ThinkStation Storage Configuration

ThinkStation PX, P7, P5 with discrete RAID controller

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Overview

The main objective of this document is to provide a detailed, step-by-step walkthrough for the seamless installation and setup of the optional hardware storage controllers available for ThinkStation PX, P7, and P5. Optional hardware storage controllers offer advanced data storage capabilities that enhance performance, redundancy, and data protection. By following the instructions provided here, users will be able to install and configure the Broadcom PCIe add-in storage controller to optimize their data storage infrastructure.

Advantages of using Broadcom PCIe add-in storage controller are:

- **Dedicated Hardware:** Broadcom RAID cards come with dedicated hardware process that handles RAID calculations and operations. This offloads the CPU(s), resulting in improved system performance, especially during heavy I/O workloads.
- **Write-Back Cache Protection:** The Broadcom 9560-16i RAID adapter offers an optional CacheVault Technology upgrade to help protect cached data in the event of a power failure. This enhances data integrity and prevents data loss in volatile memory caches.

Section 1 – Storage Controller Details

Table 1 - General overview of Broadcom adapters support on ThinkStation platforms.

	Broadcom 9560-16i (SAS3916) Adapter		Broadcom 9540-8i (SAS3808) Adapter
Platform	PX	P7	P5
Maximum Number of Drives	Up to 4 NVME	Up to 2 NVMe Up to 3 SATA	Up to 3 SATA
Connection Method	x8 SFF-8654 (SlimSAS)		
Drive Type Supported	M.2 NVMe U.2 NVMe U.3 NVMe E1.S NVMe	3.5" SATA HDD M.2 NVMe U.2 NVMe U.3 NVMe E1.S NVMe	3.5" SATA HDD
RAID Level Support	RAID 0 RAID 1 RAID 5 RAID 10*		RAID 0 RAID 1
Adapter Speed	Gen 4.0 PCIe (NVMe)	6Gb/s SATA Gen 4.0 PCIe (NVMe)	6Gb/s SATA
Additional hardware	SuperCap (Cache Backup Unit) PCIe retention bracket (RAID SuperCap Holder Kit)		PCIe retention bracket

*RAID 10 is only available on PX

Section 2 – ThinkStation PX Support

ThinkStation PX has an ability to support PCIe add-in card by utilizing front access enclosures. This section covers information about support for the Broadcom 9560-16i RAID adapter as well as the installation process for the adapter and associated parts.
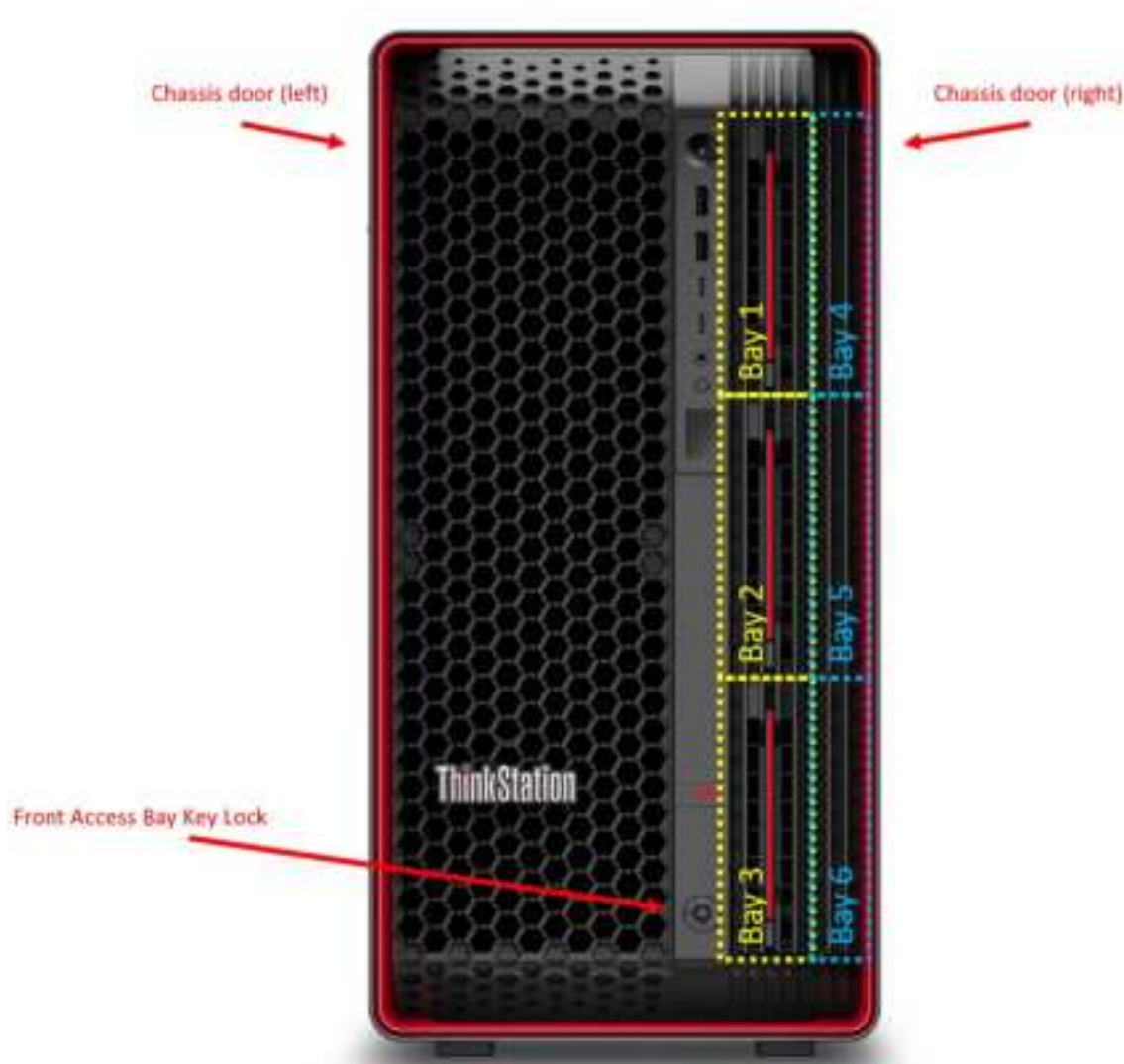
Note: Bay 1 and Bay 4 are not used with the Broadcom adapter.

Table 2 – General overview of Broadcom 9560-16i RAID adapter support on ThinkStation PX

Maximum Number Drives	One of the following: • Up to 4 x M.2 NVMe or • Up to 4 x E1.S NVMe or • Up to 2 x U.2/U.3 NVMe
Supported RAID Levels	M.2 and E1.S: • RAID 0 • RAID 1 • RAID 5 • RAID 10 U.2/U.3 NVMe: • RAID 0 • RAID 1
Drive Speed	Gen 4.0 PCIe

Notes:

- Arrays cannot be created using the Broadcom RAID controller on the following locations:
    - PCIe add-in cards
    - Onboard NVMe M.2 drives
- The Broadcom cable connects to both the motherboard and the drive bays. However, this connection to the motherboard is for the purpose of configuring and managing the drives in the supported drive bays. It does not enable hardware RAID for the onboard or PCIe based drives. The onboard and PCIe drives operate independently and are not part of the Broadcom RAID configuration.
- Mixing drives with different capacities and types within the same virtual drive group is not supported.

Hardware Requirements:

Table 3 - Compatibility and common parts requirements for Front Access Bay utilization on PX

Common Components
(These components are required to support all drive types in ThinkStation PX):
2 CPUs Storage Bay Fan Broadcom 9560-16i adapter Broadcom NVME Bay2 Gen4 cable Broadcom NVME Bay3 Gen4 cable Drive activity LED cable

Table 4 - Compatibility and unique parts requirements for Front Access Bay utilization on PX

Location	Compatibility	Unique parts

Front Access Bay 2+5	Up to 2 x NVME drives:
	
	2 x M.2 NVMe
	       or
	2 x E1.S NVMe
	       or
	1 of each
		Dual NVMe SSD Enclosure
		
		M.2 SSD Carrier
		
		E1.S SSD Carrier

Front Access Bay 3+6	Up to 2 x NVME drives:
	
	2 x M.2 NVMe
	       or
	2 x E1.S NVMe
	       or
	1 of each
		Dual NVMe SSD Enclosure
		
		M.2 SSD Carrier
		
		E1.S SSD Carrier

Front Access Bay 5	1 x U.2/U.3 NVMe	U.2/U.3 SSD enclosure with backplane
Front Access Bay 6	1 x U.2/U.3 NVMe	U.2/U.3 SSD enclosure with backplane

Notes:

- U.2/U.3 cannot be used together with M.2/E1.S enclosures.
- See Appendix for detailed parts information.

Installing M.2/E1.S Front Access Enclosures in PX

Refer to the PX Storage Whitepaper for installation instructions.

Installing U.2/U.3 Front Access Enclosures in PX

On ThinkStation PX models without Front U.2/U.3 SSD Enclosures installed previously, the user has an option to add up to two (2) U.2/U.3 SSD Enclosures in the front access bays. Below are instructions on how to install U.2/U.3 Enclosures in the front access bays.

1. Remove the Front Access 3.5" HDD Tray from 'Front Access Bay 2' and/or 'Front Access Bay 3' depending on the number of front U.2/U.3 NVMe enclosures to be installed.

   Note: Some ThinkStation PX models may have the Front Access Bay Key Lock installed. If so, make sure the front access bays are unlocked during this process. For instructions on how to unlock Front Access Bay Key Lock, please refer to the Thinkstation PX Storage Whitepaper.

2. Remove the chassis side cover (left).

   Note: Some ThinkStation PX models may have the chassis side cover key lock installed. If so, make sure the chassis side cover is unlocked. On how to unlock Side cover key lock, please refer to the Thinkstation PX Storage Whitepaper.

Side cover key lock

3. Remove the other chassis side cover (right).

   Note: There is a lock feature on the inside of the chassis that prevents the right-side cover from opening. This mechanism can slide left or right to move it to the unlocked or locked positions. To remove the side cover, move this mechanism to the unlocked position.
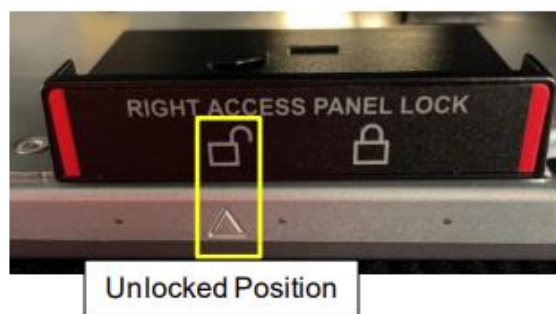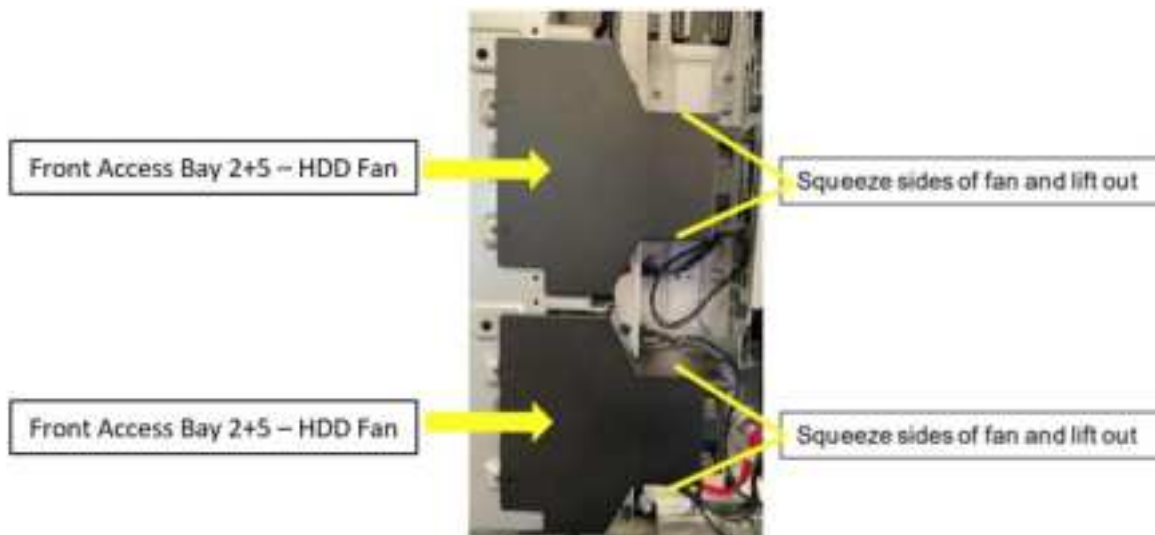

   While looking at the rear side of the system, press the gray latch to release the hooks to slide the whole chassis side cover back and out.
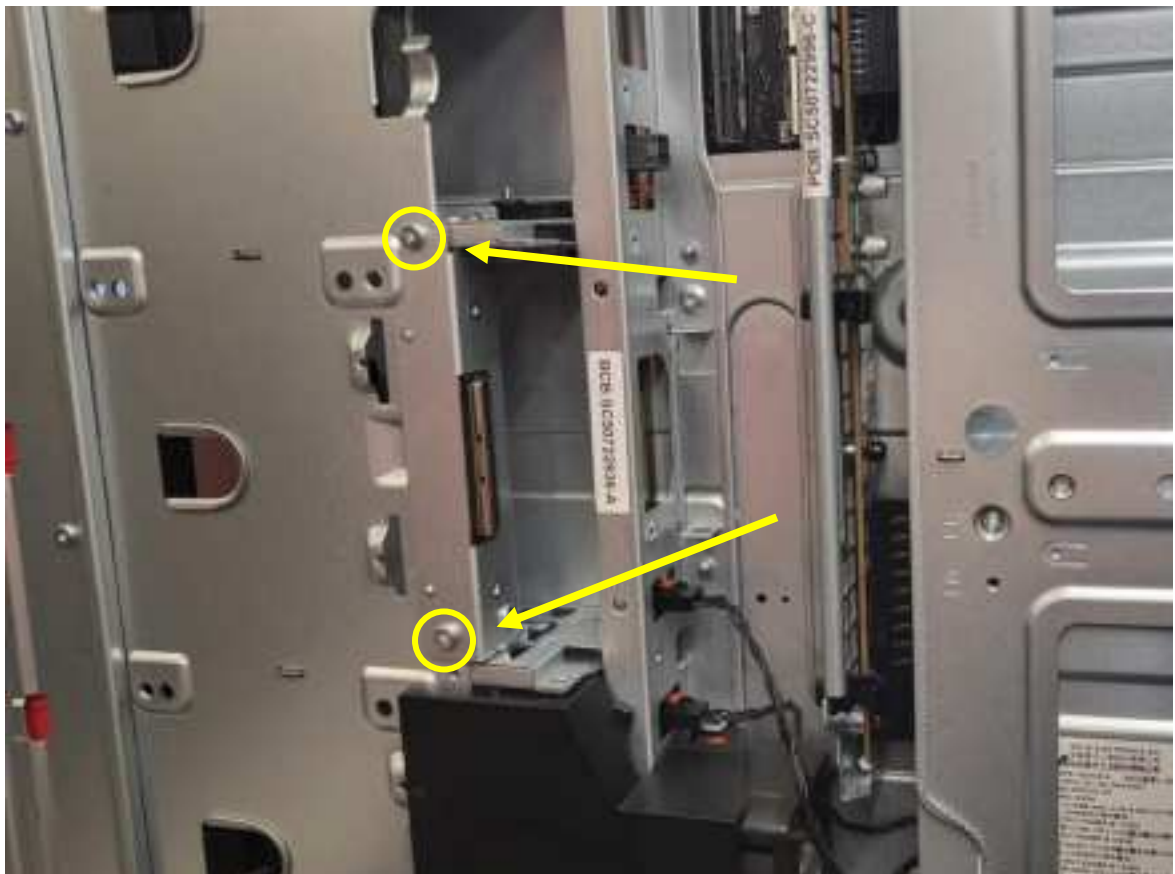
4. While looking at the right side of the system (under the motherboard), press the release tabs to remove the blank bezel for front access bays 5 and/or 6 depending on how many U.2/U.3 storage enclosures to add.

