

Intel® Virtual RAID on CPU (Intel® VROC), Intel® Rapid Storage Technology enterprise (Intel® RSTe)

Windows Software User Guide

August 2018
Revision 1.5



Revision History

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1.2	Updated for 5.3 PV Release	October 2017
1.3	Updates for Intel® Xeon® Processor D-2100 Product Family	February 2017
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1 Introduction

The Intel® Rapid Storage Technology enterprise (Intel® RSTe) 5.5 PV family of products provide enterprise RAID solutions for both NVMe SSD and SATA devices for the enterprise servers, workstations and some high-end desktops.

1. Intel® Virtual RAID on CPU (Intel® VROC) provides enterprise RAID solution on platforms that supports Intel® Volume Management Device (Intel® VMD).
2. Intel® Rapid Storage Technology enterprise (Intel® RSTe) SATA provides an enterprise RAID solution for SATA devices connected to SATA/sATA Intel® Platform Control Hub (Intel® PCH) configured for RAID.
3. Intel® Rapid Storage Technology enterprise (Intel RSTe) NVMe provides an RAID solution for Intel NVMe SSDs attached to PCIe slots managed by the Platform CPU. Intel RSTe NVMe is not intended for, nor supported on platforms that have Intel VMD capabilities (weather Intel VMD is enabled or disabled).

Note: Intel RSTe 5.5 is a high level blanket product reference for Intel VROC, Intel RSTe SATA and Intel RSTe NVMe.

1.1 Terminology

Table 1: Terminology

Term	Description
API	Application Programming Interface
Intel® ASM	Intel® Accelerated Storage Manager
BIOS	Basic Input/Output System
GB	Gigabyte
GUI	Graphical User Interface
HII	Human Interface Infrastructure
Hot-Plug	The unannounced removal and insertion of a drive while the system is powered on.
I/O	Input/Output
Initramfs	Initial Ram File system
KB	Kilobyte
Matrix RAID	Two independent RAID volumes within a single RAID array.
MB	Megabyte



Term	Description
Member Disk	An NVMe drive used within a RAID array.
NVMe	Non-volatile Memory Express
OS	Operating System
POST	Power On Self-Test
Pre-OS	A BIOS option to configure Intel VROC and Intel RSTe RAID.
RAID	Redundant Array of Independent Disks: allows data to be distributed across multiple drives to provide data redundancy or to enhance data storage performance.
RAID 0 (striping)	The data in the RAID volume is striped across the array's members. Striping divides data into units and distributes those units across the members without creating data redundancy, but improving read/write performance.
RAID 1 (mirroring)	The data in the RAID volume is mirrored across the RAID array's members. Mirroring is the term used to describe the key feature of RAID 1, which writes duplicate data from one drive to another; therefore, creating data redundancy and increasing fault tolerance.
RAID 5 (striping with parity)	The data in the RAID volume and parity are striped across the array's members. Parity information is written with the data in a rotating sequence across the members of the array. This RAID level is a preferred configuration for efficiency, fault-tolerance, and performance.
RAID 10 (striping and mirroring)	The RAID level where information is striped across a two drive arrays for system performance. Each of the drive in the array has a mirror for fault tolerance. RAID 10 provides the performance benefits of RAID 0 and the redundancy of RAID 1. However, it requires four hard drives so it's the least cost effective.
RAID Array	A logical grouping of physical drives.
RAID Volume	A fixed amount of space across a RAID array that appears as a single physical drive to the operating system. Each RAID volume is created with a specific RAID level to provide data redundancy or to enhance data storage performance.
Spare	The drive that is the designated target drive in a recovery volume.
Strip	Block size that is assigned to evenly distribute portions of the stripe across a designated number of drives within a RAID array.
Stripe	The size of the data block that is to be written in each write cycle across the RAID array.



Term	Description
Recovery Volume	A volume utilizing Intel® Rapid Recover Technology enterprise
Intel® RSTe	Intel® Rapid Storage Technology enterprise.
RWH	RAID Write Hole
SSD	Solid State Drive
TB	Terabyte
UEFI Mode	<i>Unified Extensible Firmware Interface.</i> Refers to the system setting in the BIOS
Intel® VMD	Intel® Volume Management Device
Intel® VROC	Intel® Virtual RAID on CPU

1.2 Reference Documents

Table 2: Reference Documents

Document	Document No./Location
NVM_Express_1_2_Gold_20141209.pdf	Nvmexpress.org
Intel® RSTe and Intel VROC Technical Product Specification (TPS)	335893-001US
Intel® Accelerated Storage Manager Windows Administration Guide	XXXXX-XXXXX



2 Intel® RSTe Features

2.1 New to Intel® RSTe 5.5 PV

Several new features have been added to Intel RSTe 5.5 PV product family. For a complete list of features and platform requirements, please review the *Intel® VROC and Intel® RSTe for Windows* Technical Product Specification* included in the release package.

Some of the new features are as follows:

- Support for the following platforms
 - Intel C610 series chipset
 - Intel C220/230/240 series chipset
- Support for Intel RSTe NVMe
- Enhanced Event Logging and Error Management

Note: This guide does not provide instructions on how to modify default LED management values. These details can be located within the Intel VROC and Intel RSTe for Windows* Technical Product Specification Guide.

2.2 Intel VROC Configuration Features

The key Intel VROC features are activated based on four different configurations that can be used.

1. The first is Intel VROC Pass-thru (no Intel VROC Upgrade Key installed in the platform).
2. The second is the Standard SKU (which has the Intel VROC Standard Upgrade Key installed in the platform). The Standard Upgrade Key will enable the use of RAID 0, RAID 1 and RAID 10.
3. The third is an Intel Only SSD Upgrade Key that will provide the same features as the Premium Upgrade Key, but only if used with Intel SSDs.
4. The final configuration is the Premium SKU (which has the Intel VROC Premium Upgrade Key installed in the platform). Premium Upgrade Keys will allow for the use of all RAID configurations included with the Standard SKU with the addition of RAID 5 support, and the RAID Write Hole option (which provides additional data failsafe protections).

Standard and Premium Upgrade Keys enable the use of Intel VROC features on Intel and approved 3rd party NVMe drives. Intel VROC Pass-thru is the default state, where no upgrade key has been plugged into the system, and can be upgraded based on the features desired. These features are also restricted to approved operating systems for proper operational functionality.



2.3 Scope and Limitations

This is the Intel RSTe 5.5 PV product family release package and meets Intel's production quality standards.

Here are some constraints:

1. The Intel RSTe 5.5 PV GUI requires the presence of Microsoft .NET 3.5 or greater on the system.
2. The Intel VROC and Intel RSTe will only reflect drives that are compatible for the RAID type that has been selected. Incompatible drives will not be within the selection values available. You will not be able to force this in the GUI or in the BIOS.

2.4 Supported Platforms/Chipsets/SKUs

The Intel RSTe 5.5 product package was designed to work with, tested and validated on Intel Customer Reference Boards (CRBs) outlined in this section.

2.4.1 Supported Platforms for Intel VROC

CPU	Platform	VMD Device ID	# of VMD
Intel® Xeon® Processor Scalable family - W	Intel® Xeon® Processor Scalable family workstation	201D	3 per CPU
Intel® Xeon® Processor Scalable family – SP	Intel® Xeon® Processor Scalable family server and workstation	201D	3 per CPU
Intel® Xeon® Processor D-2100 Product Family	Intel® Xeon® Processor D-2100 Product Family based platform	201D	3 per CPU
Intel® X99 High End Desktop	Intel® Xeon® Processor Scalable family server and workstation	201D	3 per CPU

Note: Intel VROC support on the Intel X99 High End Desktop platforms is restricted to Intel NVMe SSDs only. This is a platform limitation. As a result, when Intel VROC is installed onto an Intel X99 High End Desktop platform, the customer will only see Intel NVMe SSDs plugged into the platform.

Note: Intel RSTe NVMe is not supported on platforms that support Intel VROC.



2.4.2 Supported Chipset SKU for Intel RSTe SATA

Chipset	Platform	RAID controller Device ID	Intel RSTe NVMe Virtual Device ID	# of ports
Intel® C610 series chipset	Intel® C610 series chipset Platform	2826 (SATA) 2827 (sSATA)	2F9c	6 SATA 4 sSATA
Intel® C610 series chipset	Intel® C610 series chipset Platform - Refresh	2826 (SATA) 2827 (sSATA)	6F9C (refresh)	8 SATA 6 sSATA
Intel® C220 series chipset	Intel® C220 series chipset Platform	2826 (SATA)	N/A	6 SATA
Intel® C230 series chipset	Intel® C230 series chipset Platform	2826 (SATA)	A135 (Integrated Sensor Hub enabled)	8 SATA
Intel® C240 series chipset	Intel® C240 series chipset Platform	2826 (SATA)	A37C (Integrated Sensor Hub enabled)	8 SATA
Intel® 620 series chipset	Intel® Xeon® Processor Scalable family server and workstation	2826 (SATA) 2827 (sSATA)	N/A	8 SATA 6 sSATA
Intel® C422 series chipset	Intel® Xeon® Processor Scalable family workstation	2826 (SATA)	N/A	8 SATA
Intel® Xeon® Processor D-2100 Product Family	Intel® Xeon® Processor D-2100 Product Family based platform	2826 (SATA) 2827 (sSATA)	N/A	8 SATA 6 sSATA
Intel® X99 High End Desktop	Intel® Xeon® Processor Scalable family server and workstation	2826 (SATA)	N/A	8 SATA



2.5 Functionality

With the release of Intel RSTe 5.5 PV, there is management through the BIOS that will allow for creation of RAID volumes using Intel VROC and Intel RSTe when using NVMe SSDs and/or SATA drives as the vendor equipment allows. Configuration for each will be specified more directly within the documentation provided with your system.

The Intel RSTe 5.5 PV GUI enables the management of RAID Volumes on NVMe SSDs attached to PCI express slots managed by:

- The Intel VMD controller (via Intel VROC)
- The platform CPU (via Intel RSTe NVMe – Non Intel VMD supported platforms)

As well as RAID management provided for SATA drives connected to the Intel PCH in RAID mode.

2.6 Scope and Limitations

This is the Intel RSTe 5.5 PV product family release package and meets Intel's production quality standards.

Here are some constraints:

1. The Intel RSTe 5.5 PV GUI requires the presence of Microsoft .NET 3.5 or greater on the system.
2. The Intel VROC and Intel RSTe will only reflect drives that are compatible for the RAID type that has been selected. Incompatible drives will not be within the selection values available. You will not be able to force this in the GUI or in the BIOS.

2.7 Supported Operating Systems

Table 5: Supported Operating Systems

OS	Intel® C610/C220/C230 series chipset based platforms	Intel® C240 series chipset based platforms	Intel® Xeon® Processor Scalable family based platforms	Intel® Xeon® Processor Scalable family Workstation based platforms	Intel® Xeon® Processor Scalable family Server based platforms	Intel® Xeon® Processor D-2100 Product Family based platform
Windows* 7 SP2	Y	Y	Y	Y		
Windows 8.1	Y	Y				
Windows* Server 2008 R2	Y					
Windows* 10 (RS1, RS2, RS3, RS4)	Y	Y	Y	Y		
Windows* Server 2012 R2 Enterprise	Y	Y			Y	Y
Windows* Server 2016 Enterprise	Y	Y			Y	Y

Only 64bit OS is supported.



2.8 RAID 0 (Striping)

RAID 0 uses the read/write capabilities of two or more drives working in parallel to maximize the storage performance of a computer system. The following table provides an overview of the advantages, the level of fault-tolerance provided, and the typical usage of RAID 0.

Note: RAID 0 is supported for Intel VROC without an upgrade key installed into the platform.

Table 6: RAID 0 Overview

Drives Supported	2 minimum
Advantage	High transfer rates
Fault-tolerance	None – If one drive fails all data will be lost
Application	Typically used in desktops and workstations for maximum performance for temporary data and high I/O rate. 2-drive RAID 0 available in specific mobile configurations. It also should be noted that although RAID 0 can be scaled to many drives there is a performance sweet spot specific to your implementation.

2.9 RAID 1 (Mirroring)

RAID 1 volumes contain two drives where the data is copied to both of the drives in real time, to provide data reliability, in the case of a single disk failure. When one disk drive fails, all data is immediately available on the other drive without any impact to the integrity of the data. The following table provides an overview of the advantages, the level of fault-tolerance provided, and the typical usage of RAID 1.

Table 7: RAID 1 Overview

Drives Supported	2 maximum
Advantage	Redundancy of data. One drive may fail, but data will continue to be accessible. A rebuild to a new drive is recommended to maintain data redundancy.
Fault-tolerance	Excellent – Drive mirroring means that all data on one drive is duplicated on another drive.
Application	Typically used for smaller systems where capacity of one disk is sufficient and for any application(s) requiring very high availability. Available in specific mobile configurations.



2.10 RAID 5 (Striping with Parity)

RAID 5 volumes contain three (minimum) or more drives where the data and parity are striped across all the drives in the volume. Parity is a mathematical method for recreating data that was lost from a single drive, which increases fault-tolerance. If there are N drives in the RAID 5 volume, the capacity for data would be N - 1 drives. For example, if the RAID 5 volume has 5 drives, the data capacity for this RAID volume consists of 4 drives. The following table provides an overview of the advantages, the level of fault-tolerance provided, and the typical usage of RAID 5.

Table 8: RAID 5 Overview

Drives Supported	3 minimum
Advantage	High percentage of usable capacity and high read performance as well as fault-tolerance.
Fault-tolerance	Excellent - Parity information allows data to be rebuilt after replacing a failed drive with a new drive.
Application	Storage of large amounts of critical data. Generally not available in mobile configurations. As with RAID 0 Striping, although RAID 5 can be scaled to many drives there is a performance sweet spot specific to your implementation.

2.11 RAID 10

A RAID 10 volume uses four drives to create a combination of RAID levels 0 and 1. It is a striped set whose members are each a mirrored set. It provides a great balance between performance and excellent fault tolerance as it allows 2 drives to fail while still maintaining access to data but, has a low cost effectiveness. The following table provides an overview of the advantages, the level of fault-tolerance provided, and the typical usage of RAID 10.

Table 9: RAID 10 Overview

Drives Supported	4
Advantage	Combines the read performance of RAID 0 with the fault-tolerance of RAID 1.
Fault-tolerance	Excellent - Drive mirroring means that all data on one drive is duplicated on another drive.
Application	High-performance applications requiring data protection, such as video editing.



2.12 Intel® VROC RAID Write Hole Closure

The Intel RSTe 5.5 PV product family will support the ability to close the RAID Write Hole scenario in RAID 5 configurations. This applies to Intel VROC on Intel® Xeon® Scalable Platforms.

RAID Write Hole (RWH) is a fault scenario, related to parity based RAID. It occurs when a power-failure/crash and a drive-failure (e.g., strip write or complete drive crash) occur at the same time or very close to each other.

Unfortunately, these system crashes and disk failures are correlated events. This can lead to silent data corruption or irrecoverable data due to lack of atomicity of write operations across member disks in parity based RAID. Due to the lack of atomicity, the parity of an active stripe during a power-fail may be incorrect and inconsistent with the rest of the strip data; data on such inconsistent stripes does not have the desired protection, and worse, can lead to incorrect corrections (silent data errors).

The previous Intel RSTe mechanisms implemented to address the RAID Write Hole condition encompassed a combination of Dirty Stripe Journaling and Partial Parity Logging. This implementation only partially closed the RAID Write Hole. With the Intel RSTe 5.5 PV product family, the RWH solution included will completely close this condition (when RWH is enabled). When RWH is disabled, the old implementation (using Dirty Stripe Journaling and Partial Parity Logging) is used.



3 Functionality

Intel RSTe 5.5 PV, provides RAID management through the BIOS that will allow for creation of RAID volumes using Intel VROC and Intel RSTe using SATA/sSATA drives as the vendor equipment allows. Configuration for each will be specified more directly within the documentation provided with your system.

The Intel RSTe 5.5 PV GUI enables the management of RAID Volumes on NVMe SSDs attached to PCI express slots managed by:

- The Intel VMD controller (via Intel VROC)
- The platform CPU (via Intel RSTe NVMe – Non Intel VMD supported platforms)

As well as RAID management provided for SATA drives connected to the Intel PCH in RAID mode.



4 Pre Operating System Introduction

RAID Management through the BIOS Setup environment, included with the Intel RSTe 5.5 PV package, incorporates the functionality of Intel VROC and Intel RSTe Pre Operating System (Pre-OS) management components so that RAID management and control can begin within the BIOS Setup directly.

This enables the creation of RAID Volumes that can be assembled in advance of installation of an Operating System. This guide will also cover the instructions of how to load the specialized F6 Windows* drivers within the Operating System during installation to utilize this feature.

Please refer to the documentation provided with your system for the exact configuration details for enabling Intel VMD controller and setting the PCH into RAID mode. There will be a generalized series of instructions provided based on one of the Intel® Xeon® Scalable Platform Customer Reference Board (CRB) as a primer.

4.1 Navigating the Pre Operating System

The BIOS Setup environment is accessed during a system start or Power on Self-Test (POST). The option to access the Setup Menu does vary depending on manufacturer, the examples in the guide will all be presented with the value as F2.

4.2 Enabling Intel® RSTe (SATA/sSATA)

Intel RSTe allows for the creation of RAID volumes through the UEFI HII interface, that is part of the UEFI driver package, and is included with the platform BIOS. The Intel RSTe UEFI HII can be accessed via the BIOS Setup environment. To enable the ability to create RAID volumes, the steps below have been created using an Intel Customer Reference Board (CRB). Please refer to the instructions that have been supplied by the user's platform BIOS vendor, as those instructions may differ from the set below.

Step 1: Immediately following the POST, select the option that will allow for the user to access the BIOS setup menu. This example uses <F2>.

Step 2: Using the arrow keys, move the cursor to highlight the menu option **Advanced** and press <Enter>.

Step 3: Within the Advanced menu, use the arrow keys to navigate to the item **Mass Storage Controller Configuration** and press <Enter>.

Step 4: Within Mass Storage Controller Configuration, there are two menu options. The first is the sSATA Controller for Ports 0-5, and the second is the SATA Controller for Ports 0-7. Depending where you have the devices connected they may show in either menu. It is best to check each independently. To do so, highlight the desired controller and press <Enter>.

Step 5: Once the desired controller(s) have been identified, to enable the controller for RAID mode, the option by default will be lit up and set as AHCI. Press <Enter> to open a selection menu. There will be 3 options. One will disable the controller completely. The second is legacy AHCI mode. The third is RAID mode, which will turn on the Intel RSTe controller. Highlight RAID mode, and press <Enter>.

Step 6: There will be a small notification in the bottom right hand corner indicating that the configuration has changed. For these changes to be activated, a **Save Changes and Exit** command will need to be given. Press <F10> to initiate **Save Changes and Exit**.



Step 7: There will be a pop up window asking to confirm “Save configuration changes and exit? Press <Y> to continue in order to confirm and reboot the system.

Step 8: Use <F2> again after POST to enter the BIOS.

Step 9: Navigate to Advanced, and press <Enter>.

Step 10: Navigate to **PCI Configuration** and press <Enter>.

Step 11: Navigate to **UEFI Option ROM Control** and press <Enter>.

Step 12: The UEFI Option ROM Control should now show the newly enabled controller below the header, **Storage Controller**.

4.3 Enabling Intel® VMD

Intel VROC allows for the creation of RAID volumes through the UEFI HII interface, that is part of the UEFI driver package, and is included with the platform BIOS. The Intel VROC UEFI HII can be accessed via the BIOS Setup environment. With Intel VROC, Intel VMD will also need to be enabled on your new platform. This series of steps are provided based on an Intel Customer Reference Board (CCB). Please refer to the instructions that have been supplied by the user's platform BIOS vendor as those instructions may differ from the set below.

Step 1: Immediately following POST, select the option that will allow the user to access the BIOS setup menu. This example uses <F2>.

Step 2: For the Intel CRB reference BIOS, the user will want to use the arrow keys to move the cursor to Advanced (it will become highlighted) and press <Enter>.

