volumes cannot be used for boot.

When the RAID volume has been created you will be returned to the top of the "All Intel VMD Controllers" where you will see your newly created RAID volume.

CONFIGURING VROC RAID USING THE COMMAND LINE INTERFACE(CLI)

The Command Line Interface provides for RAID creation and management from a Windows Administrator Command Prompt or Administrative PowerShell window.

Failure to run command line tools with administrative privileges will result in the following failure:
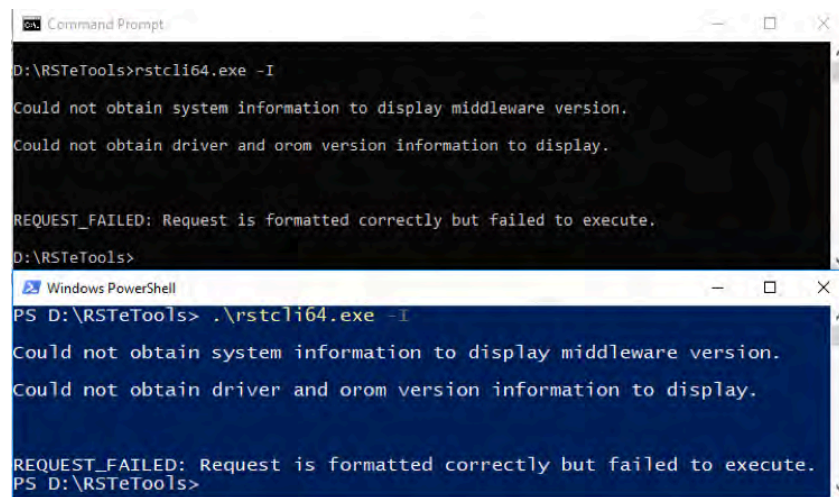
Note: In Windows PowerShell "."\" is needed before rstcli64.exe.

Help Resources:

The Intel® VROC CLI specification is available in the driver package on hp.com.

Help is available from the command line and the entire USAGE and HELP can be saved to a text file with the following command.

```
PS D:\RSTeTools> .\rstcli64.exe --help > CLI_Help.txt
```

Or

```
D:\RSTeTools>rstcli64.exe --help > CLI_Help.txt
```

There are three steps to creating arrays in VROC.

1. Collect IDs of disks to be configured in RAID.
2. Build the commands that will create the RAID.
3. Execute the commands

COLLECT DISK IDS

Disk IDs can be collected using one of the CLI information commands.

The following command will get just the Disk Information for all disks on the system:

```
D:\RSTeTools>rstcli64.exe -I -d
```

The following command gets all information available:

```
D:\RSTeTools>rstcli64.exe -I
```

Disk Information will be in the following format:

```
ID:                 5-0-1-0
Type:               Disk
Disk Type:          NVMe
State:              Normal
Size:               238.47 GB
System Disk:        False
Usage:              Pass through
Serial Number:      S34ENY0J302987
Model:              SAMSUNG MZVPW256HEGL-000H1
Logical sector size: 512 B
Socket Number:      1
Vmd Controller Number: 1
Root Port Offset:   1
Slot Number:        0
```

The first number in the ID represents a VMD controller grouping. The VMD controller grouping does not identify a physical position in the system. Disks with the same ID number are connected under the same VMD controller and can be included in a RAID volume used for the OS.

The second number will always be 0.

The third number is the disk index on a VMD controller from 0 to 3.

The fourth number is always 0.

Before creating a RAID using data from an existing disk, verify the serial number of the disk containing data corresponds to the disk ID that you use with the "-E" option when you create the RAID.

If you are keeping the OS, make sure the disk ID used in the "-E" option corresponds to the NVMe SSD showing "System Disk: True" in the Disk Information output.

Note: When creating a RAID from existing data, the size of the last partition on the disk may need to be reduced by 5MB to accommodate metadata. Most Windows 10 OS installations consume the entire disk, and will require size reduction of the last partition on the disk.

BUILD COMMANDS FOR CREATING RAID VOLUMES

```
Create Options:
------------------------------------------
| Flag | Name                            |
------------------------------------------
|  -C  | --create                        |
|  -E  | --create-from-existing          |
|  -l  | --level                         |
|  -n  | --name                          |
|  -s  | --stripe-size                   |
|  -z  | --size                          |
|  -w  | --rwh                           |
|  -j  | --jd                            |
|  -o  | --span                          |
------------------------------------------
```

RAID 0 (Stripe)

The following command creates a RAID volume with RAID level 0, size=500GB, name My500RAID0, using 4 NVMe SSDs all on the same VMD

```
rstcli64.exe -C -l 0 -z 500 -n My500RAID0 2-0-0-0 2-0-1-0 2-0-2-0 2-0-3-0
```

The following command creates a second RAID volume with level 0 using the remaining space on the SSDs left over from the creating the 500GB RAID 0 above.

```
rstcli64.exe -C -l 0 -n My2ndRAID0 2-0-0-0 2-0-1-0 2-0-2-0 2-0-3-0
```

RAID 1 (Mirror)

The following command creates a RAID volume with level 1, name PlainRAID1, using 2 NVMe SSDs on the same VMD.

```
rstcli64.exe -C -l 1 -n PlainRAID1 4-0-2-0 4-0-3-0
```

The following command creates a RAID volume with level 1, keeping data from the NVMe SSD with ID 3-0-0-0, name R1DataKept, specifying a second blank NVMe SSD on the same VMD as the other member.

```
rstcli64.exe -C -l 1 -E 3-0-0-0 -n R1DataKept 3-0-1-0
```

Note: When creating a RAID volume from existing data, it is important to verify the source disk ID corresponding to the disk that you want to keep data from. See the "Collect Disk IDs" in the section above.

