Behind the Report—Testing Addendum:

How Do Dell™ PowerEdge™ Servers Perform for Networking Workloads at the Edge?

Summary

Prowess engineers took the following steps to test the performance of Dell™ PowerEdge™ XR11 and Dell PowerEdge XR12 servers in a VMware vSAN™ cluster with virtual machines (VMs) running CentOS® and Microsoft® SQL Server®. This document provides the system configurations and the steps to reproduce our testing.

	Dell™ PowerEdge™ XR11 (1U) and Dell™ PowerEdge™ XR12 (2U)
Processor	Intel® Xeon® Gold 5318N processor
Number of CPUs	1
Cores per CPU	24
Cores/threads total	24/48
Frequency (base/SCT/MCT)	2.1 GHz/3.4 GHz
Storage controller 01	Dell™ Boot-Optimized Server Storage (BOSS)-S1 (embedded)
Disk	Micron® MTFDDAV240TDU 240 GB
Number of disks	2
Storage controller 02	PCIe® solid-state drive (SSD) backplane
Disk	1 x 400 GB Dell Enterprise NVM Express® (NVMe®) P5800x WI U.2 3 x 1.92 TB Dell Enterprise NVMe® P5500 RI U.2
Number of disks	4
Installed memory	256 GB
Memory DIMM	Micron® 32 GB
Memory speed	2,666 megatransfers per second (MT/s)
Number of memory DIMMs	8
BIOS version	1.6.5

Quantity of servers under test	3
Operating system (OS)	VMware ESXi™ 7.0.3
OS kernel	7.0.3 20036589 U3 P50
Database	Microsoft® SQL Server® 2022
OS	Ubuntu® 20.04
Kernel	Linux® 5.4.0-126-generic
Client OS	CentOS® Stream 8
Database performance	HammerDB 4.4
Network performance	iPERF® 3

Testing Procedures

The Prowess engineers completed the following testing procedures on the Dell PowerEdge XR11 and PowerEdge XR12 servers.

iPERF® 3

Install Ubuntu® 20.04

1. Mount the Ubuntu 20.04 ISO.
2. Reboot the server to install.
3. On the **Welcome** page, click **Next**.
4. On the **Keyboard configuration** page, click **Done**.
5. On the **Network connections** page, click **Done**.
6. On the **Proxy address** page, click **Done**.
7. On the **Configure Ubuntu Archive Mirror** page, click **Done**.
8. Click **Continue without updating**.
9. On the **Guided storage configuration** page, select the **Dell BOSS**, and then click **Done**.
10. On the **Storage configuration** page, click **Done**.
11. On the **Confirm destructive action** page, click **Continue**.
12. On the **Profile setup** page, enter the following:
    - Your name
    - Your server's name
    - Pick a username
    - Choose a password
    - Confirm your password
13. Click **Done**.
14. Select **Install OpenSSH Server**, and then click **Done**.
15. Click **Reboot now**.
16. Disconnect the virtual media.
17. Log in to the server with the username previously created.
18. Run the following command to install updates:

```
sudo apt update -y && sudo apt upgrade -y
```

19. Run the following commands to install prerequisites:

```
sudo apt install iperf3
```

20. Repeat steps 1–19 on a second server.
21. On the first server, run the following command to start the iPERF® server:

```
iperf3 -s -B <server target ip> -p 5101
```

22. On the second server, run the following to connect to the iPERF server as a client and run a TCP workload:

```
iperf3 -c <server target ip> -T s1 -p 5101 --logfile /tmp/run.txt -k 250000000000 -i 1
```

23. On the second server, run the following to connect to the iPERF server as a client and run a UDP workload:

```
iperf3 -c <server target ip> -T s1 -p 5101 --logfile /tmp/run.txt -t 300s -i 1s -u
```

24. Reverse the test process so that the first server becomes the client test server and the client test server becomes the iPERF server.

VMware vSAN™ over RDMA Prerequisites

The following is a list of configuration prerequisites for the network switch to support VMware vSAN over remote direct memory access (RDMA):

- Enable jumbo frames and adjust as needed
- Enable Priority-based Flow Control (PFC)
- RDMA over Converged Ethernet v2 (RoCEv2)

Microsoft® SQL Server®

VMware ESXi™ 7.0.3 and VMware vCenter Server® were already installed. We completed no setup for the installation of VMware ESXi and VMware vCenter Server.

