Support hundreds of users in a mixed workload environment in a hyperconverged Dell™ XC Series VMware® ESXi Cluster powered by Nutanix®

Powered by third generation Intel® Xeon® processors

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EXECUTIVE SUMMARY

Introduction

Datacenters have traditionally separated compute and storage resources. While this made sense for some, it also posed challenges in the areas of performance, scalability, and cost. A more modern approach brings these resources together into hyperconverged solutions, in which compute and storage share a chassis.

The Dell XC630-10 system powered by Intel processors E5-2630 v3 and using Nutanix® software is one such hyperconverged solution. Its unique architecture combines 1U form factor Dell XC630-10 appliances, Intel processors, onboard storage, and Nutanix cluster software in a flexible and scalable package that uses minimal datacenter space, which has the potential to lower power and cooling costs.

In the Principled Technologies datacenter, we set up the Dell and Intel hyperconverged solution on a VMware® vSphere® (ESXi™) 6.0 cluster. To see how well the solution functioned, we tested a mixed workload, including Microsoft® Exchange Server, Microsoft SQL Server®, file and print activity, and disk activity simulating a web server—a workload that reflects what a small to medium-sized company might do on a daily basis.

In this reference architecture, we present our findings and offer a guide and best practices for implementing this solution in your datacenter.

Objective

This reference architecture shows how the Dell XC630-10 system powered by the Intel Xeon processor E5-2630 v3 and using Nutanix software functioned well with mixed workloads when configured as a VMware vSphere cluster. It also provides best practices and a configuration guide for setting up this Dell and Intel solution running VMware vSphere in the datacenter of a medium-sized business.

Audience

We have targeted this reference architecture to an audience of IT administrators at small to medium businesses with several hundred employees. Note that we do not describe every possible configuration of each component in the Dell and Intel solution.

HARDWARE SOLUTIONS

About the Dell XC630 Web-Scale Converged Appliance

Dell XC Series Web-Scale Converged Appliances, powered by Nutanix software, let you consolidate compute and storage into a single chassis. According to Dell, these appliances install quickly, integrate easily into any datacenter, and can be deployed for multiple virtualized workloads including desktop virtualization, database, and private cloud projects. They let your enterprise grow incrementally with pay-as-you-grow, scale-out expansion; increase capacity and performance one node at a time; and meet future needs without over-provisioning.

The Dell XC630-10 is a compact 1U compute/storage node, making it attractive to companies with limited rack space and those deploying VDI and other virtualized workloads. It has 10 drive slots that can be populated with up to four SSDs (two SSDs being mandatory) and up to eight HDDs.

Learn more at www.dell.com/us/business/p/dell-xc-series/pd.

About the Dell Networking S4048-ON top-of-rack switch

The Dell Networking S4048-ON 10/40 GbE top-of-rack Open Networking switch, Dell's latest datacenter networking solution, is built to optimize performance, efficiency, flexibility, and availability in the modern datacenter. According to Dell, it offers a range of benefits, including:

- **Low latency.** To deliver the strongest performance, the S4048-ON leverages a non-blocking architecture to deliver line-rate L2 and L3 forwarding – ideal for use in high-speed, business-sensitive deployments.
- **High density.** The S4048-ON takes up only a single rack unit but offers 48 dual-speed 1/10GbE (SFP+) ports and six 40GbE uplinks. In addition to saving space, this specific level of density may simplify your migration to 40Gbps in the core of the datacenter.
- **Flexibility in the datacenter.** The S4048-ON includes several architectural features that can help you keep your datacenter running smoothly. Its I/O panel to PSU or PSU to I/O panel airflow can give you more flexibility with your hot/cold aisle arrangements, and it offers redundant, hot-swappable power supplies and fans to reduce the cost of datacenter maintenance.

Learn more at i.dell.com/sites/doccontent/shared-content/data-sheets/en/Documents/FY16Q1_201_Dell_Networking_S4048-ON_SpecSheet_040215.pdf.

SOFTWARE SOLUTIONS

Operating systems

About VMware vSphere (ESXi) 6.0

VMware vSphere (ESXi) 6.0 is the latest release of this leading server virtualization platform with management for virtual datacenters. This release includes improvements in the following areas:

- **Compute.** Increased scalability, expanded support, improved graphics, Instant Clone* Technology.
- **Storage.** vSphere Virtual Volumes, Storage Policy-Based Management (SPBM).
- **Network.** Network IO control, multicast snooping, multiple TCP/IP Stack for vMotion®.
- **Availability.** vMotion enhancements, Replication-Assisted vMotion, fault tolerance (up to four vCPUs)
- **Management.** Content Library, cross-vCenter™ Clone and Migration, enhanced user interface.

Learn more at www.vmware.com/products/vsphere#sthash.39OOD5Cl.dpuf

About Nutanix OS 4.1

According to Nutanix, the Nutanix Operating System, NOS 4.1, offers rich enterprise capabilities to meet the needs of the most demanding applications and critical infrastructure requirements in the datacenter.

The 4.1 release includes the following new capabilities:

- **Metro Availability**, which provides continuous data availability for business-critical applications during planned maintenance or unplanned disasters that affect entire sites.
- **Cloud Connect**, which seamlessly integrates public cloud services, such as Amazon Web Services (AWS), with Nutanix-powered private cloud environments.
- **Encryption Support**, encrypting user and application data to a level of FIPS 140-2 Level 2 compliance.
- **Simplified Hypervisor Upgrade**, with support for VMware ESXi, Microsoft Hyper-V®, and KVM.
- **Security/STIG Enhancements**

Learn more at www.nutanix.com/2015/01/29/announcing-general-availability-nutanix-operating-system-4-1/.

SOLUTION DESIGN AND CONFIGURATION

Overview of the scope of this guide

In this guide, we walk through the various aspects of setting up a working Nutanix cluster on a three-node Dell XC630 appliance configuration. We cover the network setup, including cabling, switch configurations, and VLAN tagging; initial cluster creation for Nutanix and vSphere, and cluster storage configuration for a three-node cluster of Dell XC630-10 appliances. We will also highlight best practices as appropriate.

Before you begin

In preparation for setting up your Nutanix environment on VMware with XC630 hosts, you will need one IP address available for the cluster's IP address and at least three IP addresses per host: one each for the host's CVM, the host's management, and the host's IPMI interface. In our environment, we used VLAN tagging to keep the IPMI network separate from the CVM traffic, but a flat network could also be set up to avoid our more complex network design. The IPMI interfaces are required for successful cluster deployment, even though their reachability does not affect the normal functioning of the Nutanix cluster post-install. Also, note that if your IPMI interfaces are not configured with routable IP addresses, some support and management functionality could potentially be impacted.

Assumptions of this guide

We assume in this guide that each Dell XC630 appliance has had ESXi 6.0 pre-installed and the Nutanix Phoenix flashing process performed already (Phoenix takes care of configuring disks, networking, and Nutanix Controller VM creation). We also assume the administrator following this guide has an existing vCenter server or appliance, DNS server, and gateway in his or her environment. We assume that before beginning the methodology steps, you have configured the iDRAC/IPMI interface on each host with an IP address and subnet mask, and provided them with the existing DNS and gateway addresses.

From a networking perspective, we designed this guide to be representative of a real-world enterprise environment, rather than a basic flat network. Though we cover setup for a more complex network infrastructure, including redundant switches, VLAN tagging to segregate traffic, and virtual link trunking, Nutanix can be deployed on a vSphere environment in a similar fashion on a simpler network.

Introduction to Nutanix architecture

Nutanix uses a hyperconverged infrastructure to provide a tiered storage solution to VMs. Every host in a Nutanix cluster houses a Controller VM (CVM), which runs the Nutanix software and handles all storage I/O operations for the host's hypervisor and all the VMs residing on that host. In the case of ESXi, the host server's SSDs and hard disk drives are directly passed through to the CVM for management.

Administrators can create a storage container from the Nutanix cluster's disks to be used as storage for all the cluster's hosted VMs. Nutanix cluster nodes typically have a small number of fast but low-capacity SSDs and a larger number of slower but high-capacity HDDs. Nutanix's storage tiering/prioritization works to move data to the most appropriate location (either local SSDs, cluster SSDs, or HDDs) based on availability of fast storage and how frequently the data in question is accessed. By converging compute and storage resources into single appliance nodes, scaling Nutanix clusters out is easy and flexible.

Solution architecture and diagrams

Every Dell XC630 appliance in a Nutanix cluster has the same basic configuration: a tier of SSD-based flash storage, a tier of hard disk drives, compute resources in the form of two Intel Xeon processors E5-2630 v3, and 192 GB of DDR4 RAM. At the hypervisor layer, each host runs VMware ESXi, which hosts a single Nutanix Controller VM, and as many other VMs as you configure for your environment (see Figure 1).

Dell XC630 host
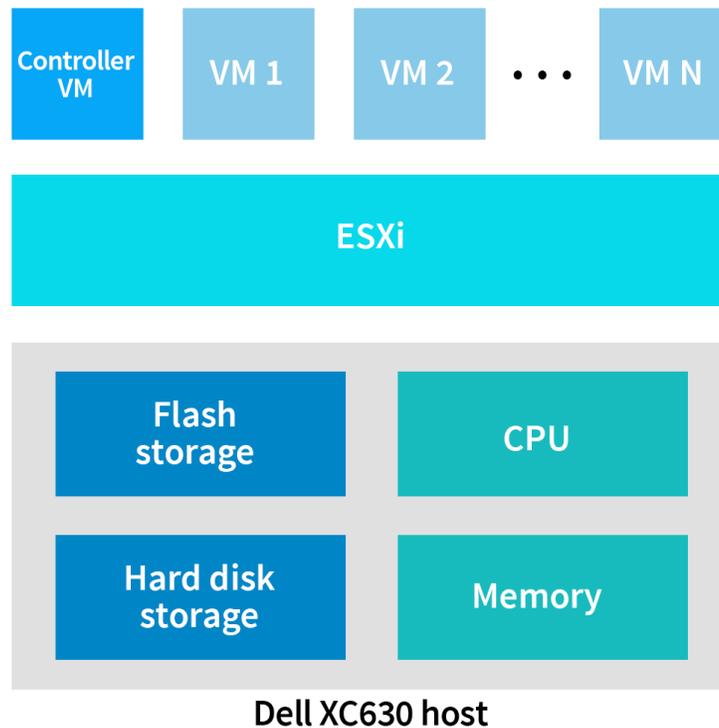
Figure 1: The structure of each node in our Nutanix cluster.

Once the cluster has been created, the flash and hard disk storage resources from each node are logically grouped and defined through software as a storage pool. From there, a container is created and used for housing the virtual hard disks and virtual machine configuration files for your environment. Although we did not use these features, Nutanix offers storage efficiency technologies such as deduplication, which removes duplicate data to increase the effective amount of storage resources available and accelerate performance, as well as thin provisioning, which allows a LUN to be created without allocating physical storage space that would go unused initially (more physical space is used as the actual space fills up). For more information on deduplication as provided by Nutanix, go to www.nutanix.com/products/features/enterprise-storage/deduplication/. Figure 2 shows how the storage for the three-node cluster we tested was configured.
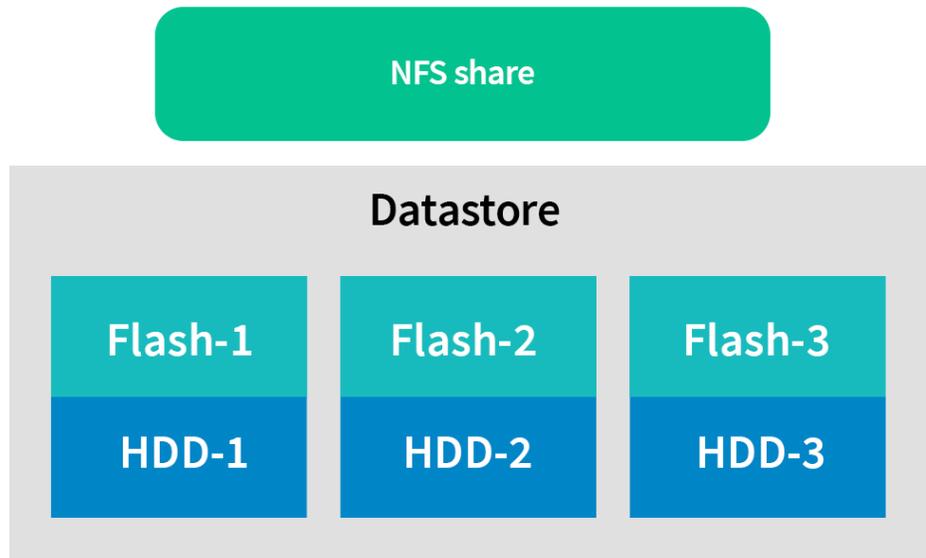
Figure 2: The Nutanix storage cluster's container is comprised of the flash and hard disk storage from each host.

Our environment used redundant 10 Gbps Dell Networking S4048-ON switches for cluster/VM traffic and vMotion, and redundant 1 Gbps Dell Networking N2024 switches for IPMI traffic. We used VLAN tagging to segregate the public traffic from the vMotion traffic and Fault Tolerance traffic, Dell Virtual Link Trunking (VLT) between the S4048-ON switches, and 1 Gbps links between the S4048-ON switches and the N2024 switches (see Figure 3).
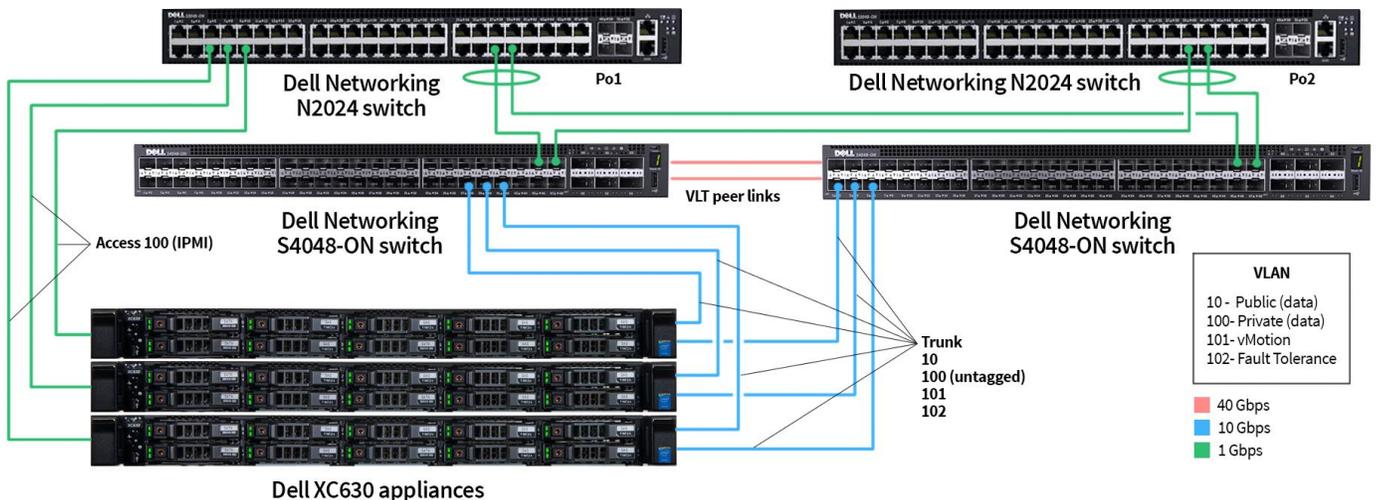
Figure 3: The network configuration for the Nutanix cluster we tested on Dell XC630 appliances.

