DELLTechnologies

# SAP HANA TDI Deployments on Dell PowerEdge Servers

## Configuration and Deployment Guidelines

January 2022

H17840.6

Validation Guide

### Abstract

This validation guide provides best-practice configuration and deployment guidelines for SAP HANA Tailored Datacenter Integration (TDI) deployments on SAP HANA certified Cascade Lake-based and Ice lake-based Dell PowerEdge systems.

Dell Technologies Solutions

DELLTechnologies

Copyright

# Contents

# Introduction

**Business case**

In today's competitive, data-intensive world, businesses require instantaneous access to information insights. Dell's SAP HANA solutions dramatically increase the speed of access to business information.

SAP HANA is a multipurpose, data-source-agnostic, in-memory database. Dell's SAP HANA solutions are optimized to run SAP HANA software on Dell servers, networking, and storage.

When SAP first introduced SAP HANA on dedicated appliances, IT architects could not apply many of their traditional practices and principles. The SAP HANA Tailored Data Center Integration (TDI) model changed that. Although SAP still specifies restrictions on SAP HANA infrastructure architectures, most of the key principles of IT system architecture can now be applied to SAP HANA systems. A holistic approach to IT architecture across the data center is achieved by using existing data center resources, providing a strong return-on-investment (ROI) case for SAP HANA adoption. The flexibility and cost-effectiveness of SAP HANA TDI make it the future-proof option for organizations planning to make SAP HANA mainstream in their data centers.

**Solution overview**

With SAP HANA TDI, you can deploy any Dell PowerEdge system that is certified by SAP, as listed under **Certified Appliances** in the Certified and Supported SAP HANA Hardware Directory, with any Dell enterprise storage system that is listed under **Certified Enterprise Storage** in the same directory.

Effective from SAP HANA TDI Phase 5, SAP supports the complete family of Intel Xeon Ice Lake and Cascade Lake platinum, gold, and silver processors, featuring eight+ cores per processor and a minimum of two sockets. The increased variety of CPU processor options enables customers to be more flexible in their hardware choices and to cost-optimize their PowerEdge systems for their specific workload requirements. SAP HANA TDI Phase Five allows for a workload-driven sizing approach by employing the SAP Application Performance Standard (SAPS) to determine the maximum RAM capacity for a specific customer application. Accordingly, customers whose workloads are less CPU-intensive might have a larger main memory capacity compared to SAP HANA appliance-based solutions that use a fixed core-to-memory sizing approach.

This Dell PowerEdge Server solution for SAP HANA TDI deployments incorporates the latest Intel Xeon CPU architectures, while PowerEdge servers provide an exceptional combination of performance, resiliency, and flexibility to meet the needs of the modern enterprise data center.

**Key benefits**

With SAP HANA TDI, all scenarios that are applicable to Dell's SAP HANA certified appliances are supported in TDI deployments using the same Dell server model. PowerEdge servers are designed for business continuity and offer outstanding enterprise-class features, including:

- **Powerful technology**—Single-server configurations ranging in size from 192 GB to 6 TB provide a consistent experience and a solid base for future expansion without forcing "rip and replace" as system requirements evolve. The latest PowerEdge

servers with Intel Ice Lake or Cascade Lake processors are certified for SAP HANA single-server and scale-out solutions and include everything that is required to support your SAP HANA implementation. For more information, see the Certified and Supported SAP HANA Hardware Directory.

- **Virtualization**—PowerEdge solutions are certified to run a virtualized SAP HANA implementation, which provides a more economical application development environment and is ready for deployment in production environments.

- **Enterprise-class availability**—With highly redundant hardware configurations and the use of both SAN/NAS technology and a highly available multinode design, Dell scale-out solutions for SAP HANA provide resiliency and easy expandability.

- **High performance**—Automated data tiering with Dell storage software provides quick access to the datasets that are most needed for analysis.

- **Backup and disaster recovery**—Dell solutions for SAP HANA can provide remote disaster recovery through SAP HANA system replication or storage-based replication. Tests are performed with the Dell Data Domain appliance to provide a high-performance, cost-effective solution.

- **Modular growth**—The scale-out solution can grow from 1.5 TB to 48 TB in modular increments without disrupting the existing system, preserving your investment as your system changes.

- **SAP applications in memory**—Dell solutions for SAP HANA support application deployment that enables production business applications to benefit from the speed and performance of in-memory computing without the need for multiple compute environments.

- **A single point of contact**—Dell Technologies is your single source for all Dell hardware components of the SAP HANA solution.

**Document purpose**

This validation guide provides guidelines for designing and configuring an SAP HANA TDI solution for servers and the associated components that run best with SAP HANA. This guide is updated periodically with the latest information.

**Audience**

This guide is for SAP Basis, system, and storage administrators and architects who design SAP HANA systems for deployment on PowerEdge servers. You should have some knowledge of Dell storage arrays, PowerEdge servers, and VMware vSphere Hypervisor.

**We value your feedback**

Dell Technologies and the authors of this guide welcome your feedback on the solution and the solution documentation. Contact the Dell Technologies Solutions team by email with your comments.

**Authors:** Benjamin Simroth, Donagh Keeshan, Dat Nguyen

**Contributor:** Aighne Kearney

**Note**: For links to additional documentation for this solution, see the Dell Technologies Solutions for SAP Info Hub.

# Technology overview

**Introduction**

SAP HANA is an in-memory data platform that can be deployed on-premises or in the cloud. Organizations use the SAP HANA platform to analyze large volumes of data and develop and deploy applications in real time.

SAP HANA combines SAP software components that are optimized on proven partner-provided hardware. Two models are available for on-premises deployment, as shown in the following figure:
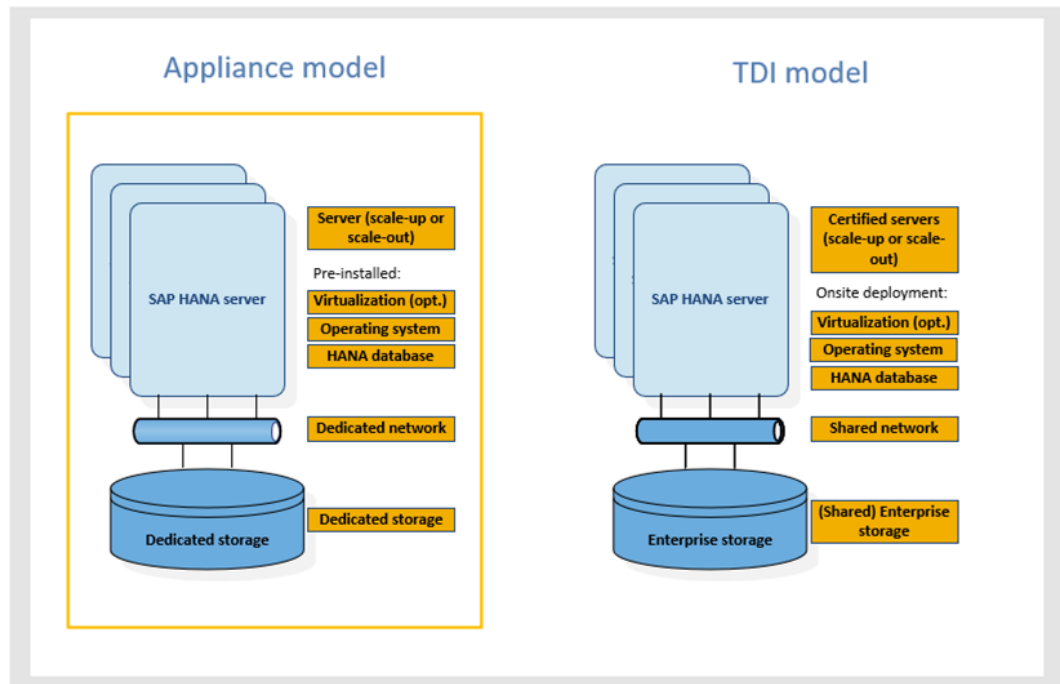


**Figure 1.**     **SAP HANA appliance model and TDI model comparison**

## Appliance model

By default, an SAP HANA appliance includes integrated storage, compute, and network components. The appliance is certified by SAP, built by an SAP HANA hardware partner with preconfigured hardware, optimized, and then shipped to customers with all its software components preinstalled, including operating systems and SAP HANA software.

Dell's preinstalled SAP HANA appliance solutions provide a faster time to market and easy integration into an SAP landscape. The appliance model is designed as a dedicated stand-alone system for predictable performance. It is important to note, however, that appliances present certain limitations for customers:

- A limited choice of servers, networks, and storage

- An inability to use existing data center infrastructure and operational processes

- Fixed sizes for SAP HANA server and storage capacities, which can lead to higher costs from a capacity shortfall and an inability to respond rapidly to unexpected growth demands.

### TDI model

The SAP HANA TDI deployment model gives customers additional flexibility to integrate SAP HANA into their data centers. Customers can:

- Choose from a broad portfolio of SAP HANA-certified servers and CPU models that can be combined with SAP-certified network and storage components.

- Seamlessly integrate SAP HANA into existing data center operations such as disaster recovery, data protection, monitoring, and management, reducing the cost, time to value, and risk of an overall SAP HANA adoption.

- Share the storage and network components for different workloads to optimize the total cost of ownership (TCO).

For more information, see the following documents:

- *SAP HANA Tailored Data Center Integration - Overview*

- *SAP HANA Tailored Data Center Integration - Frequently Asked Questions*

**Dell solutions for SAP HANA**

Dell offers a complete portfolio of SAP HANA certified solutions, including appliances and TDI solutions that are available in both bare-metal and virtual configurations. We also offer converged infrastructure (CI) and hyperconverged infrastructure (HCI) solutions for SAP HANA.

**Dell appliances for SAP HANA**

The following table shows the PowerEdge models that are supported for SAP HANA single-node (scale-up) appliance solutions:

**Table 1.    Supported PowerEdge models for preinstalled SAP HANA solutions**

| Intel Xeon CPU | PowerEdge server models |
|---|---|
| SP Ice Lake | R750 |
| SP Cascade Lake | R940, R840 |

For more information about supported SAP HANA appliance types and memory sizes, see the Certified and Supported SAP HANA Hardware Directory.

**Dell TDI solutions for SAP HANA**

The following table shows the components of a Dell solution for an SAP HANA TDI deployment:

**Table 2.    Configuration of a Dell solution for SAP HANA TDI**

| Component | Description |
|---|---|
| Server | PowerEdge servers listed in Table 3 |
| CPUs | • 2 Intel Xeon Ice Lake<br>• 2 to 4 Intel Xeon Cascade Lake |

| Component | Description |
|---|---|
| Memory | • Up to 32 DDR4 RDIMMs/LRDIMMs for 2-socket Ice Lake servers<br>• Up to 24 DDR4 RDIMMs/LRDIMMs for 2-socket Cascade Lake server<br>• Up to 48 DDR4 RDIMMs/LRDIMMs for a 4-socket Cascade Lake server |
| Operating system | SUSE Linux Enterprise Server, Red Hat Enterprise Linux, VMware vSphere (for virtual SAP HANA configurations) |
| Infrastructure switches | • Ethernet fabric: 10 GbE to 200 GbE Dell S-Series and Z-Series data center network switches<br>• SAN fabric: Dell Connectrix Fibre Channel (FC), Dell unified S4148U, or MX9116n/MX7116n modular switches |
| Storage configuration | • Local storage: All-flash or a combination of serial-attached storage (SAS) and solid-state device (SSD) drives.<br>• External storage: Dell storage arrays |
| Backup and disaster recovery | • SAP HANA system replication<br>• Backup and recovery of SAP HANA on the Dell PowerProtect appliance |
| Solution and hardware life cycle management | Dell OpenManage |

If you have questions about specific licenses and services, consult your Dell Technologies sales representative.

# Hardware requirements

**PowerEdge server models for TDI deployments**

You can choose server options from a broad portfolio based on your organization's needs. For example, the PowerEdge R940xa, R940, R840, and R740xd servers have a capacity of up to 32 internal drives and provide outstanding performance.

With the introduction of the PowerEdge R750 server with Intel Ice Lake CPUs, the maximum available memory within a single two-socket system increased to 8 TB of available DRAM capacity, or 12 TB with a combination of DRAM and PMEM in App Direct Mode.

The following table shows the PowerEdge servers that are SAP HANA certified and supported for use with Intel Ice Lake and Cascade Lake CPUs in TDI deployments:

**Table 3.     Supported PowerEdge server models for TDI deployments**

| Intel Xeon CPU | Supported PowerEdge server models* |
|---|---|
| Intel Xeon SP Ice Lake | R650, R750, R750xa, MX750c, C6520 |
| Intel Xeon SP Cascade Lake | R640, T640, R740, R740xd, R740xd2, R840, R940, R940xa |
| | FC640, M640, FC640, MX740c, MX840c |

* C servers. R: Rack servers, T: Tower servers, FC and M/MX: Modular blade servers

For more detailed information about specific servers, see the Dell Technologies website.

## PowerEdge MX for SAP HANA TDI solutions

The  PowerEdge MX platform is the latest hardware implemented for Dell solutions for SAP HANA TDI deployments.  PowerEdge MX servers can be used in SAP HANA scale-out TDI and SAP HANA scale-up (single-node) TDI deployments, including virtual configurations.

PowerEdge MX is a modular blade-based platform that integrates servers, storage, networking, and management into a single chassis that is designed for maximum density, efficiency, and manageability. As a unified, high-performance, kinetic data center infrastructure, PowerEdge MX provides the agility, resiliency, and efficiency to optimize a wide variety of traditional and new emerging data center workloads and applications. Its responsive design provides the innovation and longevity that organizations of all sizes need for their IT and digital business transformations. For more information, see the PowerEdge MX page on the Dell website.

For configuration recommendations and a demonstration of how the PowerEdge MX infrastructure can help consolidate hardware requirements and simplify the implementation of an SAP HANA scale-out solution, see Appendix A: Designing and implementing an SAP HANA scale-out landscape using the PowerEdge MX platform.

## VxRail dynamic nodes

VxRail dynamic node clusters are compute-only vSphere clusters that enable users to scale compute and storage independently based on workload needs. Built on PowerEdge servers, VxRail dynamic nodes bring all the benefits of VxRail HCI system software with a choice of external storage options, including Dell PowerStore-T, PowerMax, or Unity XT

storage. By using enterprise Fiber Channel (FC) storage as primary storage for VxRail and VCF on VxRail solutions, customers can use dynamic nodes in a three-tier vSphere architecture to support mission-critical data-centric workloads such as SAP HANA.

### *VxRail dynamic nodes supported for SAP HANA TDI*

VxRail dynamic nodes are supported as a solution for SAP HANA deployments under the SAP HANA TDI program, provided all the underlying components, the certified server, and the certified storage are supported and listed on the Certified and Supported SAP HANA Hardware Directory and that the VMware vSphere conditions for SAP HANA support are followed.

VMware vSAN HCI MESH storage is not supported for SAP HANA. Accordingly, VxRail dynamic nodes are supported for SAP HANA deployments only with certified external storage under the SAP HANA TDI program.

---

**Note:** VxRail dynamic nodes are not supported under the SAP HCI program.

---

To verify that the VxRail dynamic node model you want to use is supported for SAP HANA with external storage:

- In the VxRail Spec Sheet, look for the underlying server chassis for the VxRail dynamic node mode.

- On the Certified and Supported SAP HANA Hardware Directory, check to see if:

    - The server model is listed as a certified appliances or Intel supported server .

    - The same server model is listed if the preferred external storage is listed as certified enterprise storage for SAP HANA.

- In the SAP HANA on VMware vSphere wiki, confirm that the vSphere version and CPU generation of the VxRail dynamic node is supported for SAP HANA.

## Certified enterprise storage

The following table shows the SAP HANA certified enterprise storage components for Dell storage arrays:

**Table 1.    SAP HANA certified enterprise storage components for Dell storage arrays**

| Storage family | Storage models | Storage connector |
|---|---|---|
| PowerMax | PowerMax 2000, 8000 | SAN–FC |
| PowerStore | 500T, 1000T, 3000T, 5000T, 7000T<br>500T, 1000T, 3000T, 5000T, 7000T, 9000T | NAS–Shared file system<br>SAN–FC |
| Unity XT | 380F, 480F, 680F, 880F<br>380F, 480F, 680F, 880F | NAS–Shared file system<br>SAN–FC |
| VMAX and VMAX All-Flash | VMAX 100K, 200K, 400K<br>VMAX All Flash 250F/FX, 450F/X, 850F/FX, 950F/FX | SAN–FC |
| VPLEX | VPLEX VS6 | SAN–FC |
| Isilon F800 | F800 All-Flash | NAS–Shared file system |

| Storage family | Storage models | Storage connector |
|---|---|---|
| XtremIO X2 | XtremIO X2 (-S/-R-/T)<br>XtremIO X2-T, 1 X-Brick cluster<br>XtremIO X2-S, 1 to 4 X-Brick cluster<br>XtremIO X2-R, 1 to 8 X-Brick cluster | SAN–FC |

A broad range of Dell storage options are available to centralize overall management needs and support easy replacement using FC SAN or NAS storage connectivity. Contact your Dell Technologies sales representative about the best components for you.

