Dell™ EqualLogic™ PS6210XS hybrid storage

160% more orders per minute

49% faster response time

72% less power consumed

on an OLTP workload versus the competing industry-leading, similarly configured SAN solution

EXECUTIVE SUMMARY

Online transaction processing, or OLTP, is a class of information systems that facilitate and manage transaction-oriented applications. An essential component of any OLTP system is storage. Storage for OLTP should also deliver the performance necessary for handling utilization spikes of short duration—I/O storms—such as those generated when large numbers of transactions occur at once.

Dell EqualLogic PS Series iSCSI hybrid SAN arrays are well suited for OLTP environments. These hybrid arrays combine solid-state drives (SSDs) and traditional hard disk drives (HDDs) in the same chassis.

Additionally, EqualLogic's scale-out architecture enables organizations to grow their OLTP environments optimally for both capacity *and* performance by adding additional arrays. This is a unique advantage for EqualLogic, as traditional scale-up architectures add more disk trays to the same storage controllers, addressing capacity growth requirements while ignoring the performance needs.

How does EqualLogic hybrid SAN array compare with other OLTP storage solutions in the market? To answer this question, we evaluated two storage solutions—

one from EqualLogic and another from a leading SAN storage solution provider in the industry—in a realistic OLTP scenario.

We used a Dell EqualLogic PS6210XS hybrid array for one configuration and an industry-leading SAN storage solution for the other configuration. All other elements of the two configurations were identical. To make a fair comparison, the industry-leading SAN storage solution contained a similar number of SSDs and HDDs with approximately the same usable storage capacity, as well as a software-based caching solution that tiers data for OLTP workloads similar to the EqualLogic automatic data tiering.

We tested both configurations using the DVD Store Version 2 tool, which simulates an online ordering system; it measures database performance in orders per minute (OPM). We also compared response time, cost, and power consumption for both solutions.

In our testing, the Dell EqualLogic PS6210XS solution showed considerable advantages over the competing industry-leading SAN storage solution in all three of the following areas:

- **Performance.** The Dell EqualLogic PS6210XS solution delivered 160.0 percent more orders per minute than the competing industry-leading, similarly configured SAN.
- **Response time.** The Dell EqualLogic PS6210XS delivered a response time 49.3 percent faster than that of the industry-leading, similarly configured SAN solution.
- **Energy consumption.** The Dell EqualLogic PS6210XS solution consumed 72.6 percent less energy than the competing industry-leading, similarly configured SAN solution.

These findings make the Dell EqualLogic PS6210XS solution an extremely attractive option for OLTP deployments.

As Figure 1 shows, the Dell EqualLogic PS6210XS solution could perform 54,979 orders per minute whereas the competing industry-leading, similarly configured SAN solution performed 21,142, fewer than half as many.

