Dell EqualLogic PS4000XV performance with varying user counts running a combined database, email, and file server workload

Executive summary

Dell Inc. (Dell) commissioned Principled Technologies (PT) to determine how many users one Dell™ EqualLogic™ PS4000XV storage array[1] can support for small- and medium-business activity running on typical servers.

We used three benchmarking tools to test three types of simultaneous server activity:

- Database—DVD Store Version 2 (DS2)
- Email—Microsoft LoadGen (LoadGen)
- File server—Microsoft File Server Capacity Tool (FSCT)

To see how many users one Dell EqualLogic PS4000XV array could handle, we measured the PS4000XV throughput using the above three benchmarks. We present the normalized average throughput for a wide range of number of users.

As Figure 1 shows, the Dell EqualLogic PS4000XV could handle as many as 2,700 total users split evenly across the three types of work: 900 users running DS2 online transaction processing (OLTP), 900 users running Microsoft Exchange Server 2007, and 900 users running file server activities. As we added users, the throughput of Dell EqualLogic PS4000XV scaled almost linearly, roughly corresponding to the number of users, without any file server, database, or email overload. At 3,000 total users (1,000 users in each workload), the FSCT benchmark

KEY FINDINGS

- In our tests running email, database, and file server simultaneously, one unit of the Dell EqualLogic PS4000XV (15,000 RPM SAS disks in RAID 50) could handle as many as 2,700 simultaneous users. (See Figure 1.)

- When we increased the number of users in each workload from 100 to 900 (300 to 2,700 total users), the performance of the Dell EqualLogic PS4000XV (15,000 RPM SAS disks in RAID 50) scaled linearly with increasing I/O demand. (See Figure 1.)

- At 3,000 total users (1,000 users in each workload), although LoadGen and DVD Store benchmarks had passed the test criteria, the FSCT benchmark showed an overload condition, indicating that, even at 2,700 users, one unit of the Dell EqualLogic PS4000XV (15,000 RPM SAS disks in RAID 50) has sufficient IO headroom to accommodate additional tasks.

showed an overload condition. As a result, we report 2,700 users as user count result. However, the LoadGen and DVD Store benchmarks passed the test criteria at 3,000 total users, indicating that, even at 2,700 users, one unit of the Dell EqualLogic PS4000XV (15,000 RPM SAS disks in RAID 50) had IO headroom to accommodate additional tasks.

We used the Microsoft iSCSI initiator with the Dell™ EqualLogic™ Multipath I/O Device Specific Module (DSM) and the Dell™ EqualLogic™
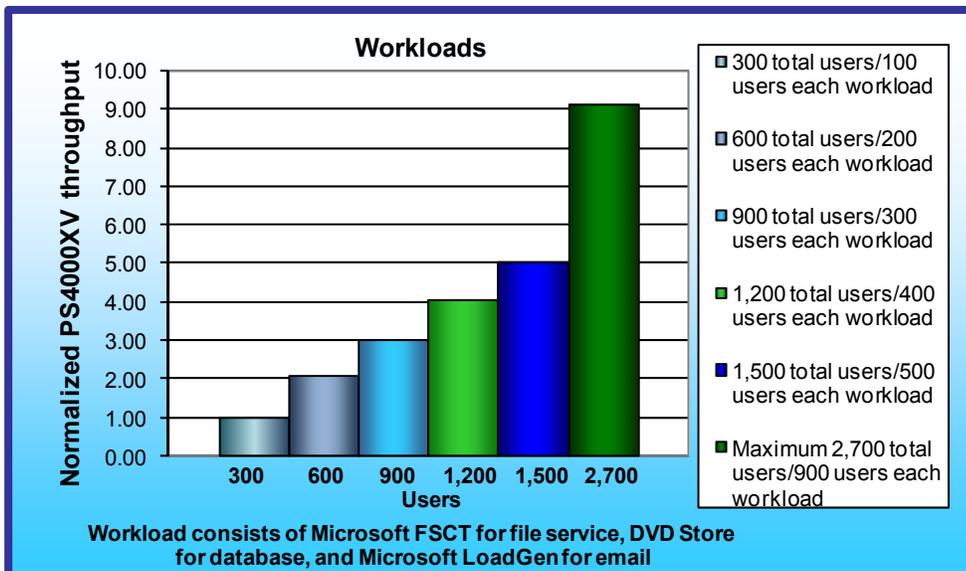
Figure 1: Normalized results the Dell EqualLogic PS4000XV processed during our combined workload. Higher numbers are better.

Chart labels:
- Title: **Workloads**
- Y-axis: **Normalized PS4000XV throughput** (0.00 to 10.00)
- X-axis: **Users** (300, 600, 900, 1,200, 1,500, 2,700)
- Legend:
  - 300 total users/100 users each workload
  - 600 total users/200 users each workload
  - 900 total users/300 users each workload
  - 1,200 total users/400 users each workload
  - 1,500 total users/500 users each workload
  - Maximum 2,700 total users/900 users each workload
- Workload consists of Microsoft FSCT for file service, DVD Store for database, and Microsoft LoadGen for email

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[1] 4.7TB usable capacity with 16 450GB 15,000RPM SAS drives using RAID50

Host Integration Toolkit v3.2.0 to connect to the Dell EqualLogic PS4000XV Array. We ran SQL Server 2008 and Microsoft Exchange Server 2007 in Hyper-V virtual machines on separate Hyper-V physical hosts. We used a separate Windows Server 2008 x64 Edition physical machine for our file server.

For each user count we tested, our three- simultaneous-benchmark workloads put greater stress on the storage than the same number of real users would; real users would not necessarily be executing a constant stream of simultaneous database, email, and file server transactions. Therefore, we expect that, under actual working conditions, total throughput from a Dell EqualLogic PS4000XV in a RAID50 setup would likely be able to support more users than the maximum number we present in this report.

More information on the three benchmarks we used appears in the Workloads section. Detailed results for the three benchmarks appear in the Test results section. We explain the steps we followed to set up each test in the Test methodology section, and the specifics of each system we used in Appendix A and B.

Workloads
We ran the following three workloads simultaneously.

DVD Store
DVD Store Version 2 is an open-source application with a back-end database component, a front-end Web application layer, and a driver layer that operates as the middle tier and actually executes the workload. DS2 models an online DVD store. Simulated customers log in; browse movies by actor, title, or category; and purchase movies. The workload also creates new customers. Browsing movies involves select operations, some of which use SQL Server 2008 full-text search and some of which do not. The purchase, login, and new customer stored procedures involve update and insert statements, as well as select statements. The workload's main reporting metric is orders per minute (OPM).

Because our goal was to isolate and test the database storage, we did not use the Web application layer. Instead, we ran the 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 Testing procedure subsection in the Test methodology section of this report.

For client machines, we used five high-end desktop systems running Windows Server 2003 R2 Enterprise Edition. Each of these client machines ran a single instance of DS2, which spawned a number of threads with a 1.5-second think time dependent on the number of users we were trying to simulate. The 1.5-second think time was to allow each thread to simulate 10 users, each of whom orders a new item once every 15 seconds. In order to simulate different numbers of users, we throttled the workload, making each client represent one fifth of the users.

We used a Dell™ PowerEdge™ 2950 with 16 GB (8 x 2 GB) of memory running the Hyper-V Update for Windows Server 2008 x64 Edition for our hypervisor host. We connected the Dell EqualLogic PS4000XV storage array to the Dell PowerEdge 2950 via a Dell™ PowerConnect™ 6248 switch using the Microsoft iSCSI initiator running in the hypervisor host. We used Windows Server 2008 x64 Edition with 4 vCPU and 12GB RAM for our database Virtual Machine (VM). We ran Microsoft SQL Server 2008 in the VM. We used a 100GB database for our DVD Store tests.

The DS2 driver application creates an orders-per-minute performance counter on each client machine. While the DVD Store client application visually outputs OPM at 10-second intervals, we chose to collect this OPM metric via a performance monitor counter on each client machine at 1-second intervals.

We ran this workload on the Dell PowerEdge 2950 server for 40 minutes.

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

Microsoft Exchange Load Generator
Our goal was to test Microsoft Exchange Server 2007 performance on the Dell EqualLogic PS4000XV. We used Microsoft Exchange Load Generator with differing numbers of users to test how many Microsoft Exchange Server

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2007 users our solution could support simultaneously with the other workloads (OLTP and file server). We created a heavy workload of 1,500 users distributed across two Mailbox databases.

Microsoft Exchange Load Generator is a simulation tool that measures the combined impact that various clients (MAPI, OWA, IMAP, POP, and SMTP) have on Exchange servers. This allows administrators to test how effectively a server running Exchange responds to e-mail loads. LoadGen sends multiple message requests to the simulation server, resulting in a diverse mail load.

We used a Dell™ PowerEdge™ 2950 with 16 GB (8 x 2 GB) of memory running the Hyper-V Update for Windows Server 2008 x64 Edition for our hypervisor host. We used Windows Server 2008 x64 Edition with 4 vCPU and 12GB RAM and Microsoft Exchange Server 2007 for our mail VM. We connected the Dell EqualLogic PS4000XV storage array to the Dell PowerEdge 2950 via a Dell™ PowerConnect™ 6248 switch using the Microsoft iSCSI initiator running in the hypervisor host.

We ran the Microsoft Exchange Load Generator benchmark for 30 minutes, starting it 10 minutes after the DVD Store workload began, and measured the performance of Microsoft Exchange Server 2007 on the Dell PowerEdge 2950 server and Dell EqualLogic PS4000XV storage.

File Server Capacity Tool (FSCT)
FSCT tests file server capacity and helps identify performance bottlenecks. Microsoft is currently developing FSCT and released version 0.7, which we used, in June 2009. Microsoft plans to release version 1.0 later in 2009.

FSCT simulates different file-service workloads in the following ways:
- By focusing on native application and OS behavior, with an emphasis on Microsoft applications (e.g., Microsoft Office applications, Windows Explorer) and Win32 applications (e.g., command line operations)
- By using pre-configured workload test scenarios, which simulate multiple requests from multiple users for server files
- By running multiple sessions per physical client, which allows a single client computer to perform the workload of multiple simulated clients

The primary results FSCT reports about the solution under test are its throughput and the total number of users it supported without overloading. FSCT also provides performance information such as latency; OS performance counters, including server CPU utilization; and network capacity. FSCT also reports the errors the test client received, and it provides such tracing information as Event Tracing for Windows.

FSCT comes with a standard workload, the HomeFolders workload. We ran that workload, which simulates 12 user scenarios that run Microsoft applications on a server the user has assigned to store his or her home directory.

FSCT requires a minimum of three computers to perform the roles of server, clients, and controller. The server machine is the system under test; the client machine(s) simulate multiple users who are running the HomeFolders workload on the server; and the controller machine coordinates the client work, captures performance counters, and gathers the workload results.

We used a Dell PowerEdge 2950 with 16 GB (8 x 2 GB) of memory running Windows Server 2008 x64 Edition for our file server. We connected the Dell EqualLogic PS4000XV storage array to the Dell PowerEdge 2950 via a Dell PowerConnect 6248 switch using the Microsoft iSCSI initiator.

You can find more information about FSCT at the blog of Jose Barreto, Principal Program Manager with the Microsoft File Server Foundation team: http://blogs.technet.com/josebda/archive/2008/10/06/fsct-a-cifs-smb-smb2-file-server-tool-for-capacity-planning-and-performance-troubleshooting.aspx.

The End User License Agreement for Microsoft's FSCT tool requires the following text accompany all results: "These test results were generated by Principled Technologies, Inc. using the Microsoft File Server Capacity Tool.

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Test results generated with this pre-release software tool may not be accurate or appropriate for your needs and should not be relied upon as your sole reference. Microsoft makes no warranties of any kind, express or implied, about this tool, or any information or materials provided with this tool, including any results generated by this tool."

Test results

We staggered the starting times of the benchmarks to allow each server to ramp up slowly. We began the benchmarks in the following order: DVD Store, FSCT, and LoadGen. We started DVD Store, which ran for 40 minutes. After 9 minutes and 30 seconds, we started FSCT, followed by LoadGen 30 seconds later. We report here that section of the DVD Store run corresponding to the 30 minutes of the LoadGen run. As we added users in 100 user increments, the throughput of Dell EqualLogic PS4000XV scaled almost linearly, roughly corresponding to the number of users, without any file server, database, or email overload. At 3,000 total users (1,000 users in each workload), although LoadGen and DVD Store benchmarks had passed the test criteria, the FSCT benchmark showed an overload condition. We then set the maximum user count for each benchmark to 900 users, 100 users less than the user count when the FSCT overload occurred, and ran the benchmarks to obtain the maximum normalized throughput reported in Figure 1.

Normalized results

Figure 2 presents normalized performance results for the Dell EqualLogic PS4000XV throughput on the three benchmarks for various number of users relative to the lowest number of users, 300 total users/100 users each benchmark. This approach makes each data point a comparative number, with higher numbers indicating better performance. Finally, we took the percentage performance improvement over the lowest number of users for the three benchmarks and averaged them. The results are the median of three runs.

