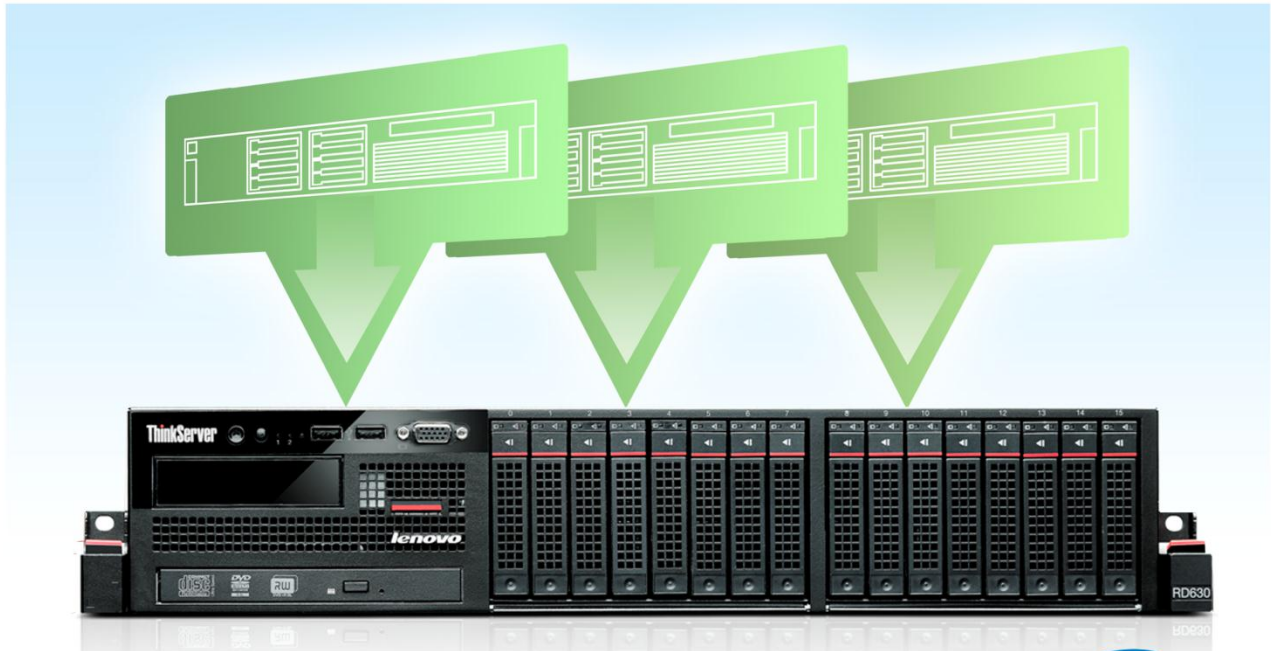# One Lenovo® ThinkServer® RD630 replaced three legacy servers

and increased total performance by **82.6%** while reducing power consumption by **58.8%**

The last time you updated your data center, virtualization allowed you to consolidate multiple older servers onto newer systems running virtual machines (VMs), maximizing resource utilization and reducing the number of servers populating your data center. Now that your business is growing, purchasing new, more powerful servers can help you consolidate even further.

Since a typical business refreshes their server hardware every four to five years, we compared the performance of a new Lenovo ThinkServer RD630 to an older HP ProLiant DL385 G5 to see not only how many of these legacy servers the ThinkServer RD630 could consolidate, but also how much of a performance increase we could expect. In the Principled Technologies labs, we found that that a single Lenovo ThinkServer RD630 was able to consolidate the database workload and outperform three HP ProLiant DL385 G5 servers by 82.6 percent, while reducing power consumption by 58.8 percent. Such a consolidation gives you a considerable increase in performance and has the potential to save data center space, power and cooling, and management costs.

THINK ABOUT A SERVER UPGRADE

Consolidating older servers in your data center is an excellent strategy to bring savings to your organization. Upgrading to new high-performing servers that can consolidate many older systems not only saves physical space in your data center, but can also reduce many costs associated with operating your infrastructure, including power and cooling costs, maintenance costs, data center port costs, and more.