The Dell XC630 is configured (by the Phoenix flashing process) with a NIC team created from the two 10Gb SFP ports on the Intel X520/i350 network daughter card. Two virtual switches come preconfigured as well: one for traffic between the host and the Nutanix CVM, and one for Nutanix cluster, vSphere management, and VM traffic. We will later create VMkernel ports on the management switch for vMotion traffic and Fault Tolerance traffic (see Figure 4).
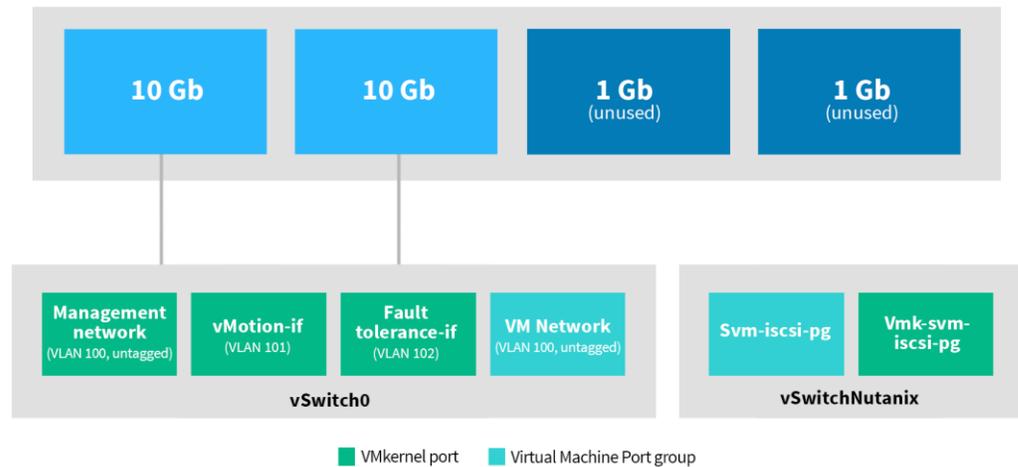
Figure 4: The structure of each XC630 host's NIC team, formed from the two 10 Gbps ports, and their virtual switches and VMkernel ports and port groups. Note that the 1 Gbps ports are unused.

Creating the Nutanix cluster

1. Perform the following on each of the Controller VMs to configure their IP addresses:
   a. Log in with the default admin credentials.
   b. Using vi, edit /etc/sysconfig/network-scripts/ifcfg-eth0, setting `BOOTPROTO=static`, `IPADDR=XX.XX.XX.XX`, `NETMASK=YY.YY.YY.YY`, and `GATEWAY=ZZ.ZZ.ZZ.ZZ`, using appropriate values for the IP address, subnet mask, and gateway. Save and close the file.
   c. Using vi, edit /etc/resolv.conf. Add a new line of `nameserver XX.XX.XX.XX`, using an appropriate IP address for your environment's DNS server.
   d. Restart network services with `/etc/init.d/network restart`.
2. On the Windows® 7 management system, be sure that Mozilla® Firefox® and Bonjour® (which is included with iTunes® or downloadable from support.apple.com/kb/DL999) are installed.

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3. Determine the IPv6 service name for one of the Dell XC630 nodes that will be added to the cluster. IPv6 service names are uniquely generated at the factory and have the following form (note the final period): NTNX-*system_service_tag-node_location-CVM.local.* On the front left side of the system is a slide-out label that contains the *system_service_tag* (for example, B57PW12). The *node_location* is *A* for one-node blocks.

4. In the Windows 7 management system, launch Mozilla Firefox, and in the URL bar, enter `http://cvm_ipv6_addr:2100/cluster_init.html`, replacing `cvm_ipv6_addr` with the IPv6 service name determined in step 2. For example, the URL we accessed was `http://NTNX-2PSNS52-A-CVM.local.:2100/cluster_init.html`

   Note: Be careful to include the period after the word `local` in the URL.
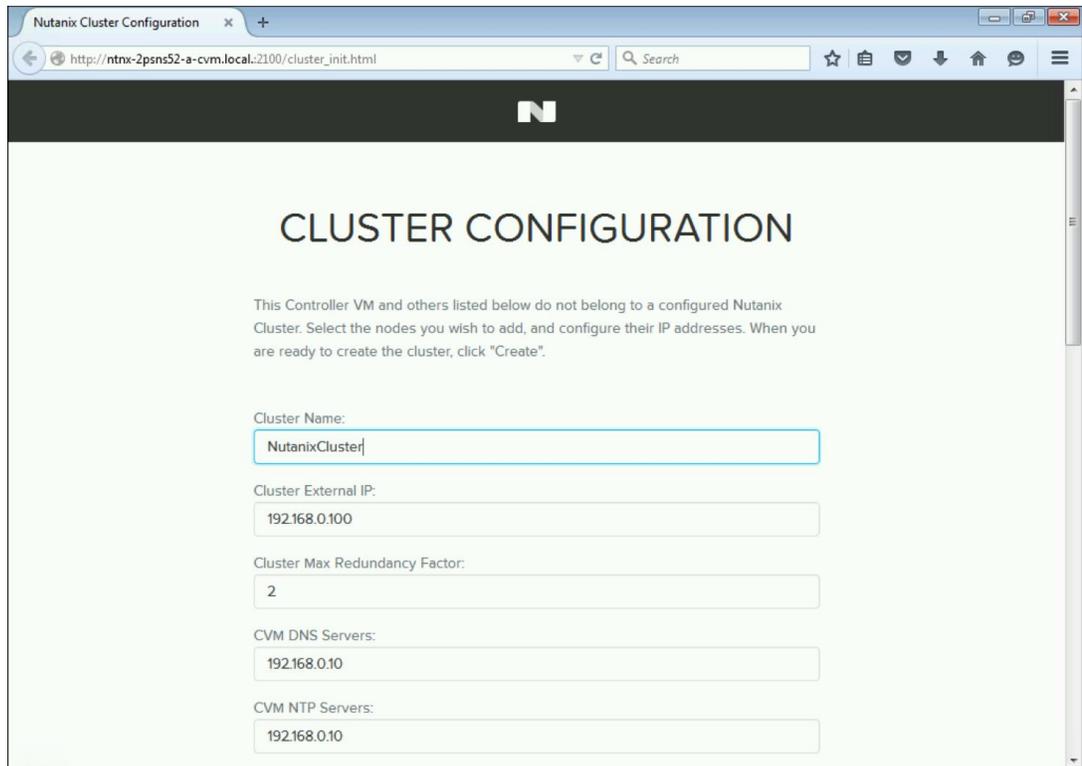
Figure 5: Providing a cluster name, external IP, CVM DNS server, and CVM NTP server.

5. In the Cluster Name field, provide an appropriate name (of 15 characters or fewer) for your Nutanix Cluster.

6. In the Cluster External IP field, provide an appropriate IP address for your Nutanix Cluster. This IP can be used to access the web console and nCLI once the cluster is created.

7. Leave the Cluster Max Redundancy Factor at 2, because we are using only three nodes. A cluster must have at least five nodes to use a redundancy factor of 3, but that configuration is beyond the scope of this guide.

8. Provide the IP address(es) of the Active Directory® domain controller(s) in the CVM DNS Servers and CVM NTP Servers fields.
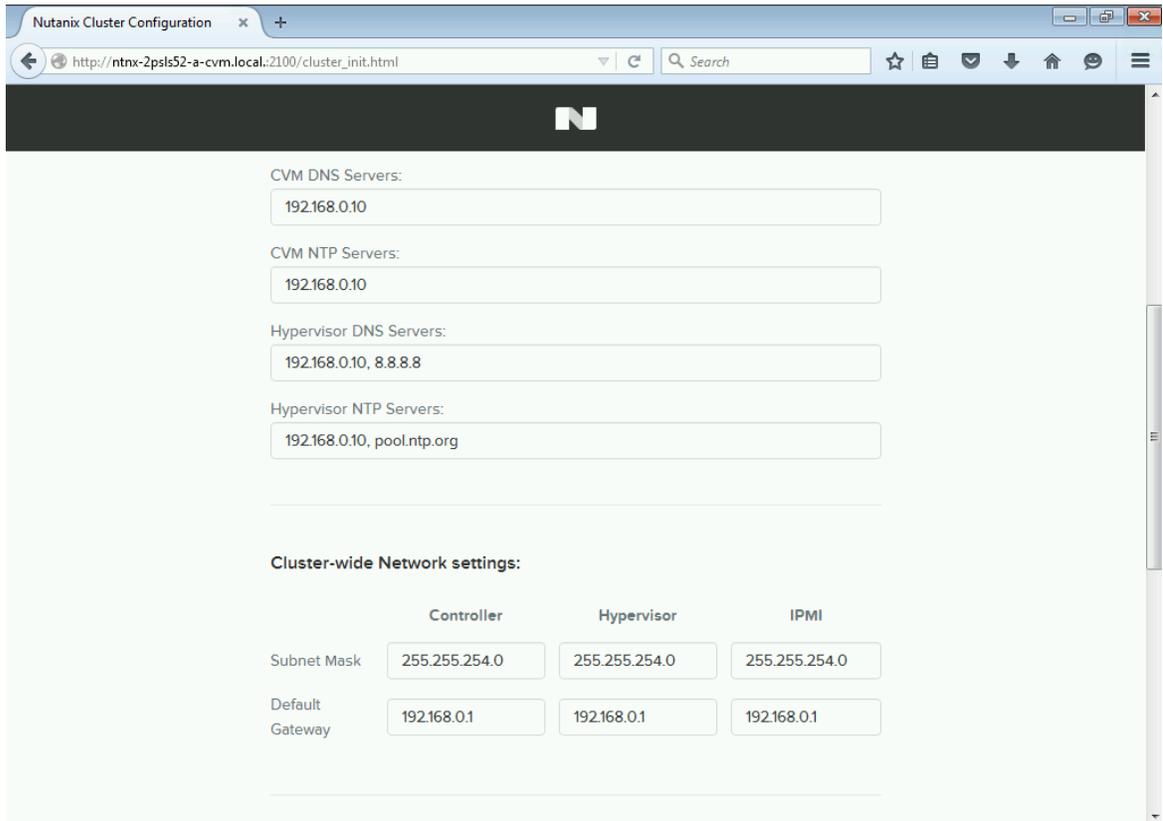
Figure 6: Providing the appropriate subnet masks and default gateways in the Cluster-wide Network settings.

9. Provide the IP address(es) of the Active Directory domain controller(s), and in the Hypervisor DNS Servers field, enter `8.8.8.8`

10. Provide the IP address(es) of the Active Directory domain controller(s), and in the Hypervisor NTP Servers field, enter `pool.ntp.org`

11. Provide the subnet masks and default gateways for each Controller, Hypervisor, and IPMI into the Cluster-wide Network Settings table, if they are not already populated.
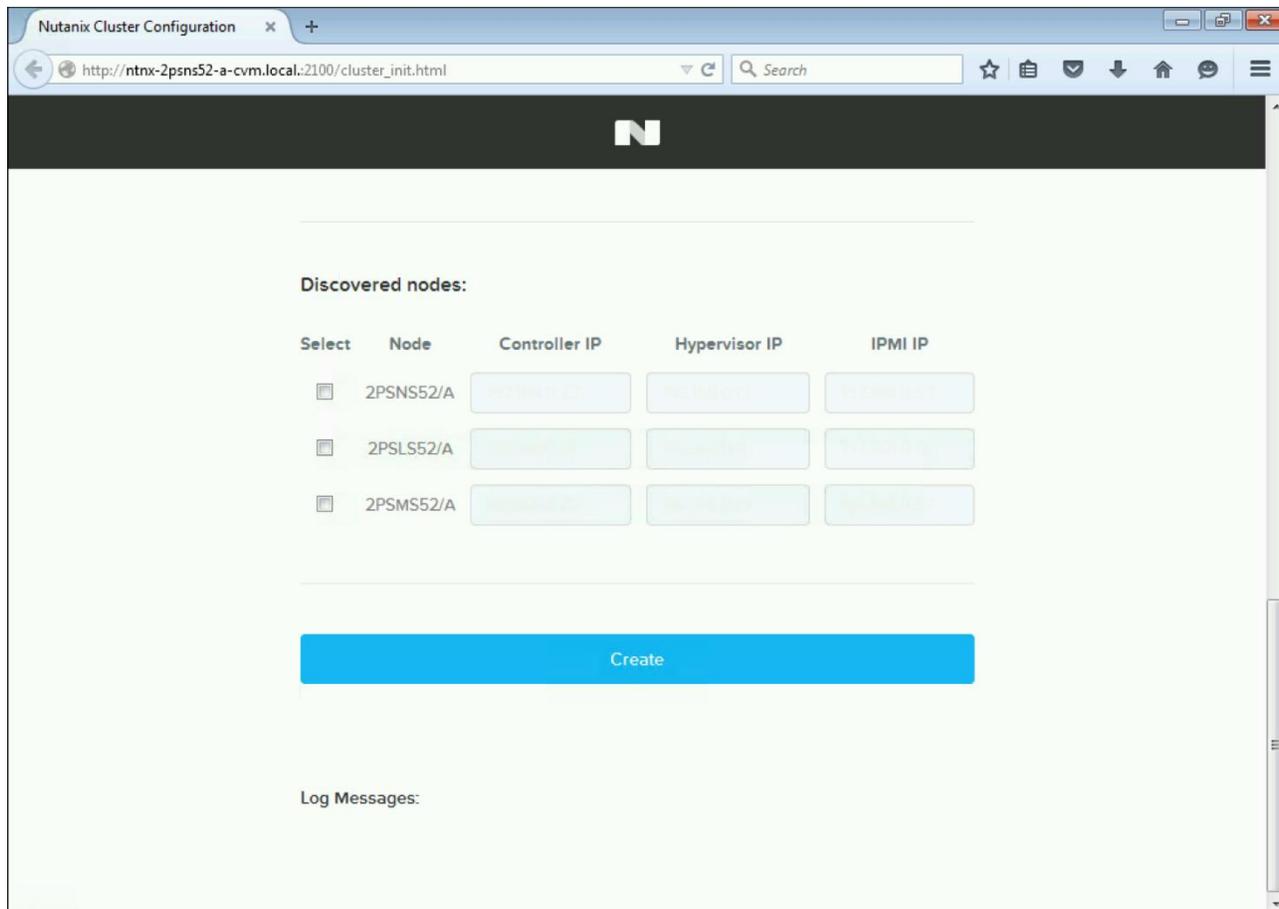
Figure 7: If IPv6 link-local connectivity is working properly, your nodes should appear in the list of Discovered nodes.