This means that **the Dell EqualLogic PS6210XS storage more than doubled the amount of work the servers could do**. In any real-world OLTP environment, this boost would be very dramatic.
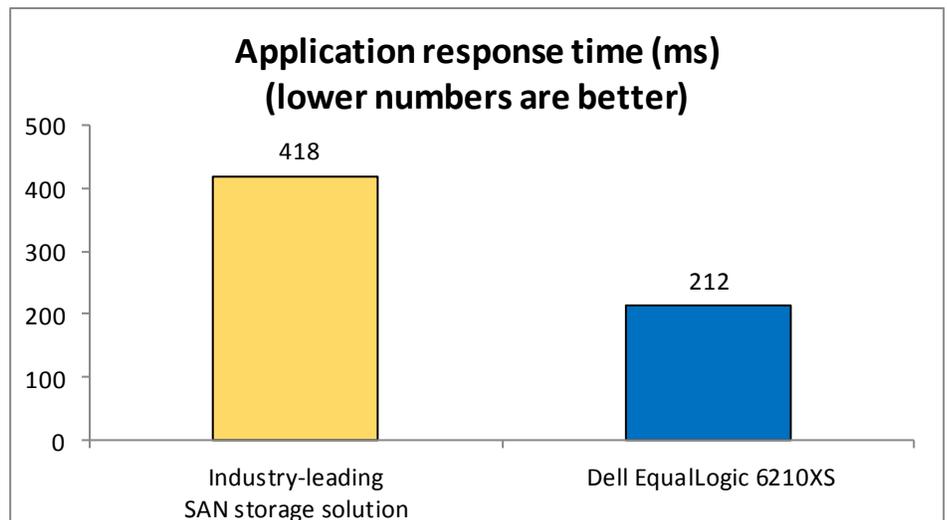
Figure 1: The Dell EqualLogic PS6210XS solution delivered 160.0 percent more orders per minute than the competing industry-leading, similarly configured SAN solution.
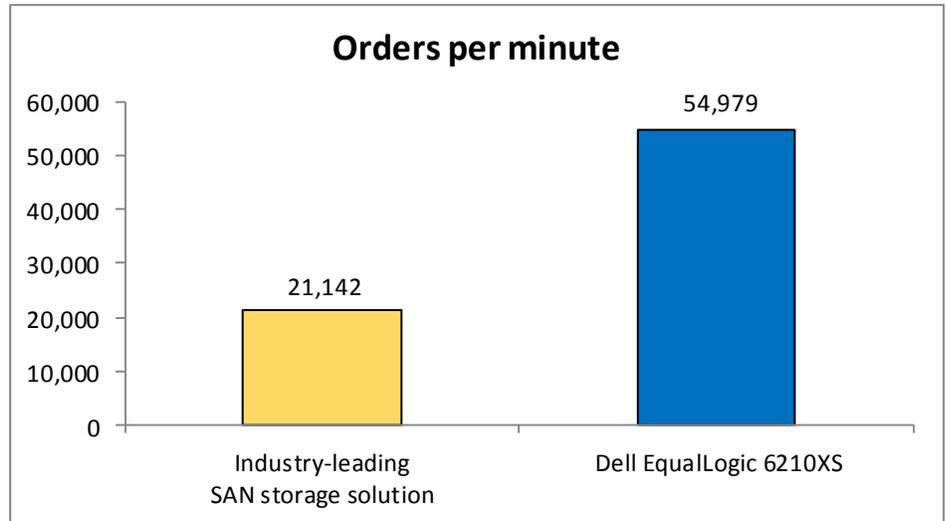
Response time is a measure of how long the database server takes to respond to inquiries; the greater the response time, the longer users must wait. As Figure 2 shows, with Dell EqualLogic PS6210XS storage, the server was able to deliver a much quicker response time—212 milliseconds, which is 49.3 percent faster than the 418-millisecond response time of the competing industry-leading, similarly configured SAN solution.

This means that **the Dell EqualLogic PS6210XS storage cut the wait time for users almost in half**. Any business that has database users can benefit substantially from the increased responsiveness of the EqualLogic PS6210XS.

Figure 2: The Dell EqualLogic PS6210XS delivered a response time 49.3 percent faster than that of the industry-leading, similarly configured SAN solution.
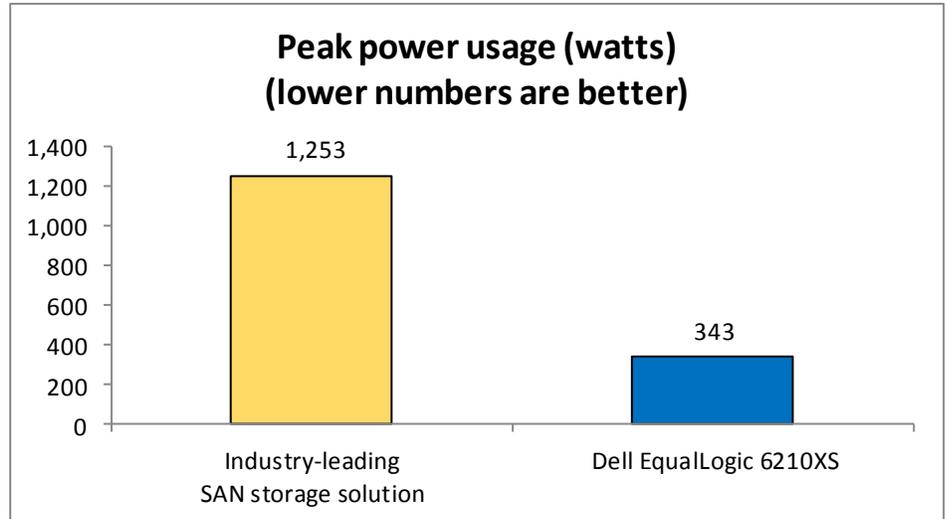
Power usage has become a significant cost factor in datacenters. Server solutions that use less power save a company month after month. We measured the power each of the server solutions used during testing. As Figure 3 shows, with Dell

EqualLogic PS6210XS storage, the server consumed less than one-third the power that the competing industry-leading, similarly configured SAN solution used.

