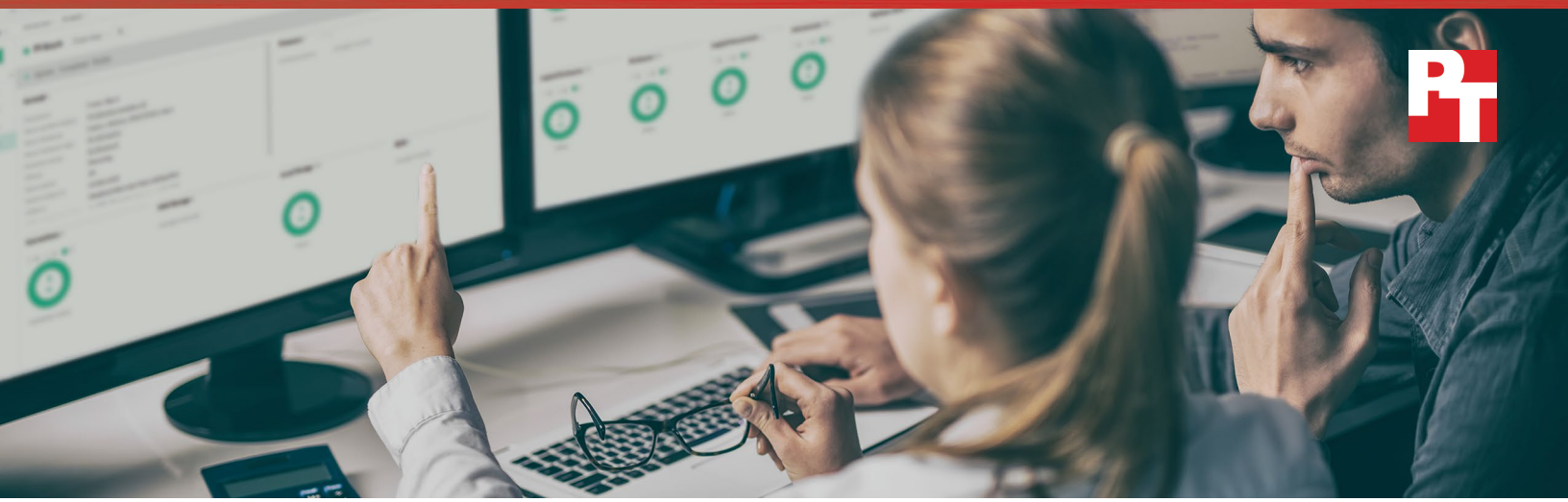


Up to 91% more

OLTP database orders per minute

Secure your sensitive data

By keeping it on premises

Composable architecture

The convenience of IaaS onsite

HPE Synergy delivered stronger database performance than Amazon Web Services while keeping sensitive data on premises

Get flexible, robust resources and retain control of uptime

While public cloud services such as Amazon Web Services™ (AWS) provide flexible access to resources, they aren't appropriate for all situations. Some types of data are subject to stringent privacy regulations that eliminate the public cloud as an option. Public cloud services also have reliability limitations. The fixed level of reliability that AWS promises might be lower than your company requires.

HPE Synergy is a solution that can deliver the performance and control you need for both traditional and cloud-native workloads, and resides in your company's datacenter. Its composable architecture lets companies provision compute, storage, and networking resources via software, providing an experience similar to public cloud services. And, because your data stays in house, Synergy is appropriate for data with strict security requirements. You can also retain greater control over reliability and accessibility than you can with the public cloud.

