Dell™ PowerEdge™ R720 server powered by the Intel® Xeon® processor E5-2650

11.4% more performance +16.7% more VMs

27.1% greater performance per watt

versus same server with the Intel Xeon processor E5-2640

When you are selecting a new server for your virtualized environment, you want as much performance as you can get to meet your current and future business needs and you want power efficiency to keep operation costs down. Configuring your chosen server, such as the Dell PowerEdge R720, with more powerful processors is an easy way to boost performance and increase power efficiency over the standard configuration.

We tested the new two-socket Dell PowerEdge R720 configured two ways: powered by the Intel Xeon processor E5-2650 and powered by the Intel Xeon processor E5-2640. The former configuration delivered considerably stronger performance as well as greater performance per watt than the configuration with the less-powerful processor.
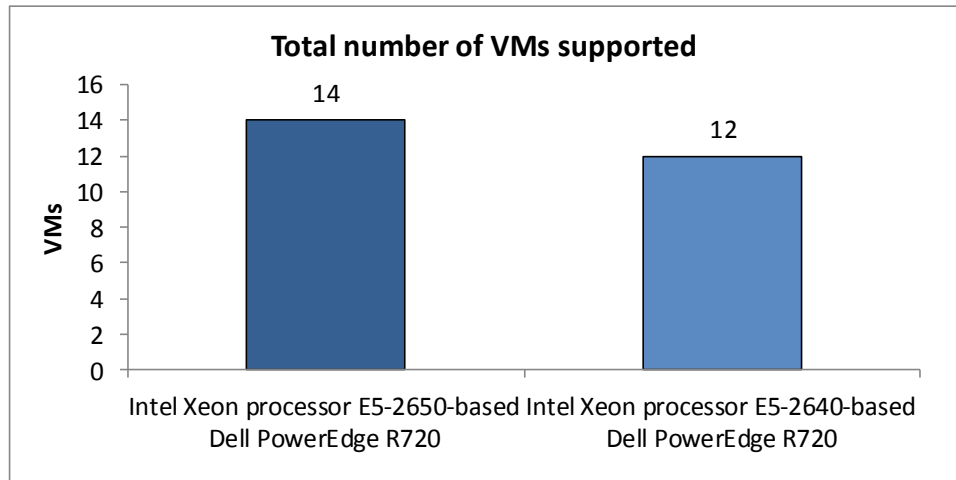
In our tests, the Intel Xeon processor E5-2650-powered Dell PowerEdge R720 could support 16.7 percent more VMware® vSphere® 5 virtual machines (VMs) than the other configuration and these VMs achieved a total of 11.4 percent more operations per minute. We also measured power usage and found that the Intel Xeon processor E5-2650-powered configuration achieved 27.1 percent greater performance per watt.

A PRINCIPLED TECHNOLOGIES TEST REPORT

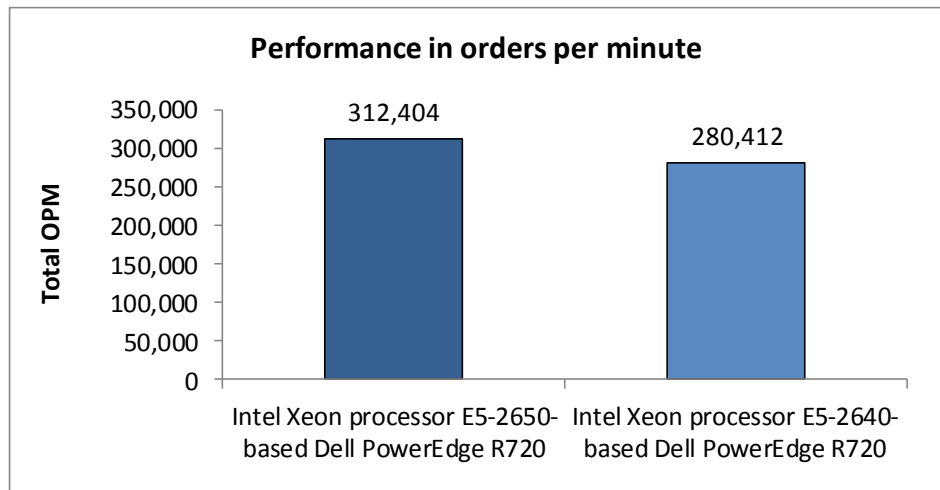# THE INTEL XEON PROCESSOR E5-2650-POWERED DELL POWEREDGE R720—SUPERIOR PERFORMANCE AND PERFORMANCE/WATT

When powered by the Intel Xeon processor E5-2650, the Dell PowerEdge R720 supported 14 VMS, each with 2 virtual CPUs and 8 GB of virtual memory. This was two more VMs than the Intel Xeon processor E5-2640-powered configuration supported. (See Figure 1.)

