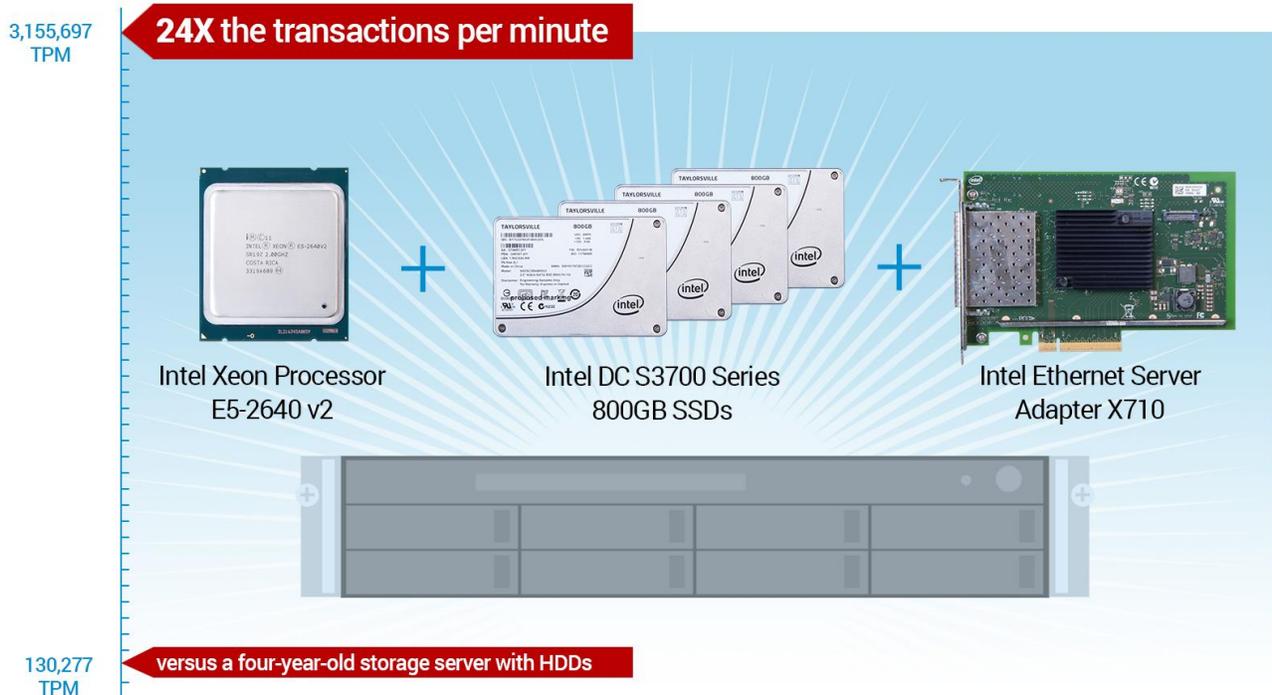


BOOSTING YOUR STORAGE SERVER PERFORMANCE WITH THE INTEL XEON PROCESSOR E5-2600 V2 PRODUCT FAMILY

Give your old storage servers a dramatic boost

The Intel® Xeon® Processor E5-2600 v2 product family delivered significantly faster performance and response time



Storage infrastructure is a key component of any datacenter. Some businesses have taken to using servers as storage arrays due to the flexibility they offer when it comes to management and upgrading hardware. If you are using an older server for your storage infrastructure, you can enjoy serious improvement by upgrading to a new server based on the powerful Intel Xeon Processor E5-2600 v2 product family and other Intel components that boost performance.

In the Principled Technologies labs, we tested an older storage server with hard disk drives (HDDs) against a new solid-state drive (SSD)-based server with the Intel processor E5-2640 v2. The newer server also used a 10Gb network interface card (NIC), versus a 1Gb NIC in the older server. The new storage server delivered more than 24 times as many transactions per minute (TPM), handled much better I/O, and delivered much better latency.

This performance gain shows the power of newer Intel technologies across the board. Whether NIC, storage, or processor, you could stand to benefit greatly by upgrading your servers with Intel's offerings.



INTEL COMPONENTS MAKE FOR A HIGH-PERFORMING STORAGE SERVER

The performance gains we saw in our testing are attributable to three primary components of the upgrade. The new storage server had a faster processor, faster storage (SSDs instead of HDDs), and a faster NIC.

