



Empower your databases with strong, efficient, scalable performance

The Dell EMC VxRail P470F handled up to 50% more database work with up to 70% faster response times than the HPE Hyper Converged 380

Databases are often the driving force behind a company's mission-critical work. They power online stores, confidential records, and customer management systems, so a solution that sustains high levels of database work can be a big advantage as your company grows.

We found that the Dell EMC™ VxRail™ P470F hyperconverged system with VMware® vSAN™ could allow you to do more database work than the HPE Hyper Converged 380 (HC 380) with StoreVirtual VSA. The four-node Dell EMC solution processed more orders with faster response times, so more users can fulfill requests quicker—whether they're placing orders in a store, accessing databases of client info, or adding to company records.

The Dell EMC VxRail P470F sustained this strong performance even after we doubled the number of virtual machines, so it can keep meeting your needs as your business and its services expand. It also leveraged inline deduplication and compression to store the same amount of data as the HPE solution in less than a third of the space, so you can reduce your datacenter space costs and delay the need to purchase more hardware as you grow. Finally, the Dell EMC VxRail solution made it much easier to scale up and tune to optimize performance for our workload.



Dell EMC VxRail P470F



Support more users:
Up to 50% more database transactions



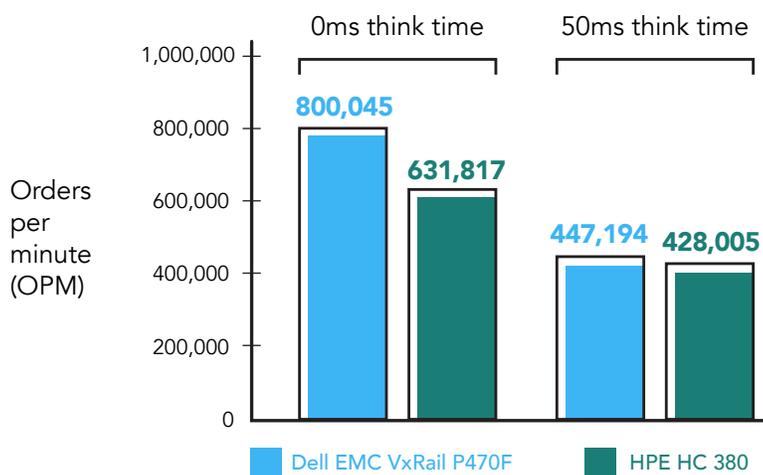
Users get answers faster:
Up to 70% faster response times



Utilize significantly fewer datastores:
Optimize performance and scale more easily

Handle more orders with ease

If your company relies on databases, you want them to be able to support a large number of simultaneous users. When we tested the two solutions with 0ms think time, the Dell EMC VxRail solution handled 26 percent more orders per minute (OPM) and delivered 19 percent more input/output operations per second (IOPS) than the HPE solution. After we upped the think time to 50ms to simulate a more realistic scenario, the Dell EMC VxRail solution maintained an advantage, delivering 4 percent more OPM and 5 percent more IOPS. (To learn more about think time, see “Think time and why it matters”.)



Together, these results show that the Dell EMC VxRail solution can process more database work than the HPE solution in the same amount of time. Depending on your business, you may have staff members relying on databases of constantly changing client information. Or perhaps you’ve got thousands of customers attempting to research and purchase your products. No matter what you use your databases for, when your hardware can handle more hits to your databases, it almost certainly means smoother business operations.

Our test tool: DVD Store 2

To create a real-world database workload, we used DVD Store Version 2.1 (DS2). DS2 models an online store where customers log in, search for products, and make purchases. It reports these actions by showing how many orders per minute the system can handle, which in turn shows you what kind of performance you could expect for your customers. DS2 also performs other actions, such as adding new customers, to exercise the wide range of database functions you might need.

To learn more about DS2, see <http://en.community.dell.com/techcenter/extras/wiki/dvd-store>. To download DS2, see <https://github.com/dvdstore>.

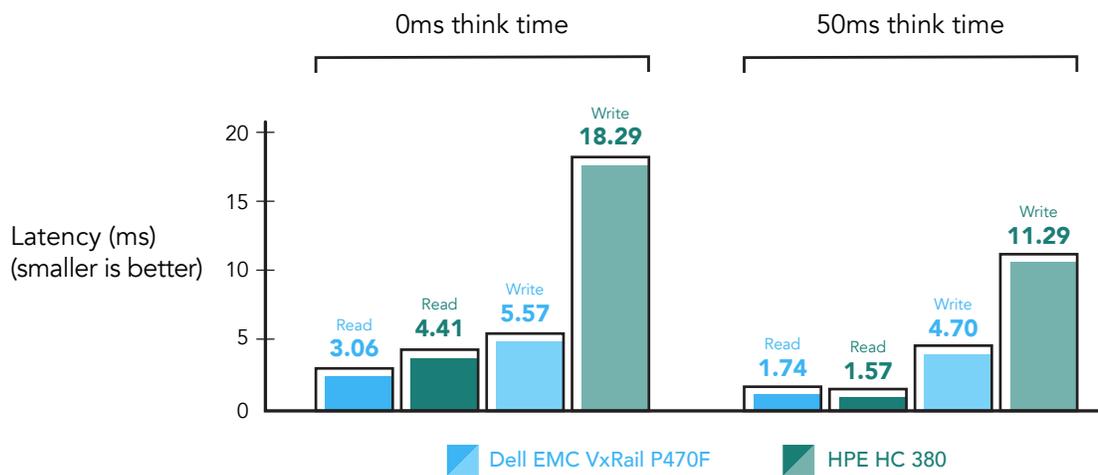
Think time and why it matters

If DS2 simulates customers shopping in an online store, think time is the amount of time between operations taken by multiple users accessing the store at the same time. We set this metric each time we run a test.

A think time of 0 ms gives us the maximum OPM a solution can deliver, making it a useful metric if you want to measure a solution’s highest possible performance. A 0ms think time is virtually impossible in the real world, however, because it is rare to have a long period of time in which one action always follows the previous action instantaneously. For this reason, we also tested with a think time of 50 ms, simulating a more realistic scenario. Though results from this test yielded lower total numbers of OPM and IOPS, they are a more realistic representation of how each solution might perform in the real world.

Fast response times for your staff and customers

For the users accessing your databases, fast response times are key. Customers are likely to leave your site if the pages they're seeking won't load, which can directly translate to lost revenue. Slow response times affect your internal operations, too. Want a recipe for a frustrated, unproductive employee? Try forcing them to wait every time they update the database they use throughout each day.



