

CONSOLIDATING OLDER DATABASE SERVERS WITH THE INTEL PROCESSOR-POWERED DELL POWEREDGE R730xd USING SANDISK DAS CACHE

DELL™ POWEREDGE™ R730XD SERVER

with SanDisk® DAS Cache supported more users with lower average response times versus a legacy system*



POWERED BY
INTEL® XEON®
E5-2695 V3
PROCESSORS



*IBM® System x3650 M3 server

Servers in your enterprise data center purchased during the last hardware refresh cycle may have reached compute, storage, and memory capacity long ago, and applications that once ran with acceptable response times and performance have since deteriorated. IT professionals and decision makers must either buy additional server hardware to scale out or force users to live with underperforming applications, or perhaps both. In addition, legacy operating system software and database software is now reaching end-of-life support. The convergence of these elements mean that you face a critical refresh decision. Your organization needs powerful compute and storage flexibility. Each application and dataset has its unique needs, and you require a server solution—including the server model, storage, and software—that is flexible enough to adjust to changing workloads and datasets.

In the Principled Technologies labs, we tested the database performance of a four-year-old IBM System x3650 M3 server running Windows Server 2003 R2. Next, we looked at the database performance of two configurations of the Dell PowerEdge R730xd, powered by Intel Xeon E5-2695 v3 processors.¹ Like the older server, the R730xd used hard disk drives (HDDs) for persistent data; in addition, it used solid-state disks (SSDs) and SanDisk DAS Cache, a server-based data read and write caching solution that accelerates application performance. One of our configurations used mixed-use

¹ Note: Both of the Dell PowerEdge R730xd configurations we tested had 26 2.5-inch storage drives.



SATA SSDs and one used PCIe SSDs. Both configurations of the Dell PowerEdge server ran local versions of Windows Server 2012 R2 and SQL Server 2014.

We learned that the mixed-use SATA SSD configuration of the Dell PowerEdge R730xd could replace six of the tested legacy servers, while decreasing response time by 59 percent on each of the individual database applications. The PCIe SSD configuration of the Dell PowerEdge R730xd could also replace six legacy servers, but decreased latency even further resulting on lower average response time- by as much as 75 percent on each of database applications we tested. (We present our detailed results in [Appendix C.](#))

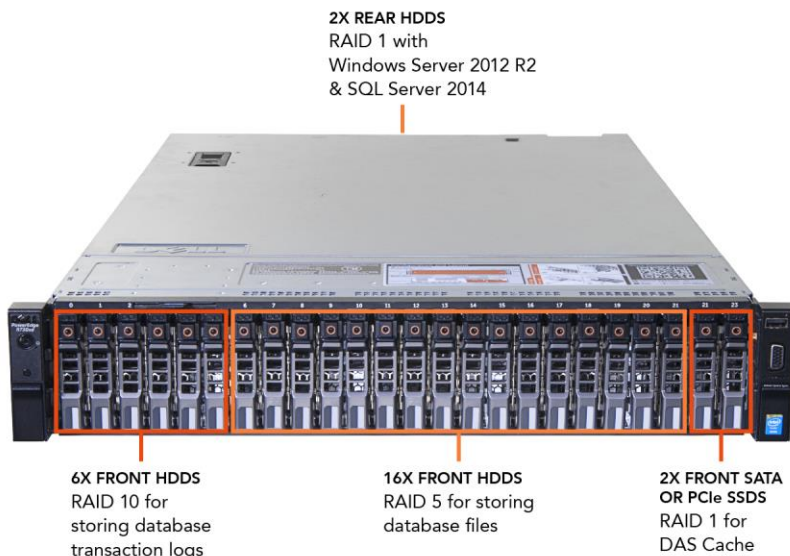
If you upgraded to the new Intel processor-powered Dell PowerEdge R730xd running SQL Server 2014, you could consolidate multiple older servers and improve application performance by delivering much faster response time. You could also experience the savings that typically come with running fewer servers—from reduced power consumption, cabling, rack space, and so forth. You would also be making an investment in your company’s future, because the storage flexibility of the R730xd means that your server can grow along with your needs.

STORAGE FLEXIBILITY IN 2U

Powered by the Intel Xeon E5-2660 v3 processors, Dell PowerEdge R730xd is Dell’s new 2U server designed with storage flexibility and agility in mind. With up to 24 DDR4 DIMMs of memory and with several storage variations, including 26 2.5-inch drives, and the hybrid R730xd chassis, which mixes high-capacity 3.5-inch disks and high-speed 1.8-inch SATA SSDs, you can tailor the server to your specific performance needs and make changes as your storage needs change. It might be that three SSDs are sufficient to handle your current database server load, but a year from now your needs will increase dramatically. With the PowerEdge R730xd, you can configure your drives the way that makes sense today and add more SATA SSDs and/or PCIe SSDs when the time comes.

