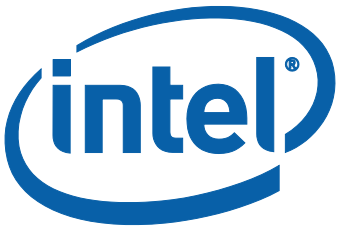


Intel® Rapid Storage Technology (Intel® RST) Release with Intel® Optane™ Memory

Installation and User Guide

Includes Latest 17.x Updates

For the Intel® Rapid Storage Technology Release Version 17.x with Intel® Optane™ Memory Support

Revision 001

July 2020

Document Number: xxxxxx-001

Contents

Tables

Figures

Revision History

Document Number	Revision Number	Description	Revision Date
xxxxxx	001	• Initial release	July 2020

§§

1 Document Overview

1.1 Purpose and Scope

This document will assist customers in evaluating, testing, configuring, and enabling Intel® Optane™ Memory, RAID 0/1/5/10, and AHCI functionality on Intel-based platforms using the Intel® Rapid Storage Technology (Intel® RST) software for the chipset components as listed in the product's Readme.txt file.

This document also describes installation procedures, caching acceleration techniques, other Intel® RST features, RAID volume management such as creating, deleting, and modifying volumes, common usage models, and any special notes necessary to enable customers to develop their Intel® RST-compatible computer systems.

1.1.1 Intel® Optane™ Memory Support

- Minimum requirements
- How to enable
- How to manage
- User pinning

1.1.2 Intel® RST Premium Feature Support

- RAID 0/1/5/10

§§

2 Intel® Rapid Storage Technology

Intel® Rapid Storage Technology (Intel® RST) provides added performance and reliability for supported systems equipped with serial ATA (SATA) hard drives (HDD's) and/or solid state drives (SSD's) and PCIe* AHCI/NVMe* SSD's to enable an optimal PC storage solution. It offers value-add features such as RAID and advanced Serial ATA* capabilities for the Microsoft* Windows* operating systems (for detailed OS support, review the Release Notes for each software release). Additionally, overall system responsiveness is boosted by the Intel® Optane™ memory system acceleration caching feature.

The RAID feature supports RAID level 0 (striping), RAID level 1 (mirroring), RAID level 5 (striping with parity) and RAID level 10 (striping and mirroring). A configuration supporting two RAID levels can also be achieved by having two volumes in a single RAID array that use Intel® RST. This configuration is known as a Matrix array. The RAID capability addresses the demand for high-performance or data-redundant desktop and mobile platforms.

The product also includes premium Intel® RST features as well as support for other premium-platform technologies.

2.1 Overview

2.1.1 RAID Levels

RAID 0 (striping)	RAID level 0 combines two to six drives so that all data is divided into manageable blocks called strips. The strips are distributed across the array members on which the RAID 0 volume resides. This improves read/write performance, especially for sequential access, by allowing adjacent data to be accessed from more than one hard drive simultaneously. However, data stored in a RAID 0 volume is not redundant. Therefore, if one hard drive fails, all data on the volume is lost. The RAID 0 volume appears as a single physical hard drive with a capacity equal to twice the size of the smaller hard drive. The Intel® SATA AHCI/RAID controllers with Intel® Rapid Storage Technology allows up to six[1] drives to be combined into a single RAID 0 array, providing additional scaling of storage performance. **NOTE:** [1] The number of drives supported in a RAID 0 array is dependent upon the chipset model. Consult the specification for your chipset to determine the maximum number of drives supported in a RAID array.

RAID 1 (mirroring)	RAID level 1 combines two hard drives so that all data is copied concurrently across the array members that the RAID 1 volume resides on. In other words, the data is mirrored across the hard drives of the RAID 1 volume. This creates real-time redundancy of all data on the first drive, also called a mirror. RAID 1 is usually used in workstations and servers where data protection is important. The RAID 1 volume appears as a single physical hard drive with a capacity equal to that of the smaller hard drive.
RAID 5 (striping with parity)	RAID level 5 combines three to six drives so that all data is divided into manageable blocks called strips. RAID 5 also stores parity, a mathematical method for recreating lost data on a single drive, which increases fault tolerance. The data and parity are striped across the array members. The parity is striped in a rotating sequence across the members. Because of the parity striping, it is possible to rebuild the data after replacing a failed hard drive with a new drive. However, the extra work of calculating the missing data will degrade the write performance to the volumes. RAID 5 performs better for smaller I/O functions than larger sequential files. RAID 5, when enabled with volume write-back cache with Coalescer, will enhance write performance. This combines multiple write requests from the host into larger more efficient requests, resulting in full stripe writes from the cache to the RAID5 volume. RAID 5 volume provides the capacity of (N-1) x smallest size of the hard drives, where N >= 3 and <=4. For example, a 3-drive RAID 5 will provide capacity twice the size of the smallest drive. The remaining space will be used for parity information.
RAID 10 (striping and mirroring)	RAID level 10 uses four hard drives to create a combination of RAID levels 0 and 1. The data is striped across a two-disk array forming a RAID 0 component. Each of the drives in the RAID 0 array is mirrored to form a RAID 1 component. This provides the performance benefits of RAID 0 and the redundancy of RAID 1. The RAID 10 volume appears as a single physical hard drive with a capacity equal to two drives of the four-drive configuration (the minimum RAID 10 configuration). The space on the remaining two drives will be used for mirroring. **NOTE:** RAID 10 is currently **not** supported on Intel® RST PCIe* Storage member disks.

2.1.1.1 Typical Usage Model for RAID Levels

RAID 0	RAID0 provides end-users the performance necessary for any disk-intensive applications; these include video production and editing, image editing, and gaming applications.
RAID 1	RAID1 provides end-users with data redundancy by mirroring data between the hard drives.
RAID 5	RAID5 provides end-users with good performance and data redundancy by striping data and parity across all the hard drives. The write performance is enhanced with volume write-back cache.
RAID 10	RAID10 provides end-users with the benefits of RAID 0 (performance) and RAID 1 (data mirroring).

2.1.2 Supported Platforms

Latest Platform support can always be found in the Readme file and Release Notes as part of the driver package here:
https://downloadcenter.intel.com/download/29350/Intel®-Rapid-Storage-Technology-Intel®-RST-Floppy-Driver-Package?v=t

2.1.3 Supported Operating Systems

Latest OS support can always be found in the Readme file and Release Notes as part of the driver package here:
https://downloadcenter.intel.com/download/29350/Intel®-Rapid-Storage-Technology-Intel®-RST-Floppy-Driver-Package?v=t

§§

3 Intel® RST Software

The Intel® RST software is the major component of the Intel® Rapid Storage Technology Suite. The software includes the Intel® RST AHCI and RAID 64-bit drivers for supported Windows* operating systems. The driver supports several Intel® Serial ATA AHCI/RAID controllers and will recognize each unique device ID and sub-class code. Because of this, the driver must be installed before the Windows* operating system is installed onto a RAID volume or a single SATA hard drive connected to the RAID controller. The OS runtime driver, in conjunction with the Intel® Rapid Storage Technology option ROM or the RST pre-OS UEFI driver, will provide boot capability for all supported RAID levels. The driver, in conjunction with the Intel® RST UI, provides RAID volume management (create, delete, migrate, etc.) within the Windows* operating system. It also displays SATA* device and RAID volume information. Included with the software package is the RAID monitor service that monitors and reports various events of the storage subsystem. Other advanced features supported include System Acceleration with Intel® Optane™ technology.

§§

4 Intel® Optane™ Memory and Storage Management UI

4.1 Introduction

The Intel® Optane™ Memory and Storage Management UI is a Windows* Store app that provides users monitoring and management capabilities for the Intel® RST storage subsystem. It offers a wide range of monitoring and management activities for the Intel® RST RAID subsystem. It also provides the support for all Intel® Optane™ Memory features including File, Folder and Application pinning.

NOTES:

1. The minimum resolution supported by Intel® Optane™ Memory and Storage Management UI is 1024x768.
2. For Windows* 10 RS4, Intel® Optane™ Memory and Storage Management UI requires to be launch as Administrator manually by right click and select "Run as Administrator." This requirement does not apply for Windows* 10 RS5 and above.

4.2 Getting Started

The Intel® Optane™ Memory and Storage Management UI software package provides high-performance RAID capabilities for supported operating systems.

The Intel® Optane™ Memory and Storage Management UI requires the Microsoft* .NET Native Framework 2.0 framework, Microsoft* .NET Native Framework 2.0 runtime and the Microsoft* VC Libs beginning with Intel® RST 17.0 HSA release.

Refer to the System Requirements and this online user's manual to set up your system's configuration and feature support level. You can also review the Readme file available with each driver release to learn more about the full system requirements and RAID BIOS configuration.

4.2.1 Understanding the Application

The Intel® Optane™ Memory and Storage Management application allows you to optimize and maintain a healthy storage system by creating volumes, customizing performance settings and managing storage system elements. This section provides you with a general overview of a storage system configuration and an individual review of all the areas contained in this application.

4.2.1.1 Storage System Configuration

The storage system combines hardware capabilities with RAID technology to provide flexible data storage units on your computer. Each data storage unit, or RAID configuration, consists of three elements that include physical SATA disks, one or two

volumes, and one array. When at least one volume is present on the system, these elements are represented in the storage system view of the Status and Manage areas. In this section, we describe each of these RAID configuration elements and explain how they relate to each other.

- **Array:**

  An array is a collection of two or more SATA disks in a RAID configuration and is the highest element in the hierarchy of a storage system. Once a volume is created, the disks you used to create that volume form an array. Refer to the Creating Additional Volumes topic for details on how you can create two volumes across the same disks. An array can include one or two RAID volumes if the hardware allows it.

- **Volume:**

  A volume is the storage area on two or more disks whose type dictates the configuration of the data stored. If you created a volume for data protection, then your storage system may include a RAID 1 volume spanning two SATA disks, which mirrors data on each disk.

- **Disks:**

  A disk (i.e., hard disk or hard disk drive) physically stores data and allows read/write data access. If a disk is used to create a volume, it becomes an array disk because it has been grouped with other disks to form an array.

The storage system can also include ATAPI devices, which cannot be used to create a volume. They are a mass storage device with a parallel interface, such as CD-ROM, DVD/Blu-ray disc, or tape drive.

4.2.1.2 Navigation

The application is organized into five main areas depicted by the top navigation buttons: Manage, Create Volume, Intel® Optane™ Memory, Performance, Settings and About.

Manage:

The ‘Manage’ tab has information on all the volume information along with all the devices attached with the system. We can initialize, verify, or delete a volume from this menu option. For more details on managing volumes, refer section 4.4.

Create Volume:

The ‘Create Volume’ tab is used to created different RAID volumes. The supported volumes are RAID0, RAID1, RAID5 and RAID10. For more details on creating volumes, refer section 4.5.

Intel® Optane™ Memory:

The 'Intel® Optane™ Memory' tab allows the user to enable, disable or manage Intel® Optane™ memory stick attached to the system. It also provides the menu for pinning files/folders or applications. For more details on creating, deleting or managing Intel® Optane™ volumes, refer section 4.6.

Performance:

The 'Performance' tab provides the meu to disable or enable LPM (Link Power Management). For more details on performance, refer section 4.7.

Settings:

The 'Settings' tab provides a link to enable or disable Optane™ notifications in Windows* notification settings. For more details, refer section 4.8.

About:

The 'About' tab contains the version and developer information. It also provides a link to support. For more details, refer section 4.9.

4.3 Storage System Status

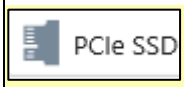
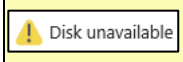
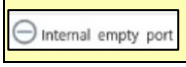
Anytime Intel® Optane™ Memory and Storage Management is launched, the application opens to the 'Manage' area. This is where the general state of health of your storage system is reported, both in the storage system view and in details. Depending on the status, volume creation and management options may be available in order to enhance or repair your storage system.

4.3.1 Storage System View

The storage system view provides a visual representation of your storage system and displays arrays, volumes, devices, and ports. Volumes and SATA disks graphics reflect their current states, which allows you to quickly identify the element that is causing the storage system to be in a state other than normal.

Note: Hovering over a designated element in the storage system view provides a snapshot of its properties. Clicking allows you to access and manage its properties.

Overview of SATA disks attached:

State	Description	Recommendation
	An internal SATA SSD disk is connected	None
	An internal PCIe* SSD (NVMe*) or Intel® Optane™ is connected.	None
	A disk has been removed from a RAID volume	Connect the removed disk or add a spare disk to start rebuilding
	An empty port	None

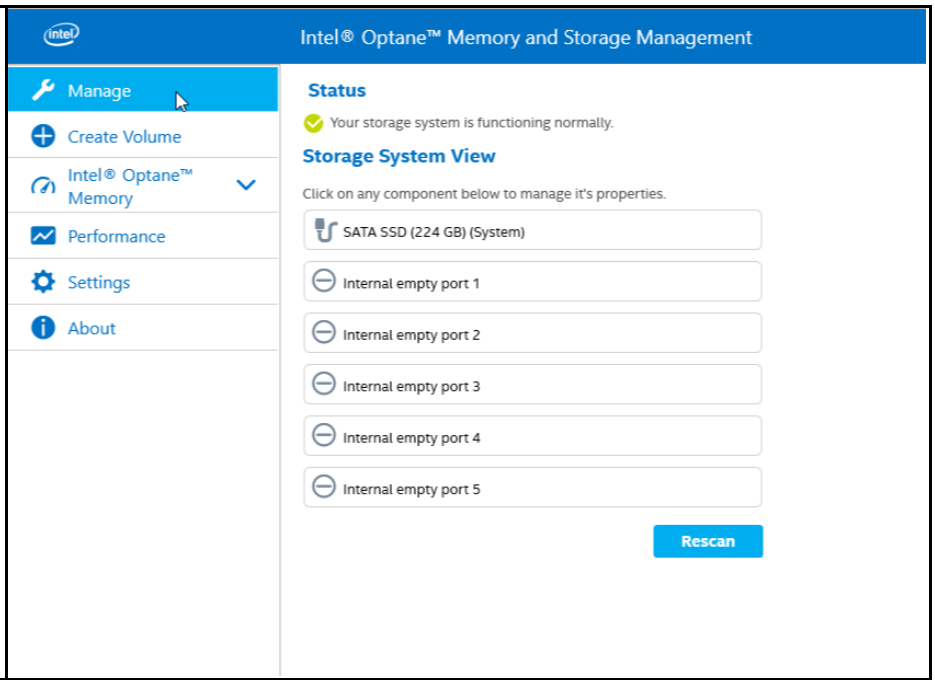
4.4 Manage

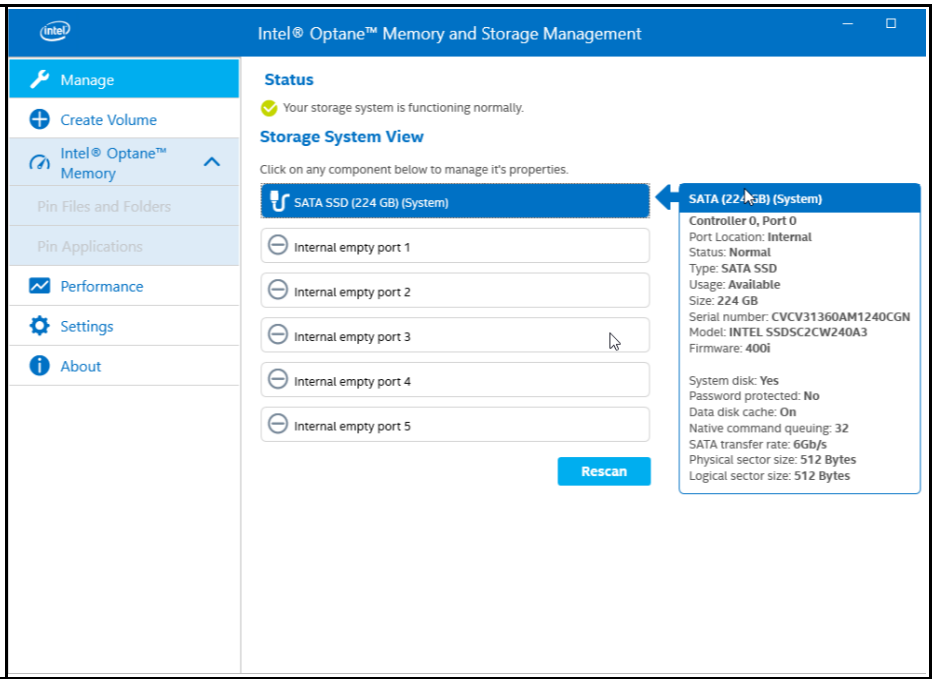
This tab gives a graphical overview of the current status of the storage subsystem of the computer. It will display only those items that are controlled by the RST driver. The following are displayed:

- Pass-through SATA and PCIe* disks
- Empty SATA ports
- RAID volumes
- Intel® Optane™ volumes

You can click on each of the objects listed above to display more detail information and actions associated with each item. Available actions are dependent upon the type of object and its current usage:

- Rename volume
- Delete volume (with exception of the boot volume)
- Data verification

Manage Main View	

Manage Detailed Object View	

4.5 Create Volume

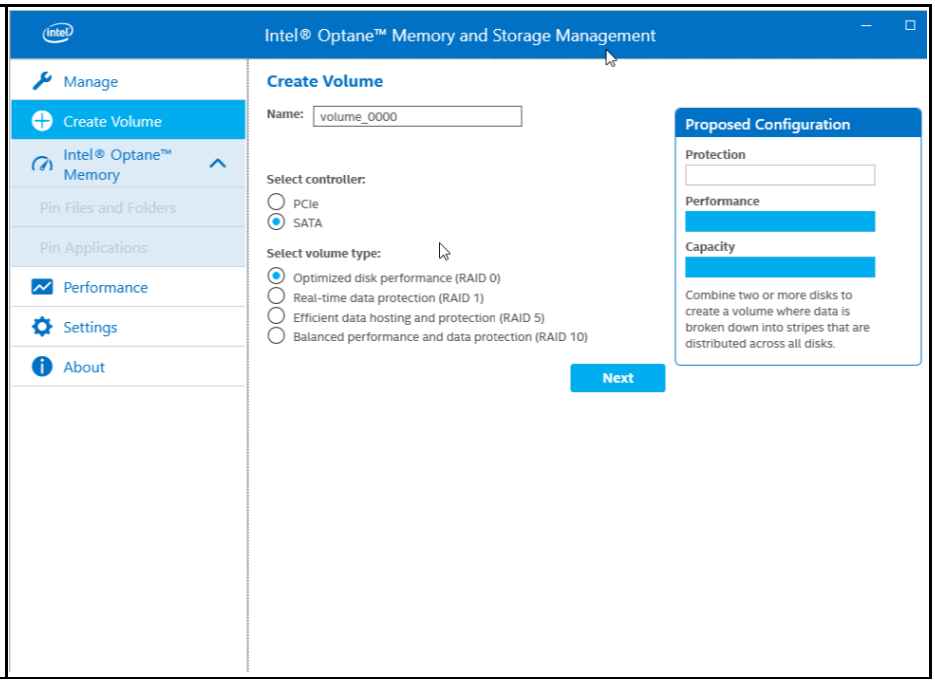
This tab allows for the management of RAID volumes. User has the capability to do the following
tasks:

- Create volume (depending on RAID level the following actions are available)
  - Disk selection
  - Selection to reserve data on one disk
  - Volume size (select a percentage to create a matrix array; 2 volumes)
  - Data strip size
  - Enable write back cache on the volume
  - Name the volume

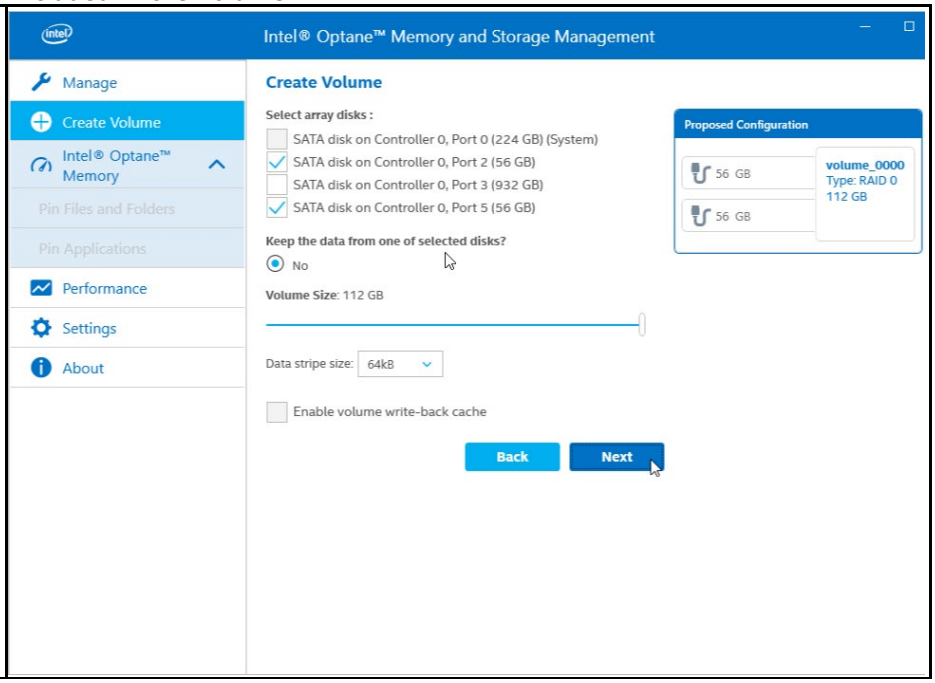
4.5.1 RAID 0

1. Select type of volume to be created

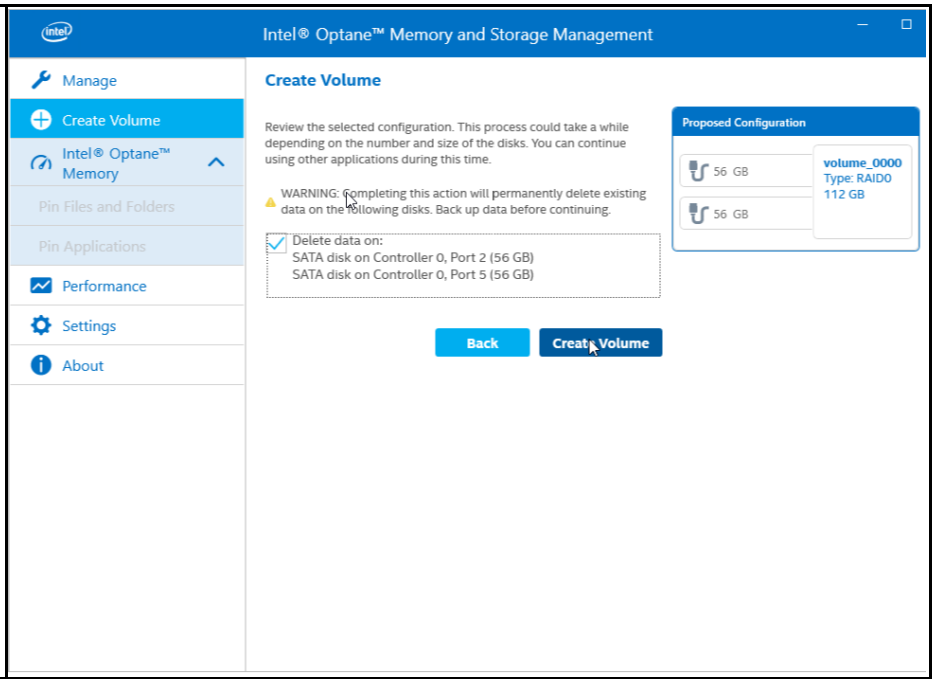
Create Volume Main View – Select volume type



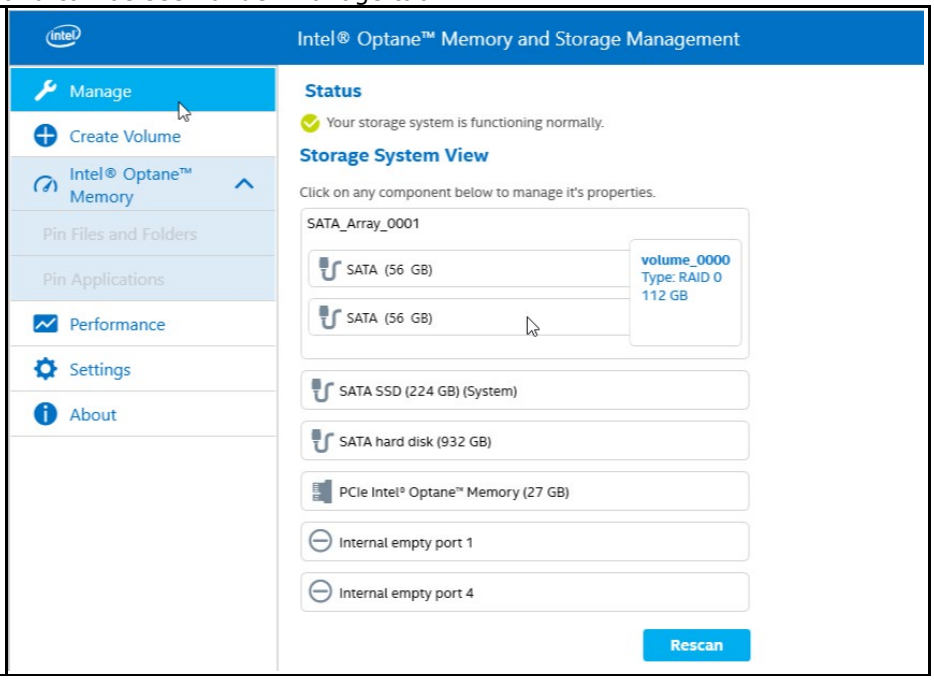
2. Select drives to be included in the volume

Create Volume Main View – Select disks	

3. Create the volume

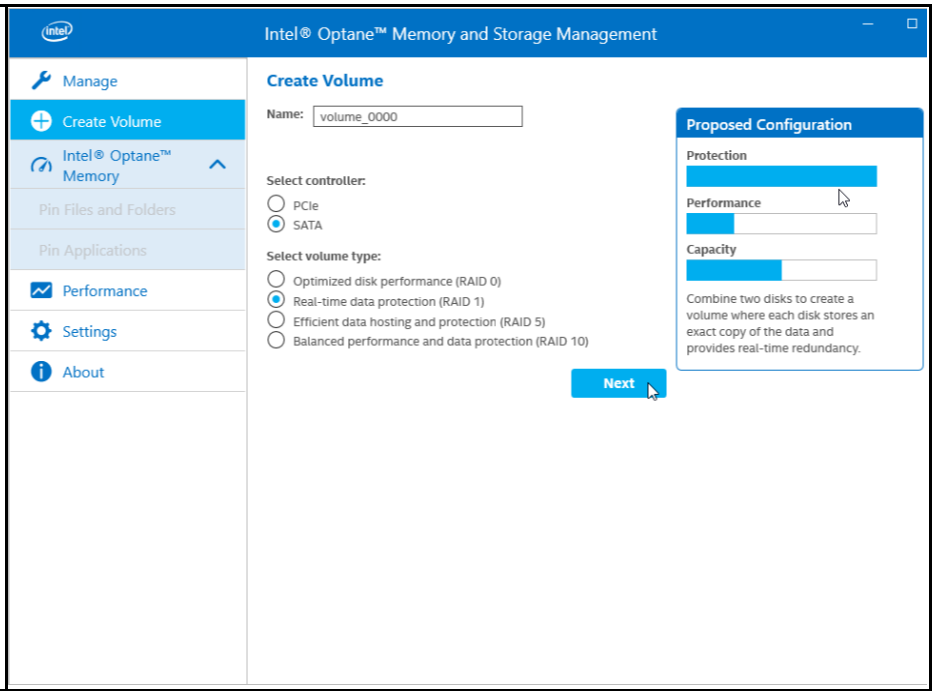
Create Volume Main View – Create volume	

4. Volume is created and can be seen under manage tab

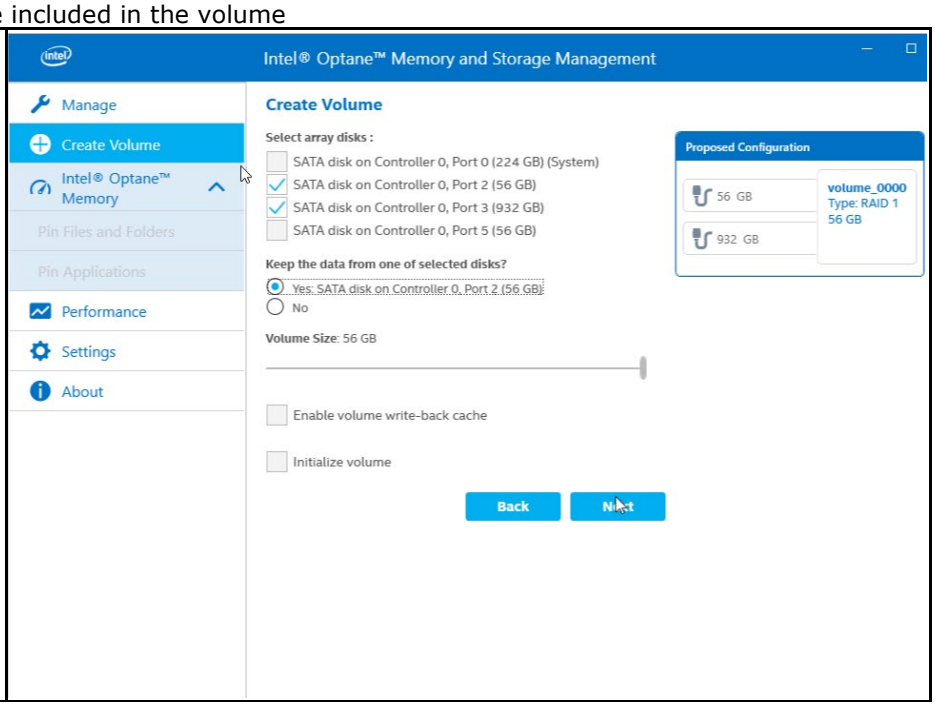
Create Volume Main View – volume created	

4.5.2 RAID 1

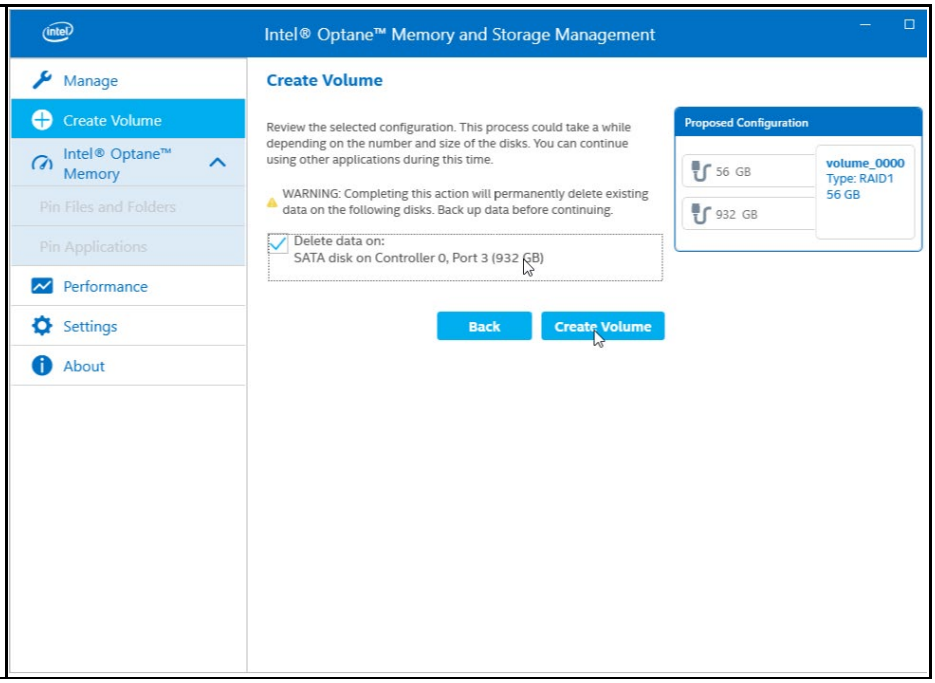
1. Select type of volume to be created

Create Volume Main View – Select volume type	

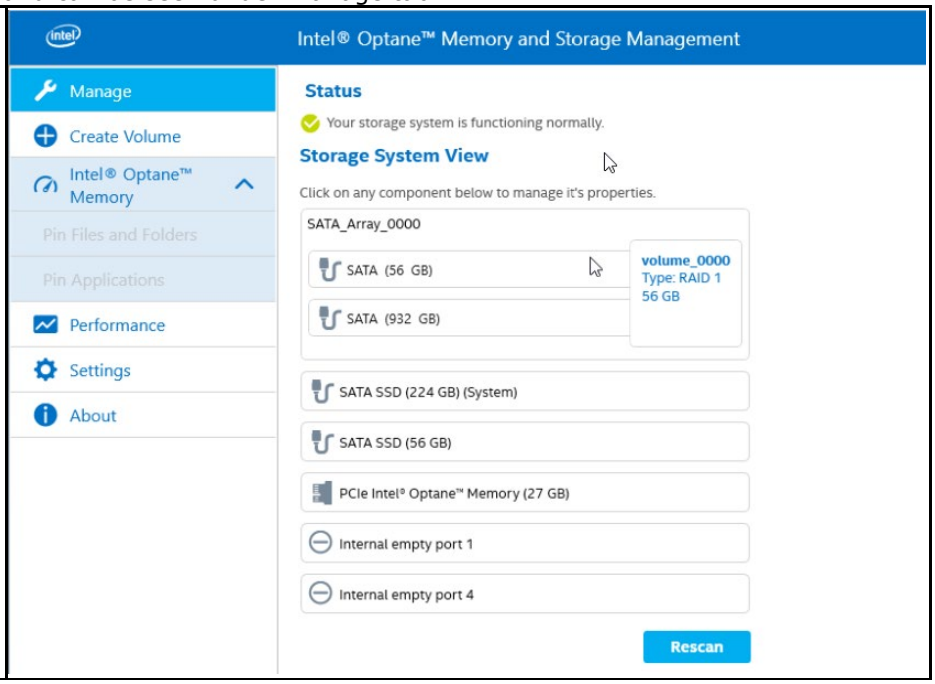
2. Select drives to be included in the volume

Create Volume Main View – Select disks	

3. Create the volume

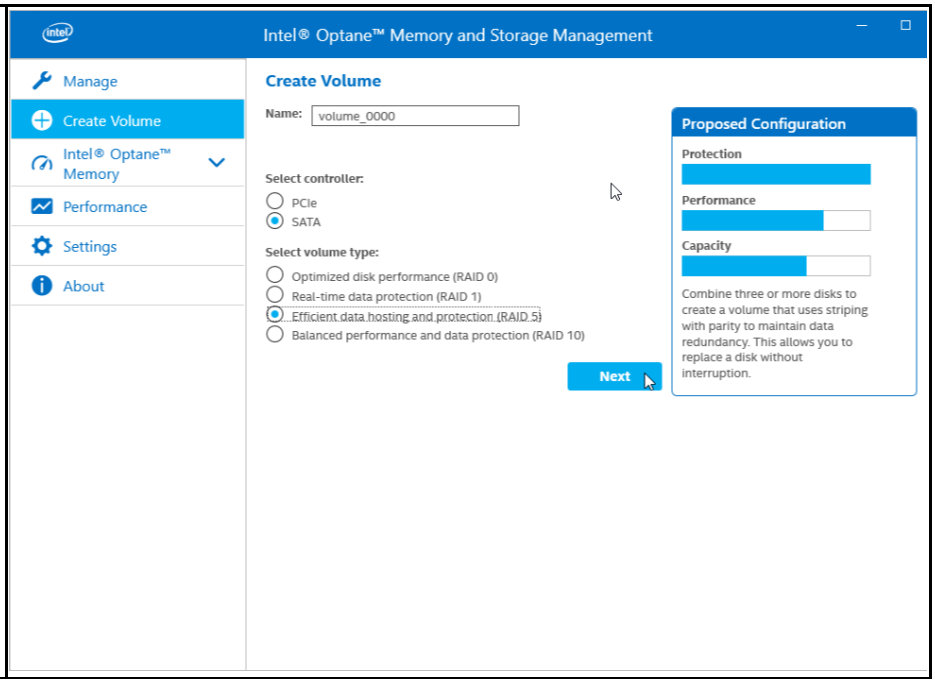
Create Volume Main View – Create volume	

4. Volume is created and can be seen under manage tab

Create Volume Main View – volume created	

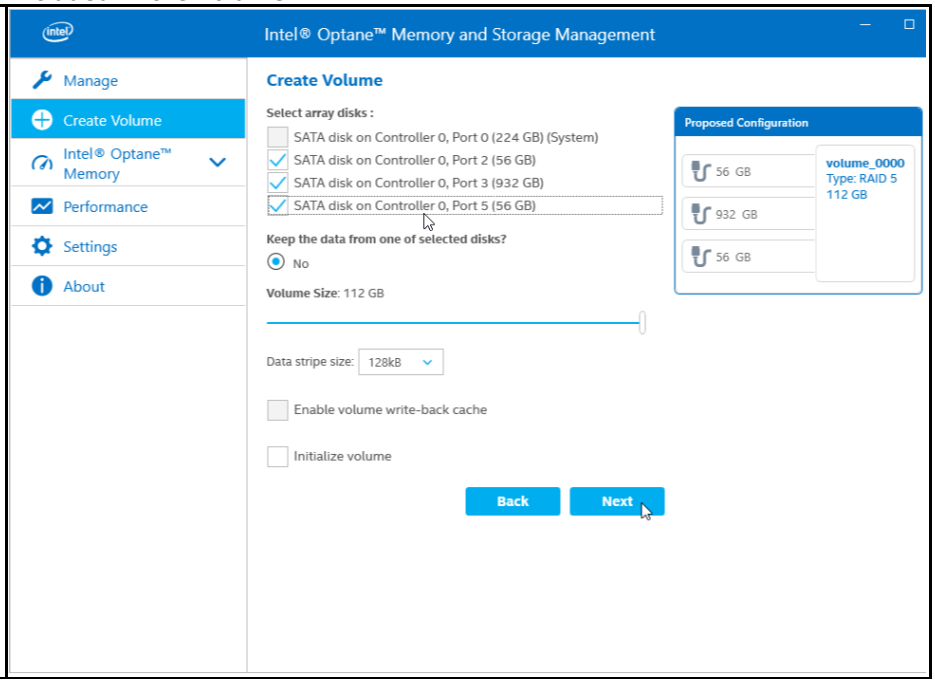
4.5.3 RAID 5

1. Select type of volume to be created

Create Volume Main View – Select volume type	

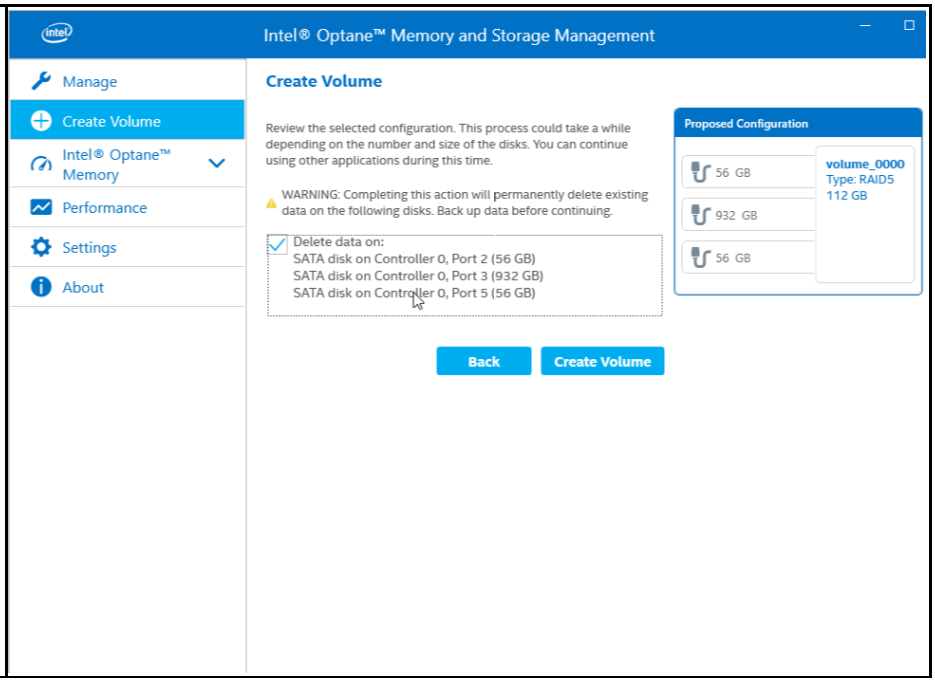
2. Select drives to be included in the volume

Create Volume Main View – Select disks

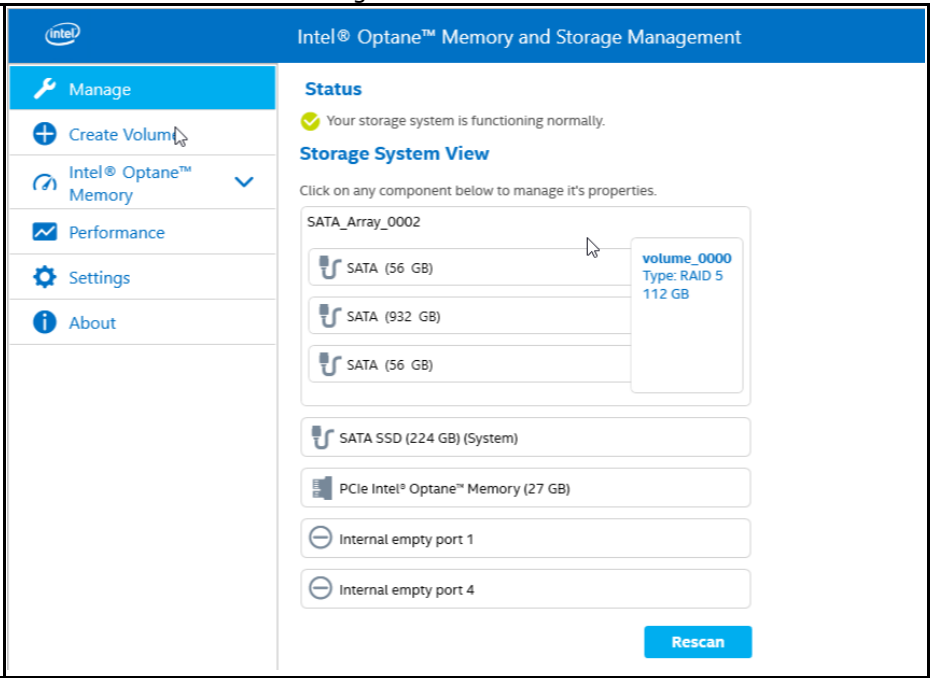


3. Create the volume

Create Volume Main View – Create volume

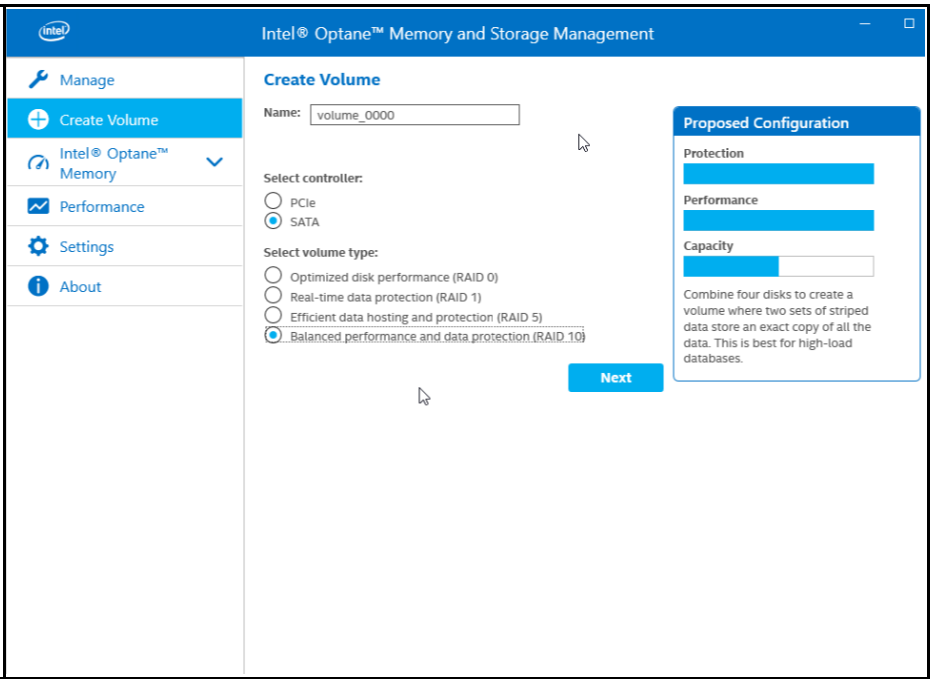


4. Volume is created and can be seen under manage tab

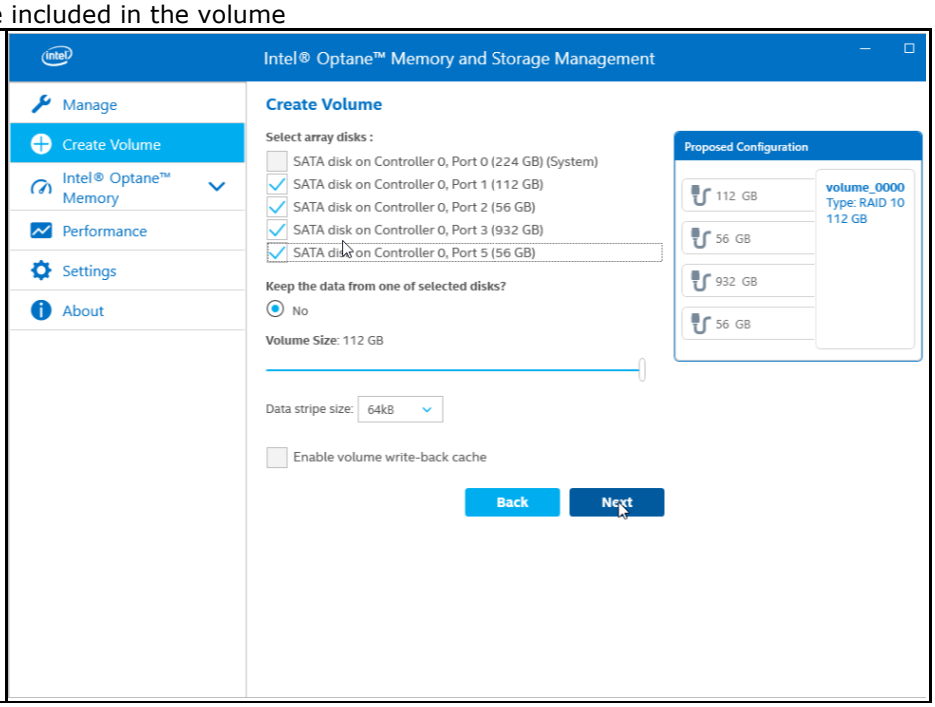
Create Volume Main View – volume created	

