

# Microsoft SQL Server 2019 Disaster Recovery Solution on Dell EMC PowerFlex family

## Abstract

This white paper highlights the design consideration of disaster recovery for SQL Server 2019 database with Always On feature on PowerFlex family.

October 2020

## Revisions

Date	Description
March 2020	Initial release
October 2020	Rebranded to PowerFlex terminologies

## Acknowledgements

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## Executive summary

In today's enterprise database environments such as SQL Server 2019, organization demand un-interrupted operations with minimum downtime and SLAs. The hyperconverged infrastructure platform facilitates improved flexibility, productivity, performance, protection, and ease of infrastructure management.

Dell EMC PowerFlex family provides a foundation that combines compute as well as high performance storage resources in a managed unified fabric. PowerFlex comes in flexible deployment options - rack, appliance or ready nodes - that enable two-layer (compute & server SAN), single-layer (HCI), and/or storage only architectures.

This white paper briefs about SQL Server 2019 Disaster Recovery (DR) solution using Always On availability group on PowerFlex family. SQL Server Always On feature offers comprehensive high availability and disaster recovery solutions.

# 1 Introduction

Modern data center workloads have varying business value and characteristics for the workload and data that govern 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. PowerFlex family is an engineered system for Dell EMC designed on five super power principals to meet the key infrastructure requirements. PowerFlex delivers:

- Unmatched performance.
- Unprecedented scale (1000 nodes and 100s-PB storage capacity).
- Built in redundant hardware components and PowerFlex mesh mirror architecture delivers unparalleled resiliency.
- Infrastructure flexibility: PowerFlex is second to none. A PowerFlex family 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.

## 1.1 Objective

This white paper demonstrates in detail about achieving SQL Server 2019 DR on PowerFlex family using Always On feature.

## 1.2 Audience

This document is intended for decision makers, business leaders, architects, cloud administrators, SQL Server database administrators, hyperconverged infrastructure administrators, and technical administrators of IT environments responsible for deployment of SQL Server databases on Dell EMC PowerFlex family with ESXi hypervisors.

The reader of this document must have a working knowledge of Dell EMC PowerFlex family, VMware vSphere technologies, Microsoft SQL Server technologies, and should have a basic familiarity with storage, compute, and network technologies and topologies.

## 1.3 Terminology

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

Table 1 Terms and definitions

<b>Term</b>	<b>Definition</b>
MDM	Meta Data Manager
SDS	Storage Data Server
SDC	Storage Data Client
SVM	Storage Virtual Machine
OS	Operating System
RCM	Release Certification Matrix
SSD	Solid-State Drive
IaaS	Infrastructure as a Service
PaaS	Platform as a Service
BaaS	Anything as a Service
RAC	Real Application Clusters
ASM	Automatic Storage Management
DAS	Direct Attached Storage
DR	Disaster Recovery
SSMS	SQL Server Management Studio
WSFC	Windows Server Failover Cluster
DDL	Data Definition Language
DML	Data Manipulation Language

## 2 Product overview

### 2.1 PowerFlex family

PowerFlex is a software-defined storage platform designed to significantly reduce operational and infrastructure complexity, empowering organizations to move faster by delivering flexibility, elasticity, and simplicity with predictable performance and resiliency at scale. The PowerFlex family provides a foundation that combines compute as well as high performance storage resources in a managed unified fabric. PowerFlex comes in flexible deployment options - rack, appliance or ready nodes - that enable two-layer (compute & server SAN), single-layer (HCI), and/or storage only architectures. PowerFlex is ideal for high performance applications and databases, building an agile private cloud, or consolidating resources in heterogeneous environments.

