

Responsiveness of Windows Vista™ and Windows Vista™ SP1 using Windows Server 2003™ and Windows Server 2008™ on common business file tasks

Executive summary

Microsoft Corporation (Microsoft) commissioned Principled Technologies (PT) to develop and run a set of tests that compare the responsiveness of Windows Vista and Windows Vista SP1 using Windows Server 2003 and Windows Server 2008 on common business file operations. We measured how responsive each operating system (OS) was when performing a set of common business file copy operations. We ran these tests with a pair of servers running Windows Server 2003 and again with the same servers running Windows Server 2008.

The goal of the tests is to provide buyers with a sense of the differences in response time they would experience when performing the same file operations on each OS/server pair.

Test operations included copying files in several ways: between folders on a local drive, from a local drive to and from a server accessed over a local area network (LAN) connection; and from a local drive to and from a server accessed over a wide area network (WAN) connection that we simulated in our lab.

We ran the tests on four client systems¹:

- Dell XPS 600 (desktop)
- Dell XPS M170 (notebook)
- Hewlett-Packard d4100e (desktop)
- Toshiba Tecra M4 (tablet)

We tested a total of four client-server OS platform combinations: each version of the client OS with each version of the server OS. We ran all the tests on the following two client operating systems:

- Windows Vista Ultimate Version 6.0, build 6000 (Vista), the one that Microsoft released to manufacturing
- Windows Vista Ultimate version 6.0, build 6001, Service Pack 1, build 17128 (Vista SP1)

We ran all the tests using the following two server operating systems:

- Windows Server 2003 R2 (Server 2003)
- Windows Server 2008 RTM Escrow build (Build 6001.17128.080101-1935) (Server 2008)

We conducted each test using a test bed that included a client system with one of the above two client operating systems and two servers, one connected via a 100Mb/s Ethernet LAN and the other via a simulated WAN. We simulated a 100Mb/s WAN environment using Shunra Desktop VE to add 100ms round trip latency to the 100Mb/s network. The Test methodology section provides details on the network setup.

KEY FINDINGS

- Windows Vista SP1 was noticeably more responsive than Windows Vista on most of the file operations in this test when we tested with Windows Server 2008.
- Windows Vista SP1 was also noticeably more responsive than Windows Vista on most of the file operations in this test when we tested with Windows Server 2003.
- Windows Server 2008 was faster on most of the file operations in this test than Windows Server 2003.

¹ The original testing included a Hewlett-Packard a1320y desktop PC. We omitted that system from the charts and analysis in this report because it produced unacceptably high variability in its test results. Appendix D provides configuration information and detailed test results for this system.

Microsoft provided the test systems and test settings. PT set up the systems; specified and developed the tests and test procedures; set up the test environment including the test servers; and executed all the tests.

In this report, we examine the performance characteristics of the two Windows client and two Windows server OS versions, not the differences among client systems. So, though all four client systems were shipping units whose configurations we detail in Appendix A, we aggregate their results in the OS comparison charts, and in the bulk of the report we refer to them as System A, System B, System C, and System D.

The 25 test operations come from a realistic business scenario that we created and scripted. The scenario covers part of the day of Bob, the head of Sales and Marketing at Acme Ventures, a company that makes network hardware and provides network services, including installation and testing. Acme Ventures has recently acquired a small company across the country, WileyBeep, which, like Acme, makes network hardware. WileyBeep specializes in servers. Bob is preparing for a training session at WileyBeep headquarters next month. He has set aside some time to assemble materials that he needs for this session and wants to share with his colleagues at WileyBeep. As he works, he copies files to and from several locations:

- the WileyBeep server via the WAN
- his local drive
- the Acme Ventures server via the LAN

The scenario includes file copy tasks using files and folders of different types and sizes. The scenario comprises five typical business projects focusing on file copy operations. Four of the projects include copy operations to or from the WAN or LAN servers. Each project involves a different source and destination:

- Project 1: Bob copies files from the LAN server to his local drive
- Project 2: Bob copies files from his local drive to the WAN server
- Project 3: Bob copies files from the WAN server to his local drive
- Project 4: Bob copies files between two folders on his local drive
- Project 5: Bob copies files from his local drive to the LAN server

This report discusses the results of those tests and provides the following response time comparisons:

- Vista SP1 vs. Vista when connected to servers running Windows Server 2008
- Vista SP1 vs. Vista when connected to servers running Windows Server 2003
- Windows Server 2008 vs. Windows Server 2003 when copying files to and from a client system running Vista SP1

Vista SP1 vs. Vista when connected to servers running Windows Server 2008

Figure 1 compares the performance of Vista SP1 and Vista on 25 common business file operations with server operations using Windows 2008 Servers.

Vista SP1 was noticeably more responsive than Vista on most of the file operations in this test when we tested with Windows Server 2008. Vista SP1 provided better performance on 18 of the 25 file operations in this test, leading by over 1 minute on two of the tasks and by a total of over 7.2 minutes on those 18 tasks. Vista SP1 showed the strongest leads in Projects 2 and 3, which copy files between the local drive and the WAN server. Vista led on seven tasks, but only by at most 12.8 seconds on an individual task and by a total of 18.5 seconds on all seven tasks.

Each bar in Figure 1 represents the average of the differences in response time on the four test systems between Vista SP1 and Vista on one operation. The bars appear in the order in which the operations appear in the scenarios. Bars above the 0.00 midline indicate tests in which Vista SP1 was faster. The yellow band contains all differences of less than 30 seconds.

Space constraints prevent us from labeling the individual operations in the figures in this section. We have labeled them all in the Test results section and in the Detailed test results appendix.

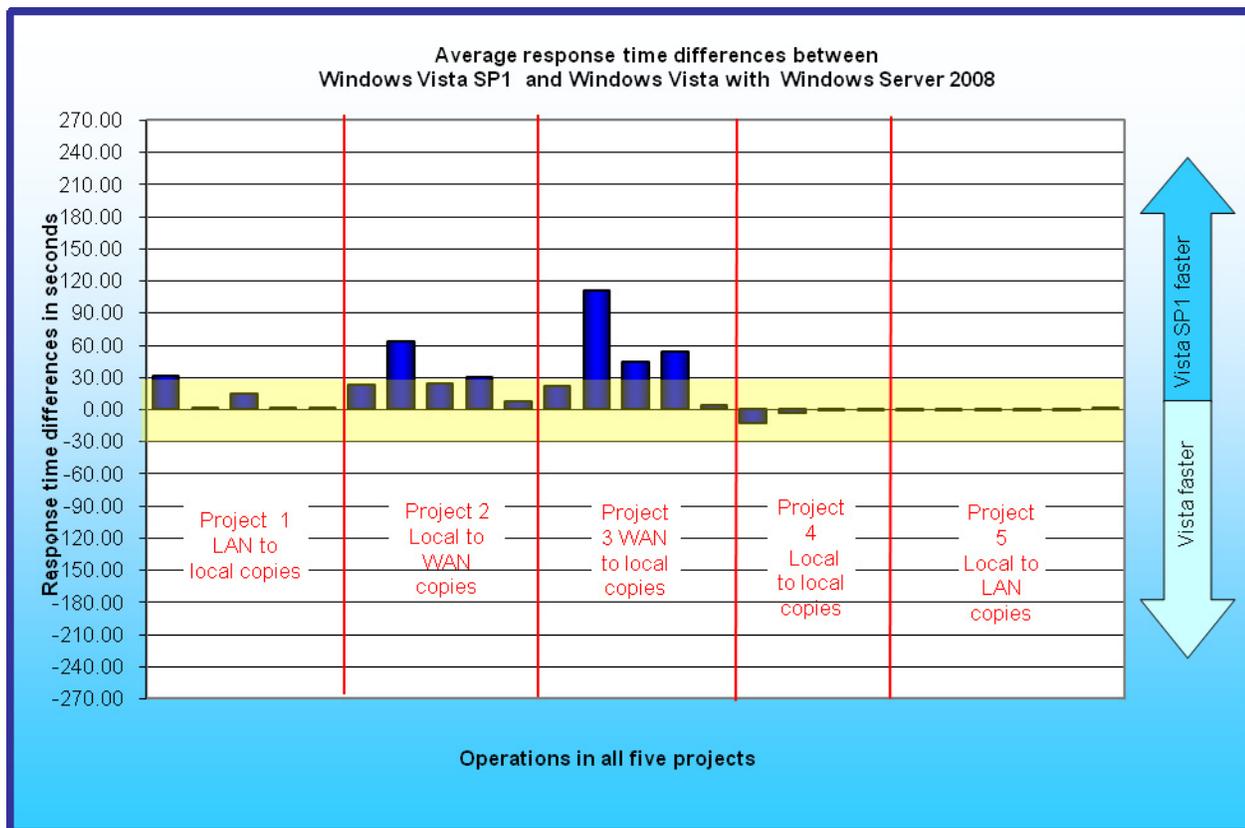


Figure 1: Average response time improvements of Vista SP1 over Vista on a variety of file operations on four systems when connected to servers running Windows Server 2008. Numbers greater than zero indicate Vista SP1 was more responsive. Differences of more than 30 seconds are outside the yellow band. We describe each of those operations in the Scenario descriptions section.

Figure 2 displays the response time difference shown in Figure 1 as a percentage of the average Windows Vista response time for each task. For example, if Windows Vista finished a task in a three-quarters of a second and

Windows Vista SP1 finished it in a half second, the graph would show a 33 percent difference (the quarter-second time difference divided by Vista's three-quarter second response time). A positive result shows Vista SP1 is faster by that percentage; a negative result shows Vista is faster by that percentage. The bars appear in the order in which the operations appear in the scenarios, which we describe below. Bars above the 0.00 midline indicate tests in which Windows Vista SP1 was faster. Windows Vista SP1 was more than 10 percent faster than Windows Vista on 17 of the tasks in this project and more than 50 percent faster on six of the tasks. Windows Vista SP1 logged its largest win on the Copy WPix WAN-to-local task, where it beat the Windows Vista time by 63 percent.

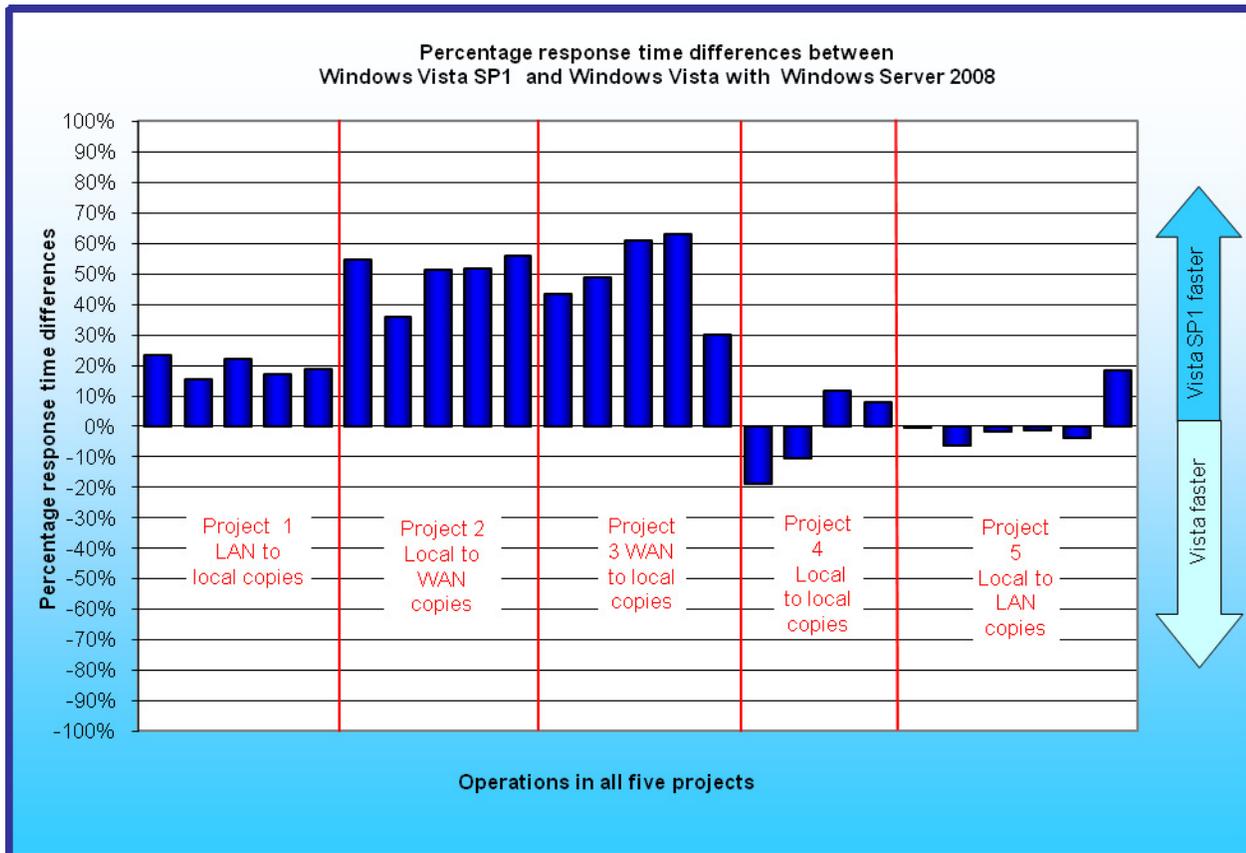


Figure 2: Percentage response time improvements of Vista SP1 over Vista on a variety of file operations on four systems when connected to servers running Windows Server 2008. Numbers greater than zero indicate Vista SP1 was more responsive. We describe each of those operations in the Scenario descriptions section.

Vista SP1 vs. Vista when connected to servers running Windows Server 2003

Figure 3 displays the average response time improvements of Vista SP1 over Vista when using Windows Server 2003 OS on the servers. SP1 logged wins on 20 of the 25 tasks. Vista led on five tasks, showing a large win on the Copy Q3 WAN-to-local task.

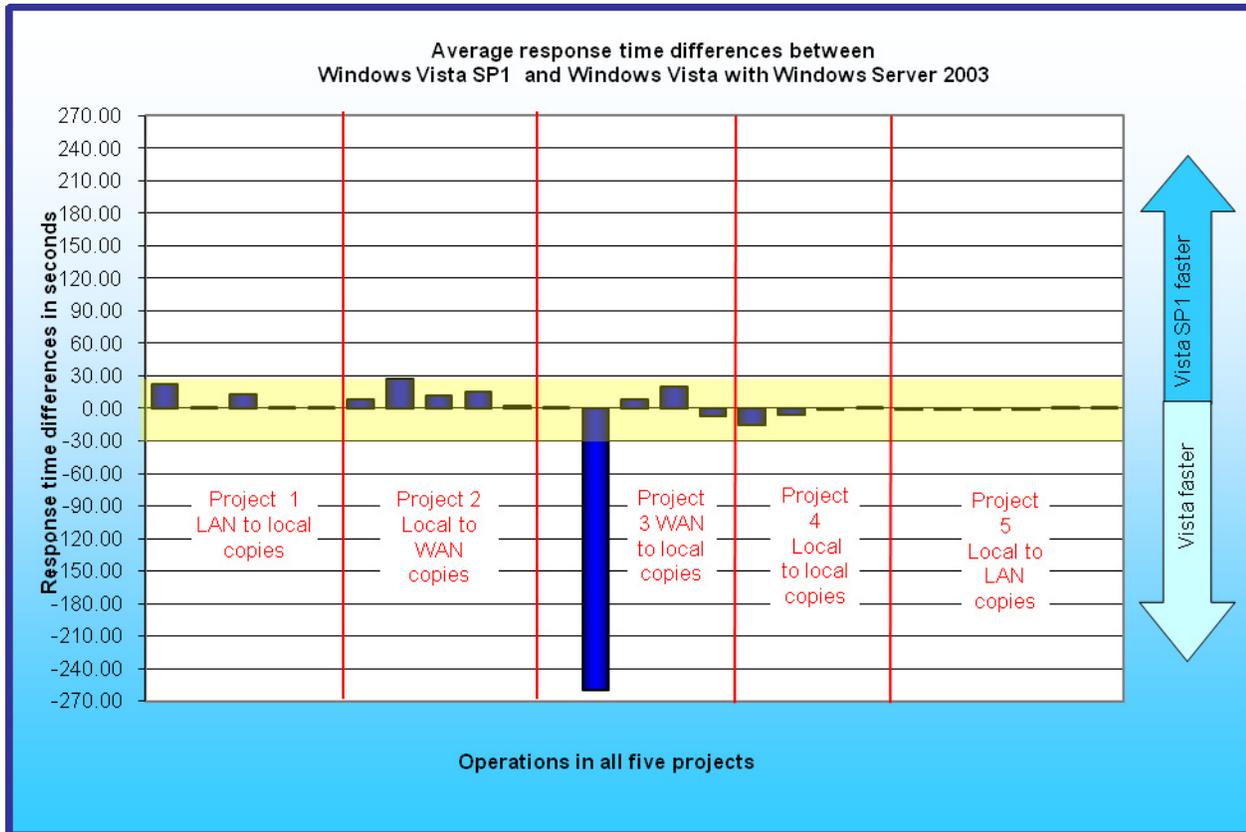


Figure 3: Average response time improvements of Vista SP1 over Vista on a variety of file operations on four systems when connected to servers running Windows Server 2003. Numbers greater than zero indicate Vista SP1 was more responsive. Differences of more than 30 seconds are outside the yellow band.

Figure 4 shows the percentage response time improvements of Vista SP1 over Vista when we tested with servers running Windows Server 2003. Two of the file copy operations that move files from the Windows Server 2003 over the WAN to the local drive of the client system show large wins for Vista. Nine of the Vista SP1 wins and four of the Vista wins were greater than 10 percent; all the Vista SP1 wins and all but two Vista wins were less than 50 percent.

