

## Dell™ PowerEdge™ T605 with AMD Opteron™ 2384 and HP ProLiant ML370 G5 Server with Intel® Xeon® E5450 comparison

### Executive summary

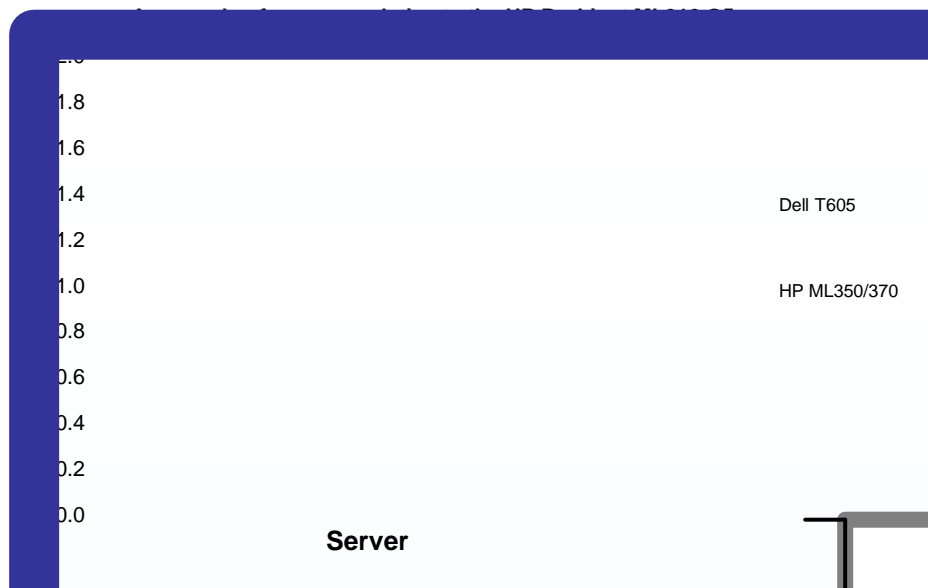
Dell Inc. (Dell) and Advanced Micro Devices Inc. (AMD) commissioned Principled Technologies (PT) to measure the performance of the following servers running Microsoft Windows Server 2008:

- Dell™ PowerEdge™ T605 with AMD Opteron™ 2384
- HP ProLiant ML370 G5 Server with Intel® Xeon® E5450

We simultaneously ran workloads that exercised three of the functions a typical small business server may have to handle: Web, email, and database services. We used WebBench to simulate Web traffic, Microsoft Exchange Load Generator (LoadGen) to simulate email activity, and SysBench to simulate database activity. The Workload section provides more information on the benchmarks.

Figure 1 presents averaged results for the two servers running the three workloads on Windows Server 2008 relative to the lower-performing server, the HP ProLiant ML370 G5. For each benchmark, we assigned a value of 100 percent to that server's results and then calculated the percentage performance improvement of the Dell PowerEdge T605. This approach makes each data point a comparative number, with higher numbers indicating better performance. Finally, we took the percentage performance improvement over the HP ProLiant ML370 G5 for the three benchmarks and averaged them.

As Figure 1 illustrates, while running on Windows Server 2008, the Dell PowerEdge T605 delivered an average of 41 percent better performance across the three benchmarks than did the HP ProLiant ML370 G5.



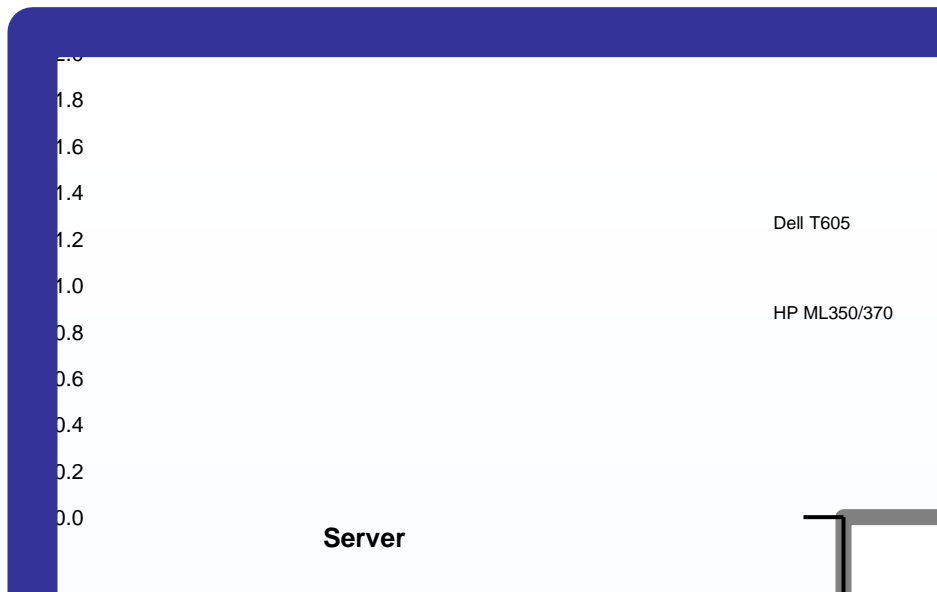
**Figure 1: Averaged performance of the test servers running Windows Server 2008 across the three benchmarks relative to the HP ProLiant ML370 G5. Higher numbers are better.**