12. Check the box next to each node that you want to add to the cluster.
13. Provide an appropriate IP address for all the components in the cluster, if the values are not already populated. The discovered nodes are not listed in a particular order, so be sure to assign the intended IP addresses to each node.
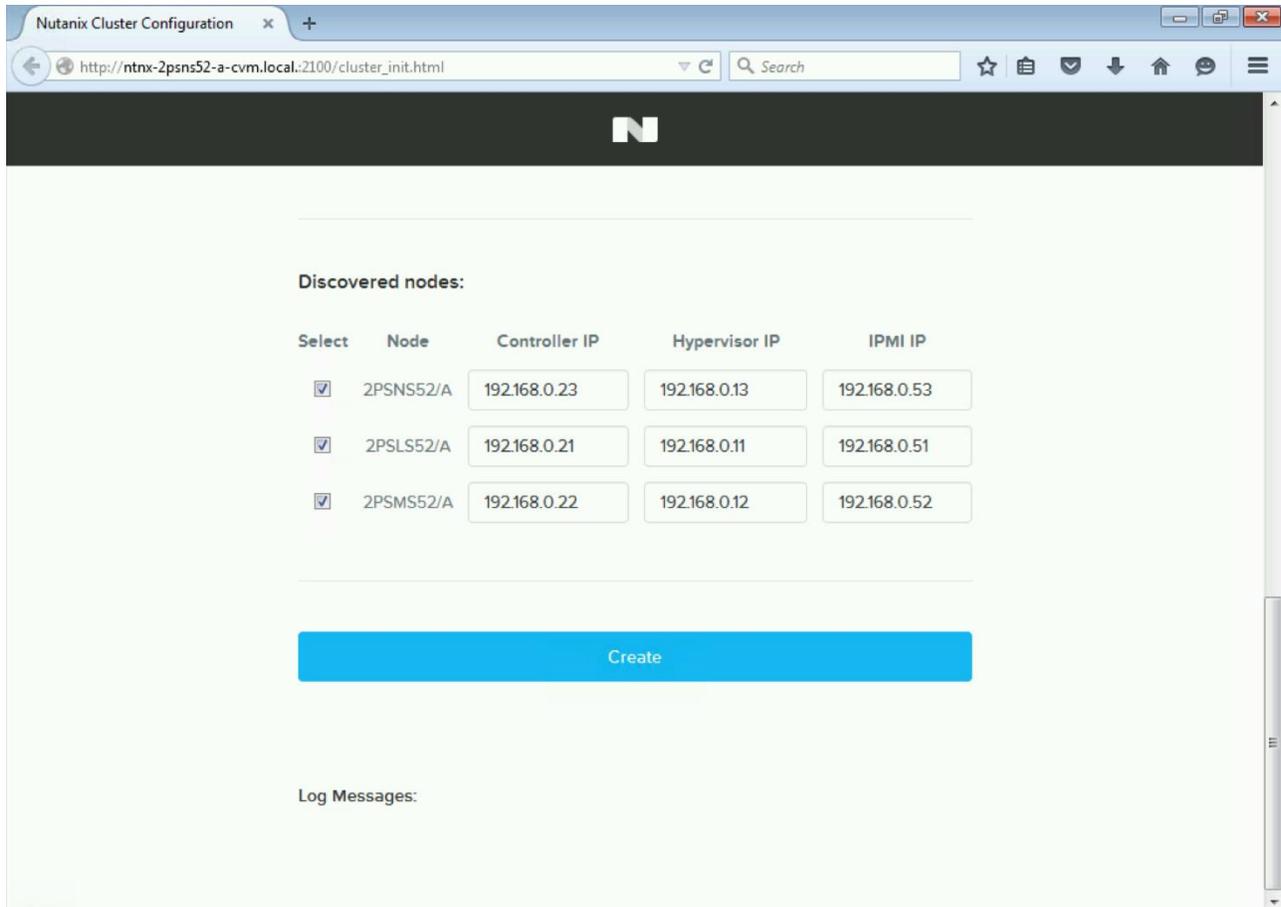
Figure 8: Provide IP addresses for the Controller, Hypervisor, and IPMI for each discovered node.

14. When you are ready to create the cluster, click Create.
15. Wait until the Log Messages section of the page indicates that the cluster has been successfully configured. The cluster starts automatically after creation succeeds.
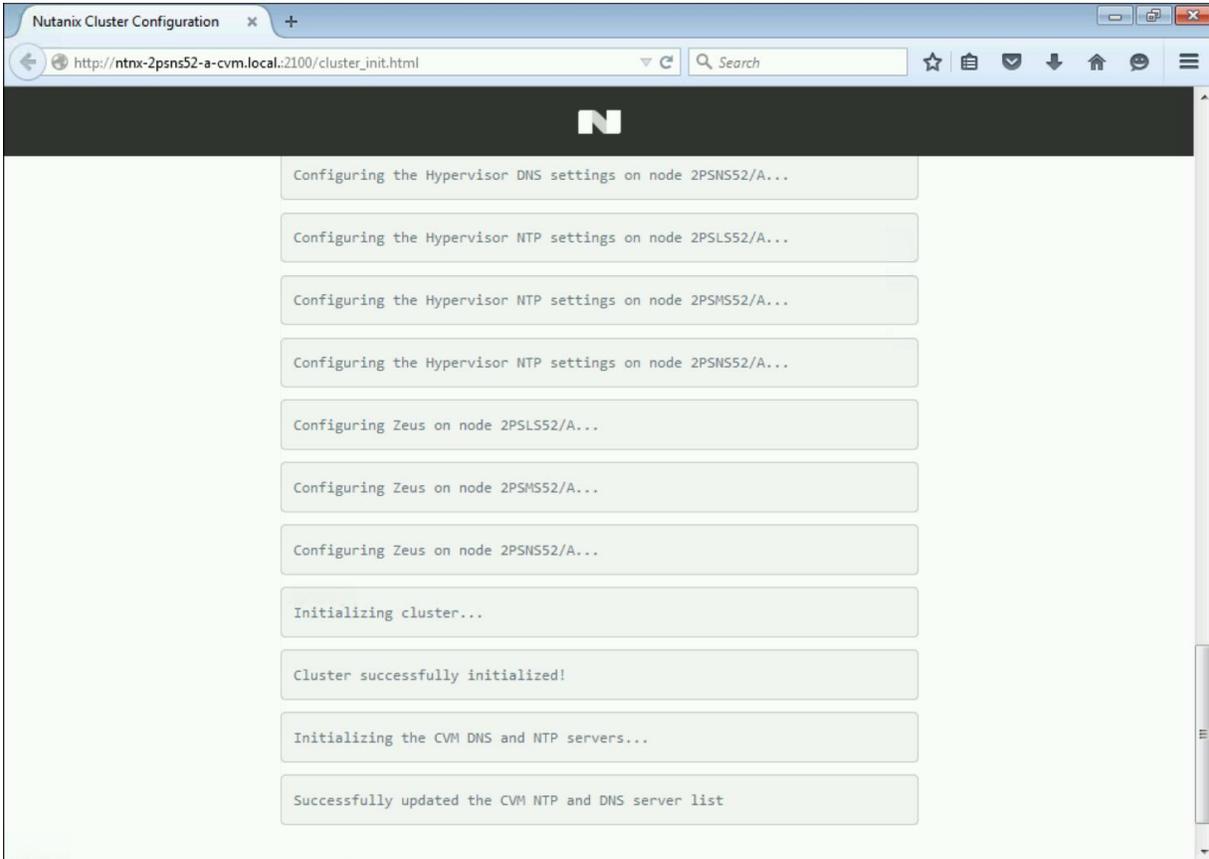
Figure 9: Log Messages output indicating successful creation of the Nutanix cluster.

16. Log onto any Controller VM with SSH.

17. Verify that all services are up on all Controller VMs by entering the command `cluster status`.


```
CVM: 192.168.0.21 Up
                Zeus    UP [8214, 8239, 8240, 8242, 8289, 8303]
           Scavenger    UP [10441, 10466, 10467, 10504]
        SSLTerminator   UP [10552, 10579, 10580, 10693]
            Acropolis   UP [10589, 10636, 10637, 13430]
               Medusa   UP [12027, 12055, 12056, 12078, 12225]
    DynamicRingChanger  UP [12415, 12444, 12445, 12559]
               Pithos   UP [12432, 12471, 12472, 12573]
             Stargate   UP [12466, 12500, 12501, 12717, 12718]
              Cerebro   UP [12502, 12531, 12532, 12719]
              Chronos   UP [12520, 12557, 12558, 12682]
              Curator   UP [12556, 12598, 12599, 12732]
                Prism   UP [12596, 12628, 12629, 12699, 13650]
                  CIM   UP [12615, 12656, 12657, 12695]
         AlertManager   UP [12644, 12680, 12681, 12747]
             Arithmos   UP [12803, 12832, 12833, 12978]
       SysStatCollector UP [12820, 12861, 12862, 13049]
               Tunnel   UP [12854, 12886, 12887]
        ClusterHealth   UP [12889, 12961, 12962, 13021, 13047, 13048, 13379, 13380]
                Janus   UP [12896, 12930, 12931, 13274]
      NutanixGuestTools UP [12921, 12976, 12977]
```

Figure 10: Verifying that all cluster services are running properly on each node in the cluster.

18. On the Windows 7 management system, enter the cluster IP address into the URL bar, and press Enter.
19. Enter a password for the cluster admin account, and re-enter it. Click the arrow button when finished.
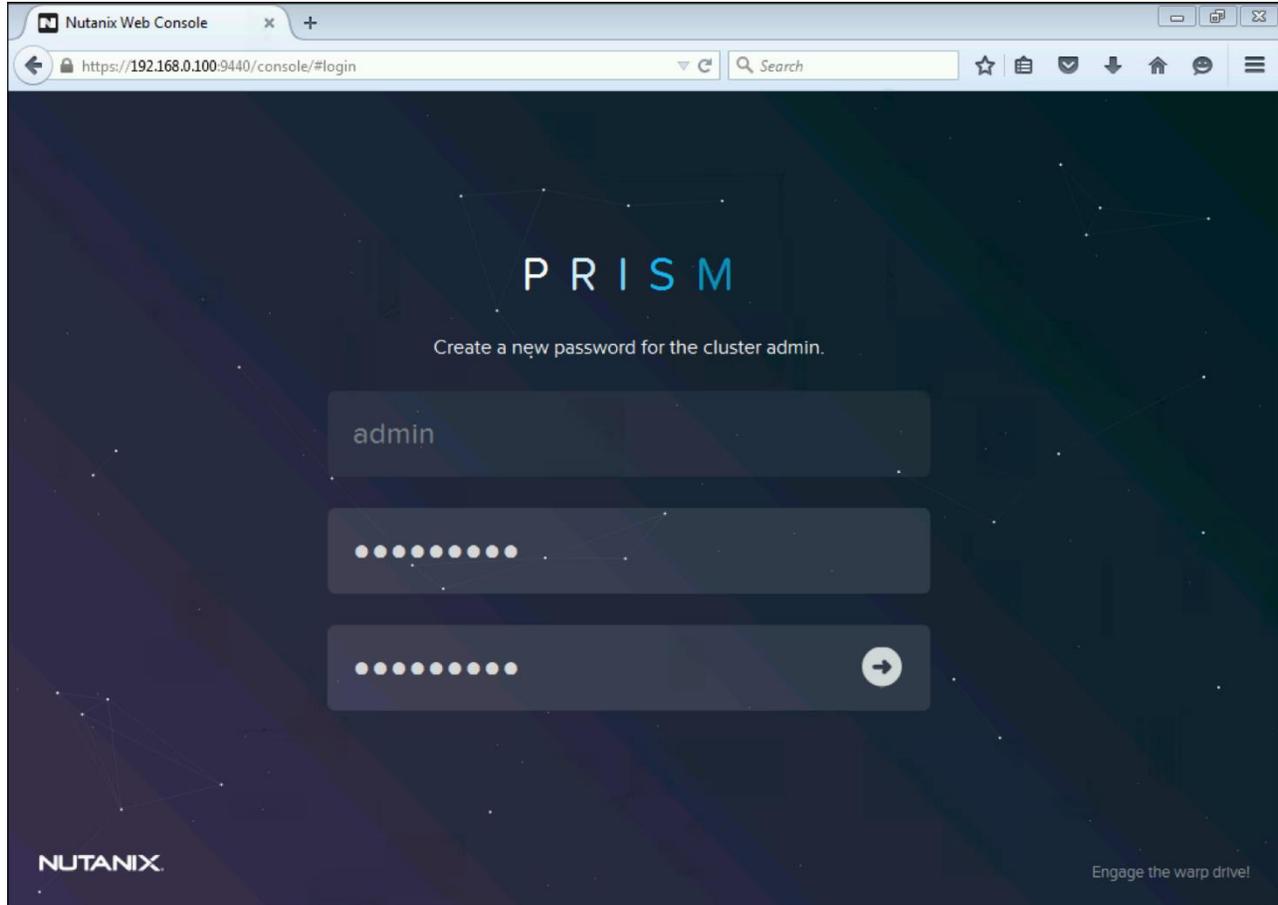
Figure 11: Providing an admin password for the Nutanix cluster.

20. Enter the admin credentials at the login prompt, and click the arrow button to log in.
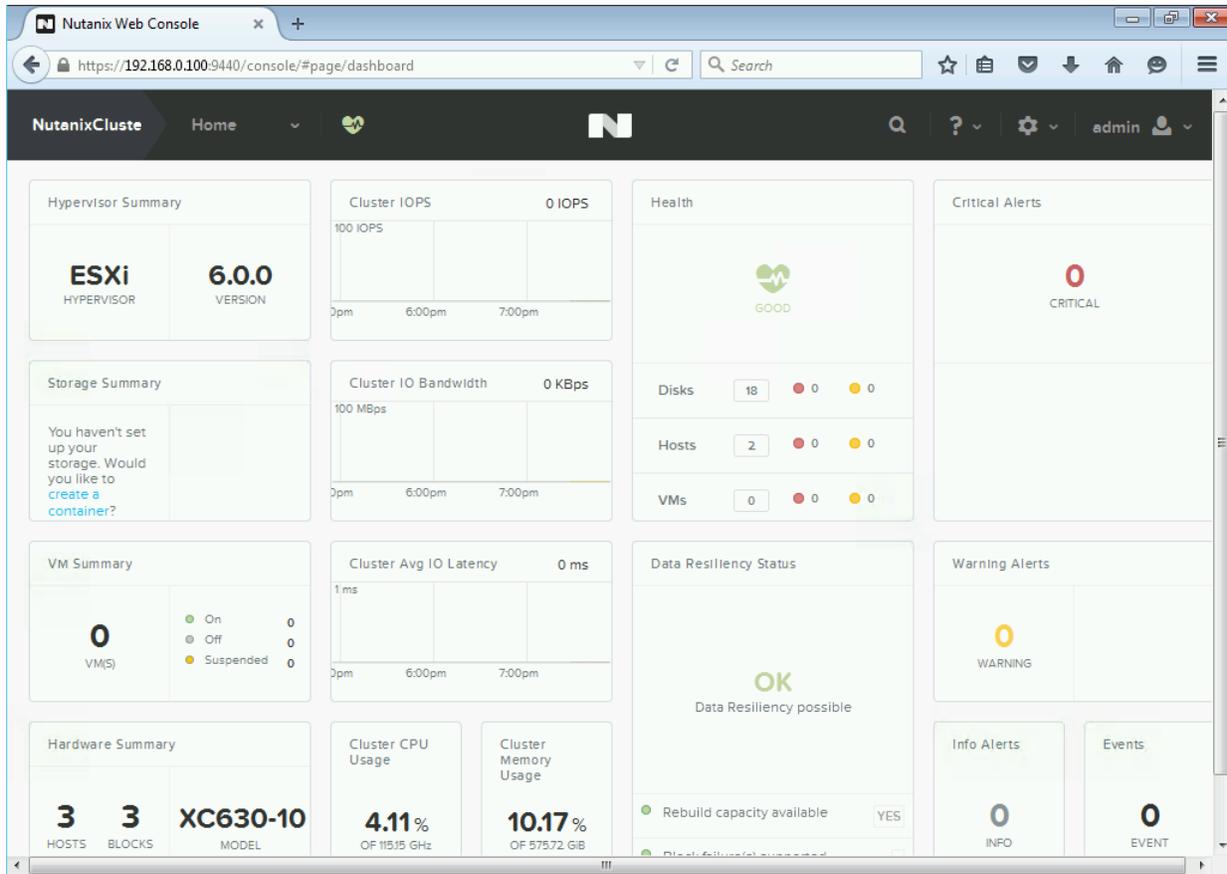
Figure 12: The Nutanix Web Console dashboard page.