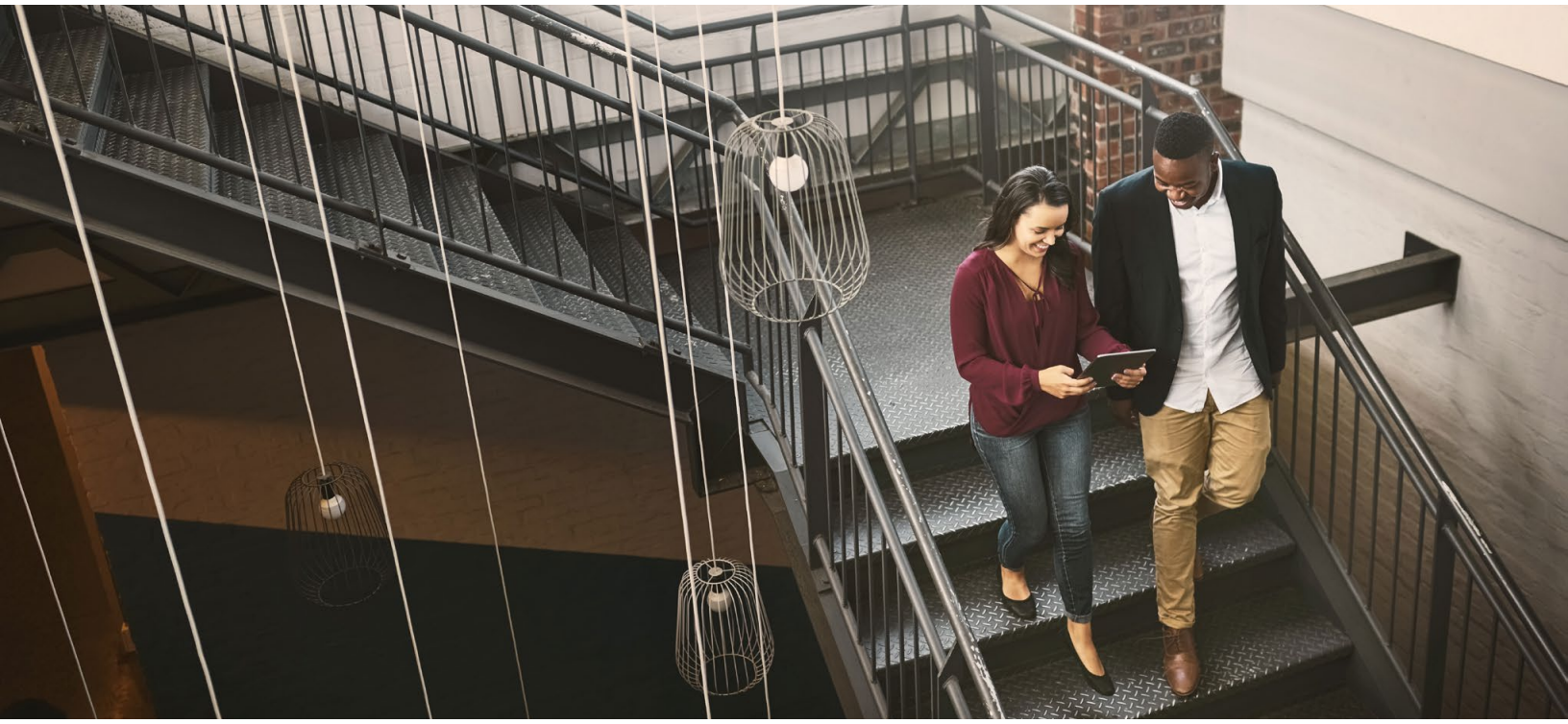
Performance is critical. To evaluate this on-premises solution against a cloud solution, Principled Technologies set up similarly configured virtual machines using HPE Synergy and AWS. While performing a database workload, the Synergy VMs outperformed the AWS VMs by as much as 91.4 percent.

With HPE Synergy, companies can provide the easy provisioning experience they expect and keep the advantages of an on-site solution. When you add strong performance to the mix, the potential business advantages of the HPE Synergy approach become clear and compelling.

HPE Synergy: The ease of infrastructure as a service with the benefits of a private datacenter

In today's information economy, success depends on a company's ability to respond quickly to change. This applies to the datacenter as much as to any other component of a business; the days when a company could afford to spend days or weeks provisioning hardware are long gone. The need to get resources up and running quickly and easily—and shift them quickly and easily to meet changing demands—can motivate employees to seek faster, more effective ways to implement business solutions. This leads many of them to public cloud services.

What if you could get similar speed and agility in house, but add improved performance, security, and features for high availability? Enter HPE Synergy. Its composable infrastructure provides fluid pools of resources that admins control using software instead of having to physically configure hardware. Being able to quickly compose and recompose resources in response to changing needs lets you seize business opportunities in a way that is similar to what public cloud services make possible.



But how well does HPE Synergy perform?