The new storage server we tested uses the Intel Xeon processor E5-2640 v2, part of the Intel Xeon Processor E5-2600 v2 product family. This product family provides one and one-half times the cores and cache than the previous generation of Intel Xeon servers. It also provides faster memory. The SSD in our storage server is the Intel DC S3700 Series 800GB SSD and the NIC is part of the Intel Ethernet Server Adapter X710 product family.

Together, these components work to deliver strong performance in terms of database TPM, strong I/O performance, and quick response time.

OUR TEST RESULTS

Database performance

From a business perspective, you may find your SQL servers running on HDDs take too much time to handle tasks, creating bottlenecks. We used the HammerDB benchmark to measure the transactions per minute each server delivered. Figure 1 shows the dramatic increase in database TPM the storage server powered by the Intel processor E5-2640 v2 delivered compared to the older storage server.

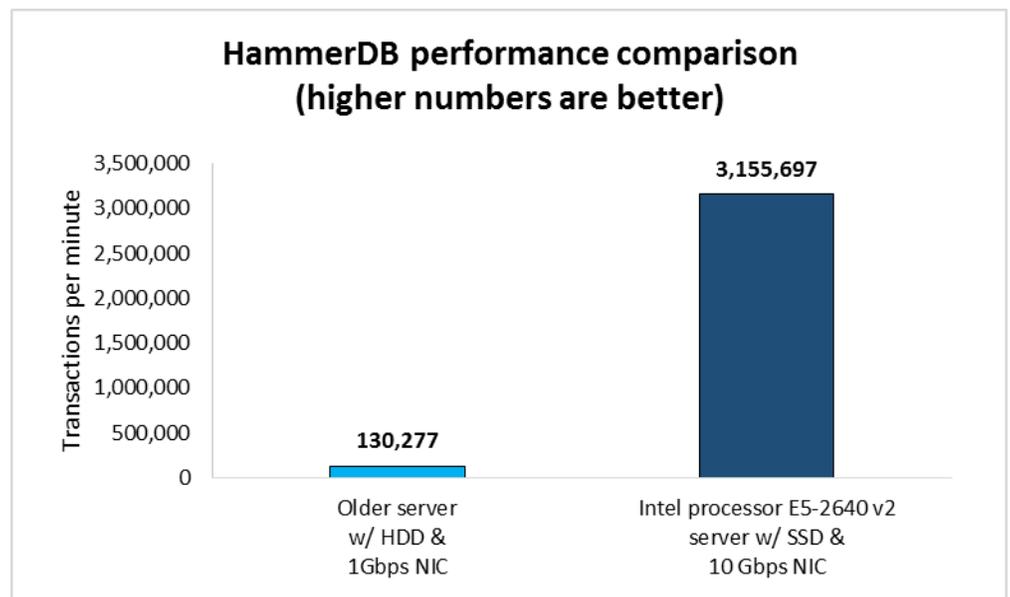


Figure 1: The database performance of the storage server powered by the Intel processor E5-2640 v2 greatly exceeded that of the older storage server.

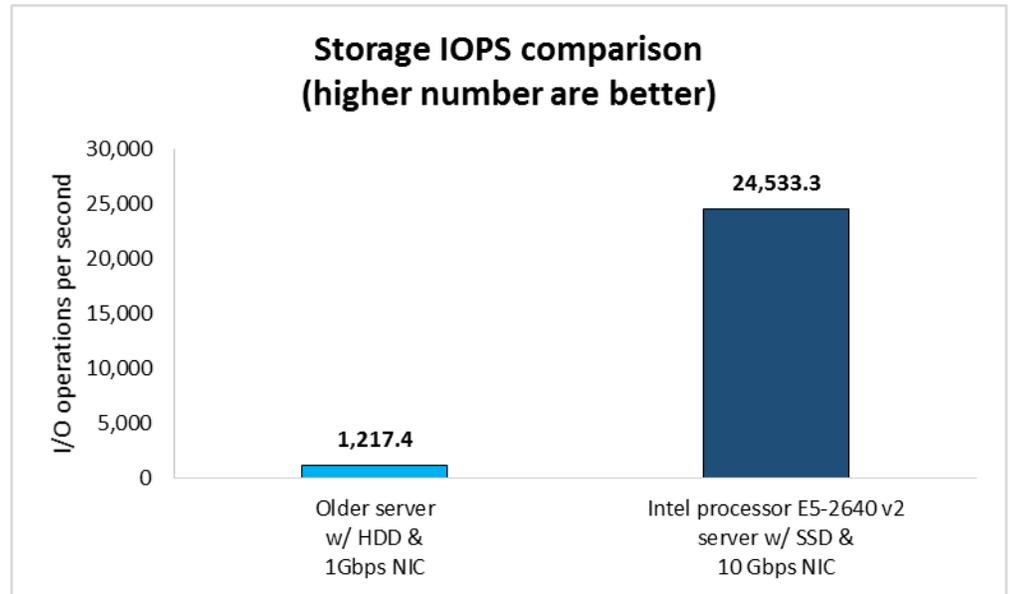
The storage server powered by the Intel Xeon processor E5-2640 v2 delivered 24 times the TPM, which means SQL servers connected to the upgraded storage server could increase productivity by 24 times. Our benchmark ran the same workload against the HDD-based storage server and the SSD-based storage server, and where the HDD