Configuring Nutanix storage

After creating the cluster, you must create a storage pool and a container. For most organizations, it will be suitable to create a storage pool comprising all the physical disks in the cluster and a container using all available capacity in the storage pool.

1. From the Nutanix Web Console main page, click the Home drop-down menu, and select Storage.
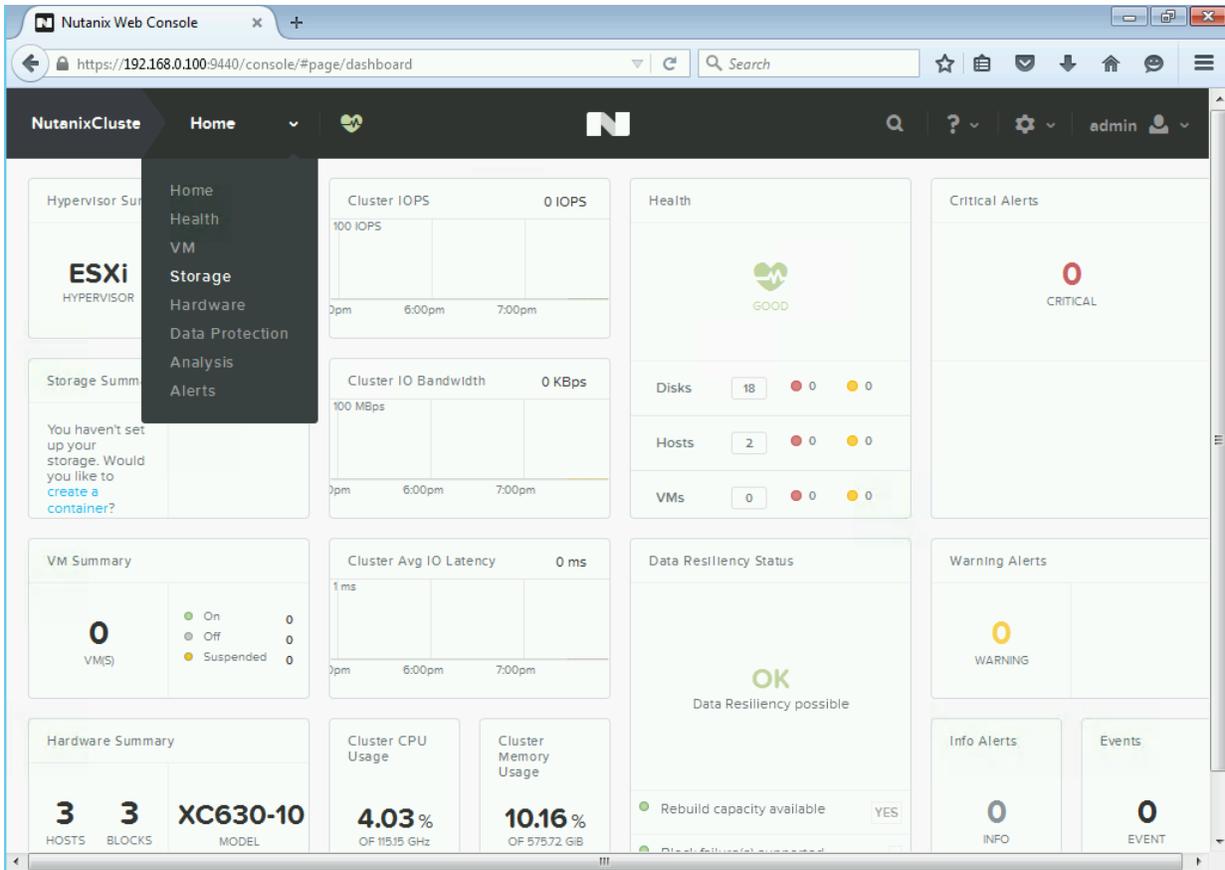
Figure 13: The Storage drop-down menu selection.

2. Click + Storage Pool in the upper-right corner. The Create Storage Pool dialog box appears.
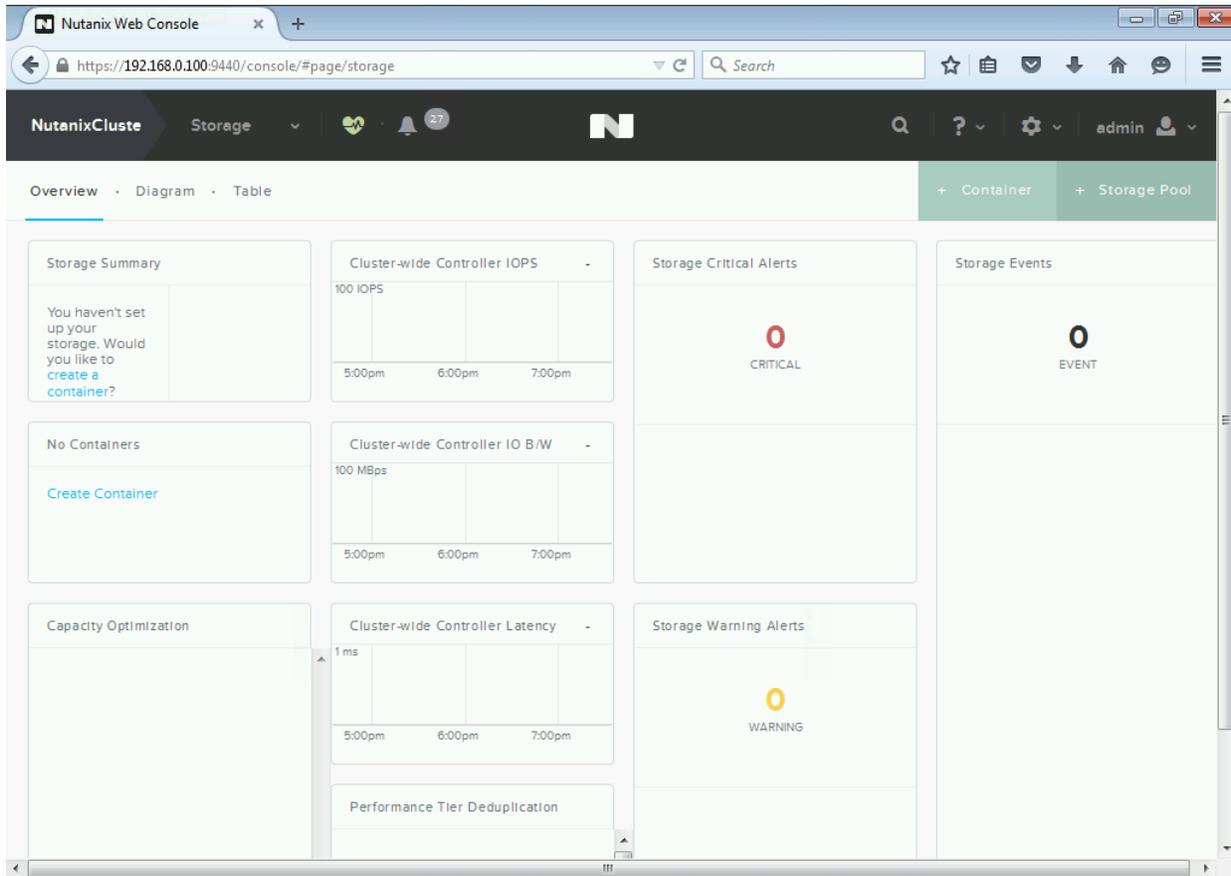
Figure 14: The Nutanix Web Console Storage page.

3. Provide a name for the storage pool, and be sure that Use unallocated capacity is checked, because that will be suitable for most environments.
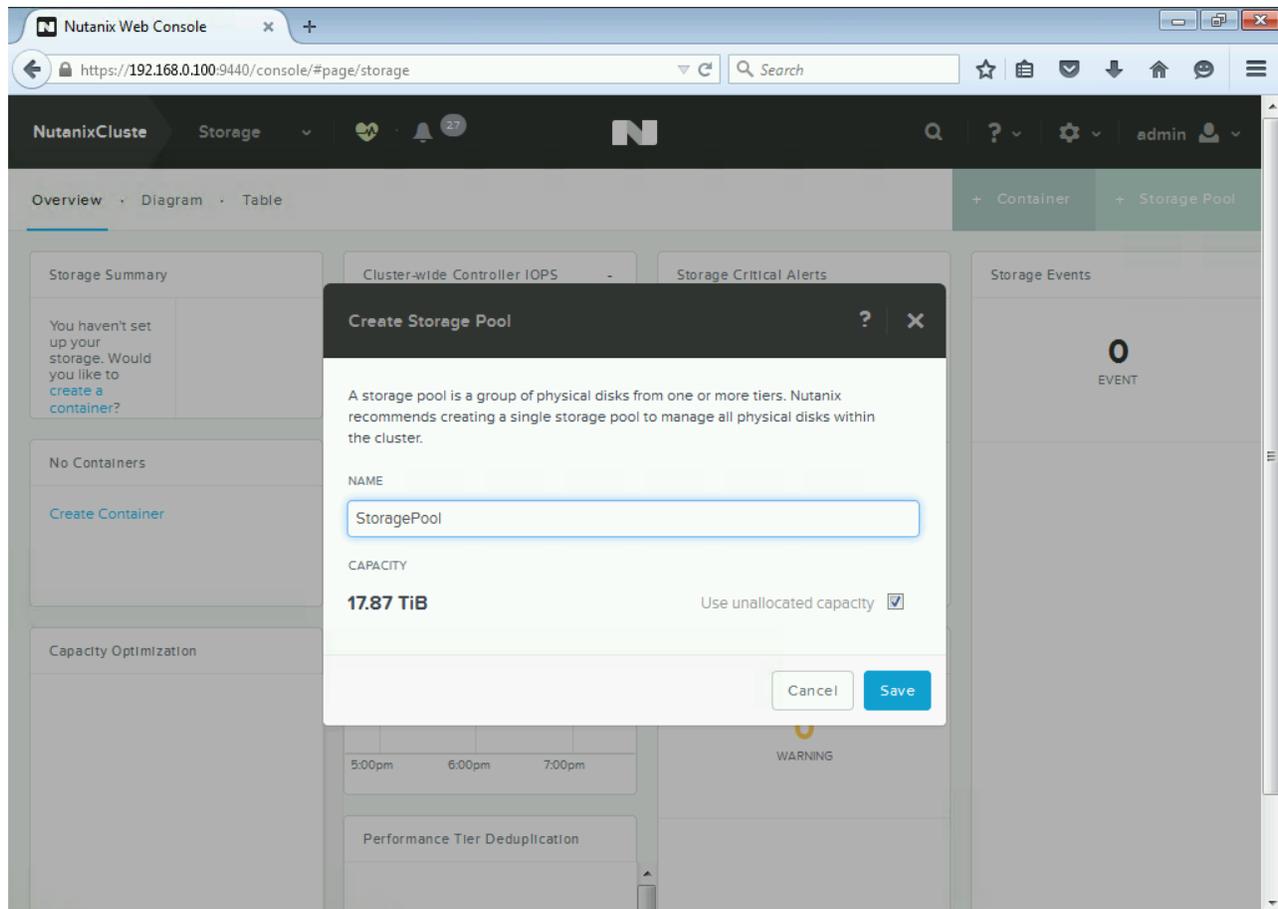
Figure 15: Creating a storage pool in the Nutanix Web Console.

4. Click Save.

5. On the Storage page, click + Container. The Create Container dialog box appears.

6. Provide a name for the container, check that the container will be created in the intended storage pool, and verify that the NFS datastore will be mounted on all ESXi hosts. Click Save.
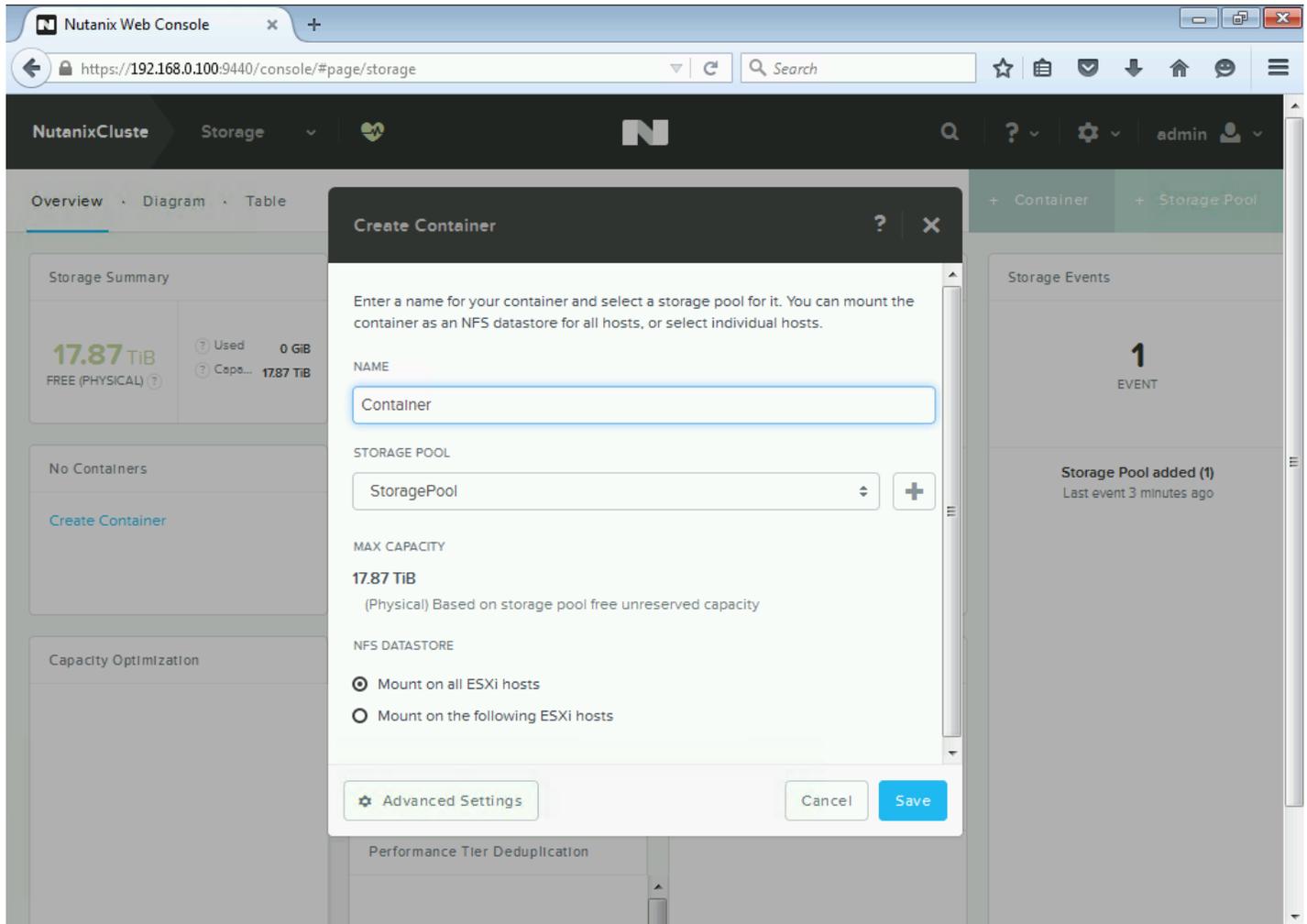
Figure 16: Creating a container in the Nutanix Web Console.