VMware vSAN Cluster Configuration

1. Connect to VMware vCenter and log in with administrator credentials.
2. Right-click on the pre-existing data center, and then select **New Cluster**.
3. On the **Basics** page, in the **Name** field, enter a name for the cluster, select **vSAN**, and then click **Next**.
4. On the **Review** page, click **Finish**.
5. On the **Cluster Quickstart** page, under **2. Add hosts**, click **Add**.
6. On the **Add new and existing hosts to your cluster** page, select the existing three PowerEdge XR11 hosts, and then click **Next**.
7. On the **Host summary** page, click **Next**.
8. On the **Ready to complete** page, click **Finish**.
9. On the **Cluster Quickstart** page, under **3. Configure Cluster**, click **Configure**.
10. On the **Distributed switches** page, in the **Name** field, enter a name for the **Distributed switch**, add necessary uplinks, and then click **Next**.
11. On the **Storage traffic** page, select the **Distributed switch**, and then click **Next**.
12. On the **Advanced options** page, leave the defaults selected, and then click **Next**.
13. On the **Claim disks** page, select the **Dell P5500** drives as **Capacity**, select the **Dell P5800x** drives as **Cache**, and then click **Next**.
14. On the **Proxy settings** page, leave the defaults selected, and then click **Next**.
15. On the **Review** page, review the configuration, and then click **Finish**.
16. Repeat these VMware vSAN cluster-configuration steps for the Dell PowerEdge XR12 cluster.

RDMA Configuration

We completed the following steps to enable and disable vSAN RDMA support:

1. Select the **vSAN** cluster within **vCenter**.
2. In the **vSAN** section, select **Services**.
3. On the **vSAN Services** page, expand **Network**, and then click **Edit**.
4. On the **Network** page, enable RDMA support by selecting the **RDMA support** toggle, and then click **Apply**.
5. Repeat the same steps to enable RDMA support on the other Dell PowerEdge XR12 vSAN cluster.
6. Repeat these steps to turn RMDA off for both vSAN clusters.

Test VM Setup

1. Download CentOS 8 Stream ISO.
2. Connect to vCenter, and then select the server that will host the VM.
3. Click **Datastores**.
4. Select **Datastore1**.
5. Click **Upload files**, and then select the CentOS 8 Stream ISO to upload.
6. Right-click on the server that will host the test VM, and then select **New Virtual Machine**.
7. Select a **Creation type** page, select **Create a new virtual machine**, and then click **Next**.
8. Select a **Name and folder** page, enter a name in the **Virtual machine name** field, and then click **Next**.
9. Select a **Compute resource** page, select the host system that will host the test VM, and then click **Next**.
10. Select a **Storage** page, select the **vSAN datastore**, and then click **Next**.
11. Select the **Compatibility** page, leave the defaults selected, and then click **Next**.
12. Select a **Guest OS** page, and then, from the **Guest OS Family** drop-down menu, select **Linux**.
13. From the **Guest OS Version** drop-down menu, select **CentOS 8 (64bit)**, and then click **Next**.
14. On the **Customize Hardware** page, update the hardware as follows:
    a. **CPU: 16**
    b. **Cores per Socket: 4**
    c. **Memory: 8 GB**
    d. **New Hard Disk: 20 GB**
    e. **New Network:** Select the **Virtual Machine** network.
15. Click **Add New Device**, and then select **Hard Disk**:
    a. **New Hard Disk: 60 GB**
16. Click **Add New Device**, and then select **Hard Disk** to add a second hard disk:
    a. **New Hard Disk: 100 GB**
17. Select the **New CD/DVD Drive** drop-down menu.
18. Select **Datastore ISO File**.
19. Select **Datastore1**, select the **CentOS 8 Stream ISO**, and then click **OK**.
20. Select the **Connect** box next to the **New CD/DVD** field, select **Connect At Power On** next to **Status**, and then click **Next**.
21. On the **Ready to complete** page, click **Finish**.

CentOS® 8 Stream Installation

1. Select the VM, and then click **Power On**.
2. On the **Welcome to CentOS Stream 8-stream** page, click **Continue**.
3. Click the **Time & Date** page, adjust to **Pacific** time zone, and then click **Done**.
4. Click the **Root Password** page, enter a root password, confirm the password, and then click **Done**.
5. Click the **Software Selection** page, select **Server**, and then click **Done**.
6. Click the **Installation Destination** page, select the **100 GiB disk**, select **Custom**, and then click **Done**.
7. Under **New CentOS Stream 8-stream Installation**, click **Click here to create them automatically** to create the mount points.
8. Update the mount points as follows:
    a. **/home: 20 GiB**
    b. **Swap: 16 GiB**
9. Click **Done**.
10. On the **Summary of Changes** page, click **Accept Change**.
11. Click the **Network & Host Name** page, update the **Host Name**, enable the **Ethernet adapter**, and then click **Done**.
12. Click **Begin Installation**.
13. When prompted, click **Reboot System**.
14. Log in to the system using the previously set root password.

