Reduce server sprawl & simplify IT management by upgrading with Intel® SSDs

Replace up to eight servers using hard drives with a new server using Intel® Data Center S3710 Series SSDs

The aging servers in Pam's datacenter still work, but research is leading her to believe it's time to step up to newer technologies. She and her IT team appreciate that an upgrade is a big investment, but they see that by replacing many older servers using hard drives with fewer new ones using solid state drives (SSDs) from Intel, they can regain datacenter space and reduce their management workload—which would free up time to tackle new IT initiatives to improve their business. Plus, customers have occasionally complained that it's difficult to make purchases from the company's website on busy sales days. New hardware should help.

Our work with the latest servers powered by Intel DC S3710 Series SSDs proves that fast storage can enhance your new server purchase. They're faster and more reliable than the hard disk drives your old servers have. This means that teams like Pam's can consolidate servers and applications and save on power, cooling, management, maintenance, and networking costs. The problem is, those teams must prove that the benefits of upgrading to SSDs on new servers outweigh the initial costs.

Pam has gathered the facts that show just how much consolidating with the latest Intel technology could help the business.

80 HDDs

legacy servers with hard disk drives

10 SSDs

consolidating to servers powered by Intel DC S3710 SSDs

improved reliability with SSDs

+

cut power and cooling costs
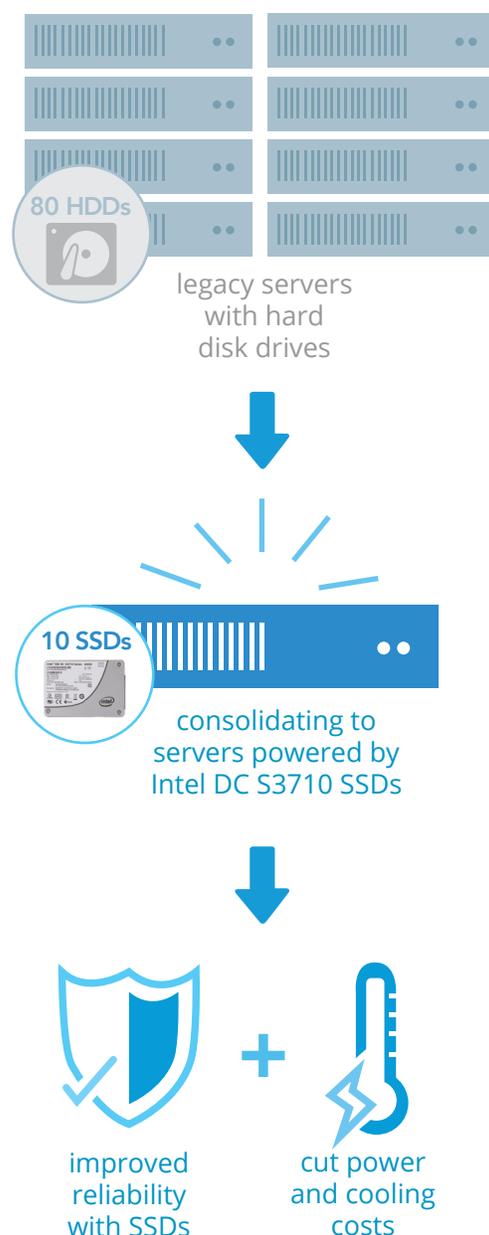
The proof is in the benefits

Pam and her company are a hypothetical example we created, but many IT organizations face exactly those challenges. Her concerns mirror those of an IT administrator at a large enterprise specializing in ecommerce. If you have a similar job, the benefits of the Intel SSD-powered solution that we outline for Pam may also apply to you and your business.

PT tested four bare-metal instances of Microsoft® SQL Server® 2014 on a legacy server with spinning hard disk drives (HDDs) and on a new server powered by Intel DC S3710 Series SSDs. We simulated a typical ecommerce workload that stresses multiple database functions to show what kind of performance a company could expect from the new hardware with SSDs vs. a legacy server with HDDs.

