SERVER CONSOLIDATION WITH THE NEC EXPRESS5800/A2040B: POWER AND PERFORMANCE ADVANTAGES OVER A LEGACY SERVER

WE PROVED
THREE GREAT BENEFITS

of consolidating **nine** legacy HP servers into **one** NEC Express5800/A2040b powered by Intel® Xeon® processor E7-4890 v2:

8X MORE VIRTUAL MACHINES
One A2040b handled 72 VMs vs 8 on a single HP

OVER TWICE AS POWER EFFICIENT
Up to 123.7% higher performance per watt

77.8% LESS RACK SPACE
Freed 14 U of rack space

in our tests compared to a HP ProLiant DL385 G6 server

As virtualization technology evolves and improves, the server performance and power requirements for supporting a virtualized data center increase. Your aging servers are struggling to meet increasing virtual workload demands. These older, lower-performing servers further tax your data center by consuming valuable space and power. You want to update, upgrade, and consolidate to a powerful new server solution that will provide an excellent virtualization platform. Powered by the Intel® Xeon® processor E7-4890 v2, the NEC Express5800/A2040b offers just that.

Here in the labs at Principled Technologies, we compared the performance of the new NEC Express5800/A2040b to an older HP ProLiant DL385 G6 as a representative legacy server. The purpose of our testing was to determine how many legacy database servers the NEC Express5800/A2040b could consolidate while maintaining steady performance within the hosted VMs. Using a realistic heavy database workload, we found that one NEC Express5800/A2040b supported 72 VMs, nine times the number of similarly performing VMs that the legacy server supported. **This means that one NEC Express5800/A2040b server could replace nine legacy servers while using 77.8 percent less rack space while being over twice as power efficient, delivering 123.7 percent more performance per watt.** This kind of consolidation can translate to considerable space and power savings for your growing data center.

UPDATE, UPGRADE, AND CONSOLIDATE YOUR DATABASE SERVERS

While virtualization makes the most of resources in a system, consolidating older systems in your data center to better performing, lower power draw servers is an excellent way to bring additional savings to your organization. By consolidating and upgrading your servers, your business receives the latest software and hardware functionality, allowing your workloads to continue running while using less space and power. However, your IT managers must ensure that the VMs they intend to introduce into a data center can handle the workloads of your business.

We created VMs on the NEC Express5800/A2040b server with Intel Xeon processor E7-4890 v2 running Microsoft® Windows Server® 2012 R2 and the HP ProLiant DL385 G6 server running Microsoft Windows Server 2008 R2. We then ran a heavy database workload on each system to find out how many older legacy servers running our database application VMs could consolidate into one NEC Express5800/A2040b server. We noted how many VMs each server supported. For both servers, we maintained CPU utilization at real-world levels, between 55 to 60 percent utilization, and set a minimum database performance threshold of 11,000 orders per minute (OPM) per VM. While running the virtualized database workload, we measured the levels of power consumption for each server.

