Replace TWO servers with ONE!
Support 50% more users!
All with plenty of system resources free for future growth!

50 USERS

75 USERS

2 HP ProLiant ML150 G3
*Microsoft® Windows
Small Business Server® 2003 R2*

DELL™ PowerEdge™ T410
*Microsoft Windows
Small Business Server 2008*

OUR FINDINGS

Upgrading from two previous-generation Intel® Xeon® Processor 5130-based HP ProLiant ML150 G3 servers running Windows Small Business Server 2003 R2 to one Intel Xeon Processor E5540-based Dell PowerEdge T410 server running Windows Small Business Server 2008 provides better email and database performance, the ability to handle more users, and headroom for future growth by having processor power to spare.

OUR PROCESS

We measured performance with workloads that exercise two common small business server functions: providing email and database services. We used Microsoft Exchange Load Generator to simulate email activity and DVD Store Version 2 (DS2) as our sample database application.

APRIL 2010

PT A PRINCIPLED TECHNOLOGIES TEST REPORT

Commissioned by Dell, Inc.

WORKLOAD

When we tested the HP ProLiant ML150 G3 servers running Windows Small Business Server 2003 R2 (the legacy servers), we ran the two benchmark workloads on two separate servers, as a small business with increasing demands might do. The primary server with Windows Small Business Server 2003 R2 and Exchange 2003 ran the email workload, and the member server with Windows Server 2003 R2 Standard and SQL Server 2005 Workgroup edition ran the database workload.

When we tested the Intel Xeon Processor E5540-based Dell PowerEdge T410 server with Windows Small Business Server 2008, we ran the two workloads simultaneously.

DVD Store

DVD Store Version 2 (DS2) 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.

Because our goal was to isolate and test database server and storage, we did not use the Web application layer. Instead, we ran the driver application on client machines directly via its command-line interface.

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 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).

For the client machine, we used a desktop-class system running Windows Server 2003 R2 Enterprise Edition x86. The client machine ran a single instance of DS2, which spawned 50 or 75 threads depending on the workload specifications, with 0.05 seconds think time. This simulated a realistic business environment. We used the default DS2 parameters and setup configuration, with the exceptions we note above and in the DVD Store setup section in the How we tested section of this report.

The DS2 driver application creates an orders-per-minute performance counter on the client machine, measuring a running average of OPM count during the test run. 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 two of the servers, the Dell PowerEdge T410 and one of the HP ProLiant ML150 G3 servers, for 40 minutes each per test run.

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

Microsoft Exchange Load Generator

Microsoft Exchange Load Generator (LoadGen) is an industry-standard tool for benchmarking a Microsoft Exchange 2003 or 2007 mail server. LoadGen performs tasks to simulate a standard user generating mail activity. While the workload was ongoing, we measured response time, or the time in milliseconds necessary for the Exchange mail server to complete a request, using the RPC Averaged Latency counter.

LoadGen measures the impact that various clients (MAPI, OWA, IMAP, POP, and SMTP) have on Exchange servers. This allows users to test how effectively a server running Exchange responds to email loads. The simulator uses a client machine to send multiple message requests to the server running Exchange, resulting in a mail load.

We created a custom workload and adjusted it for 50 or 75 users that LoadGen distributed across a single storage group with one mailbox database. We ran the Microsoft Exchange Load Generator benchmark for 30 minutes on the servers. For the client machine, we used a server running Windows Server 2003 R2 Enterprise Edition x86.

For more details about LoadGen, see http://www.microsoft.com/downloads/details.aspx?FamilyId=DDEC1642-F6E3-4D66-A82F-8D3062C6FA98&displaylang=en.

SYSTEM COMPARISON

Figure 1 highlights the key differences between the servers. Appendix A provides detailed

configuration information.

Hardware specifications	Dell PowerEdge T410 server	HP ProLiant ML150 G3 servers
CPU	Intel Xeon Processor E5540	Intel Xeon Processor 5130
CPU speed (GHz)	2.53 GHz	2.0 GHz
Number of processor packages	2	2
Number of cores per processor package	4	2
Number of hardware threads per core	2	1
Memory type	PC3-10600R	PC2-5300
Total memory (GB)	16 GB (4 x 4 GB)	4 GB (2 x 2 GB)
Hard drive	6 x 146GB SAS 15,000 RPM	4 x 160GB SATA 7,200 RPM
Operating system	Microsoft Windows Small Business Server 2008 Premium	Microsoft Windows Small Business Server 2003 R2 Premium (primary server) Microsoft Windows Server 2003 R2 Standard x86 (member server)

Figure 1: System configuration information for the test servers.

WHAT WE FOUND

For testing on the legacy servers, we ran LoadGen on the primary server for 30 minutes, and DVD Store

on the member server for 40 minutes. Each benchmark simulated 50 users.

For testing both benchmarks simultaneously on the Dell PowerEdge T410 server, we staggered the

starting times of the benchmarks to allow each server to ramp up slowly. In this case, we adjusted the

benchmark workloads to simulate 75 users to demonstrate the additional users that Windows Small Business

Server 2008 can support. We began DVD Store and allowed it to ramp up for 10 minutes before starting

LoadGen. Figure 2 shows the timeline for the benchmark runs. We computed the final result based on the 30

minutes of peak performance during the LoadGen run.

To make sure each server achieved its optimum results, we allowed each to sit idle for 10 minutes

before starting the workload.

Multiple benchmark timeline
40 minutes total time

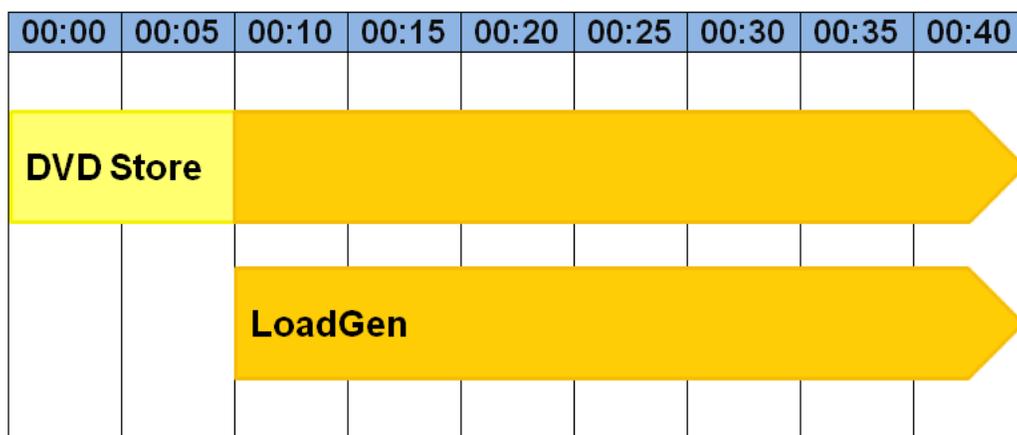| 00:00	00:05	00:10	00:15	00:20	00:25	00:30	00:35	00:40

DVD Store

LoadGen

Figure 2: The timeline we followed when starting the benchmarks for the multiple-benchmark runs on the Dell PowerEdge T410 server. The orange-shaded areas from 00:10 to 00:40 represent the period during which we measured performance.