POTENTIAL BENEFITS when upgrading to a new server powered by Intel DC S3710 SSDs and consolidating multiple legacy servers

cut power and cooling costs

save IT time

cut networking costs

keep up with increasing demands

improved reliability with SSDs

more space to grow

New server powered by Intel DC S3710 SSDs
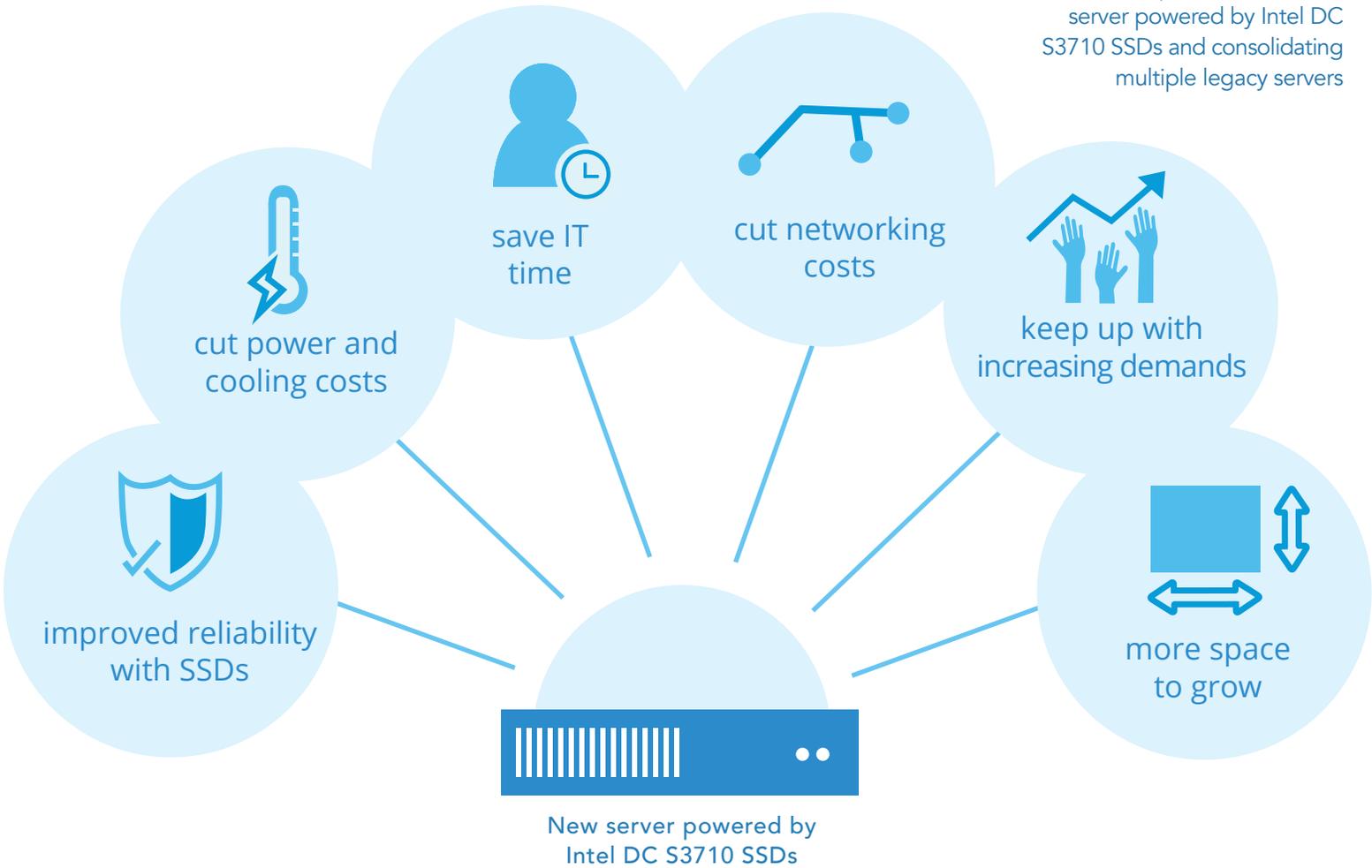
Happy customers, thriving business

Our test results indicate that upgrading to new Intel® Xeon® processor-powered servers with Intel DC S3710 Series SSDs could help ensure Pam's company's website remains responsive while offering the benefits of consolidation, so customers can find what they need and get checked out without delays. Anything that helps guarantee a responsive search or purchase during a customer's shopping experience is worth considering. Plus, SSDs fail far less often than traditional hard disk drives, so her business could stay up-and-running for its customers more consistently.

