



## Update datacenter technology to consolidate and save on virtualization

### Powerful new HPE Synergy 480 Gen10 Compute Modules can do several times the work of HPE ProLiant BL460c Server Blades

Powerful new infrastructure platforms often feature capabilities designed to meet challenges organizations currently face while older servers typically do not. Transitioning from older HPE BladeSystems to a new software-defined HPE Synergy solution featuring HPE Synergy 480 Gen10 Compute Modules offers an opportunity for your organization to gain modern capabilities, consolidate the work of older servers, and save on OpEx.

In the Principled Technologies datacenter, we gauged online transaction processing performance for Microsoft® SQL Server® on four HPE solutions. A single HPE Synergy 480 Gen10 did 4.38 times the work of an HPE BladeSystem ProLiant BL460c G6 blade, 2.94 times the work of a BL460c G7 blade, and 1.72 times the work of a BL460c Gen8 blade. Based on our ratios, organizations transitioning to a new 480 Gen10-based solution can spend less on annual VMware® vSphere® support costs and have more funds to devote to other datacenter initiatives.

Which older HPE ProLiant BL460c models does your organization use? This report shows how upgrades to today's tech improve performance capabilities while saving money in key areas.

Transition to HPE Synergy 480 Gen10 and **save up to**  
**\$590K**  
on virtualization software support for 100 servers **every year**

## Missed opportunities with extended life cycles

If legacy servers in your datacenter are adequately supporting workloads, it may seem financially prudent to extend their life cycles. These older servers, however, can use more datacenter resources than newer servers do and can rack up significant OpEx in support fees for virtualization software year after year. In addition, the longer your organization keeps legacy servers around, the greater the potential risk for failure that can create additional expenses.

Transitioning from older blade servers to a new HPE Synergy solution can introduce savings in a range of areas, such as dramatically reduced software support costs. The savings could help your organization's bottom line, and the new servers could potentially offset their acquisition CapEx with enough savings in addition to delivering the operational and performance benefits of software-defined infrastructure.

## Support more database workloads

To quantify the licensing savings that can come from refreshing older servers, PT conducted hands-on testing with a new dual-processor HPE Synergy 480 Gen10 Compute Module and with three previous-generation dual-processor HPE ProLiant BL460c models—the G6, G7, and Gen8. We configured each of the servers and compute modules in our study—in terms of amount and types of RAM and other specifications—in a way typical of the time a company would have purchased it. For details on each server and compute module, see [Appendix A](#).

We first determined how many older BladeSystem (BL) servers each new HPE Synergy 480 Gen10 would realistically be able to replace. To accomplish this, we performed the same test procedure on all four solutions:

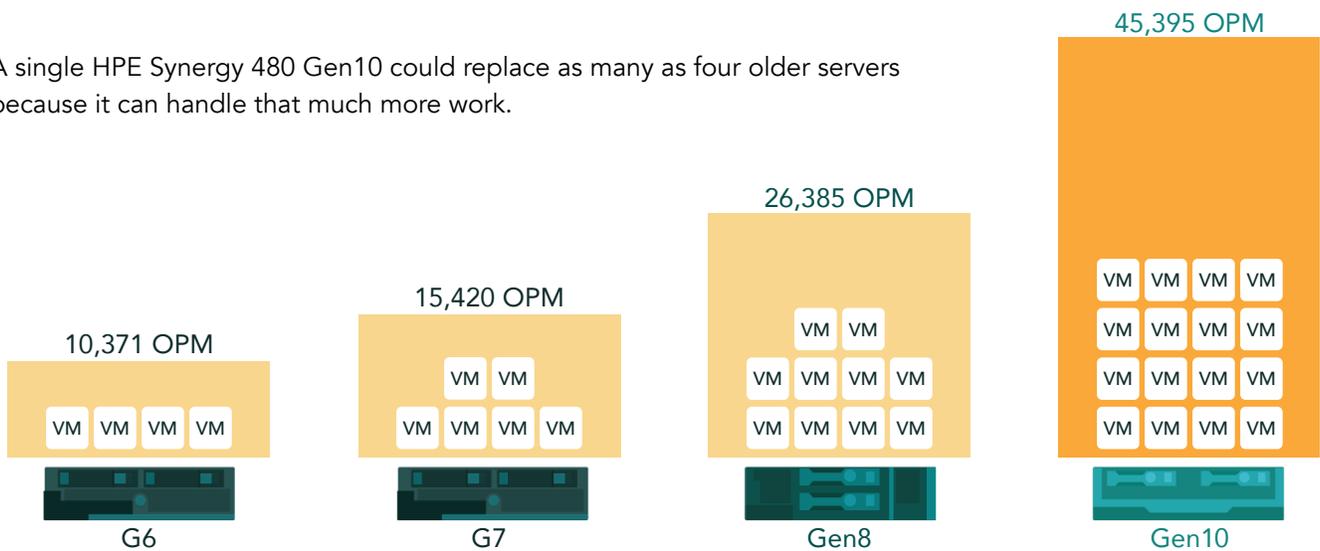
- First, we used VMware vSphere to create virtual machines running Microsoft Windows Server® 2016 and SQL Server 2016. We used vSphere 6.5 on the BL460c Gen8 servers and HPE Synergy 480 Gen10 compute modules. We used vSphere 6.0 on the BL460c G7 server because HPE does not officially support 6.5 for that model and used vSphere 5.5 on the BL460c G6 server because HPE does not officially support 6.0 or 6.5 on that model. Note: VMware will stop supporting vSphere 5.5 in 2018.<sup>1</sup>
- Next, we ran an OLTP database benchmark that measures performance in terms of how many orders per minute (OPM) the solutions processed.
- Finally, we added SQL Server VMs until the processor utilization exceeded 80 percent, the point at which organizations typically add compute resources.

Each VM within each solution accomplished roughly the same amount of database work (measured in OPM). The HPE Synergy 480 Gen10 supported 16 SQL Server 2016 VMs, which did 4.38 times as much work as the BL460c G6 and 2.94 and 1.72 times as much work as the BL460c G7 and BL460c Gen8 servers, respectively.



To isolate server performance and eliminate any potential storage bottlenecks, all four servers used the powerful HPE 3PAR StoreServ 8450 all-flash storage array. Response times within each SQL Server VM were less than 1ms across all servers, indicating that the storage handled our workloads with room to spare.

A single HPE Synergy 480 Gen10 could replace as many as four older servers because it can handle that much more work.



## Introduce composability into your datacenter with HPE Synergy

HPE Synergy is a software-defined, composable infrastructure solution that allows today's organizations to provision resources quickly and as needed while potentially improving operational efficiency for IT. Composable infrastructure:

- Helps organizations deliver compute, storage, and networking resources as services to app developers and others by pooling resources from hardware
- Allows app developers to set an app's resource requirements, which the solution meets when admins compose infrastructure from resource pools via a single interface
- Meets organizational, workload, or app changes by allocating resources on demand

HPE Synergy can address traditional applications and the emerging idea economy applications for current IT environments. It can handle your private cloud and traditional applications within a single architecture and management frame, while you put other applications in a public cloud. In addition, you can give each of your workloads the resources and the levels of compliance, security, and access that you choose.

## How does HPE Synergy work?

HPE Synergy consists of hardware frames containing various components with a uniform infrastructure, enabling modular management of hardware. IT staff control these components with a single management interface and Unified API, which defines, allocates, and attaches available resources from within the pool of available assets. Managing resources from a single "pane of glass" can reduce operational complexity for traditional workloads and increase operational efficiency for new applications and services.

IT administrators can use HPE Synergy composable infrastructure to provision storage from both HPE 3PAR and HPE Synergy Direct Attached Storage (DAS), define and stretch networks across multiple enclosures, and

deploy compute modules from anywhere within the pool defined by the management domain.

