



Powering the Future of Hyper-Convergence

SAP HANA Ecosystem on Dell EMC XC Family



Intel® Xeon® processors are the new foundation for secure and agile data centers. These processors are built for mission-critical, real-time analytics and multi-cloud workloads at any scale.

Start small and grow incrementally with pay-as-you-grow flexibility. Scale your business demands grow. Get true enterprise agility, simplified management, and quick deployment.



Cloud Evolutions

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1 Executive Summary

1.1 Introduction

Hyper-converged infrastructures (HCI) have emerged as powerful alternatives to conventional datacenter infrastructure designs. Thanks to distinctive software defined capabilities, HCI streamline and expedite deployment, management and maintenance while delivering high levels of performance.

The Dell EMC XC Family is a hyper-converged solution that combines compute, networking, and storage resources provided by industry-leading Dell EMC PowerEdge™ servers and Nutanix AOS software. The Dell EMC XC Family is a portfolio of hyper-converged infrastructure (HCI) solutions that consists of XC Series, and XC Core. Dell EMC XC Family, hyperconverged infrastructure (HCI) platform with XC740XD, XC940 and Nutanix AHV is now certified to host SAP HANA production (and non-production) environments. Also SAP's certification applies to both XC Series and XC Core offerings.

With Dell EMC XC Family, organizations like yours can expect:

- Very high levels of performance
- The ability to combine test, dev, QA, and production on a single platform
- The capacity to consolidate multiple SAP instances
- Compelling business benefits that unlock new opportunities for innovation.

This paper explores the technical capabilities, features, functionality, and benefits of using Dell EMC XC Family hyper-converged infrastructure for SAP HANA.

1.2 Scope

Cloud Evolutions conducted the testing to characterize the performance of SAP HANA using industry standard benchmarking tools simulating SAP HANA workloads on the XC Family. This document provides high level architecture, summary of the results, key findings and best practices for SAP HANA deployment on the Dell EMC XC Family.

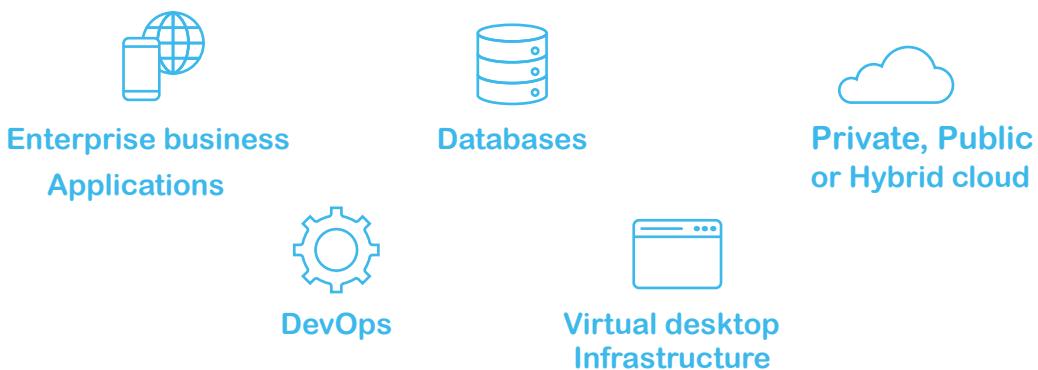
1.3 Audience

This whitepaper is intended for system integrators, systems and storage administrators, partners, customers and Dell EMC professional services involved in a SAP HANA implementation.

2 XC Family Overview

The **Dell EMC XC Family** delivers scalability, reliability, and performance for any workload in a flexible IT infrastructure.

Single integrated solution. The Dell EMC XC Family combines compute, storage and virtualization resources in 1U, 2U and 3U appliances configured to-order for specific use cases. These SAP HANA certified solutions use 14th generation PowerEdge servers and Nutanix software. The XC Family allows application and virtualization teams to quickly fulfill new service requests for all virtualized workloads, including:



- ❖ **Infrastructure That Supports Business.** Multiple applications can run seamlessly on the same scalable and cost-effective platform, enabling IT to shift from supporting operations to rapidly delivering innovations that drive growth and business value.
 - ❖ **Rapid deployment.** XC Family enables IT to run multiple virtualized workloads to realize fast deployment, reduce total cost of ownership (TCO), and simplify management.
 - ❖ **Choice of hypervisor.** The ability to choose the hypervisor enables to support a variety of applications and use cases.
 - ❖ **Simplified management.** IT administrators can manage virtualization or Virtual Machine through central control (PRISM), which reduces management effort and cost. IT administrators can manage virtual environments at a VM level using policies based on the needs of each workload.
- Infrastructure that supports Business
 - Rapid Deployment
 - Choice of Hypervisor
 - Simplified Management