The following guides describe configuration best practices for Dell enterprise storage systems that are certified for SAP HANA TDI deployments. These guides provide information about how to configure the storage to meet the SAP HANA functional requirements and key performance indicators (KPIs), and prepare the servers for Linux native multipathing and accessing enterprise storage from the SAP HANA nodes.

- Validated Storage Configuration Best Practices Guide for SAP HANA TDI on Dell EMC PowerMax Arrays
- Validated Storage Configuration Guidelines for SAP HANA TDI Deployments on Dell EMC PowerStore Systems
- Dell EMC Unity XT Validated Storage Configuration Best Practices for SAP HANA TDI Design Guide
- Storage Configuration Best Practices for SAP HANA Tailored Data Center Integration on Dell EMC VMAX Solution Guide
- Storage Configuration Best Practices for SAP HANA TDI on Dell EMC VPLEX Systems
- SAP HANA TDI on Dell EMC Isilon All-Flash Scale-Out NAS Validation Guide
- Dell EMC XtremIO Storage Configuration Best Practices for SAP HANA TDI Configuration Guide

**Note:** The SAP HANA TDI validated design guides for each storage system are available on the Dell Technologies info hub at: SAP HANA TDI guides for Dell EMC enterprise storage.

# Sizing considerations

**Introduction**

Before you deploy SAP HANA on a PowerEdge system, determine the number of production and nonproduction SAP HANA systems that you require and the CPU, memory, and disk capacity requirements for these systems.

**SAP HANA system sizing**

With SAP HANA TDI Phase 5, SAP introduced workload-driven SAP HANA system sizing, in which SAPS requirements for specific customer workloads are used to determine the type and number of processors that are required to run SAP HANA. Customers use the SAP HANA Quick Sizer tool and sizing reports to determine the optimal memory sizes, number and type of CPUs, and number and type of disks for their SAP HANA environment, and then communicate the results to Dell Technologies.

For more information, see Quick Sizer. If you need help with sizing your SAP system, consult your Dell Technologies sales representative.

With SAP HANA PowerEdge solutions, you can use internal as well as external storage for SAP HANA. Your sales representative can help you identify the best solution for the specific workload and environment.

If you are planning to install the operating system locally, consider using an M.2 SSD in combination with a BOSS controller to decouple the operating system from your workload. BOSS devices provide RAID capabilities and offer a good performance-to-price ratio. You can use Dell OpenManage tools to keep the firmware on these devices up to date as well as to monitor the system and keep a hardware inventory.

**CPU considerations**

For information about choosing the right CPU model for your workload, see Appendix B: SAPS values for SAP HANA certified PowerEdge servers and consult your Dell Technologies representative.

**Memory requirements**

Dell Technologies recommends that SAP HANA solutions have a homogenous, symmetrical assembly of DIMMs and maximum utilization of all memory channels per processor. In accordance with this recommendation, Ice Lake two-socket servers must be populated with 16 DIMMs and Cascade Lake two-socket servers must be populated with at least 12 DIMMs. Cascade Lake four-socket solutions must have at least 24 DIMMs.

The following figures show the optimal DIMM size and count for all possible memory permutations:

| Two Socket Systems | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| DIMM Size/System Memory | 128 GB | 256 GB | 512 GB | 768 GB | 1,024 GB | 1,536 GB | 2,048 GB | 4,096 GB | 8,192 GB |
| 8 GB DIMMs | 16 | 32 | | | | | | | |
| 16 GB DIMMs | | 16 | 32 | 16 + 16 | | | | | |
| 32 GB DIMMs | | | 16 | | 32 | 16 + 16 | | | |
| 64 GB DIMMs | | | | | 16 | | 32 | | |
| 128 GB DIMMs | | | | | | | 16 | 32 | |
| 256 GB DIMMs | | | | | | | | 16 | 32 |

**Figure 2.**　Supported DIMM/memory configuration for two-socket Ice Lake servers

| Two Socket Systems | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| DIMM Size/System Memory | 96 GB | 192 GB | 384 GB | 576 GB | 768 GB | 1,152 GB | 1,536 GB | 3,072 GB | 6,144 GB |
| 8 GB DIMMs | 12 | 24 | | | | | | | |
| 16 GB DIMMs | | 12 | 24 | 12 + 12 | | | | | |
| 32 GB DIMMs | | | 12 | | 24 | 12 + 12 | | | |
| 64 GB DIMMs | | | | | 12 | | 24 | | |
| 128 GB DIMMs | | | | | | | 12 | 24 | |
| 256 GB DIMMs | | | | | | | | 12 | 24 |

**Figure 3.**　Supported DIMM/memory configurations for two-socket Cascade Lake servers

| Four Socket Systems | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| DIMM Size/System Memory | 192 GB | 384 GB | 768 GB | 1,152 GB | 1,536 GB | 2,304 GB | 3,072 GB | 6,144 GB | 12,288 GB |
| 8 GB DIMMs | 24 | 48 | | | | | | | |
| 16 GB DIMMs | | 24 | 48 | 24 + 24 | | | | | |
| 32 GB DIMMs | | | 24 | | 48 | 24 + 24 | | | |
| 64 GB DIMMs | | | | | 24 | | 48 | | |
| 128 GB DIMMs | | | | | | | 24 | 48 | |
| 256 GB DIMMs | | | | | | | | 24 | 48 |

| Legend | |
|---|---|
| 🟩 | Recommended |
| 🟨 | Neutral (Mixed DIMM Configuration) |
| 🟥 | Not allowed by SAP HANA memory population rules |

**Figure 4.**　Supported DIMM/memory configurations for four-socket Cascade Lake servers

**Note:** When selecting a DIMM size, consider future memory upgrade requirements to avoid having to replace existing DIMMs at that time.

**Intel Optane memory**

PowerEdge servers with the latest Intel Xeon CPUs in combination with Intel Optane memory can lower the TCO for SAP HANA environments and increase the overall memory capacity within a machine.

Intel Optane memory on SAP HANA enables up to 15 TB of data to be stored within one four-socket server beyond the physical capabilities of DRAM. SAP HANA supports PMEM only in App Direct mode for production systems. At the time of writing, memory mode is supported for non-production systems.

Memory limits are as follows:

- **Two-socket Ice Lake systems**: 16 x 512 GB = 8 TB PMEM + 16 x 256 GB = 4 TB DRAM, yielding 12 TB.

- **Two-socket Cascade Lake systems**: 12 x 512 GB = 6 TB PMEM + 12 x 128 GB = 1.5 TB DRAM, yielding 7.5 TB.

- **Four-socket Cascade Lake systems**: 24 x 512 GB = 12 TB PMEM + 24 x 128 GB = 3 TB DRAM, yielding 15 TB.

**Note:** PMEM works only with SAP HANA certified Ice Lake and Cascade Lake servers.

Currently, SAP HANA supports the following minimum operating system versions with PMEM:

- **SLES 15 SP2 or Red Hat Enterprise Linux 8.2**: Certified for PowerEdge R750 servers

- **SLES 12 SP4**: Certified for PowerEdge R940, R840, R740, and R740xd servers by Dell for Cascade Lake.

- **SLES 15**: Certified for PowerEdge R940, R940xa, R840, R740, R740xd, R640, MX740c, and MX840c servers.

- **Red Hat Enterprise Linux 7.6 and 8**: Certified for PowerEdge R940, R940xa, R840, R740, R740xd, R640, MX740c, and MX840c servers. For support details for specific versions and solutions, see SAP Note: KB3830541.

For more information about Intel Optane memory, see SAP Note 2700084: FAQ: SAP HANA Persistent Memory (access requires login credentials).

## CPU and memory requirements

All Ice Lake and Cascade Lake CPUs with Xeon Gold or higher are compatible with Intel Optane memory. The specific processor needs depend on the total memory size (Intel Optane + DRAM). The CPU supports a specific memory size.

The following tables describe the minimum CPU requirements. Depending on performance needs, you might prefer a higher version, for example, Intel Xeon Platinum.

**Table 2.    Minimum Cascade Lake CPU memory requirements**

| Processor type | Memory limit |
|---|---|
| No suffix in processor type | 1 TB per socket (4 TB maximum) |
| M suffix in processor type | 2 TB per socket (8 TB maximum) |
| L suffix in processor type | 4.5 TB per socket (18 TB maximum) |

Intel Optane for SAP HANA can be used in two-socket or four-socket systems, as described in the following tables:

## Systems with PMEM in App Direct Mode and two Ice Lake CPU sockets populated

**Table 3.    Supported PMEM configurations for two-socket systems**

| DRAM (size) | PMEM (size) | Total capacity | Ratio |
|---|---|---|---|
| 16 x 32 GB (512 GB) | 16 x 128 GB (2,048 GB) | 2,560 GB | 1:4 |
| 16 x 64 GB (1.024 GB) | 16 x 128 GB (2,048 GB) | 3,072 GB | 1:2 |
| 16 x 64 GB (1.024 GB) | 16 x 256 GB (4.096 GB) | 5,120 GB | 1:4 |
| 16 x 128 GB (2,048 GB) | 16 x 128 GB (2,048 GB) | 4,096 GB | 1:1 |
| 16 x 128 GB (2,048 GB) | 16 x 256 GB (4.096 GB) | 6,144 GB | 1.2 |
| 16 x 128 GB (2,048 GB) | 16 x 512 GB (8.192 GB) | 10,240 GB | 1:4 |
| 16 x 256 GB (4.096 GB) | 16 x 128 GB (2,048 GB) | 6,144 GB | 1:0.5 |
| 16 x 256 GB (4.096 GB) | 16 x 256 GB (4.096 GB) | 8,192 GB | 1.1 |
| 16 x 256 GB (4.096 GB) | 16 x 512 GB (8.192 GB) | 12,288 GB | 1:.2 |

## Systems with PMEM in App Direct Mode and two Cascade Lake CPU sockets populated

**Table 4.    Supported PMEM configurations for two-socket systems**

| DRAM (size) | PMEM (size) | Total capacity | Ratio |
|---|---|---|---|
| 12 x 32 GB (384 GB) | 12 x 128 GB (1,536 GB) | 1,920 GB | 1:4 |
| 12 x 64 GB (768 GB) | 12 x 128 GB (1,536 GB) | 2,304 GB | 1:2 |
| 12 x 64 GB (768 GB)) | 16 x 256 GB (3.072 GB) | 3,840 GB | 1:4 |
| 12 x 128 GB (1,536 GB) | 12 x 128 GB (1,536 GB) | 3,072 GB | 1:1 |
| 12 x 128 GB (1,536 GB) | 12 x 256 GB (3.072 GB) | 4,608 GB | 1:2 |
| 12 x 128 GB (1,536 GB) | 12 x 512 GB (6,144 GB) | 7,680 GB | 1:4 |
| 12 x 256 GB (3,072 GB) | 12 x 128 GB (1,536 GB) | 4,608 GB | 1:0.5 |

| DRAM (size) | PMEM (size) | Total capacity | Ratio |
|---|---|---|---|
| 12 x 256 GB (3,072 GB) | 12 x 256 GB (3,072 GB) | 6,144 GB | 1:1 |
| 12 x 256 GB (3,072 GB) | 12 x 512 GB (6,144 GB) | 9,216 GB | 1:2 |

## Systems with PMEM in App Direct Mode and four Cascade Lake CPU sockets populated

**Table 5.    Supported PMEM configurations for four-socket systems**

| DRAM (size) | PMEM (size) | Total capacity | Ratio |
|---|---|---|---|
| 24 x 32 GB (768 GB) | 24 x 128 GB (3,072 GB) | 3, 840 GB | 1:4 |
| 24 x 64 GB (1,536 GB) | 24 x 128 GB (3,072 GB) | 4,608 GB | 1:2 |
| 24 x 64 GB (1,536 GB) | 24 x 256 GB (6,144 GB) | 7,680 GB | 1:4 |
| 24 x 128 GB (3,072 GB) | 24 x 128 GB (3,072 GB) | 6,144 GB | 1:1 |
| 24 x 128 GB (3,072 GB) | 24 x 256 GB (6,144 GB) | 9,216 GB | 1:2 |
| 24  x 128 GB (3,072 GB) | 24 x 512 GB (12,288 GB) | 15,360 GB | 1:2 |
| 24  x 256 GB (6,144 GB) | 24 x 128 GB (3,072 GB) | 9,216 GB | 1:0.5 |
| 24  x 256 GB (6144 GB) | 24 x 256 GB (6,144 GB) | 12,288 GB | 1:1 |
| 24  x 256 GB (6,144 GB) | 24 x 512 GB (12,288 GB) | 18,432 | 1:2 |

## Sizing recommendations for storage with PMEM

You can use any internal storage or certified Dell SAP HANA external storage. For more information, see the disk sizing requirements for scale-up systems in *SAP HANA TDI-Storage Requirements.*

Scale-out systems are more complex, as described in the following table:

**Table 6.    Recommended storage sizes for scale-out systems**

| Volume | Size |
|---|---|
| /hana/data | 1.2 x anticipated net data size on disk<br>or<br>1 x total main memory (DRAM + PMEM) |
| /hana/log | 512 GB |
| /hana/shared | 1 TB |

**Preparing the Intel Optane memory**

Configuring the Intel Optane memory DIMMs consists of two steps:

1. Creating a goal configuration from the BIOS environment

2. Creating the namespaces with an installed operating system

### Creating a goal configuration

To access the memory DIMMs, you can create a goal configuration using the `ndctl` tool at operating system level, the system setup dialog, or the Integrated Dell Remote Access Controller (iDRAC).

---

**Note:** You can perform this procedure without any operating system on the machine. The namespace creation procedure requires that an SAP HANA supported operating system that includes the `ndctl` tool is installed on the machine.

---

To create a goal configuration using the iDRAC:

1. Log in to the iDRAC of the PMEM machine and select **Configuration** > **BIOS Settings**.

2. Expand **Memory Settings** and **Persistent Memory**, as shown in the following figure:



**Figure 5.** **Persistent Memory settings**

3. Expand **Region Configuration** and **Create goal config**.

4. To create a per-socket configuration, choose **100% Persistence** and **App Direct Interleaved**.

5. Click **Apply and reboot**.

## Creating the namespaces

After you complete the goal configuration, you have prepared the regions but not yet allocated the namespaces. To list all unallocated namespaces, run the `ndctl` command using the `-i` flag:

```
linux:~ # ndctl list -i

[

  {

    "dev":"namespace24.0",

    "mode":"raw",

    "size":0,

    "uuid":"00000000-0000-0000-0000-000000000000",

    "sector_size":512,

    "state":"disabled",

    "numa_node":0

  },

  {

    "dev":"namespace26.0",

    "mode":"raw",

    "size":0,

    "uuid":"00000000-0000-0000-0000-000000000000",

    "sector_size":512,

    "state":"disabled",

    "numa_node":2

  },

  {

    "dev":"namespace25.0",

    "mode":"raw",
```

```
    "size":0,

    "uuid":"00000000-0000-0000-0000-000000000000",

    "sector_size":512,

    "state":"disabled",

    "numa_node":1

  },

  {

    "dev":"namespace27.0",

    "mode":"raw",

    "size":0,

    "uuid":"00000000-0000-0000-0000-000000000000",

    "sector_size":512,

    "state":"disabled",

    "numa_node":3

  }
}
```

### *Creating namespaces on the configured regions*

Depending on the number of populated sockets that exist in the system, you might need to repeat the create namespace procedure. Perform the following procedure two or more times, depending on the number of populated sockets in the system.