Figure 1: The Intel Xeon processor E5-2650-based Dell PowerEdge R720 performed so well in our database testing that it was able to host 16.7 percent more VMs than the same server with the less-powerful processor. Higher numbers are better.

Total number of VMs supported

Intel Xeon processor E5-2650-based Dell PowerEdge R720: 14
Intel Xeon processor E5-2640-based Dell PowerEdge R720: 12

Another way to understand the superior performance of the Intel Xeon processor E5-2650-based Dell PowerEdge R720 is though the number of database orders per minute (OPM) it achieved—11.4 percent more than the other configuration delivered. (See Figure 2.)

Figure 2: The Intel Xeon processor E5-2650-based Dell PowerEdge R720 performed so well in our database testing that it was able to perform 11.4 percent more orders per minute than the same server with the less-powerful processor. Higher numbers are better.

Performance in orders per minute

Intel Xeon processor E5-2650-based Dell PowerEdge R720: 312,404
Intel Xeon processor E5-2640-based Dell PowerEdge R720: 280,412

Better performance per watt

As we ran our performance tests, we measured the power that the servers used. As Figure 3 shows, the Intel Xeon processor E5-2650-based Dell PowerEdge R720 was more power efficient than the than the same server with the less-powerful processor, delivering 27.1 percent greater performance per watt. Performance/watt shows how many orders per minute correspond with each watt of power; higher numbers are better.

Figure 3: Due to new energy-saving features, the Intel Xeon processor E5-2650-based Dell PowerEdge R720 delivered 27.1percent greater performance/watt than the than the same server with the less-powerful processor. Higher numbers are better.
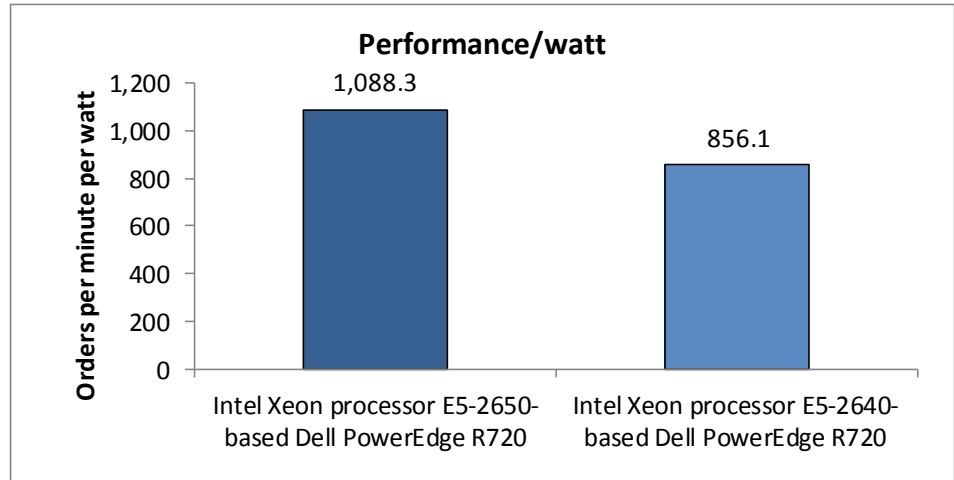
One feature of the processors that helps maximize performance is Turbo Plus. For all testing we conducted above, we enabled Turbo Plus through a BIOS setting. To quantify the effect of this feature, we also conducted testing with Turbo Plus disabled. As Figure 4 shows, enabling Turbo Plus boosted the performance of the Intel Xeon processor E5-2650-based server by up to 18.2 percent.

Figure 4: When enabled Turbo Plus the OPM of the Intel Xeon processor E5-2650-based Dell PowerEdge R720 increased by 18.2 percent. Higher numbers are better.
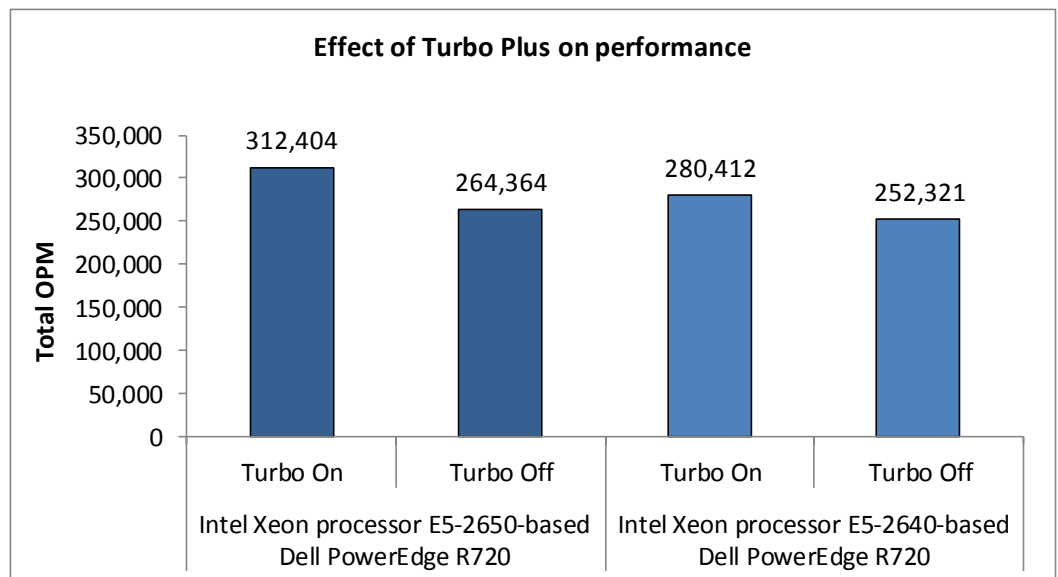
WHAT WE TESTED