2.1 Dell EMC XC Family Architecture

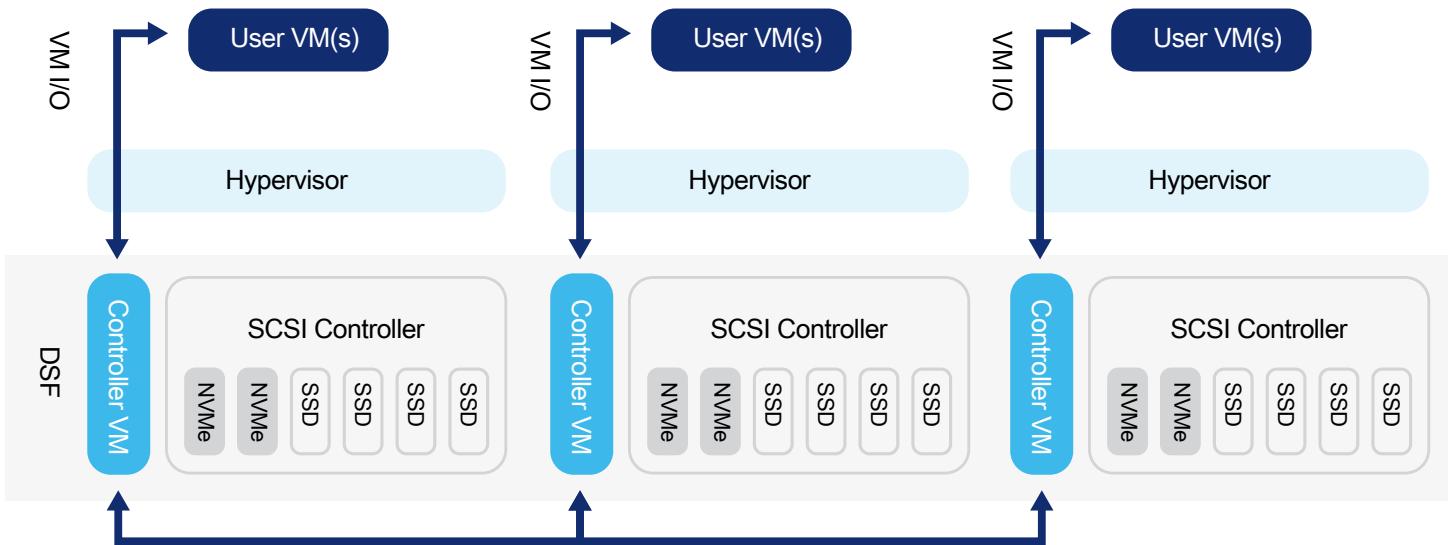


Figure 1. Dell XC Family HCI platform. Scales easily without traditional storage constraints

Distributed Storage Fabric. The XC Family provides a hyper-converged platform using Distributed Storage Fabric (DSF) to share and present local storage to all the VMs in the cluster. DSF virtualizes local storage across all nodes and presents them to the hypervisor as one integrated pool of shared storage. The DSF replicates and writes synchronously to at least one other node to ensure cluster resiliency and availability.

Data Locality of a node has the ability to keep compute and storage close together to ensure consistent performance and availability of the data. DSF uses local SSDs and disks from all nodes to store virtual machine data. Virtual machines running on the cluster write data to DSF as if they were writing to local storage.

The Dell EMC XC Family HCI provides significant advantages including:

- ❖ **Broadest compatibility:** Your choice of hypervisors without being locked-in.
- ❖ **VM-centric:** The Nutanix Controller VMs run on AHV and have direct control of the drives.
- ❖ **Fast deployment:** They come preconfigured so that you can start using the storage platform with minimal startup time.

2.2 Key Features

The XC Family makes managing infrastructure efficient with enterprise-class data management capabilities, cloud integration, comprehensive diagnostics and analytics, plus one-click hypervisor, software and firmware updates.



Based on 14th generation Dell EMC PowerEdge servers with Nutanix software and choice of industry leading hypervisors



Available in flexible combinations of CPU, memory, and SSD/HDD, including NVMe SSDs to optimize performance and efficiencies.



