

INTEL[®] OPTANE[™] PERSISTENT MEMORY

BIOS Settings



intel[®]

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OBJECTIVES

Upon completion of this course, participants will be able to:

- Use Intel BIOS to configure Intel[®] Optane[™] persistent memory
- Know where to find the PMEM configuration settings in BIOS
- Feel confident in their ability to setup and configure PMEM in an Intel server

AGENDA

CONFIGURING PMEM MODES AND OPTIONS

VIEWING AND CONFIGURING INDIVIDUAL PMEMS

MONITORING PMEM HEALTH AND UPDATING FIRMWARE

SECURITY OPTIONS

CREATING GOALS, REGIONS, AND NAMESPACES

SUMMARY

CONFIGURING MODES FOR PMEM USING INTEL BIOS

S2600WF
Intel(R) Xeon(R) Platinum 8280L CPU @ 2.70GHz 2.70 GHz
IFWI Version:SE5C620.86B.0R.64.2019.12.2.12.1559.selfboot
SE5C620.86B.02.01.0008.031920191559 393216 MB RAM
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- ▶ Main
- ▶ **Advanced**
- ▶ Security
- ▶ Server Management
- ▶ Error Manager
- ▶ Boot Manager
- ▶ Boot Maintenance Manager
- ▶ Save & Exit
- ▶ Tls Auth Configuration

Press <Enter> to select the Advanced System Setup options.

Advanced

- ▶ Processor Configuration
- ▶ Power & Performance
- ▶ UPI Configuration
- ▶ **Memory Configuration**
- ▶ Integrated IO Configuration
- ▶ Mass Storage Controller Configuration
- ▶ PCI Configuration
- ▶ Serial Port Configuration
- ▶ USB Configuration
- ▶ System Acoustic and Performance Configuration

View/Conf
informati

Memory Configuration

Total DDR4 Memory	384 GB	Selects whether 1LM or 2LM memory mode should be enabled
PMEM	3024GB-3024GB-0GB	
Effective Memory	3095247 MB	
Current Configuration	Independent	
Current Memory Speed	2666 MT/s	
Memory Operating Speed Selection	<Aut>	
IMC Interleaving	<Aut>	
Page Policy	<Aut>	
Volatile Memory Mode	<2LM>	
PMEM Error Injection	<Disabled>	
Publish ARS capability	<Enabled>	
ARS on Boot	<Auto>	
Average Power Budget (in mW)	[570]	

From the opening BIOS screen on an Intel® Server System S2600WF, click on **Advanced**, then on **Memory Configuration**, and then on **Volatile Memory Mode**. Select 1LM if you want to configure PMem in App Direct mode, 2LM if you want Memory Mode or Auto if you would prefer to set the Volatile Memory Mode using configuration tools outside of BIOS like IPMCTL or NDCTL.

VIEWING MEMORY INFORMATION

Memory Size

Memory Speed

Volatile Memory Mode

Here is a screen shot of the **Memory Configuration** screen, and as you can see there is a lot of information and settings here, including Memory Size, Memory Speed, Volatile Memory Mode and DIMM Information. Another option from this screen is to select **Memory RAS and Performance Configuration**. We will explore those options on the next slide.

DIMM Information

Memory Configuration		
Total DDR4 Memory	384 GB	Configure memory RAS (Reliability, Availability, and Serviceability) and view current memory performance information and settings.
PMEM	3024GB-0GB-3024GB	
Effective Memory	390351 MB	
Current Configuration	ADDDC	
Current Memory Speed	2666 MT/s	
Memory Operating Speed Selection	<Auto>	
IMC Interleaving	<Auto>	
Page Policy	<Auto>	
Volatile Memory Mode	<Auto>	
PMEMError Injection	<Disabled>	
Publish ARS capability	<Auto>	
ARS on Boot	<Auto>	
Average Power Budget (in mW)	[570]	
SMB Clock Frequency	<Auto>	
Snoopy mode for 2LM	<Enabled>	
Snoopy mode for AD	<Enabled>	
NUM Performance Setting	<BW Optimized>	
CR FastGo Configuration	<Option 1>	
CR Latch System Shutdown State	<Disabled>	
CR QoS	<Disable - Disable CR QoS feature>	
Thermal Throttling Thresholds Offset	<Auto>	
Attempt Fast Boot	<Auto>	
Attempt Fast Cold Boot	<Auto>	
Enable power cycle policy	<Enabled>	
MRC Promote Warnings	<Enabled>	
Promote Warnings	<Enabled>	
Halt on mem Training Error	<Enabled>	
Thermal Monitor	<Enabled>	
► Memory RAS and Performance Configuration		
DIMM Information		
CPU1_DIMM_A1	32GB Installed&Operational	
CPU1_DIMM_A2	PMEM 252GB-252GB-0GB	
CPU1_DIMM_B1	32GB Installed&Operational	
CPU1_DIMM_B2	PMEM 252GB-252GB-0GB	
CPU1_DIMM_C1	32GB Installed&Operational	
CPU1_DIMM_C2	PMEM 252GB-252GB-0GB	
CPU1_DIMM_D1	32GB Installed&Operational	

