



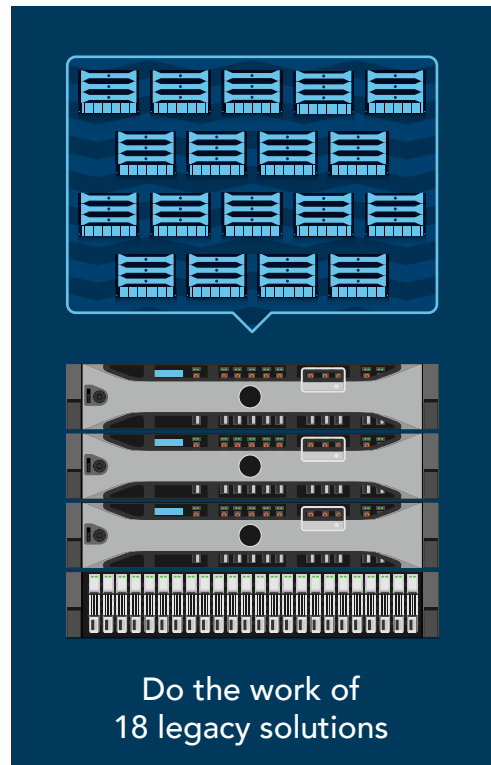
Run more applications without expanding your datacenter

when you upgrade to a Dell™ PowerEdge™ R730 and VMware® vSphere® solution powered by Intel® Xeon® processors

Moving to new servers and storage can bring myriad benefits to your business, from saving space to running more applications. But when you're considering an upgrade, how do you know which new solution is right for you?

In the datacenter at Principled Technologies, we compared a bare-metal legacy solution with a new solution featuring Intel processor-powered Dell PowerEdge R730 servers, a VMware vSphere 6 virtual environment, and Dell Storage SC4020.

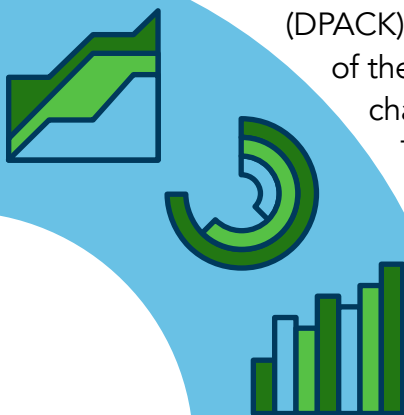
Both solutions ran the same mixed workload of database, email, and simulated file server work, but the upgraded solution handled a staggering 18 times the work of the older one. That means you can consolidate many workloads from multiple user groups or departments. You can also do significantly more work in the same amount of rack space, leaving room in the datacenter for growth, and can use virtualization to maximize the value of your resources.



Do the work of 18 legacy solutions

We used the Dell Performance Analysis Collection Kit (DPACK) to evaluate and understand the performance of the new environment. By running DPACK in your own datacenter, you can characterize your environment's performance and identify bottlenecks.

Then, take a look at the DPACK results for our newer solution to see its performance metrics. In your environment, using DPACK can highlight upgrade opportunities and help you better understand specific performance requirements.



Get performance data with DPACK

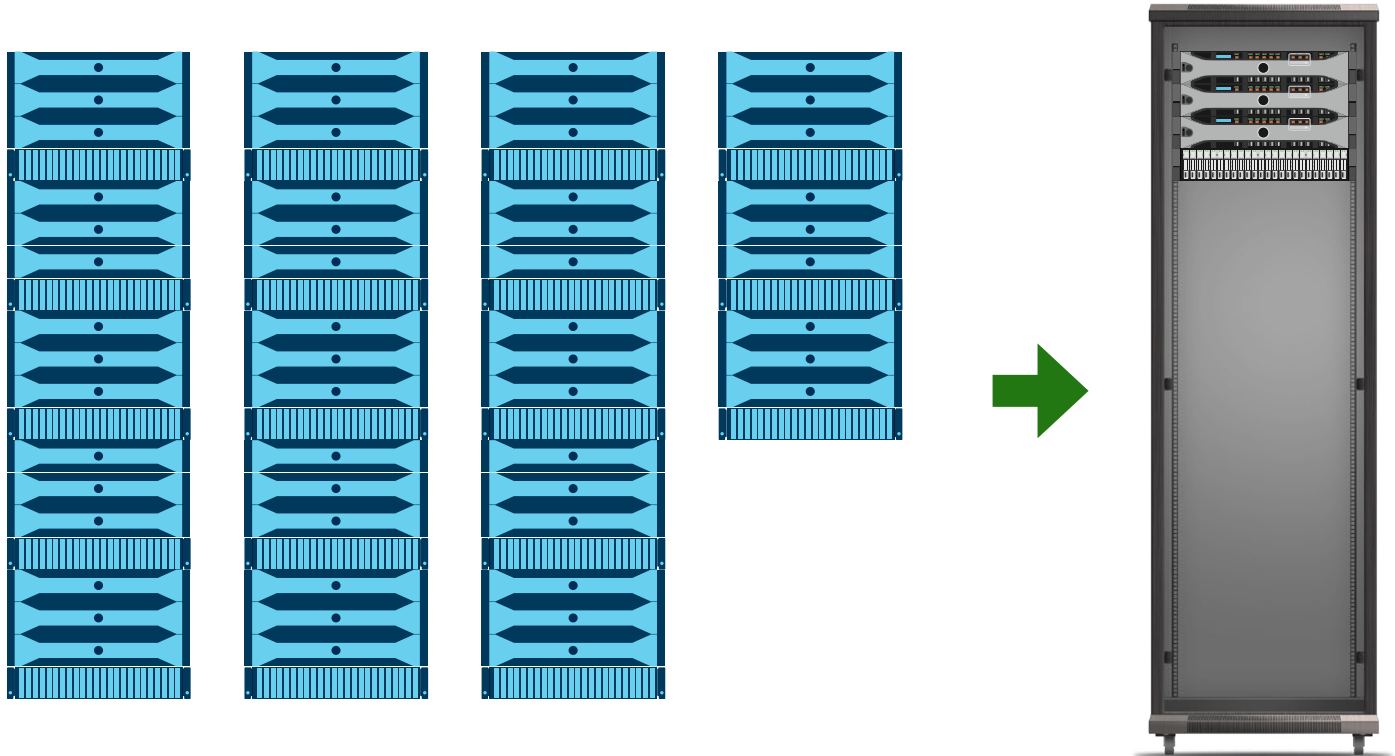
Your time to upgrade

Legacy infrastructure woes

As they get older, legacy infrastructures may struggle to keep up with the growth of business. Components in legacy hardware can degrade and begin to malfunction from use over time. What's more, legacy hardware lacks new processors that can speed up applications; new designs that can lower power consumption; and new, effective management features that can save time for IT staff and reduce downtime for users.

Do more work in the same space

In hands-on work in our datacenter, we determined that by upgrading from a legacy solution to the new Intel processor-based Dell PowerEdge R730 and VMware vSphere solution, you could do 18 times the work without taking up any more rack space. By completing so much more work in the same amount of space, your company can consolidate workloads from multiple departments. For instance, we centralized multiple Exchange mail servers, SQL databases, and file servers into one location while keeping them separate on VMs. At the same time, your business can grow without costly datacenter expansions.



Take full advantage of your resources

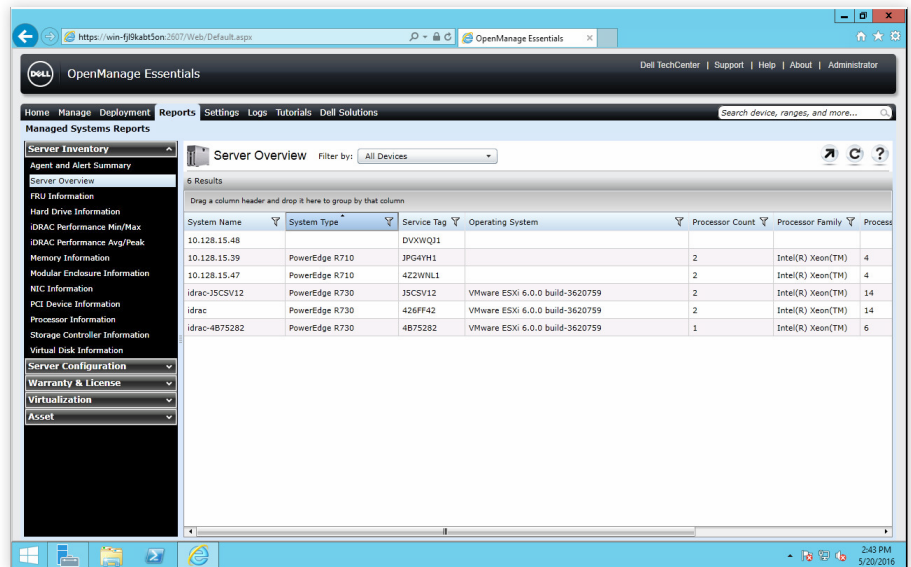
Virtualizing with VMware vSphere can help you maximize the value of your newer, more powerful hardware and better utilize compute, networking, and storage resources that would otherwise go unused. It gives you a more efficient environment and more control over precisely how your applications utilize your newly increased resources. With this control, you can use a single server to run multiple workloads, each of which might have maxed out a single server in your legacy environment.

Your current infrastructure may already be fully or partially virtualized, or you may be working with a bare-metal environment. Whatever your starting point, VMware vSphere can help you make the most of your investment in an upgraded environment.