Step 3: Using the arrow keys, move the cursor to PCI Configuration and press <Enter>.

Step 4: Using the arrow keys, move the cursor to Volume Management Device and press <Enter>.

Step 5: This step varies depending on physical configuration of the system. The reference system has 4 direct connections from the backplane to the motherboard using Oculink cables for NVMe devices. Using the arrow keys, move the cursor to CPU1 Oculink Volume Management and press <Enter>. Toggle the selection from Disabled to Enable, and press <Enter> to select.

Step 6: VMD Port 3C (PCIe SSD0) and VMD Port 3D (PCIe SSD1) by default will also be Disabled. Navigate to each in turn. Press <Enter>, and toggle the Disabled setting to Enabled and press <Enter> to set selection.

Step 7: Repeat steps 5 and 6 on CPU2 Oculink Volume Management.

Step 8: Save settings by pressing <F10> to Save Changes and Exit.

Note: Please consult the user's Platform BIOS manufacturer documentation for a complete list of options that can be configured.



4.4 Creating a RAID Volume for a Boot Disk Using Intel® VROC HII

The following instructions are for creating a bootable RAID volume using the Intel VROC UEFI HII. This procedure should only be used for a newly built system or for reinstallation of the operating system. It is advised to use the Intel RSTe GUI within the Windows* operating system for the creation of RAID volumes after the operating system is installed.

Note: Please consult the user's platform documentation for instructions on how to enter into the Intel VROC HII interface.

The following assumptions have been made:

1. It is known how to enter into the appropriate platform BIOS setup menus.
2. The Intel VMD functionality has been enabled.
3. The appropriate Intel VROC RAID Upgrade Key has been installed.
4. The appropriate number of matching NVMe SSDs have been plugged into the enabled Intel VMD controller.

Step 1: Enter into the BIOS configuration setup menu to access the Intel VROC UEFI HII interface.

Step 2: Navigate to and select **Intel® Virtual RAID on CPU**

Step 3: Navigate to and select **Create RAID Volume**

Step 4: Type in a volume name and press the <Enter> key, or press the <Enter> key to accept the default name.

Step 5: Select the RAID level by pressing the <Enter> key, and using the arrow keys to scroll through the available values. Highlight the desired RAID type and press <Enter> to set the RAID type.

Step 6: **Only data volumes are supported in this configuration, boot volumes that are spanned are not supported.**

To enable spanned volumes, use the arrow key to highlight the < > bracket and press <Enter>. This will open a small selection menu. Navigate the cursor to the X and press the <Enter> to enable volume spanning. To disable, you would set the value back to blank and press <Enter> to save the value.

Step 7: Using the arrow keys, select the drives one by one by highlighting the < > bracket on the line next to that drive's port number. Press <Enter> to open the selection menu, which will be set to blank or off status. Navigate to highlight the X and press <Enter> to include that drive within the array.

Step 8: Repeat step 7 for each drive required within this array.

Step 9: Unless the user has selected a RAID 1, select the strip size by using the arrow keys and pressing <Enter> to open the options menu. Utilize the arrow keys to select the desired strip size and press <Enter> to save the value.

Note: RAID 1 is set at default strip size value of 128k and cannot to be modified.

Step 10: Select the volume capacity and press the <Enter> key. The default value will be displayed as the maximum capacity available with the drives selected. The value is calculated in bytes. A 700GB drive would use the following math: $(700 * 1024 = 716000)$.

Note: Unless specifically selected, the default volume capacity will be 95% of the available space. This is to support disk coercion.

Step 11: Navigate to **Create Volume** and press <Enter>



Step 12: The user will then be returned to the **Intel® Virtual RAID on CPU** screen and the newly created RAID volume will be listed just below the text **Intel VROC Managed Volumes:**

Other drives or unused portions of drives will be listed under Non-RAID Physical Disks. These may be used to create additional RAID volumes.

Step 13: To exit the user interface, press <Esc>. Press <Esc> again, the user will be presented with the following message: "Changes have not saved. Save changes and exit? Press 'Y' to save and exit, 'N' to discard and exit, 'ESC' to cancel". Press <Y> to save and exit.

Note: Not saving at this time will discard the changes made, including all changes and configuration settings for the RAID array.

Step 14: To save and reboot, in order to begin operating system installation, press <Esc> to return to the Main Menu. Navigate to select Reset and press <Enter> to reboot the system back to the boot menu.

Note: For RAID 1, 5 and 10 the system will not automatically initialize these volumes via the UEFI. This will need to be accomplished once the Operating System has been installed.

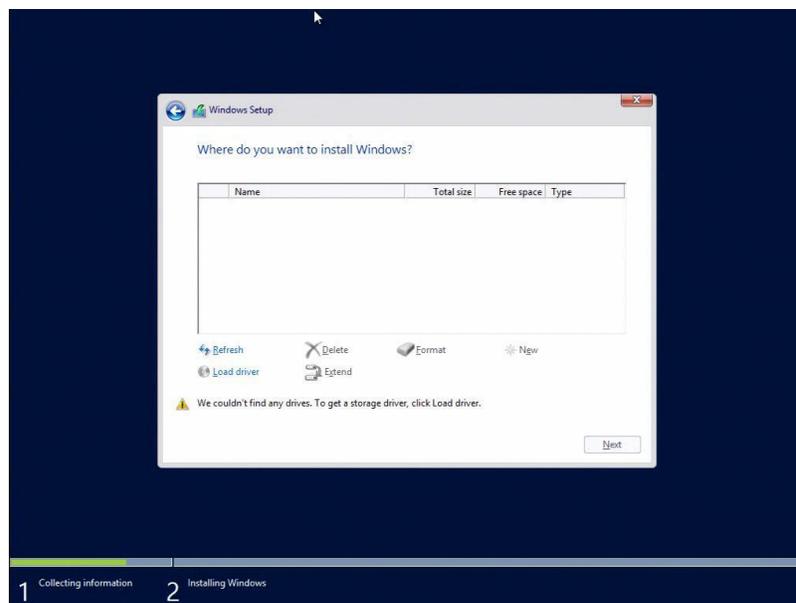
4.5 Installing Windows* Server 2012 R2 on a RAID Volume

With RAID boot volumes through Intel VROC available, additional drivers are required in order to properly install a Windows* operating system. This is a brief guide to show you the slight difference in order to introduce the F6 Drivers appropriate to utilize your BIOS created RAID volume as a system disk.

The following assumptions have been made:

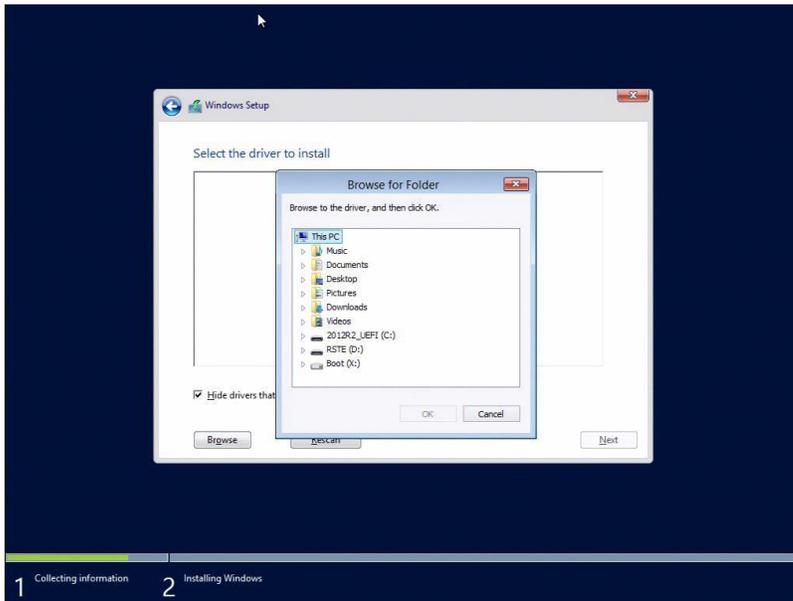
- Intel VMD has been configured and enabled.
- Intel VROC has been utilized and the RAID volume has been created

Image 1: Installation Destination Selection



1. Click on Load driver.
2. Click on the button marked Browse.

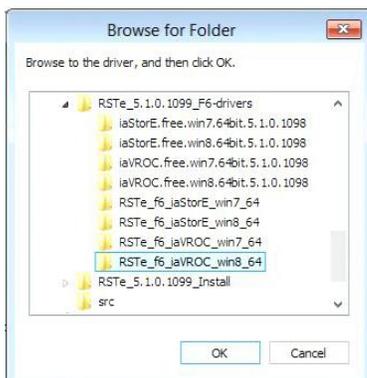
Image 2: Browse Options View



3. Navigate to where you have the correct F6 driver stored. iaStorE drivers are for SATA and sSATA drives, iaVROC will be for NVMe drives (when attached to the Intel VMD controller).

Note: There are drivers that are exclusive to Windows* 7*. Those are identified by having win7_64. All other Windows* operating systems are compatible with the drivers marked as win8_64.

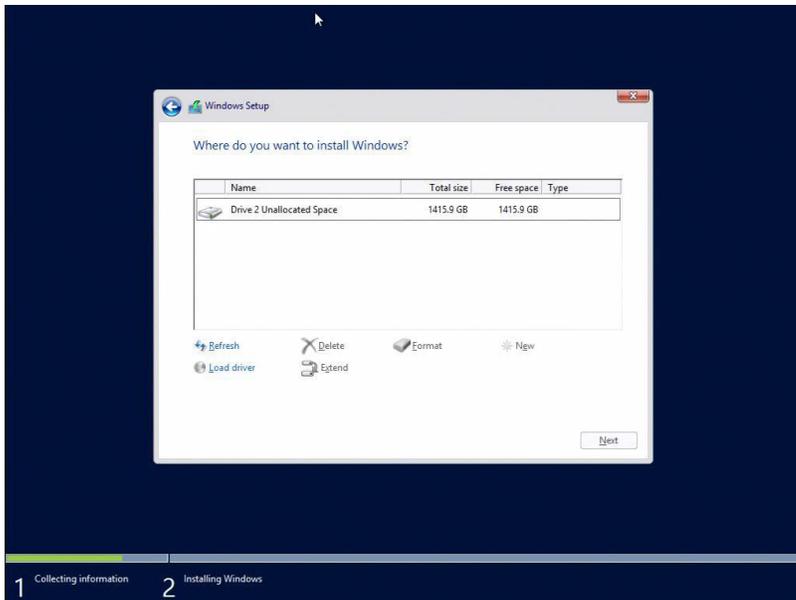
Image 3: Drivers Selection



4. The RAID Volume should now appear once the driver has installed. Select the volume and proceed with your operating system installation for Windows* as normal. If the drive does not immediately appear, use the Refresh tool to rescan the system for the RAID volume and proceed.



Image 4: Destination Selection Window Refreshed With Drivers Installed



5 Installing Intel® RSTe 5.5 PV GUI

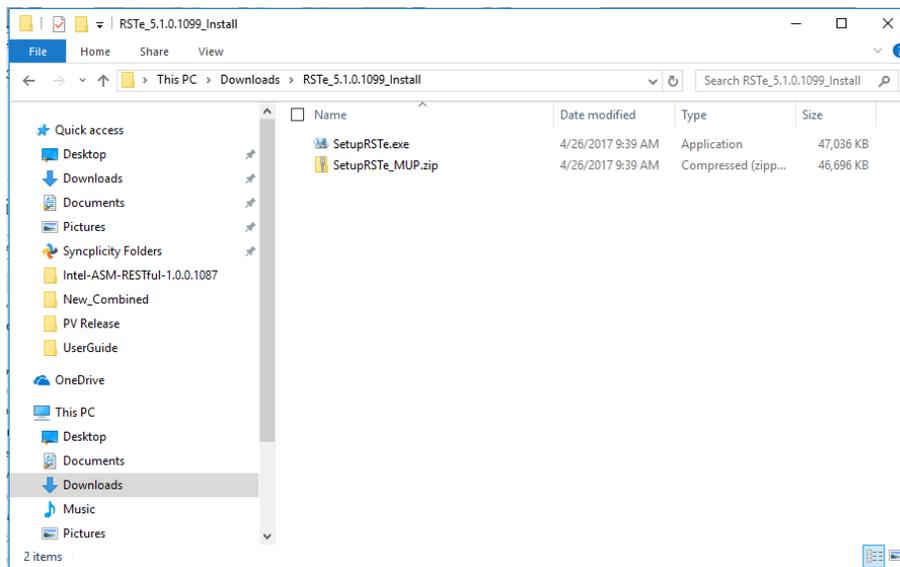
This section discusses the process of installation of the Intel RSTe 5.5 PV product family that will allow for fully integrated management of the disks installed on your Windows* system. This portion of the demonstration has been performed using Windows* Server 2016 as the operating system. The GUI interface will appear the same in all Windows* operating systems.

5.1 Installing Intel RSTe 5.5 PV Release Package

This installation example assumes you are installing Intel RSTe 5.5 PV for the first time. Installing Intel RSTe 5.5 PV can be accomplished by executing the installation executable.

1. In this example you right mouse click on “SetupRSTe.exe” and run as administrator to launch the installer.

Image 5: SetupRSTe.exe





2. The first window that will appear is the Intel® Rapid Storage Technology enterprise “Welcome” window. Select the “Next” button to continue.

Image 6: Installer Wizard Welcome



2. The second window is the “Warning” window. Select the “Next” button to continue.

Image 7: Warning





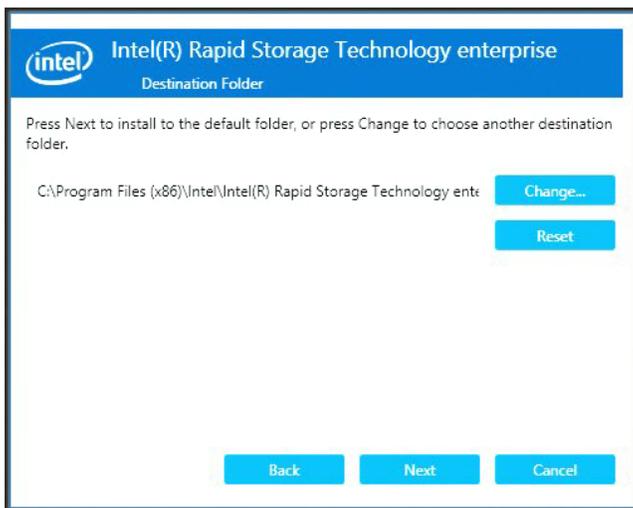
3. The next window is the End User License Agreement. Select “Accept” to accept and continue. The full text of this agreement is included in the Appendix.

Image 8: End User License Agreement



4. The next window is the “Destination Folder”. Select “Next” to install to the default folder, or press “Change” to choose another destination folder.

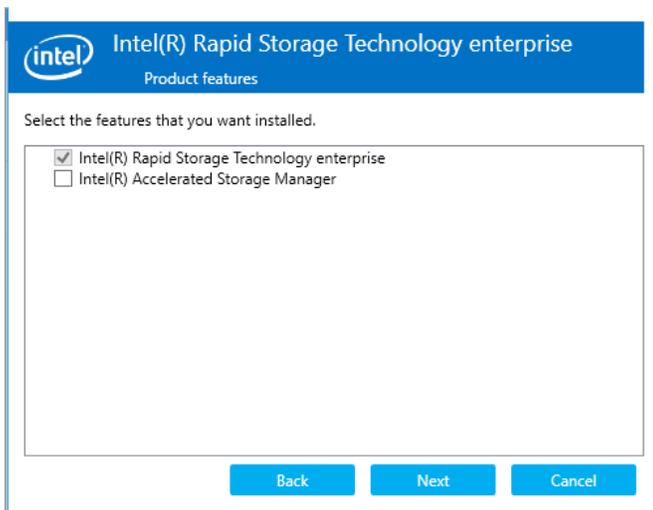
Image 9: Destination Folder for Installation





- The next window is “Product Features”. Select the products desired, then press “Next” to continue. Intel® Accelerated Storage Manager can be installed at the same time as Intel® RSTe. **Note:** ASM installation and configuration is covered within the Intel Accelerated Storage Manager Windows* Administration Guide.

Image 10: Product Feature Selection



- This is the “Confirmation” window. Press “Install” to install the selected components.

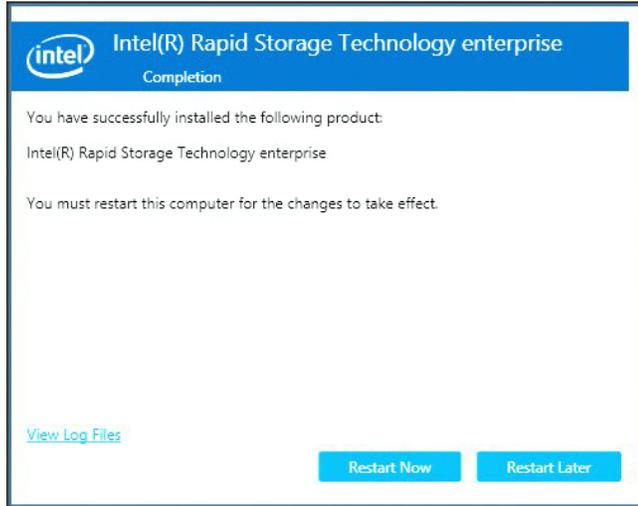
Image 11: Confirmation





11. The final window is “Completion”. It is important at this point to restart the system to complete the installation process. Select “Restart Now” to complete the installation process and reboot the system.

Image 12: Confirmation

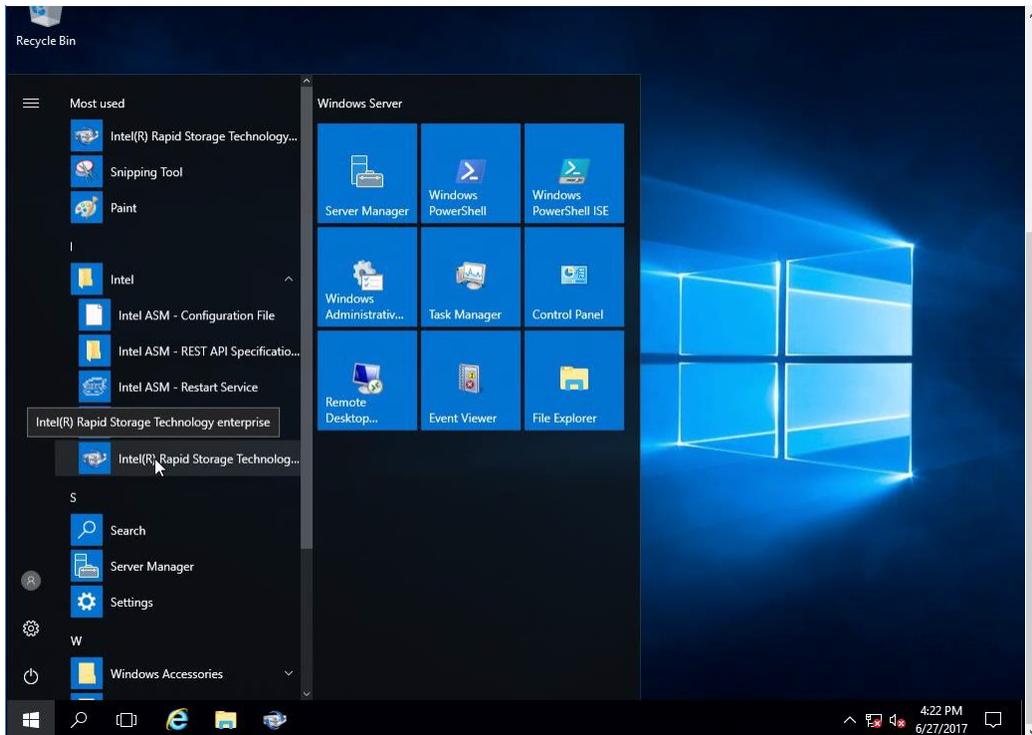




5.2 Opening the Intel RSTe GUI

Launch the Intel RSTe GUI as shown in the example below, by opening the Windows* start menu and locating the application. Then click on “Intel® Rapid Storage Technology enterprise”.