We tested using a Dell PowerEdge R720 configured two ways, each featuring different processors and different memory. We used the fastest memory each processor supports; the Intel Xeon processor E5-2650 supports up to PC3-12800 memory running at 1,600 MHz, allowing for faster response than the Intel Xeon processor E5-2640, which supports up to PC3-10600 memory running at 1,333 MHz. For detailed configuration information, see Appendix A.

We used VMware vSphere 5 to create the VMs on the servers, each of which ran a Microsoft SQL Server 2008 R2 database with two virtual CPUs and 8 GB of memory. To create the workload and test performance, we used the DVD Store Version 2.1 benchmark. We ran these tests three times and report the median run results.

To determine the total number of VMs each server could support, we tested at increasing levels of VMs until total server performance began to decrease. Our results show the number of VMs for each server that delivered the highest total OPM. This way we present the best performance for each processor.

While we were running our performance tests, we recorded statistics including processor utilization and power statistics. We then calculated performance per watt to compare the power and cooling efficiency of the servers. For step-by-step instructions on how we tested, see the appendices at the conclusion of this report.

About DVD Store Version 2.1

To create our real-world ecommerce workload, we used the DVD Store Version 2.1 (DS2) 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 (OPM) 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 information about the DS2 tool, see http://www.delltechcenter.com/page/DVD+Store.

WHAT WE FOUND

Figure 5 shows the DS2 orders per minute results, by VM, for each server. The Intel Xeon processor E5-2650-powered Dell PowerEdge R720 server was able to host 16.7 percent more VMs and could handle 11.4 percent more orders per minute than the same server powered by the Intel Xeon processor E5-2640.

VM	Intel Xeon processor E5-2650-based Dell PowerEdge R720	Intel Xeon processor E5-2640-based Dell PowerEdge R720
VM 1	22,412	23,636
VM 2	22,315	23,073
VM 3	22,293	23,448
VM 4	22,112	23,116
VM 5	22,312	23,545
VM 6	22,448	23,556
VM 7	22,277	23,547
VM 8	22,253	23,455
VM 9	22,477	23,066
VM 10	22,294	23,277
VM 11	22,379	23,527
VM 12	22,306	23,166
VM 13	22,258	
VM 14	22,268	
Total OPM	**312,404**	**280,412**

Figure 5: Orders per minute that each server handled in our DS2 test, broken down by VM.

Figure 6 presents CPU utilization and power statistics during our testing. The power results with VMs running no workloads show the power for the servers with no workloads actively running; the servers still host VMs, which uses more power than completely idle servers running no VMs. We recorded power and CPU utilization statistics with all VMs running workloads when our database tests were running.

	VMs running no workloads		All VMs running workloads		Performance/ watt	Performance/ watt % win
	Power (W)	% CPU utilization	Power (W)	% CPU utilization		
Intel Xeon processor E5-2650-based Dell PowerEdge R720	130.2	6.7	287.1	97.1	1,088.3	27.1%
Intel Xeon processor E5-2640-based Dell PowerEdge R720	138.8	8.4	327.6	98.2	856.1	

Figure 6: CPU utilization, power, and performance/watt statistics for the two servers.

IN CONCLUSION

When you upgrade the servers in your data center, configuring your two-socket Dell PowerEdge R720 with the more powerful Intel Xeon processor E5-2650 can improve performance and deliver better performance per watt. The Intel Xeon processor E5-2650, eight-core processor offers two more cores than the six-core Intel Xeon processor E5-2640, allowing for more processing power. Furthermore, the Intel Xeon processor E5-2650 supports PC3-12800 memory running at 1,600 MHz, allowing for faster response than the Intel Xeon processor E5-2640, which supports only PC3-10600 running at 1,333 MHz.