Keep your favorite parts of your current infrastructure

By moving to newer physical servers and centralized storage, you gain the benefits of the latest technologies while maintaining the hardware features on which you rely, including the flexibility of general-purpose servers and centralized storage features such as snapshots and compression. At the same time, your company has new opportunities for added density, faster workload processing, and better resource management.

This solution also enables you to use a management tool that may already be familiar to your IT staff: Dell OpenManage™ Essentials (OME). If you were previously using OME to manage a Dell server and storage infrastructure from five or six years ago, the new version of OME will allow you to manage your new servers in a similar way to how you managed your old ones. Newer hardware, such as the Dell PowerEdge R730 powered by Intel Xeon processors, can take advantage of the new features and functions in the latest version of OME while maintaining the familiar management interface your IT administrators may already use. In previous studies, we found OME can save time and improve efficiency in datacenter management.¹ These advantages may help enable a more straightforward transition from the old hardware to the new.

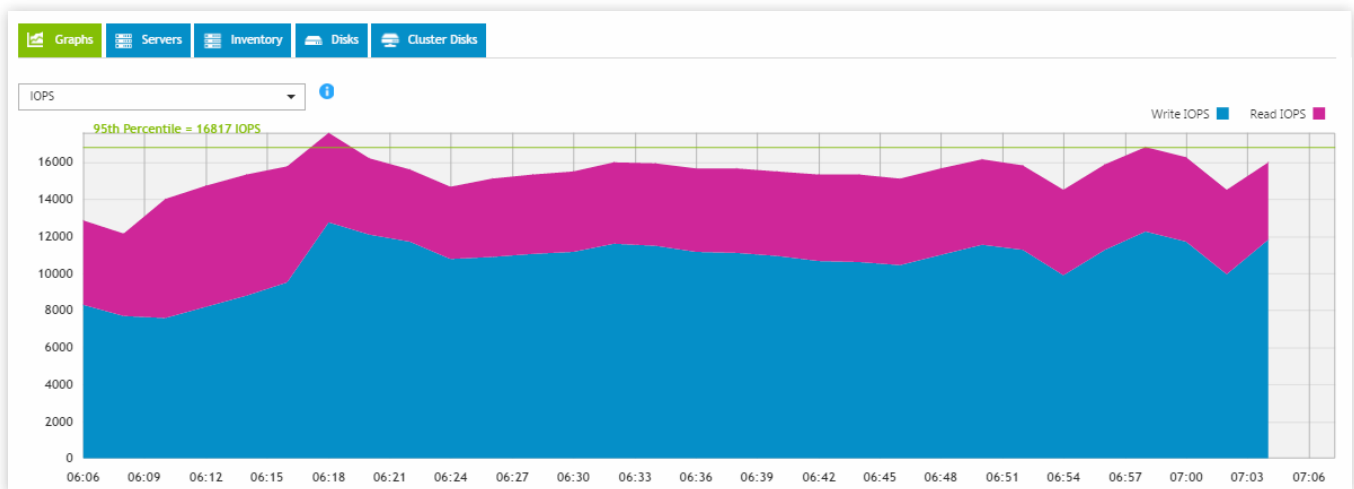


Take a look at DPACK

DPACK measures the throughput, disk I/O, memory, capacity, and CPU utilization of your servers and storage. Its reports present this data to help you better understand what hardware you'll need when you upgrade.

Using the DPACK online viewer, you can review your results in two ways: Aggregate or Individual. Aggregate results offer performance data for the full environment, while Individual results provide numbers for a specific server. When we ran DPACK on the new Dell and VMware solution, we viewed Aggregate results.

In addition to simply running DPACK in your own environment, you can contact a Dell salesperson who can help you interpret your DPACK results and size your upgraded environment. We did not test this service.



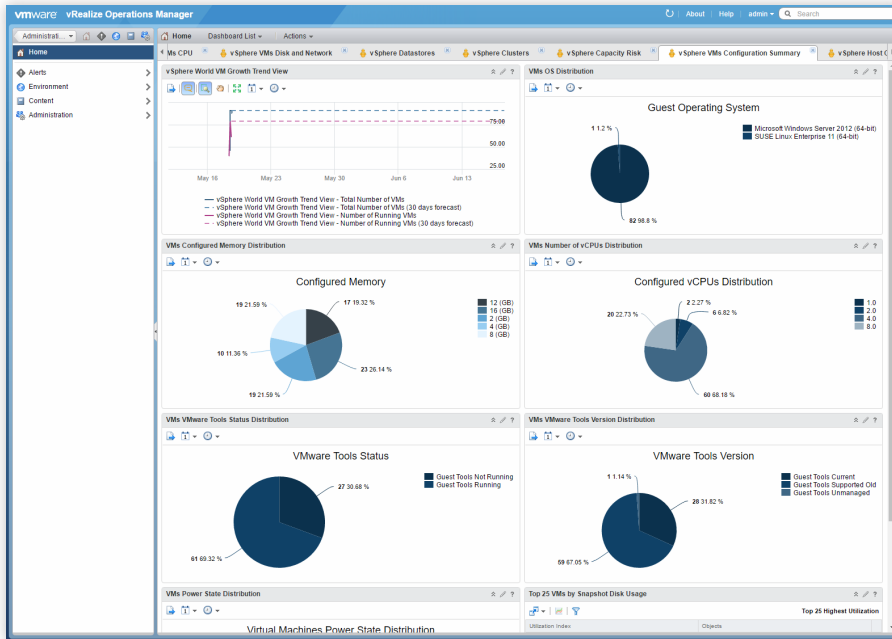
How we navigated the path to an upgraded datacenter



Our legacy environment

We created our legacy solution to approximate an infrastructure that a small enterprise might have purchased five or six years ago and still use today. This bare-metal (non-virtualized) environment contained three Dell PowerEdge R710 legacy servers with one legacy Dell EqualLogic™ PS6110 storage array. [Appendix C](#) has complete details on the solution.

Our upgraded environment



Our upgraded environment represents a possible next step for an enterprise moving from the legacy environment we chose. It contains newer products with an architecture and functionality similar to those in the legacy environment.

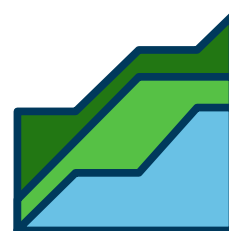
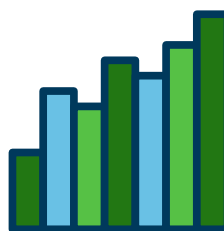
Our new solution contained three Dell PowerEdge R730 servers powered by Intel Xeon processors E5-2660 v4 and one all-flash Dell Storage SC4020 array powered by an Intel Xeon processor E3-1265L v2. We utilized VMware vSphere 6 for the hypervisor with VMware vCenter Server™ and VMware vRealize® Operations Manager™ for hypervisor management. This tool provides customizable dashboards you can use to analyze risk, monitor capacity issues, and check on your virtual environment's health. See [Appendix C](#) for more details.

What we did

On the legacy environment, each application of the mixed workload had a dedicated server. We tuned each application to its maximum performance while maintaining acceptable thresholds for storage latency—a measure of how fast storage can complete a request. For our purposes, those thresholds were under 20ms.

Then, we virtualized all legacy application servers on the upgraded solution and increased the number of VMs in sets until we reached 80 percent utilization of at least one hardware resource. In this case, that was storage capacity and allocated RAM. With additional storage capacity and RAM, you could potentially obtain an even higher consolidation ratio because CPU and storage latency thresholds were not at full capacity.

To capture data on the upgraded environment's performance, we ran DPACK. (For our DPACK results, see [Appendix D](#).)



Our workloads

We generated the workloads for each application using industry-standard tools. For a database workload, we chose Microsoft® SQL Server® 2014 running the DVD Store 2 benchmarking tool; for email, we chose Microsoft Exchange 2013 running a Microsoft Exchange Load Generator 2013 workload; and for simulated file server, we chose the Iometer tool, which generates synthetic data streams mimicking a file server workload.

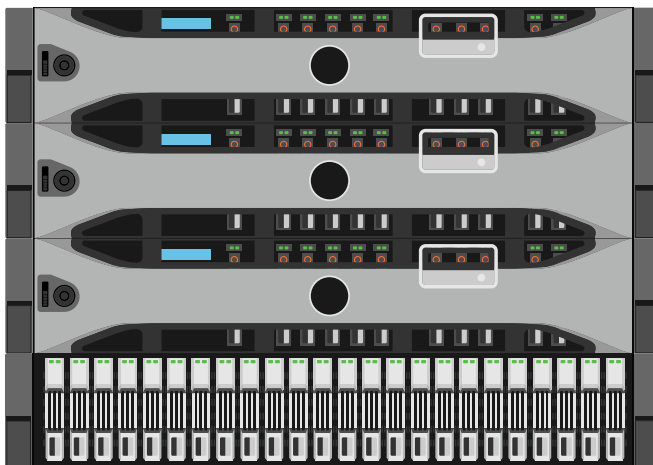
This mixed workload may reflect many companies' operations. In a traditional legacy setup, IT may assign a single application to a single server. That application uses the hardware resources it needs, but the rest of the server's resources are wasted. This problem grows with the company; as the organization splits into multiple departments with distributed IT staff, it can get even worse.

With a virtualized solution like the one from Dell, Intel, and VMware, IT can consolidate multiple different workloads onto virtualized clusters, making the most out of their storage and compute resources and letting fewer resources go to waste.

Conclusion

By upgrading from the legacy solution we tested to the new Intel processor-based Dell and VMware solution, you could do 18 times the work in the same amount of space. Imagine what that performance could mean to your business: Consolidate workloads from across your company, lower your power and cooling bills, and limit datacenter expansion in the future, all while maintaining a consistent user experience—the list of potential benefits is huge.