Normalized results				
Users	DVD Store	LoadGen	FSCT	Average
300 total users/100 users each	1.0	1.0	1.0	1.0
600 total users/200 users each	2.0	2.1	2.0	2.0
900 total users/300 users each	3.0	2.7	3.0	2.9
1,200 total users/400 users each	4.0	3.8	4.0	3.9
1,500 total users/500 users each	5.0	4.6	5.0	4.9
Maximum 2,700 total users/900 users each	8.7	8.7	9.1	8.9

Figure 2: The normalized results that the Dell EqualLogic PS4000XV solution delivered during the median run. Higher numbers are better.

DVD Store results

Figure 3 shows the number of OPM the Dell EqualLogic PS4000XV solution achieved with different numbers of users during our median run. We calculated the scores by averaging the individual client OPM for the SQL instance during the 30-minute period (minutes 10 through 40) and then adding those averages. Each result is the median of three runs. At 1,000 users (3,000 total users), when FSCT showed an overload condition, the DVD Store result was 3,740.3 OPM. This is above the minimum acceptable level of 3,200 OPM, indicating that the Dell EqualLogic PS4000XV solution had sufficient IO headroom to accommodate additional tasks. We defined the minimum acceptable level of OPM as 80 percent of the expected results (80 percent of 4 OPM times the number of users).

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Number of users	Orders per minute	Orders per minute (relative to 100 users)
100 users	388.1	1.0
200 users	774.8	2.0
300 users	1,159.1	3.0
400 users	1,541.2	4.0
500 users	1,922.1	5.0
Maximum (900 users)	3,382.9	8.7

Figure 3: The OPM results that the Dell EqualLogic PS4000XV solution delivered during median run (minutes 10 through 40) of the DVD Store test. Higher numbers are better. Note: At 1,000 users (3,000 total users), when FSCT showed an overload condition, the DVD Store result was 3,740.3 OPM. This is above the minimum acceptable level of 3,200 OPM, indicating that the Dell EqualLogic PS4000XV solution had sufficient IO headroom to accommodate additional tasks.

LoadGen results

Figure 4 shows the median Microsoft Exchange Server 2007 message-per-second results that the Dell EqualLogic PS4000XV solution delivered. We gathered these results by using the MSExchangeIS Mailbox\Messages Delivered/sec counter in Windows Performance Monitor and averaging the results of the test. Each result is the median of three runs. At 1,000 users (3,000 total users), when FSCT showed an overload condition, the LoadGen latency was under the one-second overload threshold (654 ms). This indicates that the Dell EqualLogic PS4000XV solution had sufficient IO headroom to accommodate additional tasks. We monitored the response during all successful LoadGen runs to confirm the latency was below 1 second. We only report the messages per second.

Number of users	Messages per second	Messages per second (relative to 100 users)
100 users	0.4	1.0
200 users	0.8	2.1
300 users	1.0	2.7
400 users	1.4	3.8
500 users	1.7	4.6
Maximum (900 users)	3.2	8.7

Figure 4: The messages-per-second results that the Dell EqualLogic PS4000XV solution delivered during the median run of the LoadGen test. Higher numbers are better. Note: At 1,000 users (3,000 total users), when FSCT showed an overload condition, the LoadGen latency was under the one-second overload threshold (654 ms). This indicates that the Dell EqualLogic PS4000XV solution had sufficient IO headroom to accommodate additional tasks.

FSCT results

Figure 5 shows the median FSCT scenarios-per-second results that the Dell EqualLogic PS4000XV solution delivered. Each result is the median of three runs. At 1,000 users (3,000 total users), FSCT showed an overload of 18 percent. We therefore established 900 users as our maximum user count.

Number of users	Scenarios per second	Scenarios per second (relative to 100 users)
100 users	9	1.0
200 users	18	2.0
300 users	27	3.0
400 users	36	4.0
500 users	45	5.0
Maximum (900 users)	82	9.1

Figure 5: The FSCT scenarios-per-second results that the Dell EqualLogic PS4000XV solution delivered during the median run of the FSCT test. Higher numbers are better. Note: At 1,000 users (3,000 total users), FSCT showed an overload of 18 percent.

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Test methodology

For testing, we used three Dell PowerEdge 2950 servers running Windows Server 2008 x64-bit (plus Exchange Server 2007, SQL Server 2008, or FSCT framework), which connect to one Dell EqualLogic PS4000XV storage array through a Dell PowerConnect 6248 switch. In addition to the servers, we used 23 high-end desktop class systems as file, database, and mail clients, and as one controller. Figure 6 illustrates our test bed configuration.
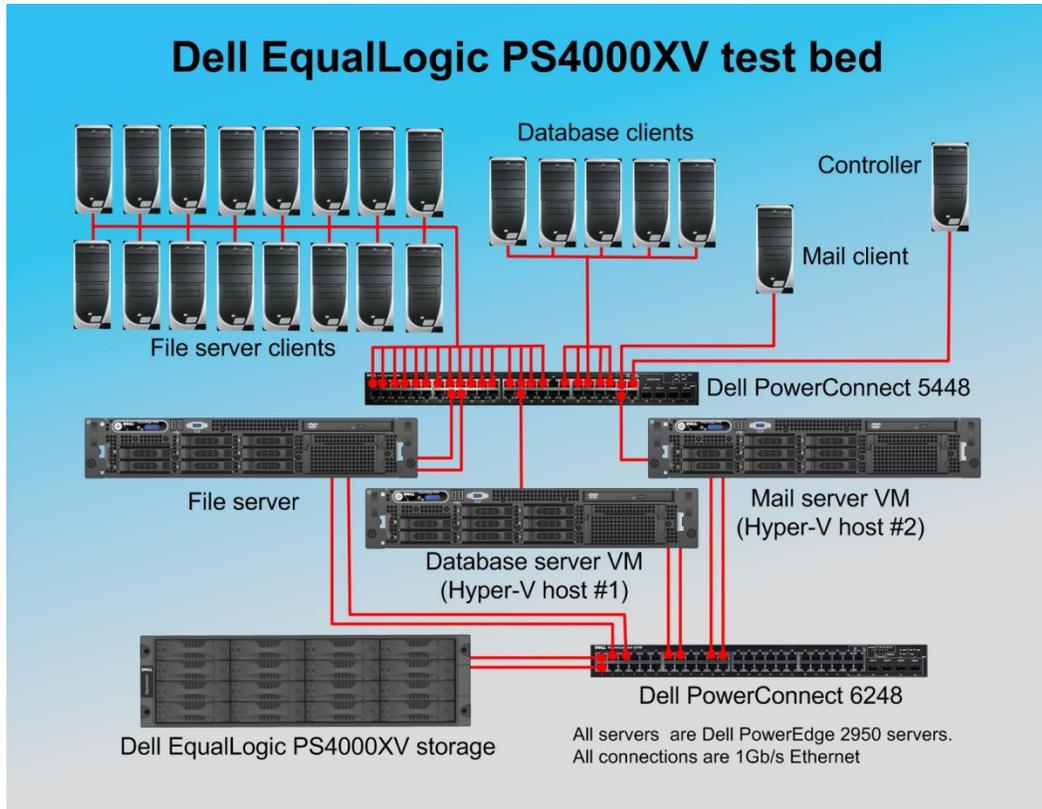
Figure 6: The Dell EqualLogic PS4000XV test bed we used in our testing.

Test bed information
Test servers
We used three test servers (one for each workload: LoadGen, DVD Store, and FSCT).

Physical server specs:
- Processor: Intel® Xeon® Processor E5405 (2.0 GHz, 32 KB + 32 KB L1 per core, 12MB L2)
- RAM: 16GB (8 x 2 GB) FB-DDR2 PC5300
- HDD1: 1 x 80GB HDD, 7.2K RPM
- 2 x Intel PRO/1000 PT adapter for connection to the storage network
- 1 x Broadcom BCM5708C integrated network adapter for client connection for database and mail, 2 x Broadcom BCM5708C integrated network adapters for client connection FSCT

Note: The file server is running on a single Dell PowerEdge 2950 and is not virtualized. The database server is running as a single VM on a separate Dell PowerEdge 2950 server running Microsoft Hyper-V Server 2008. The mail server is running as a single VM on a third separate Dell PowerEdge 2950 server running Microsoft Hyper-V Server 2008.

Virtual server specs (mail and database only):
- vCPU: 4

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- vRAM: 12 GB
- vNIC: 1
- See storage section for VHD configuration

Clients

We have three sets of clients that connect to the test servers on a separate client network (One Dell™ PowerConnect™ 5448 switch). We based the number of clients on the requirements of each workload. We used 22 clients: 1 mail client, 5 database clients, and 16 file server clients. We also used one controller machine, which has the same hardware configuration as the FSCT client systems. We used the controller to start and stop test scripts as necessary:

- FSCT Clients
  - Custom built Intel-based dual-core desktops running Windows Vista x64 and required workload files
- LoadGen Clients
  - Custom built Intel-based dual-core desktops running Windows Server 2003 x64 and required workload files
- DVD Store Clients
  - Custom built Intel-based single-core desktops running Windows Server 2003 and required workload files

Storage network switch settings (Dell™ PowerConnect™ 6248)
- Jumbo frames enabled (on NIC and all ports on the switch)
- Flow control enabled
- IP routing enabled
- Spanning tree set to rapid spanning tree protocol (RSTP)
- Link layer discovery protocol (LLDP) disabled

Dell EqualLogic PS4000XV configuration
Note: All VM storage is located on VHDs on Dell EqualLogic PS4000XV volumes.
- One Dell EqualLogic PS4000XV in one storage group/one storage pool
  - Two 100GB LUNs for the FSCT/File Sharing server volumes
  - Three separate LUNs for DVD Store storage, each with an OS VHD (30 GB), a log VHD (70 GB) and a data VHD (200 GB). Note: DVD Database is 100 GB.
  - Three separate LUNs for LoadGen storage, each with an OS VHD (30 GB), a log VHD (70 GB) and a data VHD (400 GB)

Setting up and configuring the Dell PowerEdge 2950's and Dell EqualLogic PS4000XV storage

We installed one internal drive in each of the Dell PowerEdge 2950 servers. The Dell EqualLogic PS4000XV contained 16 450GB 15,000RPM drives. We cabled the Dell EqualLogic PS4000XV to a Dell PowerConnect 6248 switch via its four available ports, and we cabled the Dell PowerEdge 2950 to the switch via two single-port Intel PRO/1000PT NICs. We configured the Dell EqualLogic PS4000XV in RAID 50 mode.

Setting up the internal storage for operating system installation
1. Enter the RAID controller BIOS by pressing Ctrl+R at the prompt.
2. Highlight Controller 0, and press F2.
3. Select Create New VD.
4. Select the drive, select RAID level 0, tab to the OK button, and press Enter. Accept the warning regarding initialization.
5. Select the new virtual drive, press F2, and select Initialization to begin Initialization.
6. Wait for the initialization operations to complete.
7. Press Escape, and choose Save and Exit to return to the boot sequence.

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Setting up the external storage
1. Using the command line, set up a storage group with the following RAID policies:
   a. Dell EqualLogic PS4000XV: RAID-50
2. Create a storage pool that you name `database` with the following members:
   a. Dell EqualLogic PS4000XV-1
3. Enable all network connections on the Dell EqualLogic PS4000XV using the following IP address scheme:
   a. IP Address: `192.168.1.##` (## being any number between 10 and 40)
   b. Subnet Mask: `255.255.248.0`
4. Create one volume in the database storage pool with no snapshot reserve, and name it `dvd-store`
5. Enable shared access to the iSCSI target from multiple initiators on the volume.
6. Create an access control record for the volume without specifying any limitations.
7. Create a read-only SNMP community name to use for group monitoring.

DVD Store

We installed Windows Server 2008 with Hyper-V on the internal volume of the Dell PowerEdge 2950 and configured the DVD Store virtual machine, SQL Server 2008 software, SQL Server transaction logs, and the SQL Server database data on the Dell EqualLogic PS4000XV volume. We installed the Host Integration Toolkit (HIT) on the server for storage management and for multipath I/O support.

Installing and configuring the server
We installed a fresh copy of Windows Server 2008 Enterprise Edition x64 on the Dell PowerEdge 2950 server.

Installing the host operating system
1. Boot the server, and insert the Windows Server 2008 x64 Edition installation CD in the DVD-ROM drive.
2. At the Language Selection screen, click Next.
3. Click Install Now.
4. Select Windows Server 2008 Enterprise (Full Installation) x64, 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. Click New.
9. Click Apply.
10. Click Next.
11. At the warning that the user's password must be changed before logging on 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.
14. Right-click the desktop, and select Personalize.
15. Click the Screen Saver link.
16. Click the Screen saver drop-down menu, and select (None).
17. Click Apply.
18. Click Change power settings.
19. Under Balanced plan, click Change plan settings.
20. From the Turn off monitor drop-down menu, select Never.
21. Click Save changes, and close the Power Options, Screen Saver Settings, and Personalization windows.

Configuring networking
1. Click Start→Control Panel→Network Connections, and click Manage Network Connections.
2. Right-click the NIC, and choose Properties.
3. Select TCP/IP (v4), and choose Properties.
4. Set the IP address, subnet, gateway, and DNS server for this NIC, which will handle outgoing server traffic (e.g., the public IP). Click OK, and click Close.
5. Repeat steps 2 through 4 twice. Note: these NICs should be on the same network segment as the Dell EqualLogic storage.

