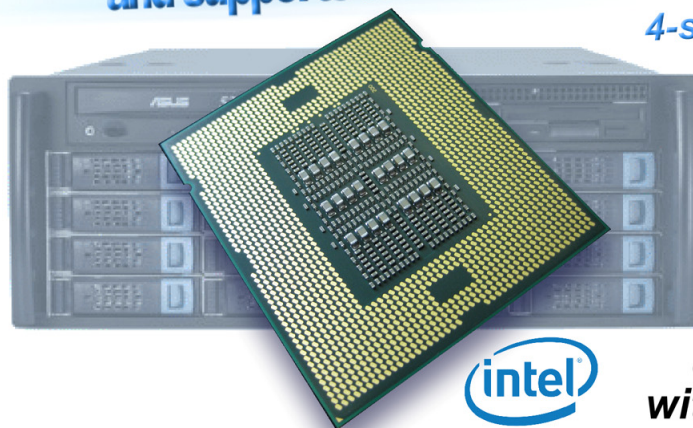


INTEL XEON PROCESSOR FOR EXPANDABLE SERVERS: DATABASE SERVER PERFORMANCE COMPARISON

Intel® Xeon® Processor X7560 delivers 150% better performance and supports four times as much RAM

4-socket server



versus



Intel Xeon
Processor X7460
4-socket server

**database servers
with a 50GB database**

OUR FINDINGS

The latest, most powerful Intel Xeon processors deliver better database server performance and increased memory capabilities compared to their predecessors. In Principled Technologies' tests in our labs, as the above graphic illustrates, a four-socket server with the new Intel Xeon Processor X7560 demonstrated significant advantages over the previous-generation Intel Xeon Processor X7460-based four-socket server in what would be a typical medium- to large-size departmental database.

OUR PROCESS

We used the open-source DVD Store benchmark to provide a workload representative of many real-world database applications. With it, we measured the performance of the four servers, each of which was running Microsoft® Windows Server® 2008 R2 Enterprise Edition with Microsoft SQL Server® 2008 R2 November CTP, demonstrating similar scaling in two separate test scenarios: a 50GB database size, with varying system memory capacity, and a 20GB database size, with equal memory capacity between the servers.



A PRINCIPLED TECHNOLOGIES TEST REPORT

Commissioned by Intel Corp.

MARCH 2010

PROJECT OVERVIEW

We tested the following servers:¹

- Four-socket server with the Intel Xeon Processor X7560 (24M Cache, 2.27GHz, 6.40GT/s Intel QPI)
- Four-socket server with the Intel Xeon Processor X7550 (18M Cache, 2.00GHz, 6.40GT/s Intel QPI)
- Two-socket server with the Intel Xeon Processor X6550 (18M Cache, 2.00GHz, 6.40GT/s Intel QPI)
- Four-socket server with the Intel Xeon Processor X7460 (16M Cache, 2.66GHz, 1066MHz FSB)

For testing, all servers ran Microsoft Windows Server 2008 R2 Enterprise Edition with Microsoft SQL Server 2008 R2 November CTP build number 10.50.1352.12 (X64). The goal of this report is to show the performance increase one can expect when upgrading to a new four-socket server with the Intel Xeon Processor X7560 or Intel Xeon Processor X7550, relative to the baseline of the four-socket server with the Intel Xeon Processor X7460 (formerly codenamed Dunnington) using two different database sizes and system memory amounts. We also tested the performance of the new two-socket server with the Intel Xeon Processor X6550, relative to the baseline of the four-socket server with the Intel Xeon Processor X7460.

NOTE: The test results of the two database sizes are NOT directly comparable due to differing workload sizes.

WORKLOAD

To build the workload, we used DVD Store Version 2 (DS2), an open-source simulation of an online e-commerce DVD store. DS2 has database components and Web server components, and includes driver programs that put heavy loads on these components. We used the included driver program to stress the database component. Each server under test ran multiple Microsoft SQL Server 2008 R2 November CTP instances to ensure we saturated the server's processors and memory. We configured each SQL Server 2008 R2 November CTP instance database with a 50GB or 20GB database.

The main DS2 metric is orders per minute (OPM), which the driver program calculates and reports via the Windows Performance Monitor utility on the client machines. We used the output from the driver program to record OPM, and we report the last OPM score the benchmark reported.