The model we tested had 8 DDR4 DIMMs of memory and 26 2.5-inch drives. [Figure 1](#) shows how we configured the PowerEdge R730xd storage drives in our testing. Because of the great flexibility of this server, this is one of many possible configurations and could be customized according to your workloads and requirements.

Figure 1: The drive configuration we used in our testing, one of many possible options with the Dell PowerEdge R70xd.



The PowerEdge R730xd supports hardware high availability, and comes standard with iDRAC8 with Lifecycle Controller and Dell OpenManage, all of which streamline management.

Learn more at www.dell.com/us/business/p/poweredge-r730xd/pd.

SANDISK DAS CACHE ACCELERATES YOUR APPLICATIONS

The Dell PowerEdge R730xd powered by Intel Xeon E5-2660 v3 processors can run SanDisk DAS Cache for Windows, which accelerates the speed of storage input-output (I/O) operations, and therefore improves the performance of I/O-intensive applications such as database applications.

DAS Cache leverages any PCIe, NVMe, SAS, or SATA SSDs on the host server to create a read-write cache for the most frequently accessed or “hot” data. Typically, a minority of the active dataset accounts for 70 percent to 80 percent of server I/O. Accelerating this hot data on a SSD-based cache tier can deliver much greater performance than using hard disk drives.

The SanDisk DAS Cache software is transparent to existing software layers and requires no changes to running applications or the underlying storage configuration.

Learn more at www.dell.com/learn/us/en/04/server-technology-components-caching

OUR TEST APPROACH AND FINDINGS

We set out to show that a single Dell PowerEdge R730xd, powered by Intel Xeon E5-2660 v3 processors, with a combination of traditional hard disk drives (HDDs) and solid-state drives (SSDs) with SanDisk DAS cache, could replace multiple IBM x3650 M3 servers using only HDDs. To do so, we used Benchmark Factory for Databases to build a moderately sized database and ran a TPC-C-like online transactional processing (OLTP) workload. (We present system configuration details in [Appendix A](#) and our precise testing steps in [Appendix B](#).)

First, we established a baseline set of parameters by testing the legacy server to see how many databases it could support, using an assumption of 5,000 users per database with default workload parameters. Our goal was to remain below 2 seconds of application response time.

We found that the legacy server could support two databases (10,000 concurrent users) while providing a response time of 1.05 seconds. When testing three and four databases, response times exceeded 8 seconds and 20 seconds respectively. Therefore, we determined the maximum number of databases for the legacy server was two.

Next, we used these established parameters—5,000 users per database using default think time—and tested the Dell PowerEdge R730xd powered by Intel to evaluate how many databases it could support using SanDisk DAS Cache with two SSD configurations, both of which used 400GB SSD capacity for caching purposes. First, we configured the Dell PowerEdge R730xd with two SATA SSDs to be used by DAS Cache as the cache pool. In this configuration, the server supported 12 SQL Server databases and 60,000 concurrent users—six times as many as the legacy server—and achieved a server response time of 0.42 seconds, 2.5 times as fast as that of the legacy server. Next, we replaced the two SATA SSDs with two PCIe SSDs for the cache pool. In this configuration, the server again supported six times as many databases and users as the legacy server and server response time improved even more— 0.26 seconds, four times as fast as that of the legacy server. We stopped consolidating at 12 SQL Server databases, as the storage acceleration consistently pushed the CPU utilization to over 75 percent.

[Figure 2](#) shows how both configurations of the Dell PowerEdge R730xd with DAS Cache running SQL Server 2014—with SATA SSDs and with PCIe SSDs— supported six times as many concurrent users as the legacy server supported.

Figure 2: Regardless of the storage configuration, the Dell PowerEdge R730xd supported six times the number of users as the HDD-based legacy server.