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Installing the Host Integration Toolkit
1. Download the Host Integration Toolkit (Setup64.exe).
2. Double-click Setup64.exe.
3. Accept the security warnings, and choose to run the EXE.
4. Click Next.
5. Click Accept, and click Next.
6. Click Typical, and click Next.
7. A Windows Firewall warning appears; leave it open for a minute.
8. Click the Start button, and choose Administrative Tools→Windows Firewall with Advanced Security.
9. In the left panel, click Inbound Rules.
10. In the center Inbound Rules panel, right-click iSCSI Service (TCP-In), and choose Enable Rule.
11. In the center Outbound Rules panel, right-click iSCSI Service (TCP-In), and choose Enable Rule.
12. Close the Windows Firewall dialog.
13. Clear the message box.
14. Click Install.
15. Click Yes to install multipath software automatically.
16. When the application prompts you to do so, choose to restart the computer.

Connecting the Microsoft iSCSI Initiator to the storage
1. Click Start, Control Panel, and double-click iSCSI Initiator.
2. Click the Discovery tab.
3. Click Add Portal…
4. Add the IP addresses of both Dell EqualLogic storage groups.
5. Click OK.
6. Click the Targets tab.
7. Find the Database volume, and select it.
8. Click Log On…
9. Check the checkbox to allow automatic logon on reboot.
10. Click OK.

Configuring additional drives in Disk Management
1. Click Start→Administrative Tools→Computer Management, and click Disk Management.
2. Right-click the uninitialized disks (if any), and choose Initialize Disk.
3. Choose MBR.
4. Right-click the 30GB volume, and choose New Simple Volume. Click Next.
5. Set the 30GB drive to drive E:\, and click Next.
6. Right-click the 70GB volume, and choose New Simple Volume. Click Next.
7. Set the 70GB drive to drive F:\, and click Next.
8. Right-click the 200GB volume, and choose New Simple Volume. Click Next.
9. Set the 200GB drive to drive G:\, and click Next.
10. Choose NTFS, default allocation unit size, and check the Perform a quick format checkbox.
11. Click Next.
12. Click Finish.

Installing system updates in Windows Server 2008 x64 Edition
We installed the following updates using the Microsoft Windows Update feature:

- Microsoft .NET Framework 3.5 Service Pack 1 and .NET Framework 3.5 Family Update (KB951847) x64
- Update for Internet Explorer 8 Compatibility View List for Windows Server 2008 x64 Edition (KB971180)
- Security Update for Windows Server 2008 x64 Edition (KB958687)
- Update for Windows Server 2008 x64 Edition (KB957388)
- Security Update for Windows Server 2008 x64-based Systems (KB938464)
- Update for Windows Server 2008 x64 Edition (KB949189)
- Security Update for Windows Server 2008 x64 Edition (KB955069)
- Security Update for Windows Server 2008 x64 Edition (KB954459)
- Security Update for Windows Server 2008 x64 Edition (KB957097)

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- Security Update for Windows Server 2008 x64 Edition (KB958690)
- Cumulative Security Update for Internet Explorer 7 for Windows Server 2008 x64 Edition (KB963027)
- Security Update for Windows Server 2008 x64 Edition (KB960803)
- Internet Explorer 8 for Windows Server 2008 x64 Edition
- Security Update for Windows Server 2008 x64 Edition (KB958623)
- Update for Windows Server 2008 x64 Edition (KB959130)
- Windows Malicious Software Removal Tool x64 - May 2009 (KB890830)
- Update for Windows Server 2008 x64 Edition (KB957200)
- Security Update for Windows Server 2008 x64 Edition (KB953733)
- Security Update for Windows Server 2008 x64 Edition (KB950762)
- Update for Windows Server 2008 x64 Edition (KB955839)
- Security Update for Windows Server 2008 x64 Edition (KB958624)
- Security Update for Windows Server 2008 x64 Edition (KB950974)
- Update for Windows Server 2008 x64 Edition (KB951978)
- Update for Windows Server 2008 for x64-based Systems (KB955020)
- Microsoft .NET Framework 3.5 Service Pack 1 and .NET Framework 3.5 Family Update (KB951847) x64
- Security Update for Windows Server 2008 x64 Edition (KB956572)
- Security Update for Windows Mail for Windows Server 2008 x64 Edition (KB951066)
- Update Rollup for ActiveX Killbits for Windows Server 2008 x64 Edition (KB960715)
- Security Update for Windows Server 2008 x64 Edition (KB960225)
- Security Update for Windows Server 2008 x64 Edition (KB956802)
- Update for Windows Server 2008 x64 Edition (KB957321)
- Update for Windows Server 2008 x64 Edition (KB952287)
- Security Update for Windows Server 2008 x64 Edition (KB958644)
- Security Update for Windows Server 2008 x64 Edition (KB959426)
- Security Update for Windows Server 2008 x64 Edition (KB952004)
- Security Update for Windows Server 2008 x64 Edition (KB951698)
- Update for Windows Server 2008 x64 Edition (KB950050)
- Cumulative Security Update for ActiveX Killbits for Windows Server 2008 x64 Edition (KB950760)
- Update for Windows Server 2008 x64 Edition (KB955302)
- Windows Update Agent 7.2.6001.788

Installing Hyper-V in Windows Server 2008
Note: Be sure you have installed all the latest critical and recommended updates for Windows Server 2008 from Windows Update. Specifically, you must install the update that upgrades Hyper-V from beta to release software. (As of this writing, this update is KB950050 on Windows Server 2008 Enterprise Edition x64.)

1. Click Start→Administrative Tools→Server Manager.
2. Click Roles.
3. Click Add Roles.
4. Click Next.
5. Select the Hyper-V role by checking the box beside it, and click Next.
6. Check the box beside the Ethernet Card you wish to use, and click Next.
7. Click Install to begin the Hyper-V installation.
8. When the installation finishes, click Close.
9. When the application prompts you to restart now, click Yes.
10. Follow the prompt to log onto the system.
11. Enter the password, and click the arrow to continue. The Resuming Configuration Wizard should start automatically.
12. Once the Resuming Configuration Wizard completes, the installation results should appear with a message that the installation succeeded.
13. Click Close.

Creating the virtual machine
We created the virtual machine with the following VM parameters:

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- Virtual processor: 4
- Virtual memory: 12,228 MB
- Virtual disk size: 30 GB

1. Click Start→Administrative Tools→Hyper-V Manager.
2. Click Connect to Server, and click OK.
3. Click Action→Virtual Network Manager…
4. Select New virtual network.
5. Select External, and click Add.
6. From the Actions menu, select New→Virtual Machine…
7. Click Next.
8. Enter a name for the virtual machine.
9. Click Next.
10. Specify the amount of memory to allocate to this virtual machine (12,228 MB), and click Next.
11. Select Not Connected on the Configure Networking screen, and click Next.
12. Select the Attach a virtual hard disk later radio button, and click Next.
13. Click Finish.
14. Close Hyper-V Manager.

Setting up and configuring the VM
After creating the VM through the Hyper-V interface, we proceeded to set up the VM, which included installing and configuring Windows Server 2008 x64 Edition with SP1.

1. Click Start→Administrative Tools→Hyper-V Manager.
2. Right-click the VM, and select Settings…
3. Select Processor.
4. Change the number of logical processors to 4, and click Apply.
5. Select Network Adapter.
6. Select the appropriate configuration from the drop-down menu, and click Apply.
7. Select Add Hardware.
8. Select SCSI Controller, and click Add.
9. Click Apply.
10. Select IDE Controller 0.
11. Select Disk Drive, and click Add.
12. Click New.
13. Click Next.
14. Click the Fixed size radio button, and click Next.
15. Enter a name for the VHD file.
16. Browse to the root of Drive E, and select Next.
17. Select the Create a new blank virtual hard disk radio button.
18. Type 30 for the number of GB for the virtual hard disk, and click Next.
19. Click Finish.
20. Click Apply.
21. Select SCSI Controller.
22. Select Disk Drive, and click Add.
23. Click New.
24. Click Next.
25. Click the Fixed size radio button, and click Next.
26. Enter a name for the VHD file.
27. Browse to the root of Drive F, and select Next.
28. Select the Create a new blank virtual hard disk radio button.
29. Type 70 for the number of GB for the virtual hard disk, and click Next.
30. Click Finish.
31. Click Apply.
32. Select SCSI Controller.

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33. Select Disk Drive, and click Add.
34. Click New.
35. Click Next.
36. Click the Fixed size radio button, and click Next.
37. Enter a name for the VHD file.
38. Browse to the root of Drive G, and select Next.
39. Select the Create a new blank virtual hard disk radio button.
40. Type 200 for the number of GB for the virtual hard disk, and click Next.
41. Click Finish.
42. Click Apply.
43. Click OK.

Installing Windows Server 2008 x64 Edition with SP1 on the VM
We installed a fresh copy of Windows Server 2008 x64 Edition with SP1 using the following steps:

1. Click Start→Administrative Tools→Hyper-V Manager.
2. Right-click the VM, and select Settings…
3. Select IDE Controller 1.
4. Select DVD Drive.
5. Select the Physical CD/DVD drive: radio button, and click Apply.
6. Select BIOS, and confirm that CD is at the top of the Startup order list. If this is not the case, adjust the list appropriately, and click Apply.
7. Click OK.
8. Right-click the VM, and select Connect…
9. Click Menu→DVD Drive→Capture appropriate DVD-ROM drive (e.g., D:).
10. Insert the Windows Server 2008 installation CD in the DVD-ROM drive.
11. Click Action→Start to start the Master VM.
12. At the Language Selection Screen, click Next.
13. Click Install Now.
14. Select Windows Server 2008 Enterprise (Full Installation) x64, and click Next.
15. Click the I accept the license terms check box, and click Next.
16. Click Custom.
17. Click Drive options (advanced).
18. Click New.
19. Click Apply.
20. Click Next.
21. At the warning that the user's password must be changed before logging on screen, click OK.
22. Type Password1 as the new password in both fields, and click the arrow to continue.
23. At the Your password has been changed screen, click OK.
24. Once the installation completes, on the Hyper-V Manager menu, click Action→Insert Integration Services Setup Disk.
25. At the prompt to restart, click Yes.
26. At the prompt, log back into the VM.
27. Right-click the desktop, and select Personalize.
28. Click the Screen Saver link.
29. Click the Screen saver drop-down menu, and select (None).
30. Click Apply.
31. Click Change power settings.
32. Under Balanced plan, click Change plan settings.
33. From the Turn off monitor drop-down menu, select Never.
34. Click Save changes, and close the Power Options, Screen Saver Settings, and Personalization windows.
35. Click Start.
36. Right-click My Computer, and select Manage.
37. Select Disk Management.

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38. If the wizard prompts you to initialize new disks, click OK. Note: If you must select a partition table, select MBR.
39. Right-click the first unallocated disk partition, and select New Simple Volume…
40. Click Next.
41. Use the entire VHD storage space, and click Next.
42. Select the drive letter to assign to the new partition, and click Next.
43. Label the volume appropriately (e.g., Database, Backup, etc.).
44. Confirm that Perform a quick format is checked, and click Next.
45. Click Finish.
46. Repeat steps 36 through 45 for the remaining volumes.

Setting up network configuration on the VM
1. Click Start→Control Panel→Network Connections, and Local Area Connection.
2. At the Local Area Connection Status screen, click Properties.
3. At the Local Area Connection Properties screen, select Internet Protocol Version 4 (TCP/IPv4), and click Properties.
4. At the Internet Protocol Version 4 (TCP/IPv4) Properties screen, select the Use the following IP address radio button.
5. Enter a valid static IP address, subnet mask, and default gateway.
6. Click OK, and click Close twice. Close the Network Connections window.

Installing system updates in Windows Server 2008 on the VM
We installed the following updates using the online Windows Update feature. Note: Reboot the VM when the installer requests you do so.