### KEY FINDINGS

- The Dell PowerEdge T605 delivered an average of 41 percent better performance across the three workloads on Windows Server 2008 than the HP ProLiant ML370 G5. (See Figure 1.)
- The Dell PowerEdge T605 produced a 59 percent higher performance-per-dollar result across the three workloads on Windows Server 2008 than the HP ProLiant ML370 G5. (See Figure 2.)
- The Dell PowerEdge T605 delivered 48 percent better performance per watt across the three workloads on Windows Server 2008 than the HP ProLiant ML370 G5. (See Figure 3.)

For each server, we took the averaged relative performance results in Figure 1 and divided them by the price. (See Appendix A.) For ease of comparison, we normalized those results to those of the HP ProLiant ML370 G5.

As Figure 2 illustrates, the Dell PowerEdge T605 produced a 59 percent higher performance-per-dollar result across the three workloads on Windows Server 2008 than the HP ProLiant ML370 G5.



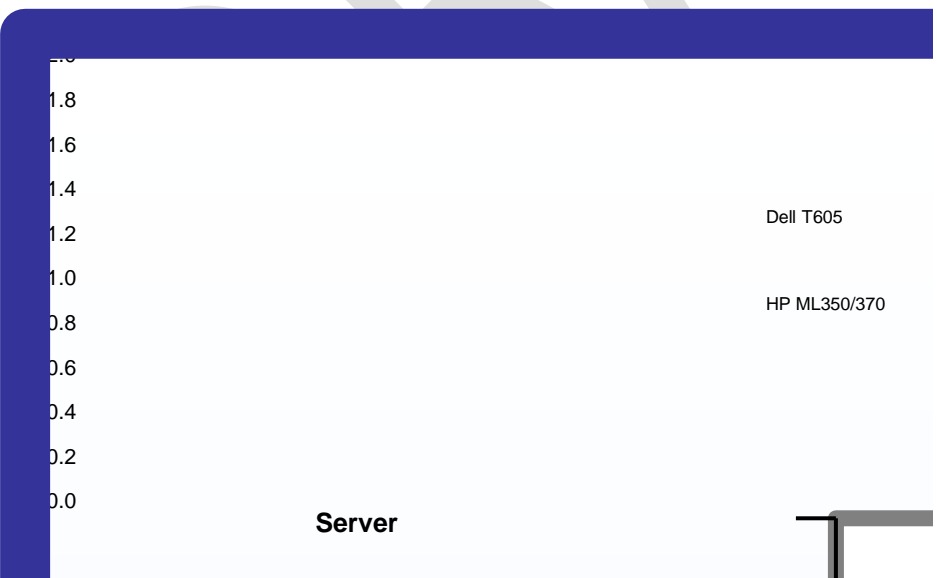
**Figure 2: Normalized performance-per-dollar result of the test servers running Windows Server 2008 across the three benchmarks, relative to the HP ProLiant ML370 G5. Higher numbers are better.**

We also measured power consumption during the workload run. We took the averaged relative performance results in Figure 1 and divided them by the active power consumption. We normalized those results to those of the HP ProLiant ML370 G5.

As Figure 3 illustrates, the Dell PowerEdge T605 delivered 48 percent better performance per watt across the three workloads on Windows Server 2008 than the HP ProLiant ML370 G5.

The HP ProLiant ML370 G5 has a larger case than the Dell PowerEdge T605. We chose this HP server,

rather than the one with the same size case (the HP ProLiant ML350 G5), because we were able to configure the ML370 with a faster processor (an Intel Xeon E5450) than the one in the ML350 (an Intel Xeon E5440). The power supplies in the two HP models were the same, so the case size should not have a significant effect on power consumption. If we had purchased the HP ProLiant ML350 G5, the HP server price would have been lower. By comparing similar configurations, we estimate that if an ML350 with the same processor had been available, it would have decreased the HP server price by about \$240, still making the HP server more expensive than the Dell.



**Figure 3: Normalized performance-per-watt results of the test servers running Windows Server 2008 across the three benchmarks, relative to the HP ProLiant ML370 G5. Higher numbers are better.**

### Workload

We ran the following three workloads simultaneously, as a typical small business server might.