Configuring Dell XC630 hosts in vCenter

This guide assumes your environment has an existing deployment of VMware vCenter Server. After creating the storage on the Nutanix cluster, add the Dell XC630 hosts to a vCenter for management. From there, configure their networking for performance and security as per Nutanix best practices.

1. In a browser, log into the vSphere Web Client for the vCenter server.
2. In the Navigator pane, right-click the vCenter server, and select Add Datacenter.
3. Provide a name for the Datacenter, and click OK.
4. In the Navigator pane, right-click the new Datacenter, and select New Cluster…

5. Provide a name for the cluster, and check the Turn ON boxes for DRS and vSphere HA. Under DRS, make sure the Automation Level is set to Fully automated.
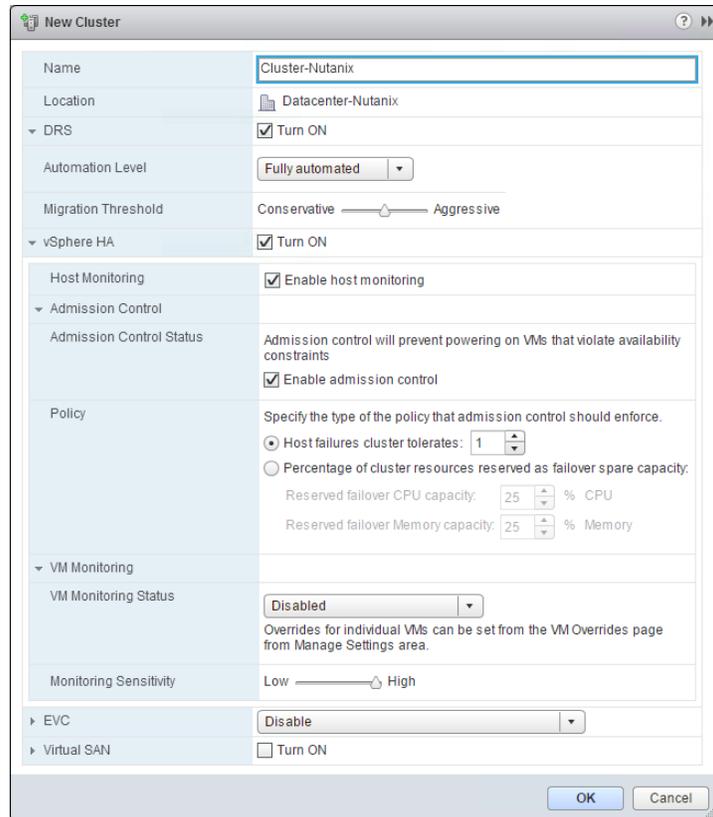
Figure 17: Creating a new HA/DRS cluster in vCenter.

6. In the Navigator pane, select one of the Dell XC630 hosts, and click the Manage tab.

7. In the Networking page, click VMkernel adapters, and click Add host networking.
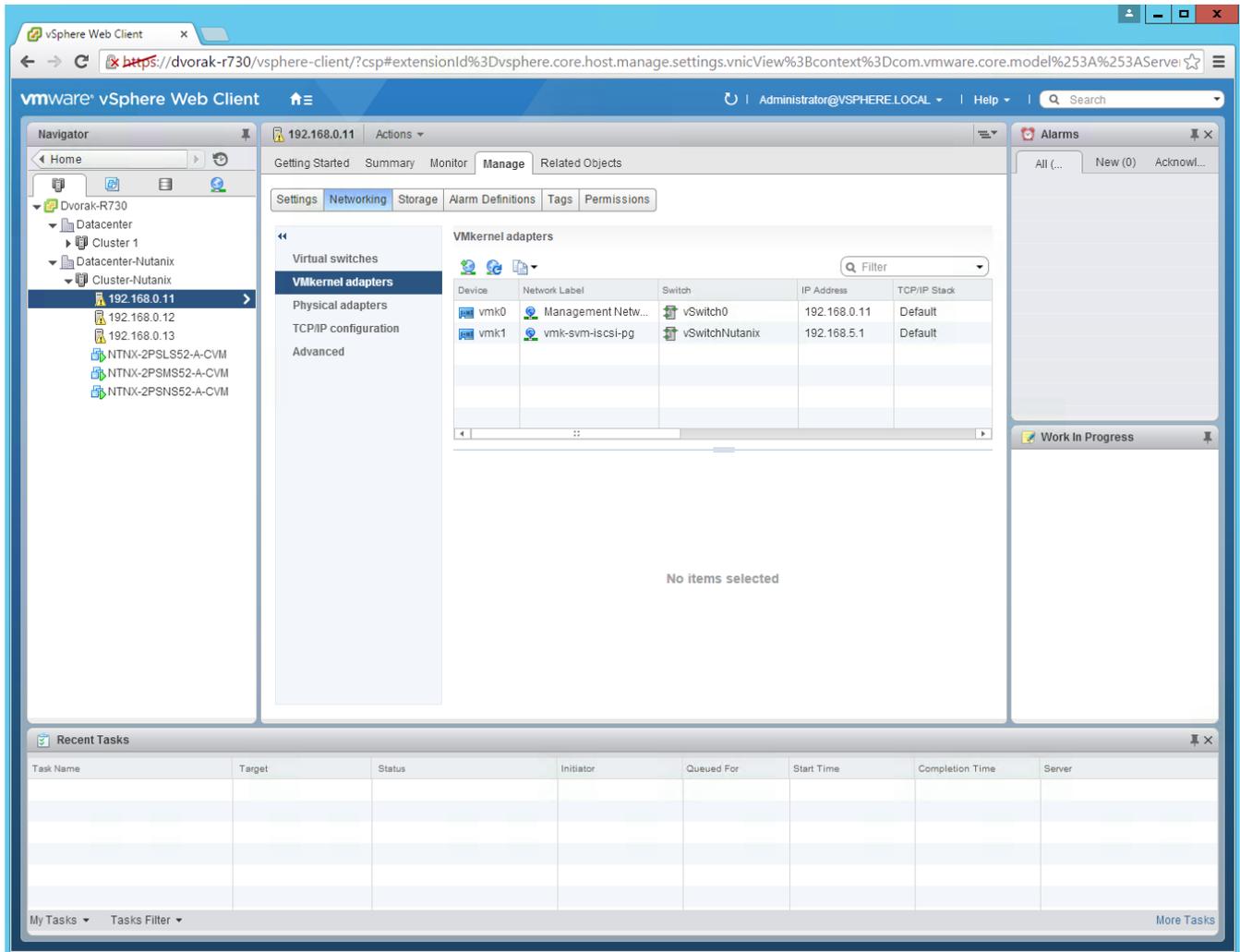
Figure 18: The network management page for an XC30 host in the vSphere Web Client, with the default network configuration.

8. Leave VMkernel Network Adapter selected, and click Next.

9. In the Select an existing standard switch field, click Browse, and select vSwitch0. Click Next.

10. Provide a network label. We create one named `vMotion-if` and another named `FaultTolerance-if` for each host.

11. Set the appropriate VLAN ID for the type of traffic intended for this port. We used VLAN 101 for vMotion, and VLAN 102 for Fault Tolerance.

12. Check the appropriate box for either vMotion traffic or Fault Tolerance logging, and click Next.
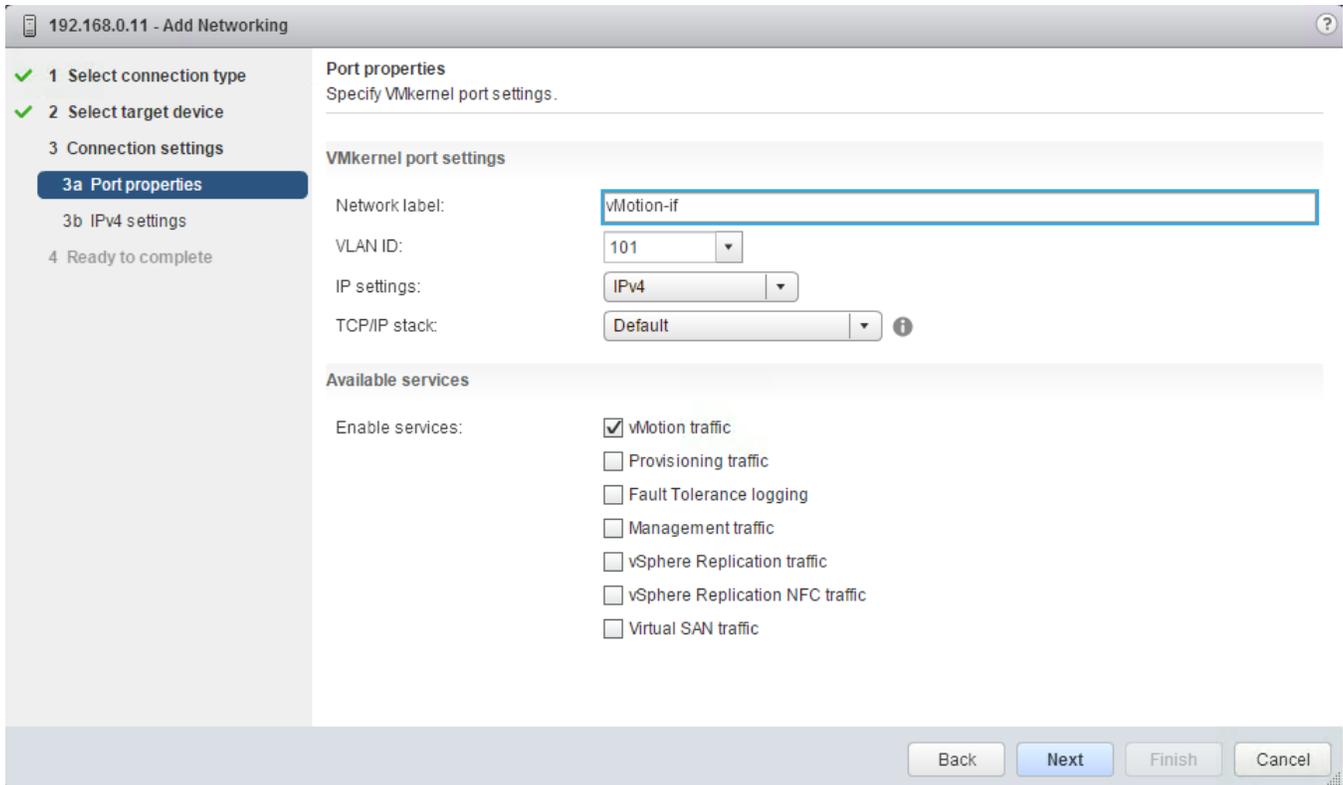
Figure 19: Enabling vMotion traffic and setting the appropriate VLAN ID on a new VMkernel port.

13. Set an appropriate static IP address, using separate subnets for vMotion and Fault Tolerance. Click Next.

14. Click Finish.

15. Repeat steps 7 through 14 for the Fault Tolerance VMkernel port.

16. Repeat steps 6 through 15 for the two remaining Dell XC630 hosts.

17. Select the first Dell XC630 host in the navigator pane, and under its Manage tab, click Networking.

18. In the Virtual switches section, select vSwitchNutanix, and click Edit.

19. Set the MTU to 9000, and click OK.

20. Repeat steps 18 and 19 for vSwitch0.
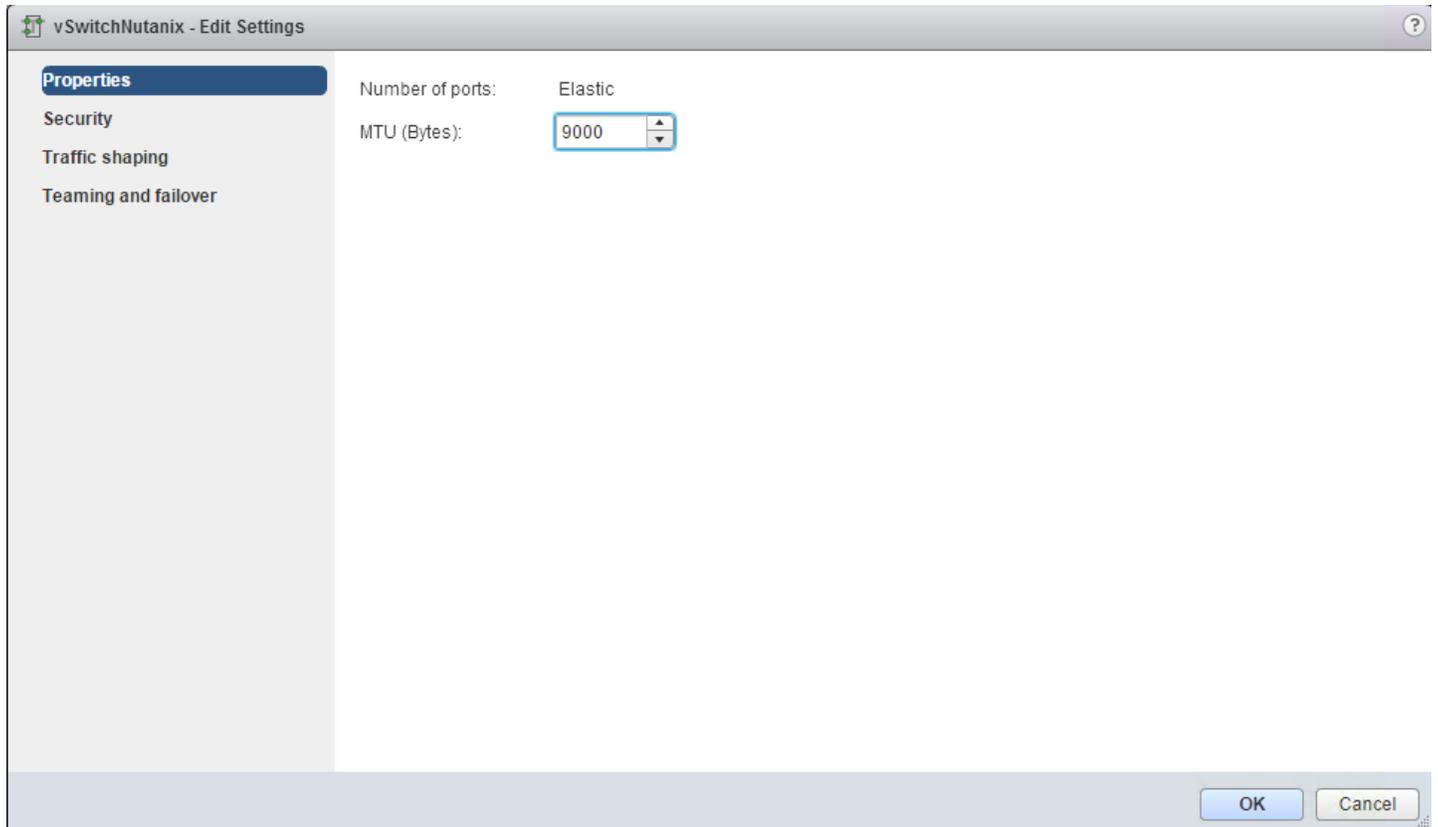
Figure 20: Enabling jumbo frames (MTU 9000) on the Nutanix vSwitch.

