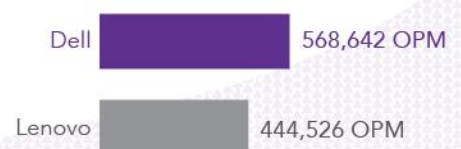


DATABASE PERFORMANCE: DELL POWEREDGE R730XD VS. LENOVO THINKSERVER RD650

PROCESS MORE ORDERS WITH THE DELL™ POWEREDGE™ R730XD

High speed performance with a hybrid drive structure using Intel® SSDs

27.9% MORE ORDERS PER MINUTE



POWERED BY THE INTEL® XEON® PROCESSOR E5-2600 v3 PRODUCT FAMILY



vs a Lenovo® ThinkServer® RD650

Database servers need big, speedy performance to support a large number of customers and provide them with a good experience. For the Dell PowerEdge R730xd, that performance comes from current-generation hardware and an increased number of drive bays to support more high-performance solid-state drives (SSDs).

In the Principled Technologies datacenter, we tested two current generation servers in a head-to-head database comparison to find out which one had better overall performance and response times with a database application. We found that the Dell PowerEdge R730xd, powered by the Intel Xeon processor E5-2600 v3 family and with the Intel SSD DC S3610 Series, delivered 27.9 percent more orders per minute (OPM) for a Microsoft® SQL Server® 2014 database application than the Lenovo ThinkServer RD650 server did. Besides the increase in processed orders, the PowerEdge R730xd delivered better user or application latency (response time) and better disk system latency than the Lenovo ThinkServer RD650—up to 24.6 percent better and 93.7 percent respectively. That's like adding more Express Checkout lanes in your local grocery store.

The Dell PowerEdge R730xd was also the clear winner in potential storage capacity. Our configuration of the PowerEdge R730xd supported three times the number of SATA SSDs as its competitor (18 versus 6), providing the necessary storage resources to deliver more OPM and better response times.



THE MORE TRANSACTIONS, THE BETTER

Your Microsoft SQL Server 2014 databases keep your business running, so selecting the right hardware is important. The Dell PowerEdge R730xd features the Intel Xeon processor E5-2600 v3 product family and the Intel SSD DC S3610 Series to help power these important database workloads. Once you've determined the size and relative goals you have for your database solution, performance and response time are what matters most. That's why we used the DVD Store benchmark to compare the database performance of the Dell PowerEdge R730xd and the Lenovo ThinkServer RD650. We configured both servers with Microsoft Windows Server® 2012 R2 and ran 10 SQL Server database VMs for our comparison. The results we report are the medians of three runs.

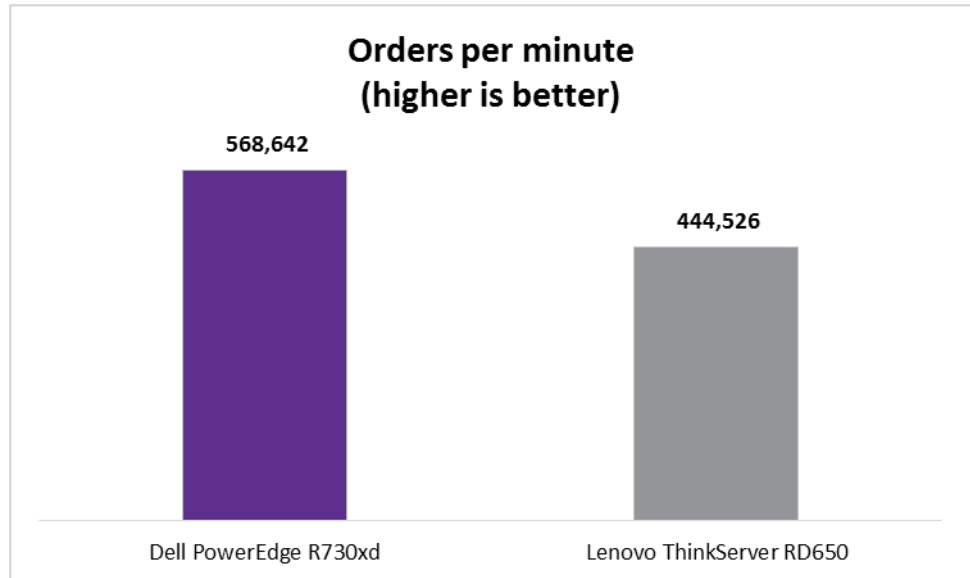
For information about the PowerEdge R730xd and our other test components, see [Appendix A](#). For detailed system configuration, see [Appendix B](#). For step-by-step testing details, see [Appendix C](#).