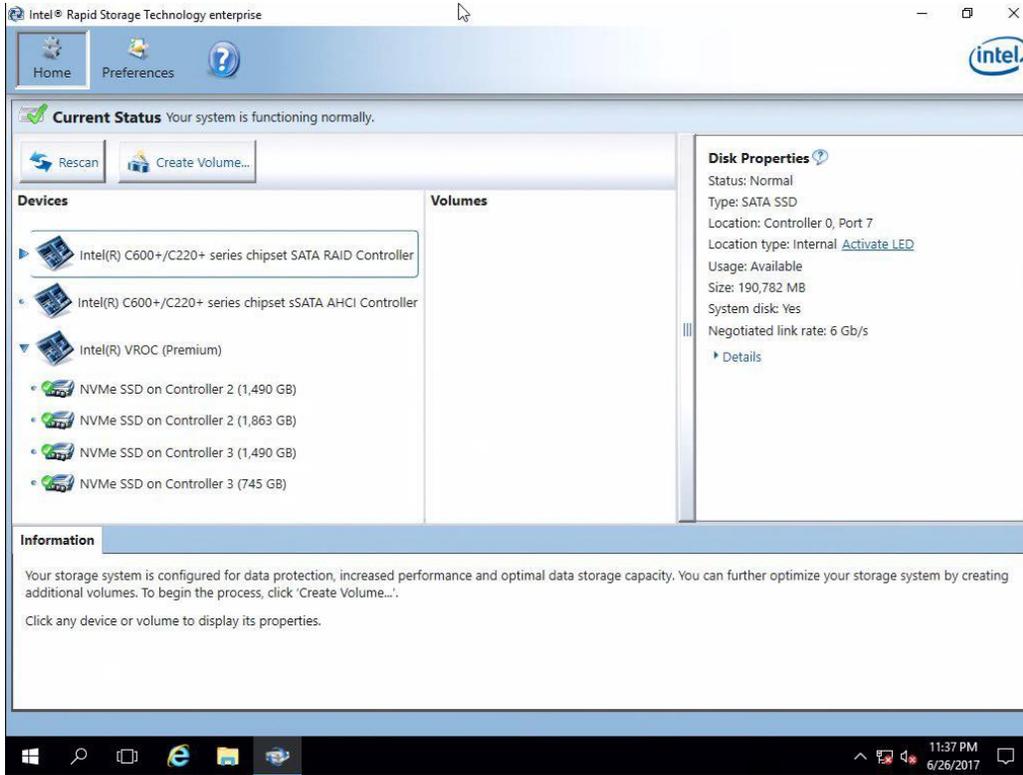
Image 13: Start Menu Location of Intel RSTe



The GUI will open to the “Home” page.

Note: The Intel VROC Upgraded Key installed on this system is the Premium Upgrade Key. This will enable all possible RAID functions and variants. You can see the status (Premium) listed next to the Intel VROC controller. For lists of what features are available with other keys and devices, please refer to the documentation provided with your system, and the Intel® VROC and Intel® RSTe for Windows* TPS.

Image 14: GUI Home



5.3 The Intel RSTe GUI Components

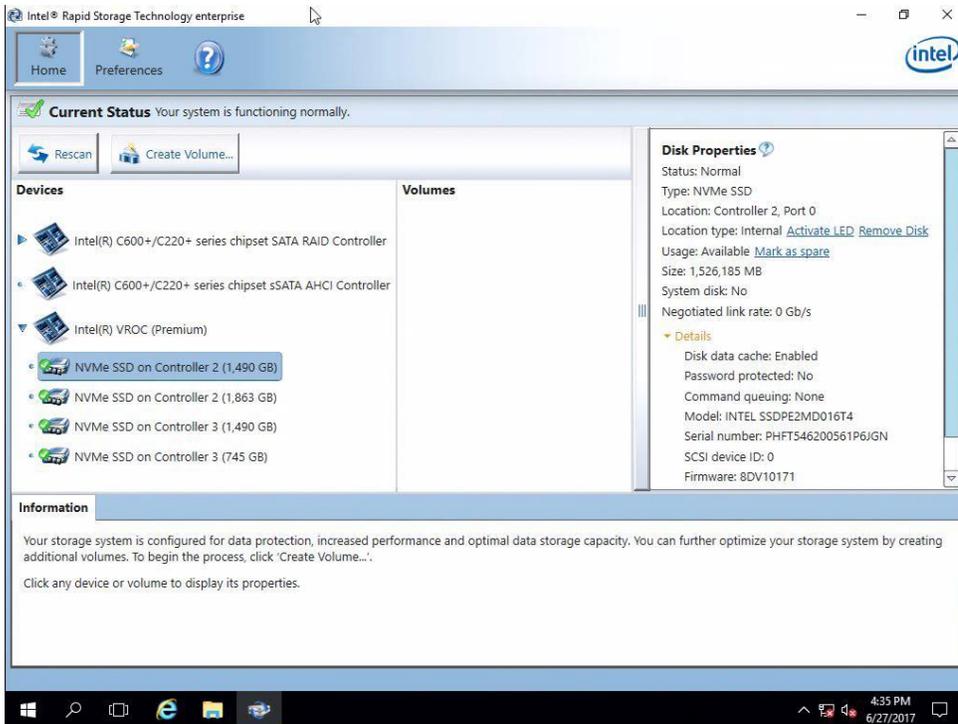
The home page is divided into several window panes; each used to convey information to the user depending in the selection made.

1. The “Devices” pane (to the left) will show the devices that are connected to the controller. This will be further broken down into sections based on SATA, sSATA and Intel VROC controllers should drives be attached within those categories. If the controller is enabled, but there are no associated drives, that controller has a dot rather than an arrow next to it. (The sSATA controller has no devices in the image below.)
2. The “Volumes” pane (in the middle) shows the RAID Arrays and RAID Volumes being managed by Intel VROC and Intel RSTe.
3. The “Properties” pane (to the right) will show the Properties of the component that is high-lighted in either the “Devices” pane or the “Volumes” pane.
4. The “Information” pane (at the bottom) will show information relative to the current status of the host controller, the devices attached to it or the Array and Volume.

Note: The arrow is pointing to a help menu option that will explain, in depth, additional information regarding the disk properties listed and what each item listed, within the Disk Properties pane, represents.



Image 15: Disk Properties

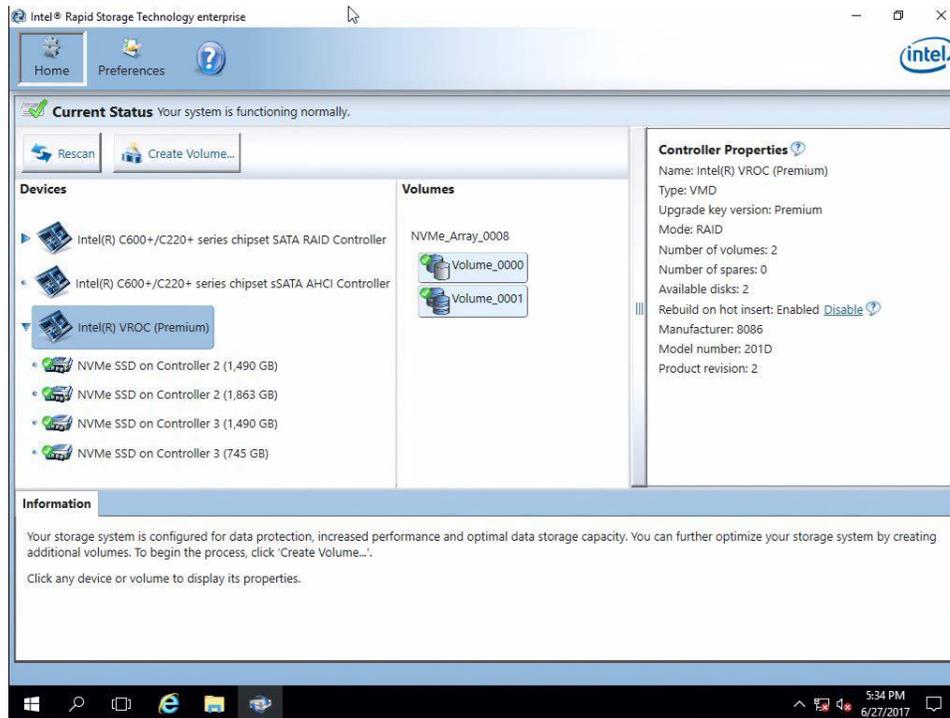


5.4 Devices

The following screenshots show the different information that is presented in the “Properties” window pane.

1. Under **Devices** in the home page of the GUI (to the left), selecting the NVMe controller, the **Controller Properties** will be shown in the properties window pane to the right.

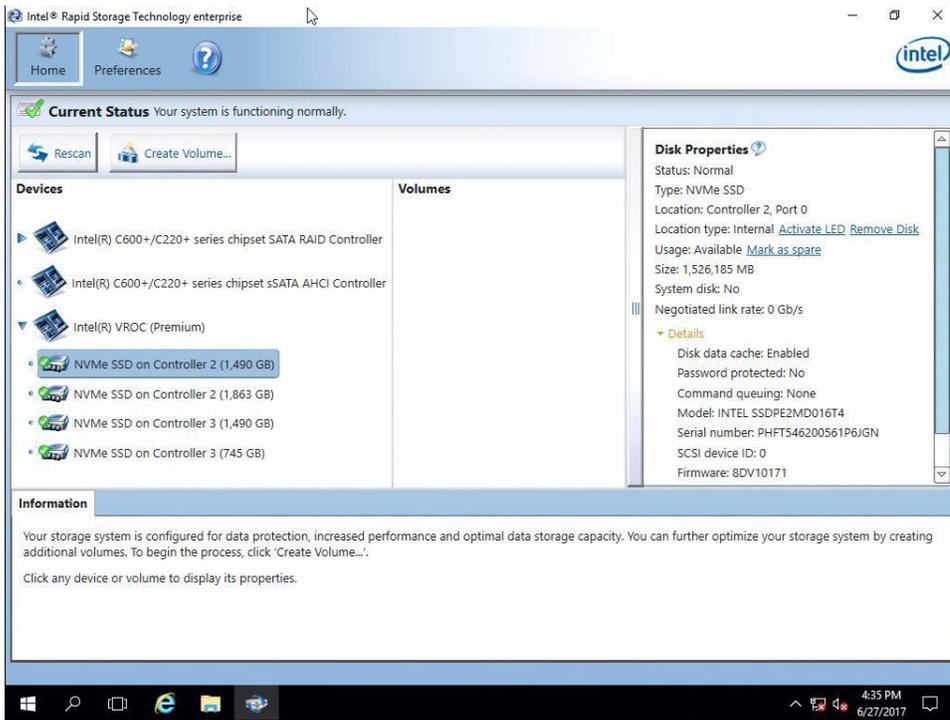
Image 16: Controller Properties





- By selecting a specific drive, the **Disk Properties** will appear to the right in the properties window pane.

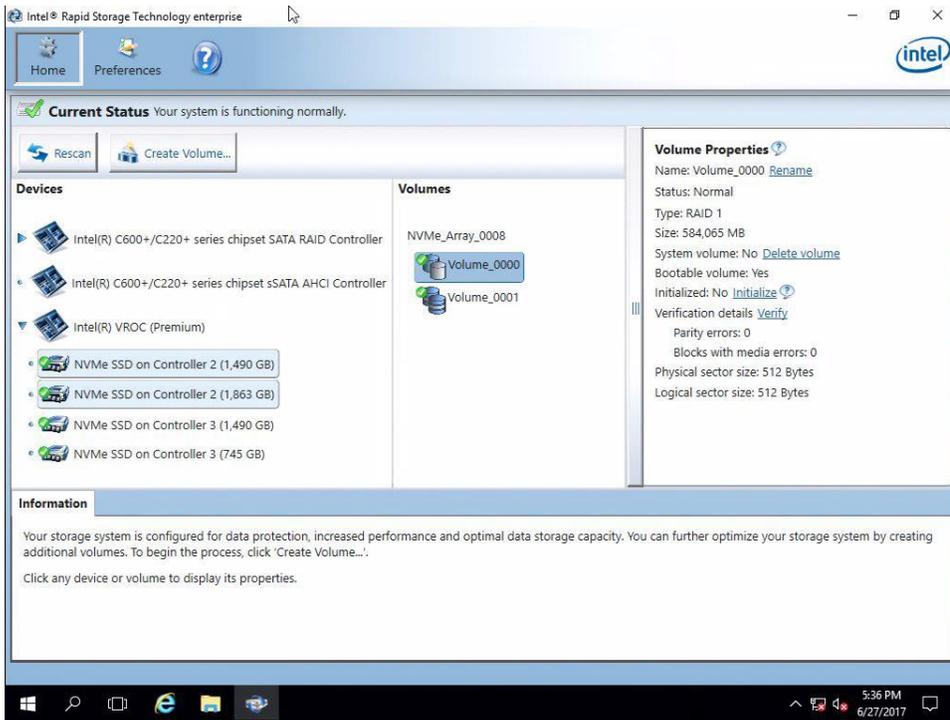
Image 17: Disk Properties





- By selecting a RAID Volume, the **Volume Properties** will appear to the right in the properties window pane.

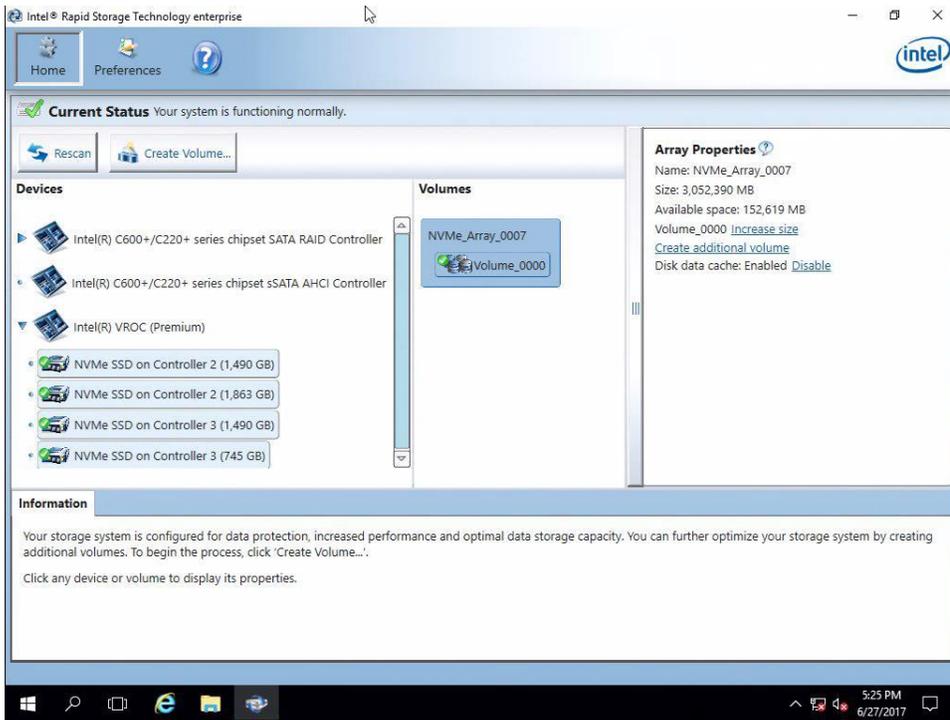
Image 18: Volume Properties





- By selecting the Array, the **Array Properties** will appear to the right in the properties window pane.

Image 19: Array Properties



6 Volume Creation

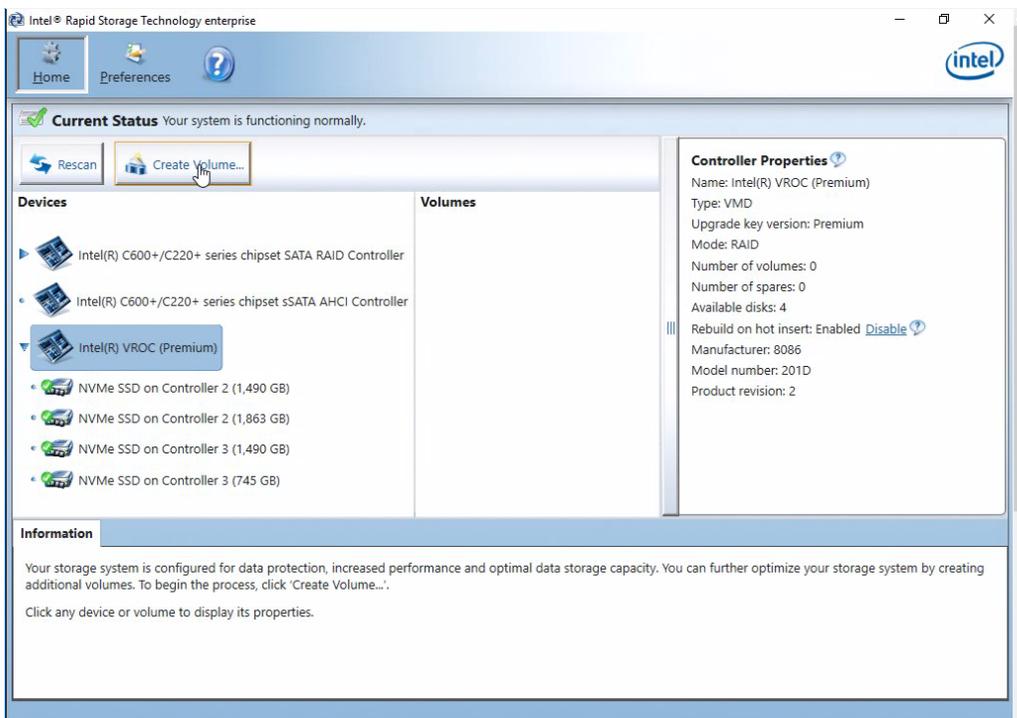
The following will provide guidance on utilizing the Intel RSTe GUI in the creation of a RAID volume. It will have the full set of drivers installed so that it will reflect the nature of the System drive on SATA in addition to the NVMe disks that will be employed as a data volume for the example. Only one example will be given as the process is extremely similar in each RAID type, it only varies mildly based on number of disks to be employed.

6.1 Create a 2 Drive RAID 0 Data Volume

The following example will step through the process of creating a 2 drive RAID 0 data volume.

1. Within the Home page select **Create Volume** to begin the process. The arrow below is pointing to the Create Volume button.