Tight integration with HPE OneView enables an HPE Synergy solution to deliver software-defined datacenter (SDDC) capabilities by leveraging HPE Synergy Composer and HPE Synergy Image Streamer. Your IT staff can use the HPE Synergy Image Streamer to create golden images and the HPE Synergy Composer to maintain resource pool inventory and availability. Together, these tools let staff deploy and redeploy datacenter assets easily and get the convenience of holistic updates with tracking, including deviation-from-standard flagging and rollback capability.

For more information on HPE Synergy, click [here](#).

## Reduce spending on vSphere licenses and yearly support

We estimated the virtualization software savings from this upgrade to HPE Synergy 480 Gen10 based on how many older servers a single HPE Synergy 480 Gen10 Compute Module could replace when performing an equivalent workload.

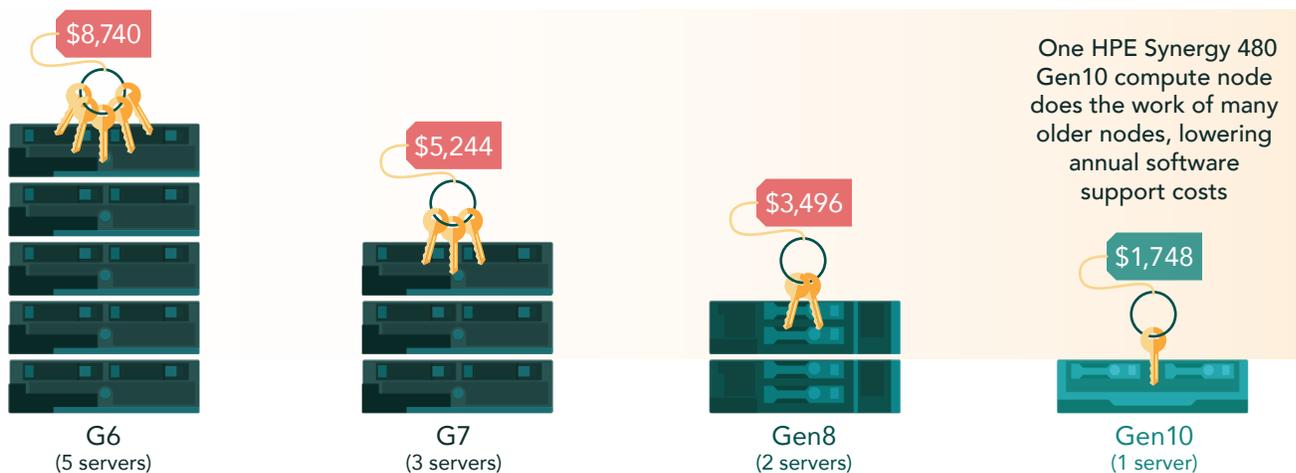
For a single dual-processor server, the upfront cost to purchase the necessary VMware vSphere Enterprise Plus licenses, including the first year of production-level support, is \$8,738.<sup>2</sup> For subsequent years, the cost of annual support is \$1,748.<sup>3</sup> These costs do not vary by server or compute node. The annual license and support cost are the same for vSphere 5.5, 6.0, and 6.5. The savings come from reducing the number of compute nodes you need to run your applications. For your organization, software license and support pricing and potential savings may vary depending on final pricing and contract terms.

If your organization runs database workloads in vSphere VMs on many older servers, you've already bought licenses for each of them. When you consolidate these database workloads onto a much smaller number of high-performing HPE Synergy 480 Gen10 Compute Modules, you can reuse some of your existing licenses. You do not have to buy new licenses and, because you only pay support for the licenses that are in use, your annual costs decrease dramatically.