CONFIGURING RAS AND PERFORMANCE OPTIONS

Here is a screen shot of the **Memory RAS and Performance Configuration** screen. RAS stands for Reliability, Accessibility and Serviceability. From here you can enable or disable Sparing, NUMA Optimization, Patrol Scrub, Cloaking and setting the Correctable Error Threshold.

Memory RAS and Performance Configuration

Capabilities

Memory Mirroring Possible	YES
Memory Rank Sparing Possible	NO
Memory ADDDC Possible	YES
ADDDC Sparing	<Enabled>
NUMA Optimized	<Enabled>
Sub_NUMA Cluster	<Disabled>
Patrol Scrub	<Enabled>
Correctable Error Threshold	<10>
Cloaking	<Disabled>

Enable/Disable Adaptive Double Device Data Correction Sparing.

↑↓=Move Highlight

F10=Save Changes and Exit
<Enter>=Select Entry

F9=Reset to Defaults
Esc=Exit

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NAVIGATING TO THE MAIN PMEM SETUP SCREENS

S2600WF
Intel(R) Xeon(R) Platinum 8280L CPU @ 2.70GHz
IFWI Version:SE5C620.86B.0R.64.2019.12.2.12.1559.selfboot
SE5C620.86B.02.01.0008.031920191559
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@2.70 GHz

393216 MB RAM

Press <Enter> to select the
Advanced System Setup

- ▶ Main
- ▶ **Advanced**
- ▶ Security
- ▶ Server Management
- ▶ Error Manager
- ▶ Boot Manager
- ▶ Boot Maintenance Manager
- ▶ Save & Exit
- ▶ Tls Auth Configuration

Advanced

- ▶ Processor Configuration
- ▶ Power & Performance
- ▶ UPI Configuration
- ▶ Memory Configuration
- ▶ Integrated IO Configuration
- ▶ Mass Storage Controller Configuration
- ▶ **PCI Configuration**
- ▶ Serial Port Configuration
- ▶ USB Configuration
- ▶ System Acoustic and Performance Configuration

View/Configure PCI
information and
settings

PCI Configuration

Memory Mapped I/O above 4 GB **<Enabled>**
MMIO High Base **<56T>**
Memory Mapped I/O Size **<256G>**
Add-in Video Adapter **<Disabled>**
Onboard Video **<Enabled>**
Fast Video **<Enabled>**
Legacy VGA Socket **<CPU Socket 1>**
ARI Support **<Enabled>**
SR-IOV Support **<Enabled>**

- ▶ PCIe Slot Bifurcation Setting
- ▶ PCIe Error Maintain
- ▶ NIC Configuration
- ▶ UEFI Network Stack
- ▶ **UEFI Option ROM Control**
- ▶ PCIe Port Oprom Control
- ▶ Processor PCIe Link Speed
- ▶ Volume Management Device

UEFI Option ROM Control

NIC Controller

iSCSI Configuration
Intel(R) Ethernet Network Adapter X722-4 -
F8:F2:1E:47:24:8C Slot:0x0321
IPv6 Network Configuration
HTTP Boot Configuration
ULAN Configuration
IPv4 Network Configuration

Intel(R) Ethernet Network Adapter X722-4 -
F8:F2:1E:47:24:8D Slot:0x0321
IPv6 Network Configuration
HTTP Boot Configuration
ULAN Configuration
IPv4 Network Configuration

Intel(R) Ethernet Network Adapter X722-4 -
F8:F2:1E:47:24:8F Slot:0x0321
IPv6 Network Configuration
HTTP Boot Configuration
ULAN Configuration
IPv4 Network Configuration
Intel(R) Ethernet Connection X722 for 10GBASE-
A4:BF:01:57:14:4F
IPv6 Network Configuration
HTTP Boot Configuration
ULAN Configuration
IPv4 Network Configuration
Intel(R) Ethernet Connection X722 for 10GBASE-
A4:BF:01:57:14:50