### WebBench

WebBench 5.0 (128-bit US version) is an industry-standard benchmark for Web server software and hardware. It uses PC clients to send Web requests to a server under test. It generates performance results by incrementally increasing the number of clients making HTTP 1.0 GET requests to the Web server; the result is a curve showing the server's performance under increasing load. The peak of that curve represents

the peak throughput of the server. WebBench reports both the total number of requests per second the server handled and the server's total throughput in bytes per second.

### LoadGen

LoadGen is an industry-standard tool for benchmarking an Exchange 2007 Mail Server. LoadGen performs tasks to simulate a standard user generating mail activity. When the workload finishes, LoadGen reports the response time, which is the number of seconds necessary to complete the task.

### SysBench

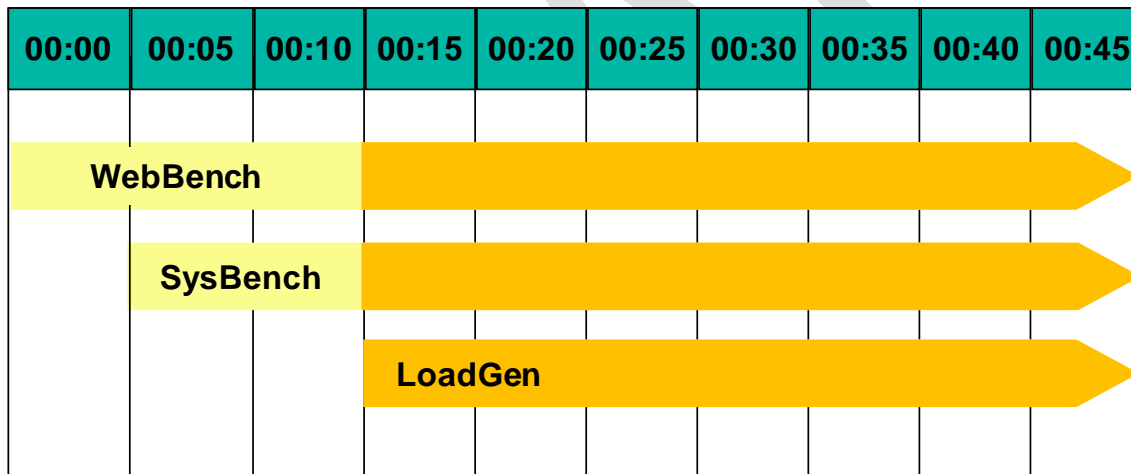
The developers at SourceForge.net ([www.sourceforge.net](http://www.sourceforge.net)) created SysBench to test various aspects of the performance of servers running database systems. The benchmark's original target was the MySQL database system ([www.mysql.com](http://www.mysql.com)), but this version worked with Microsoft SQL Server 2005 Enterprise Edition ([www.microsoft.com/sql/editions/enterprise/default.mspx](http://www.microsoft.com/sql/editions/enterprise/default.mspx)). SysBench created a 100,000-row SQL database and executed a batch of online transaction processing (OLTP) transactions against that data.

## Test results

For testing, we staggered the starting times of the benchmarks to allow each server to ramp up slowly. We began the benchmarks in the following order: WebBench, SysBench, and Microsoft LoadGen. Figure 4 shows a timeline for the benchmark runs. To obtain the final results, we removed the first parts of the WebBench and SysBench runs, and computed the results based on the 30 minutes of peak performance during the LoadGen run.

To make sure both servers achieved their optimum results, we allowed them to sit idle for 35 minutes before starting the workload.

**Multiple benchmark timeline  
45 minutes total time**



**Figure 4: The timeline we followed when starting the benchmarks for the multiple-benchmark runs on all servers. The shaded areas from 00:15 to 00:45 represent the period during which we measured performance.**

Figure 5 presents results for the servers on the three benchmarks relative to the lower-performing server, the HP ProLiant ML370 G5. For each benchmark, we assigned a value of 100 percent to that server's results and then calculated the percentage performance improvement of the Dell PowerEdge T605. This approach makes each data point a comparative number, with higher numbers indicating better performance. Finally, we took the percentage performance improvement over the HP ProLiant ML370 G5 for the three benchmarks and averaged them.

As Figure 5 shows, the Dell PowerEdge T605 running Windows Server 2008 achieved better performance on all benchmarks than the HP ProLiant ML370 G5. Each result is the median of three runs. With the exception of CPU utilization, all results are relative to the HP ProLiant ML370 G5. We used LoadGen to determine the median for all runs.

Server	Percentage CPU utilization	Web requests per second	Email response time	Database transactions per second	Average of Web, email, and database scores
Dell PowerEdge T605	93.8%	1.10	1.58	1.57	1.41
HP ProLiant ML370 G5	90.5%	1.00	1.00	1.00	1.00

Figure 5: Performance for the servers on the three benchmarks, relative to the HP ProLiant ML370 G5. Higher numbers are better.

