HARDWARE UPGRADES TO IMPROVE DATABASE PERFORMANCE WITH THE INTEL PROCESSOR-POWERED DELL POWEREDGE R730
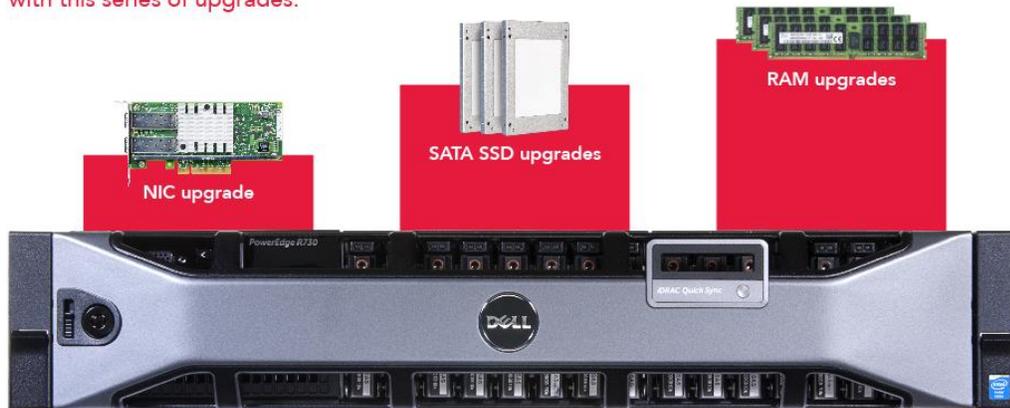
DELL™ POWEREDGE™ R730 SERVER DELIVERED

over
18X AS MANY
orders per minute

and up to
62% FASTER
data transfer

The Dell PowerEdge R730 supported a wide range of upgrade options that boosted database performance.

with this series of upgrades:

NIC upgrade

SATA SSD upgrades

RAM upgrades

PowerEdge R730

POWERED BY INTEL® XEON® E5-2690 V3 PROCESSORS

compared to the base configuration of a legacy server

Growing businesses can experience application resource problems if their hardware cannot support increased workload demands. For example, upgraded processors can provide a boost to processing-centric workloads, but applications can experience slowdown if the storage subsystem is too busy, a server's memory resources are pressured, or the network is saturated during a backup window. The servers you purchase need to be configured to not just support the underlying applications—they should enhance performance and empower end users to do more. In addition to the known basic benefits of replacing your legacy server, the new Intel Xeon E5-2690 v3 processor-powered Dell PowerEdge R730 provides a platform conducive to upgraded application performance via component upgrades, including network interface cards (NICs), SATA solid-state drives (SSDs), and memory—all key players in complex applications. These hardware upgrades, resulting in a more balanced system, can help your business avoid application performance bottlenecks and take performance to levels beyond current standards.

In our hands-on testing at Principled Technologies, we compared an HP ProLiant DL380 G7 and the Intel-powered Dell PowerEdge R730 in multiple configurations to show how resource upgrades can improve performance. We found that as we upgraded individual components in the system, we increased the number of application orders or

minimized data transfer time at each upgrade step, showing that each improvement made to the server positively affected the application output.

With all upgrades in place, our final configuration of the new PowerEdge R730, upgraded with the Intel 10GbE NIC, solid-state drives (SSDs), and greater capacities of memory, achieved 18 times better database performance overall and completed a data transfer in 58.3 percent less time per virtual machine (VM) than the HP ProLiant DL380 G7 did. Upgrading these components gives your business an option to scale up to meet application demands.

UPGRADE FOR BETTER PERFORMANCE

Any new server purchase will include technology that will likely outperform legacy servers currently in your datacenter. However, investing a bit more in component upgrades could further boost workload performance and provide a better experience for your growing number of users. When planning a server purchase, consider the impact of *not* upgrading these components.

Upgrading legacy servers allows your business to take advantage of better technology at relatively lower prices given developments in the industry. Prices of 10GbE networking components, SSDs, and memory have fallen over time, while technological advancements in each area continue to increase. The Intel Xeon E5-2690 v3 processor-powered Dell PowerEdge R730 gives your business the flexibility of upgrading components at a much lower relative cost than in the prior hardware refresh cycle.

To demonstrate the added performance from the upgrades, we first compared the new Dell PowerEdge R730 in a baseline configuration to an HP ProLiant DL380 G7. For both solutions, the test process simulated a transactional database server in production. We ran an online transactional processing (OLTP) workload to demonstrate performance improvements provided by first the system upgrade, then the SSD upgrade, and finally the memory upgrade. At each step, we also separately measured the time to transfer a backup file from each of our test VMs to a separate file server to show improvements in network throughput. Figure 1 presents a brief overview of test configurations.