IPv6 Network Configuration
HTTP Boot Configuration
ULAN Configuration
IPv4 Network Configuration

Memory Controller

Intel(R) Optane(TM) Persistent Memory
Configuration

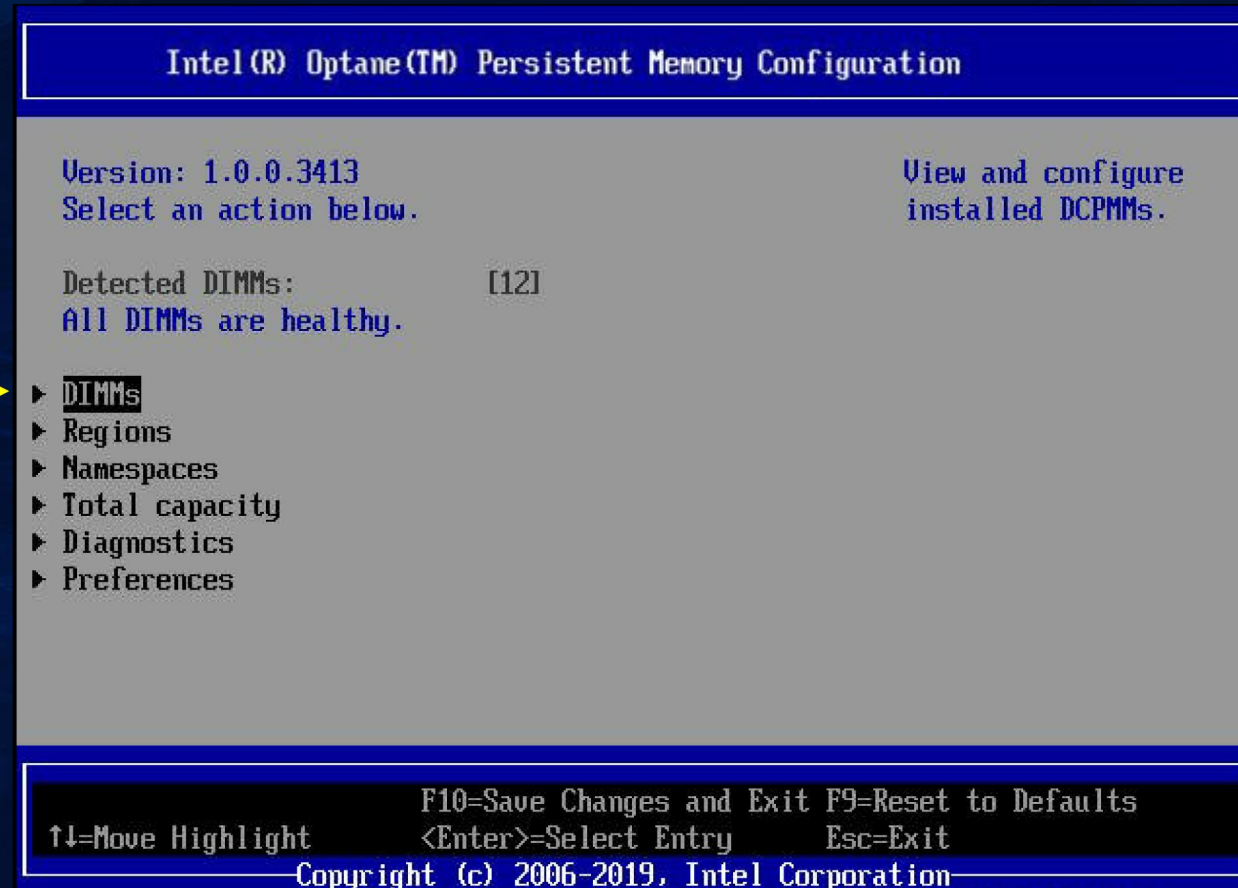
Storage Controller

LSI SAS3 HPI controller SAS3008, (PCISubDeviceId:
0x3524, PCIBus: 0xDA, PCIDevice: 0x0, PCIFunc: 0x0,
PCISlot: 0x32) Slot:0x0332
INTEL SSDPE2KE032T8-BTLN83210E263P2BGN Slot:0x0311
INTEL SSDPE2KE032T8-BTLN832107K03P2BGN Slot:0x0311