### WebBench results

We ran WebBench's default ecommerce API test suite, which generates both secure and non-secure static and dynamic HTTP 1.0 GET requests. While running the ecommerce suite, the clients must negotiate to a secure Web server port using the Secure Socket Layer (SSL) protocol. A default WebBench test suite incrementally increases the number of clients making the HTTP 1.0 GET requests to the Web server. As the workload increases the number of clients, the Web server's processor utilization also increases, until the clients saturate the processor in the Web server with work. Each workload point with a fixed number of clients is a WebBench "mix." The ecommerce API test suite begins with a mix that involves one client; the next mix involves four clients; and each subsequent mix increases the number of clients by four. We modified the test suite so it would run 12 clients, with 10 engines per client for the entire test. This allowed us to keep a constant Web load on the server. We performed only 9 mixes for testing to limit the amount of time WebBench ran.

A WebBench run reports the total requests per second a server can perform and the total throughput, in bytes per second, that the server delivered. WebBench reports these results for each mix. To obtain the results we list in Figure 6, we averaged the requests per second and throughput from the mixes that ran during the peak performance of the benchmark run, as Figure 4 illustrates.

Figure 6 shows the WebBench peak results in requests per second and in throughput (bytes per second) for the test servers. Each result is the median of three runs.

Server	Throughput (bytes per second)	Requests per second (raw)	Requests per second (relative to HP ProLiant ML370 G5)
Dell PowerEdge T605	196,359,248.5	12,381.6	1.10
HP ProLiant ML370	179,205,510.6	11,306.9	1.00

Figure 6: Median WebBench results for the two servers. Higher numbers are better.

### LoadGen results

LoadGen results show the response time each for each server, which is the time in milliseconds it took to complete a request. Because the object of the server is to handle as many requests as possible, lower scores, which show a server able to handle more requests in a given time, are better. Because the results are in response time for each task, we created a weighted average to calculate a final score. To create a weighted average, we used a similar procedure as the one that Microsoft Exchange Server 2003 Load Simulator (LoadSim) uses. (Note: LoadSim is an older tool for testing Exchange Mail Servers; Microsoft has replaced it with LoadGen.) Figure 7 shows the weighted average we used for testing.

Task name	Weight	Task name	Weight
BrowseCalendar	1	BrowseContacts	0
Logon	0	CreateContact	2
Logoff	0	BrowseTasks	0
SendMail	1	CreateTask	1
ReadAndProcessMessages	53	EditRules	0
MoveMail	0	DownloadOab	0
DeleteMail	0	EditSmartFolders	0
ExportMail	0	SynchronizeFolders	0
CreateFolder	0	Search	0
PublicFolderPost	0	InitializeMailbox	0
BrowsePublicFolder	0	UserInit	0
PostFreeBusy	2	UserTerm	0
RequestMeeting	0	ModuleInit	0
MakeAppointment	0	ModuleTerm	0
<b>Total</b>			<b>60</b>

Figure 7: Weighted average for LoadGen tasks.

Users usually run LoadGen tests on servers with large disk storage systems, i.e., a large number of total disk drives. Because our testing focused on small business servers, which do not typically have a large number of disks, the scaling between the servers was not as good as the scaling on the other benchmarks.

For testing, we used 200 Microsoft Exchange mailboxes; both servers could handle the load while performing other tasks. Figure 8 shows the average response time for both servers. Each result is the median of three runs.

Server	Average response time (in seconds)	Median 95th percentile (relative to HP ProLiant ML370 G5)
Dell PowerEdge T605	94.9	1.58
HP ProLiant ML370 G5	224.7	1.00

Figure 8: Median LoadGen results for the two servers. Lower response time is better.

## SysBench results

For testing, we created a script so each system would perform as many transactions as possible in a given time. The script processed 10,000 transactions as quickly as possible and then started over again. The output shows the completion time in seconds for each group of 10,000 transactions. We calculated the transactions per second by using the following formula:

$$\frac{\text{total transactions}}{\text{time in seconds}} = \text{transactions per second}$$

Figure 9 shows the median SysBench results and processor utilization for the two test servers. Each result is the median of three runs.

Server	Completion time (seconds)	Transactions completed	Transactions per second	Transactions per second (relative to HP ProLiant ML370 G5)
Dell PowerEdge T605	30:00	1,426,233.0	792.4	1.57
HP ProLiant ML370	30:00	909,568.0	505.3	1.00

Figure 9: Median SysBench results for the two servers. Higher numbers are better.

## Test methodology

Figure 10 summarizes some key aspects of the configurations of the two server systems; Appendix B provides detailed configuration information.