WHAT WE FOUND

Process more orders per minute with the Dell PowerEdge R730xd

In our tests, the database performance in orders per minute (OPM) that a system can handle shows useful performance correlations that could help your business. Every application and its demands are different, but by using DVD Store, we saw how both servers' performed when pushing the systems and application performance to the max, giving us an output for our particular application—OPM. Your business may measure customer logins, orders, products made, etc., but in our case, the more OPM, the more business our servers could handle. As Figure 1 shows, the Dell PowerEdge R730xd with Intel Xeon processors E5-2600 v3 and Intel SSDs beat the Lenovo ThinkServer RD650 in our head-to-head database performance test by delivering 27.9 percent more OPM—over 124,000 more orders (see Figure 1).

Figure 1: The Dell PowerEdge R730xd server delivered 27.9 percent more orders per minute in our tests.



Better response times for end users with the Dell PowerEdge R730xd

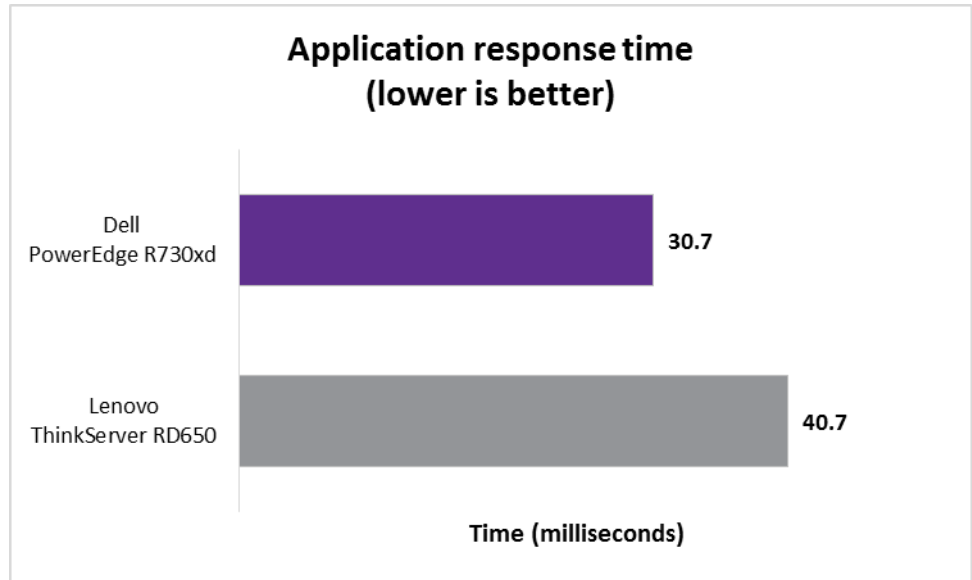
Response time, sometimes called latency, is the time it takes for one thing to respond to another. In application and infrastructure design, the goal is to decrease latency as much as possible to improve the user experience. In the case of our testing, we measured application latency and disk latency. Application latency is the amount of time the simulated user in the DVD Store application had to wait for their request to return, while disk latency refers to the amount of time that the operating system reports for the disk to respond to input/output (I/O) requests.

Even with the increased OPM the PowerEdge R730xd was able to process, application and disk latency decreased. That means that as your business processes more orders with the PowerEdge R730xd, users won't be stuck waiting as long as they would with a system such as the ThinkServer RD650. The increased number of SSDs in the Dell PowerEdge R730xd spurred the lower response times.

Application latency

Application latency directly affects your business—longer waits on an application to send or retrieve data can lead to abandoned or cancelled orders. The PowerEdge R730xd delivered a 24.6 percent better application response time than the Lenovo ThinkServer RD650 (see Figure 2).