Try running DPACK, which can help you identify bottlenecks in your environment and inform you about your current performance needs. Then consider how the consolidation ratio we proved could be helpful for your company. The Intel processor-powered Dell PowerEdge R730 solution with VMware vSphere and Dell Storage SC4020, also powered by Intel, could be the right destination for your upgrade journey.



- 1 See the Principled Technologies reports [Systems management savings with Dell OpenManage on 13G Dell PowerEdge servers](#) and [Dell OpenManage Essentials: Improve efficiency with fewer tools, more benefits](#).
- 2 <http://en.community.dell.com/techcenter/extras/w/wiki/dvd-store>
- 3 <https://www.microsoft.com/en-us/download/details.aspx?id=14060>
- 4 <http://www.iometer.org/>



DVD Store 2

We used DVD Store Version 2.1, or DS2.² DS2 is a database performance tool. It models an online store where customers log in, search for products, and make purchases. It also performs other actions, such as adding new customers, to exercise a wide range of everyday database functions.



Microsoft Exchange Load Generator 2013

Microsoft Exchange Server is an email application that businesses use widely across multiple industries. To test how well the solutions could run an Exchange server workload, we used Microsoft Exchange Load Generator 2013 (LoadGen), which functions as a sample Exchange workload and simulates a large number of users generating email activity.³



Iometer

Many businesses use file servers, so we simulated a file server workload using Iometer 1.1.⁴ Iometer uses action profiles to perform input/output (I/O) operations that approximate data operations such as reading files, writing files, and updating files.

On May 1, 2016, 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. For older systems, we chose configurations representative of typical purchases of those systems. We concluded hands-on testing on May 24, 2016.

Appendix A – Test systems

Server configuration information	3x Dell PowerEdge R710	3x Dell PowerEdge R730
BIOS name and version	Dell 6.4.0	Dell 2.0.2
Non-default BIOS settings	N/A	N/A
Operating system name and version/build number	Windows Server® 2012 R2	VMware ESXi™ 6.0 Update 2
Date of last OS updates/patches applied	03/31/16	04/14/2016
Power management policy	Performance	Performance

Processor

Number of processors	2	2
Vendor and model	Intel Xeon E5520	Intel Xeon E5-2660 v4
Core count (per processor)	4	14
Core frequency (GHz)	2.26	2.0
Stepping	D0	M0

Memory module(s)

Total memory in system (GB)	48	256
Number of memory modules	6	16
Vendor and model	Samsung® M393B1K70DH0-YH9	Hynix HMA42GR7MFR4N-TF
Size (GB)	8	16
Type	PC3-10600	PC4-17000
Speed (MHz)	1,333	2,133
Speed running in the server (MHz)	1,333	2,133

Storage controller

Vendor and model	Dell PERC 6/i	Dell PERC H730P Mini
Cache size	256MB	2GB
Firmware version	6.3.3.0002	25.3.0.0016
Driver version	6.600.21.8	6.606.12.00-1OEM

Server configuration information	3x Dell PowerEdge R710	3x Dell PowerEdge R730
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Local storage

Number of drives	2	2 (R730s 1 and 2)
Drive vendor and model	Western Digital® WD3000BKHG	Seagate ST9300653SS
Drive size (GB)	300	300
Drive information (speed, interface, type)	10K, 6Gb SAS, 2.5" HDD	15K, 6Gbps SAS, 2.5" HDD

Local storage 2

Number of drives	N/A	2 (R730 3)
Drive vendor and model	N/A	Seagate® ST9300653SS
Drive size (GB)	N/A	300
Drive information (speed, interface, type)	N/A	15K, 6Gbps SAS, 3.5" HDD

Network adapter

Vendor and model	Broadcom® BCM5709C	Intel I350-t rNDC
Number and type of ports	4 x 1GbE	2 x 1GbE
Driver version	7.4.23.2	5.3.0

Network adapter 2

Vendor and model	Intel Ethernet Server Adapter X520	Intel 82599 10GbE Controller
Number and type of ports	2 x 10GbE	2 x 10GbE
Driver version	3.9.58.9101	3.21.6iov

HBAs

Vendor and model	N/A	QLogic® QLE2562
Number and type of ports	N/A	2 x 8Gbps Fibre Channel
Driver version	N/A	2.1.24.0-1OEM

Power supplies

Vendor and model	Dell N870P-S0	Dell N870P-S0
Number of power supplies	2	2
Wattage of each (W)	870	870

Detailed configuration information for the legacy storage solution.

Storage configuration information	Dell EqualLogic PS6110
Controller firmware revision	V7.0.5 (R390599)
Number of storage controller modules	2 x 70-0477 (TYPE 14)
Number of drives	24
Drive vendor and model number	Seagate® ST9900805SS
Drive size (GB)	900
Drive information (speed, interface, type)	10K, 6Gb SAS, HDD

Detailed configuration information for the upgraded storage solution.

Storage configuration information	Dell Storage SC4020
Controller firmware revision	6.5.2
Number of storage controller modules	2 x CT-SC4020
Number of drives	24
Storage disk 1	
Drive vendor and model number	12 x Dell SanDisk LB1606R
Drive size (TB)	1.6
Drive information (speed, interface, type)	Read-Intensive, 6Gb SAS, SSD
Storage disk 2	
Drive vendor and model number	12 x Dell SanDisk LB406S
Drive size (GB)	400
Drive information (speed, interface, type)	Write-Intensive, 6Gb SAS, SSD

Appendix B – How we tested

Legacy environment

We used the following steps to configure our legacy Dell PowerEdge R710 mixed workload environment. We included notes on the VMDK settings where applicable because these steps were also used in the creation of the of the upgraded environment's virtual machines.

Performing the initial OS install and setup

Installing Windows Server 2012 R2

1. Insert the installation media into the CD/DVD drive, and restart the server.
2. When prompted to boot from DVD, press any key.
3. When the installation screen appears, click My language is English (United States).
4. 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 2012 R2 Datacenter (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.
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.

Configuring the operating system

1. Enable remote desktop access.
2. Change the hostname, and reboot when the installer prompts you.
3. Set up networking:
 - a. Click Start→Control Panel, right-click Network Connections, and select Open.
 - b. Right-click the management traffic NIC, and select Properties.
 - c. Select TCP/IP (v4), and select Properties.
 - d. Set the IP address and subnet for the NIC, which will handle management traffic, and click OK.
 - e. Click OK, and click Close.
4. Install all available Windows updates. Restart as necessary.

Configuring the Microsoft Active Directory® and Iometer server

For the legacy environment, we created a large dedicated LUN on the Dell EqualLogic PS6110 storage for the Iometer workload file. For the upgraded VMware environment, we added a 120GB VMDK for Iometer to the AD VM using the Dell Storage SC4020 datastore.

Installing Active Directory and DNS services

1. Launch Server Manager.
2. Click Manage→Add Roles and Features.
3. At the Before you begin screen, click Next.
4. At the Select installation type screen, leave Role-based or feature-based installation selected, and click Next.
5. At the Server Selection Screen, select the server from the pool, and click Next.
6. At the Select Server Roles screen, select Active Directory Domain Services. Click Add Features when prompted, and click Next.
7. At the Select Features screen, click Next.
8. At the Active Directory Domain Services screen, click Next.
9. At the Confirm installation selections screen, check Restart the destination server automatically if required, and click Install.

Configuring Active Directory and DNS services

1. After the installation completes, a screen should pop up with configuration options. If it does not, click the Tasks flag in the upper-right section of Server Manager.
2. Click Promote this server to a Domain Controller.
3. At the Deployment Configuration screen, select Add a new forest. In the Root domain name field, type `test.local`, and click Next.
4. At the Domain Controller Options screen, leave the default values, and enter a password twice.

5. To accept default settings for DNS, NetBIOS, and directory paths, click Next four times.
6. At the Review Options screen, click Next.
7. At the Prerequisites Check dialog, allow the check to complete. If there are no relevant errors, check Restart the destination server automatically if required, and click Install.
8. When the server restarts, log on using `test\Administrator` and the specified password.

Configuring the Windows Time Service on the domain controller

To ensure reliable time, we pointed our Active Directory server to a local NTP server.

1. Open a command prompt.
2. Type the following:

```
W32tm /config /syncfromflags:manual /manualpeerlist:"<ip address of a NTP server>"
W32tm /config /reliable:yes
W32tm /config /update
W32tm /resync
Net stop w32time
Net start w32time
```

Preparing AD for Microsoft Exchange

1. Create a reverse lookup zone:
 - a. Click the start button, and in the search field, type DNS.
 - b. Open the DNS manager by clicking on it in the results field.
 - c. Expand your Active Directory domain, and click Reverse Lookup Zones.
 - d. Click Action→New Zone.
 - e. On the Welcome screen, click Next.
 - f. Chose Primary Zone, and click Next.
 - g. Leave default replication scope, and click Next.
 - h. Choose IPv4, and click Next.
 - i. Enter the IP address of your domain (192.168.1 for our example).
 - j. Choose Allow both nonsecure and secure dynamic updates, and click Next.
 - k. Click Finish.
2. Insert the Exchange 2013 R2 Installation ISO in the AD DVD drive.
3. In Windows Explorer, double-click the Exchange DVD icon.
4. In the Exchange installation folder, hold down shift, and right-click.
5. Choose Open a command window here.
6. Run the following command:

```
Setup.exe /PrepareSchema /IAcceptExchangeServerLicenseTerms
```

7. When the previous command completes, run the following command:

```
Setup.exe /PrepareAD /OrganizationName:"organization name" /
IAcceptExchangeServerLicenseTerms
```

8. 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 three times.
7. Choose Certificate Authority and Certification Authority Web Enrollment.
8. Click Add Features, if prompted, to install any required features.
9. Click Next.
10. Leave defaults, and click Next.
11. Click Install.
12. When the install finishes, click Close.
13. Click the yellow warning symbol in the Server Manager, and click Configure Active Directory Certificate Services.

