White Paper

Microsoft SQL Server for Common Workload on Dell EMC VxFlex integrated rack

Abstract

This paper highlights the benefits of hosting SQL Server 2016 on Dell EMC VxFlex integrated rack.

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Revisions

Date	Description
April 2019	Initial release
July 2019	Edited VxRack FLEX to VxFlex integrated rack as per branding guidelines

Acknowledgements

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Executive summary

This white paper shows the benefits of VxFlex integrated rack when a common workload like SQL Server 2016 is hosted on it.

Dell EMC VxFlex integrated rack is a rack-scale hyperconverged engineered system that delivers flexibility, scalability, and performance for the modern data center workloads. It is powered by software defined storage VxFlex OS, widely adopted enterprise virtualization technology running on enterprise class Dell PowerEdge servers. The VxFlex integrated rack flexible architecture enables not only multi-hypervisor capabilities but also multiple deployment options such as fully hyperconverged, two-layer, hybrid, and bare-metal to become the infrastructure of choice for modern and traditional workload. Scalability comes from starting small and growing incrementally, but also growing compute and storage independently. It also delivers performance for all workloads in the environment.

1 Introduction

Modern data center workloads have varying business value and characteristics for the workload and data that governs the performance, throughput, capacity, availability, data protection, and data services requirements. Shrinking IT budgets, push for greater efficiency, and consolidation and workload requirements have made it necessary for the underlying infrastructure to deliver high performance, scalability, resiliency, and most importantly -- flexibility. VxFlex integrated rack is an engineered system for Dell EMC designed on five super power principals to meet the key infrastructure requirements. VxFlex integrated rack delivers:

- Unmatched **performance**
- Unprecedented **scale** (1000 nodes and 100s-PB storage capacity)
- Built in redundant hardware components and VxFlex OS mesh mirror architecture delivers unparalleled **resiliency**
- Infrastructure **flexibility**: VxFlex integrated rack is second to none. This system has 1000s of hardware and software configuration option combinations that can co-exist freeing customers from T-shirt size, dedicated and siloed environments, and accelerating the data center consolidation.
- **Engineered system with single call support and life cycle management**

This white paper outlines how you can deploy Microsoft SQL server on VxFlex integrated rack to meet performance, resiliency, scale, and availability requirements and take full advantage of the five integrated super powers.

1.1 Terminology

The following table defines acronyms and terms that are used throughout this document:

Term	Definition
DAS	Direct Attached Storage
MDM	Meta Data Manager
SDC	Storage Data Client
SDS	Storage Data Server
SVM	Storage Virtual Machine
IPI	Intelligent Physical Infrastructure
TPM	Transactions Per Minute
OLTP	Online Transaction Processing
DSS	Decision Support System
RCM	Release Certification Matrix
IaaS	Infrastructure as a service
PaaS	Platform as a service

1.2 Objective

This paper shows:

- VxFlex integrated rack, VxFlex OS, and VxFlex Manager overview
- An overview of Microsoft SQL on VxFlex integrated rack use case
- An overview of VxFlex integrated rack architecture
- Configuring VxFlex integrated rack system for SQL Server 2016
- VxFlex integrated rack and SQL Server 2016 deployment best practices
- Conclusion

1.3 Audience

This document is intended to serve as a reference guide for business decision makers, architects, cloud administrators, database, and application administrators-who are interested to deploy their Microsoft SQL server-based application workload on VxFlex integrated rack. It is assumed that readers have a fair understanding and experience with cloud concepts, virtualization, software defined storage, and Microsoft SQL Server.

2 Product overview

2.1 VxFlex integrated rack

Dell EMC VxFlex integrated rack is an engineered system that provides ultimate performance, reliability, scalability, agility, and flexibility for modern data center workloads, IaaS, and PaaS cloud infrastructure initiatives. The system is powered by Dell EMC VxFlex OS software-defined storage and industry-leading enterprise-class Dell EMC PowerEdge servers. It is a rack scale hyperconverged system that comes with a proprietary intelligent physical infrastructure (IPI) cabinet, offers integrated networking and dedicated system management control plane.