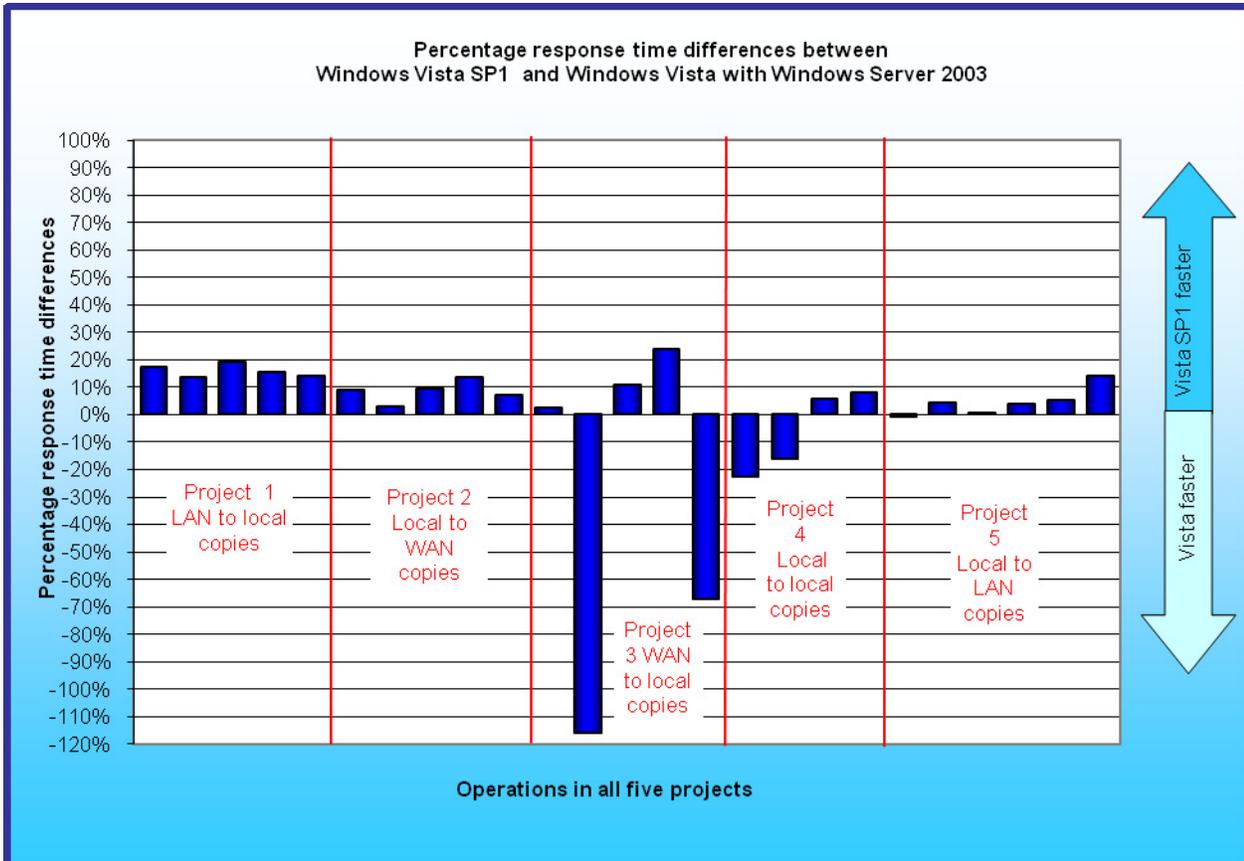


Figure 4: Percentage response time improvements of Vista SP1 over Vista on a variety of file operations on four systems when connected to servers running Windows Server 2003. Numbers greater than zero indicate Vista SP1 was more responsive.

Windows Server 2008 vs. Windows Server 2003 when copying files to and from a client system running Vista SP1

Figure 5 displays the average response time improvements of Windows Server 2008 over Windows Server 2003 for the four projects that involve file copies either to or from the servers for four Vista SP1 systems. Windows Server 2008 was faster on 17 tasks, often by a large amount, winning by over 11 minutes on one task and over 6 minutes on another. It led by over 25 minutes on the combined times of the 17 tasks. It showed the biggest wins for Projects 2 and 3, which copy files to and from the WAN server. On the four remaining tasks, Windows Server 2003 was faster, but all the differences were small: the largest win was only 1.5 seconds. The combined times for the four Windows Server 2003 wins was 3.4 seconds.

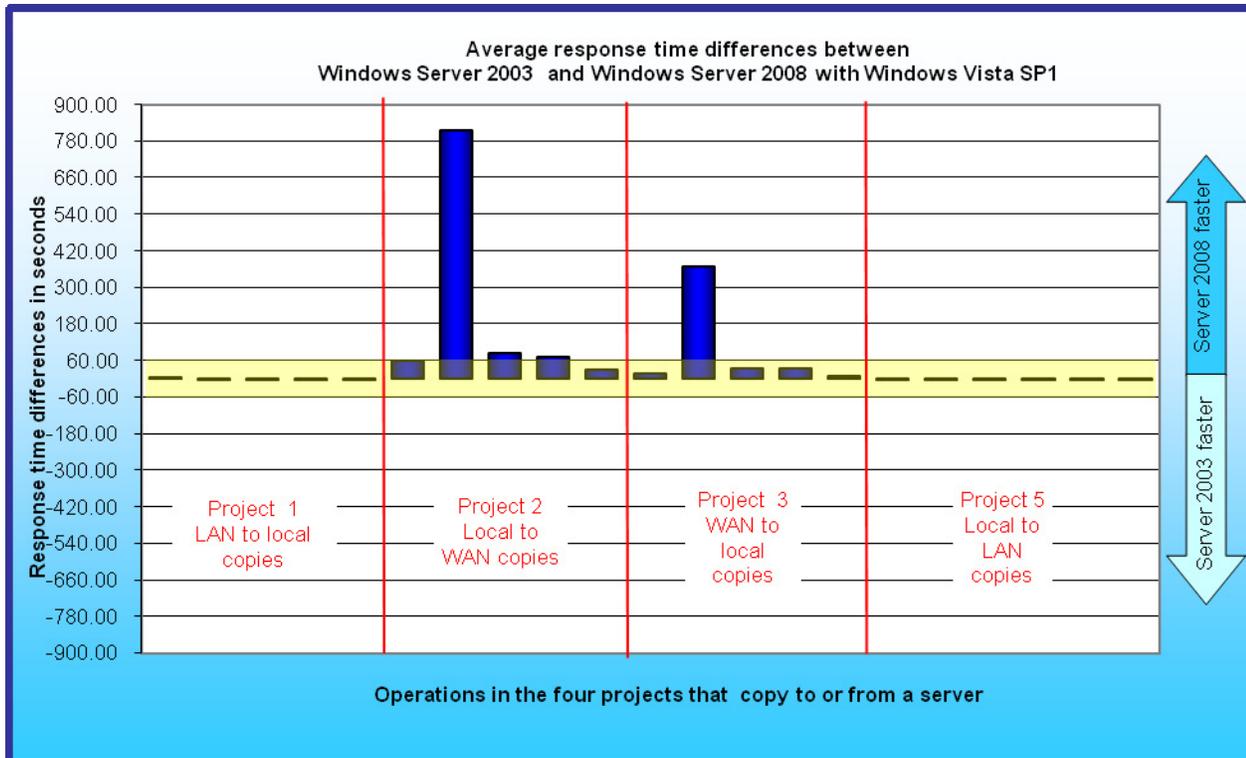


Figure 5: Average response time improvements of Windows Server 2008 over Windows Server 2003 on a variety of file copy operations on four Vista SP1 systems. Numbers greater than zero indicate Windows Server 2008 was more responsive. Differences of more than 60 seconds are outside the yellow band. We describe each of those operations in the Scenario descriptions section.

Figure 6 shows that Windows Server 2008 outperformed Windows Server 2003 on most of the file copy operations in the four projects in this test that copy files to or from the servers. The differences were dramatic for Projects 2 and 3, which copy files to and from the WAN server; Windows Server 2008 wins ranged from 38.5 percent to 163.5 percent. Windows Server 2003 led on some of the local-to-local file copy tasks in Project 5 by a high of 10.8 percent.

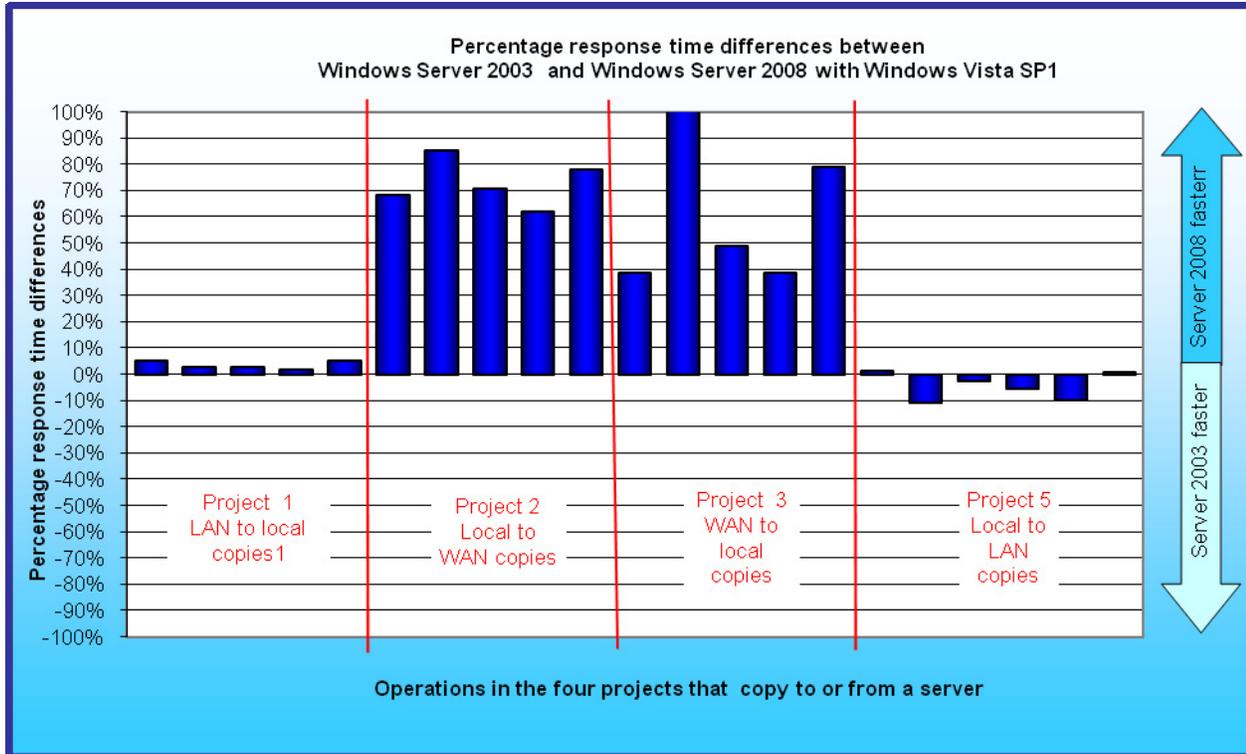


Figure 6: Percentage response time improvements of Windows Server 2008 over Windows Server 2003 on a variety of file copy operations on four Vista SP1 systems. Numbers greater than zero indicate Windows Server 2008 was more responsive. We describe each of those operations in the Scenario descriptions section.

Test results

In the following subsection, we examine the test results by project. Because the charts in this subsection show fewer operations, we have the space to label each operation by name. Appendix C contains a table of the average times for each operation on each system.

Each result we report for a system is the average of five runs on that system. Before conducting the timed runs on a given PC and OS combination, we ran the same workload three times on that system. We did so to allow each OS to “learn” and, if possible, to tune itself for the work it would be facing. This approach allowed us to mimic what would occur on many users’ PCs over the first few days they use their systems (and after each time they introduce a new application into their work mix). See the Test methodology section for greater detail on how we conducted the tests.

Project results for the comparisons of Vista SP1 and Vista when we tested with Windows Server 2003

The figures in this section show the results for each of the five projects for the comparisons of Vista SP1 and Vista when we tested with Windows Server 2003. The range for the y-axis that displays the percentage response time difference varies from graph to graph based on the range of the results for that project for both server operating systems. In each figure, the operations appear in the order in which they occurred in the projects.

The figures each provide two measures of the performance of two operating systems: average response time differences in seconds and the percentage response time improvements. The labels above each column include the difference in seconds between performance times for the two operating systems on a task. The columns themselves show the percentage that time is of the total Vista task time. This percentage measure indicates the

percentage of task time a user would save or lose on the two operating systems. To calculate the percentages, we divided the difference in performance times of the two client operating systems by the Vista performance time. The average and percentage response time measures together provide perspective on each difference, letting you know both the actual time difference and the relative weight of that difference compared to the total task time. The two measures together help indicate whether a response time difference would be noticeable to users. Having the two measures is particularly useful because of the wide range of task times in this test. For example, a 2-second time difference is more noticeable to a user on a task that takes only a few seconds to complete than that same difference would be on a task that takes minutes to complete.

Figure 7 compares the performance of Vista SP1 and Vista for the LAN-to-local file copy tasks in Project 1 when using Windows Server 2003 as the server OS. Vista SP1 led on all five tasks in this project, copying the video from the LAN to the local drive 22.3 seconds faster than Vista and the large Q3 folder 12.4 seconds faster. The Vista SP1 times were from 13.6 percent to 19.3 percent faster than the Vista times on the tasks of this project.

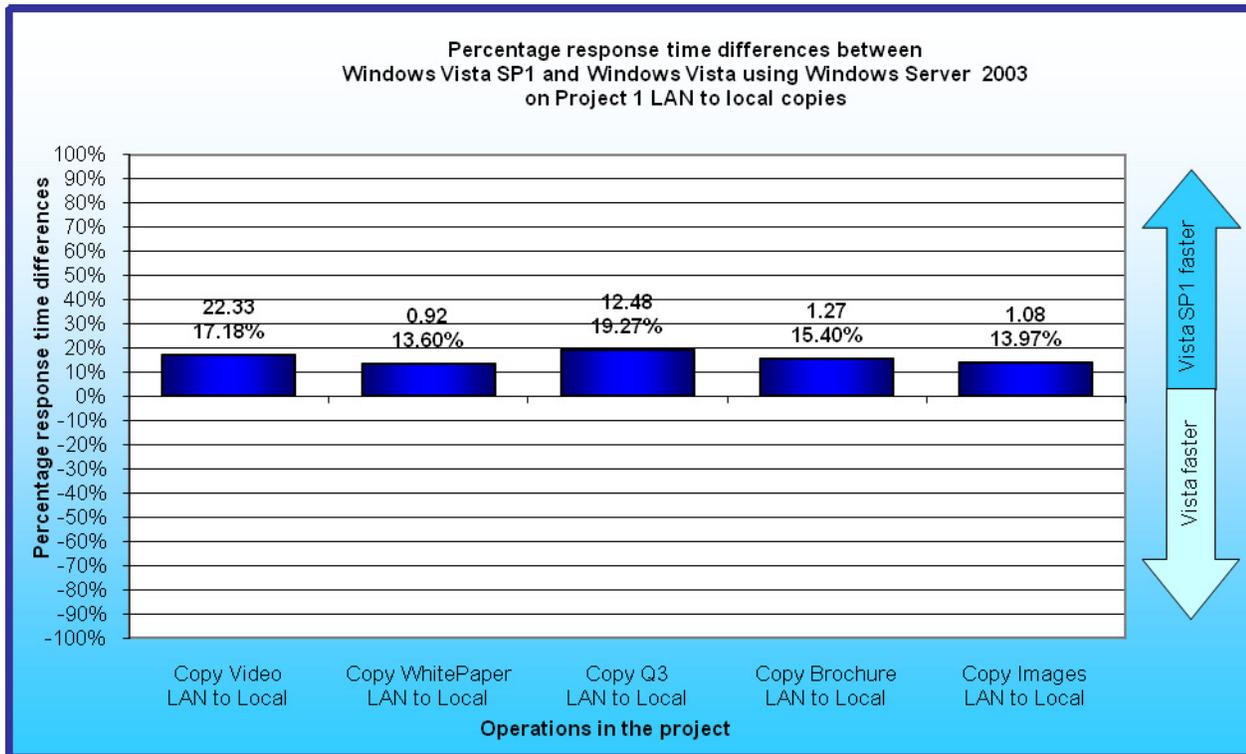


Figure 7: Average response time improvements of Vista SP1 over Vista on a variety of file operations in Project 1 on four systems when connected to servers running Windows Server 2003. Numbers greater than zero indicate Vista SP1 was more responsive.

Figure 8 compares the performance of Vista SP1 and Vista for the local-to-WAN file copy tasks in Project 3 when using Windows Server 2003 as the server OS. Vista SP1 showed dramatic response time improvements on all of these tasks, with leads ranging from 2.7 seconds to 26.8 seconds on the five operations in this project. Vista SP1 times on the project tasks were from 2.8 percent to 13.5 percent faster than Vista times.