The Dell EMC VxRail solution offered up to 69 percent faster response times than the HPE solution (see chart above). In both the 0ms and 50ms think time test scenarios, the Dell EMC VxRail P470F achieved comparable or lower read and write latencies. Users expect an immediate response from their databases—and technology in general—and those fractions of seconds can pile up to make a big difference in user experience and productivity.

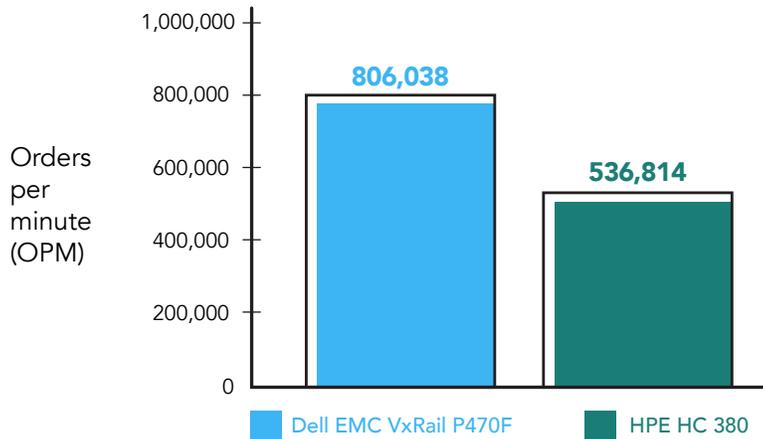


Defining hyperconverged systems

Both of the solutions we tested in this study are hyperconverged systems, which combine servers, storage, and networking into a single hardware stack controlled by software. These space-efficient platforms can break down traditional silos and reduce administrative burden, allowing fewer technical staff members to perform everyday management tasks, which makes them ideal for regional offices or remote locations. Because the entire system is modular and software-controlled, it should require minimal work to scale out by adding more hardware nodes.

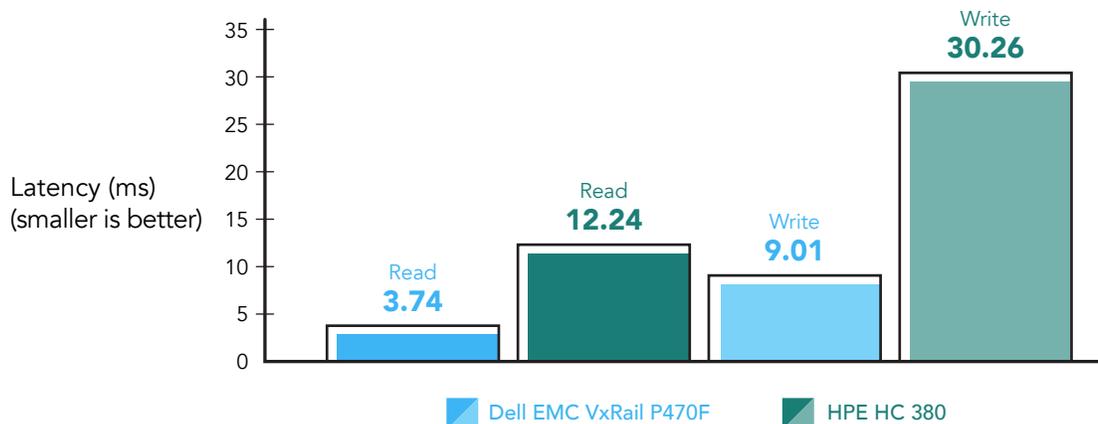
Double your workload and maintain strong performance

As your business grows and adds new products and services, you may need your database hardware to handle more work while continuing to offer a great experience for customers. Ideally, you want your solution to scale performance linearly; if your solution can handle only a little more work after you increase its workload, it's a bad sign for the solution's ability to handle your company's work moving forward.



To see how the solutions dealt with an expanded workload, we doubled the VM count from 18 to 36 VMs on both solutions, keeping think time at 50 ms to simulate a more real-world experience. Both solutions were able to do more work, but the performance of the Dell EMC VxRail P470F jumped dramatically, reaching close to linear scaling, while that of the HPE solution rose a comparatively small amount. The Dell EMC VxRail solution's advantage was most pronounced in this scenario. It handled 50 percent more orders and 22 percent more IOPS than the HPE solution. This proves that even as you increase the load on the Dell EMC VxRail, it can continue making quick work of your database requests.

It also maintained its advantage in response times, offering up to 70 percent faster response times than the HPE solution. Though latencies were higher than they were in our tests with 18 VMs, both read and write latencies consistently remained under 10 ms for the Dell EMC VxRail solution. The HPE solution's response times, on the other hand, were over 10 ms for both read and write, with write latencies reaching over 30 ms. If you're trying to give your users a smooth, positive shopping and working experience, slow response times get in the way.

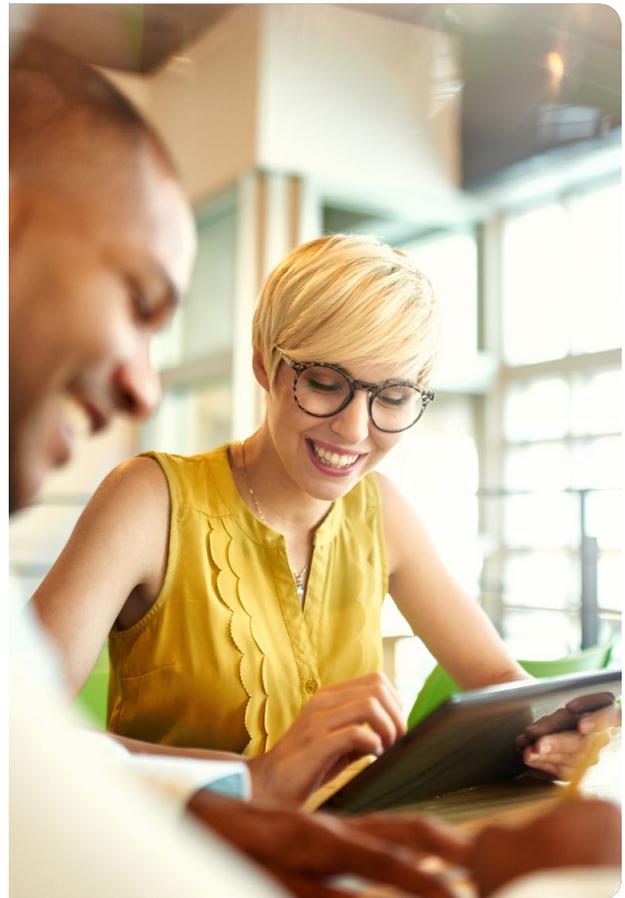


Tune to optimize performance and scale your environment more easily

When you set up a new solution in your datacenter, tuning and optimizing for your specific workload needs is essential. Our experience tuning the Dell EMC VxRail solution was straightforward. We checked a box to enable inline deduplication and compression, and while creating a VM, we created a storage policy to apply to each VM's virtual disks. With only these tuning steps, the Dell EMC VxRail solution delivered consistently strong performance in terms of OPM, IOPS, and latency.