Blank bezel for Front access Bay 5

Blank bezel for Front access Bay 6
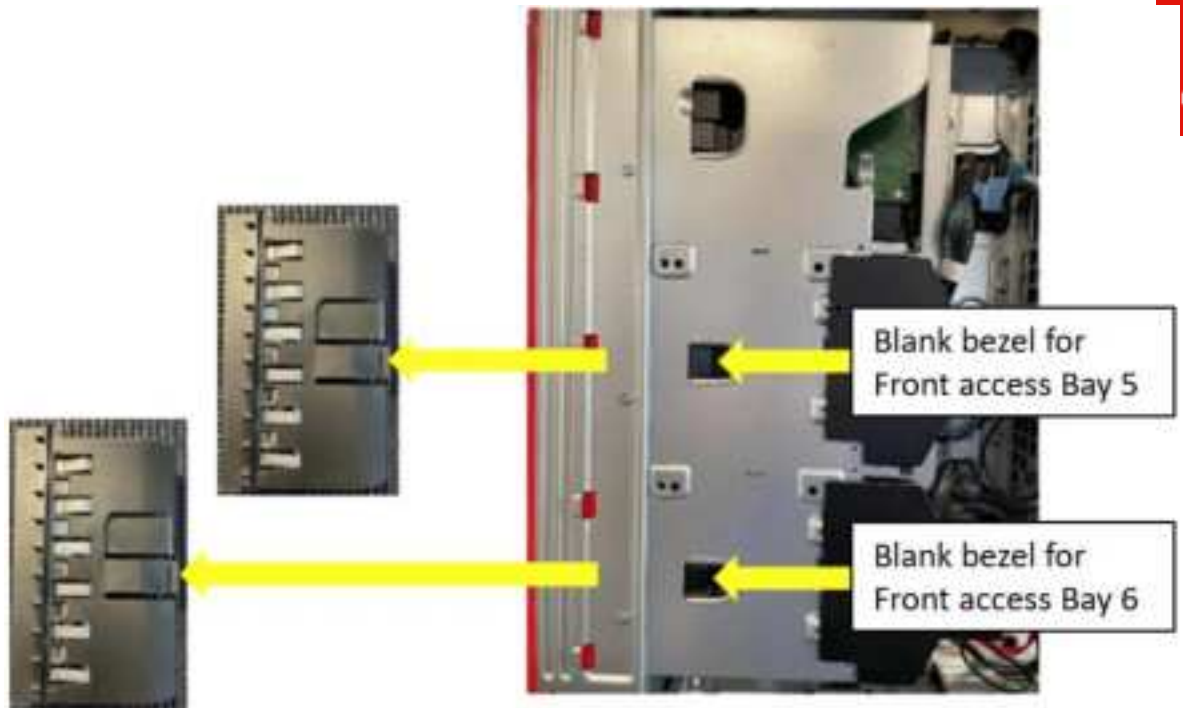
5. Remove HDD fans for the front access bay 2+5 and/or 3+6 depending on how many U.2/U.3 storage enclosures are to be added.

Front Access Bay 2+5 – HDD Fan

Squeeze sides of fan and lift out

Front Access Bay 2+5 – HDD Fan

Squeeze sides of fan and lift out

6. Install and secure backplane with provided screws.

U.2/U.3 backplane

7. Secure the U.2/U.3 SSD in a tray with the 4 provided screws (follow the nubmered guidance on the enclosure).

Spare screw location
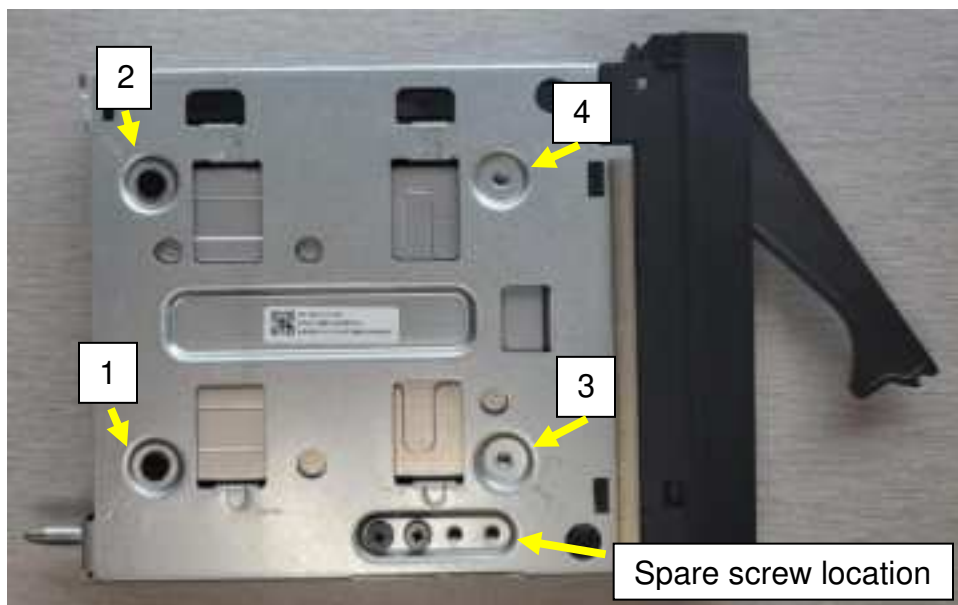
8. Slide the U.2/U.3 SSD enclosure into one of the front access bays with the handle mount located on top end. As seen in the picture below push on bottom end of the tray until it latches into the chassis. Then, press on the red handle until it clicks securely into place.

Installing the Broadcom 9560-16i RAID Adapter

To install the Broadcom Adapter in PX follow the below steps:

1. Remove both side covers from the system.
2. Install NVMe enclosures in the front access bay(s). For instructions on installing the M.2 NVMe and E1.S Front Access Bay enclosures, please refer to the PX Storage Whitepaper.

   Note: The instructions in the whitepaper are for installing M.2 enclosures. These are the same instructions for installing E1.S enclosures. If you are installing U.2/U.3 Front Access Bay enclosures, you can find detailed guidance in the previous section "Installing U.2/U.3 Front Access Enclosure in PX".

3. Guide the Broadcom NVME Bay2/Bay3 Gen4 cables from front access bay enclosures 2+5 & 3+6 to the backside of the motherboard and connect the cables as seen below.
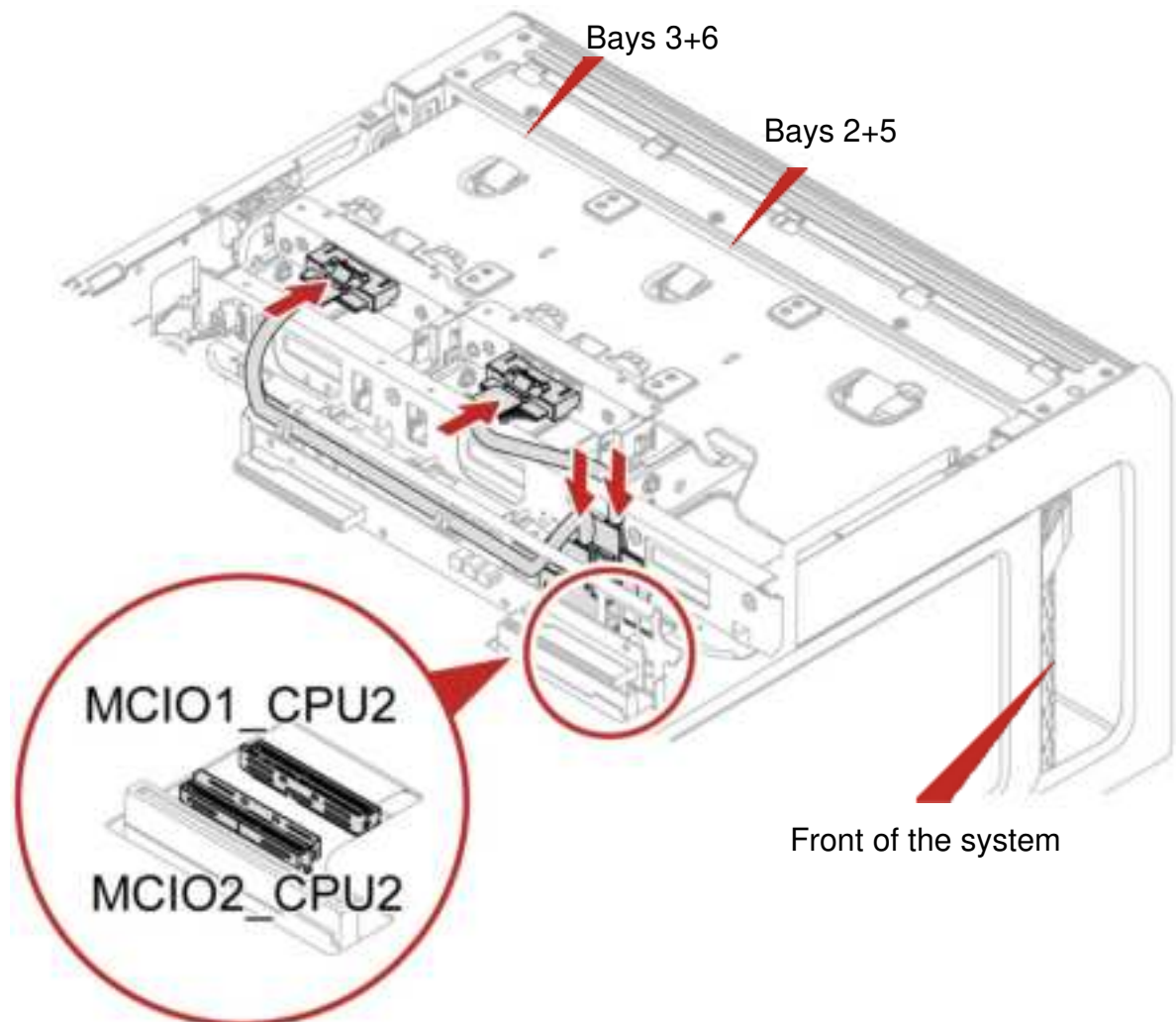
Note: Only drives in Bay 2+5 and/or Bay 3+6 are capable of supporting a Broadcom adapter.