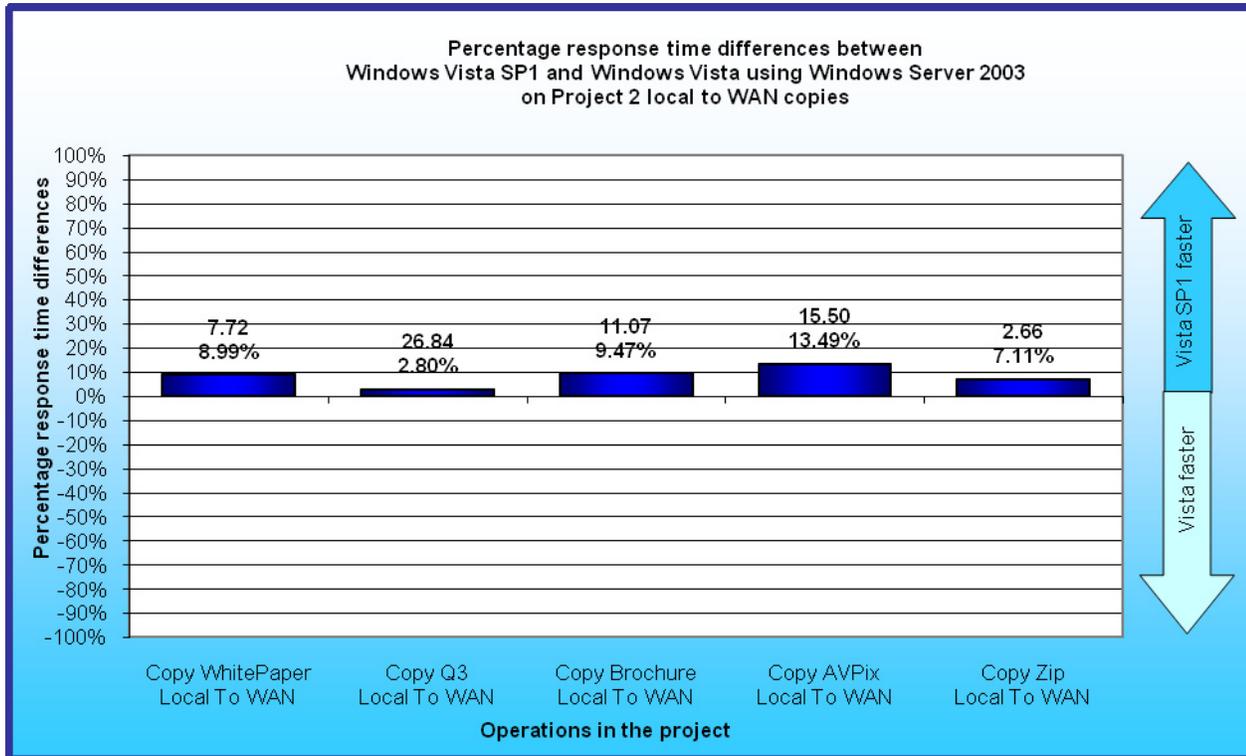


Figure 8: Percentage response time improvements of Vista SP1 over Vista on a variety of file operations in Project 2 on four systems when connected to servers running Windows Server 2003. Numbers greater than zero indicate Vista SP1 was more responsive.

Figure 9 compares the performance of Vista SP1 and Vista for the WAN-to-local file copy tasks in Project 3 when using Windows Server 2003 as the server OS. Vista SP1 led on three tasks in this project by from 1.3 seconds to 20.3 seconds. Vista showed a multi-minute response time lead on the Copy Q3 WAN-to-local task in this project and a 7-second lead on the zip file copy task.

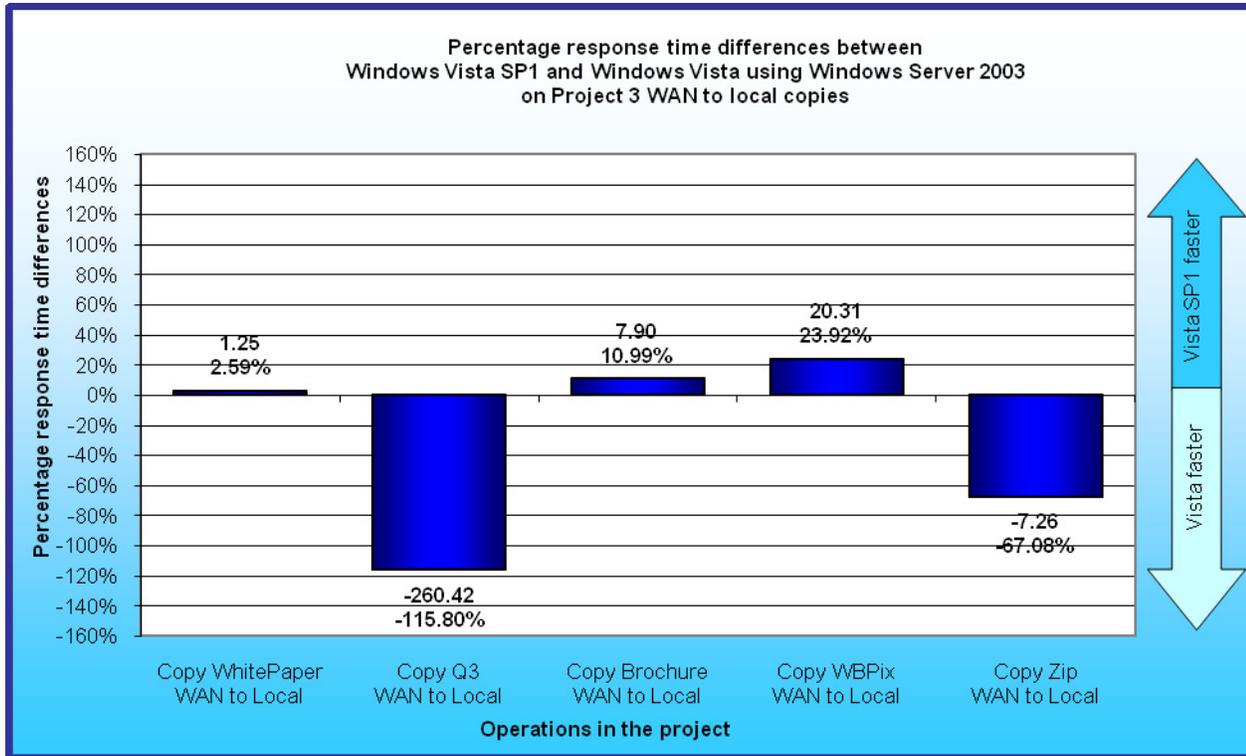


Figure 9: Percentage response time improvements of Vista SP1 over Vista on a variety of file operations in Project 3 on four systems when connected to servers running Windows Server 2003. Numbers greater than zero indicate Vista SP1 was more responsive.

Figure 10 compares the performance of Vista SP1 and Vista for the local-to-local file copy tasks in Project 4 when using Windows Server 2003 as the server OS. Vista SP1 led by small margins on two of the tasks. Vista led on the other two, copying the video 15.4 seconds (22.6 percent) faster and the Q3 folder 5.7 seconds (16.3 percent) faster.

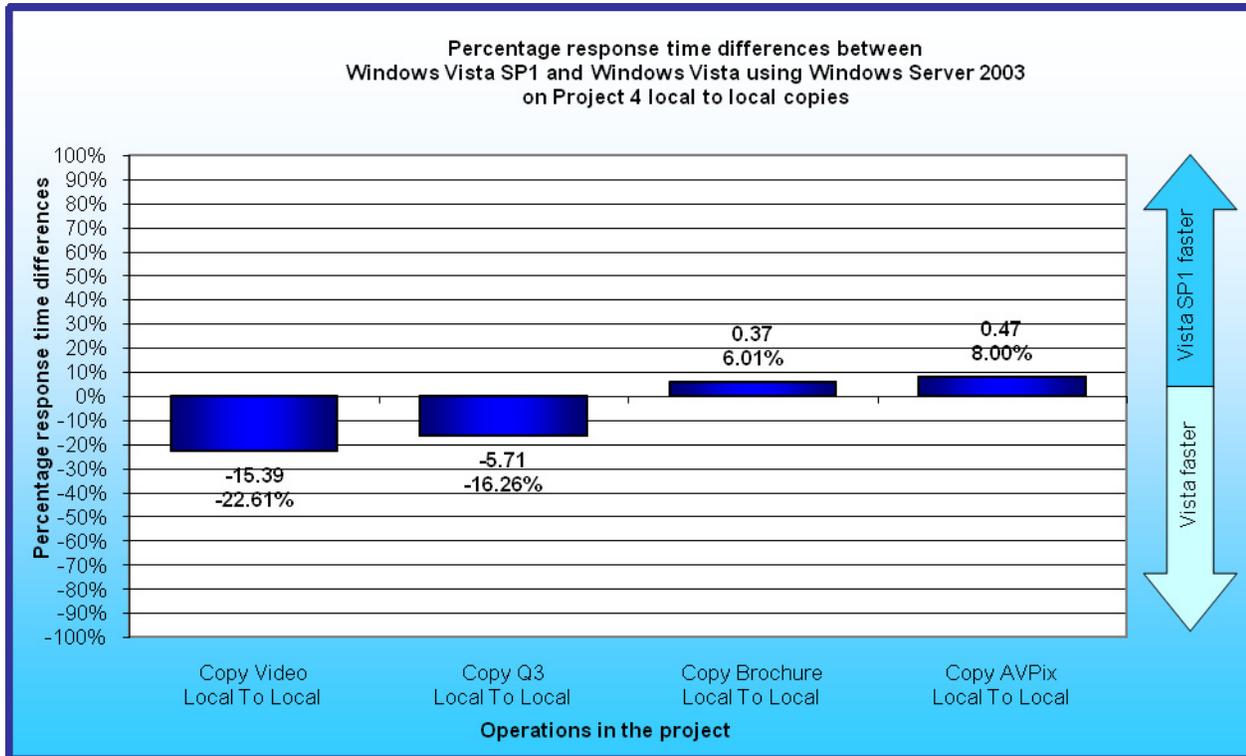


Figure 10: Percentage response time improvements of Vista SP1 over Vista on a variety of file operations in Project 4 on four systems when connected to servers running Windows Server 2003. Numbers greater than zero indicate Vista SP1 was more responsive.

Figure 11 compares the performance of Vista SP1 and Vista for the local-to-LAN file copy tasks in Project 5 when using Windows Server 2003 as the server OS. Vista SP1 showed faster response time on five of the six tasks in this project. None of the response time differences for this project were dramatic; all were under three-fourths of a second.

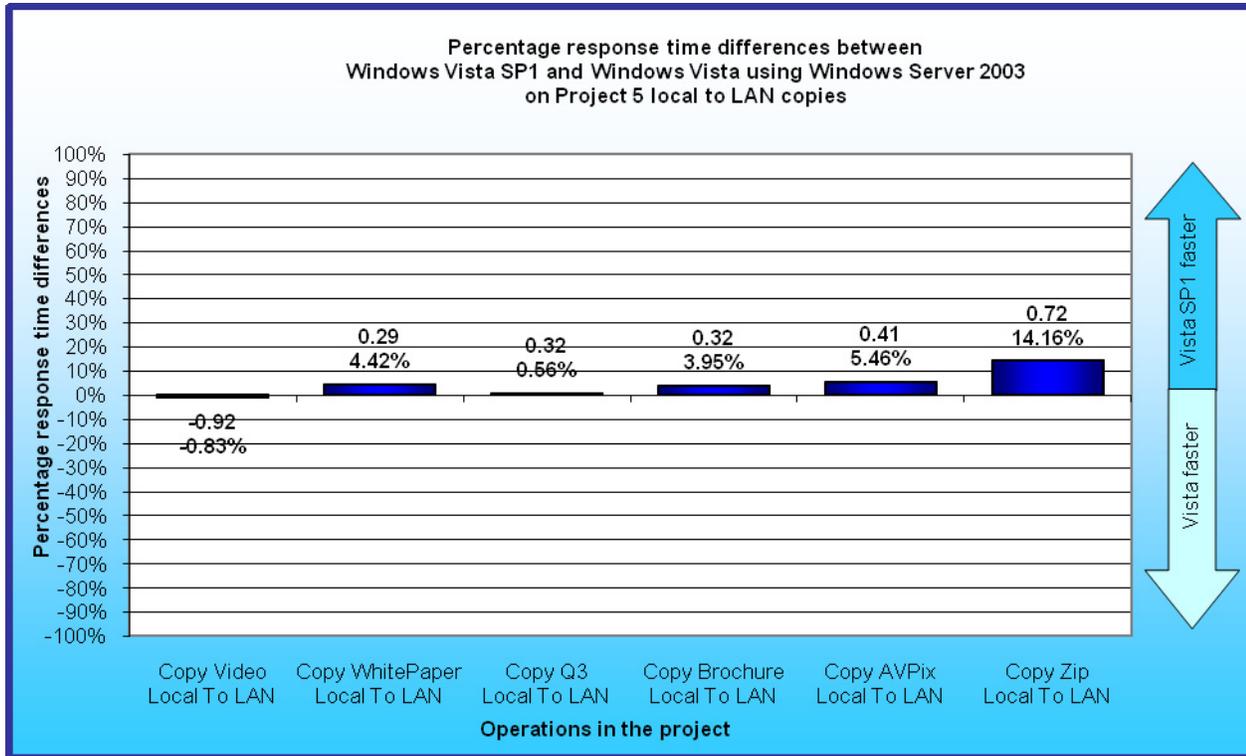


Figure 11: Percentage response time improvements of Vista SP1 over Vista on a variety of file operations in Project 5 on four systems when connected to servers running Windows Server 2003. Numbers greater than zero indicate Vista SP1 was more responsive.

Project results for the comparisons of Vista SP1 and Vista when we tested with Windows Server 2008

The figures in this section show the results for each of the five projects for the comparisons of Vista SP1 and Vista when we tested with Windows Server 2008. The range for the y-axis that displays the percentage response time difference varies from graph to graph based on the range of the results displayed in each graph. In each figure, the operations appear in the order in which they occurred in the projects.

Figure 12 compares the performance of Vista SP1 and Vista for the LAN-to-local file copy tasks in Project 1 when using Windows Server 2008 as the server OS. Vista SP1 showed response time improvements on all five tasks in this project. Vista SP1 times were from just over 1 second to over 30 seconds faster and from 15.5 percent to 23.4 percent faster than Vista times.

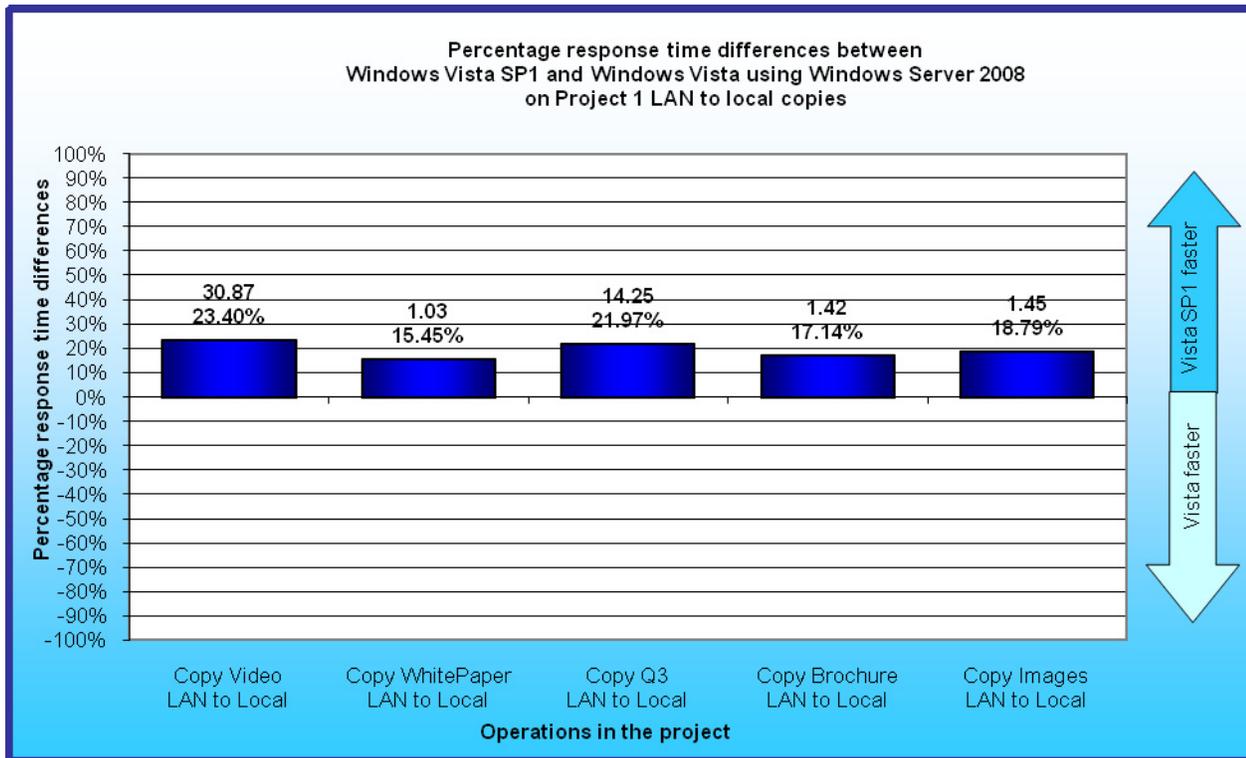


Figure 12: Percentage response time improvements of Vista SP1 over Vista on a variety of file operations in Project 1 on four systems when connected to servers running Windows Server 2008. Numbers greater than zero indicate Vista SP1 was more responsive.

Figure 13 compares the performance of Vista SP1 and Vista for the local-to-WAN file copy tasks in Project 2 when using Windows Server 2008 as the server OS. Vista SP1 led on all the tasks in this project, with wins ranging from 7 seconds on the zip copy task to over 63 seconds on the copy Q3 local-to-WAN task. Vista SP1 was from 35.8 percent to 55.9 percent faster than Windows Vista on the projects tasks.

