Consolidate and save on virtualization costs

Upgrade to HPE ProLiant BL460c Gen9 servers and reduce your software licensing footprint

When your company is determining whether your IT budget can accommodate new servers, consolidation becomes extremely important. Every server you can eliminate without sacrificing performance can decrease your ongoing expenses for space, power, cooling, and IT management. Fewer servers also require fewer VMware® vSphere® licenses to pay support costs for year after year.

Principled Technologies performed Microsoft® SQL Server® 2016 database testing on the new HPE ProLiant BL460c Gen9 server blade and on three older server blades. Our results suggest that a single HPE BL460c Gen9 could perform the work of 4 HP BL460c G6 servers, 2.67 HP BL460c G7 servers, and 1.60 HP BL460c Gen8 servers.

A company replacing older servers can reuse existing vSphere licenses and pay much less for annual support. For example, every four HP BL460c G6 server blades you replace with a single Gen9 can save $5,244 on vSphere support annually, a number that grows quickly when you have hundreds of servers. You can also reuse the licenses from one of your older servers, thus avoiding an expenditure of $8,738.

These savings, along with the other potential OpEx savings that consolidation brings, can go a long way to offsetting the capital investment in the new HPE ProLiant BL460c Gen9 servers.

Upgrade to HPE ProLiant BL460c Gen9 servers and **save up to**

75%

on virtualization software support **every year**

Older servers can be expensive even after they're paid for

Many enterprise datacenters are filled with HP servers that are several years old. These servers do a fine job of running applications in virtual machines and you've already paid for them. It's tempting to keep them in service. However, older servers can use many more datacenter resources than newer servers do. They can also rack up significant operational expenditures year after year in support fees for virtualization software.

Replacing these older servers with new HPE servers using more powerful processors delivers savings in a range of areas, including dramatically reduced software support costs.

Consolidation ratios are key

To quantify the licensing savings that can come from refreshing older servers, PT conducted hands-on testing with a new dual-processor HPE ProLiant BL460c Gen9 and with three previous-generation dual-processor HP ProLiant BL460c models—the G6, G7, and Gen8.[1] Our first order of business was to determine how many older servers each new Gen9 would realistically be able to replace.

To accomplish this, we performed the same test procedure on all four servers. First, we used VMware vSphere to create virtual machines running Microsoft Windows Server 2012 R2 and SQL Server 2016. (We used vSphere 6.0 on the G7, Gen8, and Gen9. Because HPE does not officially support 6.0 on the G6, we used vSphere 5.5 on that server.) Next, we ran an OLTP database benchmark that measures performance in terms of orders per minute (OPM). We continued to add SQL Server VMs until the processor utilization exceeded 80 percent, the point at which companies typically add compute resources.

In the chart below, each rectangle represents a virtual machine. As it shows, in our testing, the Gen9 supported 16 SQL Server 2016 VMs, 4 times as many as the G6 supported and 2.67 and 1.60 times as many as the G7 and Gen8 servers supported, respectively. Because each VM accomplished roughly the same amount of database work (measured in OPM), a single HPE ProLiant BL460c Gen9 could replace as many as four older servers.

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.