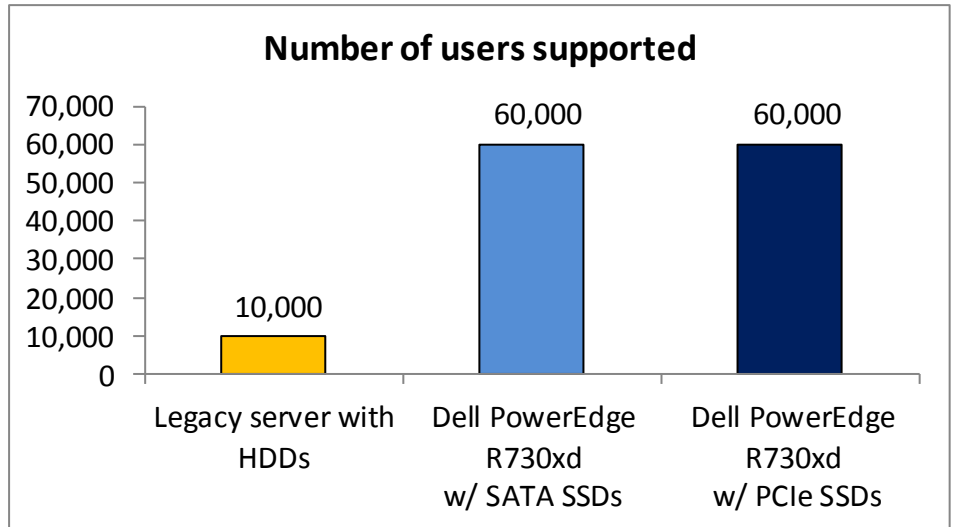
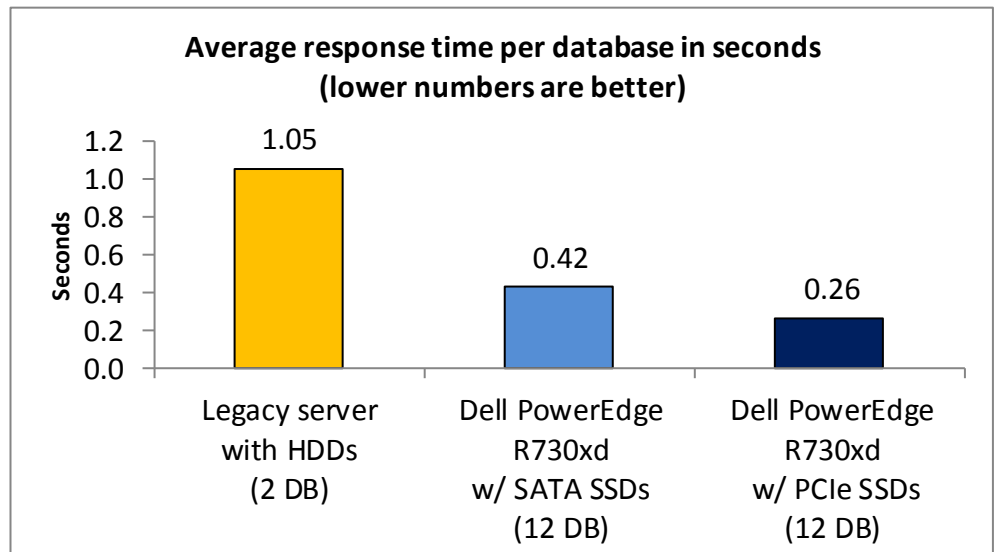


Figure 3 shows how the response time of the two Dell PowerEdge R730xd configurations—while supporting six times as many users—was much faster than that of the legacy server. With SATA SSDs, response time of the PowerEdge R730xd was less than half that of the legacy server and with PCIe SSDs, response time was one-fourth that of the legacy server.

Figure 3: Average response time for the three configurations across all databases. Lower numbers are better.



Note that the number of databases we ran on each server was a function of response time and CPU utilization. Running more than two databases on the legacy server caused response time to go above the highest acceptable 2-second response time. Running more than 12 databases on the Dell PowerEdge R730xd configurations caused the server to reach above 75 percent CPU utilization for sustained periods.

CONCLUSION

Upgrading to the new Intel Xeon E5-2695 v3 processor-powered Dell PowerEdge R730xd can benefit your data center in many ways—by replacing multiple older servers, by improving application performance through reduced response times, and by giving you an extreme flexibility when it comes to storage media.

In our labs, a single Dell PowerEdge R730xd performed the work of six legacy servers, supporting 60,000 users to the legacy server's 10,000 users. It achieved this increase while also decreasing the application's response time, which makes for a better user experience. The new server configured with SATA SSDs cut response time to less than half that of the legacy server. With PCIe SSDs, the Dell PowerEdge R730xd cut response time down to one-fourth the time of the legacy server. These data points translate to a noticeably speedier experience for users.

In addition to these improvements, the Dell PowerEdge R730xd has a very wide range of workload-optimized storage possibilities. You can configure it one way today, another way six months from now, and a third way a year from now. As your application needs—and even your budget—change over time. The Dell PowerEdge R730xd powered by Intel can grow with your business, making it an essential component of a future-ready data center.

APPENDIX A – SYSTEM CONFIGURATION INFORMATION

Figure 4 provides detailed configuration information for the test systems.