Let's say you have 44 BL460c G6 nodes running database applications. Each vSphere license covers one CPU, so a dual-processor node or module would need two licenses. By transitioning the workloads to 10 HPE Synergy 480 Gen10 compute modules, you can take 20 of your vSphere 5.5 licenses and upgrade them to 6.5 at no charge. This would cut your annual support costs by 77 percent and leave you the remaining 68 vSphere licenses for future expansion. You could quadruple your original workload before you would need to spend \$8,738 to license another dual-processor server and cover the first year of support. For our example, we assumed the organization has a Support and Subscription (SnS) contract for each software license and that there's no charge to transfer licenses from old to new servers. While under contract, the organization would get new version upgrades free of charge. License and SnS costs for vSphere versions 5.5, 6.0, and 6.5 are the same.

We based the figure below on the consolidation ratios from our analysis: 4.38 to 1 for the BL460c G6, 2.94 to 1 for the BL460c G7, and 1.72 to 1 for the BL460c Gen8. As VMware does not allow for partial licensing of a server, we rounded the BL460c G6 to five servers, the BL460c G7 to three servers, and the BL460c Gen8 to two servers.

As shown, annual production-level support for five BL460c Gen8 servers to perform the database workload of a single HPE Synergy 480 Gen10 would set you back \$8,740. That's five times the \$1,748 you would spend for support with the Gen10 compute module. These expenditures occur yearly, so extending the life cycles of older modules running your database workloads may have higher costs than you realize.



## Reduce datacenter sprawl while saving licensing costs

Enterprise datacenters typically use dozens if not hundreds of servers. Let's consider the following examples that show the benefits of transitioning to the HPE Synergy 480 Gen10-based solution on a greater scale. The figures show the number of servers and associated annual support requirements a company could replace with 10 and then 100 HPE Synergy 480 Gen10 Compute Modules. The extrapolation shows how the savings can quickly add up as you add compute modules—the more the merrier.



## Conclusion

Extending a server's life cycle sounds financially conservative, but it overlooks the benefits of transitioning to a new composable infrastructure platform. A datacenter running legacy HPE blade servers could do more work after transitioning, which can decrease licensing and support OpEx.

A company replacing many HPE ProLiant BL460c G6 servers with new HPE Synergy 480 Gen10 Compute Modules could see a consolidation ratio of five to one. This would let them transfer one-fifth of the VMware vSphere licenses they've already purchased to the new servers while keeping the remaining licenses for future growth. They could quintuple their workload before having to license additional servers at \$8,738, which includes one year of support.

In addition, yearly support costs for vSphere would shrink to one-fifth of what they have been paying. For every five HPE BL460c G6 server blades the company consolidates onto one HPE Synergy Gen10, the reduction in annual support costs would equal \$6,992. This is on top of potential savings on reduced power usage and IT management. A company replacing HPE ProLiant BL460c G7 or Gen8 servers would enjoy the same savings to a lesser degree.<sup>4</sup> Although this study focused on a virtualized database environment and hypervisor licensing, bare-metal applications that use per-socket or per-CPU licensing schemes could potentially benefit from similar consolidation approaches as well.

Purchasing new solutions may seem challenging, but spending less each year on software support, in addition to other OpEx from server consolidation, can greatly offset your investment. Take a look at how much your organization spends on virtualization software support for your older servers—you might realize that you can't afford not to upgrade.



Transition to HPE Synergy  
480 Gen10 and  
**save up to**

**\$590K** on virtualization  
software support  
for 100 servers<sup>5</sup>  
**every year**

- 1 "VMware Lifecycle Product Matrix", September 14, 2017, <https://www.vmware.com/content/dam/digitalmarketing/vmware/en/pdf/support/product-lifecycle-matrix.pdf>.
- 2 "vSphere and vSphere with Operations Management"; September 1, 2017; [http://store.vmware.com/store/vmware/en\\_US/pd/productID.284281000?src=WWW\\_eBIZ\\_productpage\\_vSphere\\_EnterprisePlus\\_Buy\\_US](http://store.vmware.com/store/vmware/en_US/pd/productID.284281000?src=WWW_eBIZ_productpage_vSphere_EnterprisePlus_Buy_US), <http://www.vmware.com/products/vsphere.html>; vSphere Enterprise Plus (1 year Production Support and Subscription) (per processor) license plus one year of production-level support.
- 3 Ibid.
- 4 Smaller companies using VMware vSphere Standard edition can also save; we provide those numbers in [Appendix C](#).
- 5 Based on \$6,992 annual support costs for four BL460c G6 servers vs. \$1,748 annual support costs for one HPE Synergy 460 Gen10 Compute Module.