RAID 5 (Striping of data and parity)

The following command creates a RAID volume with level 5 and name RAID5, using 4 NVMe SSDs all on the same VMD.

```
rstcli64.exe -C -l 5 -n RAID5 6-0-0-0 6-0-1-0 6-0-2-0 6-0-3-0
```

The following command creates RAID volume with level 5, Distributed RAID Write Hole closure, and name RAID5Dist, using 4 NVMe SSDs all on the same VMD.

```
rstcli64.exe -C -l 5 -W Distributed -n RAID5Dist 6-0-0-0 6-0-1-0 6-0-2-0 6-0-3-0
```

The following command creates RAID volume with level 5, Journaled RAID Write Hole closure, and name RAID5Journ, using 4 NVMe SSDs all on the same VMD.

```
rstcli64.exe -C -l 5 --rwh JournalingDrive --jd 5-0-3-0 -n RAID5Journ 5-0-0-0 5-0-1-0 5-0-2-0
```

RAID 10 (Stripe 2 disks and mirror each disk)

The following command creates RAID volume with level 10, spanning allowed, and name SpannedRAID10, using 2 NVMe SSDs from one VMD and 2 NVMe SSDs from a second VMD.

```
rstcli64.exe -C -l 10 -o -n SpanedRAID10 3-0-2-0 3-0-3-0 4-0-0-0 4-0-1-0
```

EXECUTE THE COMMANDS

The commands can be entered manually or executed using a batch file or PowerShell script. RAID can be created during install time at any point after the OS drivers are loaded.

To get an administrative command window at install time press and hold the "Shift" and then press the "F10" key. Release the keys after the command window appears.

CONFIGURING VROC RAID USING GRAPHICAL USER INTERFACE (GUI)

The GUI provides a convenient method for creating and managing RAID volumes for NVMe SSDs attached to PCIe and SATA disks attached to SATA RAID controllers.

When the controller is selected, the Controller Properties will appear in the pane on the right and any configurable settings will appear in blue underlined text.
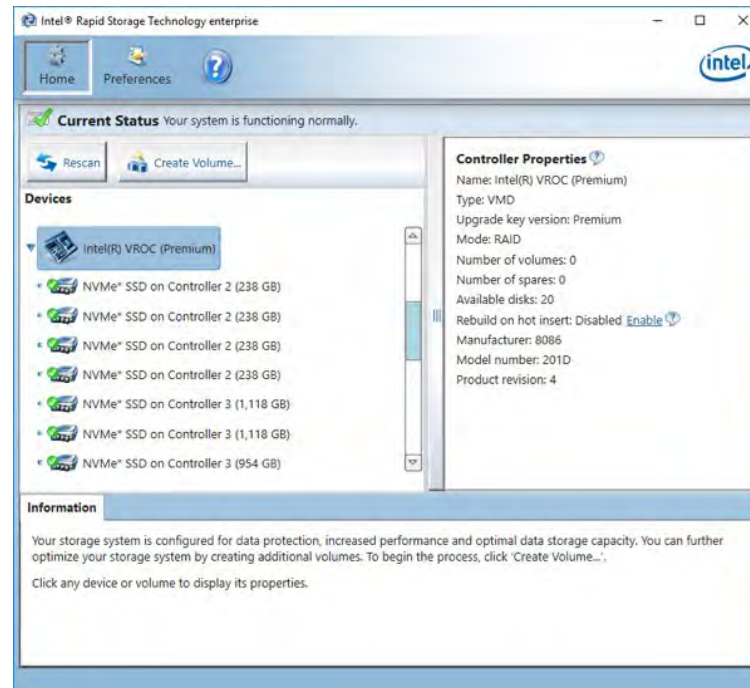
Selecting a disk will show basic Disk Properties for that specific disk. Additional information about the disk can be displayed by clicking on "Details" in blue text. Actions or and configurable settings are shown in blue underlined text.

