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Defragmentation Technology Boosts Windows NT/2000 Performance



Figure 1: Graphic analysis: The red areas represent fragmented files and the white show fragmented free space. Note that system files (green) and Paging File (yellow) are seriously affected. With a disk in this condition, performance is slowed markedly. The longer a user waits to defragment his or her disk volumes, the worse the computer runs.

**Network Speed and
Responsiveness Improve
Dramatically.**

Bob Dobbin

At CD Associates, Inc., we design and build high quality CD, CD-R and DVD analysis and testing equipment. Like many other mid-sized companies, our main corporate communication system is NT-based. We have five servers and approximately 60 workstations. This network is vital to virtually all aspects of our business existence: from e-mail and Internet access to software development and control applications. Suffice to say, the speed of our corporate production is proportional to the speed of the network.

But even more importantly, our NT network plays a central role in the delivery of our products. A CD or DVD replication facility can have many production analyzers networked together. As the speed of those networks degrade, our customer's perception of our equipment diminishes. In several cases, we have wasted thousands of dollars of customer support travel to find no problem with our data acquisition and analysis equipment, but only slows in network and disk performance. For this reason, urgency existed in finding the right reason for network slows, as well as a solution to preventing performance degradation.

Fragmentation and its Consequences

We first became aware of fragmentation after noticing that our NT network had slowed noticeably over a period of several weeks. After checking for obvious problems such as a faulty processor or a memory shortage without success, we investigated further and discovered fragmentation to be at the root of the problem.

Essentially, fragmentation affects both files and free space. Instead of files being written contiguously, they are scattered in many pieces around the disk. Similarly, rather than being pooled together, free space exists in many small pieces. Fragmentation causes a variety of situations, such as

files/applications taking a long time to open, extended reboots and backups taking much longer than they should. Some users even report files taking as much as three times longer to open. On our system, one server in particular was severely affected—48 percent fragmented. I printed out a list of several pages of files that were shattered into hundreds of fragments. One Outlook file, for instance, consisted of 2,265 pieces alone. Worse, two-thirds of the free space on the volume was badly fragmented. It was no wonder performance had stuttered badly.

Review of Solutions

Before choosing a network defragmenter, we embarked upon a thorough study of the market. Some vendors offered "optimization," the process of moving all the files on a disk to specific locations in order to minimize head movement. While the theory sounds good and may help on an individual workstation, optimization didn't appear to provide any tangible benefit to a network (see NSTL white paper, October, 1999, "System Performance and File Fragmentation in Windows NT," www.execsoft.com/whats-new/whitepaper.asp#_Toc463770003). After all, with many users logging onto a server to read and write to various files, it becomes quite difficult, if not impossible, to determine where files need to be placed in order to keep head movement low. While most companies insist that certain critical NT system files (specifically the Master File Table and Paging File—see below) can only be defragmented during boot time, one vendor claimed to take care of these types of fragmentation online. On investigation, however, we found that this approach bypasses the operating system and the Windows Application Programming Interfaces (APIs) in order to operate. As a result, it holds the potential of creating blue screens or corrupting data, not something we could afford at our facility.

In the end, we selected Executive Software's Diskeeper. In addition to being able to meet our NT performance requirements, it was the only utility to pass Microsoft's rigorous Application Specification for Windows 2000 Certification, a virtual guarantee of reliability and safety.

Defragmentation in the Lab

A network defragmenter is installed across the network using System Management Server (SMS—a software product from Microsoft that enables the system administrator to do such things as install and run new software on computers across the network, all from a single console or location). Once you have loaded the defragmentation software, you should view the state of fragmentation on your network. Open the utility, click on the Analyze button and choose which disks, partitions or machines you want to view (see Fig. 1). Print off the report so you have a document to use for later comparison.

The next step is to run defragmentation manually across the network. This is accomplished simply by clicking the Defragment button shown in Fig. 1. As the application automatically defaults to normal priority, however, you may want to reset it. If you prefer to get it done fast and don't mind a loss of system overhead, set it to "Highest." If overhead is a concern, setting it to "Lowest" means that it will take longer for defragmentation to complete.