We had a similarly positive experience scaling up from 18 to 36 VMs with the Dell EMC VxRail P470F. We simply cloned out 18 more VMs without encountering any problems.

The HPE solution, in contrast, was extremely challenging to optimize and scale. HPE best practices recommend creating more LUNs if you encounter performance issues—and initially, we did find unusual performance problems, such as high queue and kernel latencies in esxtop. Therefore, in order to tune it for ideal performance, we needed to create a LUN for each data and log VMDK in the HPE StoreVirtual management console, rescan the cluster's storage in VMware vCenter® for new devices, and create a datastore from each newly discovered device. All in all, we had to create 86 datastores for the HPE solution, while with the VxRail P470F, we could simply rely on the single datastore pre-configured with the solution. (Note that the exact number of necessary datastores for the HPE solution may vary depending on your workload and performance needs.) Only after all these steps did we achieve the best performance we could coax from the HPE solution—which was still lower than that of the Dell EMC VxRail solution on every metric we tested.



Similarly, when scaling up to 36 VMs, we had to go back and repeat the same process of creating LUNs for each data and log VMDK. Due to the increased number of VMs, we immediately ran out of available iSCSI connections in VMware vCenter, so we had to find another solution. After reconfiguring the solution by placing all the OS VMDKs into one LUN's datastore and all of the TempDB VMDKs into another LUN's datastore, we freed up the necessary iSCSI connections. All of this work required valuable time and effort, which we didn't have to expend with the Dell EMC VxRail solution.

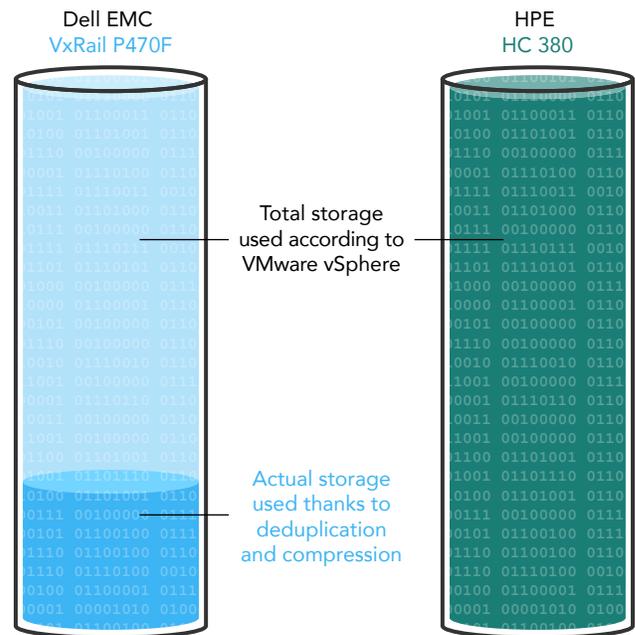
Many users trust the products they purchase to function well right out of the box. If they need to run through a long, tedious series of steps to achieve good performance or scale up their workloads, the extra work costs the company time and money.

Utilize resources more effectively

Datacenter space is limited and costly, so your business directly benefits from more efficient hardware. The more work your hardware can do and the more data it can store in the space it is allocated, the less you spend on datacenter space and cooling—and the longer you can wait before needing to purchase new hardware and expand your datacenter.

Both solutions we tested were composed of four 2U nodes, taking up a total of 8U of rack space. The Dell EMC VxRail solution, however, consistently offered an inline compression/deduplication ratio of over 2x, meaning that it could store the same amount of data in less than half the space of the HPE solution. When we scaled up to 36 VMs, this ratio reached 3.48x, consolidating the data into less than a third of the space the HPE solution required. Meanwhile, the HPE solution did not offer compression or deduplication features at all.

By compressing data and removing duplicate data, the Dell EMC VxRail solution leaves room in your storage for more data as your business grows, allowing you to delay the acquisition of more costly storage arrays.



The fast, flexible Dell EMC VxRail P470F

The Dell EMC VxRail P470F is a single-node, 2U appliance built on Dell EMC PowerEdge™ server technology. When you order your Dell EMC VxRail system, you can choose the specific configuration that fits your needs. The solution we tested utilized four nodes, but as your business needs change, you can link up to 64 nodes.

VMware technologies control the entire stack, enabling straightforward management and resource allocation. According to Dell EMC, the VxRail appliance family “are the only hyper-converged infrastructure appliances jointly engineered with VMware.”¹

For more information on the Dell EMC VxRail P470F, visit DellEMC.com/VxRail.



Boost efficiency and give more customers a great experience, today and tomorrow

Databases power your business, so the performance of the hardware behind your databases is crucial. In our datacenter, the Dell EMC VxRail P470F with VMware vSAN handled more orders per minute, delivered higher IOPS, responded more quickly, and utilized resources more efficiently than the HPE Hyper Converged 380 with HPE StoreVirtual VSA. Plus, scaling up and tuning performance for our specific workload was considerably easier with the Dell EMC VxRail solution than the HPE solution.

These differences translate to real-world benefits. With the Dell EMC VxRail solution, you can achieve shorter wait times for customers and staff, which could increase sales and innovation at your company; reduce work for your IT staff, so they can spend more time on other critical tasks; and save space, potentially helping you delay capital expenditures.

To find out more about the Dell EMC VxRail P470F, visit DellEMC.com/VxRail.

1 "Dell Delivers Industry's Broadest Hyper-converged Infrastructure Portfolio for Flexible, Scalable and Streamlined IT", accessed June 7, 2017, <http://www.dell.com/learn/us/en/uscop1/press-releases/2016-04-05-dell-delivers-industrys-broadest-hci-portfolio>

On March 17, 2017, we finalized the hardware and software configurations we tested. Updates for current and recently released hardware and software appear often, so unavoidably these configurations may not represent the latest versions available when this report appears. We concluded hands-on testing on May 15, 2017.

Appendix A: Test configuration and benchmark

About our Microsoft SQL Server database configuration

For the first part of our testing, we set up a mixed workload environment with 18 virtual machines and three different database sizes; six small (25GB) databases, six medium (100GB) databases, and six large (250GB) databases.

We created six new small database VMs, installed Microsoft SQL Server® 2016 on the VMs, and configured the VMs with 12 GB of RAM and four vCPUs. Each VM had a 40GB virtual disk, on which we installed Windows Server® 2016 and the database software, and a 10GB virtual disk for TempDB and TempLog files. We then added a 55GB VMDK to each VM to hold the database data files, and a 25GB VMDK to store the database log files.