4.5.4 RAID 10

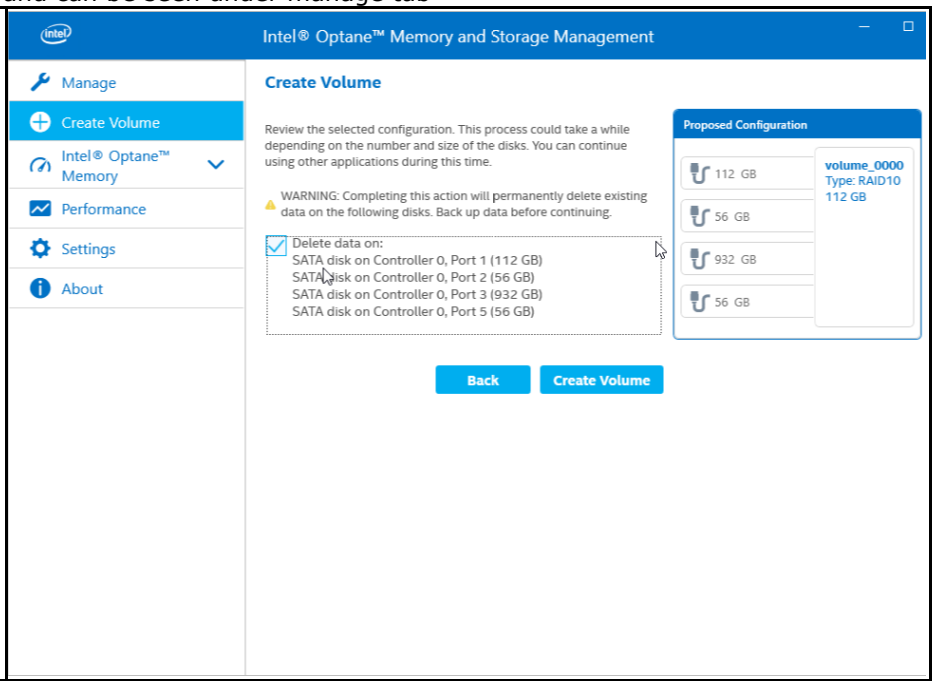
1. Select type of volume to be created

Create Volume Main View – Select volume type	

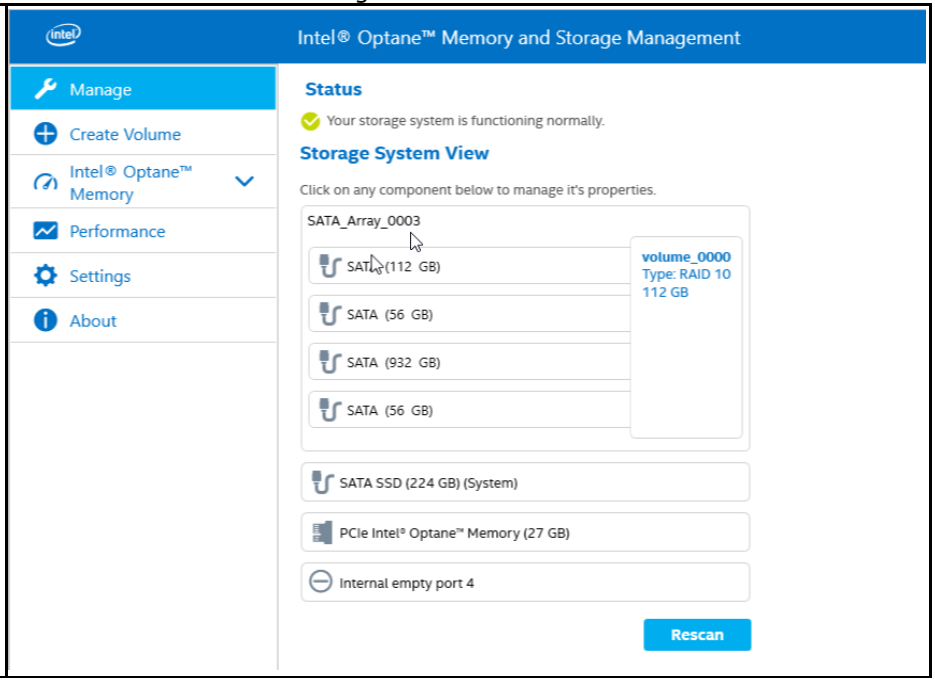
2. Select drives to be included in the volume

Create Volume Main View – Select disks	

3. Volume is created and can be seen under manage tab

Create Volume Main View – Create volume	

4. Volume is created and can be seen under manage tab

Create Volume Main View – volume created	

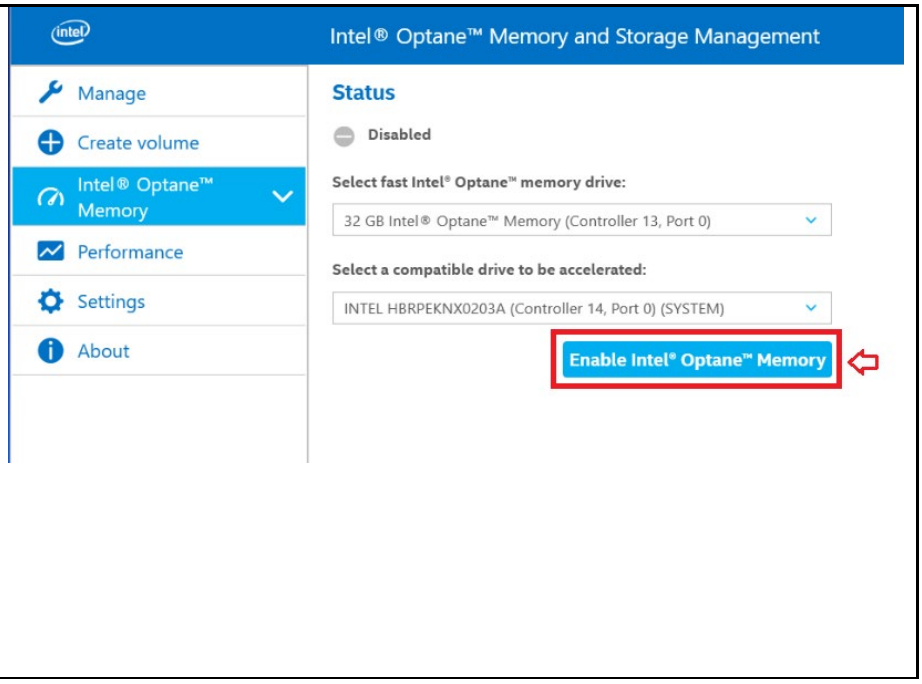
4.6 Intel® Optane™ Memory

This tab allows for the management of an accelerated Intel® Optane™ memory volume. There is a graphical view of the Intel® Optane™ memory volume and its member disks. User can click on either object in the volume and the UI will display detailed information associated with the object.

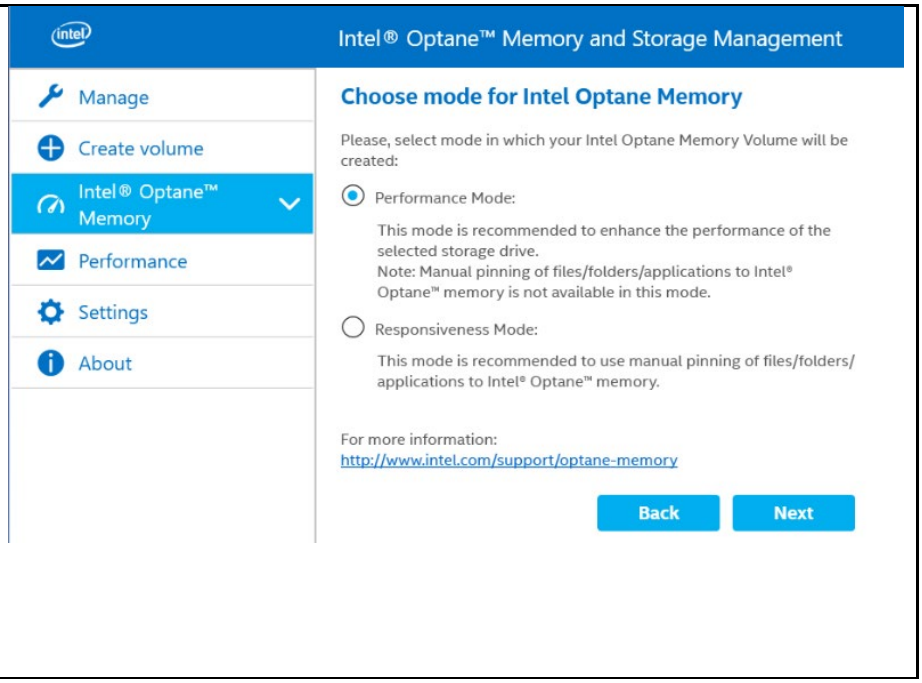
Actions available to the user are:

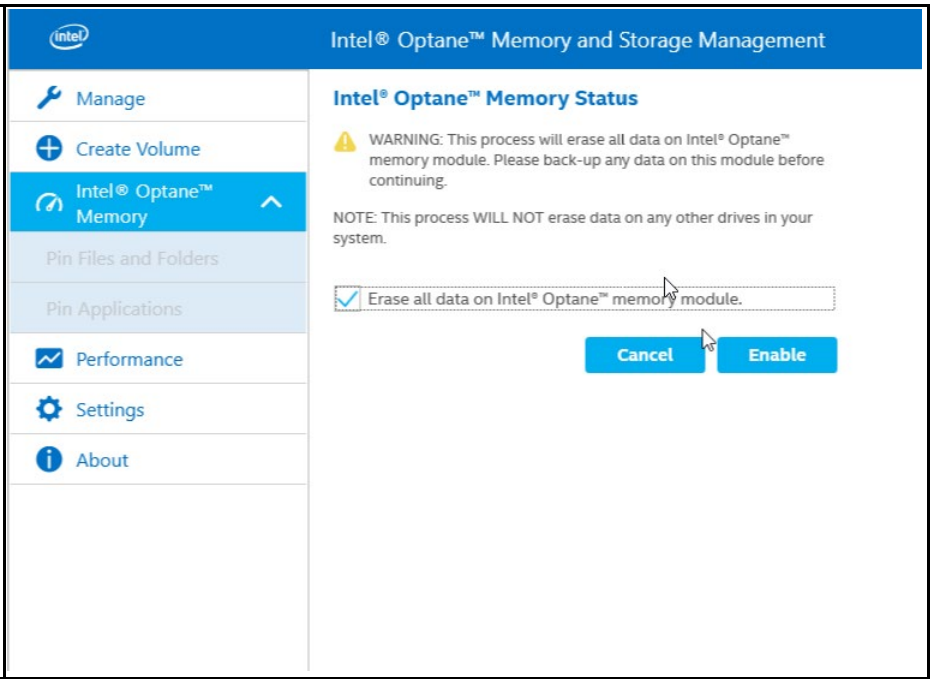
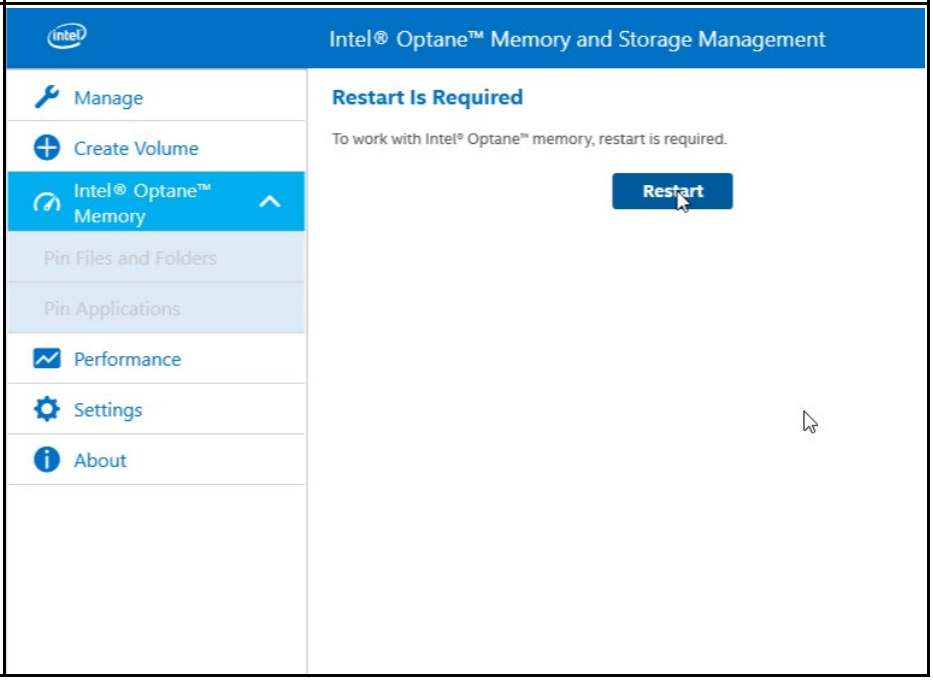
- Enable acceleration
- Disable acceleration

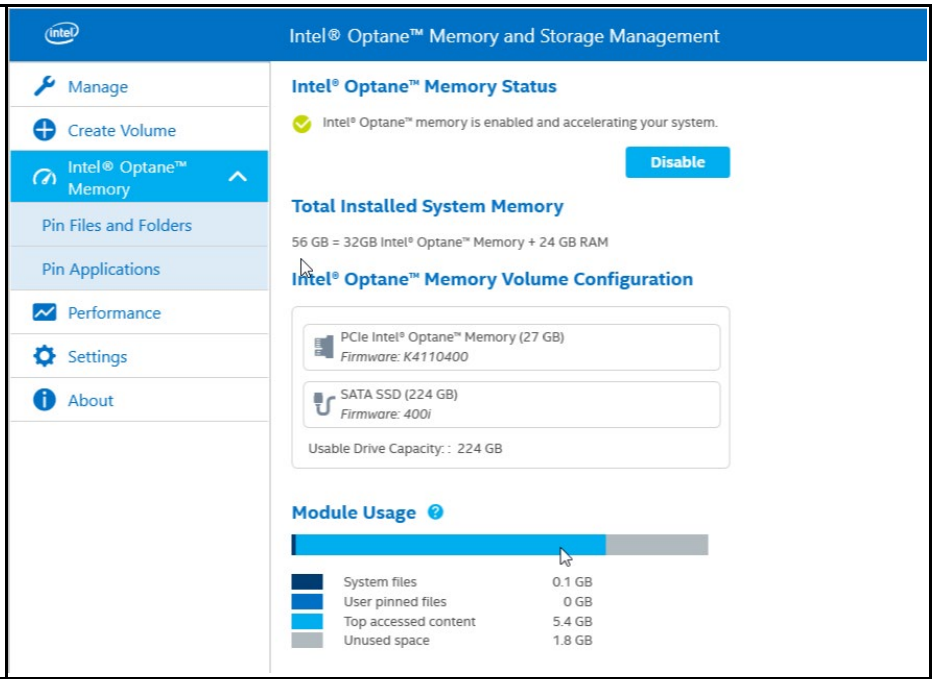
4.6.1 Enabling Intel® Optane™ Memory Volume

Intel® Optane™ Memory Main View	

Starting with Intel® RST driver version 17.8.0.1034 and UI version 17.8.1001.0 or later, for the Intel® Optane™ memory H Series (Example: Intel® Optane™ Memory H10), Intel® Optane™ Memory and Storage Management UI will present a Mode selection screen.

Intel® Optane™ Memory Mode Selection for Intel® Optane™ Memory H Series Only	

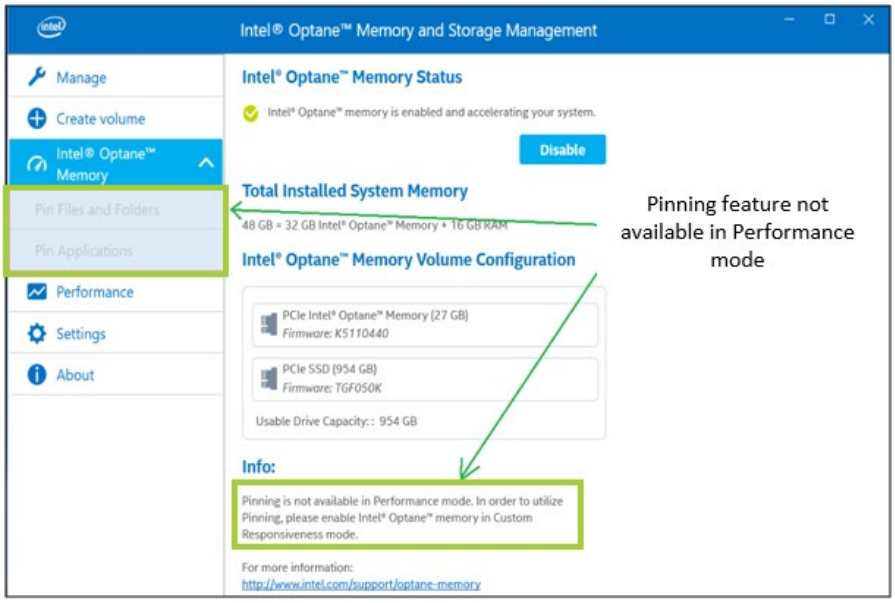
Intel® Optane™ Memory Enable Verify View	
Intel® Optane™ Memory Restart after Enable	

Intel® Optane™ Memory Status View	

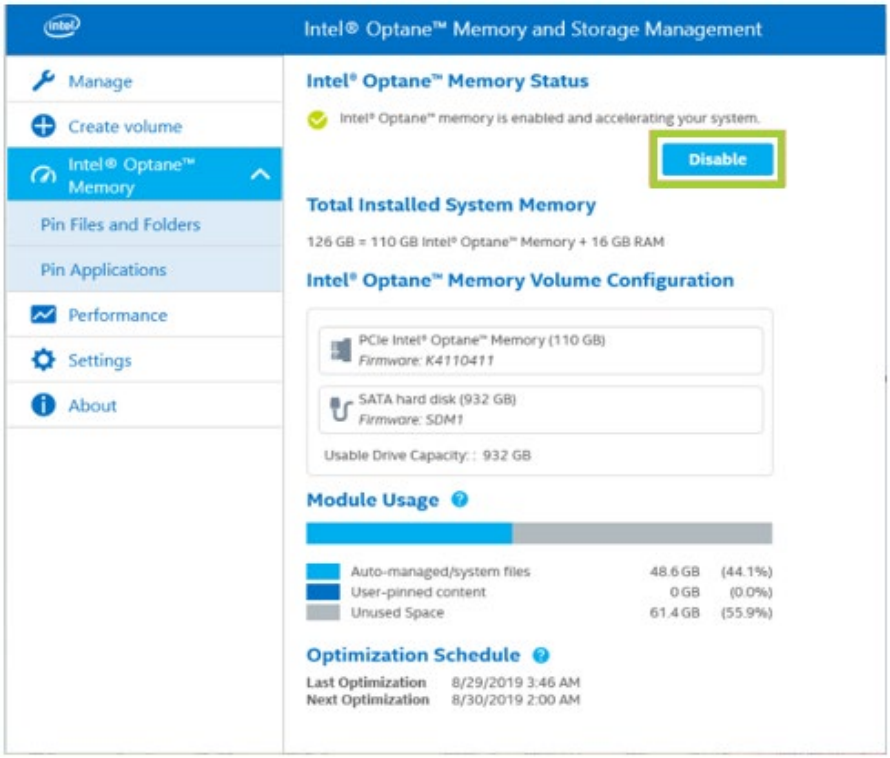
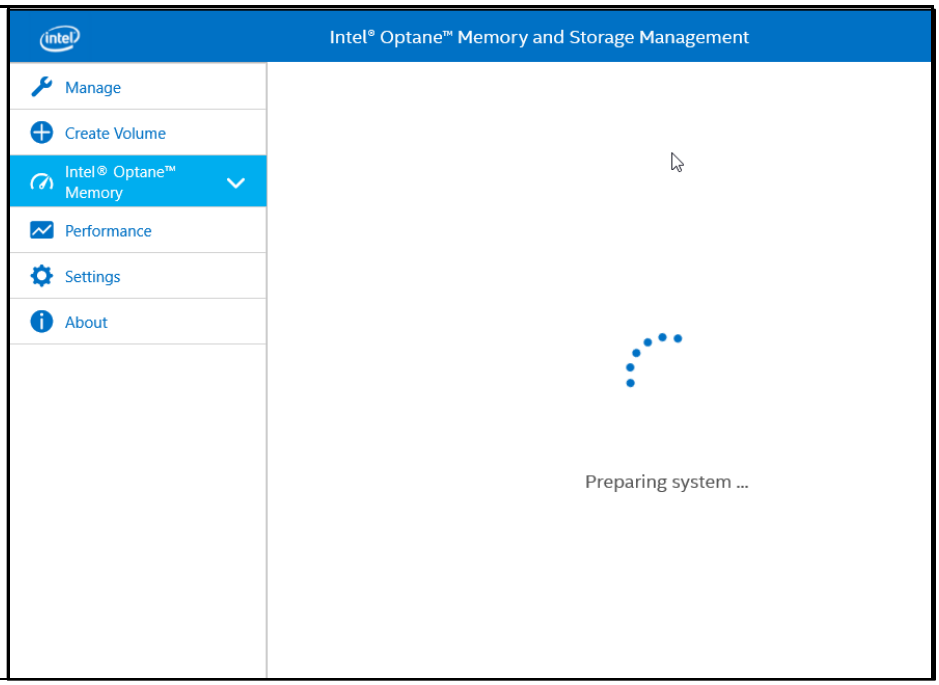
Intel® Optane™ Memory Module Usage info in Intel® Optane™ Memory tab shall present 3 categories of items:

Category	Metric	Tool Tip Text
Auto-managed/ System files	GB (% of total)	Auto-managed/system files – This portion is not available for end user pinning, it is automatically controlled and managed by the driver
User-pinned content	GB (% of total)	User-Pinned Content – This portion is available for end user pinning, it represents content currently pinned by the end user or enabled applications.
Unused Space	GB (% of total)	Unused Space – This portion is available for end user pinning. It is auto-managed by the driver and may not represent all space available for end user pinning.

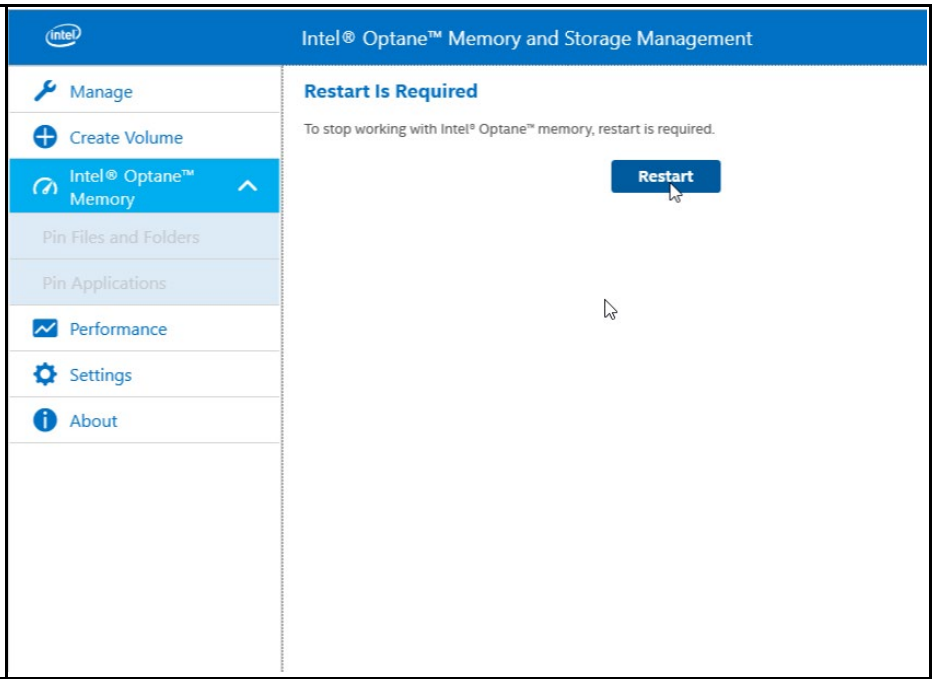
Starting with Intel® RST driver version 17.8.0.1034 and UI version 17.8.1001.0 or later, for Hybrid Intel® Optane™ drive (Example: Intel® Optane™ Memory H10), Below is the status screen when the end user select "Performance Mode".

Intel® Optane™ Memory Status View for Intel® Optane™ Memory H Series (Performance Mode)	

4.6.2 Disabling Intel® Optane™ Memory Volume

Intel® Optane™ Memory Main View	
Intel® Optane™ Memory Disabling status View	

Also, under this tab are two subtabs:

Intel® Optane™ Memory Restart View	

4.6.3 User Pinning of Files/Folders/Applications

4.6.3.1 Limitations

The following objects as seen on the Windows* desktop cannot be pinned:

- Quick Access
- This PC
- Any disk's Root directory (e.g. Local Disk (C:))
- Control Panel
- Libraries folder
- Network objects
- Recycle Bin

4.6.3.2 Minimum Requirements

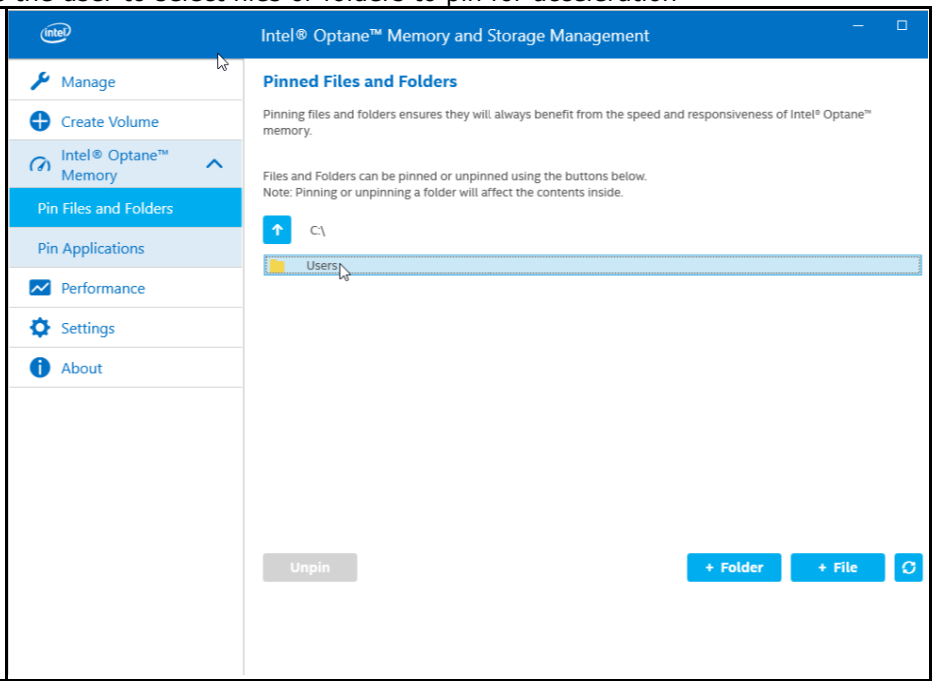
The minimum requirements to support the User Pinning feature are as follows:

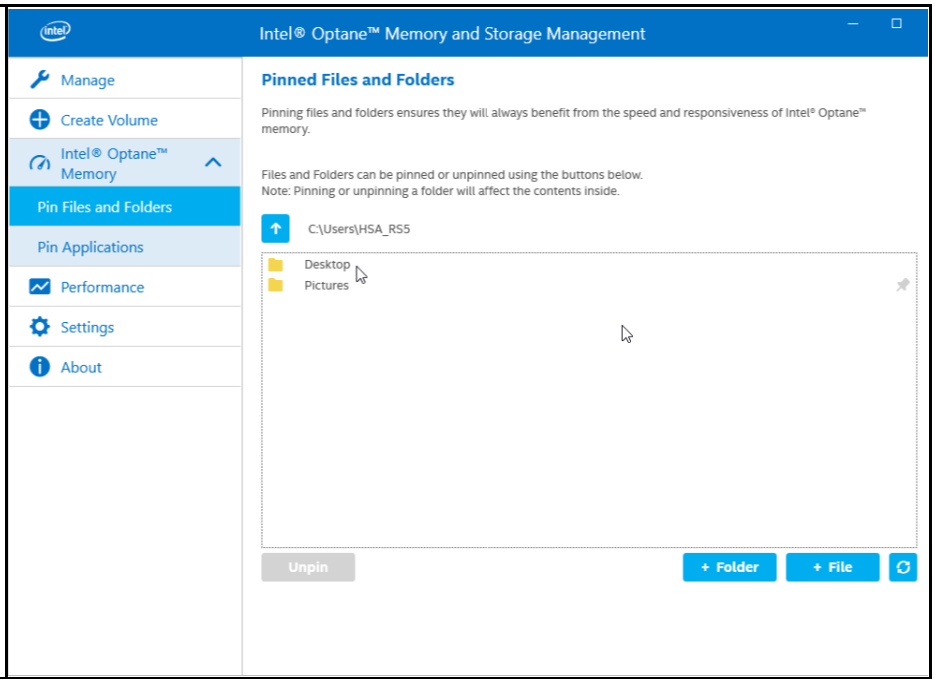
- Intel® Optane™ memory capable motherboard
- Intel® Core™, or Pentium processor
- Intel® 300/240 Series Chipset Family

- 32GB or larger Intel® Optane™ memory module installed in a PCH HW remapped port.
- Windows* 10 64bit (RS3 or later) installed
- Intel® RST 16.x PV or later release installed
- System Acceleration with Intel® Optane™ Memory enabled

4.6.4 Pin Files and Folders

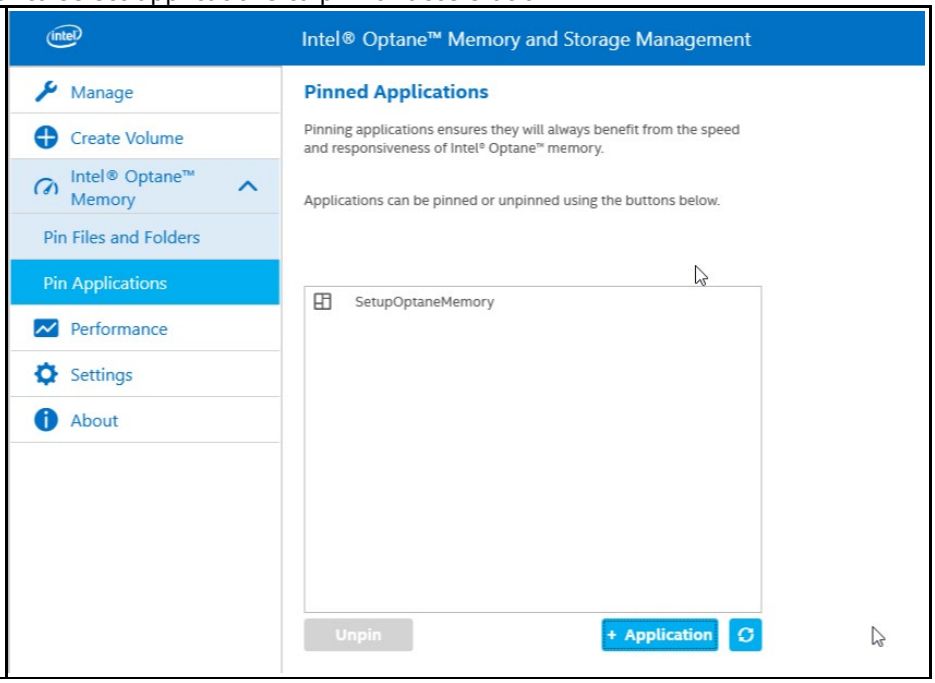
Note: Pinning is not available for 16GB memory module SKUs and for data drive acceleration (DDA). This tab allows the user to select files or folders to pin for acceleration

Intel® Optane™ Memory Pin Files and Folders View	

Intel® Optane™ Memory Currently Pinned Files and Folders View	

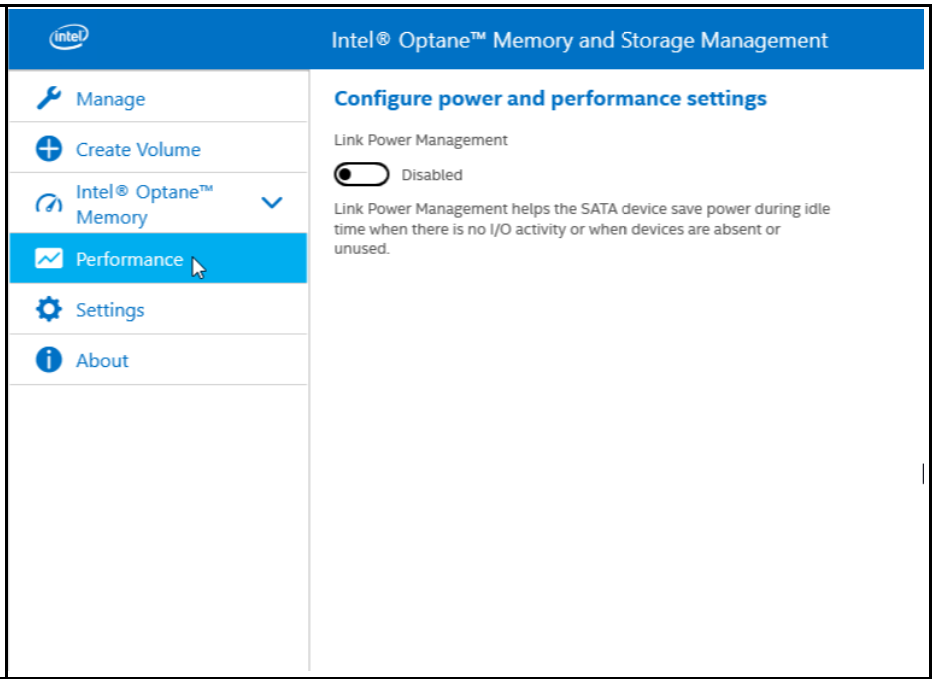
4.6.5 Pin Applications

This tab allows the user to select applications to pin for acceleration.

Intel® Optane™ Memory Currently Pinned Applications View	

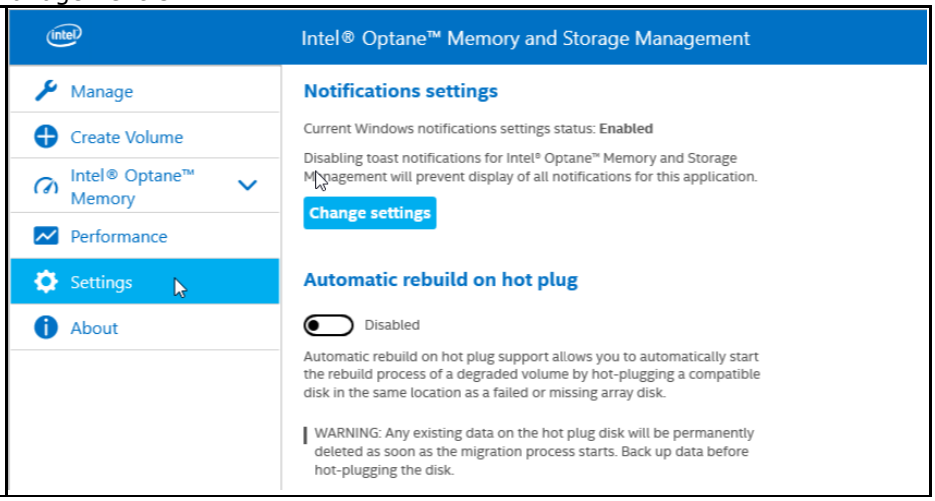
4.7 Performance

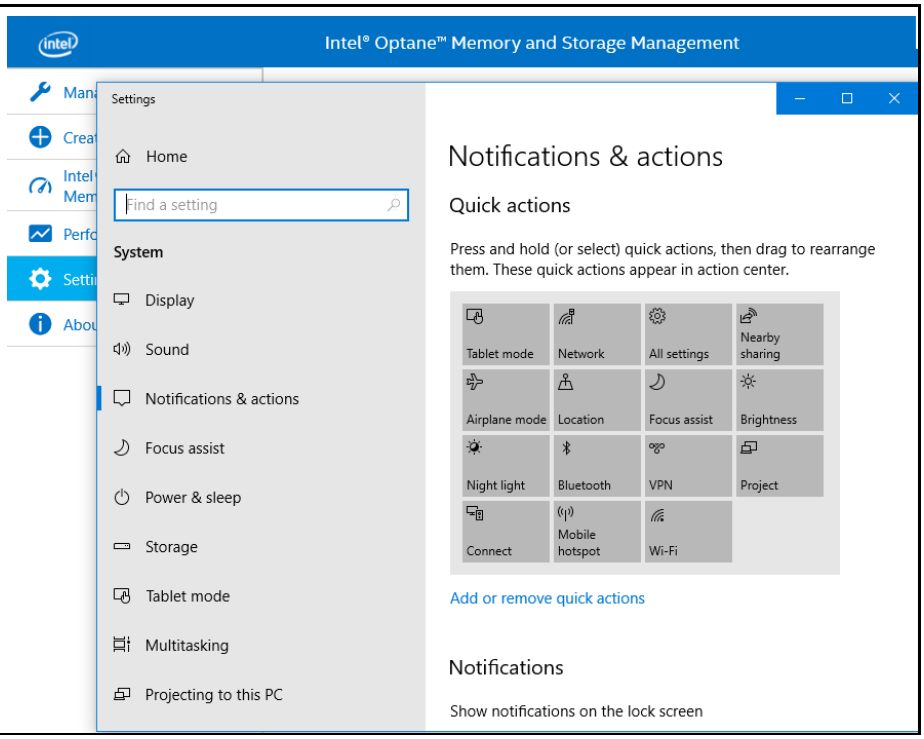
This tab allows for the enablement/disablement of Link Power Management (LPM) of SATA devices.

Performance	

4.8 Settings

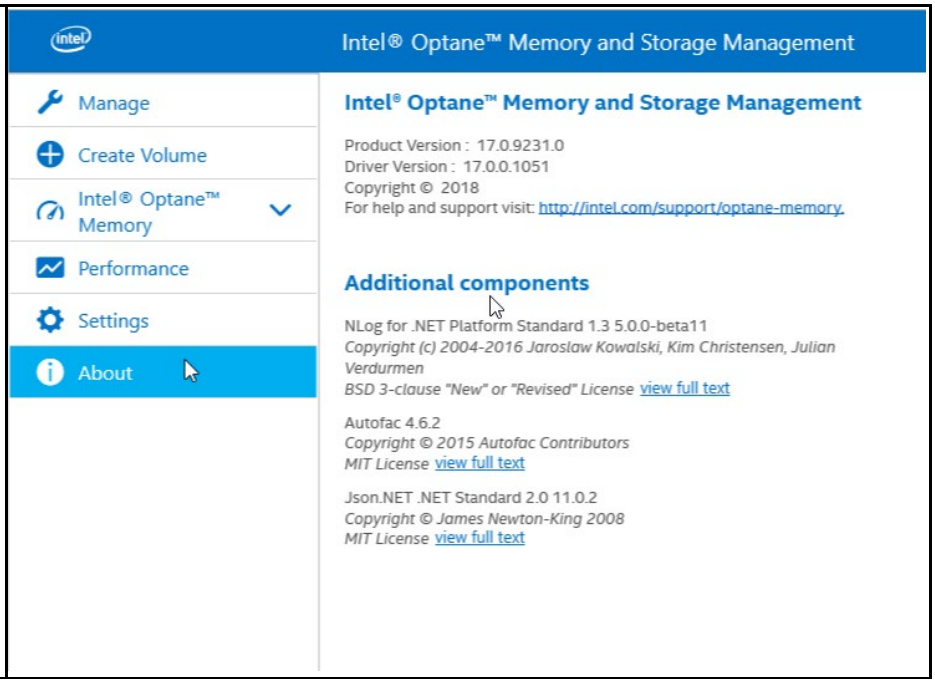
We can use this tab to change notification settings. The link in these settings will open the Windows* notification center to change Notification settings for Intel® Optane™ Memory Storage and Management UI.

Settings tab – Notification Settings and Automatic rebuild	

Notification settings in Windows*	

4.9 About

This tab allows you to get version information about the App and contact Intel® help and support.

About the Application	

4.10 Additional Operations in Intel® Optane™ Memory and Storage Management UI

Note: These features apply to all combinations of Intel® RST 17.x and above**.**

4.10.1 Adding Disk to Array

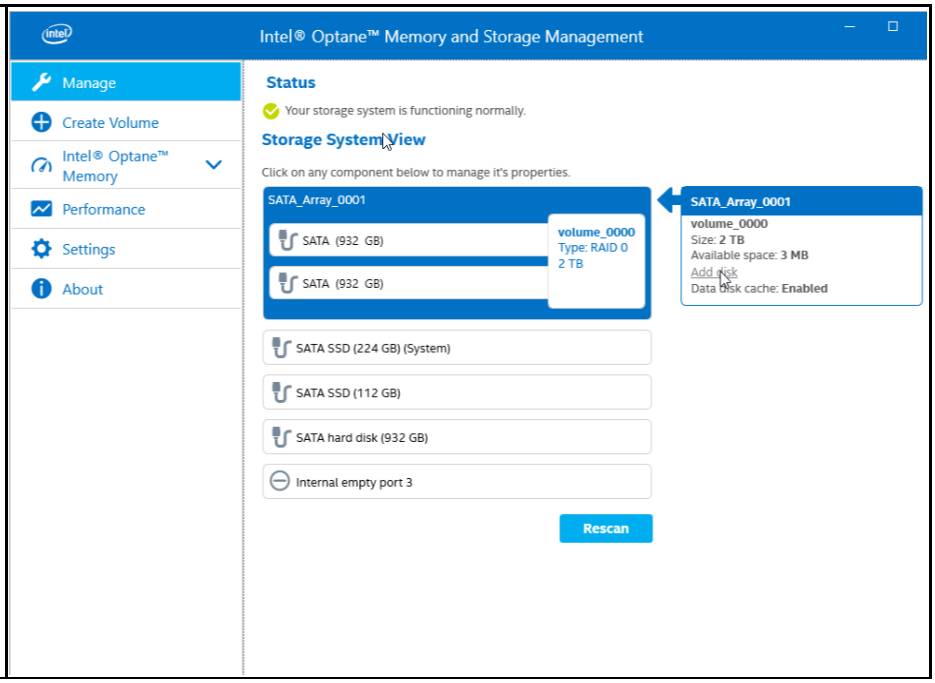
You can add one or more SATA disks to an existing array to increase the system storage capacity. This feature can be useful if you want to change to a volume type that requires additional disks.
This option is only available if:

- A RAID 0 and/or RAID 5 volume is present,
- One or more SATA disks are connected to the computer and available,
- The available disk matches the internal or external connection type of the existing array disks.

You cannot add an external disk to an array that includes internal disks, and vice versa.

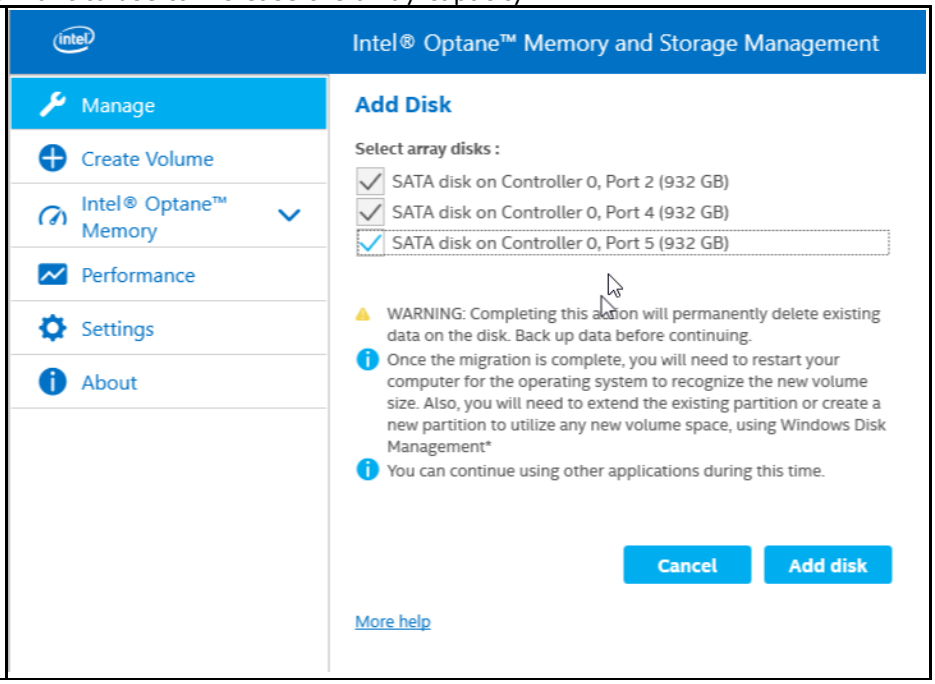
This action can also be performed from Manage Volume.

1. Under 'Status' or 'Manage', in the storage system view, click the array to which you want to add a disk. The element properties are now displayed on the left.
2. Click **Add disk**.

Select the option to add disk to a volume.	

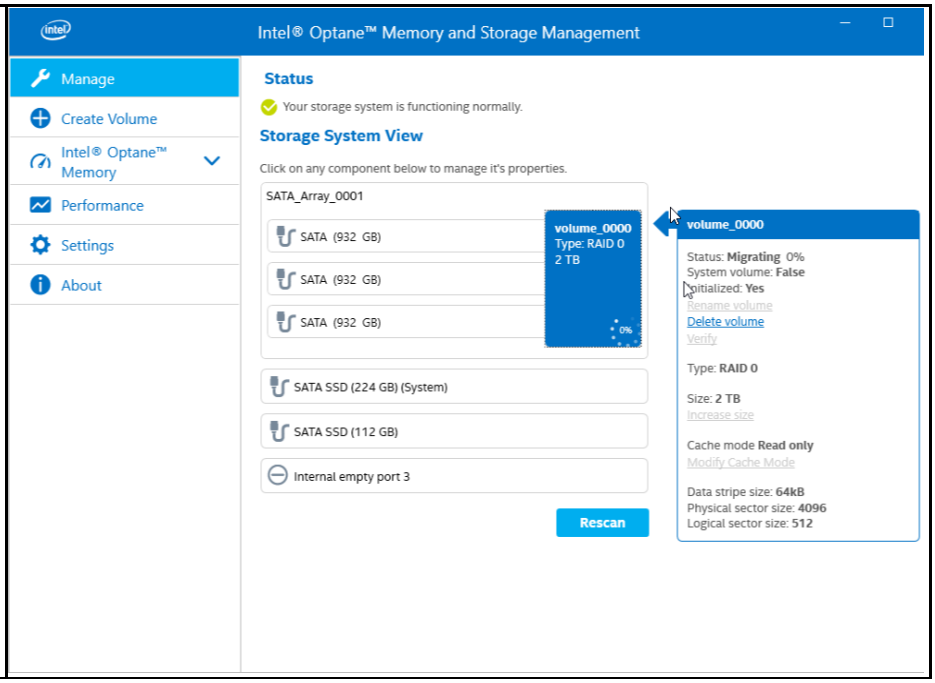
3. Select the disk you want to use to increase the array capacity.