System	IBM System x3650 M3	Dell PowerEdge R730xd
Power supplies		
Total number	2	2
Vendor and model number	Emerson® 7001484-J000 Rev H	Delta Electronics® D750E-S6
Wattage of each (W)	675	750
General		
Number of processor packages	2	2
Number of cores per processor	4	14
Number of hardware threads per core	2	2
System power management policy	Balanced	Balanced
CPU		
Vendor	Intel	Intel
Name	Xeon	Xeon
Model number	X5570	E5-2695 v3
Stepping	D0	M0
Socket type	Socket 1366 LGA	LGA2011
Core frequency (GHz)	2.93	2.30
Bus frequency	6.4 GT/s	9.6 GT/s
L1 cache	32 KB + 32 KB (per core)	64 KB x 64 KB (per core)
L2 cache	256 KB (per core)	256 (per core)
L3 cache	8 MB	35 MB
Platform		
Vendor and model number	IBM® System x3650 M3 (7945)	Dell PowerEdge R730xd
Motherboard model number	IBM 69Y4438	2GHLV12
BIOS name and version	IBM Corp. D6E162AUS-1.20 (5/7/14)	Dell 1.0.2 (8/12/14)
BIOS settings	Default	Default
Memory module(s)		
Total RAM in system (GB)	48	128
Vendor and model number	Hynix® HMT31GR7BFR4A-H9	Hynix HMA42GR7MFR4N-TF
Type	PC3-10600R	PC4-17000
Speed (MHz)	1,333	2,133
Speed running in the system (MHz)	1,067	1,067
Timing/Latency (tCL-tRCD-tRP-tRASmin)	7-7-7-20	15-15-15-36
Size (GB)	8	16
Number of RAM module(s)	6	8

System	IBM System x3650 M3	Dell PowerEdge R730xd
Chip organization	Double-sided	Double-sided
Rank	Dual	Dual
SAS disks		
Vendor and model number	Seagate® ST93000605SS	Seagate ST93000605SS
Number of disks in system	6	24
Size (GB)	300	300
Type	10K.5 SAS 6Gb/s	10K.5 SAS 6Gb/s
SATA SSDs		
Vendor and model number	N/A	SanDisk SDLFOC7M 800G 1H
Number of disks in system	N/A	2
Size (GB)	N/A	800
Type	N/A	SATA 6 Gb/s
PCIe SSDs		
Vendor and model number	N/A	Samsung® MZWEI400HAGM-000D3
Number of disks in system	N/A	2
Size (GB)	N/A	400
Type	N/A	PCIe Gen 3
Disk controller		
Vendor and model	IBM ServeRAID M5015	Dell PERC H730P Mini
Controller cache (MB)	512	2048
Controller firmware	2.130.353-1893	25.2.1.0037
Operating system		
Name	Windows Server® 2003 R2	Windows Server 2012 R2
Build number	7600	9600
File system	NTFS	NTFS
Kernel	ACPI x64-based PC	ACPI x64-based PC
Language	English	English
Ethernet		
Vendor and model number	Broadcom® BCM5709C NetXtreme® II GigE	Broadcom BCM95720 NetXtreme II GigE
Number of ports	2	4
Type	Integrated	Integrated
Optical drive(s)		
Vendor and model number	HL-DT-ST GT30N	N/A
Type	DVD-RW	N/A
USB ports		
Number	4	4
Type	2.0	3.0

Figure 4: Detailed configuration information for the test systems.

APPENDIX B – HOW WE TESTED

About Benchmark Factory 7.0

Benchmark Factory® for Databases is a database performance testing tool that allows you to conduct database workload replay, industry-standard benchmark testing, and scalability testing. Using the incorporated load testing tools, you can make changes to your database environment, while mitigating the risks of unavoidable database changes such as patches and upgrades, operating system migrations, and adjustments to virtual machine configurations. In addition, its proprietary workload capture and replay supports Oracle and SQL Server database. For this study, we used the TPC-C workload.

Learn more at software.dell.com/products/benchmark-factory/

About our testing

We used Benchmark Factory to create a 1,000-warehouse database, approximately 130 GB in size. We ran the test with 5,000 users per database and default think times for 2 hours to ensure memory consumption in each configuration. We used a 2,000-millisecond average response time as reported by Benchmark Factory as an indicator of acceptable response and analyzed disk latencies to assess performance.

We configured the legacy IBM server with 48 GB of memory, and installed eight 300GB 10k disks for storage, the default-shipping configuration of the server at its release. We configured two of those disks for a RAID 1 volume and set up the remaining six disks with RAID 5 configuration. On the RAID 1 volume, we installed Windows Server 2003 R2 x64 and SQL Server 2008 R2, and stored SQL Server transaction logs. We used the RAID 5 volume to store the database files.

