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Technical Report

Comparing the Network Performance of Windows File Sharing Environments

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Executive Summary

This technical report presents the file share performance test results observed by NetApp. The tests used Microsoft® Windows® XP and Microsoft Windows® 7 clients that accessed data from a NetApp storage controller by using SMB 1.0 (CIFS) and SMB 2.0 protocols.

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1 Introduction: Windows 7 SMB 2.0 Plus Data ONTAP = the Future

Improving employee productivity is an ongoing goal for companies. Reducing time to access data in a Microsoft Windows file sharing environment can help companies achieve this goal. However, capital expenditures can be significant for the deployment of new desktops, laptops, network infrastructure, and file storage systems. Therefore, understanding the benefits versus the costs associated with these deployments is vital.

Currently, many companies are evaluating whether or not to use Microsoft Windows 7 in next-generation Windows file sharing environments. Windows 7 offers Service Message Block (SMB) 2.0, which has been designed to be more efficient and to improve performance in Windows file sharing environments compared to SMB 1.0. We ran a series of tests to provide our customers with the most up-to-date information. These tests quantified the performance gains of using SMB 2.0 with Windows 7 and NetApp storage in WAN environments compared to using SMB 1.0 with both Windows 7 and Windows XP. We conducted tests in simulated WAN environments that included multiple throughput and response time levels to reflect common customer environments. A high-level summary of these test results is as follows:

- Deploying Windows 7 with its optimized TCP/IP stack to replace Microsoft Windows XP should significantly improve client performance regardless of the bandwidth of the LAN or WAN connection.
- For low-throughput WAN links, such as Optical Carrier (OC) 1, cable modem, wireless network, and so on, we found that the performance of Windows 7 with SMB 2.0 is equivalent to the performance of Windows 7 with SMB 1.0.
- With higher-throughput WAN connections, such as OC 3 and higher, Windows 7 combined with SMB 2.0 provides additional performance gains compared to Windows 7 using SMB 1.0 and Windows XP.

2 Windows File Sharing Environments

Modern networks typically consist of LAN environments within headquarters and branch offices, WAN connections from offices to local and remote data centers, and WAN connections extending out to remote users telecommuting by using cable modems and wireless networks. Microsoft made significant changes to the TCP/IP stack for Windows Vista®, Windows 7, and Windows Server® 2008. The goal was to improve performance and scalability for modern network environments. Key changes include:

- TCP Receive Window Size Auto-Tuning
- Compound TCP for Send Window Tuning
- Explicit Congestion Notification (ECN)

Of these features, Windows 7 has TCP Receive Window Size Auto-Tuning enabled by default; the other features are disabled.

In addition, the SMB protocol was completely overhauled with SMB 2.0. The original Common Internet File System (CIFS) protocol (a dialect of SMB) was developed for LAN environments and was a chatty protocol. Protocols such as FCP and NFS perform better than CIFS. With SMB 2.0, Microsoft tried to reduce the inefficiency and improve the performance of the protocol, particularly for WAN environments. The major changes include:

- Simplifying the amount and type of operations
- Enabling multiple SMB commands per packet
- Pipelining to allow clients to send additional requests before the response to a previous request arrives
- Increasing scalability for a larger amount of open file handles and shares
- Improving durable file handles to allow client connections to better handle network outages

Although Windows XP used a 64kB block size, Windows 7 with SMB 1.0 uses a 32kB block size, and Windows 7 with SMB 2.0 uses a 64kB block size. NetApp licenses CIFS protocol technology from Microsoft, and we incorporated SMB 2.0 into NetApp Data ONTAP® 7.3.1. Refer to [TR 3740: SMB 2.0 – Next Generation CIFS Protocol in Data ONTAP] for details on these enhancements.

3 Test Environment

We set up an emulated WAN environment and tested Windows XP, Windows 7 with SMB 1.0, and Windows 7 with SMB 2.0 clients. Each client had a single Gigabit Ethernet (GbE) interface connected into an IN port on the Linktropy 7500 Pro WAN emulator. In addition, we configured two outgoing port connections from the WAN emulator into a Cisco® 4948 switch. We connected a single FAS3140 storage controller using a single GbE connection into the Cisco switch. We conducted the tests with the WAN emulator ports configured at multiple bandwidth levels to reflect common OC transmission rates. Specifically, we tested with OC 1 (52 Mbps), OC 3 (155 Mbps), OC 12 (622 Mbps), and 1Gbps Full Duplex. In addition to limiting the available bandwidth, we used a WAN emulator to induce latency (additional response time) into the connection between the clients and the storage. We tested each of the previously defined throughput levels with a round-trip 32 ms latency (16 ms in each direction) and a 75 ms latency (37.5 ms in each direction) to simulate common WAN environments. After configuring the WAN emulator at the desired latency level, we performed a ping test from the Windows client to the NetApp storage controller to confirm that the Internet Control Message Protocol (ICMP) packets were experiencing the desired latency.

Although only a single GbE port was configured on each client system and on the NetApp storage controller, the hardware capabilities of the ports were not a limiting factor to the network. To conduct the tests, we used Robocopy, a command line-based file copy utility that is publicly available for both Windows XP and Windows 7.

Initially, the storage controller had the default option, cifs.tcp_window_size, set to 17520. This setting did not result in substantial differences in performance between Windows XP, Windows 7 (SMB 1.0), and Windows 7 (SMB 2.0). Per NetApp engineering recommendations, we increased the option, cifs.tcp_window_size, to 2096560. Please note that adjusting this option required a cifs terminate and restart, thus requiring a brief client outage in order to take effect. This setting resulted in a substantial difference in performance between the clients and the protocols. As a result, we conducted all of the remaining tests using the cifs.tcp_window_size of 2096560. In addition, the Windows 7 performance results were very inconsistent during the initial testing. For the initial test, the performance was very good as measured by the time to complete the operation. However, the results declined dramatically on repeat tests. We learned that this inconsistency was caused by a TCP issue on the Windows 7 client. This issue was addressed in http://support.microsoft.com/kb/983528. After implementing the hotfix, the performance results were consistent across multiple repeat tests; therefore, it would appear that the Microsoft hotfix resolved this issue.

These test results do not represent the maximum NetApp storage controller file services performance (as might be captured with a benchmark such as SPECsfs2008). Instead, the results capture the average time to complete the read and write operations of the target file or directory of files from a single Windows client using Robocopy to a NetApp storage controller. This type of testing is generally single threaded, which can significantly limit the overall throughput. Workloads with multithreaded operations provide a different performance characteristic and can provide additional performance results, leveraging the client and storage controller resources more effectively.

Actual home directory workloads can vary, but they generally involve both metadata and file read/write operations. In addition, clients can open, close, save, and copy files using Windows drag-and-drop; it was beyond the scope of our testing to include each of these operations. By examining the CPU and disk utilization, as measured by perfstats taken during the tests, we confirmed that the NetApp storage controller was not a bottleneck.