Consolidate with the Lenovo ThinkServer RD630

Virtualization has become increasingly popular as businesses discovered that running multiple VMs on a single physical server makes more efficient use of system resources. IT administrators must ensure the VM and its host server can complete the workload generated by the business application it hosts, even during usage spikes. Database applications in particular are typically very intensive in disk I/O and memory utilization, requiring a powerful server with a powerful storage controller and internal drives to host more than a couple of database VMs under stress.

To find how many older HP ProLiant DL385 G5 servers running database application VMs could be consolidated into a single Lenovo ThinkServer RD630, we created VMs on each server with VMware® vSphere® 5 running a heavy database workload, and noted how many VMs the servers were able to support. Additionally, we measured power consumption of the servers and the increase in performance from each VM on the Lenovo ThinkServer RD630 over the HP ProLiant DL385 G5.

We tested database performance using the DVD Store benchmark with a Microsoft® SQL Server 2008 R2 database, configuring the workload in each VM to stress the servers and establish comparable results between the two. The new Lenovo ThinkServer RD630, powered by the Intel® Xeon® processor E5-2680, supported six VMs running heavy database application workloads, three times as many as the HP ProLiant DL385 G5 (see Figure 1). Given that each VM on the Lenovo ThinkServer RD630 was running a heavy, resource intensive workload, you could expect the ThinkServer RD630 to support many more VMs in your environment depending on the demands of the applications running on each VM. Thus, a single Lenovo ThinkServer RD630 can handle the work of three of the older servers while also providing you with significantly higher performance in each VM, making it an excellent consolidation platform.

Number of VMs supported

Figure 1: A single Lenovo ThinkServer RD630 had the power to consolidate the database workloads of three HP ProLiant DL385 G5 servers.
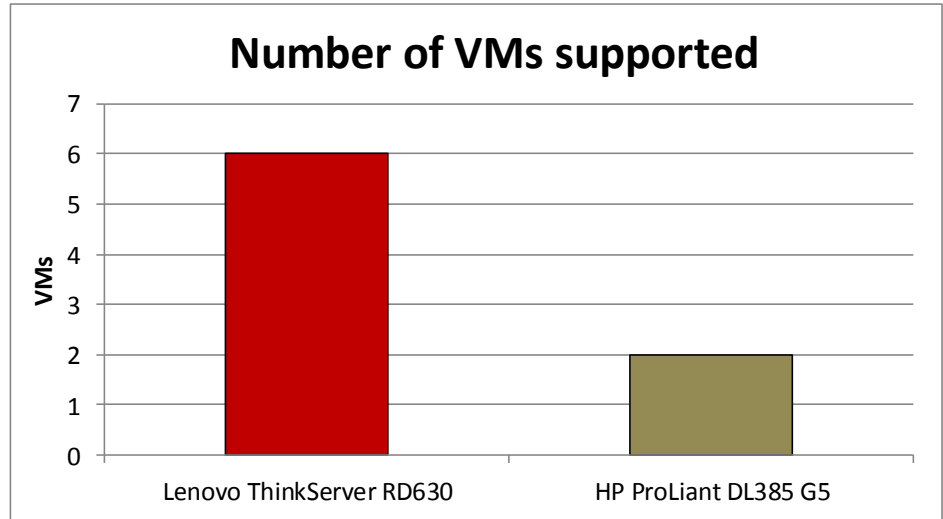
Figure 2 compares the database performance of the two servers, with the Lenovo ThinkServer RD630 demonstrating a staggering 447.7 percent increase in performance over the HP ProLiant DL385 G5. The DVD Store benchmark reports results in orders per minute (OPM) the servers could handle, with databases running in six VMs on the Lenovo ThinkServer RD630 and in two VMs running on the HP ProLiant DL385 G5.

