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# Technical
# White Paper

**Contents & navigation**

# HP Z2 Workstation: Intel® Rapid Storage Technology (RST) with VMD Platform

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## Technical
## White Paper

### Contents & navigation

# Configure Storage Controller for VMD

Enabling configure storage controller for VMD lets you manage the storage devices within the Intel® Rapid Storage Technology (RST) software framework and provides RAID capability for SATA/PCIe storage devices. "Configure storage controller for VMD" is specific BIOS settings. Changing the state to disabled will result in a loss of RAID volumes managed by Intel® RST. If you accidentally disable "Configure storage controller for VMD", change the settings back to re-enable VMD before attempting to boot to the OS.

## How Does Configure Storage Controller for VMD work?

When VMD is enabled, the SATA AHCI controller and PCH/CPU PCIe NVMe roots are global remapped to the CPU's embedded VMD controller, and then the AHCI controller and storage root complex are under VMD controller's controller. The benefit is we can create NVMe RAID with each PCH or CPU attached NVMe via Intel® RST, no matter whether the RAID volume is a boot drive or data drive.

### Controller Enable/Disable

The VMD controller is set as enabled in default and can be disabled from the BIOS menu under *Advanced > System Options > configure Storage Controller for VMD*. Uncheck the box to disable or check the box to enable the VMD controller.

- VMD controller enabled : Default; ACHI + RAID capability with the greatest flexibility for most users.
- VMD controller disabled : Can not install RST driver and only can use Microsoft inbox storage driver.
- *The shipping SKU of SATA SED on Z2 is VMD default disabled.
- Changing this option is not recommended and can result in boot failure or data loss if the VMD controller is changed after the OS is installed or if a volume already contains data. Always back up your data before making any storage system changes.

# System Requirements

## Hardware
- Specific Intel® Chipset, Refer to Supported HP Workstation
- PCIe NVMe storage device connected to a PCIe slot or M.2 slot of PCH or CPU attached
- All devices used in RAID volumes must have the same controller type, combining NVMe and AHCI devices in a RAID volume is not permitted by Intel® RST.
- A best practice is to use devices from the same manufacturer with the same model number and capacit

## Supported OS
- Windows 10x64 UEFI install
- Windows 11x64 UEFI install

### Drivers

- Intel® RST driver v19.5.1.1040.3 or newer (related to the HP workstation platform). You can download the appropriate driver version and tool for your platform from hp.com.
- You must be in VMD-enabled mode. Using the Windows Device Manager applet, open Device Manager and navigate down to Storage Controller. Expand the Storage controller category and right-click on the Intel® RST VMD Controller or Intel® RST VMD Managed Controller. Select Properties. The driver version will display on the Driver tab to check the driver version.
- You can also check the driver version through the RST GUI. Open Intel® Optane™ Memory and Storage Management application and then click About to check the driver version.

### Supported HP Workstations

- HP Z2 Workstation G9
- HP Z2 Workstation G9R

### Unsupported Devices

- M.2 PCIe AHCI storage devices
- PCIe storage devices that are not NVMe compliant
- RAID with mixed storage device types

### Unsupported OS

- Win32-bit OSs
- Linux (Kernel drivers do not have support for VMD)

# RAID Configuration Introduction and Recommendations

This is an overview of the RAID configurations and setting recommendations for the HP Z2 Workstation platforms.

## Storage Configurations and RAID

The HP Z2 workstation includes one SATA AHCI Controller and CPU/PCH PCIe NVMe* Roots, these are under the Intel® VMD controller due to the VMD controller is enabled as default to support RAID feature. The CPU attached-NVMe and PCH-attached NVMe can be created to a RAID volume which can be a boot RAID or data RAID on our HP Z2 workstation.
Mixing NVMe and SATA devices into a single RAID volume is not supported. Intel® RST supports a maximum of 4 RAID volumes in a system. An Optane volume counts as 3 RAID volumes.

*SED encryption function is not workable in the RAID environment. The shipping SKU of SATA SED on Z2 is VMD default disabled.

## Storage Features and Supported RAID Levels

The RAID levels and drives supported under the VMD controller are shown in the table below:

| Platform | Controller | Interface type | Number of ports | Drives supported | RAID capability | RAID support level |
|---|---|---|---|---|---|---|
| Z2 G9 TWR/SFF | VMD | SATA3 | 4 | SSD, SED*, HDD, ODD | 0, 1, 5, 10 | 0, 1 |
| | | M.2 PCIe 4.0 x4 | 3 | SSD, SED | 0, 1, 5, 10 | 0, 1 |
| Z2 G9 Mini | VMD | SATA3 | 0 | N/A | 0, 1, 5 | N/A |
| | | M.2 PCIe 4.0 x4 | 2 | SSD, SED* | 0, 1 | 0, 1 |

*Some SATA SED encryption functions may not be workable, but they can still be used as a normal drive under VMD-enabled mode.