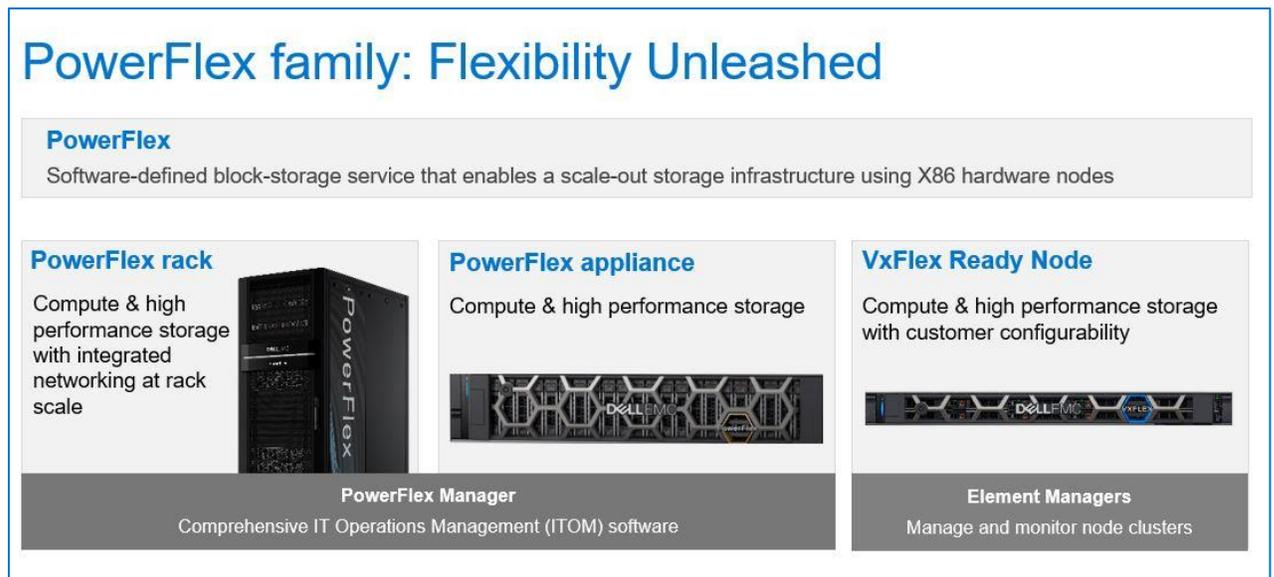


Figure 1 PowerFlex family

### 2.2 PowerFlex software components

Software is the key differentiation and the “secret sauce” in the PowerFlex offering. The PowerFlex software components not only provide software-defined storage services, they also help simplify infrastructure management and orchestration with comprehensive ITOM and LCM capabilities that span compute as well as storage infrastructure, from BIOS and firmware to nodes, software and networking.

The core foundational component in the PowerFlex family that enables Software Defined Storage (SDS) services is called PowerFlex, to represent the core value it enables for the platform. Additionally, PowerFlex Manager is a comprehensive IT Operational Management (ITOM) and Life Cycle Management (LCM) tool that drastically simplifies management and ongoing operation.

## 2.2.1 PowerFlex

PowerFlex (**previously VxFlex OS**) is the software foundation of PowerFlex software-defined storage. It is a scale-out block storage service designed to deliver flexibility, elasticity, and simplicity with predictable high performance and resiliency at scale.

PowerFlex consists of the following components:

### **Storage Data Client (SDC)**

- Provides front-end volume access to applications and file system
- Installed on servers consuming storage
- Maintains peer-to-peer connections to every SDS managing a pool of storage

### **Storage Data Server (SDS)**

- Abstracts local storage, maintains storage pools, and presents volumes to the SDCs
- Installed on servers contributing local storage to the PowerFlex cluster

### **Meta Data Manager (MDM)**

- Oversees storage cluster configurations, monitoring, rebalances, and rebuilds
- Highly available, independent cluster installed on three or five different nodes
- May reside alongside SDCs or SDSs, or on separate nodes
- Sits outside the data path

### **Gateway**

- Performs installation and configuration checks
- Acts as an endpoint for API calls and passes them to MDM

## 2.2.2 PowerFlex Manager

PowerFlex Manager is the software component in PowerFlex family that enables ITOM automation and lifecycle management capabilities for PowerFlex systems.

## 2.3 PowerFlex deployment architectures

PowerFlex software-define storage offers flexibility of deployment architecture to help best meet the specific deployment and architectural requirements. PowerFlex can be deployed in a two-layer (Server SAN), single layer (HCI), or in storage-only architectures.

### 2.3.1 Two-layer architecture

In two-layer architecture, nodes that provide storage capacity and host datasets are separated from nodes that host applications and workloads. PowerFlex manager provides LCM and IOTM for the entire infrastructure, including nodes that provide storage and nodes that host the applications. Compute and storage resources can be scaled by adding respective node to the cluster. This segregation of compute and storage resources can be helpful to minimize software licensing costs in certain situations. This architecture could be most suitable for hosting high-performance high-value databases and application workloads.

## 2.3.2 Single-layer (HCI) architecture

In this architecture, each node in the cluster contributes storage resources as well as hosts applications and workloads. This architecture allows you to scale your infrastructure uniformly and with a pre-defined building block that adds both storage and compute resources. PowerFlex Manager provides ITOM and LCM capabilities for the entire infrastructure. This architecture is most suitable for datacenter and workload consolidation.

For this paper, PowerFlex rack with **hyperconverged** deployment is considered.

## 2.3.3 Mixed architecture

Using PowerFlex storage-only nodes, a software-defined block storage environment is created that can be accessed and consumed by a number of applications and workloads that are hosted outside of PowerFlex cluster. PowerFlex Manager provides LCM and ITOM for the storage infrastructure. This is a suitable architecture where customer has existing compute infrastructure but needs high-performance SDS. This can be a starting point with the customer and may expand to a two-layer Server SAN deployment in the future as the external compute is migrated to PowerFlex.

## 2.4 SQL Server 2019

With SQL Server 2019, you can build intelligent, mission-critical applications using a scalable, hybrid database platform that has everything that is built in, from in-memory performance, and advanced security to database analytics.