Server	Dell PowerEdge T605	HP ProLiant ML370 G5
Processor frequency (GHz)	2.70	3.00
Front-side bus frequency	1,000 MHz HyperTransport	1,333 MHz
Motherboard chipset	Broadcom HT 2100 and HT 1000	Intel 5000P
RAM (32 GB in each)	8 x 4GB PC2-6400	8 x 4GB PC2-5300
Hard drive	4 x 73GB	4 x 73GB
NICs	Broadcom BCM5708C NetXtreme II GigE	Broadcom BCM5708C NetXtreme II GigE

Figure 10: Key aspects of the server configurations.

PT configured both servers (with Dell's approval), and PT purchased them.

## Installing and configuring the OS

We began our testing by installing a fresh copy of Windows Server 2008, Enterprise x64 Edition on each server. We followed this process for each installation:

1. At the Language Selection Screen, click Next.
2. Click Install Now.
3. Select Windows Server 2008 Enterprise without Hyper-V (Full Installation) x64, and click Next.
4. Click the I accept the license agreement check box, and click Next.
5. Click Custom.
6. Click Next.
7. At the warning that the user's password must be changed before entering the OS, click OK.
8. Type `Password1` as the new password.
9. At the Your password has been changed screen, click OK.

## Installing system updates

We installed the following updates using 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 Server Manager x64 Edition (KB940518)
- Update for Windows Server 2008 x64 Edition (KB949189)
- Security Update for Windows Server 2008 x64 Edition (KB955069)
- Cumulative Security Update for ActiveX Killbits for Windows Server 2008 x64 Edition (KB956391)
- 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 (KB958623)
- Update for Windows Server 2008 x64 Edition (KB959130)

- Cumulative Security Update for Internet Explorer 7 in Windows Server 2008 x64 Edition (KB958215)
- 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)
- Security Update for Windows Server 2008 x64 Edition (KB954211)
- Windows Malicious Software Removal Tool x64 – January 2009 (KB890830)
- Security Update for Windows Mail for Windows Server 2008 x64 Edition (KB951066)
- Security Update for Windows Server 2008 x64 Edition (KB956841)
- 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 Internet Explorer 7 in Windows Server 2008 x64 Edition (KB960714)
- Security Update for Windows Server 2008 x64 Edition (KB951698)
- Update for Windows Server 2008 x64 Edition (KB950050)
- Update for Windows Server 2008 x64 Edition (KB955302)
- Windows Update Agent 7.2.6001.788

## General OS settings

1. Open the control panel.
2. Double-click User Accounts.
3. Click Turn User Account Control on or off.
4. Beside Use User Account Control (UAC), uncheck the check box.
5. Reboot the system.

## Installing and configuring the mail server

### Setting up the Active Directory

1. Click Start→Administrative Tools→Server Manager.
2. Click Roles on the left side.
3. Click Add Roles.
4. Click the Skip this page by default check box, and click Next.
5. Click the Active Directory Domain Services check box, and click Next.
6. Click Next.
7. Click Install.
8. Click Close.

### Assigning static IPs to the NICs

1. Click Start→Network.
2. Click Network and Sharing Center.
3. Click Manage Network Connections.
4. Right-click Local Area Connection.
5. Click Properties.
6. Click Internet Protocol Version 4 (TCP/IPv4), and click Properties.
7. Select Use the following IP Address, and input the following numbers:
  - IP Address: 192.168.1.1
  - Subnet mask: 255.255.255.0
8. Repeat steps 4 through 7 for Local Area Connection 2 and Local Area Connection 3 using the following IP information for each:

Local Area Connection 2:  
IP Address: 10.1.1.250  
Subnet mask: 255.255.255.0  
Local Area Connection 3:  
IP Address: 10.1.2.250  
Subnet mask: 255.255.255.0

### Setting up the domain

1. Click Start, type `cmd` in the prompt, and press Enter.
2. Type `dcpromo`, and press Enter.
3. Click Next.
4. Click Next.
5. Click Next.
6. Select Create a new domain in a new forest, and click Next.
7. Type `pender.lan` as the FQDN (Fully Qualified Domain Name), and click Next.
8. Set the forest functional level to Windows Server 2003, and click Next.
9. Set the domain functional level to Windows Server 2003, and click Next.
10. Leave defaults on the Additional Domain Controller Options screen, and click Next.
11. If a warning window appears asking about dynamically assigned IP addresses, click Yes.
12. Click Yes to continue.
13. Leave defaults at the Location for Database, Log Files, and SYSVOL screen; and click Next.
14. Type `Password1` at the Directory Services Restore Mode Administrator Password screen.
15. At the summary screen, click Next.
16. Click Finish.
17. Click Restart now.

