White Paper

Cisco UCS for SAP HANA with Intel Optane DC Persistent Memory Module

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Contents

Executive summary

Organizations in every industry are generating and using more data than ever before: from customer transactions and supplier delivery information to real-time user-consumption statistics. Without reliable infrastructure that can store, process, and analyze big data sets in real time, companies cannot use this information to their advantage. The SAP HANA platform with the Cisco Unified Computing System™ (Cisco UCS®) M5 servers helps companies more easily harness information and make better business decisions that let them stay ahead of the competition. Our solutions help improve access to all your data to accelerate business decision making with policy-based, simplified management, lower deployment risk, and reduced total cost of ownership (TCO). Our innovations help enable you to unlock the intelligence in your data and interpret it with a new dimension of context and insight to help you gain a sustainable, competitive business advantage.

The Cisco solution for SAP HANA with the Cisco UCS M5 servers offers a robust platform for SAP HANA workloads. The SAP HANA platform provides a scalable database with advanced analytical capabilities and intuitive application-development tools in an in-memory data platform. SAP HANA supports Intel® Optane™ Data Center Persistent Memory Module (DCPMM). Persistent memory modules are nonvolatile memory modules that bring together the low latency of memory and the persistence of storage. Persistent memory modules provide faster access to data and retain data across power cycles, based on the mode.

To learn more about SAP HANA and Intel Optane DC persistent memory, go to http://sap.com/persistent-memory.

Solution overview

Introduction

Intel® Optane™ DC persistent memory represents an entirely new means of managing data for demanding workloads such as the SAP HANA platform. Intel Optane DC persistent memory is nonvolatile, so in-memory databases such as SAP HANA do not have to completely reload all data from persistent storage to memory, and it runs at near-DRAM speeds, maintaining today's performance expectations. It also delivers greater data density than memory technologies, which enables additional innovation and simpler IT landscapes. With its persistence, performance, and lower cost per gigabyte than conventional memory, Intel Optane DC persistent memory can help reduce total cost of ownership (TCO), reshape the way that businesses tier their data for database systems, and open new use cases for the speed and power of the SAP HANA platform.

Memory for databases is currently small, expensive, and volatile. Intel Optane DC persistent memory is denser, more affordable, and persistent, and it performs at speeds close to that of memory. These features of Intel Optane DC persistent memory can help lower TCO through reduced downtime and simplified data-tiering operations. These same features can also make SAP HANA in-memory databases economically viable for a wider range of use cases. Intel Optane DC persistent memory provides near-DRAM in-memory computing speed in a form factor similar to that of dual in-line memory modules (DIMMs) at a lower price per gigabyte than DRAM. Support for Intel Optane DC persistent memory is available with the next-generation Intel® Xeon® processor Scalable family.

Because it is nonvolatile, Intel Optane DC persistent memory enables you to keep the data in the SAP HANA platform loaded in main memory, even when power is off. Because you don't have to reload the data back into memory after downtime, restart time for the SAP HANA platform is greatly reduced. Intel Optane DC persistent memory is available in a form factor called persistent memory modules, which are similar to DIMMs, but with greater capacity than is available with conventional, volatile memory.

Audience

The intended audience for this document includes sales engineers, field consultants, professional services staff, IT managers, partner engineers, and customers deploying the Cisco solution for SAP HANA. External references are provided wherever applicable, but readers are expected to be familiar with the technology, infrastructure, and database security policies of the customer installation.

Purpose of this document

This document describes the steps required to configure a Cisco® data center solution for SAP HANA with Intel Optane Data Center Persistent Memory Module (DCPMM). This document focuses on one of the variants of Cisco's solution for SAP HANA. Although readers of this document are expected to have the knowledge needed to install and configure the products used, configuration details that are important to the deployment of this solution are provided in this document.

What's new in this release

Intel Optane DCPMM is supported on Cisco Unified Computing System™ (Cisco UCS®) servers for SAP HANA.