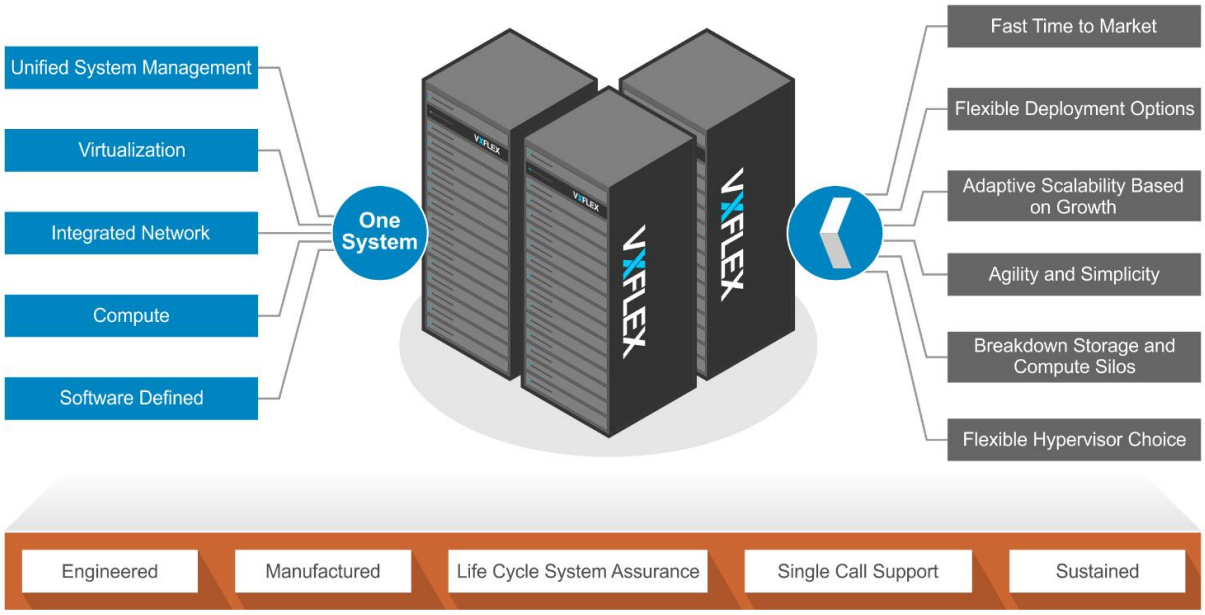

Figure 1 VxFlex integrated rack benefits

The modular design of VxFlex integrated rack enables you to add standardized units of infrastructure to the environment. With this scalable model, it is all about expanding the infrastructure in small increments, as applications require eliminating the over-provisioning that is experienced with other approaches.

The following illustration shows how easily VxFlex integrated rack scales.

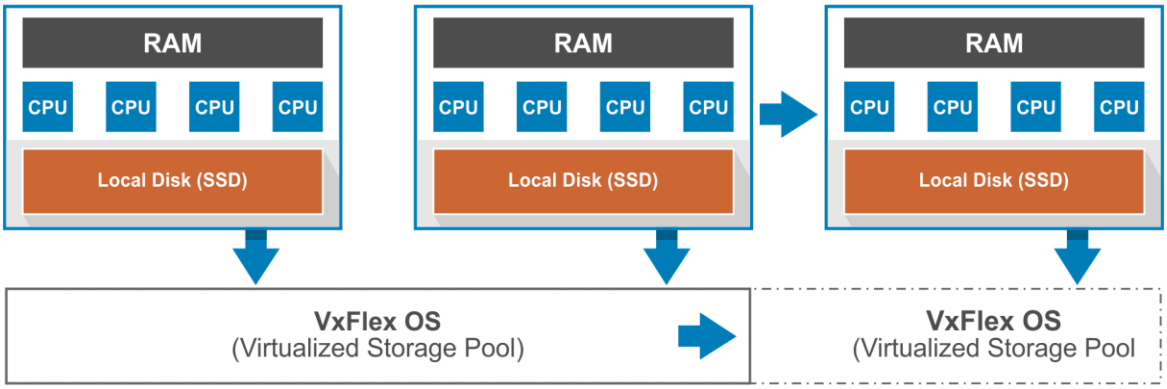

Figure 2 VxFlex integrated rack scalability

Each cabinet is equipped with redundant access switches (Cisco 93180YC-EX). A pair of aggregation switches is installed in the first cabinet and configured in access/aggregation network topology. If more than one cabinet exists, the aggregation switches can be spread across or put in other cabinets.

The entire system is built and configured at the Dell EMC factory according to the proven and tested best practices. In addition to the unmatched performance, scalability and performance, customer also enjoy one call support for all the components and end-to-end lifecycle management through a proven Release Certification Matrix (RCM) all components.