Add disk to the volume



4. Click **Add Disk**.

Disk added to the volume



Caution: Once the data migration starts, the operation cannot be canceled.

5. Once the migration has completed, restart your computer for changes to take effect. Then use Windows* Disk Management* to increase the partition size on the volumes for which a disk was added or add another partition.

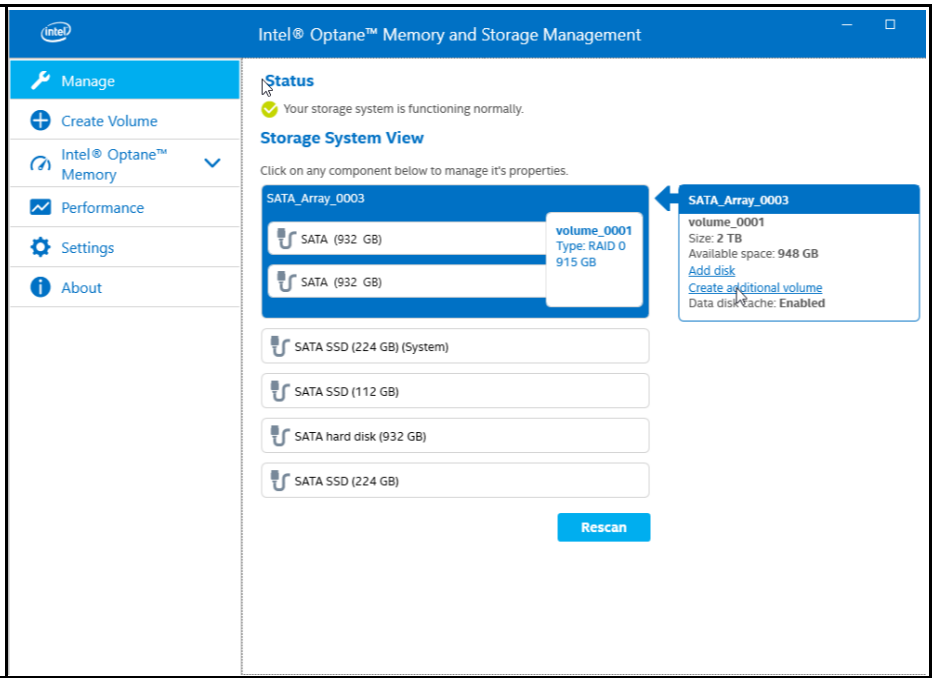
4.10.2 Creating Matrix Array

You can create a Matrix array as well. This feature can be useful if you want to have multiple RAID configurations in a single array.

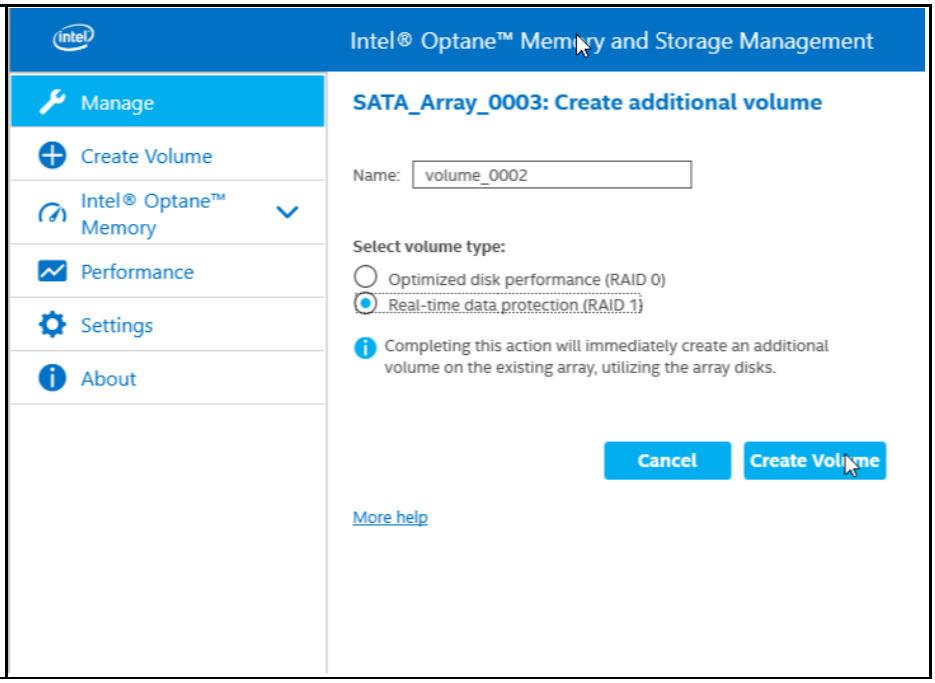
This action can also be performed from Manage Volume.

1. Under 'Status' or 'Manage', in the storage system view, click the array to which you want to add another RAID configuration. The element properties are now displayed on the left.
2. Click **Create additional volume**.

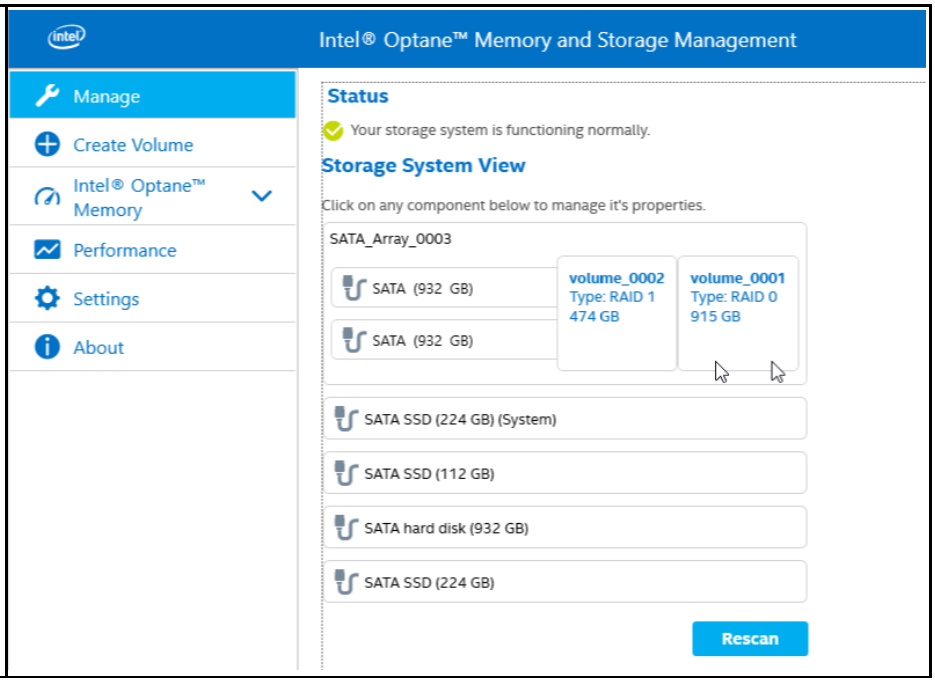
Select the option to 'Create additional volume' to a RAID volume.



3. Select the disks you want to type of volume (RAID0 or RAID) to be added to the existing array and click **Create Volume**.

Select the second RAID configuration of the Matrix Volume. Click 'Create Volume'	

4. Matrix Volume created.

Matrix Volume created	

Caution: Once the data migration starts, the operation cannot be canceled.

5. Once the migration has completed, restart your computer for changes to take effect. Then use Windows* Disk Management* to increase the partition size on the volumes for which a disk was added or add another partition.

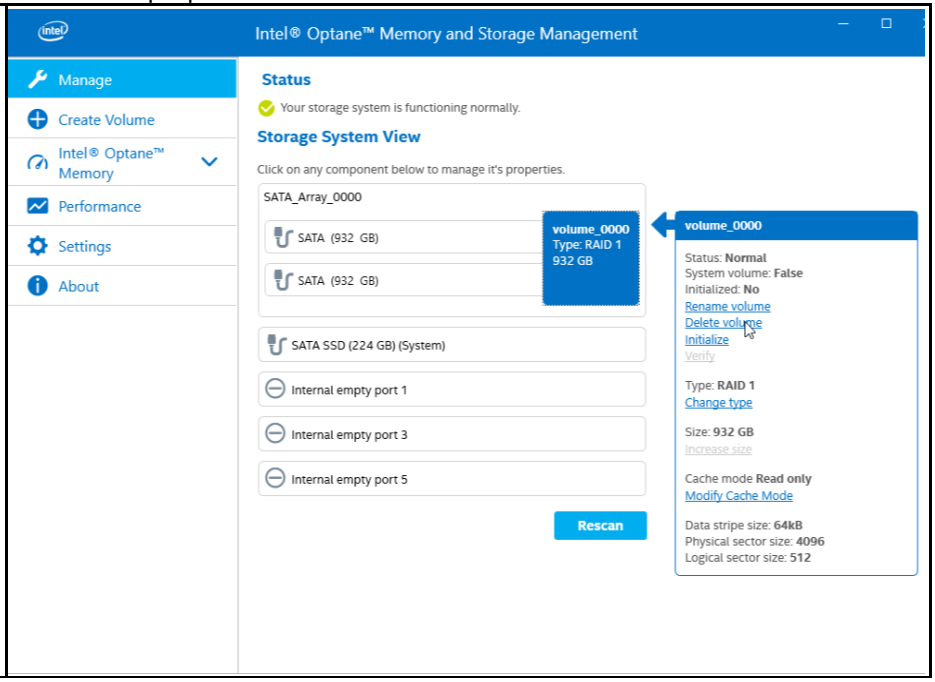
4.10.3 Deleting RAID Volume

RAID volumes can be deleted in two different ways. The method most widely used by end-users is the Windows* user interface utility. The second method is to use the Intel® Rapid Storage Technology Option ROM user interface.

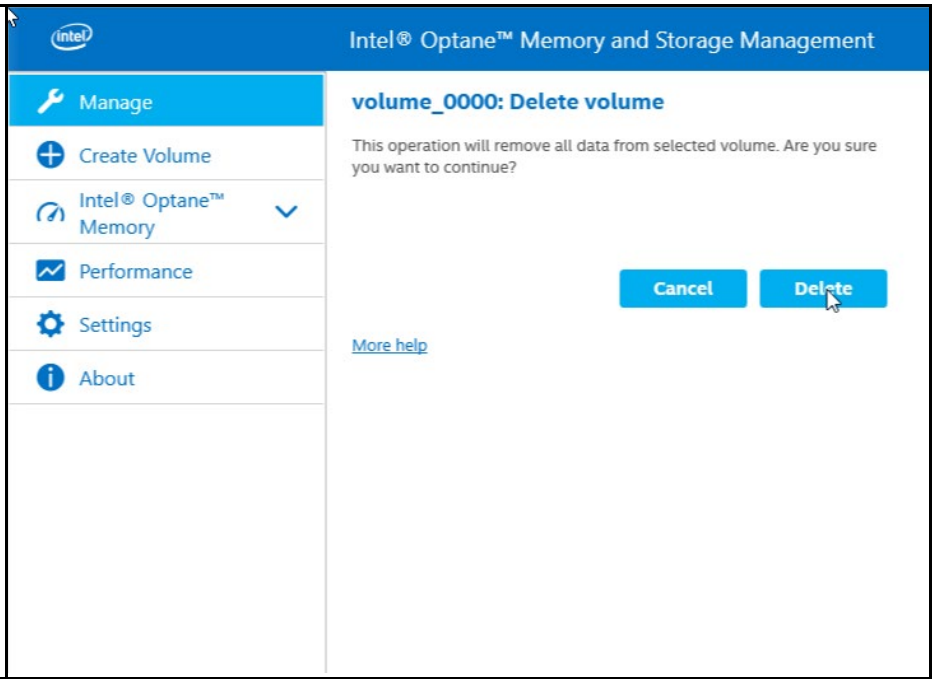
1. Run the Intel® Optane™ Memory and Storage Management UI from the following Start menu link:

   Start -> **All Programs** -> **Intel® Optane™ Memory and Storage Management** -> **Intel® Optane™ Memory and Storage Management UI**

2. Under 'Status' or 'Manage' Click on the volume you want to delete. The user will be presented with the volume properties on the left.

Selected Volume to be deleted	

3. Click **Delete**.

Delete the Volume	

4. Review the warning message and click **Yes** to delete the volume.
5. The 'Status' page refreshes and displays the resulting available space in the storage system view. You can now use it to create a new volume.

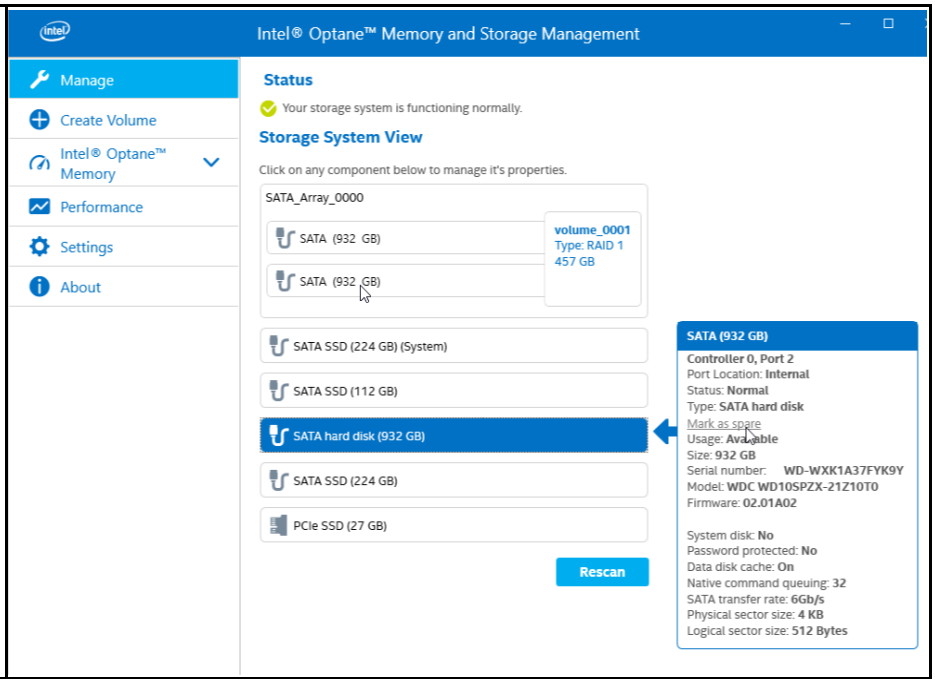
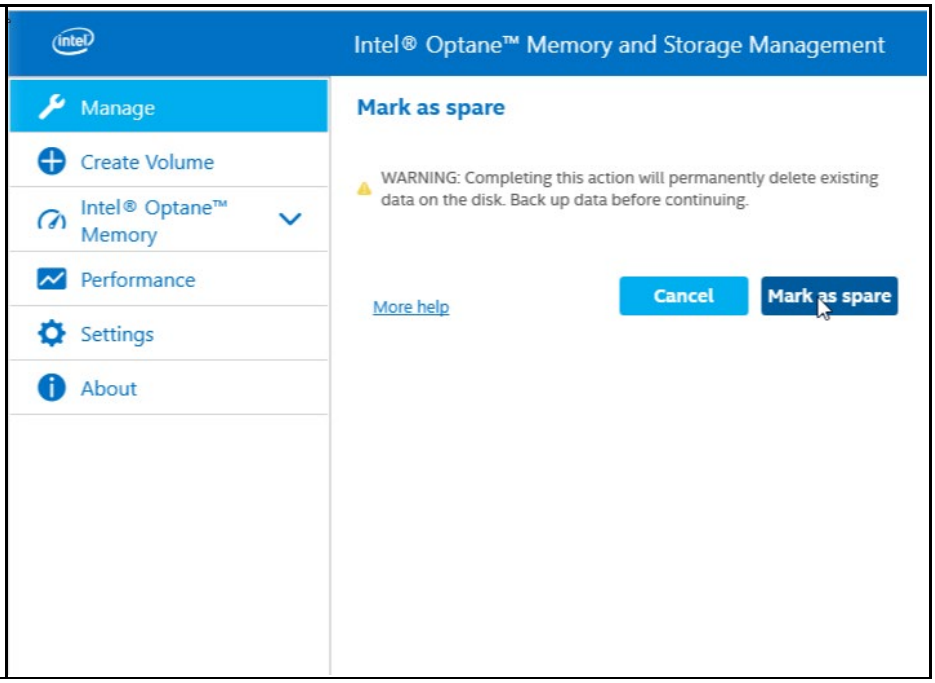
4.10.4 Marking a Disk as Spare

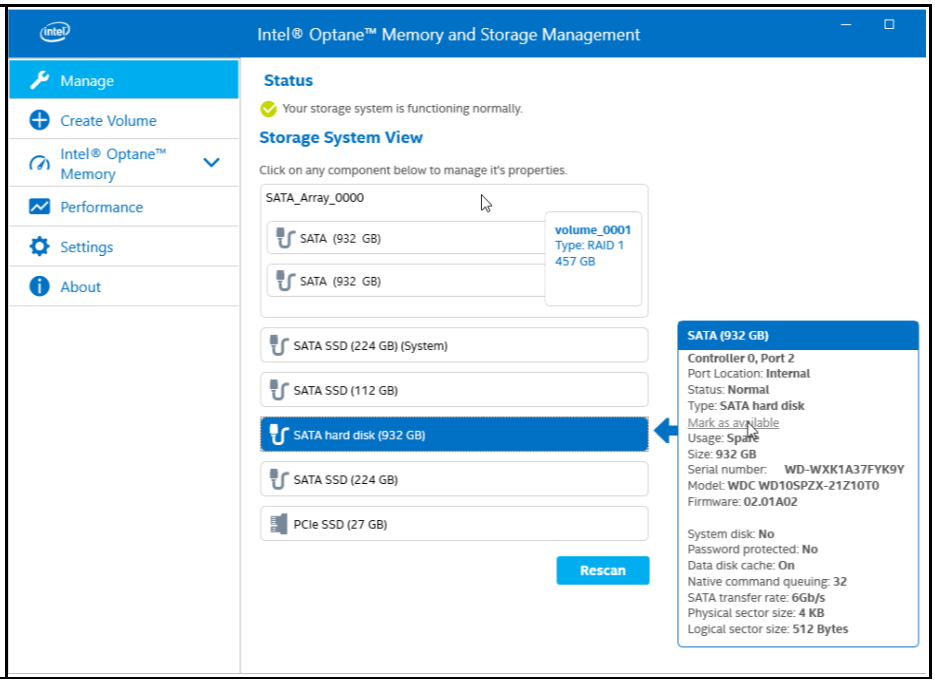
This action is only available for non-system disks in a normal state. Also, unless your mobile computer is equipped with the Intel® 5 Series Chipset or later, which provides support for up to six SATA ports, you will not be able to mark a disk as a spare. Most mobile computers are limited to one internal and one external disk, which are used to create the volume.

Marking a disk as a spare allows you to designate an available SATA disk as the default destination for automatic volume rebuilds in the event of a failed, missing or at risk array disk. However, for RAID 0 volumes, automatic rebuilds will only occur if one of its members is reported at risk.

1. Under 'Status' or 'Manage', in the storage system view, click the disk that you want to mark as a spare. The volume properties are now displayed on the left.
2. Click **Mark as spare**.
3. Click **OK**.

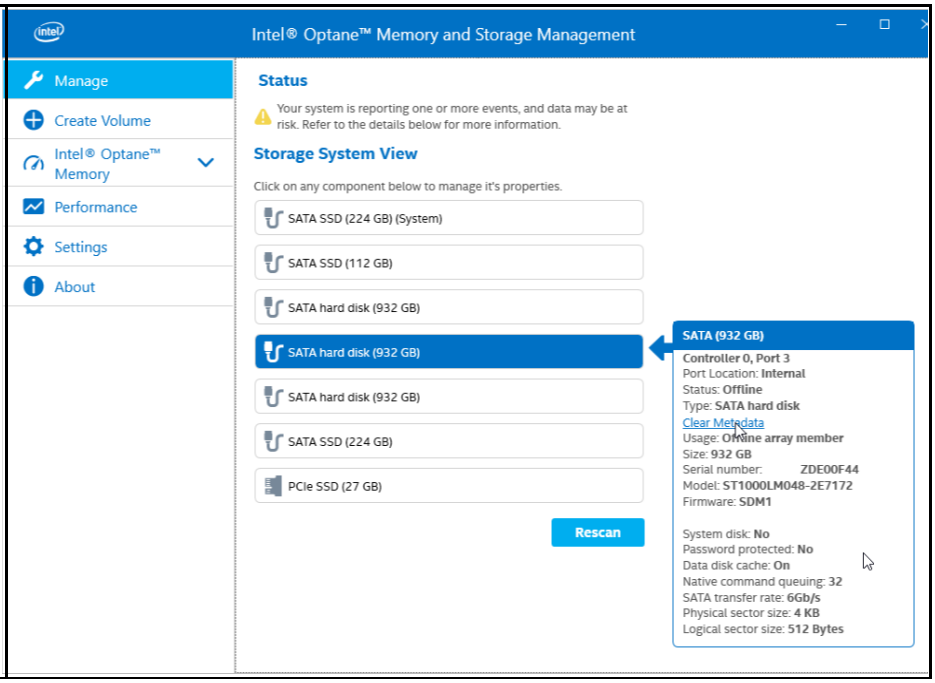
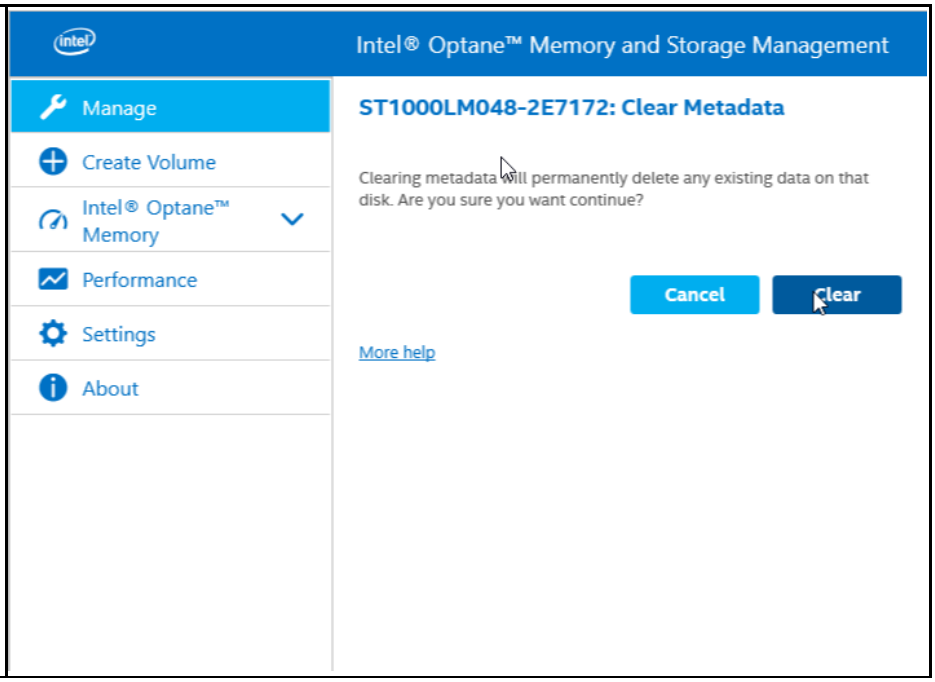
Note: **RAID 1, 5, 10, and recovery volumes can use one or more spares.**
If your system is running a version of the Intel® RST OROM that does not support disks that are 2TB or larger, you can reset such a disk to available, but disallow the marking of it as a spare.

Selecting the disk to be marked as spare	
Marking a disk as spare	

Marking a disk as available	

4.10.5 Clearing Metadata

All the Volumes maintained by Intel® RST driver has a metadata maintained by Intel® RST driver. This metadata is used by Intel® RST only for managing RAID Volumes as well as Intel® Optane™ memory volumes. This metadata is written every time a volume (RAID/ Intel® Optane™) is created and is destroyed by deleting the volume (or disabling acceleration). If any device is a part of a volume and is moved to another system, then the drive has metadata but does not have related volume making it unusable to be used for RAID configuration. In this case the metadata is of no use and we can reset it such that the drive can be used for another RAID configuration.

We get "Clear Metadata" Option for disk with	
Select "Clear Metadata" Option to clear the Intel® RST Metadata	

§§

5 System Acceleration with Intel® Optane™ Memory

5.1 Limitations

5.1.1 Hardware limits

5.1.1.1 Intel® Optane™ Memory HW Limits

1. **Fast disk** (the term "fast disk" refers to the Intel® Optane™ memory module being used as the cache device)

> *Attention**: the following terms are used interchangeably throughout this document:***
> - **Fast disk**
> - **Intel® Optane™ memory module**
> - **Intel® Optane™ device**

   - Only a single HW or SW remapped Intel® Optane™ memory module

2. **Slow[1] disk** (disk to be accelerated must be larger capacity than the fast disk) only in the following configurations and drive interfaces:
   - ***Boot Drive (System)*** (Active boot volume):
     a. SATA HDD – single pass-through[2]
     b. SATA SSD - single pass-through
     c. SSHD[3] - single pass-through
     d. Intel® brand NVMe* drive[4].
   - ***Data Drive*** (No active boot volume):
     a. SATA HDD – single pass-through[2]
     b. SATA SSD - single pass-through
     c. SSHD[3] - single pass-through
     d. Supported Intel® SSD 6 Series with QLC 3D NAND NVMe* drives
3. Intel® Optane™ Memory volume
   - Only one Optane™ Memory volume allowed per boot instance. If more than one volume detected during boot, the second volume detected will be placed offline and not accessible to the system.

NOTES:

Note[1]: The slow disk (targeted disk to be accelerated) can be data drives as well as boot drives with the active boot volume beginning with release version 16.0.2.

Note[2]: Only single pass-through disks can be accelerated. The acceleration of RAID volumes or other multiple disk configurations is not supported.

Note[3]: Self-pinning SSHDs only, SSHDs that use the Hybrid Information Feature Set are not supported.

5.1.1.2 Intel® Optane™ Memory H Series HW Limitations

Intel® Optane™ Memory H Series – Contains Intel® Optane™ Memory and Intel® QLC 3D NAND on the same M.2 Device)

1. Only one Intel® Optane™ Memory volume allowed per boot instance.
2. Only ONE (1) device can be configured as an Intel® Optane™ Memory Volume by Intel® RST as a boot or data volume.
   a. Intel® Optane™ Memory Volume is created from concatenating slow disk (NAND main storage) and fast disk (Intel® Optane™) of the SAME device.
3. Only ONE device is supported per platform. If more than one device is connected to M.2 slots in the system:
   a. Only the M.2 slot that supports the Intel® Optane™ Memory H Series will show both disk members of the same device. The devices plugged into other slots might not be detected or displayed at all in Windows*.
   b. The system might not boot in certain platforms.
4. Device must be connected to M.2 port locally connected to PCH (Check with your user manual for supported ports). Connecting via Thunderbolt™ or PCIe* bridge is not supported.
5. An Intel® Optane™ Memory H Series Volume cannot be moved (Roaming) to other platform that do not meet the specific requirements for this series listed in section 5.2.2.

5.1.2 Functional Limits

5.1.2.1 SATA Controller Mode Switching to AHCI Mode

Once the system is setup with Intel® Optane™ Memory enabled, the user cannot switch the PCH SATA controller mode from one of the Intel® RST modes to the AHCI mode. If the mode is switched and the user attempts to boot the system, the Intel® RST configuration metadata can be corrupted making the system unbootable when PCH SATA mode is switched backed to the available Intel® RST mode. To avoid this error condition the following precautions should be taken:

- All users: If you require switching the PCH SATA controller mode to AHCI for some reason, then before switching, disable Intel® Optane™ Memory prior to switching the mode. You can re-enable Intel® Optane™ Memory once the controller is switched back to the supported Intel® Optane™ mode.

5.1.2.2 Disk Defragmentation and Optimization for Intel® Optane™ Volume

The 'Defragment and Optimization' feature in Windows* will only available for Intel® Optane™ Volume if **both** members (fast drive and slow drive) have trim support.

5.1.2.3 Intel® Optane™ Memory H Series Roaming Functionality Limitation

For the H Series family, Intel® Rapid Storage Technology (Intel® RST) creates Intel® Optane™ Memory Volume by combining QLC NAND and Intel® Optane™ Memory media on the same single M.2 board. The goal of this pairing is to combine the large capacity of the QLC NAND and fast random-access performance of the Intel® Optane™ disk into a single easy-to-use volume exposed to the customer. This volume is primarily intended to serve as the boot media for the platform. **This volume will only work on with Intel® RST drivers and supported platforms. If the user attempts to move this drive/volume to non-supported platform (AHCI mode) or use non- Intel® RST storage drivers to access the disk, the volume and data will be lost permanently**.

5.2 Minimum Requirements

5.2.1 Intel® Optane™ Memory

CPU	**Intel® 7th Gen later CPU family of platforms**
PCH	PCH: Intel® 100/C230 Series, 200 Series, C240 Series, or 300 Series family of chipsets
Motherboard	Supporting Intel® RST PCH HW remapping technology or a x2 or x4 PEG port for CPU attached Intel®-branded SSDs or Intel® Optane™ memory modules
M.2 Connector	An M.2 connector is required for the Intel® Optane™ memory module; it can be down on the motherboard or on a PCIe* adapter card plugged into a PCH remapped PCIe* x2 or x4 slot or CPU PEG* port.
BIOS	UEFI-compliant system BIOS based on BIOS reference code version 1.5.0 or later. BIOS Intel® PCH SATA controller mode set to "Intel® RST…" with remapping enabled on the HSIO lanes connecting the Intel® Optane™ technology NVMe* memory module.
Intel® RST Pre-OS and Windows* Driver	Refer to section 2.1.3 for the correct version of Pre-OS and Windows* Intel® RST version.

5.2.2 Intel® Optane™ Memory H Series with Solid State Storage

Platform	Platform (Chipset and Motherboard) that supports software remapping at M.2 connector. Verify with the system manufacturer if the platform supports this series
M.2 Connector	A single M.2 that supports PCIe* 2x2 configuration and PCIe* dynamic port reconfiguration from BIOS.
BIOS	Support for the Intel® Optane™ Memory H Series (Check the User Manual or Tech Specs for the system)

Platform	Platform (Chipset and Motherboard) that supports software remapping at M.2 connector. Verify with the system manufacturer if the platform supports this series
Pre-OS	Intel® RST uEFI driver version 17.0.0.3679 or later must be integrated into the system BIOS image.
Windows* Intel® RST driver	Intel® RST SW and driver package 17.0.0.1072 or later must be installed.

5.2.3 Operating System

- Microsoft* Windows* 10 x64 bit Editions (Latest RTM, for example, Redstone X)
- GPT disks only (MBR not supported)

5.2.4 Intel® Optane™ Memory Ready" Logo: Intel® RST 5MB Metadata Requirement

This notice is for System Manufacturers and System Integrators who will ship "Intel® Optane™ Memory Ready" systems in the following configurations (or any system that they wish an end-user to be able to enable Intel® Optane™ Memory):

- Complete systems with the OS already installed AND
- PCH SATA controller mode set to (AHCI) OR (Intel® RST) OR (Intel® RST Premium) AND
- The system does not have Intel® Optane™ Memory enabled

When all these conditions exist, especially if the manufacturer or integrator partitions the system drive with a hidden partition as the final partition (the end of the disk) or if the OS installation places the WinRE partition at the end of the disk, there must be unallocated space of 5MB reserved or left at the end of the disk (at the max LBA after the final partition). This space will be required for Intel® RST metadata when updating those systems at a later date to Intel® Optane™ Memory enabled accelerated systems.

5.3 User Pinning of Files/Folders/Applications

5.3.1 Overview

User pinning functionality is available in Intel® Optane™ Memory UI, Intel® RST UI, and Windows* File Explorer. Pinning allows the user to select files, folders, and applications that they wish to pin for acceleration. All items pinned by the user are considered to be "hard" pinned which means they can only be removed/unpinned by the user. The Intel® Optane™ Memory caching policies cannot evict 'hard pinned' items

IMPORTANT NOTES:

- The pinning feature is not available when accelerating data drives (DDA). This feature is only supported when Intel® Optane™ Memory is accelerating the **system drive** (which is GPT partitioned (no MBR)), and the Intel® Optane™ memory module is **32GB** or larger. This also applies to Teton Glacier Intel® Optane™ Memory device.
- The following objects as on Windows* desktop CANNOT be pinned:
  - Quick Access
  - This PC
  - Any disk's Root directory (Example: Local Disk (C:))
  - Control Panel
  - Libraries folder
  - Network objects
  - Recycle Bin

5.3.2 Minimum Requirements

The minimum requirements to support the User Pinning feature are as follows:

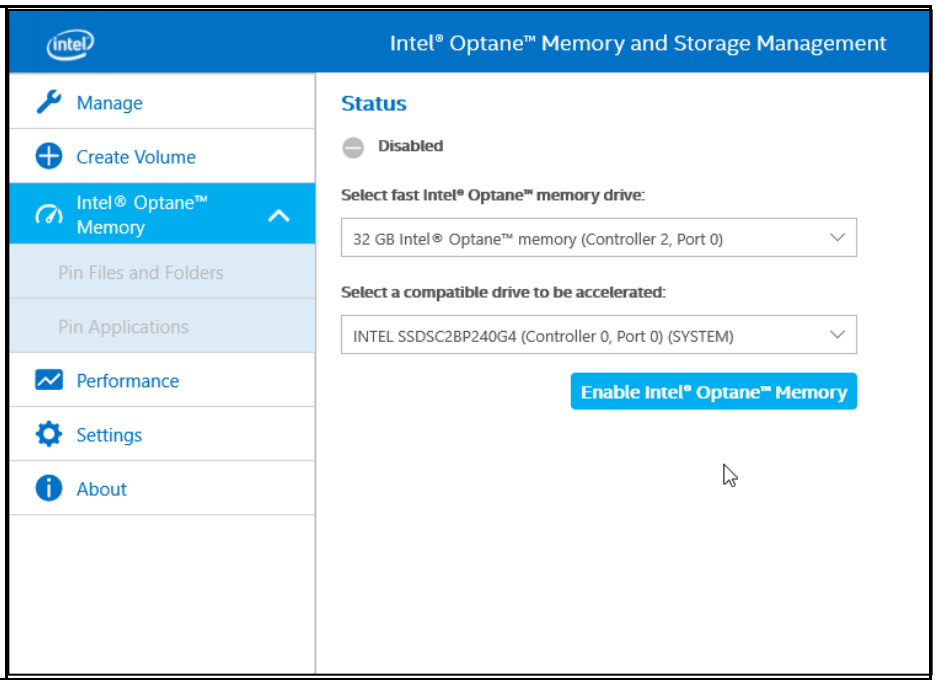
- Intel® Optane™ capable motherboard
- Intel® 8th generation core i-processor
- Intel® 300/240 Series Chipset Family (see table 2-3 for supported SKUs)
- 32GB or larger Intel® Optane™ memory module installed in a PCH HW remapped port.
- Windows* 10 64bit (RS3 or later) installed
- Intel® RST 16.5 PV or later release installed
- System Acceleration with Intel® Optane™ Memory enabled

5.3.3 Pinning Using Intel® Optane™ Memory and Storage Management UI

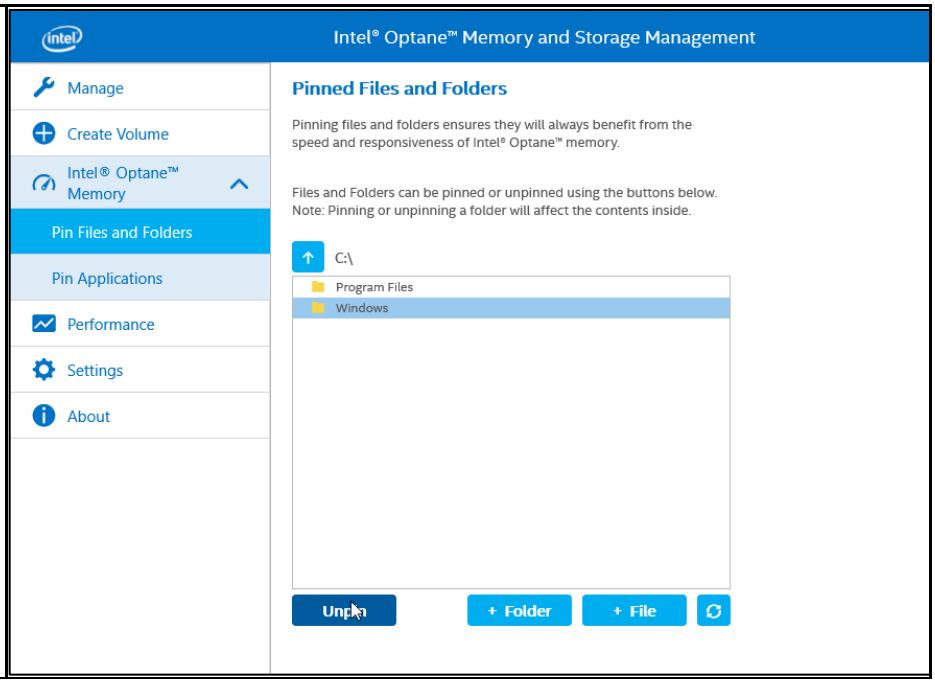
Pinning Tab: The following instructions assume that the computer supports Intel® Optane™ Memory and is already properly configured and enabled to support the User Pinning feature (see the minimum requirements for the pinning feature in the preceding section).

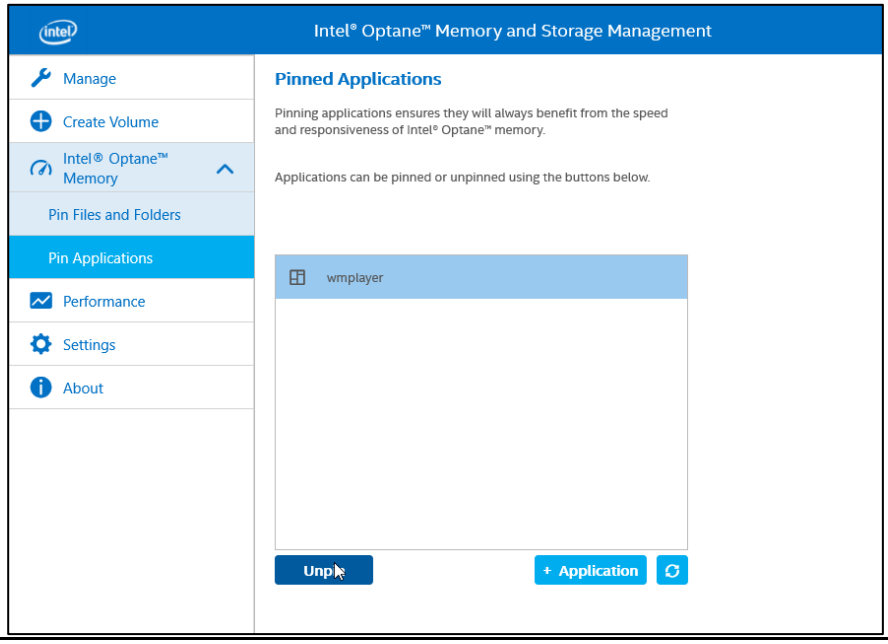
1. Launch the Intel® Optane™ Memory and Storage Management UI
2. In the left navigation pane, click **Intel® Optane™ Memory** tab to expand it.

The page displays information on Intel® Optane™ Memory status and a graphic of the current Intel® Optane™ Volume configuration.