**The following are the new features that are provided by SQL Server 2019 release:**

- Mission-critical security using Always Encrypted with secured enclave.
- Improved High Availability.
- Data virtualization with Kubernetes Orchestration.
- Intelligent database with In-Memory database, intelligent query processing, and performance.
- Improved developer experience and monitoring capabilities.
- Provides flexibility to choose platform of your choice with Linux and Container support.

### 2.4.1 Always On availability groups

SQL Server Always On is a feature that is available from SQL Server 2012 onwards. This feature enables to build comprehensive high availability and disaster recovery solutions through Always On availability groups.

Always On availability groups maximize the availability of the SQL server instances and databases. This can be accomplished by having single or group of primary databases on one node and multiple copies of secondary databases on the other nodes. Each of the nodes participating in availability group must be part of Windows Server failover cluster (WSFC).

Availability group can be configured in two modes:

- Asynchronous-commit mode
- Synchronous-commit mode

An availability group listener is a virtual network name (VNN), configured in order to connect all the clients to databases from primary or secondary replicas. This helps in faster application failover during database failover in availability groups.

## 2.4.2 Always On availability group with SQL Server 2019

SQL Server 2019 supports following enhanced features for Always On availability group:

Table 2 SQL Server 2019 feature for Always On availability group.

Feature	Description
Up to nine availability replicas	Each availability group can support up to eight secondary replicas, with up to three synchronous-commit replicas.
Several forms of availability-group failover	Supports several forms of availability-group like failover like automatic failover, manual failover and forced failover.
Flexibility	Supports availability group Listener for each of the configured availability group with flexible failover policies and automatic page repair against page corruption.
Improved performance and security	Supports encryption and compression with high performing transport.
Enhanced set of tools	Provides improved integrated set of tools for better management of availability groups with advanced SSMS and Transact-SQL.
New Software Assurance benefits for Always On	SQL Server 2019 with new improved Software Assurance provides a robust business continuity plan with lower total cost of ownership (TCO).

## 2.4.3 Distributed availability group

Distributed availability group is an availability group that span two availability groups which can be in different locations, that is running on a physical or virtual environment, on-premises or public cloud, or anywhere that support SQL Always On feature. The distributed availability group can have maximum of eighteen replicas, nine replicas from each availability group. It is important to configure the listener for each of the participating availability group, because distributed availability group is configured using listener details of the availability groups it spans.

For more information about SQL Server 2019, Always On availability group and Software Assurance, see [Technical support and resources](#).

### 3 SQL Server 2019 DR solution architecture

This section outlines the implementation of SQL Server 2019 Always On availability group across two PowerFlex clusters that are built on different PowerFlex racks that are connected using LAN. Two PowerFlex racks were used as primary data center and the DR data center, to simulate the real-time scenario.

The availability group was created using four SQL Server replicas. First stand by replica was configured in sync mode, to achieve the high availability and load balancing. Second and third replicas from DR data center were configured in async mode, to achieve the DR. Two replicas in the DR data center were used to achieve HA and load balancing during the event of DR.

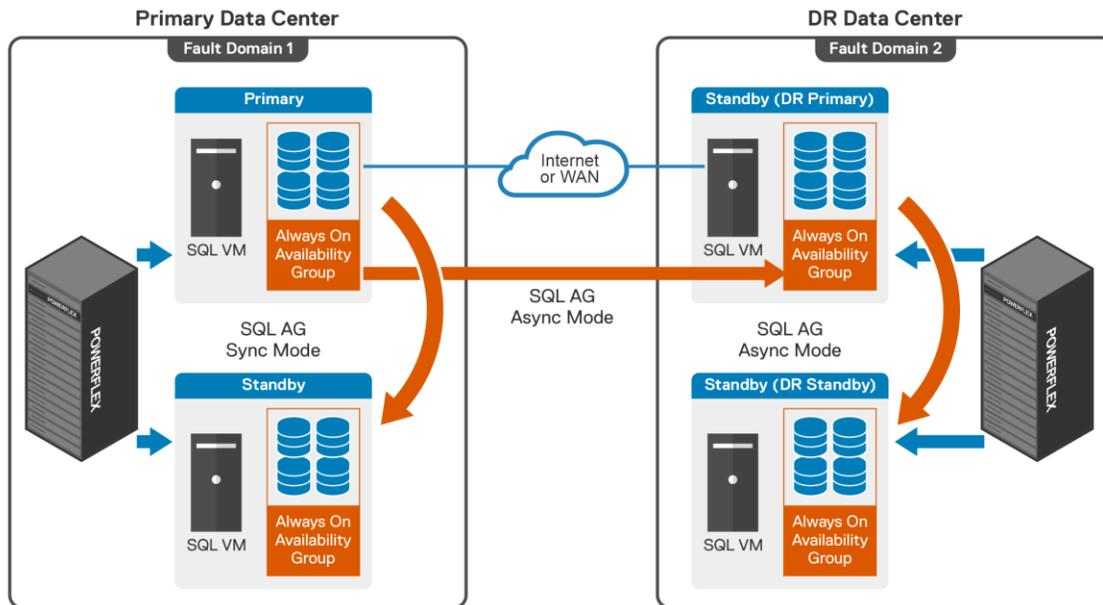


Figure 2 PowerFlex family with SQL Server 2019 Always On Availability group

#### 3.1 PowerFlex family cluster components

The SQL Server 2019 DR solution was built on hyperconverged infrastructure platform-based Dell EMC PowerFlex family. The PowerFlex family HCI system is configured with ESXi 6.7 hypervisor for compute and network and PowerFlex for software-defined storage.