Solution summary

This section briefly describes the components of the Cisco UCS solution with Intel DCPMM for SAP HANA. For detailed deployment guidance, see the following documents:

- Cisco UCS Scale-Up Solution for SAP HANA on Cisco UCS M5 Rack Servers with Red Hat Enterprise Linux for SAP Applications (white paper)
- Cisco UCS Scale-Up Solution for SAP HANA on Cisco UCS M5 Rack Servers with SUSE Linux Enterprise Server 15 for SAP Applications (white paper)
- Cisco UCS Scale-Up Solution for SAP HANA on Cisco UCS M5 Rack Servers with SUSE Linux Enterprise Server for SAP Applications (white paper)

Cisco UCS B480 M5 Blade Server and C480 M5 Rack Server

The Cisco Scale-Up Solution for SAP HANA uses the Cisco UCS B480 M5 Blade Server and C480 M5 Rack Server. Table 1 summarizes the server specifications and shows proposed disk configurations for the SAP HANA use case.

Table 1. Overview of Cisco UCS C480 M5 Rack Server configuration

CPU specifications	Intel Xeon Platinum 8276L/8280L processor: Quantity 4
Possible memory configurations	• 32-GB DDR4: Quantity 24 (768 GB) • 64-GB DDR4: Quantity 24 (1.5 TB) • 128-GB DDR4: Quantity 24 (3 TB)
Possible DCPMM memory configurations	• 128-GB DCPMM: Quantity 24 (3 TB) • 256-GB DCPMM: Quantity 24 (6 TB) • 512-GB DCPMM: Quantity 24 (12 TB)
Internal hard drive for Cisco UCS C-Series Rack Servers	• 3.8-TB solid-state disk (SSD): Quantity 8

Cisco UCS B200 M5 Blade Server,C220 and C240 M5 Rack Servers

The Cisco Scale-Up Solution for SAP HANA can also be deployed on the Cisco UCS B200 M5 Blade Server and C220 and C240 M5 Rack Servers. Table 2 summarizes the server specifications and shows proposed disk configurations for the SAP HANA use case.

Table 2. Table 2 Overview of Cisco UCS C240 and C220 M5 Rack Server and B200 M5 Blade Server configuration

CPU specifications	Intel Xeon Platinum 8276L/8280L processor: Quantity 2
Possible memory configurations	• 16-GB DDR4: Quantity 12 (192 GB) • 32-GB DDR4: Quantity 12 (384 GB) • 64-GB DDR4: Quantity 12 (768 TB) • 128-GB DDR4: Quantity 12 (1.5 TB)
Possible DCPMM memory configurations	• 128-GB DCPMM: Quantity 12(1.5 TB) • 256-GB DCPMM: Quantity 12 (3 TB) • 512-GB DCPMM: Quantity 12 (6 TB)
Internal hard drive for Cisco UCS C-Series Rack Servers	• 3.8-TB SSD: Quantity 8

Technology overview

The Cisco Integrated Management Controller (IMC) and Cisco UCS Manager Release 4.0(4) introduce support for Intel Optane DCPMM on Cisco UCS M5 servers based on second-generation Intel Xeon Scalable processors.

Configuration of Persistent memory modules using the Cisco IMC or Cisco UCS Manager is not recommended in App Direct mode for SAP HANA.

Persistent memory modules can be managed using the software utilities installed on the operating system. This approach is known as host-managed mode. The solution discussed in this document uses persistent memory modules in host-managed mode.

Goal

A goal specifies the way that persistent memory modules connected to a CPU socket are used. You can configure a persistent memory module to be used in Memory mode, App Direct mode, or Mixed mode. If a persistent memory module is configured as 100 percent Memory mode, it can be used entirely as volatile memory. If it is configured as 0 percent Memory mode, it becomes App Direct mode and can be used entirely as persistent memory. If you configure a persistent memory module as x percent Memory mode, x percent is used as volatile memory, and the remaining percentage is used as persistent memory. For example, if you configure 20 percent Memory mode, 20 percent of the persistent memory module is used as volatile memory, and the remaining 80 percent is used as persistent memory. This mode is called Mixed mode.