14. Leave defaults, and click Next.
15. Check both Certification Authority and Certification Authority Web Enrollment, and click Next.
16. Choose Enterprise CA, and click Next.
17. Choose Root CA, and click Next.
18. Choose Create a new private key, and click Next.
19. Leave defaults, and click Next.
20. Leave defaults, and click Next.
21. Leave 5 years, and click Next.
22. Leave default locations, and click Next.
23. Click Configure.
24. Close when the configuration finishes.
25. Open Internet Explorer® and navigate to localhost/certsrv/Default.asp to verify that the installation succeeded.

Installing Iometer

1. Download the Iometer 1.1.0 package for Windows from <http://www.iometer.org/doc/downloads.html>.
2. Double-click the installer, and click Run.
3. At the Welcome window, click Next.
4. At the License Agreement window, click I Agree.
5. At the Choose Components window, leave the defaults selected, and click Next.
6. At the Choose Install Location window, leave it at defaults, and click Install.
7. When the installation is complete, click Finish.

Setting up the Iometer workload

We used the following settings for each test:

1. Open Iometer.exe.
2. Create the following access specification:
 - a. Transfer Delay: 0ms
 - b. Burst Length: 1 I/O
 - c. Outstanding I/Os: 1
 - d. Under Reply Size, select No Reply.
 - e. 100% random
 - f. 80% reads
 - g. Under Align I/Os, select Sector Boundaries.
3. Under Disk Targets, set the # of Outstanding I/Os to 1.
4. Set the disk size to 209715200 (100GB).
5. Under Results Display, make sure that Iometer has selected Start of Test.
6. Under Test Setup, set the Run Time to 60 minutes and the Ramp Up Time to 600 seconds.
7. Exit Iometer.

Configuring the Microsoft Exchange 2013 Server

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 Use the following DNS server addresses, 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. To start joining the domain, select OK.
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 Exchange Server 2013 SP1 Mailbox and Client Access Server roles

For the legacy environment, we created large dedicated LUNs on the Dell EqualLogic PS6110 for the Exchange database, logs, and backup. For the upgraded VMware environment, we added a 110GB VMDK for the database, a 10GB VMDK for logs, and a 110GB VMDK for backup to the Exchange VM using the Dell Storage SC4020 datastore.

1. On the Exchange 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 and Client Access role, and click Next.
14. At the Installation Space and Location screen, leave the default 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.

Configuring Exchange

1. On the Exchange 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 then click Send Connectors.
5. On the Send Connectors page, click the New icon.
6. In the New Send Connector wizard, specify `SMTP` as the 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 the Add icon.
9. In the Add domain window, enter `*` in the Fully Qualified Domain Name (FQDN) field, and click Save.
10. Click Next.
11. In the Source Server screen, click the Add icon.
12. In the Select a Server window, select the Exchange server, click Add, and click OK.
13. Click Finish.
14. In the left pane of the EAC, click servers, select the name of the Exchange 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. As the authentication method, choose NTLM, and click Save.
17. Click Virtual Directories, and then click the Configure external access domain icon.
18. In the Select the Client Access servers to use with the external URL window, click the Add icon.
19. Select the Exchange server, and click Add. Click OK.
20. Enter the FQDN of the Exchange server in the Enter the domain field, and click Save.

21. Log into the Active Directory server using administrator credentials, and complete the following steps:
 - a. Open Server Manager, then click Tools→DNS.
 - b. In DNS Manager, in the left pane, expand the Active Directory server name→Forward Lookup Zones→test.local.
 - c. In the right pane, verify or create the DNS records as presented below.

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

22. Log back into your Exchange server.
23. In the Exchange PowerShell, run the following commands, replacing \$HostName with the host name (not FQDN) of your Exchange 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

Get-OutlookAnywhere | Set-OutlookAnywhere -ExternalHostname mail.ives.lan -InternalHostname mail.ives.lan -ExternalClientsRequireSsl $true -InternalClientsRequireSsl $true -DefaultAuthenticationMethod NTLM
```

24. Create a folder at the root of C: on the Exchange server, and share it to Everyone with read/write permissions.
25. Log back into the Exchange admin center, and navigate to Servers→certificates.
26. In the drop-down menu, choose the Exchange server, and to create a new certificate, click the plus sign.
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 Exchange 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 Exchange server, and click Finish. Example: \\exchange\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-encoded CMC...
40. Open Windows Explorer, and navigate to the share folder on the Exchange 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 Exchange server.
46. Log back into the Exchange 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: \\exchange\share\certnew.CER
50. Verify that the status has changed to Valid.
51. Edit the new entry, and click Edit.
52. Go to Services, check SMTP and IIS, and click Save.
53. On the warning message, click Yes.
54. Run the following steps on the Exchange 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 Exchange 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 Exchange 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. Using the Edit button, disable the maintenance schedule, and enable circular logging for each mailbox database.
59. Dismount and remount the databases.
60. Open the 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 exchange.domain.com
-DefaultAuthenticationMethod NTLM -ExternalClientsRequireSsl $true
```

Configuring the Microsoft SQL Server 2014 server

For the legacy environment, we created large dedicated LUNs on the Dell EqualLogic PS6110 for the SQL database, logs, and backup. For the upgraded VMware environment, we added a 60GB VMDK for the database, a 30GB VMDK for logs, and a 50GB VMDK for backup to the SQL VM using the Dell Storage SC4020 datastore.

Installing SQL Server 2014 with Service Pack 1

1. Prior to installing, add the .NET Framework 3.5 feature to the server.
2. Mount the installation DVD for SQL Server 2014.
3. Click Run SETUP.EXE. If Autoplay does not begin the installation, navigate to the SQL Server 2014 DVD, and double-click it.
4. In the left pane, click Installation.
5. Click New SQL Server stand-alone installation or add features to an existing installation.
6. Select the Enter the product key radio button, and enter the product key. Click Next.
7. To accept the license terms, click the checkbox, and click Next.
8. Click Use Microsoft Update to check for updates, and click Next.
9. To install the setup support files, click Install.
10. If there are no failures displayed, click Next.

11. At the Setup Role screen, choose SQL Server Feature Installation, and click Next.
12. 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. Click Next.
13. At the Installation Rules screen, after the check completes, click Next.
14. At the Instance configuration screen, leave the default selection of default instance, and click Next.
15. 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 Startup Type to Automatic. Click Next.
16. At the Database Engine Configuration screen, select the authentication method you prefer. For our testing purposes, we selected Mixed Mode.
17. Enter and confirm a password for the system administrator account.
18. Click Add Current user. This may take several seconds.
19. Click Next.
20. At the Error and usage reporting screen, click Next.
21. At the Installation Configuration Rules screen, check that there are no failures or relevant warnings, and click Next.
22. At the Ready to Install screen, click Install.
23. After installation completes, click Close.
24. Run through the installation again, creating a new installation of SQL with the same settings.
25. Close the installation window.

Generating the DVD Store 2 data

We generated the data using the Install.pl script included with DVD Store version 2.1 (DS2), providing the parameters for our 40GB database size and the Microsoft SQL Server 2014 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 2014. We built the 40GB database in SQL Server 2014, then performed a full backup, storing the backup file on the SQL backup LUN for quick access. We used that backup file to restore the server between test runs.

The only modifications 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. Apart from this file size modification, we created and loaded the database schema according to the DVD Store documentation. Specifically, we followed these steps:

1. Generate the data and create the database and file structure using database creation scripts in the DS2 download. Make size modifications specific to the 40GB database and the appropriate changes to drive letters.
2. Transfer the files from a 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 generated data 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 map this user to the SQL Server login.
12. Perform a full backup of the database. This backup allows a restore of the database to a pristine state relatively quickly between tests.

Our initial file size modifications.

Logical name	Filegroup	Initial size (MB)
primary	PRIMARY	3
cust1	DS_CUST_FG	6,144
cust2	DS_CUST_FG	6,144
cust3	DS_CUST_FG	6,144
cust4	DS_CUST_FG	6,144
ind1	DS_IND_FG	3,280
ind2	DS_IND_FG	3,280
ind3	DS_IND_FG	3,280
ind3	DS_IND_FG	3,280
ds_misc	DS_MISC_FG	200
orders1	DS_ORDERS	3,072
orders2	DS_ORDERS	3,072
orders3	DS_ORDERS	3,072
orders4	DS_ORDERS	3,072
Log files		
ds_log	Not applicable	25,375

Upgraded Dell PowerEdge R730 environment

We used the following steps to configure the Dell PowerEdge R730 environment with VMware vSphere. For the backing storage, we created an 18TB LUN on the Dell Storage SC4020 and mapped the LUN to our three PowerEdge R730 servers via fibre channel. Once the virtual infrastructure was in place, we used the same steps from the legacy environment to create VMs identical to each server role.

Installing VMware ESXi 6 Update 2

1. Attach the installation media.
2. Boot the server.
3. At the VMware Installer screen, press Enter.
4. At the EULA screen, to Accept and Continue, press F11.
5. Under Storage Devices, select the appropriate virtual disk, and press Enter.
6. As the keyboard layout, select US, and press Enter.
7. Enter the root password twice, and press Enter.
8. To start installation, press F11.
9. After the server reboots, press F2, and enter root credentials.
10. Select Configure Management Network, and press Enter.
11. Select the appropriate network adapter, and select OK.
12. Select IPv4 settings, and enter the desired IP address, subnet mask, and gateway for the server.
13. Select OK, and restart the management network.
14. Repeat steps 1 through 13 on all 24 servers.