	HP ProLiant DL380 G7 (legacy server)	Dell PowerEdge R730 (baseline)	Dell PowerEdge R730 w/ Intel 10GbE NIC	Dell PowerEdge R730 w/ Dell 6Gbps SATA SSDs	Dell PowerEdge R730 w/ 384GB DDR4 RAM
Network connection (Gb)	1	1	10	10	10
Drive type	8x HDDs	16x HDDs	16x HDDs	2x HDDs & 14x SSDs	2x HDDs & 14x SSDs
Memory (GB)	48	128	128	128	384
OS	Microsoft Windows Server 2008 R2	Microsoft Windows Server 2012 R2	Microsoft Windows Server 2012 R2	Microsoft Windows Server 2012 R2	Microsoft Windows Server 2012 R2
Total VMs	4	8	8	8	16

Figure 1: Overview of the legacy server configuration and the various Dell PowerEdge R730 configurations.

For our OLTP workload, we used DVD Store 2 (DS2) to create and target multiple virtual machines (VMs), all running Microsoft SQL Server 2014 with 20GB databases. We ran the workload for 30 minutes and we measured performance results using orders-per-minute (OPM) from DS2, calculated as a running average over the test period. After each test run, we also transferred a 20GB file copy from each VM to a separate file server. In that portion of the test, we measured the length of time required to complete the file copy.
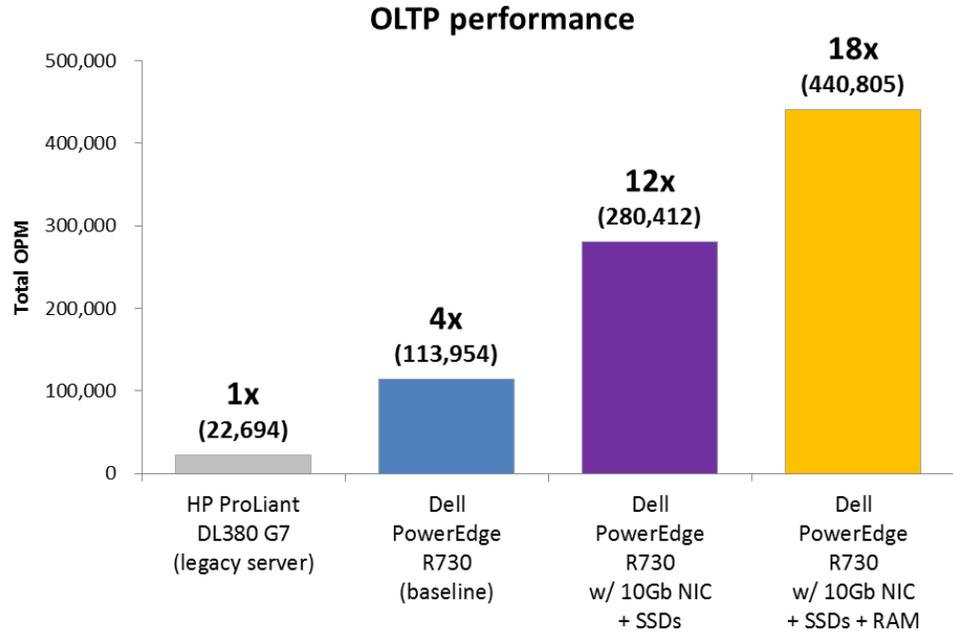
For more information about the Intel-powered Dell PowerEdge R730, component upgrade pricing, and DS2, see Appendix A. See Appendix B for detailed information about our test systems and Appendix C for detailed testing procedures.

WHAT WE FOUND
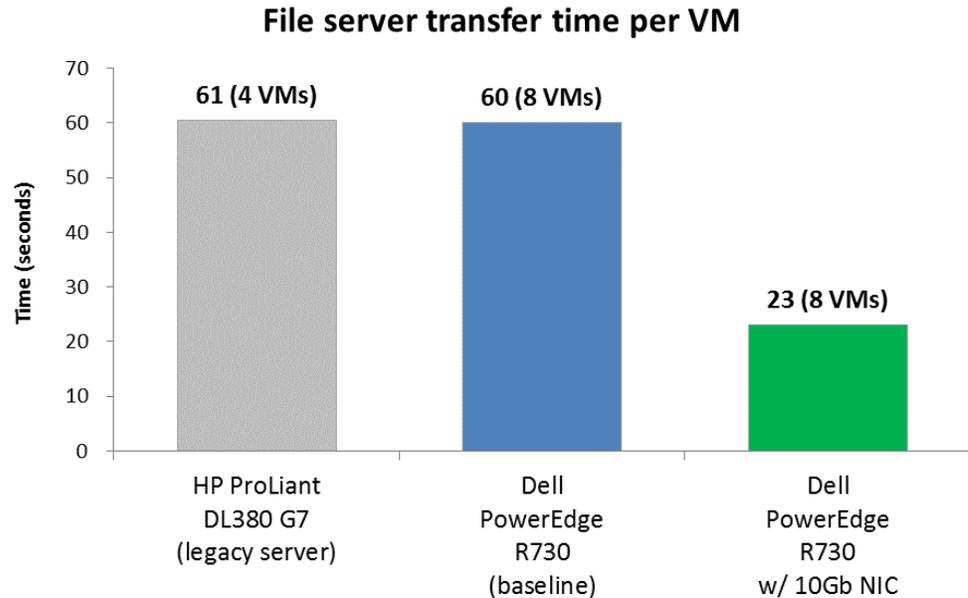## Results summary – database performance and data transfer