### Option ROM Launch Policy
RAID provides a method of combining multiple disks into a single logical volume to increase performance or create data redundancy.

### RAID 0
Creates a single volume that has data striped across two or more drives on the same controller. The size of the volume is based on the size of the smallest capacity drive times the number of drives in the RAID 0 configuration. RAID 0 is typically used to improve performance or create a larger volume from smaller drives. There is no data redundancy or parity in a RAID 0 configuration.

### RAID 1
Creates a single volume that is a mirror image of identical data on two physical drives on the same controller. The size of the mirror is limited by the smallest drive used in the RAID 1 configuration. This configuration provides data redundancy protection against a single drive failure, does not use parity, and almost doubles performance. If a drive fails, the drive can be replaced by a drive of the same capacity or larger capacity to rebuild the RAID array.

### RAID 5
Creates a single volume from three or more physical drives on the same controller. RAID 5 uses striping with parity data in distributed blocks across all member disks. A RAID 5 volume is tolerant of a single disk failure. RAID 5 has performance attributes similar to a RAID 0. RAID 5 has two options for RWH (RAID Write Hole) Closure. Distributed RWH distributes partial parity logging across all members. Journaling RWH utilizes an additional drive for partial parit logging. The journaling drive can be smaller capacity than RAID members.

### RAID 10
Creates a mirror of pair of drives, and then stripes the data on the mirrored pairs. A RAID 10 must contain two or more drive pairs, with a four drive minimum. A RAID 10 is fault tolerant to one drive per mirrored pair.

### Minimum Requirements
RAID 0- 2 disks minimum (6 max)

RAID 1- 2 disks only

RAID 5- 3 disks minimum (6 max)

RAID 10- 4 disks only

# Technical White Paper

Contents & navigation

**The types of RAID supported on a Z2 TWR/SFF are:**

- RAID0 (stripe) on SATA devices or NVMe devices.
- RAID1 (mirror) on SATA devices or NVMe devices.
- RAID 5 (stripe with parity) on SATA devices or NVMe devices. *Is capable but not supportive on Z2 TWR/SFF platform.
- RAID 10 (stripe and mirror) on SATA devices. *Is capable but not supportive on Z2 TWR/SFF platform.

*The RAID 5 and RAID 10 are functional but not certified on the HP Z2 workstation, which means we don't support RAID 5 and RAID 10 features on our HP Z2 workstation.

**The types of RAID supported on a Z2 Mini are:**

- RAID0 (stripe) on NVMe devices
- RAID1 (mirror) on NVMe devices

## Create RAID Arrays

RAID arrays can be created in four different ways. The method most widely used by end-users is to use the Intel® Optane™ Memory and Storage Management UI (HSA UI) in Windows. The second method to create a RAID volume is to use the Intel® RST pre-OS UEFI HII UI in 3rd Party option ROM Management.

**1. Pre-OS RAID creation through the UEFI driver in BIOS setup**

This can be found in the BIOS Setup menu Press F10 when powering up the system. *UEFI Drivers > 3rd Party Option ROM Management.* Or press F3 as soon as you see the Z logo on the screen after the system boots up.

Select *Intel® Rapid Storage Technology* from the pull-down menu.

The OROM will only display at power on if there are two or more RAID-capable devices attached to the controller, or a single device is attached that contains RAID metadata. In the latter case, the OROM will show that the RAID is failed or degraded.

Once in the OROM, you can Create RAID Volumes, Delete RAID Volumes, Reset Disks to non-RID, or Exit. The keys available for use are listed at the bottom of the screen.

Example: RAID volume creation on the VMD controller using the UEFI driver interface.

A. Use the Up/Down arrows to select Create RAID Volume and press Enter.

B. Use the Up/Down arrows to select Name and press Enter to pop up a box for editing the volume name. Change the name if desired and press Enter to close the edit box.

C. Use the Up/Down arrows to select RAID Level and press Enter to show available RAID levels. Use the Up/Down arrows to select the desired RAID level and press Enter to accept.

D. Use the Up/Down arrows to navigate to "< >" behind the drives you want to include in the array. Press Enter to open a selection box and use Up/Down arrows to change from blank to "X". Press Enter to accept. Continue selecting drives until you have selected all of the drives that you want to include in the RAID array.