server struggled, the SSD server excelled. Database admins can rest assured that this storage can handle demanding database workloads, regardless of the task.

I/O performance

Figure 2 shows how replacing HDDs with SSDs can increase input/output (I/O) load. The storage server powered by the Intel processor E5-2640 v2 handled more than 20 times the load that the older storage server did.

Figure 2: The disk performance of the storage server powered by the Intel processor E5-2640 v2 greatly exceeded that of the older storage server.

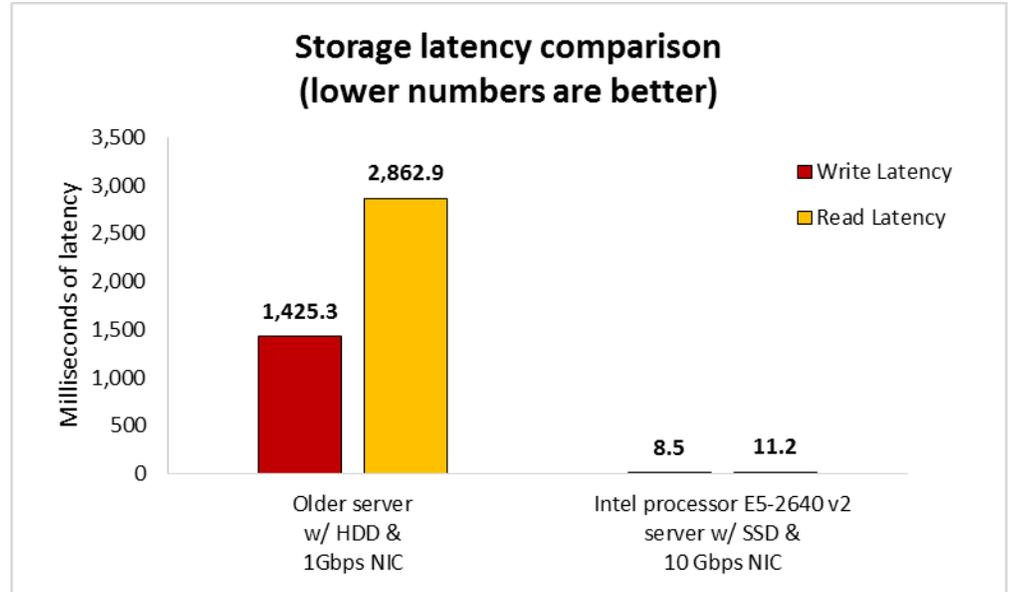


The results mirror what we saw with HammerDB and helps explain why the TPM was greater on the upgraded server. HDDs are not as well suited to handle today's modern workloads as SSDs are, and workloads can require many times more HDDs to achieve the same results from a smaller number of SSDs. This can mean wasted valuable datacenter space in addition to unrealized performance potential. SSDs can allow scaling of databases or workloads to meet the needs of your users.

Response time

Figure 3 shows the read and write latency of the two tested storage servers from the perspective of the SQL servers. The read latency of the storage server powered by the Intel processor E5-2640 v2 was less than 1 percent of that of the older storage server and the write latency was less than half a percent.

Figure 3: The response time of the storage server powered by the Intel processor E5-2640 v2 was almost instantaneous compared to that of the older storage server.