2.1.1 VxFlex OS

- VxFlex OS is a software defined block storage that uses servers' local disks and LAN to create a virtual SAN that has all the benefits of external storage. The software is purpose-built to deliver ultimate performance, data reliability, and scalability. The multiple-deployment options, on-demand scale capability, multi hypervisor support, and resilience make it suitable for virtually all type of workloads.
- VxFlex OS consists of three primary components: Meta Data Manager (MDM), Storage Data Client (SDC) and Storage Data Server (SDS).
- The MDMs work as brain of the system and are responsible for managing meta data and core functions such as rebalance and rebuild. A VxFlex OS cluster has multiple MDMs deployed as master, slaves, standby, and tiebreakers to ensure high availability. At a given point, a VxFlex OS cluster has one master, one or two slaves, and one or two tiebreaker MDMs. Optionally, it can have up to 10 standby MDMs.
- The SDC runs like an agent or daemon on a server and act like an HBA to connect to storage cluster to consume the storage needed for the application workload. The SDCs are installed on the same server that is running the application workload.
- The SDSs are daemons that contribute the storage to the storage cluster. An SDC is mapped to a primary SDS and it communicates with it directly. When an SDC gets an I/O request from the application, it sends the request to its primary SDS. In case of read operation, the primary SDS already has the data block so the read request is served directly by the primary SDS. If the I/O is a write, then the primary SDS first writes the block to its disks and the same time it writes a secondary copy of the data to any other SDS in the cluster. The other SDS becomes the secondary SDS for that

data block. Once the secondary copy is written, the primary SDS sends an acknowledgement to the SDC and that completes the I/O request.

- VxFlex OS has an efficient decentralized block I/O flow, which is combined with a distributed, sliced volume layout. This design results in a massively parallel I/O system that can scale up to thousands of nodes.
- VxFlex OS offers multiple deployment options to take the flexibility of an engineered system to next level.

You can deploy VxFlex OS in the following ways:

- Two-layer
- Hyperconverged
- Hybrid

The two-layer approach is where the SDS and SDC components are on two different nodes chassis. The following figure illustrates the two-layer deployment of VxFlex OS.

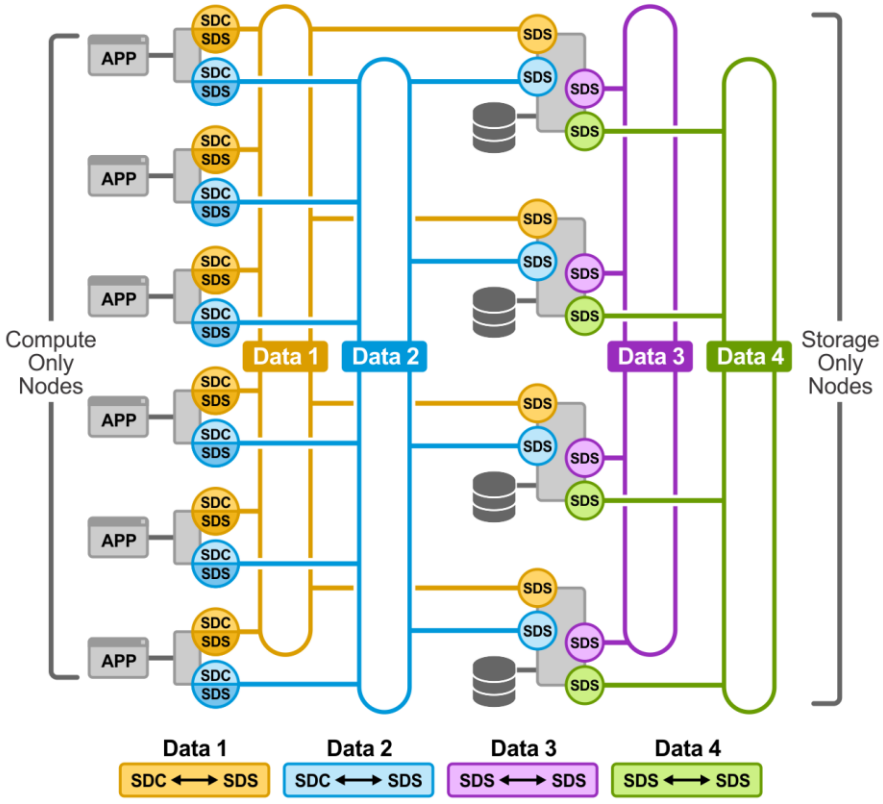

Figure 3 VxFlex OS two-layer deployment

The hyperconverged approach is where the SDS and the SDC reside on the same node chassis. In this type of deployment, the applications can reside on the same node.