Note: "Activate LED" for locating disks is not supported because this function requires out of band signaling and disks with identification LEDs.
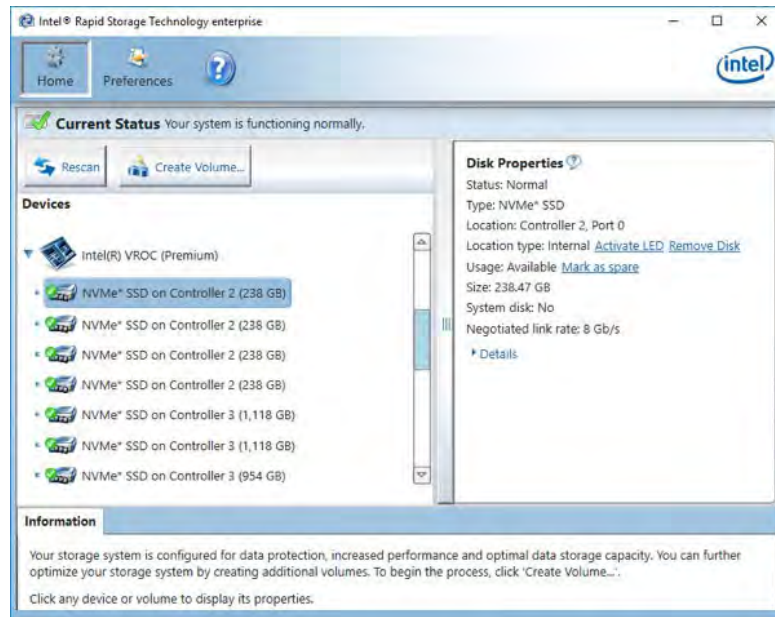
To create a RAID volume, click the "Create Volume…" button which will open the "Select" window
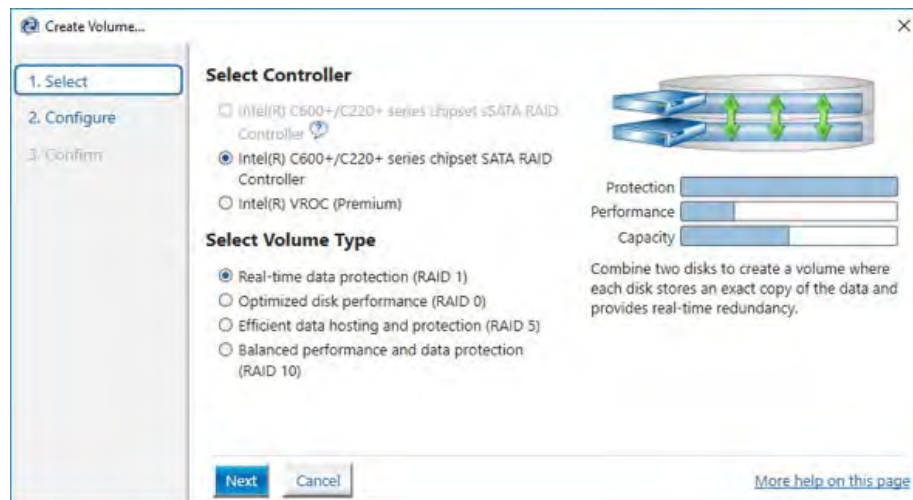
Select the Intel(R) VROC controller.
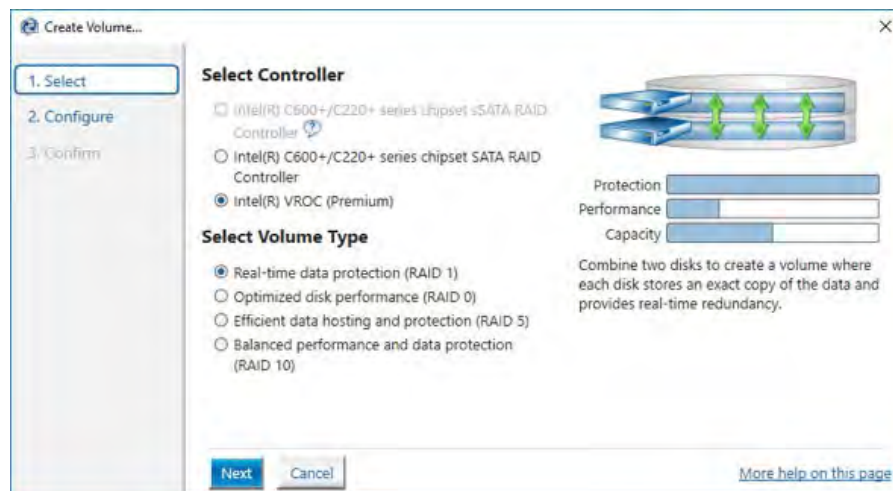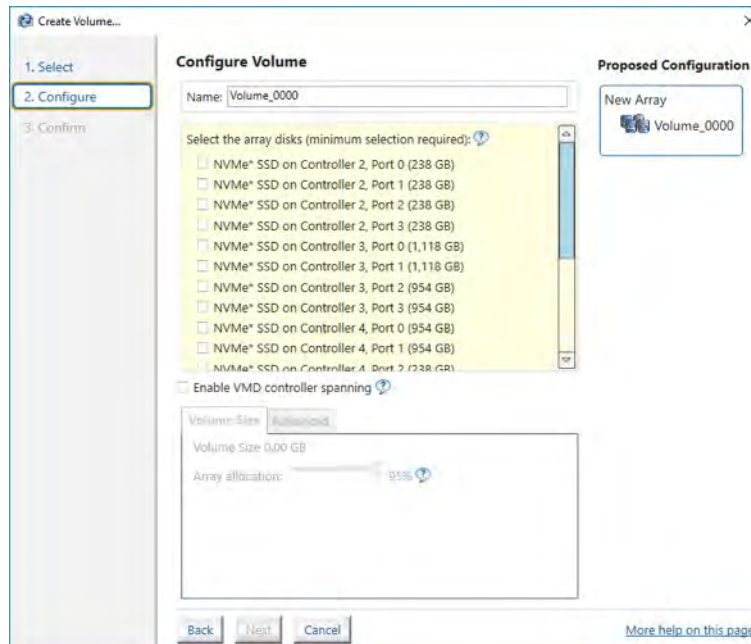
Volume types will be grayed out if not supported due to the controller type selected (VROC Standard does not support RAID 5), or if there are not enough disks available for a specific Volume Type. Select the desired Volume Type from the available options.

Click "Next" to advance to configuration of the volume.