Intel® Optane™ Memory Main Page	

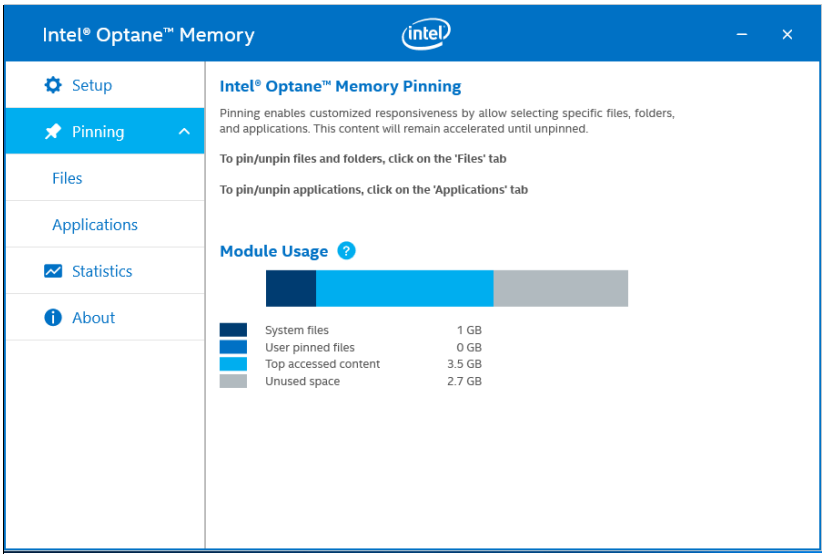
Pin Files and Folders tab:	Click on the 'Files' tab to launch the 'Currently Pinned Files and Folders' page

Currently Pinned Files and Folders Page	

How-to pin files:	1. Click [+Files] button; this launches file explorer 2. Browse to the file you wish to pin and do one of the following: a. double click on the file to pin it b. click on the file to highlight it, then click the [Open] button to pin it 3. To pin multiple files in the same folder, click on one file then use either the <Shift> key to highlight the multiple sequential files or use the <Ctrl> key to select multiple files
How-to pin folders:	1. Click [+Folder] button; this launches the 'Browse for Folder' window. 2. Browse to the folder you wish to pin and click to highlight it **NOTE: Only the files directly in the folder will be pinned. Subfolders will not be pinned. If there are only subfolders and no individual files in the folder, then pinning the folder will only pin an empty folder.** 3. Click [Select Folder] to pin the folder
How-to Unpin files/folders:	1. While in the 'Currently Pinned Files and Folders' window, use the left click button of the mouse to click through the file structure until you find the file/folder that you wish to unpin. Click on the file/folder to highlight it (for multiple files use the <Shift> or <Ctrl> key to highlight the files/folders) 2. Click the [Unpin] button to unpin the file/folder
Applications Sub-Tab:	Click on the 'Applications' tab to launch the 'Currently Pinned Applications' page
Currently Pinned Applications Page	

How-to pin applications:	1. Click [+Application] button; this launches the Windows* file Explorer window. 2. Browse to the application that you wish to pin and do one of the following: a. double click on the file to pin it b. click on the file to highlight it, then click the [Open] button to pin it
How-to Unpin applications:	1. While in the 'Currently Pinned Applications' window, use the left click button of the mouse to highlight the application you wish to unpin 2. Click the [Unpin] button to unpin the application

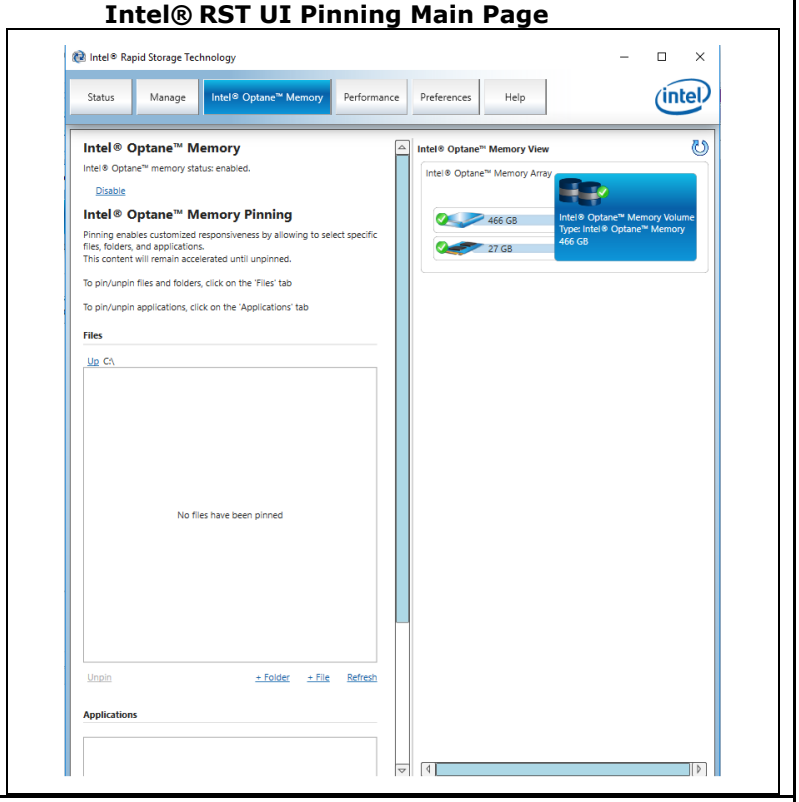
5.3.4 Pinning Using Intel® Optane™ Memory UI

Pinning Tab:	1. Launch the Intel® Optane™ Memory UI 2. Click on the 'Pinning' tab in the left navigation pane. This will bring up the 'Intel® Optane™ Memory Pinning' page of the UI. The page displays information on pinning and unpinning of files/folders and applications. Also, there is a graphical display of the current usage of the Optane™ memory module in terms of the capacity of files/content that is in the module and any un-used space remaining in the module. **Intel® Optane™ Memory UI Pinning Main Page** 
Files Sub-Tab:	Click on the 'Files' tab to launch the 'Currently Pinned Files and Folders' page

How-to pin files:	1. Click [+Document] button; this launches file explorer 2. Browse to the file you wish to pin and do one of the following: a. Double click on the file to pin it b. Click on the file to highlight it, then click the [Open] button to pin it 3. To pin multiple files in the same folder, click on one file then use either the <Shift> key to highlight the multiple sequential files or use the <Ctrl> key to select multiple files
How-to pin folders:	1. Click [+Folder] button; this launches the 'Browse for Folder' window. 2. Browse to the folder you wish to pin and click to highlight it ***Note:*** *Only the files directly in the folder will be pinned. Subfolders will not be pinned. If there are only subfolders and no individual files in the folder, then pinning the folder will only pin an empty folder.* 3. Click [OK] to pin the folder
How-to Unpin files/folders:	1. While in the 'Currently Pinned Files and Folders' window, use the left click button of the mouse to click through the file structure until you find the file/folder that you wish to unpin. Click on the file/folder to highlight it (for multiple files/folders use the <Shift> or <Ctrl> key to highlight the files/folders) 2. Click the [Unpin] button to unpin the file/folder
Applications Sub-Tab	Click on the 'Applications' tab to launch the 'Currently Pinned Applications' page
How-to pin applications:	1. Click [+Application] button; this launches the Windows* file Explorer window. 2. Browse to the application that you wish to pin and do one of the following: a. Double click on the file to pin it b. Click on the file to highlight it, then click the [Open] button to pin it
How-to Unpin applications:	1. While in the 'Currently Pinned Applications' window, use the left click button of the mouse to highlight the application you wish to unpin 2. Click the [Unpin] button to unpin the application

5.3.5 Pinning Using Intel® RST UI

Pinning Tab:	1. Launch the Intel® RST UI. 2. Click on the Intel® Optane™ Memory tab at the top of the application. This will bring up the 'Intel® Optane™ Memory' main page of the UI. *The left pane of this page displays information on pinning and unpinning of files/folders and applications.*

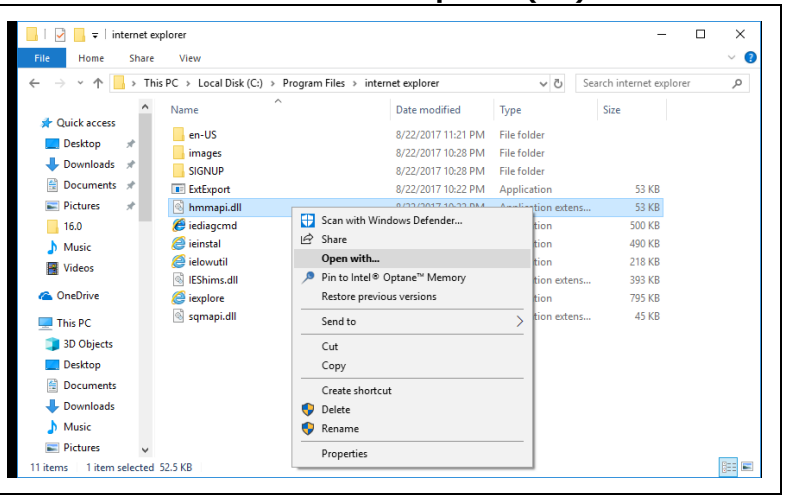
	Intel® RST UI Pinning Main Page 
Files Display Box:	Scroll down to the display box that displays Files (it also displays Folders)
How-to pin files:	1. Directly underneath the display box locate and click +File link; this launches file explorer 2. Browse to the file you wish to pin and do one of the following: a. Double click on the file to pin it b. Click on the file to highlight it, then click the [Open] button to pin it 3. To pin multiple files in the same folder, click on one file then use either the <Shift> key to highlight the multiple sequential files or use the <Ctrl> key to select multiple files
How-to pin folders:	4. Click the +Folder link; this launches the 'Browse for Folder' window. 5. Browse to the folder you wish to pin and click to highlight it ***Note:*** *Only the files directly in the folder will be pinned. Subfolders will not be pinned. If there are only subfolders and no individual files in the folder, then pinning the folder will only pin an empty folder.* 6. Click [OK] to pin the folder

How-to Unpin files/folders:	1. While in the Files' display box, use the left click button of the mouse to click through the file structure until you find the file/folder that you wish to unpin. Click on the file/folder to highlight it (multiple files/folders cannot be selected) 2. Click the [Unpin] button to unpin the file/folder
Applications Display Box:	Scroll down to the 'Applications' display box
How-to pin applications:	1. Directly underneath the display box, locate and click the +Application link; this launches the Windows* file Explorer window. 2. Browse to the application that you wish to pin and do one of the following: a. Double click on the file to pin it b. Click on the file to highlight it, then click the [Open] button to pin it
How-to Unpin applications:	1. While in the 'Applications' display box, use the left click button of the mouse to highlight the application you wish to unpin 2. Click the [Unpin] button to unpin the application

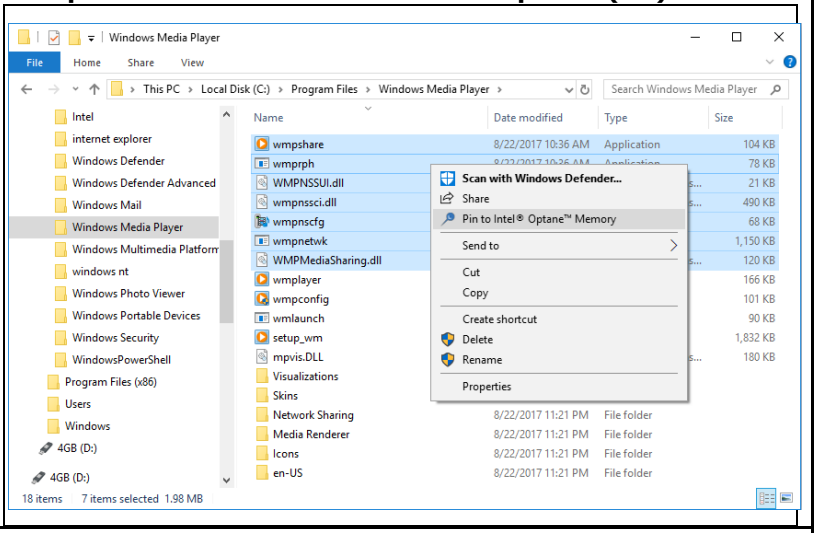
5.3.6 User Pinning Using Windows* File Explorer Application

Pinning Files (non-application):	1. Launch the Windows* File Explorer 2. Navigate to the file that you wish to pin to Intel® Optane™ memory 3. Use the mouse to right click on the file that you wish to pin to Intel® Optane™ memory 4. In the pop-up menu, left click the 'Pin to Intel® Optane™ Memory' option to pin the file. The file will be hard pinned: a. To pin multiple files in the same folder, left click on one file then use either the <Shift> key to highlight the multiple sequential files or use the <Ctrl> key to select multiple files that are not listed sequentially b. Now use the mouse to right click on one of the highlighted files c. In the pop-up menu, left click the 'Pin to Intel® Optane™ Memory' option to pin the files **File Types**: All file types highlighted will be pinned, including applications. **Pinning Types**: All files pinned will be **hard pinned**, except application executables which will be **soft pinned**.

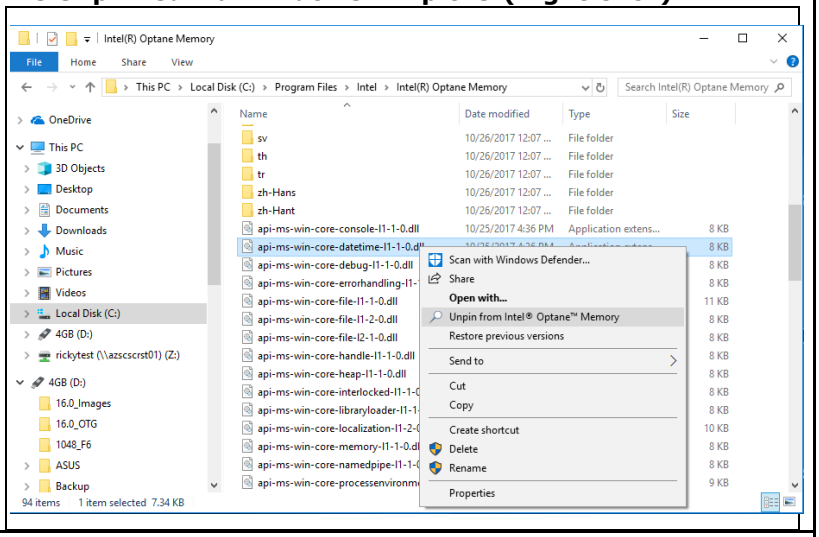
File Pinned via Windows* Explorer (RC)



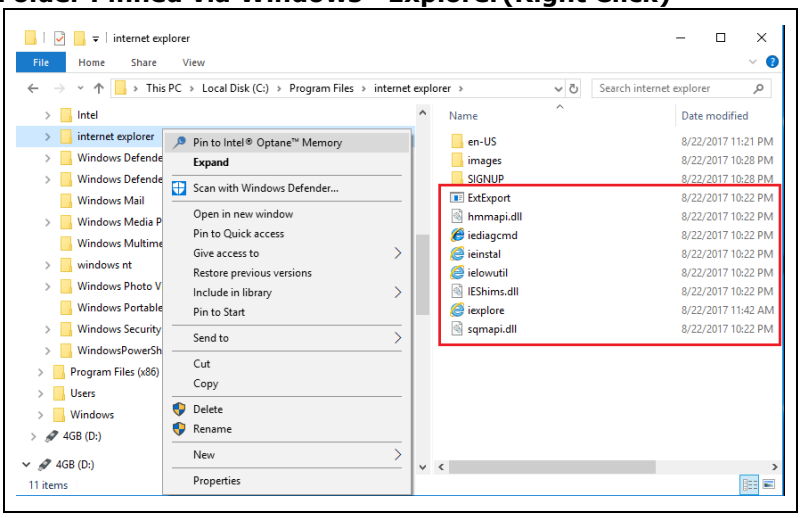
Multiple Files Pinned via Windows* Explorer (RC)



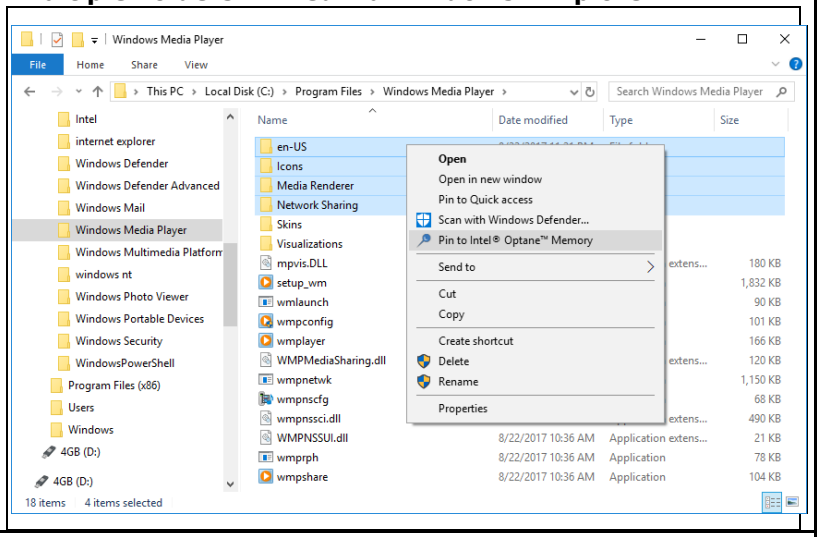
Unpinning Files:	1. Launch Windows* File Explorer 2. Navigate to the file that you wish to unpin from Intel® Optane™ memory 3. Use the mouse to right click on the file that you wish to unpin 4. In the pop-up menu, left click the 'Unpin from Intel® Optane™ Memory' option to unpin the file

	File Unpinned via Windows* Explorer(Right Click) 
Pinning Folders:	1. Launch Windows* File Explorer 2. Navigate to the folder that you wish to pin to Intel® Optane™ memory 3. Use the mouse to right click on the folder that you wish to pin to Intel® Optane™ memory 4. In the pop-up menu, left click the 'Pin to Intel® Optane™ Memory' option to pin the folder ***Note:*** *Only the files directly in the folder will be pinned. Subfolders will not be pinned. If there are only subfolders and no individual files in the folder, then pinning the folder will only pin an empty folder. In the example below, only the files in the red box will be pinned* 5. To pin multiple folders in the same folder, click on one folder then use either the <Shift> key to highlight the multiple sequential folders or use the <Ctrl> key to select multiple folders **File Types**: All file types directly in the folder will be pinned, including applications. **Pinning Types**: All files pinned will be **hard pinned**, including application.

Folder Pinned via Windows* Explorer(Right Click)

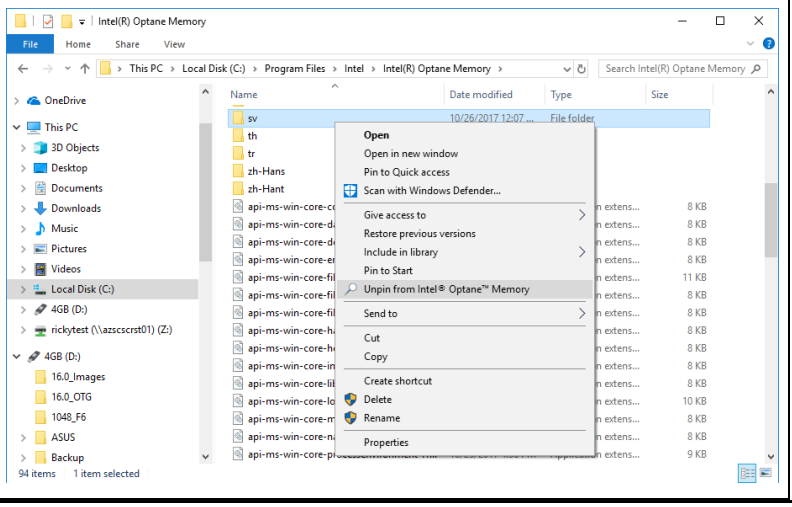


Multiple Folders Pinned via Windows* Explorer

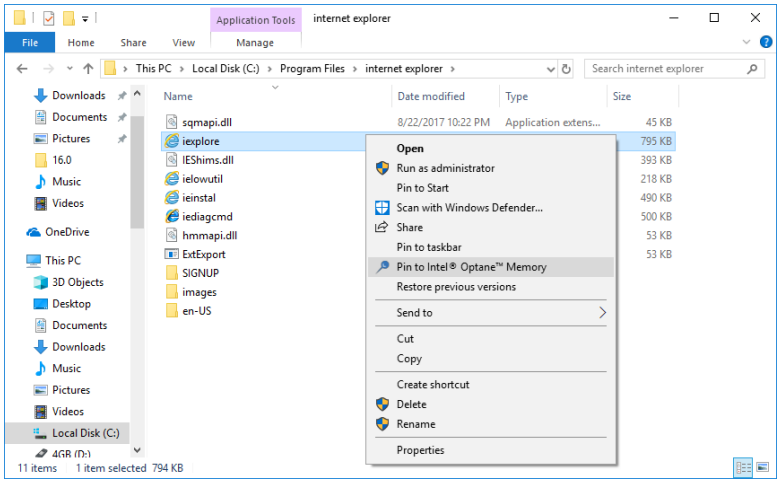


Unpinning folders:

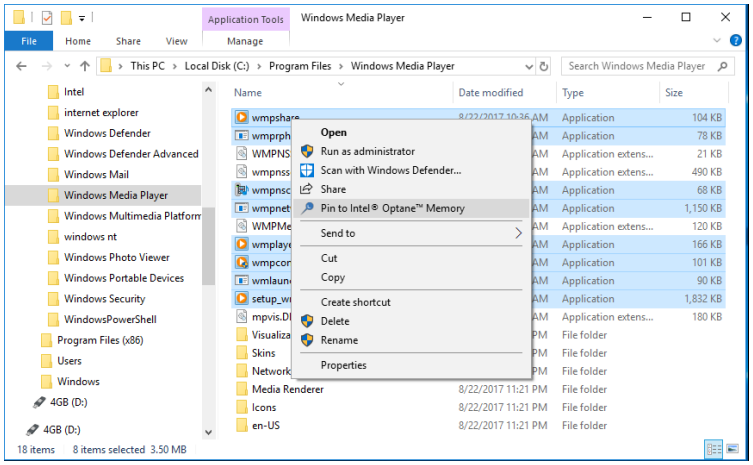
1. Launch Windows* File Explorer
2. Navigate to the folder that you wish to unpin from Intel® Optane™ memory
3. Use the mouse to right click on the folder that you wish to unpin to Intel® Optane™ memory
4. In the pop-up menu, left click the 'Pin to Intel® Optane™ Memory' option to pin the folder
5. To unpin multiple folders in the same folder, click on one folder then use either the <Shift> key to highlight the multiple sequential folders or use the <Ctrl> key to select multiple folders

	Folder Unpinned via Explorer(Right Click) 
Pinning Applications:	1. Launch the Windows* File Explorer 2. Navigate to the application that you wish to pin to Intel® Optane™ memory 3. Use the mouse to right click on the application executable file that you wish to pin to Intel® Optane™ memory 4. In the pop-up menu, left click the 'Pin to Intel® Optane™ Memory' option to pin the application. The application will be **soft pinned**: a. To pin multiple applications in the same folder, left click on one application then use either the <Shift> key to highlight the multiple sequential apps or use the <Ctrl> key to select multiple apps that are not listed sequentially b. Now use the mouse to right click on one of the highlighted apps c. In the pop-up menu, left click the 'Pin to Intel® Optane™ Memory' option to pin the apps **File Types**: All applications highlighted will be pinned. **Pinning Types**: All applications pinned will be **soft pinned**.

App Pinned via Windows* Explorer (Right Click)

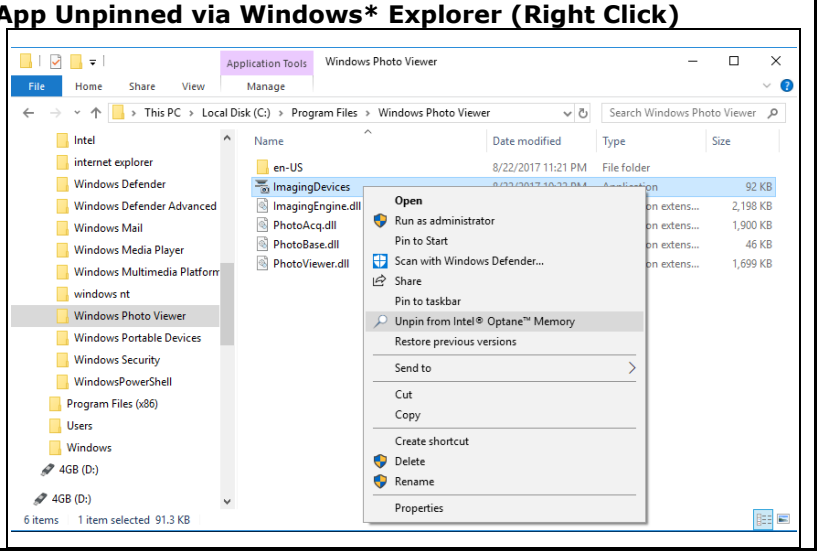


Multiple Apps Pinned via Explorer (Right Click)



How-to Unpin applications:

1. Launch Windows* File Explorer
2. Navigate to the folder that you wish to unpin from Intel® Optane™ memory
3. Use the mouse to right click on the folder that you wish to unpin to Intel® Optane™ memory
4. In the pop-up menu, left click the 'Pin to Intel® Optane™ Memory' option to pin the folder
5. To unpin multiple folders in the same folder, click on one folder then use either the <Shift> key to highlight the multiple sequential folders or use the <Ctrl> key to select multiple folders

	App Unpinned via Windows* Explorer (Right Click) 

5.4 Configuring Intel® Optane™ Memory (Post-Factory Build Environment[1])

This section documents how to enable System Acceleration with Intel® Optane™ Memory on systems that are not shipped with the feature enabled. It focuses on systems being installed/configured by end-users/system integrators/others outside of the factory environment.

Note: [1] For configuring Intel® Optane™ Memory in the factory, review the next *chapter*.

Warning: **In all Intel® Optane™ Memory enabling scenarios, all data that is on the fast disk prior to enabling will be deleted during the Intel® Optane™ Memory enabling process.**

5.4.1 Enabling Intel® Optane™ Volume on a Brand-New System

5.4.1.1 BIOS

There are no pre-OS configuration tools for Intel® Optane™ available to the end-user.

5.4.1.2 OS Runtime

This section instructs how to enable the System Acceleration with Intel® Optane™ memory after the installation of the OS. Users who want to have a completely automated Intel® Optane™ Memory configuration process after the OS installation are recommended to use this method.

5.4.1.2.1 Intel® Optane™ Memory and Storage Management UI/Installer (All User Levels)

This configuration method can be used by experienced and inexperienced users. Users who want to have a completely automated Intel® Optane™ Memory configuration process after the OS installation are recommended to use this method. It automates all of the BIOS configuration tasks involved in setting up the entire system to support System Acceleration with Intel® Optane™ Memory.

<table>
<tr><td rowspan="2">System prep:</td><td><u>Boot Drive Acceleration (requires 2 drives)</u>:

• Ensure that you have installed:
A. A SATA HDD/SSD/SSHD (the slow media to install OS)
B. An Intel® Optane™ NVMe* SSD or memory module (fast media to be the cache) in a PCH remappable port or a CPU PEG* port</td></tr>
<tr><td><u>Data Drive Acceleration (requires 3 drives):</u>

• Ensure that you have installed:
A. A drive to install the OS to (no specific requirement)
B. A SATA HDD/SSD/SSHD (the slow media data drive); must be larger than the fast media drive
C. A PCIe* Intel® Optane™ NVMe* SSD or memory module (fast media to be the cache) in a PCH remapable port or a CPU PEG* port.</td></tr>
<tr><td>BIOS Setup:</td><td>Enter the BIOS and configure the following:

1. Locate the menu to configure the SATA PCH controller
2. Set the SATA mode to one of the non-AHCI modes:
a. Intel® RST with System Acceleration with Intel® Optane™ Memory…, or
b. Intel® RST Premium with System Acceleration with Intel® Optane™ Memory…
3. Locate the setting for enabling/disabling remapping for the PCIe* port where the fast media drive is located
4. Set the port to remapped enabled (controlled by Intel® RST)</td></tr>
</table>

OS installation:	Obtain your copy of the supported Windows* 10 installation media and install the OS using the default installation or any customizations desired.
Verify OS detects Intel® Optane™ module:	1. Complete the OS installation and boot to the Windows* desktop. 2. Launch Windows* Device Manager 3. Expand 'Disk drives' and confirm that all drives are detected: A. Intel® Optane™ model disk (fast media) B. HDD/SSD (slow media) C. If accelerating a data drive, then there should be a 3rd drive for the OS 4. Exit Device Manager.
Intel® Optane™ volume creation:	*The following steps in this process will automatically accomplish all or some of the following tasks depending on the state of your system:* • *Install the required SW needed for Intel® Optane™ Memory* • *Select the proper mode for the PCH SATA controller* • *Enable remapping required for the Optane™ PCIe* NVMe* device to be detected by Intel® RST* • *Installs the Intel® Optane™ Memory UI* • *And finally, with user input, enables System Acceleration with Intel® Optane™ Memory* *If any of the above steps are already in the required state, the installer will automatically skip those steps that are not required and complete the installation and configuration process* ***Note: In Intel® Optane™ Memory and Storage Management UI, for all Intel® Optane™ Memory enabling scenarios, all data that is on the fast disk prior to enabling should be deleted before the Intel® Optane™ Memory enabling process otherwise the App would not allow the Optane™ memory to be used. The Intel® Optane™ memory disk should not be initialized***

	(does not have a valid partition table) or have Intel® RST Metadata. 1. Obtain the Intel® Optane™ Memory Storage Management from Windows* store or follow the steps given in Section Intel® Optane™ Memory and Storage Management UI/Installer (All User Levels) 2. To complete the Intel® Optane™ enabling process (*to combine the Intel® Optane™ memory device and the OS system drive into a single accelerated* Intel® *Optane™ volume*), go to the 'Intel® Optane™ Memory' page, a. Select an Intel® Optane™ drive from the "Compatible drive" drop down box (if only a single Intel® Optane™ module is present in the system then skip this step, there will be no drop down box) b. If multiple compatible drives are in the system select the drive to be accelerated: i. For OS drive acceleration select the disk labeled "SYSTEM" ii. For data drive acceleration select any disk not labeled "SYSTEM" c. Click the [Enable Intel® Optane™ Memory] button d. Click [Enable] 3. Once any necessary file migration completes, reboot to Windows* to complete the configuration process. 4. For Intel® Optane™ Memory module that support file caching (32GB and greater), a native application will be run at the boot up to move the Windows* OS pagefile. Refer to section 5.4.1.3 for more information. DO NOT interrupt this process.
Verify the system is Intel® Optane™ Memory accelerated:	From Windows* desktop, launch the Windows* Device Manager 1. Go to 'Disk Drives' and click to expand. • You should see a single drive labeled "Intel® Optane+slow media" (e.g. "Intel® Optane+1.0TBHDD") • If you are accelerating a data drive then you will see the OS drive listed as well 2. Go to Disk Manager.

	• The Intel® Optane™ memory module should not be listed. It will be combined with either the OS drive or a data drive. 3. Another method is to launch the Intel® Optane™ Memory and Storage Management UI and see the 'Intel® Optane™ Memory' page. These three items confirm that the Intel® Optane™ NVMe* SSD/memory module and the large capacity HDD/SSD have been combined to form the accelerated Intel® Optane™ volume.

5.4.1.2.2 Intel® Optane™ Memory UI/Installer (All User Levels)

This configuration method can be used by experienced and inexperienced users. Users who want to have a completely automated Intel® Optane™ Memory configuration process after the OS installation are recommended to use this method. It automates all the BIOS configuration tasks involved in setting up the entire system to support System Acceleration with Intel® Optane™ Memory.

System prep:	Boot Drive Acceleration (requires 2 drives): • Ensure that you have installed: A. A SATA HDD/SSD/SSHD (the slow media to install OS) B. An Intel® Optane™ NVMe* SSD or memory module (fast media to be the cache) in a PCH remappable port or a CPU PEG port
	Data Drive Acceleration (requires 3 drives): • Ensure that you have installed: A. A drive to install the OS to (no specific requirement) B. A SATA HDD/SSD/SSHD (the slow media data drive); must be larger than the fast media drive C. A PCIe* Intel® Optane™ NVMe* SSD or memory module (fast media to be the cache) in a PCH remappable port or a CPU PEG port.
BIOS Setup:	Enter the BIOS and configure the following: 1. Locate the menu to configure the SATA PCH controller 2. Set the SATA mode to one of the non-AHCI modes:

	a. Intel® RST with System Acceleration with Intel® Optane™ Memory…, or b. Intel® RST Premium with System Acceleration with Intel® Optane™ Memory… 3. Locate the setting for enabling/disabling remapping for the PCIe* port where the fast media drive is located 4. Set the port to remapped enabled (controlled by Intel® RST)
OS installation:	Obtain your copy of the supported Windows* 10 installation media and install the OS using the default installation or any customizations desired.
Verify OS detects Intel® Optane™ module:	1. Complete the OS installation and boot to the Windows* desktop. 2. Launch Windows* Device Manager. 3. Expand 'Disk drives' and confirm that all drives are detected: A. Intel® Optane™ model disk (fast media) B. HDD/SSD (slow media) C. If accelerating a data drive, then there should be a 3rd drive for the OS 2. Exit Device Manager.
Intel® Optane™ volume creation:	*The following steps in this process will automatically accomplish all or some of the following tasks depending on the state of your system:* • *Install the required SW needed for Intel® Optane™ Memory* • *Select the proper mode for the PCH SATA controller* • *Enable remapping required for the Intel® Optane™ PCIe* NVMe* device to be detected by Intel® RST* • *Installs the Intel® Optane™ Memory UI* • *And finally, with user input, enables System Acceleration with Intel® Optane™ Memory* *If any of the above steps are already in the required state, the installer will automatically skip those steps*

	that are not required and complete the installation and configuration process. ***WARNING: In all Intel® Optane™ Memory enabling scenarios, all data that is on the fast disk prior to enabling will be deleted during the Intel® Optane™ Memory enabling process*** 1. Obtain the Intel® Optane™ Memory SW/driver installation package and run the executable (**SetupOptaneMemory.exe**) 2. Install the defaults 3. When this part of the installation process completes the installer will prompt you to 'Restart', click [Finish] to restart the system: a. During this reboot the system will accomplish any required system configuration tasks (BIOS settings) and may reboot more than once b. When complete, the system will reboot back to the Windows* desktop 4. There will be a few seconds delay; the installation process continues and completes driver installation 5. A pop-up ("You're Almost There …") will prompt you to continue to enable Intel® Optane™; click [Next] then [Yes] and the Intel® Optane™ UI will launch 6. To complete the Intel® Optane™ enabling process (*to combine the Intel® Optane™ memory device and the OS system drive into a single accelerated Intel® Optane™ volume*), go to the 'Setup' page, a. Select an Intel® Optane™ drive from the "Compatible drive" drop down box (if only a single Intel® Optane™ module is present in the system then skip this step, there will be no drop down box) b. If multiple compatible drives are in the system select the drive to be accelerated: 1. For OS drive acceleration select the disk labeled "SYSTEM" 2. For data drive acceleration select any disk not labeled "SYSTEM" c. Click the [Enable] button

	d. Click the "Erase all data on the Intel® Optane™ memory module" box to place a check in the box e. Click [Continue] 2. Once any necessary file migration completes, click the [Restart] button to reboot 3. Reboot to Windows* to complete the configuration process. 4. For Intel® Optane™ Memory module that support file caching (32GB and greater), a native application will be run at the boot up to move the Windows* OS pagefile. Refer to section 5.4.1.3 for more information. **DO NOT interrupt this process**
Verify the system is Intel® Optane™ Memory accelerated:	From Windows* desktop, launch the Windows* Device Manager 1. Go to 'Disk Drives' and click to expand. • You should see a single drive labeled "Intel® Optane+slow media" (Example: "Intel® Optane™ +1.0TBHDD") • If you are accelerating a data-drive then you will see the OS drive listed as well 2. Go to Disk Manager • The Intel® Optane™ memory module should not be listed. It will be combined with either the OS drive or a data drive. 3. Another method is to launch the Intel® Optane™ Memory UI and see the 'Status' page. These three items confirm that the Intel® Optane™ NVMe* SSD/memory module and the large capacity HDD/SSD have been combined to form the accelerated Intel® Optane™ volume.

5.4.1.2.3 Intel® RST UI/Installer (Experienced Users)

This section instructs how to enable the System Acceleration with Intel® Optane™ technology as part of the OS installation. Experienced users who want to have full control of the configuration process are recommended to use this method.

System prep:	1. Ensure the computer HW meets the minimum requirements for this feature (see the Minimum Requirements section above). This includes installing the Intel® Optane™ memory module or Intel®

	Optane™ NVMe* SSD in the proper remapable M.2 connector or PCIe* slot. 2. Confirm that the system BIOS has a supported Intel® RST pre-OS UEFI driver integrated: a. Enter your system BIOS and locate the Intel® Rapid Storage Technology HII UI. b. At the top of the UI page confirm that the Intel® RST UEFI Driver version is 15.9.3.xxxx or later. 3. Set SATA PCH I/O controller to proper mode: a. While still in the BIOS find the page that allows you to configure the PCH and SATA mode to "Intel® RST Premium…" (**AHCI mode is not supported**) b. Enable remapping so that Intel® RST can control the Intel® Optane™ memory module or Intel® Optane™ NVMe* SSD. ***Note:*** The location of the above functions/settings in the system BIOS on your computer will vary based on the manufacturer of your computer system. If you have trouble locating these settings contact your system manufacturer. Alternately you can follow the instructions for all users in the previous section.
OS installation:	Obtain your copy of the Windows* 10 installation media and install the OS using the default installation or any customizations desired.
Verify that OS detects Optane™ module:	1. Complete the OS installation and boot to the Windows* desktop 2. Launch Windows* Device Manager 3. Expand 'Disk drives' and confirm that all drives are detected. a. Intel® Optane™ model disk (fast media) b. HDD/SSD (slow media) c. If accelerating a data drive, then there should be a 3rd drive for the OS d. Exit Device Manager.
Intel® Optane™ volume creation:	***WARNING: In all Intel® Optane™ Memory enabling scenarios, all data that is on the fast disk prior to enabling will be deleted during the Intel® Optane™ Memory enabling process*** 1. Obtain the Intel® RST SW/driver installation package and run the executable (SetupRST.exe)

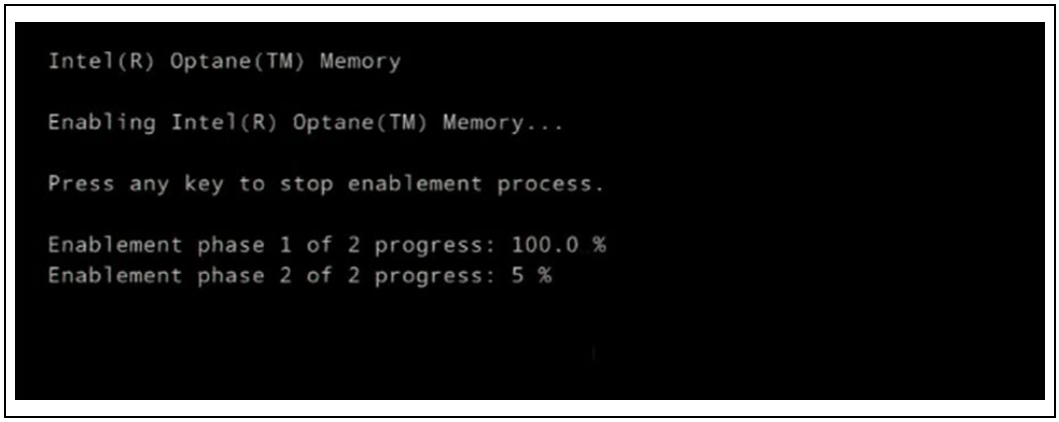
	2. Install the defaults and reboot the computer 3. From Windows* desktop, find and launch the Intel® RST UI application. 4. The application will open to the 'Status' page 5. Click the 'Intel® Optane™ Memory' tab 6. Click the "Enable" link to start the enabling process. 7. A pop-up will prompt you to select: a. From drop down, select the NVMe* fast media Intel® Optane™ device b. From drop down, select the SATA disk to be accelerated (for OS drive acceleration, select the drive labeled 'SYSTEM"; for data drive acceleration select a drive not labeled "SYSTEM") 8. Click OK to start the enable process 9. Depending on the size of your Intel® Optane™ module, the following may be seen: A. Progress indicator: Let progress indicator complete to 100% B. Text: Finalizing operation… 10. Click the [Reboot] button to complete the process 11. System reboots into Windows* to complete the enabling process. 12. For Intel® Optane™ Memory module that support file caching (32GB and greater), a native application will be run at the boot up to move the Windows* OS pagefile. Refer to section 5.4.1.3 for more information. **DO NOT interrupt this process.**
Verify system is Optane™ Memory accelerated:	From Windows* desktop, launch the Windows* Device Manager 1. Go to 'Disk Drives' and click to expand a. You should see a single drive labeled "Intel® Optane™+slow media" (Example: "Intel® Optane™+1.0TBHDD") b. If you are accelerating a data drive you will see at least one other drive that is the OS drive. 2. Go to Disk Manager a. The Intel® Optane™ module should not be listed. 3. Another method is to launch the Intel® RST UI or Intel® Optane™ UI, depending on your install, and see the Status page.

	These three items confirm that the Intel® Optane™ NVMe* SSD/memory module and the large capacity HDD/SSD have been combined to form the accelerated Intel® Optane™ volume.

5.4.1.3 Intel® Optane™ Service Pagefile Boot Optimization

For 32GB and greater Intel® Optane™ Memory module with file caching enabled, Intel® RST optimizes Windows* boot process by placing page file into Intel® Optane™ Memory. During the enabling process, the page file may not be accessible due to exclusive use by Windows* and is not placed into Intel® Optane™ Memory. In order to move the pagefile to Intel® Optane™ Memory, an optimization is done on next reboot before the Windows* is loaded. The end user will see a similar screen as figure 6.1 during the boot process after Intel® Optane™ was initially enabled:

Figure 5-1. Intel® Optane™ Optimization Process



There are two phases to this pagefile boot optimization:

- Phase 1: The space is made in Intel® Optane™ Memory module for Windows* OS pagefile.
- Phase 2: The pagefile is moved into the destination area in Intel® Optane™ Memory module.

Note: **If the end user stops this process, the performance will be impacted and reduced because the pagefile is not cached in Intel® Optane™ Memory module.**

5.4.2 System Upgrade (Windows*10 OS Already Installed)

This section covers upgrading those systems that have Windows* 10 already install by installing a new Intel® Optane™ memory module then enabling System Acceleration with Intel® Optane™ Memory.

Note: **Teton Glacer module does not support creation of Intel® Optane™ Memory Volume with existing system drive or data drive. See Teton Glacier Hardware**

Limitation for more information. For procedure to configure Teton Glacier module as Intel® Optane™ Data Volume, refer to section 5.4.2.4.

5.4.2.1 Intel® Optane™ Memory and Storage Management UI/Installer

System starting configuration:	• Windows* 10* x64 OS installed on SATA HDD/SSD • Intel® RST driver installed • System BIOS has Intel® RST pre-OS version 15.5.0.2875 or later integrated
Intel® Optane™ module installation:	1. Power down the system and install the Intel® Optane™ memory device into an M.2 connector located either on the motherboard or PCIe* adapter card plugged into a remappable PCIe* slot or module connected to CPU PEG* port 2. Reboot system to Windows*.
Verify OS detects Intel® Optane™ module:	**Note**: Unless the following conditions are met, the Intel® Optane™ memory module will not be detectable: a. Intel® RST 16.7 or later driver installed (if not installed then the Intel® Optane™ module will not be detectable yet; skip to the next section and proceed to install the 16.7 or later SW package with driver). b. The BIOS has the Intel® RST 15.9.3 or later UEFI preOS driver installed. c. The PCIe* port with the Intel® Optane™ module is remapped. 1. Boot to the Windows* desktop. 2. Launch Windows* Device Manager. 3. Expand 'Disk drives' and confirm that all drives are detected: A. Intel® Optane™ Memory module/Disk B. SATA HDD/SSD/SSHD (to be accelerated) C. Additional disk for OS if accelerating a data drive
Intel® Optane™ volume creation:	*The following steps in this process will automatically accomplish all or some of the following tasks depending on the state of your system:* *1. Install the required SW needed for Intel® Optane™* *2. If in AHCI mode, switch the PCH SATA controller to the proper 'Intel® RST…' mode*

	3. Enable remapping required for the Intel® Optane™ PCIe NVMe* device* *4. Installs the Intel® Optane™ Memory UI* *5. And finally, with user input, enable System Acceleration with Intel® Optane™ Memory* *If any of the steps above are already in the required state the installer will automatically skip those steps that are not required and complete the installation and configuration process.* ***Note: In Intel® Optane™ Memory and Storage Management UI, for all Intel® Optane™ Memory enabling scenarios, all data that is on the fast disk prior to enabling should be deleted before the Intel® Optane™ Memory enabling process otherwise the App would not allow the Intel® Optane™ memory to be used. The Intel® Optane™ memory disk should not be initialized (does not have a valid partition table) or have Intel® RST Metadata.*** 6. Obtain the Intel® Optane™ Memory Storage Management from Windows* store or follow the steps given in Section Intel® Optane™ Memory and Storage Management UI/Installer (All User Levels) 7. To complete the Intel® Optane™ enabling process (to combine the Intel® Optane™ device and the OS system drive into a single accelerated Intel® Optane™ volume), on the 'Intel® Optane™ Memory' page, click the [Enable] button and click the [Yes] button to proceed. 8. Once any necessary file migration completes, reboot to Windows* and this completes the configuration process. 9. For Intel® Optane™ Memory module that support file caching (32GB and greater), a native application will be run at the boot up to move the Windows* OS pagefile. Refer to section 5.4.1.3 for more information. **DO NOT interrupt this process**.
Verify the system is Optane™ Memory accelerated:	From Windows* desktop, launch the Windows* Device Manager 1. Go to 'Disk Drives' and click to expand. a. You should see a single drive labeled "Intel® Optane™+slow media"

	(Example: "Intel® Optane™+1.0TBHDD") 2. Go to Disk Manager. a. If you see the Intel® Optane™ volume displayed in 'Disk drives', then you should see a single Windows* OS disk. The Intel® Optane™ module should not be listed. 3. Another method is to launch the Intel® RST UI, Intel® Optane™ UI or Intel® Optane™ and Storage management UI, depending on your install, and see the Status page. These three items confirm that the Intel® Optane™ NVMe* SSD/memory module and the large capacity HDD/SSD have been combined to form the accelerated Intel® Optane™ volume.

5.4.2.2 Intel® Optane™ Memory UI/Installer

System starting configuration:	• **Windows* 10 x64 OS installed on SATA HDD/SSD** • **Intel® RST driver installed** • **System BIOS has Intel® RST pre-OS version 15.5.0.2875 or later integrated**
Intel® Optane™ module installation:	1. Power down the system and install the Intel® Optane™ memory device into an M.2 connector located either on the motherboard or PCIe* adapter card plugged into a remappable PCIe* slot or module connected to CPU PEG* port. 2. Reboot system to Windows*.
Verify OS detects Intel® Optane™ module:	**Note**: Unless the following conditions are met, the Intel® Optane™ memory module will not be detectable: • Intel® RST 15.5 or later driver installed (if not installed then the Intel® Optane™ module will not be detectable yet; skip to the next section and proceed to install the 15.5 or later SW package with driver) • The BIOS has the Intel® RST 15.9.3 or later UEFI preOS driver installed • The PCIe* port with the Intel® Optane™ module is remapped.

	1. Boot to the Windows* desktop. 2. Launch Windows* Device Manager 3. Expand 'Disk drives' and confirm that all drives are detected: A. Intel® Optane™ Memory module/Disk B. SATA HDD/SSD/SSHD (to be accelerated) C. Additional disk for OS if accelerating a data drive
Intel® Optane™ volume creation:	*The following steps in this process will automatically accomplish all or some of the following tasks depending on the state of your system:* • *Install the required SW needed for Intel® Optane™* • *If in AHCI mode, switch the PCH SATA controller to the proper 'Intel® RST…' mode* • *Enable remapping required for the Intel® Optane™ PCIe* NVMe* device* • *Installs the Intel® Optane™ Memory UI* • *And finally, with user input, enable System Acceleration with Intel® Optane™ Memory* *If any of the steps above are already in the required state, the installer will automatically skip those steps that are not required and complete the installation and configuration process.* ***WARNING: In all Intel® Optane™ Memory enabling scenarios, all data that is on the fast disk prior to enabling will be deleted during the Intel® Optane™ Memory enabling process*** 1. Obtain the Intel® Optane™ SW/driver installation package and run the executable **(SetupOptaneMemory.exe).** 2. Install the defaults. 3. When this part of the installation process completes the installer will prompt you to 'Restart', click [Finish] to restart the system: a. During this reboot the system will accomplish any required system configuration tasks (Example: BIOS settings like switching from AHCI mode) and may reboot more than once b. When complete, the system will reboot back to the Windows* desktop

	4. There will be a few seconds delay; the installation process continues and completes driver installation 5. A pop-up ("Thank you for installing…") will prompt you to continue to enable Intel® Optane™; click [Yes] and the Intel® Optane™ UI will launch 6. To complete the Intel® Optane™ enabling process (to combine the Intel® Optane™ device and the OS system drive into a single accelerated Intel® Optane™ volume), on the 'Setup' page, click the [Enable] button and click the [Yes] button to proceed 7. Once any necessary file migration completes, click the [Restart] button to reboot 8. Reboot to Windows* and this completes the configuration process. 9. For Intel® Optane™ Memory module that support file caching (32GB and greater), a native application will be run at the boot up to move the Winows OS pagefile. Refer to section 5.4.1.3 for more information. **DO NOT interrupt this process.**
Verify the system is Intel® Optane™ Memory accelerated:	From Windows* desktop, launch the Windows* Device Manager. 1. Go to 'Disk Drives' and click to expand • You should see a single drive labeled "Intel® Optane+slow media" (Example: "Intel® Optane+1.0TBHDD") 2. Go to Disk Manager • If you see the Intel® Optane™ volume displayed in 'Disk drives', then you should see a single Windows* OS disk. The Intel® Optane™ module should not be listed. 3. Another method is to launch the Intel® RST UI or Intel® Optane™ UI, depending on your install, and see the Status page. These three items confirm that the Intel® Optane™ NVMe* SSD/memory module and the large capacity HDD/SSD have been combined to form the accelerated Intel® Optane™ volume.

5.4.2.3 Intel® RST UI/Installer

This method is for upgrading a system that is in one of the Intel® RST Intel® Optane™ modes and running the Intel® RST driver

System starting configuration:	• Windows* 10 OS installed on SATA HDD/SSD. • Intel® RST driver installed. • System BIOS SATA controller set to one of the Intel® RST Intel® Optane™ modes. ***Note:*** *The system must meet minimum requirements to support System Acceleration with Intel® Optane™ technology. Refer to the 'Minimum Requirements' section above*
Intel® Optane™ module installation:	1. Power down the system and install the Intel® Optane™ device into an M.2 connector located either on the motherboard or PCIe* adapter card plugged into a remappable PCIe* slot or a CPU PEG* port. 2. Enter BIOS and enable remapping on the port where the Intel® Optane™ device is plugged into 3. Reboot to Windows*.
Verify OS detects the Intel® Optane™ device:	1. Boot to the Windows* desktop. 2. Launch Windows* Device Manager 3. Expand 'Disk drives' and confirm that newly installed Intel® Optane™ device is detected as a drive A. Intel® Optane™ Model Disk (fast media) B. HDD/SSD (slow media)
Intel® Optane™ volume creation:	***WARNING: In all Intel® Optane™ Memory enabling scenarios, all data that is on the fast disk prior to enabling will be deleted during the Intel® Optane™ Memory enabling process*** 1. Obtain the Intel® RST SW/driver installation package and run the executable (SetupRST.exe) 2. Install the defaults and reboot the computer 3. From Windows* desktop, find and launch the Intel® RST UI application. 4. The application will open to the 'Status' page 5. Click the 'Intel® Optane™ Memory' tab 6. Click the "Enable" link to start the enabling process. 7. A pop-up will prompt you to 'Select a compatible fast drive:' (the Intel® Optane™ NVMe* device) 8. Click [Yes] button to start the enable process 9. Depending on the size of your Intel® Optane™ module, a progress indicator may be displayed; let it complete to 100% 10. Click the [Reboot] button to complete the process

	11. System reboots into Windows* to complete the enabling process.
Verify the system is Intel® Optane™ Memory accelerated:	From Windows* desktop, launch the Windows* Device Manager 1. Go to 'Disk Drives' and click to expand. • You should see a single drive labeled "Intel® Optane+slow media" (e.g. "Intel® Optane+1.0TBHDD") 2. Go to Disk Manager. • If you see the Intel® Optane™ volume displayed in 'Disk drives', then you should see a single Windows* OS disk. The Intel® Optane™ module should not be listed. 3. Another method is to launch the Intel® RST UI or Intel® Optane™ UI, depending on your install, and see the Status page. These three items confirm that the Intel® Optane™ NVMe* SSD/memory module and the large capacity HDD/SSD have been combined to form the accelerated Intel® Optane™ volume.