With a performance differential so large, there needs to be an explanation for it and the latency shows what was happening. The older system had difficulty handling the load thrown at it, while the storage server powered by the Intel processor E5-2640 v2 was able to take the load and provide almost instantaneous response time. In a real-world environment, 20 milliseconds is often a maximum acceptable latency. The SQL servers connected to the older storage were experiencing average latencies of nearly three seconds.

The upgraded storage server ran smoothly the entire time and the shorter response time on the SSDs means that database admins could continue to work without experiencing unusually long response time, or lag. From a usability perspective, long response times due to a storage bottleneck can be frustrating and slow down application responsiveness.

CONCLUSION

The performance of your storage server is a critical component of database performance. Upgrading an older HDD-based server with a 1Gbps NIC to a new server equipped with components from the Intel Xeon Processor E5-2600 v2 product family, the Intel DC S3700 Series of SSDs, and the Intel Ethernet Server Adapter X710 product family can catapult performance to an entirely new level.

APPENDIX A – SYSTEM CONFIGURATION INFORMATION

Figure 4 provides detailed configuration information for the test servers.

System	Dell PowerEdge R720	Dell PowerEdge R710
Power supplies		
Total number	1	1
Vendor and model number	Dell D750E-S1	Dell N870-S0
Wattage of each (W)	750	870
Cooling fans		
Total number	6	5
Vendor and model number	San Ace 60 9GA0612P1K641	Sanyo 9GV0612P1M041
Dimensions (h x w) of each	2.5" x 2.5"	2.5" x 2.5"
Volts	12	12
Amps	0.95	1.5
General		
Number of processor packages	2	2
Number of cores per processor	8	6
Number of hardware threads per core	2	2
System power management policy	Balanced	Balanced
CPU		
Vendor	Intel	Intel
Name	Xeon	Xeon
Model number	E5-2640 v2	X5670
Stepping	M1	B1
Socket type	LGA2011	FCLGA1366
Core frequency (GHz)	2.60	2.93
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	12
Platform		
Vendor and model number	Dell PowerEdge R720	Dell PowerEdge R710
Motherboard model number	OM1GCR	OYDJK3
BIOS name and version	Dell 2.2.3 (05/20/2014)	Dell 6.4.0 (07/23/2013)
BIOS settings	Default	Default
Memory module(s)		
Total RAM in system (GB)	64	64
Vendor and model number	Samsung® M393B1K70BH1-CH9	Hynix® HMT42GR7MFR4C-PB
Type	PC3-10600R	PC3-12800R
Speed (MHz)	1333	1600
Speed running in the system (MHz)	1333	1600
Timing/Latency (tCL-tRCD-tRP-tRASmin)	9-9-9-24	13-13-13-36
Size (GB)	8 GB	16 GB
Number of RAM module(s)	8	4

System	Dell PowerEdge R720	Dell PowerEdge R710
Chip organization	Double sided	Double sided
Rank	2Rx4	2Rx4
Operating system		
Name	Windows Server® 2012 R2 Datacenter 64-bit	Windows Server 2012 R2 Datacenter 64-bit
Build number	9600	9600
File system	NTFS	NTFS
Kernel	ACPI x64-based PC	ACPI x64-based PC
Language	English	English
Graphics		
Vendor and model number	Matrox® G200e	Matrox G200e
Graphics memory (MB)	256	256
RAID controller		
Vendor and model number	PERC® H310 Mini Mono	Dell SAS 6/iR Raid Adapter
Firmware version	20.13.0-0007 A08 (05/12/2014)	00.25.47.00.06.22.03.00, A04 (11/05/2011)
Cache size	N/A	N/A
Hard drives		
Vendor and model number	Dell ST973452SS	Dell ST9146852SS
Number of drives	2	2
Size (GB)	146 GB	146 GB
RPM	15k	15k
Type	SAS 6.0	SAS 6.0
RAID	RAID 1	RAID 1
Hard drives 2		
Vendor and model number	Intel SSDSC2BA800G301	Seagate® ST9900805SS
Number of drives	4	4
Size (GB)	800 GB	900 GB
RPM	SSD	10,000
Type	SATA 6.0	SAS 6.0
Ethernet adapters		
First network adapter		
Vendor and model number	Intel Ethernet Controller X540-AT2	Broadcom® NetXtreme II GigE BCM5709C
Type	Integrated	Integrated
Second network adapter		
Vendor and model number	Intel Ethernet Controller X710	N/A
Type	PCIe	N/A

Figure 4: System configuration information for the test systems.