44,093 OPM

26,288 OPM

15,287 OPM

10,163 OPM

G6

G7

Gen8
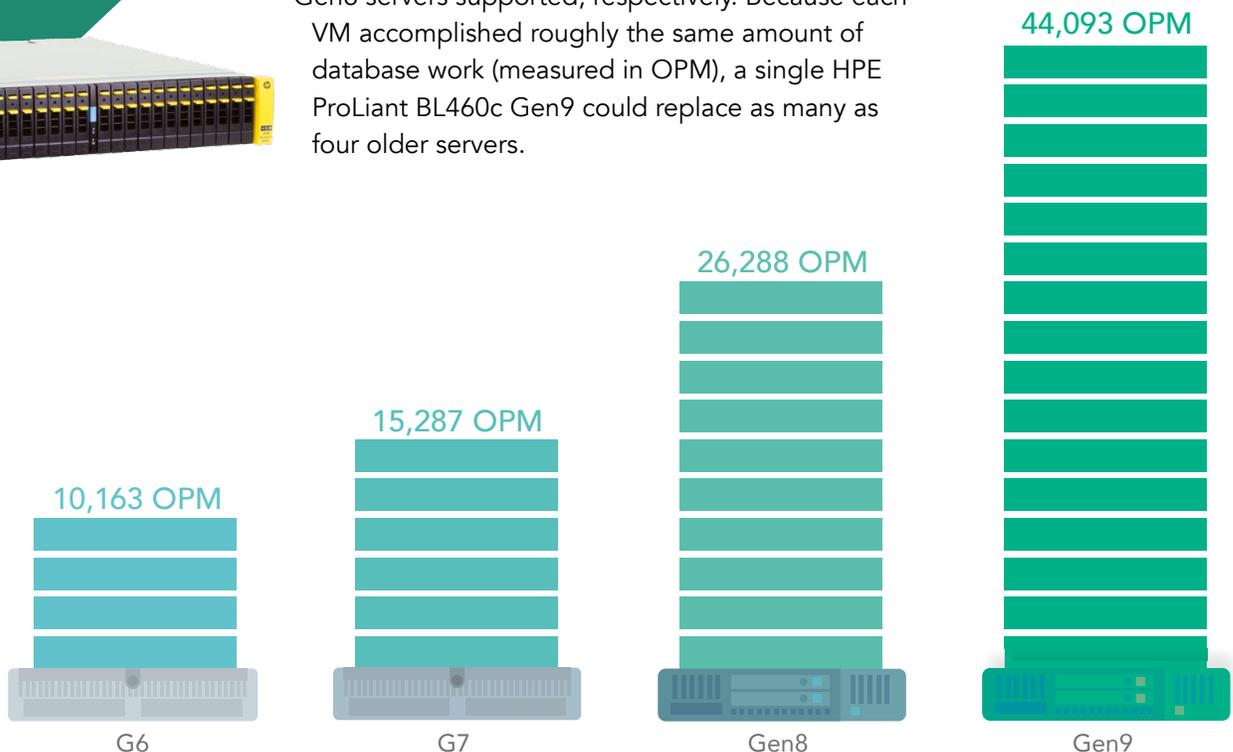
Gen9

How much can you save on virtualization software support?

Once we know how many older servers a single HPE ProLiant BL460c Gen9 could replace by performing an equivalent workload, we can estimate the virtualization software savings this refresh would provide.

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.[2] For subsequent years, the cost of annual support is $1,748.[3] These costs are identical whether the server is an older G6 model that runs 4 VMs or a new Gen9 that runs 16 VMs and accomplishes 4 times the work. (Annual license and support costs are the same for vSphere 5.5 and 6.0.)

If your company is running your database workloads in vSphere virtual machines on many older servers, you've already bought licenses for each of them. When you consolidate your workload onto a much smaller number of HPE ProLiant BL460c Gen9 servers, you can reuse a subset of your existing licenses. You buy no new licenses and, because you pay support for only the licenses that are in use, your annual costs decrease dramatically.

Say, for example, that you have 48 HP ProLiant BL460c G6 servers running database applications. If you shift these workloads to 12 Gen9 servers, you can take 24 of your vSphere 5.5 licenses and upgrade them to 6.0 at no charge.[4] You would cut your annual support costs by 75 percent and retain the remaining 72 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.

We base the figure below on the consolidation ratios we found in our testing: 4 to 1 for the G6, 2.67 to 1 for the G7, and 1.60 to 1 for the Gen8. Because VMware does not allow for licensing part of a server, we round the G7 to three servers and the Gen8 to two servers.

As shown, annual production-level support for enough older servers to perform the database workload of a single HPE ProLiant BL460c Gen9 would set you back almost $7,000. That's four times the $1,748 you would spend for support with the Gen9. And these expenditures repeat year after year after year. Hanging onto those older servers is looking less and less like a cost-saving strategy.