4. Connect Broadcom NVME Bay2/Bay3 Gen4 cables according to the next diagrams:

Bay 2+5 cable:
- Connector "1st" to motherboard port "1st"
- Connector "Bay2" to backplane for bays 2+5
- Connector "C0" will be addressed in the next step
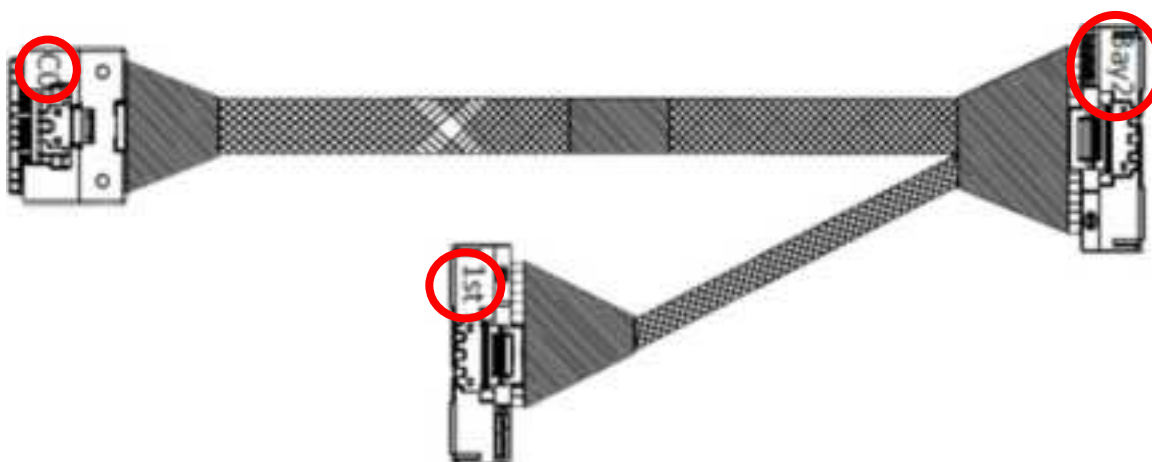
Bay 3+6 cable:
- Connector "2st" to motherboard port "2st"
- Connector "Bay3" to backplane for bays 3+6
- Connector "C1" will be addressed in the next step
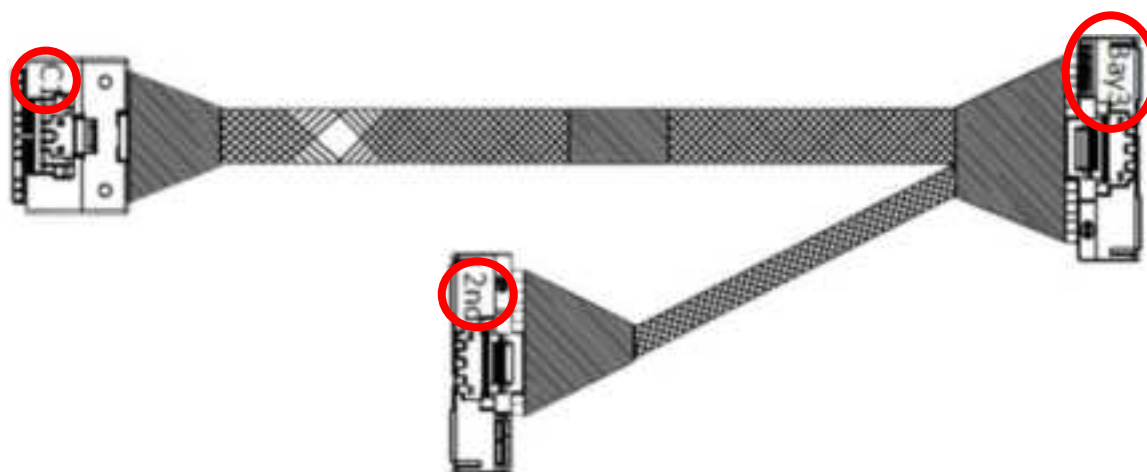
5. Install the Broadcom adapter in an open PCIe slot (refer to the HMM for PCIe slot installation order).
6. Connect the Broadcom NVME Bay2/Bay3 Gen4 cable plugs C0 & C1 to corresponding ports C0 and C1 on the Broadcom adapter.
7. Connect the drive activity LED cable to the J10 pins on the Broadcom adapter and to pins on the system board labeled "Drive_ACT".
8. Install the SuperCap retention bracket.

Back of the system
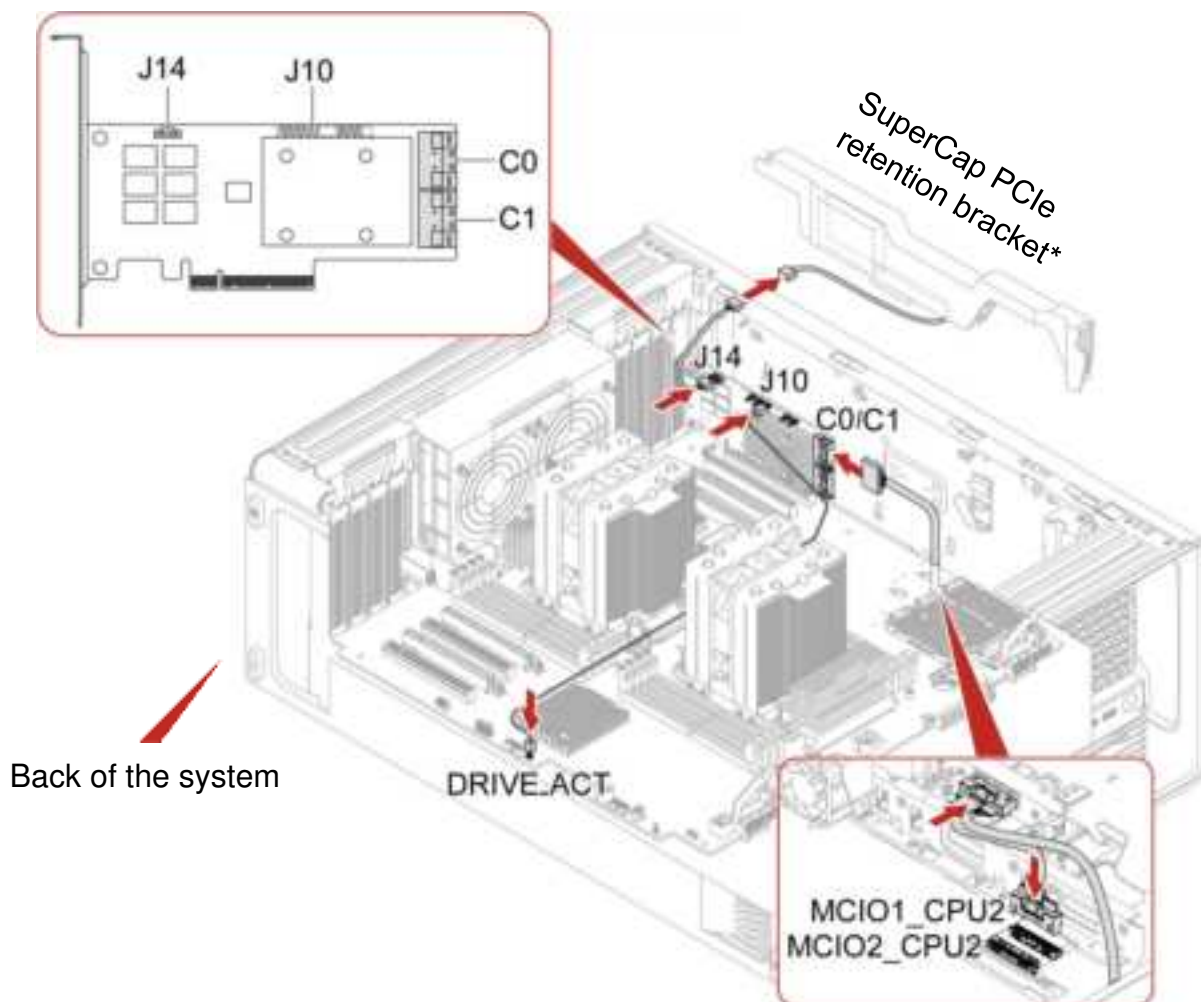
*Assembly instructions shown below.

SuperCap PCIe retention bracket assembly instructions:

  a. Connect the SuperCap (Cache Backup Unit) to the SuperCap cable.

SuperCap cable

Cache Backup Unit

  b. Open the PCIe retention bracket (shown with cover removed).

Rear of system
PCIe retaining latch

  c. Install the SuperCap into the PCIe retention bracket as seen below.

d. Install the PCIe retention bracket cover.

9. Connect the SuperCap cable to the J14 connector on the Broadcom adapter.
10. Install the PCIe retention bracket as shown below.
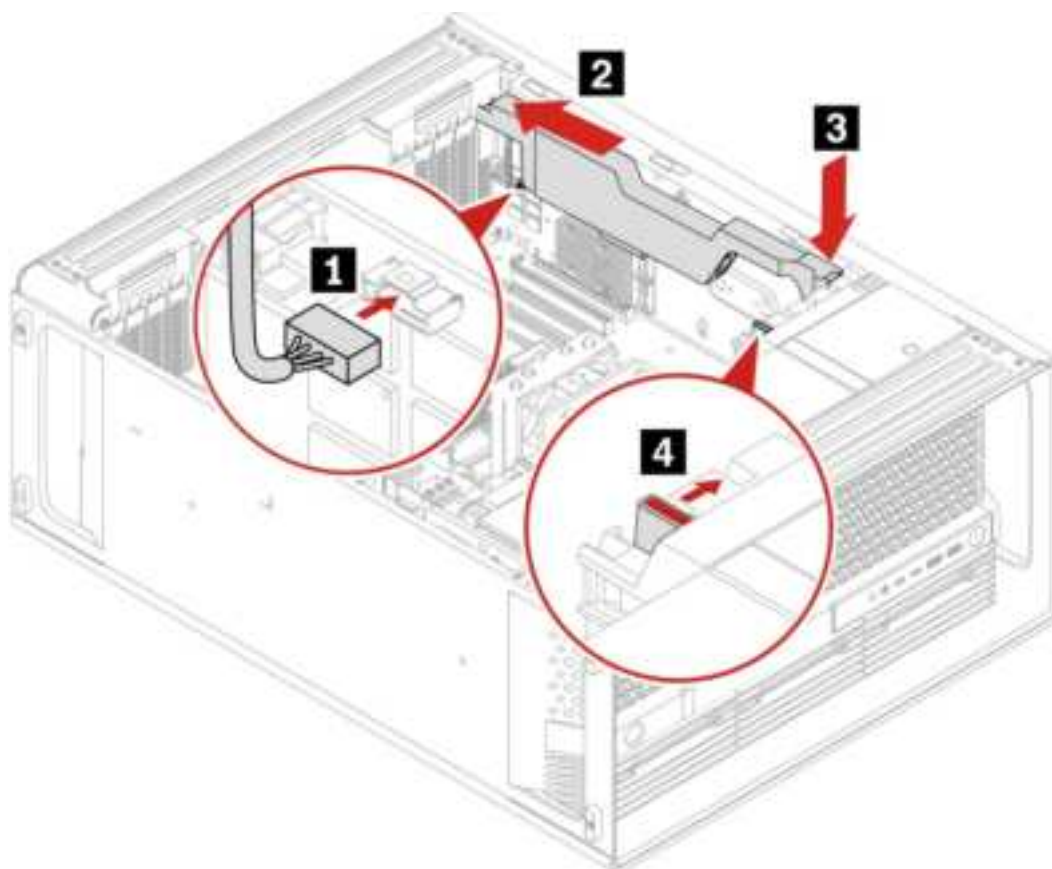
11. Reinstall left side cover.
12. Insert carrier(s) with drive(s) into the system as shown below.
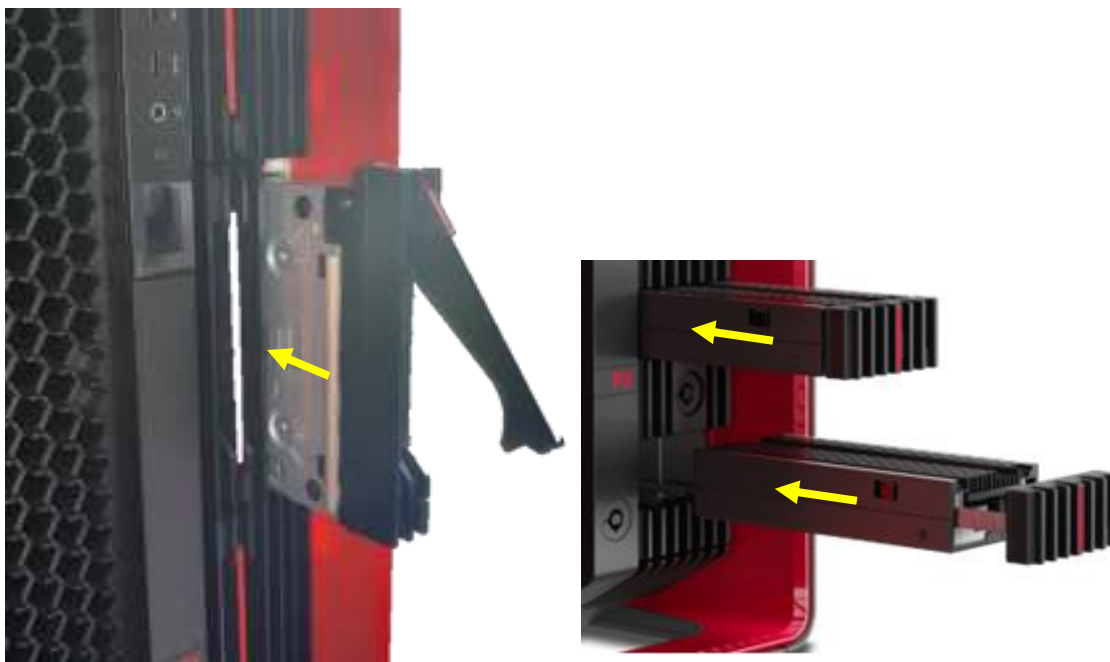
13. If required, configure RAID following the guidance in Chapter 5 Configuring RAID.

Section 3 – ThinkStation P7 Support

In the P7 system, RAID compatible drives are installed in the Internal Storage Bay and the optional 3rd HDD bay located above the CPU heatsink. When utilizing the Broadcom 9560-16i RAID adapter, users can install up to two (2) drives in the internal storage bays as well as one (1) hard drive in the optional 3rd HDD bay for SATA drive only. With this configuration, the P7 system offers support for a maximum of three (3) SATA HDDs and two (2) NVMe drives through the use of the Broadcom adapter.

Table 5 - General overview of Broadcom 9560-16i RAID adapter support on ThinkStation P7

Maximum Number Drives	One of following: • Up to 2 x M.2 NVMe or • Up to 2 x E1.S NVMe or • Up to 2 x U.2/U.3 NVMe • Up to 3 x 3.5 HDD
Supported RAID Levels	M.2/E1.S/ U.2/U.3 NVMe: • RAID 0 • RAID 1 HDD: • RAID 0 • RAID 1 • RAID 5
Drive Speed	NVMe Gen 4.0 PCIe SATA 6Gb/s SATA

Notes:

- Microsoft Windows 11 no longer supports booting from magnetic rotational media (HDDs).
- Arrays cannot span across any of the following locations:
  - Front enclosure bays
  - PCIe add-in cards
  - Onboard NVMe M.2 drives
- The Broadcom cable connects to both the motherboard and the drive bays. However, this connection to the motherboard is for the purpose of configuring and managing the drives in the supported drive bays. It does not enable hardware RAID for the onboard or PCIe based drives. The onboard and PCIe drives operate independently and are not part of the Broadcom RAID configuration.
- Mixing drives with different capacities and types within the same virtual drive group is not supported.