5.4.2.4 Intel® RST UI/Installer for Teton Glacier as Intel® Optane™ Data Volume

This method is for upgrading a system that meets Teton Glacier minimum system requirements and already has Windows* 10 installed on a SATA HDD/SSD. In this configuration, Teton Glacier can only be configured as Intel® Optane™ Data Volume (DDA).

Sytem starting configuration	• Windows* 10* x64 OS installed on SATA HDD/SSD. • Intel® RST driver and software version 17.0.0.1072 or later installed. • System BIOS has Intel® RST pre-OS version 17.0.0.3679 or later integrated.
Module installation and BIOS configuration	• Power down the system and install the TG Intel® Optane™ device into an M.2 slot that supports 2x2 configuration and PCIe* port reconfiguration from BIOS. • Refer to section 5.4.1.3 BIOS Setup for BIOS configuration and checkpoint.

Enable Intel® Optane™ Memory Data Volume	• Enable Intel®© Optane™ Memory and follow the instructions provided by Intel® RST UI. • **IMPORTANT: Make sure that the system is in AC mode before enabling Intel® Optane™ Volume.**

5.4.3 System Upgrade (Windows* 10 OS Already Installed with BIOS in AHCI Mode)

This section covers upgrading those systems that have Windows* 10 already install by installing a new Intel® Optane™ memory module then enabling System Acceleration with Intel® Optane™ Memory.

Note: **This upgrade path is only possible via the Intel® Optane™ Memory UI installer program.**

Note: **Teton Glacier device can only be configured as Data Drive Volume.**

5.4.3.1 Intel® Optane™ Memory and Storage Management UI/Installer

Refer to Section 5.4.

5.4.3.2 Intel® Optane™ UI/Installer

System starting configuration:	• Windows* 10 OS installed on SATA HDD/SSD • Intel® RST AHCI driver or default inbox AHCI driver installed • System BIOS SATA controller in AHCI mode
Intel® Optane™ memory module installation:	1. Power down the system and install the Intel® Optane™ memory module or NVMe* SSD into an M.2 connector located either on the motherboard or a PCIe* adapter card plugged into a remappable PCIe* slot or a CPU PEG* port. 2. Reboot system to Windows*.
Verify OS detects Intel® Optane™ module:	**Note:** Skip this section if the Intel® RST AHCI driver is installed. 1. Boot to the Windows* desktop 2. Launch Windows* Device Manager 3. Expand 'Disk drives' and confirm that both drives are detected: A. Intel® Optane™ memory module/disk

	B. HDD/SSD
Intel® Optane™ volume creation:	*The following steps in this process will automatically accomplish some or all of the following tasks depending on the state of your system:* • *Install the required SW needed for Intel® Optane™* • *Switch the PCH SATA controller from AHCI mode to the proper 'Intel® RST…' mode* • *Enable remapping required for PCIe* NVMe* devices* • *Installs the Intel® Optane™ Memory UI* • *And finally prompt to enable System Acceleration with Intel® Optane™ Memory* *If any of the steps above are already in the required state, the installer will automatically skip those steps that are not required and complete the installation and configuration process* ***Note: In Intel® Optane™ Memory and Storage Management UI, for all Intel® Optane™ Memory enabling scenarios, all data that is on the fast disk prior to enabling should be deleted before the Intel® Optane™ Memory enabling process otherwise the App would not allow the Intel® Optane™ memory to be used. The Intel® Optane™ memory disk should not be initialized (does not have a valid partition table) or have Intel® RST Metadata.*** ***WARNING: In Intel® Optane™ Memory enabling scenarios for Intel® RST and In Intel® Optane™ Memory UI, all data that is on the fast disk prior to enabling will be deleted during the Intel® Optane™ Memory enabling process*** 1. Obtain the Intel® RST and Intel® Optane™ SW/driver installation package and run the executable (SetupOptaneMemory.exe) 2. Install the defaults 3. When this part of the installation process completes the Intel® RST installer program will prompt for you to restart your system to continue the process (click default [Finish] to restart the computer).

	4. Depending upon the initial configuration of your system: A. During this reboot the system will accomplish any required system configuration (BIOS settings) and may reboot more than once B. When all necessary configuration processes complete, the system will reboot back to the Windows* desktop 5. The installation continues and a pop-up box will prompt you to continue to enable Intel® Optane™ volume; click [Yes] to continue 6. Click [Yes] for User Account Control pop-up 7. The Intel® Optane™ Memory UI will launch, click 'Enable' then click 'Yes' to continue to combine your OS system drive or a data drive and your Intel® Optane™ memory module (or SSD) into a single accelerated Intel® Optane™ volume 8. Once the migration process successfully completes you will be prompted to reboot to complete the process; Click 'Restart'. 9. Your computer will reboot to Windows* completing the Intel® Optane™ Memory enabling process. 10. For Intel® Optane™ Memory module that support file caching (32GB and greater), a native application will be run at the boot up to move the Windows* OS pagefile. Refer to section 5.4.1.3 for more information. **DO NOT interrupt this process.**
Verify the system is Optane™ Memory accelerated:	From Windows* desktop, launch the Windows* Device Manager. 1. Go to 'Disk Drives' and click to expand • You should see a drive labeled "Intel® Optane™+slow media" (Example: "Intel® Optane™+1.0TBHDD") 2. Go to Disk Manager • The Intel® Optane™ module should not be listed. 3. Another method is to launch the Intel® RST UI or Intel® Optane™ UI, depending on your install, and see the Status page. These three items confirm that the Intel® Optane™ NVMe* SSD/memory module and the large capacity

	HDD/SSD have been combined to form the accelerated Intel® Optane™ volume.

5.5 Intel® Optane™ Memory Member Disk Upgrades

This section covers upgrading an Optane-enabled system with a new system disk or a new Intel® Optane™ memory module. This section does not apply to Teton Glacier Memory device.

5.5.1 Slow Disk (SATA HDD, SSD, SSHD) Upgrade/Replacement

Disable Intel® Optane™:	Before replacing any component of your Intel® Optane™ Memory storage solution, you must always disable Intel® Optane™ Memory to ensure all data has been migrated from the Intel® Optane™ module and synched with the slow disk. **NOTE:** You should backup any important data prior to starting this process! *Intel® Optane™ Memory and Storage Mangement UI installed*: 1. From Windows* Start Menu, launch the Intel® Optane™ Memory and Storage Management UI. 2. Click on the 'Intel® Optane™ Memory' tab. 3. Click Disable to start the disabling process. 4. Confirm the action. 5. Once the UI has completed all tasks for disabling Intel® Optane™ and any necessary file migration has completed (progress indicator reaches 100%). 6. Restart the Windows* manually using the restart button from Start Menu to reboot the system and complete the disablement process. *Intel® Optane™ Memory UI installed*: 1. From Windows* desktop, launch the Intel® Optane™ Memory UI. 2. Click on the 'Setup' tab. 3. Click Disable to start the disabling process. 4. Confirm the action. 5. Once the UI has completed all tasks for disabling Intel® Optane™ and any necessary file migration has completed (progress indicator reaches 100%), the [Restart] button will be displayed.

	6. Click the [Restart] button to reboot the system and complete the disablement process. *Intel® RST UI installed*: 1. From Windows* desktop, launch the Intel® RST UI. 2. Click the 'Intel® Optane™ Memory' tab at the top. 3. Click Disable to start the disabling process. 4. Confirm the action. 5. Once the UI has completed all tasks for disabling Intel® Optane™ and any necessary file migration has completed (progress indicator reaches 100%), the [Reboot] button will be displayed. 6. Click the [Reboot] button to reboot the system and complete the disablement process.
Reinstall your OS or copy over your current to the new slow disk	***WARNING: In all Intel® Optane™ Memory enabling scenarios, all data that is on the fast disk prior to enabling will be deleted during the Intel® Optane™ Memory enabling process*** At this point you can reinstall the operating system and rebuild your system or you can use whatever process you wish to use to clone/copy your current system and apply it to the new slow disk: Replacing an accelerated OS drive: 1. Install the new slow media (SATA HDD, SSD, or SSHD) a. If the slow media is the OS disk, then continue with step 2. b. If the slow media is a data drive. 2. Install the Windows* 10 OS or apply clone/copy. 3. Once the OS has been installed or transferred to the new slow media, re-enable the Intel® Optane™ Memory. 4. Complete any customizations or application installs. 5. Replacing an accelerated data drive. 6. If possible, backup all data from original data drive. 7. Remove the old data drive and insert the new data drive. 8. Re-enable data drive acceleration with Intel® Optane™ Memory. 9. Copy all required data to the new data drive. 10. EOT.

5.5.2 Intel® Optane™ Memory Module Upgrade/Replacement

Disable Intel® Optane™ Memory:	1. From Windows* desktop, launch the Intel® Optane™ Memory UI. • *Or launch the Intel® RST UI.* • *Or launch Intel® Optane™ Memory and Storage Management UI.* 2. Click the 'Setup' tab at the left • *Or for the Intel® RST UI, click the Intel® Optane™ Memory tab at the top.* • *Or the Intel® Optane™ Memory and Storage Management UI, click the 'Intel® Optane™ Memory' tab.* 3. Click Disable to start the disabling process. 4. Confirm the action. 5. Once the UI has completed all tasks for disabling Intel® Optane™ and any necessary file migration has completed (after the progress indicator reaches 100%), the [Restart] *or [Reboot]* button will be displayed. • *For Intel® Optane™ Memory and Storage Management UI, you must restart manually.* 6. Click the [Restart] *or [Reboot]* button to reboot the system and complete the disablement process.
Replace the Intel® Optane™ memory module:	1. Power down the computer. 2. Open the computer and locate the old Intel® Optane™ memory module that you wish to replace. *(Note: consult your computer manufacturer for the location of the slot for the Intel® Optane™ memory module and instructions to remove and insert an M.2 module)* 3. Remove the old module and insert the new module. 4. Close the computer and power it on and boot into the Windows* OS.

Re-enable Intel® Optane™ Memory:	***WARNING: In all Intel® Optane™ Memory enabling scenarios, all data that is on the fast disk prior to enabling will be deleted during the Intel® Optane™ Memory enabling process.*** 1. From Windows* desktop, launch the Intel® Optane™ Memory UI. • *Or launch the Intel® RST UI.* • *Or launch Intel® Optane™ Memory and Storage Management UI.* 2. Click on the 'Setup' tab. • *Or for the Intel® RST UI, click the Intel® Optane™ Memory tab at the top.* • *Or the Intel® Optane™ Memory and Storage Management UI, click the Intel® Optane™ Memory tab.* 3. Click Enable to start the enabling process 4. Select the fast media to use for enabling and continue 5. Once the UI has completed all tasks for enabling Intel® Optane™ and any necessary file migration has completed (after the progress indicator reaches 100%), the [Restart] or [Reboot] button will be displayed • *For Intel® Optane™ Memory and Storage Management UI, you must restart manually.* 6. Click the [Restart] or [Reboot] button to reboot the system and complete the enablement process.

5.6 Managing Intel® Optane™ Memory

This section describes the management functions available in the various user interfaces that are available to the end-user.

5.6.1 During the OS Runtime

5.6.1.1 Intel® Optane™ Memory and Storage Management UI

This section describes management capabilities of the Intel® Optane™ Memory and Storage Management UI.

5.6.1.1.1 Enabling/Disabling Intel® Optane™ Memory Acceleration

Intel® Optane™ Memory and Storage Management UI Tab: ***Enable Intel® Optane™ configuration:***	1. From Windows* desktop, launch the Intel® Optane™ Memory and Storage Management UI. 2. Click on the 'Intel® Optane™ Memory' tab. 3. Click Enable to start the enabling process. 4. Select the fast media to use for enabling and continue. 5. Once the UI has completed all tasks for enabling Intel® Optane™ and any necessary file migration has completed, reboot the system manually and complete the enablement process.
Intel® Optane™ Memory and Storage Management UI: ***Disable Intel® Optane™ configuration:***	1. From Windows* desktop, launch the Intel® Optane™ Memory and Storage Management UI. 2. Click on the 'Intel® Optane™ Memory tab. 3. Click Disable to start the disabling process. 4. Confirm the action. 5. Once the UI has completed all tasks for disabling Intel® Optane™ and any necessary file migration has completed (progress indicator reaches 100%), reboot the system manually and complete the disablement process.
About Tab:	There are no user actions available other than to view the following information: A. The version number of the Intel® Optane™ UI B. A link to Intel® support website C. And some application licensing information

5.6.1.2 Intel® Optane™ Memory UI

This section describes management capabilities of the Intel® Optane™ Memory UI.

5.6.1.2.1 Enabling/Disabling Intel® Optane™ Memory Acceleration

Setup Tab: ***Enable Intel® Optane™ configuration:***	1. From Windows* desktop, launch the Intel® Optane™ Memory UI. 2. Click on the 'Setup' tab. 3. Click Enable to start the enabling process. 4. Select the fast media to use for enabling and continue. 5. Once the UI has completed all tasks for enabling Intel® Optane™ and any necessary file migration has completed, the [Restart] button will be displayed. 6. Click the [Restart] button to reboot the system and complete the enablement process.
Setup: ***Disable Intel® Optane™ configuration:***	1. From Windows* desktop, launch the Intel® Optane™ Memory UI. 2. Click on the 'Setup' tab. 3. Click Disable to start the disabling process. 4. Confirm the action. 5. Once the UI has completed all tasks for disabling Intel® Optane™ and any necessary file migration has completed (progress indicator reaches 100%), the [Restart] button will be displayed. 6. Click the [Restart] button to reboot the system and complete the disablement process.
Statistics Tab:	***Note:*** *This feature only supports Intel® Optane™ devices that have a capacity of 32GB or more.* There are no user interactions available other than to view the status of "Intel® Optane™ Memory Optimization Schedule". The indicators are: D. Last Optimization E. Next Scheduled Optimization
About Tab:	There are no user actions available other than to view the following information: A. The version number of the Intel® Optane™ UI B. A link to Intel® support website C. And some application licensing information

5.6.1.3 Intel® RST UI

This section describes Intel® Optane™ management capabilities of the Intel® RST UI.

Enable Intel® Optane™ configuration:	1. From Windows* desktop, launch the Intel® RST UI. 2. Click the 'Intel® Optane™ Memory' tab at the top. 3. Click Enable to start the enabling process. 4. Select the fast media to use for enabling and continue. 5. Once the UI has completed all tasks for enabling Intel® Optane™ and any necessary file migration has completed, the [Reboot] button will be displayed. 6. Click the [Reboot] button to reboot the system and complete the enablement process.
Disable Intel® Optane™ configuration:	1. From Windows* desktop, launch the Intel® RST UI. 2. Click the 'Intel® Optane™ Memory' tab at the top. 3. Click Disable to start the disabling process. 4. Confirm the action. 5. Once the UI has completed all tasks for disabling Intel® Optane™ and any necessary file migration has completed (progress indicator reaches 100%), the [Reboot] button will be displayed. 6. Click the [Reboot] button to reboot the system and complete the disablement process.

5.7 I/O Error Handling

5.7.1 Host I/O Failures

Fast Media- I/O failure:	1. Action taken by the Intel® RST SW: A. The Intel® RST driver returns the I/O error to Windows. 2. System Ending State: A. No change: Intel® Optane™ acceleration remains enabled.
Slow Media- I/O failure:	1. Action taken by the Intel® RST SW: A. Intel® RST driver returns the I/O error to the Windows 2. System Ending State: A. No change: Intel® Optane™ acceleration remains enabled.

5.7.2 Intel® RST I/O Failures:

5.7.2.1 During Intel® Optane™ Enabling

READ failure to slow drive:	1. Action taken by the Intel® RST SW: A. Write bad ECC to fast drive B. Enabling is halted and rollback to disabling C. Notify user of significant amount of errors and recommend disabling the Intel® Optane™ Memory 2. System ending state: A. System Acceleration enabled. 3. Recommended corrective action: a. Disable Intel® Optane™ Memory b. Replicate system disk to new drive c. Replace faulty slow drive with new drive d. Re-enable Intel® Optane™ Memory
WRITE failure to fast disk:	1. Action taken by the Intel® RST SW: A. Continue in WT cache mode during Intel® Optane™ Memory enabling. B. Enabling is halted and rollback to disabling C. Display failure in UI. 2. System ending state: A. Intel® Optane™ Memory disabled. 3. Recommended corrective action: A. Power down system B. Replace faulty fast media with new fast media C. Enable Intel® Optane™ Memory

5.7.2.2 During Intel® Optane™ Memory Disabling

WRITE failure to slow media:	1. Action taken A. Continue disabling Intel® Optane™ Memory 2. System ending state: A. Intel® Optane™ Memory successfully disabled 3. Recommended corrective action: A. Reboot the system normally B. Let the Intel® RST driver handle any Intel® RST specific recovery tasks.
READ failure to fast media:	1. Action taken by the Intel® RST SW: A. Write bad ECC to slow drive for LBAs that cannot be read from fast drive B. Continue the Intel® Optane™ Memory volume disabling 2. System ending state: A. Intel® Optane™ Memory disabled B. System Normal state 3. Recommended corrective action: A. None

5.7.3 Missing Media Failures

5.7.3.1 Drive Missing at Boot

Fast disk missing:	1. Action taken by the Intel® RST SW: A. If system boots and the Intel® Optane™ module is not detected by the Intel® RST UEFI driver, the Intel® RST UEFI driver will protect the current data on the slow media by disabling it and not exposing it to the boot manager. This allows the user the opportunity to locate and reinsert the missing fast media (or try additional reboots) to allow the UEFI driver additional opportunity to detect and pair the slow media and fast media and return the Intel® Optane™ volume to a normal state. 2. System ending state: A. System is unbootable. B. Slow media set to 'Disabled' state 3. Recommended corrective action: A. Power down and confirm the location of the missing Intel® Optane™ memory module.

	1. Reattach if missing 2. If not missing: a. Check the connector b. Disconnect the slow media and boot to BIOS menu c. Enter the Intel® RST HII UI d. Confirm that the Intel® Optane™ memory module is displayed (its Status should be 'Offline' in this scenario) e. If the Intel® Optane™ memory module is not present, then exit the Intel® RST HII UI and enter your BIOS menu where the SATA controller remapping function is located and confirm that the port location of the Intel® Optane™ memory module has remapping enabled f. If remapping not enabled, enable it. Save the configuration and power down the computer. 3. Reattach the slow media and power up the computer
Slow disk missing:	1. Action taken by the SW: A. If system boots and the slow media device is not detected by the Intel® RST UEFI driver, the Intel® RST UEFI driver will protect the current data on the Intel® Optane™ Memory module by disabling it and not exposing it to the boot manager. This allows the user the opportunity to locate and reinsert the missing slow media (or try additional reboots) to allow the UEFI driver additional opportunity to detect and pair the slow media and fast media and return the Intel® Optane™ volume to a normal state. 2. System ending state: A. System is unbootable. B. Fast media set to status Disabled 3. Recommended corrective action: A. Power down and confirm the location of the missing slow media drive. 1. Reattach if drive is physically missing 2. If not missing: a. Check the connection

	b. Boot into the BIOS and go to the Intel® Rapid Storage UI c. In the UI see if either the slow or fast disk is listed on the main page. d. It appears the slow disk has experienced an uncorrectable failure and may need to be replaced. Refer section 5.8 in this chapter for instructions to replace the failed slow disk.

5.7.3.2 Drive Hot Unplugged

Hot unplug fast media disk:	1. Action taken A. No Intel® RST action taken; System is expected to experience a Windows* bug check (blue screen) 2. System ending state: A. Windows* blue screen bug check B. Upon next boot, the Intel® RST driver will evaluate the storage subsystem 3. Recommended corrective action: A. Reinsert the fast media back into the remapped PCIe* slot B. Reboot the system normally C. Let the Intel® RST driver handle any Intel® RST specific recovery tasks.
Hot unplug slow media disk:	1. Action taken by the Intel® RST SW: A. No Intel® RST action taken; System is expected to experience a bug check (blue screen) 2. System ending state: A. Blue screen bug check B. Upon next boot, the Intel® RST driver will evaluate the storage subsystem 3. Recommended corrective action: A. Reinsert the slow media to its SATA port B. Reboot the system normally C. Let the Intel® RST driver handle any Intel® RST specific recovery tasks.

5.7.4 S.M.A.R.T. Events

S.M.A.R.T. event (event count threshold reached) on fast media:	1. Action taken (once the SMART event count threshold is reached): a. The fast media's block cache (BC) is placed in Write-Through mode (reduced performance) b. Pop-up message with notification of media errors with recommendation to disable Intel® Optane™ Memory and correct the problem (Example: Replace the fast media) 2. System ending state: a. Intel® Optane™ Memory remains enabled. b. Intel® Optane™ Memory placed in reduced performance mode (WT cache mode) 3. Recommended corrective action: a. Disable Intel® Optane™ Memory b. Power down the system c. Replace the Intel® Optane™ memory module d. Reboot and enable Intel® Optane™ Memory
S.M.A.R.T. event (event count threshold reached) on slow media:	1. Action taken (once the SMART event count threshold is reached): a. The fast media's block cache (BC) is placed in Write-Through mode (reduced performance) b. Pop-up tray icon notification of media errors with recommendation to disable Intel® Optane™ Memory and correct the problem (e.g. replace the fast media) 2. System ending state: a. Intel® Optane™ Memory remains enabled. b. Intel® Optane™ Memory placed in reduced performance mode (WT cache mode) 3. Recommended corrective action: a. Disable Intel® Optane™ Memory b. Power down the system c. Recover (or whatever duplication method you choose) your faulty system drive to a new drive and replace the faulty drive 4. Reboot and enable Intel® Optane™ Memory

5.7.5 Fast Media: Block Cache Errors

Intel® RST Metadata Read failure during boot:	1. Action taken by the Intel® RST SW: A. Intel® Optane™ volume is placed 'offline'. 2. System ending state: A. Intel® Optane™ volume offline. B. System unbootable 3. Recommended corrective action: A. Retry boot B. If system unbootable after several tries then the metadata is corrupted and unrecoverable
Intel® RST Metadata Write failure during shutdown	1. Action taken by the Intel® RST SW: A. Treat the same as a dirty shutdown B. Intel® RST evaluate storage subsystem at next boot 2. System ending state: A. System is bootable. B. System in normal state 3. Recommended corrective action: A. Continue power down/restart as normal
Read failure of cache frame with dirty data exceeds the preset threshold value (fast media failure could be imminent)	1. Action taken by the Intel® RST SW: a. The fast media's block cache (BC) is placed in Write Through mode (reduced performance) b. Tray icon notification of media Read errors with recommendation to disable Intel® Optane™ Memory and correct the problem (e.g. replace the fast media). c. Intel® RST evaluate storage subsystem at next boot 2. System ending state: a. BC in WT cache mode in reduced performance state. b. Intel® Optane™ Memory remains enabled 3. Recommended corrective action: a. Disable Intel® Optane™ Memory b. Power down the system c. Replace the Intel® Optane™ memory module d. Reboot and enable Intel® Optane™ Memory

5.8 Intel® Optane™ Memory Member Disk Failures Requiring Replacement of Disk

5.8.1 Slow Disk (SATA HDD, SSD, SSHD) Replacement

If your system encounters an unrecoverable catastrophic failure of the slow media (the OS system disk becomes inoperable), there is no recovery/repair available. Use the following recommended steps to get the system back up and running:

Data recovery:	No Intel® RST data recovery tools are available for a drive that has experienced mechanical or electrical failure and is considered 'inoperable'. There may be third party tools available for recovering data in this situation. Intel® has no recommendations regarding third party data recovery tools.
Disassociate the Optane™ memory module.	Disassociation of the Intel® Optane™ module is required in order to be able to reuse it to enable Intel® Optane™ with the replacement slow media. **Note:** Disassociation removes the Intel® Optane™ configuration information from the Intel® Optane™ module and deletes all data (data which is unusable cached data from the inoperable OS disk that is being replaced). Once this disassociation is completed the module can again be used to enable Intel® Optane™. 1. Boot into your system BIOS 2. Enter the Intel® Rapid Storage Technology pre-OS UI *(Note: consult your computer manufacturer for the location of this UI in your system BIOS)* 3. The slow media (Intel® Optane™ memory module) should be displayed on the main page, a. Highlight it and hit <Enter> to take you to the "Reset to non-Optane" page b. Under 'Disk Actions' highlight the action 'Reset to non-Optane' and hit <Enter> c. Highlight 'Yes' and hit <Enter> 4. The disk is now available to be used to enable System Acceleration with Intel® Optane™ Memory

Data recovery:	No Intel® RST data recovery tools are available for a drive that has experienced mechanical or electrical failure and is considered 'inoperable'. There may be third party tools available for recovering data in this situation. Intel® has no recommendations regarding third party data recovery tools.
Reinstall your OS or recover it from a previous backup	At this point you can reinstall the operating system and rebuild your system: 1. Install the new slow media (SATA HDD, SSD, or SSHD) 2. Install the Windows* 10 OS 3. Re-enable Intel® Optane™ Memory 4. Complete any customizations or application installs

5.8.2 Intel® Optane™ Memory Module Replacement

This section documents support for Intel® Optane™ memory module upgrades or replacements for systems that already have Intel® Optane™ Memory enabled.

Whether you are upgrading the memory module or replacing a faulty memory module, the following steps will apply:

Disable Optane™ Memory:	1. From Windows* desktop, launch the Intel® Optane™ Memory UI. • *Or launch the Intel® RST UI* • *Or launch Intel® Optane™ Memory and Storage Management UI* 2. Click the 'Setup' tab at the left • *Or for the Intel® RST UI, click the Intel® Optane™ Memory tab at the top* • *Or the Intel® Optane™ Memory and Storage Management UI, click the 'Intel® Optane™ Memory' tab* 3. Click Disable to start the disabling process 4. Confirm the action 5. Once the UI has completed all tasks for disabling Intel® Optane™ and any necessary file migration has completed (after the progress indicator reaches 100%), the [Restart] or [Reboot] button will be displayed

	• *For Intel® Optane™ Memory and Storage Management UI, you have to restart manually.* 6. Click the [Restart] or [Reboot] button to reboot the system and complete the disablement process
Replace the Intel® Optane™ memory module:	1. Power down the computer 2. Open the computer and locate the old or faulty Intel® Optane™ memory module that you wish to replace ***Note:*** *Consult your computer manufacturer for the location of the slot for the Intel® Optane™ memory module and instructions to remove and insert an M.2 storage module* 3. Remove the old or faulty module and insert the new module. 4. Close the computer and power it on and boot into the Windows* OS.
Re-enable Intel® Optane™ Memory:	1. From Windows* desktop, launch the Intel® Optane™ Memory UI • *Or launch the Intel® RST UI* • *Or launch Intel® Optane™ Memory and Storage Management UI* 2. Click on the 'Setup' tab • *Or for the Intel® RST UI, click the Intel® Optane™ Memory tab at the top* • *Or the Intel® Optane™ Memory and Storage Management UI, click the 'Intel® Optane™ Memory' tab* 3. Click Enable to start the enabling process 4. Select the fast media to use for enabling and continue 5. Once the UI has completed all tasks for enabling Intel® Optane™ and any necessary file migration has completed (after the progress indicator reaches 100%), the [Restart] or [Reboot] button will be displayed • *For Intel® Optane™ Memory and Storage Management UI, you have to restart manually.* 6. Click the [Restart] or [Reboot] button to reboot the system and complete the enablement process.

§§

6 Creating a RAID Volume

RAID volumes can be created three different ways. The method most widely used by end-users is to use the Intel® Rapid Storage Technology UI in Windows*. The second method to create a RAID volume is to use the Intel® Rapid Storage Technology option ROM user interface (or the Intel® RST pre-OS UEFI HII UI). The third way, used by OEMs only, is using the pre-OS RCfgSata or Windows* (including WinPE) RSTCLI 32/64 utilities.

6.1 Minimum Requirements

- BIOS: Requires a BIOS with the Intel® RST preOS UEFI driver or OptionROM integrated
- Number of disks required for the desired RAID level
  - RAID 0: 2 disks minimum (6 max)
  - RAID 1: 2 disks only
  - RAID 5: 3 disks minimum (6 max)
  - RAID 10: 4 disks only
- 5MB unallocated space at the end (max LBA) of the disk for Intel® RST metadata

6.2 Feature Limitations

Table 6-1. Disk, Volume, and Array Maximum Limitations

Configuration	Maximum
Number of arrays per system	4
Number of volumes per system	4
Number of volumes per array	2
Number of disks per volume/array	6
Number of disks per system	8

6.3 Using Intel® Optane™ Memory and Storage Management UI

Refer to the section Create Volume.

6.4 Using Intel® Rapid Storage Technology UI

1. Run the Intel® Rapid Storage Technology UI from the following Start menu link within Windows*:
   - ***Pre-Windows* 8:***

Start→Programs→Intel® Control Center (optional) ->Intel® Rapid Storage Technology→Intel® Rapid Storage Technology UI

- ***Windows* 8 and Newer:***
  The UI is not added to the Start Window upon installation and must be added manually
  File Explorer->Local Disk(C)->Program Files->Intel®->Intel® Rapid Storage Technology->IAStorUI.exe (right click and pin to start)

2. Based on the available hardware and your computer's configuration, you may be able to create a volume by selecting the 'easy to use' options such as 'Protect data' under 'Status', or by selecting a volume type under 'Create'. Based on the number of non-RAID disks available to you and the size of the disks the user will only be able to see the possible volume creation options... (Example: If you have only two disks ...you can only see options to create RAID 0, RAID1 and Recovery (Intel® RRT); if you have three disks, you can only see options for creating RAID 0, RAID 1, RAID5 and Recovery)

Note: To create a volume the user must be in admin mode and the system must be in RAID Ready mode with two or more hard disks connected to it

3. Instructions to create a volume by selecting volume type under 'Create'

   a. After selecting the volume type to create, click on 'Next'

   b. Now configure the volume by providing the volume name, selecting the hard disks to be part of the volume and strip size if applicable

      NOTE: When configuring a volume, the application will only list the disks that meet the min requirements to be part of the volume. Based on the first disk selected or the order of selection, some disks may become grayed out if one or more requirements are not met. Changing the order of selection generally helps re-enable disks that were grayed out. For Ex: If the first selection is a system disk, only disks that are of equal or greater size will be presented for selection and other remains grayed out. For more information on disk requirements refer 'creating a volume' under help file in the UI.

   c. Once the disks are selected for volume creation, the user will be presented with option, if you want preserve data on which selected disk. Click on 'Next' and select the 'Create Volume' button.

4. After the RAID volume is created, you will be shown a dialog box stating that the RAID volume was successfully created and you will you will need to use Windows* Disk Management or other third-party software to create a partition within the RAID volume and format the partition. Click OK to close this dialog box.

5. After formatting the partition, you may begin to copy files to, or install software on, the RAID volume.

6.5 Using Intel® RST Legacy Option ROM User Interface

1. Upon re-boot, you will see the option ROM status message on the screen – press CTRL-I to enter the Intel® Rapid Storage Technology option ROM user interface.

2. In the Main Menu, select option #1 'Create RAID Volume'. Enter the name you want to use for the RAID volume, then press Enter.

3. Select the RAID level by using the arrow keys, then press Enter.

4. Press Enter to select the disks to be used by the array that the volume will be created on. Press Enter when done.

5. Select the strip size (128 KB is the default for RAID 0) by using the arrow keys, then press Enter when done.

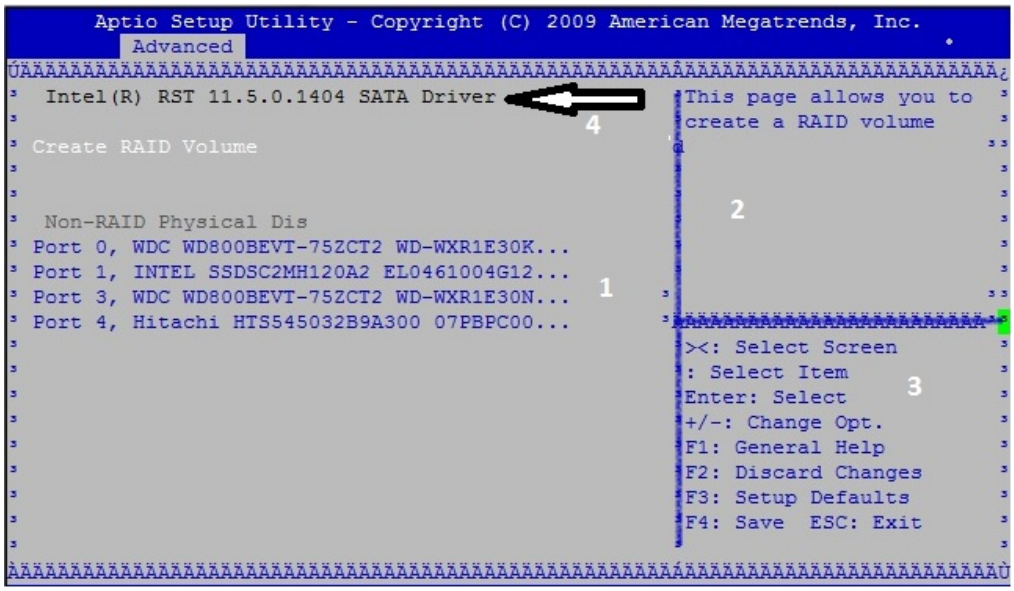
6. Enter the size for the RAID volume in gigabytes. The default value will be the maximum size. If you specify a smaller size, you will be able to create a second volume in the remaining space using the same procedure.

7. After this is done, exit the Option ROM user interface.

6.6 Using Intel® Rapid Storage Technology UEFI User Interface

Note: **This section is motherboard manufacturer dependent. Where/how the chooses to implement the UEFI UI is based on their preference.**

1. Upon re-boot, launch the Intel® RST UEFI user interface (HII compliant)



The UEFI UI is divided into three main sections:

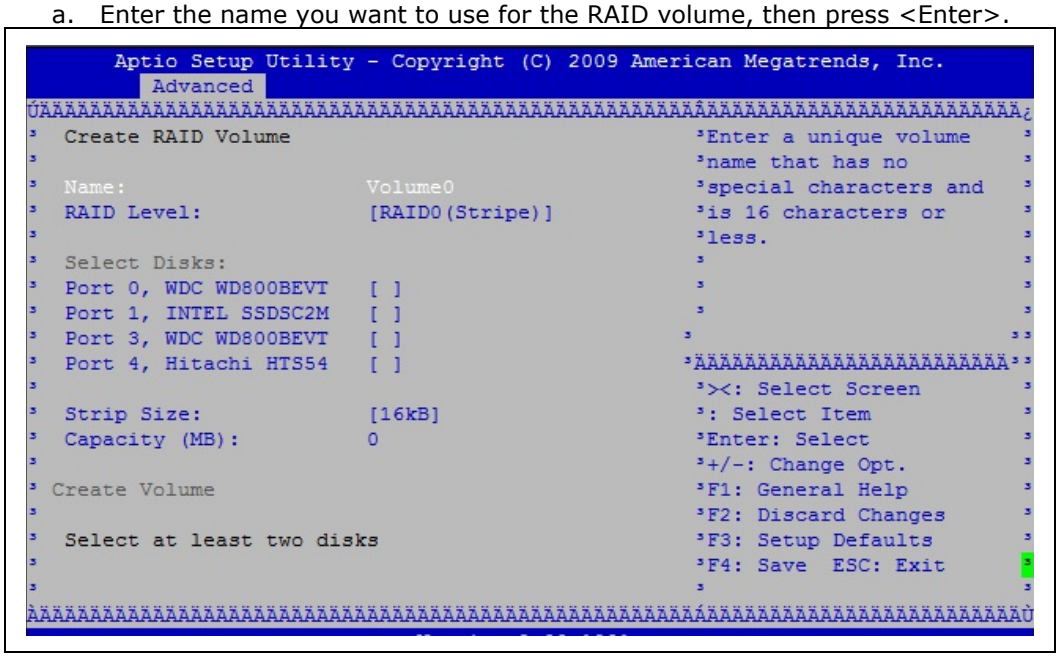
- Section 1 is the main section.
  - It displays RAID configuration and status information
  - It displays Intel® RST UEFI driver version (see arrow #4 in figure above)
  - It displays physical devices enumerated by the Intel® RST UEFI driver that are not part of the RAID volume

- Section 2 gives a brief description of current page of the UI
- Section 3 gives information on how to navigate within the current page of the UEFI UI.

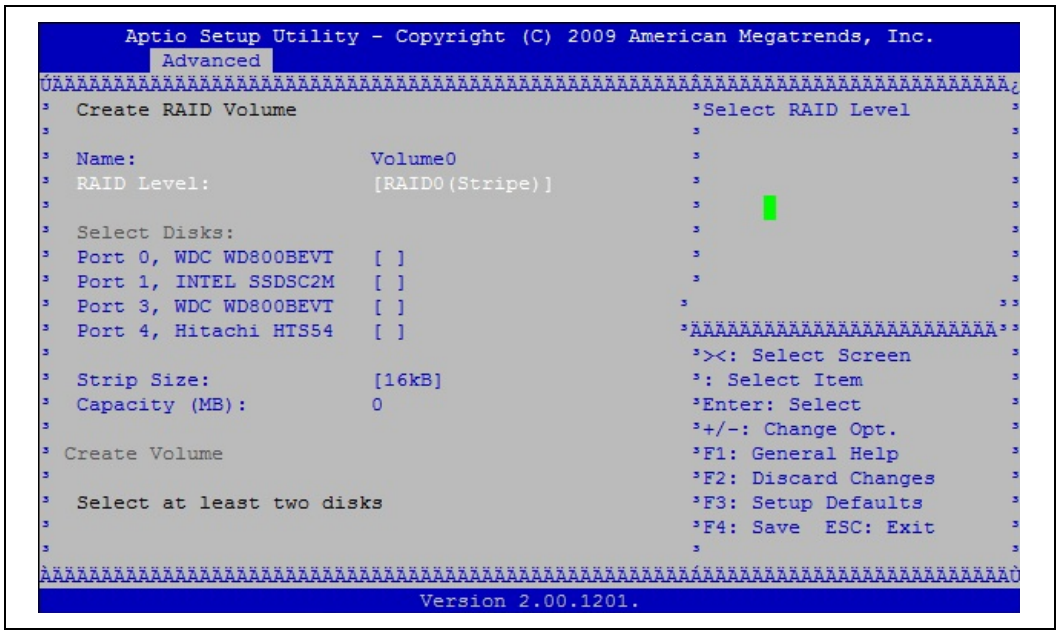
Note: **This section is not implemented by the Intel® RST UEFI driver and is specific to the BIOS that was used for documentation purposes.**

2. In the Main Menu, select 'Create RAID Volume'

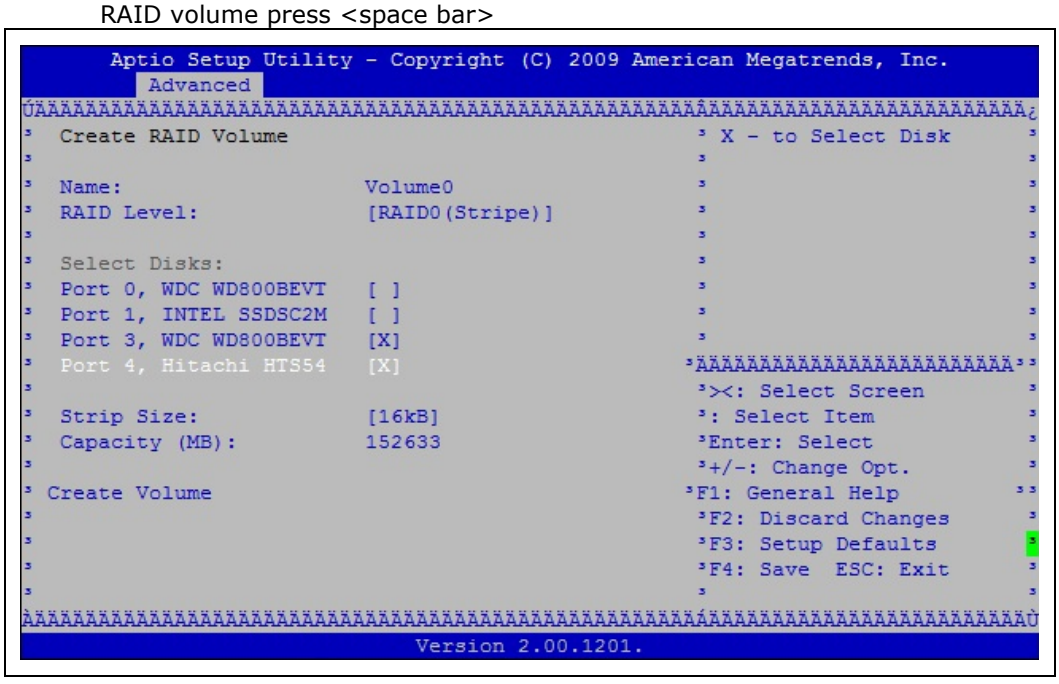
   a. Enter the name you want to use for the RAID volume, then press <Enter>.



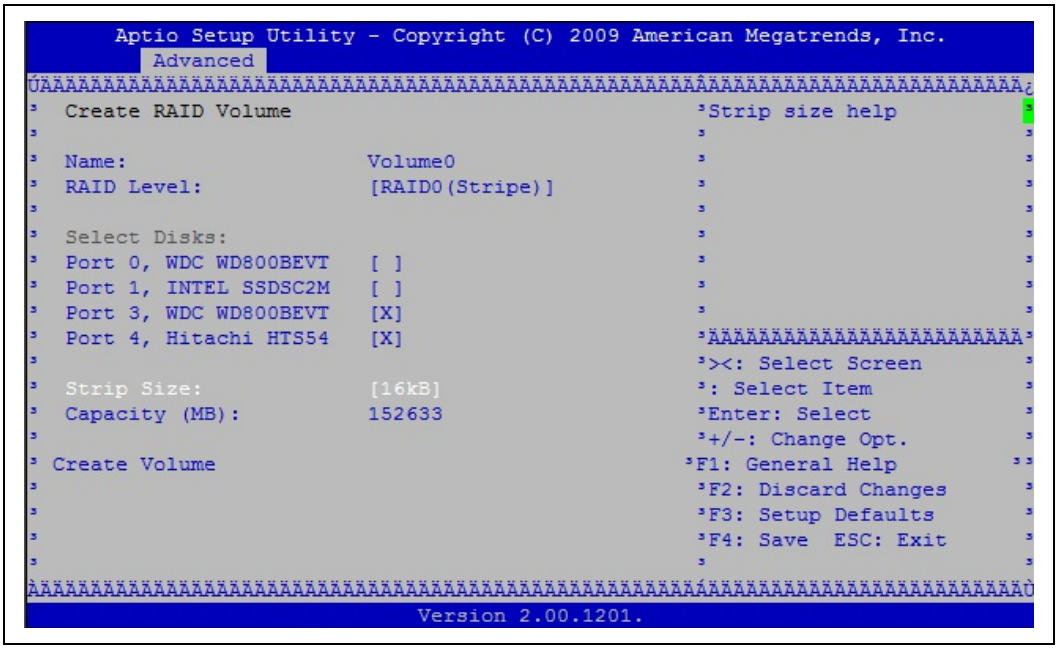
   b. Scroll down to 'RAID Level" and press <Enter> to select a RAID level.



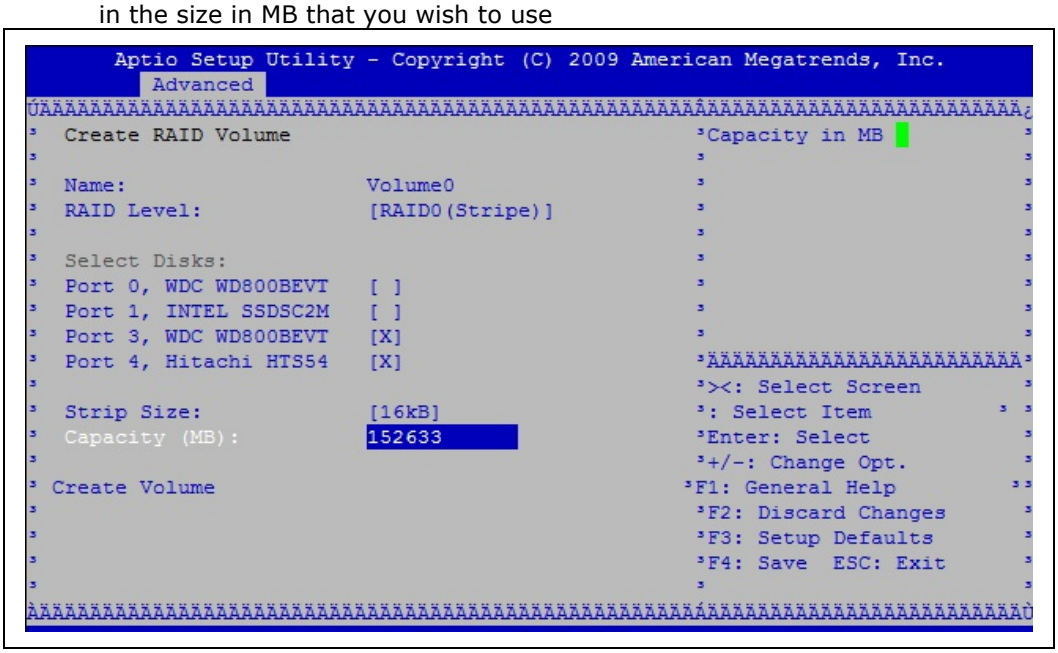
c. Scroll down to 'Select Disks' and at each disk that you wish to include in the RAID volume press <space bar>



d. Next scroll down to 'Strip Size' and press <enter> to select a Strip size or continue if you wish to use the default strip size



e. Next scroll down to 'Capacity (MB)' where the maximum capacity is selected and displayed in MB. To select a smaller capacity for the RAID volume, type in the size in MB that you wish to use

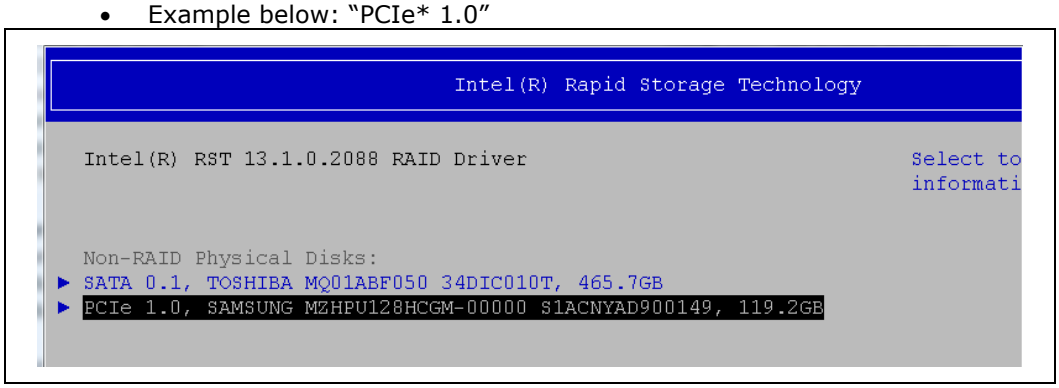


f. Next scroll down to 'Create Volume' and press <Enter>

3. After this is done, exit the Intel® RST UEFI UI.

Note: **The "Create Volume" action will only be enabled if the RAID volume options selected will result in a valid configuration.**

4. Changes in HII, Beginning with Intel® RST UEFI 13.0, for PCIe* Devices include new labeling for Devices and multiple controller management ability.
    - Device Ids numbering scheme = <Device Type><Controller ID>”.”<Device ID>
    - Example below: “PCIe* 1.0”



§§

7 Deleting a RAID Volume

RAID volumes can be deleted in three different ways. The method most widely used by end-users is the Windows* user interface utility. The second method is to use the Intel® Rapid Storage Technology Option ROM user interface. The third way, used by OEMs only, uses the RAID Configuration utility.

