Comparing the Performance of Three Network Protocols for File Transfer

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Introduction

Networking Windows for file and printer sharing can be accomplished with three different protocols, TCP/IP, NWLink (an IPX/SPX compatible protocol), and NetBEUI. All three of these protocols have been included with Microsoft Windows since Windows 95. The primary purpose of this paper is to determine through an experiment which protocol offers the highest throughput for general network file transfers. In addition to network performance, the paper will also examine some of the advantages and disadvantages of each protocol.

TCP/IP was developed in the 1970's by Vinton Cerf and Bob Kahn. It was officially adopted by the Arpanet (the early Internet) in 1983 (Hartley, 1996). Since then it has continued to be the protocol of choice for many networking applications including the Internet. The power of TCP/IP is that it is a routable protocol. This means networks are not limited to LANs; packets of data can be routed across the world making the Internet possible. Microsoft began using TCP/IP for file and printer sharing with the first release of its Windows NT operating system. Since then Microsoft has gradually moved to TCP/IP as the standard protocol for Windows networking.

IPX/SPX is heavily based on XNS which was developed by the Xerox Corporation in the late 1970's. IPX/SPX was developed by Novell for their Netware line of PC file servers. IPX/SPX is also a routable protocol meaning internetworking is possible; however, TCP/IP has traditionally been favored for this purpose. It is more likely seen in LANs. Microsoft has included IPX/SPX with Windows to provide access to these Netware servers, but it has other uses as well. It has often been used as the preferred protocol for certain LAN multiplayer games. It can also be used to network

Windows computers together for file and printer sharing. Technically Microsoft does not include IPX/SPX in Windows; instead it uses NWLink which is an IPX/SPX compatible protocol (Allen, IPX/SPX Protocol Suite).

NetBEUI was developed by IBM in the mid 1980's for use in its LAN Manager product. Microsoft began using it with their Windows for Workgroup software. Since then Microsoft has included it with all their Windows operating systems; although, with the release of Windows XP, it is no longer supported by Microsoft. Instead Microsoft has made a big push to make TCP/IP the standard for Windows networking. Beginning with Windows XP Microsoft is no longer listing NetBEUI in its list of available protocols, although it can still be installed separately from the install CD. One of the reasons for this is that NetBEUI is a non-routable protocol meaning it is only suitable for LANs on a single segment (Allen, NetBEUI Protocol).

The Experiment

The question this paper hopes to answer is, "which of the above protocols is the fastest for file transfers between two Windows computers on a LAN?". To answer this an experiment was performed to test the speed of file transfers.

The experiment was performed using two identically configured computers linked together via a CAT5 Ethernet crossover cable. A detailed list of components in the two computers can be found in Appendix A. Network speed was (a maximum of) 100 Mb/sec. The experiment was run using fresh installs of Windows 98 SE (Second Edition) and then Windows 2000 SP2 (Service Pack 2) to see if there was any difference

in performance between the two operating systems. No extra software was added (other than a "typical" install of the operating system), nor were any third party drivers used.

To perform the experiment one computer was setup as a server, while the other computer acted as a client. A shared folder on the server was mapped to a drive letter on the client. For each protocol/operating system two tests were performed with different datasets. One by uploading (to the server from the client) a single 623 MB file, and another by uploading 198 files totaling 472 MB. The second test is probably more indicative of "normal" network traffic. Files were uploaded a command-line batch file that returned the system time, uploaded the files, and returned the time again. The difference in time was then recorded. After each file transfer, the file(s) was removed from the destination (server) and each computer was rebooted. File transfers for each dataset and each protocol were performed five times (the average time will be listed in the results section.) After each protocol was tested, both computers' hard drive were defragmented (although it did not appear fragmentation was much of an issue.)

The Results

The results of the experiment are below. For ease of analysis, average times for each protocol tested are shown. A complete listing of all trial can be found in Appendix B. Dataset 1 will refer to the single 623 MB file, while Dataset 2 will refer to the 198 files totaling 472 MB. Time is measured in seconds and Throughput is measured in Megabits per second (MB/sec.)

Operating System	Protocol	Dataset	Time	Throughput
Windows 98 SE	TCP/IP	1	263	19
Windows 98 SE	TCP/IP	2	287	13
Windows 98 SE	NWLink	1	320	16
Windows 98 SE	NWLink	2	262	14
Windows 98 SE	NetBEUI	1	265	19
Windows 98 SE	NetBEUI	2	292	13
Windows 2000 SP2	TCP/IP	1	82	61
Windows 2000 SP2	TCP/IP	2	113	33
Windows 2000 SP2	NWLink	1	122	41
Windows 2000 SP2	NWLink	2	130	28
Windows 2000 SP2	NetBEUI	1	125	40
Windows 2000 SP2	NetBEUI	2	132	28

Analysis

First the results for Windows 98 SE will be analyzed, then the Windows 2000 SP2 results will be analyzed. Finally the results of Windows 98 SE and Windows 2000 SP2 will be contrasted.

Using Windows 98 SE while transferring Dataset 1 (single 623 MB file), the TCP/IP protocol had the shortest (best) time at 263 seconds. NetBEUI was close behind at 265 seconds and NWLink lagged behind with the longest transfer time of 320 seconds. For Dataset 2 (198 files totaling 623MB) under Windows 98 SE the results come in differently. NWLink had the shortest transfer time of 262 seconds. TCP/IP and

NetBEUI had longer times of 287 and 292 seconds respectively. It's interesting to note that while NWLink took the longest time (320 seconds) to transfer Dataset 1, it had the shortest time while transferring Dataset 2.