A new server with Intel DC S3710 SSDs can do

8X

the work
of a legacy server with HDDs
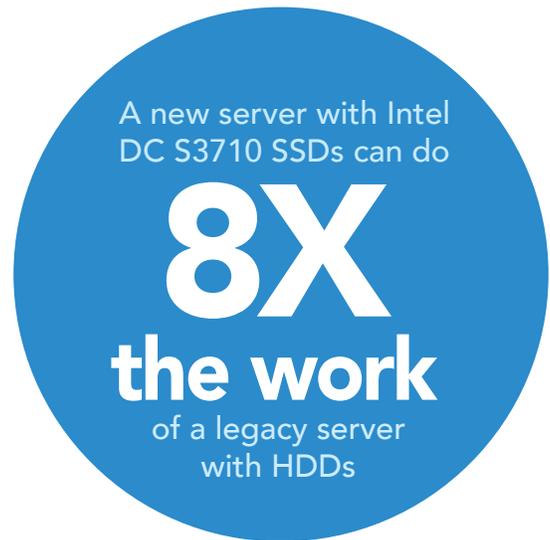
NEW SERVER WITH INTEL DC S3710 SSDS VS. LEGACY SERVER

New   76,196 OPM

Legacy   9,657 OPM

How moving to Intel DC S3710 Series SSDs can improve your databases

Hard disk drives (HDDs) have long held company data, but they have a major drawback: they use moving parts to read and write data. This means they aren't the fastest tech available and they're prone to failure when those moving parts break. Solid state drives (SSDs) read and write data to flash instead. They typically have lower annual failure rates than HDDs, which can help you avoid expensive downtime. SSDs can also use less power, inviting the potential for lower operating costs.

Intel SSD DC S3710 Series drives are available in sizes up to 1.2 TB and deliver faster read/write performance than traditional HDDs because they use flash rather than a mechanical arm. The 400GB drive we used has reported read/write throughput of 550/470 MB/s and random read/write IOPS of up to 85k/43k.[1]

[1] http://www.intel.com/content/www/us/en/solid-state-drives/solid-state-drives-dc-s3710-series.html

Do more with less

Pam's company houses a fairly large datacenter—but whether you have only a few servers in a closet or buildings full of them, that space costs money to rent or purchase, power, and cool. As your business grows, you may find yourself needing more servers, and if you've used up the space you have available to you, you'll be in a bind. By consolidating multiple systems onto a new server with Intel SSDs, you can reduce your hardware footprint and avoid a costly datacenter expansion. Our results show that you can consolidate up to eight existing servers onto a single new server with Intel DC S3710 SSDs, potentially saving big on rent and utilities. The legacy servers at Pam's company could each do only 9,657 orders per minute (OPM), while a single new server with Intel SSDs could handle 76,196 OPM.