This means that **the Dell EqualLogic PS6210XS storage reduced power usage by more than two-thirds**. This reduction can translate to dramatically lower electric bills.

Figure 3: The Dell EqualLogic PS6210XS solution consumed 72.6 percent less energy than the competing industry-leading, similarly configured SAN solution.

Peak power usage (watts) (lower numbers are better)

Industry-leading SAN storage solution: 1,253
Dell EqualLogic 6210XS: 343

Because both performance and power usage are so important to businesses, companies often consider the performance per watt that various solutions can deliver. For the database testing we performed in our labs, this metric is a simple calculation:

$$Orders\ per\ minute\ \div\ Watts$$

As Figure 4 shows, because it doubled performance while using roughly half the power, **the Dell EqualLogic PS6210XS storage solution delivered a whopping 9.5 times the performance per watt** than the competing industry-leading, similarly configured SAN solution did.

Figure 4: The Dell EqualLogic PS6210XS solution delivered 850.0 percent more orders per minute per watt than the competing industry-leading, similarly configured SAN solution.
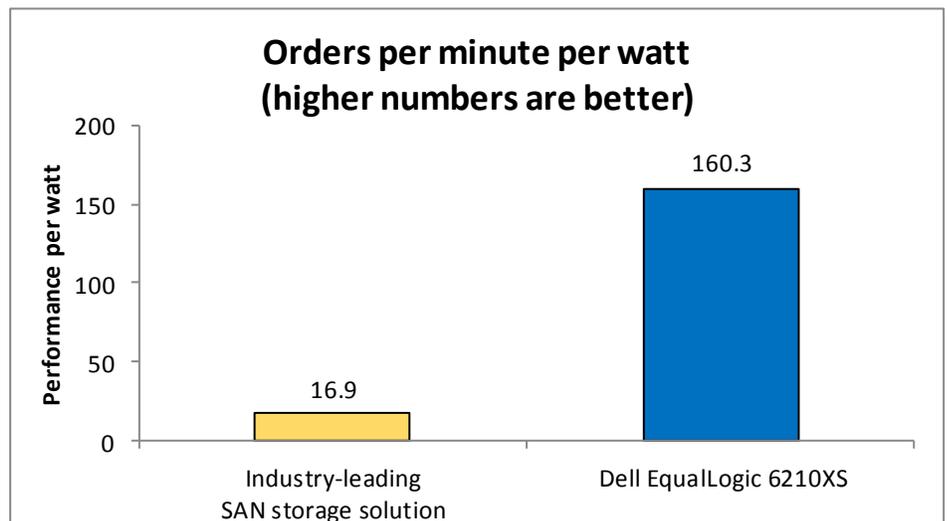
Orders per minute per watt (higher numbers are better)

Performance per watt

Industry-leading SAN storage solution: 16.9
Dell EqualLogic 6210XS: 160.3

Figure 5 summarizes our findings.

	Industry-leading SAN storage solution	Dell EqualLogic PS6210XS
Configuration	12x 200GB SSD 24x 600GB 10k SAS	7x 400GB SSD 17x 600GB 10k SAS
Raw Capacity	16.8 TB	13 TB
Usable capacity	5.8 TB	9.3 TB
Orders per minute	21,142	54,979
Application response time (ms) (lower numbers are better)	418	212
Peak power usage (watts) (lower numbers are better)	1,253	343
Orders per minute per watt (higher numbers are better)	16.9	160.3

Figure 5: Summary of OLTP solution test setup and results.

WHAT WE TESTED

Features of the Dell EqualLogic PS6210XS 10GbE iSCSI array

The EqualLogic PS6210XS 10GbE iSCSI array combines the low-latency and high-IOPS strength of solid-state storage with the raw capacity of traditional hard disk drives in a single-chassis solution. Features include:

- **Agility.** Use storage that fits the demands of your server or application. EqualLogic dynamically tiers data on SSD or HDD, depending on the performance requirements for a specific situation.
- **Upgradable.** Start out using your existing 10GbE SFP+ modules, and build out to cost-effective 10GBASE-T as your budget allows. Move volumes between storage pools without downtime, and change hardware without disruption.
- **Robust.** Vertical port sharing keeps your bandwidth at full speed, even if a network port fails. Automatic load-balancing keeps data moving reliably to and from your physical or virtual server farm.
- **Management.** EqualLogic Host Software, Host Integration Tools, and EqualLogic SAN Headquarters (SAN HQ) provide the tools administrators need to keep a high-level view of the storage system, while EqualLogic Group Manger providing the flexibility to make granular changes as needed.