Change the volume name if desired and select disks. When the first disk is selected, disks on other VMD controllers will be grayed out unless the "Enable VMD Controller spanning" box is checked.
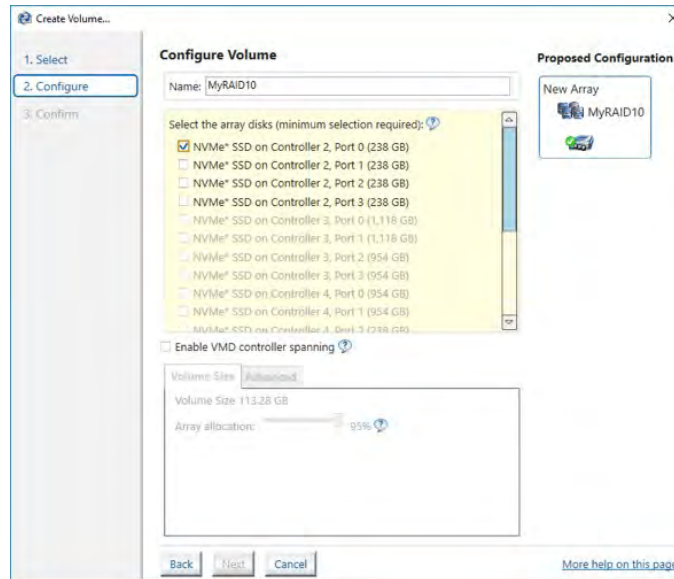
Select additional disks to complete the raid. The "Next" button will change to blue when the basic volume configuration requirements are met.
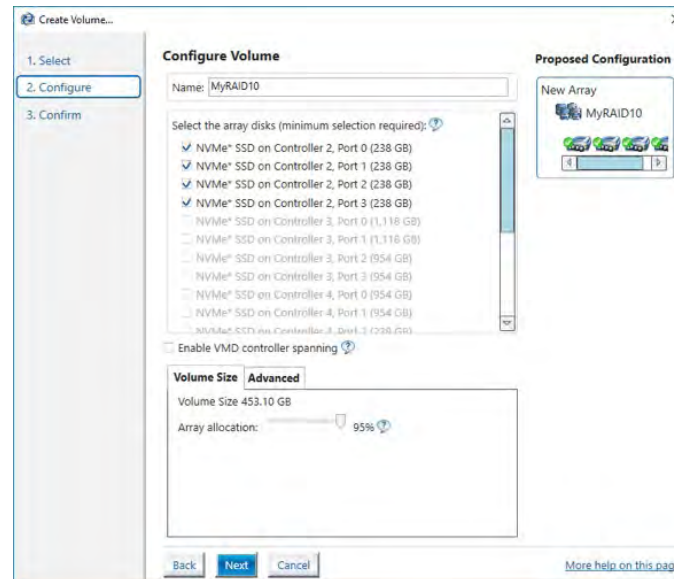
Volume Size will be automatically set to 95% to accommodate replacing a failed disk with another slightly smaller disk at some future time.

Note: When using SSDs for applications requiring extensive data writing, memory cell spares overprovisioning on SSDs can be accomplished by further reducing the volume size.

Each RAID type may have additional "Advanced" options. See the help topics within the GUI for additional information on these options. For general use RAID volumes, the stripe sizes should be left as default.

Click next to create the RAID volume. Volumes created will appear in the middle volume pane of the GUI.

Selecting an Array will display the "Array Properties" and any actions that can be performed on the Array.
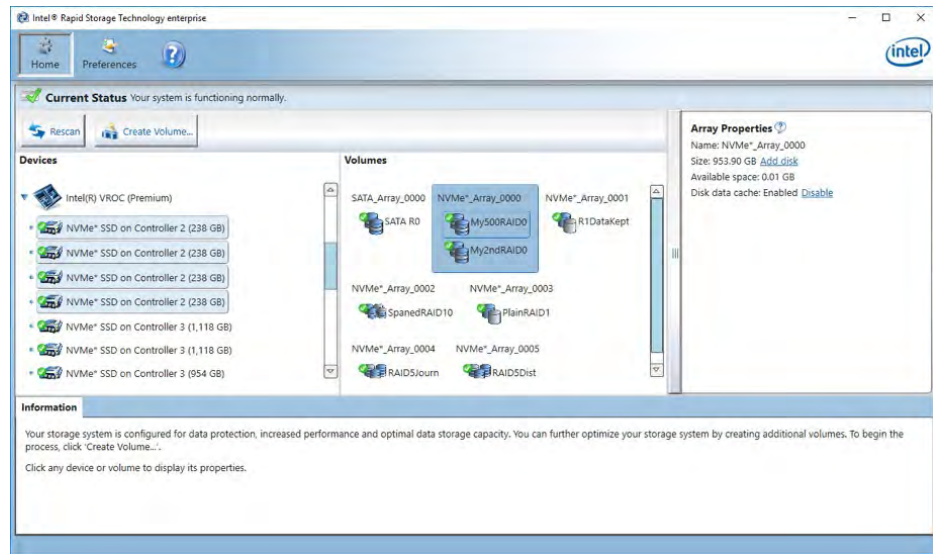
Selecting a volume in an Array will display the "Volume Properties" and any actions that can be performed on the Volume.
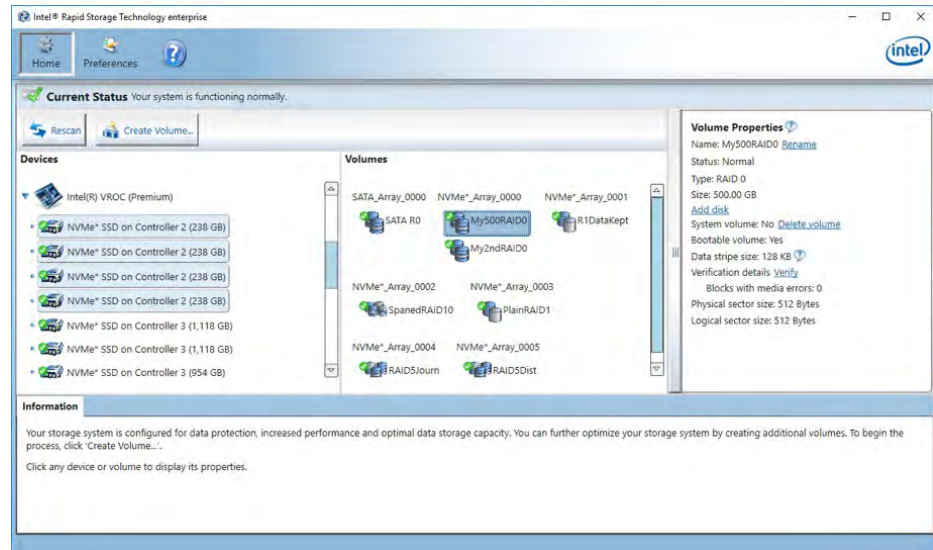
Selecting a disk will highlight any volumes that the disk is used in and will show the "Disk Properties" in the right pane.
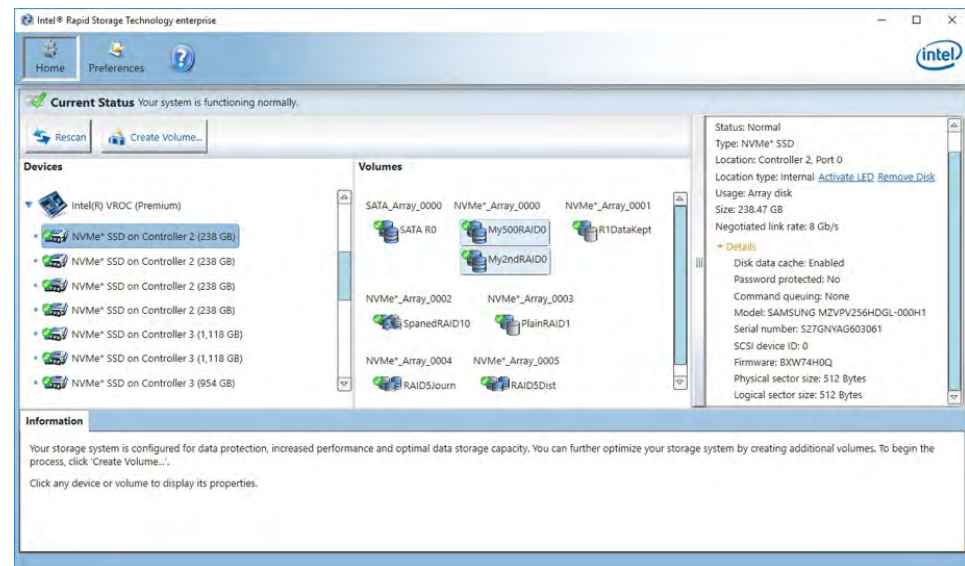
The RAID volumes will replace the individual disks previously shown in Windows "Device Manager".
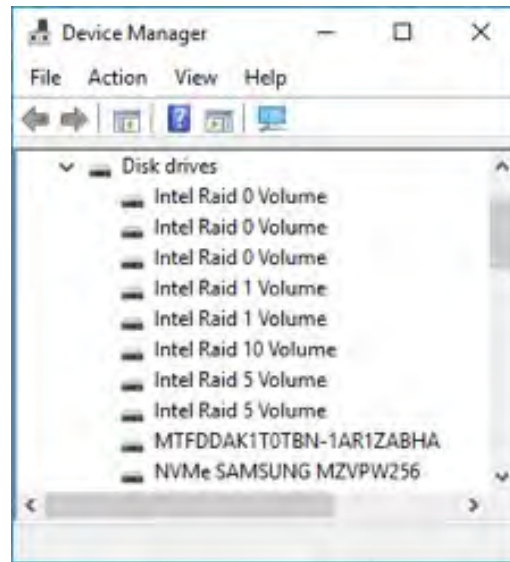
CONFIGURING VROC RAID USING UEFI SHELL COMMAND LINE TOOLS