APPENDIX B – HOW WE TESTED

ABOUT THE BENCHMARK WE USED - HAMMERDB

HammerDB is an open-source benchmark tool that tests the database performance of many databases, including Oracle Database, Microsoft® SQL Server®, PostgreSQL®, MySQL™, and more. The benchmark includes built-in workloads derived from industry-standard benchmarks, such as a transactional (TPC-C-like) workload and a data warehouse (TPC-H-like) workload. For this study, we used the transactional workload. Our tests were not official TPC results and are not comparable in any manner. For more information, visit hammerora.sourceforge.net.

OUR TESTBED SETUP

Figures 5 and 6 show our test bed setup.

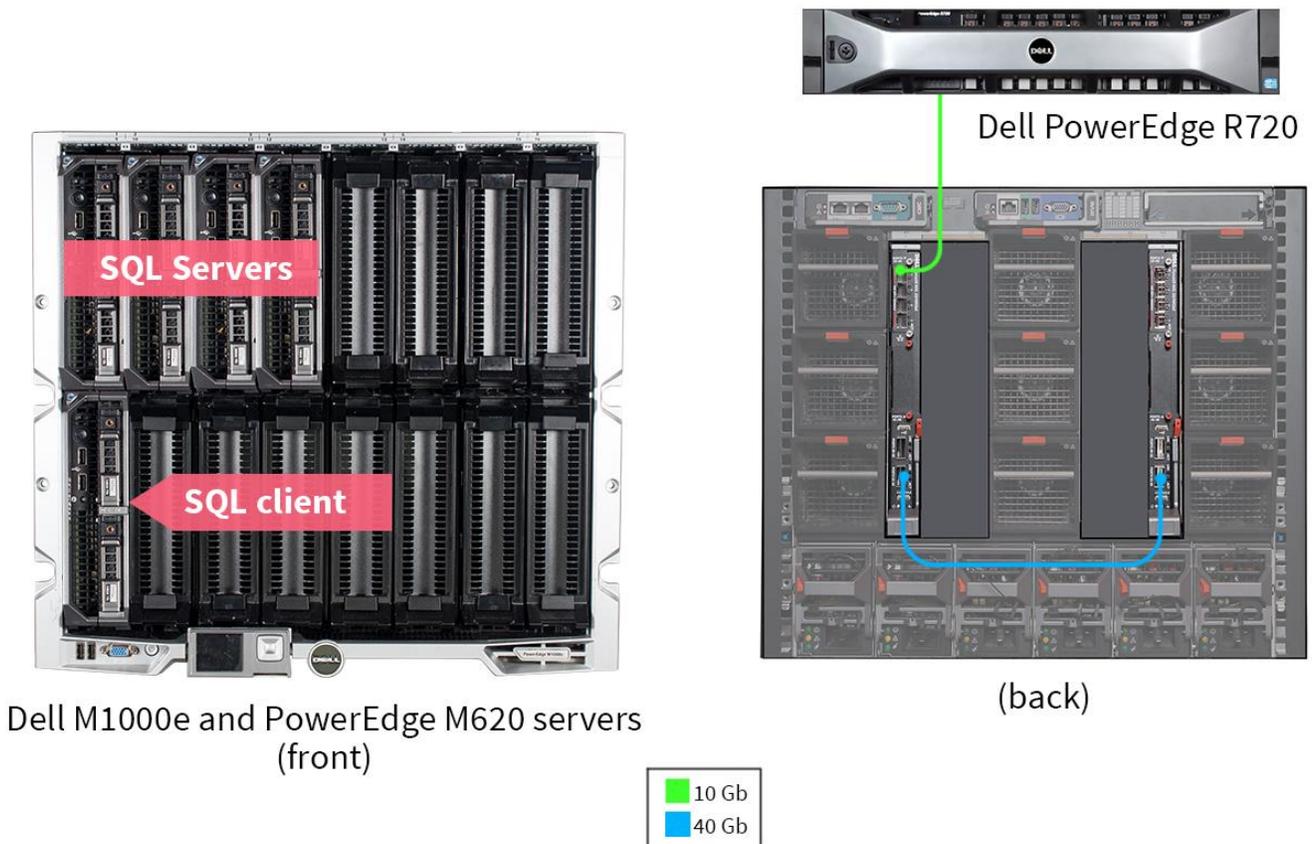


Figure 5: Setup for the newer server powered by the Intel processor E5-2640 v2.