Features of the Dell PowerEdge R710 rack server

The Dell PowerEdge R710 is a high-performance server that offers many features for maximizing performance and for minimizing operational expenses, including the following:

- **64-bit computing with large RAM capacities.** The Dell PowerEdge R710 allows for up to 144 GB of RAM via its 18 DIMM slots, which accept any of the following sizes of DDR3 RAM: 1GB, 2GB, 4GB, or 8GB. These amounts of memory, along with the 64-bit Windows software platform, allow you to virtualize multiple servers in a single machine.
- **Power.** The Dell PowerEdge R710 includes enhancements that let it use less energy than many older servers do.
- **Processors.** The Dell PowerEdge R710 uses the Intel Xeon Processor 5500 series. These processors automatically adjust their speed and energy usage to meet the requirements of your applications, improving performance and saving power.
- **Management.** The Dell PowerEdge R710, like all late-model Dell servers, comes with the Dell Lifecycle Controller. This tool simplifies management by providing a single interface for management functions and by storing critical information in the system itself. There are no CDs or USB keys to keep track of for drivers or firmware. In addition, you can use the Lifecycle Controller in conjunction with Microsoft System Center Configuration Manager 2007 to streamline remote operating system deployments.

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.

CONCLUSIONS

The effectiveness of your OLTP database environment can depend to an enormous degree on the storage system you select. We compared a database server solution using the Dell EqualLogic PS6210XS with a one using competing industry-leading SAN storage.

The EqualLogic PS6210XS solution was overwhelmingly superior in all areas we tested. It delivered twice the performance with half the response time, and used a fraction of the power.

These factors make it clear that any business that relies on its database servers and wants to get the greatest return on its storage investment must consider the Dell EqualLogic PS6210XS.

APPENDIX A – SYSTEM CONFIGURATION INFORMATION

Figure 6 provides detailed configuration information about the Dell EqualLogic PS6210XS array, and Figure 7 details the configuration of an industry-leading SAN storage solution.

Storage array	Dell EqualLogic PS6210XS array
Number of storage arrays	1
Number of storage controllers per array	2
RAID level	6 (accelerated)
10 Gbps interfaces per controller	2
Firmware version	7.0.0
Number of drives, type 1	7
Model number	LB400M
Drive size (GB)	400
Drive buffer size (MB)	N/A
Drive RPM	N/A
Drive type	SSD
Number of drives, type 2	17
Model number	ST9600205SS
Drive size (GB)	600
Drive buffer size (MB)	16
Drive type	6Gb SAS

Figure 6: Detailed configuration information for the Dell EqualLogic PS6210XS array.

Storage array	Industry-leading SAN solution
Number of storage arrays	1
Number of storage controllers per array	2
RAID level	Dual Parity
10 Gbps interfaces per controller	2
Numbers of 3.5 disk enclosures	1
Numbers of 2.5 disk enclosures	1
Drive size (GB)	200
Number of drives, type 1	12
Drive buffer size (MB)	N/A
Drive RPM	N/A
Drive type	SATA SSD
Number of drives type 2	24
Drive size (GB)	600
Drive buffer size (MB)	16
Drive type	6Gb SAS

Figure 7: Detailed configuration information for the industry-leading SAN storage solution we tested.