Deploying the VMware vCenter Server 6 Update 2

We used a client server running VMware ESXi to host our clients and virtualized management servers. For the VMware vCenter server VM, we installed Windows Server 2012 R2 and performed the following steps to install and configure vCenter.

1. Log into the vCenter VM.
2. From the VMware vCenter Server 6.0 install media, click Run to start the install wizard.
3. Select vCenter Server, and click Install.
4. At the Install wizard welcome screen, click Next.
5. Agree to the License Agreement, and click Next.
6. Select the Embedded Deployment option, and click Next.
7. Enter the system IP address.
8. Enter and confirm the password you wish to use with the Administrator account for vCenter Single Sign On, and click Next.
9. Click Next.
10. Accept the default database settings, and click Next.
11. Accept the default https port, and click Next.
12. Accept the default installation path, and click Next.
13. Uncheck Join the VMware Customer Experience Improvement Program, and click Next.
14. Click Install.
15. To exit the wizard, click Finish.
16. On the installer, click Exit.
17. Restart the server.
18. Once completed, log into the first vCenter's web client at <https://vcenter-ip-address/vsphere-client/?csp>.
19. Add all the necessary ESXi and vCenter licenses to the vCenter.

Creating the cluster and adding the hosts to VMware vCenter

We used the following steps to create each of the three clusters in each site and add the desired servers to the vCenter. The clusters on each site are management, edge, and compute.

1. Once logged into the vCenter, navigate to Hosts and Clusters.
2. Select the primary site management vCenter.
3. Right-click the vCenter object, and select New Datacenter...
4. Enter a name for the new datacenter, and click OK.
5. Right-click the new datacenter, and click New Cluster...
6. Enter a name for the new cluster.
7. Click OK.
8. Once the cluster has been created, right-click the cluster, and click Add Host.
9. Enter the IP address for the first PowerEdge R730 server, and click Next.
10. Enter the root credentials for the server, and click Next.
11. To accept the server's certificate, click Yes.
12. Review the server details, and click Next.
13. Assign the desired license, and click Next.
14. Disable Lockdown mode, and click Next.
15. Click Finish.
16. Complete steps 9 through 15 for the remaining PowerEdge R730 servers.
17. Once all the servers are added to the cluster, right click a host, and click Storage→New Datastore.
18. Select VMFS, and click Next.
19. Enter a name for the new datastore, select the Dell Storage SC4020 LUN, and click Next.
20. Accept the defaults for the partition configuration, and click Next.
21. Click Finish.
22. Once the create datastore task is complete, ensure that all the hosts in the cluster are mounted on the new datastore.

Configuring the VMware vSphere Distributed Switch for the cluster

For our networking configuration, we utilized vSphere Distributed Switches for the cluster. We then created port groups: Management, vMotion, and a port group for each Exchange VM network. Each port group utilized VLANs: 128 for Management, 1020 for vMotion, and 1001-1018 for Exchange.

1. Navigate to the Networking tab.
2. Expand the vCenter for the cluster.
3. Right-click the datacenter, and click Distributed Switch→New Distributed Switch.
4. Enter a name for the vDS, and click Next.
5. Select Distributed switch: 6.0.0, and click Next.
6. Set the number of uplinks to 2, and enter a name for the new default port group.
7. Click Next.
8. Review the settings, and click Finish.
9. Select the new vDS, and click the manage tab.
10. Under Properties, click Edit...
11. Click Advanced, and for the MTU setting, enter 9000.
12. Click OK.
13. On the left-hand side, right click the new port group that was created along with the new vDS.
14. Click Edit Settings.
15. Click VLAN, and for the VLAN (for the management port group), enter 128.
16. Click Teaming and Failover.
17. Set all the two uplinks to active.
18. Click OK.
19. Right-click the vDS, and click Distributed Port Group→New Distributed Port Group.
20. Enter a name for the new port group (e.g., vMotion), and click Next.
21. Under VLAN, set the VLAN to 1020 for vMotion.
22. Under Advanced, check the box Customize default policies configuration.
23. Click Next.
24. For Security, click Next.
25. For Traffic Shaping, click Next.
26. For Teaming and Failover, assign the two uplinks as active ports.
27. Click Next.
28. For Monitoring, click Next.
29. For Miscellaneous, click Next.
30. For Edit additional settings, click Next.
31. Review the port group settings, and click Finish.
32. Repeat steps 19-31, creating individual port groups for VLANs 1001-1018 to be used for individual Exchange environment networks.
33. Right-click the vDS, and click Add and Manage Hosts...
34. Select Add hosts, and click Next.
35. Click + New hosts...
36. Select all the hosts in the vCenter, and click OK.
37. Click Next.
38. Select Manage physical adapters and Manage VMkernel adapters, and click Next.
39. For each host, select each of the two 10Gb ports, click Assign uplink, and assign them to the two uplink ports.
40. Click Next.
41. Select the first host, and click +New adapter.
42. Click select an existing network, and click Browse.
43. Select the vMotion port group, and click OK.
44. Click Next.
45. Check the vMotion traffic box, and click Next.
46. Enter the desired network information for the new VMKernel, and click Next.
47. Click OK.
48. Select the new adapter, and click Edit adapter.
49. Click NIC settings.
50. Set the MTU to 9000.
51. Click OK.
52. Repeat steps 41-51 for each host.

53. Click Next.
54. Analyze the impact, and click Next.
55. Review the settings, and click Next.

Creating the VMs

We created three gold image VMs for each of the workloads: SQL, Exchange, and AD with Iometer. We then used these gold images to clone out three workloads multiple times until we reached capacity on our storage array for a total of 18 sets of the legacy environment.

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 desired host with available CPUs, and click Next.
6. Select the Dell Storage SC4020 LUN for the 40GB OS VMDK, and click next.
7. Click Next.
8. Select the guest OS as Windows Server 2012 R2, and click Next.
9. In the Customize Hardware section, use the following settings for each VM type:
 - a. For the SQL VM:
 - i. Set the vCPU count to 4.
 - ii. Set the Memory to 24GB, and check the Reserve all guest memory box.
 - iii. Add a 60GB VMDK for the database, a 30GB VMDK for logs, and a 50GB VMDK for SQL backup. Set all VMDKs to thick provision eager zeroed.
 - iv. For the NIC connection, select the default VM Network.
 - v. Attach a Windows Server 2012 R2 ISO to the CD/DVD drive.
 - b. For the Exchange VM:
 - i. Set the vCPU count to 4.
 - ii. Set the Memory to 12GB, and check the Reserve all guest memory box.
 - iii. Add a 120GB VMDK for the database, a 10GB VMDK for logs, and a 110GB VMDK for Exchange backup. Set all VMDKs to thick provision eager zeroed.
 - iv. Select the VLAN 1001 port group for the network adapter connection. This setting will change for each cloned Exchange VM in the order of VLAN 1002, VLAN 1003, etc.
 - v. Add a second network adapter, and set the connection to the default VM Network.
 - vi. Attach a Windows Server 2012 R2 ISO to the CD/DVD drive.
 - c. For the AD/Iometer VM:
 - i. Set the vCPU count to 4.
 - ii. Set the Memory to 2GB, and check the Reserve all guest memory box.
 - iii. Add a 120GB VMDK for Iometer. Set all VMDKs to thick provision eager zeroed.
 - iv. Select the VLAN 1001 port group for the network adapter connection. This setting will change for each cloned AD/Iometer VM in the order of VLAN 1002, VLAN 1003, etc.
 - v. Add a second network adapter, and set the connection to the default VM Network.
 - vi. Attach a Windows Server 2012 R2 ISO to the CD/DVD drive.
10. Click Next.
11. Click Finish.
12. Power on the VMs, and follow the steps outlined in the Legacy Environment section to install and configure each workload.
13. Once each configuration is complete, clone out all three VMs until capacity is reached on the Dell Storage SC4020 LUN.

Configuring the clients and running the test

We ran all test clients on a server running VMware ESXi. We used the following steps to configure each client VM.

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

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

Installing Windows Server 2012 R2

1. Insert the installation media into the CD/DVD drive, and restart the server.
2. When prompted to boot from DVD, press any key.
3. When the installation screen appears, click My language is English (United States).
4. 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 2012 R2 Datacenter (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.
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.

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 Use the following DNS server addresses, 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, select the Domain under the Member of section, and type `test.local`
9. To start joining the domain, select OK.
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. On 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 the IIS 6 Management Compatibility, ASP, and CGI checkboxes, and click Next.
13. Click Install.
14. Click Close.

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 Exchange 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 and FQDN of the Exchange server.
16. Save and close Notepad.

Preparing Load Generator

1. Log into the mail client.
2. Download and install Load Generator 2013 using all defaults.
3. Select Start→All Programs→Microsoft Exchange→Exchange Load Generator 2013.
4. When the Load Generator screen appears, select Start a new test.
5. Select Create a new test configuration, and click Continue.
6. Change the total length of simulation to 1 hour.
7. In the Specify test settings screen, type `password1` as the Directory Access Password and Mailbox Account Master Password, and click Continue with recipient management.
8. Create 500 users in the Mailbox Database, and click Continue.
9. To accept defaults for Advanced recipient settings, click Continue.
10. In the Specify test user groups screen, select the plus sign to add a user group.
11. Change the Client Type to Outlook 2007 Cached, the action profile to Outlook_250, and the Mailbox size to 250 MB, and click Continue.
12. In Remote configurations, leave the checkbox to enable distributing the workload unchecked, and click Continue.
13. Click Save the configuration file as, and name it `testcfg.xml`
14. Click Start the initialization phase (recommended before running the test).
15. Once you have initialized the database, create a backup copy of the Exchange mailbox databases.