The FAS3140 storage controller was configured for CIFS access by running CIFS setup and joining a Windows 2003 domain. Each client system, both Windows XP and Windows 7, joined the same domain. We then used Windows Explorer®, from each client, to map a drive to a single CIFS share on the FAS3140 storage controller. We configured each client with a copy of the following files and directories for use during testing:

- 100MB Microsoft Excel® File
- 1GB directory set composed of 14 directories and 300 files (.xls, .doc, and .ppt)

Windows 7 and NetApp storage systems can use SMB 1.0 or SMB 2.0. We used the NetApp option, cifs.SMB 2.0.enable on or off, to enable and disable SMB 2.0 during testing. When this option is set to off, the Windows 7 client communicates using SMB 1.0 to the NetApp storage controller. When this option is set to on, the SMB 2.0 protocol is used between the client and the FAS3140 storage controller. We made sure that the correct protocol was being tested by terminating and restarting CIFS on the NetApp storage controller and rebooting the Windows 7 client. The Windows XP systems use SMB 1.0 only for CIFS regardless of the previously mentioned setting of the cifs.SMB 2.0 enable flag.

We completed the following tests for each client (Windows XP, Windows 7/SMB 1.0, and Windows 7/SMB 2.0):

- To measure the file read performance, we used Robocopy to copy the 100MB Excel file from the FAS3140 storage controller CIFS share to a folder on the Windows client. We recorded the amount of time (reported by Robocopy) that was required to complete the operation.
  - `robocopy z:\dest 100M-2.xls c:\robo\Num1 /IS LOG+:c:\robo\%1_read_log.txt /TEE /NP`
- To measure the file write performance, we used Robocopy to copy the 100MB Excel file from a folder on the Windows client to the FAS3140 storage controller CIFS share. We recorded the amount of time (reported by Robocopy) that was required to complete the operation.
  - `robocopy c:\robo\Num1 z:\dest 100M-2.xls /IS /LOG+:c:\robo\%1_write_log.txt /TEE /NP`
- To measure the directory and file read performance, we used Robocopy to copy the 1GB directory set from the FAS3140 storage controller CIFS share to the respective folder on the Windows client. We recorded the amount of time (reported by Robocopy) that was required to complete the operation.
  - `robocopy z:\dest\Dirs-1 c:\robo\Dirs\Dirs-1 /E /IS /LOG+:c:\robo\%1_read_log.txt /TEE /NP`
- To measure the directory and file write performance, we used Robocopy to copy the 1GB directory set from the Windows client to the FAS3140 storage controller CIFS share. We recorded the amount of time (reported by Robocopy) that was required to complete the operation.
  - `robocopy c:\robo\Dirs\Dirs-1 z:\dest\Dirs-1 /E /IS /LOG+:c:\robo\%1_write_log.txt /TEE /NP`

We performed three iterations of each test to check the accuracy and consistency of the test results.

4 Results

This section shows the specific results of all of the tests. We controlled all variables associated with connectivity, latency, and bandwidth for these tests.

Note: The results will vary in real-world WAN environments. Multiple other variables can impact performance including, but not limited to, link bandwidth, hop count, link utilization, client resources, storage controller resources, and network infrastructure resources.

4.1 Test Results Summary for 32 ms Latency

Table 1 and Table 2 show the combined results measured in total time required (seconds) to complete each of the Robocopy test case operations at 32 ms latency (lower numbers are better).

The performance improvements are significant when moving from Windows XP to Windows 7 using SMB 1.0. This improvement is indicated by the reduced time to complete the operation. For the OC 3 bandwidth level and higher, moving from Windows 7 using SMB 1.0 to Windows 7 using SMB 2.0 resulted in additional performance improvement as indicated by the reduced time to complete the operation.

Additionally, for both the read- and write-related tests, we found that providing additional bandwidth allowed SMB 2.0 to generate a considerably improved performance compared to SMB 1.0 when both used Windows 7.

Table 1) Performance comparison of Windows XP, Windows 7 SMB 1.0, and Windows 7 SMB 2.0 using a 100MB File Read test at 32 ms latency.

Bandwidth Level	XP (results in seconds)	Windows 7 SMB1 (results in seconds)	Windows 7 SMB2 (results in seconds)
OC 1	99	17	17
OC 3	95	7	5
OC 12	84	7	2
GbE	86	7	1

Table 2) Performance comparison of Windows XP, Windows 7 SMB 1.0, and Windows 7 SMB 2.0 using a 100MB File Write test at 32 ms latency.

Bandwidth Level	XP (results in seconds)	Windows 7 SMB1 (results in seconds)	Windows 7 SMB2 (results in seconds)
OC 1	73	17	17
OC 3	62	7	6
OC 12	57	7	2
GbE	57	7	2

We performed read and write tests with a 1GB directory set that consisted of 13 directories and 300 files (Microsoft Excel, PowerPoint®, and Word® documents) that ranged in size from 50KB to 5MB. The results are shown in Table 3 and Table 4. Windows 7 with SMB 1.0 provided a significant improvement in performance compared to Windows XP. The amount of time required to complete the entire read/write of the directory set decreased significantly. Using higher bandwidth network connections for Windows 7 with SMB 2.0 resulted in additional improvements in performance.

Table 3) Performance comparison of Windows XP, Windows 7 SMB 1.0, and Windows 7 SMB 2.0 using a 1GB Directory Read test set at 32 ms latency.

Bandwidth Level	XP (results in seconds)	Windows 7 SMB1 (results in seconds)	Windows 7 SMB2 (results in seconds)
OC 1	1111	260	212
OC 3	1013	157	97

Bandwidth Level	XP (results in seconds)	Windows 7 SMB1 (results in seconds)	Windows 7 SMB2 (results in seconds)
OC 12	942	152	56
GbE	995	156	52

Table 4) Performance comparison of Windows XP, Windows 7 SMB 1.0, and Windows 7 SMB 2.0 using a 1GB Directory Write test set at 32 ms latency.

Bandwidth Level	XP (results in seconds)	Windows 7 SMB1 (results in seconds)	Windows 7 SMB2 (results in seconds)
OC 1	940	347	354
OC 3	824	263	239
OC 12	777	258	197
GbE	771	257	196

4.2 Test Results Summary for 75 ms Latency

Table 5 and Table 6 show the combined results measured in total time (seconds) to complete each of the Robocopy test case operations at 75 ms latency. Again, the results indicate significant improvements in performance when moving from Windows XP to Windows 7 SMB 1.0 and from Windows 7 SMB 1.0 to Windows 7 SMB 2.0. The reduced time to complete the operations indicates performance improvement.