Figure 3 presents percentage improvement results for the Intel Xeon Processor E5540-based Dell PowerEdge T410 on the two benchmarks relative to the performance of the legacy servers. For each benchmark, we assigned a value of 100 percent to the legacy server's results and then calculated the percentage performance improvement. This approach makes each data point a comparative number, with higher numbers indicating better performance.

As Figure 3 shows, one Intel Xeon Processor E5540-based Dell PowerEdge T410 server provided better performance than the legacy servers did on both database and email workloads.

Server	Email performance percentage improvement over Intel Xeon Processor 5130-based HP ProLiant ML150 G3 servers	Database performance percentage improvement over Intel Xeon Processor 5130-based HP ProLiant ML150 G3 servers	Percentage CPU utilization
Intel Xeon Processor E5540-based Dell PowerEdge T410 server	42.4%	1,341.2%	20.9%

Figure 3: Performance for the Dell PowerEdge T410 server on the benchmarks, relative to the HP ProLiant ML150 G3 legacy servers. With the exception of CPU utilization, higher numbers are better.

DVD Store results

Figure 4 shows the number of OPM the test servers achieved during our measurement period of the DS2 test on the median run. We calculated the scores by taking the last OPM data point within the 30-minute period.
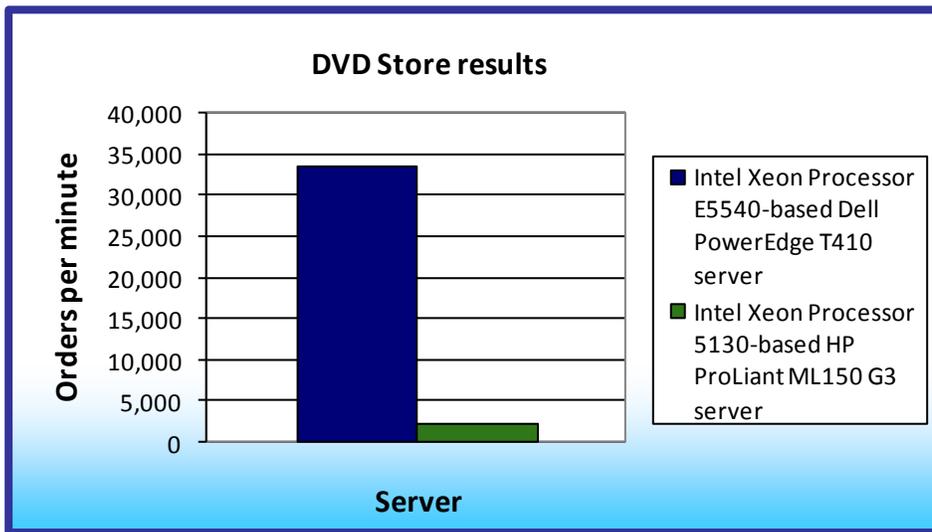

Figure 4: Median DVD Store Version 2 results for the test servers. Higher numbers are better.

The Intel Xeon Processor E5540-based Dell PowerEdge T410 server running 75 simulated users, with an OPM score of 33,537, outperformed the Intel Xeon Processor 5130-based HP ProLiant ML150 G3 server running 50 simulated users, with an OPM score of 2,327, by 1,341.2 percent.

LoadGen results

LoadGen results show the response time each for each server, which is the time in milliseconds it took to complete a request. We used the RPC Averaged Latency performance counter to compare the performance of the HP legacy server with the new Dell PowerEdge T410 server. Lower scores are better, as they indicate that a server is able to maintain a satisfactory response time for the end user.

For testing, we used a workload of 50 Microsoft Exchange mailboxes for the legacy server running Windows Small Business Server 2003 R2, and 75 Microsoft Exchange mailboxes for the new Dell PowerEdge T410 server running Windows Small Business Server 2008, using the maximum number of users permitted by each operating system.
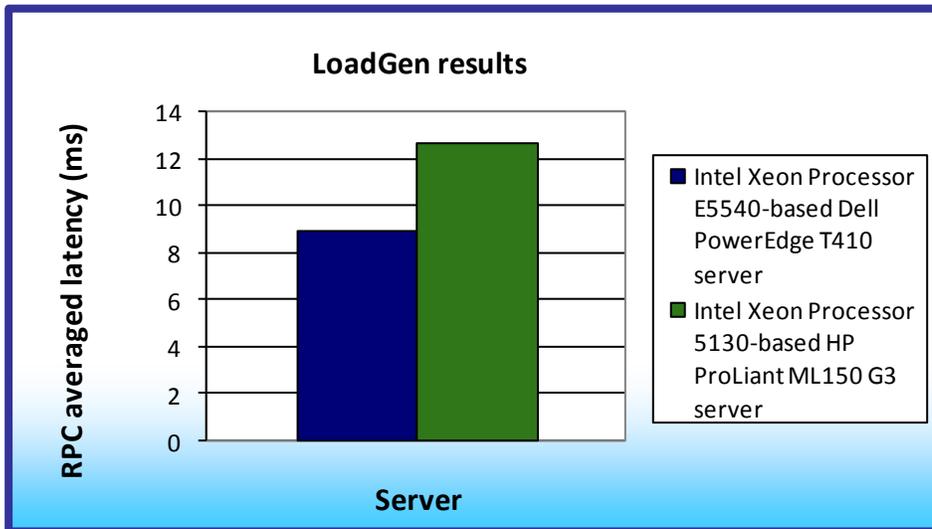
LoadGen results

Figure 5 shows the RPC Averaged Latency results of the median run of each of the servers. Lower numbers are better.

The Intel Xeon Processor E5540-based Dell PowerEdge T410 server, with a score of 8.93, outperformed the Intel Xeon Processor 5130-based HP ProLiant ML150 G3 server, with a

Figure 5: Median LoadGen results for the test servers. Lower numbers are better.

score of 12.71, by 42.4 percent.

HOW WE TESTED

To perform the test, we used a series of batch files, which we stored in the C:\ServerShare folder on the server or in the C:\ClientShare folder on the clients. We used simple file sharing to copy files from machine to machine as needed.

We added the client batch files to the startup folders on the LoadGen and DS2 clients in such a way, that when we rebooted the systems the batch files would automatically start. The client batch files ran a loop script waiting for the server to copy a semaphore file to the client. To begin the test, we then executed a script on the server, which passed the semaphore file to the clients and started the benchmarks.