We configured the R730xd with 128 GB of DDR4 memory. For storage, we created a RAID 1 volume on the two rear-facing HDDs to hold the operating system and database software, Windows Server 2012 R2 and SQL Server 2014. We then configured six front HDDs, created a RAID 10 volume with no-read-ahead to store the database transaction logs, and created a RAID 5 volume using 16 front HDDs to store the database files. For the SATA SSD DAS Cache configuration, we enabled FastPath by creating a RAID 1 volume with the no-read-ahead and write-through enabled policies, and used the two 800GB SATA SSD disks for that volume. We formatted only 400 GB of usable space to match our PCIe configuration. For our PCIe DAS Cache configuration, we used two 400GB PCIe drives, mirrored using Windows software RAID.

Running Benchmark Factory 7.0

We created a 1,000-warehouse TPC-C database on SQL Server 2008 R2, and then created a .bak file of the database. We added this index before creating the backup file:

```
CREATE INDEX orders_nc1 ON c_order
(
  o_w_id,
  o_d_id,
  o_c_id,
  o_id
)WITH (PAD_INDEX = OFF, STATISTICS_NORECOMPUTE = OFF, SORT_IN_TEMPDB = OFF, IGNORE_DUP_KEY = OFF,
DROP_EXISTING = OFF, ONLINE = OFF, ALLOW_ROW_LOCKS = ON, ALLOW_PAGE_LOCKS = ON) ON MSSQL_fg
GO
```

Using that backup file and SQL Server's built-in restore options, we were able to create the databases on each server under test. We pointed Benchmark Factory clients hosted on load generation server, to each database on the

server under test (SUT), and simultaneously ran the TPC-C job. We ran Benchmark factory using default settings to simulate a predictable, real-world user load.

We captured various performance metrics on the SUTs during the run, such as CPU and RAM utilization, drive reads and writes, and DAS Cache usage statistics (R730xd only). We started all clients simultaneously, and gathered the results when the run finished.

Creating OS, database, log and DAS Cache volumes on Dell PowerEdge R730xd

1. Power on the server and press CTL-R to enter the RAID controller configuration.
2. Press F2 to create a new virtual disk and select (2) disks:
 - RAID-1
 - VD name: OS volume
3. Click Advanced, and select Initialize.
4. Click OK.
5. Press F2 to create a new virtual disk and select (6) disks:
 - RAID-10
 - VD name: Log volume
6. Click Advanced and under Read Policy, select No Read Ahead, and select Initialize.
7. Click OK.
8. Press F2 to create a new virtual disk and select (2) SATA SSD disks:
 - RAID-1
 - VD name: Cache volume
9. Click Advanced, and under Read Policy, select No Read Ahead
10. Under Write Policy, select Write Through, and select Initialize.
11. Click OK.
12. Click Advanced and under Read Policy, select No Read Ahead, and select Initialize.
13. Click OK.
14. Press F2 to create a new virtual disk and select (16) disks:
 - RAID-5
 - VD name: Database volume
15. Click Advanced, and select Initialize.
16. Click OK.
17. Hit ESC and select OK to exit.
18. Reboot the server.

Installing Microsoft Windows Server 2012 Datacenter Edition on Dell PowerEdge R730xd and Benchmark Factory client servers

1. Insert the installation media into the CD/DVD drive, and restart the server.
2. When the option appears, press F11 to enter the Boot Manager.
3. Select BIOS Boot Menu.
4. Select SATA Optical Drive, and press Enter.

5. Press any key when prompted to boot from DVD.
6. When the installation screen appears, click My language is English (United States).
7. Leave language, time/currency format and input method as default, and click Next.
8. Click Install now.
9. When the installation prompts you, enter the product key.
10. Select Windows Server 2012 Datacenter (Server with a GUI), and click Next.
11. Check I accept the license terms, and click Next.
12. Click Custom: Install Windows only (advanced).
13. Select Drive 0 Unallocated Space, and click Next, at which point Windows begins automatically, and restarts automatically after completing.
14. When the Settings page appears, fill in the Password and Reenter Password fields with the same password.
15. Log in with the password you set up previously.

Creating new disks in Windows Server 2012 Datacenter Edition on Dell PowerEdge R730xd

1. In the Server Manager window, click Tools, and click Computer Management.
2. In the left pane, click Disk Management.
3. Right-click the shaded area, and click New Simple Volume.
4. On the New Simple Volume Wizard that pops up, click Next.
5. Select a size (maximum, for logs and database volume, and 372GB for the SATA SSDs), and click Next.
6. Assign a drive letter, and click Next.
7. For the log and database volume select Format this volume with the following settings, and leave the default settings. Click Next.
8. For the SATA SSD DAS Cache volume, select Do not format this volume to make it a RAW device.
9. Click Finish.