Additionally, for both the read- and write-related tests, the performance improved as bandwidth increased. For the read test, SMB 2.0 at the OC 3 bandwidth performed 50% better than SMB 1.0 when testing with Windows 7. The performance improvement when using SMB 2.0 versus SMB 1.0 is more pronounced at OC 12. For example, at OC 12, the file read completed in 15 seconds using SMB 1.0, but it only took 2 seconds with SMB 2.0, a 650% improvement. These results indicate that SMB 2.0 can perform well in environments that have high bandwidth and high latency.

Table 5) Performance comparison of Windows XP, Windows 7 SMB 1.0, and Windows 7 SMB 2.0 using a 100MB File Read test at 75 ms latency.

Bandwidth Level	XP (results in seconds)	Windows 7 SMB1 (results in seconds)	Windows 7 SMB2 (results in seconds)
OC 1	218	24	24
OC 3	211	16	8
OC 12	199	15	2
GbE	202	16	2

Table 6) Performance comparison of Windows XP, Windows 7 SMB 1.0, and Windows 7 SMB 2.0 using a 100MB File Write test at 75 ms latency.

Bandwidth Level	XP (results in seconds)	Windows 7 SMB1 (results in seconds)	Windows 7 SMB2 (results in seconds)
OC 1	149	25	25
OC 3	137	17	9

Bandwidth Level	XP (results in seconds)	Windows 7 SMB1 (results in seconds)	Windows 7 SMB2 (results in seconds)
OC 12	132	16	5
GbE	133	16	5

Table 7 and Table 8 show the 1GB directory set results captured during testing at 75 ms latency. The performance improvements follow the same pattern seen with the file read and write tests at 75 ms. Again, the results indicate that SMB 2.0 performs significantly better than SMB 1.0 in a high-latency environment (75 ms) coupled with high throughput (OC 3 and OC 12).

Table 7) Performance comparison of Windows XP, Windows 7 SMB 1.0, and Windows 7 SMB 2.0 using a 1GB Directory Read test set at 75 ms latency.

Bandwidth Level	XP (results in seconds)	Windows 7 SMB1 (results in seconds)	Windows 7 SMB2 (results in seconds)
OC 1	2,366	379	262
OC 3	2,290	355	150
OC 12	2,213	348	112
GbE	2,297	336	111

Table 8) Performance comparison of Windows XP, Windows 7 SMB 1.0, and Windows 7 SMB 2.0 using a 1GB Directory Write test set at 75 ms latency.

Bandwidth Level	XP (results in seconds)	Windows 7 SMB1 (results in seconds)	Windows 7 SMB2 (results in seconds)
OC 1	1,944	619	581
OC 3	1,828	598	466
OC 12	1,782	594	440
GbE	1,778	593	439

5 Analysis

In general, our tests showed that the changes in the TCP/IP stack that are available with Windows 7 and SMB 1.0 provide a significant performance improvement compared to using Windows XP and SMB 1.0. Additionally, we found that the performance was improved even further by using Windows 7 and SMB 2.0 in cases in which additional bandwidth was available across the WAN connections (for OC 3 and higher). This section takes a closer look at the reasons for the performance gains, examines the results from the storage perspective, and evaluates the CIFS load placed on and measured by the FAS3140 storage controller for the different configurations.

The following figures show the CIFS operations per second. These operations were measured at the FAS3140 during the 100MB file read and write tests using a 32 ms delay for all bandwidth levels tested.

Note: The number of operations per second (concurrency) is plotted versus the time to complete the entire read or write operation.

The measured operations were generated using the sysstat command on the FAS3140 and were captured at one-second intervals during the testing. The length of the line (on the X axis) indicates the amount of time, measured in seconds, required to complete the file read or write operation. The height of the line (on the Y axis) indicates the number of CIFS operations per second that were directed toward the FAS3140 during the course of the file read or write operation.

Figure 1 compares the client results for the 100MB file read operation at the OC 1 bandwidth level for Windows XP, Windows 7 using SMB 1.0, and Windows 7 using SMB 2.0. Recall that the Windows XP client required 101 seconds to complete this test. The Windows XP results are shown in Figure 1 as the lowest line plotted on the graph. The results show that the Windows XP client performance with its 64KB block size is constrained by low concurrency (that is, approximately 20 concurrent CIFS operations were observed at the FAS3140) and a small (nonconfigurable) TCP Receive window size.

At the OC 1 bandwidth, the Windows 7 client completes the file read in 17 seconds using either SMB 1.0 or SMB 2.0. The Windows 7 client results using SMB 1.0 are shown as the top line in Figure 1. We believe that the primary factor responsible for the performance improvement compared to Windows XP is the adjustable TCP Receive window size integrated into Windows 7. Additionally, we observed significantly higher levels of CIFS operations directed to the FAS3140 when using Windows 7 regardless of whether or not we used SMB 1.0 or SMB 2.0.

Note: In this test case, the Windows 7 client with SMB 2.0 completes the file read in the same amount of time as the Windows 7 SMB 1.0 client.

For the Windows 7 SMB 2.0 results, shown by the middle line in the figure, the concurrency is lower than the Windows 7 SMB 1.0 (an average of 100 CIFS operations compared to approximately 180 CIFS operations). However, SMB 2.0 uses a larger request size (64K versus 32K). Therefore, the Windows 7 SMB 2.0 client moves the same amount of data in the same amount of time by using a larger block size and a lower concurrency.

Figure 1) File read performance at OC 1 bandwidth with 32 ms delay.