When manual defragmentation is done, select "View Report" to see what kind of the shape the disk is now in. Don't expect instant miracles; there are certain types of system files that are not addressed during regular defragmentation files. Until these are handled, your manual defragmentation attempts may have variable levels of success.

Directories and System Files

While manual defragmentation of Windows NT takes care of many problems, it does not touch fragmentation of the Master File Table (MFT), Paging File or directories. This is due to an important NT safety factor.

Safe online defragmentation is made possible by special APIs (See http://msdn.microsoft.com/library/psdk/winbase/filesio_9z5f.htm). In accordance with these APIs, a reliable defragmenter locates all the fragments of a file and copies them to a contiguous location. It then verifies it has made an exact duplicate of the original. Finally, the pointers are changed in the MFT and the old file location is deallocated so that it is now recognized and can act as free space. This safety feature guards against corrupted files and system crashes that could otherwise be generated by online defragmentation.

The downside is that the APIs for NT do not permit online defragmentation of the MFT, the Paging File or directories. Why? Once the NT operating system starts up, system files are always open and cannot be moved or deleted. Any attempt to defragment them (except at boot time-see below), therefore, is potentially hazardous.

MFT

The MFT is an index of every file on an NTFS (NT File System) volume. As you create more files, the MFT expands. Like regular data files, the MFT is prone to fragmentation. It slows file retrieval and in extreme cases can prevent a system from rebooting. Additionally, when data files themselves are badly fragmented, it hastens MFT fragmentation, leading to a sluggish system.

Paging File

The Paging File is a virtual memory file. The NT operating system uses it to transfer data to and from RAM as needed. If the Paging File becomes fragmented, it has definite performance repercussions. It increases the time it takes to scroll through pages on screen, for instance, or adds time to the opening and closing of files. As the NT O/S always holds an active Paging File open, it is impossible for online defragmenters to access it. Paging File fragmentation, therefore, is addressed offline.

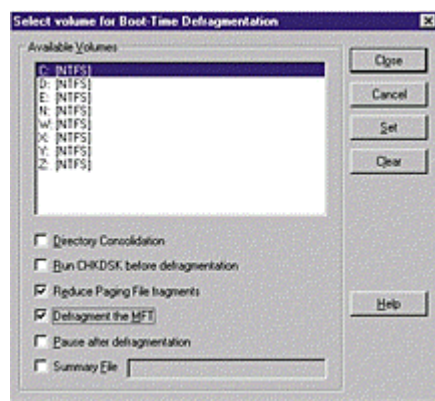


Figure 2: Boot-Time defragmentation options: On Windows NT, the safe and effective way to defragment the MFT, Paging File and directories is to do it during boot-time.

Directories

In NT, directories tend to be written randomly throughout a disk volume, breaking up free space and presenting a barrier to effective defragmentation. Any time you install a new application that creates multiple directories, for example, you end up with directories scattered all over the place. Boot-time directory consolidation groups them into a single location.

Safe Boot-Time Defragmentation

The safe and effective way to consolidate the MFT, Paging File and directories is during a reboot. To commence boot-time fragmentation, click on the "Action"

button at the top left of the screen shown in Fig. 1. Select the volumes for defragmentation, and put a check next to directories, MFT and Paging File (See Fig. 2).

For those who find it hard to countenance the idea of rebooting the system to accomplish defragmentation, there is an alternative. The latest version of Diskeeper comes with a feature known as Frag Guard that reduces the need for its boot-time mode. After you perform an initial boot time run upon installation, Frag Guard monitors system files and inhibits their tendency to splinter. It is accessed via the Actions option and clicking on Frag Guard.

Network Scheduling

Next, a maintenance schedule should be established. The product's "Set It and Forget It" scheduling handles this, running automatically in the background or after hours. It is accessed via the Action button at the top left of the main screen (see Fig. 1). This activates a pull down menu. Select "Set It and Forget It" and specify the time periods when you want the utility to run, as well as the partitions and machines. Additionally, when scheduling a network, first set the overall schedule before specifying any exceptions.