Total database performance

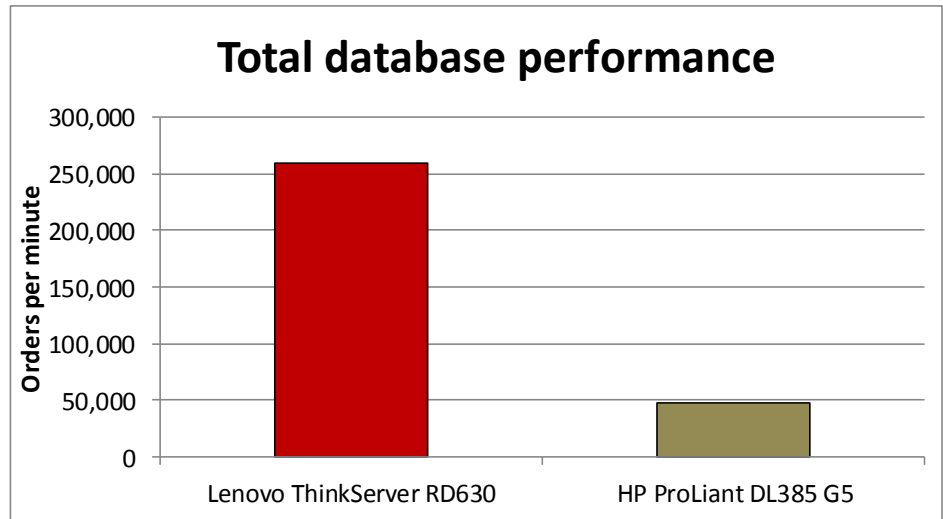**Figure 2: Total database performance, in OPM, for the two servers.**

Figure 3 shows the average database performance per VM for the two servers. Each VM on the Lenovo ThinkServer RD630 outperformed the VMs on the HP ProLiant DL385 G5 by an average of 82.6 percent more OPM.

Average database performance per VM

Figure 3: Average database performance, in OPM, per VM for the two servers.
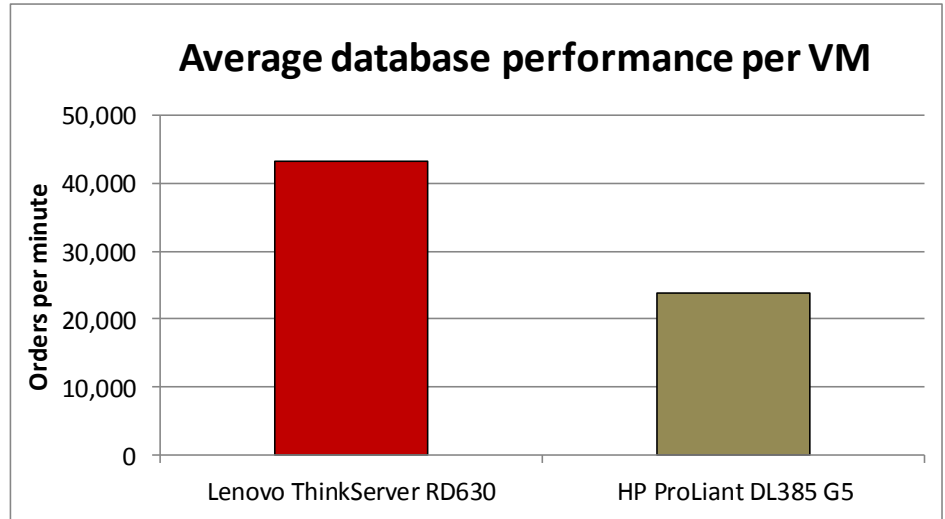
Not only do you have the potential to save on power by reducing the number of servers running in your data center, advances in newer servers allow you to get more performance at a lower power cost. When looking at the power savings that result from consolidating three HP ProLiant DL385 G5 servers into one Lenovo ThinkServer RD630, performance per watt and power per VM allows us to establish a comparison point for the two servers.

Comparing the two servers using both performance and power consumption, the Lenovo ThinkServer RD630 delivered 344.1 percent greater performance per watt, as Figure 4 shows.

Performance per watt (higher numbers are better)