10 SSDs

POTENTIAL COST SAVINGS WITH CONSOLIDATION

New servers with fewer Intel DC S3710 SSDs than HDDs

Power

Licensing

Management

Network ports & cables

80 HDDs

Legacy servers with HDDs
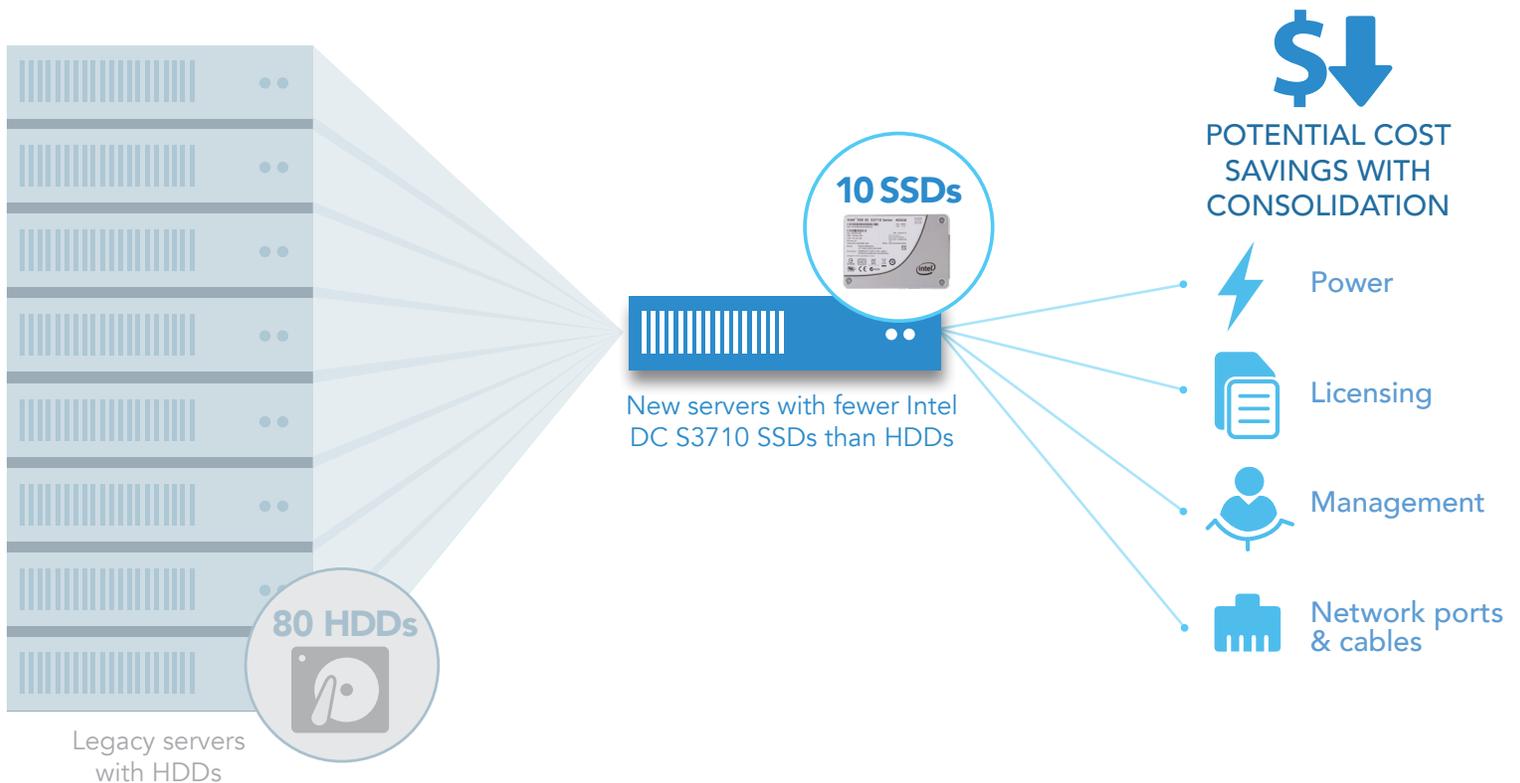
When you refresh with Intel SSDs, management can get easier

Another big perk of consolidating outdated systems and moving to new systems powered by Intel SSDs is how much time it can give back to the IT staff in charge of running your operation. Pam knows how meaningful this extra time will be: Finally, her team will be able to work on projects that will improve the future of her company, instead of constantly performing basic maintenance. Fewer servers means spending less time updating firmware and replacing broken parts as the hardware ages. It also means more time to analyze performance on each server, with the potential to increase efficiency throughout your environment. With servers powered by the Intel DC S3710 SSDs, this can mean up to seven fewer systems to manage. That's a big deal for smaller-scale operations, but it becomes even more impressive as the size of your infrastructure grows. Pam suspects that with her company's large datacenter, her team will be able to save significant management time by consolidating and simplifying their datacenter.

Streamline power and cooling, shrink your electric bills

Because Pam's company has a large datacenter, they spend thousands on power and cooling each month. Every server requires adequate cooling to keep functioning and draws electricity to run. The power bills add up – but so do the potential costs of cooling supplies like installing and running additional air conditioners. As hardware stacks grow, so does the amount of power required to keep them operating at a safe temperature. Additionally, aging servers can be less power efficient when performing the same work as newer servers, contributing further to power and cooling needs. Hard disk drives are always spinning, which means they constantly draw power. SSDs generally draw less power, and Intel SSDs are no different. According to Intel, the Intel DC S3710 Series uses less then 6.9 watts of typical active power.[1] Consolidating to a new server powered by the Intel® Xeon® processor E5-2600 v4 family can not only reduce the physical number of servers, but also takes full advantage of newer, more efficient server technology. That power translates to lost income that your business could use to improve or grow its offerings.