When it comes to frequency of scheduling, however, there are a number of variables. The size of a disk, its level of activity, the size and types of files used, the number of nodes on a network all affect how often fragmentation should be scheduled. It's best, therefore, to keep a close watch on the state of the condition across the network via the Analyze function. As a rule of thumb, if the analysis report shows that fewer than 50 files per run were moved, you have it working at an optimum level. If the number is increasing or is more than 50 files, schedule the process more frequently.

Defragmentation of the new Windows 2000 OS

Windows 2000 brings some advancements to defragmentation technology. The APIs that make online defragmentation possible have been revised to permit directories to be consolidated online (the MFT and Paging File must still be defragmented at boot-time). Also, the new operating system comes with a limited built-in manual defragmenter that is more than adequate for the individual user. It does not offer scheduling or boot-time defragmentation and only functions manually on one volume at a time. For these reasons, it's best to upgrade to a full-featured network defragmenter.

Another important development is the Windows 2000 Certification program. Microsoft is awarding the Windows Certified logo to third-party applications, providing they pass a grueling several hundred page-long checklist based on the Windows 2000 Application Specification. This ensures that software is reliable, robust and takes full advantage of new technologies built in to Windows 2000.

This quality assurance program actually makes it easy to locate software that is safe and reliable enough to be used in the lab. One of the prime reasons I chose Diskeeper, therefore, was due to its achievement of Windows 2000 Certification. It was the very first utility recognized by Redmond's certification process and remains one of a handful of utilities to pass to date. But perhaps most importantly, it is the only defragmenter to make the grade (As the list of products is regularly updated, view the current list of Windows 2000 Certified products at: <http://www.microsoft.com/WINDOWS2000/upgrade/compat/certified.asp>).



Maintaining High Performance

Based on our own experiences, the following conclusions can be made:

1. Fragmentation slows system speed and responsiveness markedly and is a definite factor in performance degradation.
2. Microsoft recommends that facilities utilizing Windows NT/2000 perform defragmentation on a regularly scheduled basis across the network.
3. Where possible, use products that are Windows 2000 Certified.

By following these points, and conducting defragmentation as outlined above, Windows NT/2000 performance can be maintained at a high level.

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Fragmentation Performance Tests

Recent studies into the subject of fragmentation show both its pervasiveness and its impact on system performance. American Business Research of Irvine, California, investigated the extent of fragmentation among 100 randomly sampled companies. 50 percent had files that contained between 2000 and 10,000 fragments on their servers, and another 33 percent discovered files fragmented into 10,333 to 95,000 pieces.

While these numbers appear alarming, they don't mean much unless viewed against system performance. Accordingly, the National Software Testing Lab (NSTL) of Conshohocken, PA recently conducted the first-ever independent performance tests of fragmentation/defragmentation on Windows NT and Windows 2000 servers and workstations. The results of these tests demonstrated that fragmentation exerted a much more substantial toll on system performance than previously realized. After running the defragmentation program, system speed and responsiveness rose impressively.

NSTL carried out tests on four common configurations of Windows 2000 and NT, running various combinations of Excel, SQL Server 7.0, Outlook and Exchange (see Fig. 1). On a Pentium II 266MHz workstation with 96 MB of memory and a 2 GB IDE hard drive running Outlook/Excel and Windows 2000, NSTL noted an 85.5 percent increase in system speed after defragmentation (74.5% on NT). On a PII 400 MHz workstation with 228 MB RAM and a 4.2 GB HD, Windows 2000 performance rose by a hefty 219.6 percent (80.6% on NT). On a Pentium Pro 200, 64 MB RAM, 2 - 4 Gig HD running Exchange Server & SQL Server, NSTL noted an 83.5 percent increase in system speed after defragmentation (56.1% on NT). On a Pentium PRO 200 with 128 MB of RAM, two 4-GB SCSI HD's running Exchange and SQL 7.0, Windows 2000 performance improved by 61.9%, compared to 19.6% for NT. The numbers increased on a Pentium PRO 200 with 64 MB of RAM, two 4-GB SCSI HD's running Exchange and SQL 7.0. Windows 2000 registered gains of 83.5% and NT at 56.1% (Note: These results can be viewed at:

<http://www.execsoft.com/whats-new/benchmarks.asp>).