Figure 4: Performance per watt for the two servers.
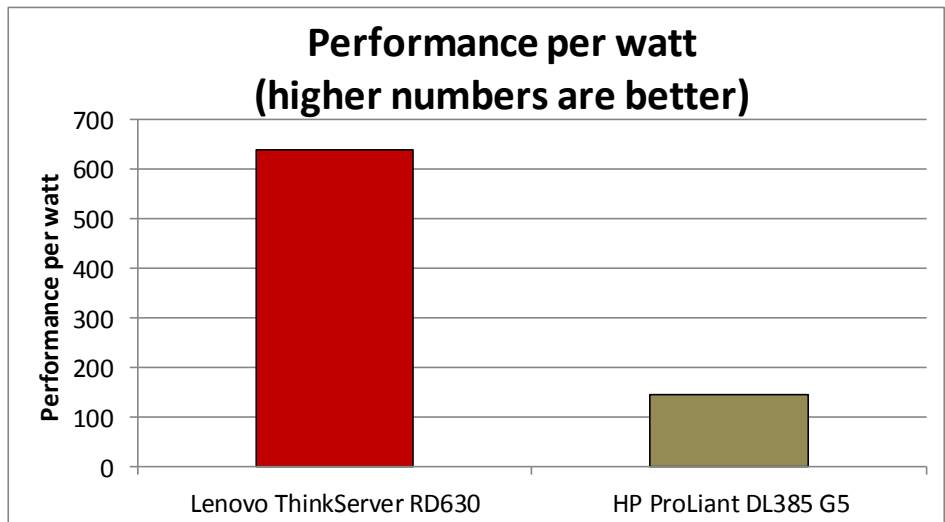
As Figure 5 shows, the Lenovo ThinkServer RD630 consumed 58.8 percent less power per VM than the HP ProLiant DL385 G5.
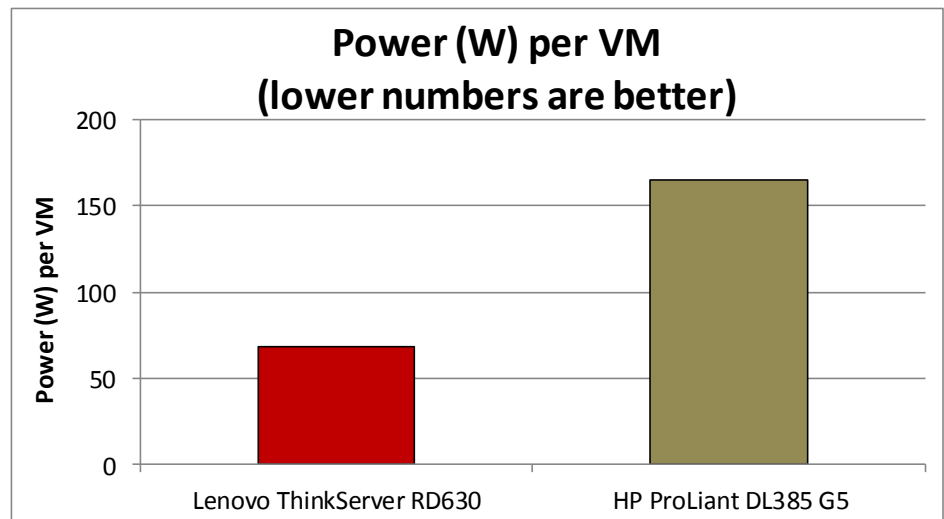
**Power (W) per VM
(lower numbers are better)**

A bar chart with y-axis labeled "Power (W) per VM" ranging from 0 to 200. The Lenovo ThinkServer RD630 bar (red) is at approximately 68, and the HP ProLiant DL385 G5 bar (olive/gold) is at approximately 165.

ABOUT THE LENOVO THINKSERVER RD630

Lenovo describes its server as follows: "The all-new Lenovo ThinkServer RD630 mainstream rack server provides powerful new choices to meet your demanding enterprise needs while offering outstanding value. Supporting two of the latest Intel Xeon E5-2600 processors, the ThinkServer RD630 can provide outstanding database and virtualization performance for deployments large or small. Nicely configured, these servers come standard with Web-based remote management, rail kits, hardware RAID, and EasyManage tool-suite for unbeatable value. You enjoy enterprise-grade performance, built-in redundancy, and world-class reliability you expect from the makers of Think products."

Below, we highlight some of the Lenovo ThinkServer RD630's key features.

- **Performance and storage capacity.** The Intel Xeon processor E5-2600 family has up to 16 cores, providing a significant performance improvement over previous-generation processors. Storage choices for the ThinkServer RD630 include up to 16 SATA, SAS and SSD hot-swap drives.
- **Reliability.** The ThinkServer RD630 comes with redundant power supplies, fans, and a selection of RAID adapters to prevent data loss.
- **Power efficiency.** The power-efficient ThinkServer RD630 features the Lenovo ThinkServer Smart Grid Technology. This feature allows IT administrators the ability to monitor and intelligently manage power consumption, even making recommendations for optimal power settings, for a server or group of servers via a central console. This power management technology helps to reduce energy

consumption and infrastructure costs. Additionally, the ThinkServer RD630 is Energy Star 1.1 certified and Climate Savers certified.