21. Click VMkernel adapters, select the vMotion-if adapter, and click Edit.

22. In the NIC settings section, set the MTU to 9000, and click OK.

23. Repeat steps 21 and 22 for the FaultTolerance-if adapter and Vmk-svm-iscsi-pg adapter.

24. In the Networking page, select vSwitch0, and click Edit.

25. Select the vmnic in the Standby adapters section, and click the up arrow button to move it to the Active adapters section.

26. Click OK.

27. Repeat steps 17 through 26 for the remaining two Dell XC630 hosts.

28. Right-click the cluster in the Navigator pane and select Settings.

29. In the VM Overrides page, select each CVM and select Edit.

30. Set the vSphere HA Restart Policy to Disabled.

31. Set the Host Isolation Response for all CVMs to Leave Powered On.

32. Set the VM Monitoring for all CVMs to Disabled.

33. In the vSphere HA page, click Edit.

34. In the Datastore for Heartbeating section, Use datastores only from the specified list, and select the Nutanix datastore.

35. In the Advanced Options, click Add, and add an option named
    `das.ignoreInsufficientHbDatastore` with a value of `true`, and
    click OK.
36. Select vSphere DRS, and set the DRS Automation Level to Manual.
37. Set the Power Management Automation Level to Off.
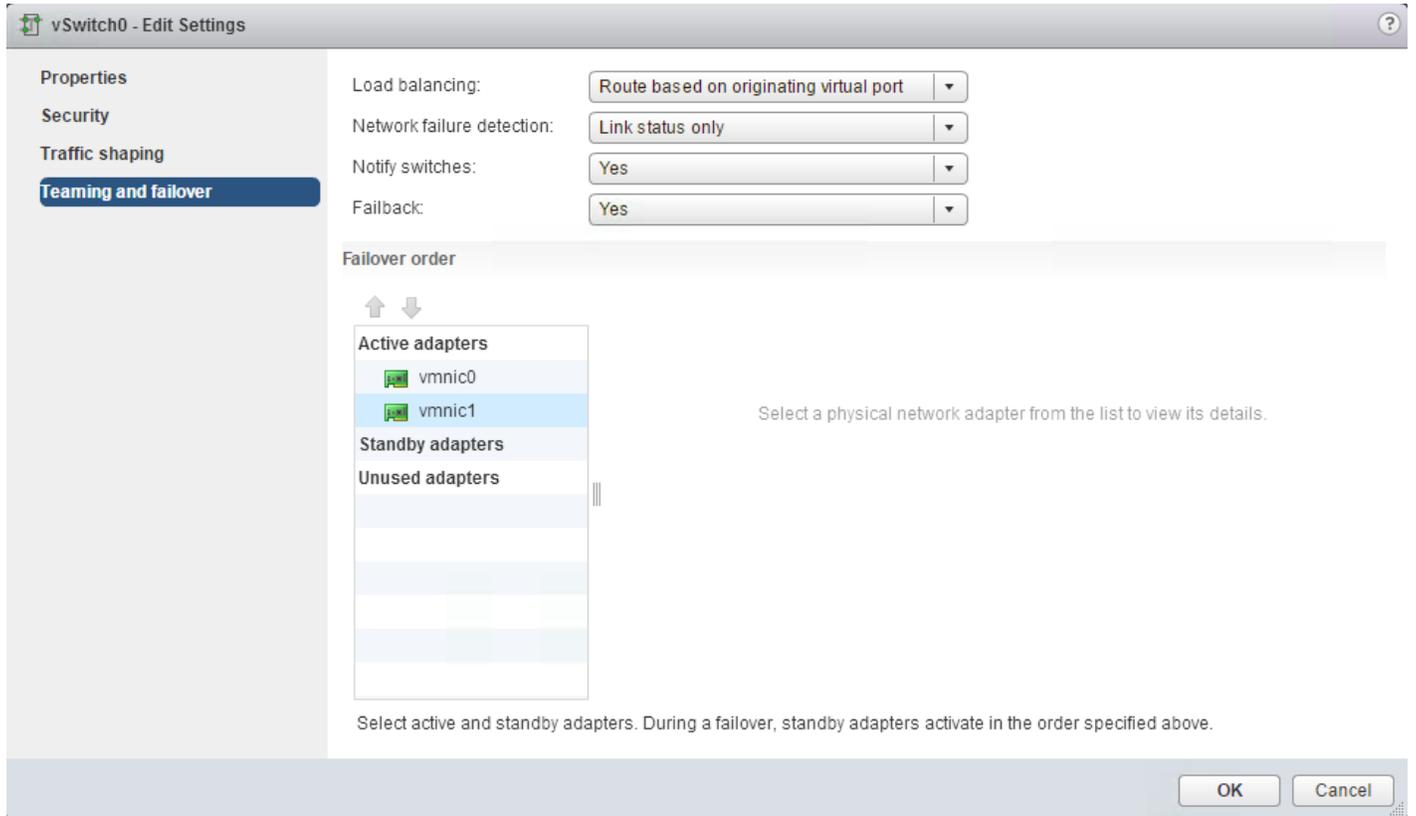
Figure 21: Setting both vmnic adapters to Active in the vSwitch0 NIC team in the vSphere Web Client.

ABOUT THE TEST ENVIRONMENT

Figure 22 presents the test hardware we used, and Figure 23 provides an overview of the VMs in our testing.

Hardware	Quantity
Dell XC630-10 1U appliance	3
Dell Networking S4048-ON 10 Gigabit switch	2
Dell Networking N2024 Gigabit switch	2

Figure 22: Test hardware.

VM	Application	Role	Host
SQL-1A	SQL Server 2014	Database server	1
SQL-1B	SQL Server 2014	Database server	1
SQL-1C	SQL Server 2014	Database server	1
SQL-2A	SQL Server 2014	Database server	2
SQL-2B	SQL Server 2014	Database server	2
SQL-2C	SQL Server 2014	Database server	2
SQL-3A	SQL Server 2014	Database server	3
SQL-3B	SQL Server 2014	Database server	3
SQL-3C	SQL Server 2014	Database server	3
CAS-1	Exchange Server 2013	Client access server	2
MBOX-1	Exchange Server 2013	Mailbox server	2
CAS-2	Exchange Server 2013	Client access server	3
MBOX-2	Exchange Server 2013	Mailbox server	3
Iometer-1A	Iometer	File/print workload	1
Iometer-1B	Iometer	Web server workload	1
Iometer-2A	Iometer	File/print workload	2
Iometer-2B	Iometer	Web server workload	2
Iometer-3A	Iometer	File/print workload	3
Iometer-3B	Iometer	Web server workload	3

Figure 23: VM overview.

WORKLOADS

For the validation tests, we set up a mixed workload consisting of some common business applications and simulated disk activity to run in concert over a 30-minute period. We ran an OLTP database workload, a Microsoft Exchange workload, and a simulated file/print server disk workload.

OLTP database workload: DVD Store

To simulate an OLTP workload, we used DVD Store 2.1, an open-source application that models an online DVD store where customers log in, search for titles, and purchase movies. We tested with Microsoft SQL Server 2014 as our database server. Higher thread count and lower think times increase CPU utilization and IOPS. For more information on DVD Store, please see

en.community.dell.com/techcenter/extras/w/wiki/dvd-store.aspx.

Testing parameters

- Database size: 4 GB
- Number of databases: one per VM
- Number of threads per VM: 60
- Actual test run time: 20 minutes
- Percentage of new customers: 20
- Number of line items: 4
- Think time: 0 seconds
- Warm-up time: 10 minutes
- Ramp rate: 10

Additional VM parameters

- Each SQL VM was built with VHDXs for the OS, SQL Database, and SQL Logs
- Each SQL VM was configured as per best practices (E:\SQL Database, F:\SQL Logs)

Output

- Orders per minute (OPM)

Exchange workload: Microsoft Load Generator 2013

The Microsoft Load Generator 2013 (LoadGen) benchmark performs tasks to simulate a typical user generating mail activity on Microsoft Exchange Server 2013. We divided our users into three mailbox databases, each with 80 users, for a total of 160 users/mailboxes. We ensured that performance was within acceptable RPC average latency thresholds. For more information on Microsoft Load Generator 2013, please see www.microsoft.com/en-in/download/details.aspx?id=40726.

Parameters

- Simulation: 8 hours
- Time: 30-minute duration
- 80 users per database (160 total)

- Client: Outlook 2007 Cached
- Action profile: Outlook_50
- Mailbox profile: 2 MB

Output

- Success/failure

Disk activity workload: Iometer

To simulate disk workloads for a file/print server and for a web server, we used Iometer, an application that allows various access specifications to be run against your disk I/O subsystem, including read/write percentages, sequential/random percentages, and block sizes. For more information on Iometer, please see www.iometer.org/.

Testing parameters for file/print server

- Test file size: 2 GB
- Number of outstanding I/Os: 1 per target
- Transfer request size: 512 KB
- Percentage Read/Write Distribution: 25% Write, 75% Read
- Percentage Random/Sequential Distribution: 100% Random
- Transfer delay: 70 ms
- Burst length: 1 I/O
- Actual test run time: 30 minutes
- Warm-up time: 1 minute

Testing parameters for web server

- Test file size: 2 GB
- Number of outstanding I/Os: 1 per target
- Transfer request size: 512 B
- Percentage Read/Write Distribution: 5% Write, 95% Read
- Percentage Random/Sequential Distribution: 100% Random
- Transfer delay: 2 ms
- Burst length: 1 I/O
- Actual test run time: 30 minutes
- Warm-up time: 1 minute

Additional VM parameters

- Each test file took up the entirety of a 2GB VHDX, on a separate volume from the OS

Output

- Latency, IOPS, MBps

VALIDATION AND TEST RESULTS

Nutanix storage cluster on Dell XC630 supporting all application workloads

- SQL/OLTP: 9 instances of SQL 2014 databases (3 per host) – ~420,000 OPM
- LoadGen/Exchange profile: Outlook_50 – 160 mailboxes
- Iometer – File/print workload
- Iometer – Web server workload

Our validation test showed that running nine SQL Server 2014 workloads with DVD Store, two Microsoft Exchange Server 2013 environments, and six disk workloads could be readily handled by a three-node cluster of Dell XC630 appliances backed by Nutanix tiered storage. Median CPU usage on each host was 44.7 percent, so your business would have room to grow from the configuration validated here (see Figure 24). Storage response time stayed low (3.7 milliseconds median) over the course of the test, with some variability on node 1, which wasn't housing an Exchange environment (see Figure 25). Over the course of the test, the hosts' disks put out a median of 1,089 IOPS per host, with node 1 delivering higher but more variable IOPS performance (see Figure 26).
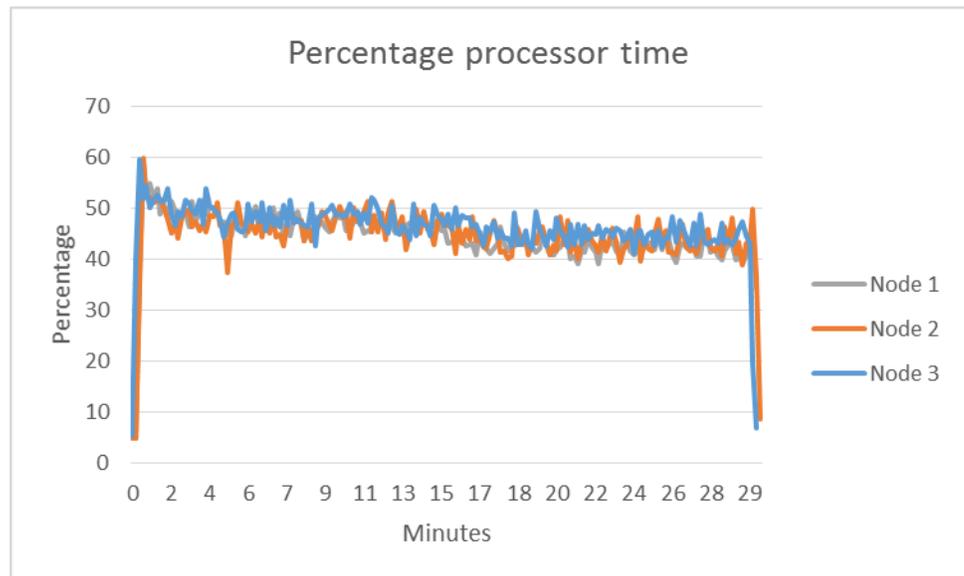
Figure 24: Percentage of processor time used by each Dell XC630 host over the test run.
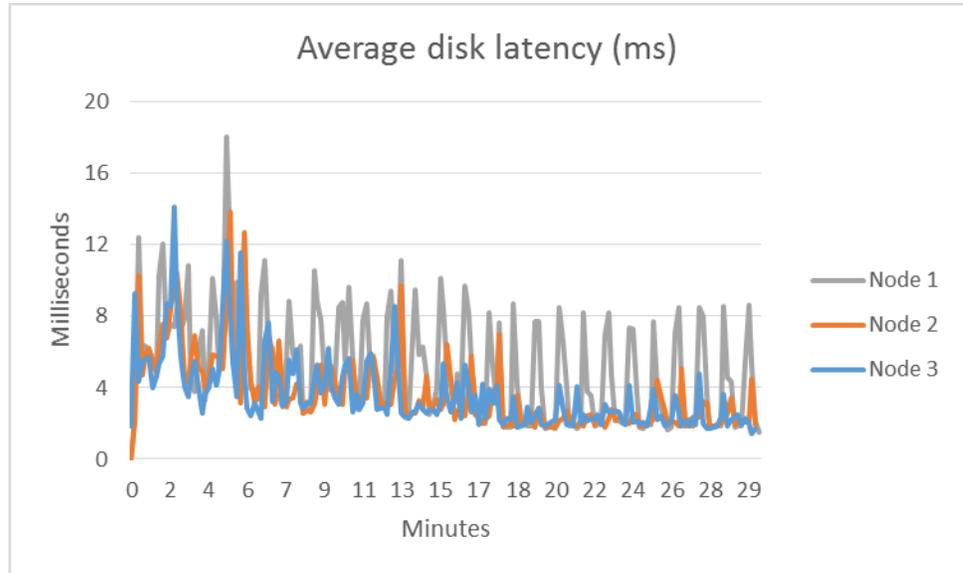
Figure 25: Average disk latency for each Dell XC630 host's disks.
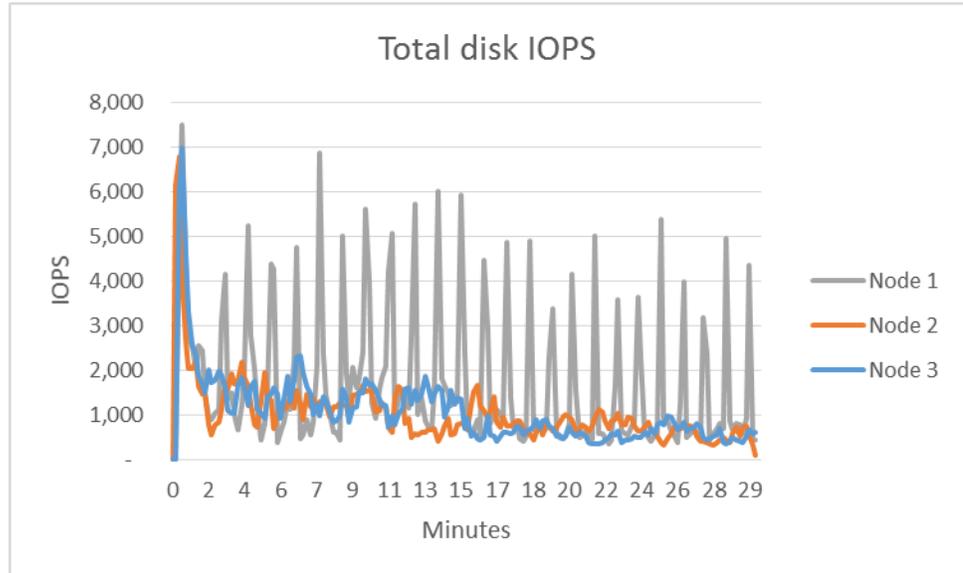
Figure 26: Total disk IOPS performed for each Dell XC630 host's disks.