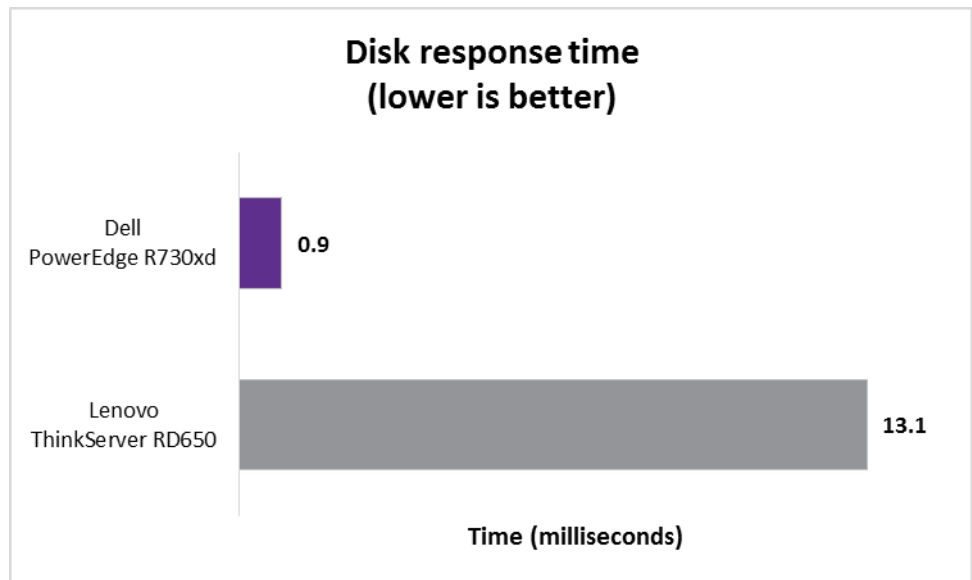
Figure 2: The Dell PowerEdge R730xd server delivered 24.6 percent better application response time in our tests.



Disk system latency

Disk system latency gives a behind-the-scenes glimpse of the benefits the PowerEdge R730xd can deliver at the I/O subsystem layer. The PowerEdge R730xd with Intel SSDs had a 93.1 percent better disk-system response time than the Lenovo ThinkServer RD650 (see Figure 3). This shorter disk-system response time speaks to how well the R730xd solution handled bursts of I/O, simulating peak times for order processing. The SSDs in the R730xd kept disk latencies below 1 ms in our tests.

Figure 3: The Dell PowerEdge R730xd server delivered 93.1 percent better disk response time in our tests.



CONCLUSION

Microsoft SQL Server 2014 users, take note. In our datacenter, we found that the Dell PowerEdge R730xd server based on the Intel Xeon processor E5-2600 v3 product family with the Intel SSD DC S3610 Series handled up to 27.9 percent more orders per minute than the Lenovo ThinkServer RD650 did. With three times the SSDs, the PowerEdge R730xd delivered better response times—up to 24.6 percent for application latency and up to 93.1 percent for disk latency—than the ThinkServer RD650. Getting more performance per server and better response times means you can give customers a better, faster ecommerce experience. This can allow you to buy, store, and power fewer servers, helping stretch your IT budget further.

APPENDIX A – ABOUT THE COMPONENTS

About the Dell PowerEdge R730xd

Dell designed the two-socket, 2U Dell PowerEdge R730xd rack server to provide the scale-out storage efficiency needed by big data users, including the option for hybrid internal storage tiering and six distinct storage configurations. The configuration we tested had two 2.5" rear HDD bays, eight 3.5" front HDD bays, and 18 1.8" front SSD bays. Powered by the latest Intel Xeon processors E5-2690 v3, the PowerEdge R730xd has 24 DIMM slots to support up to 1.5 TB of memory.

With redundant power supply units, hot-swappable hardware, and Dual SDTM card for Failsafe Hypervisors, the Dell PowerEdge R730xd supports hardware high availability. The PowerEdge R730xd comes standard with iDRAC8 with Lifecycle Controller and Dell OpenManage™, which all work to streamline management. For more details on the Dell PowerEdge R730xd, visit www.dell.com/us/business/p/poweredge-r730xd/pd.

About the Intel Xeon processor E5-2600 v3 product family

According to Intel, the Intel Xeon processor E5-2600 v3 product family “helps IT address the growing demands placed on infrastructure, from supporting business growth to enabling new services faster, delivering new applications in the enterprise, technical computing, communications, storage, and cloud.” It also delivers benefits in performance, power efficiency, virtualization, and security. The E5-2600 v3 product family has up to 50 percent more cores and cache than processors from the previous generation.