The HPE ProLiant BL460c Gen9 can use the same HPE BladeSystem c7000 enclosure as all three previous-generation BL460c server blades. This provides additional potential savings for companies who refresh their older servers.

One Gen 9 server does the work of many older servers, lowering annual software support costs.

$6,992

$5,244

$3,496

$1,748

| G6 | G7 | Gen8 | Gen9 |
| (4 servers) | (3 servers) | (2 servers) | (1 server) |
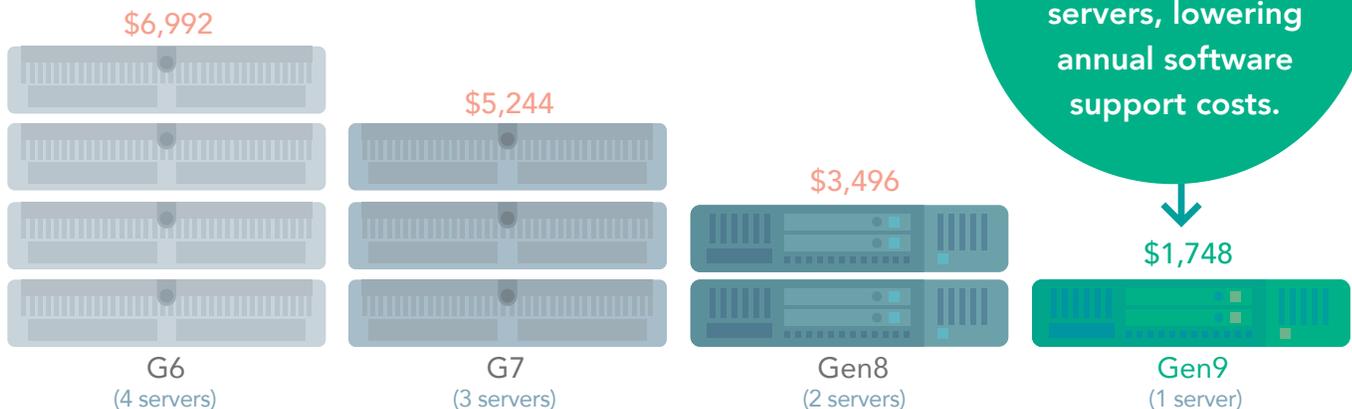
Scaling up

Enterprise datacenters typically use dozens if not hundreds of servers. Let's consider examples that illustrate the software support benefits of consolidation on a greater scale. The figures below show the number of servers and associated annual support requirements a company could replace with first 10 and then 100 HPE ProLiant BL460c Gen9 servers. Clearly, the potential for savings is enormous.

Annual software support costs to perform workloads equivalent to 10 Gen9 servers
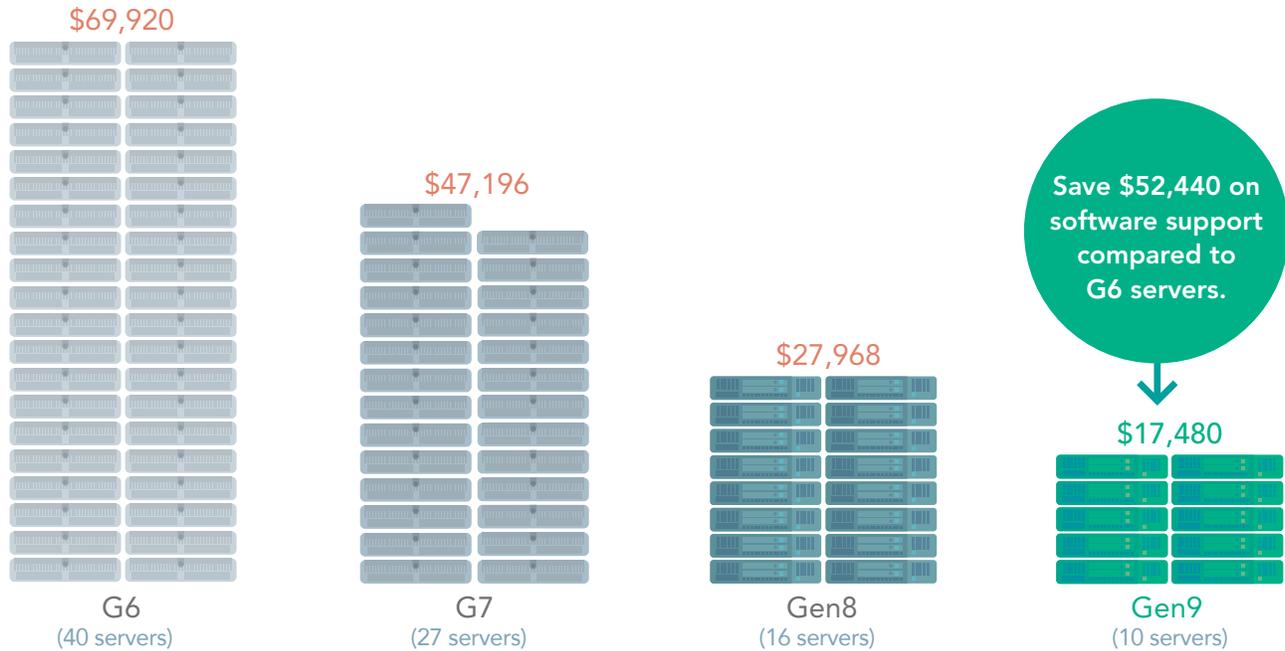
$69,920