7.1 Using Intel® Optane™ Memory and Storage Management UI

Refer to Section 4.1 Deleting RAID Volume.

7.2 Using Intel® RST User Interface Utility

1. Run the Intel® Rapid Storage Technology UI from the following Start menu link:

   Start→All Programs→Intel® Rapid Storage Technology →Intel® Rapid Storage Technology UI

2. Under 'Status' or 'Manage' Click on the volume you want to delete. The user will be presented with the volume properties on the left.

3. Click on 'Delete volume'

4. Review the warning message and click 'Yes' to delete the volume.

5. The 'Status' page refreshes and displays the resulting available space in the storage system view. You can now use it to create a new volume.

7.3 Using Option ROM User Interface

1. Upon re-boot, you will see the Intel® Rapid Storage Technology option ROM status message on the screen – press CTRL-I to enter the option ROM user interface.

2. Within this UI, select option #2 'Delete RAID volume'.

3. You should be presented with another screen listing the existing RAID volume.

4. Select the RAID volume you wish to delete using the up and down arrow keys.

5. Press the Delete key to delete the RAID volume

6. Press Y to confirm.

Note: Option #3 'Reset Hard Drives to Non-RAID' in the option ROM user interface may also be used to delete a RAID volume. This resets one or more drives to non-RAID status, by deleting all metadata on the hard drives. This has the effect of deleting any RAID volumes present. This function is provided for re-setting the hard drives when there is

a mismatch in RAID volume information on the hard drives. The option #2 'Delete RAID Volume' on the contrary, will allow deleting a volume at a time, while retaining the existing RAID array metadata (for instance Matrix RAID).

7.4 Using Intel® RST UEFI User Interface

Note: This section is manufacturer dependent. Where/how the OEM chooses to implement the UEFI UI is based on manufacturer preference.

1. Upon re-boot, enter the system BIOS and select the Intel® Rapid Storage Technology menu for the UEFI user interface
2. In the Main Menu, go to the 'RAID Volumes' section, highlight the volume to be deleted and press <Enter>
    a. Select 'Delete', then press <Enter>.
    b. At the dialogue box press <Enter> to confirm the deletion of the volume

Note: **All data on the volume will be lost!)**

3. After this is done, exit the Intel® RST UEFI UI.

§§

8 Common RAID Setup Procedures

8.1 Build a SATA RAID 0, 1, 5 or 10 System

This is the most common setup. This configuration will have the operating system striped for RAID 0, or mirrored for RAID 1, or striped with parity for RAID 5, or mirrored and striped across two or up to four drives for RAID 10. All RAID member drives must be from the same BUS PROTOCOL GROUP. To prepare for this, you must have the Intel® RAID driver on a floppy drive (USB). Procedure for creating this floppy (USB) is provided in this document, in the later sections.

1. Assemble the system using a motherboard that supports Intel® Rapid Storage Technology and attach the drives depending on the RAID level that will be built.
2. Enter System BIOS Setup and ensure that RAID mode is enabled. This setting may be different for each motherboard manufacturer. Consult the manufacturer's user manual if necessary. When done, exit Setup.

8.1.1 Using Legacy OROM User Interface

1. Upon re-boot if your system is using a legacy OROM, you will see the Option ROM status message on the screen – press CTRL-I to enter the Intel® Rapid Storage Technology Option ROM user interface.

2. Within this UI, select option '1. Create RAID Volume'. When 'Create RAID Volume' menu is displayed, fill the following items:

    a. Name: Enter a volume name, and press Enter to proceed to next menu item,

    b. RAID Level: select RAID level (0, 1, 5, 10), and press Enter to proceed to next menu item;

    c. Disks: press Enter on 'Select Disks' to select the hard drives to be used for your configuration.

    d. Within the 'SELECT DISKS' window, choose the hard drives and press Enter to return to the 'MAIN MENU'.

    e. Strip Size: Applicable for RAID levels 0, 5, and 10 only. You may choose the default size or another supported size in the list and press Enter to proceed to the next item.

    f. Capacity: The default size would be the maximum allowable size summation of all the drives in your configuration. You may decrease this volume size to a lower value. If you specified a lower capacity size volume, the remaining space could be utilized for creating another RAID volume. Press Enter to proceed to the next item.

    g. Create Volume: Press Enter to create a volume.

h. Press 'Y' to confirm the creation of volume.

3. After this is done, exit the Intel® Rapid Storage Technology option ROM user interface by pressing the Esc key or Option #4.

4. Begin OS setup by booting from the Windows* OS installation CD.

5. Installation procedures as follows: Use the 'load driver' mechanism when prompted. Insert a USB key with the Intel® RST driver and browse to the directory on the USB key where the driver that you wish to install is located. Select the driver INF file. If correct the proper Intel® controller for your system will be shown. Continue the driver install.

6. Finish the Windows* installation and install all other necessary drivers.

7. Install the Intel® Rapid Storage Technology software package obtained from the Intel® VIP website. This will add the *Intel*® Rapid Storage Technology UI that can be used to manage the RAID configuration.

8.1.2 Using UEFI HII User Interface

1. Upon re-boot if your system is using the Intel® RST UEFI Driver and the HII protocol is in the system BIOS, you will see the Intel® Rapid Storage Technology option within the BIOS setup menu.

2. Select this menu. Choose the 'Create RAID Volume'. When 'Create RAID Volume' menu is displayed, fill the following items:

   a. Name: Enter a volume name, and press Enter to proceed to next menu item,

   b. RAID Level: select RAID level (0, 1, 5, 10), and press Enter to proceed to next menu item;

   c. Disks: press space bar to 'Select Disks' to select the devices to be used for your configuration.

   d. Within the 'SELECT DISKS' window, choose the devices and press Enter to return to the 'MAIN MENU'.

   e. Strip Size: Applicable for RAID levels 0, 5, and 10 only. You may choose the default size or another supported size in the list and press Enter to proceed to the next item.

   f. Capacity: The default size would be the maximum allowable size summation of all the drives in your configuration. You may decrease this volume size to a lower value. If you specified a lower capacity size volume, the remaining space could be utilized for creating another RAID volume. Press Enter to proceed to the next item.

   g. Create Volume: Press Enter to create a volume.

   h. Press 'Y' to confirm the creation of volume.

3. After this is done, exit the Intel® Rapid Storage Technology menu HII user interface by pressing to save changes and the Esc key.

4. Begin OS setup by rebooting from the Windows* OS installation CD.

5. Installation procedures as follows: Use the 'load driver' mechanism when prompted. Insert a USB key with the Intel® RST driver and browse to the directory on the USB key where the driver that you wish to install is located. Select the driver INF file. If correct the proper Intel® controller for your system will be shown. Continue the driver install.

6. Finish the Windows* installation and install all other necessary drivers.

7. Install the Intel® Rapid Storage Technology software package obtained from the Intel® VIP website. This will add the *Intel*® Rapid Storage Technology UI that can be used to manage the RAID configuration.

8.2 Building a "RAID Ready" System

The following steps outline how to build an Intel® "RAID Ready" system with OS installed on a single SATA hard drive. A "RAID Ready" system can be upgraded to RAID 0, RAID 1, RAID5 or RAID 10 at a later time using the RAID migration feature built into Intel® Rapid Storage Technology. Intel® RST enables you to install additional SATA hard drives, and then migrate to a RAID level volume without re-installing the operating system.

1. Assemble the system using a motherboard that supports Intel® Rapid Storage Technology with Intel® Rapid Storage Technology OROM integrated into the BIOS and attach one SATA hard drive.
2. Enter System BIOS Setup; ensure that RAID mode is enabled. This setting may be different for each motherboard manufacturer. Consult your manufacturer's user manual if necessary. When done, exit Setup.
3. Begin Windows* Setup by booting from the Windows* OS installation CD.
4. Installation procedures as follows: Use the 'load driver' mechanism when prompted. Insert a USB key with the Intel® RST driver and browse to the directory on the USB key where the driver that you wish to install is located. Select the driver INF file. If correct the proper Intel® controller for your system will be shown. Continue the driver install:
5. Finish the Windows* installation and install all other necessary drivers.
6. Install the Intel® Rapid Storage Technology software package obtained from the Intel® VIP website. This will add the *Intel*® Rapid Storage Technology UI that can be used to manage the RAID configuration.

8.3 Migrating RAID 0 or RAID 1 on Existing "RAID Ready" System

If you have an existing "RAID Ready" system then you can use the following steps to migrate from a single-drive non-RAID configuration to a two drive RAID 0 or RAID 1 configuration. To prepare for this, you will need to install another drive with a capacity equal to or greater than the capacity of the drive being used as the source hard drive and belong to the same BUS PROTOCOL GROUP as the source drive.

1. Note the port number of the source hard drive already in the system; you will use this to select hard drive for preserving data for the migration.

2. Install the second drive on the system.

3. Boot Windows, then install the Intel® Rapid Storage Technology software, if not already installed, using the setup package obtained from a CD-ROM or from the Internet. This will install the necessary Intel® Rapid Storage Technology UI and start menu links.

4. Open the Intel® Rapid Storage Technology UI from the Start Menu and select the volume type under Create from the Actions menu. Click on 'Next'

5. Under the configure options provide the volume name , select disks

6. When the disks are selected, the user will be presented the option to select the disk on which to preserve the data. Here the user need to select the right disk on the which the data needs to preserved and migrated

7. After the migration is complete, reboot the system. If you migrated to a RAID 0 volume, use Disk Management from within Windows* in order to partition and format the empty space created when the two hard drive capacities are combined. You may also use third-party software to extend any existing partitions within the RAID volume.

8.4 Migrating Existing Data Hard Drive to a RAID 0 or RAID 1 Volume

If you are booting from a parallel ATA (PATA*) drive that contains the operating system, you may use the Intel® Rapid Storage Technology to create a RAID 0 or RAID 1 volume on two SATA drives. Also, if you have a single SATA hard drive that contains program or personal data, you may use the migration feature to use this hard drive as the source hard drive for a migration. After the migration is completed, you will have a two hard drive RAID 0 volume where data is striped or a two hard drive RAID 1 volume where the data is mirrored across the two SATA hard drives. To do this, the PCH I/O RAID Controller must be enabled in the BIOS and you must have the Intel® Rapid Storage Technology software installed.

Begin with a system where you are booting from a PATA hard drive. Make sure the PCH I/O RAID controller is enabled and the Intel® Rapid Storage Technology is installed. Then do the following:

1. Note the serial number of the SATA hard drive that is already installed. You will use this to select it as the source hard drive when initiating the migration.

2. Physically attach the second SATA hard drive to the available SATA port.

3. Boot to Windows*, install the Rapid Storage Technology software, if not already installed, using the setup package obtained from a CD-ROM or from the Internet. This will install the necessary Intel® Rapid Storage Technology UI and start menu links.

4. Open the Intel® Rapid Storage Technology UI from the Start Menu.

5. Follow steps 4 to 7 in section Migrate to RAID 0 or RAID 1 on an Existing "RAID Ready" System

8.5 Migrating from One RAID Level to Another

RAID level migration allows an existing RAID configuration to be migrated to another RAID configuration. The following migrations are possible.

Note: Not all migrations are supported on all chipsets. The support varies depending on the chipset and the ports supported on the chipset (For supported migrations for each chipset Intel® Rapid Storage Technology product requirements document):

Change Type From	To
2-disk recovery volume	2-disk RAID 1
2-disk RAID 1	2-disk recovery volume
2-disk RAID 1	2-disk RAID 0 3, 4, 5 or 6-disk RAID 0 3, 4, 5 or 6-disk RAID 5
2-disk RAID 0	3, 4, 5 or 6-disk RAID 5
3-disk RAID 0	4, 5 or 6-disk RAID 5
4-disk RAID 0	5 or 6-disk RAID 5
4-disk RAID 10	4, 5 or 6-disk RAID 5

Note: In order for the migration options to be accessible, the minimum required SATA hard drives for the RAID level have to be met.

Follow the procedure illustrated below:

1. Start the Intel® Rapid Storage Technology UI application:

   Start Menu ->All Programs -> Intel® Rapid Storage Technology -> Intel® Rapid Storage Technology UI

2. Under 'Status' or 'Manage', in the storage system view, click the array or volume to which you want to modify. The volume properties now display on the left.

3. Click 'Change type'.

4. In the 'Change Volume Type' dialog, type a new name if you want to change the default name.

5. Select the new volume type, and then click 'OK'.

6. The 'Manage' page refreshes and reports the new volume type.

7. After the migration starts, you can view the migration progress under status.

8. When the Status field indicates volume as ‘Normal’, the migration is complete.

8.6 Creating RAID Volume on Intel® SATA Controller While Booting to Different Controller

This configuration is for users who would like to use a RAID 0 volume as a high-performance data hard drive or use the data redundancy properties of RAID 1. Starting with a configuration where the system is booting to a Windows*, with installation on a different disk controller, the user can add two SATA hard drives and create a RAID volume on them.

1. Physically install two SATA hard drives to the system.

2. Enter System BIOS Setup; ensure that RAID mode is enabled. This setting may be different for each motherboard manufacturer. Consult your manufacturer's user manual if necessary. When done, exit Setup.

3. Boot to Windows; install the Intel® Rapid Storage Technology software, if not already installed, use the setup package obtained from a CD-ROM or from the Internet. This will install the necessary Intel® Rapid Storage Technology UI and Start menu links.

4. Use the Intel® Rapid Storage Technology UI to create a RAID 0 volume on two SATA drives according to the procedure in section Using Intel® Rapid Storage Technology UI of this document.

5. After the RAID volume is created, you will need to use Windows* Disk Management or other third-party software to create a partition within the RAID volume and format the partition. At this point, you may begin to copy files to, or install software on, the RAID volume.

§§

9 RAID Volume Data Verification and Repair Feature

This feature is available starting with Intel® Matrix Storage Manager 6.1.

9.1 Verifying and Repairing Volume Feature

The RAID volume verification feature identifies any inconsistencies or bad data on a RAID 0, RAID 1, RAID 5, or RAID 10 volume and reports the number of inconsistencies or number of blocks with media errors found during RAID volume data verification.

When the verification process is complete, a dialog will appear that displays the number of verification errors, verification errors repaired and blocks with media errors that were found.

Follow the below steps to start RAID volume data verification:

1. Under 'Status' or 'Manage' click on the RAID volume you want to perform the verify operation under 'storage system view'. The volume properties now display on the left.
2. Click on 'Advanced' and then Click on 'Verify'
3. For RAID 0 the verification process starts once you click 'verify'. For RAID1, 5, 10, Recovery volumes, a dialog box with check box option to repair the errors found automatically during the verification process is present. If the user wants to perform repair, you can select this box and then click 'verify'.
4. The verification progress is shown under 'status'
5. When the verification process is complete and the volume status is set to normal, now you can click on the volume under 'status' or 'manage'. Under the volume properties to the left under 'Advanced' you can view the number of verification errors, verification errors repaired and blocks with media errors that were found.

9.2 Verifying and Repairing Scheduler

The Verify and Repair feature includes a scheduler for the Verify and Repair (V and R) operation. To enable the scheduler, perform the following procedure:

Pre-conditions: UI installed, at least 1 RAID volume on the system that is initialized, in normal state, and a valid RAID type (RRT, R0**, R1, R5, R10) *****RAID 0 volumes can only do a Verify; they cannot be repaired***

1. Login to Windows* and launch the Intel® RST UI and click on the 'Preferences' tab at the top of the UI

2. From the 'Preferences' page, select the 'Scheduler' button on the left navigation pane to display the
3. Check mark the 'Enable scheduler' checkbox
4. Select 'Recurrence' schedule: Once (default), Daily, Weekly, or Monthly
5. Select the 'Start Date'; day for the scheduler to begin/run the V and R operation
6. Select the 'Time' of the scheduled runs on a 24-hour clock
7. Select the 'Recur every' schedule: choices will vary depending upon what is selected for 'Recurrence' (this step is not applicable for Recurrence of once)
8. Select whether or not to Automatically Repair Errors encountered during the Verify operation
9. Click 'Apply Changes' to enable

§§

10 Un-Installation

Uninstalling the RAID driver could potentially cause an end-user to lose access to important data within a RAID volume. This is because the driver can only provide functionality for the Intel® SATA RAID controller. Therefore, Intel® does not provide a way to permanently remove the driver from the system. However, disabling the Intel® SATA RAID Controller causes the operating system to not use the RAID driver.

The uninstallation application that is included with the Intel® Rapid Storage Technology software can remove all components except the RAID driver (i.e. it removes the UI application, Start Menu links, Control Panel Applet, etc.).

Use the following procedures to remove the Intel® Rapid Storage Technology software or to disable the SATA RAID controller:

10.1 Un-Installing Intel® RST Software (Except RAID Driver)

1. Run the Uninstall program from the following start menu link:
2. Start→All Programs→Intel® Rapid Storage Technology →Uninstall
3. The first dialog box that appears gives you the option of un-installing all components of the Intel® Rapid Storage Technology software except the RAID driver. Click 'OK' to do so.
4. The next dialog box is a confirmation that you would like to un-install all components of the software except the RAID driver. Click 'Yes' to confirm.
5. All components of the software will be un-installed except the RAID driver. You should no longer see any Start menu links to the UI application or a control panel applet for Intel® Rapid Storage Technology. However, the RAID configuration should still function normally.

10.2 Un-Installing Intel® Optane™ Memory and Storage Management UI (Except RAID Driver)

1. Run the Uninstall program from the following start menu link:
2. Start→All Programs→ Intel® Optane™ Memory and Storage Management UI →Uninstall
3. The first dialog box that appears gives you the option of un-installing all components of the HSA software except the RAID driver. Click 'OK' to do so.
4. All components of the software will be un-installed except the RAID driver. You should no longer see any Start menu links to the UI application or a control panel applet for Intel® Optane™ Memory and Storage Management UI. However, the RAID configuration should still function normally.

10.3 Disabling RAID Driver by Disabling RAID Controller

Warning: **If you use this method and your computer's operating system is installed to a disk attached to the Intel® SATA RAID Controller, you will no longer be able to boot into that operating system!**

1. Enter System BIOS Setup and disable RAID Mode. This setting may be different for each motherboard manufacturer. Consult your manufacturer's user manual if necessary. When done, exit Setup.

2. Reboot the system (The OS must have been installed on a disk not attached to the Intel® SATA RAID controller). You should no longer see the RAID Option ROM status screen during boot, and you should no longer see the Intel® SATA RAID Controller in Device Manager.

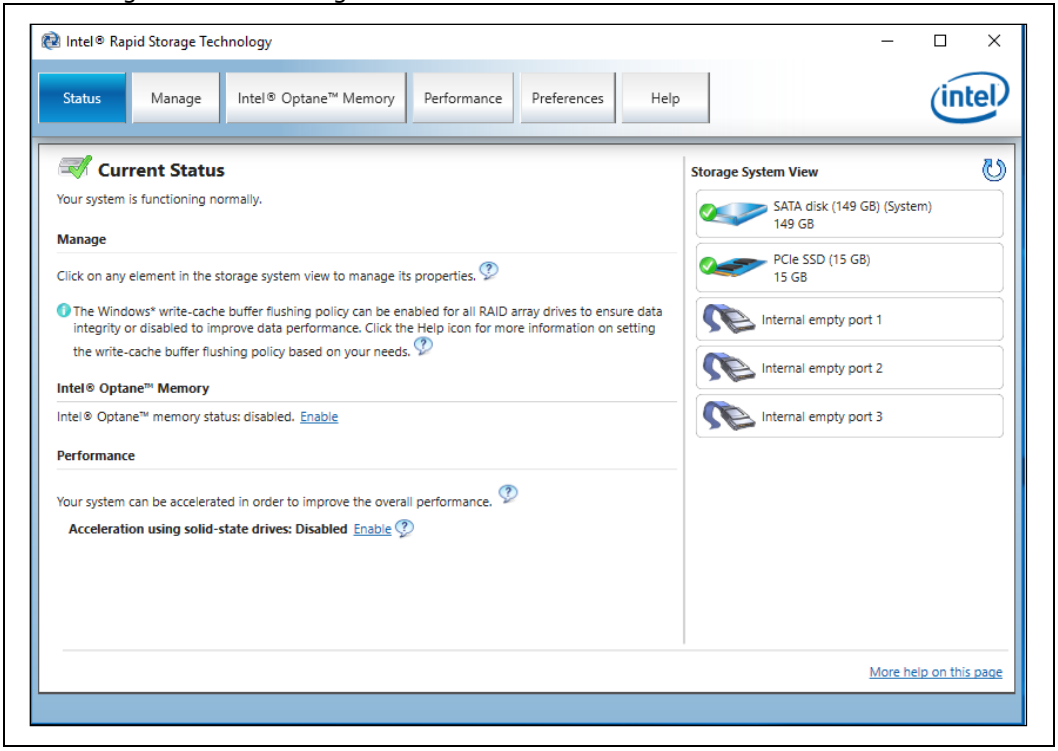
3. At this point, Windows* will no longer be using the RAID driver and you will not have Intel® RAID functionality. **All data contained in existing RAID volumes will no longer be accessible.** To re-enable Intel® RAID functionality, re-enter System BIOS Setup and re-enable RAID mode.

Note: **To Uninstall:** End-users can use this same procedure to disable the Intel® SATA RAID Controller if necessary. In fact, the uninstall program used in section 10 of this document will display a text file with a similar procedure. Run the Uninstall Program, click 'Cancel' when presented with the first dialog box, then click 'Yes' at the second dialog box to read the text document containing the procedure.

§§

11 Intel® Rapid Storage Technology UI

Note: The Intel® Rapid Storage Technology UI is not required to be installed when the storage subsystem is operating in AHCI mode. The main benefit of the Intel® RST UI is in its management and monitoring of the Intel® RST RAID storage subsystem and the management and configuration of cache accelerated volumes.



11.1 Introduction

The Intel® Rapid Storage Technology UI is a Windows*-based application that provides users monitoring and management capabilities for the Intel® RST storage subsystem. It offers a wide range of monitoring and management activities for the Intel® RST RAID subsystem (***In AHCI mode there are no management or monitoring capabilities offered by the UI application***).

11.1.1 Getting Started

The Intel® Rapid Storage Technology software package provides high-performance SATA AHCI and SATA RAID capabilities for supported operating systems.

The Intel® Rapid Storage Technology (Intel® RST) UI requires the Microsoft* .NET 4.5 framework beginning with Intel® RST 13.0 release. For prior releases, the Intel®

RST UI connects and interoperates with the Microsoft* .NET 3.0, 3.5, and 4.0 framework.

Refer to the System Requirements and the online user's manual to set up your system's configuration and feature support level. You can also review the Readme file installed with this software or visit Intel®'s online support to learn more about the full system requirements and RAID BIOS configuration.

RAID enabled systems

Redundant Array of Independent Disks (RAID) refers to multiple independent disks combined to form one logical drive. The main objective of this technology is to improve storage system performance, data protection, and increase fault-tolerance.

This technology provides support for the following features:

- **Intel® Rapid Recover Technology:**

  This technology provides full data redundancy by copying data from a designated source drive (i.e., master disk) to a designated destination drive (i.e., recovery disk). Data updates of recovery volumes can be continuous or on request.

- **Intel® Rapid Storage Technology RAID:**

  This technology provides the ability to create RAID 0, RAID 1, RAID 5, and RAID 10 volumes on desktop and mobile platforms. Data is distributed across two or more disks to provide data redundancy (exception of RAID0) or to enhance data storage performance.

- **Intel® Matrix RAID Technology:**

  This technology allows two independent RAID volumes to be created on a single array. The first volume occupies part of the array, leaving space for the second volume. The array may consist of two to six SATA disks depending on the volume types.

- **Hot plug:**

  Also referred to as hot swap, this feature allows SATA disks to be removed or inserted while the computer is turned on and the operating system is running. As an example, hot plugging may be used to replace a failed external disk.

- **Intel® Smart Response Technology caching:**

  This feature allows you to use a non-system solid state disk and configure it as a non-volatile intelligent cache device in order to accelerate a disk or volume that is part of the storage system. This configuration helps improve the overall system performance.

- **Volume migration:**

  This feature provides support for converting system data into a high-performance or protection RAID configuration.

- **Volume size increase:**

  This feature allows you to increase the data storage capacity of a volume by using 100% of the available array space or by adding one or more SATA disk to an existing volume.

- **Password-protected disks:**

  This feature provides high-level security and protection for the data on your disks with a password, denying access from any unauthorized user.

Additional features and technology supported by the driver although not directly accessible via the Intel® RST UI:

- **TRIM:**

  This feature provides support for all solid state disks (SSDs) in your storage system that meet the ATA-8 protocol requirements and are not part of an array. This feature optimizes write operations, helps devices reduce wear, and maintains unused storage area on devices as large as possible.

  Beginning with the Intel® 7 Series chipset the driver supports TRIM on SSDs in a RAID 0 configuration.

- **ODD power optimization:**

  This feature allows an unused optical disk drive (ODD) to be automatically powered off when media such as a compact disk, a DVD, or Blu-ray disk are not present in the drive and the tray[1] is closed. The ODD is powered back on by the operating system or user interaction with the device, including when the eject button is pressed. ODD power optimization is particularly valuable for mobile computers as battery life is negatively affected when the ODD is powered on and in an idle state. This feature is only supported on the following system configurations: Intel® 6 Series Chipset or later, compatible motherboards, and compatible ODDs. For more information about compatibility requirements, refer to the SATA specifications available at www.sata-io.org

  [1] For slot-loadable drives, the tray condition does not apply.

- **Native command queuing:**

  A feature that allows SATA disks to accept more than one command at a time. When used in conjunction with one or more disks that support NCQ, storage performance is increased on random workloads by allowing the disk to internally optimize the order of commands.

- **Hybrid Hinting:**

  This feature supports the use of Solid-State Hybrid Drives (SSHD). SSHD's are hard disks that contain Flash memory for use as a cache to store frequently accessed data. The driver provides hints to the SSHD to notify the drive which data would be best to store in the data cache.

- **Disks of more than two terabytes:**

  This feature provides support for hard disks and solid state disks with a capacity greater than 2 TB that are reported as pass-through devices (available) or used in a RAID configuration. In addition, booting from a system disk greater than 2 TB is allowed as long as the version of the option ROM in your system supports this feature.

Note: If a source disk is greater than 2TB and using the MBR partitioning scheme, the application will not allow data preservation in order to create a volume. Instead, a new volume will be created with no partition on it. Also, if the operating system is Windows* XP, capacity expansion operations will not be allowed for volume sizes equal or greater than 2TB.

- **AHCI-enabled systems:**

  Advanced Host Controller Interface (AHCI) is an interface specification that automatically allows the storage driver to enable advanced SATA features, such as Native Command Queuing and Native Hot Plug, on the SATA disks connected to your computer. The following features are supported on AHCI-enabled systems:

- **Native command queuing**
- **Hot plug**
- **Disks of more than two terabytes (if that size is supported by the Intel® RST UEFI pre-OS driver or legacy OptionROM)**
- **Password-protected disks**
- **ODD power optimization (Microsoft* Windows* Vista and higher)**
- **Dynamic Storage Acceleration**
- **Hybrid Hinting**

11.1.2 Understanding the Application

The Intel® Rapid Storage Technology application allows you to optimize and maintain a healthy storage system by creating volumes, customizing performance settings and managing storage system elements. This section provides you with a general overview of a storage system configuration and an individual review of all the areas contained in this application.

11.1.2.1 Storage System Configuration

The storage system combines hardware capabilities with RAID technology to provide flexible data storage units on your computer. Each data storage unit, or RAID configuration, consists of three elements that include physical SATA disks, one or two volumes, and one array. When at least one volume is present on the system, these elements are represented in the storage system view of the Status and Manage areas.

In this section, we describe each of these RAID configuration elements and explain how they relate to each other.

- **Array**

  An array is a collection of two or more SATA disks in a RAID configuration and is the highest element in the hierarchy of a storage system. Once a volume is created, the disks you used to create that volume form an array. Refer to the Creating Additional Volumes topic for details on how you can create two volumes across the same disks. An array can include one or two RAID volumes if the hardware allows it.

- **Volume**

  A volume is the storage area on two or more disks whose type dictates the configuration of the data stored. If you created a volume for data protection, then your storage system may include a RAID 1 volume spanning two SATA disks, which mirrors data on each disk.

- **Disks**

  A disk (i.e., hard disk or hard disk drive) physically stores data and allows read/write data access. If a disk is used to create a volume, it becomes an array disk because it has been grouped with other disks to form an array.

The storage system can also include ATAPI devices, which cannot be used to create a volume. They are a mass storage device with a parallel interface, such as CD-ROM, DVD/Blu-ray disc, or tape drive.

11.1.2.2 Navigation

The application is organized into five main areas depicted by the top navigation buttons: Status, Create, Manage, Accelerate, and Preferences. Depending on your computer's configuration and available hardware, Create and Accelerate may not be available.

Status

The 'Status' area provides a general state of health of your storage system. If a status other than normal is reported, the Manage sub-section will be available to provide you with basic information and actions links necessary to return the status to normal.

Create

The 'Create' area allows you to create different types of volumes to protect data, enhance disk performance, optimize disk capacity, or create a custom volume to combine benefits.

Note

The ‘Create’ area is only available if your computer supports RAID technology, and if the volume requirements are met. Refer to the Volume Requirements topic for an exhaustive list of storage system conditions to create a volume.

Manage

The 'Manage' area combines the logical and physical view of your storage system. The area displays detailed information about each element that is part of the storage system, such as volumes and disks; the storage system view shows how the selected element relates to others. Each element has its own 'Manage' area which is accessible by clicking any element displayed in the storage system view under 'Status' or 'Manage'.

The 'Manage' area also provides the actions available for the selected element, such as renaming a volume or changing the volume type.

Accelerate

The ‘Accelerate’ area allows you to manage the cache memory configuration using a non-system solid state disk as a cache device. If the cache is reported in an abnormal state, detailed information and troubleshooting actions will display. The Acceleration View is specific to the ‘Accelerate’ area and only displays in this location.

Preferences

The 'Preferences' area allows you to customize system settings by enabling the display of the notification area icon, and by selecting the type of notifications that you want the application to display.

Storage System View

The storage system view has two functions:

- It is a simplified representation of your storage system and displays graphic elements, such as arrays, volumes, devices, and ports. Each element provides general attribute information, such as status, name and size. Hovering over each element provides additional attribute details.
- You can also use the graphical view to access 'Manage' by clicking the storage system element you want to work with. For example, if an array is present, clicking the volume opens Manage Volume and clicking one of the array disks will open Manage Disk for the selected disk.

Acceleration View

The Acceleration View is a graphical representation of the acceleration configuration, and only displays the devices (disks and volumes) included in this particular configuration. You can use this view to access the 'Manage' page specific to each represented device by clicking the storage system element for which you want more detailed information.

11.1.3 Notification Area

The notification area (also called the system tray) is located on your desktop. The taskbar contains the notification area icon for Intel® Rapid Storage Technology. The icon provides storage system status and notifications such as volume and disk events based on a change of state.

The notification area icon will automatically display in the notification area once Intel® Rapid Storage Technology is installed. Both administrators and standard users can change the notification area settings using the application or directly from the notification area. Settings changes are applied on a per user basis, and do not affect other users' settings.

Opening the application from the notification area:

1. Right-click the icon.
2. Click 'Open Application'.

The notification area icon can be in the following states:

Icon	Description
	The storage system is reported in a **normal** state and your data is protected from a disk failure.
	The storage system is reported in a **warning** state and data may be at risk. We recommend that you open the application to review and resolve the reported issues.
	The storage system is reported in an **error** state and data may be lost. We recommend that you open the application to review and resolve the reported issues as soon as possible.
	The storage system is reported in a **busy** state while an operation is in progress. Once the operation is complete, all actions will be available again, allowing you to manage the storage system as long as it is reported in a normal state. You can follow the progress of the operation by hovering over the icon.
	This icon is displayed while you are attempting to open the application, but the Intel® Rapid Storage Technology service has not started running yet. The service is expected to start automatically with a delay when you launch Windows. This icon appears if you attempt to launch the application before the delay period ends. If the application fails to open, try starting the service manually using Microsoft* Windows* Services.

Selecting system notifications:

1. Right-click the icon.
2. Select the types of notifications you want to receive. The notification area menu allows you to select or deselect one option at a time. Repeat this procedure until you are finished with your selection. The same operation can also be completed using the application, from the 'Preferences' area.

Note: To hide the notification area icon, deselect 'Show the notification area icon' under 'System Preferences'.

Reviewing notifications:

1. Hover over the icon at any time to view the storage system status or the progression of an operation.
2. Small pop-up Windows* will display for a short time to notify you of specific events, such as a missing disk or the completion of an operation.
3. Open the application to view more details about storage system events in the 'Status' or 'Manage' areas.

11.2 Storage System Status

Anytime Intel® Rapid Storage Technology is launched, the application opens to the 'Status' area. This is where the general state of health of your storage system is reported, both in the storage system view and in details. Depending on the status, volume creation and management options may be available in order to enhance or repair your storage system.

11.2.1 Understanding the Status

To get the full benefits of what Intel® Rapid Storage Technology has to offer, it is critical to maintain a healthy storage system. The application helps you track and

reports any disk or volume related problems that could put the safekeeping of your data at risk.

The storage system can be in the following states:

Normal
Reports that the system is functioning as expected, SATA disks are present and connected to the computer. If an array is present, volume data is fully accessible.

The Create subsection is only available if the storage system meets the minimum requirements to create a volume. Depending on the available hardware, you may be given the option to create a volume to protect data, optimize the disk performance, or create a custom volume.

The Manage subsection is only available if the storage system reports atypical conditions in a normal state. Typically, details or a recommended action are provided to help you rectify any storage system conditions. For example, if a recovery volume was reported as read-only, we would inform you that disk files must be hidden prior to requesting updates.

The Accelerate subsection is only available if a solid state disk can be used as a cache device and an eligible disk or volume can be accelerated. This area typically provides the option to enable acceleration and reports the cache and accelerated device health state, as well as the current acceleration mode.

Warning
Reports that storage system data may be at risk due to a problem detected on one or more SATA disks.

The Manage subsection displays any SATA disk or volume states reported by the storage system that may require your attention in order to keep data fully protected and accessible. Details or a recommended action are provided to help you fix any storage system problems. For example, if the master disk in a recovery volume is reported as failed, we would recommend that you rebuild the volume to another disk.

Note
In this state, we recommend that you backup any accessible data before taking action

In this state, the Accelerate subsection typically reports that the cache volume is failing possibly because the solid state disk is reported at risk of failing (smart event). Details and a recommended action are provided to help you fix the problem reported on the solid state disk.

Error
Reports that storage system data may be lost due to a problem detected on one or more SATA disks.

The Manage subsection displays any SATA disk or volume states reported by the storage system that require your immediate attention in order to keep data fully protected and accessible. Details or a recommended action are provided to help you fix any storage system problems. For example, if the data on a RAID 1 volume appears inaccessible due to a failed array disk, we would recommend that you rebuild the volume to another disk.

Note
In this state, we recommend that you backup any accessible data before taking action

In this state, the Accelerate subsection typically reports that the cache volume has failed possibly because the solid state disk has also failed and there is data loss. Details and a recommended action are provided to help you fix the problem reported on the solid state disk.

11.2.2 Storage System View

The storage system view provides a visual representation of your storage system and displays arrays, volumes, devices, and ports. Volumes and SATA disks graphics reflect

their current states, which allows you to quickly identify the element that is causing the storage system to be in a state other than normal.

Note: Hovering over a designated element in the storage system view provides a snapshot of its properties. Clicking allows you to access and manage its properties.

Overview of SATA disks states:

State	Description	Recommendation
	An internal hard disk is reported normal.	None
	An external hard disk is reported normal.	None
	An internal solid state disk is reported as normal.	None
	An external solid state disk is reported as normal.	None
	An internal solid-state hybrid disk reported as normal.	None
	An internal disk is reported missing.	Ensure that the disk is securely connected to the SATA port and that the SATA cable is functioning properly. Refer to the Troubleshooting section for more information.
	An internal disk is reported at risk or Incompatible.	Back up your data and replace the disks as soon as possible. Refer to the Troubleshooting section for more information.
	An external hard disk is reported at risk or incompatible.	Back up your data and refer to the Troubleshooting section for more information.
	An internal solid state disk is reported as being at risk or incompatible.	Back up your data and refer to the Troubleshooting section for more information.
	An external solid state disk is reported at risk or incompatible.	Back up your data and refer to the Troubleshooting section for more information.
	An internal disk is reported offline.	Unlock all array disks to unlock the volume. Refer to the Troubleshooting section for more information.
	An internal recovery disk is reported offline.	• The recovery volume is in on request update mode. Change the volume update mode to continuous, if desired. Or, • Your computer is running on battery and data updates to the recovery disk are not available. Reconnect your computer to the power supply.
	An external disk is reported offline.	Unlock all array disks to unlock the volume. Refer to the Troubleshooting section for more information.
	An external recovery disk is reported offline.	• The recovery volume is in on request update mode. Change the volume update mode to continuous, if desired. Or, • Your computer is running on battery and data updates to the recovery disk are

State	Description	Recommendation
		not available. Reconnect your computer to the power supply.
	An internal disk is reported normal and locked.	Unlock the disk to access more options.
	An external disk is reported normal and locked.	Unlock the disk to access more options.
	An internal hard disk is reported failed.	Refer to the Troubleshooting section for more information.
	An external hard disk is reported failed.	Refer to the Troubleshooting section for more information.
	An internal solid state disk is reported as failed.	Refer to the Troubleshooting section for more information.
	An external solid state disk is reported as failed.	Refer to the Troubleshooting section for more information.

Volume states:

Volume Type	Normal	Degraded	Failed
		Refer to Troubleshooting Degraded Volumes and Caching Issues for more information.	Refer to Troubleshooting Failed Volumes and Caching Issues for more information.
RAID 0		Not applicable	
Single-disk (cache)			
Single-disk (data)		Not applicable	
RAID 1/Recovery			
RAID 5			
RAID 10			

Other storage system elements:

Element	Description	Recommendation
	A port that has no devices connected to it.	None
	An ATAPI device is present, such as CD-ROM, DVD/Blu-ray disc, or tape drive.	None

11.3 Creating a Volume

You can combine SATA disks to create a volume in order to enhance your storage system. Based on the available hardware and your computer's configuration, you may be able to create a volume by selecting an enhancement goal, such as 'Protect data' under 'Status', or by selecting a volume type under 'Create'. We recommend you get familiar with the minimum requirements in this section before starting the volume creation process.

Warning
Performing this action will permanently delete any existing data on the disks used to create a volume, unless you choose to keep the data when selecting array disks. Backup all valuable data before starting this process.

11.3.1 Volume Requirements

Creating a volume is only available as an option if the following requirements are met:

- You are logged on as an administrator.
- The computer is RAID ready (refer to the user's manual available on Intel®'s online support web site, for assistance on setting up a RAID ready system).
- Two or more SATA disks, including the operating system disk are connected, in a normal state, and unlocked (only applies to password-protected disks).
- Each of the SATA disks that are to be part of the RAID volume may not have any SMART events.

Enabling more disks:

When configuring a volume, the application will only list the SATA disks that meet the requirements listed below. For example, a locked disk connected to your computer will not be listed as an option until it is unlocked.

Based on the first disk selected, some disks may become grayed out if one or more requirements are not met. Selecting a different disk generally helps re-enable disks that were previously grayed out.

- If the first selection is a system disk, any additional SATA disks selected must be of equal or greater size to ensure that all the system files are migrated to the new volume.
- If the first selection is a non-system disk, and a system disk is then selected, the latter must be of equal or smaller size to ensure that all the system files are migrated to the new volume.
- A system volume cannot be greater than 2 TB. If your first selection is a system disk, the total size of the other disks shall not allow the volume size to exceed 2 TB. Exception: If you are creating a volume using disks that have no existing data, and your operating system is a 64-bit Edition, the application will allow a volume to be greater than 2TB.
- The SATA disks used to create a volume must have the same type of connection, internal or external. An internal disk shall not be paired with an external disk to create a volume. Some systems will support mixed connection types.

Enabling more volume types:

Depending on the input/output (I/O) controller hub that your computer is using, and the hardware connected to the system, some volume types may not be enabled in the selection list. Refer to the Readme file located in the Program Files directory for this application or to the Device Manager to determine which controller is installed on your computer. Review the controller support table below to determine which volume types you can create.

Note: Intel® 5 Series Chipset applies to both desktop and mobile platforms as well as all later chipsets.

Volume Type	Number of Disks	Controller Support
Recovery volume	2	ICH9R, ICH9DH, ICH9DO, ICH9M, ICH9M-E, ICH10R, ICH10D, ICH10DO, 5 Series/3400 Series. **NOTE:** No other volumes can be present on the system. The master disk must include 100% of the available disk space and must be less than 1.3125 TB.
RAID 0	2	ICH7R, ICH7DH, ICH7MDH, ICH7M, ICH9R, ICH9DH, ICH9DO, ICH9M, ICH9M-E, ICH10R, ICH10D, ICH10DO, 5 Series/3400 Series.
RAID 0	3 or 4	ICH7R, ICH7DH, ICH9R, ICH9DH, ICH9DO, ICH10R, ICH10D, ICH10DO, 5 Series/3400 Series
RAID 0	5 or 6	ICH9R, ICH9DH, ICH9DO, ICH10R, ICH10D, ICH10DO, 5 Series/3400 Series.
RAID 1	2	ICH7R, ICH7DH, ICH7MDH, ICH7M, ICH9R, ICH9DH, ICH9DO, ICH9M, ICH9M-E, ICH10R, ICH10D, ICH10DO, 5 Series/3400 Series.
RAID 5	3 or 4	ICH7R, ICH7DH, ICH9R, ICH9DH, ICH9DO, ICH10R, ICH10D, ICH10DO, 5 Series/3400 Series.
RAID 5	5 or 6	ICH9R, ICH9DH, ICH9DO, ICH10R, ICH10D, ICH10DO, 5 Series/3400 Series.
RAID 10	4	ICH7R, ICH7DH, ICH9R, ICH9DH, ICH9DO, ICH10R, ICH10D, ICH10DO, 5 Series/3400 Series.

11.3.2 Creation Process

Now that you have reviewed the volume requirements, this section will guide you through the three easy steps necessary to create a volume.

11.3.2.1 Selecting a Volume Type

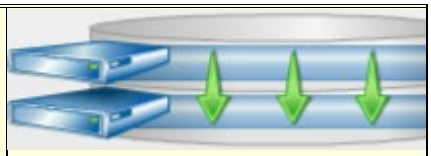
Before you can create a volume, you need to decide how you want to enhance your storage system based on your needs. Depending on the available hardware, you may have the option to combine volume types by creating more than one volume on a single array. Refer to 'Creating Additional Volumes' for more information on this type of configuration. Below is an overview of the five volume types that you can create.

Creating a two-disk volume from 'Status':

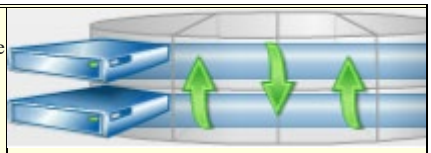
This option displays if only two disks are available, one has data such as system files, the second one does not, and the latter has a size that is equal or greater than the other. Based on this simple configuration, you can create a volume to protect data or optimize disk performance by clicking one of the two options listed in the Create subsection. When choosing this option, the application automatically configures the volume using the only two disks available and assigns default settings. Refer to the applicable procedure described in Completing the Process for details.

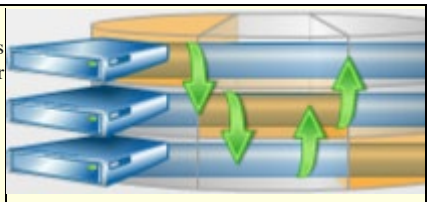
Creating a Custom Volume:

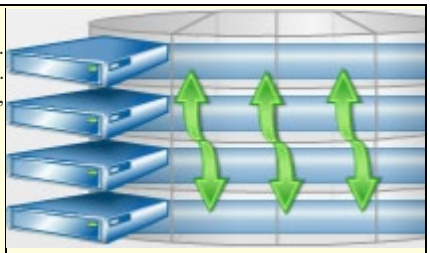
1. Click 'Create' or 'Create a custom volume' under 'Status'.
2. Select the volume type. Selecting a volume type in the list updates the graphical representation to provide a detailed description of that type.
3. Click 'Next'.

Recovery volume: **Flexible data protection** Combines two SATA disks and utilizes RAID 1 functionality to copy data from a designated master disk to a designated recovery disk. Data updates on the volume can be continuous or on request. In 'on request' mode, you can request data updates that copy changes from the master disk to the recovery disk since the last update. No other volumes can be present on the system. The master disk must include 100% of the available disk space and must be less than 1.3125 TB.	
Disks required	2
Advantage	Full data redundancy; more control over how data is copied between master and recovery disks; fast volume updates in on request mode; master and recovery disk files can be viewed in Windows* Explorer*.
Disadvantage	Storage capacity is only as large as the smallest disk.
Application	Critical data protection for mobile systems; fast restoration of the master disk to a previous or default state. Available in specific mobile configurations.