Other features include the following:

- Intel Advanced Vector Extensions 2 (AVX2)
- Intel Quick Path Interconnect link
- Up to 18 cores and 36 threads per socket
- Up to 45 MB of last level cache
- Next-generation DDR4 memory support
- Intel Integrated I/O providing up to 80 PCIe® lanes per two-socket server
- Intel AES-NI data encryption/decryption

The Intel Xeon processor E5-2600 v3 product family also uses Intel Intelligent Power technology and per-core P states to maximize energy efficiency. Learn more at www.intel.com/content/www/us/en/processors/xeon/xeon-e5-brief.html.

About the Intel SSD DC S3610 Series

According to Intel, “the Intel SSD DC S3610 Series offers the next generation of datacenter SSDs optimized for mixed read-write performance, endurance, and strong data protection.” The Intel SSD DC S3610 Series was designed to offer throughput speeds up to 550/5201 MB per second and 4K random read/write input/output operations per second (IOPs) up to 84,000/28,0001. Learn more at www.intel.com/content/www/us/en/solid-state-drives/solid-state-drives-dc-s3610-series.html.

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.

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

APPENDIX B – SYSTEM CONFIGURATION INFORMATION

Figure 4 provides detailed configuration information for the test systems.

System	Dell PowerEdge R730xd	Lenovo ThinkServer RD650
General		
Number of processor packages	2	2
Number of cores per processor	12	12
Number of hardware threads per core	2	2
System power management policy	Balanced	Balanced
CPU		
Vendor	Intel	Intel
Name	Xeon	Xeon
Model number	E5-2690 v3	E5-2690 v3
Socket type	LGA	LGA
Core frequency (GHz)	2.6	2.6
Bus frequency	8.0 GT/s	8.0 GT/s
L1 cache	12 × 32 KB	12 × 32 KB
L2 cache	12 × 256 KB	12 × 256 KB
L3 cache	30 MB	30 MB
Platform		
Vendor and model number	Dell PowerEdge R730xd	Lenovo ThinkServer RD650
Motherboard model number	0H21J3	70D4000EUX
BIOS name and version	Dell 0.3.23	1.25.0
BIOS settings	Default	Default
Memory module(s)		
Total RAM in system (GB)	128	128
Vendor and model number	Hynix HMA41GR7MF8N-TF	Hynix HMA41GR7MF8N-TF
Type	DDR4-2133P	DDR4-2133P
Speed (MHz)	2,133	2,133
Speed running in the system (MHz)	2,133	2,133
Size (GB)	8	8
Number of RAM module(s)	16	16
Chip organization	Double-sided	Double-sided
Rank	Dual Rank	Dual Rank
Operating system		
Name	Windows Server 2012 R2 Datacenter	Windows Server 2012 R2 Datacenter
Build number	11.0.9600.17239	11.0.9600.17239
File system	NTFS	NTFS
Language	English	English

System	Dell PowerEdge R730xd	Lenovo ThinkServer RD650
RAID controller		
Vendor and model number	Dell PERC H730p mini	Lenovo ThinkServer RAID 720ix AnyRAID Adapter
Firmware version	25.3.0.0004	4.230.00-3860
Driver version	6.602.7.0	6.707.7.0
Cache size (GB)	2	2
Hard disk #1		
Vendor and model number	Intel SSDSC1BG200G4R	Intel SSDSC2BB240G4L
Number of drives	18	6
Size (GB)	200	240
Type	SATA	SATA
Hard disk #2		
Vendor and model number	Dell ST2000NM0023	Lenovo ThinkServer 0C44510
Number of drives	8	9
Size (TB)	2	2
RPM	7.2k	7.2k
Type	SAS	SAS
Hard disk #3		
Vendor and model number	Seagate® ST300MM0006	Lenovo ThinkServer SL10A28382
Number of drives	2	2
Size (GB)	300	240
RPM	10k	N/A
Type	SAS	SATA
Ethernet adapter		
Vendor and model number	Broadcom® NetXtreme® Gigabit Ethernet	Lenovo ThinkServer I350-T4 AnyFabric
Type	LAN	LAN
Driver	17.0.0.3	12.11.97.1

Figure 4: Detailed configuration information of our test systems.