When DS2 is executing, simulated customers log in; browse movies by actor, title, or category; and purchase movies. Each DS2 order consists of a customer login, a number of searches for movies, and a purchase. Each search is by either title, actor, or category. The title and actor searches use full-text search. The other customer actions, including adding new customers, exercise a wide range of database functions.

¹ We found specific server information at <http://ark.intel.com>, a public website.

As we note above, because our goal was to isolate and test database server performance, we did not use the front-end Web client component of DS2. Instead, we ran the included driver application on client machines directly via its command-line interface. We used the default DS2 parameters and setup configuration, with the exceptions we note in the DVD Store setup section in the How We Tested section of this report.

Each client machine ran a single instance of DS2, with 32 threads. This simulated a heavily loaded environment; the load-generating client machines ran with no think time, blasting requests as quickly as the servers could handle them.

The DS2 driver application creates an OPM performance counter on the client. While the DVD Store client application outputs OPM at 10-second intervals visually, we chose to collect this OPM metric via a performance monitor counter on each client at 1-second intervals. We ran this workload on the servers for 30 minutes.

For more details about the DS2 tool, see <http://www.delltechcenter.com/page/DVD+Store>.

SYSTEM COMPARISON

Figure 1 shows a side-by-side comparison of the key hardware differences among the four servers. Note that the four-socket Intel Xeon Processor X7560-based server and Intel Xeon Processor X7550-based server support 1 TB of RAM, quadruple that of the four-socket Intel Xeon Processor X7460-based server. We used 8GB DIMMs for the 50GB database testing, so we tested the Intel Xeon Processor X7560-based server with 512GB of total memory. For the 20GB database testing, we tested all servers with an equal amount of total memory, so we tested the Intel Xeon Processor X7550-based server with 128GB system memory like the other servers. Appendix A presents detailed system information.

Hardware specifications	Intel Xeon Processor X7560-based server (four-socket)	Intel Xeon Processor X7550-based server (four-socket)	Intel Xeon Processor X6550-based server (two-socket)	Intel Xeon Processor X7460-based server (four-socket)
CPU	Intel Xeon Processor X7560	Intel Xeon Processor X7550	Intel Xeon Processor X6550	Intel Xeon Processor X7460
CPU speed (GHz)	2.27	2.00	2.00	2.66
Number of processor packages	4	4	2	4
Number of cores per processor package	8	8	8	6

Hardware specifications	Intel Xeon Processor X7560-based server (four-socket)	Intel Xeon Processor X7550-based server (four-socket)	Intel Xeon Processor X6550-based server (two-socket)	Intel Xeon Processor X7460-based server (four-socket)
Number of hardware threads per core	2	2	2	1
Memory type	PC3-10600R DDR3	PC3-10600R DDR3	PC3-10600R DDR3	PC2-5300F DDR2
Maximum supported memory (GB)	1,024	1,024	512	256

Figure 1: System configuration information for the four servers.

For each server, we configured two internal SAS hard drives as two RAID 1 arrays for the operating system and SQL Server 2008 R2 November CTP installations. We stored all database and log data on an EMC CX3-40 storage array, which we connected to the server via a QLogic QLE2462 dual-port fibre controller.

WHAT WE FOUND

As Figure 2 shows, using 50GB database servers, the Intel Xeon Processor X7560-based four-socket server achieved a DVD Store Version 2 score of 321,648 orders per minute (OPM), a 150.0 percent increase over the Intel Xeon Processor X7460-based four-socket server, which achieved a score of 128,671 OPM. The Intel Xeon Processor X6550-based two-socket server achieved a score of 178,332