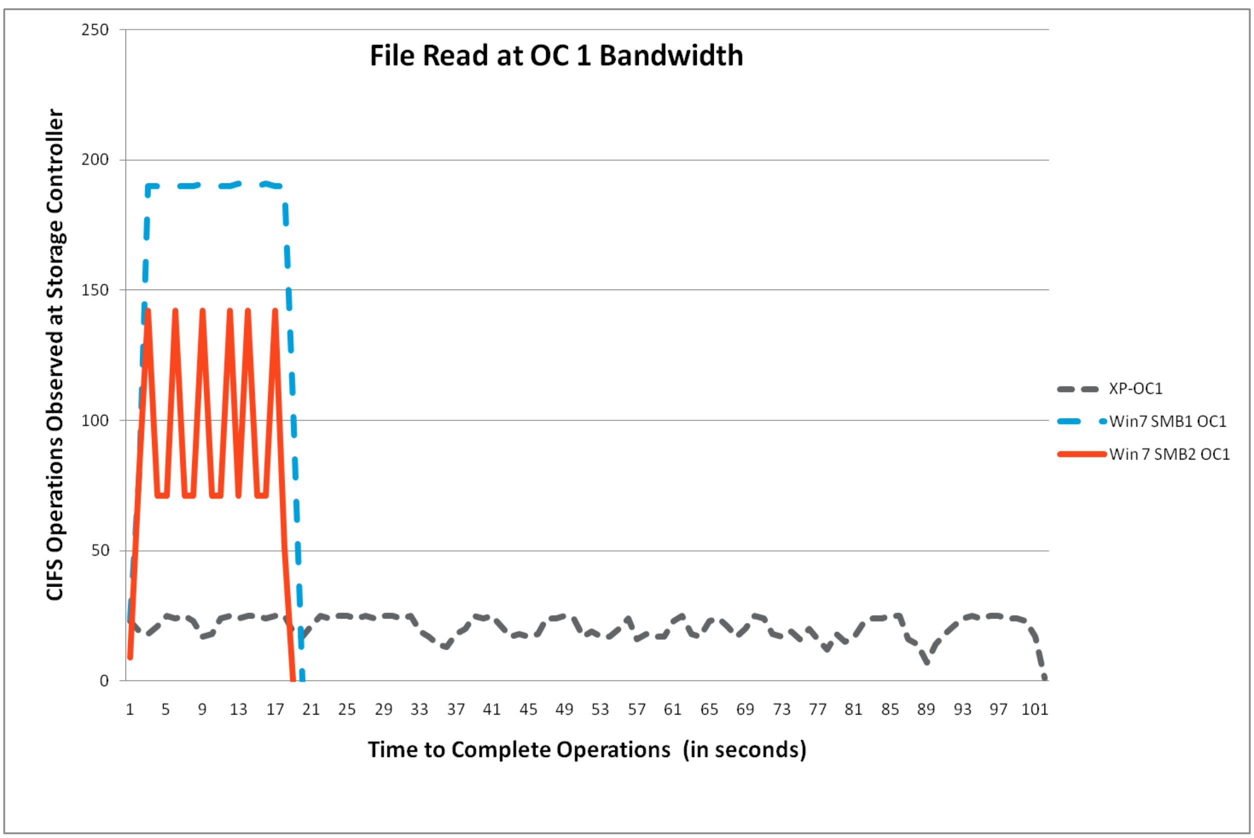


Figure 2 shows the same test results as shown in Figure 1 after increasing the available WAN bandwidth to the OC 3 level. As shown in Figure 2, when the bandwidth is increased to OC 3, the Windows XP client reads the file in 95 seconds, and the CIFS operations arrived at the storage at a rate of about 20 operations per second. Simply changing to Windows 7 and using SMB 1.0 increases the rate at which the CIFS operations arrive at the storage to an average of 468 CIFS operations per second and reduces the time to complete the file read operation to 11 seconds. Switching to Windows 7 with SMB 2.0 increased the concurrency of the CIFS operations arriving at the storage to an average of 310 and allowed the read operation to complete in 9 seconds, making it slightly faster compared to Windows 7 and SMB 1.0. We believe the improved performance for Windows 7 with SMB 2.0 versus SMB 1.0 is due to the following SMB 2.0 features:

- Compounding of operations – fewer round-trip operations to complete
- 64K block size – larger buffer size, which allows the client to more effectively use the higher bandwidth pipe
- Pipelining of requests – credit system of flow control

Figure 2) File read performance at OC 3 bandwidth with 32 ms delay.

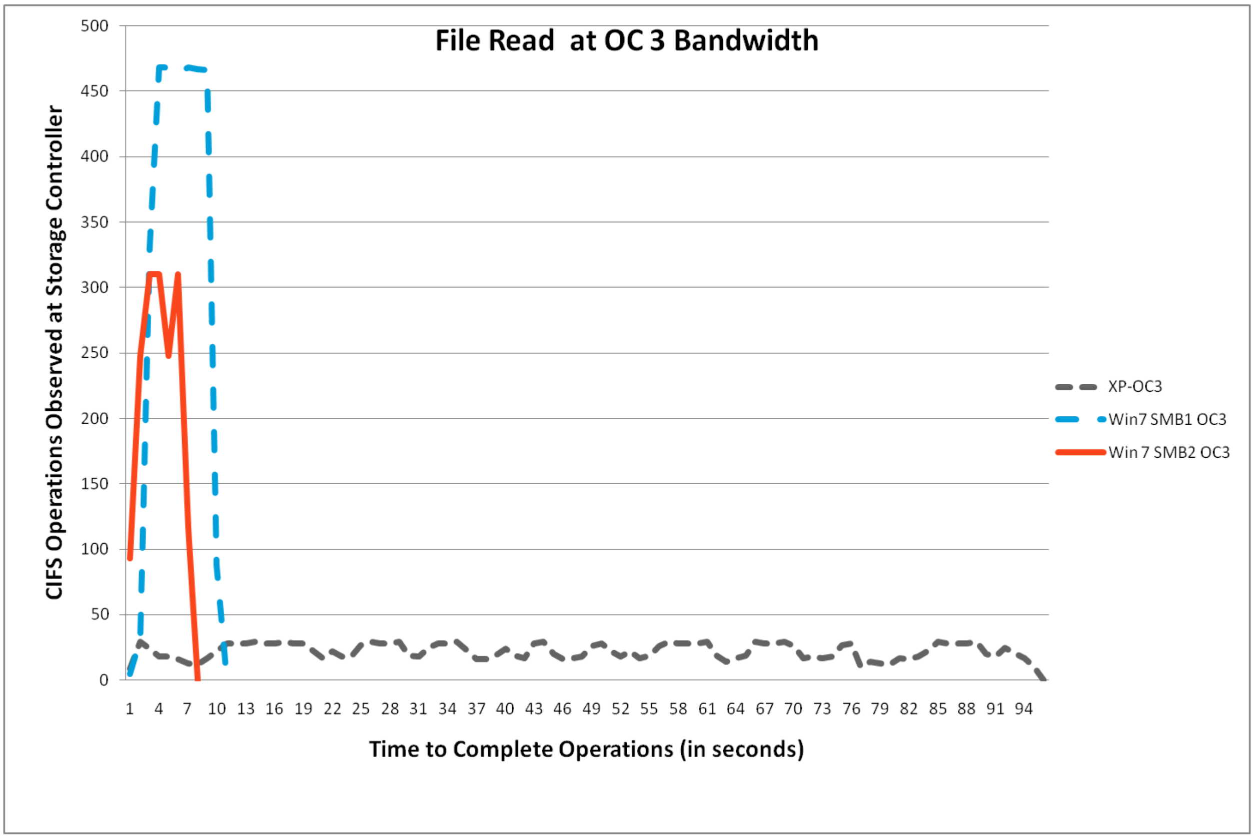


Figure 3 and Figure 4 show the results from the same test after increasing the available WAN bandwidth to the OC 12 and GbE levels, respectively. When the bandwidth is increased to OC 12, the Windows 7 client with SMB 2.0 (the top line in Figure 3) shows a dramatic improvement in performance compared to Windows 7 using SMB 1.0. For this test, the Windows 7 SMB 2.0 client operations per second (concurrency) increase to over 800 per second, while the CIFS operations using Windows 7 and SMB 1.0 remain approximately the same compared to the OC 3 results at an average of 480. We believe that the higher bandwidth link allows the Windows 7 client with SMB 2.0 to scale up the outstanding CIFS requests. This dramatically reduces the time required to complete the file read operation (10 seconds versus 7 seconds with SMB 2.0). Similar to the OC 3 bandwidth level, Windows XP did not benefit from the increased bandwidth.