RAID 1: **Real-time data protection** Combines two SATA disks where each stores an exact copy of the data to appear as a mirror of each other.	
Disks required	2
Advantage	Full data redundancy and excellent fault-tolerance; increased read transfer rate.
Disadvantage	Storage capacity is only as large as the smallest disk; slight decrease in write transfer rate.
Application	Typically used in workstations and servers to store critical data. Available in specific mobile configurations.

RAID 0: **Optimized disk performance** Combines two to six SATA disks and breaks down data into units that are spread across the array disks.	
Disks required	2 to 6
Advantage	Increased data access and storage performance; no loss in data capacity
Disadvantage	No data redundancy (if one disk fails, all data on the volume is lost).
Application	Typically used in desktops and workstations to store high performance, temporary data and software. Various RAID 0 volume configurations available in specific mobile configurations.

RAID 5: **Efficient data hosting and protection** Combines three to six SATA disks where data and parity are striped across the array disks in a rotating sequence. Parity is a mathematical method for recreating lost data to a single disk.	
Disks required	3 to 6
Advantage	Data redundancy; improved storage performance and capacity; high fault-tolerance and read performance.
Disadvantage	Time-consuming to rebuild and decreased performance during the process.
Application	Good choice for large amounts of critical data, such as file and application servers; Internet and Intranet servers. Available in mobile configurations that include the Intel® 5 Series Chipset which supports up to six SATA ports.

RAID 10 : **Balanced performance and data protection** Combines four SATA disks to create a combination of RAID types 1+0. The data is striped across a two-disk array forming a RAID 0 component. Each disk in the RAID 0 array is mirrored by a disk in the RAID 1 array, storing an exact copy of all the data.	
Disks required	4
Advantage	Combines the read performance of RAID 0 with the fault-tolerance of RAID 1, resulting in increased data access and full data redundancy, and increased storage capacity.
Disadvantage	4 disks are required, resulting in increased cost.
Application	High performance applications and high load database servers requiring data protection, such as video editing. Available in mobile configurations that include the Intel® 5 Series Chipset which supports up to six SATA ports.

11.3.2.2 Configuring the Volume

Once the volume type is selected, you are ready to configure your volume.

Recovery Volume:

1. Type a new volume name if you want to change the default name.
2. Select the master disk.
3. Select the recovery disk.
4. Select a different update mode, if desired.
5. Click 'Next'. This button will not be active until all the required selections have been made.

Advanced configuration settings:

- Enable or disable the volume write-back cache.
- Select the check box to initialize the volume. You can choose to perform this action at a later time.

RAID Volume:

6. Type a new volume name if you want to change the default name.
7. Select the required number of disks.
8. Select the disk from which you want to keep data, if desired. You can only keep data from one disk. If you want to keep data from more than one disk, you must back up all valuable data prior to creating a volume.
9. Click 'Next'. This button will not be active until all the required selections have been made.

Advanced configuration settings:

- Select the array allocation by using the slider.
- Select a data strip size.
- Enable or disable the volume write-back cache.
- Select the check box to initialize the volume. You can choose to perform this action at a later time.

Note: Currently, the application does not allow the creation of greater than 2TB volumes where the source disk is greater than 2TB and data on that disk is preserved (e.g. system volume). Target disks can be greater than 2TB but such volumes cannot. This limitation results from the lack of GPT partition scheme support. Note that volumes greater than 2TB that include member disks greater than 2TB are supported as long as array disks are unpartitioned or that no data is preserved at volume creation.

11.3.2.3 Completing the Process

If you are creating a custom volume and have configured the volume with the disk selection and other settings, you are ready to review the projected configuration and complete the volume creation process.

If you are creating a two-disk volume for data protection or disk optimization from 'Status', you can follow the procedure provided below.

Creating a two-disk volume from 'Status':

1. Under 'Status', in the Create sub-section, select the type of volume you want to create.
2. In the 'Confirm Volume Creation' dialog, review the volume configuration. Note that the volume name is the only setting that can be changed.
3. Click 'Create Volume' to confirm. The process starts immediately.
4. Once completed, a dialog displays to notify you that the volume was successfully created. Click 'OK' to close the dialog.
5. The page refreshes and displays the new volume in the storage system view as well as the data migration progress.

Creating a custom volume:

Warning
You can only keep existing data from one of the disks you select to create a volume. We recommend that you backup all valuable data before proceeding.

If you perform a driver upgrade or downgrade while the data migration is in progress and then restart your computer, the driver will not be able to recognize the volume or the data on it. If you are migrating a system volume, you will not be able to restart your system because the operating system cannot load. If you are migrating a data volume, you will have to reverse (roll back) that last performed driver update, and then restart the computer to return to a normal state.

1. Under 'Confirm', review the selected configuration.
2. Click 'Create Volume' if you want to create the volume using the selected configuration. Otherwise, click 'Back' and make any necessary changes. The process starts immediately.
3. Click 'OK' to confirm.
4. Once completed, a dialog displays to notify you that the volume was successfully created. Click 'OK' to close the dialog.
5. The 'Status' area displays the new volume in the storage system view as well as the data migration progress.

If the size of the new volume is larger than the size of the source drive, the following steps apply:

6. Once the migration status reports 100% complete, restart your computer for the operating system to recognize the new volume size.
7. Create a new partition or extend the existing partition to utilize the new volume space using Windows* Disk Management. If your system is running Microsoft* XP, you may only have the option to create a new partition.

Note: To open Windows* Disk Manager, click Start, right click My Computer, select Manage, then in the console tree select Disk Management.

11.3.3 Creating Additional Volumes

Creating multiple volumes on a single array:

You can add a volume to an existing RAID array by creating another volume that uses the available space on the array. This feature allows you to combine different volume types and their respective benefits. For example, a configuration with RAID 0 and RAID 1 on two SATA disks provides better data protection than a single RAID 0 and higher performance than a single RAID 1.

The first RAID volume occupies part of the array, leaving space for the other volume to be created. After creating the first volume with an array allocation set to less than 100% in the Configure Volume step, you will be able to add a second volume to that array.

Note: The configuration is only available if the array allocation for the first volume created is less than 100%, and space is available on that array. The application currently supports an array to include a maximum of two RAID volumes.

1. Click ‘Create’ or 'Create a custom volume' under 'Status'.
2. Select the volume type. Selecting a volume type in the list updates the graphical representation to provide a detailed description of that type.
3. Click ‘Next’.
4. Select 'Yes' to add the volume to an existing array.
5. Make any necessary changes in the Advanced section.
6. Click ‘Next’.
7. Review the selected configuration. Click 'Back' or an option in the left pane if you want to make changes.
8. Click 'Finish' to start the creation process.

Supported RAID volume combinations on a single array:

Combine	With
2-disk RAID 0	2-disk RAID 0
	2-disk RAID 1
2-disk RAID 1	2-disk RAID 0
	2-disk RAID 1
3-disk RAID 0	3-disk RAID 0
	3-disk RAID 5
3-disk RAID 5	3-disk RAID 0
	3-disk RAID 5
4-disk RAID 0	4-disk RAID 0
	4-disk RAID 5
	4-disk RAID 10
4-disk RAID 5	4-disk RAID 0
	4-disk RAID 5
	4-disk RAID 10
4-disk RAID 10	4-disk RAID 0
	4-disk RAID 5
	4-disk RAID 10
5-disk RAID 0	5-disk RAID 0
	5-disk RAID 5
6-disk RAID 0	6-disk RAID 0
	6-disk RAID 5

Visit our Online Support for additional information on RAID type combinations for each I/O controller hub.

Creating additional volumes on a new array:

You can choose to create two or more volumes on two different arrays, as long as the volume requirements are met.

1. Click ‘Create’ or 'Create a custom volume' under 'Status'.
2. Select the volume type. Selecting a volume type in the list updates the graphical representation to provide a detailed description of that type.
3. Click ‘Next’.
4. Select 'No' in order to add a volume to a new array.
5. Select the required number of disks.
6. Select the disk from which you want to keep data, if desired. You can only keep data from one disk. If you want to keep data from more than one disk, you must back up all valuable data prior to creating a volume.
7. Make any necessary changes in the Advanced section.
8. Review the selected configuration. Click 'Back' or an option in the left pane if you want to make changes.
9. Click ‘Next’.
10. Click 'Finish' to start the creation process.

Note: Systems with an Intel® RST OROM older than 9.5, will not recognize 2 volumes on a single array if the Intel® RST Windows* Driver version is 9.5 and newer.

11.4 Managing the Storage System

The 'Manage' area combines the logical and physical view of your storage system. The area displays detailed information about each element that is part of the storage system, such as volumes and disks; the storage system view shows how the selected element relates to others. Each element has its own 'Manage' area which is accessible by clicking any element displayed in the storage system view under 'Status' or 'Manage'.

The 'Manage' area also provides the actions available for the selected element, such as renaming a volume or changing the volume type.

11.4.1 Managing Arrays

You must be logged on as an administrator to perform the actions listed in this section.

You can manage arrays by clicking a selected array in the storage system view under 'Status' or 'Manage'. This allows you to review the properties and access all actions associated with that array, such as adding a disk or increasing a volume size.

11.4.1.1 Array Properties

An array is a logical grouping of physical SATA disks. The array properties listed below display to the left of the storage system view under Manage Array and report values specific to the element selected in the view.

Parameter	Value
Name	Reports the name of the array. The array name is automatically assigned and cannot be changed.
Size	Reports the total capacity of the array in megabytes (MB).
Available space	Reports the unallocated space on the array that can be used.
Disk data cache	Reports whether the data cache is enabled for all array disks.

11.4.1.2 Adding Disk to Array

You can add one or more SATA disks to an existing array to increase the system storage capacity. This feature can be useful if you want to change to a volume type that requires additional disks.

This option is only available if:

- A RAID 0 and/or a RAID 5 volume is present,
- One or more SATA disks are connected to the computer and available,
- The available disk matches the internal or external connection type of the existing array disks. You cannot add an external disk to an array that includes internal disks, and vice versa.

Refer to Connecting a Disk under Managing Disks for more information on installing SATA disks on your computer.

Warning:
Any existing data on the available disk used to increase the array size will be permanently deleted. Backup all the data you want to preserve prior to executing this action.

If you perform a driver upgrade or downgrade while the data migration is in progress and then restart your computer, the driver will not be able to recognize the volume or the data on it. If you are migrating a system volume, you will not be able to restart your system because the operating system cannot load. If you are migrating a data volume, you will have to reverse (roll back) that last performed driver update, and then restart the computer to return to a normal state.

This action can also be performed from Manage Volume. Refer to the Adding a Disk to a Volume section for more information.

1. Under 'Status' or 'Manage', in the storage system view, click the array to which you want to add a disk. The element properties are now displayed on the left.
2. Click 'Add disk'.
3. Select the disk you want to use to increase the array capacity.
4. Click 'Add Disk'. Caution: Once the data migration starts, the operation cannot be canceled.
5. Once the migration has completed, restart your computer for changes to take effect. Then use Windows* Disk Management to increase the partition size on the volumes for which a disk was added or add another partition.

Note: To open Windows* Disk Manager, click Start, right click My Computer, select Manage, then in the console tree select Disk Management

11.4.1.3 Adding a Volume

You can add a volume to an existing RAID array by combining different volume types and their respective benefits. For example, a configuration with RAID 0 and RAID 1 on two SATA disks provides better data protection than a single RAID 0 and higher performance than a single RAID 1.

The first RAID volume occupies part of the array, leaving space for the other volume to be created. After creating the first volume with an array allocation set to less than 100% in the Configure Volume step, you will be able to add a second volume to that array.

Note: This configuration is only available if the array allocation for the first volume is less than 100%, and space is available on that array. The application currently supports an array to include a maximum of two RAID volumes on a single array.

You can also complete this action using the 'Create' area.

1. Under 'Status' or 'Manage', in the storage system view, click the array to which you want to add a volume. The array properties are now displayed on the left.
2. Click 'Create additional volume'.
3. In the 'Create Additional Volume' dialog, type a new name if you want to change the default name.
4. Select the volume type, and then click 'OK'. Only the volume types available for the current configuration will display. Refer to the table below for more information.
5. The page refreshes and the array now displays the additional volume.

Supported RAID volume combinations on a single array:

Combine	With
2-disk RAID 0	2-disk RAID 0
	2-disk RAID 1
2-disk RAID 1	2-disk RAID 0
	2-disk RAID 1
3-disk RAID 0	3-disk RAID 0
	3-disk RAID 5
3-disk RAID 5	3-disk RAID 0
	3-disk RAID 5
4-disk RAID 0	4-disk RAID 0
	4-disk RAID 5
	4-disk RAID 10
4-disk RAID 5	4-disk RAID 0

Combine	With
	4-disk RAID 5
	4-disk RAID 10
4-disk RAID 10	4-disk RAID 0
	4-disk RAID 5
	4-disk RAID 10
5-disk RAID 0	5-disk RAID 0
	5-disk RAID 5
6-disk RAID 0	6-disk RAID 0
	6-disk RAID 5

Visit our Online Support for additional information on RAID type combinations for each I/O controller hub.

11.4.1.4 Increasing Volume Size

You can increase the size of a RAID volume by using the remaining available space on the array. A minimum of 32 MB must be available for this action to be available. Hovering over the array name in the storage system view displays the amount of available space in MB.

After creating a volume with an array allocation set to less than 100% in the Configure Volume step, you will be able to increase the volume size by the amount of available space on that array. If two volumes are present on a single array and capacity expansion is possible, only the space available at the end of the second volume will be used to increase the volume size.

This option is only available if:

- A RAID 0, RAID 1, RAID 5 and/or RAID 10 volume is present,
- The array allocation for the volume is less than 100% and space is available on the existing array.

Warning:
If you perform a driver upgrade or downgrade while the data migration is in progress and then restart your computer, the driver will not be able to recognize the volume or the data on it. If you are migrating a system volume, you will not be able to restart your system because the operating system cannot load. If you are migrating a data volume, you will have to reverse (roll back) that last performed driver update, and then restart the computer to return to a normal state.

Increasing the volume size from Manage Array:

1. Under 'Status' or 'Manage', in the storage system view, click the array you want to manage. The array properties are now displayed on the left.
2. Click 'Increase size' next to the volume name. If more than one volume is present on a single array, you will need to increase the size of each volume one at a time.

3. Click 'Yes' to confirm. Caution: Once the data migration starts, the operation cannot be canceled.
4. Once the migration has completed, restart your computer for changes to take effect. Then use Windows* Disk Management* to increase the partition size on the volumes, or add another partition.

Increasing the volume size from Manage Volume:

1. Under 'Status' or 'Manage', in the storage system view, click the volume whose size you want to increase. The volume properties are now displayed on the left.
2. Click 'Increase size'.
3. Click 'Yes' to confirm. Caution: Once the data migration starts, the operation cannot be canceled.
4. Once the migration has completed, restart your computer for changes to take effect. Then use Windows* Disk Management* to increase the partition size on the volumes or add another partition.

Note: To open Windows* Disk Manager, click Start, right click My Computer, select Manage, then in the console tree select Disk Management.

11.4.1.5 Enabling Disk Data Cache

Enabling the disk data cache for all SATA disks on the array allows you to enable cache memory physically present on the disks and use it to speed up data access. This action is only available from Manage Array because the data cache must be in the same state across all disks that are part of a single array.

Under Manage Array, the disk data cache is reported as enabled or disabled for all SATA disks in the array. Under Manage Disk, the disk data cache is reported as enabled or disabled for a specific disk that is part of that array. The option to change this setting is only available from Manage Array.

Warning:
Enabling the disk data cache increases the cache size and the amount of cached data that could be lost in the event of a power failure. The risk can be decreased if your computer is connected to an uninterruptable power supply (UPS).

1. Under 'Status' or 'Manage', in the storage system view, click the array you want to manage. The element properties are now displayed on the left.
2. In the Advanced section, click 'Enable' or 'Disable' depending on the option available.
3. Click 'Yes' to confirm.
4. The page refreshes and now displays the new setting.

11.4.2 Managing Volumes

You must be logged on as an administrator to perform the actions listed in this section.

You can manage existing volumes by clicking a volume in the storage system view under 'Status' or 'Manage'. This allows you to review the volume properties and access

all actions associated with that volume, such as renaming, changing type, and deleting.

11.4.2.1 Volume Properties

A volume is an area of storage on one or more SATA disks used within a RAID array. A volume is formatted by using a file system and has a drive letter assigned to it. The volume properties listed below display to the left of the storage system view under 'Manage' and report values specific to the element selected in the view.

RAID volume status table:

Status	Description
Normal	Indicates that volume data is fully accessible.
Locked	Indicates that at least one array disk is locked with a password. The volume is visible because at least one other array disk is unlocked. Refer to Unlocking Password-Protected Disks for instructions on unlocking disks.
Degraded	Indicates that one array disk is missing or has failed. A RAID 0 volume cannot be in this state because of the striping configuration.
Failed	• RAID 0 volume: indicates that one or more array disks are missing or have failed. • RAID 1 volume: indicates that both array disks are missing or have failed. • RAID 5 or 10 volume: indicates that two or more array disks are missing or have failed.
Incompatible	Indicates that the volume was moved to another system that does not support the volume type and configuration.
Inaccessible	Indicates that data on the accelerated volume cannot be accessed because it is missing, or that the accelerated volume data is not synchronized with the data on the cache volume.
Unknown	Indicates that an unknown error was detected.

Recovery volume status table:

Status	Description
Normal	Indicates that volume data is fully accessible.
Locked	Indicates that at least one array disk is locked with a password. The volume is visible because at least one other array disk is unlocked. Refer to Unlocking Password-Protected Disks for instructions on unlocking disks.
Degraded	• The recovery disk has failed, or • The master disk is missing or has failed and the volume is running off the recovery disk.
Failed	Indicates that both array disks have failed.
Incompatible	Indicates that the volume was moved to another system that does not support the volume type and configuration.
Unknown	Indicates that an unknown error was detected.

Status	Description
Power-saving mode	Indicates that the computer is running on battery power. If the volume is in continuous update mode, data updates are paused and will resume as soon as the computer is reconnected to the power supply.
Data update needed	Indicates that the recovery disk does not have a redundant copy of the data on the master disk, and you should request an update.
Running off recovery disk	Indicates that the recovery disk is the designated source drive in the volume.
Master disk read-only	Indicates that the recovery disk is the designated source drive in the volume, and that the master disk files are accessed. In this state, data recoveries from the recovery disk are not available.
Recovery disk read-only	Indicates that the recovery disk files are accessed. In this state, data updates are not available.

Busy volume states table:

Status	Description
Initializing	Indicates that data on a volume is being synchronized. This step is required prior to verifying or verifying and repairing data on a volume.
Verifying	Indicates that the volume is being scanned to detect data inconsistencies.
Verifying and repairing	Indicates that the volume is being scanned to detect data inconsistencies, and errors are being repaired. This state does not apply to a RAID 0 volume because errors cannot be repaired.
Migrating data	Indicates that data is being reorganized on the volume. This state displays when a system volume is created, the volume size is increased, or the type is changed to different RAID configuration.
Rebuilding	Indicates that data redundancy is being restored across all disks associated with the volume. A RAID 0 volume cannot be in this state because of the striping configuration.
Recovering data	Indicates that data on the master disk is being overridden by all the data on the recovery disk. This state only applies to recovery volumes.
Updating data	Indicates that the latest master disk changes are being copied to the recovery disk. This state only applies to recovery volumes.

General parameters table:

Parameter	Value
Details	Provides detailed information if a volume is in a state other than normal.
Type	Reports the volume type.
Acceleration mode	Reports the acceleration mode for the disk or volume associated with the cache device.

Parameter	Value
Size	Enhanced: Indicates that the disk or volume is accelerated for optimized data protection.
	Maximized: Indicates that the disk or volume is accelerated for optimized input/output performance.
	None: Indicates that no disk or volume is accelerated.
	Busy: Indicates that acceleration is transitioning from maximized to enhanced mode, or that acceleration is being disabled from maximized mode. In the event that errors are detected and a risk of data loss is identified, transitions from maximized mode will start automatically.
	Reports the total capacity of the volume in gigabytes (GB) in the storage system view and in megabytes (MB) in the volume properties under Manage Volume.
Data stripe size	Reports the size of each logical contiguous data block used in the volume for RAID 0, 5, and 10 volumes. The strip size is indicated in kilobytes (KB).
Write-back cache	Reports whether the write-back cache feature is enabled for the volume.
System volume	Reports whether the volume contains system files that are required to start and run the operating system.
Initialized	Reports whether the volume is initialized.
Verification errors found	Reports the number of inconsistencies found during the last volume data verification.
Block with media errors	Reports the number of blocks with media errors found during the last volume data verification.
Physical sector size	Reports the size of each sector that is physically located on the disk.
Logical sector size	Reports the size of data collection blocks.
Details	Provides detailed information if a volume is in a state other than normal.

11.4.2.2 Renaming a Volume

You can change the name assigned to a volume present in your storage system at any time. The name change will take effect immediately.

1. Under 'Status' or 'Manage', in the storage system view, click the volume that you want to rename. The volume properties are now displayed on the left.
2. Click 'Rename'.
3. Type a new volume name, and then click 'OK'.

Note: Volume names are limited to 16 English alphanumeric and special characters including spaces but cannot include a backslash "\".

11.4.2.3 Rebuilding a Volume

When a volume is reported as degraded because of a failed or missing disk, the disk must be replaced or reconnected and the volume be rebuilt in order to maintain fault-tolerance. The option to rebuild is only available when a compatible disk is connected, available and normal. If a spare disk is available, the rebuild process will start automatically when a disk fails or is missing. For RAID 0 volumes, the rebuild process will start automatically only when one of its members is reported as at risk.

Warning:
Completing this action will permanently delete existing data on the new disk and make any other volume on the array inaccessible. We recommend you backup valuable before continuing.

Rebuilding from 'Status' (manually):

1. Verify that the volume is reported as degraded in the Manage subsection. If you have more than one volume listed in this section, you will need to fix the issues reported one at a time.
2. Click 'Rebuild to another disk' next to the volume you want to rebuild.
3. In the Rebuild Volume dialog, select the disk that will replace the failed disk. Only compatible disks in a normal state will be displayed. Refer to Volume Requirements for more information.
4. Click 'OK' to confirm.
5. The volume starts rebuilding and the page refreshes displaying the progress of the operation. You can use other applications during this time, and you will be notified when the process has successfully completed.

Rebuilding from 'Manage' (manually):

6. Under 'Status' or 'Manage', in the storage system view, click the volume you want to rebuild. The element properties are now displayed on the left.
7. Click 'Rebuild to another disk', and then follow the procedure described above.

11.4.2.4 Recovering Data

Recovering data to the master disk allows you to maintain full data redundancy on the recovery volume and keep the volume data healthy. This action is only available if a recovery volume is present and running off the recovery disk.

You may have to recover data if:

- Data on the recovery and master disk is not synchronized and full data redundancy is at risk.
- Data on the master disk is invalid or inaccessible.

Warning:
Completing the action will override existing data on the master disk and update it with the data on the recovery disk. Backup all valuable data before continuing.

1. Under 'Status', in the Manage subsection, click 'Recover data' or click the recovery volume in the storage system view, and then click 'Recover data'.
2. Click 'Yes' to confirm.

3. The recovery operation starts immediately. You can follow the progress by hovering over the notification area icon or by reviewing the volume status under 'Status' or 'Manage'.

Note: If master disk is removed while the data recovery is in progress and is then reconnected, the operation will resume automatically from where it stopped as long as the volume is in on request update mode. If the volume is in continuous update mode, you will need to restart the operation by following the procedure described above,

11.4.2.5 Resetting Volume to Normal

This action is only available when a volume is reported as failed, but both array disks are present and normal, and allows you to access and try recovering healthy volume data.

In most cases, this situation will occur after one or more array disks was reported as failed or at risk, and then reset to normal.

Completing this action resets the volume state by ignoring previous events and does not repair data. Any data loss or corruption that may have occurred as a result of prior hardware failure or change of state remains. We recommend that you back up accessible data and replace failed hardware as soon as possible to prevent further data loss.

1. Under 'Status', in the Manage subsection, click 'Reset volume to normal'. You can also perform this action from Manage Volume, which is accessible by clicking the RAID 0 volume in the storage system view.
2. Click 'Yes' to confirm.
3. The page refreshes and the volume displays as normal. If the operation failed to return the volume to a healthy state, visit Intel®'s online support web site for more options.

11.4.2.6 Changing Volume Type

You can choose to change the type of an existing volume based on your storage system needs. The following configurations are possible:

Change Type From	To
2-disk recovery volume **Note** Only available if the recovery volume is in continuous update mode	2-disk RAID 1
2-disk RAID 1	2-disk recovery volume **Note** No other volumes can be present on the system. The RAID 1 volume must be less than 1.3125 TB and include 100% of the available space on the array
2-disk RAID 1	2-disk RAID 0
	3, 4, 5 or 6-disk RAID 0
	3, 4, 5 or 6-disk RAID 5

Change Type From	To
2-disk RAID 0	3, 4, 5 or 6-disk RAID 5
3-disk RAID 0	4, 5 or 6-disk RAID 5
4-disk RAID 0	5 or 6-disk RAID 5
4-disk RAID 10	4, 5 or 6-disk RAID 5

Note:
Before starting, refer to the system and volume requirements to determine which RAID types are supported by your computer and make sure the required number of SATA disks are connected. The Intel® Chipset provides support for the creation of all RAID volume types and for up to six SATA ports on a mobile platform. Changing volume type does not require re-installation of the operating system.

1. Under 'Status' or 'Manage', in the storage system view, click the volume that you want to modify. The volume properties are now displayed on the left.
2. Click 'Change type'.
3. In the 'Change Volume Type' dialog, type a new name if you want to change the default name.
4. Select the new volume type, and then click 'OK'. Caution: Once the data migration starts, the operation cannot be canceled.
5. Once the migration has completed, the 'Manage' page refreshes and reports the new volume type.

Warning:
All applications and existing volume data remain intact, but any existing data on the disks added to enable this operation will be permanently deleted. Backup data before adding these disks.

If you perform a driver upgrade or downgrade while the data migration is in progress and then restart your computer, the driver will not be able to recognize the volume or the data on it. If you are migrating a system volume, you will not be able to restart your system because the operating system cannot load. If you are migrating a data volume, you will have to reverse (roll back) that last performed driver update, and then restart the computer to return to a normal state.

11.4.2.7 Increasing Volume Size

You can increase the size of a RAID volume by using the remaining available space on the array. A minimum of 32 MB must be available for this action to be available. Hovering over the array name in the storage system view displays the amount of available space in MB.

After creating a volume with an array allocation set to less than 100% in the Configure Volume step, you will be able to increase the volume size by the amount of available space on that array. If two volumes are present on a single array and capacity expansion is possible, only the space available at the end of the second volume will be used to increase the volume size.

This option is only available if:

- A RAID 0, RAID 1, RAID 5 and/or RAID 10 volume is present,
- The array allocation for the volume is less than 100% and space is available on the existing array.

Warning
If you perform a driver upgrade or downgrade while the data migration is in progress and then restart your computer, the driver will not be able to recognize the volume or the data on it. If you are migrating a system volume, you will not be able to restart your system because the operating system cannot load. If you are migrating a data volume, you will have to reverse (roll back) that last performed driver update, and then restart the computer to return to a normal state.

Increasing the volume size from Manage Array:

1. Under 'Status' or 'Manage', in the storage system view, click the array you want to manage. The array properties are now displayed on the left.
2. Click 'Increase size' next to the volume name. If more than one volume is present on a single array, you will need to increase the size of each volume one at a time.
3. Click 'Yes' to confirm. Caution: Once the data migration starts, the operation cannot be canceled.
4. Once the migration has completed, restart your computer for changes to take effect. Then use Windows* Disk Management* to increase the partition size on the volumes or add another partition.

Increasing the volume size from Manage Volume:

1. Under 'Status' or 'Manage', in the storage system view, click the volume whose size you want to increase. The volume properties are now displayed on the left.
2. Click 'Increase size'.
3. Click 'Yes' to confirm. Caution: Once the data migration starts, the operation cannot be canceled.
4. Once the migration has completed, restart your computer for changes to take effect. Then use Windows* Disk Management* to increase the partition size on the volumes or add another partition.

Note
To open Windows* Disk Manager, click Start, right click My Computer, select Manage, then in the console tree select Disk Management

11.4.2.8 Adding a Disk to a Volume

You can add one or more SATA disks to an existing array to increase the system storage capacity. This feature can be useful if you want to change to a volume type that requires additional disks.

This option is only available if:

- A RAID 0 and/or a RAID 5 volume is present,
- One or more SATA disks are connected to the computer and available,
- The available disk matches the internal or external connection type of the existing array disks. You cannot add an external disk to an array that includes internal disks, and vice versa. In specific advanced system configurations, this condition may not apply.

Refer to Connecting a Disk under Managing Disks for more information on installing SATA disks on your computer.

Warning:
Any existing data on the available disk used to increase the array size will be permanently deleted. Backup all the data you want to preserve before completing this action.

If you perform a driver upgrade or downgrade while the data migration is in progress and then restart your computer, the driver will not be able to recognize the volume or the data on it. If you are migrating a system volume, you will not be able to restart your system because the operating system cannot load. If you are migrating a data volume, you will have to reverse (roll back) that last performed driver update, and then restart the computer to return to a normal state.

This action can also be performed from Manage Array. Refer to the Adding a Disk to an Array section for more information.

1. Under 'Status' or 'Manage', in the storage system view, click the volume to which you want to add a disk. The element properties are now displayed on the left.
2. Click 'Add disk'.
3. Select the disk you want to use to increase the array capacity.
4. Click 'Add Disk'. Caution: Once the data migration starts, the operation cannot be canceled.
5. Once the migration has completed, restart your computer for changes to take effect. Then use Windows* Disk Management* to increase the partition size on the volumes for which a disk was added, or add another partition.

Note
To open Windows* Disk Manager, click Start, right click My Computer, select Manage, then in the console tree select Disk Management.

11.4.2.9 Changing Update Mode

A recovery volume gives you the flexibility to choose between updating data on the recovery disk continuously or on request.

In continuous update mode, the latest master disk changes are copied to the recovery disk automatically, as long as both disks are connected to the computer. In on request mode, the latest master disk changes are copied to the recovery disk only when you request a data update.

The current update mode is reported in the volume properties under Manage Volume. By default, the recovery volume is created in continuous update mode.

Note
This action is only available if a recovery volume is present and in normal state. If the recovery volume is read-only because the master or recovery disk files are accessed, you will need to hide the files before the update mode can be changed.

1. Under 'Status' or 'Manage', in the storage system view, click the recovery volume. The volume properties are now displayed on the left.
2. Click ‘Change mode’, and then click 'Yes' to confirm.
3. The page refreshes and the volume properties report the new update mode.

11.4.2.10 Updating Data

You can manually copy the latest master disk changes to the recovery disk at any given time; this action allows you to synchronize data on the recovery volume, improving data protection and lowering the risk of losing valuable data in the event of a disk failure. When you request an update, only changes since the last update are copied.

Note
This action is only available if a recovery volume is present, and in 'on request' update mode.

1. Under 'Status' or 'Manage', in the storage system view, click the recovery volume. The volume properties are now displayed on the left.
2. Click 'Update data'.
3. The update process can be instantaneous or may take a while depending on the amount of data being copied. You can follow the progress by hovering over the notification area icon or by reviewing the volume status under 'Status' or 'Manage'.

Note
You can follow the progress of the update by hovering over the notification area icon or under 'Status' or Manage Volume.

11.4.2.11 Accessing Master or Recovery Disk Files

This action is only available if a recovery volume is present, in a normal state, and in on request update mode.

You can view the recovery or master disk files using Windows* Explorer* depending on the designated source drive of the recovery volume. This feature can be useful when a data recovery from or to the master disk is necessary.

Accessing recovery disk files:

This action is only available if the master disk is the designated source drive and the volume is running off that disk.

1. Under 'Status' or 'Manage', in the storage system view, click the recovery volume. The volume properties are now displayed on the left.
2. Click 'Access recovery disk files'.
3. Windows* Explorer opens and displays the files located on the recovery disk.

Accessing master disk files

This action is only available if the recovery disk is the designated source drive and the volume is running off that disk.

1. Under 'Status' or 'Manage', in the storage system view, click the recovery volume. The volume properties are now displayed on the left.
2. Click 'Access master disk files'.
3. Windows* Explorer opens and displays the files located on the master disk.

Note
When files have been accessed, the disk is displayed as missing from the array, and becomes available. Also, the volume is set to read-only and data updates are not available in this state. Hiding disk files will make the volume writable and allow data updates.

You can also access master or recovery disk files from Manage Disk.

11.4.2.12 Hiding Master or Recovery Disk Files

This action is only available if a recovery volume is present and disk files have been accessed.

When you are done viewing master or recovery disk files, you can hide the display of the files from Windows* Explorer*. Once the disk files are hidden, the disk becomes writable, and data updates on the volume are available.

Hiding recovery disk files:

This action is only available if the master disk is the designated source drive and the volume is running off that disk.

1. Under 'Status' or 'Manage', in the storage system view, click the recovery volume. The volume properties are now displayed on the left.
2. Click 'Hide recovery disk files'.
3. The disk files no longer display in Windows* Explorer.
4. The page refreshes and data updates on the volume are now available.

Hiding master disk files:

This action is only available if the recovery disk is the designated source drive and the volume is running off that disk.

1. Under 'Status' or 'Manage', in the storage system view, click the recovery volume. The volume properties are now displayed on the left.
2. Click 'Hide master disk files'.
3. The disk files no longer display in Windows* Explorer.
4. The page refreshes and data updates on the volume are now available.

Note
You can also hide master or recovery disk files from Manage Disk.

11.4.2.13 Deleting a Volume

Use caution: you cannot recover data once a volume is deleted.

When a volume is deleted, you create available space that can be used to create new volumes. Note that you cannot delete a system volume using this application because the operating system needs the system files to run correctly. Also, if the volume is a recovery volume and the master or recovery disk files are accessed, you will need to hide these files before the volume can be deleted.

Warning
When a volume is deleted, all existing data on all disks that are a part of the selected volume is permanently lost. It is recommended to complete a backup of all valuable data before continuing.

1. Under 'Status' or 'Manage', in the storage system view, click the volume you want to delete. The volume properties are now displayed on the left.
2. Click 'Delete volume'.
3. Review the warning message and click 'Yes' to delete the volume.
4. The 'Status' page refreshes and displays the resulting available space in the storage system view. You can now use it to create a new volume.

11.4.2.14 Setting Data Strip Size

You can assign a data strip size to a volume while creating a new volume or while changing the type of an existing volume. You cannot change the strip size of an existing volume without changing its type.

The strip size refers to each logical contiguous data block used in a RAID 0, RAID 5, or RAID 10 volume. This setting is not available for RAID 1 or recovery volumes, due to their redundant configuration. The default value is the recommended strip size based on the system configuration and the volume type selected; changing the pre-selection is best suited for advanced users.

The following table describes the usage scenarios for the typical strip sizes.

Usage scenarios for supported strip sizes[1]

Strip Size	Description	RAID Types
4 KB	Best for Web Servers (fast read transfer rate with slow write transfer rate).	RAID 0, 10
8 KB	Best for databases (fast read transfer rate with faster write transfer rate than with 4KB strips).	RAID 0, 10
16 KB	Good for sequential transfers.	RAID 0, 5, 10
32 KB	Best for sequential transfers.	RAID 0, 5, 10
64 KB	Best general purpose strip size.	RAID 0, 5, 10
128 KB	Best for audio and video editing.	RAID 0, 5

[1] **Disclaimer:** The data provided in this table may vary based on the brand, type, size, and speed of the disks used.

Setting the strip size when creating a volume:

1. Under 'Status', click 'Create' or 'Create a custom volume'.
2. Select the volume type, and then click 'Next'.
3. Make the required disk selection, and then select a new data strip size from the drop-down list in the Advanced section.
4. Complete the volume creation process as described in the Creation Process topic.

Setting the strip size when changing volume type:

1. Under 'Status' or 'Manage', in the storage system view, click the RAID volume that you want to modify. The volume properties are now displayed on the left.
2. Click 'Change type'.
3. Make the necessary volume type and disk selections, and then select a new data strip size.
4. Click 'OK' to change the type of the existing volume.
5. The 'Manage' page refreshes and reports the new volume configuration.

Available Strip Size Configurations:

	RAID 0	RAID 5	RAID 10
Default			
SATA disks	128 KB	64 KB	64 KB
Solid state disks	16 KB	128 KB	16 KB
Options	4 KB, 8 KB, 16 KB, 32 KB, 64 KB, 128 KB.	16 KB, 32 KB, 64 KB, 128 KB.	4 KB, 8 KB, 16 KB, 32 KB, 64 KB.

11.4.2.15 Enabling Volume Write-back Cache

You can improve the read/write performance of a RAID or recovery volume by enabling the write-back cache on one or all volumes on an array. When this feature is enabled, data may be temporarily stored in the cache memory before being written to the physical disks. Multiple I/O requests may be grouped together to improve performance. By default, the write-back cache is disabled.

Warning:
While this feature highly improves the volume and array performance, it also increases the amount of cached data that could be lost in the event of a power failure. This risk can be lowered if your computer is connected to an uninterruptable power supply (UPS)

Enabling the volume write-back cache:

1. Under 'Status' or 'Manage', in the storage system view, click the volume for which you want to enable the write-back cache. The volume properties are now displayed on the left.
2. In the Advanced section, click 'Enable', and then click 'Yes' to confirm.
3. The page refreshes and the write-back cache is now enabled.

Note
If your computer is running on battery and a recovery volume is present, the option to enable the write-back cache is not available because the recovery disk is offline and data updates are not available. If this feature was enabled prior to running the battery, write-back cache activity would be temporarily disabled until you reconnect your computer to the power supply.

Disabling the volume write-back cache:

1. Under 'Status' or 'Manage', in the storage system view, click the volume for which you want to disable the write-back cache. The volume properties are now displayed on the left.
2. In the Advanced section, click 'Disable', and then click 'Yes' to confirm.
3. The page refreshes and the write-back cache is now disabled.

11.4.2.16 Initializing a Volume

Initializing a volume is the process of synchronizing all redundant data on a volume prior to verifying or verifying and repairing that data. If you attempt to start a verification process for a volume that has not been initialized, you will be prompted to do so.

Initializing a volume:

1. Under 'Status' or 'Manage', in the storage system view, click the volume that you want to initialize. The volume properties are now displayed on the left.
2. Click 'Initialize'.
3. Click 'OK' to start the initialization process. Caution: Once the data migration starts, the operation cannot be canceled.

Initializing a volume when verifying data:

1. Under 'Status' or 'Manage', in the storage system view, click the volume that you want to verify. The volume properties are now displayed on the left.
2. Click 'Verify'.
3. When prompted to initialize the volume before verifying data, click 'OK' to start the initialization process. Caution: Once the data migration starts, the operation cannot be canceled.
4. Once complete, click 'Verify' to start the verification process.

Note
While inititialization is in progress, you can view the status in the notifications area by hovering over the Intel®(R) Rapid Storage Technology icon, or in the application under Staus or Manage Volume.

Warning
The initializating process could take a while depending on the number and size of the disks. You can continue using array disks and other applications during this time. Closing the application, or powering off and restarting your computer will not disrupt the progress of this operation.

11.4.2.17 Verifying and Repairing Data

You can verify data on an existing volume by identifying and repairing inconsistencies. Running this operation on a regular basis helps you keep valuable data and the overall storage system healthy.

1. Under 'Status' or 'Manage', in the storage system view, click the volume that you want to verify. The volume properties are now displayed on the left.
2. Click 'Verify'.
3. Select the check box if you want errors found to be repaired automatically during the verification process.
4. Click 'OK' to start the verification process.

Note
Data on a volume cannot be verified and repaired unless the volume has been initialized first. If you attempt to start a verification process for a volume that is not initialized, you will be prompted to first initialize the volume. Based on its configuration, a RAID 0 volume cannot be repaired because of the lack of redundancy.

11.4.2.18 Swapping Disks

You can change the order of designation for array disks in a recovery volume by setting the master disk as the destination drive and the recovery disk as the source drive. This action is best suited for advanced users.

Note
This action is only available if a recovery volume is present, normal, and in continuous update mode.

Swapping disks can be useful if:

- You selected the wrong disk as the master disk when you created the recovery volume,
- You think one of the disks is failing,
- You replaced the recovery disk with a faster, newer disk, and want to run off that device once it has been updated.

1. Under 'Status' or 'Manage', in the storage system view, click the recovery volume. The volume properties are now displayed on the left.
2. In the Advanced section, click 'Swap master and recovery disks'.
3. Click 'Yes' to confirm.
4. Hover over each disk in the storage system view to review their new usage.

11.4.3 Managing Disks

You must be logged on as an administrator to perform the actions listed in this section.

You can manage disks by clicking a selected disk in the storage system view under 'Status' or 'Manage'. This allows you to review the properties and access all actions associated with that disk, such as unlocking a password-protected disk or marking a disk as spare. Depending on their usage or status, some actions may not be available.

11.4.3.1 Disk Properties

The disk properties listed below display to the left of the storage system view under 'Manage' and report values such as usage and status that are specific to the disk selected in the view. Based on the detailed information provided, you can make changes to the way each disk is configured or take action on one or more disk to keep your overall storage system healthy.

Parameter	Value
Port	Reports the port number to which the disk or device is attached.
Port location	Reports whether the port is internal or external.
Usage	Array disk: a disk that has been grouped with other disks to form an array containing RAID volumes.
	Master disk: the disk that is the designated source drive in a recovery volume.
	Recovery disk: the disk that is the designated destination drive in a recovery volume.
	Spare: the disk has been designated as the destination drive for automatic volume rebuilds in the event of a failed, missing or at risk array disk. For RAID 0 volumes, automatic rebuilds will only occur when one of its array disks is reported as at risk.
	Available: the disk is physically connected to the computer, healthy, and available to be used in an array or as a spare disk. **Warning** Assigning an available disk to an array or marking it as a spare will permanently delete any existing data on that disk.
	Unknown: the disk is available but contains metadata that cannot be displayed in the operating system. Even though the disk is reported as normal, you will need to clear and reset the disk to make the disk available.
Acceleration mode	Reports the acceleration mode for the disk or volume associated with the cache device.
	Enhanced: Indicates that the disk or volume is accelerated for optimized data protection.
	Maximized: Indicates that the disk or volume is accelerated for optimized input/output performance.
	None: Indicates that no disk or volume is accelerated.
	Busy: Indicates that acceleration is transitioning from maximized to enhanced mode, or that acceleration is being disabled from maximized mode. In the event that errors are detected and a risk of data loss is identified, transitions from maximized mode will start automatically.
Status	Normal: the disk is present, functioning as expected, and unlocked.
	Locked: the disk is password-protected. Note: if a volume includes at least one locked disk, the volume will display as locked.
	At risk: an impending error condition was detected on the disk and it is now at risk of failure.
	Missing: the disk is not present or physically connected to the computer.
	Failed: the disk has failed to properly complete read and write operations in a timely manner, and it has exceeded its recoverable error threshold.
	Offline: indicates that an array disk is locked, that the recovery volume is in on request update mode, or that your computer is running on battery and data updates to the recovery volume are not available.

Parameter	Value
Size	Reports the total capacity of the disk in megabytes (MB) in the disk properties and in gigabytes (GB) in the storage system view.
Serial number	Reports the manufacturer's serial number for the disk.
Model	Reports the model number of the disk.
Firmware	Reports the version of the firmware found in the disk.
System disk	Reports whether the disk contains system files that are required to start and run the operating system.
Password protected	Reports whether the disk is protected with a password.
Disk data cache	Reports whether the data cache is enabled on this disk. This feature is controlled at the array level.
Native command queuing	Reports whether the disk supports this feature.
SATA transfer rate	Reports the data transfer rate between the SATA controller and the SATA disk. The supported rates are: • SATA 1.5 Gb/s (generation 1) • SATA 3 Gb/s (generation 2) • SATA 6 Gb/s (generation 3) The data transfer rate reported is based on the Intel® Chipset and SATA disks present in your system.
Physical sector size	Reports the size of physical sectors on the disk (bytes).
Logical sector size	Reports the size of logical sectors on the disk (bytes).

11.4.3.2 Unlocking Password-Protected Disks[1]

You can unlock a password-protected disk by entering the password which allows you to access data or use that disk to create a volume. The password is setup through the system BIOS. Locked disks can be identified with the lock icon appended to them and display a 'Locked' status in the disk properties.

11.4.3.3 Marking a Disk as Spare

This action is only available for non-system disks in a normal state. Also, unless your mobile computer is equipped with the Intel® 5 Series Chipset or later, which provides support for up to six SATA ports, you will not be able to mark a disk as a spare. Most mobile computers are limited to one internal and one external disk, which are used to create the volume.

Marking a disk as a spare allows you to designate an available SATA disk as the default destination for automatic volume rebuilds in the event of a failed, missing or at risk array disk. However, for RAID 0 volumes, automatic rebuilds will only occur if one of its members is reported at risk.

1. Under 'Status' or 'Manage', in the storage system view, click the disk that you want to mark as a spare. The volume properties are now displayed on the left.
2. Click 'Mark as spare'.
3. Click 'OK'.

Note
RAID 1, 5, 10, and recovery volumes can use one or more spares.

Warning
When marking a disk as a spare, any existing data on that disk is permanently deleted. Back up all data you want to preserve before starting this action.

Note: [1] If your system is running a version of the Intel® RST OROM that does not support disks that are 2TB or larger, you can reset such a disk to available, but disallow the marking of it as a spare.

11.4.3.4 Resetting a Disk to Available

After a disk was marked as spare, you can choose to make that spare disk available again and use it differently. Once available, the disk can be used to create a volume or be added to an existing volume if all other requirements are met.

1. Under 'Status' or 'Manage', in the storage system view, click the disk that you want to reset to available. The volume properties are now displayed on the left.
2. Click 'Reset to available'.
3. The page refreshes and the disk usage is now reported as available.

11.4.3.5 Resetting a Disk to Normal

You can reset a SATA disk to normal when the storage system reports one of the following disk statuses:

At risk:

A disk is reported at increased risk of failing in the near future that could be due to a slow degradation over time. You can choose to ignore this alert at this time by resetting the disk to normal, but it may re-appear if the disk continues to assert this condition. We recommend that you contact the manufacturer for more information to prevent potential data loss.

Failed:

A SATA disk has failed to properly complete read and write operations in a timely manner, and data may be lost. We recommend that you replace the failed disk as soon as possible to return the overall storage system to normal. In this state, data may be lost, but you can try resetting the disk to normal and attempt a data recovery. If the disk operations continue to fail, the disk will return to a failed state immediately.

If the failed disk is an array disk, refer to the Troubleshooting section for guidelines on rebuilding a failed or degraded volume.

1. Under 'Status', in the Manage subsection, locate the disk reported as at risk or failed. You 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.

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.