We found that the baseline configuration of the new PowerEdge R730 provided over four times more OPM than the HP ProLiant DL380 G7. In addition to this initial performance benefit, the PowerEdge R730 with upgraded components provided up to 18 times more OPM than the HP ProLiant DL380 G7 server did. Figure 2 summarizes the OLTP performance for each configuration.

OLTP performance

Figure 2: Total OPM achieved by the HP ProLiant DL380 G7 and the Dell PowerEdge R730 in three different configurations. Higher numbers are better.

We also found that the Intel-powered Dell PowerEdge R730 with upgraded NICs was able to perform a data transfer from each VM to a separate file server in less than half the time per VM than the HP ProLiant DL380 G7 and the baseline Dell PowerEdge R730. Figure 3 summarizes the transfer time per VM for the 1Gb configurations and the improvement seen with the 10Gb NIC upgrade.

File server transfer time per VM

Figure 3: Data transfer times in seconds per VM for the HP ProLiant DL380 G7and the Dell PowerEdge R730 with the 10Gb upgrade. Lower numbers are better.

Detailed test results

Baseline configuration

When we tested the baseline Intel-powered Dell PowerEdge R730, we doubled the number of VMs from the HP ProLiant DL380 G7, as businesses often consolidate application VMs onto new, upgraded servers. We also increased the memory available for each VM in order to take advantage of the increased memory capacity of the baseline configuration. Replacing the legacy server with the Dell PowerEdge R730 in its baseline configuration boosted performance immediately. In fact, we found the PowerEdge R730 provided over four times more OPM in our testing than the legacy server. Figure 4 compares the workload output of the older server and the Dell PowerEdge R730.

	Total orders per minute
HP ProLiant DL380 G7 (legacy server)	22,694
Dell PowerEdge R730 (baseline)	113,954

Figure 4: Performance results when upgrading to the Dell PowerEdge R730.

Storage upgrade - SATA SSDs

SSDs can dramatically boost application performance. We found that upgrading the Dell PowerEdge R730 from hard disk drives (HDDs) to SATA SSDs increased OPM by 146.0 percent over the baseline configuration and provided over 12 times the OPM achieved by the HP ProLiant DL380 G7. We replaced 14 of the 16 HDDs with SSDs and used two high-capacity HDDs to hold the OS virtual machine disk (VMDK) files. The eight 800GB SSDs (for SQL data VMDKs) and six 200GB SSDs (for SQL log VMDKs) would cost approximately $19,000. Figure 5 shows results for the legacy server and the baseline, upgraded NIC, and additional SSDs configurations of the PowerEdge R730.

	Total orders per minute
HP ProLiant DL380 G7 (legacy server)	22,694
Dell PowerEdge R730 (baseline)	113,954
Dell PowerEdge R730 with SSDs	280,412

Figure 5: Performance results when upgrading to SATA SSDs.

Memory upgrade

More memory can lead to greater application performance and greater capacity for more VMs. Specifically for database applications, more memory can mean more database pages in the database buffer cache, which reduces application response time. The baseline configuration of the PowerEdge R730 included 128GB RAM, and so we configured the eight VMs to use 16 GB per VM, giving each VM the most memory possible. For the upgraded Dell PowerEdge R730 in this comparison, we increased system RAM to 384 GB and doubled the number of VMs from the previous configuration

from eight to 16, and increased the RAM per VM to 24GB, again giving the VMs the most memory possible. VMware memory recommendation vary based on workload and application. In our case, we chose to use the full amount of system memory in each configuration and dedicate as much memory to each VM as possible to show the benefits of the upgrade.

With the additional physical RAM, we were able to provide each VM with more virtual RAM, which allowed more of the database to reside in memory. Increasing the system RAM to 384 GB delivered over 18 times more OPM than the HP ProLiant DL380 G7, over twice as many OPM than the baseline configuration, and 57 percent more OPM than the previous configuration with upgraded SSDs. The 256GB worth of 16GB DDR4 memory for the PowerEdge R730 would cost approximately $4,500, meaning the 160,393 increase in orders from the prior configuration could be achieved at just under $0.03 per order increase in cost. Figure 6 shows results for the legacy server, the baseline configuration, upgraded NIC, additional SSDs, and additional RAM configurations of the PowerEdge R730.