E. Arrays that use striping, will have an option to select strip size. You can accept the default by navigating past it or press Enter and make a selection.

F. Leave the capacity as default.

G. Use the Up/Down arrows to select Create Volume and press Enter to create the array. This will take you back to the main screen for the current controller where you can create an additional RAID array (up to 2 arrays) or view already created arrays.

**2. RAID Creation from an EFI SHELL.**

RAID arrays can be created in the EFI shell by using the shell specific Intel® RAID Utility for the controller. This is useful in a deployment environment where an organization wants to configure multiple systems identically. The utilities can also be run from an EFI bootable USB key.

The utilities are specific to a particular driver version and are available with the driver package downloadable from hp.com.

The utility is:

- RstVmdConfig.efi

A tool with the ability to create, delete, and manage any RAID/ Intel® Optane™ volumes on a VMD system. For complete help, use '/?' command line parameter for more information or refer to RstVmdConfig.txt that is released with the tool.

See the RstVmdConfig.txt in the RST_VMD_DXE_PV folder in the RST preOS package specific usage instructions.

Example:
> RstVmdConfig.efi /? Press Enter

**3. RAID creation from a Windows Administrator Command Prompt.**
RAID arrays can be created by using Intel® Optane™ Memory volume in a Windows* 10 or Windows* 11 OS system Command Line Interface (RSTCLI). The CLI is included in the Intel® RST driver package for your system, downloadable from hp.com. The RSTCLI utility must be executed from an administrator command prompt. If you attempt to execute the RSTCLI utility from a non-administrator command prompt, you will receive the following message: "Could not obtain system information to display middleware version."

The utility is:
- rstcli64.exe

See the clireadme.txt in the CliNonOEM folder in the RST driver package for specific usage instructions.

Example:
> rstcli64.exe -I -d 0-5-0-0 Press Enter

**4. RAID creation from within the OS using the Intel® Optane™ Memory and Storage Management application.**
The RST GUI provides an easy method for creating RAID arrays. The RST GUI is pre-installed on systems shipped from the factory, and can also be installed from the latest driver package available on hp.com.
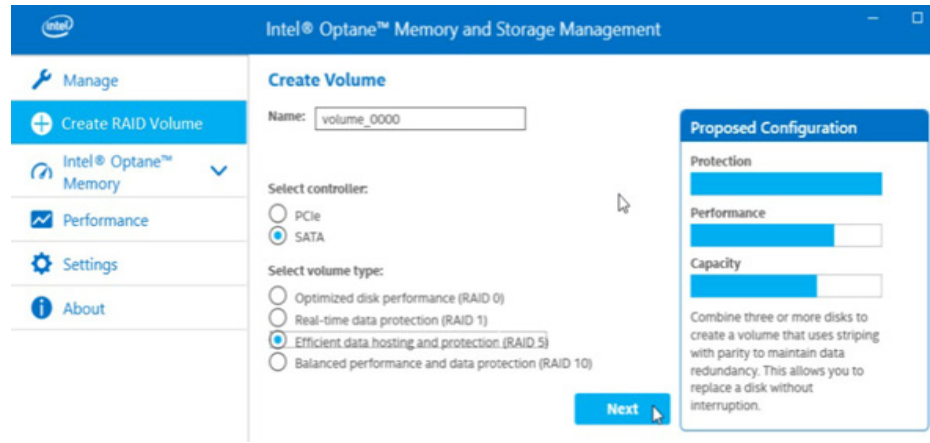
Launch Intel® Optane™ Memory and Storage Management application by navigating to it from the Start menu, or press the Windows key and then start typing "Intel®" in the Box that appears. A short list should appear that contains "Intel® Optane™ Memory and Storage Management application". Click this item with the mouse to launch the GUI.
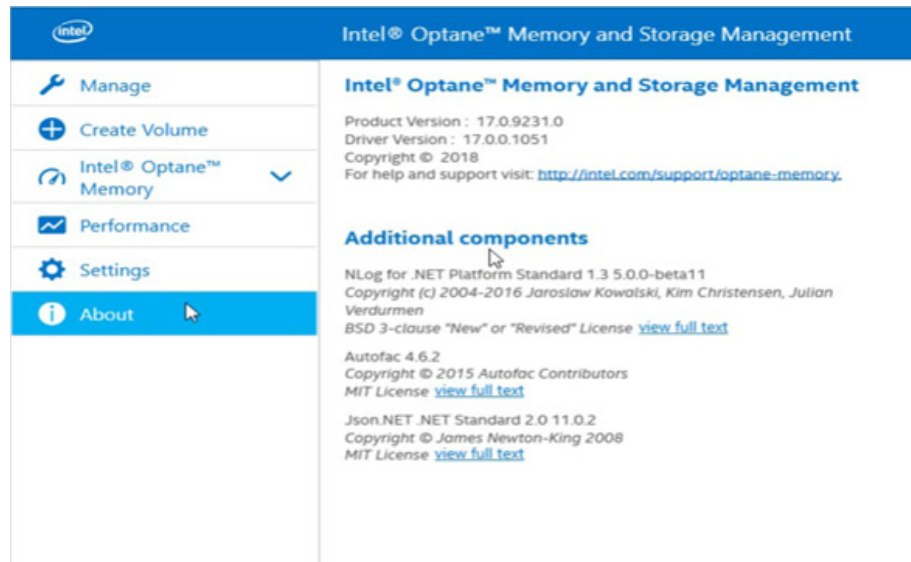
Click the "Create RAID Volume" button to start the guided RAID array creation process. Additional help is available in the "About" option and can get more information by click the right hand side URL as below picture.