Two PowerFlex clusters were built on two PowerFlex rack systems as a primary data center and DR data center. Each of the PowerFlex cluster was built using four PowerFlex nodes. Each PowerFlex family node has a Dell EMC Storage virtual machine (SVM) running on it, providing both storage clustering and storage services. For configuration details of PowerFlex nodes that were used, see [PowerFlex family cluster details](#).

### 3.1.1 PowerFlex storage

In PowerFlex family with VMware vSphere 6.7 environment, the MDM, and SDS components were installed on a dedicated SVM, whereas the SDC was installed directly on the ESXi host. The PowerFlex back-end storage consists of four SDS systems. The Storage Data Server (SDS) aggregates and serves raw local storage in a given node and shares that storage as part of PowerFlex cluster.

A single protection domain was carved out of the SSDs on these four SDS systems. A single storage pool was configured, and multiple logical volumes were created to meet the SQL Server database requirements including volumes for data, log, and backup. These volumes were mapped to the ESXi cluster and added as a datastore and later mapped as disks drive to SQL Server virtual machine using VMware Paravirtual SCSI (PVSCSI) adapters.

### 3.1.2 Virtual machine

Four identical VMs were created, two VMs on primary data center and two VMs on DR data center respectively. Each of these VMs were installed with Windows 2019 server as guest operating system. Drives were mounted and created using NTFS 64KB block size. All necessary file system was created on both the windows VMs as per SQL Server best practices suggested for PowerFlex family systems. For details, see [Best practices](#).

The configuration details of the VMs are listed in [Virtual machine details](#).

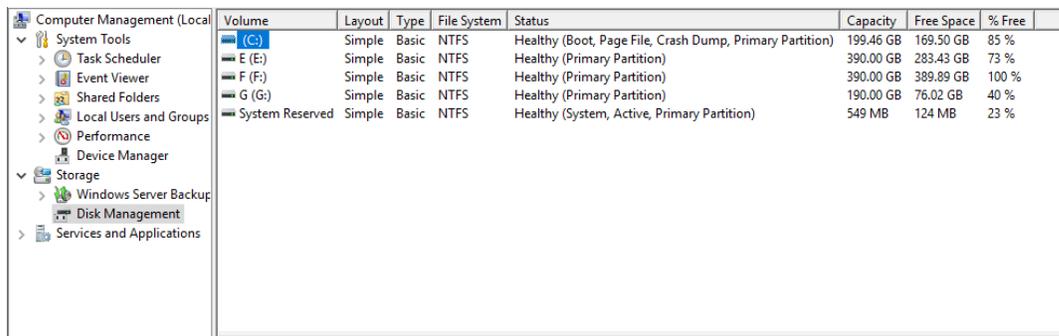


Figure 3 Windows VM disks and file structure

SQL Server 2019 Enterprise Edition was installed, and single instance SQL Server systems were created on each of the four VMs. A user database was created on primary SQL instance with datafile and logfiles as listed below:

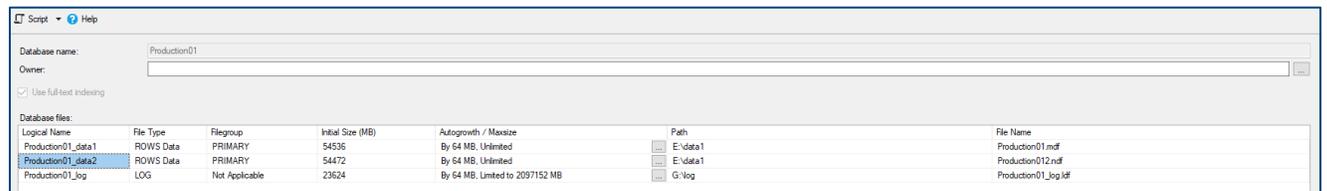


Figure 4 SQL Server 2019 database data and log file structure.

**Note:** SQL Server different editions have different maximums for number of replicas and additional capabilities. For more details, see [Technical support and resources](#).