	Total orders per minute
HP ProLiant DL380 G7 (legacy server)	22,694
Dell PowerEdge R730 (baseline)	113,954
Dell PowerEdge R730 w/ 10Gb NIC & additional SSDs	280,412
Dell PowerEdge R730 w/ 10Gb NIC, additional SSDs, and additional RAM	440,805

Figure 6: Performance results and increase when upgrading to 384GB RAM.

NIC upgrade

Network congestion is another common bottleneck that can be relieved by an upgrade to the Intel-powered Dell PowerEdge R730. An upgraded NIC can allow for critical operations such as backups and data transfers to complete in less time, minimizing time that resources are unavailable and allowing servers to quickly return to production-level performance. To show the benefits of an upgrade to 10Gb, we transferred our 20GB database backup file from each VM to a separate file server. The file server used an external iSCSI storage array connected via 10Gb to ensure that it was not the cause of a bottleneck. The dual-port 10Gb NIC for the PowerEdge R730 would cost approximately $850.

The HP ProLiant DL380 G7 and the baseline configuration of the Dell PowerEdge R730 delivered roughly the same data transfer rate per VM using the 1Gb NIC. Once we upgraded to a 10Gb NIC, we completed the data transfer in 61.7 percent less time per

VM than the baseline configuration. Figure 7 shows results for the legacy server, and the baseline and upgraded NIC configurations of the PowerEdge R730.

	Time to complete file transfer per VM (seconds)
HP ProLiant DL380 G7 (legacy server)	60.5
Dell PowerEdge R730 (baseline)	60.1
Dell PowerEdge R730 w/ 10Gb NIC	23.0

Figure 7: Performance results and increase when upgrading to a 10Gb NIC.

CONCLUSION

When it comes to upgrading your infrastructure, a new server can increase performance for your applications. However, to unleash the true potential of your new hardware, it is critical to add the right individual component upgrades. We tested a database workload with an HP ProLiant DL380 G7 and several upgraded configurations of the Dell PowerEdge R730 powered by Intel Xeon E5-2690 v3 processors to see how the upgrades enhanced performance. We found that the Dell PowerEdge R730 baseline configuration achieved over four times more OPM than the HP ProLiant DL380 G7, and upgrading to SSDs and adding system RAM allowed for even more OPM. We also found that upgrading to a 10Gb NIC dramatically decreased the file transfer time per VM over the 1Gb configurations. Our upgrades allowed the Dell PowerEdge R730 to achieve over 18 times more OPM overall, and up to 61.7 percent faster data transfer times per VM over the HP ProLiant DL380 G7. Implementing the new Dell PowerEdge R730 with targeted upgrades can push the performance potential of your server hardware purchase.

APPENDIX A – ABOUT THE COMPONENTS

About the Dell PowerEdge R730

The 2U Dell PowerEdge R730 rack server is powered by two Intel Xeon E5-2690 v3 processors and is designed for functional flexibility in the datacenter. The PowerEdge R730 has 24 DIMM slots to support up to 1.5 TB of memory, supports up to two optional internal GPU processing accelerators, and can support up to four optional NVMe Express Flash PCIe SSDs to reduce storage bottlenecks.

With redundant power supply units, hot-swappable hardware, and Dual SD card for Failsafe Hypervisors, the Dell PowerEdge R730 supports hardware high availability. The PowerEdge R730 comes standard with iDRAC8 with Lifecycle Controller and Dell OpenManage, which all work to streamline management. For more details on the Dell PowerEdge R730, visit www.dell.com/us/business/p/poweredge-r730/pd.

Figure 8 shows the pricing for the component upgrades. This information was accurate as of September 26, 2014.[1]

	Additional SSDs	Increased DDR4 memory	Upgraded 10Gb NIC
Upgrade cost (USD)	$18,904.76	$4,616.48	$849.99

Figure 8: Pricing for each individual upgrade.

About the DVD Store Version 2.1

To create our real-world OLTP workload, we used the DVD Store Version 2.1 benchmarking tool. DS2 models an online DVD store, where customers log in, search for movies, and make purchases. DS2 reports these actions in orders per minute that the system could handle, to show what kind of performance you could expect for your customers. The DS2 workload also performs other actions, such as adding new customers, to exercise the wide range of database functions you would need to run your ecommerce environment.

For more details about the DS2 tool, see www.delltechcenter.com/page/DVD+Store.

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[1] configure.us.dell.com/dellstore/config.aspx?oc=pe_r730_1356&model_id=poweredge-r730&c=us&l=en&s=bsd&cs=04

APPENDIX B – SYSTEM CONFIGURATION INFORMATION

Figure 9 provides detailed configuration information for the test systems.