Creating a Mirrored Volume for PCIe SSDs using Windows Disk Management on Dell PowerEdge R730xd

1. In the Server Manager window, click Tools, and click Computer Management.
2. Under Storage, Select Disk Management.
3. Right-click the first PCIe SSD, and select Online.
4. Right-click the second PCIe SSD, and select Online.
5. Right-click top of the unallocated space of the first PCIe SSD, and select New Mirrored Volume...
6. At the Welcome, screen click Next.
7. Select the disk under Available, click Add. Click Next.
8. Assign a drive letter, and click Next.
9. Select Do not format this volume to make it a RAW device. Click Next.
10. Click Finish.
11. At the Disk Management warning, click Yes.

Configuring Windows Update

1. In the left pane of the Server Manager window, click Local Server.
2. In the main frame, next to Windows Update, click Not configured.
3. In the Windows Update window, in the main pane, click Let me choose my settings.
4. Under Important updates, select Never check for updates (not recommended), and click OK.
5. In the left pane, click Check for updates, and install all available updates.
6. Close the Windows Update window.

Installing .Net Framework 3.5 on Dell PowerEdge R730xd

1. Click Start→Server Manager→Manage→Add Roles and Features.
2. Select Role-based or feature-based installation, and click Next.
3. Select the local server under Server Pool, and click Next twice.
4. Under Features select .NET Framework 3.5 Features, and click Next.
5. Click Install.
6. Click Close upon completion.

Installing and configuring SanDisk DAS Cache on Dell PowerEdge R730xd

1. Double-click the .msi file to start installation.
2. Select the Caching Engine and GUI Management components, and click Next.
3. Click Install to initiate the installation process.
4. Upon completion, click Finish and Reboot the server.
5. Start SanDisk DAS Cache by double-clicking on the desktop shortcut.
6. Select Configure this Machine.
7. Under Cache is Not Configured, select Configure.
8. Select Write-back as the cache mode.
9. Select the SATA SSD or PCIe SSD volume(s) you want SanDisk DAS Cache to use for caching.
10. Select the database volume to accelerate, and click Next.
11. Enter a unique Cache Name, and click Next.
12. At the summary screen, click Finish.
13. Confirm volume acceleration by clicking on the Volumes tab.

Installing SQL Server 2014 on Dell PowerEdge R730xd

1. Insert the installation DVD for SQL Server 2012 into the DVD drive.
2. Click Run SETUP.EXE. If Autoplay does not begin the installation, navigate to the SQL Server 2014 DVD, and double-click it.
3. In the left pane, click Installation.
4. Click New SQL Server stand-alone installation or add features to an existing installation.
5. Select the Enter the product key radio button, and enter the product key. Click Next.
6. Click the checkbox to accept the license terms, and click Next.
7. Click Use Microsoft Update to check for updates, and click Next.
8. Click Install to install the setup support files.

9. If there are no failures displayed, click Next.
10. At the Setup Role screen, choose SQL Server Feature Installation, and click Next.
11. At the Feature Selection screen, select Database Engine Services, Full-Text and Semantic Extractions for Search, Client Tools Connectivity, Client Tools Backwards Compatibility, Management Tools –Basic, and Management Tools – Complete. Click Next.
12. At the Installation Rules screen, after the check completes, click Next.
13. At the Instance configuration screen, leave the default selection of default instance, and click Next.
14. At the Server Configuration screen, choose NT Service\SQLSERVERAGENT for SQL Server Agent, and choose NT Service\MSSQLSERVER for SQL Server Database Engine. Change the Startup Type to Automatic. Click Next.
15. At the Database Engine Configuration screen, select the authentication method you prefer. For our testing purposes, we selected Mixed Mode.
16. Enter and confirm a password for the system administrator account.
17. Click Add Current user. This may take several seconds.
18. Click Next.
19. At the Error and usage reporting screen, click Next.
20. At the Installation Configuration Rules screen, check that there are no failures or relevant warnings, and click Next.
21. At the Ready to Install screen, click Install.
22. After installation completes, click Close.
23. Close the installation window.
24. Navigate to the SQL Server 2014 DVD, and double-click it.
25. In the left pane, click Installation.
26. Click New SQL Server stand-alone installation or add features to an existing installation.
27. At the Installation Type screen, select Perform a new Installation of SQL Server 2014. Click Next.
28. Select the Enter the product key radio button, and enter the product key. Click Next.
29. Click the checkbox to accept the license terms, and click Next.
30. At the Setup Role screen, select SQL Feature Installation. Click Next.
31. At the Feature Selection screen, select Database Engine Services and Full-Text and Semantic Extractions for Search. Click Next.
32. At the Instance Configuration screen, select named instance, and enter a name. Click Next.
33. At the Server Configuration screen, choose NT Service\SQLSERVERAGENT for SQL Server Agent, and choose NT Service\MSSQLSERVER for SQL Server Database Engine. Change the Startup Type to Automatic. Click Next.
34. At the Database Engine Configuration screen, select the authentication method you prefer. For our testing purposes, we selected Mixed Mode.
35. Enter and confirm a password for the system administrator account.
36. Click Add Current user.