### Setting up the Application Server

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

### Installing Microsoft Exchange

1. Click Start→Administrative Tools→Server Manager.
2. Click Features.
3. Click Add Features.
4. Select check box Windows PowerShell, and select Next.
5. Click Install.
6. Click Close.
7. Run Exchange 2007 SP1 install.exe.
8. Type `C:\exc` in the choose directory for extracted files text prompt.
9. Click OK.
10. Click OK.



11. In the C:\exc folder, double-click setup.exe.
12. Click Step 4 Install Microsoft Exchange Server 2007 SP1.
13. Click Next.
14. Accept License agreement, and click Next.
15. Click Next.
16. Select Typical Exchange Server installation, and click Next.
17. At the Exchange organization screen, click Next.
18. At the Client settings screen, click Next.
19. After the system finishes the readiness check, click Install.
20. Click Finish.
21. Click OK.
22. Restart the system.

### 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.

## Installing and configuring the Web server

### Deploying WebBench data

WebBench includes data that must reside on the server and that the Web server must use. We used the following procedure to load that data and set the Web server to use it:

1. Copy the file wbtrees.exe from the WebBench CD to the wwwroot directory on the server under test. (The wbtrees.exe file is on the WebBench CD at \wb50\workload. The wwwroot directory is located at C:\inetpub\wwwroot).
2. On the server, execute the wbtrees.exe file. This program copies the WebBench workload to the server.
3. In the wwwroot folder on the server, create a new folder with the name CGI-BIN.
4. Copy the file simisapi.dll to the CGI-BIN folder.
5. Click Start→Programs→Administrative Tools→Computer Management to open the management console.
6. Go to Services and Applications→Internet Information Services (IIS) Manager→ServerName.
7. Double-click ISAPI and CGI Restrictions.
8. Click Add.
9. Enter the path for the simisapi.dll, and click the check box saying Allow extension path to execute.
10. Click OK.

### Configuring Internet Information Services (IIS)

We configured the Windows Internet Information Services Web server as follows:

1. Open Computer Management.
2. Go to Services and Applications→Internet Information Services (IIS) Manager→ServerName.
3. Double-click MIME Types.
4. In the MIME Types window, click Add.
5. In the Extension field, type \*.
6. In the MIME Type field, type application/octet-stream, and click OK.
7. Double-click the server name on the left side of the window.
8. Double-click ISAPI and CGI Restrictions.

9. Click Edit Feature Settings.
10. Click the check boxes beside Allow unspecified CGI module and Allow unspecified ISAPI modules.
11. Click OK.
12. Go to Services and Applications→Internet Information Services (IIS) Manager→ServerName.
13. Double-click Logging.
14. Click Disable.

### Installing certificate services

Because WebBench includes tests that involve security, we installed Windows Certificate Services as follows:

1. Go to Services and Applications→Internet Information Services (IIS) Manager→ServerName.
2. Double-click Server Certificates.
3. Click Create Self-Signed Certificate.
4. Name it *Performance*, and click OK.
5. Go to Services and Application→Internet Information Services (IIS) Manager→ServerName→Sites→Default Web Site.
6. Click Bindings...
7. Click the https entry, and click Edit.
8. Set the SSL Certificate to Performance, and click OK.
9. Click Add.
10. Set the type to http, and set the IP address to 192.168.1.1.
11. Set the Port to 81, and click OK.
12. Click Add.
13. Set the type to https, and set the IP address to 192.168.1.1.
14. Set the SSL Certificate to Microsoft Exchange.
15. Set the Port to 444, and click OK.
16. If a warning pops up, click Yes.
17. Click OK.
18. Double-click SSL settings.
19. Uncheck the Require SSL check box.
20. Click Apply.

### Creating SSL Communication

We enabled SSL communication as follows:

1. Go to Services and Applications→Internet Information Services (IIS) Manager→ServerName.
2. Expand the Default Web site.
3. Expand wbtrees.
4. Click Wbssl.
5. Double-click SSL Settings.
6. Check Require SSL.
7. Check Require 128-bit SSL.
8. Click Apply.

We then set the following operating system tuning parameters for optimum WebBench performance. When creating the following parameters, ensure that they are DWORD files, with decimal coding (rather than hexadecimal):

- HKLM\System\CurrentControlSet\Services\Inetinfo\Parameters\MaxCachesFileSize to 1048576
- HKLM\System\CurrentControlSet\Services\HTTP\Parameters\UriMaxUriBytes to 1048576
- HKLM\System\CurrentControlSet\Control\FileSystem\NtfsDisableLastAccess to 1
- HKLM\System\CurrentControlSet\Services\Tcpip\Parameters\MaxHashTableSize to 65535