System	HP ProLiant DL380 G7	Dell PowerEdge R730
Power supplies		
Total number	2	2
Vendor and model number	HP DPS-750FB-1	Dell 0G6W6K
Wattage of each (W)	750	750
Cooling fans		
Total number	6	6
Vendor and model number	Nidec UltraFlo	NMB 06038DA-12S-EWH
Volts	12	12
Amps	2.45	1.80
General		
Number of processor packages	2	2
Number of cores per processor	4	12
Number of hardware threads per core	2	2
System power management policy	Performance	Performance
CPU		
Vendor	Intel	Intel
Name	Xeon	Xeon
Model number	X5650	E5-2690v3
Socket type	FCLGA1366	FCLGA2011
Core frequency (GHz)	2.93	2.60
Bus frequency (MHz)	6.4 GT/s	9.6 GT/s
L1 cache	32KB + 32KB (per core)	32KB + 32KB (per core)
L2 cache	256KB (per core)	256KB (per core)
L3 cache	8 MB	30 MB
Platform		
Vendor and model number	HP ProLiant DL380 G7	Dell PowerEdge R730
BIOS name and version	P67	1.0.2
BIOS settings	Performance	Performance
Memory module(s)		
Total RAM in system (GB)	48	128 / 384
Vendor and model number	Micron MT36JSZF51272PZ	Hynix HMA42GR7MFR4N
Type	PC3-10600R	PC4-2133P
Speed (MHz)	1,333	2,133
Speed running in the system (MHz)	1,333	2,133
Timing/Latency (tCL-tRCD-tRP-tRASmin)	9-9-9-24	11-11-11-33
Size (GB)	4	16
Number of RAM module(s)	12	8 / 24
Chip organization	Double-sided	Double-sided
Rank	Dual	Dual

System	HP ProLiant DL380 G7	Dell PowerEdge R730
Operating system		
Name	ESXi	ESXi
Build number	1623387	1331820
File system	VMFS	VMFS
Language	English	English
RAID controller		
Vendor and model number	HP SmartArray P410i	Dell PERC H730P Mini
Firmware version	5.70	25.2.1.0037
Driver version	5.5.0-44vmw	6.901.55.00.1vmw
Cache size (MB)	512	2048
Hard drives		
Vendor and model number	HP MBF2300RC	Dell ST9300605SS / Dell ST91000640NS
Number of drives	8	16 / 2
Size (GB)	300	300 / 1,000
RPM	10k	10k / 7.2k
Type	SAS	SAS / SAS
Solid-state drives		
Vendor and model number	N/A	SanDisk SDLFOC / Liteon OHVK3V / SanDisk SDLFOD
Number of drives	N/A	4 / 4 / 6
Size (GB)	N/A	800 / 800 / 200
RPM	N/A	N/A
Type	N/A	SATA / SATA / SATA
1Gb Ethernet adapters		
Vendor and model number	Broadcom NC382i 4-port	Broadcom BCM5720
Type	Integrated	Integrated
Driver	2.2.3d.v55.2	3.133d.v55.1
10Gb Ethernet adapters		
Vendor and model number	N/A	Intel X520 Dual-port 10GbE
Type	N/A	PCI-E
Driver	N/A	3.18.7iov

Figure 9: System configuration information for the test systems.

APPENDIX C – HOW WE TESTED

For our OLTP workload, we used DVD Store 2 (DS2) to create and target multiple virtual machines (VMs), all running Microsoft SQL Server 2014 with 20GB databases. We ran the workload for 30 minutes and we measured performance results using orders-per-minute (OPM) from DS2, calculated as a running average over the test period. After each test run, we also transferred a 20GB file copy from each VM to a separate file server which used external storage. In that portion of the test, we measured the length of time required to complete the file copy.

On the HP ProLiant DL380 G7, we created two virtual disks: two drives in RAID 1 for the OS and six drives in RAID 10 for the VM virtual disks. On the Dell PowerEdge R730 baseline configuration, we created two virtual disks: 8 drives in RAID 10 for the SQL log virtual disks, and 12 drives in RAID 10 for the SQL data disks. We installed VMware vSphere onto the internal dual SD cards.

We measured our results in the DS2 provided metric, which is orders-per-minute (OPM), calculated as a running average over the test period. We also measured the length of time required to complete the backup per VM.

Setting up the file server

For our data transfer tests, we used a separate Dell PowerEdge R620 to act as a file server running Windows Server 2012 R2 with an external iSCSI Dell EqualLogic array. The Dell PowerEdge R620 had a 10Gb connection to the Dell EqualLogic array to ensure that the file server solution did not cause a bottleneck itself. We then used Windows File Server services to enable our file transfers between the VMs and the file server.

Installing Dell EqualLogic Host Integration Tools on the file server

1. Insert the disk, and click Setup.exe.
2. At the Welcome screen, click Next.
3. At the License Agreement screen, review and accept the terms of the license agreement, and click Next.
4. At the Destination Folder screen, click Next.
5. At the Select Type screen, select Custom, and click Next.
6. At the Custom Setup screen, disable the Auto-Snapshot Manager/Microsoft Edition feature, and click Next.
7. At the Ready to Install the Program screen, click Install.
8. At the Installation Complete screen, click Finish.
9. In the pop-up window that follows to restart the system, click Yes.