Stop getting tangled up in all those cables

For big datacenters like Pam's, networking can be a nightmare. More servers means more cables and a bigger web of them to maintain and navigate. The last time there was a connectivity issue, it took Pam's team some trial and error before they were able to pinpoint the networking problem. When you have only a few cables, it's easier to identify problems so business doesn't suffer. Fewer cables also means less to manage. Plus, when you have to move servers around, it can mean fewer cables you have to reroute while ensuring proper airflow through your server racks.

And networking in sprawling datacenters doesn't come cheap. By reducing the number of servers and using SSDs, you also reduce the ports and switches that you need to cable them together. Pam thinks she could do a lot of good innovating with those savings to help grow the business even further.

New processor features bring new possibilities

Each upgrade in Intel Xeon processor technology has features that can bring something new to your infrastructure. The latest Intel Xeon processor E5-2600 v4 family is no exception; these processors contain up to 22 cores at that run at 2.2 GHz – a 20 percent increase compared to previous generations.

The Intel Xeon processor E5-2600 v4 family offers features to enhance virtualization, orchestration, and security, including cache monitoring and allocation technologies, memory bandwidth monitoring, and enhanced key security.

To learn more, read the product brief at http://www.intel.com/content/dam/www/public/us/en/documents/product-briefs/xeon-e5-brief.pdf.

[1] http://www.intel.com/content/www/us/en/solid-state-drives/solid-state-drives-dc-s3710-series.html

Reap the benefits of new servers with Intel DC S3710 SSDs

It's time to face the facts: Your aging servers with their outdated hard disk drives could be costing your business important opportunities. Replacing old servers with new servers using Intel DC S3710 Series SSDs can deliver serious benefits. By consolidating up to eight older servers into a single new server, you could save on space, management, and maintenance-related costs; simplify cooling and decrease power bills; and reduce networking costs by reducing the number of switches, ports, and cables required in your datacenter.

Pam offered the proof that it was time to upgrade, and her company snapped to action. The benefits of consolidation are clear. Isn't it time to upgrade?

80 HDDs

10 SSDs

improved reliability with SSDs

more space to grow

keep up with increasing demands

cut power and cooling costs

save IT time

cut networking costs

Eight legacy servers with HDDd

Consolidate onto 1 new server with Intel DC S3710 SSDs

Gain potential benefits beyond the initial investment
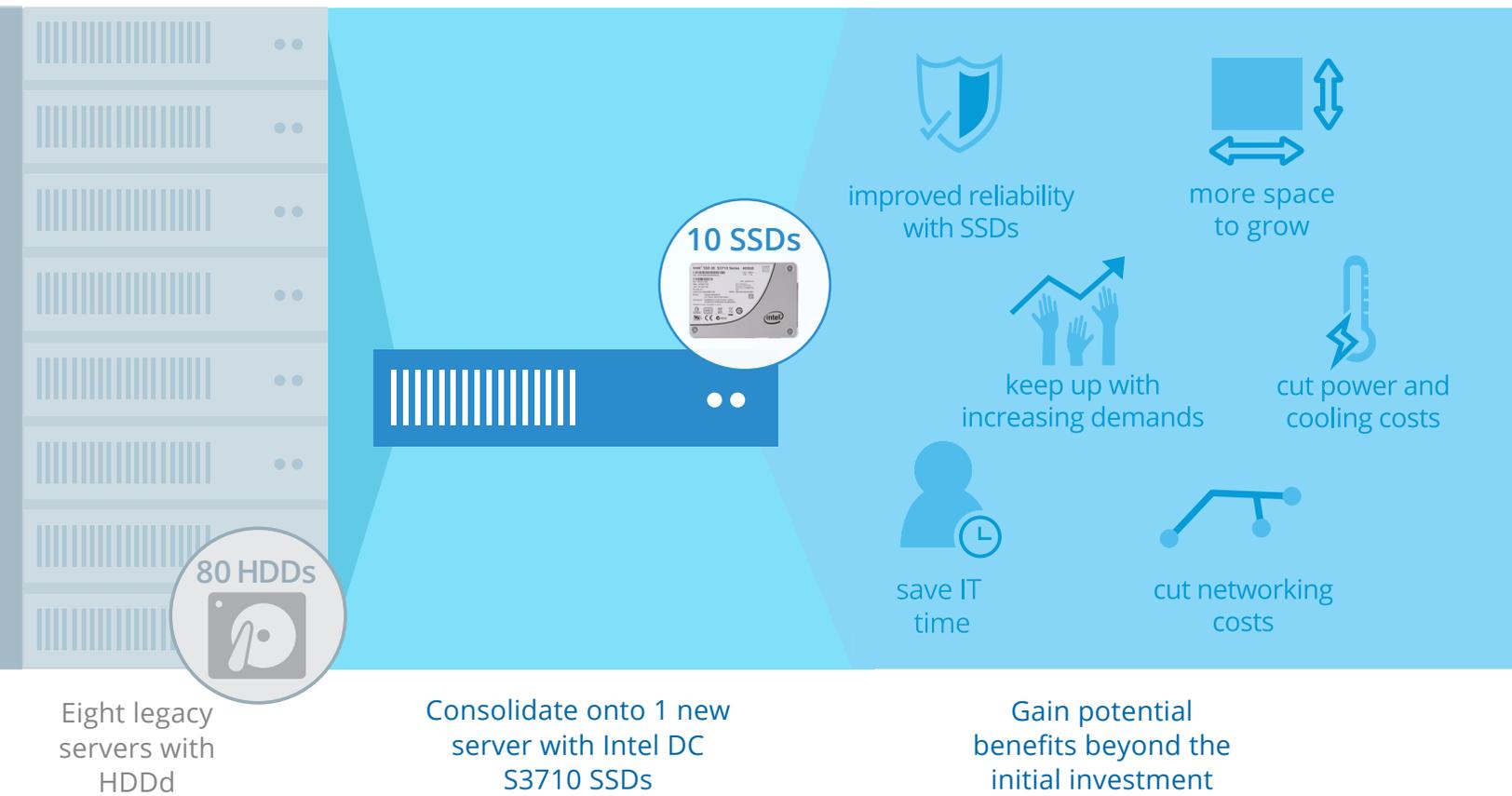
Appendix A – Test systems