- Hotfix for Windows (KB942288)
- Security Update for Windows Server 2008 x64 Edition (KB958687)
- Update for Windows Server 2008 x64 Edition (KB957388)
- Security Update for Windows Server 2008 x64-based Systems (KB938464)
- Update for Windows Server 2008 x64 Edition (KB949189)
- Security Update for Windows Server 2008 x64 Edition (KB955069)
- Security Update for Windows Server 2008 x64 Edition (KB954459)
- Security Update for Windows Server 2008 x64 Edition (KB957097)
- Security Update for Windows Server 2008 x64 Edition (KB958690)
- Cumulative Security Update for Internet Explorer 7 for Windows Server 2008 x64 Edition (KB963027)
- Security Update for Windows Server 2008 x64 Edition (KB960803)
- Internet Explorer 8 for Windows Server 2008 x64 Edition
- Security Update for Windows Server 2008 x64 Edition (KB958623)
- Update for Windows Server 2008 x64 Edition (KB959130)
- Windows Malicious Software Removal Tool x64 - May 2009 (KB890830)
- Update for Windows Server 2008 x64 Edition (KB957200)
- Security Update for Windows Server 2008 x64 Edition (KB953733)
- Security Update for Windows Server 2008 x64 Edition (KB950762)
- Update for Windows Server 2008 x64 Edition (KB955839)
- Security Update for Windows Server 2008 x64 Edition (KB958624)
- Security Update for Windows Server 2008 x64 Edition (KB950974)
- Update for Windows Server 2008 x64 Edition (KB951978)
- Update for Windows Server 2008 for x64-based Systems (KB955020)
- Microsoft .NET Framework 3.5 Service Pack 1 and .NET Framework 3.5 Family Update (KB951847) x64
- Security Update for Windows Server 2008 x64 Edition (KB956572)
- Security Update for Windows Mail for Windows Server 2008 x64 Edition (KB951066)
- Update Rollup for ActiveX Killbits for Windows Server 2008 x64 Edition (KB960715)
- Security Update for Windows Server 2008 x64 Edition (KB960225)
- Security Update for Windows Server 2008 x64 Edition (KB956802)
- Update for Windows Server 2008 x64 Edition (KB957321)
- Update for Windows Server 2008 x64 Edition (KB952287)

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- Security Update for Windows Server 2008 x64 Edition (KB958644)
- Security Update for Windows Server 2008 x64 Edition (KB959426)
- Security Update for Windows Server 2008 x64 Edition (KB952004)
- Security Update for Windows Server 2008 x64 Edition (KB951698)
- Update for Windows Server 2008 x64 Edition (KB950050)
- Cumulative Security Update for ActiveX Killbits for Windows Server 2008 x64 Edition (KB950760)
- Update for Windows Server 2008 x64 Edition (KB955302)
- Security Update for Windows Server 2008 x64 Edition (KB955069)
- Update for Windows Server 2008 for x64-based Systems (KB955020)
- Update for Windows Server 2008 x64 Edition (KB951978)
- Security Update for Windows Server 2008 x64 Edition (KB959426)
- Update for Windows Server 2008 x64 Edition (KB957388)
- Security Update for Windows Server 2008 x64 Edition (KB960225)
- Update for Windows Server 2008 x64 Edition (KB949189)
- Security Update for Windows Server 2008 x64 Edition (KB960803)
- Security Update for Windows Server 2008 x64 Edition (KB954459)
- Security Update for Windows Server 2008 x64 Edition (KB950974)
- Cumulative Security Update for Internet Explorer 7 for Windows Server 2008 x64 Edition (KB963027)
- Security Update for Windows Server 2008 x64 Edition (KB958687)
- Security Update for Windows Server 2008 x64 Edition (KB958624)
- Security Update for Windows Server 2008 x64-based Systems (KB938464)
- Update for Windows Server 2008 x64 Edition (KB957321)
- Security Update for Windows Server 2008 x64 Edition (KB958623)
- Windows Update Agent 7.2.6001.788
- Update for Windows (KB951634)

Installing SQL Server 2008 on the VM
1. Click Start→Administrative Tools→Hyper-V Manager.
2. Right-click the VM, and select Settings…
3. Select IDE Controller 1.
4. Select DVD Drive.
5. Select the Physical CD/DVD drive: radio button, and click Apply.
6. Select BIOS, and confirm that CD is at the top of the Startup order list. If this is not the case, adjust the list appropriately. Click Apply.
7. Click OK.
8. Right-click the VM, and select Connect…
9. Click Menu→DVD Drive→Capture appropriate DVD-ROM drive (e.g., D:).
10. Insert the DVD into the physical DVD drive.
11. At the AutoPlay menu, click Run SETUP.EXE.
12. If the application prompts you to install the .NET Framework, click OK.
13. Select the Accept radio button, and click Install.
14. When the installation finishes, click Exit.
15. If the application prompts you, click OK to install a hotfix for Windows (KB942288).
16. Click Restart now to restart the server upon completion.
17. After rebooting, log into the server.
18. Click Start, and click Computer.
19. Double-click the CD/DVD drive.
20. Click Installation.
21. Click New SQL Server stand-alone installation.
22. At the Setup support rules screen, click OK.
23. Specify the Enterprise Evaluation free edition. Click Next.
24. Click the checkbox to accept the license terms. Click Next.
25. Click Install to install the setup support files.
26. You may see a Windows Firewall warning. For now, ignore this, and click Next.

27. At the Feature Selection screen, select Database Engine Services, Full-Text Search, Client Tools Connectivity, Client Tools Backward Compatibility, Management Tools –Basic, and Management Tools – Complete. Click Next.
28. At the Instance configuration screen, leave the default selection of default instance, and click Next.
29. At the Disk space requirements screen, click Next.
30. At the Server configuration screen, choose NT AUTHORITY\SYSTEM for SQL Server Agent, and choose NT AUTHORITY\SYSTEM for SQL Server Database Engine. Click Next.
31. At the Database Engine Configuration screen, select Mixed Mode.
32. Enter a password for the system administrator account.
33. Click Add Current user. This may take several seconds.
34. Click Next.
35. At the Error and usage reporting screen, click Next.
36. At the Installation rules screen, click Next.
37. At the Ready to Install screen, click Next.
38. After installation completes, click Start, All Programs, Microsoft SQL Server 2008, Configuration Tools, SQL Server Configuration Manager.
39. Expand the Network Configuration node, and select the relevant instance.
40. In the right pane, right-click TCP/IP, and choose Enable.
41. In the left pane, click SQL Server Services.
42. In the right pane, right-click the relevant instance, and select Restart.
43. Click Start, Administrative Tools, and Local Security Policy.
44. Double-click Perform Volume Maintenance Tasks, and add the System account.
45. Double-click Lock Pages in Memory, and add the System account.
46. Click Start, All Programs, Microsoft SQL Server 2008, and SQL Server Management Studio.
47. In the Object Explorer pane, choose Connect→Database Engine. Choose the default instance.
48. Create a SQL Server login for the ds2user (see the DVD Store setup section below for the specific script to use).
49. Place the DVD Store backup file you prepared in the default location for SQL Server: C:\Program Files\Microsoft SQL Server\MSSQL10.MSSQLSERVER\MSSQL\Backup.

Installing SQL Server 2008 SP1
Service Pack 1 is available for download from
http://www.microsoft.com/downloads/details.aspx?FamilyID=66ab3dbb-bf3e-4f46-9559-ccc6a4f9dc19&displaylang=en.

1. Run SQLServer2008SP1-KB968369-x64-ENU.exe.
2. At the Welcome screen, click Next.
3. At the License terms screen, accept the license terms, and click Next.
4. At the Features screen, select available features, and click Next.
5. At the Check files in use screen, click Next.
6. At the Update screen, click Next.
7. When the update completes, click Next, and click Close.

Configuring additional drives in Disk Management
1. Click Start, Administrative Tools, Computer Management.
2. Click Disk Management.
3. Right-click the uninitialized disks (if any), and choose Initialize Disk.
4. Choose MBR.
5. Right-click the volume, and choose New Simple Volume. Click Next.
6. Keep the default drive space, and click Next.
7. Keep the default drive letter assignment, and click Next.
8. Choose NTFS, 64KB allocation unit size, and check the Perform a quick format checkbox. Click Next.
9. Click Finish.
10. Create the folders necessary for the database. We used <driveletter>:\SQLData for the SQL Server database volume and <driveletter>:\SQLLog for the SQL Server transaction log volume.

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Configuring the database clients

1. Install Microsoft Windows Server 2003 R2 Enterprise x64 Edition Service Pack 2 on the client machine with all defaults.
2. Copy the Client Share folder to the root of C:.
3. Install Microsoft .NET 3.0
   a. Copy the .NET ZIP file to the system.
   b. Double-click the file to unzip and open the install.
   c. Click Next.
   d. Click Finish.

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. We generated the 100GB dataset for this test. Note: We created our test data on a Linux system to take advantage of the larger RAND MAX.

Generating the data for the 100GB database

We used shell scripts to run all four of the executables that generate the data. The distribution included shell scripts for the 100GB size. We used the shell scripts specified for the large 100GB dataset. 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 100GB database:

1. `ds2_create_orders_large.sh`
2. `ds2_create_inv_large.sh`
3. `ds2_create_prod_large.sh`
4. `ds2_create_cust_large.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 100GB database version for SQL Server 2008, and then used that master copy to restore our test database to our virtual machine between each test run. We stored the backup file on a separate LUN provided to the VM for quick access.

We followed these steps to create the database:

1. We created the database and file structure using database creation scripts in the DS2 download. We made size modifications specific to our 100GB database and the appropriate changes to drive letters.
2. We created database tables, stored procedures, and objects.
3. We set the database recovery model to bulk-logged to prevent excess logging.
4. 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.
5. We created indices, full-text catalogs, primary keys, and foreign keys using the database-creation scripts.
6. We updated statistics on each table according to database-creation scripts, which sample 18 percent of the table data.
7. 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'',
```

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```
DEFAULT_DATABASE=[master],
DEFAULT_LANGUAGE=[us_english],
CHECK_EXPIRATION=OFF,
CHECK_POLICY=OFF
GO
```

8. We 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 logical processor. We used two files per filegroup on the virtual machine, since the virtual machine had 4 logical processors assigned.
- 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 added the FORCESEEK hint in the BROWSE_BY_ACTOR stored procedure because in initial testing we found that SQL Server 2008 was choosing an index scan instead of the preferred index seek, adding unnecessary overhead.
- 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 database to a pristine state relatively quickly between tests.