The results for Windows 2000 SP2 turned out to have more of a consistent pattern between the three protocols. In transferring Dataset 1, TCP/IP had the shortest average time of 82 seconds. NWLink came in next at 122 seconds and NetBEUI had the longest time at 125 seconds. The results for Dataset 2 were similar; TCP/IP had the shortest time at 113 seconds. Again NWLink and NetBEUI lagged behind at 130 and 132 seconds respectively. While transferring either Dataset1 or Dataset 2, TCP/IP had much shorter times than either NWLink or NetBEUI.

In contrasting Windows 98 SE and Windows 2000 SP1 it is clear that Windows 2000 SP2 is the platform to use when looking at network file transfers (no matter which protocol is used.) When transferring Dataset 1 (ignoring protocols for the moment) Windows 2000 SP2 has the fastest time of 82 seconds. The fastest time in Windows 98 SE for Dataset 1 is 263 seconds (more than three times Windows 2000 SP2.) The same is true for Dataset 2. The fastest time in Windows 2000 SP2 is 113 seconds, while in Windows 98 SE the fastest time is 262 seconds (well over two times Windows 2000 SP2.)

So why is Windows 2000 SP2 so much faster than Windows 98 SE in the experiment? Windows 2000 is based on Windows NT technology, which is Microsoft's network operating system. The code in Windows 2000 may be more heavily optimized for network performance when compared to operating systems based on the Windows 9x kernel. The device drivers used in Windows 2000 SP2 may also be more finely tuned

when compared to the older drivers of Windows 98 SE. Finally, Windows 2000 SP2 is a newer operating system than Windows 98 SE; it's only natural to expect better performance from that which is newer.

Conclusion

The experiment generally shows TCP/IP to be the leader in performance; however, there are other things to consider when choosing a protocol for Windows networking such as security and ease of setup. TCP/IP may be the fastest protocol in the experiment, but it poses certain security risks. Because TCP/IP is a routable protocol (and the protocol of the Internet), when a user connects to the Internet he/she may unknowingly be sharing files to the world. There are personal firewall solutions that can alleviate this problem, but in turn makes setup harder. TCP/IP also requires the most time to setup: IP addresses, subnet masks, gateways, etc… must all be configured for TCP/IP to work properly. However, TCP/IP is fast becoming the standard for all things networking, and in many environments may be a requirement.

NWLink has no setup hassles for small LANs. It is really a plug-and-play protocol. Although IPX/SPX packets can be routed, NWLink packets will also not be routed on an Internet connection so files would be safer without any additional firewalls to set up. Some multiplayer computer games also require that an IPX/SPX compatible protocol be installed although recently game manufactures are tending more toward TCP/IP. Finally NWLink would be required to connect to certain Novell Netware file servers.

NetBEUI is also a plug-and-play protocol. It is also secure in the fact that it is non-routable, so files cannot be accessed beyond the LAN. However, given the fact the NetBEUI was often the worst performer in the tests and is no longer supported by Microsoft, NetBEUI may be a poor choice. If security is a concern, IPX/SPX may be better suited to the task of file sharing on Windows networks.

In the end however, the experiment was about finding the best performing protocol for file transfers in a Windows based network. Windows 2000 SP2 in combination with TCP/IP certainly offers the best performance. Under Windows 98, the results are not quite as clear.

References

Allen, Doug. IPX/SPX Protocol Suite. [On-line http], http://hdallen.home.mindspring.com/ipxspx.htm.

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Hartley, Steven. (1996). History of the Internet. [On-line http], http://www.securenet.net/members/shartley/history/index.htm.

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Appendix A

Relevant components from the two computers used in the experiment. (Note: both computers were identically configured.)

Motherboard: Asus P2B

CPU: Intel Celeron 400MHz

Memory: Generic 64 MB SDRAM

Hard Drive: Western Digital Caviar 14300 (4311.9 MB)

Ethernet: 3Com 3C905B (100Mb/sec PCI)

Appendix B

Complete list of trials for each protocol and operating system. (Note: All times are in seconds)

Windows 98 SE

TCP/IP - 1 file / 623 MB

Trial 1	Trial 2	Trial 3	Trial 4	Trial 5
267	263	263	261	263

TCP/IP - 198 files / 472 MB

Trial 1	Trial 2	Trial 3	Trial 4	Trial 5
287	286	287	286	288

NWLink - 1 file / 623 MB

Trial 1	Trial 2	Trial 3	Trial 4	Trial 5
319	320	323	319	321

NWLink - 198 files / 472 MB

Trial 1	Trial 2	Trial 3	Trial 4	Trial 5
270	260	260	260	260

NetBEUI - 1 file / 623 MB

Trial 1	Trial 2	Trial 3	Trial 4	Trial 5
264	266	264	265	264

NetBEUI - 198 files / 472 MB

Trial 1	Trial 2	Trial 3	Trial 4	Trial 5
293	285	299	293	290

Windows 2000 Professional SP2

TCP/IP - 1 file / 623 MB

Trial 1	Trial 2	Trial 3	Trial 4	Trial 5
81	84	79	82	84

TCP/IP - 198 files / 472 MB

Trial 1	Trial 2	Trial 3	Trial 4	Trial 5
113	115	115	112	111

NWLink - 1 file / 623 MB

Trial 1	Trial 2	Trial 3	Trial 4	Trial 5
117	120	121	127	126

NWLink - 198 files / 472 MB

Trial 1	Trial 2	Trial 3	Trial 4	Trial 5
126	136	131	126	132

NetBEUI - 1 file / 623 MB

Trial 1	Trial 2	Trial 3	Trial 4	Trial 5
117	126	125	129	128

NetBEUI - 198 files / 472 MB

Trial 1	Trial 2	Trial 3	Trial 4	Trial 5
124	130	132	138	137