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 and assigned a static IP address. We then copied over the DS2 driver executable and the associated test scripts.

Running the tests

We ran all three tests simultaneously, using a script to kick off the final step of each of the following methodologies.

Running the DVD Store test

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 (OPM) 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. Shut down the target.
5. Reboot the system under test and client system.
6. Wait for a ping response from the system under test and the client system.
7. Let the system under test idle for 10 minutes.

8. 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=16
--db_size=40GB --think_time=0.100 --detailed_view=Y --warmup_time=10 --report_rate=5 --csv_
output=<drive_path>
```

Running the lometer test

1. Reboot the system under test.
2. Log in, and let the system idle for 10 minutes.
3. Open lometer, and load the test file you made earlier during setup.
4. To kick off the lometer test, click the start button.

Running 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 load a test configuration, and click Continue.
5. Leave the settings at their already determined settings, and click continue, until you get to the last stage.
6. 10 minutes after you start the DVD Store and lometer tests, click Skip initialization and start test.

Installing and configuring the management tools

We used the following steps to configure our management tool VMs for Dell Performance Analysis Collection Kit, VMware vRealize Operations Manager, and Dell OpenManage Essentials on the client servers. Each VM started with a base install of Windows Server 2012 R2.

Installing and configuring Dell OpenManage Essentials

1. Download Dell OpenManage Essentials. Open the installation media.
2. Leave Dell OpenManage Essentials checked, and click Install.
3. At the Critical Prerequisites screen, click Install All Critical Prerequisites. When the warning dialog appears, to continue installation of the critical prerequisites, click Yes.
4. At the next prerequisites screen, click Install Essentials. To install Essentials on a local database, click Yes.
5. Click Install Essentials.
6. Accept the license agreement for Dell OpenManage Essentials, and click Next.
7. Leave the Typical setup type selected, and click Next.
8. Review the installation settings, and click Install.
9. When installation completes, leave Launch Dell OpenManage Essentials checked, and click Finish.
10. When Dell OpenManage Essentials launches, click the Manage tab.
11. Click the Discovery and Inventory subtab.
12. Click Add Discovery Range.
13. At the Discovery Range Configuration wizard, enter the IP address range for the first Dell servers.
14. Click Add.
15. Click Next.
16. Leave the default Timeout and Retries ICMP parameters, and click Next.
17. Ensure the WS-Man discovery type is selected, and click Next.
18. Enter the iDRAC User ID and Password for discovery (root / calvin). Ensure that Secure Mode and Trusted Site are checked, and click Next.
19. Review the summary, and click Finish.
20. From the Manage tab, click the Discovery and Inventory subtab.
21. Click Add Discovery Range.
22. At the Discovery Range Configuration wizard, enter the IP address range for the second Dell servers.
23. Click Add.
24. Click Next.
25. Leave the default Timeout and Retries ICMP parameters, and click Next.
26. Ensure the WS-Man discovery type is selected, and click Next.
27. Enter the iDRAC User ID and Password for discovery (root / calvin). Ensure that Secure Mode and Trusted Site are checked, and click Next.
28. Review the summary, and click Finish.

Configuring Dell Performance Analysis Collection Kit (DPACK)

For this report, Dell gave us a DPACK account to download the tool and upload DPACK projects. We followed the steps below to perform DPACK data collection for each environment.

1. Download the Windows DPACK executable file to a Windows Server 2012 R2 client system.
2. Launch the executable file.
3. To agree to the license terms, click Yes.
4. Review the customer data, and click Yes.
5. To automatically upload DPACK collections to the web account, select Establish a secure (HTTPS) connection to the DPACK Web Service.
6. To generate a local IOKIT file, select Do not connect to the DPACK Web Service.
7. Click OK.
8. If DPACK has been configured previously, it will prompt you to decide if you want to use the previous setting. Click No.
9. Select the local drive listed, and click Ignore Disk.
10. Click Add Remote Server.
11. For the legacy environment, select Connect to a Windows server, and enter the IP of the first server. Then click Connect, and enter in the login credentials of the server. Repeat these steps to add the remaining two servers.