In our tests, we found that the Intel Xeon processor E5-2650-powered Dell PowerEdge R720 could support 16.7 percent more VMs as the same server powered by the Intel Xeon processor E5-2640, while delivering greater performance per watt.

APPENDIX A – SERVER CONFIGURATION INFORMATION

Figure 7 provides configuration information for the two servers we tested.

System	Dell PowerEdge R720 (Intel Xeon processor E5-2650-based)	Dell PowerEdge R720 (Intel Xeon processor E5-2640-based)
Power supplies		
Total number	2	2
Vendor and model number	Dell D750E-S1	Dell D750E-S1
Wattage of each (W)	750	750
Cooling fans		
Total number	6	6
Vendor and model number	AVC DBTC0638B2V	AVC DBTC0638B2V
Dimensions (h x w) of each	2.5" x 2.5"	2.5" x 2.5"
Volts	12	12
Amps	1.2	1.2
General		
Number of processor packages	2	2
Number of cores per processor	8	8
Number of hardware threads per core	2	2
System power management policy	Balanced	Balanced
CPUs		
Vendor	Intel	Intel
Name	Xeon	Xeon
Model number	E5-2650	E5-2640
Stepping	C1	C1
Socket type	LGA2011	LGA2011
Core frequency (GHz)	2.00	1.80
Bus frequency	8.0 GT/s	6.4 GT/s
L1 cache	32 KB + 32 KB (per core)	32 KB + 32 KB (per core)
L2 cache	256 KB (per core)	256 KB (per core)
L3 cache (MB)	20	15
Platform		
Vendor and model number	Dell PowerEdge R720	Dell PowerEdge R720
Motherboard model number	00W9X3	00W9X3
BIOS name and version	Dell 0.3.37	Dell 0.3.37
BIOS settings	Power Management set to OS Control	Power Management set to OS Control
Memory modules		
Total RAM in system (GB)	128	128
Vendor and model number	Hynix HMT31GR7BFR4C-PB	Hynix HMT31GR7BFR4A-H9
Type	PC3-12800R	PC3L-10600R
Speed (MHz)	1,600	1,333
Speed running in the system (MHz)	1,600	1,333

System	Dell PowerEdge R720 (Intel Xeon processor E5-2650-based)	Dell PowerEdge R720 (Intel Xeon processor E5-2640-based)
Timing/Latency (tCL-tRCD-tRP-tRASmin)	11-11-11-36	9-9-9-36
Size (GB)	8	8
Number of RAM module(s)	16	16
Chip organization	Double-sided	Double-sided
Rank	Dual	Dual
Operating system		
Name	VMware ESXi 5.0.0	VMware ESXi 5.0.0
Build number	515841	515841
File system	EXT3	EXT3
Kernel	5.0.0	5.0.0
Language	English	English
Graphics		
Vendor and model number	Matrox G200e	Matrox G200e
Graphics memory (MB)	8	8
RAID controller		
Vendor and model number	PERC H710P Mini	PERC H710P Mini
Firmware version	3.130.05-1311	3.130.05-1311
Cache size	1 GB	1 GB
Hard drive		
Vendor and model number	No hard drives installed[1]	No hard drives installed
Number of disks in system	N/A	N/A
Size (GB)	N/A	N/A
Buffer size (MB)	N/A	N/A
RPM	N/A	N/A
Type	N/A	N/A
Ethernet adapters		
First network adapter		
Vendor and model number	Intel I350 Gigabit Controller	Intel I350 Gigabit Controller
Type	Integrated	Integrated
Second network adapter		
Vendor and model number	Intel X450-AT2 10 Gigabit Controller	Intel X450-AT2 10 Gigabit Controller
Type	Integrated	Integrated
Optical drive(s)		
Vendor and model number	TEAC DV-28SW	TEAC DV-28SW
Type	DVD-ROM	DVD-ROM
USB ports		
Number	4 external, 1 internal	4 external, 1 internal
Type	2.0	2.0

Figure 7: System configuration information for the test servers.

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[1] In our tests, we booted VMware ESXi from an internal SD card, and did not require internal hard drives.

APPENDIX B – SETTING UP THE STORAGE

Dell EqualLogic PS6010 storage configuration overview

Our complete storage infrastructure consisted of two 10GB NICs dedicated to iSCSI traffic, a Dell PowerConnect 8024F switch dedicated to iSCSI traffic, and two Dell EqualLogic™ PS6010 storage arrays, each containing 16 drives. We cabled each Dell EqualLogic PS6010 to the Dell PowerConnect 8024F switch via the available ports, and we cabled each server to the same switch using both available 10GB NICs for iSCSI traffic.