## 3.2 PowerFlex network design

The following figure demonstrates high-level network architecture for design of SQL Server 2019 DR solution on PowerFlex family HCI system:

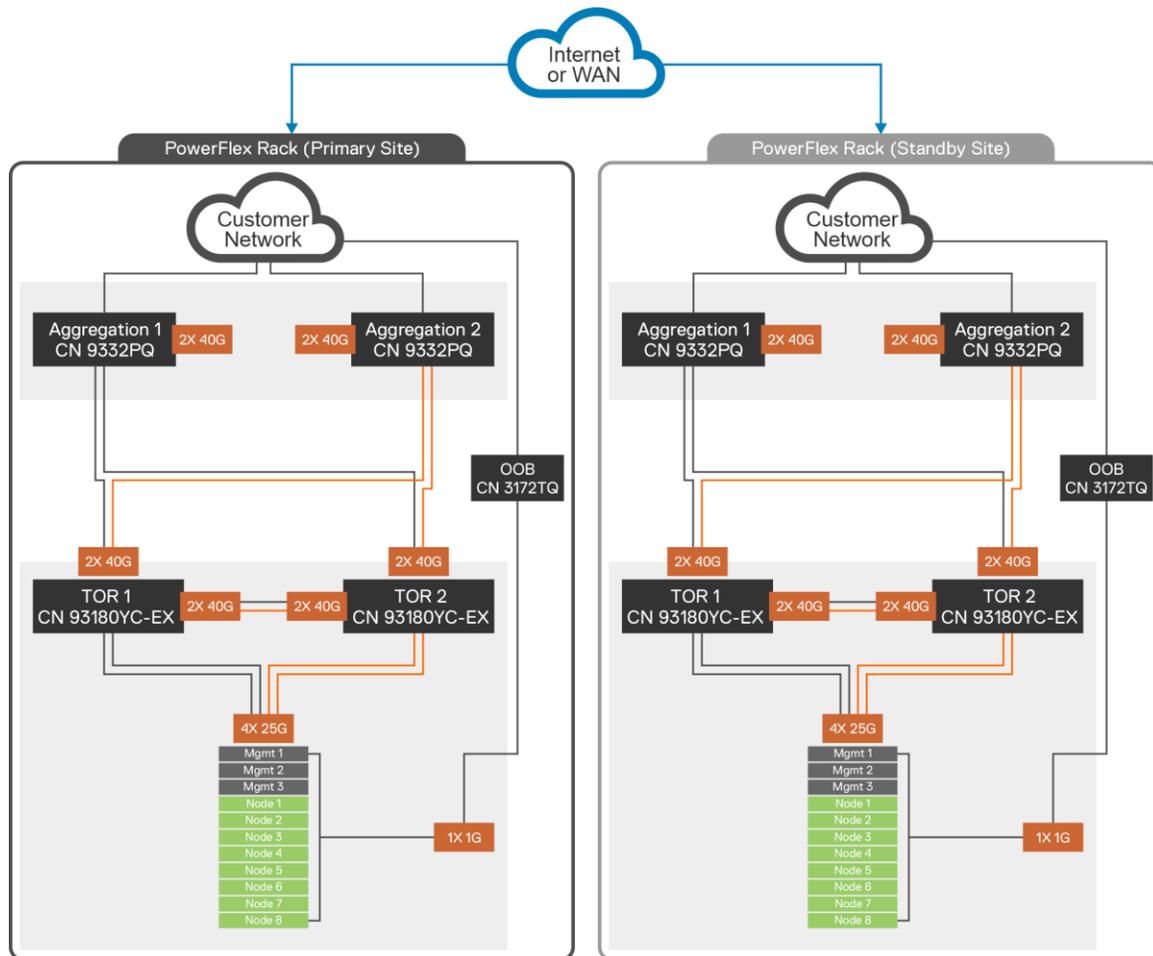


Figure 5 Network architecture

### Architecture flow

- PowerFlex family uses a pair of Cisco Nexus 93180YC-EX as TOR switches.
- PowerFlex family uses a pair of Cisco Nexus 9332PQ as Aggregation switches.
- Cisco Virtual Port Channel is configured between the TOR and Aggregation switches.
- Cisco Nexus 3172TQ switch is used for OOB traffic with 1 GbE dedicated network.
- Each node consists of four 25 GbE ports, two ports connected to each TOR (Cisco Nexus 93180YC-EX) switch.
- Both TOR (Cisco Nexus 93180YC-EX) switches have uplinks to aggregation (Cisco Nexus 9332PQ) switches for redundancy and network bandwidth aggregation.
- Both primary data center and DR data center were connected through LAN.
- Ensure to have isolated vLAN for public and private communication.
- For isolation of Always On replication traffic from regular traffic, it is recommended to use an additional dedicated vLAN.
- For network configurations details, see PowerFlex networking details.

### 3.3 DR solution prerequisites

The SQL Server DR solution on PowerFlex family was configured and built by following SQL Server recommended guidelines. The following are the pre-requisites for every VM in PowerFlex cluster participating in SQL Server DR with Always On availability group:

Table 3 Prerequisites for SQL Server DR solution using availability group.