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
```

LoadGen

We installed Windows Server 2008 with Hyper-V on the internal volume. We created three LUNs on the Dell EqualLogic PS4000XV storage and configured the Exchange server virtual machine, Exchange Server 2007 software, Exchange Server log files, and the Exchange Server database data on them. We installed the Host Integration Toolkit (HIT) on the server for storage management and for multipath I/O support.

Installing and configuring the host server

To set up this server, we installed several software components. The following subsections detail the necessary installation processes.

Installing the operating system

1.   Boot the server, and insert the Windows Server 2008 x64 with Hyper-V installation CD in the DVD-ROM drive.
2.   At the Language Selection Screen, click Next.
3.   Click Install Now.
4.   Select Windows Server 2008 Enterprise (Full Installation) x64 with Hyper-V, 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.   Click New.
9.   Click Apply.
10.   Click Next.
11.   At the warning that the user's password must be changed before logging on 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.
14.   Right-click the desktop, and select Personalize.
15.   Click the Screen Saver link.
16.   Click the Screen saver drop-down menu, and select (None).
17.   Click Apply.
18.   Click Change power settings.
19.   Under Balanced plan, click Change plan settings.
20.   From the Turn off monitor drop-down menu, select Never.
21.   Click Save changes, and close the Power Options, Screen Saver Settings, and Personalization windows.

Configuring networking

1.   Click Start→ Control Panel→Network Connections, and click Manage Network Connections.
2.   Right-click the NIC, and choose properties.
3.   Select TCP/IP (v4), and choose properties.
4.   Set the IP address, subnet, gateway, and DNS server for this NIC, which will handle outgoing server traffic (e.g., the public IP). Click OK, and click Close.
5.   Repeat steps 2 through 4 twice. Note: these NICs should be on the same network segment as the Dell EqualLogic storage.

Installing the Host Integration Toolkit

1.   Download the Host Integration Toolkit (Setup64.exe).
2.   Double-click Setup64.exe.
3.   Accept the security warnings, and choose to run the EXE.
4.   Click Next.
5.   Click Accept, then Next.
6.   Click Typical, then Next.
7.   You will see a Windows Firewall warning; leave it open for a minute.

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8. Click the Start button, and choose Administrative Tools→Windows Firewall with Advanced Security.
9. In the left panel, click Inbound Rules.
10. In the center Inbound Rules panel, right-click iSCSI Service (TCP-In), and choose Enable Rule.
11. In the center Outbound Rules panel, right-click iSCSI Service (TCP-In), and choose Enable Rule.
12. Close the Windows Firewall dialog.
13. Clear the message box.
14. Click Install.
15. Click Yes to install multipath software automatically.
16. When the application prompts you to do so, choose to restart the computer.

Connecting the Microsoft iSCSI Initiator to the storage
1. Click Start→Control Panel, and double-click iSCSI Initiator.
2. Click the Discovery tab.
3. Click Add Portal…
4. Add the IP address of both Dell EqualLogic storage groups.
5. Click OK.
6. Click the Targets tab.
7. Find the MailStore volume, and select it.
8. Click Log On…
9. Check the checkbox to allow automatic logon on reboot.
10. Click OK.

Configuring additional drives in Disk Management
1. Click Start, Administrative Tools, Computer Management.
2. Click Disk Management.
3. Right-click the uninitialized disks (if any), and choose Initialize Disk.
4. Choose MBR.
5. Right-click the 30GB volume, and choose New Simple Volume. Click Next.
6. Set the 30GB drive to drive E:\, and click Next.
7. Right-click the 70GB volume, and choose New Simple Volume. Click Next.
8. Set the 70GB drive to drive F:\, and click Next.
9. Right-click the 400GB volume, and choose New Simple Volume. Click Next.
10. Set the 400GB drive to drive G:\, and click Next.
11. Choose NTFS, default allocation unit size, and check the Perform a quick format checkbox. Click Next.
12. Click Finish.

Installing system updates in Windows Server 2008 x64 Edition
We installed the following updates using the Microsoft Windows Update feature:

- Microsoft .NET Framework 3.5 Service Pack 1 and .NET Framework 3.5 Family Update (KB951847) x64
- Update for Internet Explorer 8 Compatibility View List for Windows Server 2008 x64 Edition (KB971180)
- Security Update for Windows Server 2008 x64 Edition (KB958687)
- Update for Windows Server 2008 x64 Edition (KB957388)
- Security Update for Windows Server 2008 x64-based Systems (KB938464)
- Update for Windows Server 2008 x64 Edition (KB949189)
- Security Update for Windows Server 2008 x64 Edition (KB955069)
- Security Update for Windows Server 2008 x64 Edition (KB954459)
- Security Update for Windows Server 2008 x64 Edition (KB957097)
- Security Update for Windows Server 2008 x64 Edition (KB958690)
- Cumulative Security Update for Internet Explorer 7 for Windows Server 2008 x64 Edition (KB963027)
- Security Update for Windows Server 2008 x64 Edition (KB960803)
- Internet Explorer 8 for Windows Server 2008 x64 Edition
- Security Update for Windows Server 2008 x64 Edition (KB958623)
- Update for Windows Server 2008 x64 Edition (KB959130)
- Windows Malicious Software Removal Tool x64 - May 2009 (KB890830)
- Update for Windows Server 2008 x64 Edition (KB957200)

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- Security Update for Windows Server 2008 x64 Edition (KB953733)
- Security Update for Windows Server 2008 x64 Edition (KB950762)
- Update for Windows Server 2008 x64 Edition (KB955839)
- Security Update for Windows Server 2008 x64 Edition (KB958624)
- Security Update for Windows Server 2008 x64 Edition (KB950974)
- Update for Windows Server 2008 x64 Edition (KB951978)
- Update for Windows Server 2008 for x64-based Systems (KB955020)
- Microsoft .NET Framework 3.5 Service Pack 1 and .NET Framework 3.5 Family Update (KB951847) x64
- Security Update for Windows Server 2008 x64 Edition (KB956572)
- Security Update for Windows Mail for Windows Server 2008 x64 Edition (KB951066)
- Update Rollup for ActiveX Killbits for Windows Server 2008 x64 Edition (KB960715)
- Security Update for Windows Server 2008 x64 Edition (KB960225)
- Security Update for Windows Server 2008 x64 Edition (KB956802)
- Update for Windows Server 2008 x64 Edition (KB957321)
- Update for Windows Server 2008 x64 Edition (KB952287)
- Security Update for Windows Server 2008 x64 Edition (KB958644)
- Security Update for Windows Server 2008 x64 Edition (KB959426)
- Security Update for Windows Server 2008 x64 Edition (KB952004)
- Security Update for Windows Server 2008 x64 Edition (KB951698)
- Update for Windows Server 2008 x64 Edition (KB950050)
- Cumulative Security Update for ActiveX Killbits for Windows Server 2008 x64 Edition (KB950760)
- Update for Windows Server 2008 x64 Edition (KB955302)
- Windows Update Agent 7.2.6001.788

Installing Hyper-V in Windows Server 2008

Note: Be sure you have installed all the latest critical and recommended updates for Windows Server 2008 from Windows Update. Specifically, you must install the update that upgrades Hyper-V from beta to release software. (As of this writing, this update is KB950050 on Windows Server 2008 Enterprise Edition x64.)

1. Click Start→Administrative Tools→Server Manager.
2. Click Roles.
3. Click Add Roles.
4. Click Next.
5. Select the Hyper-V role by checking the box beside it, and click Next.
6. Check the box beside the Ethernet Card you wish to use, and click Next.
7. Click Install to begin the Hyper-V installation.
8. When the installation finishes, click Close.
9. When the application prompts you to restart now, click Yes.
10. Follow the prompt to log onto the system.
11. Enter the password, and click the arrow to continue. The Resuming Configuration Wizard should start automatically.
12. Once the Resuming Configuration Wizard completes, the installation results should appear with a message that the installation succeeded.
13. Click Close.

Creating the virtual machine

Create the virtual machine with the following VM parameters:
- Virtual processor: 4
- Virtual memory: 12,228 MB
- Virtual disk size: 30 GB

1. Click Start→Administrative Tools→Hyper-V Manager.
2. Click Connect to Server, and click OK.
3. Click Action→Virtual Network Manager…
4. Select New virtual network.

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5. Select External, and click Add.
6. From the Actions menu, select New→Virtual Machine…
7. Click Next.
8. Enter a name for the virtual machine.
9. Click Next.
10. Specify the amount of memory to allocate to this virtual machine (12,228 MB), and click Next.
11. Select Not Connected on the Configure Networking screen, and click Next.
12. Select the Attach a virtual hard disk later radio button, and click Next.
13. Click Finish.
14. Close Hyper-V Manager.

Setting up the VM
After creating the VM through the Hyper-V interface, we proceeded to set up the VM, which included installing and configuring Windows Server 2008 x64 with SP1.

Configuring the VM
1. Click Start→Administrative Tools→Hyper-V Manager.
2. Right-click the VM, and select Settings…
3. Select Processor.
4. Change the number of logical processors to 4, and click Apply.
5. Select Network Adapter.
6. Select the appropriate configuration from the drop-down menu, and click Apply.
7. Select Add Hardware.
8. Select SCSI Controller, and click Add.
9. Click Apply.
10. Select IDE Controller 0.
11. Select Disk Drive, and click Add.
12. Click New.
13. Click Next.
14. Click the Fixed size radio button, and click Next.
15. Enter a name for the VHD file.
16. Browse to the root of Drive E, and select Next.
17. Select the Create a new blank virtual hard disk radio button.
18. Type 30 for the number of GB for the virtual hard disk, and click Next.
19. Click Finish.
20. Click Apply.
21. Select SCSI Controller.
22. Select Disk Drive, and click Add.
23. Click New.
24. Click Next.
25. Click the Fixed size radio button, and click Next.
26. Enter a name for the VHD file.
27. Browse to the root of Drive F, and select Next.
28. Select the Create a new blank virtual hard disk radio button.
29. Type 70 for the number of GB for the virtual hard disk, and click Next.
30. Click Finish.
31. Click Apply.
32. Select SCSI Controller.
33. Select Disk Drive, and click Add.
34. Click New.
35. Click Next.
36. Click the Fixed size radio button, and click Next.
37. Enter a name for the VHD file.
38. Browse to the root of Drive G, and select Next.
39. Select the Create a new blank virtual hard disk radio button.

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40. Type `400` for the number of GB for the virtual hard disk, and click Next.
41. Click Finish.
42. Click Apply.
43. Click OK.

Installing Windows Server 2008 x64 Edition with SP1 on the VM
We installed a fresh copy of Windows Server 2008 x64 Edition with SP1 using the steps below.

1. Click Start→Administrative Tools→Hyper-V Manager.
2. Right-click the VM, and select Settings…
3. Select IDE Controller 1.
4. Select DVD Drive.
5. Select the Physical CD/DVD drive: radio button, and click Apply.
6. Select BIOS, and confirm that CD is at the top of the Startup order list. If this is not the case, adjust the list appropriately, and click Apply.
7. Click OK.
8. Right-click the VM, and select Connect…
9. Click Menu→DVD Drive→Capture appropriate DVD-ROM drive (e.g., D:).
10. Insert the Windows Server 2008 installation CD in the DVD-ROM drive.
11. Click Action→Start to start the Master VM.
12. At the Language Selection Screen, click Next.
13. Click Install Now.
14. Select Windows Server 2008 Enterprise (Full Installation) x64, and click Next.
15. Click the I accept the license terms check box, and click Next.
16. Click Custom.
17. Click Drive options (advanced).
18. Click New.
19. Click Apply.
20. Click Next.
21. At the warning that the user's password must be changed before logging on screen, click OK.
22. Type `Password1` as the new password in both fields, and click the arrow to continue.
23. At the Your password has been changed screen, click OK.
24. Once the installation completes, on the Hyper-V Manager menu, click Action→Insert Integration Services Setup Disk.
25. At the prompt to restart, click Yes.
26. At the prompt, log back into the VM.
27. Right-click the desktop, and select Personalize.
28. Click the Screen Saver link.
29. Click the Screen saver drop-down menu, and select (None).
30. Click Apply.
31. Click Change power settings.
32. Under Balanced plan, click Change plan settings.
33. From the Turn off monitor drop-down menu, select Never.
34. Click Save changes, and close the Power Options, Screen Saver Settings, and Personalization windows.
35. Click Start.
36. Right-click My Computer, and select Manage.
37. Select Disk Management.
38. If the wizard prompts you to initialize new disks, click OK. Note: If you must select a partition table, select MBR.
39. Right-click the first unallocated disk partition, and select New Simple Volume…
40. Click Next.
41. Use the entire VHD storage space, and click Next.
42. Select the drive letter to assign to the new partition, and click Next.
43. Label the volume appropriately (e.g., MailDB, MailBackup, etc.).
44. Confirm that Perform a quick format is checked, and click Next.

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45. Click Finish.
46. Repeat steps 36 through 45 for the remaining volumes.

Setting up network configuration on the VM
1. Click Start→Control Panel→Network Connections, and Local Area Connection.
2. At the Local Area Connection Status screen, click Properties.
3. At the Local Area Connection Properties screen, select Internet Protocol Version 4 (TCP/IPv4), and click Properties.
4. At the Internet Protocol Version 4 (TCP/IPv4) Properties screen, select the Use the following IP address radio button.
5. Enter a valid static IP address, subnet mask, and default gateway.
6. Select the Use the following DNS server addresses radio button, and enter at least one valid DNS server address.
7. Click OK, and click Close twice. Close the Network Connections window.

Installing system updates in Windows Server 2008 on the VM
We installed the following updates using the online Windows Update feature. Note: Reboot the VM when the installer requests you do so.

- Hotfix for Windows (KB942288)
- Security Update for Windows Server 2008 x64 Edition (KB958687)
- Update for Windows Server 2008 x64 Edition (KB957388)
- Security Update for Windows Server 2008 x64-based Systems (KB938464)
- Update for Windows Server 2008 x64 Edition (KB949189)
- Security Update for Windows Server 2008 x64 Edition (KB955069)
- Security Update for Windows Server 2008 x64 Edition (KB954459)
- Security Update for Windows Server 2008 x64 Edition (KB957097)
- Security Update for Windows Server 2008 x64 Edition (KB958690)
- Cumulative Security Update for Internet Explorer 7 for Windows Server 2008 x64 Edition (KB963027)
- Security Update for Windows Server 2008 x64 Edition (KB960803)
- Internet Explorer 8 for Windows Server 2008 x64 Edition
- Security Update for Windows Server 2008 x64 Edition (KB958623)
- Update for Windows Server 2008 x64 Edition (KB959130)
- Windows Malicious Software Removal Tool x64 - May 2009 (KB890830)
- Update for Windows Server 2008 x64 Edition (KB957200)
- Security Update for Windows Server 2008 x64 Edition (KB953733)
- Security Update for Windows Server 2008 x64 Edition (KB950762)
- Update for Windows Server 2008 x64 Edition (KB955839)
- Security Update for Windows Server 2008 x64 Edition (KB958624)
- Security Update for Windows Server 2008 x64 Edition (KB950974)
- Update for Windows Server 2008 x64 Edition (KB951978)
- Update for Windows Server 2008 for x64-based Systems (KB955020)
- Microsoft .NET Framework 3.5 Service Pack 1 and .NET Framework 3.5 Family Update (KB951847) x64
- Security Update for Windows Server 2008 x64 Edition (KB956572)
- Security Update for Windows Mail for Windows Server 2008 x64 Edition (KB951066)
- Update Rollup for ActiveX Killbits for Windows Server 2008 x64 Edition (KB960715)
- Security Update for Windows Server 2008 x64 Edition (KB960225)
- Security Update for Windows Server 2008 x64 Edition (KB956802)
- Update for Windows Server 2008 x64 Edition (KB957321)
- Update for Windows Server 2008 x64 Edition (KB952287)
- Security Update for Windows Server 2008 x64 Edition (KB958644)
- Security Update for Windows Server 2008 x64 Edition (KB959426)
- Security Update for Windows Server 2008 x64 Edition (KB952004)
- Security Update for Windows Server 2008 x64 Edition (KB951698)
- Update for Windows Server 2008 x64 Edition (KB950050)
- Cumulative Security Update for ActiveX Killbits for Windows Server 2008 x64 Edition (KB950760)

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- Update for Windows Server 2008 x64 Edition (KB955302)
- Security Update for Windows Server 2008 x64 Edition (KB955069)
- Update for Windows Server 2008 for x64-based Systems (KB955020)
- Update for Windows Server 2008 x64 Edition (KB951978)
- Security Update for Windows Server 2008 x64 Edition (KB959426)
- Update for Windows Server 2008 x64 Edition (KB957388)
- Security Update for Windows Server 2008 x64 Edition (KB960225)
- Update for Windows Server 2008 x64 Edition (KB949189)
- Security Update for Windows Server 2008 x64 Edition (KB960803)
- Security Update for Windows Server 2008 x64 Edition (KB954459)
- Security Update for Windows Server 2008 x64 Edition (KB950974)
- Cumulative Security Update for Internet Explorer 7 for Windows Server 2008 x64 Edition (KB963027)
- Security Update for Windows Server 2008 x64 Edition (KB958687)
- Security Update for Windows Server 2008 x64 Edition (KB958624)
- Security Update for Windows Server 2008 x64-based Systems (KB938464)
- Update for Windows Server 2008 x64 Edition (KB957321)
- Security Update for Windows Server 2008 x64 Edition (KB958623)
- Windows Update Agent 7.2.6001.788
- Update for Windows (KB951634)

Configuring additional drives in Disk Management
1. Click Start, Administrative Tools, Computer Management.
2. Click Disk Management.
3. Right-click the uninitialized disks (if any), and choose Initialize Disk.
4. Choose MBR.
5. Right-click the 70GB volume, and choose New Simple Volume. Click Next.
6. Set the 70GB drive to drive E:\, and click Next.
7. Choose NTFS, default allocation unit size, and check the Perform a quick format checkbox. Click Next.
8. Click Finish.
9. Repeat steps 5 through 8 for the second drive.

Installing the domain controller
1. Set a static IP address using the following steps:
    a. Right-click the network icon in the quick-launch bar, and choose Network and Sharing Center.
    b. Click Manage network connections.
    c. Right-click the local area connection, and choose Properties.
    d. Select Internet Protocol Version (TCP/IPv4), and click Properties.
    e. Select the Use the following IP address radio button, and type `192.168.0.101` in the IP address field.
    f. Press Tab to auto-fill 255.255.255.0 in the Subnet mask field.
    g. In the Preferred DNS server field, type `127.0.0.1` and click OK to close the IPv4 properties window.
    h. Click Close.
2. Give the computer a name using the following steps:
    a. Click Start, right-click Computer, and select Properties.
    b. Click Change Settings.
    c. Click Change.
    d. Type `mailserver` in the Computer name field, and click OK.
    e. At the Computer Name/Domain Changes pop-up window, click OK.
    f. Click OK.
    g. At the Microsoft pop-up window, click Restart Now.
3. Promote the mailserver to domain controller by following these steps:
    a. Select Start→Command Prompt.
    b. Type `dcpromo`
    c. At the Welcome pop-up window, click Next.

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d. At the Operating System Compatibility screen, click Next.
e. At the Choose a Deployment Configuration screen, select the Create a new domain in a new forest radio button, and click Next.
f. At the Name the Forest Root Domain screen, type a domain name (e.g., `mailserver.com`), and click Next.
g. At the Set Forest Functional Level screen, choose Windows Server 2008 from the drop-down menu, and click Next.
h. At the Additional Domain Controller Options screen, accept the defaults, and click Next.
i. When the Static IP assignment window pops up, click Yes, the computer will use a dynamically assigned IP address.
j. When the Active Directory domain Services Installation Wizard window pops up, click Yes.
k. At the Location for Database, Log Files, and SYSVOL screen, click Browse next to the Database folder field, and choose the C:\ drive. Click Next.
l. At the Directory Services Restore Mode Administrator Password screen, enter a password, and click Next.
m. At the Summary screen, review the selections, and click Next.
n. When the installation software prompts you to do so, insert the OS CD, and click OK.
o. At the Completing the Active Directory Installation Wizard screen, click Finish.
p. When the system prompts you to reboot the server, click Restart Now.
q. After the server reboots, log into the system.

Installing Internet Information Services 6.0
1. Select Start→Administrative Tools→Server Manager.
2. Click Add Roles.
3. At the Select Server Roles screen, click Web Server (IIS).
4. At the Add features required for Web Server (IIS) pop-up window, click Add Required Features.
5. Click Next.
6. At the Web Server (IIS) screen, click Next.
7. At the Select Role Services screen, select the IIS 6 Metabase Compatibility, IIS 6 Management Console, Basic Authentication, Windows Authentication, Digest Authentication, and Dynamic content Compression checkboxes. Click Next.
8. At the Confirm Installation Selections screen, click Install.
9. At the Installation Results screen, click Close.

Installing Exchange Server 2007 with SP1 on the VM
1. Insert the Microsoft Exchange Server 2007 with SP1 CD.
2. At the pop-up AutoPlay window, click Run Setup.EXE.
3. The installer should consider Steps 1 and 2 complete, and gray them out.
4. Click Step 3: Install Microsoft Windows PowerShell.
5. Select Start→Command Prompt.
6. At the Command Prompt window, type `ServerManagerCmd –I PowerShell` and press Enter.
7. When the installation completes, close the Command Prompt window.
8. Click the link to Step 4: Install Microsoft Exchange Server 2007 SP1.
9. Click Next to go past the introduction screen.
10. Accept the license agreement, and click Next.
11. Select No for error reporting, and click Next.
12. Select Typical Exchange Server Installation, and click Next.
13. Leave the organization name at default (First Organization), and click Next.
14. At the question about client computers running Outlook 2003 and earlier, select No, and click Next.
15. If a warning about a lack of SMTP appears after the check finishes, ignore it.
16. Click Install to start the installation process.