PT set out to compare online transaction processing (OLTP) database workload performance on two platforms: HPE Synergy and Amazon Web Services. As we will show on the following pages, the HPE Synergy VMs we tested could perform as much as 91.4 percent more database work than the AWS VMs. This performance difference translates to being able to support more users, thereby enabling your company to do more work, creating a better user experience, and potentially increasing user productivity.

HPE Synergy vs. AWS—We put them to the test

Strong database performance helps your business in a number of ways—by supporting more simultaneous users, by providing a speedy experience for those users, and by letting your datacenter handle fluctuations in demand. To compare the database performance of HPE Synergy with that of Amazon Web Services in a way that was reasonable and fair, we configured our virtual machines to be as similar as possible. The table on the next page shows the details of the VMs we tested. (We discuss processors in the sidebar on instance types.)

Once we configured our VMs, we measured performance with a tool that runs an OLTP workload and delivers results in terms of orders per minute (OPM). This tool, DVD Store 3, mimics a real-world database workload that may be similar to the workloads you're running at your own organization.

Who uses OLTP databases?

Our testing tool models an OLTP database workload, a type of workload that businesses across a range of industries run every day. Some companies use OLTP databases for specific business tasks, such as distributing payroll, tracking sales, or managing clients. Other businesses, such as those working in ecommerce, retail, or finance, may rely on OLTP databases for their primary business functions. Whatever the scale of their workloads, a great many companies require strong performance from their OLTP databases to succeed.

About DVD Store 3

To create our OLTP workload, we used the DVD Store 3 (DS3) benchmarking tool. DS3 models an online DVD store, where customers log in, search for movies, and make purchases. 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.

DVD Store 3 is based on the previous DVD Store 2. The new features in DVD Store 3 revolve around the addition of customer reviews and premium memberships. Note that due to differences between the two versions, results are not directly comparable.

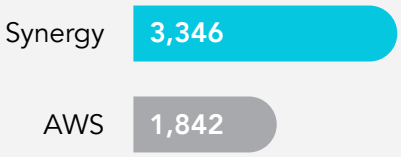
For more details about the DS3 tool, see https://github.com/dvdstore/ds3

VM configurations				
	Processor	**Number of vCPUs**	**RAM (GB)**	**Number of volumes**
AWS	Intel® Xeon® Processor E5-2686 v4	2	15.25	1x Elastic Block Storage (EBS)
Synergy	Intel Xeon Processor E5-2680 v4	2	15.25	1x 2-disk RAID 1
AWS	Intel Xeon Processor E5-2686 v4	4	30.5	1x EBS
Synergy	Intel Xeon Processor E5-2680v4	4	30.5	1x 2-disk RAID 1

Our first set of tests used instances with two vCPUs. As we show below, the HPE Synergy solution achieved 3,346 orders per minute, 81.7 percent more than the AWS OPM count of 1,842.

81.7% more OPM *with two vCPUs*

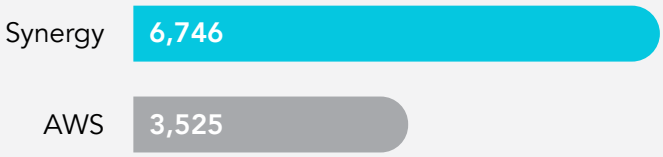
Performance in orders per minute (Two vCPUs)



When we increased our instances to four vCPUs, OPM of the two solutions roughly doubled. As we show below, the HPE Synergy solution achieved nearly twice as many OPM as AWS did, 91.4 percent more.

91.4% more OPM *with four vCPUs*

Performance in orders per minute (Four vCPUs)



About Amazon EC2 instance types

Amazon Elastic Compute Cloud (Amazon EC2) is the cloud computing component of AWS. The HPE Synergy installation we tested used Intel Xeon Processors E5-2680 v4. EC2 offers compute-optimized instances and memory-optimized instances. To most closely match the Synergy node CPUs, we chose one of the EC2 instances that use the Intel Xeon Processor E5 v4 Family. Somewhat counter-intuitively, only the memory-optimized instances use these more powerful processors. This is consistent with EC2 recommendations to use memory-optimized instances for high-performance databases.[1]

Beyond performance

Security

Maybe your industry handles categories of data that are subject to privacy regulations that prohibit you from storing information with a third party or transmitting it over networks that could be vulnerable to attack. Or maybe you want assurance that the personal information of your employees and customers won't be subject to a costly, embarrassing data breach. Many companies feel safer keeping sensitive data on premises.[2] HPE Synergy gives these companies a way to reap infrastructure-as-a-service benefits without going beyond their private datacenter.