We enabled jumbo frames on each server's iSCSI-dedicated NICs. To do this, we adjusted the MTU for the relevant vSwitches and the bound VMkernel ports. We also enabled jumbo frames on the Dell PowerConnect 8024F switch, and on each NIC on the Dell EqualLogic PS6010 storage.

Each Dell EqualLogic PS6010 contained 16 drives. We configured each Dell EqualLogic PS6010 in RAID 10 mode with a single storage pool.

For volumes, we created the following:

- Two 1TB volumes to be used to hold virtual machine operating system virtual disks and virtual machine SQL Server transaction log virtual disks.
- One 4TB volume to be used to hold virtual machine SQL Server database file virtual disk for each VM.

Setting up the external storage

1. Using the command-line console, via serial cable, reset each Dell EqualLogic PS6010 by using the reset command.
2. Supply a group name, group IP address, and IP address for the first of two arrays.
3. Reset the remaining array in the same manner, supply the group name to join and IP address created in Step 2, and supply an IP address in the same subnet for the remaining tray.
4. After group creation, using a computer connected to the same subnet as the storage, use the Dell EqualLogic Web interface to do the following:

   a. Assign IP addresses on the remaining NICs on each array. Enable the NICs.
   b. Verify matching firmware levels on each array and MTU size of 9,000 on each NIC on each array.
   c. Create a storage pool, by right-clicking Storage pools, and choosing Create storage pool.
   d. Click each member (array), and choose Yes when prompted to configure the member. Choose RAID 10 for each array.
   e. Create two 1TB volumes in the storage pool – one for VM OS usage and one for SQL Server log usage.
   f. Create one 4TB volume in the storage pool for SQL Server database usage.
   g. Enable shared access to the iSCSI target from multiple initiators on the volume.
   h. Create an access control record for the volume without specifying any limitations.

APPENDIX C – SETTING UP THE SERVER – VMWARE VSPHERE 5.0

Adjusting BIOS settings

We used the latest released BIOS updates on all systems, and adjusted the default BIOS settings. We changed the power profile to OS Control.

Installing VMware vSphere 5.0 (ESXi)

1. Insert the disk, and select Boot from disk.
2. On the Welcome screen, press Enter.
3. On the End User License Agreement (EULA) screen, press F11.
4. On the Select a Disk to Install or Upgrade Screen, select the relevant volume to install ESXi on and press Enter.
5. On the Please Select a Keyboard Layout screen, press Enter.
6. On the Enter a Root Password Screen, assign a root password and confirm it by entering it again Press Enter to continue.
7. On the Confirm Install Screen, press F11 to install.
8. On the Installation complete screen, press Enter to reboot.

Configuring ESXi after installation

1. On the 5.0.0 ESXi screen, press F2, enter the root password, and press Enter.
2. On the System Customization screen, select troubleshooting options, and press Enter.
3. On the Troubleshooting Mode Options screen:

   a. Select Enable ESXi Shell, and press Enter.
   b. Select Enable SSH, press Enter, and press ESC.
4. On the System Customization screen, select Configure Management Network.
5. On the Configure Management Network screen, select IP Configuration.
6. On the IP Configuration screen, select set static IP, enter an IP address, subnet mask, and default gateway, and press Enter.
7. On the Configure Management Network screen, press Esc. When asked if you want to apply the changes, press Y.

Updating ESXi to the latest build

1. Download the latest ESXi build from VMware.
2. Using the vSphere client from another machine, connect to the ESXi server.
3. Select the Configuration tab, and select Storage under the Hardware heading.
4. Right click the OS datastore and select Browse Datastore.
5. Click the upload button and select the build update zip file.
6. Using a telnet/ssh client from another machine, connect to the ESXi server using root credentials.
7. Run the following command using the path and name of the ESXi update.

   ```
   esxcli software vib update –d /vmfs/volumes/OS/ESXi500-201112001.zip
   ```

8. Repeat steps 6 and 7 for any subsequent systems.

Configuring iSCSI networking

We followed the steps from VMware's document, iSCSI SAN Configuration Guide version 4.1, as a guide for our configuration of iSCSI on VMware vSphere 5.0. However, we performed most steps in the VMware vSphere 5.0 client UI as opposed to the command line, as VMware has added the relevant features to the UI in vSphere 5.0.