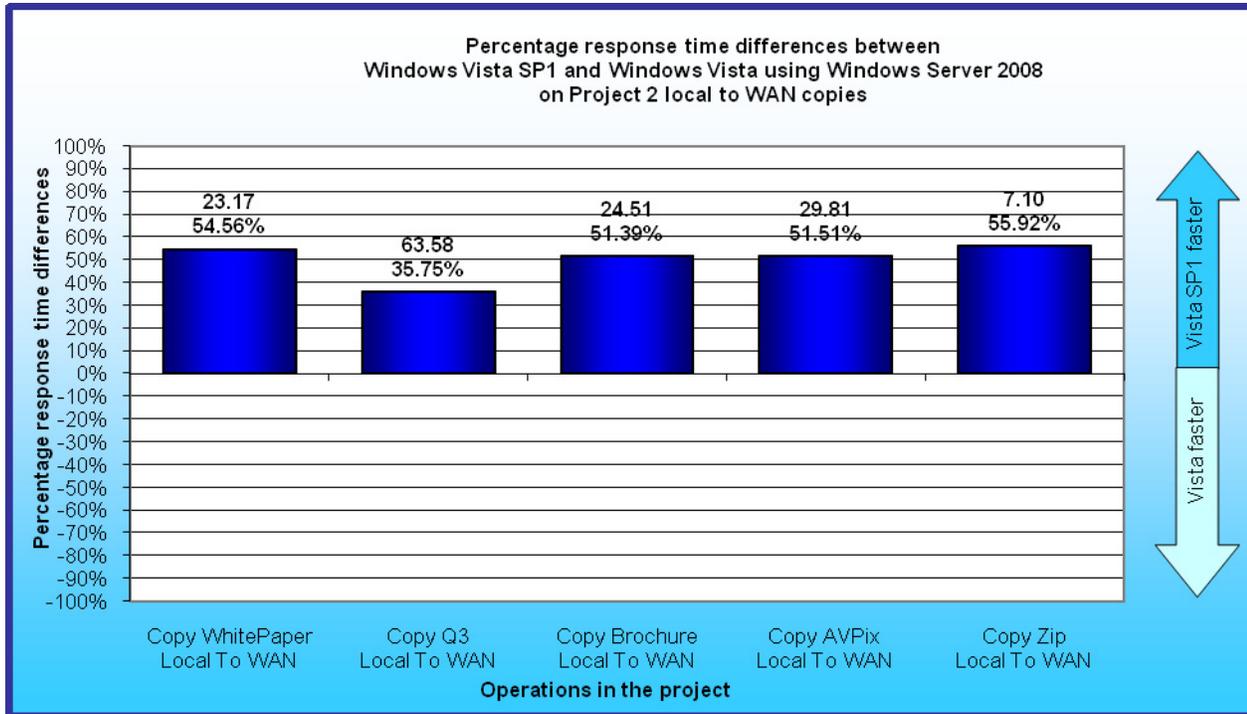


Figure 13: Average response time improvements of Vista SP1 over Vista on a variety of file operations in Project 2 on four systems when connected to servers running Windows Server 2008. Numbers greater than zero indicate Vista SP1 was more responsive.

Figure 14 compares the performance of Vista SP1 and Vista for the WAN-to-local file copy tasks in Project 3 when using Windows Server 2008 as the server OS. Vista SP1 provided faster response time on all tasks in this project, with wins ranging from 4 seconds on the zip folder copy task to over 110 seconds on the Q3 folder copy task. The Vista SP1 times were from 30.1 percent to 63 percent faster than the Vista times on the tasks of this project.

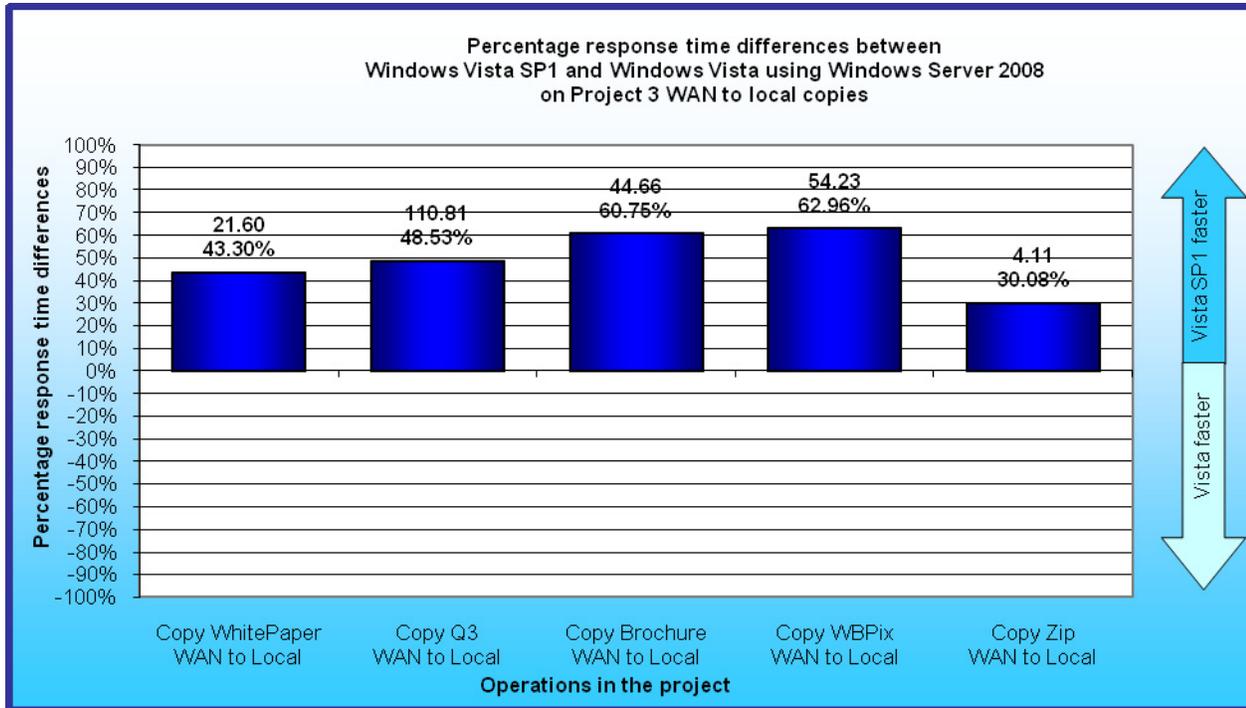


Figure 14: Percentage response time improvements of Vista SP1 over Vista on a variety of file operations in Project 3 on four systems when connected to servers running Windows Server 2008. Numbers greater than zero indicate Vista SP1 was more responsive.

Figure 15 compares the performance of Vista SP1 and Vista for the local-to-local file copy tasks in Project 4 when using Windows Server 2008 as the server OS. Vista led on two of the tasks in this project, by 12.8 seconds (18.7 percent) on the video copy task and by 3.8 seconds (10.5 percent) on the Q3 folder copy task. Vista SP1 led on the other two tasks, by 0.74 seconds (11.68 percent) on the brochure copy task and by 0.45 seconds (7.84 percent) on the AVPix copy task.

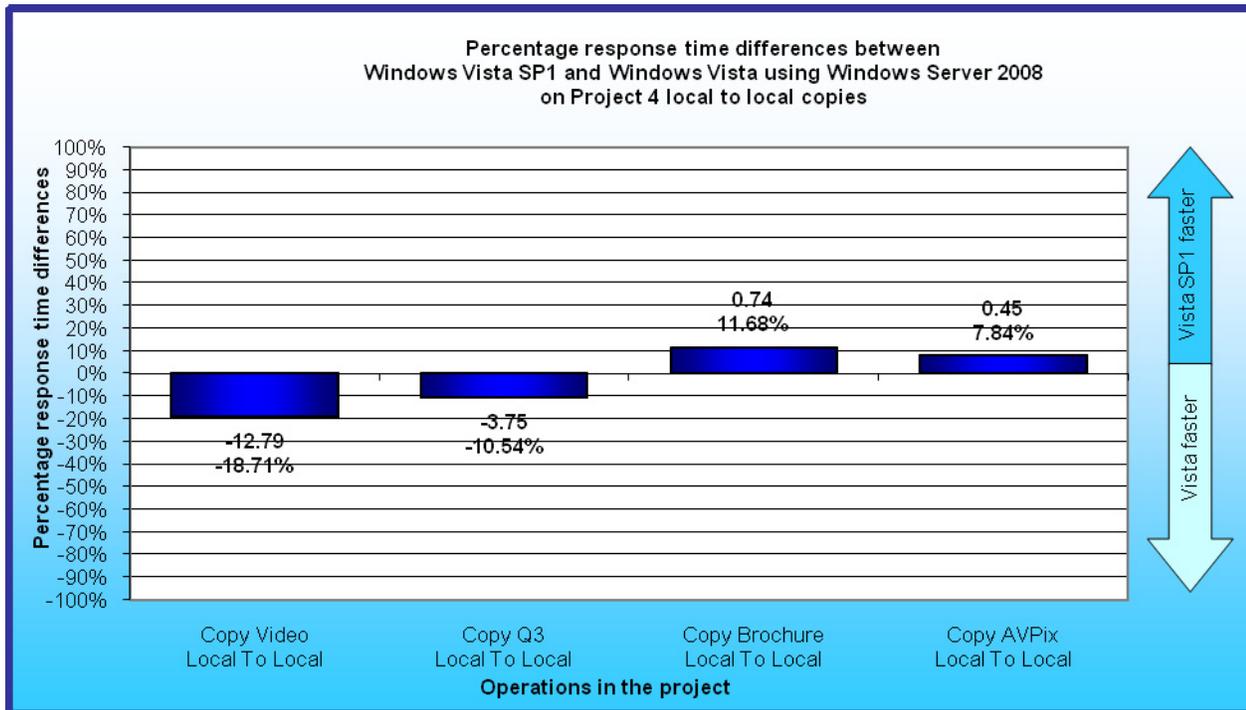


Figure 15: Percentage response time improvements of Vista SP1 over Vista on a variety of file operations in Project 4 on four systems when connected to servers running Windows Server 2008. Numbers greater than zero indicate Vista SP1 was more responsive.

Figure 16 compares the performance of Vista SP1 and Vista for the local-to-LAN file copy tasks in Project 5 when using Windows Server 2008 as the server OS. All of the differences in this project, on which Vista was faster on 5 of the 6 tasks, were under or just over a second, amounts so small that we do not expect that they would be noticeable to users.

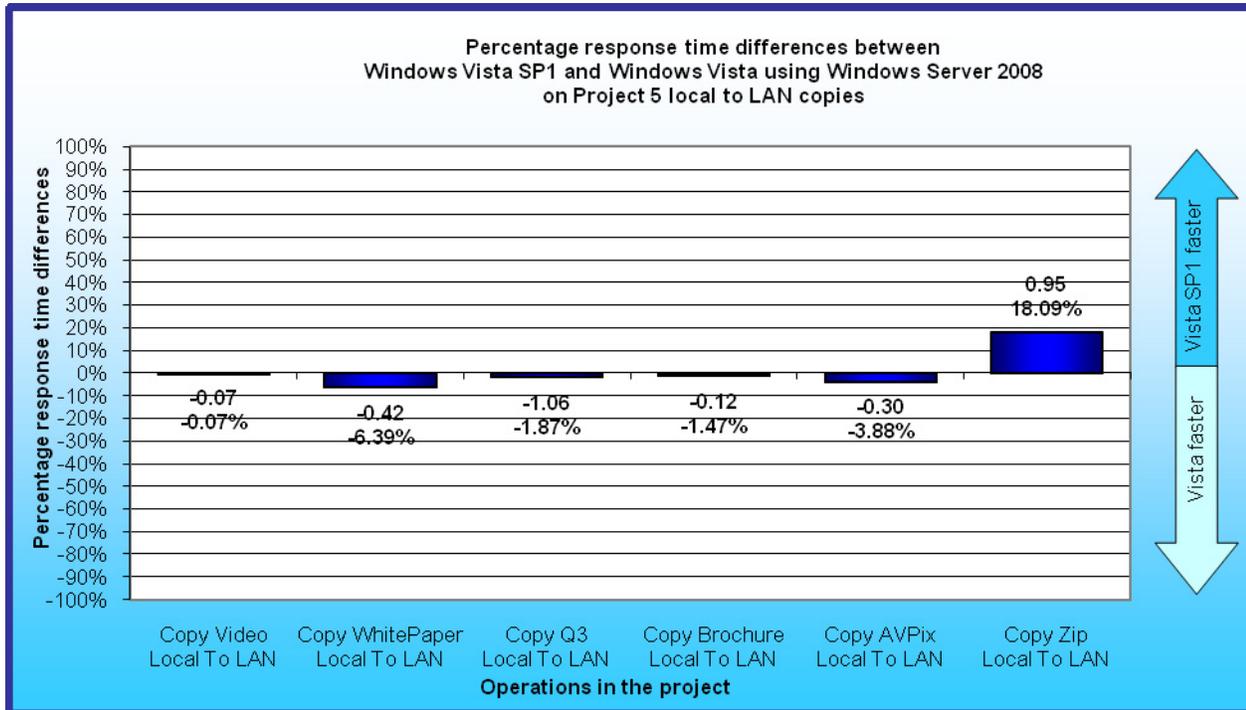


Figure 16: Percentage response time improvements of Vista SP1 over Vista on a variety of file operations in Project 5 on four systems when connected to servers running Windows Server 2008. Numbers greater than zero indicate Vista SP1 was more responsive.

Project results for the comparisons of Windows Server 2003 and Windows Server 2008 when we tested with Vista SP1

Figures in this section show the results for the four projects that copy data to or from the server. The range for the y-axis that displays the percentage response time difference varies from graph to graph based on the range of the results displayed in each graph.

Figure 17 compares the performance of Windows Server 2003 and Windows Server 2008 for the LAN-to-local file copy tasks in Project 1 when using Vista SP1 as the client OS. Windows Server 2008 was faster on all five tasks in this project. We expect that response time differences of less than 1 second would not be noticeable to users. Windows Server 2008 exceeded that cutoff on two tasks, showing a 6.6 second difference on the video copy task and a 1.6 second difference on the Q3 folder copy task. The percentage differences were small, from 1.6 percent to 5.1 percent.

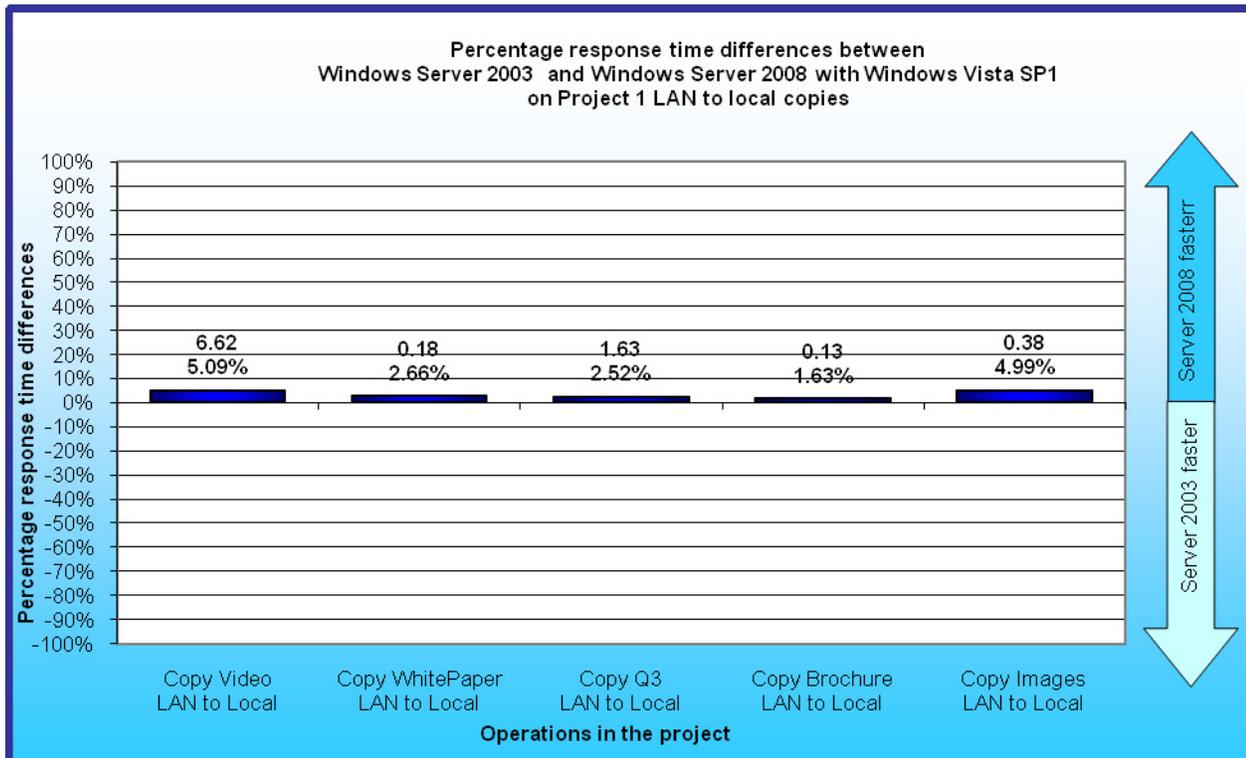


Figure 17: Percentage response time differences between Windows Server 2008 and Windows Server 2003 on a variety of file copy operations in Project 1 on four Vista SP1 systems. Project 1 operations copy files from the LAN server to the local drive.

Figure 18 compares the performance of Windows Server 2003 and Windows Server 2008 for the local-to-WAN file copy tasks in Project 2 when using Vista SP1 as the client OS. Windows Server 2008 showed dramatic performance differences over Windows Server 2003 on all of the tasks in this project, turning in times that ranged from 29 seconds to over 817 seconds faster on the tasks in this project and beating the Windows Server 2003 times by from 62.1 percent to 85.3 percent.