Between tests, we restored the Mailbox and Public Folder stores by temporarily dismounting them and restoring them from a backup. We used a script to restore the DVD Store database, which dropped the existing database and restored it from the backup. After the restore finished, we rebooted the servers and clients.

Starting LoadGen
1. Restart the Mail Client.
2. Allow the machine to boot up completely (this starts the looping batch file).

Starting DVD Store

We created a batch file to run the following parameters to begin the DVD Store test. We used the parameters below for testing the legacy server. The new server test parameters differed only in target IP address and number of threads.

```
ds2sqlserverdriver.exe --target=192.168.16.4 --ramp_rate=10 --
run_time=42 --n_threads=50 --db_size_str=V --think_time=0.05 --
database_name=DS2
```

1. Restart the DVD Store client.
2. Allow the machine to boot up completely (this starts the looping batch file).

Starting the test

1. Restart the system under test (SUT).
2. Let the SUT idle for 10 minutes.
3. Run the run.bat script on the SUT. This copies the semaphore file to the clients.
4. DVD Store begins immediately, followed by LoadGen beginning 10 minutes later.
5. After the test is complete, restore the Exchange and SQL Server databases, and restart the servers and clients.

Setting up the legacy servers

We used the BIOS RAID configuration utility to create two RAID 1 partitions in each server, one for the operating system and the other for the mailbox and SQL server databases. Following the operating system installation, we installed all recommended Windows Updates through February 19, 2010.

Preparing the primary server

Installing Windows Small Business Server 2003 R2 Premium

1. Insert the first installation CD into the drive, attach an external USB floppy drive if necessary, and boot the system.
2. Press F6 to load the HP ProLiant ML150 integrated disk controller drivers.
3. Insert the floppy disk with the disk controller drivers into the drive.
4. When the application prompts you to do so, press S to specify the additional device.
5. Highlight the correct driver, and press Enter.
6. At the Welcome to Setup screen, press Enter.
7. At the Windows Licensing Agreement screen, press F8 to agree to the terms.
8. Select the appropriate unpartitioned space, and press C to create a partition.
9. Select Format the partition using NTFS file system, and press Enter.
10. At the Regional and Language Options screen, click Next.
11. Enter Name and Organization, and click Next.
12. At the Your Product Key screen, enter your product key, and click Next.
13. At the Computer Name and Administrator Password screen, choose an appropriate name and password, and click Next.

14. At the Date and Time Settings screen, change the Date & Time and Time Zone if appropriate, and click Next.
15. At the Continuing Microsoft Windows Small Business Server Setup window, click Next.
16. If prompted by Setup Requirements, install network adapter drivers, and click Next.
17. At the Company Information window, enter the requested information, and click Next.
18. At the Internal Domain Information window, enter an appropriate DNS and NetBIOS name, and click Next.
19. At the Local Network Adapter Information window, select the appropriate network adapter, and click Next.
20. At the Local Network Adapter Configuration window, verify that the IP is set to 192.168.16.2 and the subnet mask is set to 255.255.255.0, and click Next.
21. At the Logon Information page, enter your password, select to allow it to log in automatically, and click Next.
22. At the Component Selection window, accept all defaults, and click Next.
23. At the Data Folders, click Next.
24. Click Next.
25. When the application prompts you to do so, insert Windows Small Business Server 2003 Disk 2, and click OK.
26. When the application prompts you to do so, insert Windows Small Business Server 2003 Disk 3, and click OK.
27. When the application prompts you to do so, insert Windows Small Business Server 2003 Disk 4, and click OK.
28. When the application prompts you to do so, insert Windows Small Business Server 2003 Disk 5, and click OK.
29. Click Finish.
30. Click OK to restart your computer.

Installing Windows Small Business Server 2003 R2 Technologies
1. Insert the Windows Small Business Server 2003 R2 setup.
2. At the setup window, click Install Service Pack 2 for Exchange Server 2003.
3. At the Microsoft Exchange 2003 welcome window, click Next.
4. Select I agree in the License Agreement window, and click Next.
5. At the Component Selection window, leave default options, and click Next.
6. Click Next at Installation Summary.
7. Click Finish.
8. Returning to the setup window, click Install Service Pack 2 for Windows SharePoint Services 2.0.
9. Click Yes.
10. Click Yes.
11. Click OK.
12. Returning to the setup window, click Install Windows Small Business Server 2003 R2.
13. At the welcome screen, click Next.
14. At the License Agreement window, select I agree, and click Next.
15. At the Update Services window, click Next.
16. Click Next.

17. At the Setup Successful! Window, click Finish.
18. Reboot the server.

General OS settings

1. Click Start – Control Panel – Display.
2. Click the Screen Saver tab.
3. At the drop-down menu under Screen saver, select (None).
4. Click OK.
5. Click Start – Control Panel – System.
6. On the Automatic Updates tab, click the Turn off Automatic Updates radio button.
7. Click OK.

Adding client licenses

1. At the Welcome window, click Next.
2. At the License Agreement window, select I agree, and click Next.
3. At Contact Method, select Internet, and click Next.
4. Enter the license codes, and click Next.
5. Click Finish.

Changing Exchange Mode to Native

1. Start→All programs→Microsoft Exchange→System Manager.
2. Right-click the exchange organization on the left pane, and select Properties.
3. In the General tab, click Change Mode under Change operation mode.
4. If a warning appears, click Yes.
5. Click OK.

Adding the tester user

1. Click Start→Administrative Tools→Active Directory Users and Computers.
2. In Active Directory Users and Computers, expand your domain name, and click the Users folder.
3. Click the Create a new user in the current container button.
4. Enter an appropriate first and last name, type `tester` for the user logon name, and click Next.
5. Enter an appropriate password, uncheck the User must change password at next logon option, check the Password never expires option, and click Next.
6. Leave all defaults for creating an Exchange mailbox, and click Next.
7. Click Finish.

Adding the Exchange database partition

1. Click Start→Administrative Tools→Computer Management.
2. In the left hand pane of Computer Management, click Disk Management.
3. If the application prompts you to initialize a new disk, click Yes, select the appropriate disk to initialize, and click OK.
4. Right-click the appropriate Unallocated space within the initialized disk, and select New Partition…
5. Click Next.
6. At the Select Partition Type window, accept default selections, and click Next.
7. At the Specify Partition Size window, accept defaults, and click Next.
8. Assign an appropriate drive letter, and click Next.

9. At the Format Partition window, leave all defaults, check the Perform a quick format option, and click Next.
10. Click Finish.

Enabling Circular Logging

1. Click Start→Programs→Microsoft Exchange→System Manager.
2. Expand Administrative Groups, first administrative group, servers, and server name.
3. Right-click First Storage Group, and click Properties.
4. Check the box beside Enable circular logging, and click OK.