- **Ease of use and manageability.** ThinkServers are supported by a suite of management tools that enables you to easily install, maintain, and manage your ThinkServer RD630. Systems management based on open standards and protocols mean easy integration into your existing network.

Lenovo ThinkPlus® Productivity, ThinkPlus Priority Support and available 4-hour service response further assist you in installation and IT support.

For detailed information about the Lenovo ThinkServer RD630, visit the Lenovo server site at www.lenovo.com. For details on the specific configuration we tested, see Appendix A.

WHAT WE FOUND

Figure 6 presents the results of our tests, including the number of VMs the servers could run, the total database performance in OPM, and the percentage CPU utilization the servers used to run the workloads. Note that we used a heavy, resource intensive workload on each VM in order to stress the servers and demonstrate the higher performance capacity of the Lenovo ThinkServer RD630. Assuming your workload on each VM is not as intensive, you could expect to run a higher number of VMs in your environment.

Host server	Number of VMs	Total OPM	Percentage CPU utilization
Lenovo ThinkServer RD630	6	259,989	83.4
HP ProLiant DL385 G5	2	47,467	64.3

Figure 6: Database performance results for the two servers.

Figure 7 presents the power results of our testing. While the ThinkServer RD630 used more power than the HP server did overall, it was running a much larger workload. This makes the power/VM and performance/watt statistics the more meaningful ones for comparison. The Lenovo ThinkServer RD630 used 58.8 percent less power per VM than the HP ProLiant DL385 G5, while simultaneously providing better performance per VM. The Lenovo ThinkServer RD630 delivered 344.1 percent greater total server performance per watt.

Host server	Power (W)	Power/VM (W)	Performance/watt
Lenovo ThinkServer RD630	407	68	638.8
HP ProLiant DL385 G5	330	165	143.8

Figure 7: Power, in watts, the two servers used to run the workload.

WHAT WE TESTED

We optimized the virtual hardware configuration for each VM for best performance using the available resources on each server. We configured the VMs on the HP ProLiant DL585 G5 with 2GB of memory and three vCPUs, and configured the VMs on the Lenovo ThinkServer RD630 with 4GB of memory and four vCPUs. In that way, we were able to create a real-world representation of how these servers would be utilized while under stress from a database application.

We used the DVD Store version 2.1 (DS2) benchmark to test the database performance of the servers. We ran DS2 on multiple client machines against each test server and recorded the power the servers consumed and the OPM they could handle.

For detailed configuration information on the servers we tested, see Appendix A. For detailed instructions on how we tested, see Appendix B.

About DVD Store Version 2.1

To create our real-world ecommerce 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.

IN CONCLUSION

Populating your data center with new, more powerful and energy efficient servers can deliver numerous benefits to your organization. By consolidating multiple older servers onto a new platform, you can save in the areas of data center space and port costs, management costs, and power and cooling costs.

In our tests, we found that the Lenovo ThinkServer RD630 could consolidate the workloads of three HP ProLiant DL385 G5 servers, while increasing overall performance by 82.6 percent and reducing power consumption by 58.8 percent, making the ThinkServer RD630 an excellent choice to reduce the costs associated with running your data center.

APPENDIX A – SERVER CONFIGURATION INFORMATION

Figure 8 provides detailed configuration information for the test servers.