When the bandwidth was increased to 1Gb, we did not observe any additional significant improvements in performance for the Windows 7 client using SMB 2.0 compared to using OC 12. This indicates that, at some point, adding more bandwidth does not necessarily improve performance. Therefore, our results indicate that increasing the bandwidth higher than OC 12 appears to offer diminishing returns.

Figure 3) File read performance at OC 12 bandwidth with 32 ms delay.

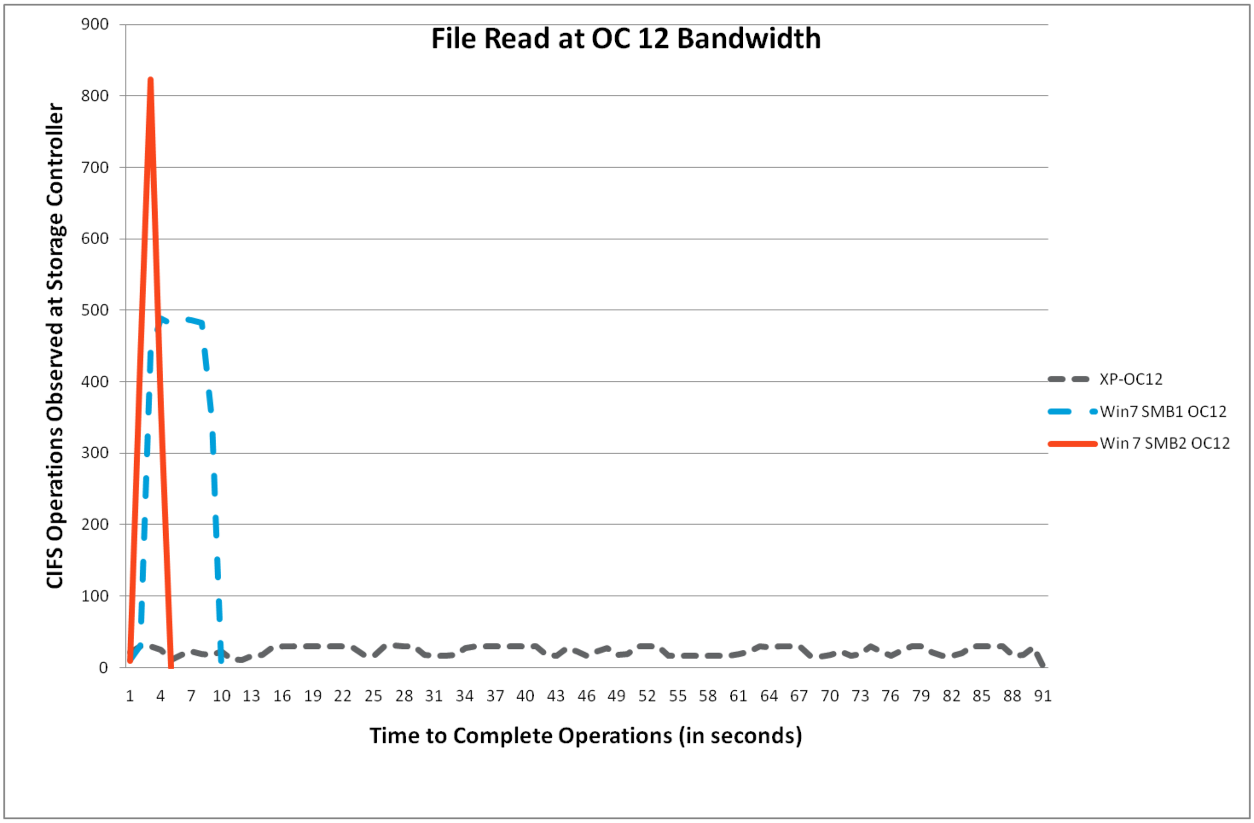
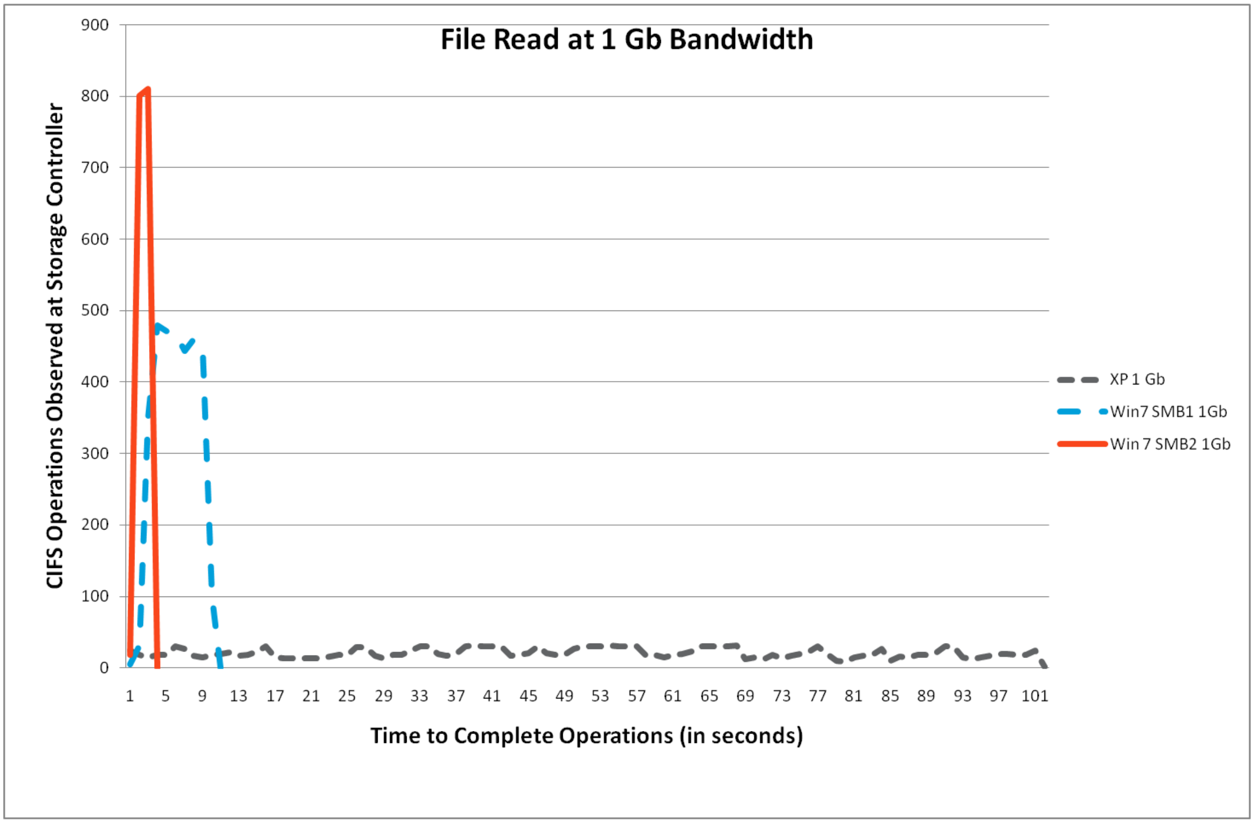


Figure 4) File read performance at 1Gb bandwidth with 32 ms delay.