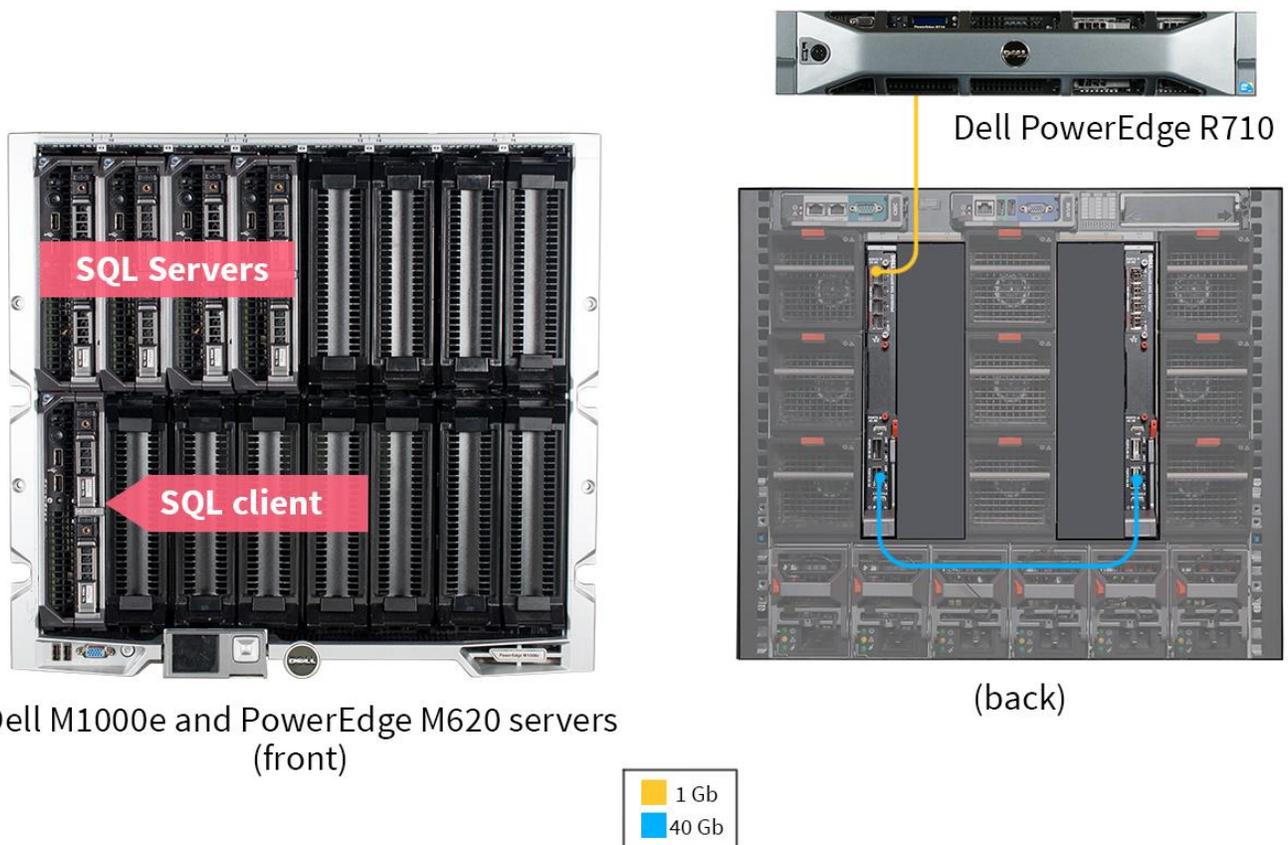


Figure 5: Setup for the older server.

INITIAL ISCSI CLIENT INSTALLATION AND CONFIGURATION

1. Install WS2012 R2 Datacenter.
2. Install updates.
3. Enable iSCSI service by pressing the Start button, typing iSCSI, and pressing Enter. When prompted, click Yes to start the iSCSI service and have it start automatically.
4. In the iSCSI Initiator Properties window, click the Configuration tab and record the initiator name displayed there.
5. Repeat steps 1 through 5 for the next three iSCSI clients.

CONFIGURING THE SYSTEM UNDER TEST

Initial setup

1. Install Windows Server 2012 R2 Datacenter.
2. Install updates.
3. Reboot the computer.
4. While the computer is booting, press the appropriate shortcut key to enter your RAID BIOS console.