How many nines?

A popular way to express the availability of a system is by citing the percentage of time the system is operational in a given year, often using a number of "nines" as shorthand. For example, 90 percent uptime is one nine and 99 percent uptime is two nines. The more nines your system promises, the less downtime you should experience—and more businesses are seeking more nines, according to a 2017 survey by Information Technology Intelligence Consulting (ITIC). Of the businesses responding to the ITIC survey, 79 percent required a minimum of four nines of uptime for most mission-critical workloads, while an additional 17 percent see five nines as the minimum.[3]

Reliability and uptime

Say you have an ecommerce site that's ticking along with orders coming in at the usual rate—until suddenly, everything stops. Your site is down. Customers who were in the middle of making purchases can't complete them, and new arrivals to your site see nothing except an error screen. How long will the outage last? How many potential customers will go elsewhere? How much money will you lose?

This nightmare can become reality for companies that rely on public cloud services; any number of events, from hardware failure to human error, can force your businesses to a halt with no warning at all. That halt can be incredibly costly. According to a 2017 ITIC survey, 81 percent of businesses estimate the average hourly cost of outages at more than $300K, with that number growing for companies in "top tier and highly regulated verticals" such as healthcare, manufacturing, and banking.[4] Another study, released in 2016 by the Ponemon Institute, estimates that an unplanned datacenter outage costs an average of $8,851 per minute for an hourly cost of well over $500K.[5]

For this reason, businesses must pay close attention to the reliability of their datacenter solutions. Public cloud services typically offer service level agreements that guarantee a certain amount of uptime, typically expressed in terms of nines (see sidebar). AWS service-level agreements promise to deliver three-and-a-half nines, or 99.95 percent uptime.[6] While that doesn't sound too bad, it translates to 4.38 hours of downtime annually, or 5.04 minutes weekly. When you imagine the potential business damage that could result from your website vanishing without warning, 5 minutes a week can feel ominous.

Of course, three nines of availability may be appropriate for some of your less sensitive applications and deliverables, making the public cloud a viable option for parts of your business. However, for mission-critical business applications and workloads—those that impact your revenue, decisions, and business continuity—four or five nines offer higher levels of safety and reliability.

With an in-house system such as HPE Synergy, you retain greater control of reliability. You can set your nines to the level that is right for your business and your budget, thus maintaining a reliable infrastructure-as-a-service (IaaS) architecture.

Part of your company's overall cloud strategy

Private cloud software, such as VMware vSphere and OpenStack, and traditional applications can both run on HPE Synergy within a single architecture and management frame, while some of your applications might be appropriate for a public cloud. You can give each of your workloads the correct resources and appropriate levels of compliance, security, and access.

How does HPE Synergy work?

With the HPE Synergy Composer, powered by HPE OneView, IT staff can deploy, monitor, update, and manage infrastructure through its life cycle from a single interface using a template process. They use the HPE Synergy Image Streamer to create these templates, or Golden Images. They can bring server nodes up and down easily and get the convenience of holistic updates with tracking, deviation-from-standard flagging, and rollbacks.