System	Dell PowerEdge R710
Power supplies	
Total number	2
Maximum wattage of each (W)	870
Cooling fans	
Total number	5
Dimensions (h x w) of each	2.5" x 2.5"
General	
Number of processor packages	2
Number of cores per processor	6
Number of hardware threads per core	2
CPU	
Vendor	Intel®
Name	Xeon®
Model number	X5670
Stepping	B1
Socket type	FCLGA1366
Core frequency (GHz)	2.93
Bus frequency (GT/s)	6.4 GT/s
L1 cache	32 KB + 32 KB (per core)
L2 cache	256 KB (per core)
L3 cache (MB)	12
Platform	
Vendor and model number	Dell PowerEdge™ R710
Motherboard model number	0N0H4P
BIOS name and version	Dell 6.3.0
BIOS settings	Default
Memory module(s)	
Total RAM in system (GB)	288 GB
Vendor and model number	Hynix HMT42GR7MFR4C-PB
Type	PC3-12800R
Speed (MHz)	1,600
Speed running in the system (MHz)	1,600
Size (GB)	16
Number of RAM module(s)	18
Rank	Dual
Chip organization	Double-sided
Hard disk	
Vendor and model number	Dell Enterprise Savvio 15k.2
Number of disks in system	2
Size (GB)	147
Buffer size (MB)	16
RPM	15K
Type	SAS

System	Dell PowerEdge R710
Controller	Dell PERC 6/i Integrated RAID Controller
Network adapter	
Vendor and model number	Intel Ethernet Controller 10 Gigabit X520-AT2
Type	PCI-E

Figure 8: Detailed configuration information for the test servers.

APPENDIX B: DETAILED CONFIGURATION INFORMATION

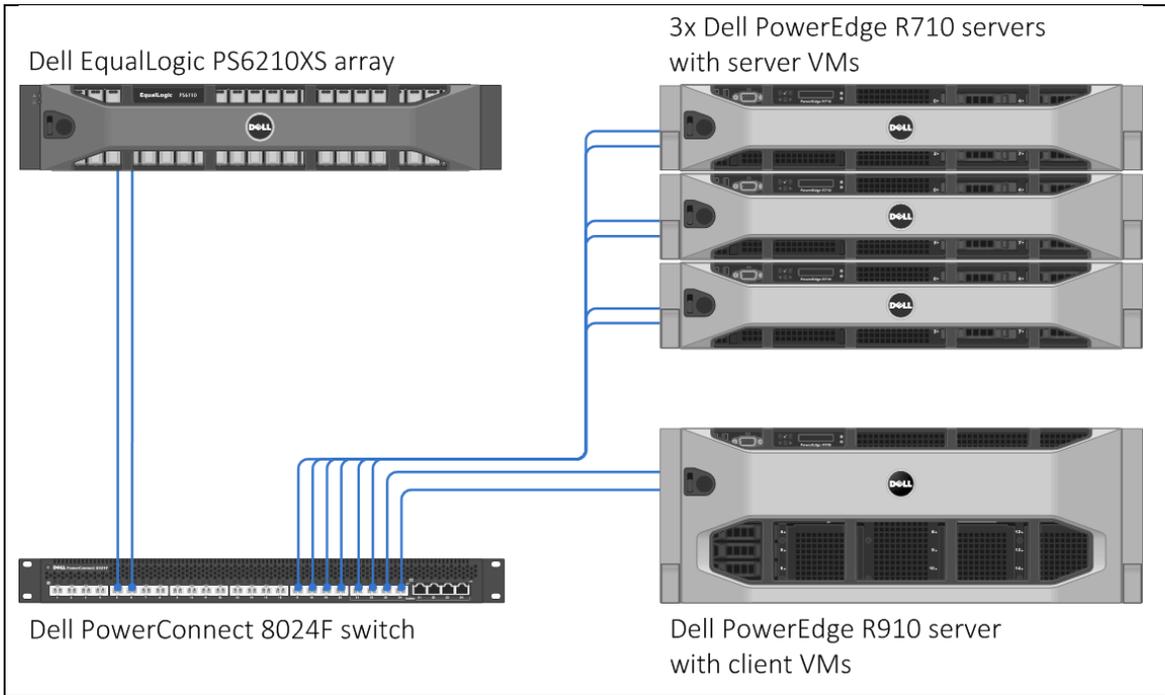Figures 9 and 10 show the test bed setup we used for the two solutions.
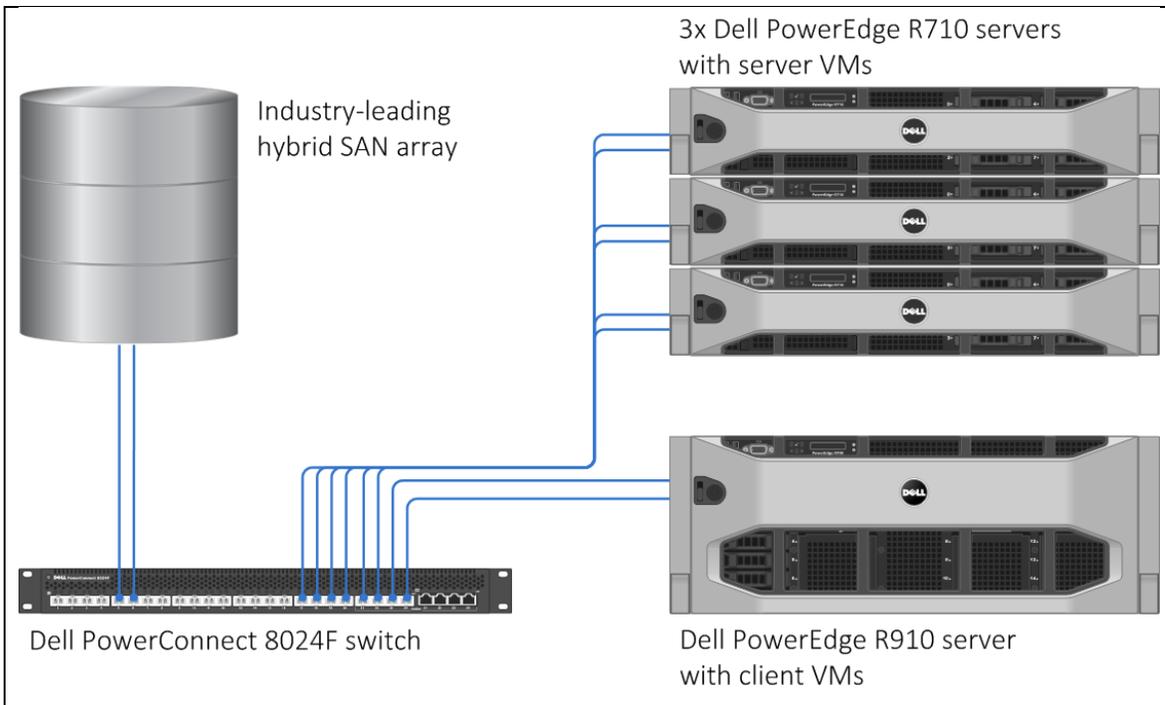