Hardware Requirements:

Common Parts

(These components are required to support all drives in ThinkStation P7):

- Broadcom 9560-16i RAID adapter
- Drive activity LED cable

Table 6 - Compatibility and unique parts requirements for NVMe and HDD drive support

Location	Combability	Unique parts
Internal Storage Bay	2 x M.2 NVMe or 2 x E1.S NVMe or 2 x U.2/U.3 NVMe	• Storage bay 6020 FAN • HDD bay for NVMe SSD kit (includes Blind Connect Board (BCB) and cable) • Broadcom NVME bay3 Gen4 cable • Internal trays for M.2 NVMe • Internal trays for E1.S SSD • Internal trays for U.2/U.3
Internal Storage Bay + Optional HDD drive bay (above CPU)	3 x HDD	• SlimSAS to 3-drop SATA cable • Optional HDD kit for 3rd 3.5" HDD

<u>Note</u>: See [Appendix](#) for detailed parts information.

Installing the components for NVMe drives:

1. Remove the side cover from the system.
2. Remove the air baffle.
3. If the BCB is not present in the system, please refer to the P7 Storage Whitepaper for BCB and NVMe drive installation instructions.

Note: Installing a BCB prevents use of 3.5" SATA drives in the drive storage bays.

4. Plug the right angle connector of the Broadcom NVMe Gen4 cable onto the NVMe BCB interface.
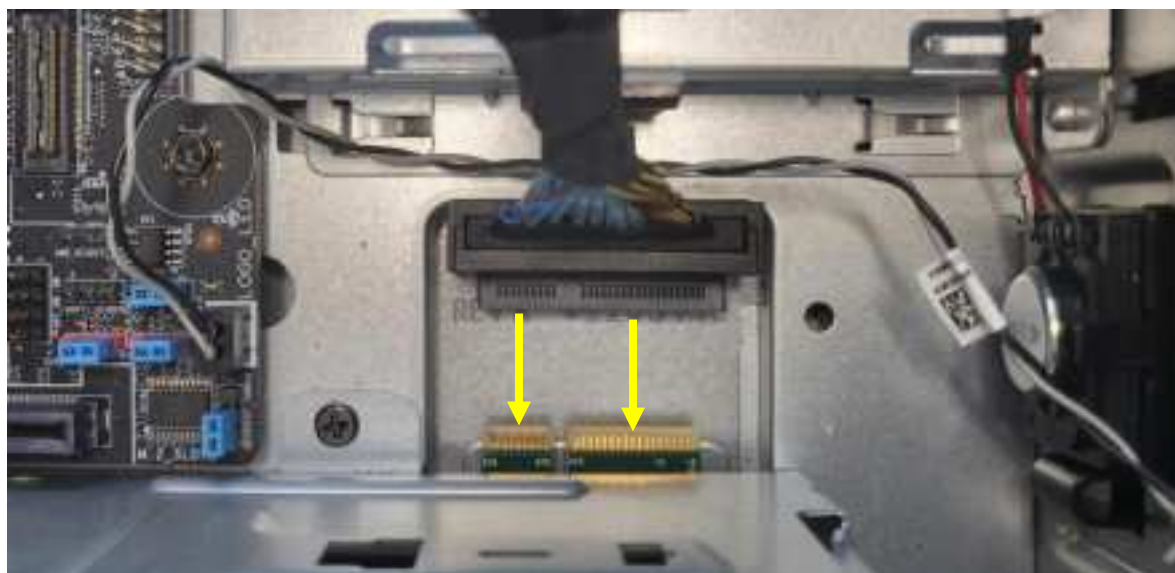
5. Connect the Broadcom NVMe Gen4 cable to the motherboard port "MB_MCIO".
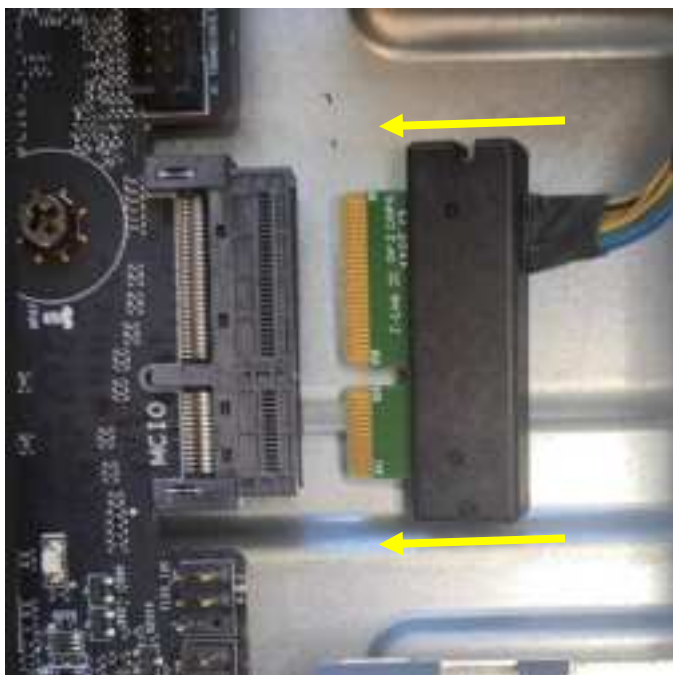
Note: When the Broadcom adapter is in use, the Front Access Bay Storage cannot be used at the same time.

6. Install the Broadcom adapter in PCIe slot (refer to the P7 HMM for PCIe slot installation order).
7. Connect the Broadcom NVMe Gen4 cable plug C0 into the C0 port on the Broadcom adapter.
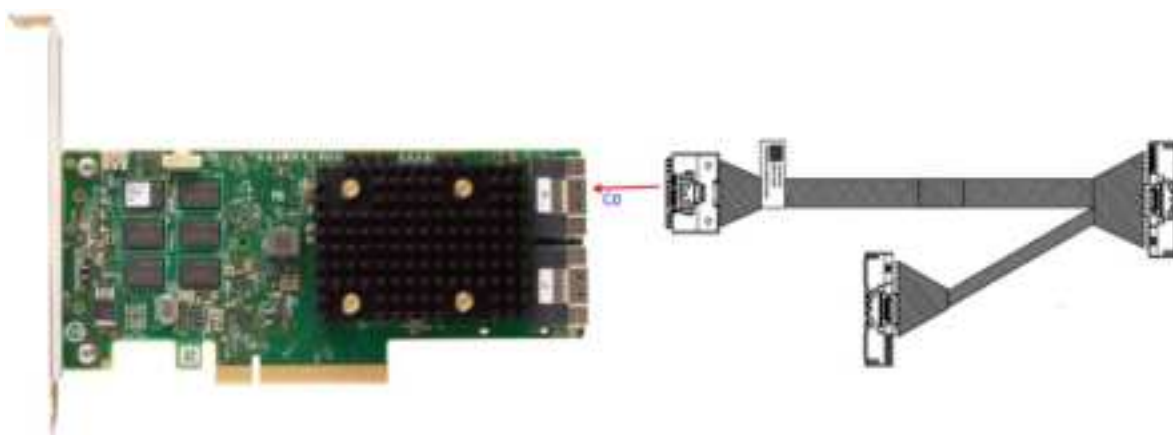
8. Connect the drive activity LED cable to J10(a) on the Broadcom adapter and to the motherboard pins labeled "Drive_ACT" (b).
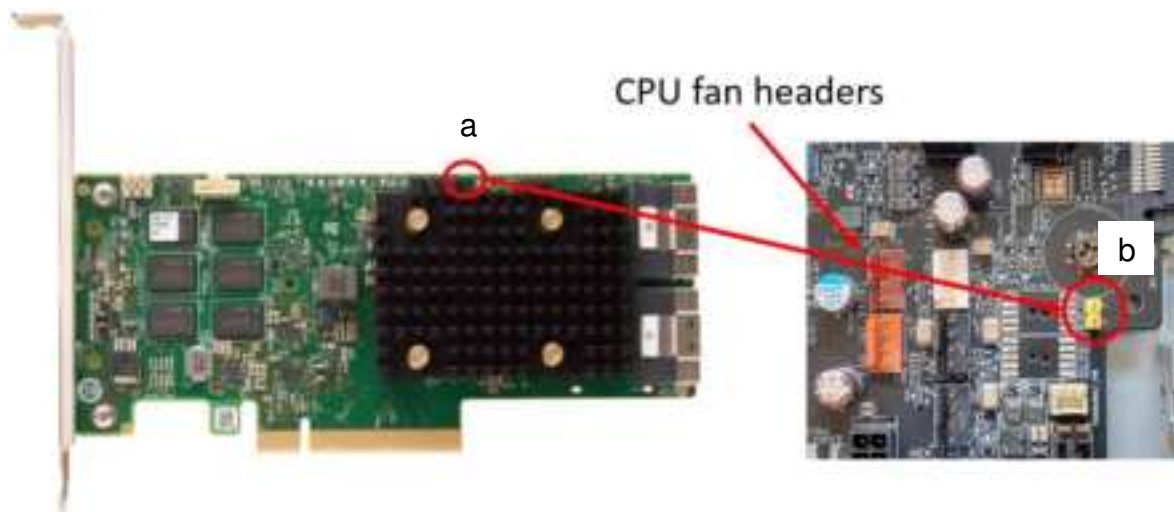
9. Connect the SuperCap to the Broadcom adapter.

   Note: For the SuperCap PCIe retention bracket assembly instructions please refer to "SuperCap PCIe retention bracket assembly instructions".

10. Install the SuperCap PCIe retention bracket as shown below.
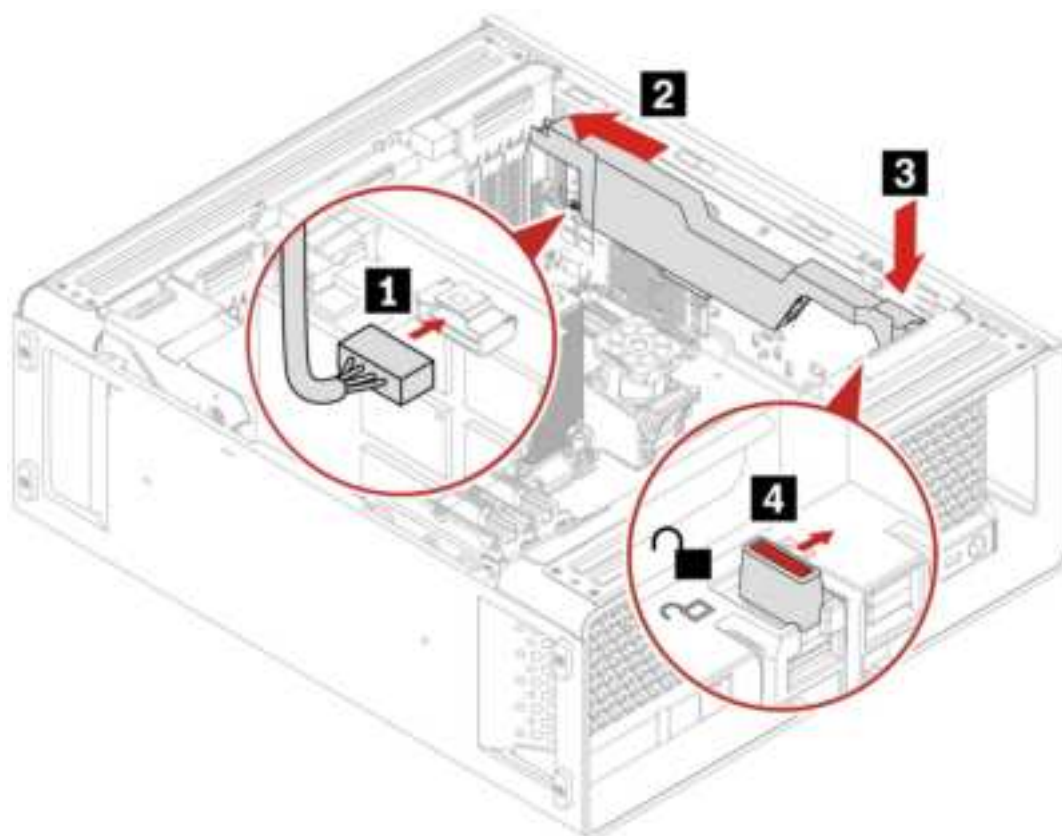
11. Install NVMe drives into carriers.
12. Reinstall air baffle.

SuperCap PCIe retention
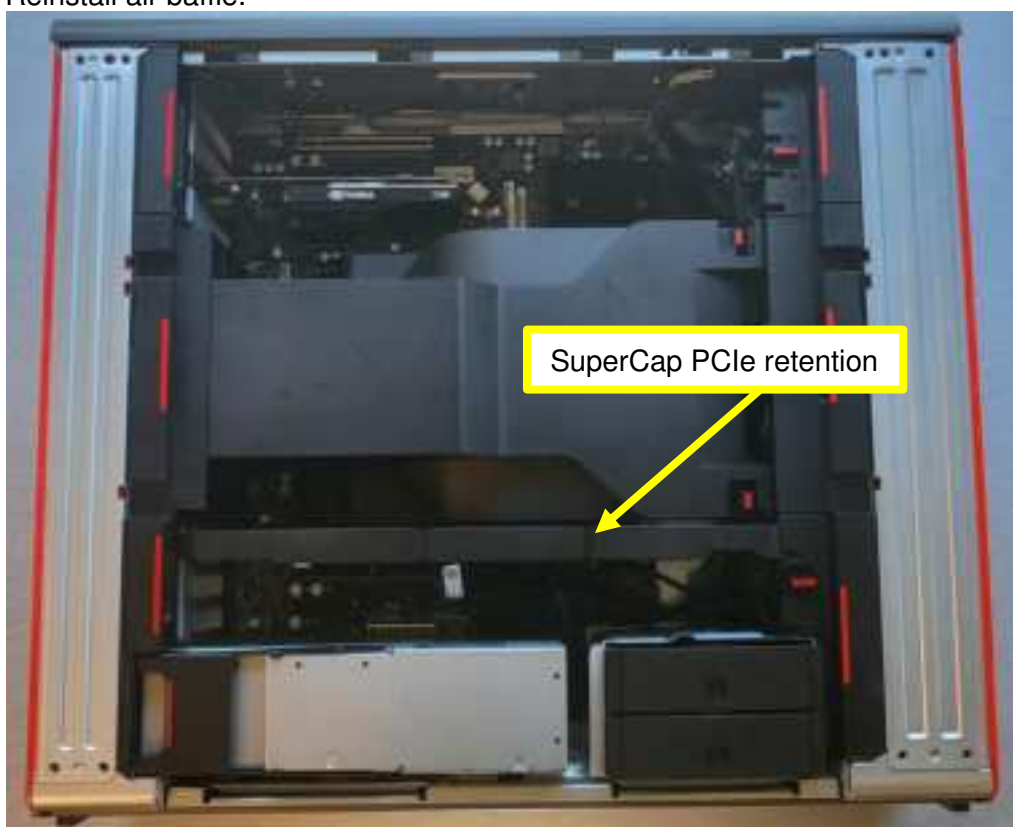
13. Install drives carriers into storage bay (use the correct drive tray for specific types of drives).

| M.2 NVMe | U.2/U.3 NVMe | E1.S NVMe |

14. Reinstall the side cover.
15. If required, configure RAID following the guidance in Chapter 5 Configuring RAID.

Installing the components for SATA HDDs:

1. Remove the side cover from the system.
2. Remove the air baffle.
3. Connect the HDD power plug to the motherboard HDD power connector and route the cable through the cable guides as shown below.