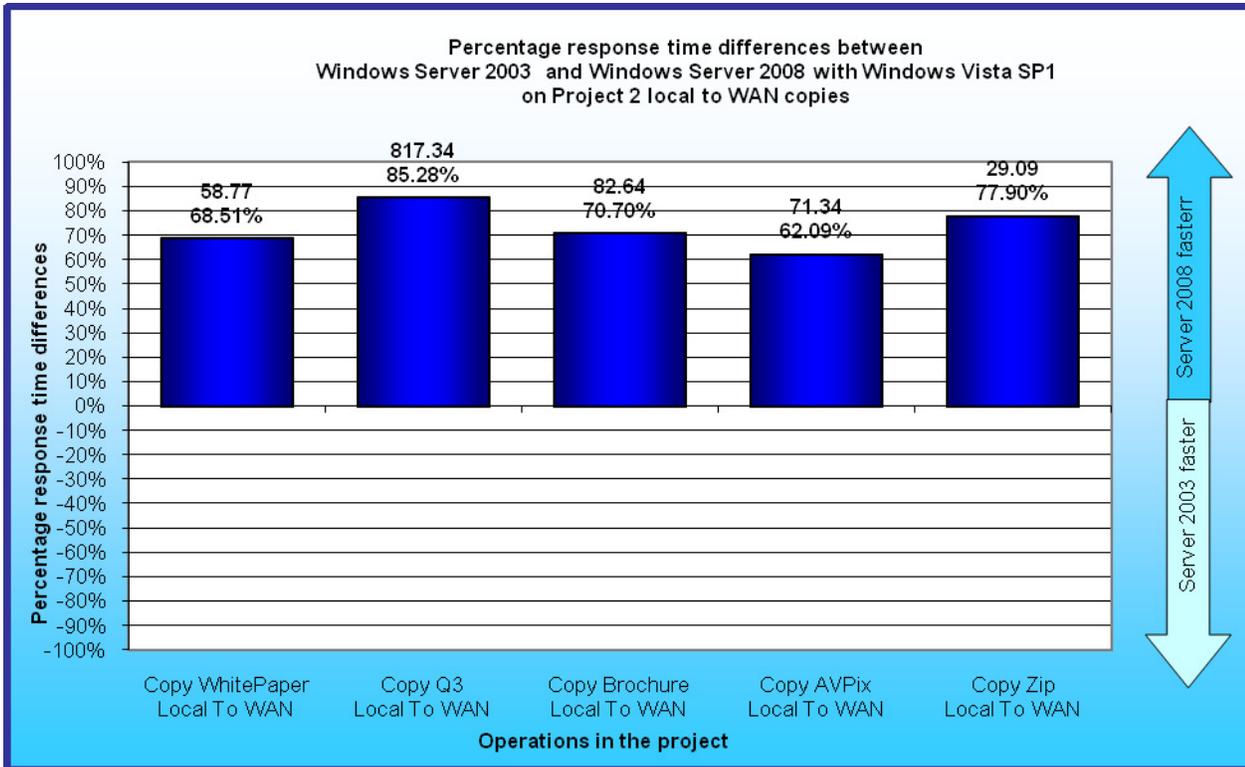


Figure 18: Percentage response time differences between Windows Server 2008 and Windows Server 2003 on a variety of file copy operations in Project 2 on four Vista SP1 systems. Project 2 operations copy files from the local drive to the WAN server.

Figure 19 compares the performance of Windows Server 2003 and Windows Server 2008 for the WAN-to-local file copy tasks in Project 3 when using Vista SP1 as the client OS. Windows Server 2008 demonstrated dramatic performance differences over Windows Server 2003 on all of the tasks in this project, turning in times that ranged from 8.5 seconds to 367.8 seconds faster on the tasks in this project. Windows Server 2008 scores were from 38.5 percent to 163.5 percent faster than the Windows Server 2003 times on the tasks in this project.

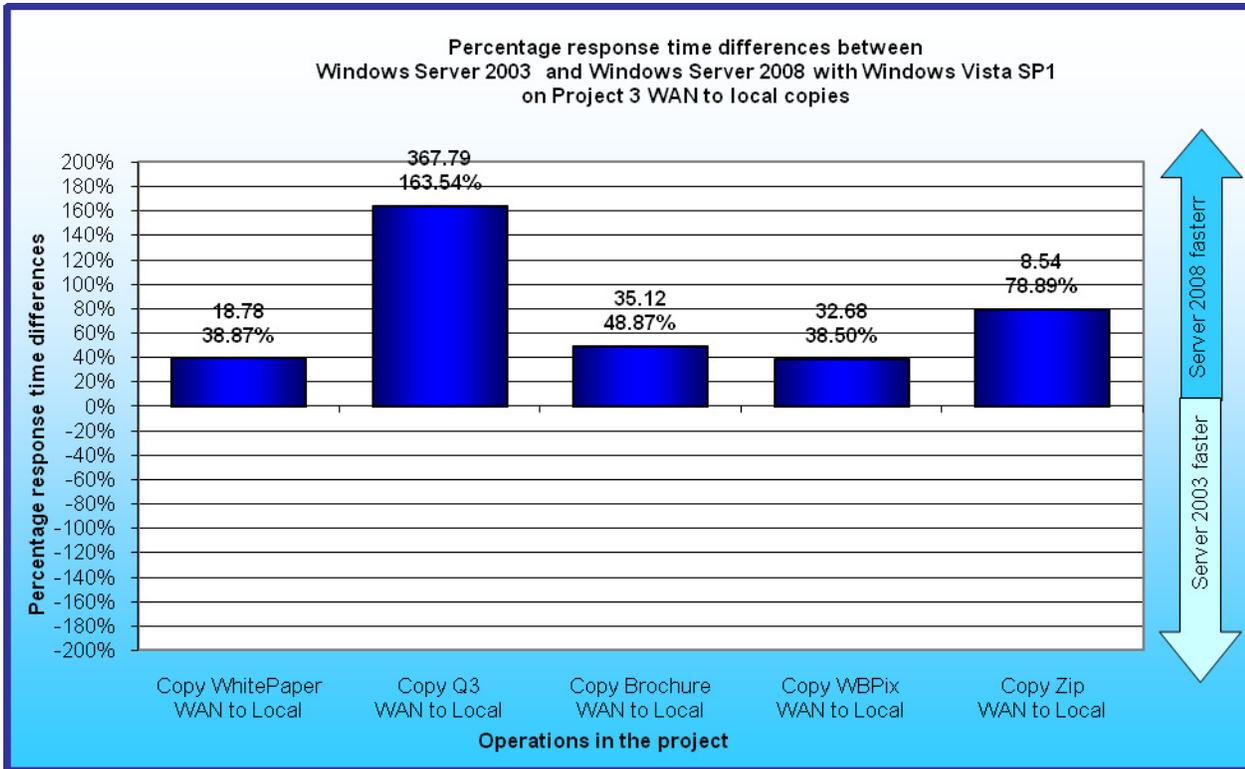


Figure 19: Percentage response time differences between Windows Server 2008 and Windows Server 2003 on a variety of file copy operations in Project 3 on four Vista SP1 systems. Project 3 operations copy files from the WAN server to the local drive.

Figure 20 compares the performance of Windows Server 2003 and Windows Server 2008 for the tasks in Project 5 when using Vista SP1 as the client OS. Only two of the wins in this project were greater than 1 second, our cutoff for wins that would be noticeable to users. These two wins, one each for Windows Server 2003 and Windows Server 2008 were both under 1.5 seconds and under 3 percent of the Windows Server 2003 task time.

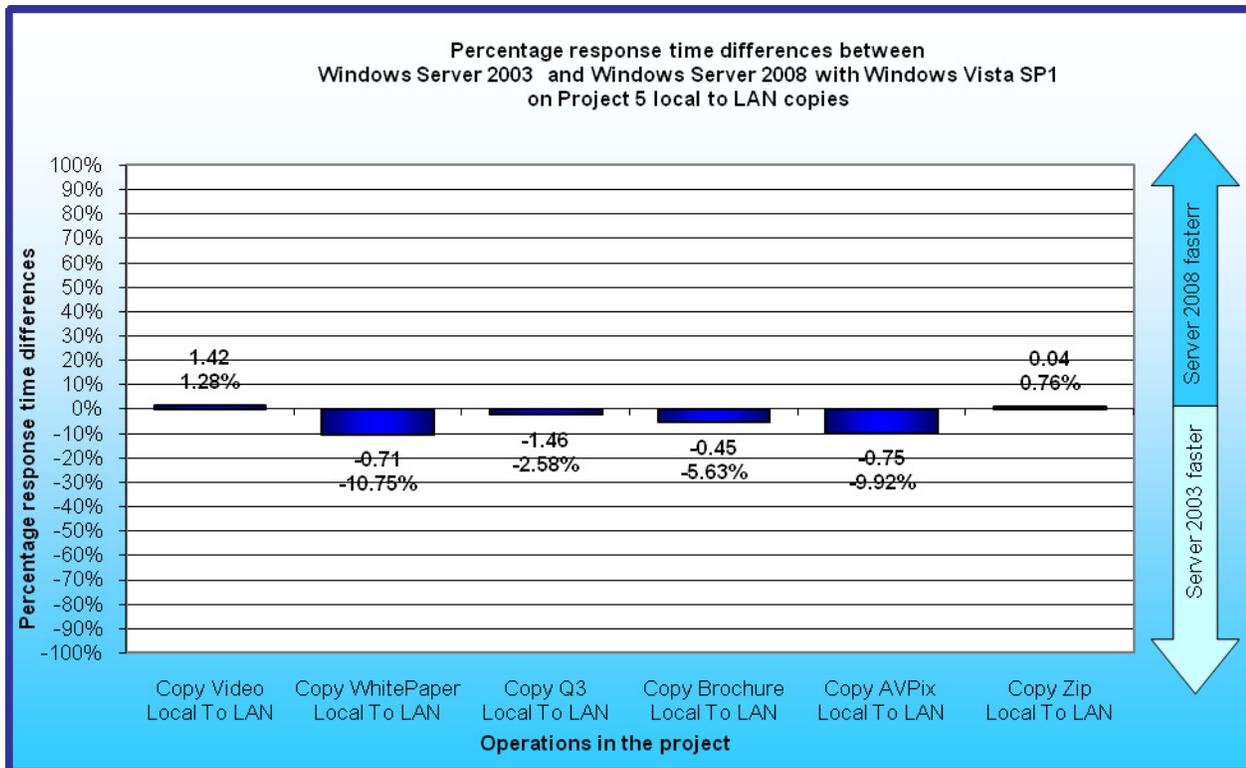


Figure 20: Percentage response time improvements of Vista SP1 over Vista on a variety of file operations in Project 5 on four systems when connected to servers running Windows Server 2008. Numbers greater than zero indicate Windows Server 2008 was more responsive.

Scenario descriptions

The file operations scenario covers part of the day of Bob, the head of Sales and Marketing at Acme Ventures, a company that makes network hardware and provides network services, including installation and testing. Acme Ventures has recently acquired a small company, WileyBeep, located across the country. Bob is planning an upcoming training meeting at the WileyBeep headquarters. He has set aside most of a day to work on the training materials and to update related collateral including a company brochure and a white paper. None of the materials are in final form, most need to be rebranded with the Acme Ventures logo, and others need more extensive edits by both Bob and Ian, his co-presenter from WileyBeep.

This scenario models Bob's copy and paste operations as he copies files for his presentation between the Acme Ventures server and his local directory via the LAN, between the local directory and the WileyBeep server via the WAN, and from one local directory to another. The scenario comprises five projects:

- **Project 1: Bob copies files from the LAN server to his local drive.** Bob starts the day by locating the source files he needs on the Acme Ventures server and copying them into a working directory on his local drive.

- **Project 2: Bob copies files from his local drive to the WAN server.** During the day, he copies many of the files and folders from Project 1 and a local zip folder into a folder on the WileyBeep server that he accesses via that WAN.
- **Project 3: Bob copies files from the WAN server to his local working directory.** Ian then edits the files in this folder and adds other files, including a folder of WileyBeep staff pictures, to the folder that Bob needs. Bob copies down the updated versions of the same files and folders from Project 2 (excluding the Acme Ventures picture folder) to his local working directory.
- **Project 4: Bob copies files between two folders on his local drive.** At the end of the day, Bob copies the edited versions of the same files and folders from Project 3 (excluding the two smallest folders) back to another directory on his local system where he is collecting all presentation files.
- **Project 5: Bob copy files from his local drive to the LAN server.** At the end of the day, Bob copies the edited versions of the same files and folders from Project 4 back to a folder on the Acme Ventures server via the LAN.

Note: The scenario focuses on the file copy and paste operations that Bob executes during a day. Scenario descriptions mention additional tasks such as the edits Bob makes to files and Ian’s edit and copy tasks. Because these tasks fall outside the scope of this study of copy and paste operations, we treat these tasks as occurring “off-camera” and neither test nor give instructions for them. We switch to a different folder of files for the copy to and paste from tasks. The folder contents are alike but the names are different.

Each of these projects involves a number of file copy and paste operations. The results of the scenario will be times for each of these tasks.

The rest of this section describes each of Bob’s five projects. For each project, we include a brief summary of the story behind the project, a list of the applications he uses in the project, a description of the content we propose to use, and a list of tasks we will initially try to time.

Project 1: Bob copies files from the LAN server to his local drive

Story summary

Bob collects materials from locations on the Acme Ventures server, pulling them down to his local machine via the LAN.

Applications

- Windows Explorer

Content

Bob individually copies the following items from various locations on the Acme Ventures server via the LAN to a working folder on his local drive:

1. **Training video**—an approximately 1GB video that his staff created that demonstrates installing and configuring Acme Ventures’ newest model network card. He wants WileyBeep staff to develop a library of similar videos and later place them on YouTube.
2. **Research white paper PowerPoint**—an approximately 35MB folder containing seven versions of two PowerPoint presentations ranging in size from approximately 2.3 MB to approximately 2.6 MB. These PowerPoint presentations demonstrate the customer focused research and analysis Bob is hoping WileyBeep staff will create for all products. Bob plans to display and discuss them in the training session, but he first needs to lightly edit them and rebrand them with the new Acme Ventures/WileyBeep logo and contact information.

3. **Q3 sales figures folder**—an approximately 540MB folder containing 35 Excel, Access, and PowerPoint files that Bob plans to use to create a Q4 sales report he has planned for the WileyBeep training session. Files range in size from a 455KB Excel spreadsheet to a 412MB Access database; with the exception of the Access database, they average approximately 3.7 MB.
4. **Acme Ventures brochure folder**—an approximately 50MB folder containing 11 versions of a Word document and an Adobe Acrobat PDF of that document. The PDF files range in size from approximately 90KB to approximately 850KB and the Word documents range from approximately 1.75 MB to approximately 5 MB.
5. **Acme Ventures product pictures folder**—an approximately 40MB folder containing 30 JPEG pictures of Acme Ventures products. The files range in size from approximately 110KB to approximately 2.25 MB. Bob wants to include product pictures in the Q4 sales presentation.

Instructions for project operations

Bob uses the following procedure to make his copies:

1. He opens a copy of Windows Explorer and browses to his working folder. We open Windows explore with an exec command within the script.
2. For each copy, Bob uses the following procedure:
 - o Bob opens Windows Explorer to the parent folder and highlights the source file or folder.
 - o He presses Ctrl-C to copy the File or Folder.
 - o He clicks on the copy of Windows Explorer that is open to the destination folder.
 - o He presses Ctrl-V to paste the file into that folder. We time the paste operation.

Project 2: Bob copies files from his local drive to the WAN server

Story summary

During the day, Bob and Ian pass their edit passes on the Acme Ventures brochure and the training session outline back and forth over the WAN. At the beginning of the day, Bob copies some of the same files he copied to his local working directory in Project 1 to Ian's working directory on the WAN server. He also copies a zip folder of report templates that he wants to share with the WileyBeep office.

Applications

- Windows Explorer

Content

Bob copies the following files and folders:

1. **Research white paper PowerPoint**—an approximately 35MB folder containing 14 PowerPoint files ranging in size from 2.3 MB to 2.6 MB
2. **Q3 sales figures folder**—an approximately 540MB folder containing 35 Excel, Access, and PowerPoint files
3. **Acme Ventures brochure folder**—an approximately 50MB folder containing 11 versions of Word document and an Adobe Acrobat PDF of that document
4. **Acme Ventures product pictures folder**—an approximately 40MB folder containing 30 JPEG pictures of Acme Ventures products
5. **Zipped folder**—an approximately 18MB zipped folder

Instructions for project operations

Bob uses the following procedure to make his copies:

1. He opens a copy of Windows Explorer which opens by default to his working folder.
2. For each copy, Bob uses the following procedure:
 - o Bob opens Windows Explorer to the parent folder and highlights the source file or folder.
 - o He presses Ctrl-C to copy the File or Folder.

- He clicks on the copy of Windows Explorer that is open to the destination folder on the remote machine.
- He presses Ctrl-V to paste the file into that folder. We time the paste operation.

Project 3: Bob copies files from the WAN server to his local working directory

Story summary

During the day, Bob and Ian pass their edit passes on the presentation materials back and forth over the WAN. After Ian finishes each edit pass, he puts edited files back into a working folder on the WileyBeep server and alerts Bob. Bob then copies each edited file or folder individually to his own local working directory via the WAN. Throughout the day, Ian also puts other materials into that directory that Bob needs.

Applications

- Windows Explorer

Content

During the course of the day, Bob pulls down the following files and folders that now include Ian's edits:

1. **Research white paper PowerPoint**—an approximately 35MB folder containing 14 PowerPoint files ranging in size from 2.3 MB to 2.6 MB
2. **Q3 sales figures folder**—an approximately 540MB folder containing 35 Excel, Access, and PowerPoint files
3. **Acme Ventures brochure folder**—an approximately 50MB folder containing 11 versions of Word document and an Adobe Acrobat PDF of that document
4. **WileyBeep product pictures folder**—an approximately 40MB folder containing 30 JPEG pictures of WileyBeep products. Ian assembled these pictures for Bob to use in the brochure.
5. **Zipped folder**—an approximately 18MB zipped folder

Instructions for project operations

Bob uses the following procedure to make his copies:

1. He opens a copy of Windows Explorer which opens by default to his working folder.
2. For each copy, Bob uses the following procedure:
 - Bob opens Windows Explorer to the parent folder and highlights the source file or folder on the remote machine.
 - He presses Ctrl-C to copy the File or Folder.
 - He clicks on the copy of Windows Explorer that is open to the destination folder on the local machine.
 - He presses Ctrl-V to paste the file into that folder. We time the paste operation.

Project 4: Bob copies files between two folders on his local drive

Story summary

Bob makes another edit pass through each of the documents he gets back from Ian and saves them to his working directory. As he finishes each file, he copies it from that working directory to another local directory where he is saving the latest version of each presentation file.