Disabling Maintenance Schedule

1. Click Start→Programs→Microsoft Exchange→System Manager.
2. Expand Administrative Groups, first administrative group, servers, and server name.
3. Expand First Storage Group:
    a. Right-click Mailbox Store (servername), and click Properties.
    b. Right-click Public Folder Store (servername), and click Properties.
4. Click the Database tab.
5. Click Customize… next to Maintenance Interval.
6. Double-click the empty gray box above Sunday.
7. Ensure that all cells on the graph turn white, and click OK.

Preparing the member server

Installing Windows Server 2003 Standard R2 SP2 x86

1. Insert the first installation CD into the drive, and boot the system.
2. At the Welcome to Setup screen, press Enter.
3. At the Windows Licensing Agreement screen, press F8 to agree to the terms.
4. Select the appropriate unpartitioned space, and press C to create a partition.
5. Select Format the partition using the NTFS file system, and press Enter.
6. At the Regional and Language Options screen, click Next.
7. Enter Name and Organization, and click Next.
8. At the Your Product Key screen, enter your product key, and click Next.
9. At the Licensing Modes screen, click Next.
10. At the Computer Name and Administrator Password screen, choose an appropriate name and password, and click Next.
11. At the Date and Time Settings screen, change the Date & Time and Time Zone if appropriate, and click Next.
12. After the system restarts automatically, follow the prompt to log into the server.
13. At the Windows Setup screen, insert the second installation CD when prompted, and click OK.
14. At the Windows Server 2003 R2 Setup Wizard Welcome screen, click Next.
15. At the Windows Server 2003 R2 Setup Wizard Summary screen, click Next.
16. Click Finish.

General OS Settings

1. Click Start – Control Panel – Display.
2. Click the Screen Saver tab.
3. At the drop-down menu under Screen saver, select (None).

4. Click OK.
5. Click Start – Control Panel – System.
6. On the Automatic Updates tab, click the Turn off Automatic Updates radio button.
7. Click OK.

Setting the IP Address

1. Click Start > Control Panel > right-click Network Connections.
2. Click Open.
3. Double-click Server Local Area Connection.
4. Click Internet Protocol (TCP/IP) and click Properties.
5. In the IP address field type `192.168.16.4`, and `255.255.255.0` for the subnet mask.
6. Click OK.
7. Click OK.
8. Close the Network Connections window.

Joining the domain

1. Right-click My Computer, and select Properties.
2. Under the Computer Name tab, click Change.
3. In the Computer Name Changes window, under the Member of section, select the Domain radial box, and type `test.local`.
4. To start joining the domain, select OK.
5. When the window appears asking for a person qualified on the domain, type `Administrator` as the username and `Password1` as the password.
6. At the Welcome pop-up window and the window warning that you must reset the computer for the changes to take effect, click OK.
7. At the System Properties window, click OK.
8. When a pop-up appears asking if you want to restart now, click Yes.

Installing SQL Server 2005 Workgroup Edition

1. Insert the Windows Small Business Server 2003 Premium Technologies CD 1.
2. At the Windows Small Business Server 2003 R2 Premium Technologies Setup window, click Install Microsoft SQL Server 2005.
3. Select I accept the licensing terms and conditions, and click Next.
4. After installing the prerequisites, click Next.
5. At the Welcome screen, click Next.
6. At the System Configuration Check, click Next. For this installation, you may ignore the possible warning regarding IIS, as it is unnecessary for this configuration.
7. At the Registration Screen, enter the appropriate name and company.
8. At the Components to Install screen, select Data Files, Full-Text Search, and Shared Management Tools under SQL Server Database Services. Under Client Components, select Connectivity Components, Management Tools, SDK, SQLXML Client Features, and Legacy Components.
9. Click Next to start the installation.
10. At the Instance Name screen, click the Default instance radio button, and click Next.
11. At the Service Account screen, select the Use the built-in System account radio button.
12. Select Local system, and click Next.

13. At the Authentication Mode screen, select Mixed Mode.
14. Specify the "sa" logon password by entering a password in both fields, and click Next.
15. At the Collation Settings screen, click Next.
16. Accept the default Error and Usage Report Settings, and click Next.
17. At the Ready to Install screen, click Install to begin the installation.
18. When the application prompts you to do so, insert the second Windows Small Business Server 2003 Premium Technologies disk, and click OK.
19. At the end of the installation in the Setup Progress screen, click Next.
20. Click Finish to complete the installation.
21. Click Start, All Programs, Microsoft SQL Server 2005, SQL Server Management Studio. Connect to the SQL Server instance.
22. Create a SQL Server login for the ds2user (see DVD Store setup section below for the specific script to use).
23. Close Microsoft Server Management Studio.
24. Restart the server before installing SQL Server 2005 SP3.

Installing Service Pack 3 for Microsoft SQL Server 2005

Service Pack 3 is available for download from
http://www.microsoft.com/downloads/details.aspx?FamilyID=ae7387c3-348c-4faa-8ae5-949fdfbe59c4&displaylang=en

1. Run SQLServer2005SP3-KB955706-x86-ENU.exe.
2. At the Welcome window, click Next.
3. At the License Terms window, select I accept the agreement, and click Next.
4. At the Feature Selection window, accept default selections, and click Next.
5. At the Authentication window, click Next.
6. At the Error and Usage Reporting Settings window, click Next.
7. At the Running Processes window, click Next.
8. Click Install.
9. If a message to reboot the computer appears, click OK.
10. At the Installation Progress window, click Next.
11. At the Installation Complete window, click Next.
12. Uncheck the Launch the User Provisioning Tool for Windows Vista after SP3 installation completes option, and click Finish.
13. Reboot the server.

Adding the SQL Server database partition

1. Click Start – Administrative Tools – Computer Management.
2. In the left hand pane of Computer Management, click Disk Management.
3. If the application prompts you to initialize a new disk, click Yes, select the appropriate disk to initialize, and click OK.
4. Right-click the appropriate Unallocated space within the initialized disk, and select New Partition…
5. Click Next.
6. At the Select Partition Type window, accept default selections, and click Next.
7. At the Specify Partition Size window, accept defaults, and click Next.
8. Assign an appropriate drive letter, and click Next.

9. At the Format Partition window, leave all defaults, check the Perform a quick format option, and click Next.
10. Click Finish.

Configuring the database server (DVD Store)

Data generation overview

We built the database schema using the scripts in the DS2 distribution package, though we made a few minor modifications. The DS2 stress tool provides options to generate 10MB, 1GB, or 100GB datasets. To get the tool to generate the 5 GB of user data we used in this test, we had to make a few straightforward changes to the source code and to the DVD Store application's scripts. Note: We created our test data on a Linux system to take advantage of the larger RAND MAX.