APPENDIX C – HOW WE TESTED

We installed Windows Server 2012 R2 on both servers using the two backplane HDDs configured in a RAID 1 and added the Hyper-V role. We configured both servers with up-to-date drivers and firmware, and Windows updates. We created an initial VM with up-to-date Windows Server 2012 R2 and SQL Server 2014, and then cloned the additional VMs from the first. A generic rack server with Hyper-V hosted the virtual DVD store clients to drive the workload on the SQL Server VMs.

Installing Microsoft Windows Server 2012 R2

1. Insert the installation media into the CD/DVD drive, and restart the server.
2. Press any key when prompted to boot from DVD.
3. When the installation screen appears, click My language is English (United States).
4. Leave language, time/currency format and input method as default, and click Next.
5. Click Install now.
6. When the installation prompts you, enter the product key.
7. Select Windows Server 2012 R2 Datacenter (Server with a GUI), and click Next.
8. Check I accept the license terms, and click Next.
9. Click Custom: Install Windows only (advanced).
10. Select Drive 0 Unallocated Space, and click Next.
11. When the Settings page appears, fill in the Password and Reenter Password fields with the same password.
12. Log in with the password you set up previously.

Configuring Windows Update

1. In the left pane of the Server Manager window, click Local Server.
2. In the main frame, next to Windows Update, click Not configured.
3. In the Windows Update window, in the main pane, click Let me choose my settings.
4. Under Important updates, select Never check for updates (not recommended), and click OK.
5. In the left pane, click Check for updates, and install all available updates.
6. Close the Windows Update window.

Installing Hyper-V®

1. Open Server Manager, and click Manage → Add Roles and Features.
2. At the Before You Begin screen, click Next.
3. At the Installation Type screen, click Next.
4. At the Server Selection screen, select one of the servers in the failover cluster.
5. At the Server Roles screen, check Hyper-V. At the prerequisite pop-up, click Add Features. Click Next.
6. At the Features screen, click Next.
7. At the Hyper-V screen, click Next.
8. At the Virtual Switches screen, click Next.
9. At the Migration screen, click Next.
10. At the Default Stores screen, enter the iSCSI storage location. Click Next.

11. At the Confirmation screen, check to automatically restart the server after installation, and click Install.

Creating the first VM

1. Click Start, type `Hyper-V Manager`, and press Enter.
2. In the right pane, click Virtual Machines→New Virtual Machine.
3. Select a node on which to install the VM, and click OK.
4. At the Before You Begin screen, click Next.
5. At the Specify Name and Location screen, give the VM a name, and click Next.
6. At the Assign Memory screen, type 8 GB, and click Next.
7. At the Configure Networking screen, use the drop-down menu to select the virtual switch, and click Next.
8. At the Connect Virtual Hard Disk screen, create a new disk, enter 50 GB, and click Next.
9. At the Summary screen, click Finish.

Installing the VM operating system on the first VM

1. From the VM console, connect to the ISO image of the installation DVD for Windows Server 2012 R2 Datacenter. If the ISO image is not stored on the host, start the VM, and connect to the ISO image.
2. Start the VM.
3. At the Language Selection Screen, click Next.
4. Click Install Now.
5. Select a full installation of the Datacenter edition, and click Next.
6. Click I accept the license terms, 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 Host Integration 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. Assign the VM a static IP address.

Installing and configuring Microsoft SQL Server 2014

We installed Microsoft SQL Server 2014 on a VM residing on the system under test. We cloned the first VM to give us 10 VMs total.

Configuring the SQL Server VM

After cloning, modify the SQL VM to contain the following settings:

- Memory: 8GB
- Virtual Processors: 4
- Additional virtual disks:
 - 60GB virtual disks for SQL database data (Thick provisioned)
 - 30GB virtual disk for SQL log data (Thick provisioned)

In the VM, configure the VM storage:

1. In the taskbar, click the Server Manager icon.
2. In the left pane, expand Storage, and click Disk Management.
3. Right-click the first volume, and choose Initialize Disk.
4. In the right pane, right-click the volume, and choose New Simple Volume...
5. At the welcome window, click Next.
6. At the Specify Volume Size window, leave the default selection, and click Next.
7. At the Assign Drive Letter or Path window, choose a drive letter, and click Next.
8. At the Format Partition window, choose NTFS, and click Next.
9. At the Completing the New Simple Volume Wizard window, click Finish.