Note: For how to install the SATA HDDs please refer to P7 Storage Whitepaper.

<image_prompt>Diagram of HDD power cable with labels HDD Power, C0, P1, P2, P3</image_prompt>

<image_prompt>Photo of computer interior showing HDD Power connector, Cable guides, C0, P1, P2, P3 labels</image_prompt>
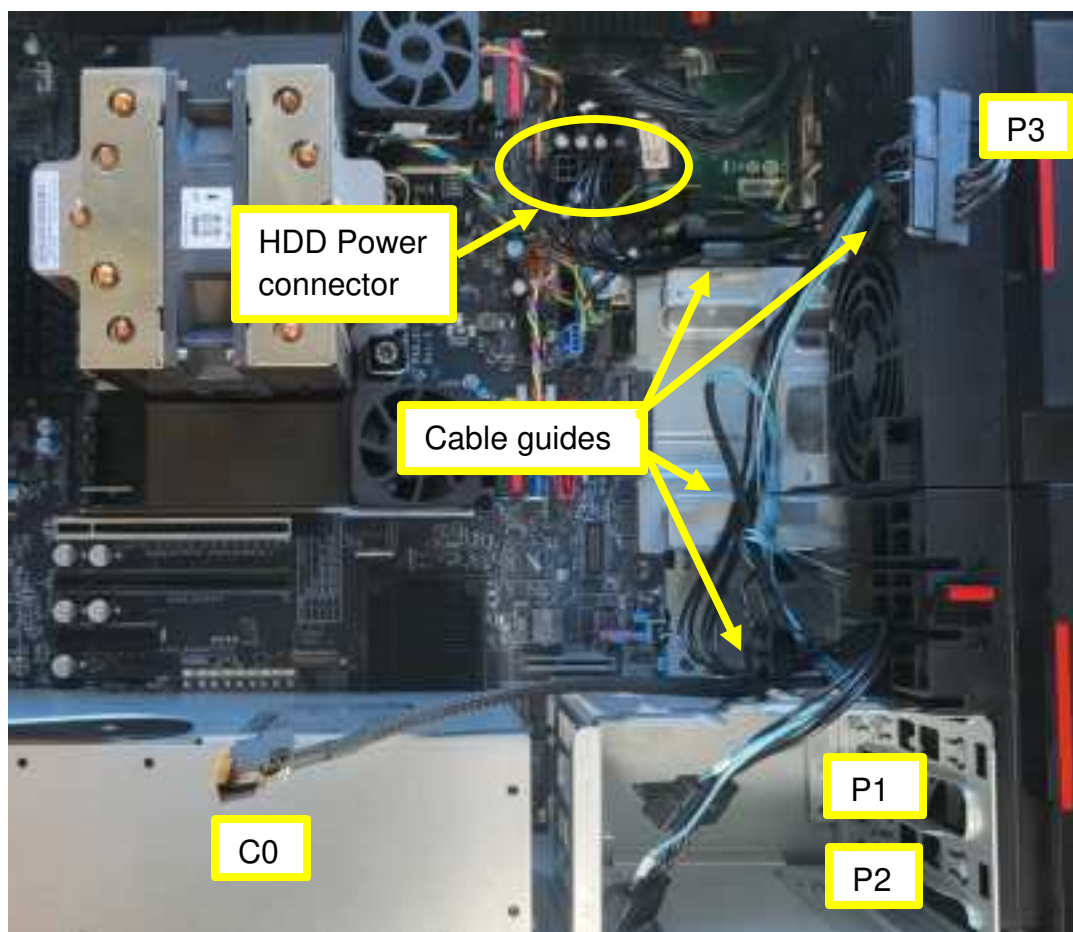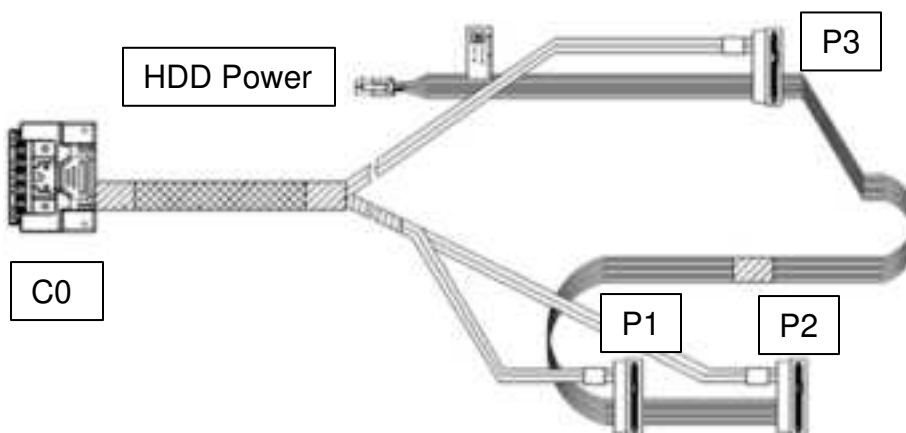
4. Install the air baffle. When installing the air baffle, ensure that the cables are not pinched.
5. If required, install the optional 3rd HDD bay.
6. Install SATA HDDs in bays.
7. Connect SATA HDDs with cables according to the next diagram:

   - Connector P3 -> Optional Storage Bay (Above CPU)
   - Connectors P1 and P2 -> Storage Bay
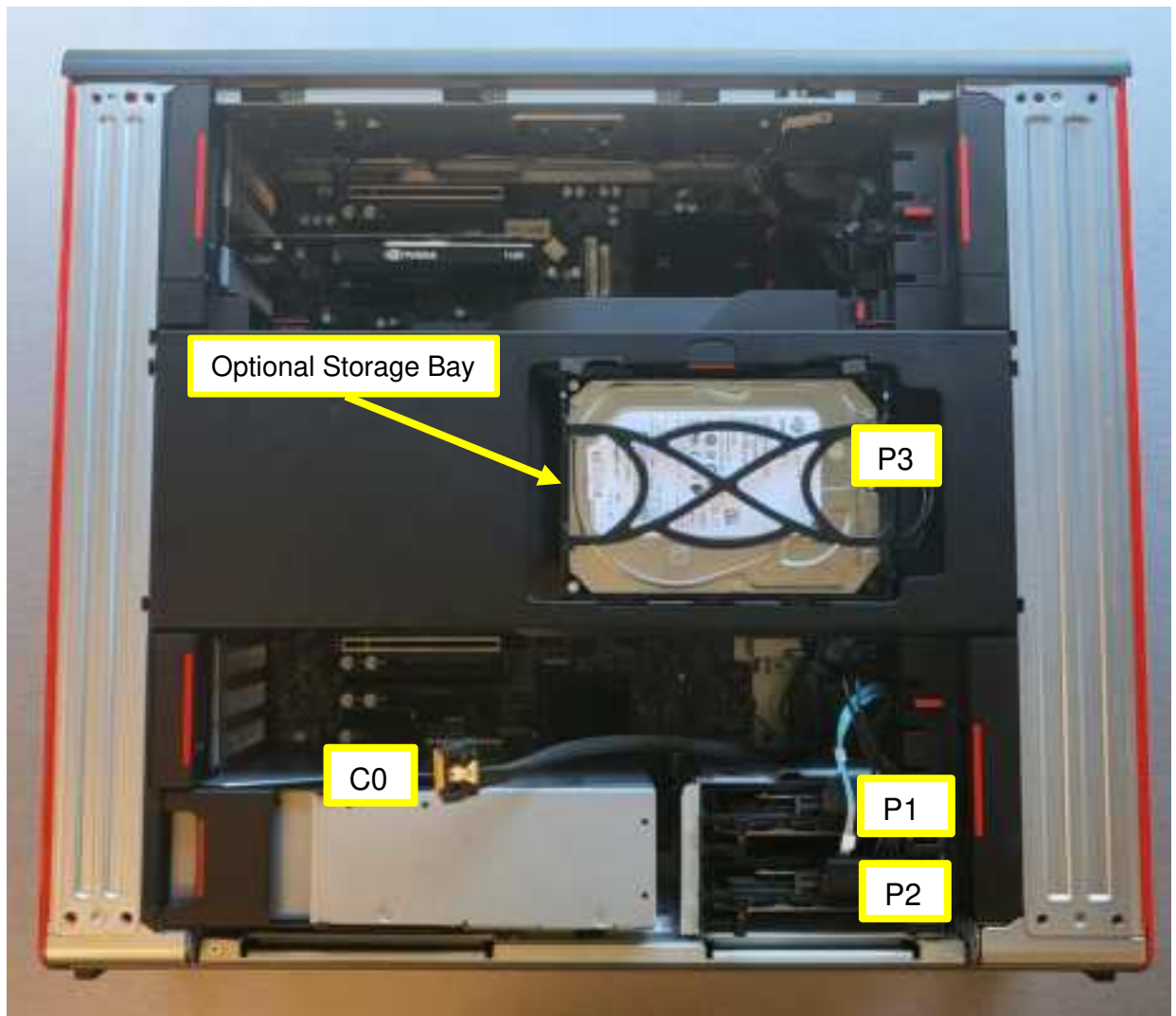
8. Install the Broadcom adapter in the appropriate PCIe slot (refer to the P7 HMM for PCIe slot installation order).
9. Connect cable C0 to port C0 on the Broadcom adapter.

10. Repeat steps 8 -12 from the section Installing the components for NVMe drives.

SuperCap PCIe retention bracket
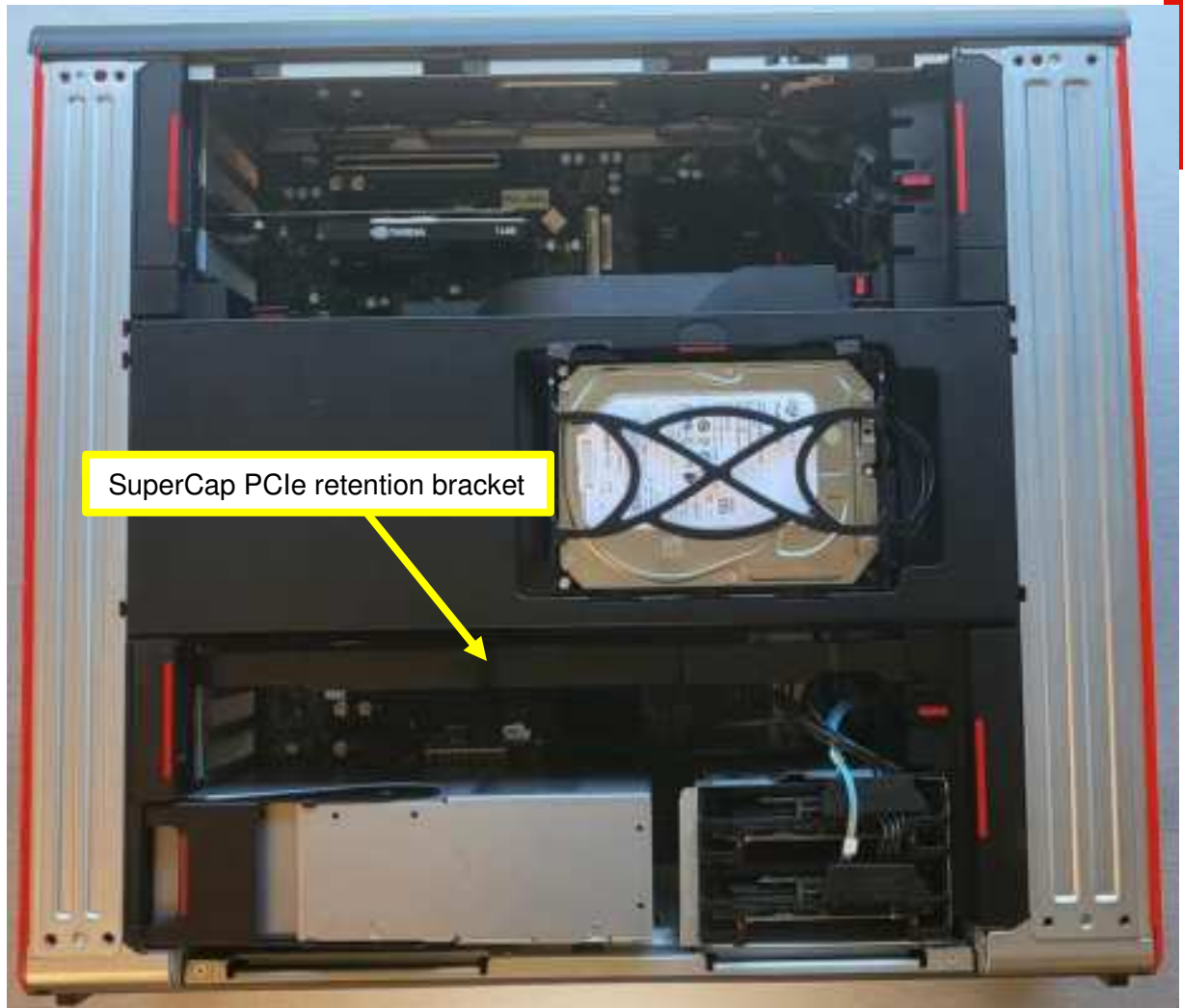
Note: If Broadcom adapter is installed in slot 7, the optional vertical M.2 drive cannot be used.