17. Once the installation is complete, click Finish. Exchange should automatically open the Exchange Management Console.

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Configuring Exchange Server 2007 on the VM

1. If Exchange does not automatically open the Exchange Management Console, select Start→All Programs→Microsoft Exchange Server 2007→Exchange Management Console.
2. In the left pane, expand Organization Configuration, and select Hub Transport.
3. In the action pane on the far right, select New Send Connector.
4. Name the send connector SMTP, select the intended use as Internet, and click Next.
5. In the Address space window, click Add.
6. In the SMTP Address Space window, type * as the address, make sure Include all subdomains is checked by default, and click OK.
7. Click Next.
8. Click Next to accept defaults for the next two pages.
9. At the New Connector page, click New to create the connector.
10. Click Finish to close the New SMTP Send Connector wizard.
11. In the left pane of the Exchange Management Console window, expand Server Configuration, and select Mailbox.
12. In the Database Management tab, right-click First Storage Group, and select New Public Folder Database.
13. Name the new public folder database `Public Folder Database` and click New.
14. At the Completion page, click Finish to close the New Public Folder Database window.
15. Close the Exchange Management Console, and reboot the server.
16. Once the server successfully reboots, log in, and select Start→All Programs→Administrative Tools→Active Directory Users and Computers.
17. At the Active Directory Users and Computers window, select test.com in the left pane, and open Users in the right pane.
18. Right-click a blank area in the Users folder, and select New→User.
19. At the New Object - User window, complete the name fields as you wish (we used first name: test, last name: tester, logon name: tester), and select Next.
20. Enter a secure password (we used Password1), and check Password never expires.
21. At the pop-up information window, click Accept.
22. Select Next to close the New Object – User window.
23. Double-click the new user to bring up the Properties window.
24. Under the Member Of tab, click Add.
25. In the Enter the object names to select dialog box, type `Domain Admins; Exchange Organization Administrators` and select Check Names to verify. Click OK.
26. Click OK to close the user Properties window and close the Active Directory Users and Computers window.
27. Select Start→All Programs→Microsoft Exchange Server 2007→Exchange Management Console.
28. In the left pane of the Exchange Management Console window, select Recipient Configuration; and in the right pane, select New Mailbox.
29. At the New Mailbox window, select User Mailbox, and click Next.
30. At the User Type page, select Existing users, and click Add.
31. Select the new account you created earlier, and click OK to add it to the selection box.
32. Click Next.
33. At the Mailbox Settings page, leave the Alias textbox with default settings, and select Browse in the Mailbox database selection spot.
34. At the Select Mailbox database window, select Mailbox Database, and click OK.
35. Click through the next screens to create the new mailbox, and close when you have done so.
36. Close the Exchange Management Console.
37. Select Start→All Programs→Microsoft Exchange→System Manager.
38. In the left window pane, expand Server Configuration and Mailbox so the First Storage Group is visible.
39. Right-click First Storage Group, and select Properties.
40. Click Browse, and change the Transaction log and System path location to E:\.
41. Check the Enable circular logging box.
42. Click Apply.
43. When the pop-up message appears asking if you want to perform this task, click Yes.

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44. When the message appears saying that all mounted stores are back online, click OK.
45. Under First Storage Group, right-click Mailbox Store, and select Properties.
46. Select the Database tab.
47. Click Browse, and move the Exchange database and Exchange streaming database to F:\.
48. Check the box beside This database can be overwritten by a restore.
49. Click Customize next to Maintenance interval.
50. Remove all blue from the boxes so the system will not perform maintenance, and click OK.
51. At the Mailbox Store Properties window, click Apply.
52. When a warning message appears, click Yes.
53. When the message that the database files have been moved appears, click OK.
54. Click OK to close the Mailbox Store Properties window.
55. Under First Storage Group, right-click Public Store, and select Properties.
56. Select the Database tab.
57. Click Browse, and move the Exchange database and Exchange streaming database to F:\.
58. Check the box beside This database can be overwritten by a restore.
59. Click Customize next to Maintenance interval.
60. Remove all blue from the boxes so the system will not perform maintenance, and click OK.
61. At the Public Store Properties window, click Apply.
62. When a warning message appears, click Yes.
63. When the message that the database files have been moved appears, click OK.
64. Click OK to close the Public Store Properties window.
65. Reboot the virtual machine.

Installing and configuring the mail client

To create the mail client, you must install several software components. Before following these instructions, make sure to statically assign an IP address for the client, and to then plug that port into the system under test. This allows the client to join the Active Directory domain. We followed this process for each installation:

1. Install Microsoft Windows Server 2003 R2 Enterprise x64 Edition Service Pack 2 on the client machine.
2. Assign a computer name of Client1 for the mail client.
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 Testbed for the workgroup.

To set up this server, we had to install several additional software components. The following subsections detail the necessary installation processes.

Joining the domain
1. Select Start→Control Panel→Network Connections→Local Area Connection.
2. Click Properties.
3. Highlight Internet Protocol (TCP/IP), and click Properties.
4. Select the Use the following DNS server addresses radio button, and enter the IP address of the DNS server in the Preferred DNS server field. Click OK.
5. Right-click My Computer, and select Properties.
6. Under the Computer Name tab, click Change.
7. At the Computer Name Changes window, under the Member of section, select the Domain radial box, and type mailserver.com
8. Select OK to start joining the domain.
9. When the window appears asking for a person qualified on the domain, type Tester as the username and Password1 as the password.
10. At the welcome pop-up window and the window warning that you must reset the computer for the changes to take effect, click OK.
11. At the System Properties window, click OK.

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12. When a pop-up appears asking if you want to restart now, click Yes to restart your computer.

Installing Internet Information Services 6.0
1. Select Start→Control Panel→Add or Remove Programs.
2. Click Add/Remove Windows Components.
3. Select Application Servers, and click Details.
4. Click ASP.NET, and make sure a check appears in the check box.
5. Select Internet Information Services (IIS), and click Details.
6. Click OK to close the Application Server window.
7. At the Windows Components Wizard, click Next to begin the installation.
8. When the system prompts you to do so, insert the OS CD, and click OK.
9. At the Completing the Windows Components Wizard window, click Finish.
10. Close the Add or Remove Programs window.

Installing Microsoft Exchange Server 2007 Management Tools and Load Generator
1. Insert the Microsoft Exchange Server 2007 with SP1 CD. The CD should automatically launch the installation software.
2. Click the link to Step 1: Install .NET Framework 2.0.
3. When you arrive at the download link, download the x64 version of the .NET Framework, and install.
4. Click the link to Step 3: Install Microsoft Windows PowerShell; this takes you to the download link.
5. When you arrive at the download link, download Microsoft Windows PowerShell, and install with defaults.
6. Search for and download SP1 for .NET Framework 2.0.
7. Install the .NET Framework 2.0 SP1 with all defaults.
8. Click the link to Step 4: Install Microsoft Exchange Server 2007 SP1.
9. Click Next to go past the introduction screen.
10. Accept the license agreement, and click Next.
11. Select No for error reporting, and click Next.
12. Select Custom Exchange Server Installation, and click Next.
13. Check Management Tools, and click Next.
14. After the check finishes, click Install to start the installation process.
15. Once installation is complete, click Finish.
16. Download and install Load Generator, using all defaults.

Preparing Load Generator
1. Log into the MailClient using the tester account.
2. Select Start→All Programs→Microsoft Exchange→Exchange Load Generator.
3. When the Load Generator window appears, select Start a new test.
4. Select Create a new test configuration, and click Continue.
5. Set the length of a simulation day to 8 hours.
6. Set the total length of the simulation to 30 minutes.
7. Type `Tester` as the Directory Access Username.
8. Type `Password1` as the Directory Access Password.
9. Type `Password1` as the Mailbox Account Master Password.
10. Click Continue with recipient management.
11. Make 750 users in each Mailbox Database, and click Continue.
12. To accept defaults for Advanced recipient settings, click Continue.
13. At the Specify test user groups window, select the plus sign to add a user group.
14. Change the Client Type to Outlook 2007 Cached and the Action Profile to Heavy.
15. Uncheck the PreTestLogon check box, and click Continue.
16. Leave defaults in Remote configurations, and click Continue.
17. Click Save the configuration file as, and name it `Loadgencfg`
18. Start the initialization process.
19. After the initialization is complete, log on to the mailserver Hyper-V host and shutdown the mailserver.
20. Create a copy of the mailserver.vhd file.

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FSCT
Installing and configuring the server
To set up this server, you must install several software components. The following subsections detail the necessary installation processes.

Installing the operating system
1. Boot the server, and insert the Windows Server 2008 x64 installation CD in the DVD-ROM drive.
2. At the Language Selection screen, click Next.
3. Click Install Now.
4. Select Windows Server 2008 Enterprise (Full Installation) x64, 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. Click New.
9. Click Apply.
10. Click Next.
11. At the warning that the user's password must be changed before logging on 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.
14. Right-click the desktop, and select Personalize.
15. Click the Screen Saver link.
16. Click the Screen saver drop-down menu, and select (None).
17. Click Apply.
18. Click Change power settings.
19. Under Balanced plan, click Change plan settings.
20. From the Turn off monitor drop-down menu, select Never.
21. Click Save changes, and close the Power Options, Screen Saver Settings, and Personalization windows
22. Open the Start menu, type `regedit` in the search field, and press Enter.
23. To allow the server to automatically log into the OS after a system reboot, change the following Registry key to have the values shown here:

    ```
    [HKEY_LOCAL_MACHINE\SOFTWARE\Microsoft\Windows NT\CurrentVersion\Winlogon]
    DefaultPassword=Password1
    AutoAdminLogon=1
    ```

24. Restart the server.

Installing system updates in Windows Server 2008 x64 Edition
We installed the following updates using the Microsoft Windows Update feature:

- Update for Windows Server 2008 x64 Edition (KB955430)
- Update for Windows Server 2008 x64 Edition (KB955430)
- Microsoft .NET Framework 3.5 Service Pack 1 and .NET Framework 3.5 Family Update (KB951847) x64
- LSI Corporation - Storage - Dell SAS 6/iR Integrated Controller
- Microsoft .NET Framework 3.5 Service Pack 1 and .NET Framework 3.5 Family Update (KB951847) x64
- Update for Windows Server 2008 x64 Edition (KB955430)
- Security Update for Windows Server 2008 x64 Edition (KB958687)
- Update for Windows Server 2008 x64 Edition (KB957388)
- Security Update for Windows Server 2008 x64-based Systems (KB938464)
- Update for Windows Server 2008 x64 Edition (KB949189)
- Security Update for Windows Server 2008 x64 Edition (KB955069)
- Security Update for Windows Server 2008 x64 Edition (KB954459)

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- Security Update for Windows Server 2008 x64 Edition (KB957097)
- Security Update for Windows Server 2008 x64 Edition (KB958690)
- Cumulative Security Update for Internet Explorer 7 for Windows Server 2008 x64 Edition (KB963027)
- Security Update for Windows Server 2008 x64 Edition (KB960803)
- Internet Explorer 8 for Windows Server 2008 x64 Edition
- Security Update for Windows Server 2008 x64 Edition (KB958623)
- Update for Windows Server 2008 x64 Edition (KB959130)
- Windows Malicious Software Removal Tool x64 - May 2009 (KB890830)
- Update for Windows Server 2008 x64 Edition (KB957200)
- Security Update for Windows Server 2008 x64 Edition (KB953733)
- Security Update for Windows Server 2008 x64 Edition (KB950762)
- Update for Windows Server 2008 x64 Edition (KB955839)
- Security Update for Windows Server 2008 x64 Edition (KB958624)
- Security Update for Windows Server 2008 x64 Edition (KB950974)
- Update for Windows Server 2008 x64 Edition (KB951978)
- Update for Windows Server 2008 for x64-based Systems (KB955020)
- Microsoft .NET Framework 3.5 Service Pack 1 and .NET Framework 3.5 Family Update (KB951847) x64
- Security Update for Windows Server 2008 x64 Edition (KB956572)
- Security Update for Windows Mail for Windows Server 2008 x64 Edition (KB951066)
- Update Rollup for ActiveX Killbits for Windows Server 2008 x64 Edition (KB960715)
- Security Update for Windows Server 2008 x64 Edition (KB960225)
- Security Update for Windows Server 2008 x64 Edition (KB956802)
- Update for Windows Server 2008 x64 Edition (KB957321)
- Update for Windows Server 2008 x64 Edition (KB952287)
- Security Update for Windows Server 2008 x64 Edition (KB958644)
- Security Update for Windows Server 2008 x64 Edition (KB959426)
- Security Update for Windows Server 2008 x64 Edition (KB952004)
- Security Update for Windows Server 2008 x64 Edition (KB951698)
- Update for Windows Server 2008 x64 Edition (KB950050)
- Cumulative Security Update for ActiveX Killbits for Windows Server 2008 x64 Edition (KB950760)
- Update for Windows Server 2008 x64 Edition (KB955302)
- Windows Update Agent 7.2.6001.788

Installing FSCT
1. Copy the x64 FSCT ZIP file to the desktop of the server.
2. Unzip the FSCT ZIP file into C:\FSCT. Create the folder if it does not already exist.
3. Delete the ZIP file from the desktop, and empty the recycle bin.

Installing and configuring the clients
Installing Microsoft Windows Vista Ultimate x64 with Service Pack 1
1. Install Windows Vista Ultimate:
   a. Boot to a Windows Vista Ultimate DVD.
   b. When the installer prompts you to do so, press any key to boot from CD or DVD.
   c. At the Language and preference screen, accept the default options, and click Next.
   d. Click Install now.
   e. Check I accept the license terms.
   f. Click Next.
   g. At the Which type of installation do you want? screen, select Custom (advanced).
   h. Click Drive options (advanced).
   i. Select the destination disk for the operating system.
   j. Click Format.
   k. At the All data stored will be permanently deleted dialog, click OK.
   l. Once the system finishes formatting the disk, click Next.

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m. Fill in the Username field, and click Next.
n. Fill in the Computer name field, and click Next.
o. When the option to enable Automatic Updates appears, click Ask me later.
p. Select the correct time zone, date, and time; and click Next.
q. At the Select your computer's current location screen, click Work location.
r. At the Thank you screen, click Start.
s. When the Windows Vista Enterprise with Service Pack 1 installation completes, close the Welcome Center Dialog.
t. At the Set network location screen, click Work location.
u. Click Close.
2. Verify that Windows Automatic Updates are off:
   a. Click Start→All Programs→Windows Updates.
   b. Click Change settings, located in the left panel.
   c. Select Never check for updates and Include recommended updates.
   d. Click OK.
   e. Click Get updates for more products.
   f. At the Microsoft Update window, select I accept the Terms of Use, and click Install.
   g. Click Security.
   h. Under Security Center, select Turn automatic updating off.
   i. Select the Never check for updates radio button.
   j. Click OK.
3. Set the Power Management settings:
   a. Click Start→Control Panel.
   b. Select Appearance and Personalization.
   c. Under Personalization, click Change screen saver.
   d. From the Screen saver drop-down menu, select None.
   e. At the Screen Saver Settings dialog box, click Change power settings.
   f. Click Change plan settings.
   g. From the Turn off the display and Put the computer to sleep drop-down menus, select Never.
   h. Click Save changes.
   i. Close the Power Options window.
   j. At the Screen Saver Settings, click OK.
   k. Close the Appearance and Personalization window.
4. Disable User Account Control (UAC):
   a. Click Start.
   b. Select Control Panel.
   c. Click User Accounts.
   d. At the main window, click Turn User Account Control on or off.
   e. Uncheck Use User Account Control (UAC) to help protect your computer.
   f. Click OK.
   g. Click Restart Now.
5. Capture the Base test image as we describe in the Capturing the base test image section above.

Installing system updates in Windows Vista x64
We installed the following updates using the Microsoft Windows Update feature:

- Security Update for Windows Vista for x64-based Systems (KB958687)
- Security Update for Windows Vista for x64-based Systems (KB955069)
- Realtek - Network - Realtek RTL8168B/8111B Family PCI-E GBE NIC
- Update for Windows Vista for x64-based Systems (KB938371)
- Security Update for Windows Vista for x64-based Systems (KB953155)
- Update for Windows Vista for x64-based Systems (KB957388)
- Security Update for Windows Vista for x64-based Systems (KB960803)
- Security Update for Windows Vista for x64-based Systems (KB960225)
- Windows Malicious Software Removal Tool x64 - May 2009 (KB890830)

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- Security Update for Windows Vista for x64-based Systems (KB959426)
- Security Update for Windows Vista for x64-based Systems (KB956802)
- Security Update for Windows Vista for x64-based Systems (KB958690)
- Update for Windows Vista for x64-based Systems (KB955020)
- Security Update for Windows Vista for x64-based Systems (KB954459)
- Security Update for Windows Vista for x64-based Systems (KB957097)
- Cumulative Security Update for Internet Explorer 7 for Windows Vista x64-based Systems (KB963027)
- Security Update for Windows Mail for Windows Vista for x64-based Systems (KB951066)
- Microsoft .NET Framework 3.5 Service Pack 1 and .NET Framework 3.5 Family Update (KB951847) x64
- Security Update for Windows Vista for x64-based Systems (KB950974)
- Security Update for Windows Vista for x64-based Systems (KB953733)
- Security Update for Windows Vista for x64-based Systems (KB956572)
- Intel Corporation - Display - Intel(R) G33/G31 Express Chipset Family
- Security Update for Windows Vista for x64-based Systems (KB958624)
- Update for Windows Vista for x64-based Systems (KB955839)
- Security Update for Windows Vista for x64-based Systems (KB954154)
- Security Update for Windows Vista x64-based Systems (KB938464)
- Update for Windows Vista for x64-based Systems (KB951978)
- Cumulative Security Update for ActiveX Killbits for Windows Vista for x64-based Systems (KB950760)
- Security Update for Windows Vista for x64-based Systems (KB952069)
- Update for Windows Vista for x64-based Systems (KB955302)
- Update Rollup for ActiveX Killbits for Windows Vista for x64-based Systems (KB960715)
- Security Update for Windows Vista for x64-based Systems (KB950762)
- Update for Windows Vista for x64-based Systems (KB952709)
- Security Update for Windows Vista for x64-based Systems (KB951698)
- Internet Explorer 8 for Windows Vista for x64-based Systems
- Definition Update for Windows Defender - KB915597 (Definition 1.57.1556.0)
- Security Update for Windows Vista for x64-based Systems (KB952004)
- Security Update for Windows Vista for x64-based Systems (KB951376)
- Update for Windows Vista for x64-based Systems (KB952287)
- Security Update for Windows Vista for x64-based Systems (KB958623)
- Security Update for Windows Vista for x64-based Systems (KB958644)
- Windows Update Agent 7.2.6001.788

Installing FSCT
1. Copy the x64 FSCT ZIP file to the desktop of the client.
2. Unzip the FSCT ZIP file into C:\FSCT. Create the folder if it does not already exist.
3. Delete the ZIP file from the desktop, and empty the recycle bin.
4. Repeat steps 1 through 3 for all clients needed.

Installing and Configuring the Controller
Installing the operating system
1. Insert the installation DVD for Windows Server 2008 x64 Edition into the DVD drive.
2. Choose the language, time and currency, and keyboard input. Click Next.
3. Click Install Now.
4. Choose Windows Server Enterprise (Full Installation). Click Next.
5. Accept the license terms, and click Next.
6. Click Custom.
7. Click the disk, and click Drive options (advanced).
8. Click New, Apply, Format, and click Next.
9. Let the installation process continue. The server will reboot several times.

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10. After the installation completes, click OK to set the Administrator password.
11. Enter the administrator password twice, and click OK.
12. Click Start, Control Panel, and double-click System.
13. Click Change Settings.
14. Click Change.
15. Enter the new computer name, and click OK.
16. Click OK to restart, click Close, and click Restart Now.
17. Right-click the desktop, and select Personalize.
18. Click the Screen Saver link.
19. Click the Screen saver drop-down menu, and select (None).
20. Click Apply.
21. Click Change power settings.
22. Under Balanced plan, click Change plan settings.
23. Change the Turn off monitor drop-down menu to Never.
24. Click Save changes, and close the Power Options, Screen Saver Settings, and Personalization windows.
25. Open the Start menu, type `regedit` in the search field, and press Enter.
26. To allow the server to automatically log into the OS after a system reboot, change the following Registry key to have the values shown here:

```
[HKEY_LOCAL_MACHINE\SOFTWARE\Microsoft\Windows NT\CurrentVersion\Winlogon]
DefaultPassword=Password1
AutoAdminLogon=1
```

27. Restart the server.

Installing system updates in Windows Server 2008 x64 Edition
We installed the following updates using the Microsoft Windows Update feature:

- Security Update for Windows Server 2008 x64 Edition (KB958687)
- Update for Windows Server 2008 x64 Edition (KB957388)
- Security Update for Windows Server 2008 x64-based Systems (KB938464)
- Update for Windows Server 2008 x64 Edition (KB949189)
- Security Update for Windows Server 2008 x64 Edition (KB955069)
- Security Update for Windows Server 2008 x64 Edition (KB954459)
- Security Update for Windows Server 2008 x64 Edition (KB957097)
- Security Update for Windows Server 2008 x64 Edition (KB958690)
- Cumulative Security Update for Internet Explorer 7 for Windows Server 2008 x64 Edition (KB963027)
- Security Update for Windows Server 2008 x64 Edition (KB960803)
- Internet Explorer 8 for Windows Server 2008 x64 Edition
- Security Update for Windows Server 2008 x64 Edition (KB958623)
- Update for Windows Server 2008 x64 Edition (KB959130)
- Windows Malicious Software Removal Tool x64 - May 2009 (KB890830)
- Update for Windows Server 2008 x64 Edition (KB957200)
- Security Update for Windows Server 2008 x64 Edition (KB953733)
- Security Update for Windows Server 2008 x64 Edition (KB950762)
- Update for Windows Server 2008 x64 Edition (KB955839)
- Security Update for Windows Server 2008 x64 Edition (KB958624)
- Security Update for Windows Server 2008 x64 Edition (KB950974)
- Update for Windows Server 2008 x64 Edition (KB951978)
- Update for Windows Server 2008 for x64-based Systems (KB955020)
- Microsoft .NET Framework 3.5 Service Pack 1 and .NET Framework 3.5 Family Update (KB951847) x64
- Security Update for Windows Server 2008 x64 Edition (KB956572)
- Security Update for Windows Mail for Windows Server 2008 x64 Edition (KB951066)
- Update Rollup for ActiveX Killbits for Windows Server 2008 x64 Edition (KB960715)
- Security Update for Windows Server 2008 x64 Edition (KB960225)

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- Security Update for Windows Server 2008 x64 Edition (KB956802)
- Update for Windows Server 2008 x64 Edition (KB957321)
- Update for Windows Server 2008 x64 Edition (KB952287)
- Security Update for Windows Server 2008 x64 Edition (KB958644)
- Security Update for Windows Server 2008 x64 Edition (KB959426)
- Security Update for Windows Server 2008 x64 Edition (KB952004)
- Security Update for Windows Server 2008 x64 Edition (KB951698)
- Update for Windows Server 2008 x64 Edition (KB950050)
- Cumulative Security Update for ActiveX Killbits for Windows Server 2008 x64 Edition (KB950760)
- Update for Windows Server 2008 x64 Edition (KB955302)
- Windows Update Agent 7.2.6001.788

Installing FSCT
1. Copy the x64 FSCT ZIP file to the desktop of the controller.
2. Unzip the FSCT ZIP file into C:\FSCT. Create the folder if it does not already exist.
3. Delete the ZIP file from the desktop, and empty the recycle bin.

Testing procedure
To perform the test, we used a series of batch files. We stored batch files either under the C:\ServerShare folder on the server or under the C:\ClientShare folder on the clients, and we used the PsExec utility to coordinate the test procedures amongst the client machines, server machine, and controller. We use simple file sharing to copy files from machine to machine, as we needed.

Preparing the systems for the run
1. On the FSCT clients:
   - Open an elevated command prompt.
   - Navigate to the FSCT folder by typing `cd c:\FSCT` and pressing Enter.
   - Type the following command line, replacing the variables with the relevant information for your run: `fsct prepare client /server <server name> /password <password> /users <number of users per client> /server_ip <server IP address> /workload <workload name>`
2. On the FSCT controller:
   - Open an elevated command prompt.
   - Navigate to the FSCT folder by typing `cd c:\FSCT` and pressing Enter.
   - Type the following command line, replacing the variables with the relevant information for your run: `fsct prepare controller`
3. On the FSCT server:
   - Open an elevated command prompt.
   - Navigate to the FSCT folder by typing `cd c:\FSCT` and pressing Enter.
   - Type the following command line, replacing the variables with the relevant information for your run: `fsct prepare server /clients <client1,client2,…> /password <password> /users <number of users per client> /volumes <volume1,volume2,…> /workload <workload name>`
   Note: We used the HomeFolders workload for all tests.

Executing the test
1. Start perfmon on all systems.
2. On the DVD store clients:
   a. Open an elevated command prompt.
   b. Run the following command: c:\clientshare\ds2sqlserverdriver.exe --target=192.168.0.5 --ramp_rate=10 --run_time=40 --n_threads=X --db_size_str=L --think_time=1.5 --database_name=DS2 where "X" equals the number of threads necessary to simulate the appropriate number of users as detailed below.
3. Wait 9 minutes and 30 seconds.
4. On the FSCT clients:

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a. Open an elevated command prompt.
b. Navigate to the FSCT folder by typing `cd c:\FSCT` and pressing Enter.
c. Type the following command line, replacing the variables with the relevant information for your run: `fsct run client /controller <controller name> /server <server name> /password <password> /timeout 10`
d. The test will begin when the controller starts.
5. On the FSCT controller:
    a. Open an elevated command prompt.
    b. Navigate to the FSCT folder by typing `cd c:\FSCT` and pressing Enter.
    c. Type the following command line, replacing the variables with the relevant information for your run: `fsct run controller /server <server name> /password <server password> /volumes <volume1,volume2,…> /clients <client1,client2,…> /min_users <minusers> /max_users <maxusers> /step <usersstep> /duration <duration> /workload <workload name>`
    Note: We did not use the step up option for this test. We used the same number of users for both min. and max. users, and set the step to 0. We ran the duration for 1,800 seconds.
6. Wait 30 seconds.
7. On the Mail client:
    a. Open an elevated command prompt.
    b. Run the following command: "C:\Program Files\Exchange Load Generator\LoadGenCmd.exe" /r /c "C:\Program Files\Exchange Load Generator\Loadgencfg.xml"
8. When the test is complete, stop Perfmon on all systems.

Cleaning up the systems
1. On the FSCT clients:
    a. Open an elevated command prompt.
    b. Navigate to the FSCT folder by typing `cd c:\FSCT` and pressing Enter.
    c. Type the following command line, replacing the variables with the relevant information for your run: `fsct cleanup client /users <number of users>`
    d. When the cleanup is finished, restart the client.
2. On the FSCT controller:
    a. Open an elevated command prompt.
    b. Navigate to the FSCT folder by typing `cd c:\FSCT` and pressing Enter.
    c. Type the following command line, replacing the variables with the relevant information for your run: `fsct cleanup controller /backup <backup directory>`
    d. When the cleanup is finished, restart the client.
3. On the FSCT server:
    a. Open an elevated command prompt.
    b. Navigate to the FSCT folder by typing `cd c:\FSCT` and pressing Enter.
    c. Type the following command line, replacing the variables with the relevant information for your run: `fsct cleanup server /clients <client1,client2,…> /users <number of users> /volumes <volume1,volume2…>`
    d. When the cleanup is finished, restart the server.
4. Shut down the mail server VM.
5. Copy the backup mailDB.vhd file to replace the current mailDB.vhd file.
6. Right-click the VM, and choose settings.
7. Choose the mailDB.vhd, and choose Physical Disk. Click Apply.
8. Choose the mail DB.vhd, and choose Virtual Disk. Click Apply.
9. Turn on the mail server VM.
10. On the DVD store VM:
    a. Click Start→All Programs→Microsoft SQL Server 2008→SQL Server Management Studio.
    b. Click New Query.
    c. Paste the restore script (listed below) into the query window.
    ```
    USE [master]
    GO
    ```

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```
IF  EXISTS (SELECT name FROM sys.databases WHERE name = N'DS2')
DROP DATABASE [DS2]
GO

RESTORE DATABASE [DS2]
FROM  DISK = N'H:\SQLBackup\DS2-100GB-2filesperfilegroup-2008.bak'
WITH  FILE = 1,
MOVE N'primary' TO N'G:\SQLData\DS2.mdf',
MOVE N'cust1' TO N'G:\SQLData\DS2_1.ndf',
MOVE N'cust2' TO N'G:\SQLData\DS2_2.ndf',
MOVE N'ind1' TO N'G:\SQLData\DS2_3.ndf',
MOVE N'ind2' TO N'G:\SQLData\DS2_4.ndf',
MOVE N'ds_misc1' TO N'G:\SQLData\DS2_5.ndf',
MOVE N'ds_misc2' TO N'G:\SQLData\DS2_6.ndf',
MOVE N'orders1' TO N'G:\SQLData\DS2_7.ndf',
MOVE N'orders2' TO N'G:\SQLData\DS2_8.ndf',
MOVE N'ds_log' TO N'E:\SQLLog\DS2_9.ldf',
NOUNLOAD,  STATS = 10
GO

USE [DS2]
GO

IF  EXISTS (SELECT * FROM sys.database_principals WHERE name =
N'ds2user')
DROP USER [ds2user]
GO

CREATE USER [ds2user] FOR LOGIN [ds2user] WITH DEFAULT_SCHEMA=[dbo]
GO

EXEC sp_addrolemember N'db_owner', N'ds2user'
GO
```