The proof of the value of consolidation with the NEC Express5800/A2040b

The NEC Express5800/A2040b supported 72 VMs running heavy database workloads, which was eight times more than the eight supported VMs on the legacy server. Figure 1 shows the number of VMs each server supported.
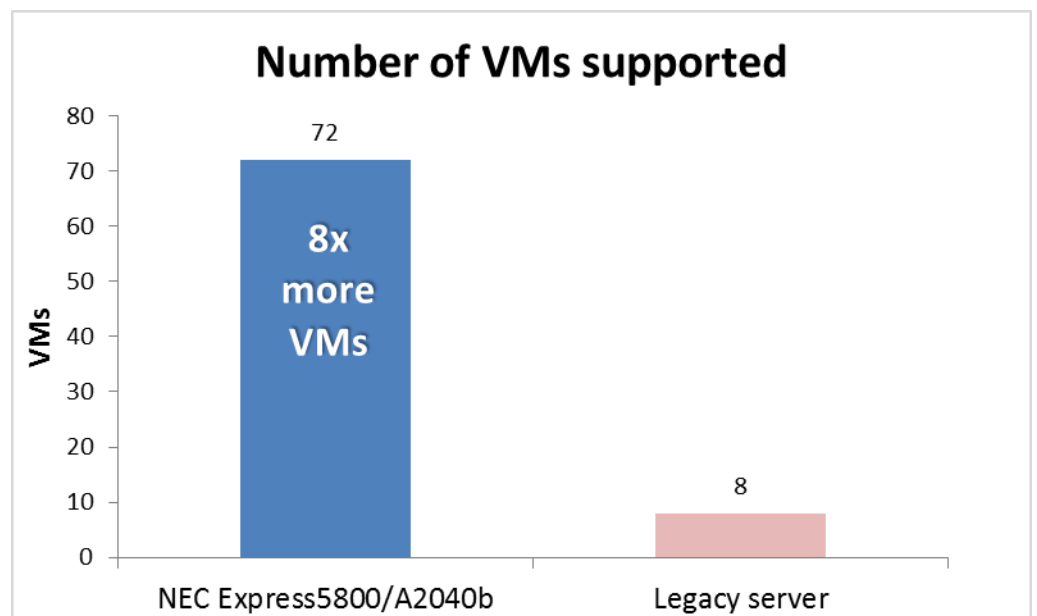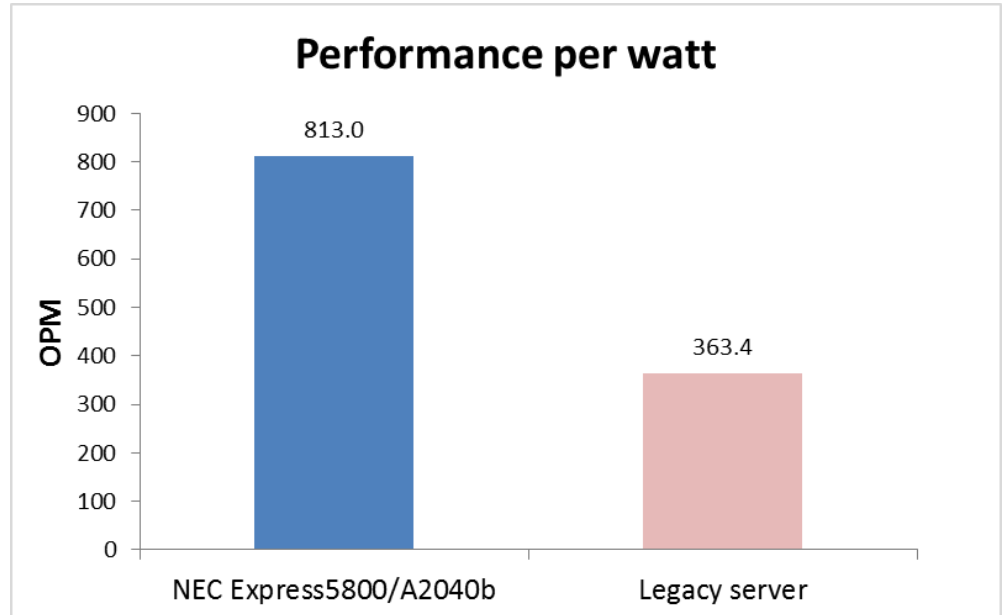
Figure 1: One NEC Express5800/A2040b consolidated the workloads of nine HP ProLiant DL385 G6 legacy servers.


Number of VMs supported

Reducing the number of older servers running in your data center can save on power, and the technology in new servers can deliver great performance at a lower cost. We analyzed the performance per watt and the power per VM of the two solutions. As Figure 2 shows, the NEC Express5800/A2040b delivered 123.7 percent greater performance per watt.

Figure 2: Performance, in OPM, per watt for the two servers. Higher numbers are better.

Performance per watt

The NEC Express5800/A2040b consumed 57.0 percent less power per VM than the HP ProLiant DL385 G6 legacy server, as shown in Figure 3.

Figure 3: Power, in watts, per VM for the two servers. Lower numbers are better.