The following figure Illustrates the hyperconverged deployment of the VxFlex OS.

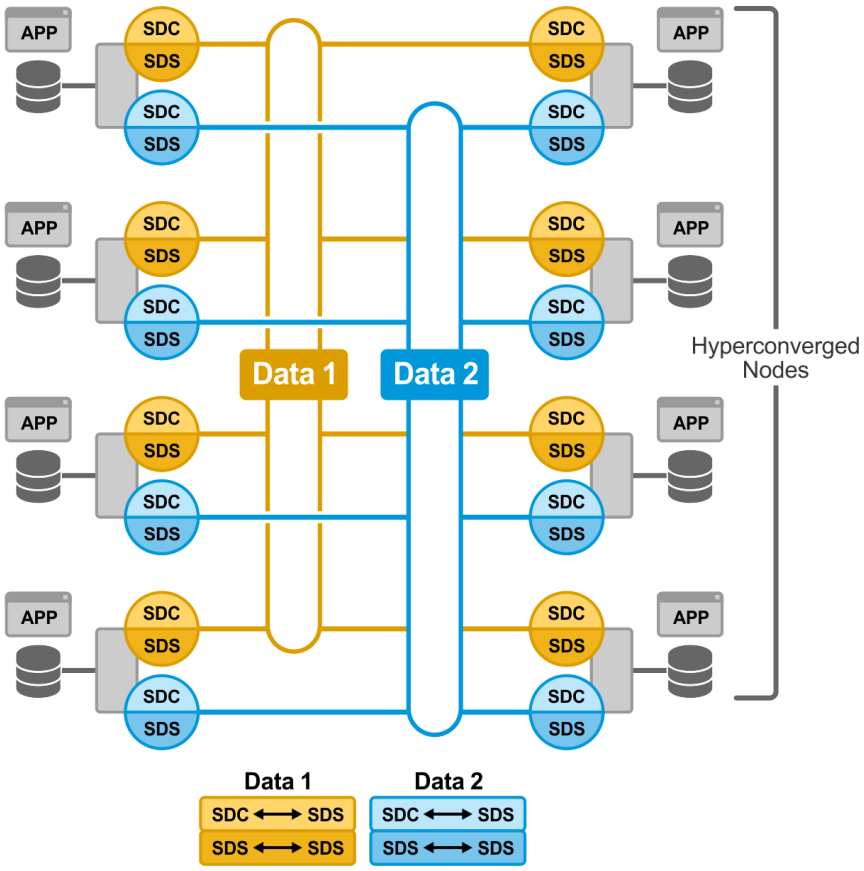

Figure 4 VxFlex OS hyperconverged deployment

A combination of these two modes is also common and is referred to as a hybrid deployment. In this case the system has some nodes running only the SDC, some running only the SDS, and others that run both at the same time.

The following figure illustrates the hybrid deployment of VxFlex OS.

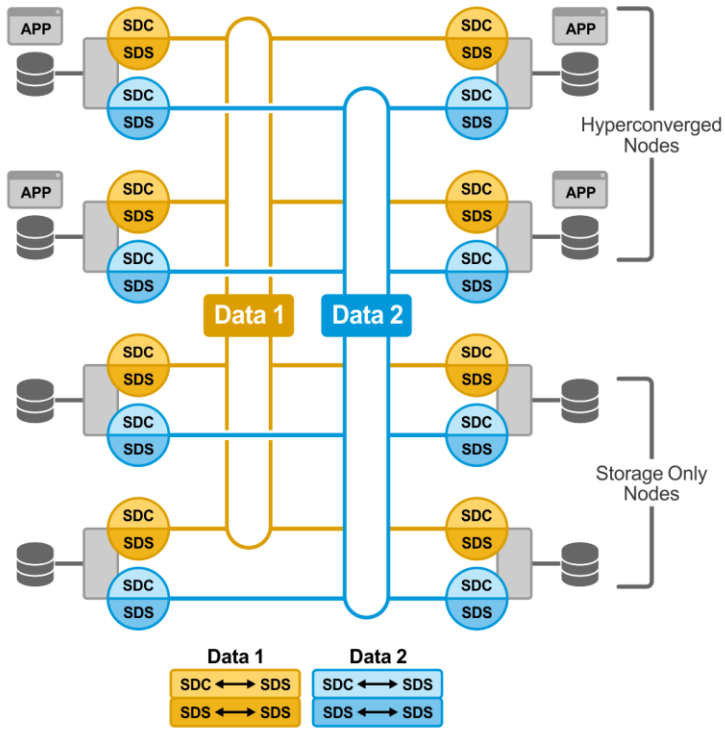

Figure 5 VxFlex OS Hybrid deployment

For this paper, the **hyperconverged** deployment option is taken in to consideration and the following sections describe the configuration.