5. In the RAID BIOS console, select the four hard drives to be tested, and disable the RAID controller on those disks.
6. Reboot your computer.

Installing Storage Spaces and iSCSI Target Server on Windows Server 2012 R2

1. Open the Server Manager, and click Manage → Add Roles and Features.
2. On the Before You Begin screen, click Next.
3. Choose Role-based or feature-based installation, and click Next.
4. Choose the local server, and click Next.
5. Expand File and Storage Services → File and iSCSI services, and check File Server, Storage Services, and iSCSI Target Server. Click Next.
6. Leave default features, and click Next.
7. Review the settings, and click Install.

Configuring Storage Spaces

1. In the Server Manager window, click File and Storage Services in the left pane.
2. Click Storage Pools.
3. Right-click the Primordial storage pool, and click New Storage Pool...
4. On the Before You Begin screen, click Next.
5. Enter a name for the new Pool, choose the group of disks, and click Next.
6. Check that all the disks have the correct Media Type (SSD or HDD), and choose all the available disks. Click Next.
7. Review your selections, and click Create.
8. Right-click the storage pool you just created, and click New Virtual Disk...
9. On the Before You Begin screen, click Next.
10. Choose the storage pool, and click Next.
11. Name the virtual disk, check the Create storage tiers on this virtual disk box, and click Next.
12. Choose the Mirror storage layout, and click Next.
13. Select the Two-way mirror resiliency option, and click Next.
14. Choose Fixed provisioning, and click Next.
15. Choose Maximum size for both tiers, and click Next.
16. Review your selections, and click Create.
17. The New Volume Wizard will open when the virtual disk finishes creation, click Next on the Before You Begin screen.
18. Choose the server and virtual disk you created, and click Next.
19. Set the volume size to the maximum capacity, and click Next.
20. Assign a drive letter, and click Next.
21. Set the File system to NTFS, the Allocation unit size to Default, and name the Volume. Click Next.
22. Review your selections, and click Create.

Configuring the iSCSI target server

1. In the Server Manager window, click File and Storage Services in the left pane.
2. Select Tasks → New iSCSI Virtual Disk.
3. In the New iSCSI Virtual Disk Wizard, select your local server and the Storage Spaces disk you created, and click Next.
4. Name the iSCSI virtual disk (we chose server1 for the first disk, server2 for the second disk, and so on), and click Next.
5. Make the iSCSI virtual disk 160 GB, make sure that Fixed size is selected, and click Next.
6. Select New iSCSI target, and click Next.
7. Name your new target (we followed the same scheme as the virtual disk: server1, server2, etc.), and click Next.
8. Click Add to add an iSCSI initiator.
9. Select Enter a value for the selected type, make sure that IQN is selected, and type the appropriate initiator name you recorded when setting up your iSCSI client. Click OK.
10. Click Next.
11. Make sure that CHAP and reverse CHAP is disabled, and click Next.
12. Review your iSCSI disk you created, and click Create.
13. Repeat steps 2 through 12 for the remaining servers.

FINISHING THE ISCSI CLIENT INSTALLATION AND CONFIGURATION

Connecting the iSCSI clients to their iSCSI targets

1. Log in to the first iSCSI client.
2. Open iSCSI Initiator.
3. In the Quick Connect text field, type the IP address of the system under test, and click Quick Connect. A confirmation window of the iSCSI target you created for the client should appear. Click Done.
4. Open the Server Manager, then click File and Storage Services in the left pane.
5. In the left pane, select Disks.
6. In the right pane, right-click the new disk, and select Bring Online.
7. Click Yes to confirm.
8. Right-click the newly online disk, and select New Volume.
9. Click Next to go past the Before you begin window.
10. Select the local server and the new disk, then click Next.
11. Accept the GPT notification by clicking OK.
12. Make sure that the volume size is equal to the available capacity, and click Next.
13. Select your drive letter (the letter does not matter, but make sure it is consistent across all iSCSI clients for ease of use), and click Next.
14. Accept the file system and allocation size, label your volume (we chose HDD for hard drives, and SSD for the solid state drives), and click Next.