Server configuration information	Intel Xeon processor E5-2699 v4 powered server with Intel SSD DC S3710 Series SSDs	Legacy server with HDDs
BIOS name and version	Intel SE5C610.8 6B.01.01.0015.012820160943	Dell™ 2.5.4
Non-default BIOS settings	Virtualization enabled	Virtualization enabled
Operating system name and version/build number	Windows Server 2012 R2 Datacenter	Windows Server 2012 R2 Datacenter
Date of last OS updates/patches applied	04/11/16	04/15/16
Power management policy	Performance	Performance
Processor		
Number of processors	2	2
Vendor and model	Intel Xeon E5-2699 v4	Intel Xeon E5-2680
Core count (per processor)	22	8
Core frequency (GHz)	2.20	2.70
Stepping	1	7
Memory module(s)		
Total memory in system (GB)	256	128
Number of memory modules	8	8
Vendor and model	Micron® 36ASF4G72PZ-2G3A1	Hynix™ HMT42GR7MFR4C-PB
Size (GB)	32	16
Type	PC4-2400	PC3-12800
Speed (MHz)	2,400	1,600
Speed running in the server (MHz)	2,400	1,600
Storage controller		
Vendor and model	LSI™ MegaRAID® SAS 9265-8i	Dell PERC H710P mini
Cache size	1GB	1GB
Firmware version	23.34.0-0005	21.3.2-0005
Driver version	6.710.11.00	6.802.19.00

Server configuration information	Intel Xeon processor E5-2699 v4 powered server with Intel SSD DC S3710 Series SSDs	Legacy server with HDDs
Local storage		
Number of drives	10	10
Drive vendor and model	Intel SSDSC2BA400G4	Seagate® ST9300605SS
Drive size (GB)	400	300
Drive information (speed, interface, type)	6Gb SATA, SSD	10K, 6Gb SAS, HDD
Network adapter		
Vendor and model	Intel I350 Gigabit	Intel Gigabit 4P X540/I350
Number and type of ports	2 x 1GbE	2 x 1GbE
Driver version	12.14.7.0	12.14.7.0
Cooling fans		
Vendor and model	Nidec® UltraFlo® V60E12BS1B5-07A016	AVC DBTC0638B2U
Number and type of ports	6	6
Power supplies		
Vendor and model	Delta DPS-750XB	Dell 0Y1MGX
Number of power supplies	2	1
Wattage of each (W)	750	1,100

Appendix B – How we tested

At Principled Technologies, we pride ourselves on the rigor and relevance of our testing. To that end, we followed scientific testing procedures and tested the two servers using a workload that performs many typical ecommerce operations to reflect the database performance each server could achieve for ecommerce businesses. Because we want you to be able to recreate our results, in this section, we provide all of the steps we followed—our complete testing methodologies.