Run the following commands:

```
linux:~ # ndctl create-namespace

{

  "dev":"namespace24.0",

  "mode":"fsdax",

  "size":"744.19 GiB (799.06 GB)",

  "uuid":"8bc41612-bebc-4ead-bbca-6cc6f0b93be0",

  "raw_uuid":"3c1b2d89-31ac-4686-a6d0-ac22260d7515",

  "sector_size":512,

  "blockdev":"pmem24",

  "numa_node":0
```

```
}

linux:~ # ndctl create-namespace

{

  "dev":"namespace26.0",

  "mode":"fsdax",

  "size":"744.19 GiB (799.06 GB)",

  "uuid":"2785910e-a01d-42fc-990c-0b8f9563e49e",

  "raw_uuid":"6f116048-9f99-4d14-b3f8-b47a8473da7e",

  "sector_size":512,

  "blockdev":"pmem26",

  "numa_node":2

}

linux:~ # ndctl create-namespace

{

  "dev":"namespace25.0",

  "mode":"fsdax",

  "size":"744.19 GiB (799.06 GB)",

  "uuid":"a4809f98-69c4-4fb0-b3f9-4cbb9293716f",

  "raw_uuid":"84272619-6a3c-42ea-8d31-95198ff67589",

  "sector_size":512,

  "blockdev":"pmem25",

  "numa_node":1

}

linux:~ # ndctl create-namespace

{

  "dev":"namespace27.0",

  "mode":"fsdax",

  "size":"744.19 GiB (799.06 GB)",

  "uuid":"ea4cf63a-9910-408a-bae6-6b503e734dd8",
```

```
                    "raw_uuid":"feae79ac-f0ab-4bf2-a7d7-4b6591dcbe0d",

                    "sector_size":512,

                    "blockdev":"pmem27",

                    "numa_node":3

                }
```

### Configuring FS-DAX and create and mount the partitions

You now have either two or four block devices configured in the system. The names of the block devices start with `pmem` and a number. These names are displayed in the listing in the last step in the "`blockdev`" section. In our example, the names are /dev/pmem24, /dev/pmem25, /dev/pmem26, and /dev/pmem27.

Create an xfs file system by running the following `mkfs.xfs` command:

```
linux:~ # mkfs.xfs /dev/pmem24
meta-data=/dev/pmem24              isize=512    agcount=4, agsize=48770944 blks
        =                         sectsz=4096  attr=2, projid32bit=1
        =                         crc=1        finobt=1, sparse=0, rmapbt=0,
reflink=0
data    =                         bsize=4096   blocks=195083776, imaxpct=25
        =                         sunit=0      swidth=0 blks
naming   =version 2               bsize=4096   ascii-ci=0 ftype=1
log      =internal log            bsize=4096   blocks=95255, version=2
        =                         sectsz=4096  sunit=1 blks, lazy-count=1
realtime =none                    extsz=4096   blocks=0, rtextents=0
linux:~ # mkfs.xfs /dev/pmem25
meta-data=/dev/pmem25              isize=512    agcount=4, agsize=48770944 blks
        =                         sectsz=4096  attr=2, projid32bit=1
        =                         crc=1        finobt=1, sparse=0, rmapbt=0,
reflink=0
data    =                         bsize=4096   blocks=195083776, imaxpct=25
        =                         sunit=0      swidth=0 blks
naming   =version 2               bsize=4096   ascii-ci=0 ftype=1
log      =internal log            bsize=4096   blocks=95255, version=2
        =                         sectsz=4096  sunit=1 blks, lazy-count=1
realtime =none                    extsz=4096   blocks=0, rtextents=0
linux:~ # mkfs.xfs /dev/pmem26
meta-data=/dev/pmem26              isize=512    agcount=4, agsize=48770944 blks
        =                         sectsz=4096  attr=2, projid32bit=1
        =                         crc=1        finobt=1, sparse=0, rmapbt=0,
reflink=0
data    =                         bsize=4096   blocks=195083776, imaxpct=25
        =                         sunit=0      swidth=0 blks
naming   =version 2               bsize=4096   ascii-ci=0 ftype=1
log      =internal log            bsize=4096   blocks=95255, version=2
        =                         sectsz=4096  sunit=1 blks, lazy-count=1
realtime =none                    extsz=4096   blocks=0, rtextents=0
linux:~ # mkfs.xfs /dev/pmem27
```

```
meta-data=/dev/pmem27              isize=512    agcount=4, agsize=48770944 blks
        =                          sectsz=4096  attr=2, projid32bit=1
        =                          crc=1        finobt=1, sparse=0, rmapbt=0,
reflink=0
data    =                          bsize=4096   blocks=195083776, imaxpct=25
        =                          sunit=0      swidth=0 blks
naming  =version 2                 bsize=4096   ascii-ci=0 ftype=1
log     =internal log              bsize=4096   blocks=95255, version=2
        =                          sectsz=4096  sunit=1 blks, lazy-count=1
realtime =none                     extsz=4096   blocks=0, rtextents=0
```

### *Creating /etc/fstab entries for PMEM devices*

For each PMEM device, perform the following steps:

1. Create a folder on which to mount the device by running the following command:

   ```
   linux:~ # mkdir -p /hana/pmem/0; mkdir /hana/pmem/1; mkdir
   /hana/pmem/2; mkdir /hana/pmem/3
   ```

2. To persist the mounting after the system reboots, add a mount entry in
   /etc/fstab for each namespace by running the following commands.

   ---
   **Note:** The x-systemd.device-timeout parameter influences how long the system
   waits for the device to be ready. This example uses 20 minutes of initializing time.
   Decrease this value if necessary depending on your landscape needs.

   ---

   ```
   /dev/pmem24 /hana/p

   mem/0 xfs noatime,dax,x-systemd.device-timeout=1200 1  2

   /dev/pmem25 /hana/pmem/1 xfs noatime,dax,x-systemd.device-
   timeout=1200 1  2

   /dev/pmem26 /hana/pmem/2 xfs noatime,dax,x-systemd.device-
   timeout=1200 1  2

   /dev/pmem27 /hana/pmem/3 xfs noatime,dax,x-systemd.device-
   timeout=1200 1  2
   ```

3. Mount all the file systems and check that they are properly mounted by running
   the following commands:

   ```
   linux:~ # mount -a -t xfs

   linux:~ # df -h|egrep "File|pmem"

   Filesystem              Size  Used Avail Use% Mounted on

   /dev/pmem24             744G  792M  744G   1% /hana/pmem/1

   /dev/pmem25             744G  792M  744G   1% /hana/pmem/2

   /dev/pmem26             744G  792M  744G   1% /hana/pmem/3

   /dev/pmem27             744G  792M  744G   1% /hana/pmem/4
   ```

### *Deploying and configuring SAP HANA*

Next, you must make SAP HANA aware of the new Intel Optane memory DIMMs:

- Upgrade existing SAP HANA installations to SAP HANA SPS03 or later. In the `[persistence]` section of the `global.ini` file, provide a line with a comma-separated list of all mounted `pmem` devices by running the following command:

```
[persistence]

basepath_persistent_memory_volumes=/hana/pmem/0;/hana/pmem/1;
/hana/pmem/2;/hana /pmem/3
```

- For new SAP HANA installations, you can extend the tool `hdblcm` with two more options besides the normal installation parameters:

```
--use_pmem --pmempath=/hana/pmem
```

HDBLCM determines and uses all `pmem` devices below that `/hana/pmem` subfolder.

SAP HANA uses the persistent memory devices and loads data to them. You can also move databases and tables individually to a specific region (DRAM or PMEM).

### Summary

Dell Technologies conducted a test with SAP Business Warehouse on SAP HANA (BWoH), which involved running complex queries through the whole SAP HANA stack (HW,OS,DB,APP).  The test results showed a similar read performance between DRAM and Intel Optane memory, indicating that this technology facilitates access to greater amounts of data while balancing TCO.

**Data management with SAP HANA**

The exponential growth of data has increased the demand for scaled-up storage and processing power to keep up with the complexities of enterprise information management. Businesses thirst for a data management strategy that satisfies their requirements for SAP HANA performance and data accessibility with a limited IT budget while lowering their TCO.

Mission-critical (or "hot") data is stored in memory on the SAP HANA database for real-time processing and analytics. Less frequently accessed (or "warm") data is saved in a lower-cost storage tier while still managed as a unified part of the SAP HANA database. Retaining and managing older data in this cost-effective way is key in maintaining data growth while minimizing the expense of hardware growth.

### SAP HANA Native Storage Extension

Native Storage Extension (NSE), a native SAP HANA feature, is a warm data solution. NSE provides an improved cost-to-performance ratio that is similar to the ratio provided by other SAP HANA warm data tiering solutions, such as SAP HANA Extensions Node and SAP HANA Dynamic Tiering.

The following figure shows the difference between standard SAP HANA in-memory storage and the storage that is offered with NSE:
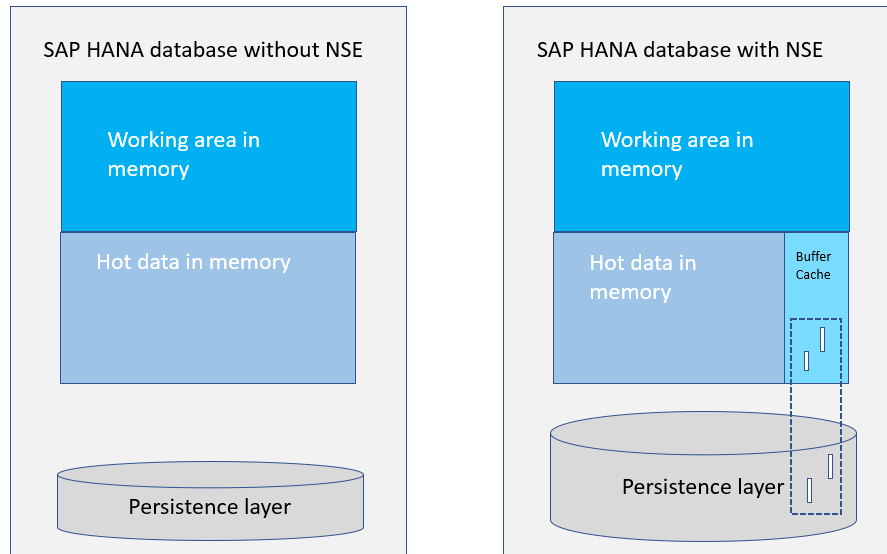
**Figure 6.        Standard SAP HANA database and SAP HANA database with NSE comparison**

The capacity of a standard SAP HANA database is limited to the amount of main memory. Using SAP HANA NSE, customers can bypass these limits by storing warm data on a storage system. A relatively small amount of SAP HANA memory for the NSE buffer cache is needed for paging operations because the buffer cache can handle up to eight times the size of warm data on disk. For example, a 2 TB SAP HANA system without NSE equates to a 1 TB database in memory. With NSE and the addition of a 500 GB buffer cache, you can expand your 1 TB database to a 5 TB database: 1 TB of hot data, 4 TB of warm data, and a 500 GB buffer cache to page data between memory and disk.

**Note:** Only SAP HANA scale-up systems are currently supported with NSE.

Hot (or "column-loadable") data resides completely in memory for fast processing and is loaded from disk in columns into SAP HANA memory. SAP HANA NSE enables you to specify certain warm data as "page loadable." This data is loaded page by page into memory as required for query processing. Unlike column-loadable data, page-loadable data does not need to reside completely in memory.

NSE reduces the memory footprint for page-loadable data. The database is partly in-memory and partly on disk, as illustrated in the following figure:
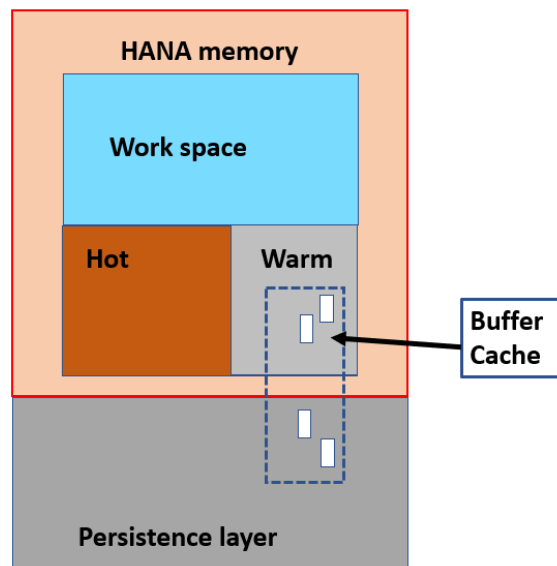
**Figure 7.     SAP HANA database with NSE**

NSE is integrated with other SAP HANA functional layers, such as the query optimizer, query execution engine, column store, and persistence layers,

For more information about SAP HANA NSE, SAP HANA NSE Data Sizing, and other NSE related topics, see SAP HANA Native Storage Extension.

NSE is subject to certain functional restrictions. For more information, see SAP Note 2771956L: SAP HANA NSE Functional Restrictions.

**Network requirements**

To support SAP HANA bandwidth requirements, SAP requires high-speed network connectivity for SAP HANA related networks. For more information, see *SAP HANA Network Requirements*.

The internode network is tested to ensure that every node can connect to every other node with the minimal throughput requirement provided by SAP.

In addition to the system networks that are required for management and vSphere for virtual HANA configurations, Dell recommends configuring the following networks for the SAP HANA environments that will use the specified function:

- Application/client network: 10 Gb/s (recommended)

- Source/servers network: 10 Gb/s (recommended)

- Internode network: 10 Gb/s (required)

- System replication network: 10 Gb/s (recommended)

- Backup network: 10 Gb/s (recommended)

- Storage network:

  - 10 Gb/s IP (required)

  - 8 Gb/s Fibre Channel (required)

- Ethernet networks: 10 GbE to 200 GbE Dell S Series and Z Series data center network switches

For SAN fabric, Dell's storage networking recommendations include Dell Connectrix FC or Dell unified S4148U switches. The unified S4148U switch supports both Ethernet and FC networks.

MX Series modular switches are part of the PowerEdge MX server. PowerEdge MX Ethernet and FC I/O modules provide cost-effective, high-performance scalable networking—25 GbE and 32 GbE FC host connectivity with 100 GbE and 32 GbE FC uplinks. For more information about the supported hardware and the latest Open Networking OS10EE, see MX-Series Modular Switches.

For information about Dell's network deployment recommendations, see the following documentation:

- Dell EMC Networking Guides
- SAP HANA Network Requirements White Paper

**Sizing considerations for an SAP landscape design**

Business and technology considerations influence the sizing of the hardware infrastructure. Consult with your Dell Technologies representative to determine a solution design that includes business requirements for performance, response times, availability, data protection, and disaster recovery for the SAP systems.

The following table describes the sequence of steps that are involved in sizing the infrastructure requirements for your TDI deployments:

**Table 7.    Infrastructure sizing steps**

| Step | Activity | Performed by |
|------|----------|--------------|
| 1 | Determine the number of SAP production systems and SAP HANA systems that are required. | Dell Technologies performs these steps when collecting your business requirements. |
| 2 | Define the SAP system landscapes. Typically, each SAP production system (enterprise resource planning or ERP, business warehouse or BW, customer relationship management or CRM, and so on) has its own SAP system landscape, consisting of a development (DEV), quality assurance (QAS), sandbox (SBX), and production (PRD) environment. | |
| 3 | Determine if virtualization is to be used. | |
| 4 | Determine the high availability requirements. | |
| 5 | Determine the DR requirements and the number of data centers or sites involved. | |
| 6 | Consider data protection requirements for backing up the SAP HANA systems. | |
| 7 | Determine an expected annual data growth and the required number of years of maintenance. | |
| 8 | Size each of the SAP HANA systems and system landscapes using the SAP Quick Sizer tool on your production systems. | Customer performs this step and then provides the results to Dell Technologies. |

| Step | Activity | Performed by |
|------|----------|--------------|
| 9 | Calculate the total compute requirements and determine the number and models of PowerEdge servers (SAPS, CPU, memory) that are required to support the SAP HANA systems in the TDI deployments | Dell Technologies performs these steps using the information that the customer provides in step 8. |
| 10 | Calculate the total storage requirements based on capacity or IOPS, or both, and determine which Dell enterprise storage system is best suited to meet the customer's business needs. | |
| 11 | Determine the backup capacity requirements. | |
| 12 | Set up the SAP HANA infrastructure and use HWCCT/HCOT to check that the SAP HANA TDI KPIs are met. | Customer or Dell Technologies Professional Services performs this step. |
| 13 | Install the SAP HANA software. | Customer or Dell Technologies Professional Services performs this step. **Note:** Only SAP HANA certified personnel can perform the installation. |

# Recommended PowerEdge settings and configuration

**Introduction**

This section describes Dell's configuration recommendations for your SAP HANA scale-up, scale-out, and virtual configurations.