Power (W) per VM
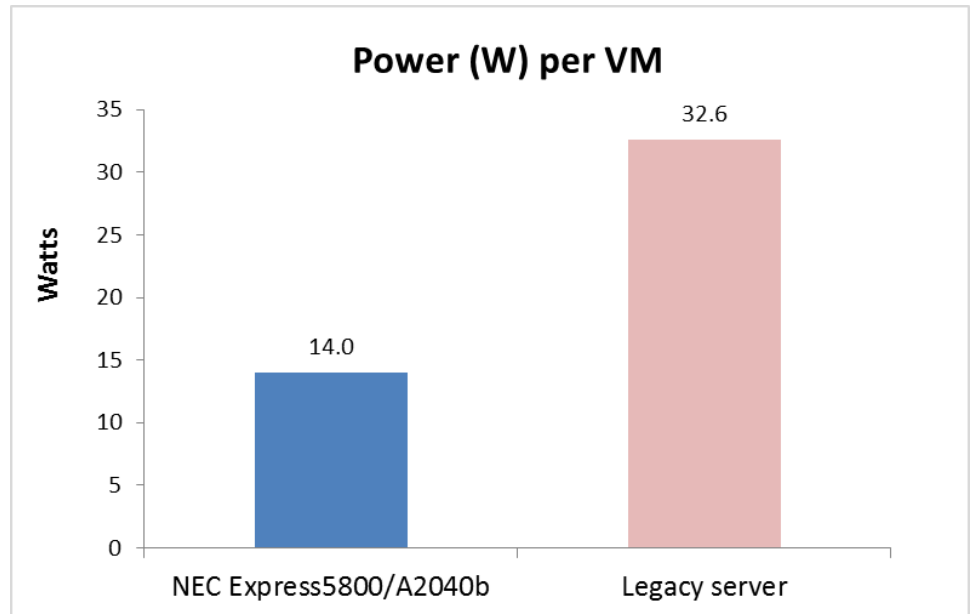
WHAT WE FOUND

Figure 4 presents the results of our tests, including the number of VMs the servers could run, the total database performance in OPM, and the percentage CPU utilization the servers required to run the workloads. We ran a realistic workload capacity to show the performance of the two servers in an environment similar to what a typical business might run.

Host system	Number of VMs	Total OPM	Percentage CPU utilization
NEC Express5800/A2040b	72	820,329	57.7
HP ProLiant DL385 G6	8	94,839	54.5

Figure 4: Database performance results for the two servers.

Although the NEC Express5800/A2040b server with Intel Xeon processor E7-4890 v2 used more power overall than the HP ProLiant DL385 G6 legacy server, the workload it ran was vastly larger due to the increased number of VMs. Considering this fact, our power per VM and performance per watt metrics provide a more useful comparison of the two server solutions. The NEC Express5800/A2040b used 57.0 percent less power per VM than the HP ProLiant DL385 G6 legacy server. In the performance per watt category, the NEC Express5800/A2040b led the HP ProLiant DL385 G6 legacy server by 123.7 percent. Figure 5 compares the results of these two metrics between the servers.

Host system	Power (W) (lower is better)	Power/VM (W) (lower is better)	Performance/watt (higher is better)
NEC Express5800/A2040b	1,009	14.0	813.0
HP ProLiant DL385 G6	261	32.6	363.4

Figure 5: Power performance (in watts) for the two servers, including power per VM and database performance per watt.

WHAT WE TESTED

We optimized the virtual hardware configuration for each VM for best performance using the available physical resources on each server. The eight VMs on the HP ProLiant DL385 G6 legacy server had 7 GB of memory and two vCPUs each, while the 72 VMs on the NEC Express5800/A2040b server with Intel Xeon processor E7-4890 v2 had 12 GB of memory and two vCPUs each. We also targeted overall CPU utilization to be from 55 percent to 60 percent. This helped to create a more accurate representation of how these servers might perform in a real-world situation under stress from a database application. We used the same enterprise-class storage for each configuration ensuring that the storage was not the bottleneck during our tests.

To test database performance for each server, we used DVD Store version 2.1 (DS2) which reports in OPM. We used a 60ms think time for both servers to generate a

database workload that achieved at least 11,000 OPM per VM. The benchmark also provided a representative workload so that we could measure power usage of both servers under load. The DVD Store 2.1 benchmark measured database performance with an 8GB Microsoft SQL Server 2008 R2 database on the legacy server and the same database upgraded to Microsoft SQL Server 2012 on the NEC Express5800/A2040b server.

For detailed configuration information of the servers, see Appendix A. See Appendix B for detailed information on how we tested the servers.