Installing .Net Framework 3.5

1. Click Start→Server Manager→Manage→Add Roles and Features.
2. Select Role-based or feature-based installation, and click Next.
3. Select the local server under Server Pool, and click Next twice.
4. Under Features select .NET Framework 3.5 Features, and click Next.
5. Click Install.
6. Click Close upon completion.

Installing Microsoft SQL Server 2014

1. Attach the installation media to the server.
2. Launch setup.exe from the installation media.
3. Choose the Installation section on the left, and click New SQL Server stand-alone installation or add features to an existing installation.
4. At the Product Key screen, enter the product key, and click Next.
5. At the License Terms screen, check I accept the license terms, and click Next.
6. At the Global Rules screen, allow the Global Rules check to finish, and click Next.
7. At the Microsoft Update screen, check Use Microsoft Update to check for updates (recommended), and click Next.
8. Once the updates have been downloaded and installed, click Next.
9. At the Install Setup Files screen, allow the setup files to install, and click Next.
10. At the Install Rules screen, allow the Install Rules check to run, and click Next.
11. At the Setup Role screen, select the SQL Server Feature Installation radio button, and click Next.

12. At the Feature Selection screen, select the features required for your installation. We selected Database Engine Services, Full-Text and Semantic Extractions for Search, Client Tools Connectivity, Client Tool Backwards Compatibility, Management Tools - Basic, and Management Tools - Complete.
13. At the Feature Rules screen, allow the Feature Rules check to run, and click Next.
14. At the Instance Configuration screen, click Next to use the default instance named MSSQLSERVER.
15. At the Server Configuration screen, click Next.
16. At the Database Engine Configuration screen, select Mixed Mode (SQL Server authentication and Windows authentication), and enter a password for the SQL Server system administrator (sa) account.
17. Click the Add Current User button.
18. In the Data Directories tab, enter the directories to be used for SQL data and logs. We used E:\ and F:\, respectively, to place the data and logs on their appropriate VHDs. Click Next.
19. At the Feature Configuration Rules screen, allow the Feature Configuration Rules check to finish, and click Next.
20. At the Ready to Install screen, click Install.
21. After the installation has completed, close the wizard.

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 Install.pl script generated the database schema.

After processing the data generation, we transferred the data files and schema creation files to a Windows-based system running SQL Server 2014. We built the 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 following steps:

1. We generated the data and created the database and file structure using database creation scripts in the DS2 download. We made size modifications specific to our 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 5 shows our initial file size modifications.

Logical name	Filegroup	Initial size (MB)
Database files		
primary	PRIMARY	5
cust1	DS_CUST_FG	6,144
cust2	DS_CUST_FG	6,144
cust3	DS_CUST_FG	6,144
cust4	DS_CUST_FG	6,144
ind1	DS_IND_FG	2,891
ind2	DS_IND_FG	2,891
ind3	DS_IND_FG	2,891
ind4	DS_IND_FG	2,891
ds_misc	DS_MISC_FG	200
orders1	DS_ORDERS	3,072
orders2	DS_ORDERS	3,072
orders3	DS_ORDERS	3,072
orders4	DS_ORDERS	3,072

Logical name	Filegroup	Initial size (MB)
Log files		
ds_log	Not applicable	18,141

Figure 5: Our initial file size modifications.

Running the test

Test start and run times

We ran all workloads concurrently to start and record all performance counters for this report. The specific testing parameters we used are included in the setup section, and the following section describes specifics for launching the 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 general steps:

1. Clean up prior outputs from the target system and the client driver system.
2. Drop the database from the target.
3. Restore the database on the target.
4. Shut down the target.
5. Reboot the 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 10 minutes.
8. Start the DVD Store driver on the client.

We used the following DVD Store parameters for testing:

```
ds2sqlserverdriver.exe --target=<target_IP> --ramp_rate=10 --run_time=30 --
n_threads=32 --db_size=20GB --think_time=0 --detailed_view=Y --warmup_time=0
--report_rate=1 --csv_output=<drive path>
```

ABOUT PRINCIPLED TECHNOLOGIES



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