Includes thin provisioning and cloning, replication, data tiering, deduplication, and compression



Hardware and software validated, tested, and supported globally by Dell EMC ProSupport



Able to grow one node at a time with non-disruptive, scale-out expansion

2.3 Primary Benefits

- ❖ **Ease of Use:** The Dell EMC XC Family can be setup in less than a hour, easy to manage, simple to maintain and offers enterprise-grade reliability.
- ❖ **Linear Scalability:** The platform has high levels of compute, networking and storage performance to meet increase workloads with no impact on latency.
- ❖ **Development efficiency:** Supports both 2-socket and 4-socket services in the same cluster, organizations can be cost-effectively use a single XC Family cluster for SAP HANA dev, test, QA and production.
- ❖ **Improved density:** XC Family performance is second to none, so organizations can benefit from increased Virtual Machine (VM) density. Multiple SAP HANA instances can run on the same cluster without performance limitations.
- ❖ **Pay-as-you-grow flexibility:** Organizations can start small and expand their XC Family cluster overtime as needs evolve, spread capital expenditure over years.

3 XC Family and SAP HANA

The XC Family supports SAP® and the SAP HANA certified solutions that enable your business to innovate faster and accelerate IT operations. SAP HANA provides both transactional and analytical processing production grade database instances on a single XC Family cluster, dramatically accelerating analytics, business processes and predictive capabilities. XC Family enables to analyze volumes of historical data quickly, and make instant decisions to drive rapid innovation.

The power of hypervisor deployment. Running the SAP HANA platform virtualized on AHV delivers a new deployment architecture to SAP HANA customers. Customers can deploy SAP HANA on premise for maximum control, in the cloud for fast time-to-value, or through a hybrid model that supports a variety of deployment scenarios. Deployment of SAP HANA on XC Family with Nutanix software provides SAP customers greater agility, high availability, security, cost savings, and easy provisioning. This solution also gives SAP customers the ability to provision instances of SAP HANA in virtual machines faster.

Improved SAP HANA performance. Virtual deployment of SAP HANA with Nutanix Enterprise Cloud OS platform can lower total cost of ownership (TCO) and improve operational performance and availability. Benefits include:

- ❖ Increased security and better monitoring of service level agreements (SLAs)
- ❖ Built-in multi-tenancy support using system encapsulation in a VM
- ❖ Abstraction of the hardware layer
- ❖ Higher hardware utilization rates
- ❖ Streamlining IT operations, processes and standards

Combine OLAP and OLTP processing. SAP HANA is an in-memory relational database management system that is deployable as an on-premise appliance, or in the cloud. It is best suited for performing real-time analytics and developing/deploying real-time applications.

3.1 Certification Benefits

Dell EMC XC740xd and XC940 server products are SAP certified hardware configurations that provide a complete Dell EMC and Nutanix solution for SAP HANA production and non-production environments. The rigorous certification process ensures all standards are met, and enables customers to fast-track their implementations and handle OLTP and OLAP workloads. Also, this certification is a proof point for technical alignment with SAP solutions.

3.2 Intel and SAP HANA

- ❖ **Intel Xeon Scalable Processors.** Intel Xeon Skylake scalable processors provide reliability, scalability, and deliver faster computing speeds for OLAP and OLTP SAP application workloads.
- ❖ **Leveraging technology.** Intel's transactional synchronization extensions (TSX) in its new Xeon scalable processors improve the performance of transactional in-memory database processing on systems with high core counts and where scalability of thread synchronization is important.
- ❖ **Value and workload efficiencies.** Intel's TSX technology enables the SAP HANA platform to deliver greater value when it runs on multi-socket servers powered by its new Xeon processors. The combination of Intel's Xeon processor with Intel's TSX and SAP HANA enables:
 - Faster performance, better reliability and uptime, and extends scalability across advanced workloads
 - Ability to minimize CPU latency, improve transactions, and reduce TCO
 - Flexibility to adapt rapidly to changing data needs by scaling up or down as required

For more information, visit

<https://www.intel.com/content/www/us/en/big-data/real-time-analysis-sap-product-brief.html>

4 Test Methodology

Following a proper methodology guarantees results that are in-line with objectives of the project scope. Test scenarios are built based on this proposed scope.