About NEC Corporation

According to NEC Corporation, the company "integrates IT and network technologies designed to benefit businesses and people around the world. NEC provides a combination of products and solutions that cross utilize the company's experience and global resources with the goal of developing advanced technologies to meet the complex and ever-changing needs of its customers. NEC brings more than 100 years of expertise in technological innovation intended to empower people, businesses and society." For more information, visit NEC at www.nec.com.

About the NEC Express5800/A2040b

According to NEC Corporation, the company "leverages their supercomputer and mainframe heritage to offer advanced reliability, availability, and serviceability (RAS) features (including redundant management cards) in the NEC Express5800/A2040b server. The server is targeted at large database and enterprise applications, in-memory databases, and server consolidation through virtualization. These heavy workloads can require significant compute power and memory capacity, as well as PCIe-based connectivity to external storage, all of which the NEC Express 5800/A2040b offers. The server is designed as a highly scalable, highly available enterprise server and can accommodate up to 4 TB of memory and up to four Intel Xeon E7-4800 v2 Product Family processors (up to 60 CPU cores and 120 threads) in a single 4U chassis."

In addition, the NEC Express 5800/A2040b offers a feature referred to as core optimization technology. According to NEC Corporation, "as core count per CPU socket increases, system cost, including SW license fee for 'core license' based SW, can dramatically increase regardless of customer's CPU demand. Customers may need access to more memory and I/O without the need for additional cores. NEC offers an Express5800 server model that allows access to all the I/O and memory – while only requiring half the number of cores (30 cores). This configuration option could provide these customers with the performance they need, while offering significant cost savings when using applications with core-based licenses."

About DVD Store Version 2.1

To create our real-world ecommerce workload, we used the DVD Store Version 2.1 benchmarking tool. DS2 models an online DVD store, where customers log in, search for movies, and make purchases. DS2 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 DS2 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.

CONCLUSION

For your data center to keep pace with the growth of your business, your database servers must be able to run as many VMs as possible with the lowest amount of power per unit of performance, and do so in the smallest amount of rack space. If you have a collection of aging servers taking up too much space and using too much power in your data center, consider consolidating them into the NEC Express5800/A2040b server powered by the Intel Xeon processor E7-4890 v2. Based on our findings, a single NEC Express5800/A2040b can replace nine HP ProLiant DL385 G6 legacy servers with VMs running heavy database workloads. This means the NEC Express5800/A2040b server can deliver similar VM database performance while using 77.8 percent less rack space, freeing up your data center space for future growth and potentially saving you from costly infrastructure expansions. What's more, the NEC Express5800/A2040b server delivered 57.0 percent power savings while running the same workload as the legacy server, which resulted in 123.7 percent better performance per watt. The added power efficiency can save your business in recurring power and cooling costs of your data center. These advantages, combined with steady performance, make the NEC Express5800/A2040b server a wise choice for your data center.

APPENDIX A – SYSTEM CONFIGURATION INFORMATION

Figure 6 provides detailed configuration information for the test systems.

System	NEC Express5800/A2040b	HP ProLiant DL385 G6
Power supplies		
Total number	4	2
Vendor and model number	Delta Electronics DPS-1200RB A	HP HSTNS-PL18
Wattage of each (W)	1,000	750
Cooling fans		
Total number	8	6
Vendor and model number	Sanyo® Denki 9GA0912P1H05	Nidec ®Ultraflow V60E12BS1A7-09A032
Dimensions (h x w) of each (inches)	3.5 x 3.5	2 x 2-1/2
Volts	12	12
Amps	2.1	2.45
General		
Number of processor packages	4	2
Number of cores per processor	15	6
Number of hardware threads per core	2	1
System power management policy	Windows Balanced Power Policy	Windows Balanced Power Policy
CPU		
Vendor	Intel®	AMD
Name	Xeon®	Opteron™
Model number	E7-4890 v2	2435
Socket type	Socket LGA 2011	Socket Fr6
Core frequency (GHz)	2.80	2.60
L1 cache	32 + 32 KB (per core)	64 + 64 KB (per core)
L2 cache	256 KB (per core)	512 KB (per core)
L3 cache	32 MB	6 MB
Platform		
Vendor and model number	NEC Express5800/A2040b (NE3400-001S)	HP ProLiant DL385 G6
Motherboard model number	BM-M	577426-001
BIOS name and version	American Megatrends Inc. 5.6.0061 (09/05/2013)	HP A22 (05/02/2011)
BIOS settings	Default	Default
Memory module(s)		
Total RAM in system (GB)	1,024	64
Vendor and model number	Samsung® M393B2G70BH0-YK0	Samsung M393T1K66AZA-CE6Q0
Type	DDR3 PC3L-12800R	DDR2 PC2-5300
Speed (MHz)	1,600	667
Speed running in the system (MHz)	1,600	667