App Direct mode is the only mode currently supported by SAP HANA 2.0 SPS 03+. The App Direct mode configures all memory modules connected to a socket as one interleaved set and creates one region for the set.

You can create a goal only at the server level for all sockets together, not for each socket separately. After a goal is created and applied on a server, the regions that are created are visible in the server inventory. A region is a grouping of one or more persistent memory modules that can be divided into one or more name spaces. When a host application uses name spaces, it stores application data in them.

Goal modification is a destructive operation. When a goal is modified, new regions are created based on the modified goal configuration. This modification results in the deletion of all existing regions and name spaces on the associated servers, which leads to the loss of data currently stored in the name spaces.

Region

A region is a grouping of one or more persistent memory modules that can be divided up into one or more name spaces. A region is created based on the persistent memory type selected during goal creation. When you create a goal with the App Direct persistent memory type, one region is created for all the memory modules connected to a socket.

Name space

A name space is a partition of a region. When you use the App Direct persistent memory type, you can create name spaces on the region mapped to the socket. A name space can be created in Raw or Block mode. A name space created in Raw mode is seen as a raw name space in the host OS. A name space created in Block mode is seen as a sector name space in the host OS.

Deleting a name space is a destructive operation and results in the loss of data stored in the name space.

Direct access

Direct access (DAX) is a mechanism that allows applications to directly access the persistent media from the CPU (through loads and stores), bypassing the traditional I/O stack (page cache and block layer).

Managing Intel Optane DCPMM from the host

The software utilities ipmctl and ndctl manage DCPMM from the Linux command line. Use ipmctl for all tasks except name-space management.

ipmctl utility

Use the ipmctl utility to configure and manage Intel Optane DCPMM. It supports functions to:

- Discover persistent memory modules on the platform
- Provision the platform memory configuration
- View and update persistent memory module firmware
- Configure data-at-rest security on persistent memory modules
- Monitor persistent memory module health
- Track performance of persistent memory modules
- Debug and troubleshoot persistent memory modules

For detailed information, see https://github.com/intel/ipmctl.

ndctl utility

Use the ndctl utility library to manage the libnvdimm (nonvolatile memory device) subsystem in the Linux kernel.

For detailed information, see https://github.com/pmem/ndctl.

For detailed information about configuring Intel Optane DCPMM, see https://software.intel.com/en-us/articles/quick-start-guide-configure-intel-optane-dc-persistent-memory-on-linux.

Solution design

This section describes the SAP HANA system with Intel Optane DCPMM requirements as defined by SAP.

Platform support and operating modes for persistent memory.

Intel Optane DCPMM is supported on servers equipped with second-generation Intel Xeon Gold processors and Intel Xeon Platinum processors. Two primary modes are supported: App Direct mode, including Block over App Direct mode, and Memory mode. App Direct mode is the only mode that is currently supported by SAP HANA 2.0 SPS 03+. In App Direct mode, the persistent memory modules appear as byte-addressable memory resources that are controlled by SAP HANA 2.0 SPS 03+. In this mode, the persistent memory space is controlled directly by SAP HANA.

Hardware sizing for SAP HANA 2.0 SPS 03+

The sizing for an SAP HANA deployment can be accomplished using a fixed core-to-memory ratio based on workload type, or by performing a self-assessment using the SAP HANA Tailored Datacenter Integration (TDI) approach and tools such as SAP Quick Sizer. The web-based SAP Quick Sizer tool can be used for sizing new (greenfield) systems as well as current production systems. The SAP Quick Sizer tool makes sizing recommendations based on the types of workloads that will be running on SAP HANA. Memory, CPU, disk I/O, network loads, and business requirements each play a part in determining the optimal configuration for SAP HANA. Because DRAM is used in addition to Intel Optane DC persistent memory, the SAP Quick Sizer tool takes into consideration the data that should be stored in DRAM and the data that should be stored in Intel Optane DC persistent memory when making recommendations. Note that SAP HANA uses persistent memory for all data that resides in the column data store.