Microsoft SQL Server 2019 Installation

1. Run the following command to install operating system updates:

```
dnf update -y && dnf upgrade -y
```

2. Run the following command to capture the IP for Secure Shell (SSH):

```
ip a
```

3. Launch an SSH client and connect to the test server through SSH with the following command:

```
ssh root@ip
```

4. Run the following command to install prerequisites for SQL Server and CentOS tuning profiles:

```
dnf install python2 compat-openssl10 tuned-profiles-mssql
```

5. Run the following command to set Python2 as the Python path:

```
alternatives –config python
```

6. Run the following command to set the MSSQL tuned profile as the default:

```
tuned-adm profile mssql
```

7. Run the following command to set the SQL Server repository location:

```
sudo curl -o /etc/yum.repos.d/mssql-server.repo
https://packages.microsoft.com/config/rhel/8/mssql-server-preview.repo
```

8. Run the following command to install SQL Server:

```
dnf install -y mssql-server
```

9. Run the following command to configure SQL Server:

```
/opt/mssql/bin/mssql-conf setup
```

10. When prompted, enter the following:
    a. **Enter your edition: 1 (Evaluation)**
    b. **Do you accept the license terms: Yes**
    c. **Enter the SQL Server system administrator password: *password***
    d. **Confirm the SQL Server system administrator password: *password***
11. Run the following command to check the status of the SQL Server service:

```
systemctl status mssql-server
```

12. Run the following command to add mssql-conf to the environment PATH:

```
echo 'export PATH="$PATH:/opt/mssql/bin"' >> ~/.bash_profile
echo 'export PATH="$PATH:/opt/mssql/bin"' >> ~/.bashrc
source ~/.bashrc
```

13. Run the following command to download the Red Hat® repo config file:

```
curl -o /etc/yum.repos.d/msprod.repo https://packages.microsoft.com/config/rhel/8/prod.repo
```

14. Run the following command to install mssql-tools with the unixODBC dev package:

```
sudo yum install -y mssql-tools unixODBC-devel dstat atop nmon
```

15. If prompted to accept the license terms, enter **Yes**.
16. Run the following command to add the tools to the PATH environment:

```
echo 'export PATH="$PATH:/opt/mssql-tools/bin"' >> ~/.bash_profile
```

17. Run the following command to get the device IDs for the data and log drives:

```
fdisk -l
```

18. Run the following command to format and mount the data drive to the SQL Server data directory:

```
mkfs.xfs -L data /dev/sdb -f; mkdir -p /mssql/data; mount /dev/sdb /mssql/data/; chmod 777
/mssql/data; chown mssql:mssql /mssql/data;
```

19. Run the following command to format and mount the logs drive to the SQL Server logs directory:

```
mkfs.xfs -L logs /dev/sdc -f; mkdir -p /mssql/logs; mount /dev/sdc /mssql/logs/; chmod 777
/mssql/logs; chown mssql:mssql /mssql/logs;
```

20. Run the following command to create additional backup and TempDB directories:

```
mkdir -p /mssql/data/backup /mssql/logs/tempdb
```

21. Run the following command to change ownership of the new directories:

```
chown -R mssql:mssql /mssql
```

22. Run the following command to get the universally unique identifiers (UUIDs) for the devices:

```
blkid
```

23. Take note of the UUIDs and update FSTAB to ensure the devices mount after reboot:

```
UUID=uuid /mssql/data xfs rw, attr2, relatime 0 0
UUID=uuid /mssql/logs xfs rw, attr2, relatime 0 0
```

24. Run the following commands to set the default directories:

```
mssql-conf set filelocation.defaultdatadir /mssql/data
mssql-conf set filelocation.defaultlogdir /mssql/log
mssql-conf set filelocation.defaultbackupdir /mssql/data/backup
```

25. Run the following command to restart SQL Server:

```
systemctl restart mssql-server.service
```

26. Run the following command to connect to SQL Server:

```
sqlcmd -S localhost -U sa
```

27. Run the following command to change the location of the TempDB:

```
ALTER DATABASE tempdb MODIFY FILE
(NAME = tempdev, FILENAME = '/mssql/logs/tempdb/tempdb.mdf', SIZE = 1024, FILEGROWTH =    8192MB)
GO
ALTER DATABASE tempdb MODIFY FILE
(NAME = templog, FILENAME = '/mssql/logs/tempdb/templog.ldf', SIZE = 1024, FILEGROWTH  = 8192MB)
GO
```