11. Reinstall the side cover.
12. If require, configure RAID following the guidance in Chapter 5 Configuring RAID.

Section 4 – ThinkStation P5 Support

In the P5 system, drives that are available for RAID are installed in the internal storage bays and optional 3rd HDD bay. This allows the P5 to support up to three (3) SATA HDDs with a Broadcom 9540-8i RAID adapter.

Table 7 - Support Summary with Broadcom 9540-8i RAID adapter

Maximum Number of Drives	Up to 3 x 3.5" SATA HDDs
Supported RAID Levels	RAID 0 RAID 1
Drive Speed	6Gb/s SATA3

Notes:

- At time of writing, only 3.5" SATA HDDs have been certified.
- Microsoft Windows 11 no longer supports booting from magnetic rotational media (HDDs).
- Mixing drives with different capacities and types within the same virtual drive group is not supported.

Hardware Requirements:

Table 8 – Compatibility, location and parts requirements for HDD support

Location	Compatibility	Hardware Required
Internal Storage Bays + Optional HDD Drive Bay	3 x 3.5" SATA HDD	Broadcom 9540-8i RAID adapter SlimSAS to 3-drop SATA cable Drive activity LED cable Optional 3rd HDD bay kit

Notes:

- See Appendix for detailed parts information.
- For installing optional 3rd HDD bay, please refer to the P5 Storage Whitepaper.

Installing the Broadcom 9540-8i RAID Adapter

To install the Broadcom Adapter in the P5 follow these steps:

1. Remove the side cover from the system.
2. Install SATA HDDs in the internal storage bays and optional 3rd HDD bay if needed.

   Note: For instructions on how to install the SATA HDDs and optional 3rd HDD bay please refer to the P5 Storage Whitepaper.

3. Connect the HDD Power connector of the SlimSAS to 3-drop SATA cable to the motherboard port "MISC_PWR1"
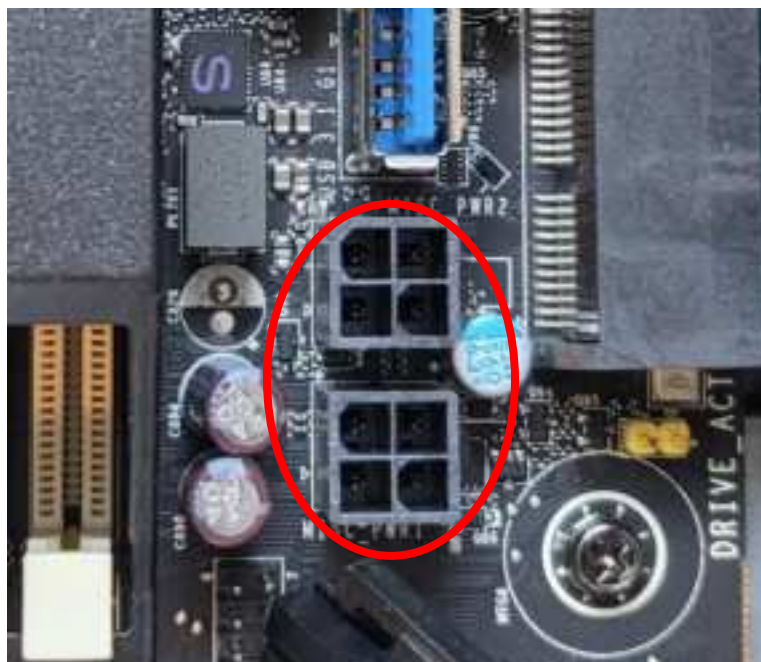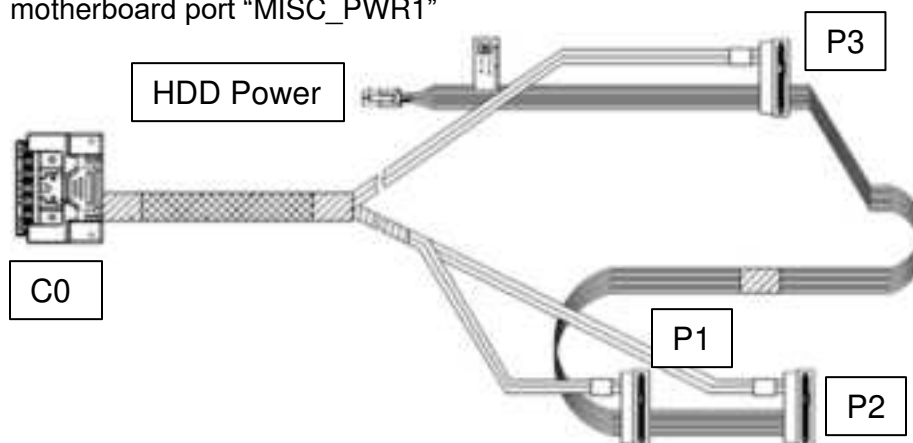
4. Attach connectors labeled P1 and P2 to HDDs that are located in the internal storage bays.
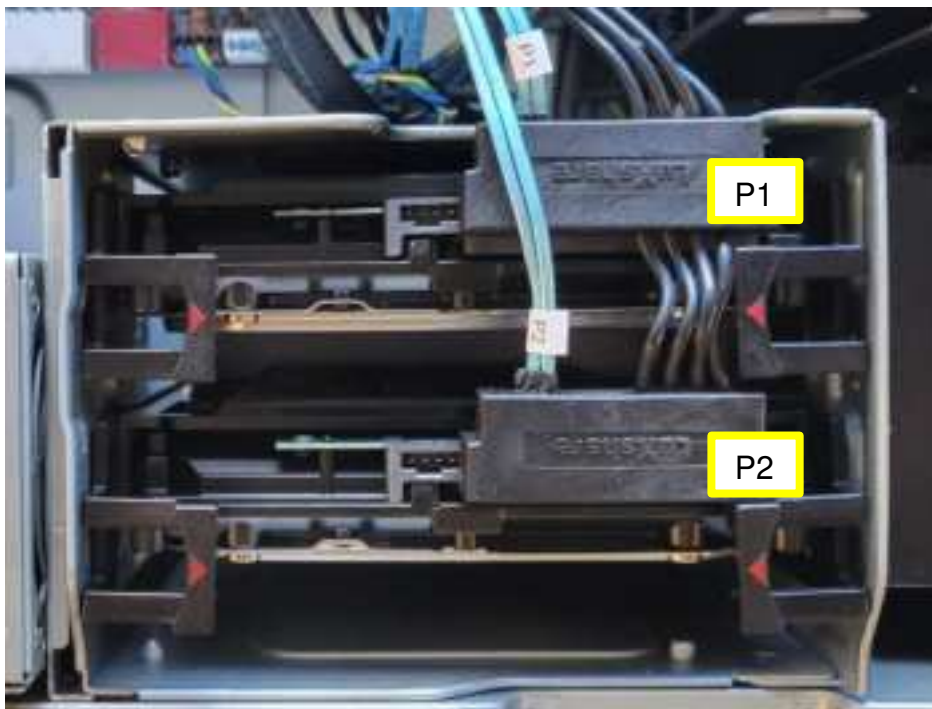
5. Attach the connector labeled P3 to the optional 3rd HDD bay. Location of P3 and cable clip within the chassis are shown in step 6.
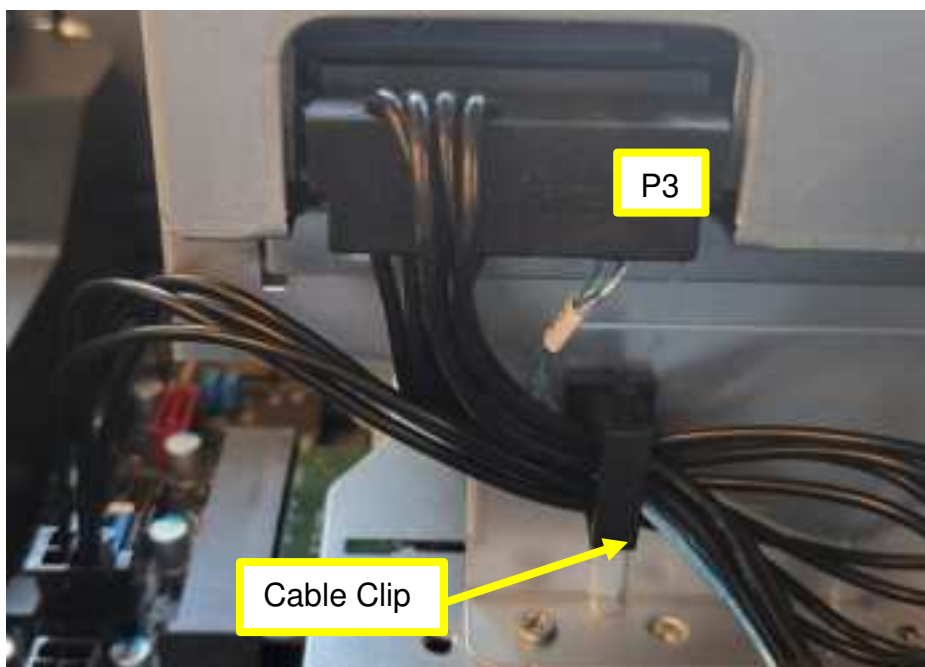
6. Utilize cable guides and clips to secure all cables routed to the locations shown below. Ensure the cables are not pinched between metal hardware components. To easily access the cable guides, remove the front fan (as shown below).
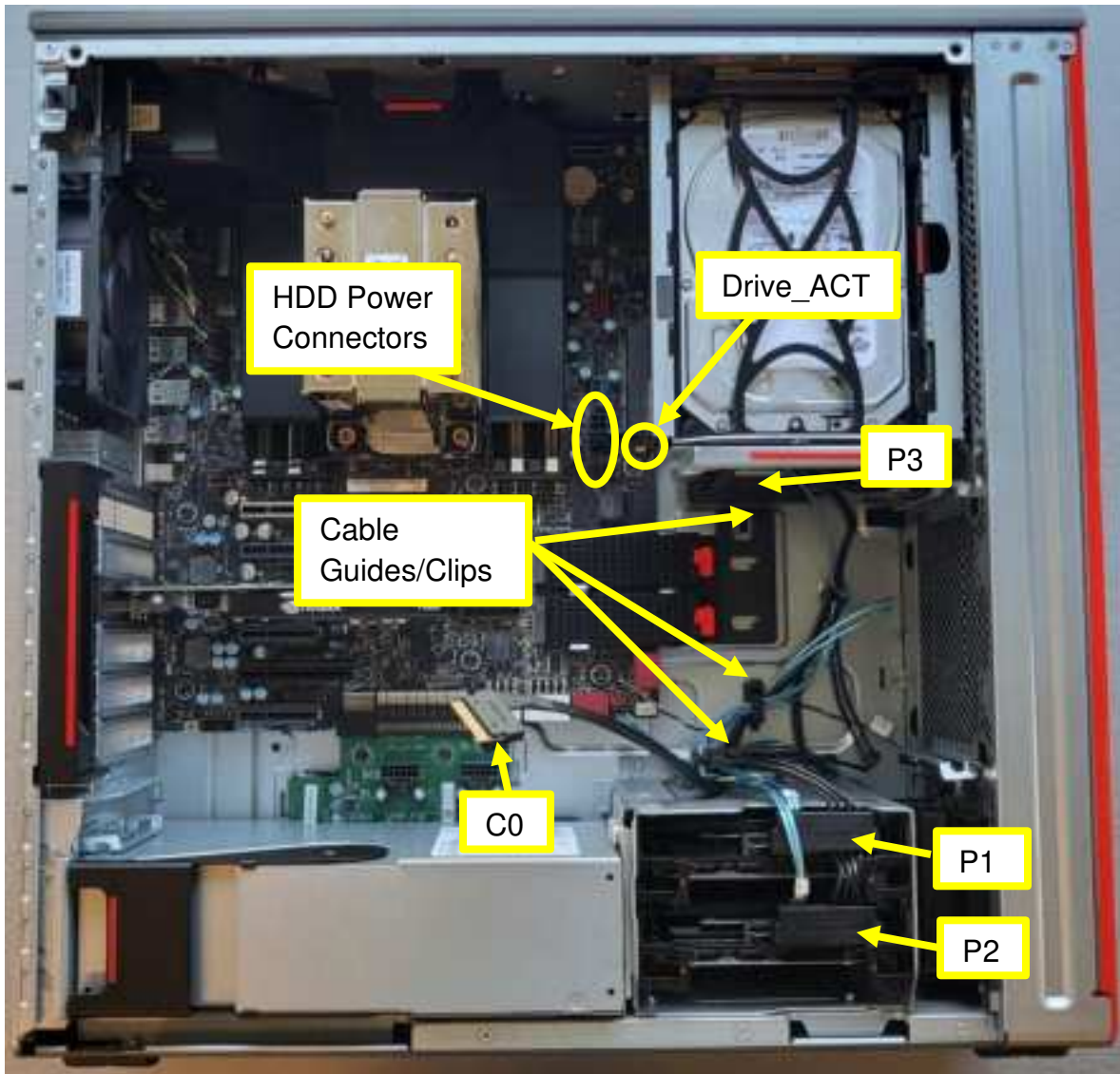
7. Install the Broadcom adapter in PCIe slot (refer to P5 HMM for PCIe slot installation order).