For more information about the SAP Quick Sizer tool, see https://www.sap.com/about/benchmark/sizing.quick-sizer.html#quick-sizer.

Ratio of DRAM to persistent memory

Intel Optane DCPMMs must be installed with DRAM DIMMs in the same system. The persistent memory modules will not function without any DRAM DIMMs installed. In two-, four-, and eight-socket configurations, each socket contains two IMCs. Each memory controller is connected to three double data rate (DDR) memory channels that are then connected to two physical DIMM persistent memory slots. In this configuration, a maximum of 12 memory slots per CPU socket can be configured with a combination of Intel Optane DCPMMs and DRAM DIMMs.

SAP HANA 2.0 SPS 03 currently supports various capacity ratios between Intel Optane DCPMMs and DIMMs. Ratio examples include the following:

- 1:1 ratio: A single 128-GB Intel Optane DCPMM is matched with a single 128-GB DDR4 DIMM, or a 256-GB Intel Optane DCPMM is matched with a single 256-GB DRAM DIMM.
- 2:1 ratio: A 256-GB Intel Optane DCPMM is matched with a 128-GB DRAM DIMM, or a 128-GB Intel Optane DCPMM is matched with a 64-GB DDR4 DIMM.
- 4:1 ratio: A 512-GB Intel Optane DCPMM is matched with a 128-GB DDR4 DIMM, or a 256-GB Intel Optane DCPMM is matched with a 64-GB DRAM DIMM.

Different-sized Intel Optane DCPMMs and DIMMs can be used together as long as supported ratios are maintained (Table 3).

Table 3. Supported ratios of Intel Optane DCPMMs to DIMMs

Memory configuration (PMM + DRAM)	CPU type	Capacity (GB) with number of CPUs			Ratio of Intel Optane DCPMMs to DIMMs
		2	4	8	
128-GB Intel Optane DCPMM + 32-GB DRAM	Base	1920	3480	7680	4:1
128-GB Intel Optane DCPMM + 64-GB DRAM	M	2304	4608	9216	2:1
128-GB Intel Optane DCPMM + 128-GB DRAM	M	3072	6144	12,228	1:1
256-GB Intel Optane DCPMM + 64-GB DRAM	M	3840	7680	15,360	4:1
256-GB Intel Optane DCPMM + 128-GB DRAM	L	4608	9216	18,432	2:1
256-GB Intel Optane DCPMM + 256-GB DRAM	L	6144	12,288	24,576	1:1
512-GB Intel Optane DCPMM + 128-GB DRAM	L	7680	15,360		4:1
512-GB Intel Optane DCPMM + 256-GB DRAM	L	9216	18,432		2:1

Sizing persistent storage

The storage size for the file system is based on the amount of memory (DRAM + Intel Optane DCPMM) on the SAP HANA host. For a single-node system with 9 TB of memory (3-TB DRAM + 6-TB Intel Optane DCPMM), the recommended file system sizes are as follows:

- /hana/data = 1.2 x memory (DRAM + Intel Optane DCPMM) = 1.2 x 9 TB = 10.8 TB
- /hana/log = 512 GB
- /hana/shared = 1 TB

Operating system

SAP HANA with Intel Optane DCPMM is supported by the following operating systems:

- SUSE Linux Enterprise Server (SLES) for SAP Applications
  - SLES for SAP Applications 12 SP4
  - SLES for SAP Applications 15
- Red Hat Enterprise Linux (RHEL)
  - RHEL 7.6 for SAP HANA
  - RHEL 7.6 for SAP Solutions

Intel Optane DCPMM configuration for SAP HANA

This section discusses how to configure the Intel Optane DCPMM for SAP HANA solution. Please follow the relevant document mentioned in the Solution summary section to deploy SAP HANA on Cisco UCS Servers.