12. For the upgraded R730 environment, select Connect to a VMware vCenter Server, and enter the IP address of the vCenter server. Then click Connect. Click OK at the warning, and enter in the vCenter credentials. Select the R730 cluster, and click OK.
13. Once all desired servers are connected, select any undesired disks from the list, and click Ignore Disk.
14. Change the capture duration to 4 hours.
15. Click Start capture.

Note: For our testing, we started the capture right before kicking off each test run. We cancelled the capture at the end of roughly 1 hour, capturing data only when the servers were under load.

Installing and configuring VMware vRealize Operations Manager (vROPS)

Installing vROPS

1. Download the vRealize Operations Manager Appliance from VMware.
2. Open a browser, and connect to the vSphere Web Client.
3. Enter administrative credentials, and click Login.
4. In the left menu pane, click vCenter.
5. In the left menu pane, click Hosts and Clusters.
6. At the top of the center pane, select Actions->Deploy OVF Template...
7. Select Local File, and to locate the vRealize Operations Appliance OVA file, click the Browse button. Select the file, and click Open. Click Next.
8. Check the box "Accept extra configuration options", and click Next.
9. To accept the EULA, click Accept, and click Next.
10. Select the vSphere datacenter to which you want to deploy the appliance, and click Next.
11. Accept the default configuration "Small", and click Next.
12. Select the virtual disk format "Thin Provision". Choose the datastore for housing the virtual machine files, and click Next.
13. Select the destination virtual network from the pull-down list, and click Next.
14. In Customize template, select Networking Properties and provide the IP address information for the virtual machine. Leave it blank if you prefer to use DHCP. Click Finish.

Configuring vROPS

1. Power on the virtual machine, and open the console in vSphere client.
2. Verify the IP address of the vROPS server, open a web browser, and connect to the vROPS page to begin configuration.
3. Click Express Installation.
4. Click Next.
5. Enter and re-enter a password for the default "admin" user. Click Next.
6. Click Finish.
7. When the initialization process completes, enter the username admin and the password you created for that user. Click Login.
8. Continue the configuration by clicking Next.
9. To accept the terms of the agreement, check the box, and click Next.
10. Enter the product key or accept the default for a product evaluation, and click Next.
11. Click Next.
12. Click Finish.
13. In the solutions section, select the VMware vSphere solution. To configure, click the gears icon in the top of that section.

14. Select vCenter Adapter. For Instance settings, enter a display name and a description. Enter the vCenter Server address, and to add a new credential, click the green plus sign.
15. Enter a credential name, like vCenter Administrator, and enter the username and password for the user. We used administrator@vsphere.local and the relevant password. Click OK.
16. Click Test Connection.
17. To accept the certificate, click OK. Click OK.
18. Click Save Settings. Click OK.
19. Select the vCenter Python Actions Adapter.
20. Select vCenter Adapter. For Instance settings, enter a display name and a description. Enter the vCenter Server address, and to add a new credential, click the green plus sign.
21. Enter a credential name, like vCenter Administrator, and enter the username and password for the user. We used administrator@vsphere.local and the relevant password. Click OK.
22. Click Test Connection.
23. To accept the certificate, click OK. Click OK.
24. Click Save Settings. Click OK.
25. Click Next.
26. Accept default settings for monitoring pools, and click Next.
27. Click Finish.

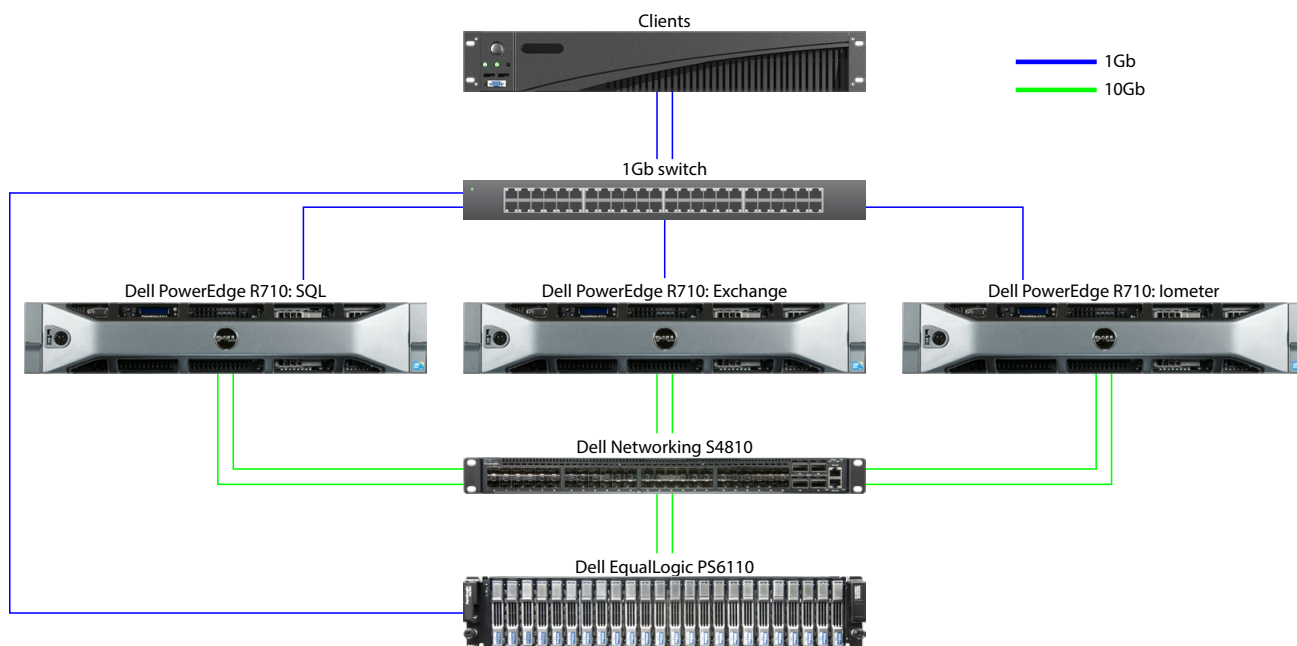
Appendix C – Our setup

Legacy environment

For our legacy environment, we configured three identical Dell PowerEdge R710 servers. Each server contained 48 GB of RAM and dual Intel Xeon E5520 processors. We installed Windows Server 2012 R2 with updates on each server and configured each server for its individual workload purpose. For the database workload server, we installed SQL Server 2014 SP1 with updates and configured a single SQL instance with a 40GB database for the DVD Store 2 server to target. For the mailbox workload server, we installed Microsoft Exchange 2013 with updates. We then generated a typical 500-mailbox environment using a Load Generator 2013 client. Finally, we configured the file server with Iometer and configured it to act as the Active Directory server for the Exchange environment. We cabled all three servers to a standard 1Gb Ethernet switch using the onboard NICs for client and management traffic. For information on our test methodology, see [Appendix B](#).