The processes for creating and managing RAID from the UEFI shell and CLI in the OS are similar.

1. Collect IDs of disks using the Status and Information commands.
2. Build the commands that will create the RAID.
3. Execute the commands.

The UEFI application for VROC RAID management is:

RCfgRSTeRS.efi

The following command will display help:

Note: Although the help menu shows RCfgRSTeRS.exe, the correct usage in the UEFI shell is RCfgRSTeRS.efi.

```
/?    Displays Help Screen.  Other options ignored.
/Y    Suppress any user input. Used with options /C, /D, & /X.
/Q    Quiet mode / No output. Should not be used with status commands.

      COMMANDS - Only one at a time.
/C    Create a volume with the specified name.
      /S, /DS, /SS, /L, /RWH, & /JD can be specified along with /C.
/SS   Specify strip size in KB.  Only valid with /C.
/L    Specify RAID Level (0, 1, 10, or 5).  Only valid with /C.
/S    Specify volume size in GB or percentage if a 'Z' is appended.
      Percentage must be between 1-100.  Only valid with /C.
/DS   Selects the disks to be used in the creation of volume.
      List should be delimited by spaces.
/D    Delete Volume with specified name.
/X    Remove all metadata from all disks. Use with /DS to delete
      metadata from selected disks.
/I    Display All Drive/Volume/Array Information.  /P can be specified.
/P    Pause display between sections. Only valid with /I or /ST.
/U    Do not delete the partition table. Only valid with /C on RAID 1 volumes.
/ST   Display Volume/RAID/Disk Status.
/R    Rebuild volume. Selects the disk that will be used for rebuild in OS.
      Use with /DS
/SP   Marks the selected drive(s) as spare(s). Use with /DS
/RWH  Set rwh policy for rwh. Use with /C or /JV.
      Off, Distributed and JournalingDrive are available options.
/JD   Selects journaling drive. Only valid with /RWH:JournalingDrive.
/JV   Journaling volume. Changes rwh policy for existing volume.
      Use with /RWH
/V    Display version information
```

Note: Disk IDs from the status command (RCfgRSTeRS.efi /ST) are 0 based hex numbers. Disk IDs from the Information command (RCfgRSTeRS.efi /I) are 1 based decimal. The create command uses 0 based IDs but can be entered as decimal or hex.

The information command (RCfgRSTeRS.efi /I) displays all Disk/Volume/Array Information. Use the "/P" option to pause the output after small sections are displayed.

The disks will be numbered from 1 to the total number of disks installed on VMD controllers in the system.