Below are the steps to configure Intel Optane DCPMM for SAP HANA

1. Install tools to manage Intel Optane DCPMM
2. Create Goal to configure Intel Optane DCPMM for App Direct mode.
3. App Direct mode will create a persistent memory region for each CPU
4. Create namespace for each persistent memory region, which creates block device in fsdax mode
5. Create xfs filesystem on each persistent memory block device and mount on SAP HANA server
6. Set the SAP HANA base path to use persistent memory

Installing tools on the SAP HANA server

Follow the github links below to install the latest version of ipmctl and ndctl on the SAP HANA Linux server.

For ipmctl utility https://github.com/intel/ipmctl

For ndctl utility library https://github.com/pmem/ndctl

Configuring Intel Optane DCPMM

The **show -dimm** command displays the persistent memory modules discovered in the system and verifies that software can communicate with them. Among other information, this command outputs each DIMM ID, capacity, health state, and firmware version.

Here is an example of output from the **ipmctl show -dimm** command:

```
ipmctl show -dimm
DimmID | Capacity  | HealthState | ActionRequired | LockState | FWVersion
==============================================================================
 0x0021 | 502.5 GiB | Healthy     | 0              | Disabled  | 01.02.00.5367
 0x0001 | 502.5 GiB | Healthy     | 0              | Disabled  | 01.02.00.5367
 0x0011 | 502.5 GiB | Healthy     | 0              | Disabled  | 01.02.00.5367
 0x0121 | 502.5 GiB | Healthy     | 0              | Disabled  | 01.02.00.5367
 0x0101 | 502.5 GiB | Healthy     | 0              | Disabled  | 01.02.00.5367
 0x0111 | 502.5 GiB | Healthy     | 0              | Disabled  | 01.02.00.5367
 0x1021 | 502.5 GiB | Healthy     | 0              | Disabled  | 01.02.00.5367
 0x1001 | 502.5 GiB | Healthy     | 0              | Disabled  | 01.02.00.5367
 0x1011 | 502.5 GiB | Healthy     | 0              | Disabled  | 01.02.00.5367
 0x1121 | 502.5 GiB | Healthy     | 0              | Disabled  | 01.02.00.5367
 0x1101 | 502.5 GiB | Healthy     | 0              | Disabled  | 01.02.00.5367
 0x1111 | 502.5 GiB | Healthy     | 0              | Disabled  | 01.02.00.5367
 0x2021 | 502.5 GiB | Healthy     | 0              | Disabled  | 01.02.00.5367
 0x2001 | 502.5 GiB | Healthy     | 0              | Disabled  | 01.02.00.5367
 0x2011 | 502.5 GiB | Healthy     | 0              | Disabled  | 01.02.00.5367
 0x2121 | 502.5 GiB | Healthy     | 0              | Disabled  | 01.02.00.5367
 0x2101 | 502.5 GiB | Healthy     | 0              | Disabled  | 01.02.00.5367
 0x2111 | 502.5 GiB | Healthy     | 0              | Disabled  | 01.02.00.5367
 0x3021 | 502.5 GiB | Healthy     | 0              | Disabled  | 01.02.00.5367
 0x3001 | 502.5 GiB | Healthy     | 0              | Disabled  | 01.02.00.5367
 0x3011 | 502.5 GiB | Healthy     | 0              | Disabled  | 01.02.00.5367
 0x3121 | 502.5 GiB | Healthy     | 0              | Disabled  | 01.02.00.5367
 0x3101 | 502.5 GiB | Healthy     | 0              | Disabled  | 01.02.00.5367
 0x3111 | 502.5 GiB | Healthy     | 0              | Disabled  | 01.02.00.5367
```