SUMMARY

If your business is considering using a hyperconverged computer/storage solution rather than disparate dedicated appliances, a Nutanix storage cluster powered by Dell XC630 appliances could bring many benefits. Thanks to its powerful Dell servers with Intel processors, this space-efficient solution was able to handle nine SQL Server 2014 OLTP workloads at over 420,000 OPM, 160 mailboxes in Microsoft Exchange 2013, and file/print and web server disk workloads; that's enough to meet your present demands and still have room for future growth. With software-defined tiered storage, high availability, and a redundant network architecture, the hyperconverged solution based on Dell XC630 appliances can help your business get the job done.

APPENDIX A – DETAILED SYSTEM CONFIGURATION

Figure 27 shows the configuration details of the test system.

System	Dell XC630-10
Power supplies	
Total number	2
Vendor and model number	Dell 0TFR9VA01
Wattage of each (W)	1100
General	
Number of processor packages	2
Number of cores per processor	8
Number of hardware threads per core	2
System power management policy	Performance Per Watt (OS)
CPU	
Vendor	Intel
Name	Xeon
Model number	E5-2630 v3
Socket type	FCLGA2011-3
Core frequency (GHz)	2.4
Bus frequency	8 GT/s
L1 cache	32 + 32 KB (per core)
L2 cache	256 KB (per core)
L3 cache	20 MB
Platform	
Vendor and model number	Dell XC630-10
Motherboard model number	0CNCJW
BIOS name and version	1.3.6
BIOS settings	Defaults
Memory module(s)	
Total RAM in system (GB)	192
Vendor and model number	Micron® 36ASF2G72PZ-2G1A2
Type	PC4-2133
Speed (MHz)	1,866
Speed running in the system (MHz)	1,866
Size (GB)	16
Number of RAM module(s)	12
Chip organization	Double-sided
Rank	2Rx4
Operating system	
Name	VMware ESXi 6.0.0
Build number	3029578
Language	English

System	Dell XC630-10
RAID controller	
Vendor and model number	PERC H730 Mini
Firmware version	25.3.0.0016
Cache size (GB)	1
RAID configuration	None
Hard disk types	
SSDs	
Vendor and model number	Intel SSDSC2BA200G3R
Number of disks	2
Size (GB)	200
RPM	N/A
Type	SATA 6 Gbps
HDDs	
Vendor and model number	Seagate® ST91000640SS
Number of disks	7
Size (GB)	1,000
RPM	7,200
Type	SATA 6 Gbps
Ethernet adapters	
Vendor and model number	Intel 4-port X520/I350 rNDC
Firmware	15.0.28
Type	On-board
USB ports	
Number	2
Type	USB 2.0

Figure 27: Configuration specifications of our test system.

APPENDIX B – DETAILED CONFIGURATION METHODOLOGY

Configuring application VMs

In this section, we walk through how to configure the applications we tested. We created and configured VMs for Exchange Server 2013, SQL Server 2014, and Iometer for ESXi via the vSphere Web Client. The Exchange CAS VMs were configured with two vCPUs and 16 GB of RAM, and the Exchange Mailbox VMs were configured with four vCPUs and 16 GB of RAM. Each SQL Server 2014 VM was configured with four vCPUs and 8 GB of RAM, and each Iometer VM was configured with one vCPU and 4 GB of RAM.

Creating VMs for ESXi in the vSphere Web Client

We used the vSphere Web Client to create the VMs for our application environments. Here we walk through creating a sample VM, providing generic details about the virtual hardware, which can be customized as necessary. We created the VMs on the host we wanted them to reside on, though the host for each VM can be changed after creation.

1. Log into the vSphere Web Client in a browser with administrator credentials.
2. Right-click the host on which you want to create the new VM, and select New Virtual Machine→New Virtual Machine…
3. Select Create a new virtual machine, and click Next.
4. Enter a name for the virtual machine, and click Next.
5. Select the desired host as a compute resource, and click Next.
6. Select the Nutanix storage cluster's NFS container as the storage for the VM, and click Next.
7. Click Next.
8. Select an appropriate Guest OS Family and Version, and click Next.
9. At the Customize hardware screen, set the number of vCPUs, the amount of RAM, and the size and number of hard disks and their SCSI controllers. In addition, provide installation media to the VM, and click Next.
10. Review the selected settings, and click Finish.

Configuring Microsoft Exchange 2013 for Load Generator 2013
Preparing AD for Exchange

Perform the following steps once on your infrastructure's Active Directory server.

1. Insert the Exchange 2012 SP1 Installation ISO in the AD VM DVD drive.
2. In Windows Explorer, double-click the Exchange DVD icon.
3. In the Exchange installation folder, hold down shift, and right-click.
4. Choose Open a command window here.
5. Run the following command: `Setup.exe /PrepareSchema /IAcceptExchangeServerLicenseTerms`
6. When the previous command completes, run the following command: `Setup.exe /PrepareAD /OrganizationName:"organization name" /IAcceptExchangeServerLicenseTerms`
7. Close the command window when the setup finishes.

Installing Active Directory Certificate Services

1. Launch Server Manager, and select Add roles and features.
2. At the Add Roles and Features Wizard, click Next.
3. Select Role-based or feature-based installation, and click Next.
4. Choose Active Directory Certificate Services.
5. Click Add Features, if prompted, to install any required features.
6. Click Next.
7. Click Next.
8. Click Next.
9. Choose Certificate Authority and Certification Authority Web Enrollment.
10. Click Add Features, if prompted, to install any required features.
11. Click Next.
12. Leave defaults, and click Next.
13. Click Install.
14. Click Close when the install finishes.
15. Click on the yellow warning symbol in the Server Manager, and click Configure Active Directory Certificate Services.
16. Leave defaults, and click Next.
17. Check both Certification Authority and Certification Authority Web Enrollment, and click Next.
18. Choose Enterprise CA, and click Next.
19. Choose Root CA, and click Next.
20. Choose Create a new private key, and click Next.
21. Leave defaults, and click Next.
22. Leave defaults, and click Next.
23. Leave 5 years, and click Next.
24. Leave default locations, and click Next.
25. Click Configure.
26. Close when the configuration finishes.
27. Open Internet Explorer® and navigate to localhost/certsrv/Default.asp to verify that the installation succeeded.

Installing Exchange Server 2013 SP1 Mailbox and Client Access Server roles

We created two VMs each to serve as Mailbox and CAS servers for our Exchange environments and edited the hardware settings in each. The Mailbox servers had four vCPUs and 16 GB of memory, and the CAS servers had two vCPUs and 16 GB of memory. We also provided the Mailbox VMs with a 200GB data disk and a 200GB logs disk each for Exchange's database and logs, respectively. We gave each CAS VM a 100GB disk onto which we would install Exchange. We set static IPs on all the VMs and joined the domain. We ran the following commands on both Mailbox VMs and both CAS VMs as appropriate. By the end of these steps, we had two functional and separate Exchange Server setups, sharing an Active Directory.

1. On each Mailbox and CAS server, log into the server using domain administrator credentials.

2. Open Windows PowerShell and run the following command:

```
Install-WindowsFeature AS-HTTP-Activation, Desktop-Experience, NET-
Framework-45-Features, RPC-over-HTTP-proxy, RSAT-Clustering, RSAT-
Clustering-CmdInterface, RSAT-Clustering-Mgmt, RSAT-Clustering-
PowerShell, Web-Mgmt-Console, WAS-Process-Model, Web-Asp-Net45, Web-
Basic-Auth, Web-Client-Auth, Web-Digest-Auth, Web-Dir-Browsing, Web-Dyn-
Compression, Web-Http-Errors, Web-Http-Logging, Web-Http-Redirect, Web-
Http-Tracing, Web-ISAPI-Ext, Web-ISAPI-Filter, Web-Lgcy-Mgmt-Console,
Web-Metabase, Web-Mgmt-Console, Web-Mgmt-Service, Web-Net-Ext45, Web-
Request-Monitor, Web-Server, Web-Stat-Compression, Web-Static-Content,
Web-Windows-Auth, Web-WMI, Windows-Identity-Foundation
```

3. Restart the server.

4. Download the Microsoft Unified Communications Managed API 4.0, Core Runtime 64-bit.
   (go.microsoft.com/fwlink/p/?linkId=258269)

5. Run UcmaRuntimeSetup.exe.

6. When the installation completes, click Finish.

7. Navigate to the location of the Exchange installation media, and double-click Setup.exe.

8. At the Check for Updates? screen, check the Connect to the Internet and check for updates checkbox, and click Next.

9. When the updates complete, click Next.

10. At the Introduction screen, click Next.

11. At the License Agreement screen, check the box to accept the terms, and click Next.

12. At the Recommended Settings screen, check the Don't use recommended settings checkbox, and click Next.

13. At the Server Role Selection, select Mailbox or Client Access role as appropriate, and click Next.

14. At the Installation Space and Location screen, provide an appropriate location for the installation, and click Next.

15. At the Malware Protection Settings, select yes to disable, and click Next.

16. At the Readiness Checks screen, allow the verification to complete. If there are no failures, click Install.

17. When the installation completes, click Finish, and restart the server.

18. Repeat steps 1 through 17 for the remaining Exchange VMs.

Configuring Exchange

1. On the CAS server, open the Exchange Admin Center by using a browser and navigating to https://localhost/ecp

2. Enter the domain administrator credentials, and click Sign in.

3. If prompted, select the language and time zone, and click Save.

4. In the left pane, click Mail flow, and click Send connectors.

5. On the Send connectors page, click the New icon.

6. In the new Send connectors wizard, specify an appropriate name and select Internet as the type. Click Next.

7. In the Network settings screen, choose MX record associated with recipient domain, and click Next.

8. In the Address space screen, click Add.

9. In the Add domain window, enter the desired address space in the Fully Qualified Domain Name (FQDN) field, and click Save.

10. Click Next.

11. In Source server screen, click Add.

12. In the Select a Server window, select the mailbox server, click Add, and click OK.

13. Click Finish.

14. In the left pane of the EAC, click servers, select the name of the CAS server, and click Edit.

15. Click Outlook Anywhere, and enter the appropriate FQDN of the Client Access Server for the external and internal hostname field. For example, exchangeserver.test.local.

16. Choose NTLM as the authentication method, and click Save.

17. Click Virtual Directories, and click the Configure external access domain icon.

18. In the Select the Client Access servers to use with the external URL window, click Add.

19. Select the CAS server, and click Add. Click OK.

20. In the Enter the domain field, enter the FQDN of the CAS server, and click Save.

21. Log into the Active Directory server using administrator credentials, and complete the following steps:

    a. Open Server Manager, and click Tools→DNS.

    b. In DNS Manager, expand the Active Directory server name→Forward Lookup Zones→test.local in the left pane.

    c. In the right pane, verify or create the DNS records as presented in Figure 28.

Type	Host or child domain/alias name	FQDN	FQDN of mail server
Mail Exchanger (MX)	Leave blank	domain.com	casserver.domain.com
Alias (CNAME)	Autodiscover	Autodiscover.domain.com	casserver.domain.com
Alias (CNAME)	Owa	Owa.domain.com	casserver.domain.com

Figure 28: DNS records.

22. Log back into your CAS server.

23. In the Exchange PowerShell, run the following commands, replacing "$HostName" with the host name (not FQDN) of your CAS server.

```
Set-EcpVirtualDirectory "$HostName\ECP (Default Web Site)" -InternalUrl
((Get-EcpVirtualDirectory "$HostName\ECP (Default Web
Site)").ExternalUrl)


Set-WebServicesVirtualDirectory "$HostName\EWS (Default Web Site)" -
InternalUrl ((get-WebServicesVirtualDirectory "$HostName\EWS (Default Web
Site)").ExternalUrl)
```

```
Set-ActiveSyncVirtualDirectory "$HostName\Microsoft-Server-ActiveSync
(Default Web Site)" -InternalUrl ((Get-ActiveSyncVirtualDirectory
"$HostName\Microsoft-Server-ActiveSync (Default Web Site)").ExternalUrl)


Set-OabVirtualDirectory "$HostName\OAB (Default Web Site)" -InternalUrl
((Get-OabVirtualDirectory "$HostName\OAB (Default Web
Site)").ExternalUrl)


Set-OwaVirtualDirectory "$HostName\OWA (Default Web Site)" -InternalUrl
((Get-OwaVirtualDirectory "$HostName\OWA (Default Web
Site)").ExternalUrl)


Set-PowerShellVirtualDirectory "$HostName\PowerShell (Default Web Site)"
-InternalUrl ((Get-PowerShellVirtualDirectory "$HostName\PowerShell
(Default Web Site)").ExternalUrl)


Get-OfflineAddressBook | Set-OfflineAddressBook -
GlobalWebDistributionEnabled $True -VirtualDirectories $Null
```

24. Create a folder at the root of C: on the CAS server, and share it to Everyone with read/write permissions.
25. Log back into the Exchange admin center, and navigate to Servers→certificates.
26. Choose the CAS server in the drop-down menu, and click the plus sign to create a new certificate.
27. Choose Create a request for a certificate from a certification authority, and click Next.
28. Name the certificate, and click Next.
29. Do not request a wildcard certificate, and click Next.
30. Click Browse, choose the CAS server, and click OK. Click Next.
31. Leave defaults, and click Next.
32. Leave defaults, and click Next.
33. Enter your organization information, and click Next.
34. Enter the path to the share you created on the CAS server, and click Finish. Example:
    \\cas\share\myrequest.REQ
35. Log into the AD server, and open Internet Explorer.
36. Browse to localhost/CertSrv
37. Click Request a certificate.
38. Choose advanced certificate request.
39. Choose Submit a certificate request by using a base-64-endcoded CMC…