## Installing and configuring the database server

### Installing Microsoft SQL Server 2005

1. Insert the SQL Server 2005 CD into the server.
2. Click the Server Components link under the Install section to begin the installation.
3. Accept the license agreement, and click Next.
4. Click Install to install the prerequisites.
5. After the Prerequisites complete installing screen, click Next.
6. At the Welcome screen, click Next.
7. At the System Configuration Check, assuming everything has a status of success, click Next.
8. Enter the registration information, and click Next.
9. At the Components to Install screen, select SQL Server Database Services and Workstation Components, Books Online and development tools.
10. Click Advanced, and click Next.
11. Click Next to start the installation.
12. For Instance Name, leave the default option, and click Next.
13. At the Service Account screen, select Use the built-in system account (Local system), and click Next.
14. Keep the default option for Authentication Mode, and click Next.
15. For Collation Settings, leave the defaults, and 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 installation software prompts you to do so, insert Microsoft SQL Server 2005 disk 2, and click OK.
19. If a compatibility error occurs during the installation, click Run program.
20. When the setup process completes, click Next.
21. Click Finish to complete the installation.

### Download and install 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-8ae5-949fdbe59c4&displaylang=en>.

1. Run SQLServer2005SP3-KB955706-x64-ENU.exe.
2. At the Welcome screen, click Next.
3. At Accept the License Agreement, click Next.
4. At the Feature Selection screen, keep the defaults, and click Next.
5. At the Authentication screen, click Next.
6. At the Error and Usage Reporting Settings screen, click Next.
7. At the Running Processes screen, click Next.
8. Click Install.
9. If a compatibility error occurs during the installation, click Run program.
10. Click Next.
11. At the Installation Complete screen, click Next.
12. Click Finish.
13. Reboot the system.

### Creating the test database and generating data

1. Select Start→All Programs→Microsoft SQL Server 2005→SQL Server Management Studio.
2. Type the server name in the Connect to Server window.
3. Click Connect to connect to the server.
4. Right-click the Databases folder in the left window, and select New Database from the pop-up menu.
5. In the Database name field, type `sbtest`, and click OK.
6. Open a command prompt by selecting Start→Run, type `cmd`, and click OK.
7. In the command prompt, type `cd c:\` to change to C:\.
8. To prepare the database, type `sysbench.exe --test=oltp --oltp-table-size=100000 prepare`, and press Enter.
9. When the command finishes, the C:\ prompt appears.

10. Type `exit`, and press Enter to close the command prompt.
11. In SQL Server 2005 Management Studio, stop the database service by right-clicking Server in the left windowpane, and then select Stop from the drop-down menu.
12. Using Windows Explorer, create the folder `C:\backup`.
13. With Windows Explorer, copy all sbtest files from `C:\Program File\Microsoft SQL Server\MSSQL.1\MSSQL\Data\` to `c:\sysbench_backup`. (You should see two files: `sbtest.mdf` and `sbtest_log.ldf`.)
14. Once the copy completes, close Windows Explorer.
15. Restart the database service using SQL Server 2005 Management Studio by right-clicking server and selecting Start.

## Installing the mail test client

We began our testing by installing a fresh copy of Microsoft Windows Server 2003 R2, Enterprise x64 Edition Service Pack 2 on the test client. 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 correctly join the domain. 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 `pender`.
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.

### 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 200 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 `PenderAverage.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. Use this process to back up that database:

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. 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\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\mailstore`, and all the files from `C:\Program Files\Microsoft\Exchange Server\Mailbox\Second Storage Group` to `C:\backup\publicstore`. 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.

### Running the test

#### Running WebBench

1. Restart the Web Controller.
2. On the desktop, double-click the Web Controller shortcut.

3. Go to the top bar, and click Clients→Start Log In...
4. Restart all of the Web Clients.
5. Wait for all of the Web Clients to appear on the left side of the WebBench Controller Program.
6. Click OK.
7. When the application prompts you to add a test suite, click Yes.
8. Select 45minute\_Pender 12 client ecommerce\_api\_template.tst.
9. Give the run an appropriate name (e.g., Pender\_WB\_Run1).
10. Click OK.
11. When the Would you like to start executing the test suites? Screen appears, do not click Yes or No. Instead, leave the screen.

### **Running LoadGen**

1. Restart the Mail Client.
2. Leave the screen sitting when it boots up.

### **Running SysBench**

1. Restart the system under test (SUT).
2. Let the SUT idle for 10 minutes.
3. Run c:\SBSbench\_run1.cmd.
4. When the script tells you to, start WebBench.
5. LoadGen and SysBench will begin automatically in the next 15/30 minutes, respectively.
6. Run the restore\_all script between each run.

### **Network test bed configuration**

To generate the workload, we used a network with 14 client PCs. We split 12 of the clients into two segments, or subnets, of 4 clients each. We configured these clients with Windows XP Professional with Service Pack 2 and all critical updates available as of June 7, 2007. We connected each segment to the server under test via one NETGEAR GS724T Gigabit Smart Switch. To balance the load on the server and to prevent a network throughput bottleneck, we connected each segment to a separate network port. We used the remaining two clients for the WebBench controller and LoadGen client.