Figure 9: Test bed setup for the Dell EqualLogic PS6210XS storage solution.

Figure 10: Test bed setup for the industry-leading SAN storage solution.

SETTING UP THE STORAGE

To host the data for our testing, we first created an EqualLogic storage group called EQL. In the EQL group, we added a Dell EqualLogic PS6210XS array to the group and created an accelerated RAID 6 pool called EQL. We configured the industry-leading SAN array as per vendor-specified best practices and we updated the array to current supported software and firmware levels. We used all available SAS disks and added all available SSDs as cache.

Configuring the EqualLogic PS6210XS

We configured the EqualLogic PS6210XS array with 2 x 3TB LUNS.

1. Using the command-line console, via serial cable, reset the EqualLogic PS6210XS by using the `reset` command.
2. Supply a group name, group IP address, and IP address for eth0.
3. After group creation, using a computer connected to the same subnet as the storage, use the Dell EqualLogic Web interface to do the following:
   a. Click the array, and choose Yes when prompted to configure the member. Choose RAID 6 (accelerated).
   b. Create two LUNs.
   c. Enable shared access to the iSCSI target from multiple initiators on the volume.
   d. Create an access control record for the volume.

Configuring the industry-leading SAN array

Using vendor-supported tools we configured the industry-leading SAN array to use all available disk space on each controller to present 2 x 2.8TB, cache-enabled LUNS. We set all network interfaces to MTU 9000.

SETTING UP AND CONFIGURING DELL R710 SERVERS, LOCAL STORAGE, AND BIOS SETTINGS

We installed and configured three Dell PowerEdge R710 servers with system defaults and enabled the Performance power profile. We configured each server's PERC RAID controller for RAID 1, and installed the server OS on the local RAID 1 storage. We installed vSphere 5.5 on all three servers.

Installing vSphere 5.5 on a Dell PowerEdge R710

1. Insert the ESXi 5.5 disk, and select Boot from disk.
2. On the Welcome screen, press Enter.
3. On the End User License Agreement (EULA) screen, press F11.
4. On the Select a Disk to install or Upgrade screen, select the relevant volume to install ESXi on, and press Enter.
5. On the Please Select a Keyboard Layout screen, press Enter.
6. On the Enter a Root Password screen, assign a root password, and confirm it by entering it again. Press Enter to continue.
7. On the Confirm Install screen, press F11 to install.
8. On the Installation Complete screen, press Enter to reboot.