Editing the ds2_create_orders.c module

The module ds2_create_orders.c defines constants that define the maximum values for the customer ID and the product ID. The constants for the 5GB database size did not exist. We added the constants for this size.

On the command line for the ds2_create_orders.c module, we specified the size. The available options were S (small), M (medium), and L (large). We added the case V for the 5GB database. In the switch statement that sets the values for the variables max_cust_id and max_prod_id, we added cases that assigned them the proper values for the 5GB database size.

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

```
gcc –o ds2_create_orders ds2_create_orders.c –lm
```

Editing the ds2_create_cust.c module

We had to make the same changes to the ds2_create_cust.c module that we made to the ds2_create_orders.c module. On the command line for the ds2_create_cust.c module, we specified the size. The available options were S (small), M (medium), and L (large). We added the case V for the 5GB database. In the switch statement that sets the values for the variables max_cust_id and max_prod_id, we added cases that assigned them the proper values for the 5GB database size.

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

```
gcc –o ds2_create_cust ds2_create_cust.c –lm
```

Generating the data for the 5GB database

We used shell scripts to run all four of the executables that generate the data. The distribution did not include shell scripts for the 5GB size. We wrote shell scripts based on the ds2_create_cust_large.sh and ds2_create_orders_large.sh scripts. The ds2_create_prod and ds2_create_inv executables did not ship with associated shell scripts, so we created shell scripts using the instructions in the readme files. We ran the shell scripts in the following order to generate the data for the 5GB database:

1. ds2_create_orders_5gb.sh
2. ds2_create_inv_5gb.sh
3. ds2_create_prod_5gb.sh
4. ds2_create_cust_5gb.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 the 5GB database in SQL Server 2005, and then performed a full backup, storing the backup file on the C: drive for quick access. We used that backup file to restore on both servers between test runs.

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 5GB 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 default SQL Server instance, we created a ds2user SQL Server login using the following Transact SQL (TSQL) script:

```
USE [master]
GO
CREATE LOGIN [ds2user] WITH PASSWORD=N'',
DEFAULT_DATABASE=[master],
DEFAULT_LANGUAGE=[us_english],
```

```
CHECK_EXPIRATION=OFF,
CHECK_POLICY=OFF
GO
```

8. We set the database recovery model back to full.
9. We made the following changes in the build scripts:

- Because we varied the size of the datasets, we sized the files in our scripts to reflect the database size and the number of files per filegroup. We allowed for approximately 40 percent free space in our database files to ensure that filegrowth activity did not occur during the testing.
- We followed Microsoft's recommendation of having 0.25 to 1 file per filegroup per core. The legacy HP server has four cores and the Dell PowerEdge T410 has eight cores. We used four files per filegroup in all cases.
- 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 2005 or SQL Server 2008.
- When running tests in SQL Server 2008, we added the FORCESEEK hint in the BROWSE_BY_ACTOR and BROWSE_BY_TITLE stored procedures 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 included this in the initial build and backup process we describe above.
- We created a SQL Server login we called `ds2user` and mapped a database user to this login. We made each such user a member of the db_owner fixed database role.
- Using the DVD Store scripts as a reference, we created the full-text catalog and index on the PRODUCTS table manually in SQL Server Management Studio.
We then performed a full backup of the database. This backup allowed us to restore the databases to a pristine state relatively quickly between tests.