Most of the setup options for DCPMM are found in the **Intel® Optane™ Persistent Memory Configuration** screen. We will go over some of the options in the following slides but to get there from the opening BIOS screen, you need to select **Advanced**, then **PCI Configuration**, then **UEFI Option ROM Control**, then **Intel® Optane™ Persistent Memory Configuration**

PMEM MEMORY CONFIGURATION IN INTEL BIOS

This is the main **PMem Memory Configuration** screen in the Intel BIOS. You will get a count of detected DIMMS as well as a quick check on their health. From this screen you can access DIMM specific info, Regions, Namespaces, Capacity readings, Diagnostics, and Preferences. On the next slide we will look at what is available when clicking on the **DIMMs** link.



VIEWING INDIVIDUAL PMEM DIMM INFORMATION

Persistent Memory Modules

Select a specific DIMM to view more information. [View DIMM details.](#)

DIMMs on socket 0x0000:


- ▶ **DIMM ID 0x0011**
- ▶ DIMM ID 0x0021
- ▶ DIMM ID 0x0001
- ▶ DIMM ID 0x0111
- ▶ DIMM ID 0x0121
- ▶ DIMM ID 0x0101

DIMMs on socket 0x0001:

- ▶ DIMM ID 0x1011
- ▶ DIMM ID 0x1021
- ▶ DIMM ID 0x1001
- ▶ DIMM ID 0x1111
- ▶ DIMM ID 0x1121

Persistent Memory Module

View settings or select an action below.


DIMM UID	8089-A2-1837-00000D4E
DIMM handle	0x0011
DIMM physical ID	0x002C
Manageability state	<Manageable>
Health state	<Healthy>
Health state reason	None
Capacity	252.4 GiB
Firmware version	01.02.00.5346
Firmware API version	01.14
Lock state	<Disabled>
Staged firmware version	N/A
Firmware update status	Update loaded successfully
Manufacturer	Intel
Show more details +	

- ▶ Monitor health
- ▶ Update firmware
- ▶ Configure security
- ▶ Configure data policy
- ▶ View DIMMs
- ▶ Back to main menu

In the previous screen **PMEM Memory Configuration**, when you select **DIMMs**, you are presented with the screen above on the left, and from there, you can click on a specific DIMM module to get information about that DIMM which is presented on the screen to the right. From this screen, aside from getting a lot of information about the DIMM like the handle number, the health, the capacity, and the firmware version, you can probe deeper into the health of the DIMM, you can update the firmware, and you can configure security and data policy on the DIMM. Clicking on Show More Details will display even more information about the DIMM as we will see in the next slide.

VIEWING MORE DIMM INFORMATION PART 1

In the **Persistent Memory Module** screen, when you select **Show More Details** you are presented with the screen to the right (plus the screen on the next slide). As you can see there is a wealth of information about the DIMM including the serial number, the manufacturing date, the channel position, and the controller revision, just to name a few.

Persistent Memory Module	
Show more details +	
Serial number	0x00000C43
Part number	NMA1XBD256GQS
Socket	0x0
Memory controller ID	0x0
Vendor ID	0x8089
Device ID	0x5141
Subsystem vendor ID	0x8089
Subsystem device ID	0x97A
Device locator	CPU1_DIMM_A2
Subsystem revision ID	0x18
Interface format code	0x0301 (Non-Energy Backed Byte Addressable)
Manufacturing info valid	[1]
Manufacturing date	18-37
Manufacturing location	0xA2
Memory type	Logical Non-Volatile Device
Memory bank label	NODE 1
Data width label [b]	64
Total width [b]	72
Speed [MHz]	2666
Channel ID	0x0000
Channel position	[1]
Revision ID	0x0
Form factor	<DIMM>
Manufacturer ID	0x8089
Controller revision ID	B0 (0x0020)
Is new	[0]
Memory capacity	0 B
App Direct capacity	252.0 GiB
Unconfigured capacity	0 B
Inaccessible capacity	465.2 MiB
Reserved capacity	0 B
Peak power budget [mW]	[20000]
Avg power budget [mW]	[15000]
Max average power budget [mW]	[18000]
Package sparing capable	[1]
Package sparing enabled	[1]
Package spares available	[1]
Configuration status	<Valid>
SKU violation	[0]

Show or hide additional details about the DIMM.