## Appendix A – Price information

Figure 11 provides the list price information for the test systems as of January 13, 2009. Prices exclude tax and shipping costs.

System	Dell PowerEdge T605	HP ProLiant ML370 G5
Price as of January 13, 2009	\$6,951	\$7,831

Figure 11: List price information for the test systems. Prices exclude tax and shipping costs.

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## Appendix B – Test system configuration information

Figure 12 provides detailed configuration information about each of the test server systems, which we list in alphabetical order.

Servers	Dell PowerEdge T605	HP ProLiant ML370 G5
<b>General</b>		
Number of processor packages	2	2
Number of cores per processor package	4	4
Number of hardware threads per core	1	1
System power management policy	Balanced	Balanced
<b>CPU</b>		
Vendor	AMD	Intel
Name	AMD Opteron 2384	Intel Xeon E5450
Stepping	2	A
Socket type	Socket F	Socket 771 LGA
Core frequency (GHz)	2.70	3.00
Front-side bus frequency	1,000 MHz HyperTransport	1,333 MHz
L1 cache	64 KB + 64 KB (per core)	32 KB + 32 KB (per core)
L2 cache	2 MB (4 x 512 KB)	12 MB (2 x 6,144 KB)
<b>Platform</b>		
Vendor and model number	Dell OTP407	HP 013046-001
Motherboard chipset	Broadcom HT 2100 and HT 1000	Intel 5000P
BIOS name and version	Dell 3.0.2 (09/29/2008)	HP P57 (09/29/2008)
BIOS settings	Default	Default
<b>Memory module(s)</b>		
Vendor and model number	Samsung M393T5160QZA-CF7	Samsung M395T5160QZ4-CE66
Type	PC2-6400	PC2-5300
Speed (MHz)	800	666
Speed in the system currently running @ (MHz)	800	666
Timing/latency (tCL-tRCD-iRP-tRASmin)	6-6-6-18	5-5-5-15
Size (MB)	32,762	32,768
Number of RAM modules	8 x 4,096 MB	8 x 4,096 MB
Chip organization	Double-sided	Double-sided
Channel	Dual	Dual
<b>Hard disk</b>		
Vendor and model number	Seagate ST373455SS	Seagate ST973451SS
Number of disks in system	4	4
Size (GB)	73	73
Buffer size (MB)	16	16
RPM	15,000	15,000
Type	SAS	SAS
Controller	Dell PERC 6/i Adapter RAID Controller	Smart Array P400 Controller
Controller driver	Dell 2.23.0.64 (07/01/2008)	HP 6.12.4.64 (3/31/2008)
<b>Operating system</b>		



<b>Servers</b>	<b>Dell PowerEdge T605</b>	<b>HP ProLiant ML370 G5</b>
Name	Windows Server 2008 Enterprise x64 Edition	Windows Server 2008 Enterprise x64 Edition
Build number	6001	6001
Service Pack	SP1	SP1
Microsoft Windows update date	January 15, 2009	January 15, 2009
File system	NTFS	NTFS
Kernel	ACPI X64-based PC	ACPI X64-based PC
Language	English	English
Microsoft DirectX version	10	10
<b>Graphics</b>		
Vendor and model number	ATI ES 1000	ATI ES 1000
Chipset	ATI ES 1000	ATI ES 1000
BIOS version	BK-ATI VER008.005.032.000	BK-ATI VER008.005.013.000
Type	Integrated	Integrated
Memory size (MB)	32	32
Resolution	1,024 x 768 x 32-bit	1,024 x 768 x 32-bit
Driver	ATI Technologies Inc. 8.240.50.3000 (1/21/2008)	ATI Technologies Inc. 8.240.50.3000 (1/21/2008)
<b>Network card/subsystem</b>		
Vendor and model number	Broadcom BCM5708C NetXtreme II GigE	Broadcom BCM5708C NetXtreme II GigE
Type	Integrated	Integrated
Driver	4.4.15.0 (5/14/2008)	4.4.15.0 (5/14/2008)
Additional network adapter	Intel PRO/1000 PT Dual Port Server Adapter	Intel PRO/1000 PT Dual Port Server Adapter
Driver	9.12.36.0 (12/04/2008)	9.12.36.0 (12/04/2008)
<b>Optical drive</b>		
Vendor and model number	TSSTcorp DVD+RW TS-H653F	HL-DT-ST DVD-ROM GDR-H30N
Type	DVD-RW	DVD-ROM
Interface	SCSI	IDE
<b>USB ports</b>		
Number of ports	7	4
Type of ports (USB 1.1, USB 2.0)	2.0	2.0

Figure 12: Detailed system configuration information for the two servers.

## About Principled Technologies

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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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