The following fields from the information command output may be of use in helping to identify devices for RAID configuration:
Drive: Manufacturer and Model number.
SerialNo: The disk's serial number.
DeviceId: RAID member status, (Member Disk) or (Non-RAID Disk).
VMD Controller Number: VMD controller number on a socket (CPU).
Socket Number: CPU number either 0 or 1 (on two CPU systems).
Root Port Offset: 0 to 3 (Each X16 PCIe slot has 4 root port offsets).
Slot Number: PCIe slot number.

```
Disk 2 / 20
  Drive: SAMSUNG MZVPV256HDGL-000H1
  SerialNo:S27GNYAG603068
  FreeBlks:0x0000000000000000          TotalBlks:0x000000001DCF32B0
  DeviceId:0x1 (Member Disk)
  VMD Controller Number: 0
  Socket Number: 0
  Root Port Number: 1
  Root Port Offset: 1
  Slot Number: 4
  PCI Bus:Device.Function: 02:00.0
  CfgStatus:(0) Ok
  CheckBox:0x0
  State:(0x13A)     Array:0x0
      CONFIGURED_DISK
      USABLE_DISK
      DETECTED_DISK
      CLAIMED_DISK
      CONFIG_ON_DISK
Block Size:512
```

A summary of the VMD controllers is displayed at the end of the Information output.

```
---------------------------------
 Total Physical Disks on VMD controllers: 20
 Total Missing Disks on VMD controllers: 0

RAID Volumes on Intel VMD Controllers:
Volume 1 / 1
   SerialNo:MyRAID10
   RaidLevel:10      TargetId:0x0      MemberDisks:4          StripSize:64KB
   TotalBlocks: 0x0000000030043800      Domains/Mirrors:2      CfgStatus:0x0
   BytesPerBlock:0x200      Action:0      Array:0
   MapState:0      MigrState:0      MigrType:0
   Block Size:512
---------------------------------
 Total Volumes on Intel VMD Controllers = 1

RAID Arrays on Intel VMD Controllers:
Array 1 / 1
   Action:0        NumDisks:4      RAIDDevs:1        CheckBox:0x0
   State:0        TotalGB: 953.89          FreeGB:185.63
---------------------------------
 Total Arrays on Intel VMD Controllers = 1
```

The Status command (RCfgRSTeRS.efi /ST) provides a simplified status of volumes and drives. The Status command for "Disk 2 / 20" above shows the same disk as "ID: 0x1" in the Status output below.

```
ID:               0x1
ID bitmap:        2
State:            Non-RAID Disk
Size:             238.47GB
Serial Number:    S27GNYAG603068
Model Number:     SAMSUNG MZVPV256HDGL-000H1
Block Size:       512
```

CONFIGURATION EXAMPLES USING UEFI SHELL COMMANDS

Note: The UEFI shell utilities run using limited resources. Some RAID configurations will be slow to complete. The system may appear hung with no visible activity for approximately 10 minutes. Consider only using UEFI shell commands for simple RAID configurations that do not require changes from default settings.

The examples below will use a set of 4 NVMe SSDs in a Z Turbo Quad Pro card on PCIe slot 6. The Information command (RCfgRSTeRS.efi /I) displays the following for these 4 SSDs:

```
Disk 13 / 20
   Drive: SAMSUNG MZVPW256HEGL-000H1
   SerialNo:S34ENY0J302995
   TotalBlks:0x000000001DCF32B0
   DeviceId:0xC (Non-RAID Disk)
   VMD Controller Number: 1
   Socket Number: 1
   Root Port Number: 2
   Root Port Offset: 0
   Slot Number: 6
   PCI Bus:Device.Function: 01:00.0
   CfgStatus:(0) ok
   CheckBox:0x0
   State:(0x50)      Array:0xFFFFFFFF
      DETECTED_DISK
      PASSTHRU_DISK
   Block Size:512
Disk 14 / 20
   Drive: SAMSUNG MZVPW256HEGL-000H1
   SerialNo:S34ENY0J302987
   TotalBlks:0x000000001DCF32B0
   DeviceId:0xD (Non-RAID Disk)
   VMD Controller Number: 1
   Socket Number: 1
   Root Port Number: 2
   Root Port Offset: 1
   Slot Number: 6
   PCI Bus:Device.Function: 02:00.0
   CfgStatus:(0) ok
   CheckBox:0x0
   State:(0x50)      Array:0xFFFFFFFF
      DETECTED_DISK
      PASSTHRU_DISK
   Block Size:512
Disk 15 / 20
   Drive: SAMSUNG MZVPW256HEGL-000H1
   SerialNo:S34ENY0J302985
   TotalBlks:0x000000001DCF32B0
   DeviceId:0xE (Non-RAID Disk)
   VMD Controller Number: 1|
   Socket Number: 1
   Root Port Number: 2
   Root Port Offset: 2
   Slot Number: 6
   PCI Bus:Device.Function: 03:00.0
   CfgStatus:(0) ok
   CheckBox:0x0
   State:(0x50)      Array:0xFFFFFFFF
      DETECTED_DISK
      PASSTHRU_DISK
   Block Size:512
Disk 16 / 20
   Drive: SAMSUNG MZVPW256HEGL-000H1
   SerialNo:S34ENY0J302984
   TotalBlks:0x000000001DCF32B0
   DeviceId:0xF (Non-RAID Disk)
   VMD Controller Number: 1
   Socket Number: 1
   Root Port Number: 2
   Root Port Offset: 3
   Slot Number: 6
   PCI Bus:Device.Function: 04:00.0
   CfgStatus:(0) ok
   CheckBox:0x0
   State:(0x50)      Array:0xFFFFFFFF
      DETECTED_DISK
      PASSTHRU_DISK
   Block Size:512
```