The data we report represents the median of our three runs. You should be able to achieve similar outcomes yourself by recreating our configurations and using our test procedures. Complete the following steps on both the legacy server and the Intel Xeon processor E5-2600 v4 family-powered server.

On both the legacy and upgraded systems, we configured two drives in a RAID1 volume for the OS and database log files, and the remaining eight drives into a RAID10 volume for the database files. Each system under test had four instances of SQL Server installed, with one 100GB database per instance.

Installing Microsoft Windows Server 2012 R2 Datacenter Edition
1. Insert the installation USB drive into the front USB port, and restart the server.
2. Enter the Boot Manager.
3. Select BIOS Boot Menu.
4. Select the USB drive, and press Enter.
5. When prompted to boot from DVD, press any key.
6. When the installation screen appears, leave language, time/currency format, and input method as default, and click Next.
7. Click Install now.
8. When the installation prompts you, enter the product key.
9. Select Windows Server 2012 Datacenter Edition (Server with a GUI), and click Next.
10. Check I accept the license terms, and click Next.
11. Click Custom: Install Windows only (advanced).
12. Select Drive 0 Unallocated Space, and click Next. This starts Windows automatically, and Windows will restart automatically after completing.
13. When the Settings page appears, fill in the Password and Reenter Password fields with the same password.
14. Log in with the password you set up previously.

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. Under Server pool, select the local server, and click Next. Click Next again.
4. Under Features, select .NET Framework 3.5 Features, and click Next.
5. Click Install.
6. Upon completion, click Close.

Installing SQL Server 2014
1. Mount the installation DVD for SQL Server 2014.
2. Click Run SETUP.EXE. If Autoplay does not begin the installation, navigate to the SQL Server 2014 DVD, and double-click it.
3. In the left pane, click Installation.
4. Click New SQL Server stand-alone installation or add features to an existing installation.
5. Select the Enter the product key radio button, and enter the product key. Click Next.
6. Click the checkbox to accept the license terms, and click Next.
7. Click Use Microsoft Update to check for updates, and click Next.
8. To install the setup support files, click Install.
9. If there are no failures displayed, click Next.
10. At the Setup Role screen, choose SQL Server Feature Installation, and click Next.
11. At the Feature Selection screen, select Database Engine Services, Full-Text and Semantic Extractions for Search, Client Tools Connectivity, Client Tools Backwards Compatibility, Management Tools – Basic, and Management Tools – Complete. Click Next.

12. At the Installation Rules screen, after the check completes, click Next.
13. At the Instance configuration screen, leave the default selection of default instance, and click Next.
14. At the Server Configuration screen, choose NT Service\SQLSERVERAGENT for SQL Server Agent, and choose NT Service\MSSQL$DS3_X for SQL Server Database Engine. Change the Startup Type to Automatic. Click Next.
15. At the Database Engine Configuration screen, select the authentication method you prefer. For our testing purposes, we selected Mixed Mode.
16. Enter and confirm a password for the system administrator account.
17. Click Add Current user. This may take several seconds.
18. Click Next.
19. At the Error and usage reporting screen, click Next.
20. At the Installation Configuration Rules screen, check that there are no failures or relevant warnings, and click Next.
21. At the Ready to Install screen, click Install.
22. After installation completes, click Close.
23. Close the installation window.
24. Open SQL Server 2014 Configuration Manager, and expand Protocols for MSSQL$DS3_X.
25. Right-click Named Pipes, and choose Enabled.
26. Click OK, and restart the SQL service.
27. Repeat steps 4 through 26 three more times for a total of four SQL instances to be installed.

Enabling Lock pages in memory
1. Click Start, type `gpedit.msc`, and press Enter.
2. In the Local Group Policy Editor, expand Computer Configuration→Windows SettingsSecurity Settings→Local Policies.
3. Select User Rights Assignment, and scroll down to Lock pages in memory in the right pane.
4. Right-click Lock pages in memory, and click Properties.
5. Click Add User or Group, and add your SQL user account for each of the four instances (NT SERVICE\MSSQL$DS3_X).
6. Click OK.