$47,196

$27,968

Save $52,440 on software support compared to G6 servers.

$17,480

G6	G7	Gen8	Gen9
(40 servers)	(27 servers)	(16 servers)	(10 servers)

Annual software support costs to perform workloads equivalent to 100 Gen9 servers

$699,200

$466,716

$279,680

Save $524,400 on software support compared to G6 servers.

$174,800

G6	G7	Gen8	Gen9
(400 servers)	(267 servers)	(160 servers)	(100 servers)
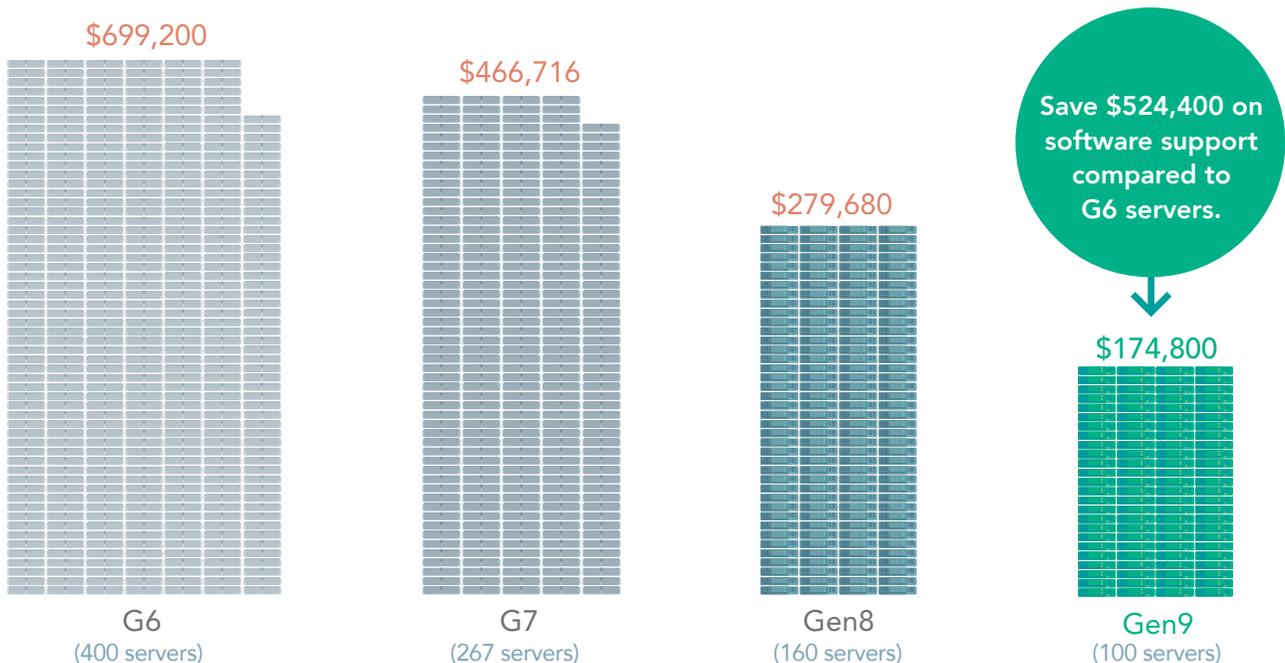
Conclusion