The Status command (RCfgRSTeRS.efi /ST) displays the following for these 4 SSDs:

```
ID:             0xC
ID bitmap:      1000
State:          Non-RAID Disk
Size:           238.47GB
Serial Number:  S34ENY0J302995
Model Number:   SAMSUNG MZVPW256HEGL-000H1
Block Size:     512

ID:             0xD
ID bitmap:      2000
State:          Non-RAID Disk
Size:           238.47GB
Serial Number:  S34ENY0J302987
Model Number:   SAMSUNG MZVPW256HEGL-000H1
Block Size:     512

ID:             0xE
ID bitmap:      4000
State:          Non-RAID Disk
Size:           238.47GB
Serial Number:  S34ENY0J302985
Model Number:   SAMSUNG MZVPW256HEGL-000H1
Block Size:     512

ID:             0xF
ID bitmap:      8000
State:          Non-RAID Disk
Size:           238.47GB
Serial Number:  S34ENY0J302984
Model Number:   SAMSUNG MZVPW256HEGL-000H1
Block Size:     512
```

Note: For RAID creation the decimal Disk numbers reported by the Information command need to be decremented by 1.
The Disk IDs used for RAID creation in the following examples will be 12, 13, 14, 15 decimal or 0xC, 0xD, 0xE, 0xF hex.

RAID 0 EXAMPLE:
The following 2 commands create a RAID 0 volume using the same 4 NVMe SSDs.

RCfgRSTeRS.efi /C:MyRAID0 /L:0 /DS:12 13 14 15
or
RCfgRSTeRS.efi /C:MyRAID0 /L:0 /DS:0xC 0xD 0xE 0xF

```
FS6:\> RCfgRSTeRS.efi /C:MyRAID0 /L:0 /DS:0xC 0xD 0xE 0xF
Creating Volume...
Volume Name: "MyRAID0"
RAID Level:  0
Size:        927937 MB
Strip Size:  128KB
Ports Selected: Disk(ID:0xC) Disk(ID:0xD) Disk(ID:0xE) Disk(ID:0xF)
Are you sure you want to create this volume?(y/n)
Creating Volume....Successfully created volume

You MUST restart your system for your changes to take effect.
Any drives you have created or changed must be formatted
AFTER you restart.
```

RAID 1 EXAMPLE:
The following command creates a RAID 1 volume using 2 NVMe SSDs.
RCfgRSTeRS.efi /C:MyRAID1 /L:1 /DS:12 13
or
RCfgRSTeRS.efi /C:MyRAID0 /L:0 /DS:0xC 0xD 0xE 0xF

```
FS6:\> RCfgRSTeRS.efi /C:MyRAID1 /L:1 /DS:12 13
Creating Volume...
Volume Name: "MyRAID1"
RAID Level:  1
Size:        231984 MB
Strip Size:  N/A
Ports Selected: Disk(ID:0xC) Disk(ID:0xD)
Are you sure you want to create this volume?(y/n)
Creating Volume....Successfully created volume

You MUST restart your system for your changes to take effect.
Any drives you have created or changed must be formatted
AFTER you restart.
```

RAID 5 EXAMPLE:

Note: The RAID 5 RWH commands may take around 10 minutes to complete following confirmation to create the volume. After confirmation to create the volume, "Creating Volume...." will be displayed. If the system is rebooted during this time, the RAID 5 volume will be created with RWH distributed. The journaling disk can be added later using the GUI in the OS. A smaller capacity disk can be used as the journaling disk since the Journaling disk is only used for temporary journaling of data that hasn't been completely written to the RAID volume.

The following EFI shell command line output shows the process of creating a RAID 5 volume with the RWH Journaling option. A disk needs to be assigned as a journaling disk prior to creating the RAID volume that uses the journaling disk.

```
FS6:\> RCfgRSTeRS.efi /JD:0xF
Are you sure you want to mark disk 0xF as 'Journal drive?'(y/n)
Disk:0xF marked as 'Journal Drive'.
FS6:\> RCfgRSTeRS.efi /C:RAID5Journ /L:5 /DS:0xC 0xD 0xE /RWH:JournalingDrive /JD:0xF
Creating Volume...
Volume Name: "RAID5Journ"
RAID Level:  5
Size:        463968 MB
Strip Size:  64KB
RWH policy:  JournalingDrive
JD:          0xF
Ports Selected: Disk(ID:0xC) Disk(ID:0xD) Disk(ID:0xE)
Are you sure you want to create this volume?(y/n)
Creating Volume....Successfully created volume

You MUST restart your system for your changes to take effect.
Any drives you have created or changed must be formatted
AFTER you restart.
```

RAID 10 EXAMPLE:

The following 2 commands create a RAID 10 volume using 4 NVMe SSDs.

RCfgRSTeRS.efi /C:MyRAID10 /L:10 /DS:12 13 14 15
or
RCfgRSTeRS.efi /C:MyRAID10 /L:10 /DS:0xC 0xD 0xE 0xF

```
FS6:\> RCfgRSTeRS.efi /C:MyRAID10 /L:10 /DS:0xC 0xD 0xE 0xF
Creating Volume...
Volume Name: "MyRAID10"
RAID Level:  10
Size:        463968 MB
Strip Size:  64KB
Ports Selected: Disk(ID:0xC) Disk(ID:0xD) Disk(ID:0xE) Disk(ID:0xF)
Are you sure you want to create this volume?(y/n)
Creating Volume....Successfully created volume

You MUST restart your system for your changes to take effect.
Any drives you have created or changed must be formatted
AFTER you restart.
```

MIGRATION TO VROC RAID

RAID migration is the process of creating a new RAID volume while keeping data from one disk. A data disk or OS disk can be used as the source of the preserved data. Migration can be initiated from the OS CLI or OS GUI. A single disk can be migrated to RAID 0, RAID 1, RAID 5, or RAID 10.

Note : Always create a backup before making any changes to the storage system.