2.1.2 VxFlex Manager

VxFlex Manager is a VxFlex integrated rack Management and Orchestration (M&O) tool that provides a single pane of glass for provisioning, managing, monitoring, alerting, life cycle management, and reporting. It increases efficiency by reducing time-consuming manual operations that are required to implement, provision, and manage operations for your VxFlex integrated rack. Through automation, you can deploy and manage operations for your VxFlex integrated rack.

Using VxFlex Manager, you can:

- Quickly discover and inventory nodes in your VxFlex integrated rack deployment
- Grow or shrink the VxFlex integrated rack environment by adding or removing nodes
- Run your VxFlex integrated rack aligned to IT operations management practices
- Monitor, alert, report, and troubleshoot technical issues

2.2 Microsoft SQL Server 2016

With SQL Server 2016, you can build intelligent, mission-critical applications using a scalable, hybrid database platform that has everything built in, from in-memory performance, and advanced security to in-database analytics. The SQL Server 2016 release adds new security features, querying capabilities, Hadoop and cloud integration, R analytics and more, along with numerous improvements and enhancements.

The following table shows key features that are new or enhanced in SQL Server 2016:

Table 1 SQL Server 2016 features

Feature	Description
Faster results	SQL Server 2016 has made improvement in delivering faster results. Faster results are being achieved by having significant achievement in In-memory OLTP, In-Memory Analytics, and analysis services.
Increased security	The three new features that are introduced in SQL Server 2016 are Always Encrypted, Row Level Security, and Dynamic Data Masking.
Seamless data integration	SQL Server 2016 facilitates access to diverse types of data, which includes integration between relational, unstructured, and semi-structured data.
SQL Server Azure	All Azure SQL databases come standard with high availability and a minimum of three replicas. Azure SQL database has come close to par with on-prem SQL Server databases.
Reporting service enhancements	SQL Server 2016 has a better development environment for reporting with more data visualization. Reports are compatible with mobile as well and a new environment for mobile reports is supported.
Better High Availability (HA)	SQL Server 2016 has made significant improvements to availability groups in this version.

For information about new features in SQL Server 2016, see What's new in SQL Server 2016.

3 Solution architecture

To demonstrate the deployment of SQL Server 2016 in brief, we used four VxFlex integrated hyperconverged nodes deployed running ESXi. This is the minimum configuration for a VxFlex integrated rack set up.

Note: Dell EMC does not recommend running a production SQL Server environment with four VxFlex integrated rack nodes. You must have a minimum of 8 nodes for best price and performance.

In our lab environment for this paper, for the compute side, we created one VM on each host (16 vCPU and 64 GB RAM). For the storage side, from the tests perspective we created a protection domain using the 4 hosts. The solution architecture of the VxFlex integrated rack system for a protection domain that had 4 nodes used for testing along with key components is shown in following figure.