Figures 5 through 8 provide the same information as the previous figures for the 100MB file write tests at all WAN bandwidth configurations. We observed the same general points for these tests as we did for the 100MB file read tests:

- The performance using Windows XP does not benefit from the increased bandwidth.
- At the OC 1 bandwidths, Windows 7 using both SMB 1.0 and SMB 2.0 generates approximately the same performance, which is considerably better than the performance of Windows XP.
- At the OC 3 bandwidths, Windows 7 using both SMB 1.0 and SMB 2.0 generates a comparable yet improved performance compared to that of OC 1.
- At the OC 12 bandwidth, Windows 7 using SMB 2.0 delivers a significantly better overall performance compared to the performance of Windows 7 using SMB 1.0.
- At the GbE bandwidths, Windows 7 using SMB 2.0 does not result in any significant performance improvement compared to the performance of OC 12.

Figure 5) File write performance at OC 1 bandwidth with 32 ms delay.

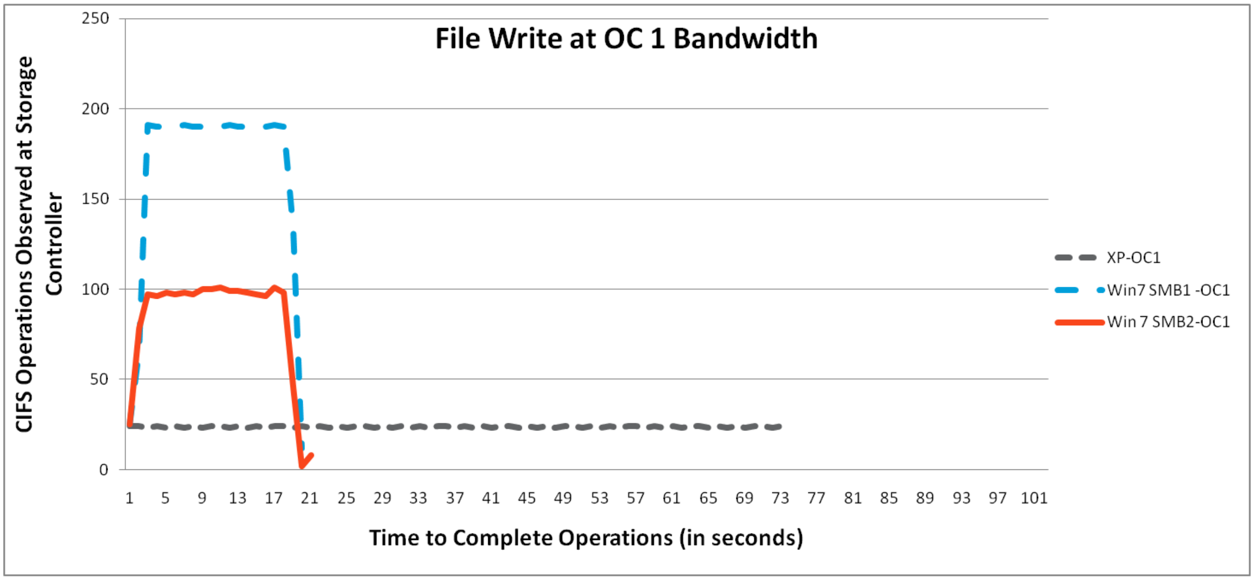


Figure 6) File write performance at OC 3 bandwidth with 32 ms delay.

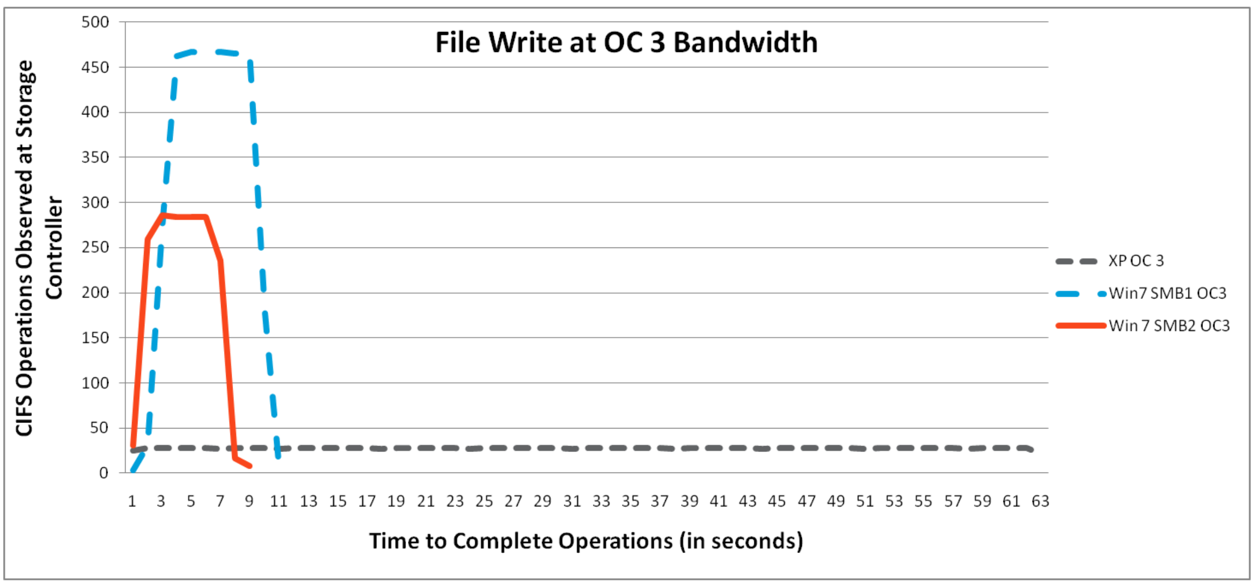


Figure 7) File write performance at OC 12 bandwidth with 32 ms delay.