For the backing legacy storage, we configured a Dell EqualLogic PS6110 array with 24 10K HDDs and 10Gb iSCSI connectivity. We cabled each of the EqualLogic's controllers to a 10Gb Dell Networking S4810 switch with redundant paths. We then installed an Intel Ethernet Server Adapter X520 in each PowerEdge R710 and cabled both ports on each card to the S4810. We then configured each port for iSCSI traffic and multipath I/O using native Windows tools and the EqualLogic HIT Kit software. We presented each server with individual LUNs on the EqualLogic PS6110 for their specific workloads: three LUNs for the SQL database, logs, and backups to the database server; three LUNs for the Exchange mailbox database, logs, and backups to the mailbox server; and one LUN for the Iometer work file to the file server. See below for a detailed diagram of our legacy environment test bed.

Our legacy environment test bed

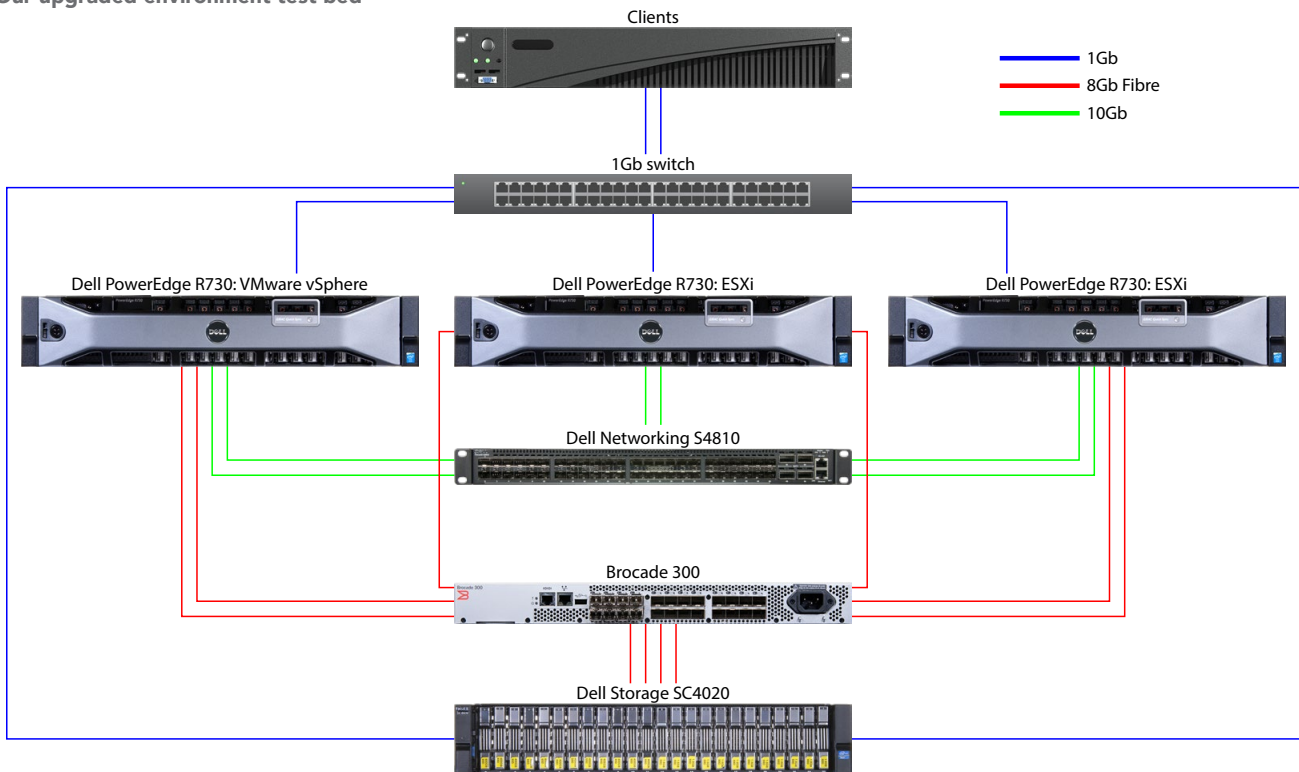


Upgraded environment

For our upgraded environment, we configured three identical Dell PowerEdge R730 servers. Each server contained 256 GB of RAM and dual Intel Xeon E5-2660 v4 processors. We installed VMware vSphere 6 Update 2 on each server and created a three-node cluster in VMware vCenter Server. We cabled each server to a standard 1Gb switch using the onboard 1Gb NICs for client, management, and VM traffic. Additionally, we cabled the onboard 10Gb NICs to a Dell Networking S4810 switch for vMotion traffic. We configured all networks using VMware best practices.

For the backing storage, we configured a Dell Storage SC4020 array with twelve write-intensive SSDs and twelve mixed-used SSDs. For storage connectivity, we connected two 8Gb fibre channel ports from each of the two storage controller modules to a Brocade 300 fibre switch with NPIV enabled. We then installed a QLogic GLE2562 8Gb fibre channel card in each PowerEdge R730 and cabled both ports to the Brocade switch. We created a single 18TB LUN on the storage and mapped the LUN to the PowerEdge R730 servers for VM storage with read and write cache enabled on the storage. See below for a detailed diagram of our upgraded environment test bed.

Our upgraded environment test bed



Each server hosted a mix of database workload VMs, mailbox workload VMs, and file workload VMs, with each VM matching the software configuration of the legacy servers. With load-balancing, each PowerEdge R730 ran six sets of legacy workload VMs. We resized the VMs resources lower than the legacy environment servers to allow for maximum resource utilization and workload consolidation because our test VMs were performing at the level of the legacy environment or better. We also reserved all RAM for each VM to avoid memory contention. All VMDKs were thick provisioned eager zeroed. For each VM type, we used the following VM hardware settings:

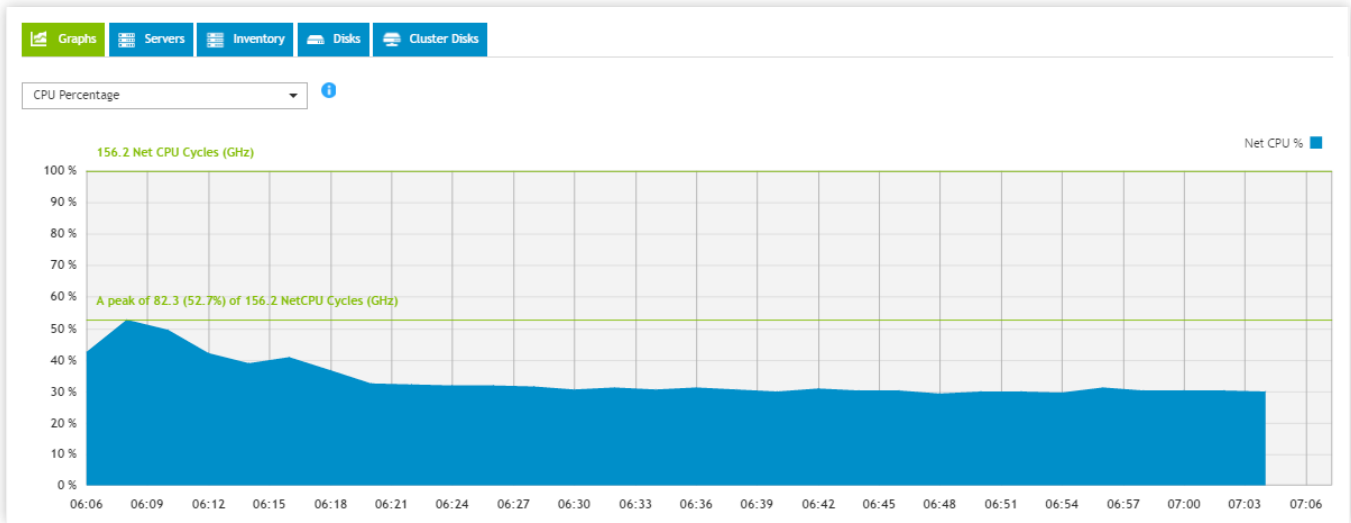
Workload	vCPU	RAM (GB)	OS VMDK (GB)	Data VMDK (GB)	Log VMDK (GB)	Backup VMDK (GB)
Database	4	24	40	60	30	50
Mailbox	4	12	60	120	10	120
File	4	2	40	120	N/A	N/A

Appendix D – DPACK data

While we were testing, we ran DPACK on the upgraded Dell and VMware environment. Below are screenshots of the DPACK reports covering an hour-long test run in which the new solution is doing 18 times the work of the legacy solution. We used this data for the performance analysis of our test runs, specifically CPU, IOPS, and storage latency.

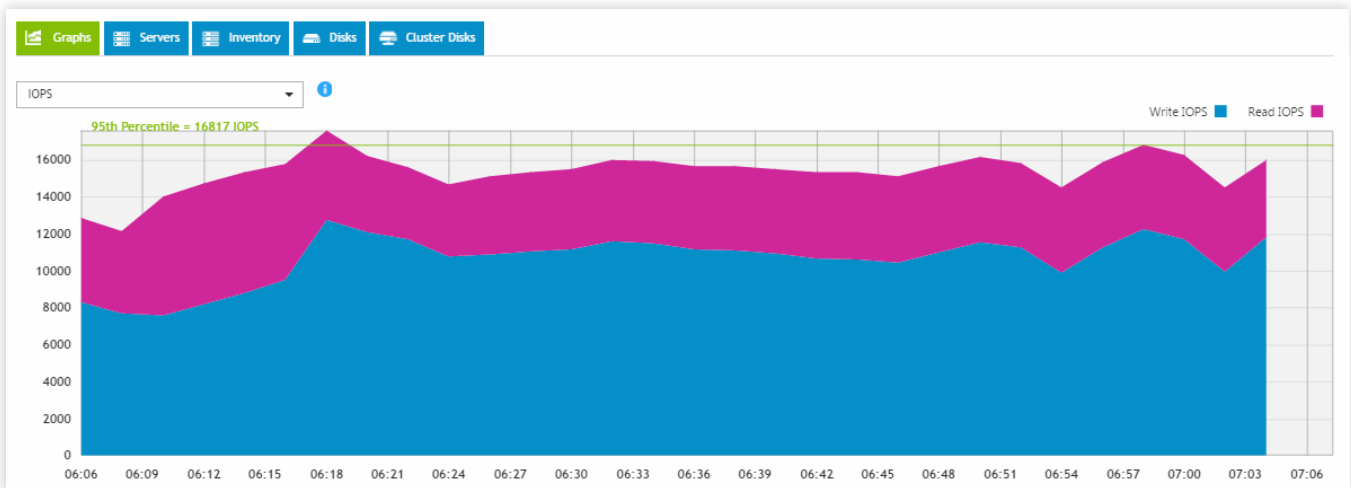
CPU

In the screenshot below, the upgraded environment achieved a peak CPU of 52.7 percent with an average of approximately 33 percent at a steady state. Storage capacity became our bottleneck. If we had added more storage capacity, we could have provisioned additional VMs on each host to get the most out of the compute resources because this environment was virtualized.



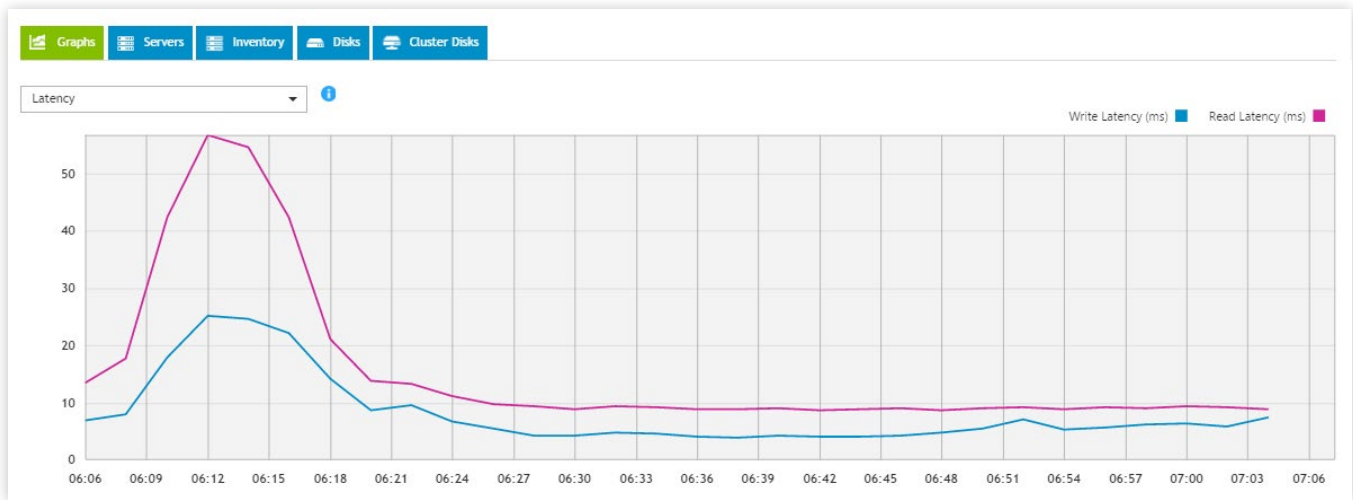
IOPS

The upgraded environment with the all-flash array peaked at 17,576 IOPS during our testing.



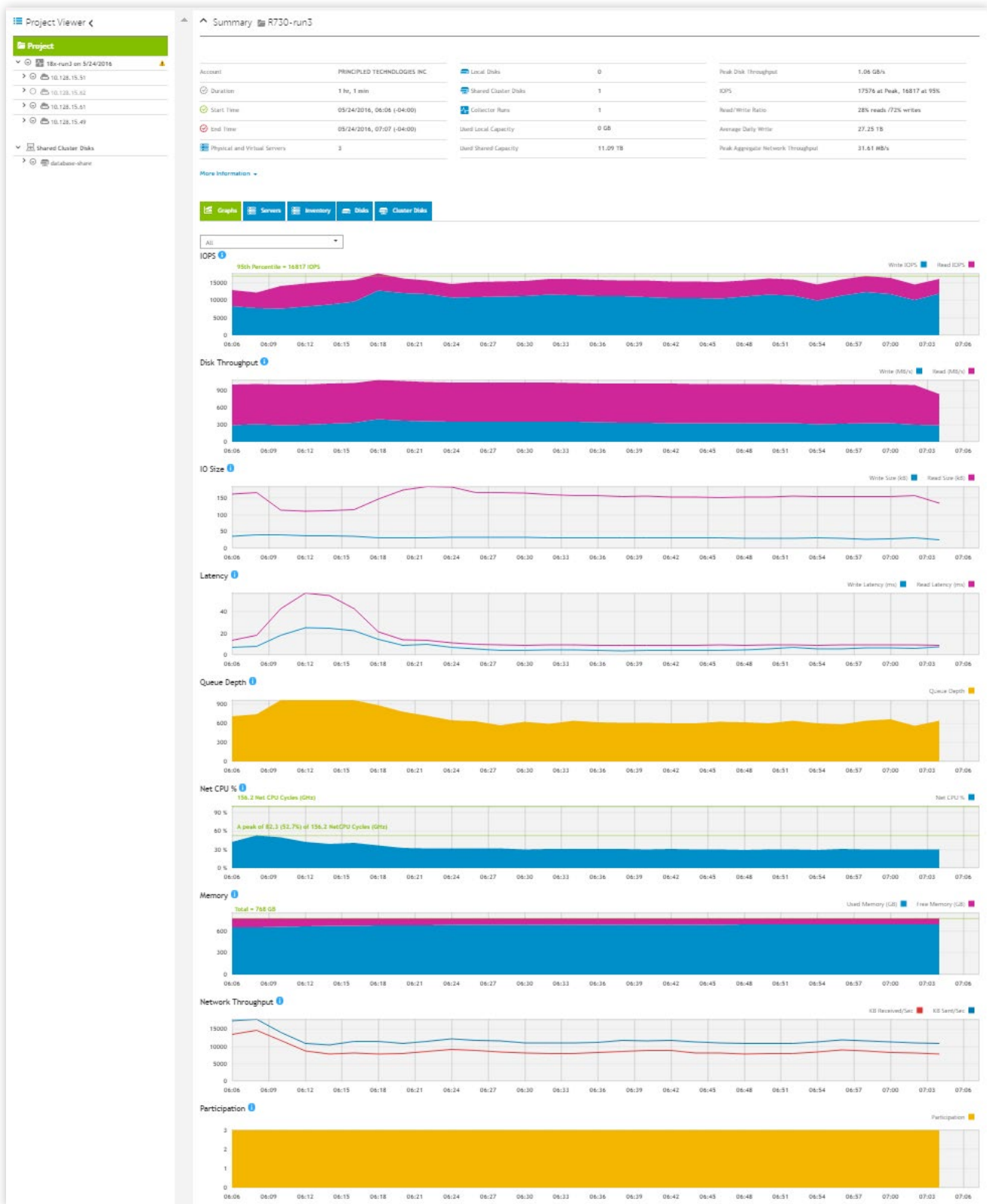
Latency

Though the upgraded environment hit a peak of 56.7ms read and 25.1ms write latency early during the Exchange workload ramp-up, the latency during a steady performance state remained fairly even, at approximately 5ms write and 9ms read latency.



Additional DPACK counters

DPACK also provides many other graphs showing metrics like memory utilization, network and storage throughput, I/O size, and more. We did not use these graphs in our analysis. When you examine all the graphs together, the data they provide can give you a clear picture of your current environment's performance needs as well as potential bottlenecks and limitations.



This project was commissioned by Dell.



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