Type	Prerequisites
Operating System	Ensure operating system installed, updated, and configured on all participating nodes are of the same version.
SQL Server Version	Ensure all the participating nodes in an availability group are of the same version. Always On availability groups are only supported in Enterprise Edition, starting from SQL server 2012. Only SQL Server 2016 standard edition is an exception to this as it supports basic availability group.
WSFC	All the SQL Server nodes that are participating in the availability group should be part of the single Windows Server Failover Cluster.
Windows Domain	Recommended to create dedicated domain user account for SQL Server service account. All the replicas in an availability group should be in same windows domain. Ensure that windows domain and active directory are configured as per the SQL server Always On guidelines.
Windows firewall	This must be set to allow the communication between each of the replicas in the availability group.
PowerFlex family cluster	Ensure that enough disk space and hardware resources are available on standby instances. Data synchronization fails if disk runs out of space. Enough hardware resource at standby instance ensures that it can handle the same workload as primary instance during the failover.

Follow SQL Server recommended guidelines while configuring Always On availability groups. For more details, see [Technical support and resources](#).

### 3.4 Solution design

PowerFlex family-based SQL Server DR solution was built by creating an availability group using Always On. This availability group was created using four replicas, two replicas from primary data center and two replicas from DR data center with one user database. All the SQL Server instances were configured on same windows domain and were part of one WSFC. Active directory users were created for each replica and used for SQL Server service account.

The availability group was created with sync mode for first replica to achieve high availability within the primary data center. And async mode for third and fourth replicas from the DR data center to achieve SQL Server DR. SQL Server AUTO\_SEEDING option was used to seed all three standby replicas. Initially the standby SQL Server instances were not having any user database in it. Once availability group was created, user database in the primary SQL Server instance was copied and created in standby SQL Server instances. There after the data were synchronized from primary replica to all three standby replicas created with SEEDING\_MODE=AUTOMATIC.

The following figure illustrates solution architecture diagram of the setup used:

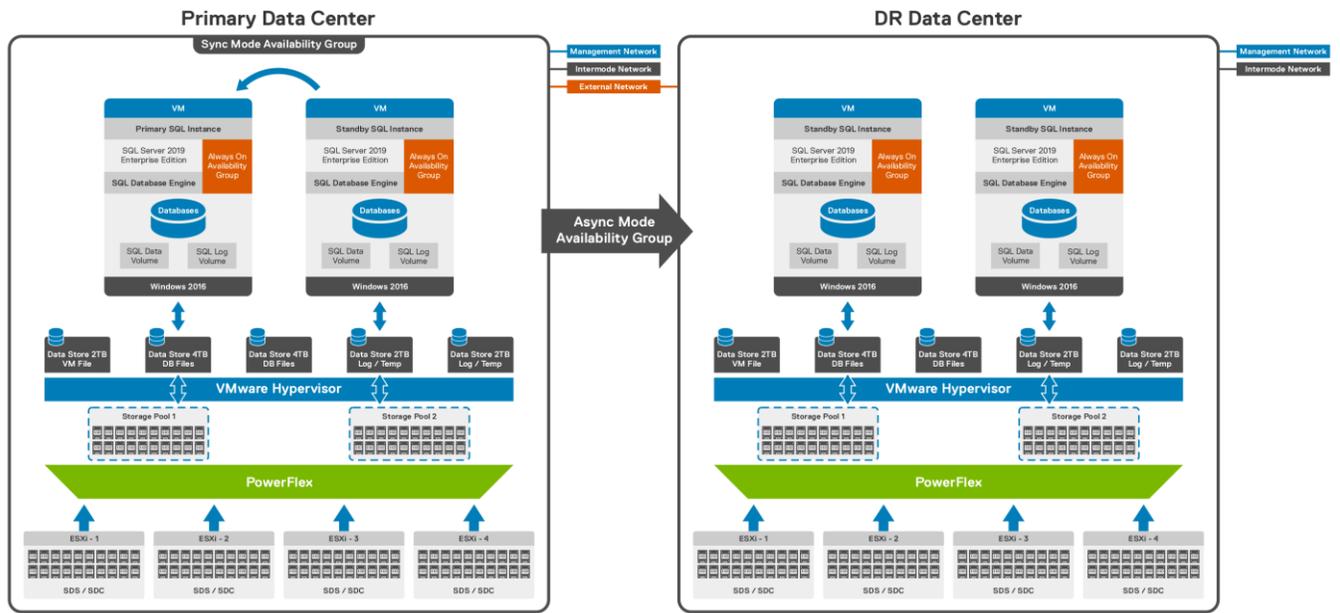


Figure 6 Solution architecture for SQL Server 2019 DR using Always On availability group on PowerFlex family.

## 4 SQL Server 2019 DR procedure and validation

SQL Server DR solution for PowerFlex family was built using Always On availability group. This solution was built using four replicas and an availability group. The availability group was created with one primary and three standby replicas, with one standby replica from primary data center and two standby replicas from DR data center.