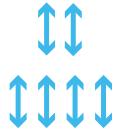
Scope of the project include:



Multiple SAP HANA production systems supporting online transaction processing (OLTP) and online analytical processing (OLAP) workloads running in parallel on the XC940-24 node.



Multiple SAP environments includes development, test and production deployed in a single cluster



SAP HANA deployed in a cluster with combination of 2 and 4 socket servers.

The goal is to demonstrate that the performance of SAP HANA is enhanced and scales linearly when deployed on Dell EMC XC Family with Intel Xeon processors.

4.1 Goals and Objectives

The primary objectives of this test include:



Deploy three SAP HANA production VMs on a Dell EMC XC940-24 to run in parallel and validate that there is no negative performance impact.



Demonstrate that the entire SAP HANA ecosystem can be deployed in a **single** Dell EMC XC Family cluster.



Demonstrate linear scalability depending on your growth and load requirements and integrate a mix of XC940-24/XC740xd-24 in a **single** cluster.



Manage production and non-production environments (development and test systems) in a **single** Dell EMC XC Family cluster.



Demonstrate high-performance, linear scalability, greater flexibility, and deliver improved business intelligence on SAP HANA.

4.2 Solution Infrastructure

The SAP HANA ecosystem was deployed and validated on an XC Family cluster with two XC940-24 and two XC740xd-24 nodes. All four nodes were on AOS version 5.9.

SAP HANA certified environment for the Dell EMC Family cluster was configured as follows (for details see Appendix A):

- ❖ In the 4-node cluster, two XC940-24 nodes were used for a production environment and two XC740xd-24 nodes were used for a test/development environment.
- ❖ In one XC940-24 node, three SAP HANA stand-alone production SAP HANA instances were deployed.
- ❖ In the other XC940-24 node, two SAP BW (SAP NetWeaver) systems and a SAP S/4 HANA Business suite were deployed.

Refer to Figure 4 for entire SAP HANA ecosystem deployed on XC Family cluster.

5 Results and Analysis

5.1 SAP HANA Performance Characterization

Test results illustrate that there is no performance impact when three SAP HANA production databases were deployed on one XC940.

Below are the observations:

- Average throughput of 1928.64 MB/s and highest throughput of 2125.07 MB/s.
- Average latency of 526 Microsec and lowest at 511 Microsec (see Table 1 and Figure 2).

The test results presented below shows how XC Family consistently met the expectations maintaining high throughputs at low latencies eliminating the need of data duplication between operational (OLTP) and decision support systems (OLAP).

SAP HANA nodes delivered uniform performance among all SAP HANA production databases under the following test configurations.

Table 1. Throughput and latency for three SAP HANA production database VMs running in parallel on XC940

VM	Number of threads	Measured throughput	Measured latency in microsec
■ VM1	256	1793.41	511
■ VM2	256	1867.45	535
■ VM3	256	2125.07	534

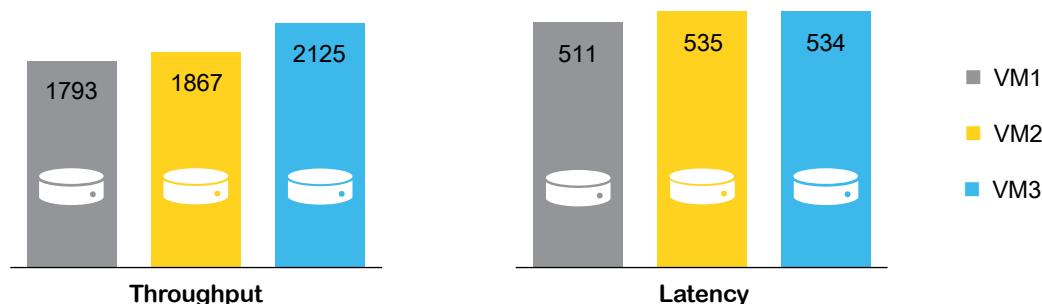


Figure 2. Throughput and latency for three SAP HANA production database VMs running in parallel on XC940



Actionable insight: Test cases validate three SAP HANA production databases running in parallel on a single XC940-24 within XC Family cluster with little or no impact on latency.

5.2 SAP HANA Scalability

A single Dell EMC XC940 supported up to three SAP HANA databases driving VM density higher when compared XC740xd. Industry standard tests simulated OLTP type of SAP HANA workloads while additional databases were added upto three to demonstrate scaling capability. The results validated how throughput performance of SAP HANA databases scaled linearly on XC Family node with little or no impact on the latency. These tests demonstrated the scalability of SAP HANA production databases on the XC Family cluster node with increasing workloads. Benchmark reports were used to determine if the subject hardware met the latency and throughput requirements that SAP HANA in-memory database demands. Table 2 and Figure 3 established the fact that the XC Family scales and performs.