System	NEC Express5800/A2040b	HP ProLiant DL385 G6
Timing/Latency (tCL-tRCD-tRP-tRASmin)	9-9-9-24	5-5-5-15
Size (GB)	16	8
Number of RAM module(s)	64	8
Chip organization	Double-sided	Double-sided
Rank	Dual	Dual
Operating system		
Name	Windows Server 2012 R2 Datacenter	Windows Server 2008 R2 Enterprise
Build number	9600	7601
File system	NTFS	NTFS
Kernel	ACPI x64-based PC	ACPI x64-based PC
Language	English	English
Graphics		
Vendor and model number	Microsoft Basic Display Adapter	ATI ES1000
Driver	Microsoft Corporation 6.3.9600.16384 (06/21/2006)	ATI Technologies Inc. 8.240.50.5000 (06/23/2009)
RAID controller		
Vendor and model number	LSI™ MegaRAID®SAS 9265CV-8i	HP Smart Array P410i
Firmware version	3.230.05-2100	3.00
Driver version	6.701.4.0	6.12.6.65
Cache size (MB)	512	512
Hard drives		
Vendor and model number	Hitachi® HUC109030CSS600	HP DG0300BALVP
Number of drives	8	2
Size (GB)	300	300
RPM	10k	10k
Type	SAS	SAS
Ethernet adapters		
Vendor and model number	Broadcom® BCM5718 NetXtreme® Gigabit Ethernet	Broadcom® BCM5709C NetXtreme® II Gigabit Ethernet
Type	PCI-Express	PCI-Express
Driver	Broadcom 15.6.1.3 (3/22/2013)	Broadcom 4.8.4.1 (12/23/2008)
Fibre Channel adapter		
Vendor and model number	Emulex® LPe12002-M8-N	HP StorageWorks AJ763A
Type	PCI-Express	PCI-Express
Driver	2.76.2.1 (8/21/2013)	2.10.211.0 (1/22/2009)
Optical drive(s)		
Vendor and model number	MATSHITA DVD-RAM UJ8A0AS ATA Device	TEAC DV-285-W ATA Device
Type	DVD-RAM	DVD-ROM
USB ports		
Number	4	4

System	NEC Express5800/A2040b	HP ProLiant DL385 G6
Type	2.0	2.0

Figure 6: System configuration information for the test systems.

APPENDIX B - HOW WE TESTED

Setting up the storage

To host the VMs for our testing, we used an enterprise-class 8Gb Fibre Channel storage array and configured storage groups and LUNs as follows.

We created a pair of LUNs for each of the four drives assigned to each VM:

- One pair of 3TB LUNs for the OS volumes on 15 x 600GB 10K SAS drives (RAID 10).
- One pair of 350GB LUNs for the database index volumes on 8 x 200GB SSDs (RAID 10)
- One pair of 4.5TB LUNs for the database volumes on 76 x 300GB 15K SAS drives (RAID 10)
- One pair of 1TB LUNs for the SQL logging data on 48 x 600GB 10K SAS drives (RAID 10)

We divided the OS and SQL data for each VM to four VHDs, each assigned to one of the two corresponding LUNs described above. For each data type, we distributed all odd-numbered VMs into one LUN and all even-numbered VMs into the other.