Then, we created six new medium database VMs, installed Microsoft SQL Server 2016 on the VMs, and configured the VMs with 50 GB of RAM and six vCPUs. Each VM had a 40GB virtual disk, on which we installed Windows Server 2016 and the database software, and a 10GB virtual disk for TempDB and TempLog files. We then added a 185GB VMDK to each VM to hold the database data files, and a 40GB VMDK to store the database log files.

Then, we created six new large database VMs, installed Microsoft SQL Server 2016 on the VMs, and configured the VMs with 128 GB of RAM and eight vCPUs. Each VM had a 40GB virtual disk, on which we installed Windows Server 2016 and the database software, and a 10GB virtual disk for TempDB and TempLog files. We then added two 220GB VMDKs to each VM to hold the database data files, and one 95GB VMDK to store the database log files.

Finally, we used DS2's data-generation tool to create the initial database schemas. We used database size parameters of 25GB, 100GB, and 250GB in DS2's workload generator to create approximately 25 GB, 100 GB, and 250 GB of data. We then imported those databases into Microsoft SQL Server VMs to create the indexes. For details, including the DS2 configuration files, see [Appendix B](#).

For the scale-up portion of the testing, we doubled the VM count to 36: 12 small 25GB databases, 12 medium 100GB databases, and 12 large 250GB databases. We followed the same procedures to create and configure these virtual machines. The small 25GB database each VMs had 12GB RAM, four vCPUs, a 55GB VMDK to hold the database data files, and a 25GB VMDK to store the database log files. The medium 100GB database VMs each had 50GB RAM, six vCPUs, a 185GB VMDK to hold the database data files, and a 40GB VMDK to store the database log files. The large 250GB database VMs each had 128GB RAM, eight vCPUs, a 220GB VMDK to hold the database data files, and a 95GB VMDK to store the database log files.

About Microsoft SQL Server 2016

According to Microsoft, "SQL Server 2016 is the biggest leap forward in Microsoft data platform history. Gain real time insights across your transactional and analytical data with a scalable database platform that has everything built in, from unparalleled in-memory performance, new security innovations and high availability, to advanced analytics that make mission-critical applications intelligent."

Learn more about Microsoft SQL Server 2016 at <https://www.microsoft.com/en-us/server-cloud/products/sql-server/>.

Appendix B: System configuration information

Server configuration information	Dell EMC VxRail P470F (four-node cluster)	HPE Hyper Converged 380 (four-node cluster)
BIOS name and version	Dell EMC VxRail P470F 2.2.5	HP ProLiant System BIOS P89 v2.22
Operating system name and version/build number	VMware ESXi™, 6.0.0, 5050593	VMware ESXi, 6.0.0, 3620759
Date of last OS updates/patches applied	03/13/2017	03/15/2017
Power management policy	Performance	Custom
Processor		
Number of processors	2	2
Vendor and model	Intel® Xeon® E5-2699 v4	Intel Xeon E5-2699 v4
Core count (per processor)	22	22
Core frequency (GHz)	2.20	2.20
Stepping	1	1
Memory module(s)		
Total memory in system (GB)	1536	1536
Number of memory modules	24	24
Vendor and model	Hynix HMAA8GL7MMR4N-UH	Micron® MTA72ASS8G72LZ-2G3A1PI
Size (GB)	64	64
Type	PC4-2400T	PC4-2400T
Speed (MHz)	2,400	2,400
Speed running in the server (MHz)	2,133	2,400
Storage controller		
Vendor and model	Dell HBA330 Mini	Smart Array P440ar Controller
Cache size (GB)	0	4000
Firmware version	09.17.20.07	4.02
Driver version	10.00.03.00-1OEM.600.0.0.2768847	6.0.0.118-1OEM
Local storage (caching tier)		
Number of drives	3	N/A
Drive vendor and model	Dell HUSMM1680ASS204	N/A
Drive size (GB)	800GB	N/A
Drive information (speed, interface, type)	12 Gb/s, SAS, SSD	N/A
Local storage (storage tier)		
Number of drives	5	8
Drive vendor and model	Dell HUSMR1619ASS204	Intel SSD DC S3610
Drive size (GB)	1.92	1.6
Drive information (speed, interface, type)	12 Gb/s, SAS, SSD	6 Gb/s, SATA, SSD

Server configuration information	Dell EMC VxRail P470F (four-node cluster)	HPE Hyper Converged 380 (four-node cluster)
Network adapter		
Vendor and model	Intel Ethernet 10G X520/I350	HP Ethernet 10Gb 560FLR-SFP+
Number and type of ports	2 x 10 Gb, 2 x 1 Gb	2 x 10 Gb
Driver version	17.5.10	1.1200.0
Cooling fans		
Number of cooling fans	6	6
Power supplies		
Vendor and model	Dell L1100E-S1	HP HSTNS-PL41
Number of power supplies	2	2
Wattage of each (W)	1100	800

Appendix C: How we tested

In our labs, we tested a mixed OLTP workload on the Dell EMC VxRail P470F with VMware VSAN versus the HPE HC380 with HPE StoreVirtual VSA in two different phases. For phase 1, we tested 18 VMs at 0ms think time to stress the storage on each solution. In phase 2, we introduced a small amount of think time to simulate a more real-world situation. We tested our original 18 VMs at 50ms think time and then scaled up the VM count to 36, again testing at 50ms think time.

Once our networking checklist was complete, engineers from both Dell EMC and HPE came out to finish the installations. Both hyper-converged systems come with VMware vSphere 6, vCenter 6, and the storage solutions mentioned above pre-installed. We did not make any modifications to the hardware or server OS after the engineers completed the initial setup configuration.

After the engineers completed the setup, we created six small SQL Server database VMs, six medium SQL Server database VMs, and six large SQL Server database VMs on each cluster for our testing environment. We ran the DS2 benchmark against the SQL Server VMs and measured OPM, latency, and IOPs for each solution.

It is important to note that we originally configured the HC 380 storage to match the VxRail as closely as possible. The VxRail uses VMware VSAN storage, and it is presented to each host in the cluster as one large datastore automatically after the Dell EMC engineer completed the setup. When we configured the HC 380 to match by creating one LUN and datastore, we saw significant KAVG and QAVG latencies in esxtop. To alleviate this latency issue, we created a LUN in HPE StoreVirtual VSA CMC and a corresponding datastore for each VMDK we would need for all 18 VMs. This took significantly more time and steps.

When we doubled the VM count to 36 for phase 2, the scale up portion, we ran into the vSphere 6 limit for the maximum number of iSCSI initiator paths (1024). To work around this issue, we consolidated the OS and TempDB LUNs and datastores into two LUNs and datastores large enough to hold all of the OS and TempDB VMDKs. We put each VM's OS and TempDB VMDK in their respective datastores, and created a new LUN and datastore for each remaining Data and Log VMDK.