Editing the workload script - 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
```

Setting up the new server

We used the BIOS RAID configuration utility to create three RAID 1 partitions on the Dell PowerEdge T410 server, one for the operating system and the other two for the mailbox and SQL server databases, respectively. Following the operating system installation, we installed all important Windows Updates through February 19, 2010.

Installing Windows Small Business Server 2008 Premium Edition

1. Insert the installation DVD, and boot the system.
2. At the Install Windows screen, leave default selections, and click Next.
3. Click Install now.
4. When prompted to Type your product key for activation, enter your product key. Click Next.
5. When prompted to Please read the license terms, select I accept the license terms. Click Next.
6. At the Which type of installation do you want? screen, click Custom (advanced).
7. Select the appropriate Disk or partition and format if necessary. Click Next.
8. At the Continue installation screen, click Next.
9. When prompted to Verify the click and time zone settings, click Open Date and Time to verify the click and time zone settings, and adjust as necessary. Click Next.
10. If the installation cannot detect a network adapter, install the necessary drivers as prompted. When all the drivers are finished installing, proceed to Step 11.
11. In the Get Important Updates window, select Do not get the most recent installation updates. Click Next.
12. When the Connecting your server phase is complete, enter relevant Company information, and click Next.
13. In the Personalize your server and your network window, type `newserver` in the Server name field and `test` in the Internal domain name field.
14. In the Add a network administrator account window, enter a First and Last name in the relevant fields. In the Administrator user name field, type `user`. In the Administrator Password and Confirm Password fields, type `Password1`. Click Next.

---

15. In the Install security services window, uncheck both options, and click Next.
16. In the That is all the information needed window, review the settings, and click Next.
17. When the installer finishes Expanding and Installing files, the system reboots and the installation is complete.

General OS settings

1. Right-click the Desktop, and select Personalize from the menu.
2. Click the Screen Saver tab.
3. From the Screen Saver drop-down menu, select (None).
4. Click OK.
5. Click Start→All Programs→Windows Update.
6. In the left hand pane, click the Change settings link.
7. Click the Never check for updates (not recommended) radio button.
8. Click OK.
9. Click Start→Control Panel.
10. Double-click Windows Firewall.
11. In the left hand pane, click the Turn Windows Firewall on or off link.
12. Click the Off radio button, and click OK.
13. From the Control Panel, double-click User Accounts.
14. Click Turn User Account Control on or off.
15. Beside Use User Account Control (UAC), uncheck the check box.
16. Reboot the system.

Installing Service Pack 2 for Exchange Server 2007

Download and install Microsoft Windows Installer 4.5. from this link:
http://www.microsoft.com/downloads/details.aspx?FamilyId=5A58B56F-60B6-4412-95B9-54D056D6F9F4&displaylang=en

Download Service Pack 2 for Exchange Server 2007 from this link:
http://www.microsoft.com/downloads/details.aspx?FamilyID=4C4BD2A3-5E50-42B0-8BBB-2CC9AFE3216A&displaylang=en

Download the Exchange Server 2007 SP2 Install Tool for Small Business Server 2008 from this link:
http://www.microsoft.com/downloads/details.aspx?familyid=FFD2FE61-9278-489E-9B96-3816394C9CB6&displaylang=en

1. Double-click the downloaded Exchange Server 2007 Service Pack 2 x64 file.
2. At the Choose Directory For Extracted Files screen, choose a folder to extract the files.
3. At the Extraction Complete screen, click OK.
4. Double-click the downloaded Exchange SP2 Install Tool for SBS 2008.
5. At the Do you want to run this file window, click Run.
6. Read the License Agreement, check the I accept the terms in the License Agreement checkbox, and click Next.
7. At the Change destination folder screen, leave the default Folder name, and click Next.
8. At the Completed the Microsoft Exchange Server 2007 SP2 Installation Tool Setup Wizard, verify that the Install Microsoft Exchange Server 2007 SP2 checkbox is selected, and click Finish.
9. When prompted, browse to the folder where you extracted Exchange Server 2007 SP2, and click OK.

10. At the Install Service Pack 2 for Microsoft Exchange Server 2007 screen, click Next.
11. At the Prepare the server environment wait for the tool to finished preparing the installation, then click Next. The Microsoft Exchange 2007 Service Pack 2 window will remain open in the background and an Exchange Server 2007 installation window will appear in the foreground.
12. Click Install Microsoft Exchange Service Pack 2.
13. At the Introduction screen, click Next.
14. At the license agreement screen, click the I accept the terms in the license agreement radio button, and click Next.
15. At the Readiness screen, wait for the check to finish, and click Upgrade.
16. At the Completion screen, click Finish.
17. Click Close.
18. At the Installing Microsoft Exchange 2007 Service Pack 2 screen, click Next.
19. At the Setup finished successfully screen, click Finish.

Assigning static IPs to the NICs

1. Click Start→Control Panel.
2. Right-click Network Connections, and click Open.
3. Right-click Local Area Connection.
4. Click Properties.
5. Click Internet Protocol Version 4 (TCP/IPv4), and click Properties.
6. Select Use the following IP Address, and input the following numbers:

   IP Address: `192.168.16.2`
   Subnet mask: `255.255.255.0`

Setting up the Application Server

1. Click Start→Administrative Tools→Server Manager.
2. Click Roles on the left-side window pane.
3. Click Add Roles.
4. Click the Application Server check box.
5. When the Add features required for Application Server? screen appears, click Add Required Features.
6. Click Next.
7. Click Next
8. At the Select Role Services page for Application Server, click the Web Server (IIS) Support check box.
9. Click Next.
10. Click Next.
11. At the Select Role Services page for Web Server (IIS), click IIS 6 Management Compatibility, ASP, and CGI check boxes; and click Next.
12. Click Install.
13. Click Close.

Enabling Circular Logging

1. Click Start→All Programs→Microsoft Exchange Server 2007→Exchange Management Console.
2. Expand Server Configuration, and click Mailbox.
3. Right-click First Storage Group, and click Properties.
4. Check the box beside Enable circular logging, and click OK.

Disabling Maintenance Schedule

1. Click Start→All Programs→Microsoft Exchange Server 2007→Exchange Management Console.
2. Expand Server Configuration, and click Mailbox.
3. Right-click Mailbox Database, and click Properties.
4. Click Customize.
5. Double-click the empty gray box above Sunday.
6. Ensure that all cells on the graph turn white, and click OK.
7. Click OK.

Creating and configuring the LoadGen tester user

1. Click Start, and click Administrative Tools.
2. Click Active Directory Users and Computers.
3. Expand test.lan, and click Users.
4. Right-click the right pane, highlight New, and click User.
5. Select a name for the user, and type `tester` as the User logon name.
6. Click Next.
7. Type `Password1` for the password.
8. Uncheck User must change password at next logon, check Password never expires, and click Next.
9. Click Next.
10. Click Finish.
11. Right-click your newly created user, and select Properties.
12. Click the Member Of tab.
13. Click Add.
14. In Enter the object names to select, type `Domain Admins` and click Check Names.
15. Click OK.
16. Click Add again.
17. In Enter the object names to select, type `Exchange Organization Administrators` and click Check Names.
18. Click OK.
19. Click Add again.
20. In Enter the object names to select, type `Administrators` and click Check Names.
21. Click OK.
22. Click OK again.
23. Click Start, and click Exchange Management Console.
24. Expand Recipient Configuration, and click Mailbox.
25. At the right-pane menu, click New Mailbox...
26. Select User Mailbox, and click Next.
27. At the User Type screen, select Existing users, and click Add...
28. Select your tester user, and click Next.
29. At the Mailbox settings screen, select Browse, choose the Mailbox Database, and click OK.
30. Click Next.
31. Click New.
32. Click Finish.

Removing SQL Server 2005 Express Tools

1. Click Start→Control Panel→Programs and Features.
2. When the Uninstall or change a program screen opens, click Microsoft SQL Server Management Studio Express, and click Uninstall.
3. Click Yes to confirm the uninstall.