**PowerEdge settings**

For factory-installed servers, Dell recommends the following settings for an SAP HANA solution:

- Memory Configuration Type: **Performance Optimized**
- BIOS and Advance System Configuration Settings: **Performance Optimized**
- Advanced System Configurations: **UEFI BIOS Boot Mode with GPT Partition**

### BIOS settings

Dell recommends the following performance settings in the PowerEdge System BIOS:

- Physical SAP HANA configuration:
  - Virtualization Technology: **Disabled**

- Virtual SAP HANA configuration:
  - Logical Processors: **Enabled**
  - Virtualization Technology: **Enabled**

## *Configuring BIOS settings on a PowerEdge server*

**Note:** The following steps are performed on a PowerEdge R940 server for illustration purposes. The steps might vary on different server models.

You can change system BIOS settings in various different locations, as follows:

- Integrated Dell Remote Access Controller (iDRAC) UI: Set the **First Boot Device/Next boot** to **BIOS Boot Manager**.

- OpenManage: Enter the BIOS by pressing F2 during restart.

- System BIOS:

  - To access the processor settings, select **System BIOS** > **System BIOS Settings** > **Processor Settings**, as shown in the following figure::



**Figure 8.    PowerEdge R940 System BIOS settings**

The processor settings are displayed, as shown in the following figure:
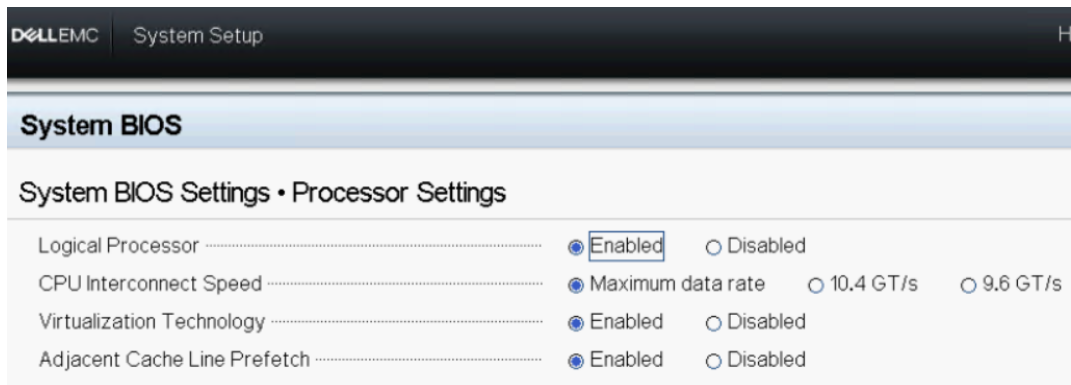


**Figure 9.      PowerEdge R940 Processor settings**

  - To access Memory Operating Mode, select **System BIOS** > **System BIOS Settings** > **Memory Settings**, as shown in the following figure:
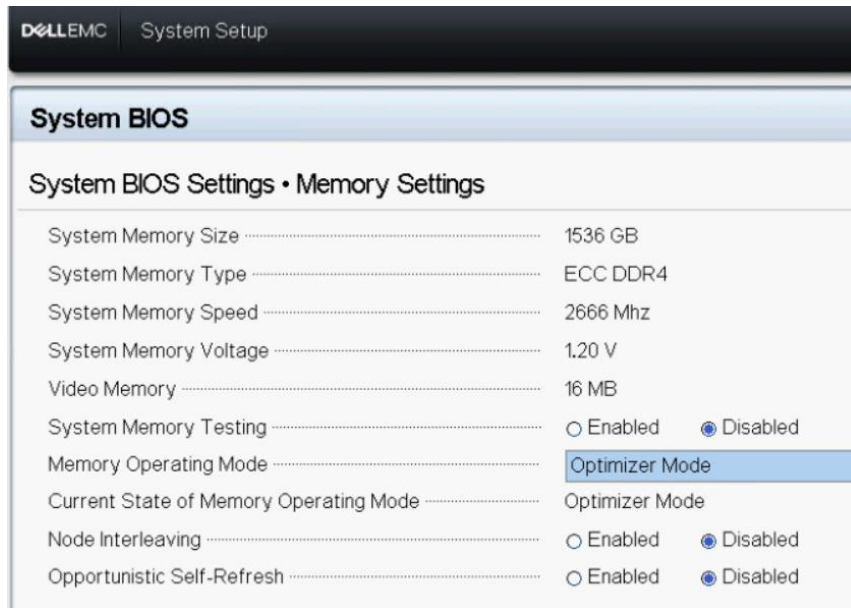
**Figure 10.     PowerEdge R940 Memory Operating Mode setting**

## Generic settings

Dell recommends the following best practices for configuring the PowerEdge servers:

- Use the latest BIOS and firmware.

- Use the latest vendor-subscribed host bus adapter (HBA) drivers.

- Enable Intel Hyper-Threading.

For more information, see the *Architecture Guidelines and Best Practices for Deployments of SAP HANA on VMware vSphere: Architecture and Technical Considerations Guide*.

For detailed deployment architecture and recommended settings for all your hardware and software components, contact your Dell Technologies sales representative.

**Scale-out considerations**

Because Dell's SAP HANA solutions are on scalable building blocks, you can easily add blocks of 1.5 TB or 3 TB to scale out to a 48 TB solution. SAP HANA certified enterprise storage components for Dell storage arrays with dual redundant controllers provide the persistent storage for the SAP HANA database. All components, including storage, fabric, network, and controllers, are highly redundant.

**Operating systems**

The SAP HANA hardware certification program has certified hardware on specific operating system versions. For the supported combinations, see the Certified and Supported SAP HANA Hardware Directory.

### Supported operating systems for SAP HANA

You will need one of the following Enterprise Linux distribution products, in the version specified in the index page of the Certified and Supported SAP HANA Hardware Directory, to run SAP HANA:

- Red Hat Enterprise Linux for SAP Solutions

- Red Hat Enterprise Linux for SAP HANA

- SUSE Linux Enterprise Server for SAP Applications

- SUSE Linux Enterprise Server

**Note:** Dell strongly recommends using Red Hat Enterprise Linux for SAP Solutions or SUSE Linux Enterprise Server for SAP Applications because of their features and extended support cycles.

For information about SAP HANA support for the intended operating system version, see SAP Note 2235581 - SAP HANA: Supported Operating Systems (access requires login credentials). This SAP note also provides the recommended settings for the operating system version. Ensure that you always apply these settings to the installed operating systems.

## Operating system support life cycle

The following sections provide the end-of-support dates for the latest operating system versions associated with SAP HANA TDI: SUSE, Red Hat, and VMware ESXi.

### *SUSE Linux Enterprise Server*

The following table provides end-of-support dates for SUSE operating system versions.

The information in the table is subject to change. For the most current information, see SUSE Product Support Lifecycle.

**Table 8.    SUSE operating system versions: End of support**

| Operating system | End of support |
|---|---|
| SLES 12 for SAP Applications | August 1, 2019 |
| SLES 12 SP1 for SAP Applications | May 31, 2020 |
| SLES 12 SP2 for SAP Applications | March 31, 2021 |
| SLES 12 SP3 for SAP Applications | June 30, 2022 |
| SLES 12 SP4 for SAP Applications | June 30, 2023 |
| SLES 12 SP5 for SAP Applications | October 31, 2024 |
| SLES 15 for SAP Applications | December 31, 2022 |
| SLES 15 SP1 for SAP Applications | January 31, 2024 |
| SLES 15 SP2 for SAP Applications | December 31, 2024 |
| SLES 15 SP3 for SAP Applications | TBD |

### *Red Hat Enterprise Linux*

The following table provides end-of-support dates for Red Hat Enterprise Linux operating system versions. The information in the table is subject to change. For the most current information, see Red Hat Enterprise Linux Life Cycle.

**Table 9.    Red Hat Enterprise Linux operating system versions: End of support**

| Operating system | End of support |
|---|---|
| Red Hat Enterprise Linux 7.4 for SAP Solutions | August 31, 2021 |

| Operating system | End of support |
|---|---|
| Red Hat Enterprise Linux 7.6 for SAP Solutions | October 31, 2022 |
| Red Hat Enterprise Linux 7.7 for SAP Solutions | August 30, 2023 |
| Red Hat Enterprise Linux 7.9 for SAP Solutions | June 30, 2024 |
| Red Hat Enterprise Linux 8.0 for SAP Solutions | December 31, 2020 |
| Red Hat Enterprise Linux 8.1 for SAP Solutions | November 30, 2023 |
| Red Hat Enterprise Linux 8.2 for SAP Solutions | April 30, 2024 |
| Red Hat Enterprise Linux 8.4 for SAP Solutions | May 30, 2025 |

### VMware ESXi

The following table provides end-of-support dates for VMware ESXi hypervisor versions. For the latest list, see VMware Lifecycle Product Matrix.

**Table 10.    VMware ESXi hypervisor versions: End of support**

| VMware version | End of support |
|---|---|
| **ESXi 6.0** | March 12, 2020 |
| ESXi 6.5 and 6.7 | October 15, 2022 |
| ESXi 7.0 | April 2, 2025 |

# Conclusion

Enterprises can now take advantage of the breakthrough technology of SAP HANA to achieve better business performance while keeping cost and complexity to a minimum. SAP has certified the PowerEdge servers for use in SAP HANA installations on production and nonproduction systems and on single-node (scale-up) and scale-out systems. By using the TDI approach with PowerEdge servers and selecting the right infrastructure architecture for your SAP HANA deployment, your organization can look ahead to faster and better IT innovation and responsiveness to meet your evolving business requirements.

# References

**Dell Technologies documentation**

The following Dell Technologies documentation provides additional relevant information. If you do not have access to a document, contact your Dell Technologies representative.

- Dell Technologies Solutions for SAP Info Hub

- Dell EMC servers

- Dell EMC Networking Guides

  Under **MX-Series Modular Switches (PowerEdge MX)**:

  - PowerEdge MX IO Guide

  - PowerEdge MX SmartFabric Configuration and Troubleshooting Guide

  - MX Series Fibre Channel Storage Network Deployment with Ethernet IOMs

  - PowerEdge MX SmartFabric Deployment – Video

  - PowerEdge MX Network Architecture Guide

**VMware documentation**

The following VMware documentation provides additional information:

- SAP Community Wiki: SAP HANA on VMware vSphere

- Architecture Guidelines and Best Practices for Deployments of SAP HANA on VMware vSphere: Architecture and Technical Considerations Guide

- Virtualize Applications: SAP HANA on vSphere—Support Status and Best Practices Summary

- SAP and VMware—Overview

- SAP Solutions on VMware Best Practices Guide

**SAP documentation**

The following SAP resources provide additional information:

- Quick Sizer

- SAP HANA on VMware vSphere

- SAP Help Portal

- SAP HANA Tailored Data Center Integration – Overview

- SAP HANA Tailored Data Center Integration – Frequently Asked Questions

**Note:** The following documentation requires an SAP username and password.

- SAP Note 2399079—Elimination of hdbparam in HANA 2

# Appendix A: Designing and implementing an SAP HANA scale-out landscape using the PowerEdge MX platform

**Overview**

This section describes how to design and implement the SAP HANA scale-out solution using PowerEdge MX kinetic infrastructure that was tested and validated in Dell Technologies laboratories.

The SAP HANA TDI scale-out solution described in this guide uses the following PowerEdge MX platform components and Dell enterprise storage:

- **MX7000 chassis**: A 7U modular chassis that hosts flexible blocks of resources and provides outstanding efficiency through shared power, cooling, networking, I/O, and management.

- **PowerEdge MX networking modules**: Modular switches that are designed to reduce network management complexity and grow with business needs.

- **PowerEdge MX840c**: An SAP HANA certified, four-socket, double-width sled with elastic compute resources for database-driven, mission-critical applications and performance workloads.

- **Dell Unity 650F**: An SAP HANA certified enterprise storage system with integrated architecture for block file with concurrent support for native NAS, iSCSI, and Fibre Channel (FC) protocols.

### Network requirements

The SAP HANA scale-out solution requires numerous cables such as FC and Ethernet connections using rack servers in a fully redundant fabric configuration. The following figure shows a logical view of the minimum different network requirements:
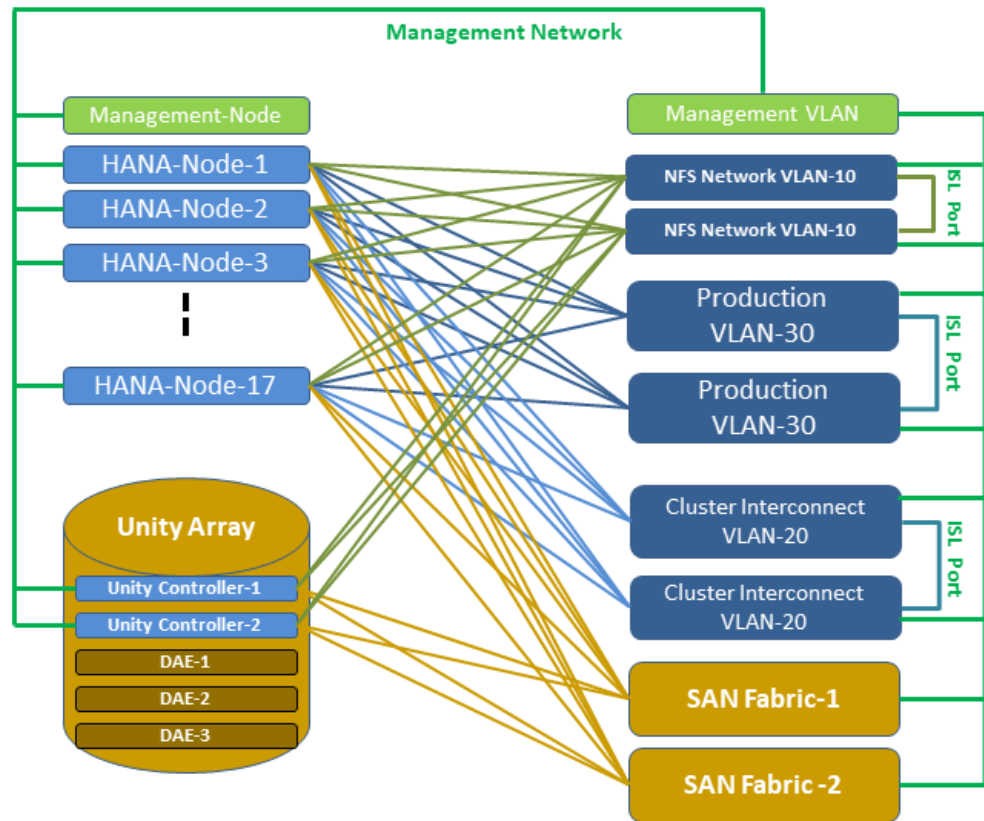
**Figure 11.     SAP HANA scale-out network configuration using MX9116n/MX7116n switches**

A significant benefit of using the MX PowerEdge platform for an SAP HANA scale-out solution is its modular network infrastructure. This infrastructure helps to eliminate most network/fabric cabling from SAP HANA nodes to the virtual switch layer. Only switch interconnect links and network/fabric uplinks are required, as shown in the following figure:

FSE to FEM (200GbE)

FSE VLTi (200GbE)

Fabric uplinks (10GbE) for NFS share

Fabric uplinks (10GbE) for HANA external

Fabric uplinks (1GbE) for management network

FC SAN links (16/32Gb)
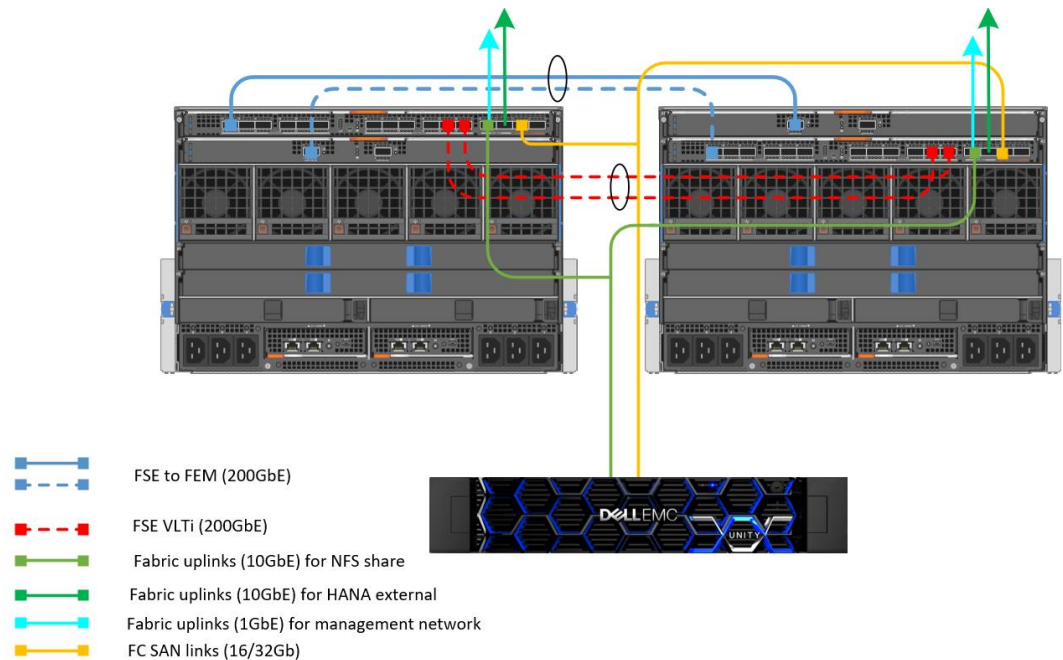
**Figure 12.    Network cabling for an SAP HANA scale-out solution using two PowerEdge MX7000 chassis**

The preceding illustration shows two PowerEdge MX7000 chassis, which can support up to eight MX840c servers (with four CPU sockets each), cascaded in a pair of Dell modular network MX9116n/MX7116n switches. For illustration purposes, we used Dell Unity array 650F and other network/fabric uplinks.