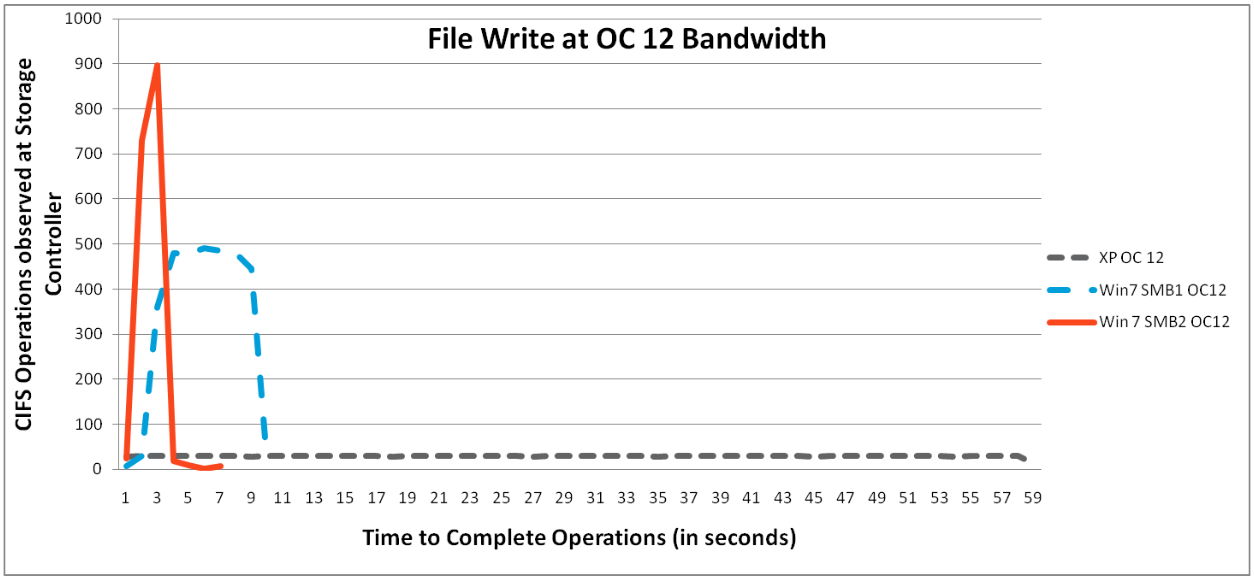


Figure 8) File write performance at 1Gb bandwidth with 32 ms delay.

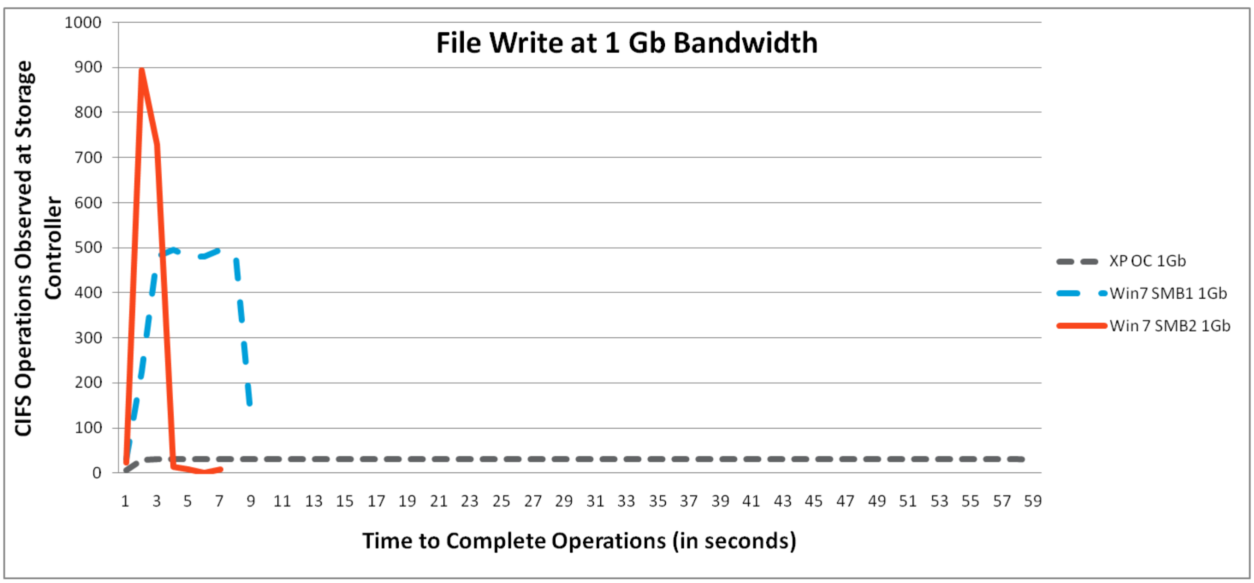
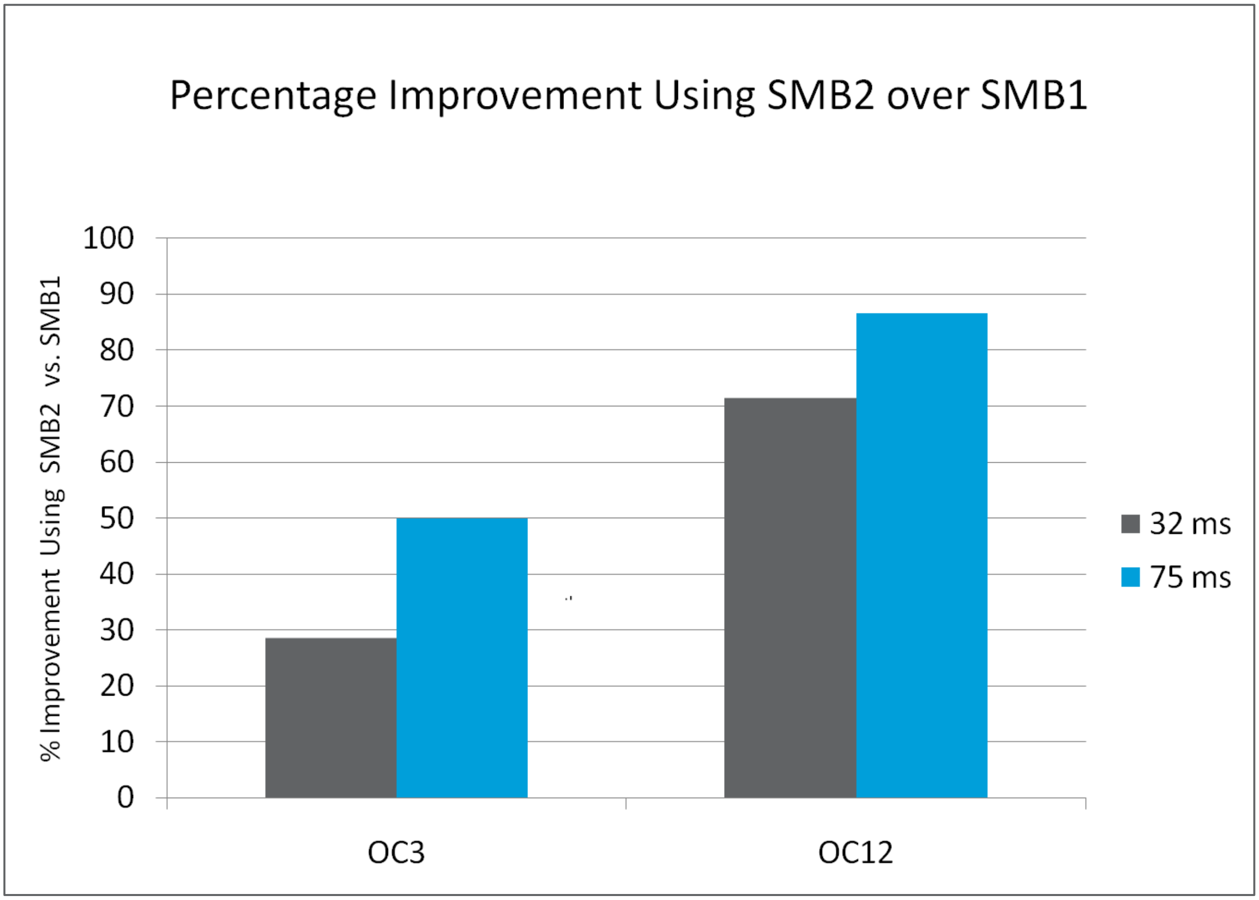