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, and restart computer when updates are finished.
7. Repeat steps 1 through 6 until there are no more updates.

Configuring the DVD Store 3 benchmark

Data generation overview

We generated the data using the Install_DVDStore.pl script included with DVD Store version 3 (DS3), providing the parameters for our 100GB database size and the Microsoft SQL Server 2014 platform. We ran the Install_DVDStore.pl script on a utility system running Linux®. The Install_DVDStore.pl script also 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 100GB 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. We created and loaded the database schema 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 DS3 download. We made size modifications specific to our 100GB 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 (T-SQL) script:

```
USE [master]
GO
CREATE LOGIN [ds2user] WITH PASSWORD=N'',
    DEFAULT_DATABASE=[master],
    DEFAULT_LANGUAGE=[us_english],
    CHECK_EXPIRATION=OFF,
    CHECK_POLICY=OFF
GO

EXEC master..sp_addsrvrolemember @loginame = N'ds2user',
    @rolename = N'sysadmin'

USE [DS3]
CREATE USER [ds3DS3user] FOR LOGIN [ds2user]
EXEC sp_addrolemember N'db_owner', N'ds3DS3user'

USE [master]
    CREATE USER [ds3masteruser] FOR LOGIN [ds2user]
EXEC sp_addrolemember N'db_owner', N'ds3masteruser'
```

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.

Logical name	Filegroup	Initial size (MB)
Database files		
primary	PRIMARY	10
cust1	DS_CUST_FG	40,511
cust2	DS_CUST_FG	40,511
ind1	DS_IND_FG	31,274
ind2	DS_IND_FG	31,274
member1	DS_MEMBER_FG	243
member2	DS_MEMBER_FG	242
ds_misc	DS_MISC_FG	200
orders1	DS_ORDERS_FG	20,008
orders2	DS_ORDERS_FG	20,007
review1	DS_REVIEW_FG	15,314
review2	DS_REVIEW_FG	15,313
Log files		
ds_log	Not applicable	38,887

Our initial file size modifications.

Configuring the database workload clients

For our testing, we used four virtual clients for the Microsoft SQL Server clients. We then targeted each virtual client to a separate SQL Instance on the SUT. To create these clients, we installed Windows Server 2008 R2, assigned a static IP address, and installed .NET 3.5.

Running the DVD Store tests

We created a series of batch files, SQL scripts, and shell scripts to automate parts of the test cycle. In order for the legacy system to handle the DVD Store workload, we had to load a portion of each of the four databases into memory before running the test. 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 each database from the target.
3. Restore each 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 and the client system.
7. Let the test server idle for 5 minutes.
8. On the legacy system, start the DVD Store driver on each client, one at a time, until each instance has approximately 30GB committed to memory in resource monitor.
9. Let the legacy system idle for another 5 minutes and then rerun the DVD Store driver on each client, changing the warmup time to zero seconds.
10. On the upgraded system, start the DVD Store driver on each client.

We used the following DVD Store parameters for testing:

```
ds3sqlserverdriver.exe --target=<target_IP> --ramp_rate=10 --run_time=30 --n_threads=32
--db_size=100GB --think_time=0 --detailed_view=Y --warmup_time=15 --out_filename=<drive
path>
```

Appendix C – Detailed test results

To create our real-world ecommerce workload, we used the DVD Store Version 3 benchmarking tool. DS3 models an online DVD store, where customers log in, search for movies, make purchases, create new reviews, rate reviews, and become premium members. DS3 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 DS3 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.

Please note that DS3 OPM results are not directly comparable to results from the previous version of the benchmark, DS2, because several actions the tool performs have changed.

The following tables present the OPM results of three runs for each system, broken down by each database instance. Elsewhere in this paper, we report the median of the three runs.

Intel Xeon processor E5-2600 v4 family with Intel SSDs			
Instance	Run 1	Run 2	Run 3
1	19,083	19,268	19,069
2	19,057	19,121	18,865
3	18,914	19,121	18,865
4	19,142	19,112	19,047
Total	76,196	76,687	76,059
Median	76,196		

Legacy server with HDDs			
Instance	Run 1	Run 2	Run 3
1	2,408	2,230	2,480
2	2,368	2,538	2,650
3	2,592	2,300	1,981
4	2,592	2,843	2,546
Total	9,428	9,911	9,657
Median	9,657		

This project was commissioned by Intel.