The PowerEdge MX7000 chassis is a 7U enclosure with eight front slots for blade-based servers (for up to four PowerEdge MX840c nodes) or storage sleds. The MX7000 chassis supports up to two pairs of redundant general-purpose switches or pass-through modular bays (Fabrics A and B) and a redundant pair of storage-specific switch bays (Fabric C). Up to 25Gbps Ethernet, 32Gbps FC, and 12Gbps SAS are also supported for the server's front-end I/O ports. The chassis has up to six power supply units (PSUs) as well as OpenManage Enterprise Modular Edition embedded management software running on up to two redundant MX9002m management modules.

## Using Dell modular network modules in PowerEdge MX

The PowerEdge MX platform introduced the concept of scalable fabric architecture. A scalable fabric spans multiple chassis, enabling them to behave like a single chassis from a networking perspective.

A scalable fabric consists of two main components: a pair of MX9116n Fabric Switch Engines (FSEs) in the first two chassis and additional pairs of MX7116n Fabric Expander Modules (FEMs) in the remaining chassis. Each MX7116n FEM connects to the MX9116n FSE corresponding to its fabric and slot. All I/O modules (IOMs) participating in the fabric are configured in either Full Switch or SmartFabric mode.

The Networking MX9116n FSE operates in one of two modes:

- **SmartFabric Mode**—Switches operate as layer 2 I/O aggregation devices and are managed through the Open Manage Enterprise Modular console.

- **Full Switch Mode**—This mode is enabled by default, making all switch-specific OS10EE capabilities available.

The following figure shows three MX7000 chassis in a single scalable fabric architecture. The number of chassis is expandable to ten.
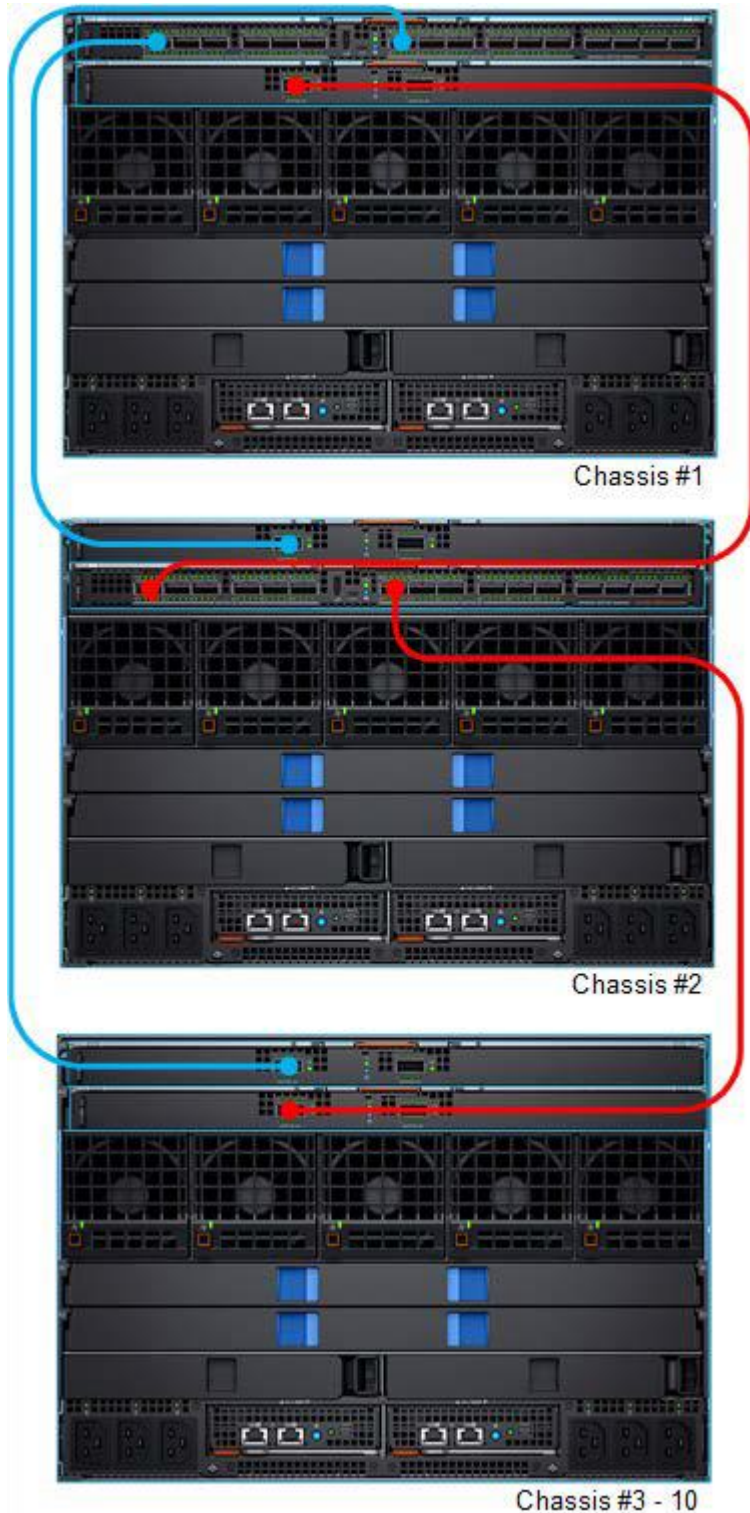


**Figure 13.    Scalable fabric example using Fabric A**

The first two chassis each contain one MX9116n FSE and one MX7116n FEM. As shown in the diagram, chassis 3 to 10 each contain two MX7116n FEMs. All connections shown use QSFP28-DD (2x100GB) connections.

In an SAP HANA scale-out solution using the PowerEdge MX platform, one pair of MX9116n FSEs and additional FEM pairs for additional MX7000 chassis are used for all the required networks, including FC SAN. This helps to consolidate all the required network switches into one scalable fabric, keeping the fabric administration to a minimum and saving the data center footprint compared to an approach using rack servers.

The following figure shows the Dell SAP HANA (16+2) scale-out solution using PowerEdge MX:
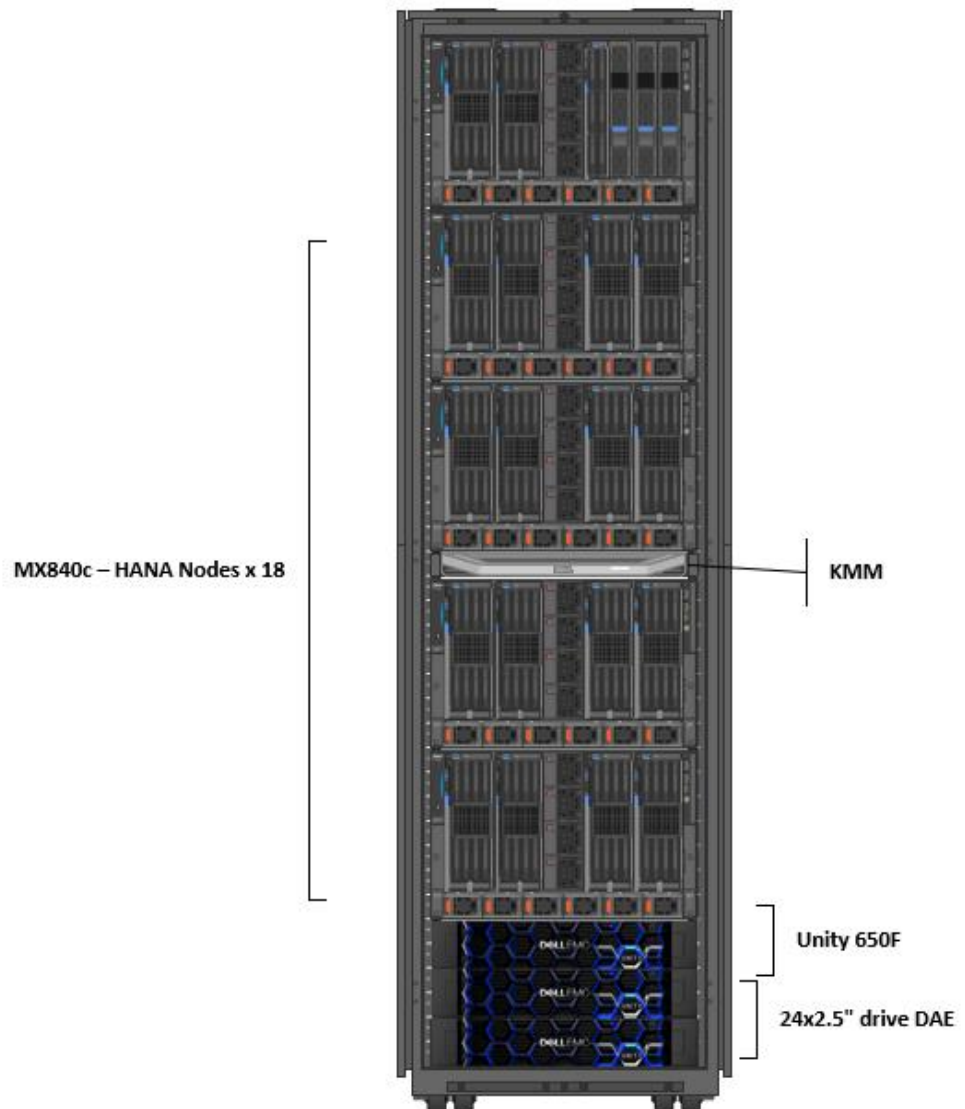


**Figure 14.    Dell SAP HANA (16+2) scale-out solution using PowerEdge MX**

The entire hardware requirement can fit in a 42U rack. The previous SAP HANA scale-out solution's rack design required double the rack space.

## SAP HANA 6 TB scale-out solution

The following table shows the hardware components of an SAP HANA scale-out (2+1) solution using PowerEdge MX servers:

**Table 11.    Dell SAP HANA 6 TB scale-out solution**

| Component | Configuration |
|---|---|
| SAP HANA nodes | 2 x PowerEdge MX840c active SAP HANA nodes + 1 to 2 MX840c standby SAP HANA nodes. each with:<br>• SUSE Linux Enterprise Server for SAP Applications or Red Hat Enterprise Linux for SAP Solutions<br>• 2 x 25GbE dual port Mezzanine CNA cards |
| Storage | Any SAP HANA certified Dell EMC enterprise storage |
| Storage fabric and network | One pair of MX9116n modular switches to support both FC and all other Ethernet networks required by the SAP HANA scale-out landscape. |

Two 25 GbE dual port mezzanine cards are used in each of the PowerEdge MX840c servers. 25 GbE ports are partitioned with specific bandwidth allocation, connected to the described fully redundant Scalable Fabric, and configured as bonded network or multipath I/O devices for Ethernet and FC fabric respectively to ensure that there is no single point of failure for the networks that an SAP HANA scale-out landscape requires.

The following figure shows the VLAN ID assignment in the deployed SAP HANA scale-out landscape:
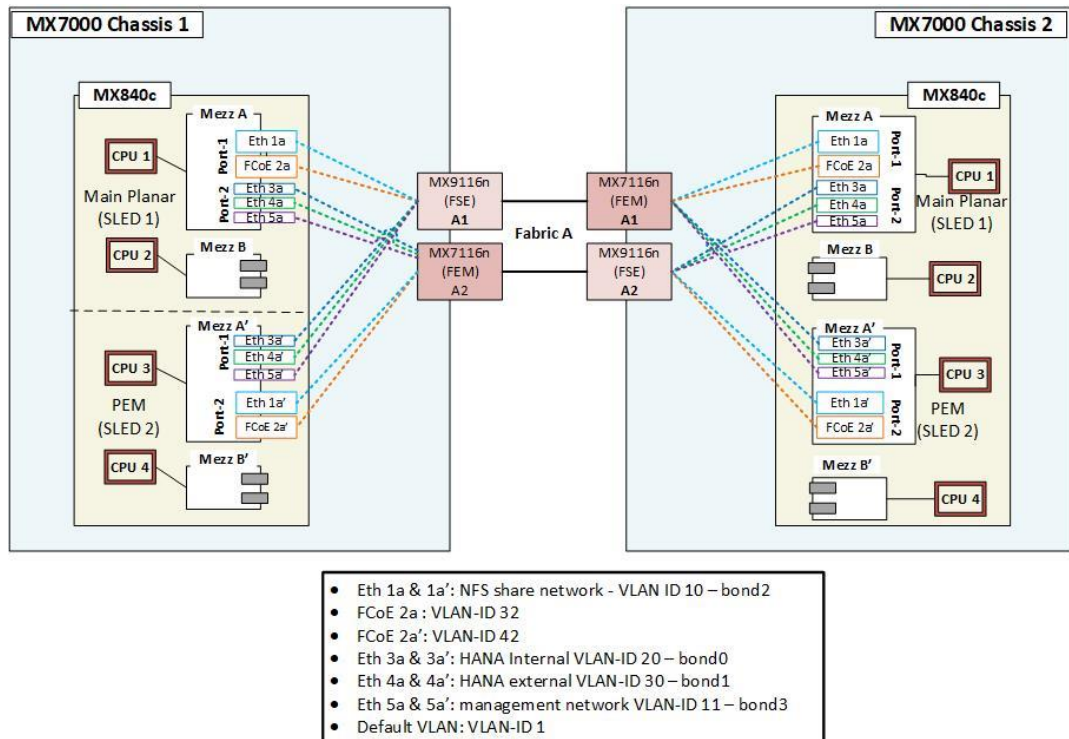


**Figure 15.    Network port partition on MX840c**

The preceding figure and following table show how the 25GE mezzanine ports are partitioned. FC-related NIC partitions are configured as FCoE HBAs for FC SAN fabrics.

- The Unity array's FC front-end HBAs are connected through the SAN fabric to MX9116n's native FC uplinks.

- The MX7000 Fabric B module pair and future support of 25 GbE quad port mezzanine I/O cards can provide more network expansion capability if required.

A NIC partition such as 2a is allocated to have a minimum transfer bandwidth of 65 percent of the total available 25GE connection. Also, NIC partition 2a can have up to 100 percent of the available transfer bandwidth if NIC partition 1a is idle.

**Table 12.    CNA configuration within MX840c HANA database hosts**

| Mezz/CAN slot | Port number | Partition number/label | Partition type | Partition minimum TX bandwidth | Partition maximum TX bandwidth | Application function |
|---|---|---|---|---|---|---|
| Mezz 1A | Port 1 | Partition 1 - 1a | NIC | 35 | 100 | NFS network |
| | | Partition 2 - 2a | FCoE | 65 | 100 | FC SAN |
| | Port 2 | Partition 1 - 3a | NIC | 48 | 100 | HANA internal network |
| | | Partition 2 - 4a | NIC | 48 | 100 | HANA external network |
| | | Partition 3 - 5a | NIC | 4 | 100 | Management network |
| Mezz 2A | Port 1 | Partition 1 - 3a' | NIC | 48 | 100 | HANA internal network |
| | | Partition 2 - 4a' | NIC | 48 | 100 | HANA external network |
| | | Partition 3 - 5a' | NIC | 4 | 100 | management network |
| | Port 2 | Partition 1 - 1a' | NIC | 35 | 100 | NFS network |
| | | Partition 2 - 2a' | FCoE | 65 | 100 | FC SAN |

**Controlling, automating, and managing the SAP HANA configuration**

PowerEdge MX networking switches support Dell OS10 Enterprise Edition and operate in either Full Switch or SmartFabric mode. Users have more control over IOM in Full Switch mode because IOM operates as a regular switch. SmartFabric offers several key features that are crucial for the latest fabric solutions, such as automation, life cycle management, scalability, and manageability.