System	Lenovo ThinkServer RD630	HP ProLiant DL385 G5
Power supplies		
Total number	2	2
Vendor and model number	Delta Electronics DPS-800RB	HP 379124-001
Wattage of each (W)	800	1000
Cooling fans		
Total number	6	6
Vendor and model number	AVC 2B06038B12G	Nidec® B35441-94
Dimensions (h x w) of each	3" x 1-7/8"	2-1/2" x 1-1/2"
Volts	12	12
Amps	2.7	1.5
General		
Number of processor packages	2	2
Number of cores per processor	8	4
Number of hardware threads per core	16	1
System power management policy	Balanced	Balanced
CPU		
Vendor	Intel	AMD
Name	Xeon	Opteron™
Model number	E5-2680	2356
Stepping	C1	B3
Socket type	2011 LGA	F - 1207
Core frequency (GHz)	2.70	2.30
L1 cache	32 KB (per core)	64 KB
L2 cache	256 KB (per core)	512 KB (per core)
L3 cache	20 MB (shared)	2 MB (shared)
Platform		
Vendor and model number	Lenovo ThinkServer RD630	HP ProLiant DL385 G5
BIOS name and version	American Megatrend Inc. 2.14 Lenovo BIOS 0.21	HP BIOS A09 (05/02/2011)
BIOS settings	Default	Default
Memory module(s)		
Total RAM in system (GB)	160	8
Vendor and model number	Samsung® M393B1K70CH0-CH9	Qimonda® HYS72T512220EP
Type	PC3-10600R DDR3	PC2-5300P
Speed (MHz)	1,333	667
Speed running in the system (MHz)	1,333	667
Timing/Latency (tCL-tRCD-tRP-tRASmin)	9-9-9-24	5-5-5-15
Size (GB)	8	4
Number of RAM module(s)	20	2

System	Lenovo ThinkServer RD630	HP ProLiant DL385 G5
Chip organization	Double-sided	Double-sided
Rank	Dual	Dual
Operating system (host)		
Name	VMware ESXi 5	VMware ESXi 5
Build number	5.0.0	5.0.0
Operating system (virtualized)		
Name	Windows Server 2008 R2	Windows Server 2008 R2
Build number	7601	7601
Service pack	SP1	SP1
File system	NTFS	NTFS
Kernel	ACPI x64-based PC	ACPI x64-based PC
Language	English	English
RAID controller		
Vendor and model number	LSI™ MegaRaid® SAS 9260-8i	HP Smart Array P400 Controller
Firmware version	2.120.183-1415	7.22
Cache size (MB)	512	512
Hard drives #1		
Vendor and model number	Seagate® ST9600204SS	HP MBF2300RC
Number of drives	2	8
Size (GB)	600	300
RPM	10,000	10,000
Type	SAS	SAS 6.0 Gb/s
Hard drives #2		
Vendor and model number	STEC® M16ISD2-200UCP	N/A
Number of drives	4	N/A
Size (GB)	200	N/A
Type	SATA/SSD 300 Gb/s	N/A
Ethernet adapters		
First network adapter		
Vendor and model number	Intel I350	HP NC373i Gigabit Server Adapter
Type	Integrated	Integrated
Second network adapter		
Vendor and model number	Intel I350	HP NC373i Gigabit Server Adapter
Type	Integrated	Integrated
Third network adapter		
Vendor and model number	Intel 82574L	N/A
Type	Integrated	N/A
Optical drive(s)		
Vendor and model number	HL-DT-ST CD-ROM	HL-DT-ST CD-ROM
Type	SATA	SATA

System	Lenovo ThinkServer RD630	HP ProLiant DL385 G5
USB ports		
Number	7	5
Type	2.0	2.0

Figure 8: System configuration information for the test servers.

APPENDIX B - HOW WE TESTED

Setting up the servers – VMware vSphere 5.0

Configuring partitions on the servers

Boot the server and enter RAID controller configuration when prompted (F8 for HP and CTRL+H for Lenovo).Following the setup wizard, we configured two drives in a RAID 1 configuration for one partition and six in a RAID 10 for a second partition for the HP ProLiant DL585 G5. For the Lenovo ThinkServer RD630, we assigned the 600GB SAS drives in a RAID 1 configuration for one partition and the 4 SSD drives in a RAID10 configuration for the second partition.

Installing VMware vSphere 5.0 (ESXi) on the servers

1. Insert the disk, and select Boot from disk.
1. On the Welcome screen, press Enter.
2. On the End User License Agreement (EULA) screen, press F11.
3. On the Select a Disk to Install or Upgrade Screen, select the relevant volume to install ESXi on and press Enter. (We choose to install to internal USB devices.)
4. On the Please Select a Keyboard Layout screen, press Enter.
5. On the Enter a Root Password Screen, assign a root password and confirm it by entering it again. Press Enter to continue.
6. On the Confirm Install Screen, press F11 to install.
7. 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, select enable ESXi Shell, and press Enter.
4. Select Enable SSH, press Enter, and press ESC.
5. On the System Customization screen, select Configure Management Network.
6. On the Configure Management Network screen, select IP Configuration.
7. On the IP Configuration screen, select set static IP, enter an IP address, subnet mask, and default gateway, and press Enter.
8. On the Configure Management Network screen, press Esc. When asked if you want to apply the changes, press Y.