In our final configuration, we have 12 small SQL Server database VMs, 12 medium SQL Server database VMs, and 12 large SQL Server database VMs. We again ran the DS2 benchmark against the SQL Server VMs and measured OPM, latency, and IOPs for each solution.

We used the following steps to configure our environment.

Creating the HPE HC 380 StoreVirtual LUNs

1. Log into the vCenter VM with the StoreVirtual CMC.
2. Launch the StoreVirtual CMC program.
3. Log into the storage cluster.
4. In the navigation pane on the left, right-click the storage cluster, and select New Volume.
5. On the basic tab, fill in the Volume Name, Description, and Reported Size fields.
6. Click Assign and Unassign Servers.
7. Select the checkbox next to the server(s) you wish to select, and click OK.
8. Click the Advanced tab.
9. Verify the Data Protection Level is set to Network RAID-10 (2-Way Mirror).
10. Verify the Provisioning is set to Full.
11. Click OK.
12. Repeat steps 4 through 11 for every datastore that you will create.

Creating the HPE HC 380 datastores

1. Log into the HC 380 vCenter.
2. Click Hosts and Clusters.
3. In the navigation pane on the left, click the first host in the cluster.
4. Navigate to Manage→Storage→Storage Devices.
5. Rescan the storage to see the newly created LUNs.
6. Repeat steps 3 through 5 for the remaining hosts in the cluster.
7. In the navigation pane on the left, click the cluster.
8. Navigate to Related Objects→Datastores.
9. Click the Create New Datastore icon to create a new datastore.
10. On the location tab, click Next.
11. On the Type tab, select VMFS and click Next.
12. On the Name and device selection tab, enter a datastore name.
13. Select a host from the drop-down menu to view the available storage devices.
14. Select the device that corresponds with the correct LUN created by matching the iSCSI initiator and device name.

15. Click Next.
16. On the Partition Configuration tab, select Use all available partitions.
17. Click Next.
18. Click Finish.

Creating the small VMs on the HPE HC 380

We created one small gold image VM for SQL Server using the following steps.

1. In VMware vCenter, navigate to Virtual Machines.
2. To create a new VM, click the icon.
3. Leave Create a new virtual machine selected, and click Next.
4. Enter a name for the virtual machine, and click Next.
5. Place the VM on the cluster, and click Next.
6. Select the desired datastore for the 40GB OS VMDK, and click Next.
7. Select the guest OS as Microsoft Windows Server 2016 (64-bit), and click Next.
8. In the Customize Hardware section, use the following settings:
 - a. Set the vCPU count to 4.
 - b. Set the Memory to 12GB, and check the Reserve all guest memory box.
 - c. Add 1 x 10GB VMDK for TempDB & TempLogs, 1 x 55GB VMDK for data, 1 x 25GB VMDK for log. Set all VMDKs to thick provision eager zeroed.
 - d. Create two additional SCSI controllers, and assign the data VMDK to one and the log VMDK to the other.
 - e. Attach a Windows Server 2016 ISO to the CD/DVD drive.
9. Click Next.
10. Click Finish.

Creating the medium VMs on the HPE HC 380

We created one medium gold image VM for SQL Server using the following steps.

1. In VMware vCenter, navigate to Virtual Machines.
2. To create a new VM, click the icon.
3. Leave Create a new virtual machine selected, and click Next.
4. Enter a name for the virtual machine, and click Next.
5. Place the VM on the cluster, and click Next.
6. Select the desired datastore for the 40GB OS VMDK, and click Next.
7. Select the guest OS as Microsoft Windows Server 2016 (64-bit), and click Next.
8. In the Customize Hardware section, use the following settings:
 - a. Set the vCPU count to 6.
 - b. Set the Memory to 50GB, and check the Reserve all guest memory box.
 - c. Add 1 x 10GB VMDK for TempDB & TempLogs, 1 x 185GB VMDK for data, 1 x 40GB VMDK for log. Set all VMDKs to thick provision eager zeroed.
 - d. Create two additional SCSI controllers, and assign the data VMDK to one and the log VMDK to the other.
 - e. Attach a Windows Server 2016 ISO to the CD/DVD drive.
9. Click Next.
10. Click Finish.

Creating the large VMs on the HPE HC 380

We created one large gold image VM for SQL Server using the following steps.

1. In VMware vCenter, navigate to Virtual Machines.
2. To create a new VM, click the icon.
3. Leave Create a new virtual machine selected, and click Next.
4. Enter a name for the virtual machine, and click Next.
5. Place the VM on the cluster, and click Next.
6. Select the desired datastore for the 40GB OS VMDK, and click Next.
7. Select the guest OS as Microsoft Windows Server 2016 (64-bit), and click Next.
8. In the Customize Hardware section, use the following settings:
 - a. Set the vCPU count to 8.
 - b. Set the Memory to 128GB, and check the Reserve all guest memory box.
 - c. Add 1 x 10GB VMDK for TempDB & TempLogs, 2 x 220GB VMDK for data, 1 x 95GB VMDK for log. Set all VMDKs to thick provision eager zeroed.
 - d. Create three additional SCSI controllers, and assign each data VMDK to one and the log VMDK to the third.
 - e. Attach a Windows Server 2016 ISO to the CD/DVD drive.
9. Click Next.
10. Click Finish.

Creating the VM storage policy for the Dell EMC VxRail P470F

1. Click the home drop-down menu, and select Policies and Profiles.
2. Select VM Storage Policies.
3. Click the icon to Create a new VM storage policy.
4. Enter a name, and click Next.
5. Click Next.
6. On the Rule-Set 1 tab, from the Rules based on data services drop-down menu, select VSAN.
7. Click the <Add rule> drop-down menu, and select Number of failures to tolerate.
8. Set the Number of failures to tolerate to 1.
9. Click the <Add rule> drop-down menu, and select Fault tolerance method.
10. Set the Fault tolerance method to RAID-1 (Mirroring) – Performance.
11. Click Next.
12. Click Next.
13. Click Finish.

Creating the small VMs on the Dell EMC VxRail P470F

We created one small gold image VM for SQL Server using the following steps.