On November 3, 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 November 3, 2017.

## Appendix A: System configuration information

### Servers and compute modules

Server/compute modules configuration information	HP ProLiant BL460c G6	HP ProLiant BL460c G7	HP ProLiant BL460c Gen8	HPE Synergy 480 Gen10 Compute Module
General				
Number of processor packages	2	2	2	2
Number of cores per processor	4	6	10	16
Number of hardware threads per core	2	2	2	2
System power management policy	Default	Default	Default	Default
CPU				
Vendor	Intel®	Intel	Intel	Intel
Name	Xeon®	Xeon	Xeon	Xeon
Model number	X5570	X5670	E5-2680 v2	Gold 6130
Socket type	FCLGA1366	FCLGA1366	FCLGA2011	FCLGA3647
Core frequency (GHz)	2.93	2.93	2.80	2.10
Bus frequency (GT/s)	6.4	6.4	8.0	10.4
L1 cache	32 KB + 32 KB (per core)	32 KB + 32 KB (per core)	32 KB + 32 KB (per core)	32 KB + 32 KB (per core)
L2 cache	256 KB	256 KB	256 KB	16 MB
L3 cache	8 MB	12 MB	25 MB	22 MB
Platform				
Vendor and model number	HP ProLiant BL460c G6	HP ProLiant BL460c G7	HP ProLiant BL460c Gen8	HPE Synergy 480 Gen10
Motherboard model number	507864-B21	603718-B21	641016-B21	854354-001
BIOS version	I24	I27	I31	I31
Mezzanine card 1	QLogic® QMH2462	QLogic QMH2462	HP FlexFabric 554M	Smart Array P416ie-M SR Gen10
Mezzanine card 2	NA	NA	NA	HPE Synergy 3830C 16G FC HBA
Mezzanine card 3	NA	NA	NA	HPE Synergy 3820C 10/20Gb CNA
Integrated LOM	HP Flex-10 Embedded Ethernet	FlexFabric Embedded Ethernet	HP Flex-10 530FLB	QLogic 57840

Server/compute modules configuration information	HP ProLiant BL460c G6	HP ProLiant BL460c G7	HP ProLiant BL460c Gen8	HPE Synergy 480 Gen10 Compute Module
Memory module(s)				
Total RAM in system (GB)	96	96	128	512
Vendor and model number	Samsung® M393B1K70DH0-YH9Q9	Samsung M393B1GH73BH0-YH9	Hynix® HMT42GR7MFR4C-PB	Samsung M393A4K0BB2-CTD7Q
Type	PC3L-10600R	PC3L-10600R	PC3-12800R	PC4-21300R
Speed (MHz)	1,333	1,333	1,600	2,666
Speed running in the system (MHz)	1,333	1,333	1,600	2,666
Size (GB)	8	8	16	32G
Number of RAM module(s)	12	12	8	16
Chip organization	Double-sided	Double-sided	Double-sided	Double-sided
Rank	Dual	Dual	Dual	Dual
Firmware				
Integrated Lights-Out firmware version	2.12	1.50	1.20	2.55