4. At the Microsoft SQL Server Management Studio Express Warning pop up screen, click Yes.

Installing SQL Server 2008 on the server

1. Insert the DVD.
2. At the AutoPlay menu, click Run SETUP.EXE.
3. If the application prompts you to install the .NET Framework, click OK.
4. Select the Accept radio button, and click Install.
5. When the installation finishes, click Exit.
6. If the application prompts you, click OK to install a hotfix for Windows (KB942288).
7. Click Restart now to restart the server upon completion.
8. After rebooting, log into the server.
9. Click Start, and click Computer.
10. Double-click the CD/DVD drive.
11. Click Installation.
12. Click New SQL Server Stand-Alone Installation.
13. At the Setup Support Rules screen, wait for the check to complete. If there are no failures or relevant warnings, click OK.
14. Select the Enter the product key radio button and type in the product key. Click Next.
15. Click the checkbox to accept the license terms. Click Next.
16. Click Install to install the setup support files.
17. If there are no failures displayed, click Next. You may see a Computer domain controller warning and a Windows Firewall warning. For now, ignore these.
18. At the Feature Selection screen, select Database Engine Services, Full-Text Search, Client Tools Connectivity, Client Tools Backwards Compatibility, Management Tools –Basic, and Management Tools – Complete. Click Next.
19. At the Instance configuration screen, leave the default selection of default instance, and click Next.
20. At the Disk space requirements screen, click Next.
21. 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.
22. At the Database Engine Configuration screen, select Mixed Mode.
23. Enter and confirm a password for the system administrator account.
24. Click Add Current user. This may take several seconds.
25. Click Next.
26. At the Error and usage reporting screen, click Next.
27. At the Installation rules screen, check that there are no failures or relevant warnings, and click Next.
28. At the Ready to Install screen, click Install.
29. After installation completes, click Next.
30. Click Close.

31. Create a SQL Server login for the ds2user (see the DVD Store setup section below for the specific script to use).
32. 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, wait for the installer to complete its check, and click Next.
6. At the Update screen, click Update.
7. When the update completes, click Next, and click Close.

Installing the mail test client (LoadGen)

We began our testing by installing a fresh copy of Microsoft Windows Server 2003 R2, Enterprise x86 Edition Service Pack 2 on the test client and installed all recommended Windows Updates as well as the optional .NET Framework and Windows PowerShell installations. Before following these instructions, make sure to statically assign an IP address for the client, and then plug that port into the system under test. This allows the client to join the domain correctly. We followed this process for each installation:

1. Assign a computer name of `Clientx` for the mail client, where `x` is the client number.
2. For the licensing mode, use the default setting of five concurrent connections.
3. For the administrator log on, enter a password.
4. Select Eastern Time Zone.
5. Use typical settings for the Network installation.
6. Assign a name of `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. Right-click My Computer, and select Properties.
2. Under the Computer Name tab, click Change.
3. In the Computer Name Changes window, under the Member of section, select the Domain radial box, and type `test.local`.
4. To start joining the domain, select OK.
5. When the window appears asking for a person qualified on the domain, type `Administrator` as the username and `Password1` as the password.

6. At the Welcome pop-up window and the window warning that you must reset the computer for the changes to take effect, click OK.
7. At the System Properties window, click OK.
8. When a pop-up appears asking if you want to restart now, click Yes.

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 Active Directory Services, and make sure a check appears in the check box.
5. Select Internet Information Services (IIS), and click Details.
6. Click NNTP Services and SMTP Services, make sure a check appears in both check boxes, and click OK.
7. Click OK to close the Application Server window.
8. At the Windows Components Wizard, click Next to begin the installation.
9. When the system prompts you to do so, insert the OS CD, and click OK.
10. At the Completing the Windows Components Wizard window, click Finish.
11. Close the Add or Remove Programs window.

Making additional preparations for the client when testing Exchange Server 2003

Adding an additional domain controller on an existing domain

1. Click Start →Run, type CMD and click OK.
2. At the command prompt screen, type dcpromo
3. At the Welcome to the Active Directory Installation Wizard window, click Next.
4. At the Operating System Compatibility window, click Next.
5. Select Additional domain Controller at the Domain Controller Type window, and click Next.
6. At the Network Credentials, enter a user name and corresponding password with administrative privileges, and click Next.
7. Leave test.local as the Domain name, and click Next.
8. Leave the default options in the Database and Log Folders window, and click Next.
9. Leave defaults at the Shared System Volume, and click Next.
10. Enter an appropriate Restore Mode Password, and click Next.
11. At the Summary window, click Next.
12. Click Finish.

Installing Exchange Server 2007 and Load Generator

1. Insert the Microsoft Exchange Server 2007 x86 Management Tools CD. The CD should automatically launch the installation software.
2. If Windows Updates did not offer these options, install the latest versions of .NET Framework and Windows PowerShell.
3. Click the link to Step 4: Install Microsoft Exchange Server 2007 SP1.
4. Click Next to go past the introduction screen.
5. Accept the license agreement, and click Next.
6. Select No for error reporting, and click Next.
7. Select Custom Exchange Server Installation, and click Next.
8. Check Management Tools, and click Next.

9. After the check finishes, click Install to start the installation process.
10. Once the installation completes, click Finish.
11. Disable the network card.
12. Download and install Load Generator using all defaults.
13. Re-enable the network card.

Preparing Load Generator

1. Select Start→All Programs→Microsoft Exchange→Exchange Load Generator.
2. When the Load Generator window appears, select Start a new test.
3. Select Create a new test configuration, and click Continue.
4. In the Specify test settings window, type `Password1` as the Directory Access Password and Mailbox Account Master Password, and click Continue with recipient management.
5. Enter the appropriate number of users in the Mailbox Database, and click Continue.
6. To accept defaults for Advanced recipient settings, click Continue.
7. In the Specify test user groups window, select the plus sign (+) to add a user group.
8. Change the Client Type to Outlook 2003 Cached for testing Windows Small Business Server 2003, or Outlook 2007 Cached for testing Windows Small Business Server 2008, and the Action Profile to Average, and click Continue.
9. Leave defaults in Remote configurations, and click Continue.
10. Click Save the configuration file as, and name it `Averagecfg.xml`.
11. Click Start the initialization phase (recommended before running the test) to start initialization. The initialization process might take a few hours.

Making additional preparations for the client when testing Exchange Server 2007

Installing Exchange Server 2007 and Load Generator

1. Insert the Microsoft Exchange Server 2007 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 to go to the download link.
5. When you arrive at the download link, download Microsoft Windows PowerShell, and install with defaults.
6. Search for and then download .NET 2.0 SP1 x64.
7. Install 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 the installation completes, click Finish.
16. Download and install Load Generator using all defaults.

Preparing Load Generator

1. Select Start➔All Programs➔Microsoft Exchange➔Exchange Load Generator.
2. When the Load Generator window appears, select Start a new test.
3. Select Create a new test configuration, and click Continue.
4. In the Specify test settings window, type `Password1` as the Directory Access Password and Mailbox Account Master Password, and click Continue with recipient management.
5. Make 75 users in the Mailbox Database, and click Continue.
6. To accept defaults for Advanced recipient settings, click Continue.