The real-time OLTP like workload was created on a single user database. The solution was then validated by simulating primary replica failure, VMware vSphere vMotion of SQL Server VM, by performing DDL/DML operations on the database and triggering the DR.

### 4.1 Configuration steps for availability group

This section discusses in detail about pre-configuration and configuration steps that are followed to build and validate Always On availability group for SQL Server 2019.

#### 4.1.1 Pre-configuration steps

The following prerequisites were met before creating Always On availability group on PowerFlex family.

- Two PowerFlex clusters were built on PowerFlex family systems to be used as primary and DR data center respectively.
- Configured the network between two clusters as per the network prerequisites.
- Created four VMs, two on primary data center and two on DR data center.
- Configured network between these four VMs to establish the communication using vLAN.
- Set the Windows domain and created AD users on all four VMs.
- Created four SQL Server instances by installing Microsoft SQL Server 2019 Enterprise Edition on all four VMs.
- Created WSFC for these four VMs.
- Created user database named production01 on primary SQL Server instance.
- Created OLTP workload on production01 database using Hammer DB.
- Enabled Always On feature on all four SQL Server instances.

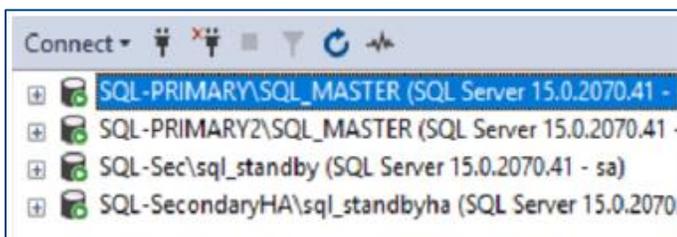


Figure 7 Displays four SQL Server instances used for availability group

## 4.1.2 Configuration of availability group

To configure, connect to the primary SQL Server instance from SSMS and create an availability group from Always ON option.

SQL2019\_AG: hosted by SQL-PRIMARY\SQL\_MASTER (Replica role: Primary) Last updated: 2/7/2020 10:42:44 AM

Availability group state: ✔ Healthy [Start Failover Wizard](#)

Primary instance: SQL-PRIMARY\SQL\_MASTER [View Always On Health Events](#)

Failover mode: Automatic [View Cluster Quorum Information](#)

Cluster state: SQL\_DRC cluster (Normal Quorum)

Cluster type: Windows Server Failover Cluster

Availability replica: [Add/Remove Columns](#)

Name	Role	Availability Mode	Failover Mode	Seeding Mode
<a href="#">SQL-PRIMARY\SQL_MASTER</a>	Primary	Synchronous commit	Automatic	Automatic
<a href="#">SQL-PRIMARY2\SQL_MASTER</a>	Seco...	Synchronous commit	Automatic	Automatic
<a href="#">SQL-SEC\SQL_STANDBY</a>	Seco...	Asynchronous commit	Manual	Automatic
<a href="#">SQL-SECONDARYHA\SQL_STANDBYHA</a>	Seco...	Asynchronous commit	Manual	Automatic

Group by [Add/Remove Columns](#)

Name	Replica	Synchronization State	Failover Read...	Issues
SQL-PRIMARY\SQL_MASTER				
<span style="color: green;">✔</span> Production01	SQL-PRIMARY\SQL_MASTER	Synchronized	No Data Loss	
<span style="color: green;">✔</span> Production01	SQL-PRIMARY2\SQL_MASTER	Synchronized	No Data Loss	
<span style="color: green;">✔</span> Production01	SQL-SEC\SQL_STANDBY	Synchronizing	Data Loss	
<span style="color: green;">✔</span> Production01	SQL-SECONDARYHA\SQL_STANDBYHA	Synchronizing	Data Loss	

Figure 8 Availability group creation for four replicas with Sync and Async mode.

The primary site was hosted with two SQL Server 2019 instances 'SQL-PRIMARY\SQL\_MASTER' and 'SQL-PRIMARY2\SQL-MASTER'. The DR site was hosted with two SQL Server 2019 instances 'SQL-SEC\SQL\_STANDBY' and 'SQL-SECONDARY\SQL\_STANDBYHA'. An availability group that is named 'SQL2019\_AG' was configured between these four instances for 'Production01' database.

## 4.1.3 Test objectives

The validation of the SQL Server 2019 DR solution that is built using Always On availability group covers four major scenarios:

- Auto failover from primary replica to HA standby replica, when primary replica was down.
- Data synchronization between primary and standby replicas.
- VM migration was performed for VM hosting primary replica.
- Manual failover from primary data center replicas to DR data center replicas during primary data center was powered off.