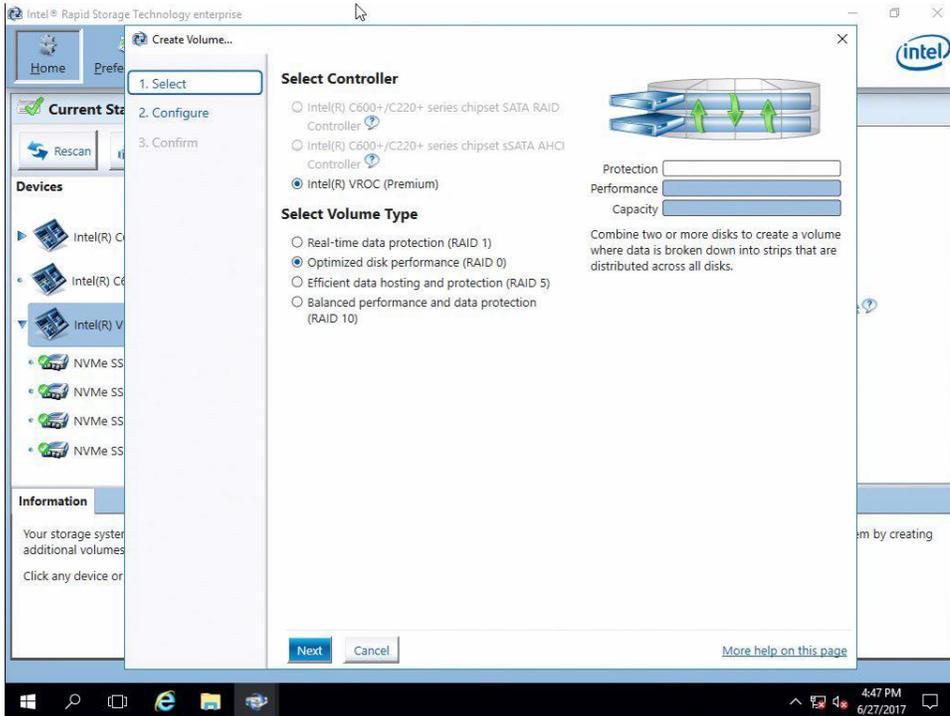
Image 20: Create Volume





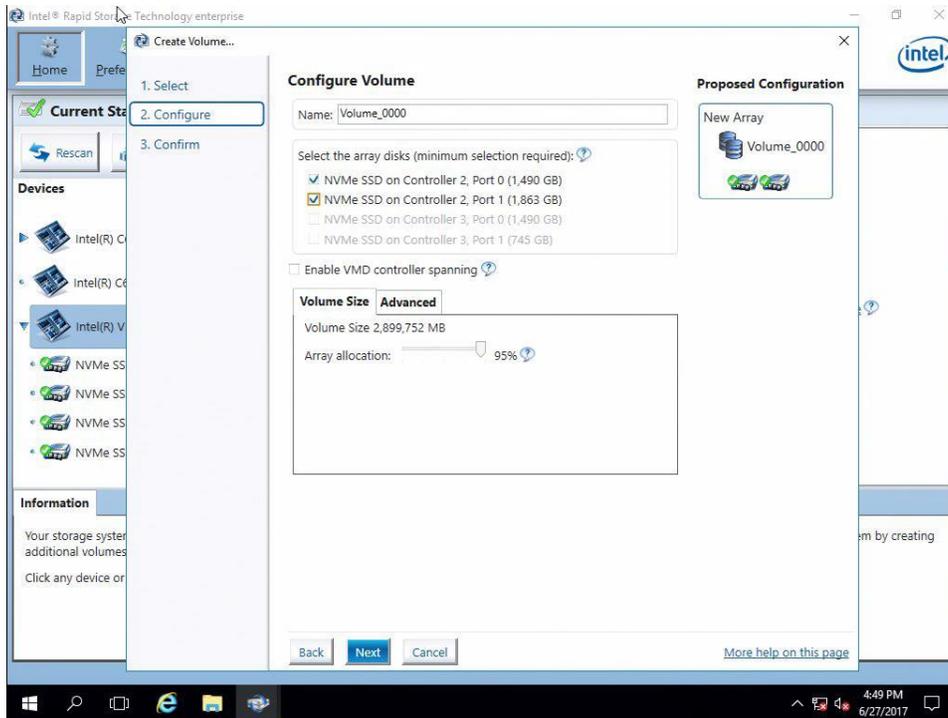
2. Select the **NVMe Devices** controller if not already selected. Next select **Optimized Disk Performance (RAID 0)**. Then, select **Next** to continue.

Image 21: Select Controller



3. To configure the volume, you can first specify the **Name** of the volume. In this example it has been left as default (**Volume_0000**). Next select two drives available to be included in the volume. Then click **Next**.

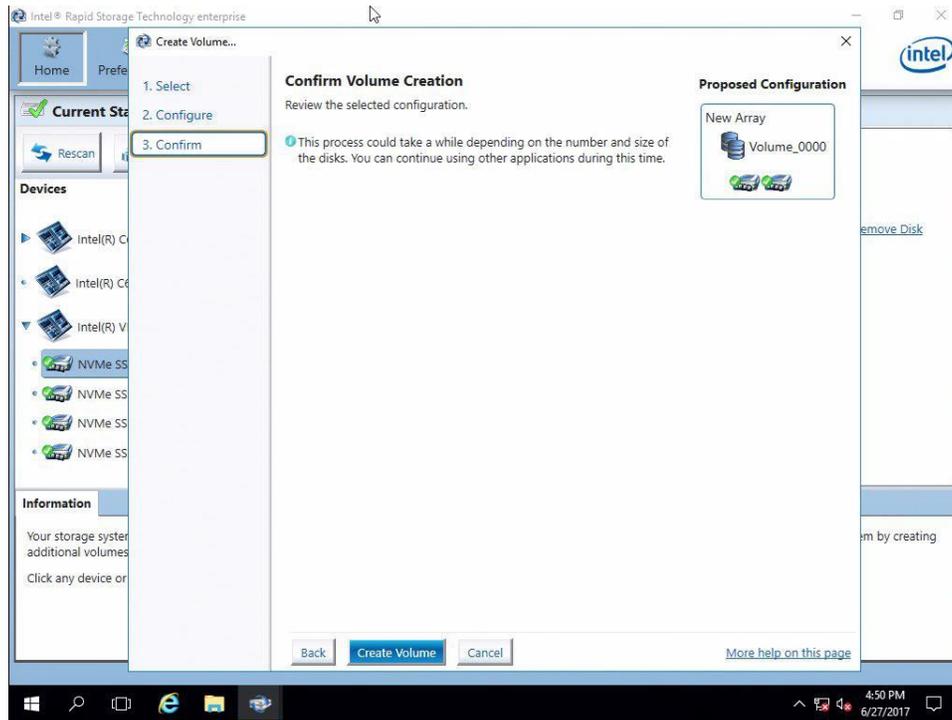
Image 22: Configure Volume





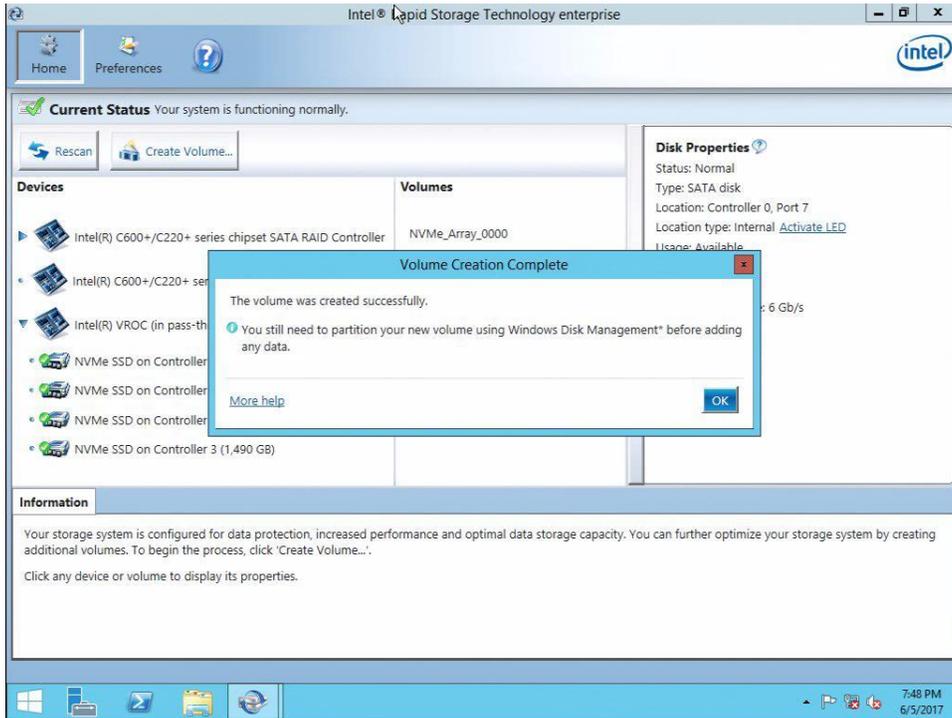
4. Click on **Create Volume**.

Image 23: Confirm Volume Creation



5. Click **OK** to continue. This will complete the volume creation process.

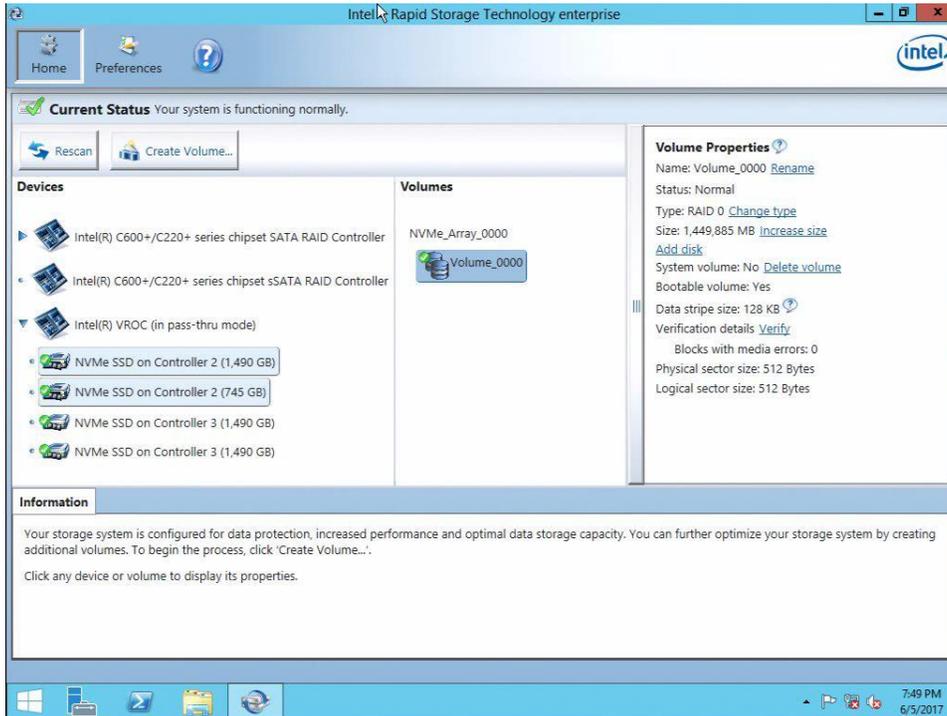
Image 24: Volume Creation Complete





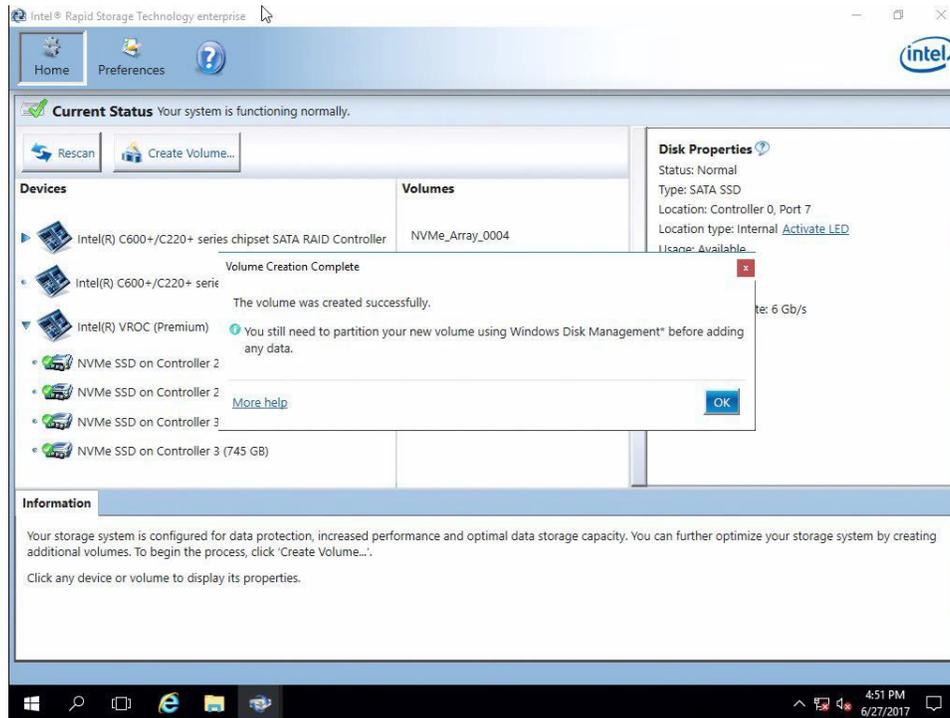
- RAID volume (**Volume_0000**), the “Properties” pane (right) will refresh to show the current status, properties and available options of the newly created RAID volume.

Image 25: Volume Properties



7. Formatting and mounting of the volume will still be required within Disk Management just as with any new drive added within a Windows* environment.

Image 26: Volume Creation Complete



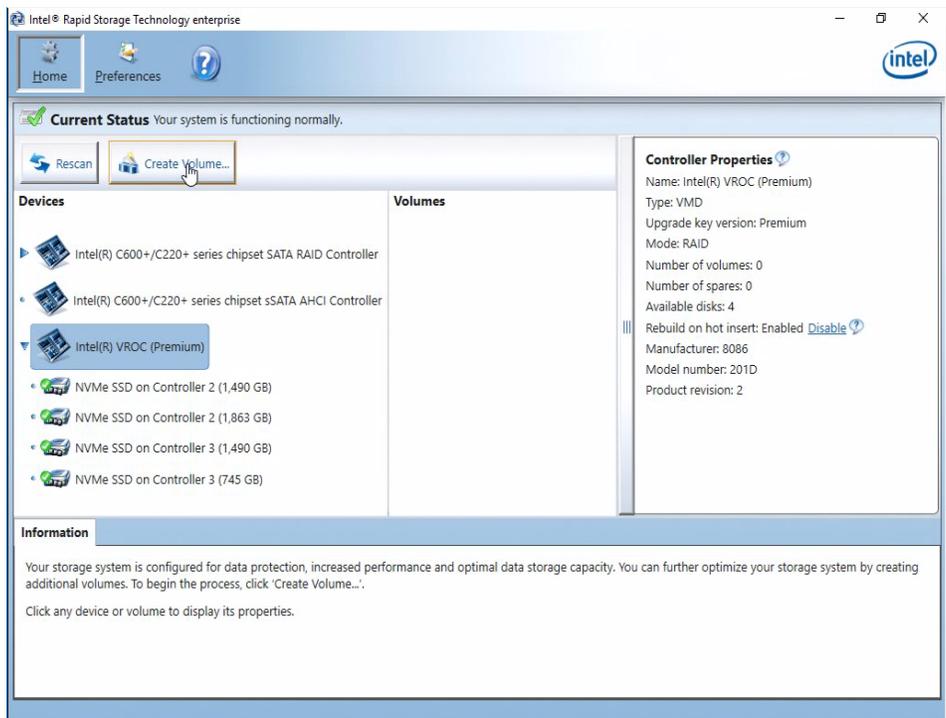


6.2 Create a 3 Drive RAID 5 Data Volume

The following example will step through the process of creating a 3 drive RAID 5 data volume.

1. Click on **Create Volume...** to begin.

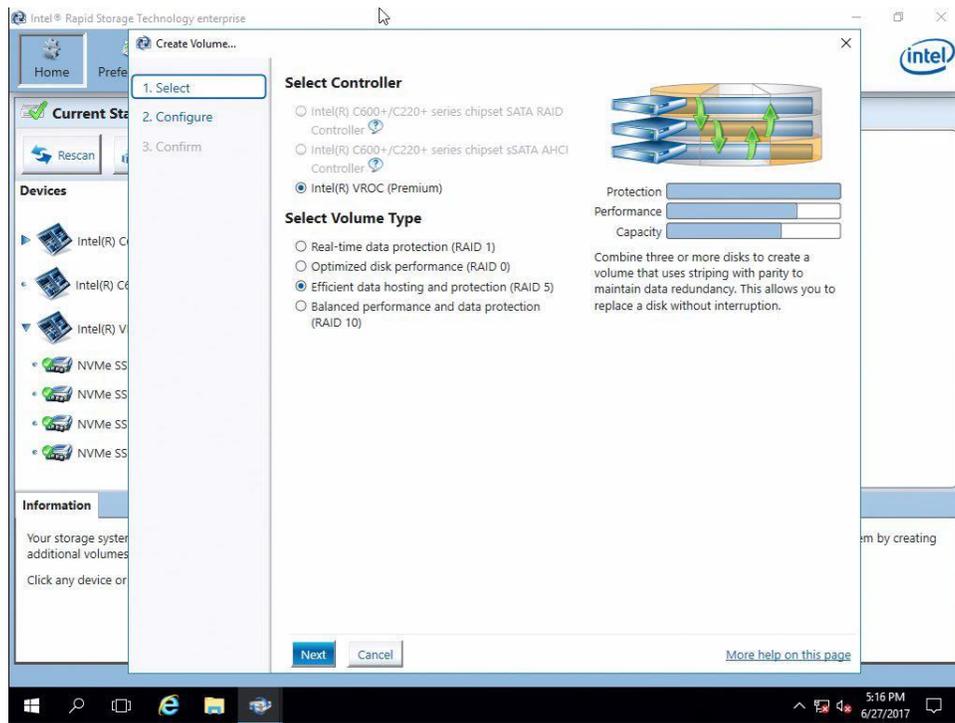
Image 27: Create Volume





2. Select the **NVMe Devices** controller if not already selected. Next select **Efficient data hosting and protection (RAID 5)**. Then, select **Next** to continue.

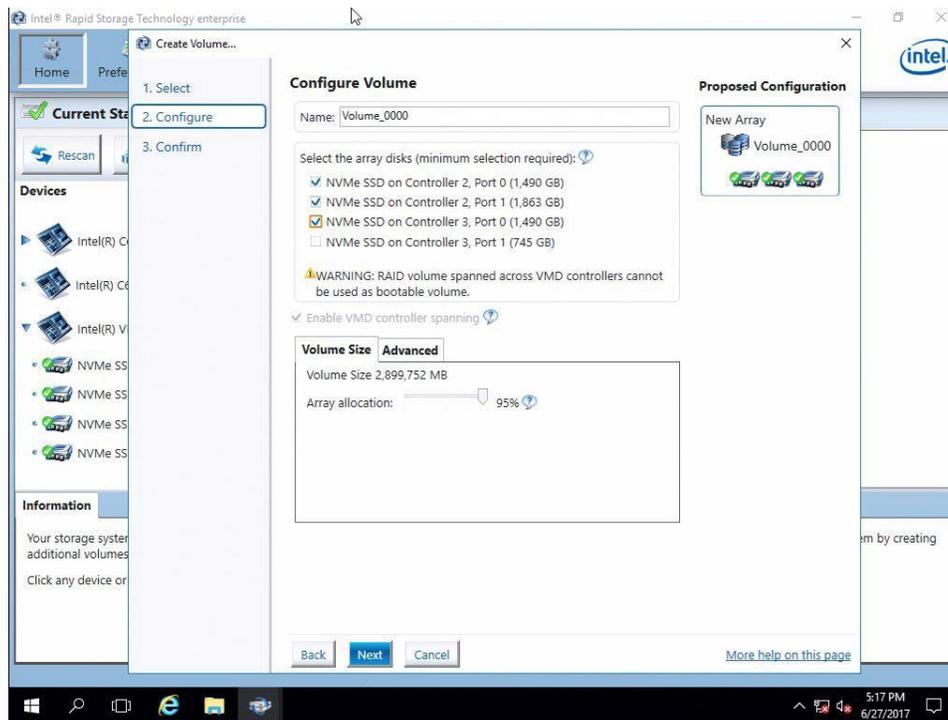
Image 28: Select Controller





- To configure the volume, you can first specify the **Name** of the volume. In this example it has been left as default (**Volume_0000**). Next select three available drives to be included in the volume. As this system has direct connections for the NVMe drives to the board, there are 2 drives per Intel VMD controller. The volume must be spanned across them. This will light up the WARNING: RAID volume spanned across Intel VMD controllers cannot be used as bootable volume. The check in the box to enable Intel VMD controller spanning must be selected before you will be allowed to select drives from additional controllers. Then click **Next**.