37. Click Next.
38. At the Installation Configuration Rules screen, check that there are no failures or relevant warnings, and click Next.
39. At the Ready to Install screen, click Install.
40. After installation completes, click Close.
41. Repeat steps 24 through 40 to install a third SQL server instance.

Creating OS and database volumes on the legacy server

1. Power on the server, and press CTL-H to enter the RAID controller configuration.
2. Select Adapter 0, and select Start.
3. Select Configuration Wizard, and select New Configuration, click Next.
4. Select Virtual Drive Configuration, and click Next.
5. Select Manual Configuration, and click Next.
6. Select the first two disks, and click Add to tray to add them to Drive Group0.
7. Click Accept DG, and click Next.
8. Click Add to SPAN, and click Next.
9. Select RAID 1, and click Update Size. Click Accept.
10. Select Yes on the Write Back with BBU mode prompt.
11. Click Next, and click Accept.
12. Select Yes to Save the Configuration.
13. Select Cancel on the SSD caching screen.
14. Select Yes to initialize the drives.
15. Click Home.
16. Select Configuration Wizard, and select Add Configuration. Click Next.
17. Select Virtual Drive Configuration, and click Next.
18. Select Manual Configuration, and click Next.
19. Select the remaining six disks, and click Add to tray to add them to Drive Group1
20. Click Accept DG, and click Next.
21. Click Add to SPAN, and click Next.
22. Select RAID 5, and click Update Size. Click Accept.
23. Select Yes on the Write Back with BBU mode prompt.
24. Click Next, and click Accept.
25. Select Yes to Save the Configuration.
26. Select Cancel on the SSD caching screen.
27. Select Yes to initialize the drives.
28. Click Home.
29. Select Exit, and choose Yes Exit Application.
30. Reboot the System.

Installing Microsoft Windows Server 2003 R2 Enterprise Edition on the legacy server

1. Insert the installation media into the CD/DVD drive, and restart the server.
2. At the Welcome to Setup screen, press Enter.
3. At the Windows Licensing Agreement screen, press F8.
4. Select the appropriate drive, and press Enter.
5. Select Format the partition using NTFS file system, and press Enter.
6. At the Regional and Language Options screen, click Next.
7. At the Your Product Key screen, enter your product key, and click Next.
8. At the Computer Name and Administrator Password screen, choose an appropriate name and password, and click Next.
9. At the Date and Time Settings screen, select the appropriate settings, and click Next.
10. At the Networking Settings screen, select Typical settings, and click Next.
11. At the Workgroup or Computer Domain, select the default setting, and click Next.
12. After the server reboots, log in and insert Windows Server DC 2, and click OK.
13. At the Welcome to the Windows Server 2003 R2 setup Wizard, click Next.
14. At the End-user License Agreement, select I accept the terms in the license agreement, and click Next twice.
15. Click Finish.
16. Click the Update this server link.
17. Click Install Now.
18. Click Express to get the high-priority updates.
19. Click Install updates and Accept the license terms.
20. Restart the server upon completion.

Installing SQL server 2008 R2 SP2 on legacy server

1. Insert the installation media into the CD/DVD drive.
2. Click Run SETUP.EXE. If Autoplay does not begin the installation, navigate to the SQL Server 2008 R2 DVD, and double-click.
3. If the installer prompts you with a .NET 3.5 installation prompt, click Yes to install .NET Framework.
4. Accept the terms of the license agreement, and click Install.
5. Upon completion of .NET Framework 3.5, click Exit.
6. At the software update installation wizard for Hotfix for Windows x64 (KB942288-v4), click Next.
7. Select Agree at the software license terms screen.
8. Reboot the server.
9. Log in, and click Run SETUP.EXE. If Autoplay does not begin the installation, navigate to the SQL Server 2008 R2 DVD, and double-click.
10. In the left pane, click Installation.
11. Click New installation or add features to an existing installation.
12. At the Setup Support Rules screen, wait for the check to complete. If there are no failures or relevant warnings, click OK.

