Disk Defragmentation – Background

Fragmentation: A Fact of Life

Fragmentation is a natural occurrence that cannot be avoided, but it can be controlled.

Every hard drive stores files in chunks called *clusters.* In the Microsoft® Windows XP® operating system, clusters usually are 4,096 bytes in size. A file of that size or smaller needs just one cluster. But a file that is 4,097 bytes in size requires two clusters (leaving most of the second one empty). A 50MB file uses more than 12,200 clusters.[1]
In an ideal world, all of a file's clusters would be located adjacent to each other in one long, unbroken chain. With contiguous clusters, a hard drive's performance improves. Files can be read more quickly since the drive's read/write heads don't need to move a great deal.

But that's theory. In the real world, files are very often stored in clusters scattered across the drive. This is fragmentation, a natural occurrence. The result is degraded system performance that continues to erode as a disk's content becomes increasingly fragmented through ordinary use as files are created, deleted, and modified. Fragmentation can't be avoided, but it can be controlled.

Big Disks, Big Files, Big Problems

Defragmentation is the only way to reverse inevitable performance degradation.

Hard drives are bigger. For less than $600, consumers can purchase a complete name-brand personal computer, including a flat-panel monitor and a 160GB hard drive. On its XPS line of performance PCs, Dell offers drives up to 500GB (50,000 times the capacity of the 10MB drive offered in the IBM® PC/XT in March 1983). Just a few years ago, PCs with hard drives bigger than 1GB were a rarity. Now, even laptop PCs with 100GB drives are increasingly common.

As hard drive capacities soar, files are rapidly growing in size. Video files can exceed 1GB and image files from photo-editing applications[2] often are as large as 300MB. With high-definition video just around the corner and the digital camera megapixel arms race escalating, file sizes will continue to skyrocket. In commercial server-based database applications, files exceeding 1TB (equivalent to one million MB) are increasingly common.

Big drives and big files result in far more disk fragmentation than just a few years ago. And with these large files often broken into hundreds, or perhaps thousands of fragments, system performance can quickly slow to a crawl.

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[1] For more information on cluster size, see support.microsoft.com/kb/140365/EN-US.
[2] Such as Adobe® Photoshop® and Corel® Paint Shop Pro®.

Regular Defragmentation Is Essential

Fragmentation occurs every day. Automatic defragmentation maintains peak hard drive performance.

Disk drive capacity doubles roughly every 18 months. In this environment of spiraling drive capacity and enormous file sizes, the need to defragment more frequently is crucial to maintaining disk health and high performance levels.

Automatic defragmentation, enabled by default in Diskeeper 2008 avoids performance degradation. Handling file fragmentation as it occurs keeps defragmentation times brief and system resource consumption minimal. The alternative, performing infrequent manual, weekly or monthly defragmentation is almost certain to run for a considerable length of time and tie up system resources. Worse, the computer user will incur a performance penalty from the daily buildup of file fragmentation until the disk has been defragmented.

As you'll see in the reviewer's guide, with Diskeeper, defragmentation is completely automatic and invisible to the user.

Defragmentation Improves Performance

Independent tests clearly demonstrate the pitfalls of fragmentation and the benefits gained by running Diskeeper.

- Testing by independent laboratory NSTL resulted in performance gains of 67.9% to 176.1% for systems running Microsoft Outlook. Performance with Microsoft Excel improved 83.6 percent.
- Tests by Windows IT Pro documented fragmentation related performance degradation of up to 198% with Internet Explorer, and up to 123% when performing a comprehensive anti-spyware scan. Saving a large document in Microsoft Word resulted in fragmentation related performance degradation of up to 1,489%.

Frequent Defrag Extends Disk Life

Fragmented files require excessive disk head movement when they are accessed. Defragmenting a fragmented file uses resources one time, once fragmentation is eliminated the disk saves resources every time that file is accessed. Running a defragmentation job only handles fragmented files, so in the long run performing frequent defragmentation reduces resource consumption and extends disk life.

Diskeeper 2008 is the ultimate automatic defragmenter. It operates in the background invisibly, defragmenting as needed. This approach reduces disk head movement, extends disk life and ensures systems stay at peak performance.

Cost Effective For Corporations

Degraded disk performance is not just a user problem. It affects the entire corporation. Diskeeper restores productivity, extends hard drive life spans, and reduces help-desk calls.

- Automated disk defragmentation frees users from manually maintaining their systems, saving time.
- Reduced disk activity leads to longer life spans and fewer crashes.
- Server efficiency improvements allows administrators to assign more users to a server, saving on infrastructure costs.
- Improved system stability reduces the number of help-desk calls.
- Fragmentation is a productivity robber. Losing just four minutes per day to slower PC performance is equivalent to a loss of more than 16,600 hours in a corporation with 1,000 employees.[3]

Systems File Fragmentation

The impact of fragmentation on system performance differs based on the usage of the fragmented files. For example, a single infrequently used Microsoft Office document is unlikely to have an impact on overall system performance. However, fragmentation of a paging file, which provides virtual memory to all applications on a system, will likely have a more noticeable impact.