1. In VMware vCenter, navigate to Virtual Machines.
2. To create a new VM, click the icon.
3. Leave Create a new virtual machine selected, and click Next.
4. Enter a name for the virtual machine, and click Next.
5. Place the VM on the cluster, and click Next.
6. Select the desired datastore for the 40GB OS VMDK, and click Next.
7. Select the guest OS as Microsoft Windows Server 2016 (64-bit), and click Next.
8. In the Customize Hardware section, use the following settings:
 - a. Set the vCPU count to 4.
 - b. Set the Memory to 12GB, and check the Reserve all guest memory box.
 - c. Add 1 x 10GB VMDK for TempDB & TempLogs, 1 x 55GB VMDK for data, 1 x 25GB VMDK for log. Set all VMDKs to the VM storage policy previously created.
 - d. Create two additional SCSI controllers, and assign the data VMDK to one and the log VMDK to the other.
 - e. Attach a Windows Server 2016 ISO to the CD/DVD drive.
9. Click Next.
10. Click Finish.

Creating the medium VMs on the Dell EMC VxRail P470F

We created one medium gold image VM for SQL Server using the following steps.

1. In VMware vCenter, navigate to Virtual Machines.
2. To create a new VM, click the icon.
3. Leave Create a new virtual machine selected, and click Next.
4. Enter a name for the virtual machine, and click Next.
5. Place the VM on the cluster, and click Next.
6. Select the desired datastore for the 40GB OS VMDK, and click Next.
7. Select the guest OS as Microsoft Windows Server 2016 (64-bit), and click Next.
8. In the Customize Hardware section, use the following settings:
 - a. Set the vCPU count to 6.
 - b. Set the Memory to 50GB, and check the Reserve all guest memory box.
 - c. Add 1 x 10GB VMDK for TempDB & TempLogs, 1 x 185GB VMDK for data, 1 x 40GB VMDK for log. Set all VMDKs to the VM storage policy previously created.
 - d. Create two additional SCSI controllers, and assign the data VMDK to one and the log VMDK to the other.
 - e. Attach a Windows Server 2016 ISO to the CD/DVD drive.
9. Click Next.
10. Click Finish.

Creating the large VMs on the Dell EMC VxRail P470F

We created one large gold image VM for SQL Server using the following steps.

1. In VMware vCenter, navigate to Virtual Machines.
2. To create a new VM, click the icon.
3. Leave Create a new virtual machine selected, and click Next.
4. Enter a name for the virtual machine, and click Next.
5. Place the VM on the cluster, and click Next.
6. Select the desired datastore for the 40GB OS VMDK, and click Next.
7. Select the guest OS as Microsoft Windows Server 2016 (64-bit), and click Next.
8. In the Customize Hardware section, use the following settings:
 - a. Set the vCPU count to 8.
 - b. Set the Memory to 128GB, and check the Reserve all guest memory box.
 - c. Add 1 x 10GB VMDK for TempDB & TempLogs, 2 x 220GB VMDK for data, 1 x 95GB VMDK for log. Set all VMDKs to the VM storage policy previously created.
 - d. Create three additional SCSI controllers, and assign each data VMDK to one and the log VMDK to the third.
 - e. Attach a Windows Server 2016 ISO to the CD/DVD drive.
9. Click Next.
10. Click Finish.

Installing Windows Server 2016 onto the VMs

1. Attach the Windows Server 2016 ISO to the virtual machine.
2. Open the VM console and start the VM.
3. When prompted to boot from DVD, press any key.
4. When the installation screen appears, leave language, time/currency format, and input method as default, and click Next.
5. Click Install now.
6. When the installation prompts you, enter the product key.
7. Select Windows Server 2016 Datacenter Edition (Server with a GUI), and click Next.
8. Check I accept the license terms, and click Next.
9. Click Custom: Install Windows only (advanced).
10. Select Drive 0 Unallocated Space, and click Next. This starts Windows automatically, and Windows will restart automatically after completing.
11. When the Settings page appears, fill in the Password and Reenter Password fields with the same password.
12. Log in with the password you set up previously.

Installing SQL Server 2016

1. Attach the installation media ISO for SQL Server 2016 to the VM.
2. Click Run SETUP.EXE. If Autoplay does not begin the installation, navigate to the SQL Server 2016 DVD, and double-click it.
3. In the left pane, click Installation.
4. Click New SQL Server stand-alone installation or add features to an existing installation.
5. Click the checkbox to accept the license terms, and click Next.
6. Click Use Microsoft Update to check for updates, and click Next.
7. To install the setup support files, click Install.
8. If there are no failures displayed, click Next.
9. At the Setup Role screen, choose SQL Server Feature Installation, and click Next.
10. At the Feature Selection screen, select Database Engine Services, Full-Text and Semantic Extractions for Search, Client Tools Connectivity, Client Tools Backwards Compatibility, Management Tools – Basic, and Management Tools – Complete.
11. Click Next.
12. At the Instance configuration screen, leave the default selection of default instance, and click Next.
13. At the Database Engine Configuration screen, select the authentication method you prefer. For our testing purposes, we selected Mixed Mode.
14. Enter and confirm a password for the system administrator account.
15. Click Add Current user. This may take several seconds.
16. Click Next.
17. At the Error and usage reporting screen, click Next.
18. At the Installation Configuration Rules screen, check that there are no failures or relevant warnings, and click Next.
19. At the Ready to Install screen, click Install.
20. Close the installation window.

Enabling Lock pages in memory

1. Inside the VM, click Start, type gpedit.msc, and press Enter.
2. In the Local Group Policy Editor, expand Computer Configuration→Windows Settings→Security Settings→Local Policies.
3. Select User Rights Assignment, and in the right pane, scroll down to Lock pages in memory.
4. Right-click Lock pages in memory, and click Properties.
5. Click Add User or Group, and add your SQL user account.
6. Click OK.

Configuring DVD Store 2

Data generation overview

We generated the data using the Install.pl script included with DVD Store version 2.1, providing the parameters for our 25GB, 100GB, and 250GB, database sizes and the Microsoft SQL Server 2016 platform. We ran the Install.pl script on a utility system running Linux®. The Install.pl script also generated the database schema.

After processing the data generation, we transferred the data files and schema creation files to a Windows-based system running SQL Server 2016. We built the databases in SQL Server 2016, and then performed a full backup. We used that backup file to restore the server between test runs.

The only modification we made to the schema creation scripts were the specified file sizes for our database. We explicitly set the file sizes higher than necessary to ensure that no file-growth activity would affect the outputs of the test. Besides this file size modification, the database schema was created and loaded according to the DVD Store documentation. Specifically, we followed the steps below:

1. Generate the data and create the database and file structure using database creation scripts in the DS2 download. Make size modifications specific to your databases and the appropriate changes to drive letters.
2. Transfer the files from the Linux data generation system to a Windows system running SQL Server.
3. Create database tables, stored procedures, and objects using the provided DVD Store scripts.
4. Set the database recovery model to bulk-logged to prevent excess logging.
5. Load the data we generated into the database. For data loading, use the import wizard in SQL Server Management Studio. Where necessary, retain options from the original scripts, such as Enable Identity Insert.
6. Create indices, full-text catalogs, primary keys, and foreign keys using the database-creation scripts.
7. Update statistics on each table according to database-creation scripts, which sample 18 percent of the table data.