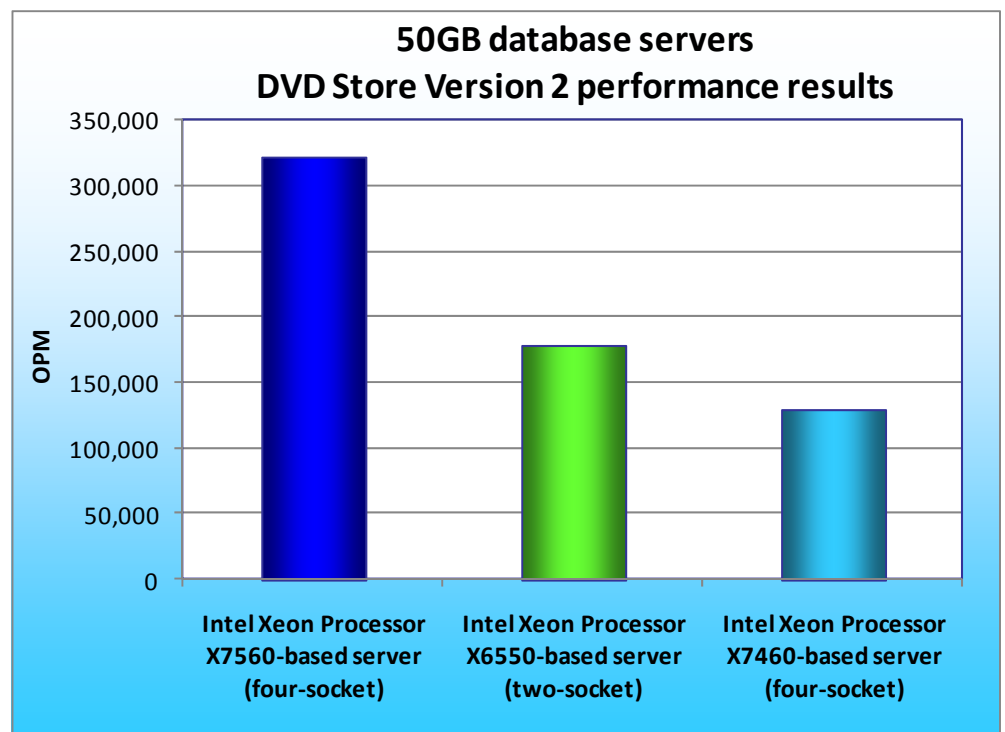


Figure 2: DVD Store Version 2 performance results, in OPM, for 50GB database servers with the Intel processors. Higher numbers are better.

OPM, a 38.6 percent increase over the Intel Xeon Processor X7460-based four-socket server.

Figure 3 shows the OPM results using 50GB database servers for the Intel Xeon Processor X7560-based four-socket server, the Intel Xeon Processor X6550-based two-socket server, and the Intel Xeon Processor X7460-based four-socket server. We ran multiple SQL Server 2008 R2 November CTP instances on these servers. The results show the OPM recorded by each test client and the total OPM for each server.

To find the peak number of SQL Server 2008 R2 November CTP instances each server could handle, we started by running one instance on each server. We performed additional runs, adding an instance for each run, until we found the server’s peak OPM score. We performed an additional run with one more SQL Server 2008 November CTP instance and made sure the server’s OPM score dropped below the previous results. We then ran two additional runs at the previous number of instances. We report the median of the three runs. We followed this same procedure for both 50GB and 20GB database testing.

50GB database servers			
OPM	Intel Xeon Processor X7560-based server (four-socket)	Intel Xeon Processor X6550-based server (two-socket)	Intel Xeon Processor X7460-based server (four-socket)
Client 1	67,677	43,375	42,979
Client 2	61,524	44,028	42,422
Client 3	63,881	44,776	43,270
Client 4	63,702	46,153	
Client 5	64,864		
Total OPM	321,648	178,332	128,671

Figure 3: OPM from the median run for each 50GB database server. Higher numbers are better.

As Figure 4 shows, using 20GB database servers, the Intel Xeon Processor X7550-based four-socket server achieved a DVD Store Version 2 score of 367,562 OPM, a 149.7 percent increase over the Intel Xeon Processor X7460-based four-socket server, which achieved a score of 147,192 OPM. The Intel Xeon Processor X6550-based two-socket server achieved a score of 214,033 OPM, a 45.4 percent increase over the Intel Xeon Processor X7460-based four-socket server.

Figure 5 shows the OPM results using 20GB database servers for the Intel Xeon Processor X7550-based four-socket server, the Intel Xeon Processor X6550-based two-socket server, and the Intel Xeon Processor X7460-based four-socket server. We ran multiple SQL Server 2008 R2 November CTP instances on these servers. The results show the OPM recorded by each test client and the total OPM for each server. We report the median of three runs.