Creating the goal

The default **create -goal** command creates an interleaved region configured for App Direct mode. Here is an example of output from the **ipmctl create -goal** command:

```
ipmctl create -goal
The following configuration will be applied:
 SocketID | DimmID | MemorySize | AppDirect1Size | AppDirect2Size
==================================================================
 0x0000   | 0x0021 | 0.0 GiB    | 502.0 GiB      | 0.0 GiB
 0x0000   | 0x0001 | 0.0 GiB    | 502.0 GiB      | 0.0 GiB
 0x0000   | 0x0011 | 0.0 GiB    | 502.0 GiB      | 0.0 GiB
 0x0000   | 0x0121 | 0.0 GiB    | 502.0 GiB      | 0.0 GiB
 0x0000   | 0x0101 | 0.0 GiB    | 502.0 GiB      | 0.0 GiB
 0x0000   | 0x0111 | 0.0 GiB    | 502.0 GiB      | 0.0 GiB
 0x0001   | 0x1021 | 0.0 GiB    | 502.0 GiB      | 0.0 GiB
 0x0001   | 0x1001 | 0.0 GiB    | 502.0 GiB      | 0.0 GiB
 0x0001   | 0x1011 | 0.0 GiB    | 502.0 GiB      | 0.0 GiB
 0x0001   | 0x1121 | 0.0 GiB    | 502.0 GiB      | 0.0 GiB
 0x0001   | 0x1101 | 0.0 GiB    | 502.0 GiB      | 0.0 GiB
 0x0001   | 0x1111 | 0.0 GiB    | 502.0 GiB      | 0.0 GiB
 0x0002   | 0x2021 | 0.0 GiB    | 502.0 GiB      | 0.0 GiB
 0x0002   | 0x2001 | 0.0 GiB    | 502.0 GiB      | 0.0 GiB
 0x0002   | 0x2011 | 0.0 GiB    | 502.0 GiB      | 0.0 GiB
 0x0002   | 0x2121 | 0.0 GiB    | 502.0 GiB      | 0.0 GiB
 0x0002   | 0x2101 | 0.0 GiB    | 502.0 GiB      | 0.0 GiB
 0x0002   | 0x2111 | 0.0 GiB    | 502.0 GiB      | 0.0 GiB
 0x0003   | 0x3021 | 0.0 GiB    | 502.0 GiB      | 0.0 GiB
 0x0003   | 0x3001 | 0.0 GiB    | 502.0 GiB      | 0.0 GiB
 0x0003   | 0x3011 | 0.0 GiB    | 502.0 GiB      | 0.0 GiB
 0x0003   | 0x3121 | 0.0 GiB    | 502.0 GiB      | 0.0 GiB
 0x0003   | 0x3101 | 0.0 GiB    | 502.0 GiB      | 0.0 GiB
 0x0003   | 0x3111 | 0.0 GiB    | 502.0 GiB      | 0.0 GiB
Do you want to continue? [y/n] y
Created following region configuration goal
 SocketID | DimmID | MemorySize | AppDirect1Size | AppDirect2Size
==================================================================
 0x0000   | 0x0021 | 0.0 GiB    | 502.0 GiB      | 0.0 GiB
 0x0000   | 0x0001 | 0.0 GiB    | 502.0 GiB      | 0.0 GiB
 0x0000   | 0x0011 | 0.0 GiB    | 502.0 GiB      | 0.0 GiB
 0x0000   | 0x0121 | 0.0 GiB    | 502.0 GiB      | 0.0 GiB
 0x0000   | 0x0101 | 0.0 GiB    | 502.0 GiB      | 0.0 GiB
 0x0000   | 0x0111 | 0.0 GiB    | 502.0 GiB      | 0.0 GiB
 0x0001   | 0x1021 | 0.0 GiB    | 502.0 GiB      | 0.0 GiB
 0x0001   | 0x1001 | 0.0 GiB    | 502.0 GiB      | 0.0 GiB
 0x0001   | 0x1011 | 0.0 GiB    | 502.0 GiB      | 0.0 GiB
 0x0001   | 0x1121 | 0.0 GiB    | 502.0 GiB      | 0.0 GiB
```

```
 0x0001    | 0x1101 | 0.0 GiB    | 502.0 GiB        | 0.0 GiB
 0x0001    | 0x1111 | 0.0 GiB    | 502.0 GiB        | 0.0 GiB
 0x0002    | 0x2021 | 0.0 GiB    | 502.0 GiB        | 0.0 GiB
 0x0002    | 0x2001 | 0.0 GiB    | 502.0 GiB        | 0.0 GiB
 0x0002    | 0x2011 | 0.0 GiB    | 502.0 GiB        | 0.0 GiB
 0x0002    | 0x2121 | 0.0 GiB    | 502.0 GiB        | 0.0 GiB
 0x0002    | 0x2101 | 0.0 GiB    | 502.0 GiB        | 0.0 GiB
 0x0002    | 0x2111 | 0.0 GiB    | 502.0 GiB        | 0.0 GiB
 0x0003    | 0x3021 | 0.0 GiB    | 502.0 GiB        | 0.0 GiB
 0x0003    | 0x3001 | 0.0 GiB    | 502.0 GiB        | 0.0 GiB
 0x0003    | 0x3011 | 0.0 GiB    | 502.0 GiB        | 0.0 GiB
 0x0003    | 0x3121 | 0.0 GiB    | 502.0 GiB        | 0.0 GiB
 0x0003    | 0x3101 | 0.0 GiB    | 502.0 GiB        | 0.0 GiB
 0x0003    | 0x3111 | 0.0 GiB    | 502.0 GiB        | 0.0 GiB
A reboot is required to process new memory allocation goals.
```