We implemented our SAP HANA scale-out solution in SmartFabric mode for proof of concept and certification purposes. With SmartFabric Services (SFS), customers can quickly and easily deploy and automate datacenter networking fabrics. The most burdensome tasks were creating NIC partitions from the first SAP HANA server as a template server and creating different VLAN IDs and network uplinks on the MX9116n pair. The template is easily and automatically deployed to the next SAP HANA server as well as its Ethernet and SAN fabric configuration on the switches involved. For more information, see the following documents:

- Dell EMC PowerEdge MX SmartFabric Configuration and Troubleshooting Guide.

- Dell EMC PowerEdge MX Series Fibre Channel Storage Network Deployment with Ethernet IOMs

In addition to being able to assign VLANs to server profiles, SFS automates quality of service (QoS) settings based on user input. When a VLAN is created, the user selects the related traffic type—iSCSI, vMotion, and so on—and the SFS engine assigns the correct QoS setting to that VLAN.

Users can also select a "metal" such as gold, bronze, and so on to assign their own priority values to traffic. The following table shows the traffic types and related settings:

**Table 13.    Traffic types and QoS settings**

| Traffic type | Used for | QoS setting |
|---|---|---|
| General purpose (bronze) | Low priority data traffic | 2 |
| General purpose (silver) | Standard/default priority data traffic | 3 |
| General purpose (gold) | High priority data traffic | 4 |
| General purpose (platinum) | Extremely high priority data traffic | 5 |
| Cluster interconnect | Cluster heartbeat VLANs | 5 |
| Hypervisor management | Hypervisor management connections such as the ESXi management VLAN | 5 |
| Storage - iscsi | Used for iSCSI VLANs | 5 |
| Storage – fcoe | Used for FCoE VLANs | 5 |
| Storage - data replication | Used for VLANs supporting storage data replication such as for VMware VSAN | 5 |
| VM migration | Used for VLANs supporting vMotion and similar technologies | 5 |
| VMware ft logging | Used for VLANs supporting VMware fault tolerance | 5 |

# Appendix B: SAPS values for SAP HANA certified PowerEdge servers

**Introduction**

[SAP HANA TDI Phase 5](#) introduced important changes and benefits for customers who are planning for SAP HANA deployments:

- The new workload-driven sizing approach allows for SAPS-based sizing. The Quick Sizer tool and SAP HANA sizing reports have been enhanced to provide separate CPU (SAPS) and RAM sizing results, enabling customers to fine-tune their configurations for their specific workload and to purchase systems with the optimal number of cores and memory.

- The increased variety of CPU processors that are supported enables customers to be more flexible when choosing SAP HANA compute nodes from the PowerEdge Ice Lake- and Cascade Lake-based range of systems and to cost-optimize the servers for their workload requirements.

**SAPS values for PowerEdge servers**

The following tables show the estimated SAPS values for PowerEdge 15G Ice Lake and 14G Cascade Lake servers with over 90 percent utilization.The SAPS values for the top-end platinum CPU models, the Intel Xeon Platinum 8380 (Ice Lake) and 8280 (Cascade Lake), are certified with SAP. These certified values are presented in bold in the tables. Dell extrapolated the SAPS values for all other PowerEdge server models from these results using SPECint2017. All the listed models are SAP HANA certified with [SAP HANA TDI Phase 5](#). those that do not meet the SAP HANA minimum requirement of two sockets and eight cores per socket.

---

**Note:** Dell performed internal testing with the SD benchmarks to validate the extrapolated SAPS values across the platinum, gold, and silver CPU ranges. The results showed that the extrapolations were accurate to within a 5 to 10 percent range in our laboratory environment. "M/L" editions of a CPU model have the same extrapolated SAPS values as non-M and non-L editions of that model. The SAP Quick Sizer tool bases calculations on a 65 percent utilization with greenfield sizing. For brownfield sizing, calculate 60-65 percent utilization from the extrapolated SAPS values listed in the tables below. The extrapolated values are for bare-metal environments. You can expect a performance degradation of approximately 10 percent with virtualized environments.

---

### PowerEdge 15G Ice Lake-based systems SAPS tables

**Table 14.    PowerEdge R750 Ice Lake-based systems with SAPS values**

| PowerEdge server | Number of cores | Number of sockets | Number of cores per socket | SAPS | SAPS per core |
|---|---|---|---|---|---|
| PowerEdge R750 (Intel Xeon Gold 5315Y, 3.20 GHz) | 16 | 2 | 8 | 66,207 | 4,138 |
| PowerEdge R750 (Intel Xeon Gold 5317, 3.00 GHz) | 24 | 2 | 12 | 96,214 | 4,009 |
| PowerEdge R750 (Intel Xeon Gold 5318N, 2.10 GHz) | 48 | 2 | 24 | 150,990 | 3,146 |

| PowerEdge server | Number of cores | Number of sockets | Number of cores per socket | SAPS | SAPS per core |
|---|---|---|---|---|---|
| PowerEdge R750 (Intel Xeon Gold 5318Y, 2.10 GHz) | 48 | 2 | 24 | 150,037 | 3,126 |
| PowerEdge R750 (Intel Xeon Gold 5320, 2.20 GHz) | 52 | 2 | 26 | 170,042 | 3,270 |
| PowerEdge R750 (Intel Xeon Gold 6314U, 2.30 GHz) | 32 | 1 | 32 | 104,788 | 3,275 |
| PowerEdge R750 (Intel Xeon Gold 6326, 2.90 GHz) | 32 | 2 | 16 | 124,793 | 3,900 |
| PowerEdge R750 (Intel Xeon Gold 6330, 2.00 GHz) | 56 | 2 | 28 | 171,948 | 3,070 |
| PowerEdge R750 (Intel Xeon Gold 6330N, 2.20 GHz) | 56 | 2 | 28 | 168,137 | 3,002 |
| PowerEdge R750 (Intel Xeon Gold 6334, 3.60 GHz) | 16 | 2 | 8 | 70,017 | 4,376 |
| PowerEdge R750 (Intel Xeon Gold 6336Y, 2.40 GHz) | 48 | 2 | 24 | 167,184 | 3,483 |
| PowerEdge R750 (Intel Xeon Gold 6338, 2.00 GHz) | 64 | 2 | 32 | 194,810 | 3,044 |
| PowerEdge R750 (Intel Xeon Gold 6338N, 2.20 GHz) | 64 | 2 | 32 | 194,810 | 3,044 |
| PowerEdge R750 (Intel Xeon Gold 6342, 2.80 GHz) | 48 | 2 | 24 | 180,045 | 3,751 |
| PowerEdge R750 (Intel Xeon Gold 6346, 3.10 GHz) | 32 | 2 | 16 | 133,843 | 4,183 |
| PowerEdge R750 (Intel Xeon Gold 6348, 2.60 GHz) | 56 | 2 | 28 | 198,621 | 3,547 |
| PowerEdge R750 (Intel Xeon Gold 6354, 3.00 GHz) | 36 | 2 | 18 | 146,703 | 4,075 |
| PowerEdge R750 (Intel Xeon Platinum 8351N, 2.40 GHz) | 36 | 1 | 36 | 115,743 | 3,215 |

| PowerEdge server | Number of cores | Number of sockets | Number of cores per socket | SAPS | SAPS per core |
|---|---|---|---|---|---|
| PowerEdge R750 (Intel Xeon Platinum 8352S, 2.20 GHz) | 64 | 2 | 32 | 201,479 | 3,148 |
| PowerEdge R750 (Intel Xeon Platinum 8352V, 2.10 GHz) | 72 | 2 | 36 | 206,718 | 2,871 |
| PowerEdge R750 (Intel Xeon Platinum 8352Y, 2.20 GHz) | 64 | 2 | 32 | 202,431 | 3,163 |
| PowerEdge R750 (Intel Xeon Platinum 8358, 2.60 GHz) | 64 | 2 | 32 | 222,913 | 3,483 |
| PowerEdge R750 (Intel Xeon Platinum 8358P, 2.60 GHz) | 64 | 2 | 32 | 215,292 | 3,364 |
| PowerEdge R750 (Intel Xeon Platinum 8360Y, 2.40 GHz) | 72 | 2 | 36 | 235,297 | 3,268 |
| PowerEdge R750 (Intel Xeon Platinum 8368, 2.40 GHz) | 76 | 2 | 38 | 250,062 | 3,290 |
| PowerEdge R750 (Intel Xeon Platinum 8368Q, 2.60 GHz) | 76 | 2 | 38 | 250,062 | 3,290 |
| **PowerEdge R750 (Intel Xeon Platinum 8380, 2.30 GHz)** | **80** | **2** | **40** | **261,970** | **3,275** |
| PowerEdge R750 (Intel Xeon Silver 4309Y, 2.80 GHz) | 16 | 2 | 8 | 62,396 | 3,900 |
| PowerEdge R750 (Intel Xeon Silver 4310, 2.10 GHz) | 24 | 2 | 12 | 80,496 | 3,354 |
| PowerEdge R750 (Intel Xeon Silver 4310T, 2.30 GHz) | 20 | 2 | 10 | 70,494 | 3,525 |
| PowerEdge R750 (Intel Xeon Silver 4314, 2.40 GHz) | 32 | 2 | 16 | 110,980 | 3,468 |
| PowerEdge R750 (Intel Xeon Silver 4316, 2.30 GHz) | 40 | 2 | 20 | 132,414 | 3,310 |

**Table 15.  PowerEdge R750xa Ice lake-based systems with SAPS values**

| PowerEdge server | Number of cores | Number of sockets | Number of cores per socket | SAPS | SAPS per core |
|---|---|---|---|---|---|
| PowerEdge R750xa (Intel Xeon Gold 6314U, 2.30 GHz) | 32 | 1 | 32 | 102,883 | 3,215 |
| PowerEdge R750xa (Intel Xeon Gold 6330, 2.00 GHz) | 56 | 2 | 28 | 171,471 | 3,062 |
| PowerEdge R750xa (Intel Xeon Gold 6338, 2.00 GHz) | 64 | 2 | 32 | 191,953 | 2,999 |
| PowerEdge R750xa (Intel Xeon Gold 6338N, 2.20 GHz) | 64 | 2 | 32 | 190,524 | 2,977 |
| PowerEdge R750xa (Intel Xeon Gold 6346, 3.10 GHz) | 32 | 2 | 16 | 133,367 | 4,168 |
| PowerEdge R750xa (Intel Xeon Gold 6348, 2.60 GHz) | 56 | 2 | 28 | 196,239 | 3,504 |
| PowerEdge R750xa (Intel Xeon Gold 6354, 3.00 GHz) | 36 | 2 | 18 | 146,227 | 4,062 |
| PowerEdge R750xa (Intel Xeon Platinum 8351N, 2.40 GHz) | 36 | 1 | 36 | 112,885 | 3,136 |
| PowerEdge R750xa (Intel Xeon Platinum 8352S, 2.20 GHz) | 64 | 2 | 32 | 197,668 | 3,089 |
| PowerEdge R750xa (Intel Xeon Platinum 8352V, 2.10 GHz) | 72 | 2 | 36 | 204,337 | 2,838 |
| PowerEdge R750xa (Intel Xeon Platinum 8352Y, 2.20 GHz) | 64 | 2 | 32 | 196,239 | 3,066 |
| PowerEdge R750xa (Intel Xeon Platinum 8358, 2.60 GHz) | 64 | 2 | 32 | 218,150 | 3,409 |
| PowerEdge R750xa (Intel Xeon Platinum 8358P, 2.60 GHz) | 64 | 2 | 32 | 218,150 | 3,409 |
| PowerEdge R750xa (Intel Xeon Platinum 8360Y, 2.40 GHz) | 72 | 2 | 36 | 231,010 | 3,208 |
| PowerEdge R750xa (Intel Xeon Platinum 8368, 2.40 GHz) | 76 | 2 | 38 | 245,299 | 3,228 |
| PowerEdge R750xa (Intel Xeon Platinum 8368Q, 2.60 GHz) | 76 | 2 | 38 | 245,299 | 3,228 |
| PowerEdge R750xa (Intel Xeon Gold 5317, 3.00 GHz) | 24 | 2 | 12 | 95,738 | 3,989 |
| PowerEdge R750xa (Intel Xeon Gold 5318S, 2.10 GHz) | 48 | 2 | 24 | 149,085 | 3,106 |
| PowerEdge R750xa (Intel Xeon Gold 5320, 2.20 GHz) | 52 | 2 | 26 | 167,661 | 3,224 |
| PowerEdge R750xa (Intel Xeon Gold 5320T, 2.30 GHz) | 40 | 2 | 20 | 132,890 | 3,322 |
| PowerEdge R750xa (Intel Xeon Gold 6312U, 2.40 GHz) | 24 | 1 | 24 | 85,736 | 3,572 |
| PowerEdge R750xa (Intel Xeon Gold 6326, 2.90 GHz) | 32 | 2 | 16 | 123,364 | 3,855 |
| PowerEdge R750xa (Intel Xeon Gold 6334, 3.60 GHz) | 16 | 2 | 8 | 69,541 | 4,346 |
| PowerEdge R750xa (Intel Xeon Gold 6338T, 2.10 GHz) | 48 | 2 | 24 | 151,943 | 3,165 |

| PowerEdge server | Number of cores | Number of sockets | Number of cores per socket | SAPS | SAPS per core |
|---|---|---|---|---|---|
| PowerEdge R750xa (Intel Xeon Gold 6342, 2.80 GHz) | 48 | 2 | 24 | 177,663 | 3,701 |
| PowerEdge R750xa (Intel Xeon Silver 4309Y, 2.80 GHz) | 16 | 2 | 8 | 61,920 | 3,870 |
| PowerEdge R750xa (Intel Xeon Silver 4310, 2.10 GHz) | 24 | 2 | 12 | 77,638 | 3,235 |
| PowerEdge R750xa (Intel Xeon Silver 4310T, 2.30 GHz) | 20 | 2 | 10 | 67,160 | 3,358 |
| PowerEdge R750xa (Intel Xeon Silver 4314, 2.40 GHz) | 32 | 2 | 16 | 109,551 | 3,423 |
| PowerEdge R750xa (Intel Xeon Silver 4316, 2.30 GHz) | 40 | 2 | 20 | 130,509 | 3,263 |

**Table 16.    PowerEdge R750xs Ice lake-based systems with SAPS values**

| PowerEdge server | Number of cores | Number of sockets | Number of cores per socket | SAPS | SAPS per core |
|---|---|---|---|---|---|
| PowerEdge R750xs (Intel Xeon Gold 6330, 2.00 GHz) | 56 | 2 | 28 | 170,995 | 3,053 |
| PowerEdge R750xs (Intel Xeon Platinum 8352V, 2.10 GHz) | 72 | 2 | 36 | 204,337 | 2,838 |
| PowerEdge R750xs (Intel Xeon Platinum 8352Y, 2.20 GHz) | 64 | 2 | 32 | 197,192 | 3,081 |
| PowerEdge R750xs (Intel Xeon Platinum 8358P, 2.60 GHz) | 64 | 2 | 32 | 211,481 | 3,304 |
| PowerEdge R750xs (Intel Xeon Platinum 8360Y, 2.40 GHz) | 72 | 2 | 36 | 231,010 | 3,208 |
| PowerEdge R750xs (Intel Xeon Silver 4309Y, 2.80 GHz) | 16 | 2 | 8 | 62,396 | 3,900 |
| PowerEdge R750xs (Intel Xeon Silver 4310, 2.10 GHz) | 24 | 2 | 12 | 80,020 | 3,334 |