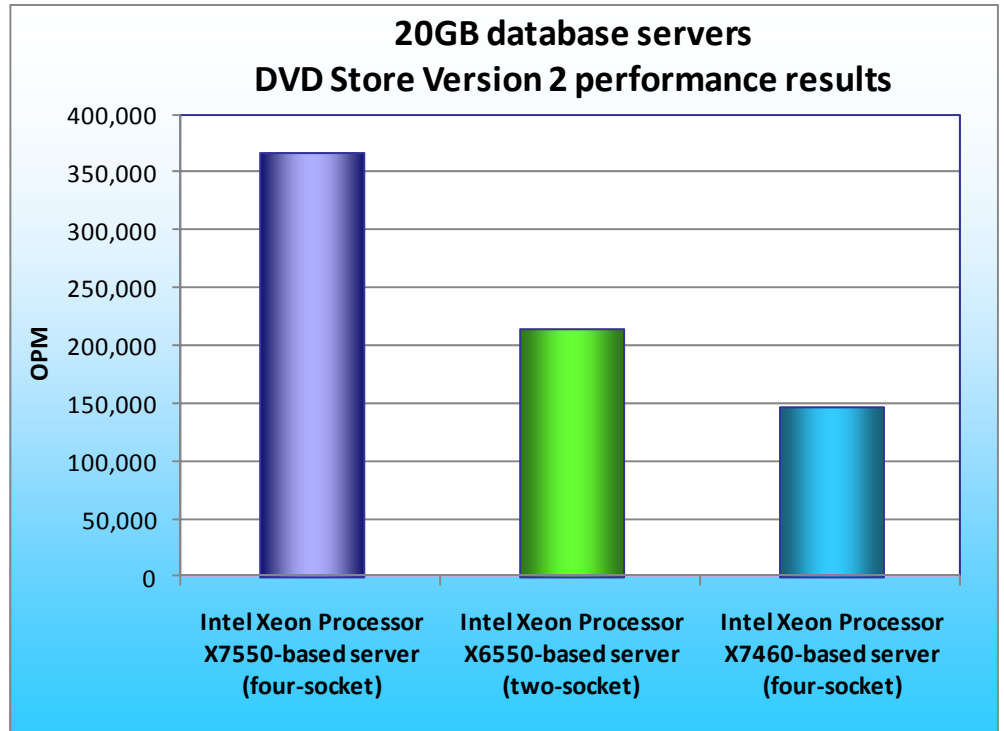


Figure 4: DVD Store Version 2 performance results, in OPM, for 20GB database servers with the Intel processors. Higher numbers are better.

20GB database servers			
OPM	Intel Xeon Processor X7550-based server (four-socket)	Intel Xeon Processor X6550-based server (two-socket)	Intel Xeon Processor X7460-based server (four-socket)
Client 1	78,066	71,592	49,198
Client 2	70,581	67,902	48,215
Client 3	76,652	74,539	49,779
Client 4	72,090		
Client 5	70,173		
Total OPM	367,562	214,033	147,192

Figure 5: OPM from the median run for each 20GB database server. Higher numbers are better.

HOW WE TESTED

Setting up and configuring the EMC storage

We used an EMC® CLARiiON® Fibre Channel connected SAN for this testing. The CX3-40 has two Storage Processors (SP), SP-A and SP-B. We used a QLogic QLE2462 dual-port host bus adapter (HBA) in each server for testing. We cabled one HBA port to each SP (A and B) on the SAN to balance the load between SPs. We used seven enclosures of disks on the SAN; with one exception, each enclosure had 15 disks. One of the trays had only 13 disks.

We ran multiple SQL Server R2 November CTP instances on the test servers. We created two RAID groups for each of the SQL Server R2 November CTP instances, one for data and one for logs. The data RAID group was composed of 13 disks. The log RAID group was composed of three disks. We then created one 400GB LUN in the data RAID group and one 96GB LUN in the logs RAID group. To balance processing load and disk transfers, we assigned the data LUN and the log LUN to different SPs.

Setting up the servers

We installed a fresh copy of Windows Server 2008 R2 Enterprise Edition on each server.

Installing Windows Server 2008 R2 Enterprise Edition on the hosts

1. Boot the server, and insert the Windows Server 2008 R2 installation DVD in the DVD-ROM drive.
2. At the Language Selection Screen, click Next.
3. Click Install Now.
4. Select Windows Server 2008 R2 Enterprise (Full Installation), and click Next.
5. Click the I accept the license terms check box, and click Next.
6. Click Custom.
7. Click Drive options (advanced).
8. Ensure you select the proper drive, and click New.
9. Click Apply.
10. Click Next.
11. At the User's password must be changed before logging on warning screen, click OK.
12. Type Password1 as the new password in both fields, and click the arrow to continue.
13. At the Your password has been changed screen, click OK.