1. Using the vSphere client from another machine, connect to the ESXi server.
2. Add the necessary vSwitches:
   a. Click the host, click the Configuration tab, and click Networking.
   b. Click Add Networking.
   c. Choose VMkernel, and click Next.
   d. Choose create a vSphere standard switch.
   e. Choose the first NIC associated with iSCSI traffic.
   f. Assign the network label and assign IP settings.
   g. Click Finish.
   h. Repeat steps b through g for the second NIC assigned to iSCSI traffic.
3. Add the iSCSI software storage adapter:
   a. Click the host, click the Configuration tab, and click Storage adapters.
   b. Click Add.
   c. Click Add software iSCSI adapter.
   d. Click OK.
4. Configure the iSCSI software storage adapter:
   a. Right-click the iSCSI adapter that was just added to the system, choose Properties, and ensure it is enabled.
   b. Inside the iSCSI adapter Properties window, click the Network Configuration tab.
   c. Under VMkernel port bindings, click Add and add both VMkernel adapters to the VMkernel port bindings list.
5. Enable jumbo frames in ESXi:
   a. Click the host, click the Configuration tab, and click Networking.
   b. On the first vSwitch used for iSCSI, click Properties.
   c. Select the vSwitch.
   d. Click Edit.
   e. Modify the MTU to 9,000.
   f. Click OK.
   g. In the vSwitch Properties window, choose the VMkernel port.
   h. Click Edit.
   i. Modify the MTU to 9,000.
   j. Click OK.
   k. Click Yes if warned about datastore access.
   l. Click Close.
   m. Repeat steps b through l for each of the remaining three NICs dedicated to iSCSI traffic.
6. Access provisioned Dell EqualLogic storage:
   a. In the vSphere client, click the host, click the Configuration tab, and click Storage adapters.
   b. Right-click the iSCSI software storage adapter.
   c. Click Dynamic discovery.
   d. Click Add.
   e. Enter the Dell EqualLogic group IP address.
   f. Click Close.
   g. Click Yes when prompted to rescan the HBA.

Configuring VM networking

1. Using the vSphere client from another machine, connect to the ESXi server.
2. Add the necessary vSwitch for the network that DVD Store traffic will use:
   a. Click the host, click the Configuration tab, and click Networking.
   b. Click Add Networking.
   c. Choose Virtual Machine, and click Next.
   d. Choose create a vSphere standard switch.
   e. Choose the NIC associated with VM traffic.
   f. Assign the network label and assign IP settings.
   g. Click Finish.

Configuring the external volumes

1. In the vSphere client, select the host.
1. Click the Configuration tab.
2. Click Storage, and click Add Storage…
3. Choose Disk/Lun.
4. Select the disk, and click Next.
5. Accept the default of VMFS-5 for the file system.
6. Review the disk layout, and click Next.
7. Enter the datastore name, and click Next.
8. Accept the default of using maximum capacity, and click Next.
9. Click Finish.
10. Repeat steps 3 through 10 for the remaining LUNs.

Creating the first VM

1. In the vSphere client, connect to the ESXi host.
2. Click the Virtual Machines tab.
3. Right-click, and choose New Virtual Machine.
4. Choose Custom, and click Next.
5. Assign a name to the virtual machine, and click Next.
6. Select the first assigned OS Datastore on the external storage, and click Next.
7. Choose Virtual Machine Version 8, and click Next.
8. Choose Windows, and choose Microsoft Windows Server 2008 R2 (64-bit), and click Next.
9. Choose 1 virtual socket, and 2 virtual processors per core, and click Next.
10. Choose 8GB RAM, and click Next.
11. Click 1 for the number of NICs, select vmxnet3, and click Next.
12. Leave the default virtual storage controller, and click Next.
13. Choose to create a new virtual disk, and click Next.
14. Make the OS virtual disk size 30 GB, choose thick-provisioned lazy zeroed, specify the OS datastore on the external storage, and click Next.
15. Keep the default virtual device node (0:0), and click Next.
16. Click Finish.
17. Right-click the VM, and choose Edit Settings.
18. On the Hardware tab, click Add…
19. Click Hard Disk, and click Next.
20. Click Create a new virtual disk, and click Next.
21. Specify 30GB for the virtual disk size, choose thick-provisioned lazy zeroed, and specify the DB datastore.

22. Choose SCSI(1:0) for the device node, and click Next.
23. On the Hardware tab, click Add…
24. Click Hard Disk, and click Next.
25. Click Create a new virtual disk, and click Next.
26. Specify 30GB for the virtual disk size, choose thick-provisioned lazy zeroed, and specify the Logs datastore.
27. Choose SCSI(1:1) for the device node, and click Next.
28. Click SCSI Controller 1, and choose Change Type.
29. Choose VMware Paravirtual, and click OK.
30. Click Finish, and click OK.
31. Start the VM.
32. Attach the Windows Server 2008 R2 SP1 ISO image to the VM and install Windows Server 2008 R2 on your VM.

APPENDIX D – CONFIGURING THE VMS

See the above sections regarding the initial creation of the virtual machine. We provide steps below for installing the operating system, Microsoft SQL Server, and configurations of the VMs.