## 4.1.4 Test activities and results

- **First scenario:** Upon bringing down the primary replica it was observed that, standby replica from the primary data center became the primary replica. This resulted in to, continuation of all the transactions from old primary replica to new primary replica.
- **Second scenario:** Performed couple of DML and DDL operations on primary replica. During this it was observed, all the changes made on primary replica were synchronized instantaneously in to standby replicas.
- **Third scenario:** Migrated the VM hosting primary replica using VMware vSphere vMotion, to rule-out the impact of live migration of SQL VMs on Always On availability group. This scenario arises, during physical host failure or any hardware failure on the physical host hosting SQL VMs. During the vMotion, no impact on the availability group and replicas were found.
- **Fourth scenario:** The primary data center goes down making both the SQL Server replicas inaccessible, due to primary data center power off. The DR was triggered by triggering forced manual failover, and two SQL Server replicas in the DR data center was made available. First as a primary replica for all the transactions and second as a standby replica for HA and load balancing. To achieve this, the replica mode of the standby replica at DR data center was flipped to 'Sync' mode.

---

**Note:** Availability group that is configured in async mode will have some data loss while triggering forced manual failover. It is recommended to follow SQL Server 2019 Forced Manual Failover of an Always On Availability Group. For details, see [Technical support and resources](#).

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## 5 Best practices

It is recommended to follow the best practices and guidelines that are mentioned in the following documents:

- For cluster formation and network configuration, see [Dell EMC PowerFlex family Overview - Transformation without trade-offs](#).
- For networking best practices and design consideration, see [DELL EMC VXFLEX OS - Networking Best Practices and Design Considerations](#).
- For building the SQL VM and instances to achieve the optimal performance, see [Benefits of Hosting SQL Server 2016 on Dell EMC PowerFlex family](#).
- For configuring and creating Always On Availability group, see [Prerequisites, Restrictions, and Recommendations for Always On availability groups](#).
- For ESXi 6.5 configuration on PowerFlex hyperconverged platform, see [Dell EMC PowerFlex with ESXi 6.0, ESXi 6.5 and ESXi 6.7 \(55323\)](#).

In addition, it is recommended to have isolated network for Always On replication traffic with an additional dedicated vLAN.

## 6 Conclusion

This paper gives the guidelines for SQL Server DR solution on PowerFlex family using Always On feature. Also, it describes the PowerFlex family HCI based system and recommended best practices for SQL Server DR using Always On.

SQL Server 2019 DR solution was successfully built by following all the best practices and recommendation from Microsoft. The solution was validated successfully by simulating multiple production systems like incidents.

## A Appendix

### A.1 PowerFlex family cluster details

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

Table 4 Software resources

Resource		Version	Purpose
Dell EMC Software	PowerFlex	3.0	PowerFlex software solution to create virtual SAN
VMware software	VMware ESXi server	6.7	VMware hypervisor
	VMware vCenter	6.7	VMware management
Microsoft software	Microsoft Windows Server	2019	Application virtual machine operating system
	Microsoft SQL Server	2019 Enterprise Edition - 2019.150.2070.41	Database Servers

### A.2 PowerFlex cluster node details

The following table summarizes the hardware details of each node in the PowerFlex cluster that were used to carry out the performance tests.

Table 5 Hardware details

Model	CPU	Memory	Storage
PowerEdge R640	2 x Intel(R) Xeon(R) Gold 6152 CPU @ 2.10 GHz	392,645 MB	10 x 1.92 TB Toshiba SSD

## A.3 PowerFlex network details

The following table summarizes the network details of PowerFlex clusters that were used to carry out the performance tests.

Table 3 PowerFlex networking details

Components	Description
Cisco Nexus 93180YC-EX	10 Gbps & 25 Gbps TOR switches
Cisco Nexus 9332PQ	40 Gbps Aggregation switches
Cisco Nexus 3172TQ	1 Gbps & 10 Gbps Management switches.
Data Domain	2 x 10 Gbps links
Application traffic	2 x 25 Gbps links
PowerFlex storage traffic	2 x 25 Gbps links

## A.4 Virtual machine details

The following table summarizes the VM details that were configured to carry out the performance tests.

Table 4 VM details

CPU	Memory	Storage	Guest OS
8 core/vCPU	128 GB	2.4 TB vdisks	Windows Server 2019

## B Technical support and resources

### B.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.

---

- [SQL Server Central](#)
- [SQL Server 2019](#)
- [SQL Server Always On availability group technology and capabilities](#)
- [SQL Server Always On availability group prerequisites, restrictions, and recommendations](#)
- [SQL Server Always ON distributed availability group](#)
- [SQL Server 2019 and Software Assurance Licensing Guide](#)
- [Blog - New high availability and disaster recovery benefits for SQL Server](#)
- [Hammer DB.](#)
- [SQL Server 2019 Forced Manual Failover of an Always On Availability Group](#)

### B.2 Additional resources

- Dell EMC Online Support site (registration required)  
<https://www.dell.com/support>
- Dell EMC Hyperconverged Infrastructure  
<https://www.dell.com/hci>
- Dell EMC PowerFlex integrated systems  
<https://www.delltechnologies.com/en-us/storage/powerflex.htm>
- Dell EMC PowerFlex product overview and white paper  
<https://infohub.delltechnologies.com/t/powerflex-14/>