8. Attach connector C0 of the SlimSAS 3-drop SATA cable to the Broadcom adapter port C0.
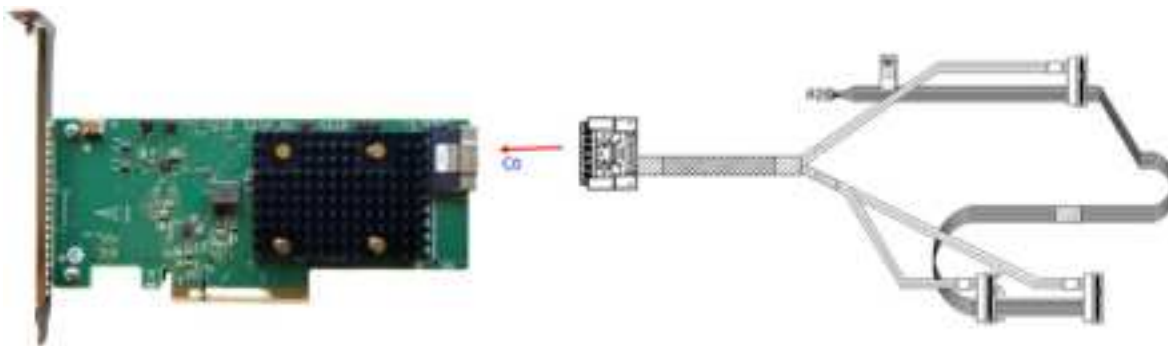
9. Connect the drive LED activity cable to J10(a) on the Broadcom adapter and to the motherboard pins labeled "Drive_ACT" (b).

10. Install the PCIe retention bracket.
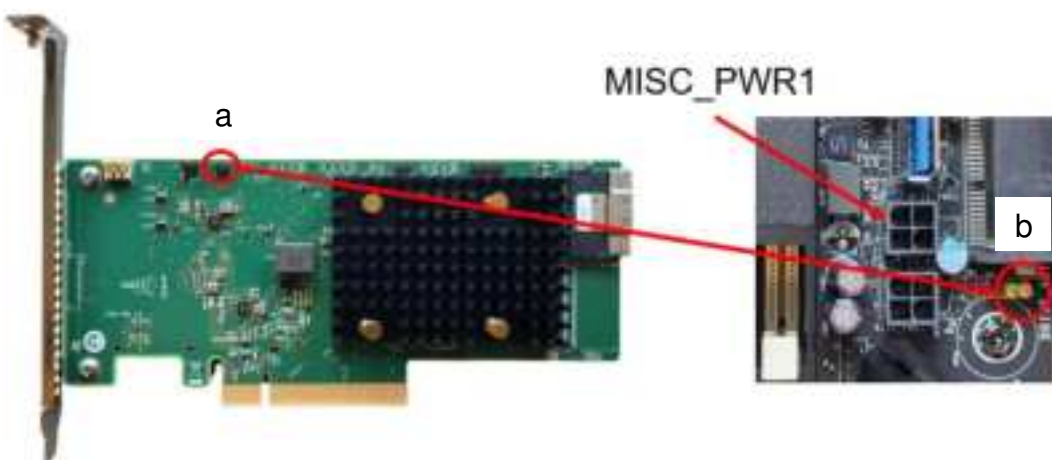
PCIe retention bracket

11. If required, configure RAID following the guidance in Chapter 5 Configuring RAID.

Section 5 – Configuring RAID Arrays

Follow the instructions below to create a basic RAID array using the Broadcom adapter. M.2 SSDs are used in the example below.

1. Install the drives for the RAID array into the system. See the previous sections to determine the correct hardware and placement of the storage devices.
2. Power on the system and press the "F1" function key at the "Lenovo" splash screen indicated below to enter BIOS.

3. Select the "Advanced" menu option on the screen as seen below.

4. Select the "BROADCOM <MegaRAID > Configuration Utility" menu.

5. Select the "Main Menu".
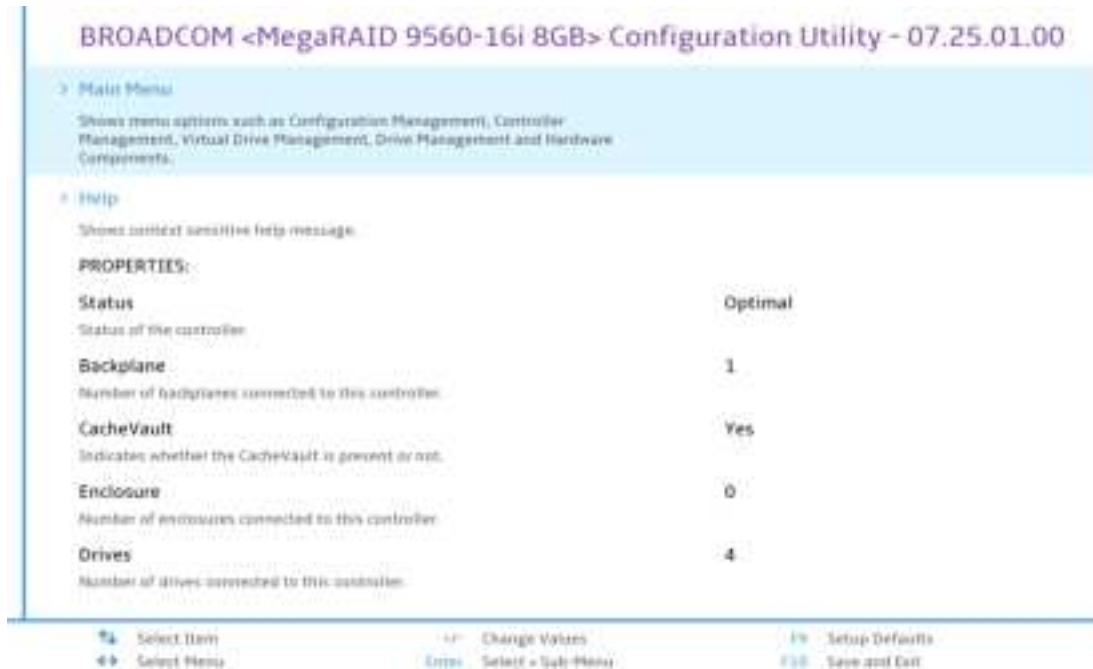
6. Select Configuration Management".
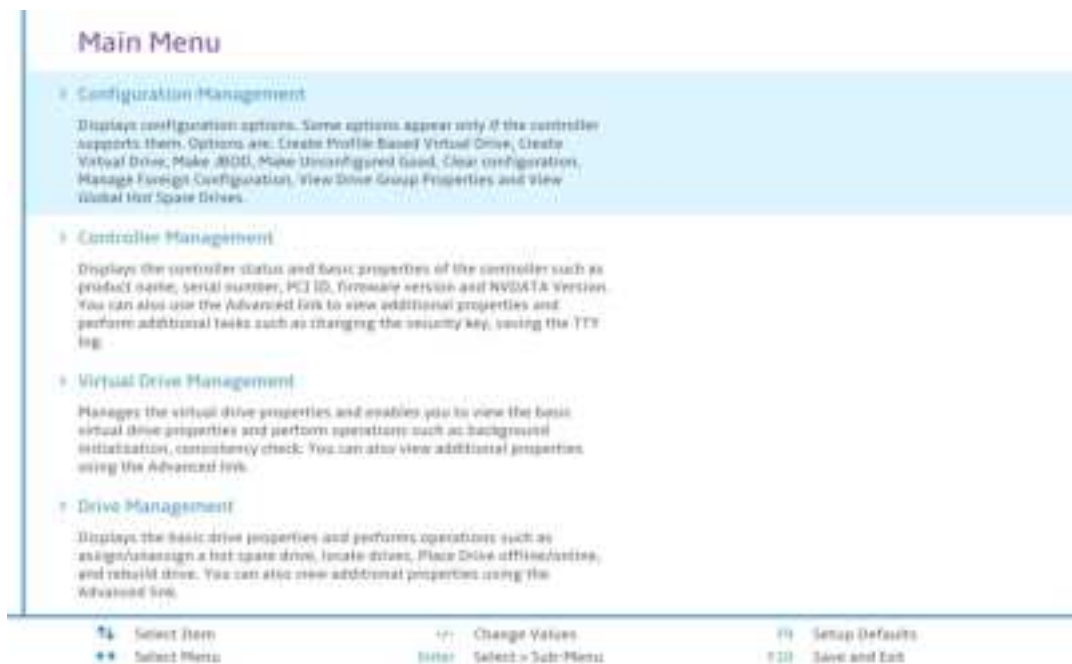
7. Select "Make Unconfigured Good".

8. Select the drives to use in the RAID array that are not listed as "Unconfigured Good" and select "OK".
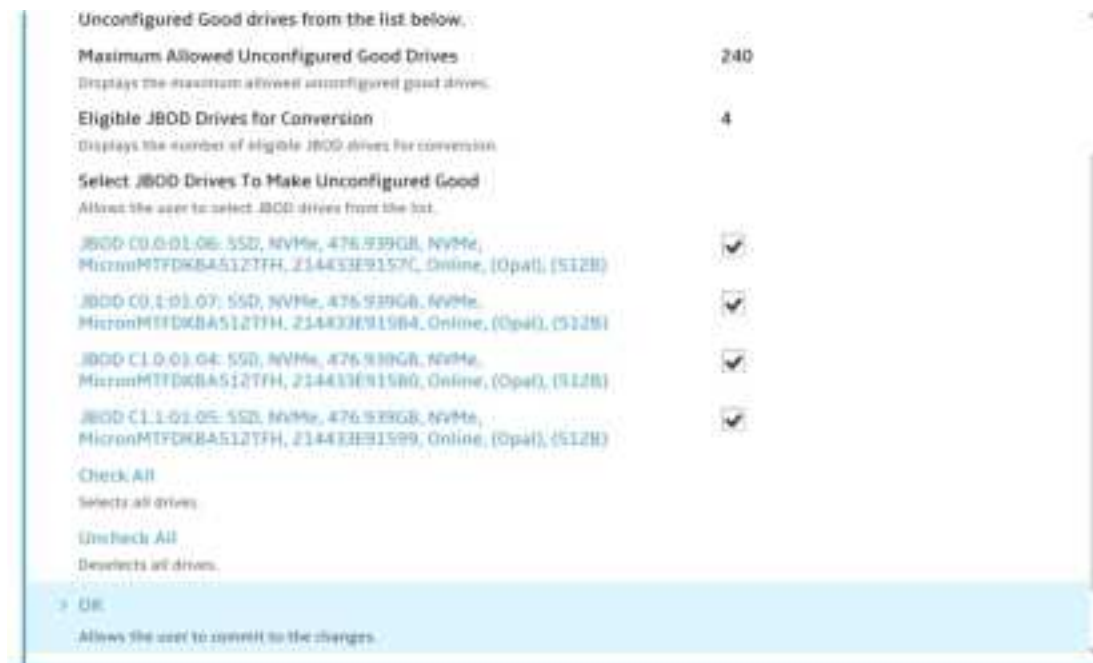
9. Select the checkbox next to "Confirm" and then select "Yes".

Warning

If you have any existing data in the JBOD drive, the data will be lost. Are you sure you want to proceed?

Confirm ✔

Yes

> No

10. Select "Ok".

Success

The operation has been performed successfully.
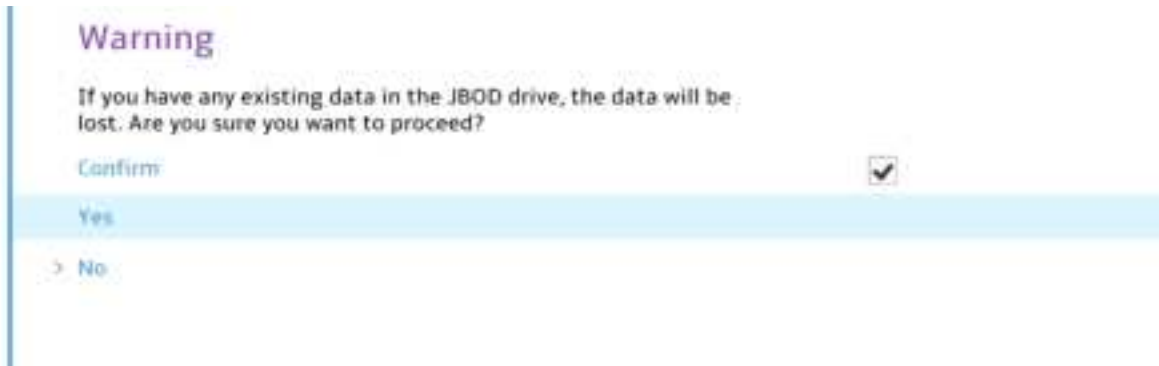
> OK

11. Select "Create Virtual Drive".

Configuration Management

> Auto Configure RAID 0

Configures a Unconfigured Good drive to single drive RAID 0. After performing this operation, if you insert any new configurable drive, that drive will remain as a Unconfigured Good drive.

> Create Virtual Drive

Creates a virtual drive by selecting the RAID level, drives, and virtual drive parameters.

> Create Profile Based Virtual Drive

Creates a virtual drive by using a wizard. The wizard makes intelligent choices based on the profile selected by the user. The profile based virtual drive creation method has special requirements. Refer MegaRAID Software User Guide for details.

> Make JBOD

Allows changing the state of the drive from unconfigured good to JBOD.

> Clear Configuration

Deletes all existing configurations on the RAID controller and discards the pinned cache on missing configuration.

12. Select the drop-down menu next to "Select RAID Level" and select the RAID array type to configure.

Note: Available RAID levels will depend on the Broadcom adapter in use as well as the number of drives connected to Broadcom adapter.

13. Select the "Select Drives".

14. Select the drop-down menu next to "Select Media Type" and select "Both" to show all drives configured on the Broadcom adapter. RAID arrays can only be made up of drives from single media type.