Running the Remote Setup Wizard for the Dell EqualLogic PS6110XS from the file server

1. Press the Windows key and open Remote Setup Wizard.
2. At the Welcome screen, leave the radio button on Initialize a PS Series array, and click Next. The Remote Setup Wizard will search for uninitialized PS Series arrays.
3. At the All PS Series arrays have been initialized screen, select the storage array, and click Next.
4. At the Initialize Array screen, enter the appropriate information, and click Next. For our testing, we used PS6110XSstorage for Member Name, 192.168.20.8 for IP Address, 255.255.255.0 for Subnet Mask, and 192.168.20.1 for Default Gateway.
5. Under Group Information, leave the Create a new group radio button selected, and click Next.
6. At the Create a New Group screen, enter the appropriate information. For our testing, we used grpmanager for the Group Name, and 192.168.20.100 for the Group IP Address.

7. Select the desired RAID level. We selected RAID 10 for the RAID Policy.

8. Under Credentials for New Group, enter the passwords.

9. Under IP Address, enter the storage server's IP address, and click Next.

10. On the Initialization Successful pop-up, click OK.

11. Click Finish.

Configuring the Dell EqualLogic PS6110XS storage

1. Press the Windows key, click Internet Explorer, and enter the IP address of the Dell EqualLogic PS Series Group Manager. For our testing, we used 192.10.1.100.

2. Log into Group Manager using the credentials you created during the Remote Setup Wizard.

3. Expand Members, click the member PS6110XSStorage, and in the right pane, select the Network tab.

4. Right-click the management port, and select Enable interface.

5. Click Yes in the Enable network interface popup that appears.

6. Click OK in the Warning popup that appears.

7. Right-click, and select Modify IP settings.

8. Enter the desired IP address for the management port, and click OK. For our testing we used 192.20.1.200 for the IP address and 255.255.255.0 for the Subnet mask.

9. Create the volumes:

10. In the left pane, click Volumes, and, in the adjacent pane, click Create volume.

    a. Name the volume Data and click Next.

    b. Type 300 for the Volume size, and click Next. For our testing purposes we did not create a snapshot reserve with the volume.

    c. On the Step 3 – iSCSI Access screen, click the Allow simultaneous connections from initiators with different IQN names checkbox, and enter the IQN from the storage server.

    d. Click Finish.

Configuring the test server and VMs

We installed VMware vSphere 5.5 on both the HP ProLiant DL380 G7 and the Dell PowerEdge R730. On the HP ProLiant DL380 G7, we installed vSphere onto the first two hard drives in a RAID 1. On the Dell PowerEdge R730, we installed vSphere onto the internal dual SD cards.

Installing VMware ESXi onto the servers

Repeat these steps for the HP ProLiant DL380 G7 and the Dell PowerEdge R730.

1. On the HP ProLiant DL380 G7, use the RAID controller configuration utility during POST to create a RAID1 pair with default options. Select this virtual drive as the boot drive.

2. Insert the installation media and power on the server, choosing to boot from the DVD drive.

3. Select the standard ESXi installer and allow the files to copy into memory.

4. Press F11 at the welcome screen.

5. Press Enter at the keyboard language selection screen.

6. Enter a password twice for the root user and press Enter.

7. On the Dell PowerEdge R730, choose to install to the Dell s Dual SD Cards. On the HP ProLiant DL380 G7, choose the OS virtual drive.

8. Allow the installer to finish installing ESXi and reboot the server.

9. At the home screen, press F2 and enter your credentials.

10. Select Configure Management Network.

11. Select IP Configuration.

12. Enter your static IP information and press Enter.

13. Select DNS Configuration.

14. Enter a hostname and press Enter.

15. Press Esc and then Y to restart the management network.

Installing VMware vCenter Server Virtual Appliance

We used vCenter's VM cloning and host management features in order to help facilitate the testing setup. Use the steps above to install vSphere onto a separate server. Navigate to the IP address and download the vSphere desktop client. Use the client to connect to the server, and follow these steps.

1. Click File→Deploy OVF Template…

2. Browse to the location of your VMware vCenter Server Appliance .ova or .ovf file and click Next.

3. Read over the template properties and click Next.

4. Enter a name for the virtual appliance and click Next.

5. Choose a datastore for the virtual appliance and click Next.

6. Choose hard disk configuration options for the virtual appliance and click Next.

7. Choose the networking configuration for the virtual appliance and click Next.

8. Click Finish and allow the virtual appliance to deploy.

9. Power on the virtual appliance and login to the console. The VMware default username is `root` and the default password is `vmware`.