Installing the VM operating system on the VMs

1. Connect to the ISO image of the installation DVD for Windows Server 2008 R2 SP1 Enterprise from the VM console. If the ISO image is not stored on the host, start the VM first and then connect to the ISO image.
2. Start the VM.
3. At the Language Selection Screen, click Next.
4. Click Install Now.
5. Select Windows Server 2008 R2 Enterprise (Full Installation), and click Next.
6. Click the I accept the license terms check box, and click Next.
7. Click Custom.
8. Click Next.
9. At the User's password must be changed before logging on warning screen, click OK.
10. Enter the desired password for the administrator in both fields, and click the arrow to continue.
11. At the Your password has been changed screen, click OK.
12. Install the latest VMware tools package on the VM. Restart as necessary.
13. Connect the machine to the Internet, and install all available Windows updates. Restart as necessary.
14. Enable remote desktop access.
15. Change the hostname and reboot when prompted.
16. Create a shared folder to store test script files. Set permissions as needed.
17. Set up networking:
    a. Click Start→Control Panel, right-click Network Connections, and choose Open.
    b. Right-click the VM traffic NIC, and choose Properties.
    c. Select TCP/IP (v4), and choose Properties.
    d. Set the IP address, subnet, gateway, and DNS server for the virtual NIC, which will handle outgoing server traffic. Click OK, and click Close.
18. In the VM, configure the VM storage:
    a. Click the Server Manager icon in the taskbar.
    b. In the left pane, expand Storage and click Disk Management.
    c. Right-click the first volume, and choose Initialize Disk.
    d. In the right pane, right-click the volume and choose New Simple Volume…
    e. At the welcome window, click Next.
    f. At the Specify Volume Size window, leave the default selection, and click Next.
    g. At the Assign Drive Letter or Path window, choose a drive letter, and click Next.
    h. At the Format Partition window, choose NTFS and 64K allocation unit size, and click Next.
    i. At the Completing the New Simple Volume Wizard window, click Finish.
    j. Repeat steps c through i for the remaining VM volumes.
19. Copy the pre-created DVD Store backup file to the backup virtual disk inside the first VM.

Installing SQL Server 2008 R2 SP1 on the first VM

1. Open the vSphere console for the VM or connect to the VM with RDP.
2. Log into the virtual machine.
3. Connect to the ISO image of the installation DVD for SQL Server 2008 R2 Enterprise from the VM console or the menu in the vSphere Client.

4. Click Run SETUP.EXE. If Autoplay does not begin the installation, navigate to the SQL Server 2008 R2 DVD, and double-click.
5. If the installer prompts you with a .NET installation prompt, click Yes to enable the .NET Framework Core role.
6. In the left pane, click Installation.
7. Click New installation or add features to an existing installation.
8. At the Setup Support Rules screen, wait for the check to complete. If there are no failures or relevant warnings, click OK.
9. Select the Enter the product key radio button, and enter the product key. Click Next.
10. Click the checkbox to accept the license terms, and click Next.
11. Click Install to install the setup support files.
12. If there are no failures displayed, click Next. You may see a Computer domain controller warning and a Windows Firewall warning. For now, ignore these.
13. At the Setup Role screen, choose SQL Server Feature Installation.
14. At the Feature Selection screen, select Database Engine Services, Full-Text Search, Client Tools Connectivity, Client Tools Backwards Compatibility, Management Tools –Basic, and Management Tools – Complete. Click Next.
15. At the Installation Rules screen, click Next once the check completes.
16. At the Instance configuration screen, leave the default selection of default instance, and click Next.
17. At the Disk space requirements screen, click Next.
18. At the Server configuration screen, choose NT AUTHORITY\SYSTEM for SQL Server Agent, and choose NT AUTHORITY\SYSTEM for SQL Server Database Engine. Click Next.
19. At the Database Engine Configuration screen, select Mixed Mode.
20. Enter and confirm a password for the system administrator account.
21. Click Add Current user. This may take several seconds.
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 Next.
27. Click Close.
28. Create a SQL Server login for the ds2user (see the Configuring the database server (DVD Store) section for the specific script to use).
29. Copy the pre-created DVD Store backup to the specified backup VHD volume.
30. Click Start→All Programs→Microsoft SQL Server 2008 R2→Configuration Tools, and click SQL Server Configuration Manager.
31. Expand SQL Server Network Configuration, and click Protocols for MSSQLSERVER.
32. Right-click TCP/IP, and select Enable.
33. Close the SQL Server Configuration Manager.
34. Click Start→All Programs→Microsoft SQL Server 2008 R2, and click SQL Server Management Studio.
35. Log in using the default credentials.
36. Right click on the SQL server root and click on Properties.
37. In the Server Properties window, select Database Settings.
38. Under the Recovery section in the right pane, enter 1440 into the Recovery interval (minutes): field.
39. Click OK and close the Server Management Studio.
40. Download and install Microsoft SQL Server 2008 R2 SP1.