      d. Press F5 to execute the restore.

Changing the number of Users

1. FSCT
   a. During the Execute section, change the min_users and max_users in the controller command line to the appropriate number of users for the test.
   b. All Prepare, Clean up, and Run Client commands remain the same regardless of the number of users chosen.
2. Exchange
   a. Open Exchange Load Generator on the Exchange client.
   b. Select Start a new test.
   c. Choose Use the following saved configuration file, and browse to the Loadgencfg.xml file.
   d. Click Continue.
   e. Enter the total number of users for the run in the available box at the top of the window, and click Distribute users evenly across databases. The number of users should appear in the two database windows.
   f. Click Continue.
   g. At the Advanced recipient settings page, click Continue.
   h. When the Recipient creation is finished, click Continue on the Specify test user groups page.
   i. At the Remote configurations page, click Continue.

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   j. At the Configuration summary page, click Save the configuration file as…, and save the file as Loadgencfg.xml.

   k. At the warning asking if you want to replace the existing file, choose Yes.

   l. Click OK, and close the Load Generator.

3. DVD store

   a. Using the chart below, change the number of threads per client to represent the number of users for the run.

   b. 100 users = 2 threads per client (10 total threads)
     200 users = 4 threads per client (20 total threads)
     300 users = 6 threads per client (30 total threads)
     400 users = 8 threads per client (40 total threads)
     500 users = 10 threads per client (50 total threads)
     900 users = 18 threads per client (90 total threads)

Appendix A – Storage array configuration information

Figure 7 presents detailed configuration information for the storage array.

Storage array	Dell EqualLogic iSCSI SAN
Array	Dell EqualLogic PS4000XV
Disks	16 X 15,000RPM SAS disks
Active storage cache (GB)	2
Number of active storage controllers	1
Number of active storage ports	2
Firmware revision	v4.1.1
Switch type/model/firmware revision	One Dell PowerConnect 6248v2.2.0.3
Disk vendor and model number	16x Seagate ST3450856SS
Disk size (GB)	450
Disk buffer size (MB)	16
Disk RPM	15,000
Disk type	SAS

Figure 7: Detailed configuration information for the storage array system.

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Appendix B – Server configuration information

We used a SQL Server 2008 database server to generate the workload and create demand on the storage. Figure 8 provides detailed configuration information for this server.

Server	Dell PowerEdge 2950
General	
Number of processor packages	2
Number of cores per processor package	4
Number of hardware threads per core	1
System Power Management Policy	Always On
CPU	
Vendor	Intel
Name	Xeon E5405
Stepping	6
Socket type	Socket 771-LGA
Core frequency (GHz)	2.0
Front-side bus frequency (MHz)	1,333
L1 cache	32 KB + 32 KB (per core)
L2 cache	12 MB (2 x 6 MB shared)
Platform	
Vendor	Dell Inc.
Motherboard model number	0M332H
Motherboard chipset	Intel 5000X
Motherboard revision number	12
Motherboard serial number	JD6HWG1
BIOS name and version	Dell 2.5.0 (9/12/2008)
BIOS settings	Default
Chipset INF driver	Microsoft 6.0.6001.18000 (6/21/2006)
Memory module(s)	
Vendor and model number	Samsung M395T5750EZ4-CE66
Type	FB-DDR2 PC5300
Speed (MHz)	667
Speed in the system currently running @ (MHz)	667
Timing/Latency (tCL-tRCD-iRP-tRASmin)	5-5-5-15
Total size (MB)	16,384
Number of RAM modules	8 x 2,048 MB
Chip organization	Double-sided
Channel	Dual
Hard disk	
Number of disks in system	1
Vendor and model number	Western Digital WD800AAJS-18
Size (GB)	80

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Server	Dell PowerEdge 2950
Buffer size (MB)	8
RPM	7,200
Type	SATA 3.0 Gbps
Vendor and model number	Seagate Cheetah 15K.5 ST373455SS
Size (GB)	73
Buffer size (MB)	8
RPM	15,000
Type	SAS 3.0 Gbps
Controller	Standard Dual Channel PCI IDE Controller
Controller driver	Microsoft 6.0.6001.18000 (6/21/2006)
Operating system	
Name	Windows Server 2008 Enterprise x64
Build number	6001
Service Pack	SP1
Microsoft Windows update date	6/1/2009
File system	NTFS
Language	English
Microsoft DirectX version	10
Graphics	
Vendor and model number	ATI ES1000
Type	Integrated
Memory size (MB)	16
Resolution	1,024 x 768
Driver	Microsoft 6.0.6001.18000 (6/21/2006)
Network card/subsystem	
Vendor and model number	Broadcom BCM5708c NetXtreme II
Type	Integrated
Driver	Microsoft 3.7.19.0 (6/21/2006)
Vendor and model number	Intel PRO/1000 PT Server Adapter
Type	PCI Express
Driver	Microsoft 9.11.5.7 (6/21/2006)
Optical drive	
Vendor and model number	TEAC CD-224E-N
Type	CD/DVD-ROM
Interface	SATA
Dual/single layer	Dual
USB ports	
Number of ports	4
Type of ports (USB 1.1, USB 2.0)	2.0

Figure 8: Detailed system configuration information for the test server.

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About Principled Technologies

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 you assess how it will fare against its competition, its performance, whether it's ready to go to market, 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.

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