Reboot the server for new memory allocations.

Showing the regions created

Use the command **ipmctl show -region** to see the regions that were created. Here is an example of output from the **ipmctl show -region** command.

```
ipmctl show -region

 SocketID | ISetID             | PersistentMemoryType | Capacity   | FreeCapacity | HealthState
=================================================================================================
 0x0000   | 0xf3c67f48e25d2ccc | AppDirect            | 3012.0 GiB | 3012.0 GiB   | Healthy
 0x0001   | 0x03447f48e45c2ccc | AppDirect            | 3012.0 GiB | 3012.0 GiB   | Healthy
 0x0002   | 0x4fa67f48cf692ccc | AppDirect            | 3012.0 GiB | 3012.0 GiB   | Healthy
 0x0003   | 0xe0327f48d25d2ccc | AppDirect            | 3012.0 GiB | 3012.0 GiB   | Healthy
```

Using the default namespace mode

Filesystem-DAX mode is the default name-space mode. If you specify **ndctl create-namespace** with no options, a block device (/dev/pmemX[.Y]) is created that supports the DAX capabilities of Linux file systems. DAX removes the page cache from the I/O path and allows mmap(2) to establish direct mappings to persistent memory media.

In this mode, applications can either directly load and access storage using a persistent memory region or continue to use a storage API, thus requiring no changes to the application.

Creating a name space for each region

Use the **ndctl create-namespace** command to create a name space for each region. You must run this command for each CPU in the server. Here is an example of output from the **ndctl create-namespace** command on a server with four CPUs.

```
ndctl create-namespace
{
  "dev":"namespace3.0",
  "mode":"fsdax",
  "map":"dev",
  "size":"2964.94 GiB (3183.58 GB)",
```

```
  "uuid":"43002f2c-b37c-4cec-9474-d3d8b1223e65",
  "raw_uuid":"7df74ccf-1032-4c12-905f-cd9e5e1ac1be",
  "sector_size":512,
  "blockdev":"pmem3",
  "numa_node":3
}
ndctl create-namespace
{
  "dev":"namespace2.0",
  "mode":"fsdax",
  "map":"dev",
  "size":"2964.94 GiB (3183.58 GB)",
  "uuid":"45e0fc9e-149c-4616-b308-eb10eecd5e19",
  "raw_uuid":"6242e069-6637-4d75-a364-e2049fdf9bd7",
  "sector_size":512,
  "blockdev":"pmem2",
  "numa_node":2
}
ndctl create-namespace
{
  "dev":"namespace1.0",
  "mode":"fsdax",
  "map":"dev",
  "size":"2964.94 GiB (3183.58 GB)",
  "uuid":"9375a814-ac10-498a-9e73-3e28e7242519",
  "raw_uuid":"4f6f69ce-6aaa-4076-be81-ab7504f43b58",
  "sector_size":512,
  "blockdev":"pmem1",
  "numa_node":1
}
ndctl create-namespace
{
  "dev":"namespace0.0",
  "mode":"fsdax",
  "map":"dev",
  "size":"2964.94 GiB (3183.58 GB)",
  "uuid":"83425d72-c451-4eb7-b450-8dc3f4b1978a",
  "raw_uuid":"d8633063-012f-4b0b-be95-29ed455abcf8",
  "sector_size":512,
  "blockdev":"pmem0",
  "numa_node":0
}
```