The financial benefits of server consolidation are obvious and dramatic. Being able to perform the same amount of work—or more—with fewer servers can decrease your operating expenditures in a number of important areas. However, companies can be reluctant to spend money to replace servers that are functioning well.

One expense of keeping older models in service is easy to overlook or underestimate: the greater costs they incur for virtualization software licensing and support compared to new servers. As we demonstrated in this study, a company replacing a fleet of HP ProLiant BL460c G6 servers with new HPE ProLiant BL460c Gen9 servers could realize a consolidation ratio of four to one. This would let them transfer one-quarter of the VMware vSphere licenses they've already purchased to the new servers while retaining the remaining licenses for future growth. They could quadruple their workload before having to license additional servers at $8,738 (including one year of support).

In addition, yearly support costs for vSphere would shrink to one-quarter of what they have been paying. For every four HP BL460c G6 server blades a company consolidated onto one Gen9, the reduction in annual support costs would equal $5,244. This is on top of potential savings on reduced power usage and IT management and increased available space in the c7000 to scale. A company replacing HP ProLiant BL460c G7 or Gen8 servers would enjoy the same savings to a lesser degree.[5]

New servers do require a capital expenditure. However, spending less year after year on software support—on top of the other OpEx savings companies typically realize with server consolidation—can greatly offset the investment. After a close look at how much you're spending on virtualization software support for your older servers, you might determine that you can't afford not to upgrade.

Upgrade to HPE ProLiant BL460c Gen9 servers, reuse your existing vSphere licenses, **and cut annual support costs by**

75%[6]

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1 To reflect real-world datacenter conditions, we configured each of the servers 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, see Appendix A.
2 vSphere Enterprise Plus (1 year Production Support and Subscription) (per processor). License plus one year productionlevel support. 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
3 Ibid.
4 We assume the enterprise has a Support and Subscription (SnS) contract for each software license. While under contract, you get new version upgrades free of charge. License and SnS costs for vSphere versions 5.5 and 6.0 are the same.
5 Smaller companies using VMware vSphere Standard edition can also save; we provide those numbers in Appendix D.
6 Based on $6,992 annual support costs for four G6 servers vs. $1,748 annual support costs for one Gen9 server.

On November 9, 2016, 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 9, 2016.

Appendix A – About the hardware and software we tested

About the HPE ProLiant BL460c Gen9

According to HPE, the ProLiant BL460c Gen9 Server Blade is designed for a wide range of configuration and deployment options. It uses Intel® Xeon® E5-2600 v4 processors with up to 21 percent bin to bin performance gain over the previous generation, plus 2400MT/s HPE DDR4 SmartMemory offering up to 33 percent higher throughput. Additional support includes tiered storage controller options, 12Gb/s SAS, 20Gb FlexibleLOMs, support for M.2, NVMe, and HPE ProLiant Persistent Memory options.

To learn more about the HP ProLiant BL460c Gen9, visit

https://www.hpe.com/us/en/product-catalog/servers/proliant-servers/pip.hpe-proliant-bl460c-gen9-server-balde.7271227.html

About the HPE BladeSystem c7000 blade enclosure

According to HPE, the BladeSystem c7000 enclosure is designed to provide all the power, cooling, and I/O infrastructure companies need to support modular server, interconnect, and storage components today and throughout the next several years. The 10Uenclosure holds up to 16 server and/or storage blades plus optional redundant network and storage interconnect modules. It includes a shared 7.1 Tbps high-speed NonStop mid-plane for wire-once connectivity of server blades to network and shared storage. Power is delivered through a pooled-power backplane, and power input flexibility is provided with choices of single-phase AC input, three-phase AC input, -48V DC input, and high voltage DC input.