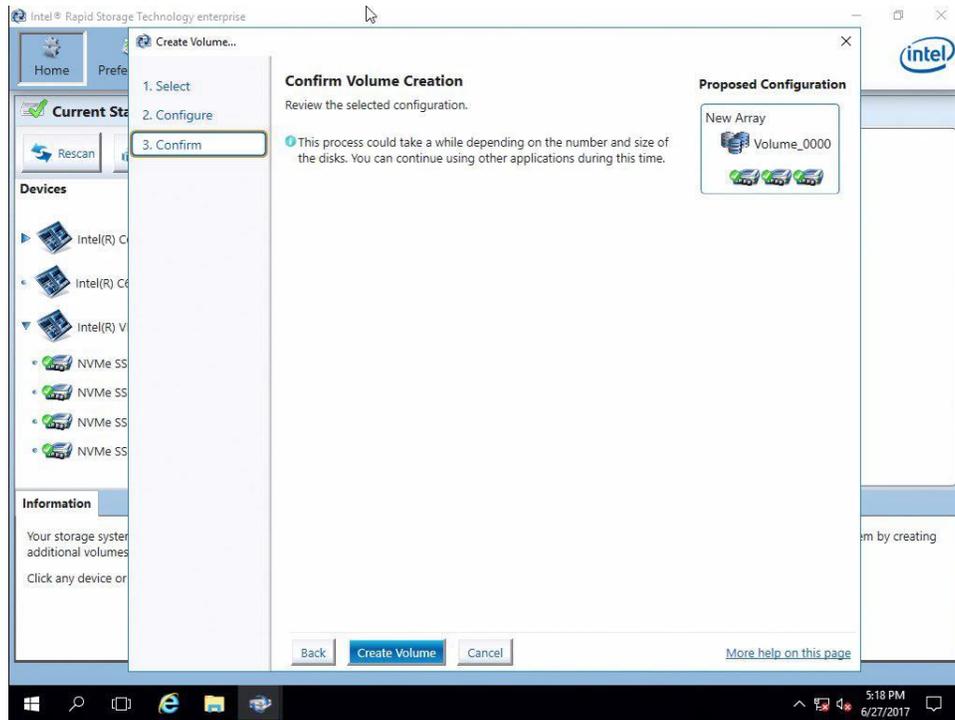
Image 29: Configure Volume





4. Click on **Create Volume**.

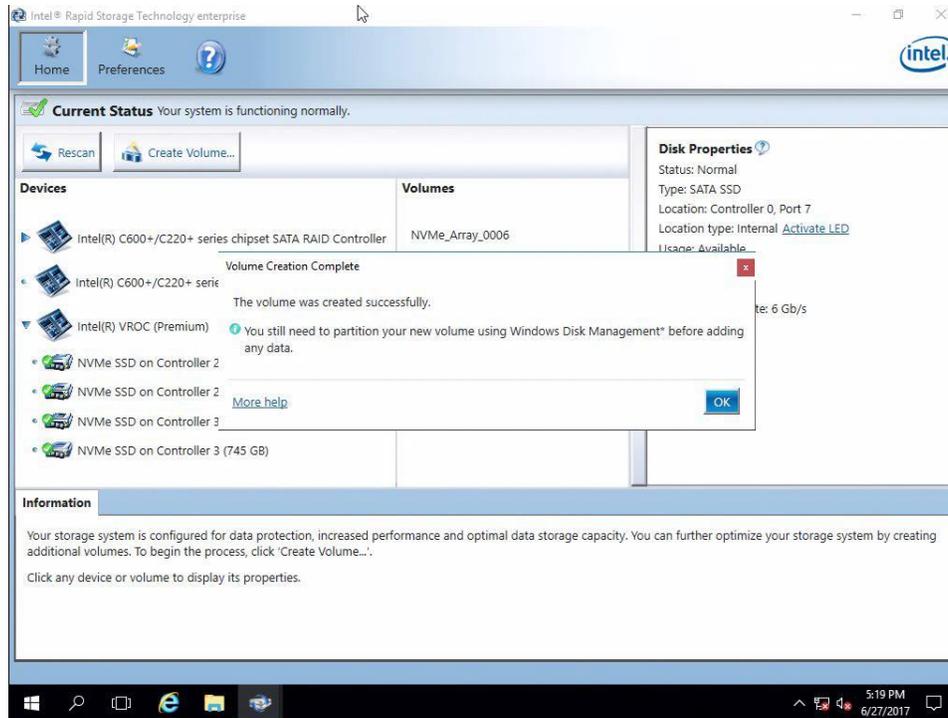
Image 30: Confirm Volume Creation



5. Click **OK** to finish.



Image 31: Volume Creation Complete

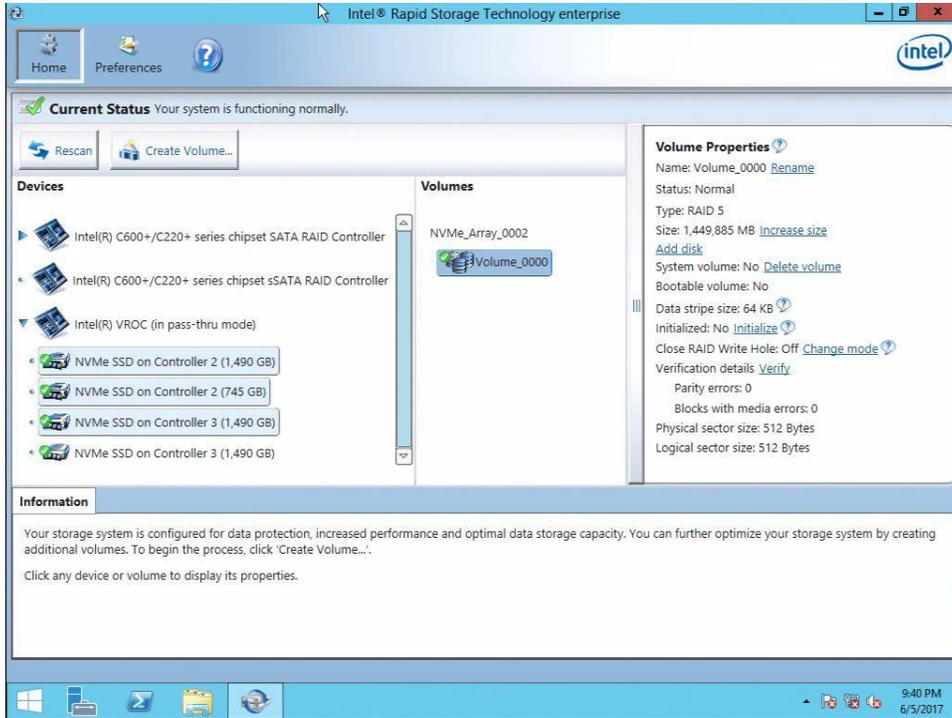


6. Under the Volumes section the new Array and RAID Volume are displayed. By selecting the RAID volume (**Volume_0000**), the “Properties” pane (to the right) will refresh to show the current status, properties and available options of the newly created RAID volume.
7. For RAID 5 volumes, the option to enable RAID Write Hole closure is available. This is a means of allowing for data integrity to be maintained even if a power loss is experienced. It is best selected at the onset of creation of the volume, before data is transferred to it. Changing the mode with data existing can put that data at risk. It will allow you to select a drive that has not already been associated to the array as the additional disk member and allow you to select the mode of distributed or journaling within the advanced pane during creation of the RAID or at time of addition. It is recommended that if this feature is to be used, it be enabled during the volume creation to prevent risk of data loss.

Note: The arrow is pointing to the help icon that will provide additional information for RAID Write Hole.



Image 32: RAID 5 Volume Properties



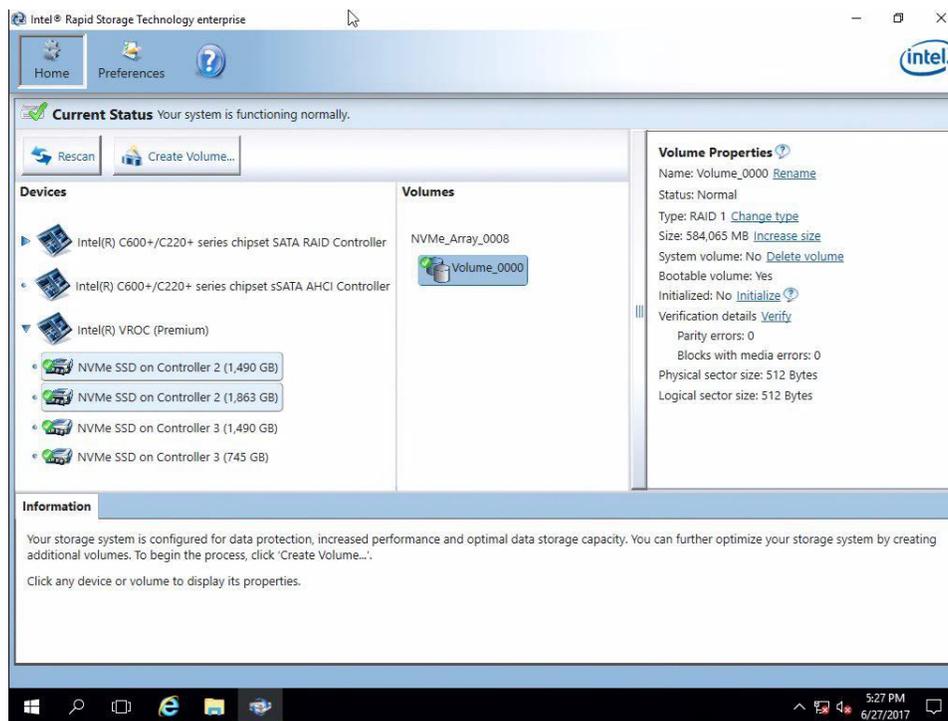


6.3 Create a Matrix RAID Configuration

The following example will step through the process of creating 2 RAID volumes (RAID 1 and 0) on a single array.

1. Follow the steps in section 7.1 to create a 2 drive RAID 1 volume. It is advised not to use the entire disk space for the first volume in order to have room for the second volume on the array. When completed, the Intel RSTe GUI should show as follows. Next, click on **Create Volume...**

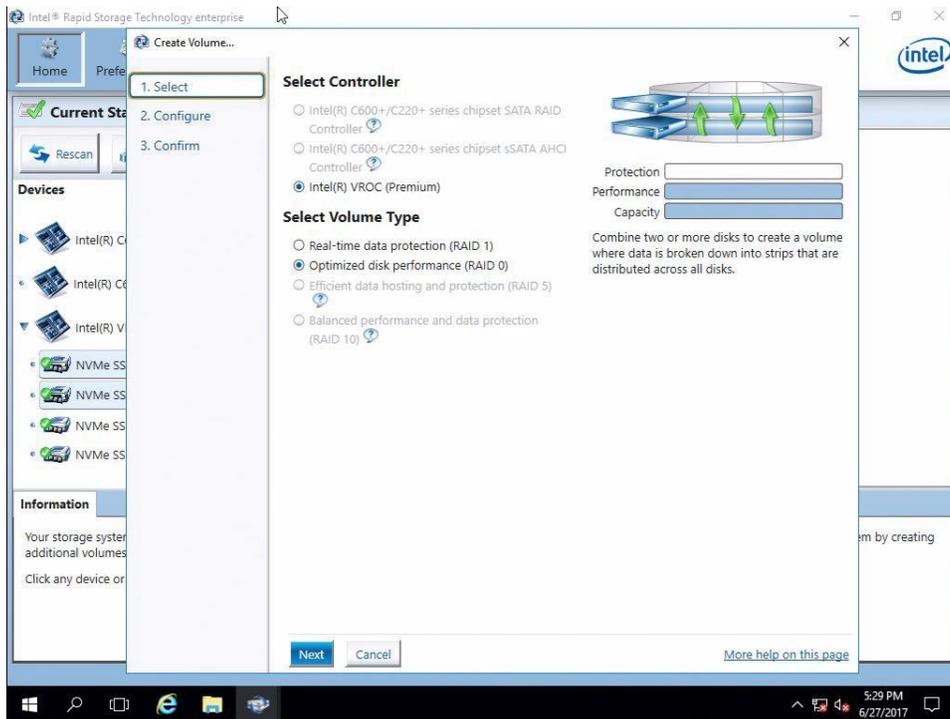
Image 32: Create Volume





2. Select the **NVMe Devices** controller if not already selected. Then select **Optimized Disk Performance (RAID 0)**. Finally, select **Next** to continue.

Image 33: Controller Selection

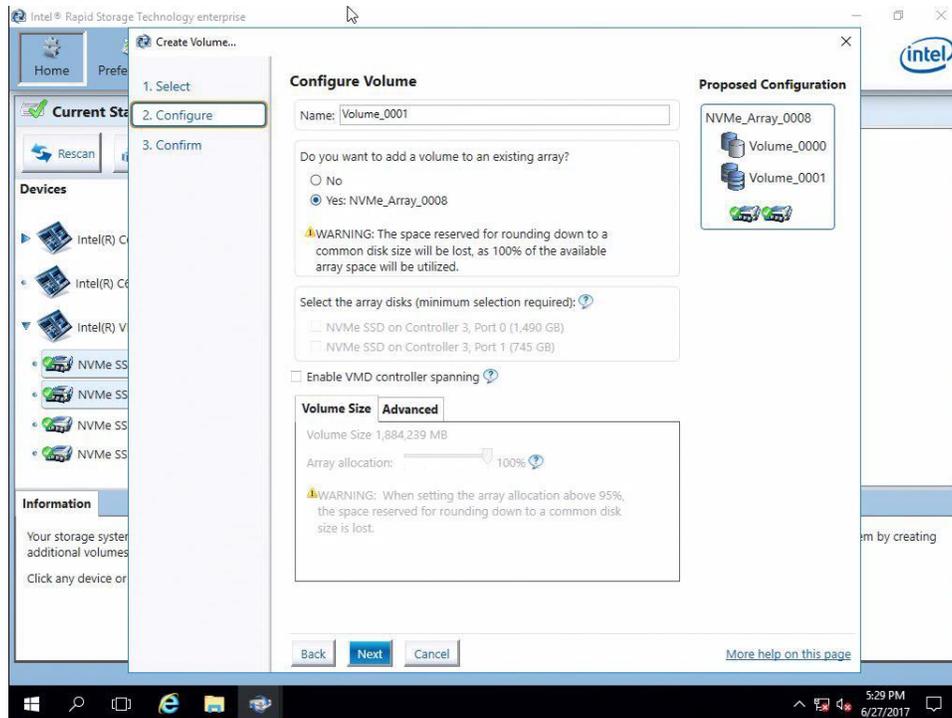




- Specify the **Name** of the volume or simply leave as default value. In this example it has been left as default (**Volume_0000**). Next, under the section “Do you want to add a volume to an existing array?” select **Yes: NVMe_Array_<arrayNumber>**. Then click **Next**.

Note: The second array will consume the remaining space on the array that is available.

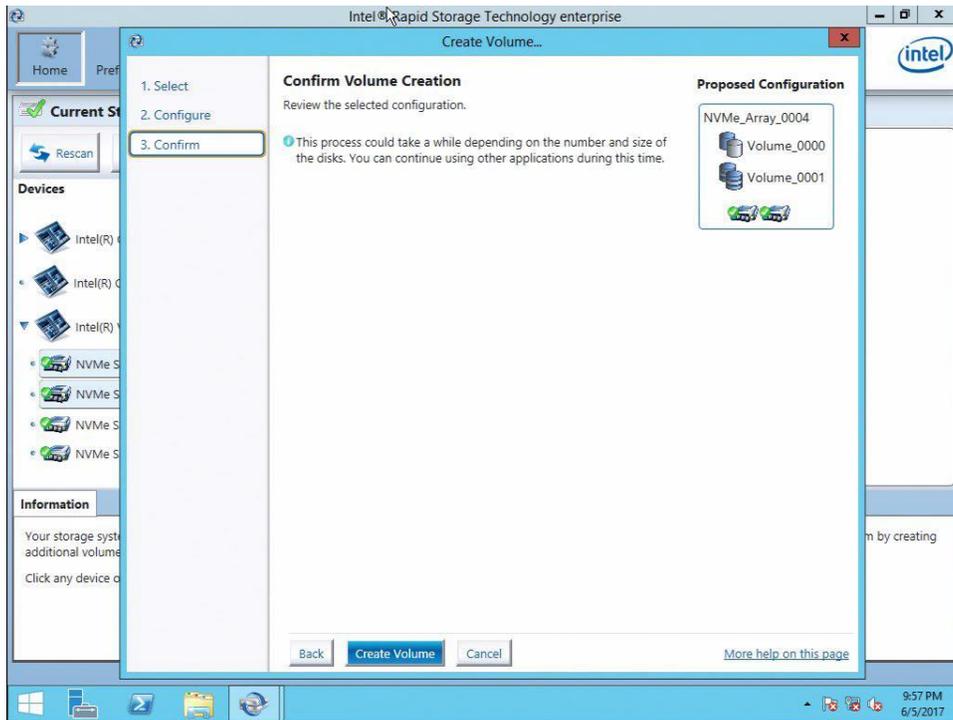
Image 34: Configure Volume





4. Click on **Create Volume**.

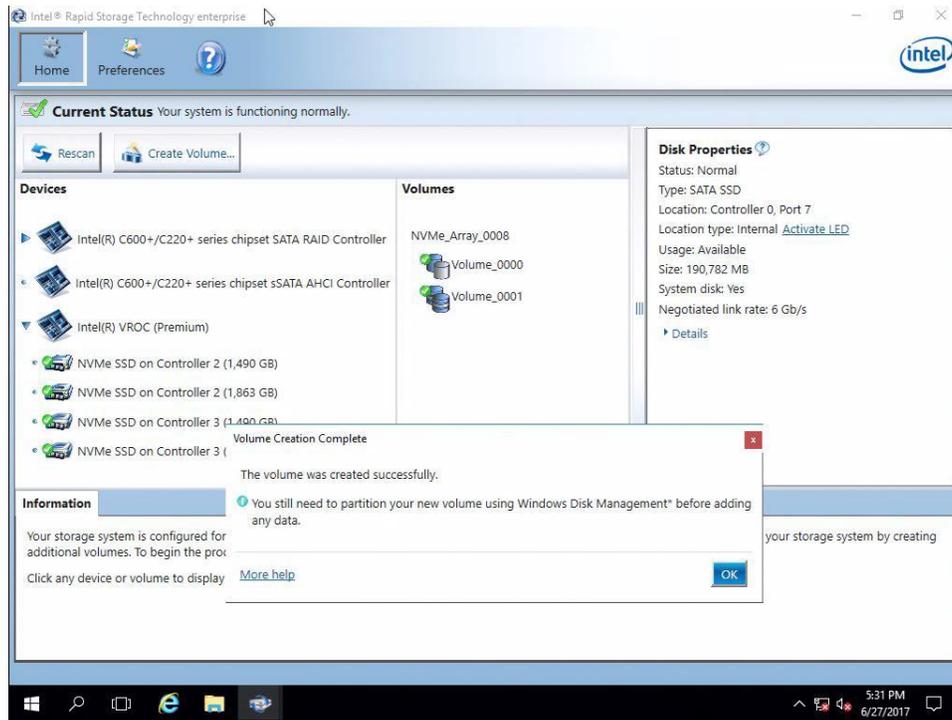
Image 35: Confirm Volume Creation





5. Click **OK** to finish.

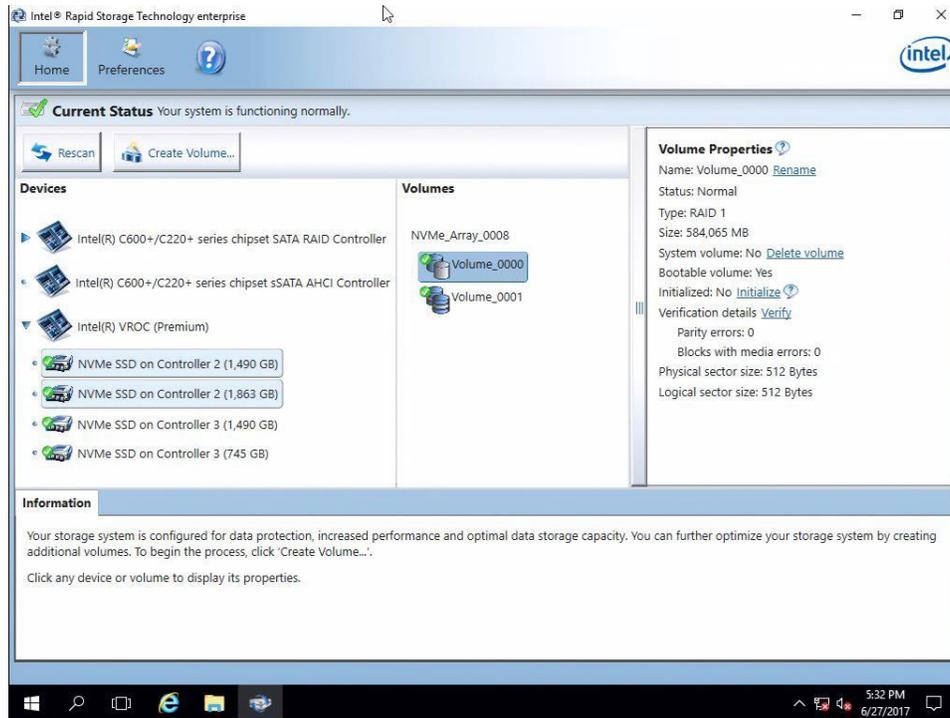
Image 37: Volume Creation Complete





- Under the Volumes section, both new Arrays and RAID Volumes (Volume_0000 and Volume_0001) will appear. By selecting either RAID Volumes, the “Properties” pane (right) will refresh to show all properties and available options of the selected volume.