Setting up network configuration on the server

1. Click Start→Control Panel→Network and Internet→Network Connections, and double-click the Local Area Connection assigned to client/server network traffic.
2. Select Internet Protocol Version 4 (TCP/IPv4), and click Properties.
3. In the Internet Protocol Version 4 (TCP/IPv4) Properties screen, select the Use the following IP address radio button.
4. Enter a valid static IP address, subnet mask, and default gateway.

5. Click OK, and click Close to exit.

Installing system updates in Windows Server 2008 R2

We installed the following updates on each server using the Windows Update feature:

- Security Update for Windows Server 2008 R2 x64 Edition (KB972270)
- Security Update for Windows Server 2008 R2 x64 Edition (KB974571)
- Cumulative Security Update for Internet Explorer 8 for Windows Server 2008 R2 x64 Edition (KB978207)
- Windows Malicious Software Removal Tool x64 - January 2010 (KB890830)
- Update for Windows Server 2008 R2 x64 Edition (KB974431)
- Update for Windows Server 2008 R2 x64 Edition (KB976098)
- Security Update for ActiveX Killbits for Windows Server 2008 R2 x64 Edition (KB973525)
- Security Update for Windows Server 2008 R2 x64 Edition (KB975467)

Installing SQL Server 2008 R2 November CTP on the server

1. Insert the installation DVD for SQL Server 2008 R2 November CTP build number 10.50.1352.12 (X64) into the DVD drive.
2. If autoplay does not begin the installation, navigate to the SQL Server 2008 DVD, and double-click.
3. If prompted with a .NET installation prompt, click Yes to enable the .NET Framework Core role.
4. At the SQL Server Installation Center screen, click Installation.
5. Click New installation or add features to an existing installation.
6. At the Setup Support Rules screen, click OK.
7. At the Product Key screen, specify the free Enterprise edition evaluation, and click Next.
8. At the License Terms screen, accept the license terms, and click Next.
9. At the Setup Support Files screen, click Install.
10. At the Setup Support Rules screen, click Next.
11. At the Setup Role screen, choose SQL Server Feature Installation, and click Next.
12. At the SQL Server 2008 R2 Feature Selection screen select the following features: Database Engine Services, Full-Text Search, Client Tools Connectivity, Client Tools Backwards Compatibility, Management Tools – Basic, Management Tools – Complete, and click Next.
13. At the Installation Rules screen, click Next.
14. At the Instance Configuration screen, leave the defaults, and click Next.
15. At the Disk Space Requirements screen, click Next.
16. At the Server Configuration screen, choose the service account, fill in a password if necessary, and click Next.
17. At the Database Engine Configuration screen, select Mixed Mode, fill in a password for the system administrator (sa) account, click Add Current User, and click Next.
18. At the Error Reporting screen, click Next.
19. At the Installation Configuration Rules screen, click Next.
20. At the Installation screen, click Install.
21. At the Complete screen, click Close.

Installing and configuring the database clients

For the DS2 scripts, we used a number of clients to simulate a number of users putting a load on the server. For our clients, we created a folder we called C:\ClientShare to store workload scripts, and shared this folder for access from our controller machine. We installed the .NET 3.5 framework on each client, as the DS2 test executable requires at least .NET2.0. We created a performance counter log on each client machine to track the number of orders per minute each database instance returns. We followed this process for each installation:

1. Install Microsoft Windows Server 2003 R2 Enterprise x86 Edition Service Pack 2 on the client.
2. Assign a computer name of `Clientx` for the database client, where `x` is the client number.
3. For the licensing mode, use the default setting of five concurrent connections.
4. Enter a password for the administrator log on.
5. Select Eastern Time Zone.
6. Use typical settings for the Network installation.
7. Type `Workgroup` for the workgroup.
8. Install Windows Updates, .NET 3.5 framework, and copy the DVD Store client executable into the `c:\clientshare` folder.

DVD Store setup

Data generation overview

We built the database schema using the scripts in the DS2 distribution package, though we made a few minor modifications. The DS2 stress tool provides options to generate 10MB, 1GB, or 100GB datasets. To get the tool to generate the 50 GB and 20 GB of user data we used in this test, we had to make a few straightforward changes to the source code and to the DVD Store application's scripts. Note: We created our test data on a Linux system to take advantage of the larger RAND MAX.