- 40GB VHD for the OS
- 25GB VHD for most of the database
- 8GB VHD for the index files from the database
- 18GB VHD for the logging data

Test bed configuration

Both servers used two 8Gb Fibre Channel connections between the test server and the Fibre Channel switch, which was connected to the storage with another pair of 8Gb Fibre Channel connections. The VMs on the HP ProLiant DL385 G6 server were connected to the test network through two 1Gb Ethernet connections. The VMs on the NEC server were connected to the testing network through six 1Gb Ethernet connections. We created 80 virtual clients across a cluster of four hosts and each host connected to the testing network with two 1Gb Ethernet connections.

Configuring the systems under test

We configured BIOS for each server with system defaults and RAID 1 for the RAID controller. We installed the server OS on the local storage, configuring the HP ProLiant DL385 G6 server with Windows Server 2008 R2 SP1, and the NEC server with Windows Server 2012 R2.

Installing Microsoft Windows Server 2008 R2 SP1 on the HP ProLiant DL385 G6

1. Choose the language, time and currency, and keyboard input. Click Next.
2. Click Install Now.
3. Select Windows Server 2008 R2 Enterprise (Full Installation), and click Next.
4. Accept the license terms, and click Next.
5. Click Custom.
6. Click the Disk, and click Next.
7. After the installation completes, click OK.

8. Enter the administrator password twice, and press Enter.

9. Click OK.

Installing Microsoft Windows Server 2012 R2 on the NEC Express5800/A2040b

1. Choose the language, time and currency, and keyboard input. Click Next.

2. Click Install Now.

3. Select Windows Server 2012 Datacenter, and click Next.

4. Accept the license terms, and click Next.

5. Click Custom.

6. Click the Disk, and click Next.

7. After the installation completes, click OK.

8. Enter the administrator password twice, and press Enter.

9. Click OK.

Configuring Microsoft Windows Server

1. Install all available Windows updates. Restart as necessary.

2. Enable remote desktop access.

3. Change the hostname, and reboot when the installer prompts you.

4. Set up networking for the management network:

   a. Click Start→Control Panel, right-click Network Connections, and select Open.

   b. Right-click the management traffic NIC, and select Properties.

   c. Select TCP/IP (v4), and select Properties.

   d. Set the IP address and subnet for the NIC, which will handle management traffic, and click OK.

   e. Click OK, and click Close.

5. Set up networking for the VM traffic network:

   a. Click Start→Control Panel, right-click Network Connections, and select Open.

   b. Right-click the VM traffic NIC, and select Properties.

   c. Select TCP/IP (v4), and select Properties.

   d. Set the IP address and subnet for the NIC, which will handle VM traffic, and click OK.

   e. Click OK, and click Close.

Adding the Fibre Channel volumes

1. Log into Windows using the appropriate credentials.

2. Open the start menu, type `Hard Disk Partitions`, select Settings, and press Enter.

3. Right-click all offline disks, and select Online. Skip any disks that give an error.

4. If prompted, select Initialize Disk, and click Ok.

Installing Multipath I/O (MPIO) for Windows Server 2008 R2

1. Click Start→Administrative Tools→Server Manager.
2. Click Features, and click Add Features on the right.
3. Select Multipath I/O, and click Next.
4. Click Install.

Installing MPIO for Windows Server 2012

1. Open Server Manager, and click Manage→Add Roles and Features.
2. At the Before You Begin screen, click Next.
3. At the Installation Type screen, click Next.
4. At the Server Selection screen, click Next.
5. At the Server Roles screen, click Next.
6. At the Features screen, select MPIO. Click Next.
7. At the Confirmation screen, check the box to automatically restart the server after installation, and click Install.

Configuring MPIO on the system under test

1. Click Start, and type `MPIO`. Press Enter.
2. At the bottom, click Add.
3. Click OK.
4. If prompted, reboot the system.
5. Select the Discover Multi-Paths tab, and click Add
6. Click OK. If prompted, reboot the system.

Configuring the Fibre Channel (FC) volumes on the system under test

1. Log into Windows using the appropriate credentials.
2. Open the start menu, type `Hard Disk Partitions`, select Settings, and press Enter.
3. Right-click the volume space, and select Create Simple Volume.
4. At the Specify Volume Size window, leave the default selection, and click Next.
5. At the Assign Drive Letter or Path window, choose a drive letter, and click Next.
6. At the Format Partition window, choose NTFS, and click Next.
7. At the Completing the New Simple Volume Wizard window, click Finish.
8. Repeat steps 3 through 7 for all unallocated volumes.