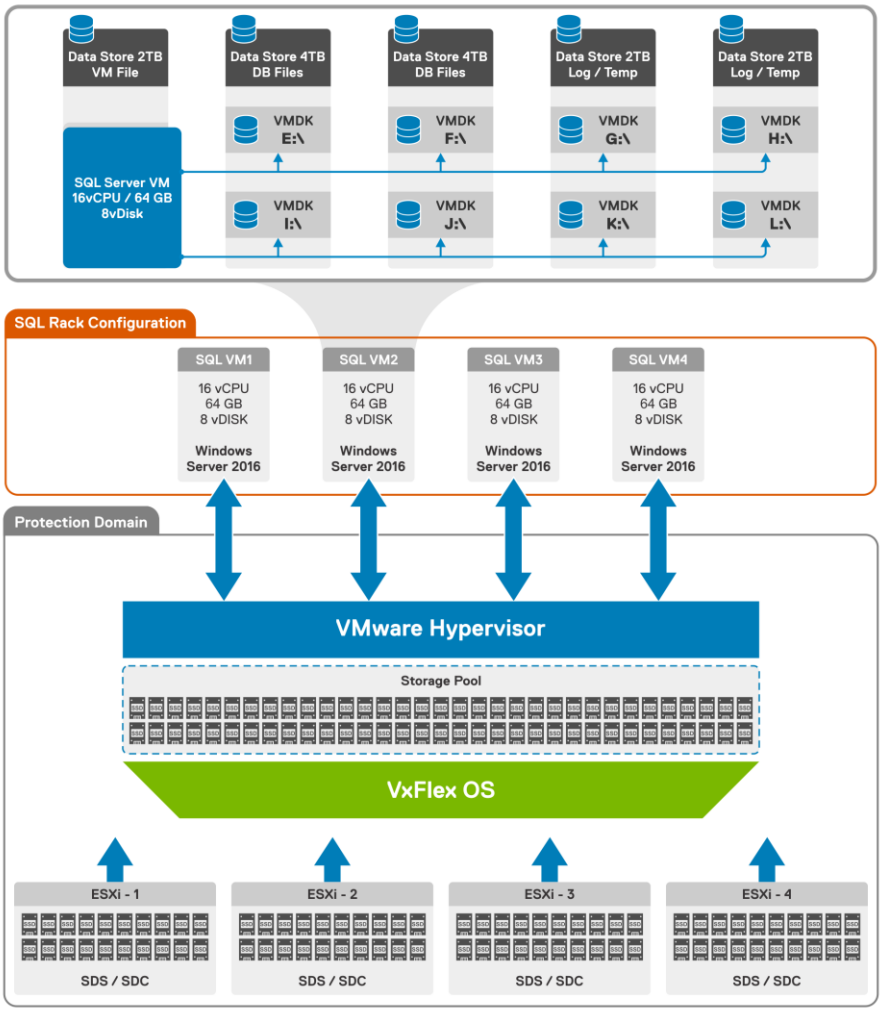

Figure 6 VxFlex integrated rack logical architecture

3.1 Networking layout

The VxFlex integrated rack cluster was deployed using VxFlex Manager, which incorporates standard best networking practices for deployment. Figure 7 provides a high-level overview of the physical connectivity of VxFlex integrated rack components with Cisco Nexus 93180YC-EX switches and VxFlex R640 nodes. The VxFlex integrated rack nodes support 25 GB connectivity.

Table 2 VxFlex integrated rack networking details

Components	Description
Data and management network	25-GbE switch
VxFlex integrated rack internode connection (VM traffic)	25-GbE switch
iDRAC inband network	1-GbE switch;
Cabling	CAT6 coaxial and 10G twin axial
TOR	Top of Rack switch
Aggregation	A Layer-2 aggregation switch is just a switch that provides connectivity for several other Layer-2 switches.