Applications

- Windows Explorer

Content

During the course of the day, Bob copies the following files and folders from the one local directory to the other:

1. **Training video**—an approximately 1GB video

2. **Q3 sales figures folder**—an approximately 540MB folder containing 35 Excel, Access, and PowerPoint files
3. **Acme Ventures brochure folder**—an approximately 50MB folder containing 11 versions of Word document and an Adobe Acrobat PDF of that document
4. **WileyBeep product pictures folder**—an approximately 40MB folder containing 30 JPEG pictures of Acme Ventures products

Instructions for project operations

Bob uses the following procedure to make his copies:

1. He opens a copy of Windows Explorer and browses to his working folder.
2. For each copy, Bob uses the following procedure:
 - o Bob opens Windows Explorer to the parent folder and highlights the source file or folder.
 - o He presses Ctrl-C to copy the File or Folder.
 - o He clicks on the copy of Windows Explorer that is open to the destination folder.
 - o He presses Ctrl-V to paste the file into that folder. We time the paste operation.

Project 5: Bob copy files from his local drive to the LAN server

Story summary

When Bob and Ian finish working with each file or folder, Bob copies them from his local directory to the Acme Ventures server via the LAN.

Applications

Windows Explorer

Content

Bob individually copies the following files and folders from his local drive via the LAN to the Acme Ventures server:

1. **Training video**—an approximately 1GB video
2. **Research white paper PowerPoint**—an approximately 35MB folder containing 14 PowerPoint files ranging in size from 2.3 MB to 2.6 MB
3. **Q3 sales figures folder**—an approximately 540MB folder containing 35 Excel, Access, and PowerPoint files
4. **Acme Ventures brochure folder**—an approximately 50MB folder containing 11 versions of Word document and an Adobe Acrobat PDF of that document
5. **WileyBeep product pictures folder**—an approximately 40MB folder containing 30 JPEG pictures of Acme Ventures products
6. **Zipped folder**—an approximately 18MB zipped folder

Instructions for project operations

Bob uses the following procedure to make his copies:

1. He opens a copy of Windows Explorer and browses to his working folder.
2. For each copy, Bob uses the following procedure:
 - o Bob opens Windows Explorer to the parent folder and highlights the source file or folder on the local system.
 - o He presses Ctrl-C to copy the File or Folder.
 - o He clicks on the copy of Windows Explorer that is open to the destination folder on the Acme Ventures server over the LAN.
 - o He presses Ctrl-V to paste the file into that folder. We time the paste operation.

Test methodology

PT developed the scenarios and the test script we used for this evaluation. The script uses ScenCap to execute a variety of common operations and runs on both versions of Vista. ScenCap is a Microsoft-developed application that uses the Windows accessibility interfaces to create and replay scenarios containing user actions. ScenCap also lets developers mark the start and end times of functions it performs.

Software this test requires

This test requires licensed copies of Vista OS for the clients and a Windows Server OS for the servers. We used the following OS versions:

- Microsoft Windows Server 2003 R2 Enterprise Edition
- Windows Server 2008 RTM Enterprise (Build 6001.080118-1840)
- Windows Vista Ultimate Version 6.0, build 6000
- Windows Vista Ultimate version 6.0, build 6001, Service Pack 1, build 17128

In our tests, we used Symantec Norton Ghost 2003 to create sector-by-sector disk images of the systems after we had installed the OS. We created one image for Vista and one for Vista SP1 for each test system. Before testing, we used Norton Ghost 2003 to restore the appropriate image to the hard drive on the test system.

We installed and ran a licensed copy of Shunra VE Desktop v2.6 Build 1060.001 on the WAN servers and used it to add 100ms round trip latency to the 100Mb/s network in order to simulate WAN conditions.

Hardware this test requires

All test systems must meet Microsoft's Windows Vista Ready requirements (Source: <http://www.microsoft.com/windows/products/windowsvista/buyorupgrade/capable.mspx>). In addition, each must have a network adapter and a valid network path to the LAN and WAN servers. We recommend that all machines under test have the latest available drivers for their particular hardware configuration.

Each test bed also requires two identically configured servers and a network switch. We connected the servers and test systems with a NETGEAR ProSafe 16 Port 10/100 Switch (FS116) via an Ethernet adapter.

Setting up the test servers

For the Windows Server 2003 test bed, we began by installing a fresh copy of Microsoft Windows Server 2003 R2 Enterprise Edition, Service Pack 2 on each server as follows:

1. We used the default BIOS settings on all servers.
2. Assign a computer name of WANSERVER or LANSERVER.
3. Enter a password1 for the administrator logon.
4. Select Eastern Time Zone.
5. Use typical settings for the Network installation.
6. Use "workgroup" for the workgroup.
7. Connect the servers to the NETGEAR ProSafe 16 Port 10/100 Switch (FS116) via an Ethernet adapter.
8. Set the IP address to 192.168.168.11 for WANSERVER and 192.168.168.10 for LANSERVER.

Use the following process to install Shunra VE Desktop on the WAN server for the Windows Server 2003 test bed:

1. Download the Shunra VE Desktop Installation folder to the Desktop.
2. Install Shunra VE Desktop:
 - a. Open the Shunra VE Desktop installation folder.
 - b. Open the Standard Edition (full version) folder.
 - c. Open the VEDesktop folder.
 - d. Double-click the VE-Desktop_Setup.exe file.

- e. At the Welcome to the InstallShield Wizard dialog box, click Next.
- f. At the License Agreement dialog box, click Yes.
- g. At the Shunra VE Desktop Client v2.6 Readme dialog box, click Next.
- h. At the Choose Destination Location dialog box, click Next.
- i. At the InstallShield Wizard Complete dialog box, click the radio button next to Yes, I want to restart my computer now and click Finish.

We applied updates from the Microsoft Windows Update site. Appendix C lists the updates.

For the Windows Server 2008 test bed, we began by installing a fresh copy of Microsoft Windows Server 2008 RTM Enterprise (Build 6001.080118-1840) on each server as follows:

1. Assign a computer name of WANSERVER or LANSERVER.
2. Enter a password1 for the administrator logon.
3. Select Eastern Time Zone.
4. Use typical settings for the Network installation.
5. Use “workgroup” for the workgroup.
6. Connect the servers to the NETGEAR ProSafe 16 Port 10/100 Switch (FS116) via an Ethernet adapter.
7. Set the IP address to 192.168.168.11 for WANSERVER and 192.168.168.10 for LANSERVER.

Use the following process to install Shunra VE Desktop on the WAN server for the Windows Server 2008 test bed:

1. Download the Shunra VE Desktop Installation folder to the Desktop.
2. Install Shunra VE Desktop:
 - a. Open the Shunra VE Desktop installation folder.
 - b. Open the Standard Edition (full version) folder.
 - c. Open the VEDesktop folder.
 - d. Double-click the VE-Desktop_Setup.exe file.
 - e. At the Welcome to the InstallShield Wizard dialog box, click Next.
 - f. At the License Agreement dialog box, click Yes.
 - g. At the Shunra VE Desktop Client v2.6 Readme dialog box, click Next.
 - h. At the Choose Destination Location dialog box, click Next.
 - i. At the InstallShield Wizard Complete dialog box, click the radio button next to Yes, I want to restart my computer now and click Finish.

Setting up a system for test using these scripts

To get the most accurate and repeatable results possible, you must set up all test systems carefully, starting with a clean hard disk. Each test system must be able to access the Internet during setup so it can download software updates.

Installing Microsoft Windows Vista Ultimate

Use the following process to install a clean version of Windows Vista Ultimate with updated drivers and Windows Updates on each system under test:

1. Install Windows Vista Ultimate Build 6000.
 - a. Boot to a Windows Vista Ultimate Build 6000 DVD.
 - b. When prompted to press any key to boot from CD or DVD, press any key.
 - c. At the language and preference screen, accept the default options, and click Next.
 - d. Click Install now.
 - e. Do not enter a Product key. Uncheck Automatically activate Windows when I'm online, and click Next.
 - f. At the Do you want to enter your product key now screen, click No.
 - g. Select Windows Vista Ultimate, and check I have selected the edition of Windows that I purchased. Click Next.

- h. Check I accept the license terms, and click Next.
 - i. Select Custom (advanced) at the Which type of installation do you want screen.
 - j. Click Drive options (advanced).
 - k. Select the Disk you want to install Windows Vista Ultimate on, and click Format.
 - l. At the All data stored will be permanently deleted dialog, click OK.
 - m. Once the system finishes formatting the disk, click Next.
 - n. Leave the password blank. Type `USER` in the Username field, and click Next.
 - o. Type a computer name, and click Next.
 - p. Click Use recommended settings.
 - q. Select the correct Time zone, date, and time, and click Next.
 - r. At the Select your computer's current location screen, click Public location.
 - s. Click Start at the Thank you screen.
 - t. When the Windows Vista installation completes, close the Welcome Center Dialog.
 - u. At the Set network location screen, click Public location, and click Close.
2. Disable Hide extensions for known file types and set up folders.
 - a. On the desktop, click Start, Computer.
 - b. Select Organize→Folder and Search Options.
 - c. Select the View tab.
 - d. Uncheck Hide extensions for known file types.
 - e. Uncheck Use check boxes to select if it is not already unchecked.
 - f. Check Show hidden files and folders.
 - g. Click OK.
 - h. Select Organize→Layout→Menu Bar. (Note: When you finish, the Menu Bar should appear on the folder view.)
 - i. In the address bar, type `C:\` and press Enter.
 - j. The script will not run if the Folder view is collapsed in the lower left-hand pane. If it is collapsed, click the up arrow to reopen the Folder view.
3. Close the Explorer window.
4. Change the Power Options.
 - a. Click Start→Control Panel.
 - b. Click Hardware and Sound.
 - c. Click Power Options.
 - d. Under Preferred plans, High Performance, click Change plan settings.
 - e. Verify that Turn off the display and Put the computer to sleep options are set to Never. Note: If you make changes to these settings, click Save changes, and then click Change plan settings under High Performance.
 - f. Click Change advanced power settings.
 - g. Click the plus (+) sign next to Additional settings. Change the Require a password on wakeup setting to No. If the machine is a laptop, change this setting to No for both On battery and Plugged in.
 - h. Click OK.
 - i. Click File→Close to exit the Edit Plan Settings dialog.
5. Verify that Windows Aero is the default color scheme.
 - a. Right-click the desktop and select Personalize.
 - b. Click Window Color and Appearance.
 - c. If an Appearance Settings dialog with a Color scheme drop-down appears, select Windows Aero from the Color Scheme drop-down list, and press OK. If instead a Windows Color and Appearance dialog displays, then Windows Aero is already the default Color Scheme.
6. Turn off Windows Security Center Pop-up Alerts. Doing so prevents such alerts from occurring during testing and affecting results.
 - a. Open the system Control Panel.
 - b. Double-click Security Center.
 - c. Click Change the way Security Center Alerts me on the left.
 - d. Uncheck Firewall, Automatic Updates, and Virus Protection.
 - e. Click OK.
 - f. Close the Security Center main page.

7. Verify that Windows Automatic Updates are off. Turning off Windows Automatic Updates prevents such updates from occurring during testing and affecting results. (We would have preferred to set the updates to occur at a far future date, but we are not aware of an option for doing so.)
 - a. Click Start.
 - b. Right-click My Computer, and select Properties.
 - c. Select the Automatic Updates tab.
8. Change the IP address to 192.168.168.31 (mask 255.255.255.0)
 - a. Open Control Panel.
 - b. Open Network and Sharing Center.
 - c. Click on Manage network connections.
 - d. Right-click Local area connection and select Properties.
 - e. At the security dialog, select Continue.
 - f. Select Internet Protocol Version 4 and select Properties.
 - g. Enter 192.168.168.31 for the IP address and 255.255.255.0 for the subnet mask.
 - h. Click OK, and exit the network settings.
9. Add the servers to the hosts file.
 - a. Click Start→All Programs→Accessories. Right-click Notepad→Select Run as Administrator to open Notepad as Administrator.
 - b. Click File→Open and enter C:\windows\system32\drivers\etc\hosts.
 - c. At the bottom of the list of hosts, add the following on separate lines:


```
192.168.168.10 lanserver
192.168.168.11 wanserver
```
 - d. Close Notepad, and click Yes to save changes.

Installing Microsoft Windows Vista Ultimate Service Pack 1

Use the following process to apply Windows Vista Critical and Recommended Updates and driver updates and then install Windows Vista Ultimate Service Pack 1 on the Vista Image:

1. Install all Windows Vista Critical and Recommended Updates and driver updates from the Microsoft Updates site.
2. Install available driver updates from vendor Web sites.
3. Install Windows Vista SP1
 - a. Insert the Windows Vista Service Pack 1 update DVD.
 - b. In Computer\DVD Drive (D:), double-click the Windows 6.0-KB936330-X86 executable file.
 - c. At the User Account Control dialog box, click Continue.
 - d. At the Install Windows Service Pack dialog box, click Next.
 - e. Check I accept the license terms, and click Next.
 - f. Close any open programs, and click Install. The installation will take up to 1 hour.
 - g. At the Installation was successful dialog box, click Finish.

Copying the code and content files to the system under test

1. Unzip the PTVistaXPPerf code and content file (PTVistaXPPerf.zip).
2. Copy the PTVistaXPPerf code and content folder (PTVistaXPPerf) to the C:\PTVistaXPPerf folder.
3. Create a share named SALES on the LANSERVER. Copy the contents of the LANSERVER folder to that share.
4. Create a share named SALES on the WANSERVER. Copy the contents of the WANSERVER folder to that share.

Installing PTVistaXPPerf on the system under test

Use the following process to install PTVistaXPPerf on the Windows Vista test systems:

1. The release files include three folders, one each for the test system and the LAN and WAN servers.
 - a. Copy the PTVistaXPPerf folder to the C: drive on the test system.
 - b. Copy the contents of the LANSERVER folder to the root of \\LANSERVER\sales (E:\sales).

- c. Copy the contents of the WANSERVER folder to the root of \\WANSERVER\sales (E:\sales)
2. Bring up a command-line interface, which you will use to perform the rest of this installation.
 - a. Click Start→All Programs→Accessories. Right-click Command Prompt→Select Run as Administrator to open the command-line interface window as Administrator.
3. Type `cd\PTVistaXPPerf`, and press Enter.
4. Type `setupfilecopy`, and press Enter.
5. The test script will now install on the system.

The setup script reboots the system as the final setup step.

Running the test script

Use the following process to get the test bed ready to run the test:

1. Use Norton Ghost 2003 to restore the appropriate image (either Windows Vista or Windows Vista SP1) to the hard drive on the test system.
2. Start both servers.
3. Verify that the network is correct (either Server 2003 or Server 2008).

Use the following process to run Shunra VE Desktop on the WAN server in order to create round trip latency of 100 ms.

1. Click Start→All Programs→Shunra VE Desktop Client→VE Desktop Client.
2. Right-click the Shunra VE Desktop icon in the System Tray, and click Open.
3. Set the sliding Latency button to Low.
4. Click Play.

Use the following process to run the test script on the Windows Vista test systems:

1. Reboot the system.
2. Bring up a command-line interface, which you will use to run the script.
 - a. Click Start→All Programs→Accessories. Right-click Command Prompt→Select Run as Administrator to open the command-line interface window as Administrator.
3. Type `cd\PTVistaXPPerf`, and press Enter.
4. Type `run -p -results c:\results` (to set the directory in which the tool will place its results), and press Enter.
5. Click Start→All Programs→Accessories. Right-click Command Prompt→Select Run as Administrator to open the command-line interface window as Administrator.
6. To run the scenario type `run -i 1 -s 8 -ir 1 -nopurge 1 -wab 300 -scenariotype filecopy -label [MachineNameandOS]`, and press Enter. (This command runs the FileCopy Scenario a total of eight times: one run after rebooting, one run after return from standby, and one run immediately after the previous run. It waits 300 seconds after an initial reboot before starting, does not purge memory, and identifies the results files with MachineNameandOS.)
7. At the completion of the run, check the results in `c:\results`. Each set of results is in a separate subdirectory there. A `status.txt` file states whether the set of runs passed or failed. A log file gives information about the run, including an error message for failed sets of runs. The `IndividualRunCSV` folder includes a CSV file containing the results for the set of runs.

Appendix A—Test system configurations

This appendix includes a diagram of the test beds we set up for this testing and provides detailed configuration information about the client test systems and about the computers we used as LAN and WAN servers.

Test bed configurations

For testing, we built four identically configured servers and put two in each of two test beds. This allowed us to test two clients at the same time, one in each test bed. Figure 22 diagrams the Windows Server 2003 test bed. For each test, we ran with either Windows Server 2003 or Windows Server 2008 on both test bed servers and with Shunra VE Desktop on the WAN server. Figure 21 diagrams the Windows Server 2003 test bed and Figure 22 the Windows Server 2008 test bed.