Installing the Hyper-V role on the system under test

1. Open Server Manager, and click Manage→Add Roles and Features.
2. At the Before You Begin screen, click Next.
3. At the Installation Type screen, click Next.
4. At the Server Selection screen, select the server, and click Next.
5. At the Server Roles screen, check Hyper-V. At the prerequisite pop-up, click Add Features. Click Next.

6. At the Features screen, click Next.

7. At the Hyper-V screen, click Next.

8. At the Virtual Switches screen, click Next.

9. At the Migration screen, click Next.

10. At the Default Stores screen, enter the iSCSI storage location. Click Next.

11. At the Confirmation screen, choose to automatically restart the server after installation, and click Install.

Creating the first VM

1. Click Start, type `Hyper-V Manager`, and press Enter.

2. In the right pane, click Virtual Machines→New Virtual Machine.

3. Select a node on which to install the VM, and click OK.

4. At the Before You Begin screen, click Next.

5. At the Specify Name and Location screen, enter a name for the VM, and click Next.

6. At the Assign Memory screen, type `7 GB` for the HP ProLiant DL385 G6 server or `12 GB` for the NEC Express5800/A2040b server, and click Next.

7. At the Configure Networking screen, use the drop-down menu to select the virtual switch, and click Next.

8. At the Connect Virtual Hard Disk screen, create a new disk, enter 40GB as the size, and click Finish.

9. At the Summary screen, click Finish.

Installing the VM operating system on the first VM

1. From the VM console, connect to the ISO image of the installation DVD for Windows Server 2012 Datacenter. If the ISO image is not stored on the host, start the VM, and connect to the ISO image.

2. Start the VM.

3. At the Language Selection Screen, click Next.

4. Click Install Now.

5. Select Enterprise edition, and click Next.

6. Click I accept the license terms, and click Next.

7. Click Custom.

8. Click Next.

9. At the User's password must be changed before logging on warning screen, click OK.

10. Enter the desired password for the administrator in both fields, and click the arrow to continue.

11. At the Your password has been changed screen, click OK.

12. Install the latest Host Integration Tools package on the VM. Restart as necessary.

13. Connect the machine to the Internet, and install all available Windows updates. Restart as necessary.

14. Enable remote desktop access.

15. Change the hostname, and reboot when prompted.

16. Set up networking:

    a. Click Start→Control Panel, right-click Network Connections, and choose Open.

b. Right-click the VM traffic NIC, and choose Properties.

c. Select TCP/IP (v4), and choose Properties.

d. Assign the VM a static IP address.

Installing and configuring Microsoft SQL Server

We installed Microsoft SQL Server 2012 on all 72 VMs residing on the NEC Express5800/A2040b server, and Microsoft SQL Server 2008 on all eight VMs residing on the HP ProLiant DL385 G6 server.

Configuring the SQL Server VM

1. After cloning, modify the SQL VM to contain the following settings:

   - Virtual Processors: 2

   - Additional virtual disks:

     o 8GB VHD for the index files from the database

     o 25GB VHD for the remaining database files

     o 18GB VHD for the logging data

2. In the VM, configure the VM storage:

   a. In the taskbar, click the Server Manager icon.

   b. In the left pane, expand Storage, and click Disk Management.

   c. Right-click the first volume, and choose Initialize Disk.

   d. In the right pane, right-click the volume, and choose New Simple VoIume…

   e. At the welcome window, click Next.

   f. At the Specify Volume Size window, leave the default selection, and click Next.

   g. At the Assign Drive Letter or Path window, choose a drive letter, and click Next.

   h. At the Format Partition window, choose NTFS, and click Next.

   i. At the Completing the New Simple Volume Wizard window, click Finish.

Installing SQL Server

1. Open the console for the VM or connect to the VM with RDP.

2. Mount the installation ISO to the VM.

3. Click Run SETUP.EXE. If Autoplay does not begin the installation, navigate to the SQL Server Installation DVD, and double-click.

4. If the installer prompts you with a .NET installation prompt, click Yes to enable the .NET Framework Core role.

5. In the left pane, click Installation.

6. Click New SQL Server stand-alone installation or add features to an existing installation.

7. At the Setup Support Rules screen, wait for the rule check to complete. If there are no failures or relevant warnings, click OK.