Figure 9 provides a summary of the performance improvement comparing medium latency (32 ms) to high latency (75 ms). It appears that as the latency in the WAN increases, the performance of the SMB 2.0 is magnified versus the SMB 1.0. Therefore, at 32 ms at OC 3 and OC 12, SMB 2.0 is 29% and 71% better than SMB 1.0. But when the latency is increased to 75 ms, the performance gains are more dramatic: SMB 2.0 is 50% and 87% better than SMB 1.0. These results indicate that the performance of SMB 2.0 improves as the latency becomes higher.

Figure 9) Percentage improvement in Windows 7 with SMB 2.0 versus SMB 1.0 using OC 3 and OC 12 WANs at 32 ms and 75 ms.



6 Windows 2008 Server Comparison

We performed additional tests in our lab environment with a Windows 2008 R2 server. The purpose of these tests was to confirm that the FAS3140 test results for SMB 1.0 and SMB 2.0 were similar to a Windows 2008 server. We found that our results did match the performance from the Windows 2008 server for the bandwidth and latency levels tested. Tables 9–12 show the averages of these results compared to the results from the NetApp storage controller.

Table 9) Performance comparison for a 100MB File Read at 32 ms latency (results in seconds).

Bandwidth	XP - FAS3140	XP - Win2K8	Win7 - SMB1 - FAS3140	Win 7 - SMB1 - Win2K8	Win 7 - SMB2 - FAS3140	Win 7 - SMB2 - Win2K8
OC 1	99	93	17	17	17	17
OC 3	95	82	7	7	5	5
OC 12	84	77	7	7	1	1
GbE	86	78	7	7	1	1

Table 10) Performance comparison for a 100MB File Write test at 32 ms latency (results in seconds).

Bandwidth	XP - FAS3140	XP - Win2K8	Win7 - SMB1 - FAS3140	Win 7 - SMB1 - Win2K8	Win 7 - SMB2 - FAS3140	Win 7 - SMB2 - Win2K8
OC 1	73	73	17	17	17	18
OC 3	62	61	7	7	6	6
OC 12	57	57	7	7	2	2
GbE	57	57	7	7	2	2

Table 11) Performance comparison for a 100MB File Read test at 75 ms latency (results in seconds).

Bandwidth	XP - FAS3140	XP - Server 2008	Win7 - SMB1 - FAS3140	Win 7 - SMB1 - Sever 2008	Win 7 - SMB2 - FAS3140	Win 7 - SMB2 - Server 2008
OC 1	218	195	24	17	17	17
OC 3	211	184	16	16	5	8
OC 12	199	177	15	16	2	7
GbE	202	179	16	15	1	7

Table 12) Performance comparison for a 100MB File Write test at 75 ms latency (results in seconds)

Bandwidth	XP - FAS3140	XP - Server 2008	Win7 - SMB1 - FAS3140	Win 7 - SMB1 - Sever 2008	Win 7 - SMB2 - FAS3140	Win 7 - SMB2 - Server 2008
OC 1	149	147	25	18	17	18
OC 3	137	137	17	17	6	7
OC 12	132	132	16	16	2	5
GbE	133	131	16	16	2	6

7 Conclusion

Customers can take advantage of new Windows 7 client networking and CIFS SMB 2.0 protocol enhancements to improve productivity by reducing the time required to complete operations with NetApp CIFS file share environments. Our tests indicate that moving from Windows XP to Windows 7 can provide immediate measurable performance improvements for many LAN and WAN environments. Further performance benefits might be achieved by using Windows 7 with SMB 2.0 for high-throughput, high-latency WAN environments. NetApp continues to partner with Microsoft to bring innovative new NAS solutions such as SMB 2.0 that help customers go further, faster.

This technical report shows the specific results of all of our tests. We controlled all variables associated with connectivity, latency, and bandwidth for these tests. Your results may vary in real-world WAN environments. Multiple other variables can impact performance including, but not limited to, link bandwidth, hop count, link utilization, client resources, storage controller resources, and network infrastructure resources.

Appendixes

Hardware and Software

- FAS3140 running Data ONTAP 7.2.3P3
  - Options SMB 2.0. enable off/on
  - Options cifs.tcp_window_size 2096560
- Server running Windows XP SP3
  - Intel® Pentium® 4 CPU 1.80 GHz, 1GB RAM, 32 bit
- Server running Windows 7 Professional
  - Intel® Xeon™ dual processor CPU 3.60 GHz, 4GB RAM, 32 bit
  - Microsoft hotfix KB #983528 http://support.microsoft.com/kb/983528
- Linktropy 7500 Pro (WAN emulator)
  - 3.1.4
- Cisco 4948 Ethernet Switch
- Server running Windows 2008 SP2
  - Intel Xeon CPU 2.00 GHz, 13GB RAM, 64 bit

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  http://media.netapp.com/documents/tr-3740.pdf
- Microsoft's SMB 2.0 Performance white paper by the Tolly Group
  www.microsoft.com/downloads/en/details.aspx?FamilyID=04cad8b9-9f9f-453a-893a-458d22dbb3c5&DisplayLang=en

Refer to the Interoperability Matrix Tool (IMT) on the NetApp Support site to validate that the exact product and feature versions described in this document are supported for your specific environment. The NetApp IMT defines the product components and versions that can be used to construct configurations that are supported by NetApp. Specific results depend on each customer's installation in accordance with published specifications.

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