Editing the `ds2_create_orders.c` module

The module `ds2_create_orders.c` defines constants that define the maximum values for the customer ID and the product ID. The constants for the 50GB and 20GB database size did not exist. We added the constants for this size.

On the command line for the `ds2_create_orders.c` module, we specified the size. The available options were S (small), M (medium), and L (large). We added the case F for the 50GB database and the case W for the 20GB database. In the switch statement that sets the values for the variables `max_cust_id` and `max_prod_id`, we added cases that assigned them the proper values for the 50GB and 20GB database size.

We recompiled the `ds2_create_orders.c` module on Linux, following the instructions in the header comments. We used the following command line:

```
gcc -o ds2_create_orders ds2_create_orders.c -lm
```

Editing the `ds2_create_cust.c` module

We had to make the same changes to the `ds2_create_cust.c` module that we made to the `ds2_create_orders.c` module. On the command line for the `ds2_create_cust.c` module, we specified the size. The available options were S (small), M (medium), and L (large). We added the case F for the 50GB database and the case W for the 20GB database. In the switch statement that sets the values for the variables `max_cust_id` and `max_prod_id`, we added cases that assigned them the proper values for the 50GB and 20GB database size.

We recompiled the `ds2_create_cust.c` module on Linux, following the instructions in the header comments. We used the following command line:

```
gcc -o ds2_create_cust ds2_create_cust.c -lm
```

Generating the data for the 50GB database

We used shell scripts to run all four of the executables that generate the data. The distribution did not include shell scripts for the 50GB size. We wrote shell scripts based on the `ds2_create_cust_large.sh` and `ds2_create_orders_large.sh` scripts. The `ds2_create_prod` and `ds2_create_inv` executables did not ship with associated shell scripts, so we created shell scripts using the instructions in the readme files. We ran the shell scripts in the following order to generate the data for the 50GB database:

1. `ds2_create_orders_50gb.sh`
2. `ds2_create_inv_50gb.sh`
3. `ds2_create_prod_50gb.sh`
4. `ds2_create_cust_50gb.sh`

We waited until the processes finished before we moved onto the next step.

Generating the data for the 20GB database

We used shell scripts to run all four of the executables that generate the data. The distribution did not include shell scripts for the 20GB size. We wrote shell scripts based on the `ds2_create_cust_large.sh` and `ds2_create_orders_large.sh` scripts. The `ds2_create_prod` and `ds2_create_inv` executables did not ship with associated shell scripts, so we created shell scripts using the instructions in the readme files. We ran the shell scripts in the following order to generate the data for the 20GB database:

1. ds2_create_orders_20gb.sh
2. ds2_create_inv_20gb.sh
3. ds2_create_prod_20gb.sh
4. ds2_create_cust_20gb.sh

We waited until the processes finished before we moved onto the next step.

Creating the database

We modified the database creation SQL Server scripts in the DVD Store distribution package to build the database schema, which includes the file structure, tables, indices, stored procedures, triggers, and so on. We built a master copy of the 50GB and 20 GB database version for SQL Server 2008 R2 November CTP, and then used that master copy to restore our test database to the server between each test run. We stored the backup file on the C: drive of each server for quick access.

We followed these steps to create the database:

1. Create the database and file structure using database creation scripts in the DS2 download. Make size modifications specific to your 50GB and 20GB database and the appropriate changes to drive letters.
2. Create database tables, stored procedures, and objects.
3. Set the database recovery model to bulk-logged to prevent excess logging.
4. Load the data you generated into the database.
5. Create indices, full-text catalogs, primary keys, and foreign keys using the database-creation scripts.
6. Update statistics on each table according to database-creation scripts, which sample 18 percent of the table data.
7. On each SQL Server R2 November CTP instance, create 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
```

8. Set the database recovery model back to full.

We made the following changes in the build scripts:

- Because we varied the size of the datasets, we sized the files in our scripts to reflect the database size and the number of files per filegroup. We allowed for approximately 40 percent free space in our database files to ensure that filegrowth activity did not occur during the testing.

- We followed Microsoft's recommendation of having 0.25 to 1 file per filegroup per core. We used 8 files per filegroup on all servers.
- We did not use the DBCC PINTABLE command for the CATEGORIES and PRODUCTS tables, both because Microsoft recommends against this practice and because the commands do nothing in SQL Server 2008.
- We created a SQL Server login we called ds2user and mapped a database user to this login. We made each such user a member of the db_owner fixed database role.
- Using the DVD Store scripts as a reference, we created the full-text catalog and index on the PRODUCTS table manually in SQL Server Management Studio.

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.

Editing the workload script - ds2xdriver.cs module

To use the 50GB or 20GB database we created earlier, we had to change the following constants:

- In the routine Controller(), we changed the string sizes. We added the F option for 50 GB database and the W option for the 20GB database size. DS2 uses the sizes string to interpret the db_size_str option.
- In the class Controller, we changed the arrays MAX_CUSTOMER and MAX_PRODUCT. To each, we added values specifying the bounds for the customer and product IDs. The Controller() routine uses these arrays.
- We added a command-line parameter for the database name:

```
-database_name
```

Editing the workload script - ds2sqlserverfns.cs module

We changed the connection string to increase the number of available connections, to not use the default administrator (sa) account, and to include a parameter for the database name. We raised the available connections limit from the default of 100 to 200 to allow room for experimentation. We created a user account we called ds2User and used that account.

The ds2connect routine in the ds2sqlserverfns.cs module defines sConnectionString. We used the following string; the changes we made appear in bold:

```
string sConnectionString = "User ID=ds2User;Initial
Catalog="+dbname+";Max Pool Size=200;Connection Timeout=120;Data
Source=" + Controller.target;
```

Recompiling the ds2sqlserverdriver.exe executable

We recompiled the ds2xdriver.cs and ds2sqlserverfns.cs module in Windows by following the instructions in the header comments. Because the DS2 instructions were for compiling from the command line, we used the following steps:

1. Open a command prompt.
2. Use the cd command to change to the directory containing our sources.
3. Run the batch file C:\Program Files\Microsoft Visual Studio 9.0\Common7\Tools\vsvars32.bat. This sets up the environment variables for us.
4. Execute the following command:

```
csc /out:ds2sqlserverdriver.exe ds2xdriver.cs ds2sqlserverfns.cs  
/d:USE_WIN32_TIMER /d:GEN_PERF_CTRS
```

Testing procedure

To perform the test, we used a series of batch files. We stored batch files on each client, either under the C:\ServerShare folder or the C:\ClientShare folder, and we used the PsExec, Plink, and WinSCP utilities to coordinate the test procedures amongst the client machine, server machine, and controller. We use simple file sharing or secure FTP to copy files from machine to machine as we needed.

The testing procedure consisted of the following steps:

1. Execute batch files and shell scripts to clean up prior outputs on clients, the server, and the controller.
2. Pause for 5 minutes to wait for background tasks to complete before server reboot.
3. Reboot the clients, and wait for a ping response from the clients involved in testing.
4. Wait 10 additional minutes for any background tasks to complete.
5. Start the workload connections.
6. Start the workload ramp up period.
7. Start the workload.
8. Stop the workload.
9. Copy all output files to the controller.
10. Drop the database on each instance.
11. Restore the database on each instance.

APPENDIX A – SERVER CONFIGURATION INFORMATION

Figure 6 provides detailed configuration information about the test servers.

Servers	Intel Xeon Processor X7560-based server (four-socket)	Intel Xeon Processor X7550-based server (four-socket)	Intel Xeon Processor X6550-based server (two-socket)	Intel Xeon Processor X7460-based server (four-socket)
General processor setup				
Number of processor packages	4	4	2	4
Number of cores per processor package	8	8	8	6
Number of hardware threads per core	2	2	2	1
CPU				
Vendor	Intel	Intel	Intel	Intel
Name	Xeon X7560	Xeon X7550	Xeon X6550	Xeon X7460
Stepping	D0	D0	D0	A1
Socket type	LGA1567	LGA1567	LGA1567	Socket P (478)
Core frequency (GHz)	2.27	2.00	2.00	2.66
Bus frequency	6.4 GT/s	6.4 GT/s	6.4 GT/s	1,066
L1 cache (KB)	32 KB + 32 KB (per core)	32 KB + 32 KB (per core)	32 KB + 32 KB (per core)	32 KB + 32 KB (per core)
L2 cache (KB)	256 KB (per core)	256 KB (per core)	256 KB (per core)	3 x 3 MB (each 3 MB shared by 2 cores)