40. Open Windows Explorer and navigate to the share folder on the CAS server where the certificate request is stored.
41. Open the certificate with notepad, and copy the content between BEGIN NEW CERTIFICATE REQUEST and END NEW CERTIFICATE REQUEST.
42. Paste the copied content into the Saved Request window.
43. Choose Web Server in the Certificate Template drop-down menu, and click Submit.
44. Choose Base 64 encoded, and download the certificate.
45. Copy the new certificate into the share folder on the CAS server.
46. Log back into the CAS server and open the Exchange Admin Center.
47. Go to Servers→Certificates, and highlight the certificate you began before (should say Pending request in the status column).
48. Click Complete on the right side.
49. Type the path to the certificate, including the certificate name, and click OK. Example: \\cas\share\certnew.CER
50. Verify that the status has changed to Valid.
51. Edit the new entry, and click Edit.
52. Go to services and check SMTP and IIS, click Save.
53. On the warning message, click Yes.
54. Perform the following steps on the CAS and AD servers:
    a. Click Start, and type MMC
    b. Click File→Add/Remove Snap-in.
    c. Choose Certificates, and click Add.
    d. Choose Computer account, and click Next.
    e. Choose Local computer, and click Finish.
    f. Click OK.
    g. Expand Certificates→Trusted Root Certificate Authorities→Certificates.
    h. Click Action→All Tasks→Import.
    i. Click Next.
    j. Browse to the share folder on the CAS server, and choose the new certificate you created. Click Next.
    k. Leave defaults, and click Next.
    l. Click Finish.
    m. On the Import was successful message, click OK.
55. Log into the CAS server, and open the Exchange admin center.
56. Navigate to Servers→Databases.
57. Restart the Microsoft Exchange Information Store service on the MB server.
58. Click Edit, and disable the maintenance schedule and enable circular logging for each mailbox database.
59. Dismount and remount the databases.
60. Open Exchange Management shell, and enter the following to move the paths of the default mailbox:

```
Move-Databasepath "DatabaseName" –EdbFilepath "E:\Newlocation\DBname.edb"
–LogFolderpath "F:\Newlocation"
```

61. When prompted, type A and press Enter.
62. Open Exchange Management Shell, and enter the following:

```
Get-OutlookAnywhere |Set-OutlookAnywhere -ExternalHostname cas.domain.com
-DefaultAuthenticationMethod NTLM -ExternalClientsRequireSsl $true
```

Installing and configuring the Exchange 2013 mail test clients and completing LoadGen configuration on the Exchange Server 2013

For our testing, we used one virtual client machine to run each instance of Load Generator 2013. To create the mail clients, we installed several software components. We followed this process for each installation:

Installing Windows Server 2008 R2 SP1 Enterprise Edition

1. Insert the installation DVD for Windows Server® 2008 R2 SP1 Enterprise into the DVD drive.
2. At the Language Selection Screen, click Next.
3. Click Install Now.
4. Select Windows Server 2008 R2 Enterprise (Full Installation), and click Next.
5. Click the I accept the license terms checkbox, and click Next.
6. Click Custom.
7. Click Next.
8. At the User's password must be changed before logging on warning screen, click OK.
9. Enter the desired password for the administrator in both fields, and click the arrow to continue.
10. At the Your password has been changed screen, click OK.
11. Click Start, type change power-saving settings and press Enter.
12. Click Change plan settings.
13. Change the Turn off the display drop-down menu to Never.
14. Click Save changes, and close the Power Options, Screen Saver Settings, and Personalization screens.

To set up this server, we had to install several additional software components. The following subsections detail the necessary installation processes.

Joining the domain

1. Set a static IP.
2. Select Start→Control Panel→Network Connections→Local Area Connection.
3. Click Properties.
4. Highlight Internet Protocol (TCP/IP), and click Properties.
5. Select the Use the following DNS server addresses radio button, and enter the IP of the DNS server in the Preferred DNS server field. Click OK.
6. Right-click My Computer, and select Properties.
7. Under the Computer Name tab, click Change.
8. In the Computer Name Changes screen, under the Member of section, select the Domain radial box, and type test.local.
9. Select OK to start joining the domain.

10. When the screen appears asking for a person qualified on the domain, type `Administrator` as the username and `Password1` as the password.
11. At the Welcome pop-up window and the window warning that you must reset the computer for the changes to take effect, click OK.
12. At the System Properties screen, click OK.
13. When a pop-up appears asking if you want to restart now, click Yes to restart your computer.

Installing Internet Information Services

1. Click Start→Administrative Tools→Server Manager.
2. In the left pane, click Roles.
3. Click Add Roles.
4. Click the Application Server checkbox.
5. When the Add features required for Application Server? screen appears, click Add Required Features.
6. Click Next.
7. Click Next.
8. At the Select Role Services page for Application Server, click the Web Server (IIS) Support checkbox.
9. Click Add Required Support Role Services.
10. Click Next.
11. Click Next.
12. At the Select Role Services page for Web Server (IIS), click IIS 6 Management Compatibility, ASP, and CGI checkboxes; then, click Next.
13. Click Install.
14. Click Close.

Installing Load Generator

Download and install Load Generator 2013 using all defaults.

Importing the certificate and editing the hosts file

1. Click Start, and type `MMC`.
2. Click File→Add/Remove Snap-in.
3. Choose Certificates, and click Add.
4. Choose Computer account, and click Next.
5. Choose Local computer, and click Finish.
6. Click OK.
7. Expand Certificates→Trusted Root Certificate Authorities→Certificates.
8. Click Action→All Tasks→Import.
9. Click Next.
10. Browse to the share folder on the CAS server, and choose the new certificate you created. Click Next.
11. Leave defaults, and click Next.
12. Click Finish.
13. On the Import was successful message, click OK.

14. Open the Notepad program, and use File→Open to open the hosts file stored at C:\Windows\System32\drivers\etc.
15. Add the IP address and FQDN of the CAS server.
16. Save and close Notepad.

Preparing Load Generator

1. Log into the mail client.
2. Select Start→All Programs→Microsoft Exchange→Exchange Load Generator 2013.
3. When the Load Generator screen appears, select Start a new test.
4. Select Create a new test configuration, and click Continue.
5. Change the total length of simulation to 1 hour.
6. In the Specify test settings screen, type `Password1` as the Directory Access Password and Mailbox Account Master Password, and click Continue with recipient management.
7. Create 750 users in the Mailbox Database, and click Continue.
8. To accept defaults for Advanced recipient settings, click Continue.
9. In the Specify test user groups screen, select the plus sign to add a user group.
10. Change the Client Type to Outlook 2007 Cached, the action profile to Outlook_200, and the Mailbox size to 250 MB, and click Continue.
11. In Remote configurations, click Continue.
12. Click Save the configuration file as, and name it `testcfg.xml`
13. Click Start the initialization phase (recommended before running the test).
14. Once you have initialized the database, create a backup copy of the Exchange mailbox databases.

Installing and configuring Iometer

1. On the Iometer VMs, open a web browser, and navigate to sourceforge.net/projects/Iometer/files/Iometer-stable/1.1.0/Iometer-1.1.0-win64.x86_64-bin.zip/download.
2. Run the installer wizard with defaults.
3. Launch Iometer.
4. In the Topology pane, click the manager with the VM's host name.
5. In the Disk Targets tab, check the box next to the empty disk to be used for testing.
6. In the Access Specifications tab, click New.
7. Select the new specification, and click Edit.
8. Set the parameters based on the workload you want to test.
9. Click OK.
10. Click Add.
11. In the Test Setup tab, enter the run time details, and provide a description for the test.
12. When ready to test, click the green flag button, and provide an output file path.

Installing Microsoft SQL Server 2014

1. Insert the installation DVD for SQL Server 2014 into the DVD drive.
2. Click Run SETUP.EXE. If Autoplay does not begin the installation, navigate to the SQL Server 2014 DVD, and double-click.
3. If the installer prompts you with a .NET installation prompt, click Yes to enable the .NET Framework Core role.
4. In the left pane, click Installation.
5. Click New installation or add features to an existing installation.
6. At the Setup Support Rules screen, wait for the check to complete. If there are no failures or relevant warnings, click OK.
7. Select the Evaluation edition, and click Next.
8. Click the checkbox to accept the license terms, and click Next.
9. Click Install to install the setup support files.
10. If no failures are displayed, click Next. You may see a Computer domain controller warning and a Windows Firewall warning. For now, ignore these.
11. At the Setup Role screen, choose SQL Server Feature Installation.
12. At the Feature Selection screen, select Database Engine Services, Full-Text Search, Client Tools Connectivity, Client Tools Backwards Compatibility, Management Tools – Basic, and Management Tools – Complete. Click Next.
13. At the Installation Rules screen, once the check completes, click Next.
14. At the Instance configuration screen, leave the default selection of default instance, and click Next.
15. At the Disk space requirements screen, click Next.
16. At the Server configuration screen, choose NT Service\SQLSERVERAGENT for SQL Server Agent, and choose NT Service\MSSQLSERVER for SQL Server Database Engine. Change the SQL Server Agent Startup Type to Automatic. Click Next.
17. On the Data Directories tab, enter the SQL Server directories of the data and logs volumes created earlier.
18. At the Database Engine Configuration screen, select Mixed Mode.
19. Enter and confirm a password for the system administrator account.
20. Click Add Current user. This may take several seconds.
21. Click Next.
22. At the Error and usage reporting screen, click Next.
23. At the Installation Configuration rules screen, check that there are no failures or relevant warnings, and click Next.
24. At the Ready to Install screen, click Install.
25. After installation completes, click Close.
26. Download and install Cumulative Update 6 for SQL Server 2014 at support.microsoft.com/en-us/kb/3031047.

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 2008 R2, assigned a static IP address, and installed .NET 3.5.

Configuring the database

We generated the data using the Install.pl script included with DVD Store version 2.1 (DS2), providing the parameters for our 4GB database size and the database platform on which we ran, Microsoft SQL Server 2014. We ran the Install.pl script on a utility system running Linux®. The database schema was also generated by the Install.pl script.

After processing the data generation, we transferred the data files and schema creation files to a Windows-based system running SQL Server 2014. We built the database in SQL Server 2014, and performed a full backup, storing the backup file on the C: drive for quick access. 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 deliberately 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 performed the following steps:

1. We generated the data and created the database and file structure using database creation scripts in the DS2 download. We made size modifications specific to our database and the appropriate changes to drive letters.
2. We transferred the files from our Linux data generation system to a Windows system running SQL Server.
3. We created database tables, stored procedures, and objects using the provided DVD Store scripts.
4. We set the database recovery model to bulk-logged to prevent excess logging.
5. We loaded the data we generated into the database. For data loading, we used the import wizard in SQL Server Management Studio. Where necessary, we retained options from the original scripts, such as Enable Identity Insert.
6. We created indices, full-text catalogs, primary keys, and foreign keys using the database-creation scripts.
7. We updated statistics on each table according to database-creation scripts, which sample 18 percent of the table data.
8. On the SQL Server instance, we created a ds2user SQL Server login using the following Transact SQL (TSQL) 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. We set the database recovery model back to full.

10. We created the necessary full text index using SQL Server Management Studio.

11. We created a database user and mapped this user to the SQL Server login.

12. We performed a full backup of the database. This backup allowed us to restore the databases to a pristine state relatively quickly between tests.

Running the test

Test start and run times

We ran the workloads with one client per target database. The specific testing parameters we used for the benchmark are included below.

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 aggregate OPM reported by the clients for each run.

Each complete test cycle consisted of the general steps listed below.

1. Clean up prior outputs from the target system and the client driver system.
2. Drop the database from the target servers.
3. Restore the database on the target servers.
4. Shut down the target.
5. Reboot the host and client systems.
6. Wait for a ping response from the server under test (the hypervisor system), the client system, and the target.
7. Let the test server idle for 10 minutes.
8. Start the DVD Store driver on each client.

   We used the following DVD Store parameters for testing:

   ```
   ds2sqlserverdriver.exe --target=<target_IP> --ramp_rate=10 --run_time=20
   --n_threads=64 --db_size=4GB --think_time=0 --detailed_view=Y --
   warmup_time=10 --csv_output=<drive path>
   ```

APPENDIX C – CONFIGURING THE S4048-ON SWITCH

```
! Version 9.8(0.0P5)
! Last configuration change at Sat Sep 22 06:03:25 2015 by admin
! Startup-config last updated at Sat Sep 22 05:38:40 2015 by default
!
boot system stack-unit 1 primary system: A:
boot system stack-unit 1 secondary system: B:
!
redundancy auto-synchronize full
!
hostname Switch-A
!
default-vlan disable
!
protocol spanning-tree rstp
 no disable
 bridge-priority 0
!
vlt domain 100
 peer-link port-channel 100
 back-up destination 192.168.0.82
!
stack-unit 1 provision S4048-ON
!
interface TenGigabitEthernet 1/1
 description "uplink to N2024 switch"
 no ip address
 mtu 12000
 speed 1000
!
 port-channel-protocol LACP
  port-channel 111 mode active
 dampening 10 100 1000 60
 no shutdown
!
interface TenGigabitEthernet 1/2
 description "XC-node-1a"
 no ip address
 mtu 12000
 portmode hybrid
 switchport
 no shutdown
!
interface TenGigabitEthernet 1/3
 description "XC-node-2a"
 no ip address
 mtu 12000
 portmode hybrid
```

```
 switchport
 no shutdown
!
interface TenGigabitEthernet 1/4
 description "XC-node-3a"
 no ip address
 mtu 12000
 portmode hybrid
 switchport
 no shutdown
!
!
interface fortyGigE 1/49
 description VLT-peerlink
 no ip address
 no shutdown
!
interface fortyGigE 1/50
 description VLT-peerlink
 no ip address
 no shutdown
!
interface ManagementEthernet 1/1
 ip address 192.168.0.81/23
 no shutdown
!
interface Port-channel 100
 description "VLTi - interconnect link"
 no ip address
 channel-member fortyGigE 1/49,1/50
 no shutdown
!
interface Port-channel 111
 description lacp to dell tor
 no ip address
 mtu 12000
 switchport
 vlt-peer-lag port-channel 100
 no shutdown
!
interface Vlan 1
!
interface Vlan 10
 description public-net
 no ip address
 tagged TenGigabitEthernet 1/2-1/13
 tagged fortyGigE 1/51
 tagged Port-channel 100,111
 no shutdown
!
interface Vlan 100
```

```
 description priv-net
 no ip address
 mtu 12000
 tagged fortyGigE 1/51
 tagged Port-channel 100,111
 untagged TenGigabitEthernet 1/2-1/13
 no shutdown
!
interface Vlan 101
 description vMotion-net
 no ip address
 mtu 12000
 tagged TenGigabitEthernet 1/2-1/13
 tagged Port-channel 111
 no shutdown
!
interface Vlan 102
 description FT-net
 no ip address
 mtu 12000
 tagged TenGigabitEthernet 1/2-1/13
 tagged Port-channel 111
 no shutdown
!
ip ssh server enable
!
protocol lldp
 advertise management-tlv system-description system-name
!
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
 boot-type normal-reload
 config-scr-download enable
!
end
```

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