Fragmentation affects all files, even system files. For example, the Master File Table (MFT) grows in size as the number of files and directories increases. As it grows, the MFT is almost certain to occupy non-contiguous clusters, becoming fragmented. Even the metafiles within the MFT can be allocated in non-contiguous clusters and therefore can become fragmented.

Why Does Fragmentation Occur?

When the operating system deletes a file, it frees the associated clusters for use by another file. When the operating system saves a new file, it locates an available cluster, saves some of the file, and then jumps ahead to the next available cluster until the entire file is stored. Because files are constantly being written, deleted and resized, fragmentation is a natural, unavoidable occurrence. Not only do files become fragmented, free space becomes fragmented, too.

Web browsers create many fragmented files. As users visit web sites, the operating system stores temporary files on the hard drive. Those files are purged at some future point – generally when the user clears the cache files. It's not uncommon for a PC to store tens of thousands of these files simultaneously, including images, cookies, scripts, and other file types. The result is a patchwork of fragmented files that becomes an enormous drag on system performance and health.

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[3] Calculated as (4 min. per day × 5 days per week × 50 weeks per year × 1,000 employees / 60 min. per hour = 16,666 hours).

Windows Defragmenter Is Not Enough

Yes, it's true. Microsoft Windows includes a built-in disk defragmentation utility. Is it enough? No way!

The defragmentation software supplied with the Windows operating system is a duct tape solution. Though Microsoft has improved disk defragmentation for Vista (as noted) the built-in defragmenter in Windows still falls short on many counts:

- Does not include a native scheduler, it must be started manually for each use
  - Vista defragmentation is only pre-scheduled to run once a week (build 5384); presents high possibility of missed defragmentation (e.g. the machine is powered off) and can extend into user production time the following day against the will of the system administrator. Missed defragmentation reschedules for the next available interval.
- Not capable of performing complete defragmentation (no boot time defragmentation of paging files)
- Does not contain advanced sequencing technology to increase file access time
- Is usually run reactively only after PC performance deteriorates
- Cannot be used across a network in any capacity
- Designed for a time when 3GB drives were the norm and file sizes were much smaller, it often cannot defragment large files or large volumes
  - Vista defragmentation is not well suited for large disks. Defragmentation run times and resources increase and speed slows dramatically as the number of files on a volume increases. The increase in time required to defragment a volume is far greater than the increase in the number of files needing to be defragmented.
  - With Vista, the amount of memory required for defragmentation grows linearly with the amount of files being defragmented. This memory can grow beyond the system's capacity if a sufficiently large number of files are present on the volume. This can result in a hung system.
- High resource usage that severely tax the PC while it runs
  - Vista resource usage has been reduced, but it is no where near able to operate in the background.
- Does not consolidate free space
- Runs very slowly
- Provides extremely limited reporting tools. Note, Vista provides even less reporting than its predecessors.

Diskeeper 2008 addresses these shortcomings:

- Invisi-taking, a new technology in Diskeeper 2008, ensures that automatic defragmentation runs transparently in the background.
- Fully automatic operation eliminates the need to schedule defragmentation.
- Thoroughly defragments applications, systems files and free space
- Calibrates file performance by learning which files are used most (I-FAAST)
- Runs proactively to avoid compounding problems
- Works across networks; supports multi-terabyte server volumes
- Supports very high-capacity drives and easily handles extremely large files with ease

- Provides robust reporting, allowing users to easily assess the state of disk performance and health. Diskeeper 2008 provides many historical reporting tools to illustrate the ROI of automatic defragmentation.

Target Audience

Every system, from the entry-level home PC to the largest enterprise servers with huge amounts of storage, is subject to fragmentation and the resulting erosion in performance. Diskeeper offers different editions of Diskeeper 2008 for each market segment. (Please refer to the separate document that describes the features of each edition of Diskeeper 2008.)

Business Users. For those who rely on their PCs for a living, slow computer performance can kill productivity and an ill-timed crash can have disastrous results. Diskeeper eliminates fragmentation-related slowdowns and crashes.

Corporate System Administrators. Routine manual defragmentation of every machine on a corporate network is impractical due to the labor and time that would be required. That's why most corporations that rely on manual defragmentation wind up never defragmenting at all.

Diskeeper keeps every machine defragmented all the time with no intervention required. Likewise, servers that need to run 24/7 can't be taken down for manual defragmentation. The Diskeeper product line includes Server editions specially designed to keep large servers defragmented with no performance loss during defragmentation.

Novice Users. By automating the defragmentation process, Diskeeper makes the computer "maintenance free," eliminating the need for non-expert users to intervene in ongoing disk maintenance.

Power Users. For power users who regard their computers as finely-tuned machines, Diskeeper offers detailed reports and screens that show exactly what's going on "under the hood."

Gamers. For gamers frustrated by slow load times, choppy animation, and low frame rates, Diskeeper optimizes load times, speeds transitions between game phases, and eliminates disk-related slowdowns.

Web Surfers. Browsing is a disk intensive affair as Windows constantly writes to and reads files from the internet cache. With sites frequently serving up hundreds of temporary files, surfing leads to serious fragmentation. Diskeeper eliminates this problem, providing lightning-fast Internet cache reads and writes, eliminating fragmentation buildup.