Image 38: Volumes Selection



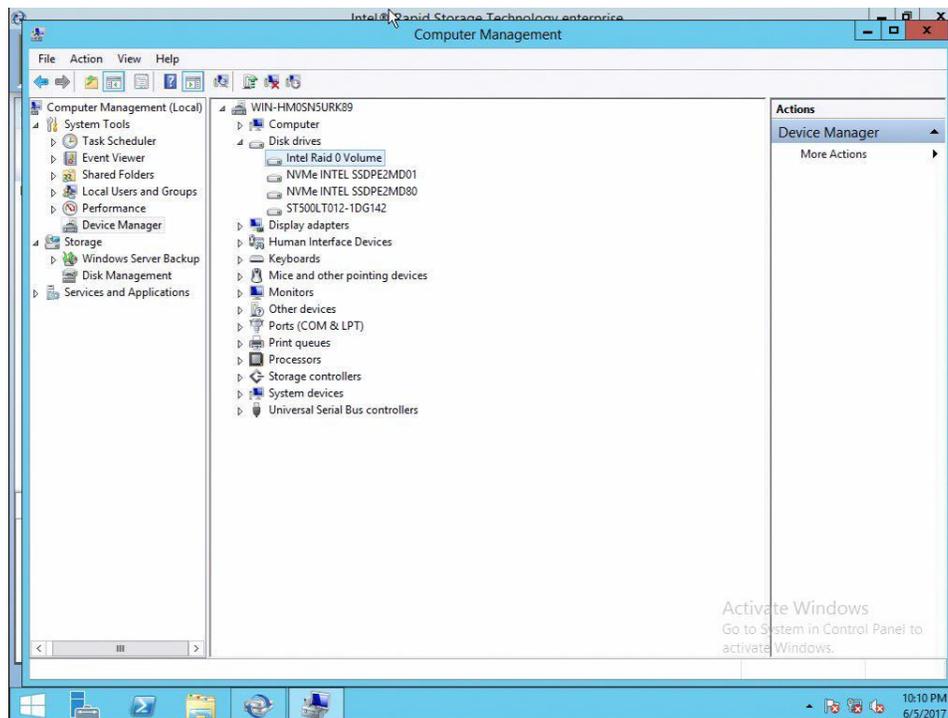


6.4 Viewing RAID Volumes in Windows Control Panel Applets

Attached are some screen captures that show what Windows* **Device Manager** and **Disk Management** control panel applet may display after the RAID volume has been created.

1. Bring up **Computer Management** and select Windows* **Device Manager**. The newly created RAID volume should be shown under **Disk drives**

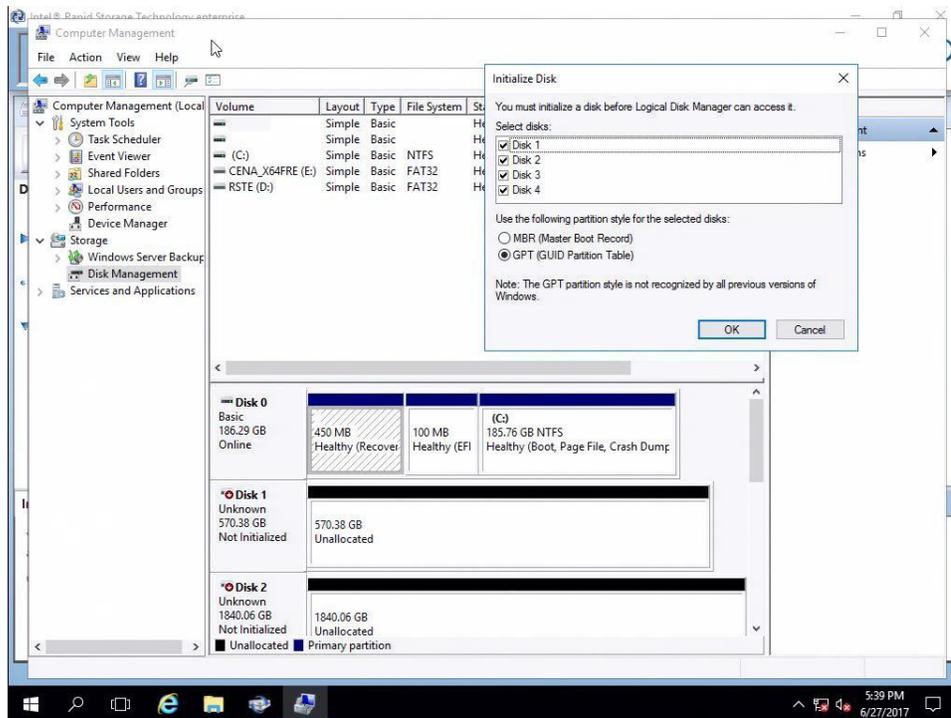
Image 39: Computer Management



- Under **Storage** -> **Disk Management**, the newly created RAID volume is now available to format. This will include attached disks that have not been added to RAIDs.

Note: Thumb drives that were used as installation media will be assigned letter drive values as seen here.

Image 40: Disk Management



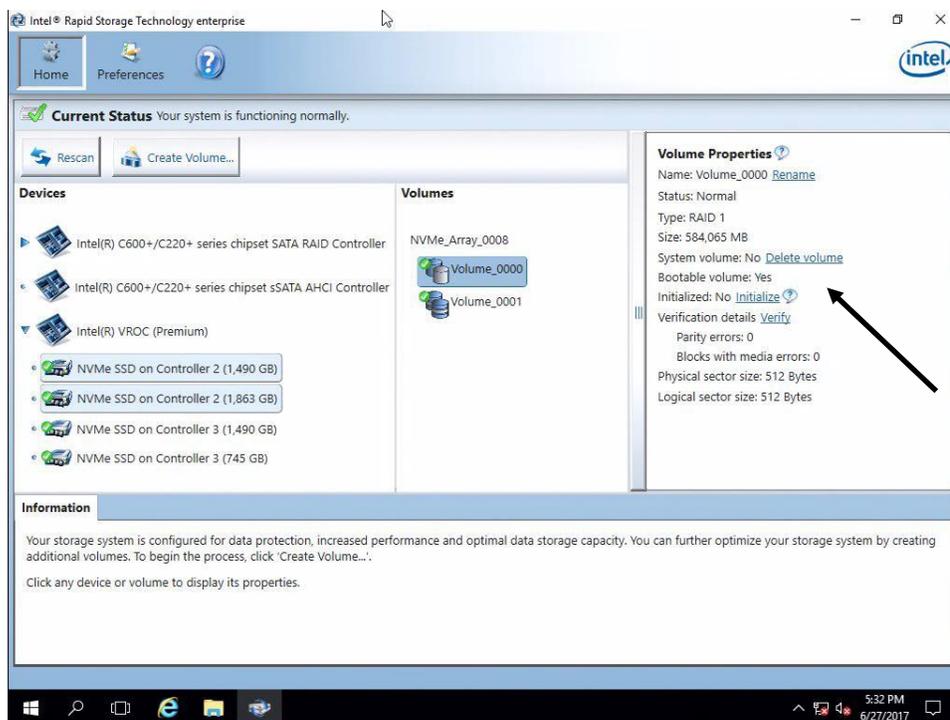
7 Deleting a Volume

The following steps through the RAID Volume deletion process.

1. Select (left mouse click) the RAID Volume to be deleted in the middle under **Volumes**. Then on the right side in the **Volume Properties** window pane select **Delete Volume**.

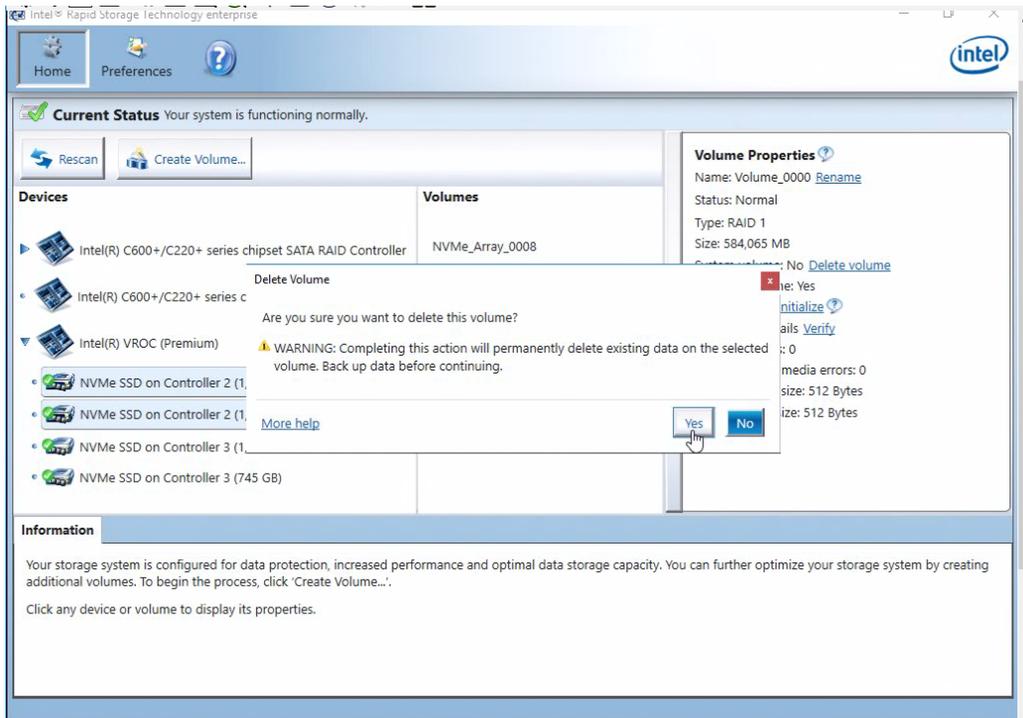
Note: The arrow below is pointing to the option that is Delete volume. It is only available if you have a volume selected. Please take care in selection for deletion of volumes, as the data cannot be recovered.

Image 41: Delete Volume



2. Select **Yes** at the warning to complete the process.

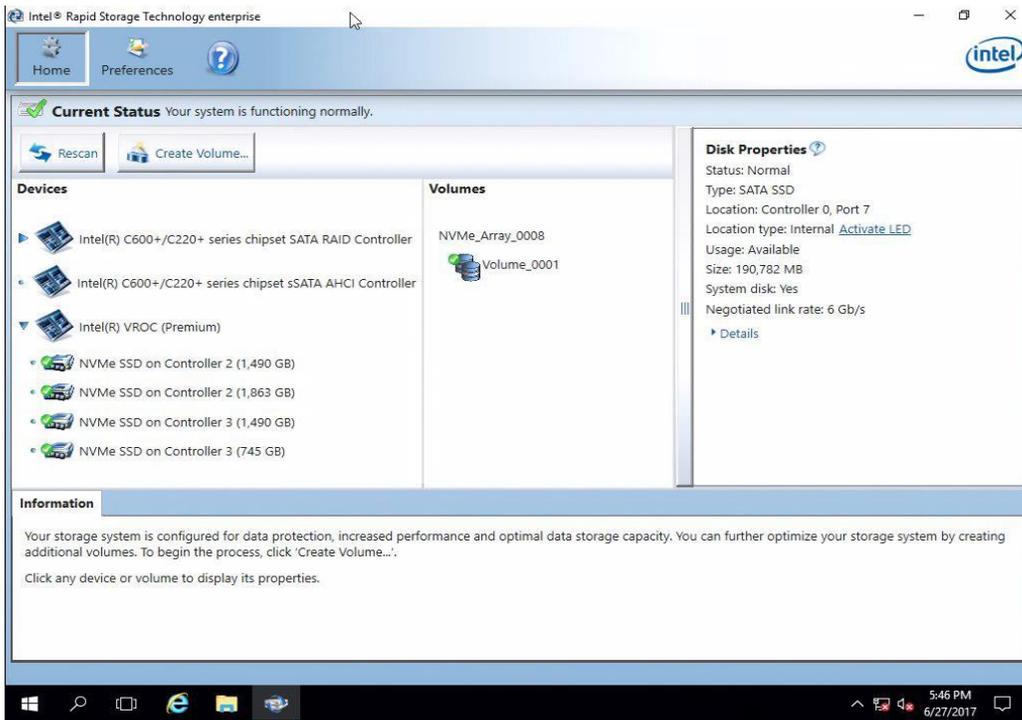
Image 41: Confirm Deletion





- When the process has completed, the volume will no longer show in the GUI as shown below.

Image 42: Volume Removed





8 Intel VROC Trial Period

The Intel VROC package comes with a 90 day trial period that will enable Intel VROC Premium mode (in Windows* only) for data volumes without requiring an Intel VROC Upgrade Key. This allows the user to test and experience Intel Premium mode for 90 days. The trial period will begin at the time that the first Intel VROC RAID volume is created.

8.1 Intel VROC Trial Period Recommendations and Limitations

The following are key limitations with the Intel VROC Trial Period feature

- The Intel VROC Trial Period does not extend to the Intel VROC UEFI HII environment. As a result, RAID volumes generated in the Intel RSTe 5.5 PV GUI during this trial period will not be seen in the Intel VROC UEFI HII user interface.
- Intel recommends **not** attempting to migrate a system drive into a RAID volume. This is to prevent the system from becoming unbootable because the trial period does not extend to the Intel VROC UEFI HII environment.
- Intel recommends **not** using Intel VROC Trial Period RAID volume for any mission critical data. It is only intended for evaluation purposes and the data cannot be guaranteed (either in the Intel VROC UEFI HII environment or after the period expires).

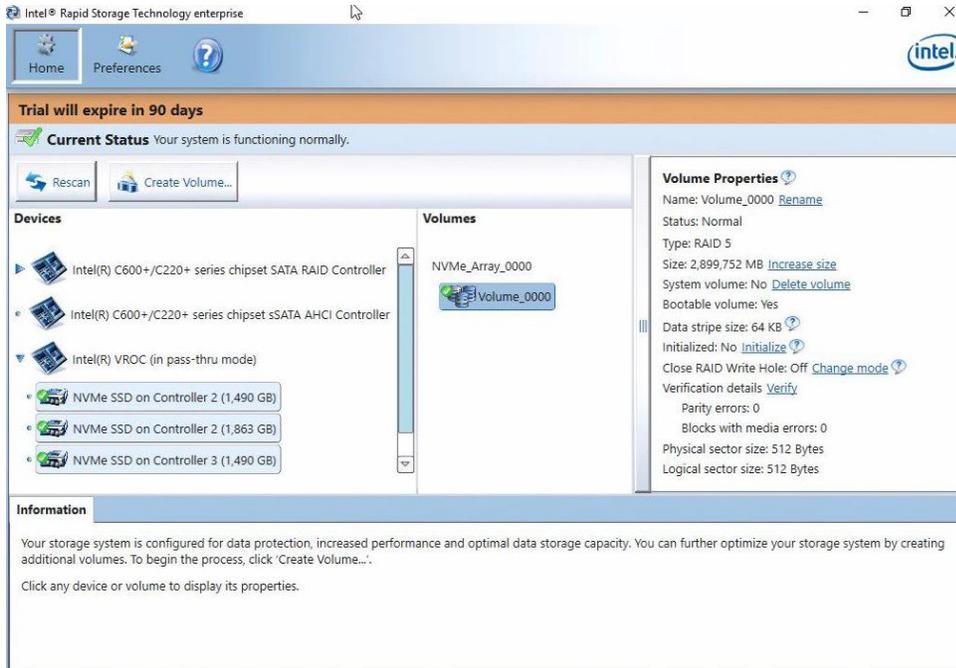
8.2 Intel VROC Trial Period Usage

Since this Intel VROC Trial Period mode only applies to platforms that do not have Intel VROC Upgrade Keys installed, the System Report will report that Intel VROC is in Pass-thru mode.

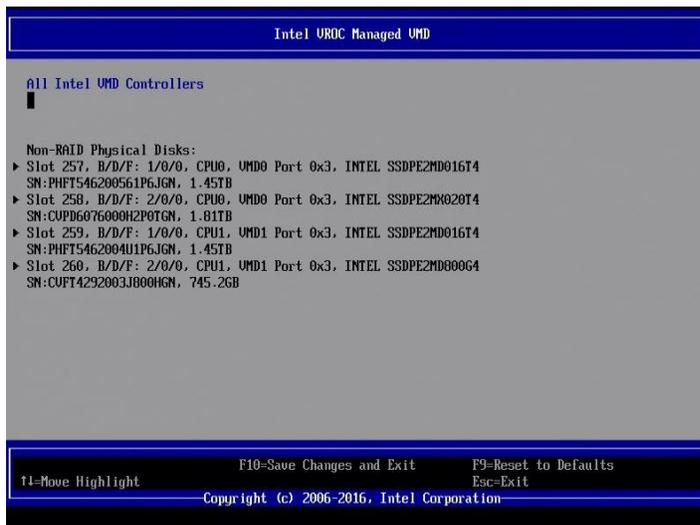
Prior to initiating the trial period (by creating a RAID volume) the Intel RSTe 5.5 PV GUI will show no indication of a trial period being activated. Once Intel RSTe 5.5 PV GUI has been installed, the trial period will begin once the first trial RAID volume is created.