## Virtual machines

Virtual machine configuration information	HP ProLiant BL460c G6	HP ProLiant BL460c G7	HP ProLiant BL460c Gen8	HPE Synergy 480 Gen10 Compute Module
VMware vSphere version	5.5.0, 5230635	6.0.0, 5572656	6.5.0, 5969303	6.5.0, 5969303
vCPU count	4	4	4	4
Memory (GB)	10	10	10	10
Virtual disk (GB)	50 (OS), 30 (DB), 20 (LOG)			
Virtual disk controller	LSI Logic SAS	LSI Logic SAS	LSI Logic SAS	LSI Logic SAS
Virtual NIC	VMXNET 3	VMXNET 3	VMXNET 3	VMXNET 3
OS	Windows Server 2016	Windows Server 2016	Windows Server 2016	Windows Server 2016

## Storage

Storage	HPE 3PAR StoreServ 8450
Storage controllers	
Vendor and model number	HPE 3PAR OS 3.3.1.215
Number of controllers	2
Number of shelves	2

Storage	HPE 3PAR StoreServ 8450
Network ports	12 x 16Gb Fibre Channel
RAID configuration	RAID 5 (3+1)
Drive vendor and model number	48 x HPE DOPE1920S5xnNMRI
Drive size (GB)	1,920
Drive information (speed, interface, type)	SAS SSD

## Enclosures

System	HP BladeSystem c7000	HPE Synergy 12000
Chassis firmware		
Primary Firmware version	1.7	2.01.01
Hardware Version	412152-B21	797740-B21
First I/O module		
Model	HP VC Flex-10 Enet Module	HPE Synergy 12Gb SAS Connection Module
Occupied bay(s)	1 and 2	1
Second I/O module		
Model	HP VC FlexFabric 10Gb/24-Port Module	Virtual Connect SE 16Gb FC Module for HPE Synergy
Occupied bay(s)	3 and 4	2
Third I/O module		
Model	HP 4Gb Fibre Channel Pass-thru Module	Virtual Connect SE 40Gb F8 Module for HPE Synergy
Occupied bay(s)	5 and 6	3
Fourth I/O module		
Model	NA	HPE Synergy 12Gb SAS Connection Module
Occupied bay(s)	NA	4
Fifth I/O module		
Model	NA	Virtual Connect SE 16Gb FC Module for HPE Synergy
Occupied bay(s)	NA	5
Sixth I/O module		
Model	NA	HPE Synergy 20Gb Interconnect Link Module
Occupied bay(s)	NA	6

## Appendix B: How we tested

### Installing VMware vSphere onto the servers and compute modules

We installed the VMware vSphere 5.5, 6.0, and 6.5 hypervisors onto the servers' and compute modules' local hard drives, which we placed in a RAID1 pair. (We installed VMware vSphere 5.5 on the BL460c G6 compute modules, 6.0 on the BL460c G7 compute modules, and 6.5 on the BL460c Gen8 and HPE Synergy 480 Gen10 compute modules.)

1. Connect an external optical drive to the front of the server using the HP KVM dongle.
2. Insert the VMware vSphere 6.0 installation media into the optical drive.
3. Boot the server to the VMware vSphere installer.
4. Press F11 to begin the installation wizard.
5. Select the RAID1 pair as the installation location.
6. Select US English as the keyboard type and language.
7. Enter the root password for the host.
8. Press Enter to start the installation.
9. When the installation completes, press Enter to reboot the host.
10. After the host reboots, set the management network IP address.
11. Add the host to vCenter, and enable SSH and ESXi shell.

### Configuring the networking

We used a Brocade M6505 top-of-rack switch to handle Fibre Channel traffic between the servers/compute modules and the HPE 3Par Storage. For the BL460c G6 and BL460c G7 compute modules, we used the 4Gb Fibre Channel Pass-thru module to directly connect each mezzanine card to the top-of-rack switch. For the BL460c Gen8 and HPE Synergy 480 Gen10 compute modules, we created Ethernet Networks on the FlexFabric 10Gb/24-port modules and assigned Fibre Channel Server Profiles to the servers or compute modules.