8. Select the Specify a free edition and from the drop-down menu, and select Evaluation. Click Next.

9. Choose to accept the license terms, and click Next.

10. If no failures are displayed after the setup support files are installed, click Next.

11. At the Setup Role screen, choose SQL Server Feature Installation.

12. 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.

13. At the Installation Rules screen, click Next after the check completes.

14. At the Instance configuration screen, leave the default selection of default instance, and click Next.

15. At the Disk Space Requirements screen, click Next.

16. At the Server Configuration screen, check that NT AUTHORITY\SYSTEM is selected for SQL Server Agent and SQL Server Database Engine. Click Next.

17. Assuming there are no failures, click Next.

18. At the Database Engine Configuration screen, select Mixed Mode.

19. Enter and confirm a password for the system administrator account.

20. Click Add Current user. This may take several seconds.

21. Click the Data Directories tab, and enter the appropriate drive and folders for database and logs.

22. Click Next.

23. At the Error and usage reporting screen, click Next.

24. At the Installation Configuration Rules screen, check that there are no failures or relevant warnings, and click Next.

25. At the Ready to Install screen, click Install.

26. After installation completes, click Close.

27. Create a SQL Server login for the ds2user (see the [Configuring the database (Data generation overview)](#) section for the specific script to use).

28. Copy the pre-created DVD Store backup to the specified backup volume.

29. Download and install any available updates for Microsoft SQL Server.

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.

Configuring the database

We generated the data using the Install.pl script included with DVD Store version 2.1 (DS2), providing the parameters for our 8GB database size and the database platform on which we ran: Microsoft SQL Server. We ran the Install.pl script on a utility system running Linux. The Install.pl script 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. We built the 8GB database in SQL Server, 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. Other than this file size modification, we created and loaded the database in accordance to the DVD Store documentation. Specifically, we followed these steps:

1. We generated the data, and created the database and file structure using database creation scripts in the DS2 download. We made size modifications specific to our 8GB database, and made 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 (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. 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.

Figure 8 shows our initial file size modifications.

Logical name	Filegroup	Initial size (MB)
Database files		
primary	PRIMARY	3
cust1	DS_CUST_FG	5,120
cust2	DS_CUST_FG	5,120
ind1	DS_IND_FG	2,048
ind2	DS_IND_FG	2,048
ds_misc	DS_MISC_FG	2,048
orders1	DS_ORDERS	2,560

Logical name	Filegroup	Initial size (MB)
orders2	DS_ORDERS	2,560
Log files		
ds_log	Not applicable	12,288

Figure 8: Our initial file size modifications.

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 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 (the hypervisor system), the client system, and the target.
7. Let the test server idle for 20 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=30 --
n_threads=16 --db_size=8GB --think_time=0.06 --detailed_view=Y --
warmup_time=30 --report_rate=1 --csv_output=<drive path>
```

ABOUT PRINCIPLED TECHNOLOGIES

![Principled Technologies logo]

Principled Technologies, Inc.
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We provide industry-leading technology assessment and fact-based marketing services. We bring to every assignment extensive experience with and expertise in all aspects of technology testing and analysis, from researching new technologies, to developing new methodologies, to testing with existing and new tools.

When the assessment is complete, we know how to present the results to a broad range of target audiences. We provide our clients with the materials they need, from market-focused data to use in their own collateral to custom sales aids, such as test reports, performance assessments, and white papers. Every document reflects the results of our trusted independent analysis.

We provide customized services that focus on our clients' individual requirements. Whether the technology involves hardware, software, Web sites, or services, we offer the experience, expertise, and tools to help our clients assess how it will fare against its competition, its performance, its market readiness, and its quality and reliability.

Our founders, Mark L. Van Name and Bill Catchings, have worked together in technology assessment for over 20 years. As journalists, they published over a thousand articles on a wide array of technology subjects. They created and led the Ziff-Davis Benchmark Operation, which developed such industry-standard benchmarks as Ziff Davis Media's Winstone and WebBench. They founded and led eTesting Labs, and after the acquisition of that company by Lionbridge Technologies were the head and CTO of VeriTest.