VIEWING MORE DIMM INFORMATION PART 2

This is the rest of the information that is displayed when **Show More Details** has been selected from the **Persistent Memory Module** screen. I won't tire you by reading all the items on this screen but as you can see, there is a LOT of information.

Persistent Memory Module

Show more details + [X] Show or hide additional

(Information continued from last slide)

ARS status	<Completed>
Overwrite DIMM status	<Not started>
Last shutdown time	Tue Jan 28 01:34:14 UTC 2020
First fast refresh	[0]
Viral policy enable	[0]
Viral state	[0]
Latched Last shutdown status	PMIC 12V/DDR1 1.2V Power Loss (PLI), PM Warm Reset Received, Controller's FW State Flush Complete, Write Data Flush Complete, PM Idle R
Unlatched Last shutdown status	PMIC 12V/DDR1 1.2V Power Loss (PLI), PM Warm Reset Received, Controller's FW State Flush Complete, Write Data Flush Complete, PM Idle R
Security capabilities	Encryption, Erase
Modes supported	Memory Mode, App Direct
Boot status	Success
AIT DRAM enabled	<1>
Error injection enabled	<0>
Boot status	Success
AIT DRAM enabled	<1>
Error injection enabled	<0>
Media temperature injection enabled	<0>
Software triggers enabled	<0>
Software triggers enabled details	None
Poison error injections counter	[0]
Poison error clear counter	[0]
Media temperature injections counter	[0]
Software triggers counter	[0]
Master Passphrase Enabled	[0]

- ▶ Monitor health
- ▶ Update firmware
- ▶ Configure security
- ▶ Configure data policy
- ▶ View DIMMs
- ▶ Back to main menu

MONITORING PMEM HEALTH

In the previous screen **Persistent Memory Module**, when you select **Monitor Health**, you are presented with the screen to the right, and from there you can see the values for various sensors as well as how many times the thresholds have been exceeded or not met on things like the temperature of the Media on the DIMM or the controller temperature. You also can get a reading here of how much “life” is left in the DIMM expressed as a percentage. There is also information on the Power On time, Up time, Power cycles and Firmware error counts. Finally, at the bottom of the screen you can set non-critical thresholds. Be sure to Apply Changes if you update any settings.

Monitor Health	
Sensor Type	<Health>
Value	<Healthy>
Sensor Type	<Controller temperature>
Value	<41 C>
Non-critical threshold	[98]
Critical lower threshold	[99]
Critical upper threshold	[99]
Fatal threshold	[102]
State	<Normal>
Alarm enabled state	<0>
Sensor Type	<Media temperature>
Value	<38 C>
Non-critical threshold	[82]
Critical lower threshold	[83]
Critical upper threshold	[83]
Fatal threshold	[85]
State	<Normal>
Alarm enabled state	<0>
Sensor Type	<Percentage remaining>
Value	<100 %>
Non-critical threshold	[50]
State	<Normal>
Alarm enabled state	<0>
Sensor Type	<Latched dirty shutdown count>
Value	<0>
Sensor Type	<Power on time>
Value	<25652918 S>
Sensor Type	<Up time>
Value	<16112 S>
Sensor Type	<Power cycles>
Value	<86>
Sensor Type	<FW error count>
Value	<0>
Sensor Type	<Unlatched dirty shutdown count>
Value	<0>
Modify non-critical thresholds	
Controller temperature [C]	[98]
Media temperature [C]	[82]
Percentage remaining [%]	[50]
▶ Apply changes	
▶ Back to DIMM details	
▶ View DIMMs	
▶ Back to main menu	

UPDATING PMEM FIRMWARE

In the previous screen the **Persistent Memory Module**, when you select **Update Firmware**, the screen to the right is what you are presented with. You can specify a file containing the new firmware code and then select **Update**.

Update Firmware

Specify the firmware image to load on the DIMM on the next system restart and select Update.
Warning! Modifying the settings of a single DIMM may result in an unusable configuration.

Current firmware version:	01.02.00.5346
Selected firmware version:	None
File:	<input type="text"/>
Staged firmware version:	N/A

- Update
- Back to DIMM details
- View DIMMs
- Back to main menu

Please provide file path relative to the root directory of the device containing the new firmware. For example:
"\\firmware\\newFirmware.bin".