### Configuring the storage

We first created a Common Provisioning Group large enough to hold 32 workload virtual machines. We created a total of 16 LUNS (Virtual Volumes) on the HPE 3Par all-flash storage to maximize storage concurrency. We sized eight of the LUNs to hold the OS and SQL data VMDKs for four VMs. We sized the remaining eight LUNs to hold the SQL log VMDKs for four VMs. We then exported each Virtual Volume to the four solutions' FC HBAs.

### Creating the workload virtual machines

We created varying numbers of workload virtual machines for our testing depending on the generation under test. We used 4 VMs for the BL460c G6 server, 6 VMs for the BL460c G7 server, 10 VMs for the BL460c Gen8 server, and 16 VMs for the HPE Synergy 480 Gen10 compute module. Each VM had 4 vCPUs and 10 GB of memory, and a connection to our testing network. We installed Windows Server 2016 and SQL Server 2016 onto each VM. When cloning the VMs, we placed four VMs onto each HPE 3Par Virtual Volume to maximize storage concurrency.

#### Creating the base VM

1. In VMware vCenter, navigate to Virtual Machines.
2. Click the Create a new VM 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 a host with available CPUs, and click Next.
6. Select the first HPE 3Par data-sized Virtual Volume for the 50GB OS VMDK, and click Next.
7. Click Next.
8. Select the guest OS as Windows Server 2016, and click Next.
9. In the Customize Hardware section, make the following changes:
  - Increase the vCPUs to 4.
  - Increase the VM memory to 10,240 MB.
  - Add a 30GB VMDK for SQL data, and select the VMware Paravirtual controller and Thick Provisioned Eager Zeroed.
  - Add a 20GB VMDK for SQL logs, and select the VMware Paravirtual controller and Thick Provisioned Eager Zeroed. Place the VMDK in the first HPE 3Par log-sized datastore
10. Connect the VM to the test network.
11. Click Next.
12. Click Finish.

## Installing Windows Server 2016 guest OS onto the VMs

1. Attach the Windows Server 2016 ISO to the virtual machine.
2. Open the VM console, and start the VM.
3. When prompted to boot from DVD, press any key.
4. When the installation screen appears, 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 2016 Datacenter Edition (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. This starts Windows automatically, and Windows will restart automatically after completing.
11. When the Settings page appears, the same password in the Password and Reenter Password fields.
12. Log in with the password you set up in the previous step.

## Installing .NET Framework 3.5

1. In the VM, open Server Manager.
2. Click Manage→Add Roles and Features.
3. Select Role-based or feature-based installation, and click Next.
4. Under Server pool, select the local server, and click Next. Click Next again.
5. Under Features, select .NET Framework 3.5 Features, and click Next.
6. Click Install.
7. Upon completion, click Close.

## Installing SQL Server 2016

1. Attach the installation media ISO for SQL Server 2016 to the VM.
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. Click the checkbox to accept the license terms, and click Next.
6. Click Use Microsoft Update to check for updates, and click Next.
7. To install the setup support files, click Install.
8. If no failures are displayed, click Next.
9. At the Setup Role screen, choose SQL Server Feature Installation, and click Next.
10. 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.
11. Click Next.
12. At the Instance configuration screen, leave the default selection of default instance, and click Next.
13. At the Database Engine Configuration screen, select the authentication method you prefer. For our testing purposes, we selected Mixed Mode.
14. Enter and confirm a password for the system administrator account.
15. Click Add Current user. This may take several seconds.
16. Click Next.
17. At the Error and usage reporting screen, click Next.
18. At the Installation Configuration Rules screen, check that there are no failures or relevant warnings, and click Next.
19. At the Ready to Install screen, click Install.
20. Close the installation window.

## Enabling Lock pages in memory

1. In the VM, click Start, type `gpedit.msc` and press Enter.
2. In the Local Group Policy Editor, expand Computer Configuration→Windows Settings→Security 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.
6. Click OK.
7. Repeat steps 1 through 6 for the legacy base VM.