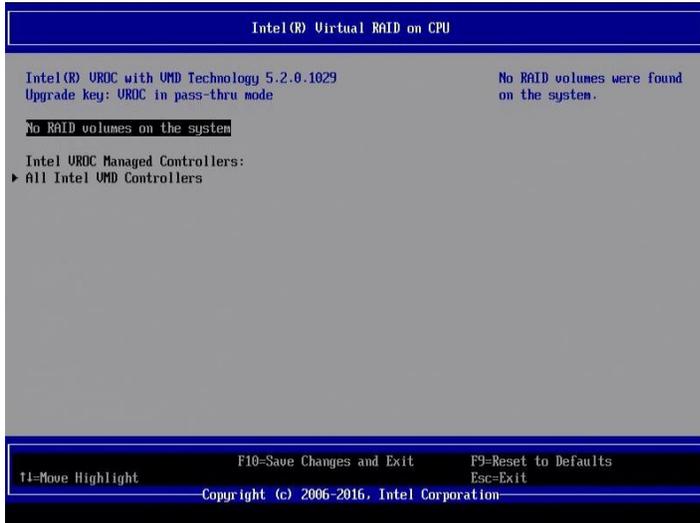


The status of the trial is displayed in the Intel RSTe 5.5 PV GUI as:

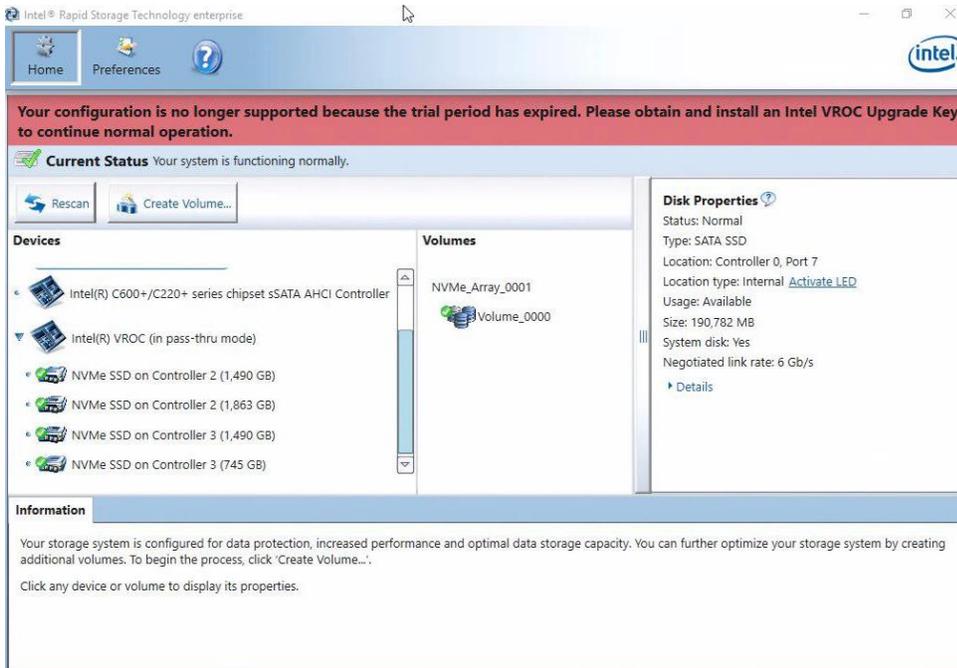


Note: During the trial period, the Intel VROC UEFI HII will not display that RAID volume, and will show the attached drives as non-RAID disks:





After 90 days, the trial period will expire and be displayed in the GUI as:



Note: At the end of the trial period, any RAID volume generated will be displayed in the Intel RSTe 5.5 PV GUI, but they will not be accessible.

Once the Intel VROC Upgrade Key is installed in the platform (either during the trial period or after the trial period expires) the environment will become operational and all RAID volumes will be accessible as normal.



9 Troubleshooting

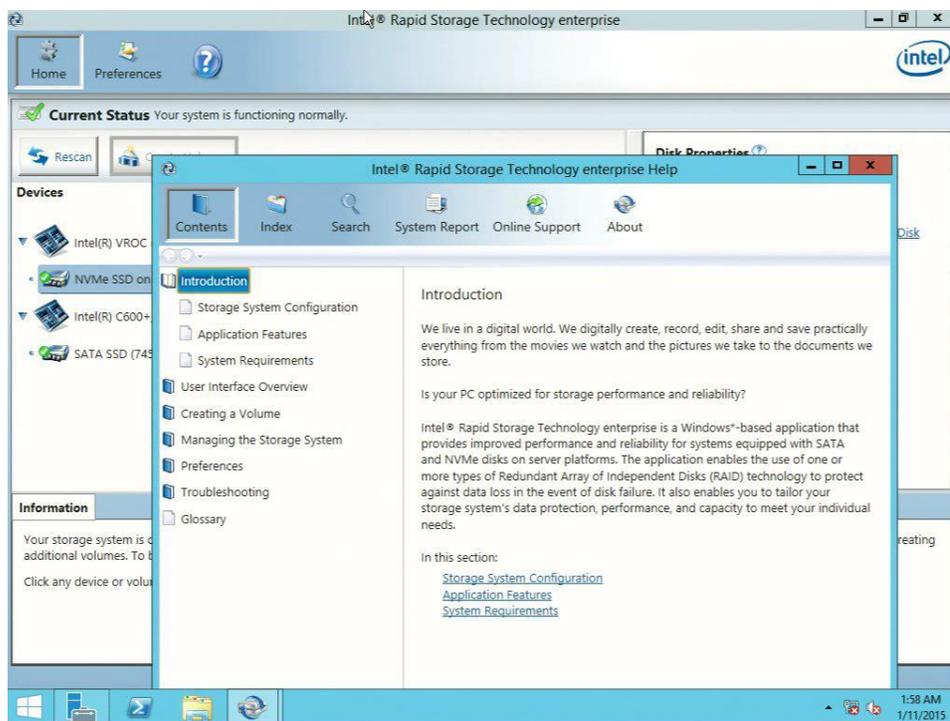
This section will address some of the basic troubleshooting tips that can be used to diagnose and possibly self-treat a handful of issues.

9.1 System Reports

Troubleshooting issues on a Server, Workstation or High-end desktop may be required. One of the tools that is helpful in doing so is called a system report. This tool is embedded within the Help section within the Intel RSTe GUI.

1. First, click on the icon on the top row that reads **Help**. It is the button that has the white “?” on the blue shield.

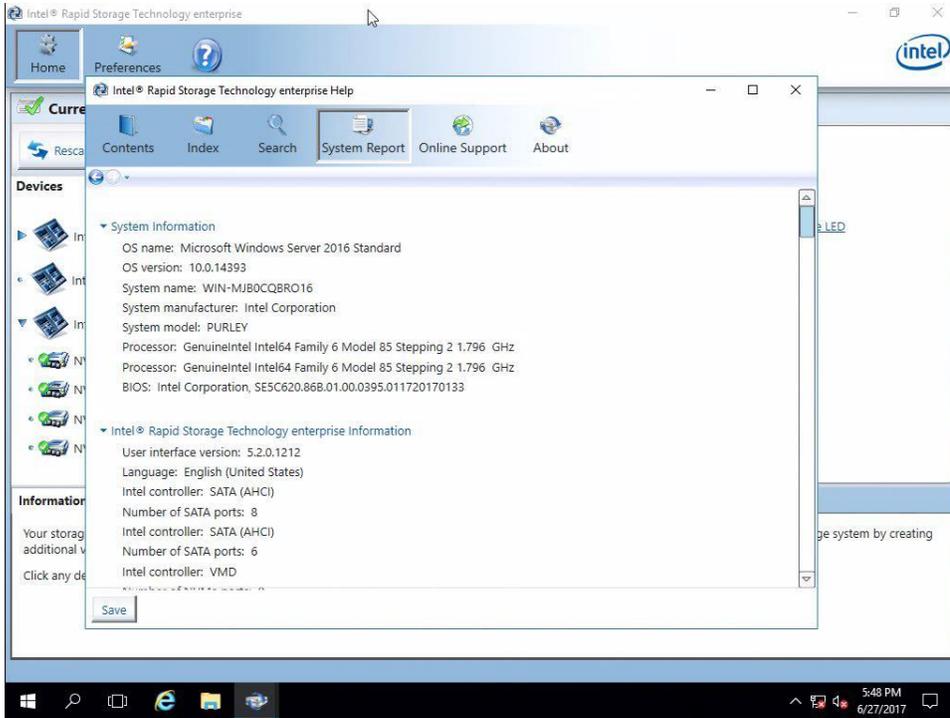
Image 43: Help



This brings a new window to the forefront of the screen.



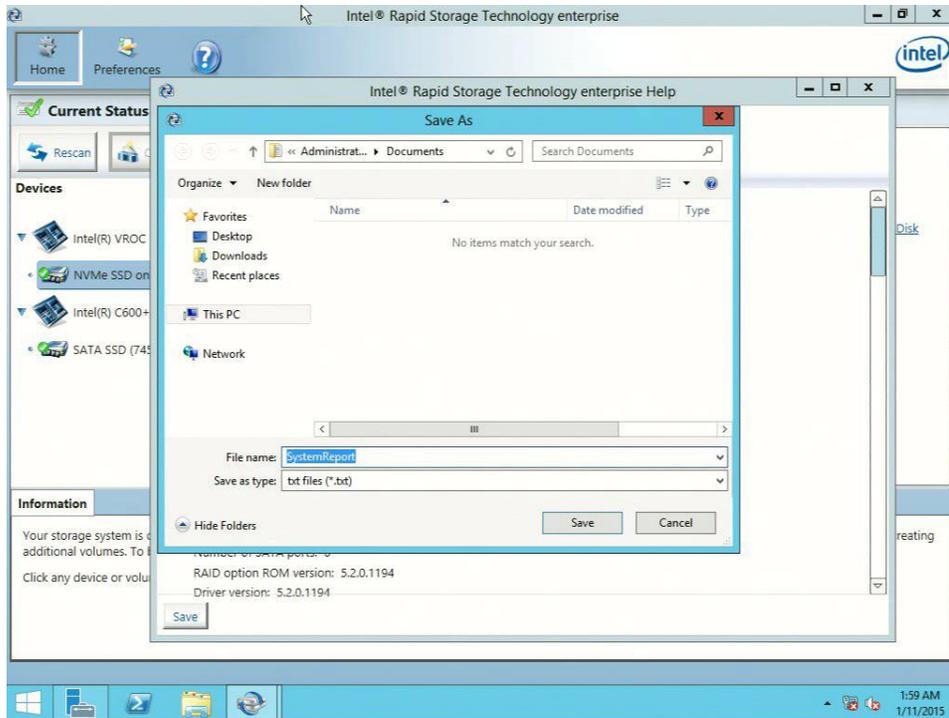
2. Click on the icon that reads **System Report**.



This is the data regarding all items active on this system. This states the status and activity for all functions as it relates to the Intel RSTe product family.



- Next, click on the **Save** button at the bottom left corner of the **System Report**.



Windows* will allow for the user to select where the file is saved to, by default it will be saved in that user's documents folder. This may be altered at the discretion of the user. Once the location and name have been set, click **Save** to save the file.

This file is now ready for the support representative that needs to review the data. Please follow their instructions in regards to how to transmit or forward this file to this individual.

9.2 Drive States and Recovery

This section explains how to resolve the most common problems that may occur while using the application. If the user has any questions regarding installing, using or maintaining this product, the user can also visit Intel's online support site which provides the user with self-help resources and electronic problem submission.

9.2.1 Failed Volumes

This section explains how to resolve the most common problems that may occur while using the application. If the user has any questions regarding installing, using or maintaining this product, the user can also visit Intel's online support site which provides the user with self-help resources and electronic problem submission.



Table 10: Failed Volumes

RAID 0 A RAID 0 volume is reported as failed when one of its members is disconnected or has failed. In both cases, the volume and its data are no longer accessible.	
Cause	Solution
Missing array disk	Follow this procedure to recover data: <ol style="list-style-type: none">1. Power off the user's computer and reconnect the missing disk.2. Turn on the user's computer. During the system startup, the volume status will display as 'Normal' in the Intel Rapid Storage Technology enterprise option ROM user interface.3. Once the operating system is running, open Intel Rapid Storage Technology enterprise from the Start menu or click the Intel Rapid Storage Technology enterprise notification area icon.4. Under 'Status', verify that the volume and disks status display as 'Normal'. The user can also review this information under 'Manage'.
Failed array disk	<p>In most cases, the volume cannot be recovered and any data on the volume is lost. However, before deleting the volume, the user can try resetting the disks to normal, and then attempt a data recovery. If the read/write data access consistently fails, the disk will likely return to a failed state immediately. Refer to Troubleshooting Disk Events for instructions on resetting a disk to normal.</p> <p>This procedure deletes the failed volume:</p> <ol style="list-style-type: none">1. Power off the user's computer and replace the failed NVMe or SATA disk with a new one that is of equal or greater capacity.2. Turn on the user's computer. During the system startup, the volume status will display as 'Failed' in the Intel Rapid Storage Technology enterprise option ROM user interface.3. Press Ctrl-I to access the main menu of the option ROM user interface.4. Select Delete RAID Volume from the main menu.5. From the Delete Volume menu, select the failed RAID volume, using the up and down arrow keys.6. Press the 'Delete' key to delete the volume, then 'Y' to confirm.7. Create a new RAID 0 volume using the new disk. If the failed disk was part of the system volume, the user will also need to reinstall the operating system.



<p>RAID 5 A RAID 5 volume is reported as failed when two or more of its members have failed.</p>	
Cause	Solution
Two or more array disks failed	<p>In most cases, the volume cannot be recovered and any data on the volume is lost. However, before deleting the volume, the user can try resetting the disks to normal, and then attempt a data recovery. If the read/write data access consistently fails, the disk will likely return to a failed state immediately. Refer to Troubleshooting Disk Events for instructions on resetting a disk to normal.</p> <p>This procedure deletes the failed volume:</p> <ol style="list-style-type: none"> 1. Power off the user's computer and replace the failed NVMe or SATA disks with new ones that are of equal or greater capacity. 2. Turn on the user's computer. During the system startup, the volume status will display as 'Failed' in the Intel Rapid Storage Technology enterprise UEFI HII. 3. Go into the BIOS setup and go to the Intel RSTe UEFI HII. 4. Select Delete RAID Volume from the main menu. 5. From the Delete Volume menu, select the failed RAID volume, using the up and down arrow keys. 6. Press the 'Delete' key to delete the volume, then 'Y' to confirm. 7. Create a new RAID 5 volume using the new disks. If the failed disk was part of the system volume, the user will also need to reinstall the operating system.
<p>RAID 10 A RAID 10 volume is reported as failed when two adjacent members are disconnected or have failed, or when three or four of its members are disconnected or have failed.</p>	
Cause	Solution
Two adjacent array disks missing (visual inspection)	<ol style="list-style-type: none"> 1. Power off the user's computer and reconnect the missing disks. 2. The rebuild operation will start automatically. The user can follow the progress by hovering over the notification area icon or by reviewing the volume status under 'Status' or 'Manage'.
Three or four array disks missing	<p>In most cases, the volume cannot be recovered and any data on the volume is lost. This procedure deletes the failed volume:</p> <ol style="list-style-type: none"> 1. Power off the user's computer and reconnect the missing disks. 2. Turn on the user's computer. During the system startup, the volume status will display as 'Failed' in the Intel Rapid Storage Technology enterprise UEFI HII. 3. Go into the BIOS setup and go to the Intel RSTe UEFI HII. 4. Select Delete RAID Volume from the main menu. 5. From the Delete Volume menu, select the failed RAID volume, using the up and down arrow keys. 6. Press the 'Delete' key to delete the volume, then 'Y' to confirm. 7. Create a new RAID 10 volume using the new disks. 8. The user will then need to reinstall the operating system on the new volume.



<p>Two or more array disks failed</p>	<p>In most cases, the volume cannot be recovered and any data on the volume is lost. However, before deleting the volume, the user can try resetting the disks to normal, and then attempt a data recovery. If the read/write data access consistently fails, the disk will likely return to a failed state immediately. Refer to Troubleshooting Disk Events for instructions on resetting a disk to normal.</p> <p>This procedure deletes the failed volume:</p> <ol style="list-style-type: none">1. Power off the user's computer and replace the failed NVMe or SATA disks with new ones that are of equal or greater capacity.2. Turn on the user's computer. During the system startup, the volume status will display as 'Failed' in the Intel Rapid Storage Technology enterprise UEFI HII.3. Go into the BIOS setup and go to the Intel RSTe UEFI HII.4. Select Delete RAID Volume from the main menu.5. From the Delete Volume menu, select the failed RAID volume, using the up and down arrow keys.6. Press the 'Delete' key to delete the volume, then 'Y' to confirm.7. Create a new RAID 10 volume using the new disks.8. The user will then need to reinstall the operating system on the new volume.
---------------------------------------	---

9.2.2 Degraded Volumes

Table 11: Degraded Volumes

<p>RAID 1</p> <p>A RAID 1 volume is reported as degraded when one of its members is disconnected or has failed. Data mirroring and redundancy are lost because the system can only use the functional member.</p>
<p>RAID 5</p> <p>A RAID 5 volume is reported as degraded when one of its members is disconnected or has failed. When two or more array disks are disconnected or have failed, the volume is reported as failed.</p>
<p>RAID 10</p> <p>A RAID 10 volume is reported as degraded when one of its members is disconnected or has failed, or when two non-adjacent members are disconnected or have failed. When two or more array disks are disconnected or have failed, the volume is reported as failed.</p>



Cause	Solution
Missing array disk	<p>If the user can reconnect the missing disk, follow this procedure to rebuild the volume:</p> <ol style="list-style-type: none"> 1. Power off the user's computer and reconnect the missing disk. 2. Turn on the user's computer and the rebuild operation will start automatically. <p>If the user cannot reconnect the missing disk and a NVMe or SATA disk is available and normal, follow this procedure to rebuild the volume:</p> <ol style="list-style-type: none"> 1. If a NVMe or SATA disk is compatible, available and normal, follow this procedure to rebuild the volume: 2. Select the disk the user wants to use to rebuild the volume, and then click 'Rebuild'. 3. The rebuild operation starts immediately. The user can follow the progress by hovering over the notification area icon or by reviewing the volume status under 'Status' or 'Manage'. 4. Once the operation has successfully completed, the array disk and volume status will display as 'Normal'. <p>Note: If there is no available disk present, the user will need to power off the user's computer and connect a new NVMe or SATA disk that is at an equal or greater capacity than the failed disk. Once the user's computer is back up and running the user can follow the rebuild procedure described above.</p>
Failed array disk	<p>We recommend that the user rebuild the degraded volume to a new disk to return the volume and overall storage system status to normal. However, the user can try resetting the disk to normal, which will prompt the volume to start rebuilding automatically. But if the read/write data access consistently fails, the disk will likely return to a failed state immediately and the user will need to rebuild the volume to another disk.</p> <p>If a NVMe or SATA disk is compatible, available and normal, follow this procedure to rebuild the volume:</p> <ol style="list-style-type: none"> 1. Under 'Status', click 'Rebuild to another disk'. 2. Select the disk the user wants to use to rebuild the volume, and then click 'Rebuild'. 3. The rebuild operation starts immediately. The user can follow the progress by hovering over the notification area icon or by reviewing the volume status under 'Status' or 'Manage'. 4. Once the operation successfully completed, the array disk and volume status will display as 'Normal'. <p>Note: If there is no available disk present, the user will need to power off the user's computer and connect a new NVMe or SATA disk that is at an equal or greater capacity than the failed disk. Once the user's computer is back up and running the user can follow the rebuild procedure described above.</p>



9.2.3 Other Volume States

Table 12: Other Volume States

Incompatible	
Cause	Solution
1) Indicates that the volume was moved to another system that does not support the volume type and configuration.	<p>In this situation, volume data is accessible to the operating system and can be backed up, but the volume cannot operate because the user's system does not support its RAID configuration.</p> <p>Here are the user's options:</p> <ul style="list-style-type: none"> Reconnect the volume to the computer where the volume was originally created, and continue using it. Delete the volume, and then create a new volume with a RAID configuration that is supported by the current system. Follow the procedure described above to delete the volume. <p>WARNING: When a volume is deleted, all existing data on the member disks of the selected volume is permanently erased. It's recommended that the user backup all valuable data prior to beginning this action.</p>
2) Indicates that the Intel VROC Upgrade Key is incorrect or missing.	<p>In this situation, volume data may not be accessible to the operating system.</p> <p>Here are the user's options:</p> <ul style="list-style-type: none"> Install the proper Intel VROC Upgrade Key
Unknown	
Cause	Solution
The volume is in an unexpected state due to a configuration error.	The application is unable to detect the exact nature of the problem. Try restarting the user's computer. If the error persists, back up all valuable data and delete the volume using the option ROM user interface. Refer to the user's manual accessible from the Online Support area for details on using the option ROM.
Missing volume	
Cause	Solution
A driver upgrade or downgrade was performed while a data migration was in progress.	<p>The driver cannot recognize the volume or read its data if a driver upgrade or downgrade was performed during a volume migration. Volume migrations occur after one of the following operations was initiated:</p> <ol style="list-style-type: none"> Creation of a system volume or data volume while preserving data. Volume type change combined with disk addition to the new RAID configuration. Volume size increase. Disk addition to an existing array. <p>Troubleshooting a data volume</p> <ol style="list-style-type: none"> If the data migration involved a data volume, the user will need to reverse the driver upgrade or downgrade operation and return to the original driver version. This will restore driver and volume compatibility. Once the operation has completed, restart the user's computer. Open the application and make sure that the volume displays again in the storage system view. Data migration operation should resume immediately.