To learn more about the HP BladeSystem c7000 blade enclosure, visit

https://www.hpe.com/us/en/product-catalog/storage/disk-enclosures/pip.hpe-bladesystem-c7000-enclosures.1844065.html

About the HPE 3PAR StoreServ 8450

The HPE 3PAR StoreServ 8450 we used in our testing is part of the HPE 3PAR StoreServ family of flash-optimized data storage systems. According to HPE, these next-generation, tier 1 storage arrays are built for virtualization and the cloud. "All 3PAR arrays feature unique architectural advantages that enable them to handle the unpredictable workloads characteristic of virtualized environments. Deploying 3PAR StoreServ Storage removes the performance bottlenecks and architectural limitations of legacy storage arrays so that customers can increase VM density without deploying additional physical servers or sacrificing reliability."

To learn more about the HPE 3PAR StoreServ 8450 all-flash storage array, visit

https://www.hpe.com/us/en/product-catalog/storage/disk-storage/pip.hpe-3par-storeserv-8000-storage.8737813.html

About Microsoft SQL Server 2016

SQL Server 2016 delivers performance and security features built-in for mission-critical transactional systems and data warehouses, along with an integrated business intelligence and advanced analytics solution for building data analytics applications. High-performance features are key to ensuring your applications can deliver a smooth transactional experience and also potentially support demanding real-time operational analytics.

To learn more about Microsoft SQL Server 2016, visit

https://www.microsoft.com/en-us/cloud-platform/sql-server

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 membership. 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

Appendix B – System information

System	HP ProLiant BL460c G6	HP ProLiant BL460c G7	HP ProLiant BL460c Gen8	HPE ProLiant BL460c Gen9
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	Performance	Performance	Performance	Performance
CPU				
Vendor	Intel®	Intel	Intel	Intel
Name	Xeon®	Xeon	Xeon	Xeon
Model number	X5570	X5670	E5-2680 v2	E5-2698 v3
Socket type	FCLGA1366	FCLGA1366	FCLGA2011	FCLGA2011-3
Core frequency (GHz)	2.93	2.93	2.80	2.30
Bus frequency (GT/s)	6.4	6.4	8	9.6
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	256 KB
L3 cache	8 MB	12 MB	25 MB	40 MB
Platform				
Vendor and model number	HP ProLiant BL460c G6	HP ProLiant BL460c G7	HP ProLiant BL460c Gen8	HPE ProLiant BL460c Gen9
Year released	2009	2010	2012	2014
Motherboard model number	507864-B21	603718-B21	641016-B21	779806-S01
BIOS version	I24	I27	I31	I36
Mezzanine card	QLogic® QMH2462	QLogic QMH2462	HP FlexFabric 554M	HP FlexFabric 554M
Integrated LOM	HP Flex-10 Embedded Ethernet	FlexFabric Embedded Ethernet	HP Flex-10 530FLB	HP FlexFabric 536FLB
Memory module(s)				
Total RAM in system (GB)	96	96	128	256
Vendor and model number	Samsung® M393B1K70DH0-YH9Q9	Samsung M393B1GH73BH0-YH9	Hynix® HMT42GR7MFR4C-PB	Hynix HMA42GR7MFR4N-TF
Type	PC3L-10600R	PC3L-10600R	PC3-12800R	PC4-2133P
Speed (MHz)	1,333	1,333	1,600	2,133
Speed running in the system (MHz)	1,333	1,333	1,600	2,133

System	HP ProLiant BL460c G6	HP ProLiant BL460c G7	HP ProLiant BL460c Gen8	HPE ProLiant BL460c Gen9
Size (GB)	8	8	16	16
Number of RAM module(s)	12	12	8	16
Chip organization	Double-sided	Double-sided	Double-sided	Double-sided
Rank	Dual	Dual	Dual	Dual
Virtualization software				
VMware vSphere version	5.5	6.0	6.0	6.0
Firmware				
Integrated Lights-Out firmware version	2.12	1.50	1.20	2.20