## Configuring the DVD Store 3 benchmark

### Generating the data

We generated the data using the Install.pl script included with DVD Store version 3 (DS3), providing the parameters for our 10GB database size and the Microsoft SQL Server 2016 platform. We ran the Install.pl script on a utility system running Linux®. The Install.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 2016. We built the 10GB database in SQL Server 2016, 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 modifications we made to the database schema-creation scripts were in the file sizes we specified for our database. We explicitly set the file sizes larger than necessary to ensure that no file-growth activity would affect the outputs of the test. Besides this file size modification, the database schema was created and loaded according to the DVD Store documentation. Specifically, we followed the steps below:

1. We generated the data and created the database and file structure using database schema-creation scripts in the DS2 download. We made size modifications specific to our 10GB database and changed the drive letters as appropriate.
2. We transferred the files from our Linux data generation system to a Windows system running SQL Server 2016.
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
```

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 performed a full backup of the database. This backup allowed us to restore the databases to a pristine state relatively quickly between tests.

The following tables shows our initial file size modifications.

Logical name	Filegroup	Initial size (MB)
Database files		
Primary	PRIMARY	4
cust1	DS_CUST_FG	3,106
cust2	DS_CUST_FG	3,106
ind1	DS_IND_FG	3,107
ind2	DS_IND_FG	3,107
ds_misc	DS_MISC_FG	200
orders1	DS_ORDERS	1,503
orders2	DS_ORDERS	1,504
Log files		
ds_log	Not applicable	147

## 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.

## 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 throughout the test. We report the last OPM reported by each client/target pair.

Each complete test cycle consisted of the following 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:

```
ds2sqlserverdriver.exe --target=<target_IP> --ramp_rate=10 --run_time=15 --n_threads=8 --db_size=10GB  
--think_time=100 --detailed_view=Y --warmup_time=15 --report_rate=1 --csv_output=<drive path>
```

## Appendix C – VMware vSphere Standard pricing

Most companies with large numbers of servers will likely use the Enterprise Plus edition of VMware vSphere to take advantage of features exclusive to Enterprise Plus such as vDS and Storage DRS. However, some smaller companies who do not need the additional features might elect to use the Standard Edition. The table below, which uses the consolidation ratios in the body of this report along with Standard edition pricing, shows the savings such companies could expect.<sup>1</sup>

	HP ProLiant BL460c G6	HP ProLiant BL460c G7	HP ProLiant BL460c Gen8	HPE Synergy 480 Gen10 Compute Module
<b>Number of servers and annual software support costs to perform workloads equivalent to 1 HPE Synergy 460 Gen10 Compute Module</b>				
Number of servers/compute modules	5	3	2	1
Annual software support costs	\$8,740.00	\$5,244.00	\$3,496.00	\$1,748.00
<b>Number of servers and annual software support costs to perform workloads equivalent to 10 HPE Synergy 460 Gen10 Compute Module</b>				
Number of servers/compute modules	44	30	18	10
Annual software support costs	\$76,912.00	\$52,440.00	\$31,464.00	\$17,480.00
<b>Number of servers and annual software support costs to perform workloads equivalent to 100 HPE Synergy 460 Gen10 Compute Module</b>				
Number of servers/compute modules	438	295	173	100
Annual software support costs	\$765,624.00	\$515,660.00	\$302,404.00	\$174,800.00

Each 2-socket server costs \$1,748 annually for vSphere support based on VMware vSphere Enterprise Plus 1 Year Support & Subscription cost of \$874 per CPU

1 “vSphere and vSphere with Operations Management”; September 1, 2017; vSphere Standard (1 year Production Support and Subscription) (per processor) license plus one year of production-level support; <http://www.vmware.com/products/vsphere.html>; [http://store.vmware.com/store/vmware/en\\_US/cat/categoryID.65651900?](http://store.vmware.com/store/vmware/en_US/cat/categoryID.65651900?)

This project was commissioned by HPE.



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