Table 2. Linear scaling of throughput and average latency of three SAP HANA Database VMs on single XC940

Number of VMs in the test	KPI	
	Total throughput	Avg latency in microsec
■ One	2059.59	514
■ Two	3663.71	519
■ Three	5785.93	526

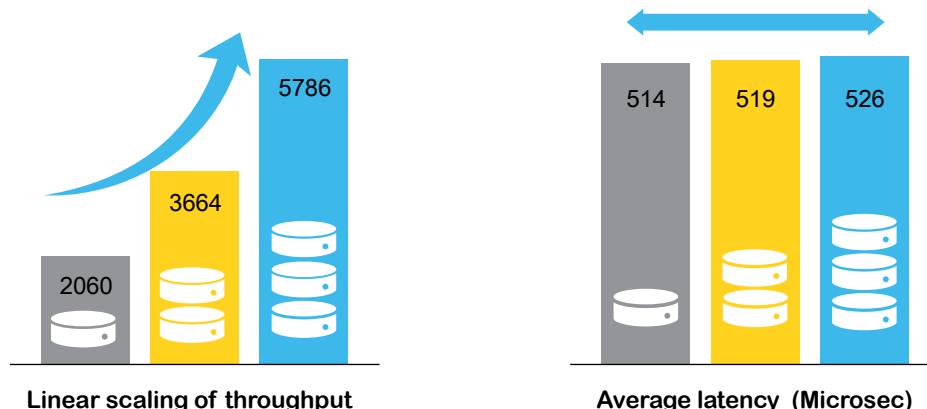


Figure 3. Linear scaling of throughput and average latency of three SAP HANA Database VMs on single XC940



Actionable insight: Testing demonstrates scale up capability of SAP HANA databases on a node and the ability to meet increasing throughput demand from OLTP type of workloads with no impact on latency.

6 Key Findings

The Dell EMC XC Family is now a certified hardware solution to run SAP HANA workloads on the same software that is certified for SAP NetWeaver and other SAP applications and use cases. XC Family devices draw on a foundation of hyper-convergence to create a single environment and flexible solution capable of solving unique challenges faced by SAP customers.

This architecture converges servers, storage, data protection, virtualization, and networking and this convergence:

- Simplified operations with one-click feature, for example, operations like performing infrastructure software and firmware upgrades with zero-downtime.
- Enhanced the user experience by offering full application automation, and multi-cloud management, creating a software-defined solution that is ideally suited for deployment in primary data centers.

Key Observations



Easily combines development, test and production environments in a single cluster.



Entire SAP HANA ecosystem deployed in single cluster with no performance impact



Start small and grow big – add ‘n’ number of nodes to the infrastructure that can scale in each XC Family solution which combines both 2-socket and 4-sockets servers in a cluster.



More computing capabilities with flexibility and cost-effective HCI products, up to 6TB of memory and, 80TB of storage in single XC940 (3U).

7 Conclusion

In summary:

- You can deploy multiple (up to three) SAP HANA production databases on a single Dell EMC XC940 without degrading throughput performance and latency.
- Throughput from SAP HANA databases scaled linearly when new databases were added to a Dell EMC XC940 node to meet the demand.
- None of the SAP HANA databases, while running in parallel on a single XC940, became a noisy neighbor.

These tests results prove that the XC Family can enhance the performance of SAP HANA database workloads, offering a scalable, agile platform for complex, challenging requirements.

These tests also proved that virtualizing SAP HANA has no impact on latency and throughput. These findings open up new perspectives for SAP and SAP HANA users who want to pursue digital transformation and make it their IT future-proof.

Dell EMC is a recognized leader and visionary in hyper-converged infrastructure with a mature product line and customer focused support. With proven capabilities, XC Family can enhance IT and enable new levels of operational and business productivity.

This configuration, to start small and grow big incrementally with pay as you grow flexibility, significantly reduces the total cost of ownership (TCO).