System	HP BladeSystem c7000
Chassis firmware	
Primary Firmware version	1.7
Hardware Version	412152-B21
First I/O module	
Model	HP VC Flex-10 Enet Module
Occupied bay(s)	1 and 2
Second I/O module	
Model	HP VC FlexFabric 10Gb/24-Port Module
Occupied bay(s)	3 and 4
Third I/O module	
Model	HP 4Gb Fibre Channel Pass-thru Module
Occupied bay(s)	5 and 6

Storage	HP 3PAR StoreServ 8450
Storage controllers	
Vendor and model number	HPE 3Par StoreServ 8450
Number of controllers	4
Software version	3.2.2
Drive enclosures	
Vendor and model number	HP VC Flex-10 Enet Module
Number of shelves	2
Drives per shelf	12
Drive type	HPE 762770 6Gb SAS SSD
Storage adapters	
Vendor and model number	Emulex LPE16002
Number of adapters	4
Type and speed	16Gb Fibre Channel

Appendix C – How we tested

Installing VMware vSphere onto the servers

1. Connect an external optical drive to the front of the server using the HP KVM dongle.
2. Insert the VMware vSphere installation media into the optical drive as follows:

    • For the G7, Gen8, and Gen9 servers, use vSphere 6.0.
    • For the G6 server, use vSphere 5.5.
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 and the HPE 3Par Storage. For the G6 and G7 servers, we used the 4Gb Fibre Channel Pass-thru module to directly connect each mezzanine card to the top-of-rack switch. For the Gen8 and Gen9 servers, we created Ethernet Networks on the FlexFabric 10Gb/24-port modules and assigned Fibre Channel Server Profiles to both servers.

Configuring the storage

We first created a RAID1 Common Provisioning Group large enough to hold 16 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 servers' FC HBAs.

Creating the workload virtual machines

We created 16 workload virtual machines for our testing. Each VM had 4 vCPU and 10 GB of memory, and a connection to our testing network. We installed Windows Server 2012 R2 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 2012 R2, and click Next.
9. In the Customize Hardware section, make the following changes:

    • Increase the vCPUs to 2.
    • 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 2012 R2 guest OS onto the VMs

1. Attach the Windows Server 2012 R2 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 2012 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.

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 DS3 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 table 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
member1	DS_MEMBER_FG	100
member2	DS_MEMBER_FG	100
ds_misc	DS_MISC_FG	200
orders1	DS_ORDERS	1,503
orders2	DS_ORDERS	1,504
review1	DS_REVIEW_FG	1,353
review2	DS_REVIEW_FG	1,353
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:

```
ds3sqlserverdriver.exe --target=<target_IP> --ramp_rate=10 --run_time=15 --n_threads=8 --db_size=10GB
--think_time=0.1 --detailed_view=Y --warmup_time=15 --report_rate=1 --csv_output=<drive path>
```

Appendix D – 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.[7]

	HP ProLiant BL460c G6	HP ProLiant BL460c G7	HP ProLiant BL460c Gen8	HP ProLiant BL460c Gen9
Number of servers and annual software support costs to perform workloads equivalent to 1 Gen9 server				
Number of servers	4	3	2	1
Annual software support costs	$2,584	$1,938	$1,292	$646
Number of servers and annual software support costs to perform workloads equivalent to 10 Gen9 servers				
Number of servers	40	27	16	10
Annual software support costs	$25,840	$17,442	$10,336	$6,460
Number of servers and annual software support costs to perform workloads equivalent to 100 Gen9 servers				
Number of servers	400	267	160	100
Annual software support costs	$258,400	$172,482	$103,360	$64,600

7   vSphere Standard (1 year Production Support and Subscription) (per processor). License plus one year production-level support. http://www.vmware.com/products/vsphere.html, http://store.vmware.com/store/vmware/en_US/cat/categoryID.65651900?

This project was commissioned by HPE.

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