8. On the SQL Server instance, create a ds2user SQL Server login using the following Transact-SQL (T-SQL) script:

```
USE [master]
GO
CREATE LOGIN [ds2user] WITH PASSWORD=N'',
    DEFAULT_DATABASE=[master],
    DEFAULT_LANGUAGE=[us_english],
    CHECK_EXPIRATION=OFF,
    CHECK_POLICY=OFF
GO
```

9. Set the database recovery model back to full.
 10. Create the necessary full text index using SQL Server Management Studio.
 11. Create a database user and mapped this user to the SQL Server login.
 12. Set the compatibility level to 2014.
 13. Perform a full backup of the database, which lets you restore the databases to a pristine state relatively quickly between tests.

The table below shows our initial file size modifications for the three database sizes.

Logical name	Filegroup	Initial size (MB) Small database	Initial size (MB) Medium database	Initial size (MB) Large database
Database files				
primary	PRIMARY	8	8	8
cust1	DS_CUST_FG	5,144	20,504	50,776
cust2	DS_CUST_FG	5,144	20,504	50,776
cust3	DS_CUST_FG	5,144	20,504	50,776
cust4	DS_CUST_FG	5,144	20,504	50,776
ind1	DS_IND_FG	5,120	15,360	35,840
ind2	DS_IND_FG	5,120	15,360	35,840
ind3	DS_IND_FG	5,120	15,360	35,840
ind4	DS_IND_FG	5,120	15,360	35,840
ds_misc	DS_MISC_FG	300	200	392
orders1	DS_ORDERS	3,072	10,028	25,004
orders2	DS_ORDERS	3,072	10,028	25,004
orders3	DS_ORDERS	3,072	10,028	25,004
orders4	DS_ORDERS	3,072	10,028	25,004
Log files				
ds_log	Not applicable	20,480	36,008	90,152

Configuring the database workload client

For our testing, we used a virtual client for the Microsoft SQL Server client. To create this client, we installed Windows Server 2012 R2, assigned a static IP address.

Running the DVD Store tests

We created a series of batch files, SQL scripts, and shell scripts to automate the complete test cycle. DVD Store outputs an orders-per-minute metric, which is a running average calculated through the test. In this report, we report the last OPM reported by each client/target pair.

Each complete test cycle consisted of the following general steps:

1. Clean up prior outputs from the target system and the client driver system.
2. Drop the database from the target.
3. Restore the database on the target.
4. Reboot the target.
5. Wait for a ping response from the server under test and the client system.
6. Let the test server idle for 10 minutes.
7. Start the DVD Store driver on the client.

We used the following DVD Store parameters for testing:

```
ds2sqlserverdriver.exe --target=<target_IP> --ramp_rate=10 --run_time=60 --n_threads=32 --db_size=<25/100/250>GB --think_time=0 --detailed_view=Y --warmup_time=30 --report_rate=1 --csv_output=<drive path>
```

We ran this test three times and took the median run from each solution.