15. In the confirmation window, click Next to start the volume creation.
16. In the results window, click Close.

Installing 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 the I accept the license terms box, 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 the use Microsoft Update to check for updates (recommended) box, 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 the radio button for 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 HAMMERDB CLIENTS

1. Install Windows Server 2012 R2 Datacenter.
2. Install updates.
3. Download the most recent HammerDB release from <http://hammerora.sourceforge.net/download.html>.
4. Run the HammerDB installation file, select your language, and click OK.

5. When prompted, click Yes to install HammerDB.
6. At the Welcome window, click Next.
7. Accept the default install location and click Next.
8. Accept the default setup type and click Next to start the installation.
9. Click Finish to complete the installation.
10. Download Microsoft ODBC Driver 11 for SQL Server from <http://www.microsoft.com/en-us/download/details.aspx?id=36434>.
11. Run the installer you downloaded.
12. In the Welcome window, click Next.
13. Accept the terms of the license agreement and click Next.
14. Accept the default installation options, and click Next.
15. Click Install to begin the installation.
16. When the installation completes, click Finish to close the installer.

RUNNING THE TEST

We used HammerDB to create a 5,000-warehouse TPC-C database on SQL Server, and then created a .bak file of the database.

Using that backup file and SQL Server's built-in restore options, we were able to create the databases on each SQL server. We pointed HammerDB clients, hosted on the client system, to each database on the SQL servers, and simultaneously ran the TPC-C job.

We captured various performance metrics on the SUTs during the run, such as CPU and RAM utilization, and drive reads and writes. We started all clients simultaneously, and gathered the results when the run finished. Follow these steps to recreate how we ran the test.

Client 1 pre-test configuration

1. Open HammerDB.
2. Select Options → Benchmark.
3. In the Benchmark Options window, select MSSQL Server, and click OK.
4. In the left pane, expand TPC-C, then Driver Script, and double-click Options.
5. Use the following options for the TPC-C Driver Script:
 - SQL Server: server1 (or your first SQL server hostname)
 - SQL Server Port: 1433 (default)
 - SQL Server ODBC Driver: ODBC Driver 11 for SQL Server
 - Authentication: SQL Server Authentication
 - SQL Server User ID: sa (default)
 - SQL Server User Password: Your password
 - SQL Server Database: tpcc
 - TPC-C Driver Script: Timed Test Driver Script
 - Total Transactions per User: 1000000 (default)

- Exit on SQL Server Error: unchecked (default)
 - Keying and Thinking Time: unchecked (default)
 - Checkpoint when complete: unchecked (default)
 - Minutes of Rampup Time: 2 (default)
 - Minutes for Test Duration: 20
6. Click OK.
 7. In the left pane, double-click Load to load the driver script.
 8. Click Options → Mode.
 9. In the Mode Options window, select Master Mode, and click OK.
 10. Click Yes.
 11. Record the Master mode ID, and click OK.

Additional client pre-test configuration

1. Open another instance of HammerDB.
2. Select Options → Benchmark.
3. In the Benchmark Options window, select MSSQL Server, and click OK.
4. In the left pane, expand TPC-C, then Driver Script, and double-click Options.
5. Use the following options for the TPC-C Driver Script:
 - SQL Server: server2 (or your second SQL server hostname)
 - SQL Server Port: 1433 (default)
 - SQL Server ODBC Driver: ODBC Driver 11 for SQL Server
 - Authentication: SQL Server Authentication
 - SQL Server User ID: sa (default)
 - SQL Server User Password: Your password
 - SQL Server Database: tpcc
 - TPC-C Driver Script: Timed Test Driver Script
 - Total Transactions per User: 1000000 (default)
 - Exit on SQL Server Error: unchecked (default)
 - Keying and Thinking Time: unchecked (default)
 - Checkpoint when complete: unchecked (default)
 - Minutes of Rampup Time: 2 (default)
 - Minutes for Test Duration: 20
6. Click OK.
7. In the left pane, double-click Load to load the driver script.
8. Click Options → Mode.
9. In the Mode Options window, select Slave Mode, enter the Master ID you wrote down previously, and click OK.
10. Repeat steps 1 through 9 for the remaining two servers.

Running the test

1. Return to the master HammerDB instance, expand Virtual User in the left pane, and double-click Options.
2. Increase the number of virtual users to 128, check all checkboxes in the options window, and click OK.
3. Double-click Create.
4. Click the green arrow button to run the virtual users.
5. At the end of the test, gather your results from the four HammerDB instances.

ABOUT PRINCIPLED TECHNOLOGIES



Principled Technologies, Inc.
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