L3 cache	24	18	18	16
Thermal design power (TDP, in watts)	130	130	130	130
Platform				
Vendor and model number	Intel	Intel	Intel	Intel Fox Cove
Motherboard model number	QSSC-S4R	QSSC-S4R	QSSC-S4R	S7000FC4UR
Motherboard chipset	Intel ID3407	Intel ID3407	Intel ID3407	Intel ID3600

Servers	Intel Xeon Processor X7560-based server (four-socket)	Intel Xeon Processor X7550-based server (four-socket)	Intel Xeon Processor X6550-based server (two-socket)	Intel Xeon Processor X7460-based server (four-socket)
BIOS name and version	Intel QSSC-S4R.QCI.01.00.0023.020920102021 (02/09/2010)	Intel QSSC-S4R.QCI.01.00.0023.020920102021 (02/09/2010)	Intel QSSC-S4R.QCI.01.00.0023.020920102021 (02/09/2010)	SFC4UR.86B.01.00.0030 (12/10/2009)
BIOS settings	Default	Default	Default	Default
Memory modules				
50GB database testing				
Vendor and model number	Samsung M393B1K70BH1-CH9	N/A	Samsung M393B1K70BH1-CH9	Kingston KVR667D2D4F5/8G
Type	PC3-10600R DDR3	N/A	PC3-10600R DDR3	PC2-5300F DDR2
Speed (MHz)	1,333	N/A	1,333	667
Speed in the system currently running @ (MHz)	1,066	N/A	1,066	667
Timing/Latency (tCL-tRCD-iRP-tRASmin)	9-9-9-27	N/A	9-9-9-27	5-5-5-15
Size (GB)	512	N/A	256	256 GB
Number of RAM modules	64 x 8 GB	N/A	32 x 8 GB	32 x 8 GB
Chip organization	Double-sided	N/A	Double-sided	Double-sided
20GB database testing				
Vendor and model number	N/A	Kingston KVR1333D3D8R9S/2 Gv	Hynix HMT15R7BFR4C-G7 DB AA	Kingston KVR667D2D4F5/4GI
Type	N/A	PC3-10600R DDR3	PC3-8500R DDR3	PC2-5300F DDR2
Speed (MHz)	N/A	1,333	1,333	667
Speed in the system currently running @ (MHz)	N/A	1,066	1,066	667
Timing/Latency (tCL-tRCD-iRP-tRASmin)	N/A	9-9-9-27	9-9-9-27	5-5-5-15
Size (GB)	N/A	128	128	128

Servers	Intel Xeon Processor X7560-based server (four-socket)	Intel Xeon Processor X7550-based server (four-socket)	Intel Xeon Processor X6550-based server (two-socket)	Intel Xeon Processor X7460-based server (four-socket)
Number of RAM modules	N/A	64 x 2 GB	32 x 4 GB	32 x 4 GB
Chip organization	N/A	Double-sided	Double-sided	Double-sided
Hard disk				
Vendor and model number	Seagate ST9146802SS	Seagate ST9146802SS	Seagate ST9146802SS	Fujitsu MBB2147RC
Number of disks in system	2	2	2	2
Size (GB)	146	146	146	147
Buffer size (MB)	16	16	16	16
RPM	10,000	10,000	10,000	10,000
Type	SAS 3GB/s	SAS 3GB/s	SAS 3GB/s	SAS 3GB/s
Controller	Intel RAID Controller RS2BL080	Intel RAID Controller RS2BL080	Intel RAID Controller RS2BL080	Intel 631xESB/6321ESB/3100 Chipset Serial ATA Storage Controller-2680
Operating system				
Name	Windows Server 2008 R2 Enterprise	Windows Server 2008 R2 Enterprise	Windows Server 2008 R2 Enterprise	Windows Server 2008 R2 Enterprise
Build number	7600	7600	7600	7600
File system	NTFS	NTFS	NTFS	NTFS
Language	English	English	English	English
Network card/subsystem				
Vendor and model number	Intel 82576NS	Intel 82576NS	Intel 82576NS	Intel PRO/1000 EB
Type	Integrated	Integrated	Integrated	Integrated
Fibre adapter				
Vendor and model number	QLogic QLE2462 dual port controller	QLogic QLE2462 dual port controller	QLogic QLE2462 dual port controller	QLogic QLE2462 dual port controller
Type	PCI Express	PCI Express	PCI Express	PCI Express
USB ports				
Number	5	5	5	5
Type	USB 2.0	USB 2.0	USB 2.0	USB 2.0

Figure 6: Detailed configuration information for the test servers.

ABOUT PRINCIPLED TECHNOLOGIES



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