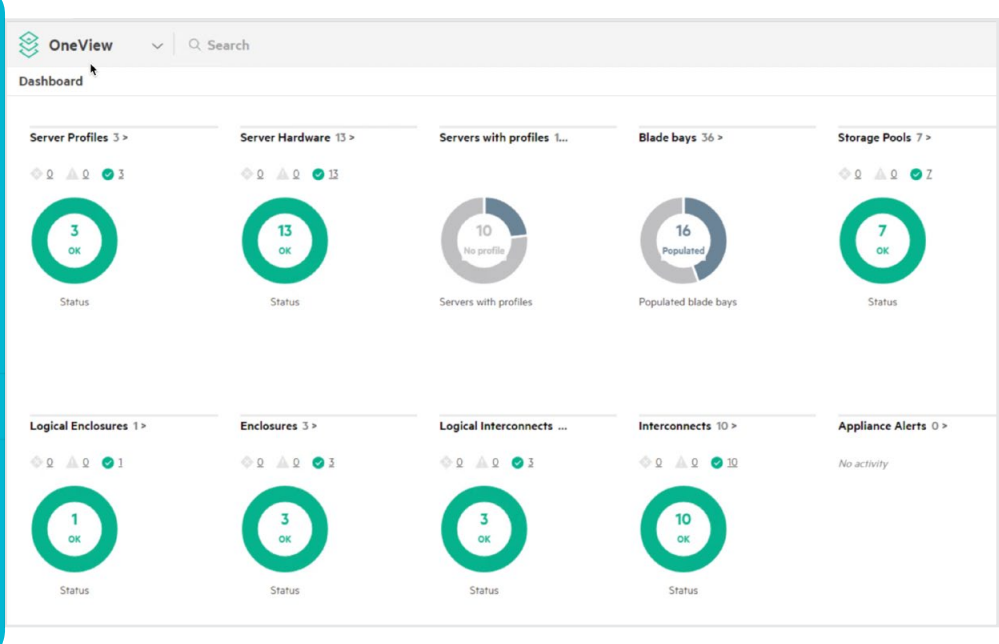


Figure 1: HPE OneView dashboard

In conclusion

A strong infrastructure-as-a-service solution has the potential to provide a number of benefits for your business, including:

- Flexibility, so your employees can implement compute resources where and when they need them with ease
- Agility, so your business can respond to opportunities quickly and easily with automated workload and application deployment
- Performance, so you can continue growing while still delivering great service to your customers and employees

Implementing HPE Synergy in your on-site datacenter could deliver the provisioning of IaaS without as many of the security and availability concerns as using a public cloud service can introduce. In our database tests, it also delivered better database performance.

Principled Technologies testing demonstrated that HPE Synergy virtual machines outperformed similarly configured Amazon Web Services VMs by as much as 91.4 percent when executing OLTP database workloads.

By using HPE Synergy to run their workloads, companies that need to keep sensitive data on premises and those that want to maintain control of reliability levels can enjoy the provisioning capabilities of IaaS along with excellent performance.

To learn more about HPE Synergy, go to https://www.hpe.com/us/en/integrated-systems/synergy.html. To read about a Principled Technologies study that shows how HPE Synergy simplified and streamlined server management tasks compared to Cisco UCS®, see the report "Deploy and manage servers more efficiently with HPE Synergy" at http://facts.pt/JvTFrq.

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1 "Amazon EC2 Instance Types," accessed July 27, 2017, https://aws.amazon.com/ec2/instance-types/

2 "Cloud vs. on-premises: Finding the right balance," accessed July 27, 2017, http://www.computerworld.com/article/3192897/cloud-computing/cloud-vs-on-premises-finding-the-right-balance.html

3 "ITIC 2017 Hourly Cost of Downtime and Minimum Reliability Requirements Survey," Laura DiDio, accessed September 17, 2017, https://www.knowbe4.com/hubfs/ITIC%20KnoBe4%202017%20Hourly%20Cost%20of%20Downtime%20and%20Reliability%20Requirements%20Survey%206.2017.pdf?t=1498078426497

4 See endnote 3.

5 "Cost of Data Center Outages," Ponemon Institute, accessed September 17, 2017, https://planetaklimata.com.ua/instr/Liebert_Hiross/Cost_of_Data_Center_Outages_2016_Eng.pdf

6 "Amazon EC2 FAQs", accessed September 17, 2017, https://aws.amazon.com/ec2/faqs/

On May 5, 2017, we finalized the hardware and software configurations we tested. Updates for current and recently released hardware and software appear often, so unavoidably these configurations may not represent the latest versions available when this report appears. For older systems, we chose configurations representative of typical purchases of those systems. We concluded hands-on testing on July 20, 2017.

Note: Principled Technologies performed our testing of HPE Synergy on an installation in the HPE datacenter in Houston, TX. PT technical staff traveled to Houston, where they verified the Synergy hardware and software and provided validation services for the test bed. They performed testing by remotely accessing the Synergy installation from the PT datacenter in Durham, NC.