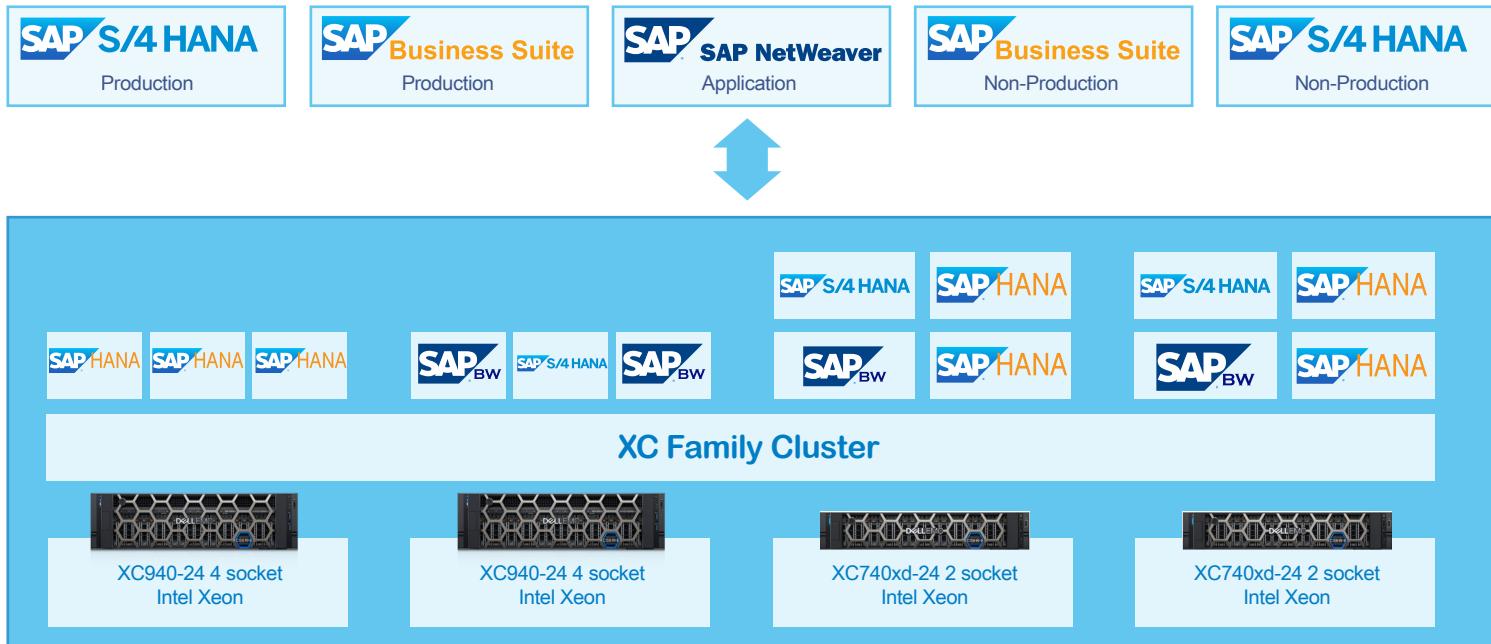


Figure 4: Entire SAP HANA Ecosystem deployed on XC Family cluster

8 SAP HANA Sizing and Best Practices

Your ability to leverage and gain maximum performance from your SAP investment is greatly dependent upon the correct configuration of your hardware infrastructure and processors. Therefore, it is critical that SAP HANA is optimally sized to reap the benefits offered by the XC Family.

Insufficient and over-provisioned sizing of SAP HANA could limit the performance and slow processing to a crawl; while under-provisioning can cause processing delays and conflicts that can increase operational expenses.

Dell EMC recommends following published guidelines for allocating CPU, memory and storage to achieve exceptional performance. You can find SAP HANA sizing considerations below.

8.1 CPU configuration

Dell EMC XC Family is certified for SAP HANA on dual socket and quad socket Intel Scalable Xeon CPUs. The CPUs used in this project are Intel Xeon Gold 6144, 6146, and 6150 processors. One, two or three SAP HANA production databases are supported on the XC940 and a single production database is supported on the XC740xd. More information can be found in the XC SAP HANA [Best Practices Guide](#).

Dell EMC XC Family is certified on 2-socket and 4-socket Intel Xeon CPUs. Dell EMC recommends using one socket for each SAP HANA production VMs and set NUMA node affinity so that a single virtual machine is confined to a socket. This way, three SAP HANA VMs are deployed with three SAP HANA production databases on one XC940 node thereby increasing the VM density by threefold when compared with XC740xd. Ensure all cores of the Intel processor are dedicated to each of the HANA production VMs using nonuniform memory access (NUMA) node affinity feature.