15. Select each drive to use as part of the RAID array and select "Apply Changes".

16. Select "OK".

17. Select "Save Configuration".

18. Select the checkbox next to "Confirm" and select "Yes".
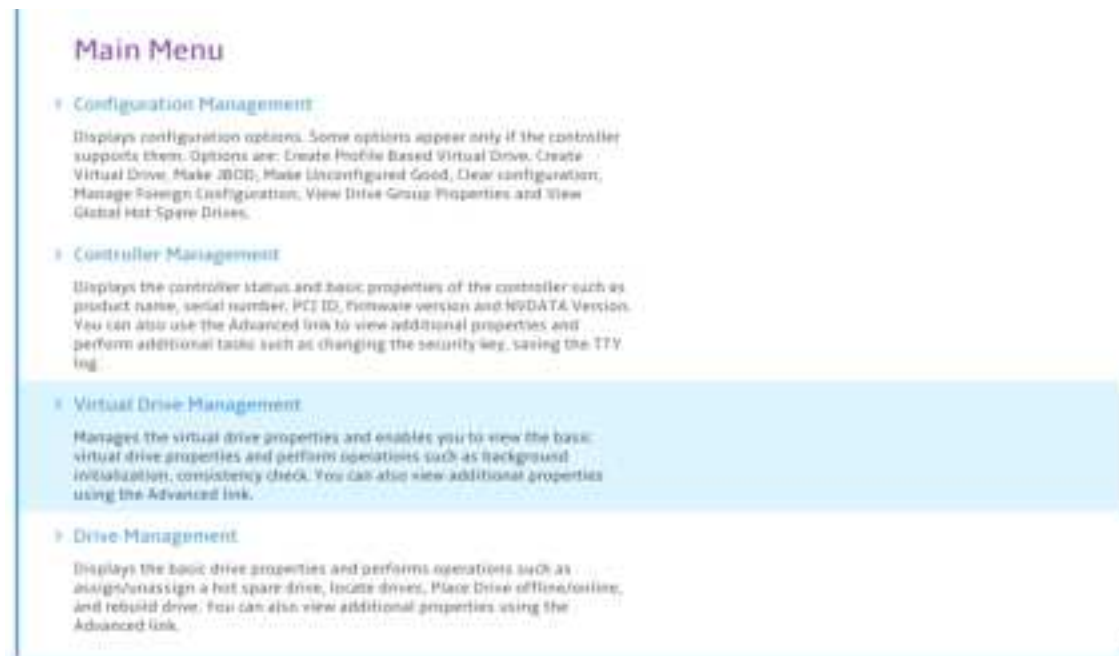

19. Select "OK".

20. After the RAID array has been successfully created, the following message should be seen.

21. To view the created RAID array, return to the "Main Menu" of Broadcom utility and select "Virtual Drive Management".

22. Select the virtual drive to view properties.

23. When work with the RAID arrays(s) has been completed, press function "F10" to "Save and Exit" BIOS.

Section 6 – Deleting RAID Arrays

Follow the instructions below to delete an existing RAID array using the Broadcom PCIe add-in storage controller.

1. Power on the system and press the "F1" function key at the "Lenovo" splash screen indicated below to enter BIOS.
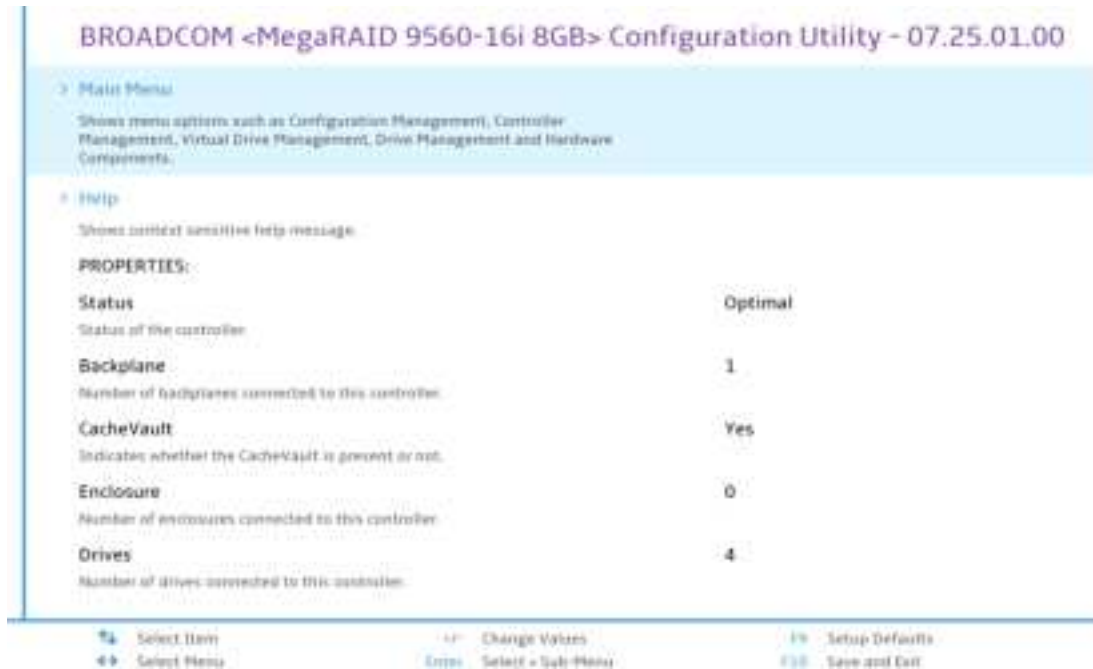
2. Select the "Advanced" menu option on the screen indicated below.
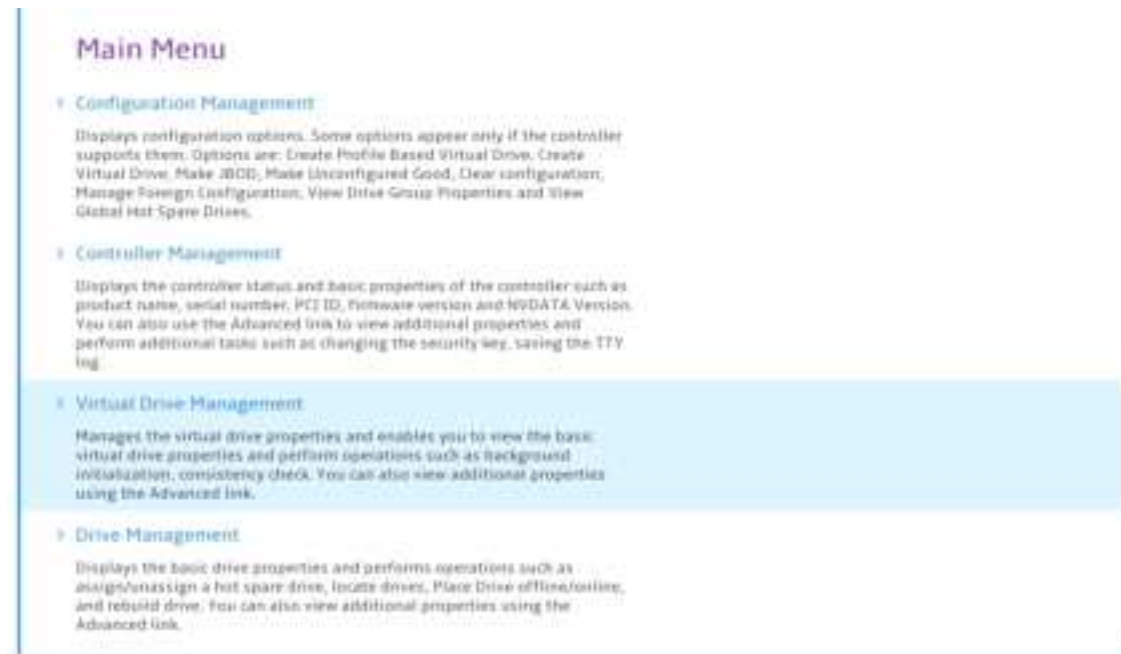

3. Select the "BROADCOM <MegaRAID > Configuration Utility" menu.
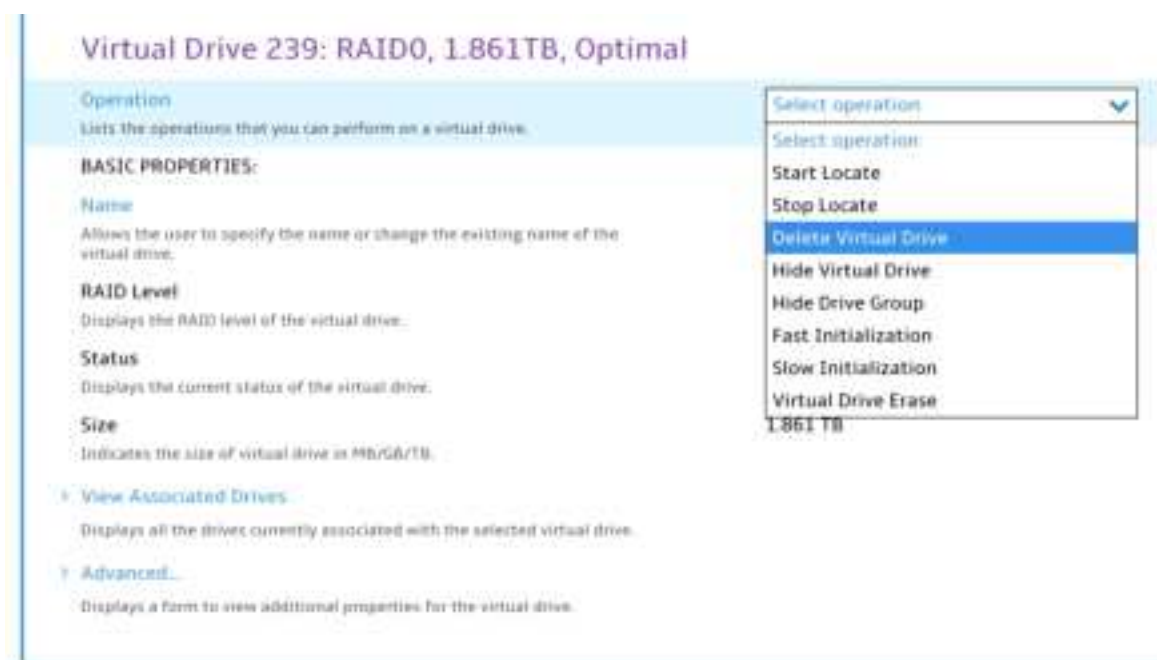
4. Select the "Main Menu".

5. Select "Virtual Drive Management".

6. Select the virtual drive to view properties.

7. In the virtual drive properties window select the dropdown menu next to
   "Operation" to perform a specific operation on the virtual drive. One of the options
   is to delete the virtual drive.

8. Press "Go" to delete the selected RAID array.

Virtual Drive 239: RAID0, 1.861TB, Optimal

Operation	Delete Virtual Drive
Lists the operations that you can perform on a virtual drive.	

> Go
Starts the selected operation or opens another form.

BASIC PROPERTIES:

Name
Allows the user to specify the name or change the existing name of the virtual drive.

RAID Level	RAID0
Displays the RAID level of the virtual drive.	

Status	Optimal
Displays the current status of the virtual drive.	

Size	1.861 TB
Indicates the size of virtual drive in MB/GB/TB.	

> View Associated Drives
Displays all the drives currently associated with the selected virtual drive.

9. Select the checkbox next to "Confirm" and select "Yes".

Warning

Creating Virtual Drives will cause the data on the associated Drives to be permanently deleted.
Are you sure you want to continue with this operation?

Confirm   ✔

Yes

> No

10. Select "OK".

Success

The operation has been performed successfully.

> OK

Section 8 – Appendix

Part	Picture	Platform
NVMe Bay 2 Gen4 cable, 650mm *FRU: SC10X18649*		PX
NVMe Bay 3 Gen4 cable, 650mm *FRU: SC11A17276*		PX
Front access bay U.2/U.3 SSD enclosure with backplane *FRU: 5M11H28531*		PX

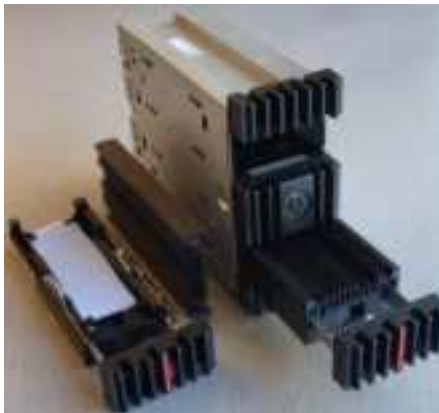|		
Front access bay dual NVMe SSD enclosure with M.2 carriers *Option PN: 4XH1M64236* *FRU: 5M11H28529*	 Option PN includes additional parts.	PX
Front access bay dual NVMe SSD enclosure with E1.S carriers *FRU: 5M11H28530*		PX
Storage bay fan *FRU: 5M11H28534*	 Included with option PN 4XH1M64236	PX

Broadcom 9560-16i SATA/PCIe PCIe x8 adapter *FRU: 5A71F30923*		PX/P7
SuperCap (cache backup unit) *FRU: 00FC994*		PX/P7
PCIe retention bracket (RAID SuperCap holder kit) *FRU: 5M11C16915*		PX/P7
SuperCap cable, 240mm *FRU: 5C10U58719*		PX/P7

HDD LED activity cable, 550mm *FRU:* *5C10U58340*		PX/P7/P5
Blind Connect Board (BCB) for internal NVMe SSDs *FRU:* *5C51K23022*		P7
Broadcom NVMe Gen4 cable, 600mm *FRU:* *5C10U58384*		P7

| Internal tray for M.2 SSD
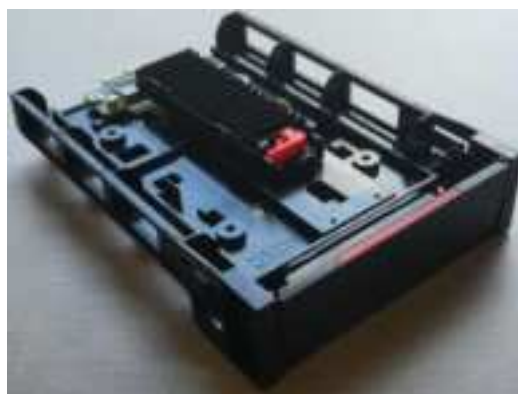
FRU:
5M11C16906 | | P7 |
| Internal tray for U.2/U.3

FRU:
5M11H28778 | | P7 |
| Internal tray for E1.S

FRU: TBD | | P7 |

3-drop SATA cable for P7/P5 *FRU: 5C10U58704*		P7/P5
Broadcom 9540-8i SATA/PCIe PCIe x8 adapter *FRU: 5R11B66431*		P5
PCIe retention bracket (top retention holder kit) *FRU: 5M11H28592*		P5

Revision History

Version	Date	Author	Changes/Updates
1.0	10.5.2023	A.Panteleev	Initial release