Note: RAID volumes require at least 5MB of free space at the end of the disk for metadata. RAID creation will fail if the source disk does not have enough free space at the end of the disk. When using the GUI, a pop-up will appear with the following error:

🚫 Not enough disk space for Metadata, please reduce the source partition by 5 MB.

To prevent this error use "Disk Manager" to reduce the last partition on the disk by 5MB prior to attempting migration.

When the OS GUI is used to migrate to a RAID volume, delete all partitions on the disks that do not contain the data you want to keep. This will allow the software to automatically recommend which disk to keep data from. Partitions on the disk can be deleted using the "Disk Manager" applet in Windows or using "Diskpart" from the command line and selecting each disk then using the "clean" command.

MIGRATION USING THE OS CLI

The following OS CLI command migrates the data from disk 3-0-0-0 to a RAID 1 volume.

```
rstcli64.exe -C -l 1 -E 3-0-0-0 -n R1DataKept 3-0-1-0
```

Note: When creating a RAID volume from existing data, it is important to verify the source disk ID corresponding to the disk that you want to keep data from. See the "Collect Disk IDs" in the OS CLI section above. To reduce the possibility of error, remove all disks from the system except the disks targeted to be in the RAID.

MIGRATION USING THE OS GUI

The following example migrates the OS from a single disk to RAID 10. Follow the steps for RAID creation in section "Configuring VROC RAID Using Graphical User Interface (GUI)" above up to the "Configure Volume" step where disks are selected.

For a bootable RAID all devices need to be on the same VMD controller. Select the disk identified as the "System" disk. This will result in disks on other VMD controllers being grayed out. The spanning option will be removed and the option to keep data will appear with the OS disk being selected as the disk to keep data from.
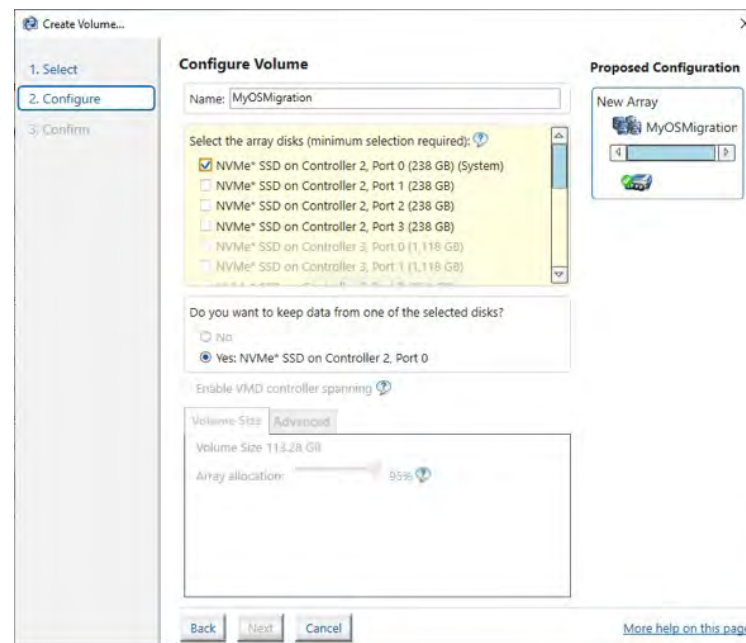
Select additional disks to complete the RAID volume. The "Next" button changes to blue when the minimum configuration requirements for the RAID have been met.

Click "Next" and follow the prompts to complete and confirm creation of the RAID volume.

Migration will start immediately, but the full size of the volume may not be available until the system is rebooted and the migration is complete.

LINUX CONFIGURATION

VROC is supported with select Linux distributions. Data RAID can be configured through BIOS or the UEFI shell. See "Configuring VROC RAID in BIOS" and "Configuring VROC RAID Using UEFI Shell Command Line Tools" in this document.

The following Linux distributions are supported with support for additional distributions in process:

• Red Hat Enterprise Linux (RHEL) 7.3 GA (Intel® VROC)

• Red Hat Enterprise Linux (REHL) 7.4 GA (Intel® VROC)

• SUSE Linux Enterprise Server (SLES) 12 SP3 (Intel® VROC)

• Red Hat Enterprise Linux (RHEL) 6.7, 6.8, 7.2 and 7.3 GA (Intel® RSTe)

• SUSE Linux Enterprise Server (SLES) 11 & 12 (Intel® RSTe)

Note: Intel® VMD has been upstreamed and is included in the Linux 4.14 kernel.

Future VROC versions will support additional Linux distributions. See the Intel® VROC User Guide for Linux in the Linux VROC driver package on hp.com for information on currently supported Linux Distributions.

INSTALLATION OF VROC FOR LINUX

Installation of VROC for Linux requires a patch process to provide feature updates and fixes. VROC will not function properly if the patch is not applied correctly.

The quickest way to get started with VROC on Linux is to install the patch before enabling VMD.

1. Make sure the VROC key is not installed on the motherboard.

2. Make sure VROC is disabled on every slot in BIOS.

3. Follow the instructions for **"Installation with Intel VMD disabled"** in the Intel® VROC Linux User Manual provided with the Linux VROC driver package.

If VMD is already enabled and cannot be easily disabled, follow the instructions for **"Installation with Intel® VMD enabled"** in the Intel® VROC Linux User Manual provided with the Linux VROC driver package.

For additional information on RAID management in Linux, see the Intel® VROC Linux User Manual provided with the Linux VROC driver package available on hp.com.

RESOURCES, CONTACTS, OR ADDITIONAL LINKS

hp.com/go/whitepapers
This site includes white papers on USB 3.0 Technology, Battery Charging technology, Thunderbolt™ 2 Technology, etc.

hp.com/support/HP Z8 G4_manuals

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CONTACT US