Listing the active name spaces

Use the **ndctl list** command to list all the active name spaces. Here is an example of output from the **ndctl list** command.

```
ndctl list
 [
  {
    "dev":"namespace3.0",
    "mode":"fsdax",
    "map":"dev",
    "size":3183575302144,
    "uuid":"43002f2c-b37c-4cec-9474-d3d8b1223e65",
    "blockdev":"pmem3"
  },
  {
    "dev":"namespace2.0",
    "mode":"fsdax",
    "map":"dev",
    "size":3183575302144,
    "uuid":"45e0fc9e-149c-4616-b308-eb10eecd5e19",
    "blockdev":"pmem2"
  },
  {
    "dev":"namespace1.0",
    "mode":"fsdax",
    "map":"dev",
    "size":3183575302144,
    "uuid":"9375a814-ac10-498a-9e73-3e28e7242519",
    "blockdev":"pmem1"
  },
  {
    "dev":"namespace0.0",
    "mode":"fsdax",
    "map":"dev",
    "size":3183575302144,
    "uuid":"83425d72-c451-4eb7-b450-8dc3f4b1978a",
    "blockdev":"pmem0"
  }
]
```

Creating the file system and mounting the persistent memory modules

Use this set of commands to create the file system and mount the persistent memory modules. This example uses a server with four CPUs. It therefore has four regions.

```
mkfs -t xfs -f /dev/pmem0
mkfs -t xfs -f /dev/pmem1
mkfs -t xfs -f /dev/pmem2
mkfs -t xfs -f /dev/pmem3

mkdir -p /hana/pmem/nvmem0
mkdir -p /hana/pmem/nvmem1
mkdir -p /hana/pmem/nvmem2
mkdir -p /hana/pmem/nvmem3

mount -t xfs -o dax /dev/pmem0 /hana/pmem/nvmem0
mount -t xfs -o dax /dev/pmem1 /hana/pmem/nvmem1
mount -t xfs -o dax /dev/pmem2 /hana/pmem/nvmem2
mount -t xfs -o dax /dev/pmem3 /hana/pmem/nvmem3
```

Setting the SAP HANA base path to use persistent memory.

The directory that SAP HANA uses as its base path must point to the XFS file system. Define the base path location with the configuration parameter basepath_persistent_memory_volumes in the persistence section of the SAP HANA global.ini file. This section can contain multiple locations separated by semicolons. Changes to this parameter require a restart of SAP HANA services.

```
[persistence]
basepath_datavolumes = /hana/data/AEP
basepath_logvolumes = /hana/log/AEP
basepath_persistent_memory_volumes=/hana/pmem/nvmem0;/hana/pmem/nvmem1;/hana/pmem/nvmem2;/hana
/pmem/nvmem3
```

At startup, SAP HANA tests for a DAX-enabled file system at the location defined in the base path. After SAP HANA verifies that the file system is DAX enabled, all tables will use persistent memory by default. Save points help ensure that the contents of data in persistent memory is consistent with the persistence and data log volumes.

Conclusion

Cisco UCS M5 servers with second-generation Intel Xeon Scalable processors and Intel Optane DC persistent memory, combined with DRAM, revolutionizes the SAP HANA landscape by helping organizations achieve lower overall TCO, ensure business continuity, and increase the memory capacities of their SAP HANA deployments. Intel Optane DC persistent memory can transform the traditional SAP HANA data-tier infrastructure and revolutionize data processing and storage. Together, these technologies give organizations faster access to more data than ever before and provide better performance for advanced data processing technologies.

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