*The GUI has been installed on our HP Z2 workstation, user can update to the latest version of the GUI through Windows* Store. If the GUI has been uninstalled previously, the user can manually go to Microsoft* App Store to install the GUI. Of course, the GUI has included in the driver package and downloadable from hp.com.

## RAID1 Volume Rebuild When Abnormal Shutdown Observed

Since the RAID1 volume is a single volume that is a mirror image of identical data on two physical drives on the same controller. Intel® RST driver will do the automatic data verification and rebuild while the RST driver discovers unexpected shutdown events in the OS event viewer.

Example: using a desktop but the power went out or accidentally unplugged while using desktop.

This kind of abnormal shutdown we called the dirty shutdown and this will be logged in the Windows OS as an unexpected shutdown event.

The RST driver found this abnormal event and then do the data verification or rebuild to protect the user's data but the performance will drop at this moment since the data rebuild. Of course, more data need more time to finish.

# Z

## Technical White Paper

Contents & navigation

## RAID1 Volume Rebuild Symptom on the Specific Condition

Due to the OS's mechanism, hardware configuration change or specific BIOS setting change may cause the RAID1 volume to do verification or rebuild.

The root cause is the fast-start-up algorithm from Microsoft's OS. The specific hardware change or specific BIOS setting change Is considered fast-start-up failed and then OS will pop the unexpected shutdown event in the OS event viewer.

Can find there is an error event "Event 29" and a critical event "event41" in the windows event viewer. Open the RST driver UI " Intel® Optane™ Memory and Storage Management" by searching this name in the left corner search bar and can find the RAID1 volume is "verify and repairing" or "rebuilding".

**The specific change is:**
- Memory DIMM capacity or brand be changed.
- The graphic card, TBT card, LAN card, and audio, of these PCIe devices, be changed.
- F10 BIOS setup menu > Advance > PCIe slots > Slot settings
- F10 BIOS setup menu > Advance > Build-in Device Options > embedded LAN controller
- F10 BIOS setup menu > Advance > Build-in Device Options > Integrated Video
- F10 BIOS setup menu > Advance > Build-in Device Options > VGA Boot Device
- F10 BIOS setup menu > Advance > Build-in Device Options > Video memory size
- F10 BIOS setup menu > Advance > Build-in Device Options > Audio device

Due to these changes involving driver and port change in OS, RST driver should do the check whether the data loss while these change. This is expected behavior but will cause the performance drop at this moment.

**HP Z2 workstation recommendation**
- Waiting for the RST driver verify/rebuild process to finish

We recommended letting the RST driver do this check or rebuild since this is a safe way to make sure system data is okay.

- Manually cancel the "verify and repairing" process in Intel® Optane™ Memory and Storage Management

Searching" Intel® Optane™ Memory and Storage Management" through the left corner search bar and click it > select the RAID1 volume which is doing "verify and repairing" > click the right-hand side window of selected RAID1 volume > click the cancel button which is under the "verify and repairing"

- Disable Fast-start-up in Windows OS

Avoid these setting changes that cause the performance drop in the normal boot but increase the boot time.

Search "control panel" through the search bar in the left corner > find the "power option" and lick it > select "choose what the power buttons do" > uncheck " Turn on fast startup(recommended)" in shutdown settings

*Disable this option will increase the boot time by about 10~20%