Configuring ESXi after installation (data network)

1. On the ESXi 5.5 screen, press F2, enter the root password, and press Enter.
2. On the System Customization screen, select Troubleshooting Options, and press Enter.
3. On the Troubleshooting Mode Options screen, select Enable ESXi Shell, and press Enter.
4. Select Enable SSH, press Enter, and press Esc.
5. On the System Customization screen, select Configure Management Network.
6. On the Configure Management Network screen, select IP Configuration.
7. On the IP Configuration screen, select Set static IP; enter an IP address, subnet mask, and default gateway; and press Enter.
8. On the Configure Management Network screen, press Esc. When asked if you want to apply the changes, press Y.
9. Log into the host as `root` with the vSphere client.
10. Select the Configuration tab, and click Networking.
11. Configure vSwitch0 by clicking Add Networking…
12. Click the Network Adapters tab.
13. Click Add…
14. Select vmnic0, and click Next.
15. In the vSwitch0 properties, click Add…
16. Create a virtual machine network, click Next, and click Finish.

Configuring ESXi after installation (storage network)

1. Select the Configuration tab, and click Networking.
2. Click Add networking.
3. Select VMkernel, and click Next.
4. Select Create a vSphere standard switch, and click Next.
5. Type iSCSI, and click Next.
6. Enter the appropriate IP address and subnet mask, and click Next.
7. Click Finish.
8. On vSwitch1, click Properties.
9. Click vSwitch, and then click Edit.
10. Type `MTU 9000`, click OK.
11. Click iSCSI and Edit.
12. Type `MTU 9000`, click OK.

Creating the vSphere data stores on iSCSI targets

Note: All data stores are created once on the first vSphere host. Additional vSphere nodes do not require datastore re-creation.

1. Log into the host as `root` with the vSphere client.
2. Click Configuration tab→Storage→Add Storage.
3. Select the first EqualLogic volume, and click Next.

4. Select VMFS-5, and click Next.
5. Review the disk layout, and click Next.
6. For Datastore name, type EQL1 and click Next.
7. For Capacity, select Maximum Available Space, and click Next.
8. Click Finish to create the data store.
9. Repeat steps 1 through 8 to create the second data store on iSCSI storage.

Setting up the first virtual machine

1. Connect to the first ESX server via the VMware vSphere Web client.
2. Log in as `root` to the ESX server.
3. Click the Virtual Machines tab.
4. Right-click, and choose New Virtual Machine.
5. Choose Custom, and click Next.
6. Assign the name to the virtual machine, and click Next.
7. Select the first host, and click Next.
8. Select the first LUN for the storage, and click Next.
9. Choose Virtual Machine Version 9, and click Next.
10. Choose Windows, choose Microsoft Windows Server® 2012 (64-bit), and click Next.
11. For CPUs, select one virtual processor socket, with four cores per virtual socket, and click Next.
12. Choose 64GB RAM, and click Next.
13. Click 1 for the number of NICs, select VMXNET3, connect to the vSwitch0 network, and click Next.
14. Leave the default virtual storage controller, and click Next.
15. Choose to Create a new virtual disk, and click Next.
16. Set the OS virtual disk size to 85GB, choose thick-provisioned lazy-zeroed, specify the OS datastore on the external storage, and click Next.
17. Keep the default virtual device node (0:0), and click Next.
18. Click Finish.
19. Right-click the VM, and choose Edit Settings.
20. Click the Resources tab, and click Memory.
21. Select reserve all guest memory, and click OK.
22. Connect the VM virtual CD-ROM to the Microsoft Windows Server 2012 installation disk.
23. Start the VM.

Installing the VM operating system on the first VM

1. At the Language Selection Screen, click Next.
2. Click Install Now.
3. Select Windows Server 2012 Enterprise (Full Installation), and click Next.
4. Click the I accept the license terms checkbox, and click Next.
5. Click Custom.

6. Click Next.

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

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

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

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

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

12. Enable remote desktop access.

13. Change the hostname, and reboot when prompted.

14. Create a shared folder to store test script files. Set permissions as needed.

15. 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.