↑↓=Move Highlight

F10=Save Changes and Exit
<Enter>=Select Entry

F9=Reset to Defaults
Esc=Exit

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CONFIGURING PMEM SECURITY

In the previous screen **Persistent Memory Module**, when you select **Configure Security**, the screen to the right is what you are presented with. If you select to set a password, it is stored and automatically applied to unlock PMEMs before the operating system starts running, but the secure erase action still requires the passphrase. Secure erase is used to erase the encrypted data on the DIMM. Freeze lock is used to lock the security settings of the DIMM.

Configure Security

Specify the security settings on the DIMM.
Warning! Modifying the settings of a single DIMM may result in an unusable configuration.

State: <Disabled>

Please type in your new password

Enable security
Secure erase
Freeze lock

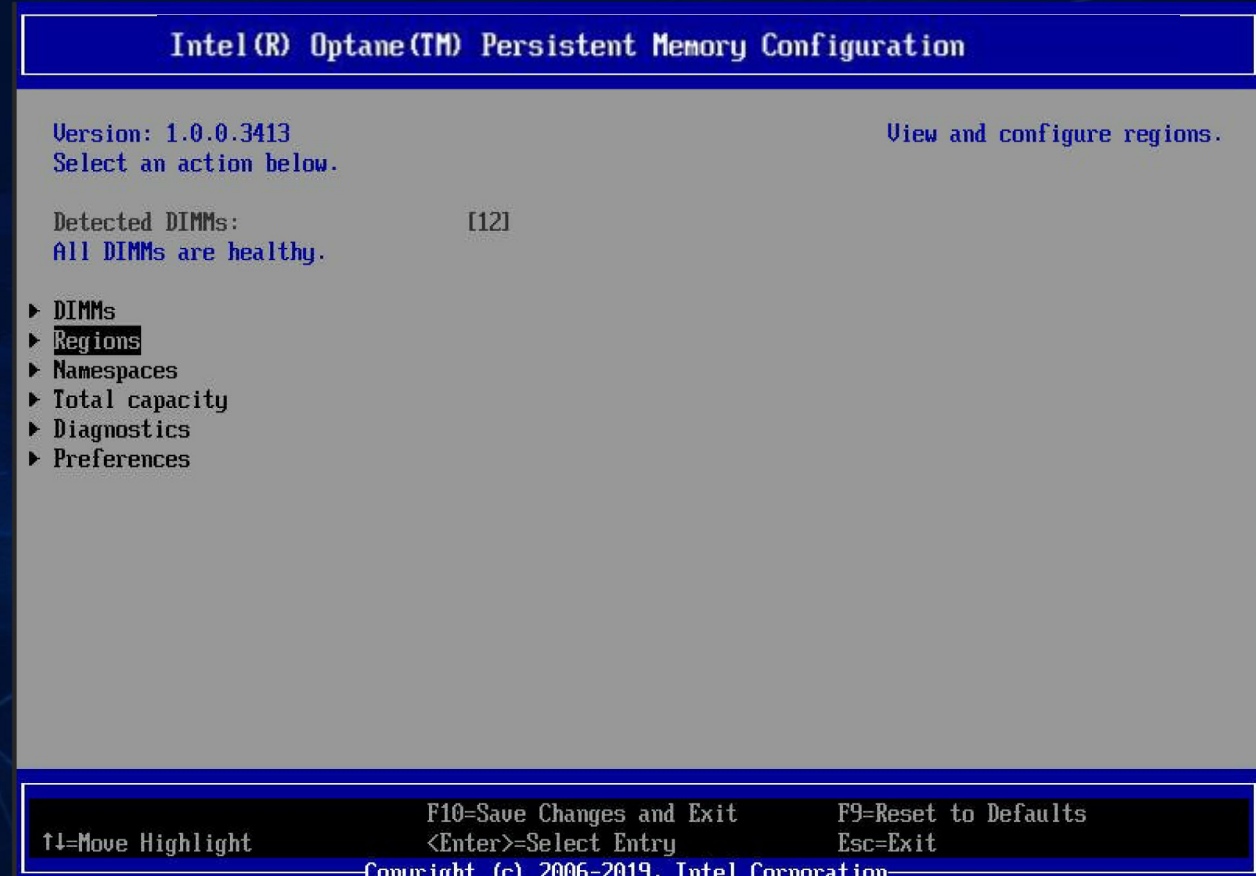
- ▶ Back to DIMM details
- ▶ View DIMMs
- ▶ Back to main menu

<Enter>=Complete Entry Esc=Exit Entry

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SETTINGS IN BIOS FOR APP DIRECT

To use DCPMM in App Direct mode, several steps need to be performed, including creating a **goal** which identifies how much memory to use, creating **regions** which are a group of one or more DCPMMs, and create **namespaces** which define a contiguously addressed range of non-volatile memory conceptually similar to a hard disk partition. From the **PMEM Memory Configuration** BIOS screen you can do all of these steps. Note that creating a goal is part of the creating namespaces process. Also note that from this screen you can get to an option for running diagnostics on the PMEM which we will look at later in this presentation.