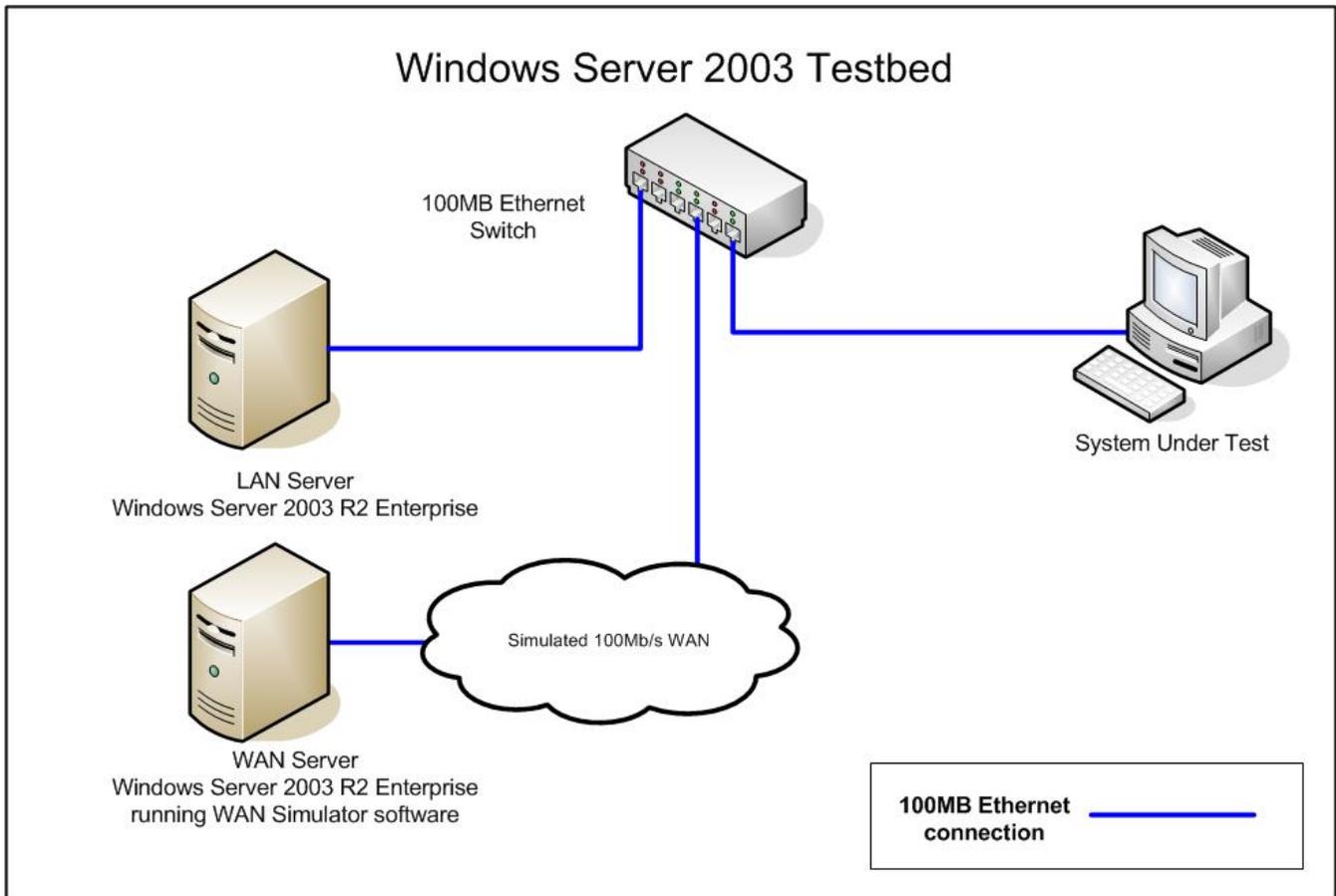


Figure 21: Windows Server 2003 test bed diagram.

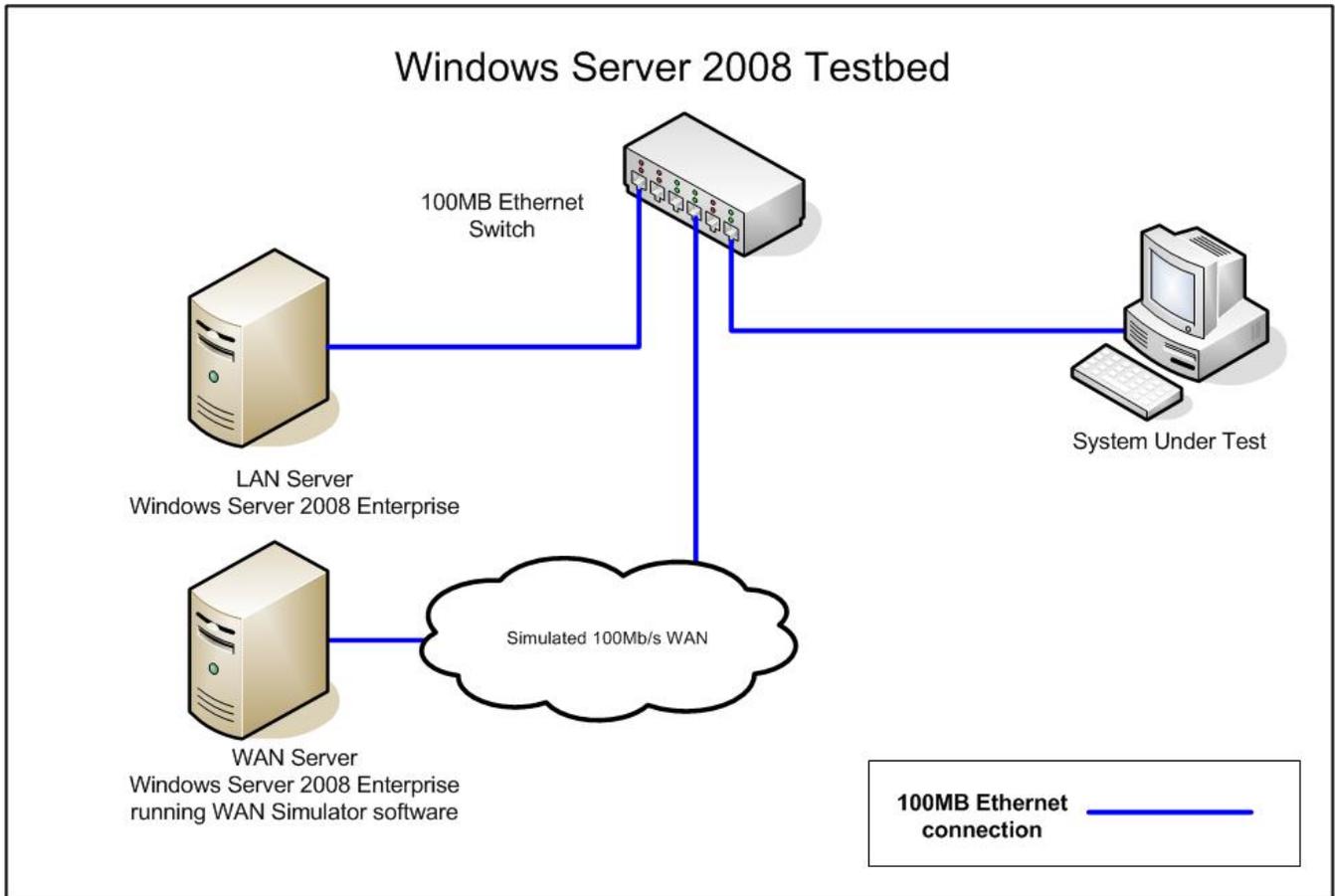


Figure 22: Windows Server 2008 test bed diagram.

Test client system configurations

Figure 23 provides detailed configuration information about each of the test systems, which we list in alphabetical order.

System	Dell XPS M170	Dell XPS 600	HP d4100e	Toshiba Tecra M4
General				
Processor and OS kernel: (physical, core, logical)/(UP, MP)	1P1C1L / UP	1P2C2L / MP	1P2C2L / MP	1P1C1L / UP
Number of physical processors	1	1	1	1
Single/dual-Core processors	Single	Dual	Dual	Single
Processor HT Status	NA	NA	NA	NA
System Power Management Policy	High performance	High performance	High performance	High performance
Notebook processor power saving option	Enhanced Intel SpeedStep Technology	NA	NA	Enhanced Intel SpeedStep Technology
Notebook dimensions (Length x Width x Height)	15½" x 11½" x 2" (min) 12" (max)	NA	NA	13" x 11" x 1½" (min) 12" (max)
Notebook weight	8 lbs. 10 oz.	NA	NA	6 lbs. 2 oz.
CPU				
System type	Laptop	Desktop	Desktop	Tablet PC
Vendor	Intel	Intel	AMD	Intel
Name	Pentium M 760	Pentium D 940	Athlon 64 X2 3800+	Pentium M 740
Stepping	8	2	1	8
Socket type	mPGA-479M	LGA775	Socket 939	mPGA-479M
Core frequency (GHz)	2.0	3.2	2.0	1.73
Front-side bus frequency (MHz)	533	800	2,000 MHz HyperTransport Technology	533
L1 cache	32 KB + 32 KB	16 KB + 12 Kμops	64 KB + 64 KB per core	32 KB + 32 KB
L2 cache	2 MB	2 MB	512 KB per core	2 MB
Platform				
Vendor and model number	Dell XPS M170	Dell XPS 600	HP d4100e	Toshiba Tecra M4
Motherboard model number	Dell 0F8460	Dell OUH741	Asus Amberine A8AE-LE	Toshiba Portable PC
Motherboard chipset	Intel i915PM/GM	NVIDIA nForce4 SLi Intel Edition	ATI Radeon Xpress 200 (RS480)	Intel i915PM/GM
Motherboard revision number	03	A3	10	03
Motherboard serial number	8MV5S91	3YRJS91	MXG61802G4NA660	46053511H
BIOS name and version (Vista SP1)	Dell A05	Dell A11	Phoenix v3.15	Toshiba v2.03

System	Dell XPS M170	Dell XPS 600	HP d4100e	Toshiba Tecra M4
BIOS name and version (Vista)	Dell A05	Dell A11	Phoenix v3.14	Toshiba v2.03
BIOS settings	Default	Default	Default	Default
Memory module(s)				
Vendor and model number	Hyundai Electronics HYMP564S64BP6-C4	Samsung M3 78T2953CZ3-CE6	Infineon 64D64320HU5C	Hyundai Electronics HYMP564S64BP6-C4
Type	PC2-4200	PC2-5300	PC3200	PC4200
Speed (MHz)	533	667	400	533
Speed running in the system (MHz)	266	333	200	266
Timing/Latency (tCL-tRCD-tRP-tRASmin)	4-4-4-12	5-5-5-13	3-3-3-8	4-4-4-12
Size	1 GB	2 GB	1 GB	1 GB
Number of memory module(s)	2 x 512 MB	2 x 1 GB	2 x 512 MB	2 x 512 MB
Chip organization	Double-sided	Double-sided	Double-sided	Double-sided
Channel	Dual	Dual	Dual	Dual
Hard disk				
Vendor and model number	Fujitsu MHV2080AH	Seagate ST3160828AS	Seagate ST3160023AS	Toshiba MK4032GSX
Number of disks in system	1	1	1	1
Size	80 GB	160 GB	160 GB	40 GB
Buffer Size	8 MB	8 MB	8 MB	8 MB
RPM	5,400	7,200	7,200	5,400
Type	Ultra ATA	SATA 300 Mb/s	SATA 150 Mb/s	SATA 150 Mb/s
Controller	Intel 82801FBM (ICH6-M)	nForce4 MCP	ATI SB400	Intel 82801FBM (ICH6-M)
Driver (Vista SP1)	Microsoft 6.0.6001.17128	Microsoft 6.0.6001.17128	Microsoft 6.0.6001.17128	Microsoft 6.0.6001.17128
Driver (Vista)	Microsoft 6.0.6000.16387	Microsoft 6.0.6000.16386	Microsoft 6.0.6000.16386	Microsoft 6.0.6000.16387
Graphics				
Vendor and model number	NVIDIA GeForce Go 7800 GTX	NVIDIA GeForce 7800 GTX	NVIDIA GeForce 7300 LE	NVIDIA GeForce Go 6200 TE
Chipset	GeForce Go 7800 GTX	GeForce 7800 GTX	GeForce 7300 LE	GeForce Go 6200 TE
BIOS version	5.70.02.19.12	5.70.02.11.15	5.72.22.34.21	5.43.02.49.E2
Type	PCI-E	PCI-E	PCI-E	PCI-E
Memory size	256 MB	256 MB	256 MB	64 MB
Resolution	1,920 x 1,200	1,280 x 1,024	1,280 x 1,024	1,400 x 1,050
Driver (Vista SP1)	NVIDIA 7.14.10.9686	NVIDIA 7.15.11.6371	NVIDIA 7.14.10.9687	NVIDIA 7.14.10.9686
Driver (Vista)	NVIDIA 7.14.10.9686	NVIDIA 7.14.10.9686	NVIDIA 7.14.10.9686	NVIDIA 7.14.10.9686

System	Dell XPS M170	Dell XPS 600	HP d4100e	Toshiba Tecra M4
Audio				
Vendor and model number	SigmaTel C-Major Audio	Creative SB Audigy 2ZS	Realtek AC'97	SoundMax Integrated Digital Audio
Driver (Vista SP1)	SigmaTel 5.10.0.4255	Creative 6.0.1.1220	Realtek Semiconductor 6.0.1.6183	Analog Devices 5.12.1.5240
Driver (Vista)	SigmaTel 5.10.0.4255	Creative 6.0.1.1220	Realtek Semiconductor 6.0.1.6183	Analog Devices 5.12.1.5240
Ethernet				
Vendor and model number	Broadcom 570x Gigabit Controller	NVIDIA nForce Networking Controller	Realtek RTL8139	Marvell Yukon 88E8053 Gigabit Controller
Type	Integrated	Integrated	Integrated	PCI-E
Driver (Vista SP1)	Microsoft 10.10.0.1	NVIDIA 65.7.4.0	Microsoft 5.640.630.2006	Microsoft 9.0.32.3
Driver (Vista)	Microsoft 9.20.0.3	Microsoft 6.2.0.126	Microsoft 5.640.630.2006	Microsoft 9.0.32.3
Modem				
Vendor and model number	Conexant D110 MDC V.9x	Conexant D850 56K V.90 DFVc Modem	NA	Toshiba Software Modem
Driver (Vista SP1)	Microsoft 7.39.6.1	Microsoft 7.39.6.1	NA	Microsoft 2.1.69.0
Driver (Vista)	Microsoft 7.39.6.0	Microsoft 7.39.6.0	NA	Microsoft 2.1.69.0
Optical drive(s)				
Vendor and model number	TSSTcorp TSL462C	Sony DDU1615	TSSTcorp TS-H552D	Matshita UJDA750
Type	DVD-ROM/CD-RW	DVD-ROM	DVD-RW	DVD-ROM/CD-RW
Single / Dual Layer	NA	NA	Dual	NA
USB ports				
Number of ports	6	8	6	3
Type of ports (USB1.1, USB2.0)	USB2.0	USB2.0	USB2.0	USB2.0
IEEE 1394 ports				
Number of ports	1	3	2	1
Monitor				
CRT / LCD	UXGA LCD	ViewSonic Optiquest Q7	ViewSonic Optiquest Q7	SXGA LCD
Screen size	17"	17"	17"	14.1"
Refresh rate	60 Hz	60 Hz	60 Hz	60 Hz
Wireless				
Vendor and model number	Intel PRO/Wireless 2200BG	NA	NA	Intel PRO/Wireless 2200BG

System	Dell XPS M170	Dell XPS 600	HP d4100e	Toshiba Tecra M4
Driver (Vista SP1)	Microsoft 9.1.0.104	NA	NA	Microsoft 9.1.0.104
Driver (Vista)	Microsoft 9.1.0.104	NA	NA	Microsoft 9.1.0.104
Battery				
Type	Lithium Ion	NA	NA	Lithium Ion
Size (Length x Width x Height)	8¼" x 3" x 1"	NA	NA	5" x 2¾" x 1"
Rated capacity	7,200 mAh / 11.1V 80WHr	NA	NA	4,700 mAh / 10.8V 50WHr
Weight	1 lb.	NA	NA	11 oz.

Figure 23: Client system configurations

Test server configurations

Figure 24 provides detailed configuration information about the test servers. We built four identically configured servers so that we could test two clients at a time each in a test bed with a LAN and WAN server.

	Test server we built
General	
Processor and OS kernel: (physical, core, logical) / (UP, MP)	1P,2C,2L/MP
Number of physical processors	1
Single/Dual-Core processors	Dual
System Power Management Policy (Windows Server 2008)	High performance (always on)
System Power Management Policy (Windows Server 2003)	High performance (always on)
CPU	
Vendor	Intel
Name	Core 2 Duo
Model number	E6400
Stepping	6
Socket type	775 LGA
Core frequency (GHz)	2.13
Front-side bus frequency (MHz)	1066
L1 cache	32 KB + 32 KB (per core)
L2 cache	2048 KB (shared)
Platform	
Vendor	Intel
Motherboard model number	Intel DQ965GF
Motherboard chipset	Intel Q965
Motherboard revision number	C1
Motherboard serial number	BQGF64300DXU
BIOS name and version	Intel CO96510J.86A.4462.2006.0804.2059
BIOS settings	Setup Default
Memory module(s)	
Vendor and model number	Samsung M378T2953EZ3-CE6
Type	PC2-5300 DDR2
Speed (MHz)	667
Speed running in the system (MHz)	667
Timing/Latency (tCL-tRCD-tRP-tRASmin)	5-5-15-20
Size	2 x 1,024 MB
Number of memory module(s)	2
Chip organization	Double-sided
Channel	Dual
Hard disk OS	
Vendor and model number	Seagate ST3320620AS
Size	320 GB
Buffer size	16 MB
RPM	7,200
Type	SATA 300 Mb/s
Controller	Intel 82801H0 (ICH8D0)
Controller driver (Windows Server 2008)	Microsoft 6.0.6001.17051
Controller driver (Windows Server 2003)	Microsoft 5.2.3790.0
Hard disk data	

	Test server we built
Vendor and model number	Seagate ST3500320AS
Size	500 GB
Buffer size	32 MB
RPM	7,200
Type	SATA 300 Mb/s
Controller	Intel 82801H0 (ICH8D0)
Controller driver (Windows Server 2008)	Microsoft 6.0.6001.17051
Controller driver (Windows Server 2003)	Microsoft 5.2.3790.0
Operating system Windows Server 2008	
Name	Microsoft Windows Server 2008 Enterprise
Build number	6001
Service pack	SP1
File system	NTFS
Kernel	ACPI Multiprocessor PC
Language	English
Microsoft DirectX version	10
Operating system Windows Server 2003	
Name	Microsoft Windows Server 2003 R2 Enterprise Edition
Build number	3790
Service pack	SP2
File system	NTFS
Kernel	ACPI Multiprocessor PC
Language	English
Microsoft DirectX version	9.0c
Graphics	
Vendor and model number	Intel GMA 3000
Type	Integrated
Chipset	Intel GMA 3000
BIOS version	1348
Memory size	128 MB
Resolution	1,280 x 1,024
Driver (Windows Server 2008)	Intel 6.14.10.4864
Driver (Windows Server 2003)	Microsoft 5.2.3790.0
Sound card/subsystem	
Vendor and model number	N/A
Driver (Windows Server 2008)	N/A
Driver (Windows Server 2003)	N/A
Ethernet	
Vendor and model number	Intel Pro/1000 GT Desktop Adapter
Driver (Windows Server 2008)	Intel 8.2.17.0
Driver (Windows Server 2003)	Intel 8.9.1.0
Optical drive(s)	
Vendor and model number	TSSTcorp SH-S183L
Type	DVD/CD-ROM (RW)
Interface	SATA
Dual/Single layer	Dual Layer
USB ports	
Number	10
Type	2.0
IEEE 1394	
Number	1

	Test server we built
Monitor	
Type	ViewSonic Optiquest Q7
Screen size	17"
Refresh rate	60 Hz

Figure 24: Test server configurations

Appendix B—Windows updates

This appendix lists all the updates we applied to the test systems and servers from the Windows Update site. Figure 25 lists the Windows Vista updates that we installed on each test system.