10. Run /opt/vmware/share/vami/vami_config_net to configure the networking.

11. Using a Web browser on the same network, navigate to `https://<vCenter virtual appliance IP address>:5480` and log in with the default credentials.

12. Follow the wizard to configure vCenter. We used no time synchronization, embedded database, and no active directory.

Creating vSphere datastores

Prior to the steps below, create the RAID volumes on each server. For the HP ProLiant DL380 G7, we used eight drives. We created a RAID1 pair for the hypervisor OS using the first two drives. We created a RAID10 array using the remaining six drives.

On the Dell PowerEdge R730 configurations using HDDs, we split the disks into a 10-drive RAID10 array for the OS and SQL data VMDKs, and a six-drive RAID10 array for the SQL log VMDKs.

On the Dell PowerEdge R730 configurations using SSDs, we created a RAID1 pair from the two hard disk drives for the OS VMDKs. We then created an eight-drive RAID10 array using the 800GB SSDs for the SQL data VMDKs. Finally,

we created a six-drive RAID10 array using the 200GB SSDs for the SQL log VMDKs. We then followed the steps below to present the storage to the hypervisor.

1. In VMware vCenter, navigate to Datastores and click the New Datastore icon.
2. Choose a location for the datastore (ours was the default datacenter) and click Next.
3. Leave the VMFS radio button selected and click Next.
4. Enter a name for the datastore and select a host from the drop-down menu.
5. Select the LUN to be used and click Next.
6. Leave the VMFS-5 radio button selected and click Next.
7. Click Next.
8. Click Finish.

Creating the virtual switches

1. Use the VMware vSphere desktop client to log in to the host server.
2. Select the host and click the Configuration tab.
3. Click Networking.
4. Click Add Networking.
5. Leave the Virtual Machine radio button selected and click Next.
6. Select the client-network facing network adapter and click Next.
7. Give the network a name and click Next.
8. Click Finish.
9. Repeat steps 4-8 to create a network for the data transfers. Select the 10Gb network adapter for the 10Gb scenarios.

Creating the VM

1. In VMware vCenter, navigate to Virtual Machines.
2. Click the icon to create a new VM.
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 appropriate host (HP ProLiant DL380 G7 or Dell PowerEdge R730) and click Next.
6. Select the appropriate datastore for the 35GB OS VMDK and click next.
7. Click Next.
8. Select the guest OS as Windows Server 2008 R2 on the legacy VMs and as Windows Server 2012 on the Dell PowerEdge R730 VMs and click Next.
9. In the Customize Hardware section, make the following changes:
10. Add a second CPU.
11. Increase the memory to 10240MB, 16384MB, or 24576MB, for the 4, 8, and 16 VM scenarios, respectively.
12. Add a 50GB VMDK for SQL data and select the VMware Paravirtual controller and Thick Provisioned Eager Zeroed. Place the VMDK in the appropriate datastore.
13. Add a 30GB VMDK for SQL logs and select the VMware Paravirtual controller and Thick Provisioned Eager Zeroed. Place the VMDK in the appropriate datastore.
14. Connect the VM to the client network and to the file-transfer network.

15. Click Next.
16. Click Finish.
17. Follow the instructions below to install the guest OS.

Installing the VM operating systems

We installed Windows Server 2008 R2 onto the legacy VMs, and installed Windows Server 2012 R2 onto the VMs that resided onto the Dell PowerEdge R730. After connecting the appropriate installation media to the VM, follow the instructions given below to install the OS.

Installing the Microsoft Windows Server 2008 R2 operating system on the legacy system VM

1. Choose the language, time and currency, and keyboard input. Click Next.
2. Click Install Now.
3. Select Windows Server 2008 R2 Datacenter (Full Installation), and click Next.
4. Accept the license terms, and click Next.
5. Click Custom.
6. Click the Disk, and click Next.
7. After the installation completes, click OK.
8. Enter the administrator password twice, and press Enter.
9. Click OK.

Installing the Microsoft Windows Server 2012 R2 operating system on the Dell PowerEdge R730 VM

1. Choose the language, time and currency, and keyboard input. Click Next.
2. Click Install Now.
3. Select Windows Server 2012 R2 Datacenter, and click Next.
4. Accept the license terms, and click Next.
5. Click Custom.
6. Click the Disk, and click Next.
7. After the installation completes, enter the administrator password twice, and click Finish.

Configuring the Microsoft Windows Server operating systems in the VMs

1. Install all available Windows updates. Restart as necessary.
2. Enable remote desktop access.
3. Bring the SQL data and log VMDKs online and create NTFS volumes on each.
4. Change the hostname, and reboot when the installer prompts you.
5. Set up networking for the client network:
   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 client traffic, and click OK.
   e. Click OK, and click Close.
6. Set up networking for the file transfer network:
   a. Click Start→Control Panel, right-click Network Connections, and select Open.
   b. Right-click the VM 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 file-transfer traffic, and click OK.

e.　Click OK, and click Close.