Configuring VM networking on ESXi

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 VMware datastores on the servers

We created datastores on HP ProLiant DL385 G5 and the Lenovo ThinkServer RD630 using the parameters in Figure 9, following the steps below.

Host	Datastore name
HP ProLiant DL385 G5	Datastore
HP ProLiant DL385 G5	extra_6_disk_raid10
Lenovo ThinkServer RD630	DatastoreLenovo
Lenovo ThinkServer RD630	4_disks_SSD_raid10

Figure 9: Datastore parameters for the servers we tested.

1. Using the vSphere client, select Home→Datastore and Datastore Clusters.
2. Right-click Cluster and select Add new Datastore.
3. Select the appropriate host, and click Next.
4. Leave default Storage type as Disk/LUN, and click Next.
5. Select the desired Disk/LUN, and click Next.
6. Select VMFS-5, and click Next.
7. Click Next.
8. Enter corresponding datastore name from above, and click Next.
9. Keep default capacity of Maximum available space, and click Next.
10. Click Finish.
11. Repeat all steps above to create the remaining datastores using the partitions you created above in the Configuring partitions section.

Creating the first VM

We created the first virtual machine for each platform using the parameters in Figures 10 and 11 and following the steps below.

Basic VM settings	
HP ProLiant DL385 G5	
Memory (GB)	2
CPUs	3
Lenovo ThinkServer RD630	
Memory (GB)	4
CPUs	4

Figure 10: Basic VM settings for the servers.

	Datastore	Size (GB)	Node	Provisioning
HP VM virtual disk settings				
Hard Disk 1	datastore	40	0:0	Thick, Lazy Zeroed
Hard Disk 2	extra_6_disk_raid10	20	1:0	Thick, Lazy Zeroed
Hard Disk 3	datastore	15	1:1	Thick, Lazy Zeroed
Hard Disk 4	extra_6_disk_raid10	2	1:2	Thick, Lazy Zeroed
Lenovo VM virtual disk settings				
Hard Disk 1	datastorelenovo	20	0:0	Thick, Lazy Zeroed
Hard Disk 2	4_disks_SSD_raid10	10	0:1	Thick, Lazy Zeroed

	Datastore	Size (GB)	Node	Provisioning
Hard Disk 3	4_disks_SSD_raid10	2	0:3	Thick, Lazy Zeroed
Hard Disk 4	datastorelenovo	15	0:4	Thin

Figure 11: Virtual disk settings for the servers.

1. In the vSphere client, connect to the vCenter Server, and browse 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 corresponding OS Datastore, and click Next.
7. Choose Virtual Machine Version 8, and click Next.
8. Choose Windows, choose Microsoft Windows Server 2008 R2 (64-bit), and click Next.
9. Choose the preferred system number of virtual processors from Figure 9, and click Next.
10. Choose the appropriate amount of memory listed in Figure 9, and click Next.
11. Click 1 for the number of NICs, select vmnicX, 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. Reference Figure 10 to assign OS virtual disk parameters, (e.g., 40 GB, thick-provisioned lazy zeroed), specify the OS datastore, 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. Reference Figure 10 for the appropriate virtual disk size, choose thick-provisioned lazy zeroed, and specify the datastore for backup and SQL Server data usage.
22. Choose SCSI(0:1) 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. Reference Figure 10 for the appropriate virtual disk size, choose thick-provisioned lazy zeroed, and specify the datastore for backup and SQL Server data usage (storage pool 2).
27. Choose SCSI(1:0) for the device node, and click Next.
28. On the Hardware tab, click Add…
29. Click Hard Disk, and click Next.
30. Click Create a new virtual disk, and click Next.
31. Reference Figure 10 for the appropriate virtual disk size, choose thick-provisioned lazy zeroed, and specify the datastore for SQL Server log virtual disks.
32. Choose SCSI(1:1) for the device node, and click Next.
33. Click SCSI Controller 1, and choose Change Type.
34. Choose VMware Paravirtual, and click OK.
35. Click Finish, and click OK.
36. Start the VM.
37. Attach the Windows Server 2008 R2 SP1 ISO image to the VM, and install Windows Server 2008 R2 on your VM.