CREATING PMEM GOALS IN BIOS

Regions

Current configuration

► Region ID 1

Persistent memory type: App Direct

Capacity: 1.4 TiB

Free capacity: 1.4 TiB

► Region ID 2

Persistent memory type: App Direct

Capacity: 1.4 TiB

Free capacity: 1.4 TiB

Memory allocation goal configuration

No goal configuration specified.

► **Create goal config**

► Back to main menu

1 →

F10=Save Changes and Exit F9=Reset to Defaults

↑↓=Move Highlight <Enter>=Select Entry Esc=Exit

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2 →

Create Goal Config

Select the scope of the new region then set the desired sizes.

Create goal config for: <Platform>

Reserved [I]: [0]

Memory Mode [I]: [0]

Persistent memory type: <App Direct>

Namespace Label version: **App Direct**

► Create goal config

► Back to Regions menu

► Back to main menu

Select the type of the persistent memory capacity to create.

App Direct

App Direct Not Interleaved

↑↓=Move Highlight <Enter>=Complete Entry Esc=Exit Entry

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Creating a goal is a two-step process. The first step is to select **Create Goal Config** from the **Regions** screen. Once you do that you will be presented with the screen on the right side of this slide. When creating a goal, there are several options. One option is to select if the goal is for the entire platform (which is the default) or if you want to create a goal for one socket on the platform. Another option is determining if the memory will be standard App Direct which is interleaved or if the memory will be App Direct non-interleaved. Once you have made your selections, the second and final step is to click on **Create Goal Config** in the **Create Goal Config** screen. A reboot is required.

VIEWING PMEM REGION SETTING IN BIOS

Regions

Current configuration

View region details.

Region ID 1

Persistent memory type: App Direct

Capacity: 1.4 TiB

Free capacity: 1.4 TiB

Region ID 2

Persistent memory type: App Direct

Capacity: 1.4 TiB

Free capacity: 1.4 TiB

Memory allocation goal configuration

DIMM ID 0x0001

MemorySize: 0 B

AppDirect1Size: 252.0 GiB

AppDirect2Size: 0 B

New: A reboot is required for the memory allocation goal to be processed by the BIOS.

DIMM ID 0x0011

MemorySize: 0 B

↑↓=Move Highlight

F10=Save Changes and Exit

F9=Reset to Defaults

<Enter>=Select Entry

Esc=Exit

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Region

View settings.

View and configure regions.

Region ID: 0x0001

DIMM ID: 0x0001, 0x0011, 0x0021, 0x0101, 0x0111, 0x0121

ISet ID: 0x51AE7F48F7F92CCC

Persistent memory type: App Direct

Capacity: 1.4 TiB

Free capacity: 1.4 TiB

Health: Healthy

Socket ID: 0x0000

Back to Regions menu

Back to main menu

↑↓=Move Highlight

F10=Save Changes and Exit

F9=Reset to Defaults

<Enter>=Select Entry

Esc=Exit

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To view region settings, select a region from the **Regions** screen and when you press Enter you will see a screen similar to the one on the right side of this slide, showing the Region ID, the DIMMs that are part of that region, the persistent memory type (standard interleaved or non-interleaved), the capacity, the health and the socket the region is tied to.

CREATING PMEM NAMESPACE SETTING IN BIOS

From the **PMEM Memory Configuration** BIOS screen you can also select to create a namespace. The screen on the right is what is displayed and allows options for giving the namespace a name or label, associating it with a region, and assigning a size to the namespace.

Create Namespace

Create a namespace.