**Table 17.    PowerEdge MX750c Ice lake-based systems with SAPS values**

| PowerEdge server | Number of cores | Number of sockets | Number of cores per socket | SAPS | SAPS per core |
|---|---|---|---|---|---|
| PowerEdge MX750c (Intel Xeon Gold 5317, 3.00 GHz) | 24 | 2 | 12 | 95,262 | 3,969 |
| PowerEdge MX750c (Intel Xeon Gold 5318S, 2.10 GHz) | 48 | 2 | 24 | 149,561 | 3,116 |
| PowerEdge MX750c (Intel Xeon Gold 5318Y, 2.10 GHz) | 48 | 2 | 24 | 150,037 | 3,126 |
| PowerEdge MX750c (Intel Xeon Gold 5320, 2.20 GHz) | 52 | 2 | 26 | 169,090 | 3,252 |
| PowerEdge MX750c (Intel Xeon Gold 5320, 2.20 GHz) | 52 | 2 | 26 | 169,090 | 3,252 |
| PowerEdge MX750c (Intel Xeon Gold 5320T, 2.30 GHz) | 40 | 2 | 20 | 134,795 | 3,370 |
| PowerEdge MX750c (Intel Xeon Gold 6312U, 2.40 GHz) | 24 | 1 | 24 | 83,830 | 3,493 |
| PowerEdge MX750c (Intel Xeon Gold 6314U, 2.30 GHz) | 32 | 1 | 32 | 104,788 | 3,275 |
| PowerEdge MX750c (Intel Xeon Gold 6314U, 2.30 GHz) | 32 | 1 | 32 | 104,788 | 3,275 |

| PowerEdge server | Number of cores | Number of sockets | Number of cores per socket | SAPS | SAPS per core |
|---|---|---|---|---|---|
| PowerEdge MX750c (Intel Xeon Gold 6326, 2.90 GHz) | 32 | 2 | 16 | 124,317 | 3,885 |
| PowerEdge MX750c (Intel Xeon Gold 6330, 2.00 GHz) | 56 | 2 | 28 | 171,948 | 3,070 |
| PowerEdge MX750c (Intel Xeon Gold 6330N, 2.20 GHz) | 56 | 2 | 28 | 166,232 | 2,968 |
| PowerEdge MX750c (Intel Xeon Gold 6334, 3.60 GHz) | 16 | 2 | 8 | 70,017 | 4,376 |
| PowerEdge MX750c (Intel Xeon Gold 6338, 2.00 GHz) | 64 | 2 | 32 | 187,189 | 2,925 |
| PowerEdge MX750c (Intel Xeon Gold 6338N, 2.20 GHz) | 64 | 2 | 32 | 189,571 | 2,962 |
| PowerEdge MX750c (Intel Xeon Gold 6342, 2.80 GHz) | 48 | 2 | 24 | 178,140 | 3,711 |
| PowerEdge MX750c (Intel Xeon Gold 6346, 3.10 GHz) | 32 | 2 | 16 | 131,938 | 4,123 |
| PowerEdge MX750c (Intel Xeon Gold 6348, 2.60 GHz) | 56 | 2 | 28 | 197,192 | 3,521 |
| PowerEdge MX750c (Intel Xeon Gold 6354, 3.00 GHz) | 36 | 2 | 18 | 145,274 | 4,035 |

| PowerEdge server | Number of cores | Number of sockets | Number of cores per socket | SAPS | SAPS per core |
|---|---|---|---|---|---|
| PowerEdge MX750c (Intel Xeon Platinum 8352M, 2.30 GHz) | 64 | 2 | 32 | 189,095 | 2,955 |
| PowerEdge MX750c (Intel Xeon Platinum 8352S, 2.20 GHz) | 64 | 2 | 32 | 191,000 | 2,984 |
| PowerEdge MX750c (Intel Xeon Platinum 8352V, 2.10 GHz) | 36 | 1 | 36 | 104,312 | 2,898 |
| PowerEdge MX750c (Intel Xeon Platinum 8352Y, 2.20 GHz) | 64 | 2 | 32 | 198,621 | 3,103 |
| PowerEdge MX750c (Intel Xeon Platinum 8352Y, 2.20 GHz) | 64 | 2 | 32 | 196,716 | 3,074 |
| PowerEdge MX750c (Intel Xeon Platinum 8358, 2.60 GHz) | 64 | 2 | 32 | 222,913 | 3,483 |
| PowerEdge MX750c (Intel Xeon Platinum 8358, 2.60 GHz) | 64 | 2 | 32 | 222,436 | 3,476 |
| PowerEdge MX750c (Intel Xeon Platinum 8358P, 2.60 GHz) | 64 | 2 | 32 | 210,529 | 3,290 |
| PowerEdge MX750c (Intel Xeon Platinum 8360Y, 2.40 GHz) | 72 | 2 | 36 | 229,581 | 3,189 |
| PowerEdge MX750c (Intel Xeon Platinum 8362, 2.80 GHz) | 64 | 2 | 32 | 220,531 | 3,446 |

| PowerEdge server | Number of cores | Number of sockets | Number of cores per socket | SAPS | SAPS per core |
|---|---|---|---|---|---|
| PowerEdge MX750c (Intel Xeon Platinum 8368, 2.40 GHz) | 76 | 2 | 38 | 234,820 | 3,090 |
| PowerEdge MX750c (Intel Xeon Platinum 8368, 2.40 GHz) | 76 | 2 | 38 | 232,439 | 3,058 |
| PowerEdge MX750c (Intel Xeon Platinum 8380, 2.30 GHz) | 80 | 2 | 40 | 247,204 | 3,090 |
| PowerEdge MX750c (Intel Xeon Silver 4309Y, 2.80 GHz) | 16 | 2 | 8 | 59,539 | 3,721 |
| PowerEdge MX750c (Intel Xeon Silver 4310, 2.10 GHz) | 24 | 2 | 12 | 80,496 | 3,354 |
| PowerEdge MX750c (Intel Xeon Silver 4310T, 2.30 GHz) | 20 | 2 | 10 | 70,017 | 3,501 |
| PowerEdge MX750c (Intel Xeon Silver 4314, 2.40 GHz) | 32 | 2 | 16 | 109,551 | 3,423 |
| PowerEdge MX750c (Intel Xeon Silver 4316, 2.30 GHz) | 40 | 2 | 20 | 132,414 | 3,310 |

Table 18.    PowerEdge R650 Ice lake-based systems with SAPS values

| PowerEdge server | Number of cores | Number of sockets | Number of cores per socket | SAPS | SAPS per core |
|---|---|---|---|---|---|
| PowerEdge R650 (Intel Xeon Gold 5315Y, 3.20 GHz) | 16 | 2 | 8 | 66,207 | 4,138 |

| PowerEdge server | Number of cores | Number of sockets | Number of cores per socket | SAPS | SAPS per core |
|---|---|---|---|---|---|
| PowerEdge R650 (Intel Xeon Gold 5317, 3.00 GHz) | 24 | 2 | 12 | 95,738 | 3,989 |
| PowerEdge R650 (Intel Xeon Gold 5318Y, 2.10 GHz) | 48 | 2 | 24 | 149,561 | 3,116 |
| PowerEdge R650 (Intel Xeon Gold 5320, 2.20 GHz) | 52 | 2 | 26 | 170,042 | 3,270 |
| PowerEdge R650 (Intel Xeon Gold 6312U, 2.40 GHz) | 24 | 1 | 24 | 86,212 | 3,592 |
| PowerEdge R650 (Intel Xeon Gold 6314U, 2.30 GHz) | 32 | 1 | 32 | 103,359 | 3,230 |
| PowerEdge R650 (Intel Xeon Gold 6326, 2.90 GHz) | 32 | 2 | 16 | 124,317 | 3,885 |
| PowerEdge R650 (Intel Xeon Gold 6330, 2.00 GHz) | 56 | 2 | 28 | 171,471 | 3,062 |
| PowerEdge R650 (Intel Xeon Gold 6330N, 2.20 GHz) | 56 | 2 | 28 | 166,232 | 2,968 |
| PowerEdge R650 (Intel Xeon Gold 6334, 3.60 GHz) | 16 | 2 | 8 | 69,541 | 4,346 |
| PowerEdge R650 (Intel Xeon Gold 6336Y, 2.40 GHz) | 48 | 2 | 24 | 166,232 | 3,463 |
| PowerEdge R650 (Intel Xeon Gold 6338, 2.00 GHz) | 64 | 2 | 32 | 193,858 | 3,029 |
| PowerEdge R650 (Intel Xeon Gold 6338N, 2.20 GHz) | 64 | 2 | 32 | 192,429 | 3,007 |
| PowerEdge R650 (Intel Xeon Gold 6342, 2.80 GHz) | 48 | 2 | 24 | 179,092 | 3,731 |
| PowerEdge R650 (Intel Xeon Gold 6346, 3.10 GHz) | 32 | 2 | 16 | 133,843 | 4,183 |
| PowerEdge R650 (Intel Xeon Gold 6348, 2.60 GHz) | 56 | 2 | 28 | 196,716 | 3,513 |

| PowerEdge server | Number of cores | Number of sockets | Number of cores per socket | SAPS | SAPS per core |
|---|---|---|---|---|---|
| PowerEdge R650 (Intel Xeon Gold 6354, 3.00 GHz) | 36 | 2 | 18 | 146,703 | 4,075 |
| PowerEdge R650 (Intel Xeon Platinum 8351N, 2.40 GHz) | 36 | 1 | 36 | 110,504 | 3,070 |
| PowerEdge R650 (Intel Xeon Platinum 8352M, 2.30 GHz) | 64 | 2 | 32 | 193,381 | 3,022 |
| PowerEdge R650 (Intel Xeon Platinum 8352S, 2.20 GHz) | 64 | 2 | 32 | 201,479 | 3,148 |
| PowerEdge R650 (Intel Xeon Platinum 8352V, 2.10 GHz) | 72 | 2 | 36 | 205,766 | 2,858 |
| PowerEdge R650 (Intel Xeon Platinum 8352Y, 2.20 GHz) | 64 | 2 | 32 | 201,002 | 3,141 |
| PowerEdge R650 (Intel Xeon Platinum 8358, 2.60 GHz) | 64 | 2 | 32 | 220,055 | 3,438 |
| PowerEdge R650 (Intel Xeon Platinum 8358P, 2.60 GHz) | 64 | 2 | 32 | 215,768 | 3,371 |
| PowerEdge R650 (Intel Xeon Platinum 8360Y, 2.40 GHz) | 72 | 2 | 36 | 232,915 | 3,235 |
| PowerEdge R650 (Intel Xeon Platinum 8362, 2.80 GHz) | 64 | 2 | 32 | 224,342 | 3,505 |
| PowerEdge R650 (Intel Xeon Platinum 8368, 2.40 GHz) | 76 | 2 | 38 | 243,394 | 3,203 |
| PowerEdge R650 (Intel Xeon Platinum 8368Q, 2.60 GHz) | 76 | 2 | 38 | 248,633 | 3,271 |
| PowerEdge R650 (Intel Xeon Platinum 8380, 2.30 GHz) | 80 | 2 | 40 | 253,873 | 3,173 |
| PowerEdge R650 (Intel Xeon Silver 4309Y, 2.80 GHz) | 16 | 2 | 8 | 61,920 | 3,870 |
| PowerEdge R650 (Intel Xeon Silver 4310, 2.10 GHz) | 24 | 2 | 12 | 80,020 | 3,334 |

| PowerEdge server | Number of cores | Number of sockets | Number of cores per socket | SAPS | SAPS per core |
|---|---|---|---|---|---|
| PowerEdge R650 (Intel Xeon Silver 4314, 2.40 GHz) | 32 | 2 | 16 | 110,027 | 3,438 |
| PowerEdge R650 (Intel Xeon Silver 4316, 2.30 GHz) | 40 | 2 | 20 | 129,080 | 3,227 |

Table 19.    PowerEdge R650xs Ice lake-based systems with SAPS values

| PowerEdge server | Number of cores | Number of sockets | Number of cores per socket | SAPS | SAPS per core |
|---|---|---|---|---|---|
| PowerEdge R650xs (Intel Xeon Gold 6326, 2.90 GHz) | 32 | 2 | 16 | 123,364 | 3,855 |
| PowerEdge R650xs (Intel Xeon Gold 6330, 2.00 GHz) | 56 | 2 | 28 | 171,948 | 3,070 |
| PowerEdge R650xs (Intel Xeon Gold 6336Y, 2.40 GHz) | 48 | 2 | 24 | 161,945 | 3,374 |
| PowerEdge R650xs (Intel Xeon Platinum 8352V, 2.10 GHz) | 72 | 2 | 36 | 202,431 | 2,812 |
| PowerEdge R650xs (Intel Xeon Platinum 8352Y, 2.20 GHz) | 64 | 2 | 32 | 199,574 | 3,118 |
| PowerEdge R650xs (Intel Xeon Platinum 8358P, 2.60 GHz) | 64 | 2 | 32 | 214,815 | 3,356 |
| PowerEdge R650xs (Intel Xeon Platinum 8360Y, 2.40 GHz) | 72 | 2 | 36 | 231,010 | 3,208 |

Table 20.    PowerEdge C6520 Ice Lake-based systems with SAPS values

| PowerEdge server | Number of cores | Number of sockets | Number of cores per socket | SAPS | SAPS per core |
|---|---|---|---|---|---|
| PowerEdge C6520 (Intel Xeon Gold 5315Y, 3.20 GHz) | 16 | 2 | 8 | 66,207 | 4,138 |

| PowerEdge server | Number of cores | Number of sockets | Number of cores per socket | SAPS | SAPS per core |
|---|---|---|---|---|---|
| PowerEdge C6520 (Intel Xeon Gold 5317, 3.00 GHz) | 24 | 2 | 12 | 93,357 | 3,890 |
| PowerEdge C6520 (Intel Xeon Gold 5318N, 2.10 GHz) | 48 | 2 | 24 | 143,845 | 2,997 |
| PowerEdge C6520 (Intel Xeon Gold 5318S, 2.10 GHz) | 48 | 2 | 24 | 150,514 | 3,136 |
| PowerEdge C6520 (Intel Xeon Gold 5318Y, 2.10 GHz) | 48 | 2 | 24 | 150,037 | 3,126 |
| PowerEdge C6520 (Intel Xeon Gold 5320, 2.20 GHz) | 52 | 2 | 26 | 169,566 | 3,261 |
| PowerEdge C6520 (Intel Xeon Gold 5320T, 2.30 GHz) | 40 | 2 | 20 | 134,319 | 3,358 |
| PowerEdge C6520 (Intel Xeon Gold 6312U, 2.40 GHz) | 24 | 1 | 24 | 85,259 | 3,552 |
| PowerEdge C6520 (Intel Xeon Gold 6314U, 2.30 GHz) | 32 | 1 | 32 | 105,264 | 3,290 |
| PowerEdge C6520 (Intel Xeon Gold 6326, 2.90 GHz) | 32 | 2 | 16 | 124,317 | 3,885 |
| PowerEdge C6520 (Intel Xeon Gold 6330, 2.00 GHz) | 56 | 2 | 28 | 170,519 | 3,045 |
| PowerEdge C6520 (Intel Xeon Gold 6330N, 2.20 GHz) | 56 | 2 | 28 | 167,661 | 2,994 |
| PowerEdge C6520 (Intel Xeon Gold 6334, 3.60 GHz) | 16 | 2 | 8 | 69,541 | 4,346 |
| PowerEdge C6520 (Intel Xeon Gold 6336Y, 2.40 GHz) | 48 | 2 | 24 | 163,850 | 3,414 |
| PowerEdge C6520 (Intel Xeon Gold 6338, 2.00 GHz) | 64 | 2 | 32 | 194,810 | 3,044 |
| PowerEdge C6520 (Intel Xeon Gold 6338N, 2.20 GHz) | 64 | 2 | 32 | 191,476 | 2,992 |