Configuring additional VMs on VMware vSphere 5.0

1. Log into the vCenter Server, which manages the host.
2. Right-click the first VM, and choose Clone.
3. Name the new VM.
4. Choose the cluster, and select the host.
5. For the storage screen, choose advanced and direct the new virtual disks to the applicable datastores.
6. Choose to customize using the customization wizard. Save the clone details as a new customization specification.
7. Continue cloning each VM, modifying the customization specification as necessary for IP addressing and so on.
8. Ensure in each VM that the necessary virtual disks are all online, the hostname is renamed, and the IP addressing was properly assigned by the customization wizard.
9. Modify the SQL Server hostname of each VM using the instructions provided by Microsoft (http://msdn.microsoft.com/en-us/library/ms143799.aspx).
10. To configure automatic start for your specified number of VMs, click the Host configuration tab in the vSphere client, and click Virtual Machine Startup/Shutdown.

APPENDIX E - CONFIGURING THE DATABASE (DVD STORE)

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 6GB 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 2008 R2 SP1. We built the 6GB database in SQL Server 2008 R2 SP1, and then performed a full backup, storing the backup file on the C: drive for quick access. We used that backup file to restore on both servers between test runs. We performed this procedure once, and used the same backup file for VMware vSphere 5.0 virtual machines.

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 6GB 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 8 shows our initial file size modifications.

Logical name	Filegroup	Initial size (MB)
Database files		
primary	PRIMARY	2
cust1	DS_CUST_FG	2,160
cust2	DS_CUST_FG	2,160
cust3	DS_CUST_FG	2,160
cust4	DS_CUST_FG	2,160
cust5	DS_CUST_FG	2,160
cust6	DS_CUST_FG	2,160
cust7	DS_CUST_FG	2,160
cust8	DS_CUST_FG	2,160
ind1	DS_IND_FG	1,280
ind2	DS_IND_FG	1,280
ind3	DS_IND_FG	1,280
ind4	DS_IND_FG	1,280
ind5	DS_IND_FG	1,280
ind6	DS_IND_FG	1,280
ind7	DS_IND_FG	1,280
ind8	DS_IND_FG	1,280
ds_misc1	DS_MISC_FG	256
ds_misc2	DS_MISC_FG	256
ds_misc3	DS_MISC_FG	256
ds_misc4	DS_MISC_FG	256
ds_misc5	DS_MISC_FG	256
ds_misc6	DS_MISC_FG	256
ds_misc7	DS_MISC_FG	256
ds_misc8	DS_MISC_FG	256
orders1	DS_ORDERS	1,536
orders2	DS_ORDERS	1,536
orders3	DS_ORDERS	1,536
orders4	DS_ORDERS	1,536
orders5	DS_ORDERS	1,536
orders6	DS_ORDERS	1,536
orders7	DS_ORDERS	1,536
orders8	DS_ORDERS	1,536
Log files		
ds_log	Not Applicable	6,144

Figure 8: Our initial file size modifications.

Editing the workload script – ds2xdriver.cs module

A new feature of DVD Store version 2.1 is the ability to target multiple targets from one source client. We used this functionality, and in order to record the orders per minute output from each specific database target, we modified the ds2xdriver to output this information to log files on each client system. To do this, we used the StreamWriter method to create a new text file on the client system, and the WriteLine and Flush methods to write the relevant outputs to the files during the tests.

After making these changes, we recompiled the ds2xdriver.cs and ds2sqlserverfns.cs module in Windows by following the instructions in the DVD Store documentation. Because the DS2 instructions were for compiling from the command line, we used the following steps on a system with Visual Studio installed:

1. Open a command prompt.
2. Use the `cd` command to change to the directory containing our sources.
3. Execute the following command:

```
csc /out:ds2sqlserverdriver.exe ds2xdriver.cs ds2sqlserverfns.cs
/d:USE_WIN32_TIMER /d:GEN_PERF_CTRS
```

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. For each scenario, we ran three test cycles, and chose the median outcome.

1. Clean up prior outputs from the host system and all client driver systems.
2. Drop all databases from all target VMs.
3. Restore all databases on all target VMs.
4. Shut down all VMs.
5. Reboot the host system and all client systems.
6. Wait for a ping response from the server under test (the hypervisor system), all client systems, and all VMs.
7. Let the test server idle for twenty minutes.
8. Start the DVD Store driver on all respective clients.
   We used the following DVD Store parameters for testing the virtual machines in this study:

```
ds2sqlserverdriver.exe --target=<target_IP> --ramp_rate=10 --run_time=30 --
n_threads=32 --db_size=6GB --think_time=0 --detailed_view=Y --warmup_time=1
```

ABOUT PRINCIPLED TECHNOLOGIES

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