	<p>Troubleshooting a system disk</p> <p>If the data migration involved a system disk or volume, it is highly likely that the user will not be able to start the user's system because the driver cannot read the system files. The following options may allow the user to load the operating system again:</p> <ol style="list-style-type: none"> 1. Restore to the last known good configuration. 2. Boot from a flash drive that supports NTFS partitioning and includes the storage driver files. 3. Bring the corrupt disk to another system, and then replace the storage driver files from a compatible driver version. Return the disk to the original system and try booting. <p>Troubleshooting a system volume</p> <p>If the data migration involved a system disk or volume, it is highly likely that the user will not be able to start the user's system because the driver cannot read the system files. The following options may allow the user to load the operating system again:</p> <ol style="list-style-type: none"> 1. Restore the last known good configuration. 2. Bring all corrupted volume disks to another system, and then replace the storage driver files from a compatible driver version. Return the corrupted volume disks to the original system and try booting.
--	---

9.2.4 Disk Events

Table 13: Disk Events

State	Cause	Solution
<p>At risk</p> 	<p>An impending error condition was detected on an internal or external disk and is now at risk of failure.</p>	<p>The application is detecting early warning signs of failure with an NVMe or SATA disk that result from a slow degradation over time. When a disk is reported at risk, the user can reset that disk to normal, but we recommend that the user contacts the manufacturer for more information to prevent potential data loss. Follow this procedure to reset the disk to normal:</p> <ol style="list-style-type: none"> 1. Under 'Status', in the Manage subsection, locate the disk reported as at risk. The user can also perform this action from Manage Disk, which is accessible by clicking the disk in the storage system view. 2. Click 'Reset disk to normal!'. The page refreshes instantly, returning to a normal state. <p>Note: Completing this action clears the event on the disk and does not delete existing data. However, ignoring early warning signs of disk failure may result in data loss.</p> <p>If the disk reported at risk is included in a RAID volume and a compatible spare disk is available, the rebuild process will start automatically. Once complete, the disk reported at risk becomes available and the user can reset it to normal to return to a healthy state.</p>

	<p>An unexpected error was detected on a disk that has RAID configuration data (metadata) on it.</p>	<p>In this state, it is likely that some or all of the disk data is inaccessible. After backing up any accessible data, the user will need to clear the metadata and reset the disk to return to a normal state.</p> <p>WARNING: Completing this action will permanently delete existing metadata. Back up any accessible data before continuing.</p> <ol style="list-style-type: none"> Under 'Status', in the Manage subsection, locate the disk reported as at risk. The user can also perform this action from Manage Disk, which is accessible by clicking the disk in the storage system view. Click 'Clear and reset disk', and then click 'Yes' to confirm. Once complete, the page refreshes with the disk returning to a normal state.
<p>Missing</p> 	<p>An array disk is not present or physically connected to the computer.</p>	<p>Ensure that the disk is securely connected to the NVMe or SATA port and that the data cable is functioning properly. If the disk is lost or cannot be reconnected, the user will need to connect a new NVMe or SATA disk, and then rebuild the volume to that new disk. Refer to Degraded or Failed Volumes in this section for instructions on how to rebuild a volume.</p>
<p>Failed</p> 	<p>An internal or external disk has failed to properly complete read and write operations in a timely manner, and it has exceeded its recoverable error threshold.</p>	<p>Back up the user's data and we recommend that the user replace the disk as soon as possible. If the failed disk is an array disk, the volume will be reported as degraded or failed depending on its configuration. Refer to Degraded or Failed Volumes in this section for instructions on resolving the problem.</p> <p>In a failed state, disk data may be lost, but the user can try resetting the disk to normal, and then attempt a data recovery. Follow this procedure to reset the failed disk to normal:</p> <ol style="list-style-type: none"> Under 'Status', in the Manage subsection, locate the disk reported as failed. The user can also perform this action from Manage Disk, which is accessible by clicking the disk in the storage system view. Click 'Reset disk to normal!'. The page refreshes instantly, returning to a normal state. <p>Note: If the failed array disk is part of a redundant volume, the volume will start rebuilding automatically as soon as the disk is reset to normal.</p>



9.2.5 Software Errors

Table 14: Software Errors

Message	Cause	Solution
An unknown error occurred while running this application. If the problem persists, please restart the user's computer or try reinstalling the application.	This error may be related to: <ol style="list-style-type: none"> 1. Missing components 2. Corrupted application 3. Application unable to connect to the service 4. Application fails to start. 	Restart the user's computer or try reinstalling the application.
Intel® Rapid Storage Technology enterprise is trying to connect to the service.	The application is launched and is attempting to connect to the service in order to run.	If the connection succeeds, the application opens and is fully functional; if the connection fails, the error message described above is displayed. Try starting the service manually using Microsoft Windows* Services, or follow the recommended solution listed above to resolve the problem.
The Intel® Rapid Storage Technology enterprise service cannot be started in safe mode.	The user's computer was started in safe mode and the operating system is running with a limited set of files and drivers. Intel Rapid Storage Technology enterprise cannot start or run in safe mode.	Once the user is done troubleshooting application or driver problems in safe mode, the user will need to exit safe mode, restart the user's computer, and then let the operating system start normally. The Intel Rapid Storage Technology enterprise service can now be started and open the application.
Multiple users cannot run the application at the same time.	One or more users are attempting to open the application while an instance of the application is already running.	Make sure only one instance of the application is running at a time.
An error occurred due to insufficient resources, and the operation could not be completed. Please try again later.	The Intel® Rapid Storage Technology enterprise driver does not have sufficient resources to execute the request. Another operation may be in progress and needs to complete before being able to handle a new request.	Wait a few moments, then try performing the action again.
An unknown error occurred during the volume creation process. Please try recreating the volume.	An unexpected error occurred during the operation, and the application cannot identify its origin. The volume could not be created.	Verify that the user's hardware is properly connected and try recreating the volume.
An error occurred while an operation was in progress. The operation could not be completed.	An unexpected error occurred during an operation, such as a data migration or a rebuild, and the application cannot identify its origin	Restart the operation. If the error persists, try restarting the user's computer and then the operation.



9.3 Troubleshooting Using the UEFI Shell

This portion will discuss troubleshooting with two tools that are available within the Pre-OS kit. These two tools are within the `efi_standalone_rste_rs` folder. The first is `HWKeyCheckRSTeRS.efi` and the second will be `RCmpVROC.efi`. Copy these tools to a USB drive and are executed from a UEFI Shell. All media will be attached to a mapped thumb drive. The examples show that the media was mapped as `FS0:\`. To change from the starting location to the thumb drive `FS0`, type `FS0:\` and press Enter. The command will list all files within the directory tree. The command `map -r` will allow you to return back to all mapped drives and try a different thumb drive if more than one is mapped.

9.3.1 HWKeyCheckRSTeRS.efi

This command is used to determine if your system is able to detect a hardware upgrade key's presence plugged into the motherboard.

If there is no key installed, the output will read as follows:

```
FS0:\> HWKeyCheckRSTeRS.efi
Intel(R) UEFI VROC HW Key Check Utility for Purley and Basin Falls platforms

Purley platform detected, lpcDeviceId = 0xA242!

Intel(R) VROC in pass-thru mode - no valid HW key inserted
```

If there is a hardware key installed, the message will be altered as follows:

```
FS0:\> HWKeyCheckRSTeRS.efi
Intel(R) UEFI VROC HW Key Check Utility for Purley and Basin Falls platforms

Purley platform detected, lpcDeviceId = 0xA242!

Premium Intel(R) VROC HW Key verified
```

9.3.2 RCmpVROC.efi

This command will be used to send system information to a text file from within the UEFI shell to your thumb drive. If you need this file to be saved elsewhere, you will have to direct the output to that location. For simplicity, this guide is having the file saved to the same media as what is holding the UEFI shell commands.



```

FS0:\> RCmpURDC.efi > RCcmURDC.2.txt
FS0:\> ls
Directory of: FS0:\
05/01/2016  16:30          735,717  fio-master.zip
04/28/2016  15:23 <DIR>           8,192  fio-master
04/19/2017  11:29       21,415,936  rste-5.1_PU_rhel7.3.iso
04/11/2017  07:14 <DIR>           4,096  rpm
04/11/2017  07:14 <DIR>           4,096  src
03/30/2017  06:12       7,060,871  updates.img
05/12/2017  10:18           776  script.sh
01/31/2017  13:19       415,170  fio-2.12-1.fc25.x86_64.rpm
03/09/2017  16:24 <DIR>           4,096  fio_benchmark
04/27/2017  15:04       2,406  fioscript_4kRandomMixed.sh
03/13/2017  12:51       2,322  fioscript.sh
05/12/2017  13:02       13,468  libaio-devel-0.3.107-10.el6.x86_64.rpm
05/12/2017  13:19       21,708  libaio-0.3.107-10.el6.x86_64.rpm
04/19/2017  11:28       8,674,876  IntelASM-1.1.0.2-RHEL7.zip
05/31/2017  14:07       1,480  BOOTEX.LOG
06/26/2017  13:23 <DIR>           4,096  F5_Bios_v5.2.0.1219
06/26/2017  13:27 <DIR>           4,096  Installer_5.2.0.1219
06/14/2017  15:33       26,336  HWKeyCheckRSTeRS.efi
06/14/2017  15:33       35,808  RCmpURDC.efi
06/28/2017  22:58         6,124  RCcmURDC.txt
06/28/2017  23:14         6,124  RCcmURDC.2.txt
    
```



10 Appendix

10.1 Intel RSTe CLI Usage

The Intel® RSTe Command Line Interface tools are restricted to OEMs manufacturing environment and can be run from a Windows* or WinPE* environment to perform RAID configurations via command line scripting in a command prompt. It provides OEMs with the ability to create, delete, and manage RAID volumes on a system within a Windows* environment using command line parameters that make it possible to perform these functions by using scripts or shell commands.

The command syntax for the RSTCLI64 utility is shown below by running command "rstcli64.exe -help". Note that commands are Case Sensitive.

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        |
-----

```

Create Usage:

Creates a new volume and array or creates a new volume on an existing array.
--create --level x [--size y] [--stripe-size z] [--rwh a] [--jd b] [--span] --name string
[--create-from-existing diskId] diskId {[diskId]}

Create Examples:

```

-C -l 1 -n Volume 0-1-0-0 0-2-0-0
-C -l 1 -E 0-1-0-0 -n VolumeWithData 0-2-0-0
-C -l 1 -n Volume -o 2-0-0-0 3-0-1-0
-C -n newVolume -l 5 -W Distributed 0-1-0-0 0-2-0-0 0-3-0-0
--create --level 5 --rwh JournalingDrive --jd 0-0-0-0 --name newVolume 0-1-0-0 0-2-0-0 1-0-0-0 --span
--create --level 0 --size 5 --name RAID0Volume 0-3-0-0 0-4-0-0 0-5-0-0
--create -help

```

```

*****
|WARNING: If --span is set and the volume you created contains disks from|
|different VMD Controllers it cannot be used as a bootable volume.    |
*****

```

Information Options:

```

-----
| Flag | Name          |
-----
|-l | --information |
|-a | --array       |
|-c | --controller  |
-----

```



```
| -d | --disk      |
| -e | --enclosure |
| -v | --volume   |
-----
```

Information Usage:
 Displays disk, volume, array, enclosure, and controller information.
 --Information --controller|--array|--disk|--enclosure|--volume
 {[device]}

Information Examples:
 -l -v Volume
 -l -d 0-5-0-0
 --information --array Array_0000
 --information --help

Manage Options:

```
-----
| Flag | Name          |
-----
| -M | --manage      |
| -x | --cancel-verify |
| -D | --delete      |
| -p | --verify-repair |
| -f | --normal-volume|
| -F | --normal      |
| -i | --initialize   |
| -L | --locate      |
| -T | --delete-metadata|
| -Z | --delete-all-metadata |
| -N | --not-spare   |
| -P | --volume-cache-policy |
| -R | --rebuild     |
| -S | --spare       |
| -t | --target      |
| -U | --verify      |
| -w | --write-cache |
| -W | --rwh         |
| -j | --jd          |
-----
```

Manage Usage:
 Manages arrays, volumes and disks present in the storage system.
 --manage --cancel-verify volumeName
 --manage --delete volumeName
 --manage --verify-repair volumeName
 --manage --normal-volume volumeName
 --manage --normal diskId
 --manage --initialize volumeName
 --manage --locate diskId
 --manage --delete-metadata diskId
 --manage --not-spare diskId
 --manage --volume-cache-policy off|wb --volume volumeName
 --manage --rebuild volumeName --target diskId
 --manage --spare diskId
 --manage --verify volumeName
 --manage --write-cache true|false --array arrayName



```
--manage --delete-all-metadata  
--manage --rwh policy --volume volumeName
```

Manage Examples:

```
-M -D VolumeDelete  
-M -F 0-2-0-0  
-M -U VolumeVerify  
-M -W Distributed -v vol  
--manage --spare 0-3-0-0  
--manage --write-cache true --array Array_0000  
--manage --delete-all-metadata  
--manage --rwh JournalingDrive --jd 0-1-0-0 --volume vol  
--manage --help
```

Modify Options:

Flag	Name
-m	--modify
-A	--Add
-X	--expand
-l	--level
-n	--name
-s	--stripe-size
-v	--volume

Modify Usage:

Modifies an existing volume or array.

```
--modify --volume VolumeName --add diskId [[diskId]]  
--modify --volume VolumeName --expand  
--modify --volume VolumeName --level L [--add diskId [[diskId]]]  
[--stripe-size s] [--name N]  
--modify --volume VolumeName --name n
```

Modify Examples:

```
-m -v Volume_0000 -A 0-3-0-0 0-4-0-0  
-m -v ModifyVolume -l 5  
--modify --volume Volume --name RenameVolume  
--modify --volume Volume --level 5 --add 2-0-0-0 --stripe-size 64  
--modify --help
```

OPTIONS:

```
-A <<host>-<bus>-<target>-<lun>>, --add <<host>-<bus>-<target>-<lun>>  
Adds new disks to an existing volume.
```

```
-a, --array  
Lists information about the arrays in the storage system.
```

```
-C, --create  
Creates a new volume and array or creates a new volume on an existing  
array.
```

```
-c, --controller  
Lists information about the controllers in the storage system.
```

```
-D <Volume name>, --delete <Volume name>  
Deletes the specified volume.
```



- d, --disk
Lists information about the disks in the storage system.
- E <<host>-<bus>-<target>-<lun>>, --create-from-existing
<<host>-<bus>-<target>-<lun>>
Identifies the disk if data is to be migrated from one of the disks.
Disk identifier is SCSI address.
- e, --enclosure
Lists information about the enclosures in the storage system.
- F <<host>-<bus>-<target>-<lun>>, --normal
<<host>-<bus>-<target>-<lun>>
Resets failed or SMART event disk to normal.
- f <Volume name>, --normal-volume <Volume name>
Resets failed RAID 0 volume to normal and recovers data.
- h, --help
Displays help documentation for command line utility modes, options,
usage, examples, and return codes. When used with a mode switch
(create, information, manage, or modify), instructions for that mode
display. For example, --create --help displays Create option help.
- I, --information
Displays disk, volume, array, enclosure, and controller information.
- i <Volume name>, --initialize <Volume name>
Initializes the redundant data on a RAID 1, 5 or 10 volume.
- j, --jd
Journaling drive.
- L <<host>-<bus>-<target>-<lun>>, --locate
<<host>-<bus>-<target>-<lun>>
Locates device and blinks the LED.
- l <0, 1, 5, 10>, --level <0, 1, 5, 10>
Changes the Raid type of an existing volume. Options are migrations
from RAID 1 to RAID 0 or 5, RAID 0 to RAID 5, and RAID 10 to RAID 5.
- M, --manage
Manages arrays, volumes and disks present in the storage system.
- m, --modify
Modifies an existing volume or array.
- N <<host>-<bus>-<target>-<lun>>, --not-spare
<<host>-<bus>-<target>-<lun>>
Resets a spare disk to available.
- n <Volume name>, --name <Volume name>
Specifies a name for the volume created. Renames an existing volume in
Modify mode.
- o, --span
Flag, which enables spanning while creating or modifying volume.
- P <Volume name>, --volume-cache-policy <Volume name>
Sets volume cache policy to either off or wb.
- p <Volume name>, --verify-repair <Volume name>
Verifies and repairs the volume.



- q, --quiet
Suppresses output for create, modify, and manage modes. Not valid on info mode.
- R <Volume name>, --rebuild <Volume name>
Rebuilds the degraded volume.
- r, --rescan
Forces the system to rescan for hardware changes.
- S <<host>-<bus>-<target>-<lun>>, --spare <<host>-<bus>-<target>-<lun>>
Marks a disk as a spare.
- s <size in KB>, --stripe-size <size in KB>
Sets a stripe size in kilobytes (2¹⁰ bytes) for a volume. Valid when creating or changing the type of a volume and for RAID 0, RAID 5 and RAID 10. Options are 4, 8, 16, 32, 64 and 128 KB.
- T <<host>-<bus>-<target>-<lun>>, --delete-metadata <<host>-<bus>-<target>-<lun>>
Deletes the metadata from the specified disk.
- t <<host>-<bus>-<target>-<lun>>, --target <<host>-<bus>-<target>-<lun>>
Indicates the pass-through disk to be used for rebuilding a degraded volume.
- U <Volume name>, --verify <Volume name>
Verifies data on the volume.
- u <password>, --unlock <password>
Unlocks a disk.
- V, --version
Displays version information.
- v, --volume
Lists information about the volumes on the system. Stipulates the volume to act on when used in Modify or Manage mode.
- W, --rwh
Close RAID Write Hole policy. Options are Off, Distributed, JournalingDrive.
- w <true or false>, --write-cache <true or false>
Enables or disables write cache for all disks that are part of an array.
- X, --expand
Expands a volume to consume all available space in an array.
- x <Volume name>, --cancel-verify <Volume name>
Cancels a verify operation in progress.
- xml
XML output of the current system state.
- xmlfile <foo.xml>
File Name for XML file.
- Z, --delete-all-metadata
Deletes the metadata from all disks on the system.



-z <size in GB>, --size <size in GB>

Sets a size in gigabytes. This is an optional switch. If the size is not specified or specified to 0, then the maximum size available will be used.

RETURN CODES:

0, Success

Request completed successfully.

1, Request Failed

Request is formatted correctly but failed to execute.

2, Invalid Request

Unrecognized command, request was formatted incorrectly.

3, Invalid Device

Request not formatted correctly, device passed in does not exist.

4, Request Unsupported

Request is not supported with the current configuration.

5, Device State Invalid

Request is not supported with the current device state.

20, Invalid Stripe Size

Stripe size is not supported.

21, Invalid Name

Volume name is too long, has invalid characters, or already exists.

Volume name cannot exceed 16 English characters.

22, Invalid Size

Size requested is invalid.

23, Invalid Number Disks

Number of disks requested is invalid.

24, Invalid RAID Level

RAID level requested is invalid.

34, Incorrect RWH policy

Raid Write Hole policy was incorrect.

35, RWH policy is same

Passed policy is same as previous one. There is no need to change it.

36, Invalid JD

Passed journaling drive is invalid.

37, RWH disk unmark failure

Failed to unmark journaling drive.

Intel(R) Rapid Storage Technology enterprise (Intel(R) RSTe) for CLI is an end user command line utility used to perform basic RAID operations on RAID-enabled systems. Intel(R) RSTe for CLI supports RAID 0, RAID 1, RAID 5 and RAID 10 volumes. Intel(R) RSTe for CLI supports creating RAID volumes using the Create mode and managing RAID volumes using the Manage mode.