Appendix A: System configuration information

Server configuration information	
Server model	HPE Synergy 480 Gen9
Number of servers	1
BIOS name and version	I37 v2.20 (09/14/2016)
Non-default BIOS settings	N/A
Operating system name and version	VMware® ESXi® 6.0.0
Date of last OS updates/patches applied	06-14-17
Power management policy	Default
Processor	
Number of processors	2
Vendor and model	Intel Xeon E5-2680 v4
Core count (per processor)	14
Core frequency (GHz)	2.40
Stepping	M0
Memory module(s)	
Total memory in system (GB)	256
Number of memory modules	8
Vendor and model	HPE SmartMemory 809083-091
Size (GB)	32
Type	DDR4
Speed (MHz)	2,400
Speed running in the server (MHz)	2,400

Server configuration information	
Storage controller	
Vendor and model	HPE Smart Array P542D/2GB
Firmware version	4.52
Cluster storage	
Number of drives	16
Drive vendor and model	HP 480GB 6G SATA MU-2 SFF SC SSD
Drive size (GB)	480
Drive information (speed, interface, type)	SSD
Network adapter	
Vendor and model	HPE Synergy 3820C 10/20Gb CNA
Number and type of ports	2
Cooling fans	
Number of cooling fans	10
Power supplies	
Vendor and model	HPE Synergy 12000F
Number of power supplies	6
Wattage of each (W)	2650

Appendix B: How we tested

Setting up the virtual infrastructure

We ran DVD Store version 3 on an HPE Synergy platform with an HPE Synergy 480 Gen9 server, and a HPE Synergy D3940 Storage Module with HP 480GB SSDs. We used VMWare ESXi to create the HPE Synergy virtual machine. To compare to equivalent AWS instances, we used two configurations with the following specifications:

- vCPU count set to 2 (4 for the 2nd configuration)
- Virtual Memory set to 15.25 GB (30.5 GB for the 2nd configuration)
- Primary Drive size set to 1 TB

In addition, we ran DVD Store version 3 on two AWS EC2 instances (r4.large and r4.xlarge) both configured to run Microsoft® Windows Server® 2016 and Microsoft® SQL Server® 2016. We used SQL Server 2016 Enterprise Edition on the HPE VMs and the r4.xlarge AWS instance. The r4.large AWS instance only came with SQL Server 2016 Standard Edition.

Creating the first HPE VM in ESXi

1. In VMware vCenter®, navigate to Virtual Machines.
2. To create a new VM, click the icon.
3. Leave Create a new virtual machine selected, and click Next.
4. Enter a name for the virtual machine, and click Next.
5. Place the VM on the desired host with available CPUs, and click Next.
6. Select the appropriate datastore to host the VM, and click Next.
7. In the Customize Hardware section, use the above settings.
8. Click Next.
9. Click Finish.

Installing Microsoft Windows Server 2016 Datacenter Edition on the HPE VM

1. Boot the VM to the installation media.
2. When prompted, press any key to boot from DVD.
3. When the installation screen appears, leave language, time/currency format, and input method as default, and click Next.
4. Click Install now.
5. When the installation prompts you, enter the product key.
6. Check I accept the license terms, and click Next.
7. Click Custom: Install Windows only (advanced).
8. Select Windows Server 2016 Datacenter Edition (Desktop Experience), and click Next.
9. Select Drive 0 Unallocated Space, and click Next.
   Windows installation will begin automatically, and restart on completion.
10. When the Settings page appears, use the appropriate credentials to fill in the Password and Reenter Password fields.
11. Use the previous password to log in.

Installing VMware Tools™ on the HPE VM

1. To mount the appropriate image to the VM's virtual CD-ROM drive, right-click the VM in vCenter, and click Install VMware Tools.
2. Ensure the VM is powered on, and log in as an administrator.
3. To start the installation wizard, navigate to the virtual CD-ROM drive in the VM, and double-click setup.exe.
4. Follow the wizard, and select the Typical installation option.
5. When the VMware Tools installation completes, restart the VM.

Installing SQL Server 2016 on the HPE VM

1. Mount the installation DVD for SQL Server 2016.
2. Click Run SETUP.EXE. (If Autoplay does not begin the installation, navigate to the SQL Server 2016 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 Enter the product key radio, and enter the product key. Click Next.
6. To accept the license terms, click the appropriate checkbox, 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. Click Next.
12. Wait for the check to complete, and at the Installation Rules screen, 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\MSSQLSERVER for SQL Server Database Engine. Change the Startup Type to Automatic. Click Next.
15. At the Database Engine Configuration screen, select the appropriate authentication method. (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, ensure 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.