Windows Vista Critical and Recommended Updates
Definition Update 1.14.1652.4 for Beta Windows Defender (KB915597)
Windows Update software 6.0.5520.16388

Figure 25: The Windows Vista updates we applied to each test system.

Figure 26 lists the Windows Vista updates that we installed on each test system prior to installing Windows Vista Service Pack 1 and running the Windows Vista SP1 tests.

Windows Vista SP1 Critical and Recommended Updates (applied on 01/08/2008)
Service Pack for Microsoft Windows (KB936330)
Update for Microsoft Windows (KB938371)
Update for Microsoft Windows (KB935509)
Update for Microsoft Windows (KB937954)
Update for Microsoft Windows (KB937287)
Cumulative Update for Media Center for Windows Vista (KB941229)
Cumulative Update for Media Center for Windows Vista (KB935652)
Hotfix for Microsoft Windows (KB932471)
Security Update for Microsoft Windows (KB925902)
Security Update for Microsoft Windows (KB929123)
Security Update for Microsoft Windows (KB929916)
Security Update for Microsoft Windows (KB930178)
Security Update for Microsoft Windows (KB931213)
Security Update for Microsoft Windows (KB933579)
Security Update for Microsoft Windows (KB933729)
Security Update for Microsoft Windows (KB935807)
Security Update for Microsoft Windows (KB936021)
Security Update for Microsoft Windows (KB936782)
Security Update for Microsoft Windows (KB938123)
Security Update for Microsoft Windows (KB938127)
Security Update for Microsoft Windows (KB941202)
Security Update for Microsoft Windows (KB941568)
Security Update for Microsoft Windows (KB941569)
Security Update for Microsoft Windows (KB942615)
Security Update for Microsoft Windows (KB942624)
Security Update for Microsoft Windows (KB943078)
Update for Microsoft Windows (KB905866)
Update for Microsoft Windows (KB929399)
Update for Microsoft Windows (KB929735)
Update for Microsoft Windows (KB930857)
Update for Microsoft Windows (KB931099)
Update for Microsoft Windows (KB931573)
Update for Microsoft Windows (KB933928)
Update for Microsoft Windows (KB935280)
Update for Microsoft Windows (KB936357)
Update for Microsoft Windows (KB936824)
Update for Microsoft Windows (KB936825)
Update for Microsoft Windows (KB938194)

Windows Vista SP1 Critical and Recommended Updates (applied on 01/08/2008)
Update for Microsoft Windows (KB938952)
Update for Microsoft Windows (KB938979)
Update for Microsoft Windows (KB941600)
Update for Microsoft Windows (KB941649)
Update for Microsoft Windows (KB941651)
Update for Microsoft Windows (KB942763)
Update for Microsoft Windows (KB939159)

Figure 26: The Windows Vista SP1 updates we applied to each test system prior to running the Windows Vista SP1 tests.

Figure 27 lists all the updates we applied to Windows Server 2003 from the Windows Update site on 12/26/2007

Windows Critical and Recommended Updates for Windows Server 2003
Security Update for Internet Explorer 7 for Windows Server 2003 (KB938127)
Security Update for Windows Server 2003 (KB941569)
Security Update for Windows Server 2003 (KB944653)
Cumulative Security Update for Internet Explorer 6 for Windows Server 2003 (KB942615)
Security Update for Windows Server 2003 (KB941568)
Update for Windows Server 2003 (KB942840)
Update for Windows Server 2003 (KB942763)
Windows Malicious Software Removal Tool—December 2007 (KB890830)
Security Update for Windows Server 2003 (KB943460)
Windows Internet Explorer 7 for Windows Server 2003
Update for Windows Server 2003 (KB936357)
Security Update for Outlook Express for Windows Server 2003 (KB941202)
Security Update for Windows Server 2003 (KB933729)
Security Update for Microsoft .NET Framework, Version 1.1 Service Pack 1 (KB933854)
Security Update for Windows Server 2003 (KB936021)
Security Update for Windows Server 2003 (KB938127)
Security Update for Windows Server 2003 (KB921503)
Security Update for Windows Server 2003 (KB936782)
Security Update for Windows Server 2003 (KB926122)
Security Update for Windows Media Player 6.4 (KB925398)
Security Update for Windows Server 2003 (KB935839)
Security Update for Windows Server 2003 (KB935840)
Cumulative Security Update for Outlook Express for Windows Server 2003 (KB929123)
Security Update for Windows Server 2003 (KB924667)
Update for Windows Server 2003 (KB927891)
Windows Malicious Software Removal Tool—May 2007 (KB890830)
Security Update for Windows Server 2003 (KB931784)
Security Update for Windows Server 2003 (KB930178)
Security Update for Windows Server 2003 (KB925902)
Microsoft Corporation—Other Hardware—Microsoft UAA Bus Driver for High Definition Audio
Windows Server 2003 Service Pack 2 (32-bit x86)

Figure 27: The Windows Server 2003 updates that we installed on each Windows Server 2003 test server.

Appendix C—Detailed test results

Figure 28 details the performance results for each of the test operations on each client system when running in the Windows Server 2003 test bed. Figure 29 provides the same data for the Windows Server 2008 test bed. Each result is how long the operation took to complete on the test operating system. Each result is the average of five runs of the same operation in the same system state on each system.

	System A		System B		System C		System D	
	Vista SP1	Vista						
Copy video LAN to local	107.04	124.35	109.49	132.93	105.16	120.32	108.95	142.35
Copy white paper LAN to local	5.72	6.47	5.93	7.44	5.62	6.46	6.08	6.65
Copy Q3 LAN to local	51.81	61.97	52.71	67.45	51.73	60.80	52.77	68.72
Copy brochure LAN to local	6.79	7.74	7.10	9.01	6.76	7.79	7.26	8.45
Copy images LAN to local	6.21	7.15	6.84	8.67	6.26	7.22	7.25	7.81
Copy white paper local to WAN	77.18	85.16	79.43	85.82	77.54	86.13	78.11	86.01
Copy Q3 local to WAN	920.42	957.53	935.81	959.05	934.36	958.07	935.79	959.10
Copy brochure local to WAN	104.74	116.59	106.90	116.99	105.67	116.86	105.99	117.15
Copy AV Pix local to WAN	98.89	114.48	100.09	115.24	99.01	114.51	99.59	115.37
Copy zip local to WAN	34.30	36.94	35.21	36.88	34.52	37.46	34.71	38.08
Copy white paper WAN to local	46.89	48.17	47.20	48.34	46.91	48.35	47.26	48.40
Copy Q3 WAN to local	483.42	222.16	486.82	227.13	483.85	221.08	487.14	229.19
Copy brochure WAN to local	63.73	71.44	64.13	72.09	63.78	71.91	64.27	72.07
Copy WB Pix WAN to local	64.37	84.57	64.73	85.17	64.45	84.80	64.81	85.05
Copy zip WAN to local	17.99	10.75	18.15	10.87	18.00	10.73	18.23	10.97
Copy video local to local	59.17	54.72	93.71	69.78	71.01	46.28	109.94	101.49
Copy Q3 local to local	28.05	28.80	50.47	38.26	32.61	25.78	52.04	47.49
Copy brochure local to local	5.15	5.25	5.88	6.80	5.17	5.12	7.09	7.61
Copy AV Pix local to local	4.93	5.11	5.14	6.21	4.59	4.97	6.82	7.03
Copy video local to LAN	101.53	101.20	103.22	101.26	137.31	138.88	104.43	101.48
Copy white paper local to LAN	5.88	6.19	6.18	6.45	7.06	7.26	6.22	6.62
Copy Q3 local to LAN	51.29	52.18	52.00	52.83	68.53	68.62	53.67	53.14
Copy brochure local to LAN	7.17	7.52	7.56	7.76	8.66	8.91	7.54	8.01
Copy AV Pix local to LAN	6.67	7.04	6.95	7.37	7.88	8.17	7.09	7.67
Copy zip local to LAN	3.99	4.63	4.29	4.59	4.59	5.44	4.49	5.56

Figure 28: Performance results for each of the test operations on each system under Vista and Vista SP1 on test systems communicating with a server running Windows Server 2003.

	System A		System B		System C		System D	
	Vista SP1	Vista						
Copy video LAN to local	100.90	125.06	101.25	132.96	100.79	121.23	101.22	148.37
Copy white paper LAN to local	5.65	6.45	5.67	7.30	5.60	6.42	5.71	6.59
Copy Q3 LAN to local	50.58	61.84	50.63	67.75	50.55	60.54	50.75	69.38
Copy brochure LAN to local	6.78	7.63	6.80	8.91	6.74	7.82	7.04	8.67
Copy images LAN to local	6.10	7.03	6.28	8.74	6.19	7.16	6.44	7.87
Copy white paper local to WAN	18.81	36.88	19.36	46.37	19.73	46.28	19.30	40.35
Copy Q3 local to WAN	103.27	172.40	118.25	179.84	117.79	181.44	117.70	177.64
Copy brochure local to WAN	22.76	47.15	23.17	47.84	23.86	48.04	22.94	47.73
Copy AV Pix local to WAN	27.73	57.71	28.15	57.99	28.20	58.05	28.15	57.73

	System A		System B		System C		System D	
	Vista SP1	Vista						
Copy zip local to WAN	5.44	12.51	5.52	12.77	6.06	12.67	5.37	12.84
Copy white paper WAN to local	27.73	50.06	27.43	49.86	29.12	49.85	28.85	49.76
Copy Q3 WAN to local	119.29	225.11	116.54	229.72	115.87	228.57	118.37	229.93
Copy brochure WAN to local	28.76	71.72	28.07	74.41	28.78	75.67	29.80	72.26
Copy WB Pix WAN to local	33.11	84.60	31.04	86.97	31.79	87.94	31.69	85.01
Copy zip WAN to local	8.52	14.77	8.48	14.67	7.22	12.63	13.98	12.56
Copy video local to local	58.07	55.14	91.50	70.98	68.58	46.33	106.42	100.96
Copy Q3 local to local	26.98	27.80	48.68	38.75	31.45	25.47	50.47	50.54
Copy brochure local to local	5.03	5.18	5.51	7.19	4.58	5.18	7.15	7.68
Copy AV Pix local to local	5.12	5.03	5.31	6.46	4.46	4.84	6.50	6.87
Copy video local to LAN	100.99	101.16	100.97	101.21	137.52	136.56	101.32	101.59
Copy white paper local to LAN	6.43	6.10	7.05	6.52	7.62	7.29	7.10	6.59
Copy Q3 local to LAN	52.69	52.04	53.90	52.81	70.41	69.10	54.35	53.15
Copy brochure local to LAN	7.32	7.43	7.98	7.93	9.14	8.94	8.30	7.98
Copy AV Pix local to LAN	7.33	7.05	7.77	7.57	8.41	8.11	8.09	7.69
Copy zip local to LAN	3.95	4.77	4.27	5.07	4.70	5.43	4.29	5.74

Figure 29: Performance results for each of the test operations on each system under Vista and Vista SP1 on test systems communicating with a server running Windows Server 2008.

Appendix D – Configuration and test results for the HP a1320y

Figure 30 provides detailed configuration information about the Hewlett-Packard a1320y desktop system. We omitted that system from the body of this report because it produced unacceptably high variability in its test results.

System	Hewlett-Packard a1320y
General	
Processor and OS kernel: (physical, core, logical)/(UP, MP)	1P1C2L / MP
Number of physical processors	1
Single/dual-core processors	Single
Processor HT status	Enabled
System Power Management Policy (Vista)	High performance
Notebook processor power saving option	NA
Notebook dimensions (length x width x height)	NA
Notebook weight	NA
CPU	
System type	Desktop
Vendor	Intel
Name	Pentium 516
Stepping	9
Socket type	LGA775
Core frequency (GHz)	2.93
Front-side bus frequency (MHz)	533
L1 cache	16 KB + 12 Kμops
L2 cache	1 MB
Platform	
Vendor and model number	HP a1320y
Motherboard model number	Asterope
Motherboard chipset	ATI RS400
Motherboard revision number	01
Motherboard serial number	MXG61801W2NA620
BIOS name and version	American Megatrends v3.07
BIOS settings	Default
Memory module(s)	
Vendor and model number	Hyundai Electronics HYMP564U64P8-C4
Type	PC2-4200
Speed (MHz)	533
Speed running in the system (MHz)	266
Timing/Latency (tCL-tRCD-tRP-tRASmin)	4-4-4-12
Size	512 MB
Number of memory module(s)	1 x 512 MB
Chip organization	Single-sided
Channel	Single

System	Hewlett-Packard a1320y
Hard disk	
Vendor and model number	Western Digital WD400BD-60LRA0
Number of disks in system	1
Size	40GB
Buffer size	2 MB
RPM	7200
Type	SATA 300 Mb/s
Controller	ATI SB400
Driver	Microsoft 6.0.6000.16386
Graphics	
Vendor and model number	ATI Radeon Xpress 200
Chipset	ATI Radeon Xpress 200 Series
BIOS version	BK-ATI VER008.0461.003.000
Type	Integrated
Memory size	256MB
Resolution	1280 x 1024
Driver	ATI 8.383.0.0
Audio	
Vendor and model number	Realtek High Definition Audio
Driver	Realtek Semiconductor Corp. 6.0.1.5372
Ethernet	
Vendor and model number	Realtek RTL8139
Type	Integrated
Driver	Microsoft 5.640.630.2006
Modem	
Vendor and model number	CXT Data Fax SoftModem with SmartCP
Driver	CXT 7.61.0.0
Optical drive(s)	
Vendor and model number	Asus DVD-E616A
Type	DVD-ROM
Single / Dual Layer	NA
USB ports	
Number of ports	6
Type of ports (USB1.1, USB2.0)	USB2.0
IEEE 1394 ports	
Number of ports	2
Monitor	
CRT / LCD	ViewSonic Optiquest Q7
Screen size	17"
Refresh rate	60 Hz
Wireless	
Vendor and model number	NA
Driver	NA
Battery	
Type	NA
Size (length x width x height)	NA
Rated capacity	NA
Weight	NA

Figure 30: Test system configuration.

Figure 31 details the performance results for each of the test operations on a Hewlett-Packard a1320y desktop PC when running in the Windows Server 2003 test bed. Figure 32 provides the same data for the Windows Server 2008 test bed. Each result is how long the operation took to complete on the test operating system. Each result is the average of five runs of the same operation in the same system state on each system.

	Hewlett-Packard a1320y	
	Vista SP1	Vista
Copy video LAN to local	108.97	121.78
Copy white paper LAN to local	6.08	7.28
Copy Q3 LAN to local	52.66	61.89
Copy brochure LAN to local	7.16	8.88
Copy images LAN to local	6.75	8.90
Copy white paper local to WAN	77.84	85.46
Copy Q3 local to WAN	934.38	961.87
Copy brochure local to WAN	106.09	117.22
Copy AV Pix local to WAN	99.70	114.91
Copy zip local to WAN	34.80	37.04
Copy white paper WAN to local	47.32	48.82
Copy Q3 WAN to local	485.92	223.31
Copy brochure WAN to local	64.27	72.52
Copy WB Pix WAN to local	64.75	85.47
Copy zip WAN to local	18.17	10.91
Copy video local to local	70.18	47.33
Copy Q3 local to local	31.64	27.15
Copy brochure local to local	5.24	5.68
Copy AV Pix local to local	5.14	5.16
Copy video local to LAN	109.46	138.46
Copy white paper local to LAN	6.03	7.50
Copy Q3 local to LAN	51.80	70.17
Copy brochure local to LAN	7.44	9.33
Copy AV Pix local to LAN	7.04	8.58
Copy zip local to LAN	4.11	4.92

Figure 31: Performance results for each of the test operations on the test system under Vista and Vista SP1 when running in the Windows Server 2003 test bed.

	Hewlett-Packard a1320y	
	Vista SP1	Vista
Copy video LAN to local	101.43	123.31
Copy white paper LAN to local	5.90	7.07
Copy Q3 LAN to local	50.47	63.20
Copy brochure LAN to local	6.95	8.87
Copy images LAN to local	6.65	8.76
Copy white paper local to WAN	18.81	43.58
Copy Q3 local to WAN	103.99	180.14
Copy brochure local to WAN	22.78	48.20
Copy AV Pix local to WAN	27.83	57.76
Copy zip local to WAN	5.58	12.53
Copy white paper WAN to local	25.54	51.09
Copy Q3 WAN to local	113.65	223.40
Copy brochure WAN to local	28.56	73.76
Copy WB Pix WAN to local	32.57	73.13
Copy zip WAN to local	8.75	11.08
Copy video local to local	66.49	47.33
Copy Q3 local to local	31.49	27.18
Copy brochure local to local	5.07	5.48
Copy AV Pix local to local	4.83	5.03
Copy video local to LAN	101.79	138.60
Copy white paper local to LAN	6.64	7.50
Copy Q3 local to LAN	52.94	59.16
Copy brochure local to LAN	7.81	13.50
Copy AV Pix local to LAN	7.31	13.04
Copy zip local to LAN	4.26	5.54
Figure 32: Performance results for each of the test operations on the test system under Vista and Vista SP1 when running in the Windows Server 2008 test bed.		

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Principled Technologies, Inc.
1007 Slater Road, Suite 250
Durham, NC 27703
www.principledtechnologies.com
info@principledtechnologies.com

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