| PowerEdge server | Number of cores | Number of sockets | Number of cores per socket | SAPS | SAPS per core |
|---|---|---|---|---|---|
| PowerEdge C6520 (Intel Xeon Gold 6338T, 2.10 GHz) | 48 | 2 | 24 | 153,848 | 3,205 |
| PowerEdge C6520 (Intel Xeon Gold 6342, 2.80 GHz) | 48 | 2 | 24 | 179,569 | 3,741 |
| PowerEdge C6520 (Intel Xeon Gold 6346, 3.10 GHz) | 32 | 2 | 16 | 133,367 | 4,168 |
| PowerEdge C6520 (Intel Xeon Gold 6348, 2.60 GHz) | 56 | 2 | 28 | 201,955 | 3,606 |
| PowerEdge C6520 (Intel Xeon Gold 6354, 3.00 GHz) | 36 | 2 | 18 | 146,227 | 4,062 |
| PowerEdge C6520 (Intel Xeon Platinum 8351N, 2.40 GHz) | 36 | 1 | 36 | 113,838 | 3,162 |
| PowerEdge C6520 (Intel Xeon Platinum 8352S, 2.20 GHz) | 64 | 2 | 32 | 202,908 | 3,170 |
| PowerEdge C6520 (Intel Xeon Platinum 8352V, 2.10 GHz) | 72 | 2 | 36 | 205,766 | 2,858 |
| PowerEdge C6520 (Intel Xeon Platinum 8352Y, 2.20 GHz) | 64 | 2 | 32 | 200,050 | 3,126 |
| PowerEdge C6520 (Intel Xeon Platinum 8358, 2.60 GHz) | 64 | 2 | 32 | 224,342 | 3,505 |
| PowerEdge C6520 (Intel Xeon Platinum 8358P, 2.60 GHz) | 64 | 2 | 32 | 213,386 | 3,334 |
| PowerEdge C6520 (Intel Xeon Platinum 8360Y, 2.40 GHz) | 72 | 2 | 36 | 232,439 | 3,228 |
| PowerEdge C6520 (Intel Xeon Platinum 8360Y, 2.40 GHz) | 72 | 2 | 36 | 231,963 | 3,222 |
| PowerEdge C6520 (Intel Xeon Platinum 8362, 2.80 GHz) | 64 | 2 | 32 | 226,247 | 3,535 |
| PowerEdge C6520 (Intel Xeon Platinum 8368, 2.40 GHz) | 76 | 2 | 38 | 236,726 | 3,115 |

| PowerEdge server | Number of cores | Number of sockets | Number of cores per socket | SAPS | SAPS per core |
|---|---|---|---|---|---|
| PowerEdge C6520 (Intel Xeon Platinum 8368, 2.40 GHz) | 76 | 2 | 38 | 231,963 | 3,052 |
| PowerEdge C6520 (Intel Xeon Platinum 8368Q, 2.60 GHz) | 76 | 2 | 38 | 245,299 | 3,228 |
| PowerEdge C6520 (Intel Xeon Platinum 8380, 2.30 GHz) | 80 | 2 | 40 | 252,920 | 3,162 |
| PowerEdge C6520 (Intel Xeon Silver 4309Y, 2.80 GHz) | 16 | 2 | 8 | 61,444 | 3,840 |
| PowerEdge C6520 (Intel Xeon Silver 4310, 2.10 GHz) | 24 | 2 | 12 | 80,020 | 3,334 |
| PowerEdge C6520 (Intel Xeon Silver 4310T, 2.30 GHz) | 20 | 2 | 10 | 69,541 | 3,477 |
| PowerEdge C6520 (Intel Xeon Silver 4314, 2.40 GHz) | 32 | 2 | 16 | 108,598 | 3,394 |
| PowerEdge C6520 (Intel Xeon Silver 4316, 2.30 GHz) | 40 | 2 | 20 | 131,938 | 3,298 |

## PowerEdge 14G Cascade Lake-based systems SAPS tables

Table 21.    PowerEdge R940/R940xa Cascade Lake-based systems with SAPS values

| PowerEdge server | Number of cores | Number of sockets | Number of cores per socket | SAPS | SAPS per core |
|---|---|---|---|---|---|
| PowerEdge R940 (Intel Xeon Gold 5217, 3.00GHz) | 32 | 4 | 8 | 121,048 | 3,783 |
| PowerEdge R940 (Intel Xeon Gold 5218, 2.30GHz) | 64 | 4 | 16 | 210,088 | 3,283 |
| PowerEdge R940 (Intel Xeon Gold 5220, 2.20GHz) | 72 | 4 | 18 | 230,456 | 3,201 |
| PowerEdge R940 (Intel Xeon Gold 6222V, 1.80GHz) | 80 | 4 | 20 | 229,292 | 2,866 |
| PowerEdge R940 (Intel Xeon Gold 6226, 2.70GHz) | 48 | 4 | 12 | 189,719 | 3,952 |
| PowerEdge R940 (Intel Xeon Gold 6230, 2.10GHz) | 80 | 4 | 20 | 258,390 | 3,230 |
| PowerEdge R940 (Intel Xeon Gold 6234, 3.30GHz) | 32 | 4 | 8 | 147,818 | 4,619 |
| PowerEdge R940 (Intel Xeon Gold 6238, 2.10GHz) | 88 | 4 | 22 | 282,251 | 3,207 |
| PowerEdge R940 (Intel Xeon Gold 6240, 2.60GHz) | 72 | 4 | 18 | 258,972 | 3,597 |
| PowerEdge R940 (Intel Xeon Gold 6242, 2.80GHz) | 64 | 4 | 16 | 238,604 | 3,728 |
| PowerEdge R940 (Intel Xeon Gold 6246, 3.30GHz) | 48 | 4 | 12 | 209,506 | 4,365 |
| PowerEdge R940 (Intel Xeon Gold 6248, 2.50GHz) | 80 | 4 | 20 | 279,341 | 3,492 |
| PowerEdge R940 (Intel Xeon Gold 6252, 2.10GHz) | 96 | 4 | 24 | 303,201 | 3,158 |
| PowerEdge R940 (Intel Xeon Platinum 8253, 2.20GHz) | 64 | 4 | 16 | 186,227 | 2,910 |
| PowerEdge R940 (Intel Xeon Platinum 8268, 2.90GHz) | 96 | 4 | 24 | 349,758 | 3,643 |
| PowerEdge R940 (Intel Xeon Platinum 8270, 2.70GHz) | 104 | 4 | 26 | 359,651 | 3,458 |
| PowerEdge R940 (Intel Xeon Platinum 8276, 2.20GHz) | 112 | 4 | 28 | 342,193 | 3,055 |
| **PowerEdge R940 (Intel Xeon Platinum 8280, 2.70GHz)** | **112** | **4** | **28** | **380,020** | **3,393** |

**Table 22.    PowerEdge R840/MX840c Cascade Lake-based systems with SAPS values**

| PowerEdge server | Number of cores | Number of sockets | Number of cores per socket | SAPS | SAPS per core |
|---|---|---|---|---|---|
| PowerEdge R840 (Intel Xeon Gold 5218, 2.30GHz) | 64 | 4 | 16 | 212,630 | 3,322 |
| PowerEdge R840 (Intel Xeon Gold 6222V, 1.80GHz) | 80 | 4 | 20 | 231,322 | 2,892 |
| PowerEdge R840 (Intel Xeon Gold 6226, 2.70GHz) | 48 | 4 | 12 | 189,264 | 3,943 |
| PowerEdge R840 (Intel Xeon Gold 6230, 2.10GHz) | 80 | 4 | 20 | 257,609 | 3,220 |
| PowerEdge R840 (Intel Xeon Gold 6238, 2.10GHz) | 88 | 4 | 22 | 284,480 | 3,233 |
| PowerEdge R840 (Intel Xeon Gold 6240, 2.60GHz) | 72 | 4 | 18 | 257,025 | 3,570 |
| PowerEdge R840 (Intel Xeon Gold 6242, 2.80GHz) | 64 | 4 | 16 | 237,748 | 3,715 |
| PowerEdge R840 (Intel Xeon Gold 6246, 3.30GHz) | 48 | 4 | 12 | 208,541 | 4,345 |
| PowerEdge R840 (Intel Xeon Gold 6248, 2.50GHz) | 80 | 4 | 20 | 278,638 | 3,483 |
| PowerEdge R840 (Intel Xeon Gold 6252, 2.10GHz) | 96 | 4 | 24 | 300,252 | 3,128 |
| PowerEdge R840 (Intel Xeon Gold 6262V) | 96 | 4 | 24 | 276,886 | 2,884 |
| PowerEdge R840 (Intel Xeon Platinum 8253, 2.20GHz) | 64 | 4 | 16 | 197,442 | 3,085 |

| PowerEdge server | Number of cores | Number of sockets | Number of cores per socket | SAPS | SAPS per core |
|---|---|---|---|---|---|
| PowerEdge R840 (Intel Xeon Platinum 8260M, 2.40GHz) | 96 | 4 | 24 | 319,529 | 3,328 |
| PowerEdge R840 (Intel Xeon Platinum 8268, 2.90GHz) | 96 | 4 | 24 | 349,320 | 3,639 |
| PowerEdge R840 (Intel Xeon Platinum 8270, 2.70GHz) | 104 | 4 | 26 | 364,508 | 3,505 |
| PowerEdge R840 (Intel Xeon Platinum 8276, 2.20GHz) | 112 | 4 | 28 | 335,885 | 2,999 |
| **PowerEdge R840 (Intel Xeon Platinum 8280, 2.70GHz)** | **112** | **4** | **28** | **380,280** | **3,395** |

**Table 23. PowerEdge R740, R740xd, MX740c Cascade Lake Refresh-based systems with SAPS values**

| PowerEdge server | Number of cores | Number of sockets | Number of cores per socket | SAPS | SAPS per core |
|---|---|---|---|---|---|
| PowerEdge R740xd (Intel Xeon Bronze 3206R, 1.90 GHz) | 16 | 2 | 8 | 30,268 | 1,892 |
| PowerEdge R740xd (Intel Xeon Silver 4210R, 2.40 GHz) | 20 | 2 | 10 | 64,617 | 3,231 |
| PowerEdge R740xd (Intel Xeon Silver 4214R, 2.40 GHz) | 24 | 2 | 12 | 81,054 | 3,377 |
| PowerEdge R740xd (Intel Xeon Silver 4215R, 3.20 GHz) | 16 | 2 | 8 | 57,248 | 3,578 |
| PowerEdge R740xd (Intel Xeon Gold 5218R, 2.10 GHz) | 40 | 2 | 20 | 120,164 | 3,004 |
| PowerEdge R740xd (Intel Xeon Gold 5220R, 2.20 GHz) | 48 | 2 | 24 | 146,805 | 3,058 |
| PowerEdge R740xd (Intel Xeon Gold 6208U, 2.90 GHz) | 16 | 1 | 16 | 57,248 | 3,578 |
| PowerEdge R740xd (Intel Xeon Gold 6226R, 2.90 GHz) | 32 | 2 | 16 | 118,464 | 3,702 |
| PowerEdge R740xd (Intel Xeon Gold 6230R, 2.10 GHz) | 52 | 2 | 26 | 153,606 | 2,954 |
| PowerEdge R740xd (Intel Xeon Gold 6238R, 2.20 GHz) | 56 | 2 | 28 | 163,809 | 2,925 |

| PowerEdge server | Number of cores | Number of sockets | Number of cores per socket | SAPS | SAPS per core |
|---|---|---|---|---|---|
| PowerEdge R740xd (Intel Xeon Gold 6240R, 2.40 GHz) | 48 | 2 | 24 | 146,805 | 3,058 |
| PowerEdge R740xd (Intel Xeon Gold 6242R, 3.10 GHz) | 40 | 2 | 20 | 153,606 | 3,840 |
| PowerEdge R740xd (Intel Xeon Gold 6246R, 3.40 GHz) | 32 | 2 | 16 | 136,602 | 4,269 |
| PowerEdge R740xd (Intel Xeon Gold 6248R, 3.00 GHz) | 48 | 2 | 24 | 175,145 | 3,649 |
| PowerEdge R740xd (Intel Xeon Gold 6258R, 2.70 GHz) | 56 | 2 | 28 | 184,781 | 3,300 |

**Table 24.    PowerEdge R740/R740xd Cascade Lake-based systems with SAPS values**

| PowerEdge server | Number of cores | Number of sockets | Number of cores per socket | SAPS | SAPS per core |
|---|---|---|---|---|---|
| PowerEdge R740 (Intel Xeon Silver 4214, 2.20GHz) | 24 | 2 | 12 | 75,953 | 3,165 |
| PowerEdge R740 (Intel Xeon Gold 5218, 2.30GHz) | 32 | 2 | 16 | 103,727 | 3,241 |
| PowerEdge R740 (Intel Xeon Gold 5220, 2.20GHz) | 36 | 2 | 18 | 108,261 | 3,007 |
| PowerEdge R740 (Intel Xeon Gold 6230N, 2.30GHz) | 40 | 2 | 20 | 125,266 | 3,132 |
| PowerEdge R740 (Intel Xeon Gold 6242, 2.80GHz) | 32 | 2 | 16 | 115,630 | 3,613 |
| PowerEdge R740 (Intel Xeon Gold 6248, 2.50GHz) | 40 | 2 | 20 | 140,003 | 3,500 |
| PowerEdge R740 (Intel Xeon Gold 6254, 3.10GHz) | 36 | 2 | 18 | 140,003 | 3,889 |
| PowerEdge R740 (Intel Xeon Platinum 8253, 2.20GHz) | 32 | 2 | 16 | 90,690 | 2,834 |
| PowerEdge R740xd (Intel Xeon Silver 4208, 2.10GHz) | 16 | 2 | 8 | 47,159 | 2,947 |
| PowerEdge R740xd (Intel Xeon Silver 4210, 2.20GHz) | 20 | 2 | 10 | 60,082 | 3,004 |
| PowerEdge R740xd (Intel Xeon Silver 4214, 2.20GHz) | 24 | 2 | 12 | 76,520 | 3,188 |
| PowerEdge R740xd (Intel Xeon Silver 4214, 2.20GHz) | 24 | 2 | 12 | 74,819 | 3,117 |
| PowerEdge R740xd (Intel Xeon Silver 4215, 2.50GHz) | 16 | 2 | 8 | 52,657 | 3,291 |
| PowerEdge R740xd (Intel Xeon Silver 4216, 2.10GHz) | 16 | 1 | 16 | 48,122 | 3,008 |

| PowerEdge server | Number of cores | Number of sockets | Number of cores per socket | SAPS | SAPS per core |
|---|---|---|---|---|---|
| PowerEdge R740xd (Intel Xeon Silver 4216, 2.10GHz) | 32 | 2 | 16 | 99,192 | 3,100 |
| PowerEdge R740xd (Intel Xeon Gold 5215, 2.50GHz) | 20 | 2 | 10 | 68,584 | 3,429 |
| PowerEdge R740xd (Intel Xeon Gold 5217, 3.00GHz) | 16 | 2 | 8 | 60,082 | 3,755 |
| PowerEdge R740xd (Intel Xeon Gold 5218N, 2.30GHz) | 32 | 2 | 16 | 108,261 | 3,383 |
| PowerEdge R740xd (Intel Xeon Gold 5220S, 2.70GHz) | 36 | 2 | 18 | 113,363 | 3,149 |
| PowerEdge R740xd (Intel Xeon Gold 6210U, 2.50GHz) | 20 | 1 | 20 | 70,285 | 3,514 |
| PowerEdge R740xd (Intel Xeon Gold 6226, 2.70GHz) | 24 | 2 | 12 | 93,524 | 3,897 |
| PowerEdge R740xd (Intel Xeon Gold 6230, 2.10GHz) | 40 | 2 | 20 | 126,966 | 3,174 |
| PowerEdge R740xd (Intel Xeon Gold 6238, 2.10GHz) | 44 | 2 | 22 | 138,869 | 3,156 |
| PowerEdge R740xd (Intel Xeon Gold 6240, 2.60GHz) | 36 | 2 | 18 | 128,100 | 3,558 |
| PowerEdge R740xd (Intel Xeon Gold 6244, 3.60GHz) | 16 | 2 | 8 | 75,386 | 4,712 |
| PowerEdge R740xd (Intel Xeon Gold 6246, 3.30GHz) | 24 | 2 | 12 | 102,593 | 4,275 |
| PowerEdge R740xd (Intel Xeon Gold 6252, 2.10GHz) | 48 | 2 | 24 | 150,205 | 3,129 |
| PowerEdge R740xd (Intel Xeon Gold 6252N, 2.30GHz) | 48 | 2 | 24 | 154,173 | 3,212 |
| PowerEdge R740xd (Intel Xeon Platinum 8260, 2.40GHz) | 48 | 2 | 24 | 153,606 | 3,200 |
| PowerEdge R740xd (Intel Xeon Platinum 8268, 2.90GHz) | 48 | 2 | 24 | 171,744 | 3,578 |
| PowerEdge R740xd (Intel Xeon Platinum 8270, 2.70GHz) | 52 | 2 | 26 | 180,246 | 3,466 |
| PowerEdge R740xd (Intel Xeon Platinum 8276M, 2.20GHz) | 56 | 2 | 28 | 167,777 | 2,996 |
| **PowerEdge R740xd (Intel Xeon Platinum 8280, 2.70GHz)** | **56** | **2** | **28** | **193,850** | **3,462** |