13. Select the Enter the product key radio button, and enter the product key. Click Next.
14. Click the checkbox to accept the license terms, and click Next.
15. Click Install to install the setup support files.
16. If there are no failures displayed, click Next.
17. At the Setup Role screen, choose SQL Server Feature Installation.
18. At the Feature Selection screen, select Database Engine Services, Full-Text Search, Client Tools Connectivity, Client Tools Backwards Compatibility, Management Tools –Basic, and Management Tools – Complete. Click Next.
19. At the Installation Rules screen, click Next once the check completes.
20. At the Instance configuration screen, leave the default selection of default instance, and click Next.
21. At the Disk space requirements screen, click Next.
22. At the Server configuration screen, choose NT AUTHORITY\SYSTEM for SQL Server Agent, and choose NT AUTHORITY\SYSTEM for SQL Server Database Engine and select Automatic startup for all services. Click Next.
23. At the Database Engine Configuration screen, select Mixed Mode.
24. Enter and confirm a password for the system administrator account.
25. Click Add Current user. This may take several seconds.
26. Click Next.
27. At the Error and usage reporting screen, click Next.
28. At the Installation Configuration rules screen, check that there are no failures or relevant warnings, and click Next.
29. At the Ready to Install screen, click Install.
30. After installation completes, click Next.
31. Click Close.
32. Double-click SQLServer2008R2SP2.exe
33. At the SQL Server 2008 R2 update screen, click Next.
34. Accept the license terms, and click Next.
35. At the Select Features Screen click Next.
36. At the Check Files In Use, click Next. Click Update.
37. Upon completion, click Close.

Installing Benchmark Factory 7.0 on client servers

1. Download the Benchmark Factory 7.0 trial software from <http://www.quest.com/benchmark-factory/>
2. Double-click the 64-bit MSI file, and click Next on the welcome screen.
3. Choose I accept the terms in the license agreement, and click Next.
4. Leave the default installation folder, and click Next.
5. Check Install the default, service based, repository database, and click Install.

Installing the Microsoft ODBC Driver 11 for SQL Server client servers

1. Download software from <http://www.microsoft.com/en-us/download/confirmation.aspx?id=36434>
2. Double-click the msodbcsql.exe file, and click Run.
3. At the Welcome screen, click Next.
4. Accept the license software agreement, and click Next.
5. At the Feature Selection screen, click Next.
6. Click Install, and click Finish.

Configuring Benchmark Factory client servers

1. Open the Benchmark Factory client.
2. Click Edit→Settings
3. Under General, select Benchmarks and then TPC-C.
4. Change the Benchmark scale to 1,000, and click Apply. Click Ok
5. Select the New Connection Icon.
6. Under Database Connection method for BMF select Microsoft SQL Server (ODBC)
7. Click Add DNS.
8. Select the System Data Source, and click Next....
9. Select the ODBC Driver 11 for SQL Server, and click Finish.
10. Enter a name and select the server you want to connect to, and click Next.
11. Select SQL Server login ID authentication and enter credentials, and click Next.
12. Select Change the default database to, and select the target database.
13. Click Next, and click Finish.
14. Click Test Data Source to confirm configuration.
15. Click Ok.
16. Return to the New Connection Screen, and select the recently created Data Source Name.
17. Enter a User Name and Password.
18. Click Create Connection.
19. Click the New Job Wizard Icon.
20. Select the connection for the database under test.
21. Click Add workload.
22. Select TPC-C, and click Import test.
23. Right-click Create Objects for TPC-C and select remove to eliminate the create database option.
24. Select TCP-C Transaction Mix, and click the User Load tab.
25. Under Selected User Load, click Delete All.
26. Under User Load select 5,000, and click Add.
27. Click the Timing tab and enter 2 hours for sampling time and 10 minutes for pre-sampling time.
28. Click the Agent Icon select the client server and add 10 agents.
29. Click Run Job to start the test.
30. Perform steps 1 through 29 on all other clients.

APPENDIX C – DETAILED TEST RESULTS

Figure 5 presents the detailed results of our testing.

# of supported databases	Legacy server		R730xd with DAS Cache - (2) SATA SSDs		R730xd with DAS Cache (2) PCIe SSDs	
	Response time (ms)	Avg. transactions/sec	Response time (ms)	Avg. transactions/sec	Response time (ms)	Avg. transactions/sec
1	0.924	251.85	0.403	257.97	0.248	260.34
2	1.180	252.93	0.442	257.87	0.281	260.16
3			0.378	258.57	0.231	260.58
4			0.435	257.77	0.271	260.11
5			0.417	258.02	0.264	260.20
6			0.453	257.96	0.283	259.98
7			0.435	258.15	0.278	260.28
8			0.459	257.80	0.277	260.30
9			0.444	258.04	0.284	260.28
10			0.434	258.26	0.258	260.54
11			0.452	257.94	0.263	260.48
12			0.410	258.56	0.210	261.21
Total average	1.052	252.39	0.423	258.01	0.262	260.37
Total users supported	10,000		60,000		60,000	
Total transactions/sec	505		3,097		3,124	
Avg. database volume latency sec/read	0.702		0.169		0.067	
Avg. database volume latency sec/write	0.663		0.096		0.022	
% of reduction in average response time			59.8%		75.1%	

Figure 5: Detailed results.

ABOUT PRINCIPLED TECHNOLOGIES



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