11.4.3.6 Accessing Disk Files

This action is only available if a recovery volume is present, in a normal state, and is on request update mode.

This feature allows you to view the files on the designated destination drive in a recovery volume using Windows* Explorer*. For example, you may want to review the recovery disk files prior to starting a data recovery in the event that data on the master disk is inaccessible or corrupted.

When the volume status is normal, the recovery disk is the designated destination drive and files are accessible. When the volume status is running off the recovery disk, the master disk is the designated destination drive and files are accessible. You can review the usage of each disk by hovering over the array disks in the storage system view or by clicking one of the disks to review its properties under Manage Disk.

1. Under 'Status' or 'Manage', in the storage system view, click the recovery or the master disk depending on the volume status. The disk properties are now displayed on the left.
2. Click 'Access files'.
3. Windows* Explorer opens and displays the files located on the disk.

Note
When files have been accessed, the disk is displayed as missing from the array, and becomes available. Also, the volume is set to read-only and data updates are not available in this state. Hiding disk files will make the volume writable and allow data updates.

Warning
Windows* Explorer will not open if the disk does not have any partitions on it.

11.4.3.7 Hiding Disk Files

This action is only available if a recovery volume is present and disk files have been accessed.

When you are done viewing master or recovery disk files, you can hide the display of the files from Windows* Explorer*. Once the disk files are hidden, the disk becomes writable, and data updates on the volume are available.

1. Under 'Status' or 'Manage', in the storage system view, click the disk whose files are accessed. The disk properties are now displayed on the left.

2. Click 'Hide files'.
3. The disk files no longer display in Windows* Explorer.
4. The page refreshes and data updates on the volume are now available.

Note
You can also hide master or recovery disk files from Manage Volume.

11.4.3.8 Connecting a Disk

Installing new hardware is one of the steps you may have to take to keep you storage system healthy or to extend the life of a computer that is running out of storage space.

Intel® Rapid Storage Technology provides hot plug support, which is a feature that allows SATA disks to be removed or inserted while the computer is turned on and the operating system is running. As an example, hot plugging may be used to replace a failed external disk.

Our application provides support for SATA 1.5 Gb/s (generation 1), SATA 3 Gb/s (generation 2), and 6 Gb/s (generation 3) data transfer rates. The rate support depends on the Intel® Chipset and SATA disks present in your system. Visit our Online Support for additional information on chipset features and benefits.

Follow these procedures to replace or connect a disk in case you need to power off your computer:

Replacing a disk:

1. Power off your computer.
2. Replace the disk that reports a problem.
3. Turn your computer back on. If the replaced disk was part of an array, you will need to follow the procedure provided in the Troubleshooting section based on the volume state and type.

Note
To install an external disk, plug it into you computer and connect the power cord.

To remove and install an internal disk, you should be comfortable opening your computer case and connecting cables. Follow the manufacturer's installation guide to complete this procedure. If you are replacing the system disk, you will have to re-install the operating system after you connect the disk because the system disk contains the files required to start and run your computer.

Installing a new disk (to increase storage space):

1. Power off your computer.
2. Connect the new disk.
3. Turn your computer back on. During the system startup, the application's option ROM should automatically detect the new disk if it is installed correctly. Once you open the application, verify under 'Status', in the storage system view, that the new disk displays. You can then access management options by clicking that disk.

11.4.4 Managing Ports

A port is a connection point on your computer where you can physically connect a device, such as a SATA disk or ATAPI device. A port transfers I/O data between the device and the computer.

If a port is reported as empty in the storage system view, you can use that port to connect a new device in order to increase the storage system capacity. Currently, the maximum number of internal ports that can be used to connect devices is six.

The port properties listed below display to the left of the storage system view under 'Manage' and report values specific to the element selected in the view.

Parameter	Value
Port	Reports the port number to which the disk or device is attached.
Port location	Reports whether the port is internal or external.

11.4.5 Managing ATAPI Devices

An ATAPI device is a mass storage device with a parallel interface such as a CD-ROM, DVD/Blu-ray disc, tape drive, or solid-state disk. The ATAPI properties listed below display to the left of the storage system view under 'Manage' and report values specific to the selected element.

Parameter	Value
Port	Reports the port number to which the disk or device is attached.
Port location	Reports whether the port is internal or external.
Serial number	Reports the manufacturer's serial number for the device.
Model	Reports the model number of the device.
Firmware	Reports the version of the firmware found in the device.
SATA transfer rate	Reports the transfer mode between the SATA controller and the ATAPI device. The typical values for this parameter are: • SATA 1.5 Gb/s (generation 1) • SATA 3 Gb/s (generation 2) • SATA 6 Gb/s (generation 3) The data transfer rate reported is based on the Intel® Chipset and SATA disks present in your system.

11.4.6 Managing Solid-State Hybrid Drives (SSHD)

To increase performance, some hard drive manufactures are now including non-volatile memory to be used as a data cache on hard drives. These drives are called Solid-State Hybrid Drives. Hybrid Hinting is a feature by which the Intel® RST driver will send information to a SSHD, notifying the drive which data would be best to store in the data cache. There are no extra steps to manage SSHD's.

Intel® RST enables Hybrid Hinting when the following minimum requirements are met:

- SSHD must have a minimum of 8GB of non-volatile cache.
- SSHD must have a maximum of 1TB of non-volatile cache.

This feature also increases the power efficiency of a mobile computer by retaining stored data and reading data from the cache instead of the SATA disk itself.

11.5 Preferences

System preferences allow you to decide whether you want the notification area icon to display. In addition, you can select the types of notifications you want to receive, such as storage system warnings or errors, and be notified of any reported problems while the application is closed.

Both administrators and standard users can change the notification area settings using the application or directly from the notification area. Settings changes are applied on a per user basis, and do not affect other users' settings.

Showing system notifications:

By default, System preferences are set to show the notification area icon. If you previously chose to hide the notification area icon, follow these steps to display the icon again:

1. Under 'Preferences', select 'Show the notification area icon'.
2. Click 'Apply Changes'. Verify that the icon is now displayed in the notification area.

Hiding system notifications:

Once you hide the notification area icon, the service no longer reports storage system information, warnings, or errors through the notification area. You will need to use the application to monitor the health of the storage system. Follow these steps to hide the notification area icon:

1. Under 'Preferences', deselect 'Show the notification area icon'.
2. In the 'Hide Notification Area Icon' dialog, click 'Yes' to confirm.
3. Verify that the icon is no longer displayed in the notification area.

Selecting system notifications:

1. Under 'Preferences', make sure that 'Show the notification area icon' is selected.
2. Select the types of notifications you want to receive.

Note
Storage system information provides details on any changes of state other than warnings or errors, such as new disks being detected or locked.

Storage system warnings report the cause for the overall warning state of the storage system, such as a degraded RAID volume due to a missing disk.

Storage subsystem errors report the cause for the overall error state of the storage system, such as a failed volume due to a failed disk.

§§

12 Glossary

Term	Definition
ATA	Advanced Technology Attachment
BIOS	Basic Input/Output System
BOM	Bill Of Materials
CD	Compact Disc
Chipset	Term used to define a collection of integrated components required to make a PC function.
Hard drives	Physical hard drives attached to a RAID controller
DEVSLP	Serial ATA Device Sleep
DOS	Disk Operating System
GB	Giga-byte
HDD	Hard Drive
I/O	Input/Output
ICH	I/O Controller Hub
ICH9	Intel® 82801IR/DO SATA RAID Controller
IDE	Integrated Drive Electronics
INF	Information file (.inf) used by Microsoft* operating systems that support the Plug and Play feature. When installing a driver, this file provides the OS needed information about driver filenames, driver components, and supported hardware.
Intel® Option ROM (OROM)	Standard Plug and Play option ROM that provides a pre-operating system user interface for the Intel® RAID implementation.
MB	Mega-byte
Migration	Term used to describe the movement of data from one configuration or usage model to another.
OEM	Original Equipment Manufacturer
Option ROM	A code module built into the System BIOS that provides extended support for a particular piece of hardware. For this product, the Option ROM provides boot support for RAID 0/1/5/10 volumes, and provides a user interface for configuring and managing RAID 0/1/5/10 volumes.
OS	Operating System
PATA	Parallel ATA
PCH	Platform Controller Hub is the new term for Intel® chipsets
PCI	Peripheral Components Interconnect
PFW	Package for the Web
PIO	Programmed Input Output
PnP	Plug and Play

Term	Definition
Port 0..3	Term used to describe the point at which a SATA drive is physically connected to the SATA Controller. Port n is the nth of the four available ports in ICH9 systems, where n=0..3
RAID	Redundant Array of Independent Disks
RAID 0	A RAID level where data is striped across multiple physical hard drives (aka striping)
RAID 1	A RAID level where data is mirrored between hard drives to provide data redundancy (aka mirroring)
RAID 5	A RAID level where data and parity are stripped across the hard drives to provide good read/write performance and data redundancy. The parity is stripped in a rotating sequence (aka Stripping and rotating parity).
RAID 10	A RAID level where information is striped across a two disk array for system performance. Each of the drives in the array has a mirror for fault tolerance. (aka Stripping and mirroring)
RAID volume	A block of capacity allocated from a RAID Array and arranged into a RAID topology. Operating Systems typically interpret a RAID volume as a physical hard drive.
RAM	Random Access Memory. Usually refers to the system's main memory
ROM	Read Only Memory
Intel® RST	Intel® Rapid Storage Technology
RTD3	Runtime D3
SATA	Serial ATA
SCSI	Small Computer System Interface
SP#	Service Pack (number)
Strip	Grouping of data on a single physical hard drive within a RAID volume
SRT	Intel® Smart Response Technology
SSD	Solid State Drive
SSHD	Solid-State Hybrid Drive
Stripe	The sum of all strips in a horizontal axis across physical hard drives within a RAID volume
UI	User Interface

12.1 Glossary

A B C D E F H I L M N O P R S U V W

- A
  - **Accelerated disk or volume**
    A disk or RAID volume that has its non-volatile cache enabled in either maximized or enhanced mode.
  - **Access master or recovery disk files:**
    Action to view the files located on the master or recovery disk of a recovery volume using Windows* Explorer*. Selecting this option sets the volume in read-only and volume updates are not allowed. This action is only available when the recovery volume is in on request update mode or running off the recovery disk.
  - **Activate port LED:**
    Action to locate the port connected to a disk present on the system by activating the Light Emitting Diode (LED) light.
  - **AHCI:**
    An interface specification that allows software to communicate with SATA devices such as host bus adapters, and enables advanced SATA features such as Native Command Queuing, native hot plugging, and power management. Advanced Host Controller Interface (AHCI).
  - **Array:**
    An abstraction layer or collection of two or more disks used to manage RAID volumes existing on a same collection of disks. RAID arrays are not visible to the operating system.
  - **At risk:**
    Status indicative that a disk or device has experienced a SMART event, and that an impending error condition was detected and the disk or device is now at risk of failure.
  - **ATAPI device:**
    A mass storage device with a parallel interface such as CD-ROM, CD-RW, DVD-ROM, Blu-ray Disc, and tape drives. Advanced Technology Attachment Packet Interface (ATAPI).
- B
  - **Blocks with media errors:**
    Number of inconsistencies found during the data verification of a RAID volume. This feature only applies to the verification process or the verification and repair process.
    Bus Protocol Group:
    A bus protocol group represents a set of bus protocols with similar performance characteristic. Bus Protocol Groups are listed here in ascending order of speed:1
    1- SATA
    2- PCIe*
- C
  - **Cache**
    A resource allocation on a storage component used for temporary data operations. Cache can be allocated in components such as RAM or non-volatile memory.
  - **Cache device**
    The selected solid state disk used for cache storage in an SRT configuration.
  - **Cache volume**
    The portion of the cache device (a solid state disk) that holds the non-volatile cache data in an SRT configuration. That portion is configured into a single-disk RAID-0 volume.
  - **Change volume type:**
    Action to change the volume from one RAID configuration to another, and move data from one RAID volume to another. A RAID 1 volume can also be converted to a recovery volume, and vice versa.
  - **Continuous update mode:**
    Update mode assigned to a recovery volume, where data on the master disk is copied to the recovery disk automatically, as long as both disks are connected to the system.
- D
  - **Data stripe size:**

Size of a grouping of data on a single physical disk within a RAID volume. Reported in kilobytes (KB).

- **Data volume**
  The portion of extra space on the cache device (a solid state disk) that can be used for data storage. That portion is configured into a single-disk RAID-0 volume.
- **Degraded:**
  Volume status indicative that one member has failed or is missing. This status only applies to recovery, RAID 1, RAID 5, and RAID 10 volumes.
- **Disassociating a cache**
  The action of removing the association between the non-volatile cache and the accelerated disk or volume.
- **Disk data cache:**
  A cache memory within a hard drive that temporarily stores frequently used data sectors for faster access. As a result, overall hard drive performance is improved.
- **Disk:**
  A hard or floppy disk. Also known as hard drive or hard disk drive.

· E

- **E-mail notification:**
  Alert mechanism that allows the user to receive storage system information, warning, and error notifications by e-mail via SMTP. By default, this feature is disabled and requires configuration settings such as the SMTP host and e-mail addresses to be set up.
- **Enhanced Mode**
  An acceleration mode that uses write-through, non-volatile cache to improve performance. The mode also is known as "separation safe" because all host-write requests are written to the accelerated disk or volume and possibly to the non-volatile cache.

· F

- **Failed:**
  Volume and disk status indicative that one or more array members are missing or have failed.
- **Firmware:**
  Permanent instructions and data programmed directly into the read-only memory (ROM) for controlling the operation of the computer. Firmware usually requires updates to fix defects or add features to the hardware.

· H

- **Hide master or recovery disk files:**
  Action to close the display of files located on a master or recovery disk in a recovery volume after viewing them in Windows* Explorer*. This option is only available when 'Access recovery disk files' or 'Access master disk files' was previously selected. Once disk files are hidden, volume updates can resume.
- **Hot plug:**
  Action to remove or insert a SATA disk when the system is powered on.

· I

- **Increase volume size:**
  Action to expand the data storage capacity of a volume by utilizing the available array space on a RAID 0, RAID 1, RAID 5, or RAID 10 volume.
- **Initialize:**
  Process of synchronizing all redundant data on a volume prior to creating a volume, verifying and repairing data, or changing volume type. Initialization is still required for non-redundant volumes such as RAID 0 to ensure that data is readable before starting the verification process.
- **Intel® Rapid Recover Technology:**
  Official name for Intel®'s technology that allows the user to copy data from a master disk (source) to a recovery disk (destination) either continuously or on request.
- **Intel® Rapid Storage Technology:**
  Official name for Intel®'s Windows-based software to provide support for high-performance, fault-tolerant, and capacity SATA RAID arrays on select supported chipsets. Intel® Rapid Storage Technology also provides support for Intel® Rapid

Recover Technology, AHCI Native Command Queuing, and matrix RAID for two RAID volumes on a single array.

- L
  - **Locked:**
    Volume and disk status indicative that the data is protected with a password and cannot be accessed until disks are unlocked.
- M
  - **Mark as spare:**
    Action to designate an available and compatible SATA disk as the default destination for automatic rebuilds in the event that an array member fails or is missing.
  - **Master disk:**
    The disk that is the designated source drive in a recovery volume.
  - **Maximized Mode**
    An acceleration mode that uses write-back, non-volatile cache to improve performance better than the enhanced Mode. This mode is optimized for input/output performance and power savings.
    Memory Group
    A memory group represents a set of backend storage media types with similar performance characteristics. Memory Groups are listed here in ascending order of speed:
    1- Spindle Device (HDD)
    2- NAND Spindle Hybrid Device (SSHD)
    3- PCH SATA NAND Device (SSD)
    4- PCIe* NAND Device (SSD)
  - **Migrating:**
    Volume status indicative that data is being moved/transferred across selected storage devices due to a change request in the storage system configuration, such as changing volume type, creating a volume preserving existing data, increasing the volume capacity, or changing data stripe size.
- N
  - **Native Command Queuing:**
    Command protocol in SATA that allows multiple commands to be outstanding within a disk at the same time. The commands are dynamically reordered to increase disk performance.
  - **Normal:**
    Volume, disk, and device status indicative that they are in a healthy state, functioning as expected, disks are properly connected, and data is fully accessible.
- O
  - **Offline:**
    Disk status indicative that an array disk is locked (the volume status displays as locked), that the recovery volume is in on request update mode, or that your computer is running on battery and data updates to the recovery volume are not available.
  - **On request update mode:**
    Update mode assigned to a recovery volume, where data on the master disk is copied to the recovery disk when the user requests it. Only changes since the last update process are saved to the recovery disk.
  - **Option ROM:**
    Firmware that is called by the system BIOS in order to communicate and provide support for a hardware device. For this product, the option ROM provides boot support for RAID volumes as well as a user interface for configuring and managing RAID volumes. Also known as OROM.
- P
  - **PCIe* Storage Device:**
    A storage device that connects to the PCIe* bus. PCIe* devices can contain either an
    AHCI or NVMe* communication controller.
    Port:
    An internal or external data connection of a computer (e.g., SATA controller) to which a peripheral device (e.g., SATA disk) can be attached.
- R

- **RAID 0:**
  A RAID type or configuration where data is striped across multiple physical disks. Data is split into manageable blocks called strips across array members. Striping does not create data redundancy but improves read/write performance.
- **RAID 1:**
  A RAID type or configuration where data is mirrored across a second physical disk in the array. Mirroring is a key feature that ensures real-time data redundancy and increased fault tolerance. There is no striping.
- **RAID 10:**
  A RAID type or configuration that uses four disks to create a combination of RAID type 0 and 1. The data is striped across a two-disk array forming a RAID 0 component. Each of the disks in the RAID 0 array is mirrored by a disk in the RAID 1 array.
- **RAID 5:**
  A RAID type or configuration where data and parity are striped into manageable blocks called strips across three or more physical disks. This type is a preferred configuration as it combines efficiency, fault-tolerance, and data performance.
- **RAID:**
  Redundant Array of Independent/Inexpensive Disks is a technology used for computer data storage schemes that divide and/or replicate data among multiple disks. RAID can be designed to provide increased data reliability or increased I/O (input/output) performance, or both. A number of standard schemes have evolved which are referred to as levels or types. Intel® Rapid Storage Technology software supports RAID 0, RAID 1, RAID 5, and RAID 10 configurations (refer to each RAID type definition for more information).
- **Read-only:**
  Recovery volume status indicative that the recovery or master disk files are accessed, allowing files on the disk to be read or copied, but not changed or saved.
- **Rebuild:**
  The process of restoring a recovery, RAID 1, RAID 5, and RAID 10 volume in the event that a volume disk has failed or is missing. If a spare disk is present and compatible, the application will automatically use it as a replacement for the failed disk. An automatic rebuild process will also occur if a RAID 1 member is removed and then reconnected, in order to re-establish the mirroring. This process does not apply to RAID 0 volumes.
- **Recover data:**
  The action of retrieving data in the event that a recovery volume has failed due to a missing or failed master disk. Data from the recovery disk is copied to a new or healthy master disk, restoring data redundancy. Selecting this option will overwrite all master disk data with data on the recovery disk.
- **Recovery disk:**
  The disk that is the designated destination drive in a recovery volume.
- **Recovery volume:**
  A two-disk redundant volume that includes a master disk (source) and a recovery disk (destination) and uses Intel® Rapid Recover Technology. This configuration provides flexibility of volume data updates and maximum data redundancy.
  Remapped:
  Remapping hardware in the chipset allows a PCIe* STORAGE DEVICE to appear to the OS as if it were an extra port on the Chipset's internal AHCI controller rather than a separate controller on the PCIe* bus
- **Repair:**
  The process of fixing verification errors and blocks with media errors found during the verification process. This feature is only available for volumes with a normal or at risk status. A RAID 0 cannot be repaired due to its non-redundant configuration.
- **Reset disk to normal:**
  Action to return a failed or at risk disk to a normal state. We recommend that you contact the manufacturer for more information to prevent potential data loss.
- **Reset to available:**
  Action to return a disk previously marked as a spare to an available state.
- **Reset volume to normal:**

Action to return a failed volume where both array disks are present and normal to a normal state. This feature allows you to access and attempt a recovery of healthy volume data.

- S
  - **SATA disk:**
    A disk with an interface that transmits data using a serial protocol in order to communicate with the SATA controller.
  - **SATA transfer rate:**
    Rate at which the SATA controller and SATA disk communicate with each other. Transfer rates are important when large contiguous blocks of data are being used, such as video and image files. Reported in gigabits/seconds (Gb/s).
  - **SATA:**
    A successor to ATA and PATA, SATA is a computer bus technology primarily designed for transfer of data between storage devices such as hard drives or optical devices, and a computer. Benefits of this technology are: usage of high-speed serial cables, air cooling to work more efficiently, faster transfers, the ability to remove devices while operating (hot plugging), enables more reliable operation with tighter data integrity checks. Also known as Serial Advanced Technology Attachment or Serial ATA.
  - **Single-disk RAID 0**
    A RAID-0 volume that has one (1) disk as its array disk. This is the volume type used to create the non-volatile cache region on a solid state disk being used for caching. This volume type creates an OS-visible volume that enables access to extra space on the solid state disk that is not being used for caching.
  - **Size:**
    Reports the total capacity of a physical device such as a SATA disk, a volume, or an array.
  - **Storage system:**
    One or more physical disks or devices that act as a unit for data storage.
  - **System disk:**
    A disk that contains system files required to start and run the operating system. By default, the Windows* operating system files are in the WINDOWS* folder, and the supporting files are in the WINDOWS\System32 folder.
  - **System volume:**
    A volume that refers to the disk(s) volume that contains the hardware-specific files that are needed to start Windows, such as Ntldr, Boot.ini, and Ntdetect.com, as well as the Windows* operating system files and supporting files. The system volume can be the same volume as the boot volume.
- U
  - **Unknown:**
    Disk status indicative that its usage could not be determined, due to a possible incompatibility between this software version and the disk configuration, or a virus. Also a volume status indicative that the volume is in an unexpected state due to a configuration error. Data on the volume can no longer be accessed.
  - **Update mode:**
    Type of update assigned to a recovery volume. The update mode can be set to continuous, where master disk changes are automatically saved to the recovery disk, or set to on request, where updates of the recovery disk can be requested immediately.
- V
  - **Verify:**
    Action of scanning data to detect any types of data damage, disk read errors, and volume data inconsistencies. As an option, errors found can be corrected on redundant RAID volumes. This feature is only available for volumes with a normal or at risk status.
  - **Volume size:**
    Amount of data that can be stored on a volume; reported in bytes (B) or %.
  - **Volume type:**
    Configuration of a volume which determines how data is stored and managed to improve read/write performance, increase fault tolerance and/or storage capacity.
  - **Volume write-back cache:**

A cache memory used to enhance the read/write performance of a RAID volume by grouping multiple I/O requests into fewer requests and by writing from the cache to the volume at defined intervals.

- **Volume:**
  A fixed amount of space across a RAID array that is structured to emulate a single physical hard drive and appears as such to the operating system. Volumes have drive letters assigned to them and some volumes can span multiple hard disks.

W

- **Windows* Disk Management:**
  Microsoft* Windows* system utility for managing the disks and partitions or volumes that they contain. Disk Management allows the initialization of new disks, volume creation, and formatting. Most disk-related tasks can be performed using this system utility without shutting down or restarting the computer; most configuration changes take effect immediately.
- **Write-back cache allocation:**
  Size of the dynamic random access memory (DRAM) that is allocated for write-back caching on all volumes present on the system. The cache size is set to 16 megabytes (MB) by default.

§§

13 Troubleshooting

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

13.1 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: 1. Power off your computer and reconnect the missing disk. 2. Turn on your computer. During the system startup, the volume status will display as 'Normal' in the Intel® Rapid Storage Technology option ROM user interface. 3. Once the operating system is running, open Intel® Rapid Storage Technology from the Start menu or click the Intel® Rapid Storage Technology notification area icon. 4. Under 'Status', verify that the volume and disks status display as 'Normal'. You can also review this information under 'Manage'.
Failed array disk	In most cases, the volume cannot be recovered and any data on the volume is lost. However, before deleting the volume, you 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. This procedure deletes the failed volume: 1. Power off your computer and replace the failed SATA disk with a new one that is of equal or greater capacity. 2. Turn on your computer. During the system startup, the volume status will display as 'Failed' in the Intel® Rapid Storage Technology 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, you will also need to reinstall the operating system.

RAID 5 A RAID 5 volume is reported as failed when two or more of its members have failed.	
Cause	**Solution**
Two or more array disks failed	In most cases, the volume cannot be recovered and any data on the volume is lost. However, before deleting the volume, you 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. This procedure deletes the failed volume: 1. Power off your computer and replace the failed SATA disks with new ones that are of equal or greater capacity. 2. Turn on your computer. During the system startup, the volume status will display as 'Failed' in the Intel® Rapid Storage Technology 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 5 volume using the new disks. If the failed disk was part of the system volume, you will also need to reinstall the operating system.

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.

Cause	Solution
Two adjacent array disks missing	1. Power off your computer and reconnect the missing disks. 2. The rebuild operation will start automatically. You 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	In most cases, the volume cannot be recovered and any data on the volume is lost. This procedure deletes the failed volume: 1. Power off your computer and reconnect the missing disks. 2. Turn on your computer. During the system startup, the volume status will display as 'Failed' in the Intel® Rapid Storage Technology 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 10 volume using the new disks. 8. You will then need to reinstall the operating system on the new volume.
Two or more array disks failed	In most cases, the volume cannot be recovered and any data on the volume is lost. However, before deleting the volume, you 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. This procedure deletes the failed volume: 1. Power off your computer and replace the failed SATA disks with new ones that are of equal or greater capacity. 2. Turn on your computer. During the system startup, the volume status will display as 'Failed' in the Intel® Rapid Storage Technology 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 10 volume using the new disks. 8. You will then need to reinstall the operating system on the new volume.

13.2 Degraded Volumes

Recovery Volume

A recovery volume is reported as degraded when the recovery disk has failed or when the master disk is disconnected or has failed. Data mirroring and redundancy are lost because the system can only use the functional member.

Cause	Solution
Recovery disk failed	We recommend that you rebuild the degraded volume to a new disk to return the volume and overall storage system status to normal. However, you can try resetting the disk to normal, but 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. If a SATA disk is compatible, available and normal, follow this procedure to rebuild the volume: 1. Under 'Status', click 'Rebuild to another disk'. 2. Select the disk you want to use to rebuild the volume, and then click 'Rebuild'. 3. The rebuild operation starts immediately. You 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 recovery disk and volume status will display as 'Normal'. 5. Once completed, the volume returns to the last update mode to which it was set before the issue was reported. **NOTE:** If there is no available disk present, you will need to power off your computer and connect a new SATA disk that is equal or greater capacity than the failed disk. Once your computer is back up and running you can follow the rebuild procedure described above.
Master disk missing	If you can reconnect the missing master disk, follow this procedure to recover data: 1. Power off your computer and reconnect the missing disk. 2. Turn on your computer and the system will automatically boot from the recovery disk. 3. Under 'Status', in the Manage subsection, click 'Recover data' or click the recovery volume in the storage system view, and then click 'Recover data'. 4. Click 'Yes' to confirm. 5. The recovery operation starts immediately and cannot be canceled. You can follow the progress by hovering over the notification area icon or by reviewing the volume status under 'Status' or 'Manage'. 6. Once completed, the volume returns to the last update mode to which it was set before the issue was reported. If you cannot reconnect the missing disk and a SATA disk is available and normal, follow this procedure to rebuild the volume: 1. Under 'Status', click 'Rebuild to another disk'. 2. Select the disk you want to use to rebuild the volume, and then click 'Rebuild'.

	3. The rebuild operation starts immediately. You 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 master disk and volume status will display as 'Normal'. 5. Once completed, the volume returns to the last update mode to which it was set before the issue was reported. If you cannot reconnect the missing disk or rebuild to an available disk, you will need to power off the computer and connect a new SATA disk. Once rebuilt, the recovery volume will be limited to its original size even if the new disk is larger than the original master disk. Once your computer is back up and running you can follow the rebuild procedure described above.
Master disk failed	We recommend that you rebuild the degraded volume to a new disk to return the volume and overall storage system status to normal. However, you can try resetting the disk to normal, but if the read/write data access consistently fails, the disk will likely return to a failed state immediately. 1. To reset the failed master disk and the volume to normal, follow this procedure: 2. Under 'Status', click 'Reset disk to normal'. Note that the volume is now running off the recovery disk, and that the master disk is reported as offline. 3. Under 'Status', in the Manage subsection, click 'Recover data' or click the recovery volume in the storage system view, and then click 'Recover data'. **Warning** Starting this action will override existing data on the master disk and update it with the data on the recovery disk. Backup all valuable data before continuing. Click 'Yes' to confirm. The recovery operation starts immediately and cannot be canceled. You can follow the progress by hovering over the notification area icon or by reviewing the volume status under 'Status' or 'Manage'. Once the operation successfully completed, the master disk and volume status will display as 'Normal'. If a SATA disk is compatible, available and normal, follow this procedure to rebuild the volume: Under 'Status', click 'Rebuild to another disk'. Select the disk you want to use to rebuild the volume, and then click 'Rebuild'. The rebuild operation starts immediately. You can follow the progress by hovering over the notification area icon or by reviewing the volume status under 'Status' or 'Manage'. Once the operation successfully completed, the master disk and volume status will display as 'Normal'. Once completed, the volume returns to the last update mode to which it was set before the issue was reported. **Note**

	If there is no available disk present, you will need to power off your computer and connect a new SATA disk. Once rebuilt, the recovery volume will be limited to its original size even if the new disk is larger than the original master disk. Once your computer is back up and running you can follow the rebuild procedure described above.

RAID 1 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.	
RAID 5 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.	
RAID 10 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 fails. When two or more array disks are disconnected or have failed, the volume is reported as failed.	
Cause	**Solution**
Missing array disk	If you can reconnect the missing disk, follow this procedure to rebuild the volume: 1. Power off your computer and reconnect the missing disk. 2. Turn on your computer and the rebuild operation will start automatically. If you cannot reconnect the missing disk and a SATA disk is available and normal, follow this procedure to rebuild the volume: If a SATA disk is compatible, available and normal, follow this procedure to rebuild the volume: Select the disk you want to use to rebuild the volume, and then click 'Rebuild'. The rebuild operation starts immediately. You can follow the progress by hovering over the notification area icon or by reviewing the volume status under 'Status' or 'Manage'. Once the operation successfully completed, the array disk and volume status will display as 'Normal'. **Note:** If there is no available disk present, you will need to power off your computer and connect a new SATA disk that is equal or greater capacity than the failed disk. Once your computer is back up and running you can follow the rebuild procedure described above.
Failed array disk	We recommend that you rebuild the degraded volume to a new disk to return the volume and overall storage system status to normal. However, you 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 you will need to rebuild the volume to another disk. If a SATA disk is compatible, available and normal, follow this procedure to rebuild the volume: 1. Under 'Status', click 'Rebuild to another disk'.

	2. Select the disk you want to use to rebuild the volume, and then click 'Rebuild'. 3. The rebuild operation starts immediately. You 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'. **Note:** If there is no available disk present, you will need to power off your computer and connect a new SATA disk that is equal or greater capacity than the failed disk. Once your computer is back up and running you can follow the rebuild procedure described above.
User switching SATA Controller Mode from RST/RAID -> AHCI -> RST/RAID	

13.3 Other Volume States

Locked	
Cause	**Solution**
At least one (but not all) disk included in the volume is locked with a password.	In this state, the overall storage system health is still reported as normal, but we recommend that you unlock the disks to make the volume data fully accessible. Follow this procedure to unlock a disk: 1. Under 'Status' or 'Manage', in the storage system view, click the disk you want to unlock. The disk properties are now displayed on the left. 2. Click 'Unlock'. 3. Enter the password, and then click 'Unlock'. 4. Repeat this procedure for all locked disks included in the volume in order to unlock the volume. **NOTE:** If all the disks included in a volume are locked, the volume is no longer displayed

Incompatible	
Cause	**Solution**
Indicates that the volume was moved to another system that does not support the volume type and configuration.	In this situation, volume data is accessible to the operating system and can be backed up, but the volume cannot operate because your system does not support its RAID configuration. Here are your options: 1. Reconnect the volume to the computer where the volume was originally created, and continue using it. 2. 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. **Warning** When a volume is deleted, all existing data on the member disks of the selected volume is permanently erased. It's recommended that you backup all valuable data prior to beginning this action.
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 your 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.
Power-Saving Mode (Recovery Volumes only)	
Cause	**Solution**
Your computer is running on battery and the volume is in continuous update mode. Data updates to the recovery disk or a data recovery operation are not occurring.	Data mirroring and redundancy are lost, and your data is at risk in the event of a disk failure. Reconnect your computer to the power supply, and the operation that was in progress prior to running on battery will resume automatically. **NOTE:** If a data recovery was in progress, the overall storage subsystem health is reported as degraded because the operation could not be completed.

Data Update Needed (Recovery Volumes only)	
Cause	**Solution**
The data on the recovery disk is not synchronized with the data on the master disk.	Data mirroring and redundancy are lost, and your data is at risk in the event of a disk failure. Follow this procedure to update data on the recovery disk: 1. Under 'Status' or 'Manage', in the storage system view, click the recovery volume. The volume properties are now displayed on the left. 2. Click 'Update data'. 3. Select the check box if you do not want this confirmation message to display each time you request an update. Click 'Yes' to confirm. 4. The update process can be instantaneous or may take a while depending on the amount of data being copied. You can follow the progress by hovering over the notification area icon or by reviewing the volume status under 'Status' or 'Manage'.
Running Off Recovery Disk (Recovery Volumes only)	
Cause	**Solution**
Your computer was booted from the recovery disk using the option ROM, and the volume is operating from that disk. With this reverse configuration, the recovery disk is the designated source drive and data updates to the master disk are not available.	Data mirroring and redundancy are lost, and your data is at risk in the event of a disk failure. A data recovery from the recovery disk to the master disk is required to maintain full redundancy. **Warning** Completing this action will overwrite all master disk data with the data on the recovery disk. Backup all valuable data prior to starting this action. 1. Under 'Status' or 'Manage', in the storage system view, click the recovery volume. The volume properties are now displayed on the left. 2. Click 'Recover data', then 'OK' to confirm. 3. Once complete, we recommend that you restart your computer from the master disk using the option ROM user interface to return to a normal state.

Recovery Disk Read-Only (Recovery Volumes Only)	
Cause	**Solution**
The recovery disk files have been accessed and display in Windows* Explorer*.	In this state, any data written to the master disk is not copied to the recovery disk because it is read-only. Data mirroring and redundancy may be lost and we recommend that you hide the recovery files to resume data updates. Follow this procedure to hide recovery disk files from Manage Disk or from Manage Volume: 1. Under 'Status' or 'Manage', in the storage system view, click the recovery volume or the recovery disk. The element properties are now displayed on the left. 2. Click 'Hide Files' from Manage Disk or 'Hide recovery disk files' from Manage Volume. 3. The Windows* Explorer window closes. 4. You can resume data updates by clicking 'Update data' under Manage Volume. To copy the latest changes to the recovery disk automatically, change the update mode to continuous from the same area.
Master Disk Read-Only (Recovery Volumes Only)	
Cause	**Solution**
Your computer was booted from the recovery disk using the option ROM, and the volume is operating from that disk. The master disk files have been accessed and are displayed in Windows* Explorer*.	Data mirroring and redundancy are lost, and your data is at risk in the event of a disk failure. We recommend that you hide the master disk files when finished with your review, and proceed with a data recovery to the master disk in order to maintain full redundancy. Follow this procedure to hide master disk files from Manage Disk: 1. Under 'Status' or 'Manage', in the storage system view, click the recovery volume or the master disk. The element properties are now displayed on the left. 2. Click 'Hide Files' from Manage Disk or 'Hide master disk files' from Manage Volume. The Windows* Explorer window closes and the volume is displayed as running off recovery disk. Refer to the 'Running off recovery disk' procedure above to recover data to the master disk.

Missing volume	
Cause	**Solution**
A driver upgrade or downgrade was performed while a data migration was in progress.	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: • 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. **Troubleshooting a data volume:** If the data migration involved a data volume, you 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 your computer. Open the application and make sure that the volume displays again in the storage system view. Data migration operation should resume immediately. **Troubleshooting a system disk:** If the data migration involved a system disk or volume, it is highly likely that you will not be able to start your system because the driver cannot read the system files. The following options may allow you to load the operating system again: Restore a known good configuration. Boot from a flash drive that supports NTFS partitioning and includes the storage driver files. 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. **Troubleshooting a system volume:** If the data migration involved a system disk or volume, it is highly likely that you will not be able to start your system because the driver cannot read the system files. The following options may allow you to load the operating system again: Restore a known good configuration. Bring all corrupted array disks to another system, and then replace the storage driver files from a compatible driver version. Return the disks to the original system and try booting.

13.4 Disk Events

State	Cause	Solution
	An internal or external disk is protected and locked with a password.	In this state, the overall storage system health is reported as normal, but to make the data fully accessible, you will need to follow this procedure to unlock the disk: 1. Under 'Status' or 'Manage', in the storage system view, click the disk you want to unlock. The disk properties are now displayed on the left. 2. Click 'Unlock'. 3. Enter the password, and then click 'Unlock'.
At risk 	An impending error condition was detected on an internal or external disk and is now at risk of failure.	The application is detecting early warning signs of failure with a SATA disk that result from a slow degradation over time. When a disk is reported at risk, you can reset that disk to normal, but we recommend that you contact the manufacturer for more information to prevent potential data loss. Follow this procedure to reset the disk to normal: 1. Under 'Status', in the Manage subsection, locate the disk reported as at risk. You 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. **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. **NOTE:** 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 you can reset it to normal to return to a healthy state.

State	Cause	Solution
	An unexpected error was detected on a disk that has RAID configuration data (metadata) on it.	In this state, it is likely that some or all of the disk data is inaccessible. After backing up any accessible data, you will need to clear the metadata and reset the disk to return to a normal state. **Warning**: Completing this action will permanently delete existing metadata. Back up any accessible data before continuing. 1. Under 'Status', in the Manage subsection, locate the disk reported as at risk. You can also perform this action from Manage Disk, which is accessible by clicking the disk in the storage system view. 2. Click 'Clear and reset disk', and then click 'Yes' to confirm. 3. Once complete, the page refreshes with the disk returning to a normal state.
	An array disk is not present or physically connected to the computer.	Ensure that the disk is securely connected to the SATA port and that the SATA cable is functioning properly. If the disk is lost or cannot be reconnected, you will need to connect a new 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.
	The recovery or master disk files have been accessed and display in Windows* Explorer*.	Hide the recovery or master disk files to return the disk status to offline and resume data updates in on request mode. 1. Under 'Status' or 'Manage', in the storage system view, click the recovery volume or the recovery disk. The element properties are now displayed on the left. 2. Click 'Hide Files' from Manage Disk or 'Hide recovery disk files' from Manage Volume. 3. The Windows* Explorer window closes.

State	Cause	Solution
Failed 	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.	Back up your data and we recommend that you 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. In a failed state, disk data may be lost, but you can try resetting the disk to normal, and then attempt a data recovery. Follow this procedure to reset the failed disk to normal: 1. Under 'Status', in the Manage subsection, locate the disk reported as failed. You 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. **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.
Offline 	An internal or external array disk is locked and data on that disk cannot be read.	We recommend that you unlock the disk to make the volume data fully accessible. If more than one array disk is locked, unlock all those disks to unlock the volume.
	The recovery volume is in on request update mode.	Change the volume update mode to continuous. 1. Under 'Status' or 'Manage', in the storage system view, click the recovery volume. The volume properties are now displayed on the left. 2. Click 'Change mode', and then click 'Yes' to confirm. 3. The page refreshes and the volume properties report the new update mode.
	Your computer is running on battery and data updates to the recovery disk are not available as long as that disk is offline.	Reconnect your computer to the power supply in order to return the recovery disk to a normal state.

13.5 Caching Issues

Cache Volume is Missing
Regardless of what the acceleration mode currently is, cache and volume data is most likely lost. Devices that are part of the acceleration configuration display in the following states: • Solid state disk: Inaccessible • Cache volume: No longer displays • Data volume (if applicable): No longer displays • Accelerated volume (if applicable): No longer displays • Accelerated disk (if applicable): Offline • Array disks: Offline
Cause
The solid state disk was removed or the disk is present but cannot be detected.
Solution
The application provides the option to clear the metadata on the array disks or previously accelerated disk and reset these disks to a normal state. 1. Under Status, in the Manage subsection, click 'Clear and reset' next to each array disk reported as offline. You can also perform this action under 'Manage' by clicking any offline disk reported in the storage system view. 2. Click 'Yes' to confirm. The array disk now displays as an available disk in a normal state and can be used to create a new volume

Cache Volume is Failing
Cause
An impending error condition (e.g., SMART events) was detected on the solid state disk that is used as a cache device. As a result, both the disk and cache volume are at risk of failure.
Solution
Early warning signs of failure with the solid state disk are detected that result from a slow degradation over time. When a disk used as a cache device is reported at risk, you can reset that disk to normal or replace the solid state disk after resetting it to available. Regardless of which option you choose, we recommend that you contact the manufacturer for more information to prevent potential data loss. Current acceleration mode: Enhanced Follow this procedure to reset the disk to normal: 1. Under 'Status', in the Manage subsection, locate the disk reported as at risk. You can also perform this action from Manage Disk, which is accessible by clicking the failing disk in the storage system view. 2. Click 'Reset disk to normal'. The page refreshes instantly, returning to a normal state. 3. The cache volume should also return to a normal state and caching activity should resume. 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. Follow this procedure to replace the failing solid state disk: 1. Click 'Accelerate', and then click 'Disable acceleration'. 2. In the dialog, click 'Yes' to confirm. 3. The page refreshes and reports the acceleration as disabled. 4. Click 'Reset to available'. 5. In the dialog, select the check box to confirm that you understand that data on the cache and data volumes will be deleted. 6. Click 'Yes' to confirm. 7. The page refreshes and the storage system displays the solid state disk usage as available. 8. Power off your computer and replace the failing solid state disk with a healthy one. 9. Power on your computer. You can enable acceleration again in order to resume caching activity. **Note:** If the last acceleration mode was maximized, that application will automatically transition acceleration to enhanced mode in order to avoid data loss. While transitioning, the mode will display as busy and no acceleration actions will be available until the process is complete. **Current acceleration mode: Maximized** 1. If a compatible spare is detected, the volume rebuild operation will start automatically. Once the process is complete, the cache volume will display in a normal state and caching activity will resume. 2. If no compatible spare is detected, the acceleration mode will automatically transition to enhanced in order to avoid data loss. You can then follow the procedures described above to return the solid state disk and cache volume to normal.

Cache Volume has Failed
Cause
The solid-state disk that is used as a cache device has failed to properly complete read and write operations in a timely manner and it has exceeded its recoverable error threshold. In this state, both cache and data volumes are reported as failed and acceleration is automatically disabled.
Solution
Back up any recoverable data and replace the solid- state disk as soon as possible. In a failed state, disk data may be lost, but you can try recovering it by resetting the disk to normal.
1. In the Manage subsection, under 'Status', locate the disk reported as failed. Alternately, perform this action from Manage Disk, 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. 3. If the disk operations continue to fail, the disk will return to a failed state immediately and should be replaced. Follow this procedure: 4. Click 'Accelerate'. 5. Click 'Reset to available'. 6. In the dialog, select the check box to confirm that you understand that data on the cache and data volumes will be deleted. 7. Click 'Yes' to confirm. The page refreshes and the storage system displays the solid state disk usage as available. 1. Power off your computer and replace the failed solid state disk with an operational one. 2. Power on your computer. To resume the caching activity, enable acceleration again. If acceleration was in maximized mode prior to being automatically disabled, the disk or volume previously associated with the cache will be reported as failed if the data cleaning was unsuccessful. If data cleaning was successful, once the mode transition is complete, the accelerated disk or volume previously associated with the cache will be reported as normal.

Accelerated disk or volume is missing
Cause
The accelerated disk or volume cannot be detected (e.g., the device was moved to another system) and is reported as inaccessible. Caching activity is no longer occurring.
Solution
If the disk or volume can be reconnected: 1. Power off your computer and reconnect the missing disk or volume. 2. Restart your computer. 3. Once the operating system is running, open the application. 4. Under 'Status', in the Accelerate subsection, verify the accelerated device is properly reported as well as the acceleration mode. Caching activity should resume immediately. If the disk or volume cannot be reconnected, follow this procedure to disassociate the cache and the missing device: 1. Click 'Accelerate'. 2. Click 'Disassociate'. 3. Click 'Yes' to confirm. 4. The page refreshes and you can now select another disk or volume to accelerate.

Accelerated Disk or Volume is Reporting an Issue
Cause
• Accelerated disk is reported as being at risk or failed. • Accelerated volume is reported as degraded or failed.
Solution
Refer to Troubleshooting Disk Events, Failed Volumes, or Degraded Volumes for detailed procedure on fixing the issue. If you cannot fix the issue reported on the accelerated disk or volume, follow this procedure to disassociate the cache and the missing device: 1. Click 'Accelerate'. 2. Click 'Disassociate'. 3. Click 'Yes' to confirm. The page refreshes and you can now select another disk or volume to accelerate.

13.6 Software Errors

Message	Cause	Solution
An unknown error occurred while running this application. If the problem persists, restart your computer or try reinstalling the application.	This error may be related to: Missing components Corrupted application Application unable to connect to the service Application fails to start.	Restart your computer or try reinstalling the application.
Intel® Rapid Storage Technology 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 service cannot be started in safe mode.	Your computer was started in safe mode and the operating system is running with a limited set of files and drivers. Intel® Rapid Storage Technology cannot start or run in safe mode.	Once you are done troubleshooting application or driver problems in safe mode, you will need to exit safe mode, restart your computer, and then let the operating system start normally. The Intel® Rapid Storage Technology 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. Try again later.	The Intel® Rapid Storage Technology 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. 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 your hardware is properly connected and try recreating the volume.

Message	Cause	Solution
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 your computer and then the operation.
An error occurred and the selected disk or volume could not be accelerated. Restart your computer, and then try the operation again.	The cache memory allocation was likely increased to use full solid state disk capacity (up to 64 GB) while enabling acceleration.	Follow these steps to accelerate a disk or volume: • Restart your computer to complete the process of allocating the requested cache size. • Launch the application. • Try enabling acceleration again by clicking 'Enable acceleration'.

13.7 UI Error Handling

Errors can occur while performing different operations. If an error appears, it will also contain an error code which can used to identify the error. We can lookup online for handling the UI error codes. The page contains the error codes along with the meaning of the error and their possible solutions.

We can refer to the Intel® Website support page in the link below:
https://www.intel.com/content/www/us/en/support/articles/000024113/memory-and-storage/intel-optane-memory.html

§§