Configuring the VMs

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

Installing the VM operating system on the first VM

1. Insert the installation DVD for Windows Server 2008 R2 SP1 Enterprise into the DVD drive, and attach the physical DVD drive to the VM. Alternatively, use an ISO image and connect to the ISO image from the VM console.
2. Open the VM console on vSphere.
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.
2. Log into the virtual machine.
3. Insert the installation DVD for SQL Server 2008 R2 into the vSphere host server's DVD drive.
4. Attach the physical DVD drive to the VM.

5. Click Run SETUP.EXE. If Autoplay does not begin the installation, navigate to the SQL Server 2008 R2 DVD, and double-click.
6. If the installer prompts you with a .NET installation prompt, click Yes to enable the .NET Framework Core role.
7. In the left pane, click Installation.
8. Click New installation or add features to an existing installation.
9. At the Setup Support Rules screen, wait for the check to complete. If there are no failures or relevant warnings, click OK.
10. Select the Enter the product key radio button, and enter the product key. Click Next.
11. Click the checkbox to accept the license terms, and click Next.
12. Click Install to install the setup support files.
13. 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.
14. At the Setup Role screen, choose SQL Server Feature Installation.
15. 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.
16. At the Installation Rules screen, click Next once the check completes.
17. At the Instance configuration screen, leave the default selection of default instance, and click Next.
18. At the Disk space requirements screen, click Next.
19. 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.
20. At the Database Engine Configuration screen, select Mixed Mode.
21. Enter and confirm a password for the system administrator account.
22. Click Add Current user. This may take several seconds.
23. Click Next.
24. At the Error and usage reporting screen, click Next.
25. At the Installation Configuration rules screen, check that there are no failures or relevant warnings, and click Next.
26. At the Ready to Install screen, click Install.
27. After installation completes, click Next.
28. Click Close.
29. Create a SQL Server login for the ds2user.
30. Copy the pre-created DVD Store backup to the specified backup VHD volume.
31. Click Start→All Programs→Microsoft SQL Server 2008 R2→Configuration Tools, and click SQL Server Configuration Manager
32. Expand SQL Server Network Configuration, and click Protocols for MSSQLSERVER.
33. Right-click TCP/IP, and select Enable.
34. Download and install Microsoft SQL Server 2008 R2 SP1.

Configuring additional VMs on vSphere

1. Log into the vCenter Server, which manages the host.
1. Right-click the first VM, and choose Clone.
2. Name the new VM.
3. Choose the cluster, and select the host.
4. For the storage screen, choose advanced and direct the new virtual disks to the applicable datastores. Choose to customize using the customization wizard. Save the clone details as a new customization specification.
5. Continue cloning each VM, modifying the customization specification as necessary for IP addressing and so on.
6. 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.

7. Modify the SQL Server hostname of each VM using the instructions provided by Microsoft (http://msdn.microsoft.com/en-us/library/ms143799.aspx).
8. 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.

Configuring the database (DVD Store)

We generated the data using the Install.pl script included with DVD Store version 2.1 (DS2), providing the parameters for our 4GB database size and the database platform on which we ran: Microsoft SQL Server. 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. We built the 4GB database in SQL Server 2008 R2, 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 all 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 4GB 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 12 details our initial file size modifications.

Logical name	Filegroup	Initial size (MB)
Database files		
primary	PRIMARY	3
cust1	DS_CUST_FG	2,048
cust2	DS_CUST_FG	2,048
ind1	DS_IND_FG	1,024
ind2	DS_IND_FG	1,024
ds_misc	DS_MISC_FG	1,024
orders1	DS_ORDERS	1,024
orders2	DS_ORDERS	1,024
Log files		
ds_log	Not Applicable	10,240

Figure 12: The file size modifications we used in our testing.

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 one hour.
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=45 --
n_threads=10 --db_size=4GB --think_time=0.1 > C:\outputresultsfile.txt
```

ABOUT PRINCIPLED TECHNOLOGIES

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Principled Technologies, Inc.
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