Creating an AWS EC2 instance

1. Log into the AWS console.
2. From the top drop-down menu, click Services.
3. Mouse-over Compute, and select EC2.
4. At the EC2 Dashboard, at the sidebar, click Instances.
5. At the Instances page, at the top, click Launch Instance.
6. On Step 1, scroll down to Microsoft Windows Server 2016 with SQL Server 2016 Enterprise, and click Select.
7. On Step 2, check the box next to the desired instance, and click Next: Configure Instance Details.
8. On Step 3, keep all default settings, and click Next: Add Storage.
9. On Step 4, change the size of the storage to 1000 GB, and click Review and Launch.
10. On Step 7, click Launch.
11. At the dialog box, at the first drop-down menu, select Create a new key pair.
12. Under Key pair name, enter a name, and click Download Key Pair.
13. Click Launch Instances.
14. At the Launch Status page, at the bottom of the page, click View Instances.
15. At the Instances page, wait for the instance to start.
16. Once the Instance State changes to running, select the newly created instance, and click Connect.
17. On the dialog box, click Download Remote Desktop File, and click Get Password.
18. In the next dialog box, click Choose File, browse to the downloaded .pem file, and click Open.
19. Click Decrypt Password, record the provided password, and click Close.
20. Using Remote Desktop Connection, open the downloaded .rdp file, and accept the security warning.
21. Enter the provided password in the Windows Security window, check the Remember me box, and click OK.
22. If prompted with a security certificate warning, click Yes.
23. Once the desktop loads, click Start, and open SQL Server Management Studio.
24. Using the password identical to the Windows credential, log in.
25. In the navigation tree, right-click the server name, and click Properties.
26. Change Authentication to Mixed Mode, and click OK.

Configuring the database (DVD Store)

Generating the data

We generated the data using the Install.pl script included with DVD Store version 3 (DS3), providing the parameters for our 100GB database size and the database platform we used. To generate the database schema, we ran the Install.pl script on a utility system running Linux®.

After processing the data generation, we transferred the data files and schema creation files to a Windows-based system running SQL Server 2016. We built the 100GB database in SQL Server, and performed a full backup, storing the backup file remotely for quick access. We used the backup file to restore the database when necessary.

The only modifications 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. Other than this file size modification, we created and loaded the database in accordance with the DVD Store documentation. Specifically, we followed these steps:

1. Generate the data, and create the database and file structure using database creation scripts in the DS3 download. Make size modifications specific to our 100GB database, and make the appropriate changes to drive letters.
2. Transfer the files from our Linux data generation system to a Windows system running SQL Server.
3. Create database tables, stored procedures, and objects using the provided DVD Store scripts.
4. Set the database recovery model to bulk-logged to prevent excess logging.
5. Load the data we generated into the database. For data loading, use the import wizard in SQL Server Management Studio. Where necessary, retain options from the original scripts, such as Enable Identity Insert.
6. Create indices, full-text catalogs, primary keys, and foreign keys using the database-creation scripts.
7. Update statistics on each table according to database-creation scripts, which sample 18 percent of the table data.
8. On the SQL Server instance, create 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. Set the database recovery model back to full.
10. Create the necessary full text index using SQL Server Management Studio.
11. Create a database user, and map this user to the SQL Server login.
12. Perform a full backup of the database. This backup allows you to restore the databases to a pristine state.

The table below shows our initial file size modifications.

Logical name	Filegroup	Initial size (MB)
Database files		
primary	PRIMARY	10
ds_misc	DS_MISC	392
cust1	DS_CUST	40,511
cust2	DS_CUST	40,511
orders1	DS_ORDERS	40,016
orders2	DS_ORDERS	40,016
ind1	DS_INDEX	31,274
ind2	DS_INDEX	31,274
member1	DS_MEMBER	243
member2	DS_MEMBER	243
review1	DS_REVIEW	15,313
review2	DS_REVIEW	15,313
Log files		
ds_log	Not applicable	77,773

Running the DVD Store tests

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 provide 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 and the client system.
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:

```
ds3sqlserverdriver.exe --target=<target_IP> --ramp_rate=10 --run_time=60 --n_threads=32 --db_
size=100GB --think_time=0 --detailed_view=Y --warmup_time=5 --report_rate=1 –out_filename=<drive path>
```

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