Appendix D: Pre-installation checklist switch configuration

```
! Version 9.5(0.1)
! Last configuration change at Mon Apr  3 17:37:57 2017 by admin
! Startup-config last updated at Fri Apr 21 09:19:03 2017 by admin
!
boot system stack-unit 0 primary system: A:
boot system stack-unit 0 secondary system: B:
boot system stack-unit 0 default system: A:
boot system gateway 0.0.0.0
!
redundancy auto-synchronize full
!
hardware watchdog
!
hostname S4810-A
!
username admin password 7 297a4f435cb9010182895c1658f993e7 privilege 15
!
stack-unit 0 provision S4810
!
stack-unit 0 stack-group 11
!
interface TenGigabitEthernet 0/0
  no ip address
  mtu 12000
  portmode hybrid
  switchport
  no shutdown
!
interface TenGigabitEthernet 0/1
  no ip address
  mtu 12000
  portmode hybrid
  switchport
  spanning-tree rstp edge-port
  no shutdown
!
interface TenGigabitEthernet 0/2
  no ip address
  mtu 12000
  portmode hybrid
  switchport
  spanning-tree rstp edge-port
  no shutdown
!
interface TenGigabitEthernet 0/3
  no ip address
  mtu 12000
  portmode hybrid
  switchport
  spanning-tree rstp edge-port
  no shutdown
!
interface TenGigabitEthernet 0/4
  no ip address
  mtu 12000
  portmode hybrid
  switchport
  spanning-tree rstp edge-port
  no shutdown
!
interface TenGigabitEthernet 0/5
  no ip address
  mtu 12000
  portmode hybrid
```

```
switchport
spanning-tree rstp edge-port
no shutdown
!
interface TenGigabitEthernet 0/6
no ip address
mtu 12000
portmode hybrid
switchport
spanning-tree rstp edge-port
no shutdown
!
interface TenGigabitEthernet 0/7
no ip address
mtu 12000
portmode hybrid
switchport
spanning-tree rstp edge-port
no shutdown
!
interface TenGigabitEthernet 0/8
no ip address
mtu 12000
portmode hybrid
switchport
spanning-tree rstp edge-port
no shutdown
!
interface TenGigabitEthernet 0/9
no ip address
mtu 12000
portmode hybrid
switchport
spanning-tree rstp edge-port
no shutdown
!
interface TenGigabitEthernet 0/10
no ip address
mtu 12000
portmode hybrid
switchport
spanning-tree rstp edge-port
no shutdown
!
interface TenGigabitEthernet 0/11
no ip address
mtu 12000
portmode hybrid
switchport
spanning-tree rstp edge-port
no shutdown
!
interface TenGigabitEthernet 0/12
no ip address
mtu 12000
portmode hybrid
switchport
spanning-tree rstp edge-port
no shutdown
!
interface TenGigabitEthernet 0/13
no ip address
mtu 12000
portmode hybrid
switchport
spanning-tree rstp edge-port
no shutdown
```

```
!  
interface TenGigabitEthernet 0/14  
  no ip address  
  mtu 12000  
  portmode hybrid  
  switchport  
  spanning-tree rstp edge-port  
  no shutdown  
!  
interface TenGigabitEthernet 0/15  
  no ip address  
  mtu 12000  
  portmode hybrid  
  switchport  
  spanning-tree rstp edge-port  
  no shutdown  
!  
interface TenGigabitEthernet 0/16  
  no ip address  
  mtu 12000  
  portmode hybrid  
  switchport  
  spanning-tree rstp edge-port  
  no shutdown  
!  
interface TenGigabitEthernet 0/17  
  no ip address  
  mtu 12000  
  portmode hybrid  
  switchport  
  spanning-tree rstp edge-port  
  no shutdown  
!  
interface TenGigabitEthernet 0/18  
  no ip address  
  mtu 12000  
  portmode hybrid  
  switchport  
  spanning-tree rstp edge-port  
  no shutdown  
!  
interface TenGigabitEthernet 0/19  
  no ip address  
  mtu 12000  
  portmode hybrid  
  switchport  
  spanning-tree rstp edge-port  
  no shutdown  
!  
interface TenGigabitEthernet 0/20  
  no ip address  
  mtu 12000  
  portmode hybrid  
  switchport  
  spanning-tree rstp edge-port  
  no shutdown  
!  
interface TenGigabitEthernet 0/21  
  no ip address  
  mtu 12000  
  portmode hybrid  
  switchport  
  spanning-tree rstp edge-port  
  no shutdown  
!  
interface TenGigabitEthernet 0/22  
  no ip address
```

```
mtu 12000
portmode hybrid
switchport
spanning-tree rstp edge-port
no shutdown
!
interface TenGigabitEthernet 0/23
no ip address
mtu 12000
portmode hybrid
switchport
spanning-tree rstp edge-port
no shutdown
!
interface TenGigabitEthernet 0/24
no ip address
mtu 12000
portmode hybrid
switchport
spanning-tree rstp edge-port
no shutdown
!
interface TenGigabitEthernet 0/25
no ip address
mtu 12000
portmode hybrid
switchport
spanning-tree rstp edge-port
no shutdown
!
interface TenGigabitEthernet 0/26
no ip address mtu 12000
portmode hybrid
switchport
spanning-tree rstp edge-port
no shutdown
!
interface TenGigabitEthernet 0/27
no ip address
mtu 12000
portmode hybrid
switchport
spanning-tree rstp edge-port
no shutdown
!
interface TenGigabitEthernet 0/28
no ip address
mtu 12000
portmode hybrid
switchport
spanning-tree rstp edge-port
no shutdown
!
interface TenGigabitEthernet 0/29
no ip address
mtu 12000
portmode hybrid
switchport
spanning-tree rstp edge-port
no shutdown
!
interface TenGigabitEthernet 0/30
no ip address
mtu 12000
portmode hybrid
switchport
spanning-tree rstp edge-port
```

```
no shutdown
!
interface TenGigabitEthernet 0/31
no ip address
mtu 12000
portmode hybrid
switchport
spanning-tree rstp edge-port
no shutdown
!
interface TenGigabitEthernet 0/32
no ip address
mtu 12000
portmode hybrid
switchport
spanning-tree rstp edge-port
no shutdown
!
interface TenGigabitEthernet 0/33
no ip address
mtu 12000
portmode hybrid
switchport
spanning-tree rstp edge-port
no shutdown
!
interface TenGigabitEthernet 0/34
no ip address
mtu 12000
portmode hybrid
switchport
spanning-tree rstp edge-port
no shutdown
!
interface TenGigabitEthernet 0/35
no ip address
mtu 12000
portmode hybrid
switchport
spanning-tree rstp edge-port
no shutdown
!
interface TenGigabitEthernet 0/36
no ip address
mtu 12000
portmode hybrid
switchport
spanning-tree rstp edge-port
no shutdown
!
interface TenGigabitEthernet 0/37
no ip address
mtu 12000
portmode hybrid
switchport
spanning-tree rstp edge-port
no shutdown
!
interface TenGigabitEthernet 0/38
no ip address
mtu 12000
portmode hybrid
switchport
spanning-tree rstp edge-port
no shutdown
!
interface TenGigabitEthernet 0/39
```

```

no ip address
mtu 12000
portmode hybrid
switchport
spanning-tree rstp edge-port
no shutdown
!
interface TenGigabitEthernet 0/40
no ip address
mtu 12000
portmode hybrid
switchport
spanning-tree rstp edge-port
no shutdown
!
interface TenGigabitEthernet 0/41
no ip address
mtu 12000
portmode hybrid
switchport
spanning-tree rstp edge-port
no shutdown
!
interface TenGigabitEthernet 0/42
no ip address
mtu 12000
portmode hybrid
switchport
spanning-tree rstp edge-port
no shutdown
!
interface TenGigabitEthernet 0/43
no ip address
mtu 12000
portmode hybrid
switchport
spanning-tree rstp edge-port
no shutdown
!
interface fortyGigE 0/48
description ISL to Switch2
no ip address
mtu 12000
!
port-channel-protocol LACP
port-channel 100 mode active
no shutdown
!
interface fortyGigE 0/52
no ip address
mtu 12000
shutdown
!
interface fortyGigE 0/56
description ISL to Switch2
no ip address
mtu 12000
!
port-channel-protocol LACP
port-channel 100 mode active
no shutdown
!
interface fortyGigE 0/60
no ip address
mtu 12000
shutdown
!

```

```

interface ManagementEthernet 0/0
  no ip address
  shutdown
!
interface ManagementEthernet 1/0
  no shutdown
!
interface ManagementEthernet 2/0
  no shutdown
!
interface ManagementEthernet 3/0
  no shutdown
!
interface ManagementEthernet 4/0
  no shutdown
!
interface ManagementEthernet 5/0
  no shutdown
!
interface ManagementEthernet 6/0
  no shutdown
!
interface ManagementEthernet 7/0
  no shutdown
!
interface ManagementEthernet 8/0
  no shutdown
!
interface ManagementEthernet 9/0
  no shutdown
!
interface ManagementEthernet 10/0
  no shutdown
!
interface ManagementEthernet 11/0
  no shutdown
!
interface Port-channel 100
  description ISL to Switch2
  no ip address
  portmode hybrid
  switchport
  no shutdown
!
interface Vlan 1
!untagged Port-channel 100
!
interface Vlan 10
  ip address 10.200.0.6/16
  untagged TenGigabitEthernet 0/0-43
  no shutdown
!
interface Vlan 20
  no ip address
  tagged TenGigabitEthernet 0/1-43
  tagged Port-channel 100
  shutdown
!
interface Vlan 30
  no ip address
  tagged TenGigabitEthernet 0/1-43
  tagged Port-channel 100
  shutdown
!
interface Vlan 40
  no ip address
  tagged TenGigabitEthernet 0/1-43

```

```
    tagged Port-channel 100
    shutdown
    !
ip route 0.0.0.0/0 10.200.0.1
    !
ip ssh server enable
    !
ip igmp snooping enable
    !
protocol lldp
    !
line console 0
line vty 0
line vty 1
line vty 2
line vty 3
line vty 4
line vty 5
line vty 6
line vty 7
line vty 8
line vty 9
    !
reload-type normal-reload
    !
end
```

This project was commissioned by Dell EMC.



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