Name

Region ID

Mode

Capacity input

Units

Capacity

<0x0001>

<None>

<Remaining>

<GiB>

1512.0

Name of namespace

▶ Create namespace

▶ Back to Namespaces

▶ Back to main menu

↑↓=Move Highlight

F10=Save Changes and Exit

F9=Reset to Defaults

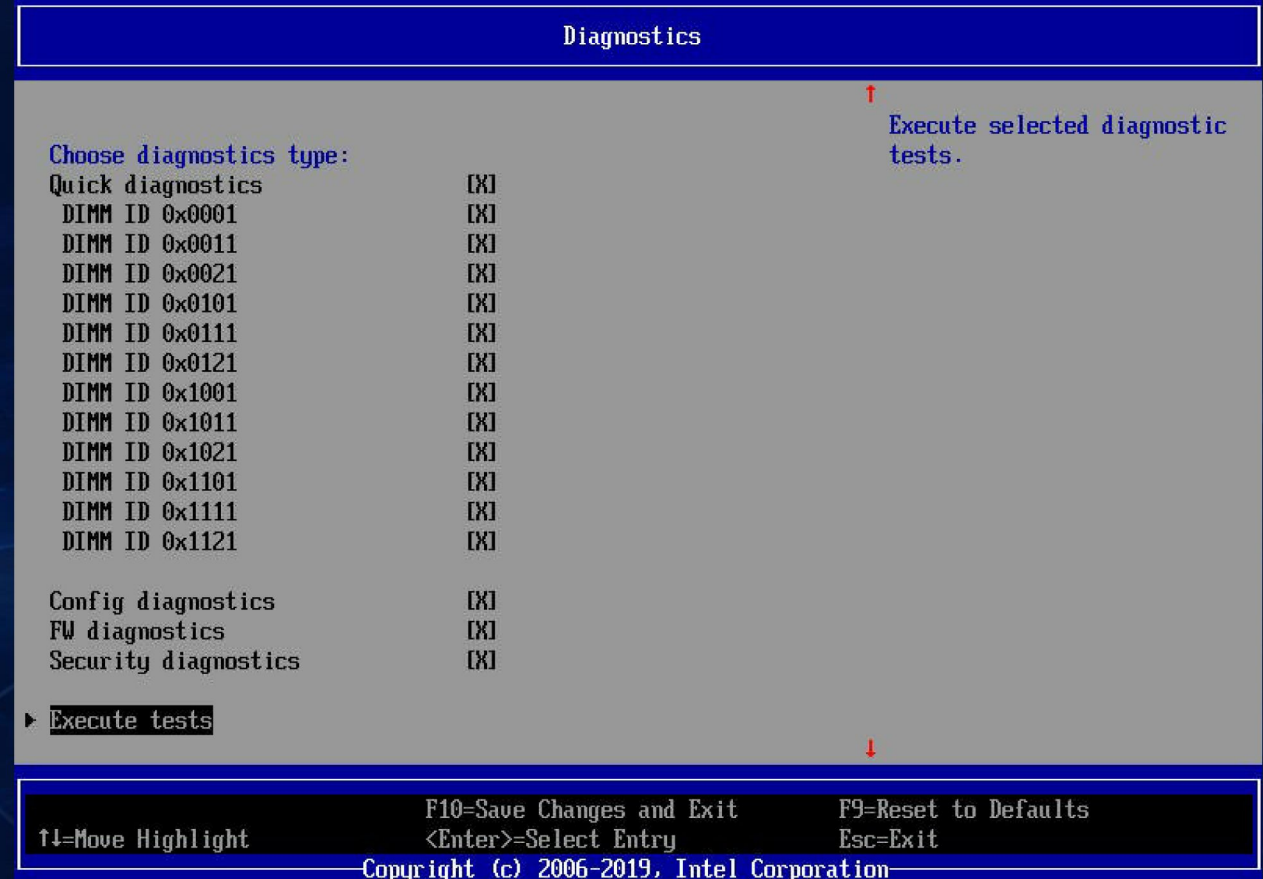
<Enter>=Select Entry

Esc=Exit

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RUNNING DIAGNOSTICS ON

From the **PMEM Memory Configuration** BIOS screen you can select **Diagnostics** which will allow you to run diagnostics on individual DIMMs or all of them, as well as validating the configuration parameters, and checking the firmware and security settings.



SUMMARY

- The Intel BIOS is a powerful tool for configuring and diagnosing Intel® Optane™ DC persistent memory modules (DCPMMs)
- BIOS can configure the DCPMMs for Memory Mode or App Direct Mode
- In BIOS, you can configure Goals, Regions, and Namespaces required for App Direct operations
- BIOS has a health check option for DCPMM modules