7. In the Specify test user groups window, select the plus sign (+) to add a user group.
8. Change the Client Type to Outlook 2007 Cached and the Action Profile to Average, and click Continue.
9. Leave defaults in Remote configurations, and click Continue.
10. Click Save the configuration file as, and name it `Average.cfg`
11. Click Start the initialization phase (recommended before running the test) to start initialization. The initialization process might take a few hours.

Backing up the mail database

On the test server, once you have set up LoadGen and created its initial mail database, you need to

back up that database so you can have clean copies for each test.

For Windows Small Business Server 2003 R2

1. Click Start – All Programs – Microsoft Exchange – System Manager.
2. In Exchange System Manager, expand the Servers folder in the left pane.
3. Expand the First Storage Group, right-click Mailbox Store, and select Dismount Database from the menu.
4. On the Do you want to continue? pop-up message, click Yes.
5. Right-click Public Folder Database, and select Dismount Database from the menu.
6. On the Do you want to continue? pop-up message, click Yes. The red arrow appears when you have dismounted the Public Folder Store.
7. Using Windows Explorer, create two new folders: C:\backup\Mailbox Store and C:\backup\Public Folder Store.
8. With Windows Explorer, copy priv1.edb and priv1.stm from C:\Program Files\Exchsrvr\MDBDATA to C:\backup\Mailbox Store, and pub1.edb and pub1.stm from C:\Program Files\\Exchsrvr\MDBDATA to C:\backup\Public Folder Store. This process may take several minutes.
9. Close Windows Explorer.
10. In System Manager console, right-click Mailbox Database, and select Mount Database from the menu.
11. Right-click the Public Folder Database, and select Mount Database from the menu.
12. Close Exchange System Manager.

For Windows Small Business Server 2008

1. Select Start➔All Programs➔Microsoft Exchange Server 2007➔Exchange Management Console in the mail server.
2. In the left pane, under Server Configuration, click Mailbox.
3. In the right pane, right-click Mailbox Database, and select Dismount Database from the menu.
4. At the Do you want to continue? pop-up message, click Yes.

5. Right-click Public Folder Database, and select Dismount Database from the menu.
6. At the Do you want to continue? pop-up message, click Yes. The red arrow appears when you have dismounted the Public Folder Store.
7. Using Windows Explorer, create two new folders: `C:\backup\mailstore` and `C:\backup\publicstore`.
8. With Windows Explorer, copy all files from C:\Program Files\Microsoft\Exchange Server\Mailbox\First Storage Group to C:\backup. This process may take several minutes.
9. Close Windows Explorer.
10. In Exchange Management Console, right-click Mailbox Database, and select Mount Database from the menu.
11. Right-click the Public Folder Database, and select Mount Database from the menu.
12. Close Exchange System Manager.

Changing the default location of your mail database

On the test server, you will need to move the default location of your mail database to the Exchange server database partition.

For Windows Small Business Server 2003 R2

1. Click Start – All Programs – Microsoft Exchange – System Manager.
2. In Exchange System Manager, expand the Servers folder in the left pane.
3. Expand the First Storage Group, right-click Mailbox Store and select Properties
4. Click the Database tab, and click Browse… under Exchange Database, browse over to the designated Exchange database partition, create a new folder named `Mailbox Store`, and click Save.
5. Click Browse… under Exchange streaming database, browse over to the designated Exchange database partition, select the Mailbox Store folder, and click Save.
6. Click OK.
7. If a warning appears, click Yes to continue.
8. Click OK.
9. Under the First Storage Group, right-click Public Folder Store, and select Properties.
10. Click the Database tab, and click Browse… under Exchange Database, browse over to the designated Exchange database partition, create a new folder named `Public Folder Store`, and click Save.
11. Click Browse… under Exchange streaming database, browse over to the designated Exchange database partition, select the Public Folder Store folder, and click Save.
12. Click OK.
13. If a warning appears, click Yes to continue.
14. Click OK.

For Windows Small Business Server 2008

1. Click Start, and click Exchange Management Console.
2. Right-click Mailbox Database.
3. Select Move Database Path.
4. Click Browse, navigate to C:\Loadgen, and click Save.
5. Click Move.

6. When the application prompts you to dismount the mailbox database, click Yes.
7. Click Finish.

Client configuration

To generate the workload, we used a network with two client PCs: one for DVD Store and the other for LoadGen, each running Windows Server 2003 R2 Enterprise x86. We connected each segment to the server or servers under test via one NETGEAR GS716T ProSafe Gigabit Smart Switch.

APPENDIX A – SERVER CONFIGURATION INFORMATION

Figure 6 provides detailed configuration information about the two test servers.

Servers	HP ProLiant ML150 G3	Dell PowerEdge T410
General dimension information		
Height (inches)	18	18
Width (inches)	8.5	8.5
Depth (inches)	25	23.5
Power supplies		
Total number	1	2
Wattage of each (W)	650	580
Cooling fans		
Total number	4	1
First fan		
Dimensions (h x w)	4.75" x 4.75"	4.75" x 4.75"
Second fan		
Dimensions (h x w)	4.75" x 4.75"	N/A
Third fan		
Dimensions (h x w)	3" x 3"	N/A
Fourth fan		
Dimensions (h x w)	3" x 3"	N/A
General processor setup		
Number of processor packages	2	2
Number of cores per processor package	2	4
Number of hardware threads per core	1	2
System power management policy	Always On	Balanced
CPU		
Vendor	Intel	Intel
Name	Xeon 5130	Xeon E5540
Stepping	B2	D0
Socket type	LGA771	LGA1366
Core frequency (GHz)	2.00	2.53
L1 cache	4 x 32 KB	4 x 32 KB
L2 cache	4 MB	4 x 256 KB
L3 cache	N/A	8 MB
Platform		
Vendor and model number	HP ProLiant ML150 G3	Dell PowerEdge T410
Motherboard model number	BTI ML-1 94V-0	0M638F
Motherboard revision number	B1	13
BIOS name and version	HP O07 (09/22/2007)	Dell Inc. 1.0.2 (03/11/2009)

Servers	HP ProLiant ML150 G3	Dell PowerEdge T410
BIOS settings	SATA RAID Enabled	Default
Memory modules		
Total RAM in system (GB)	4	16
Number of types of memory modules	1	1
Vendor and model number	Elpida EBE21FD4AGFD-6E-E	Crucial CT51272BB1339.36SFD1
Type	PC2-5300	PC3-10600R
Speed (MHz)	667	1,333
Speed in the system currently running @ (MHz)	667	1,066
Timing/latency (tCL-tRCD-iRP-tRASmin)	5-5-5-15	8-8-8-19
Size (GB)	2	4
Number of RAM modules	2	4
Chip organization	Double-sided	Double-sided
Hard disk		
Vendor and model number	Seagate ST3160815AS	Seagate ST3146855SS
Number of disks in system	4	6
Size (GB)	160	146
Buffer size (MB)	8	16
RPM	7,200	15,000
Type	SATA	SAS
Operating system		
Primary server		
Name	Windows Small Business Server 2003 R2 Premium	Windows Small Business Server 2008 Premium
Build number	3790	6001
File system	NTFS	NTFS
Language	English	English
Member server		
Name	Windows Server 2003 Standard R2 SP2	N/A
Build number	3790	N/A
File system	NTFS	N/A
Language	English	N/A
Network card/subsystem		
Vendor and model number	HP NC7781 Gigabit Server Adapter	Broadcom BCM5716C NetXtreme II GigE
Type	Integrated	Integrated
Optical drive		
Vendor and model number	TSSTcorp TS-H192C	TSSTcorp TS-H653F

Servers	HP ProLiant ML150 G3	Dell PowerEdge T410
USB ports		
Number	5	6
Type	2.0	2.0

Figure 6: Configuration information for the two test servers.

ABOUT PRINCIPLED TECHNOLOGIES

![Principled Technologies logo]

Principled Technologies, Inc.
1007 Slater Road, Suite 300
Durham, NC, 27703
www.principledtechnologies.com

We provide industry-leading fact-based marketing and technology assessment services that help technology vendors and buyers understand the real differences among products. We bring to every assignment extensive experience with and expertise in all aspects of technology marketing, testing, and analysis; from researching new technologies, to developing new methodologies, to testing with existing and new tools, to delivering the results in whatever form best communicates them.

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, white papers, PowerPoint presentations, and videos. Every piece of collateral reflects the results of our trusted independent analysis.

We customize our services to focus on each client's requirements. Whether the technology involves hardware, software, Web sites, or services, we offer the experience, expertise, and tools to assess how it will fare against its competition and to highlight its strengths.

Our founders, Mark L. Van Name and Bill Catchings, have worked together in technology assessment for 25 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.