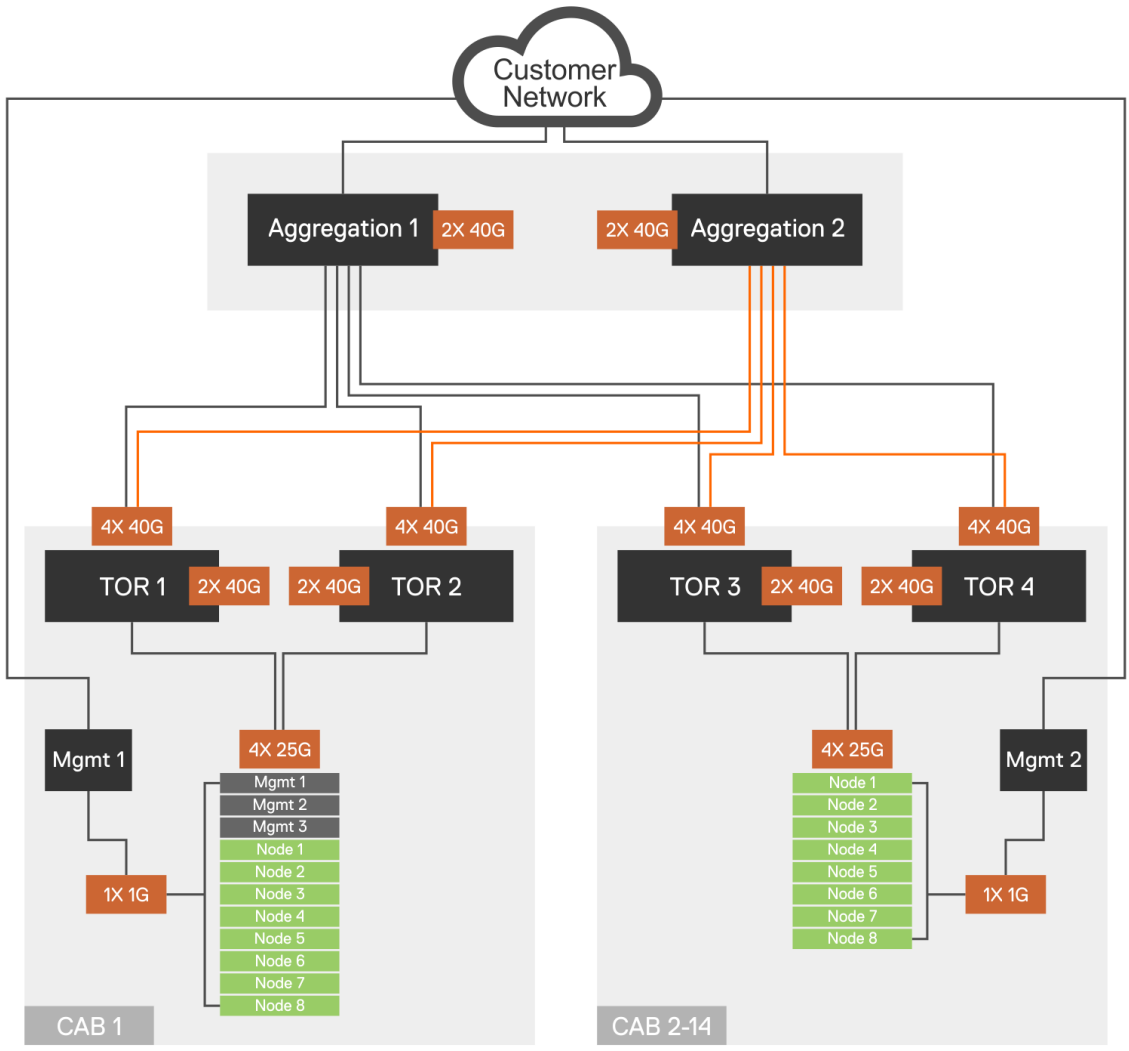

Figure 7 VxFlex integrated rack – Networking details

3.2 Storage layout

From VxFlex OS standpoint, there was a single VxFlex OS cluster with a protection domain, each consisting of 4 ESXi hosts. Each host had 10 disks and was fully populated with 1.7 TB SSD Toshiba disks. The cluster had 40 disks in all.

From the available 40 disks within the storage pool from a single protection domain, different volumes were carved out. These volumes were mapped to the SQL VMs and used to carry out the basic IO characterization disks test: OLTP test with SQL and DSS test with SQL.

For more information about the VxFlex integrated rack configuration, see Appendix: VxFlex integrated rack cluster details.

3.3 SQL database layout

The SQL Server 2016 was running on Windows Server 2016 guest VMs.

The SQL Server virtual machine consists of 16 virtual CPUs, 64 GB RAM, and thin-provisioned disks in the layout described in Table 3.

Table 3 SQL layout

Disk size (GB)	Drive	Disk purpose
90 GB	Drive C:	Windows operating system disk
100 GB	Drive D:	Database disk 1
102 GB	Drive E:	Database disk 2
104 GB	Drive F:	Database disk 3
106 GB	Drive G:	Database disk 4
150 GB	Drive H:	DB Log 1
150 GB	Drive L:	DB Log 2
120 GB	Drive T:	Temp DB Log

After the drives are provisioned, the SQL Server data and log drives were formatted with a 64 KB NTFS cluster size. This size optimizes I/O performance with no overhead and offers a good balance between flexibility, performance, and ease of use. The operating system and the SQL binary drives use the standard 4 KB NTFS cluster size.

4 Best practices

The following sections outline the best practices followed in this solution.

4.1 VxFlex integrated rack best practices

- Minimum number of nodes for production workload is 8.
- Homogenous node types are recommended for predictable performance.
- Maximum number of devices in a storage pool is 300.
- Recommended maximum number of nodes in a protection domain is 32.
- Change the passwords for all default accounts.
- To remotely access VxFlex integrated rack nodes, use secure communication – HTTPS (TCP port 443).
- Ensure VxFlex integrated rack system is compliant to an RCM

4.2 VxFlex OS best practices

- Configure high-performance profile for MDM, SDS, and SDC.
- Disable Read Flash Cache and Read RAM cache for all flash clusters.
- To improve I/O concurrency, check with VxFlex integrated rack platform team to increase the per device queue length value to 256 per host.
- Ensure that the customize power plan is set to High Performance.