16. Shut down the VM.

17. Clone the VM, hosting three VMs on each Dell PowerEdge R710 host.

Installing and configuring Microsoft SQL Server 2012

We installed Microsoft SQL Server 2012 on the VMs residing on the systems under test.

Configuring the SQL Server VM

After cloning, modify the SQL VM to contain two additional virtual disks:

- 400GB virtual disks for SQL database (Thick provisioned, eager-zeroed)
- 140GB virtual disks for SQL log data (Thick provisioned, eager-zeroed)

In the VM, configure the VM storage:

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

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

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

4. In the right pane, right-click the volume, and choose New Simple Volume…

5. At the welcome window, click Next.

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

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

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

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

Installing SQL Server 2012

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 2012 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. Click the checkbox 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 2012. We installed SQL Server 2012 SP1 and CU5.

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

Data generation overview

We generated the data using the Install.pl script included with DVD Store version 2.1 (DS2), providing the parameters for our 400GB 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 database schema was also generated by the Install.pl script.

After processing the data generation, we transferred the data files and schema creation files to a Windows-based system running SQL Server 2012. We built the 400GB database in SQL Server 2012, 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. 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 creation scripts in the DS2 download. We made size modifications specific to our 400GB database and the appropriate changes to drive letters.
2. We transferred the files from our Linux data generation system to a Windows system running SQL Server.
3. We created database tables, stored procedures, and objects using the provided DVD Store scripts.
4. We set the database recovery model to bulk-logged to prevent excess logging.
5. We loaded the data we generated into the database. For data loading, we used the import wizard in SQL Server Management Studio. Where necessary, we retained options from the original scripts, such as Enable Identity Insert.
6. We created indices, full-text catalogs, primary keys, and foreign keys using the database-creation scripts.
7. We updated statistics on each table according to database-creation scripts, which sample 18 percent of the table data.
8. On the SQL Server instance, we created a ds2user SQL Server login using the following Transact SQL (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 11 shows our initial file size modifications.

Logical name	Filegroup	Initial size (MB)
Database files		
primary	PRIMARY	5
cust1	DS_CUST_FG	46,589
cust2	DS_CUST_FG	46,589
cust3	DS_CUST_FG	46,589
cust4	DS_CUST_FG	46,589
ind1	DS_IND_FG	28,607
ind2	DS_IND_FG	28,607
ind3	DS_IND_FG	28,607
ind4	DS_IND_FG	28,607
ds_misc	DS_MISC_FG	470
orders1	DS_ORDERS	22,540
orders2	DS_ORDERS	22,540
orders3	DS_ORDERS	22,540
orders4	DS_ORDERS	22,540
Log files		
ds_log	Not applicable	102,400

Figure 11: Our initial file size modifications.

Running the test

Test start and run times

We ran all workloads concurrently in order to start and record all performance counters for this report. The specific testing parameters we used for the benchmark are included in the setup sections, and specifics for launching these tests are described below.

About running the DVD Store tests

We created a series of batch files, SQL scripts, and shell scripts to automate the complete test cycle. DVD Store outputs an orders-per-minute metric, which is a running average calculated through the test. In this report, we report the last OPM reported by each client/target pair. To ensure all threads successfully connected during the test run, we performed a very light run with a single thread, prior to the actual run.

Each complete test cycle consisted of the following general steps:
1. Clean up prior outputs from the target systems and the client driver systems.
2. Drop the database from the targets.
3. Restore the database on the targets.
4. Shut down the targets.
5. Reboot the host and client systems.

6. Wait for a ping response from the servers under test (the hypervisor systems), the client systems, and the targets.
7. Let the test servers idle for 10 minutes.
8. Start the DVD Store driver on the clients.
   We used the following DVD Store parameters for the initial warm-up period.
   ```
   ds2sqlserverdriver.exe --target=<target_IP> --ramp_rate=10 --run_time=30 --
   n_threads=1 --db_size=400GB --think_time=0.5 --detailed_view=Y --
   warmup_time=0 --report_rate=1 --csv_output=<drive path>
   ```
9. Clean up outputs from the target systems and the client driver systems for the warm-up period.
10. Let the test servers idle for another 10 minutes.
11. Start the DVD Store driver on the clients.
    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=400GB --think_time=0 --detailed_view=Y --
    warmup_time=5 --report_rate=1 --csv_output=<drive path>
    ```

ABOUT PRINCIPLED TECHNOLOGIES

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.