Installing and configuring Microsoft SQL Server 2008 R2 and 2014

　　　　We installed Microsoft SQL Server 2008 R2 onto the legacy VMs, and Microsoft SQL Server 2014 onto the VMs residing on the Dell PowerEdge R730.

Installing SQL Server 2008 R2 in the VM

1. Attach the installation media to the VM.
2. In the VM guest operating system, run setup.exe.
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 SQL Server stand-alone installation or add features to an existing installation.
6. At the Setup Support Rules screen, wait for the rule check to complete. If there are no failures or relevant warnings, click OK.
7. Enter your license key, and click Next.
8. Choose to accept the license terms, and click Next.
9. If no failures are displayed after the setup support files are installed, click Next.
10. At the Setup Role screen, choose SQL Server Feature Installation.
11. 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.
12. At the Installation Rules screen, click Next after the check completes.
13. At the Instance configuration screen, leave the default selection of default instance, and click Next.
14. At the Disk Space Requirements screen, click Next.
15. At the Server Configuration screen, check that NT AUTHORITY\SYSTEM is selected for SQL Server Agent and SQL Server Database Engine. Click Next.
16. Assuming there are no failures, click Next.
17. At the Database Engine Configuration screen, select Mixed Mode.
18. Enter and confirm a password for the system administrator account.
19. Click Add Current user. This may take several seconds.
20. Click the Data Directories tab, Click the Data Directories tab, enter E:\ for the default data locations and F:\ for the default log locations.
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.

Installing SQL Server 2014 in the VM

1. Open the console for the VM or connect to the VM with RDP.
2. Mount the installation ISO to the VM.
3. Click Run SETUP.EXE. If Autoplay does not begin the installation, navigate to the SQL Server 2014 DVD, and double-click.

4. If the installer prompts you with a .NET installation prompt, click Yes to enable the .NET Framework Core role.
5. In the left pane, click Installation.
6. Click New SQL Server stand-alone installation or add features to an existing installation.
7. At the Setup Support Rules screen, wait for the rule check to complete. If there are no failures or relevant warnings, click OK.
8. Select the Specify a free edition and from the drop-down menu, select Evaluation. Click Next.
9. Click the checkbox to accept the license terms, and click Next.
10. If no failures are displayed after the setup support files are installed, click Next.
11. At the Setup Role screen, choose SQL Server Feature Installation.
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, click Next after the check completes.
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, check that NT AUTHORITY\SYSTEM is selected for SQL Server Agent and SQL Server Database Engine. Click Next.
17. Assuming there are no failures, click Next.
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 the Data Directories tab, enter E:\ for the default data locations and F:\ for the default log locations.
22. Click Next.
23. At the Error and usage reporting screen, click Next.
24. At the Installation Configuration Rules screen, check that there are no failures or relevant warnings, and click Next.
25. At the Ready to Install screen, click Install.
26. After installation completes, click Close.
27. Download and install any available updates for Microsoft SQL Server 2014.

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
Data generation overview

We generated the data using the Install.pl script included with DVD Store version 2.1 (DS2), providing the parameters for our 20GB database size and the database platform on which we ran: Microsoft SQL Server. 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 20GB database in SQL Server 2014, and then 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 explicitly set the file sizes higher than necessary to ensure that no file-growth activity would affect the outputs of the test. Besides this file size modification, the database schema was created and loaded according to the DVD Store documentation. Specifically, we followed the steps below:

1. 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 20GB 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 then performed a full backup of the database. This backup allowed us to restore the databases to a pristine state relatively quickly between tests.

Figure 10 shows our initial file size modifications.

Logical name	Filegroup	Initial size (MB)
Database files		
primary	PRIMARY	4
Customer files (8)	DS_CUST_FG	2,560 each
Index files (8)	DS_IND_FG	1,536 each
ds_misc files (8)	DS_MISC_FG	1,536 each
Orders files (8)	DS_ORDERS	1,536 each
Log files		
ds_log	Not Applicable	10,240

Figure 10: Our initial file size modifications.

Running the test

About running the data transfers

We used copies of the 20GB DS2 database files to serve as our test files for the data transfer. We ran a batch file from the file server to pull the database file from each VM under test.

About running the DVD Store tests

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

Each complete test cycle consisted of the 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.
3. Restore the database on the target.
4. Shut down the target.
5. Reboot the host and client system.
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 20 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=30 --
n_threads=32 --db_size=20GB --think_time=0.02 --detailed_view=Y --
warmup_time=15 --report_rate=1 --csv_output=<drive path>
```

ABOUT PRINCIPLED TECHNOLOGIES

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We provide industry-leading technology assessment and fact-based marketing services. We bring to every assignment extensive experience with and expertise in all aspects of technology testing and analysis, from researching new technologies, to developing new methodologies, to testing with existing and new tools.

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