4.3 VxFlex integrated rack network best practices

- Confirm with VxFlex integrated rack platform team to enable Jumbo frames for Windows VM, SVM, and at ESXi host.
- The Paravirtual SCSI (PVSCSI) controller should be used on guest VMs for high performance.
- Enable secure network protocol options only (for example, HTTPS and Secure Shell (SSH).
- Avoid autonomous certificate deployments to ones that are fully integrated with site trust infrastructures and train people to not accept self-signed certificates.
- Separate management and control traffic from production application traffic. You can provide this separation by using VLANs.
- According to VxFlex integrated rack standard, separate VMware vSphere vMotion traffic from production traffic.

4.4 SQL Server best practices

The following best practices were used for the standard version of SQL Server 2016 VM configurations:

General:

- Perform a current state analysis to identify workloads and sizing.
- Start with a proof of concept, and then test, optimize, iterate, and scale.

Drive configuration:

- Distribute databases and logfiles across multiple VMDKs.
- Distribute vdisks across four SCSI controllers.
- Use 64-KB NTFS allocation for database and log drives.

- Size for at least 20 percent free disk space on all drives.
- Create drives of slightly different sizes.

SQL Server datafiles:

- Split each database into multiple files: one file per vCPU.
- Size database files equally.
- Enable Autogrow in 256 MB or 512 MB increments to start.
- Do not shrink databases as it causes severe Index fragmentation.

SQL Server logfiles:

- Under most circumstances, one log per database (including TempDB) should be enough.
- Log files fill sequentially, so extra files do not increase performance.

Temp database:

- Use multiple TempDB files, all the same size.
- Do not autogrow TempDB files.
- If cores < 8, the number of TempDB files = cores.
- If cores > 8, start with eight TempDB files and monitor for performance.
- Size TempDB 1 at 10 percent of database size.
- One TempDB drive should be enough for most environments.

RAM:

- More RAM can increase SQL database read performance.
- Configure SQL Server maximum memory per previous section guidance.
- Size each VM to fit within a NUMA node's memory footprint.

vCPUs:

- Do not over allocate vCPUs to VMs.
- At virtual level, 1 socket has 8 CPU cores

5 Conclusion

This paper demonstrates how you can deploy SQL Server 2016 on VxFlex integrated rack to meet performance, resiliency and scale. In addition, it states the best practices for deployment of VxFlex integrated rack, and SQL Server 2016.

Very common workloads like SQL are best suited for VxFlex integrated rack to achieve optimal and fast performance.

Table 4 Benefits of SQL Server 2016 VM on VxFlex integrated rack

Feature	Description
Modular incremental scale	The VxFlex integrated rack has four nodes to begin with and can easily scaled as needed. The VxFlex integrated rack can scale unprecedently up to 1000 nodes with 100s-PB of Storage
High performance	For a common workload like SQL Server, VxFlex integrated rack storage delivers low latency with very high number of TPMs when tested in a controlled environment. This shows SQL Server performs at its best when deployed on to VxFlex integrated rack
VxFlex OS GUI	The VxFlex OS enables ease of creating volumes, shows the different statistics of the SDS and SDC during real time making it possible for the users to monitor performance of SQL VMs and take any relevant decisions.
VxFLEX Manager	This tool enables users to create and deploy a VxFlex integrated rack cluster along with VxFLEX OS deployment very quickly. SQL VMs can then be provisioned, and overall deployment time is drastically reduced.
VxFlex integrated rack configuration options	Since there are different configuration options to set up VxFlex integrated rack, it gives a great flexibility to the user to set up based on his choice and get the performance as per need.

6 Technical support and resources

6.1 Related resources

See the following referenced or recommended resources that are related to this document:

Note: The following links are open to customers although some may require registration for access.

- VxFlex OS blog
- VxFlex integrated rack Datasheet
- Microsoft Diskspd
- Hammer DB
- SQL Server

6.2 Additional resources

Referenced or recommended publications:

Dell.com is focused on meeting customer needs with proven services and support.

Dell EMC Technical Resource Center on DellEMC.com provides expertise that helps to ensure customer success on Dell EMC VxFlex integrated rack platforms.

A Appendix

A.1 VxFlex integrated rack cluster details

The following table summarizes the software resources that were used to carry out the performance tests.

Table 5 Software resources

Resource		Version	Purpose
Dell EMC Software	VxFlex OS	2.6.0.1	VxFlex OS software solution to create virtual SAN
VMware software	VMware ESXi server	6.5	VMware hypervisor
	VMware vCenter	6.5	VMware management
Microsoft software	Microsoft Windows Server	2016	Application virtual machine operating system
	Microsoft SQL Server	2016 Standard Edition (SP2)	Database Servers