8.2 Memory configuration

The maximum memory supported for a HANA database is 2.3TB. Each of the XC Family nodes used for testing had 384GB. With NUMA architecture, each processor has dedicated local memory and can access the non-local memory of the other processors using an advanced memory controller. Even though this is a high-performance connection, access to local memory is always faster than access to the non-local memory of the other processors.

For a dual socket XC740xd, the memory is equally divided and 50 percent is assigned to the SAP HANA VM. With the XC940, the memory is divided to four equal sizes and 75 percent is allocated to the three SAP HANA VMs.

The remaining memory in each node is reserved for the Nutanix Controller VM. With NUMA architecture, each processor has dedicated local memory and can access the non-local memory of the other processors using an advanced memory controller.

8.3 Storage Configuration

Dell EMC XC Family storage recommendations were followed where needed for creating a data and log volume for the SAP HANA VMs. Four virtual disks (vDisks) were created for SAP HANA data and log volumes. On each VM, SAP HANA data volume and log volumes were created by adding four vDisks each. Two volume groups were created for SAP HANA data and logs using these vDisks with 64KB stripe size across four vDisks. Two logical volumes were created on these two volume groups. These volumes are mounted on VM data and log directories to provide storage for SAP HANA.

For SAP HANA production installations, Dell EMC recommends using flash drives for the SAP HANA persistence (data and log volumes) to meet the SAP HANA KPIs. Using flash devices for SAP HANA production installations we can achieve microsecond latencies. Regarding storage performance, both write and read operations must be considered. A certain minimum speed of writing raw data to storage is critical.

Typically, vendors of enterprise database management systems recommend a physical separation of the data and log volumes. The same is true for SAP HANA as the I/O requirements for accessing the data volume are different from those of log volume. The log volume is accessed using a sequential write I/O pattern while the data volume is accessed using a random read write pattern. Therefore, with separated volumes, a better performance can be reached for the redo log writing.

For more information, refer to sizing [best practices](#).

9 Appendix A

System Configuration Information

Server Configuration	Dell EMC XC940-24	Dell EMC XC940-24	Dell EMC XC740xd-24	Dell EMC XC740xd-24
BIOS Version	1.4.9	1.4.9	1.4.9	1.4.9
Processor				
Number of processors	4	4	4	4
Vendor and model	Intel Xeon Gold 6144	Intel Xeon Gold 6146	Intel Xeon Gold 6150	Intel Xeon Gold 6150
Core count (per processor)	8	12	18	18
Core frequency	3.50GHz	3.20 GHz	2.70 GHz	
Memory Modules				
Total memory in GB	384	384	384	384
Maximum capacity in GB	6144	6144	3072	3072
Number of memory modules	24	24	12	12
Size in GB	16	16	32	32
Type	DDR-4	DDR-4	DDR-4	DDR-4
Speed in MHz	2666	2666	2400	2400
Speed running in the server	2666	2666	2400	2400
Storage Controller				
Vendor and model	Dell EMC	Dell EMC	Dell EMC	Dell EMC
Firmware version	2.5.13.3011	2.5.13.3011	2.5.13.3011	2.5.13.3011
Driver version	15.17.09.06	15.17.09.06	15.17.09.06	15.17.09.06
Local Storage				
Number of drives	12	12	12	12
Drive vendor and model	Samsung MZILS400HEGR0D3	Samsung MZILS400HEGR0D3	Samsung MZILS400HEGR0D3	Samsung MZILS400HEGR0D3
Drive size in GB	400	400	400	400
Drive information	12 Gb/s	12 Gb/s	12 Gb/s	12 Gb/s
Network Adapter				
Vendor and model	MLNX 25GbE 2P ConnectX4LX			
Firmware version	14.20.18.22	14.20.18.22	14.20.18.22	14.20.18.22
Power Supplies				
Vendor and model	Dell EMC RDNT, FLX	Dell EMC RDNT, FLX	Dell EMC RDNT, Delta	Dell EMC RDNT, Delta
Number of power supplies	2	2	2	2
Wattage of each	1600	1600	1100	1100

Welcome to the Dell EMC-Nutanix stack: a single platform that multiplies business possibilities.

For more information visit:

<https://www.dell.com/en-us/converged-infrastructure/xseries/technical-resources.htm#saphana>
<http://bit.ly/2Q4Xj2n>



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