28. Run the following command to exit SQLCmd:

```
exit
```

29. Run the following command to restart SQL Server services:

```
systemctl restart mssql-server.service
```

30. Run the following command to connect to SQL Server:

```
sqlcmd -S localhost -U sa
```

31. Run the following commands to add additional TempDB files:

```
ALTER DATABASE tempdb
ADD FILE (NAME = tempdb2, FILENAME = '/mssql/logs/tempdb/tempdb2.ndf', SIZE = 1024,
FILEGROWTH = 8192MB);
ALTER DATABASE tempdb
ADD FILE (NAME = tempdb3, FILENAME = '/mssql/logs/tempdb/tempdb3.ndf', SIZE = 1024,
FILEGROWTH = 8192MB);
ALTER DATABASE tempdb
ADD FILE (NAME = tempdb4, FILENAME = '/mssql/logs/tempdb/tempdb4.ndf', SIZE = 1024,
FILEGROWTH = 8192MB);
ALTER DATABASE tempdb
ADD FILE (NAME = tempdb5, FILENAME = '/mssql/logs/tempdb/tempdb5.ndf', SIZE = 1024,
FILEGROWTH = 8192MB);
ALTER DATABASE tempdb
ADD FILE (NAME = tempdb6, FILENAME = '/mssql/logs/tempdb/tempdb6.ndf', SIZE = 1024,
FILEGROWTH = 8192MB);
ALTER DATABASE tempdb
ADD FILE (NAME = tempdb7, FILENAME = '/mssql/logs/tempdb/tempdb7.ndf', SIZE = 1024,
FILEGROWTH = 8192MB);
ALTER DATABASE tempdb
ADD FILE (NAME = tempdb8, FILENAME = '/mssql/logs/tempdb/tempdb8.ndf', SIZE = 1024,
FILEGROWTH = 8192MB);
GO
```

32. Run the following command to restart SQL Server services:

```
systemctl restart mssql-server.service
```

33. Run the following command to delete previous TempDB files:

```
rm -rf /var/opt/mssql/data/temp*
```

34. Run the following commands to install additional packages:

```
subscription-manager repos --enable codeready-builder-for-rhel-8-$(arch)-rpms
dnf install https://dl.fedoraproject.org/pub/epel/epel-release-latest-8.noarch.rpm
dnf install -y epel-release
```

35. Run the following command to download HammerDB 4.4:

```
wget https://github.com/TPC-Council/HammerDB/releases/download/v4.4/HammerDB-4.4-Linux.tar.gz
```

36. Run the following command to extract HammerDB 4.4:

```
tar -xvzf HammerDB-4.4-Linux.tar.gz
```

37. Run the following command to change the directory to HammerDB:

```
cd HammerDB-4.4/
```

38. Run the following commands to setup HammerDB and build the schema:

```
./hammerdbcli
dbset db mssqls
dbset bm TPC-C
diset tpcc mssqls_count_ware 250
diset tpcc mssqls_num_vu 20
diset connection mssqls_pass TestPassword1
buildschema
```

39. Run the following command to back up the TPC-C® database:

```
sqlcmd -S localhost -U SA -Q "BACKUP DATABASE [tpcc] TO DISK = N'/mssql/data/backup/tpcc_
bkup.bak' WITH NOFORMAT, NOINIT, NAME = 'tpcc-full', SKIP, NOREWIND, NOUNLOAD, STATS = 10"
```

40. Run the following command to create a startup.sh script:

```
nano startup.sh
```

41. Copy the following commands into the script:

```
#!/bin/bash
dstat -trdlD total,sda,sdb,sdc 75 --output /tmp/pass$1.csv --noheaders >> /tmp/dstatlog.
txt &
./nmon -f -s 60 -c 75
cd HammerDB-4.4 && ./hammerdbcli auto hammerdb_script.tcl
```

42. Run the following command to update the crontab:

```
crontab -e
```

43. Enter the following command:

```
@reboot (sleep 90; sh $HOME/startup.sh)
```

44. Save and close the crontab file.
45. Shutdown the test VM and copy the VM three (3) times to each of the ESXi hosts.
46. Run the test by starting all of the test VMs at the same time.