



White Paper

The Benefits of Disk Optimization in a Corporate Environment



Introduction

The seemingly mundane area of disk defragmentation and disk optimization can actually provide dramatic improvements to an organization's bottom line. This is why many of the world's Global 1000 companies and thousands of small- and medium-size businesses use PerfectDisk to improve their system performance and overall IT environment. PerfectDisk helps keep your company's servers up and running.

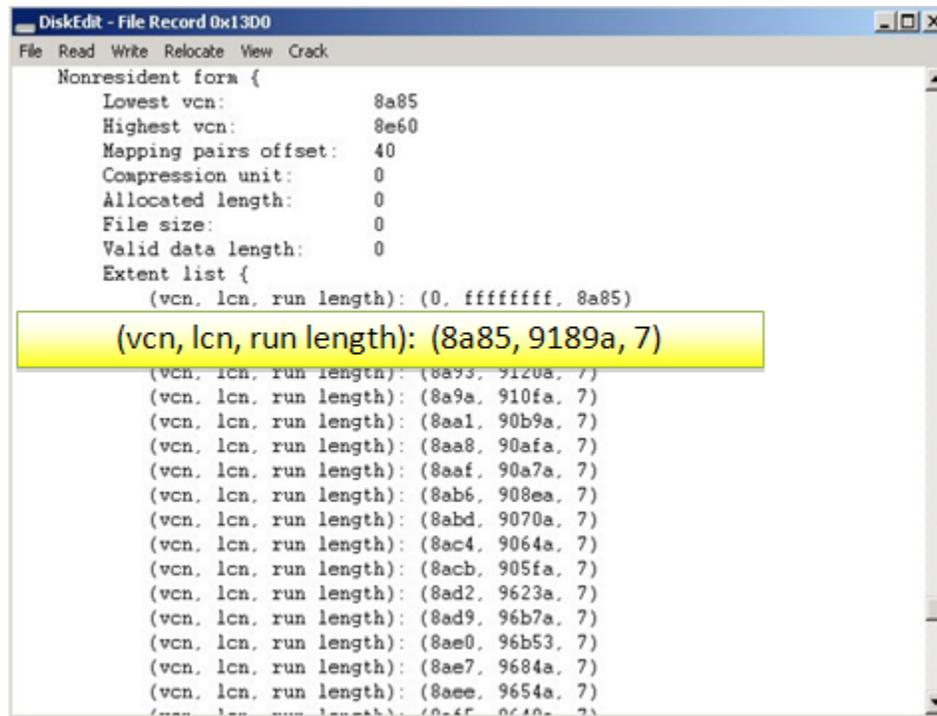
In addition, Raxco offers additional products that provide exceptional system response on both physical and virtual Windows Servers. Disk optimization is the process of logically organizing disks so they are accessed in the fastest possible time. Disk optimization provides users with the best system response, faster backups, faster application launches, better disk space utilization, and less resource consumption. In the event a performance issue arises, proactive disk optimization reduces troubleshooting time by eliminating file and free space fragmentation as a problem.

What is Disk Optimization?

Simply put, disk optimization is the process of keeping disks organized to produce the fastest possible read/write times. This is accomplished by keeping the files in as few pieces as possible and consolidating the free space on the disk. The negative impact of file and free space fragmentation are well-documented in Microsoft's TechNet and in other Windows forums.

There are two kinds of file and free space fragmentation, logical and physical. Disk optimization deals with the logical fragmentation which is how the Windows NTFS file system "sees" the disk. When a file is created NTFS creates a record for the new file in the Master File Table (MFT) which is the index to the volume. Windows then requests space for the file and NTFS looks at a special file (\$Bitmap) that keeps track of used and free space. If \$Bitmap can locate enough contiguous free space to accommodate the file the starting address and the length of the allocated piece is passed to the MFT where it is recorded in the Extent List for the file. A single entry in the Extent List means a file is contiguous.

It is inevitable that at some point the \$Bitmap file will not be able to allocate contiguous free space for a file. When this happens \$Bitmap offers space wherever it can find until it provides enough to accommodate the entire file size. Each piece of free space has its starting address and length recorded in the file's MFT record Extent list. The figure below illustrates a list of fragments in a MFT record (a single fragment entry is highlighted).



File Fragments Listed in MFT Record Extent List

The Virtual Cluster Number (VCN) represents which piece of the file the fragment represents (1st, 2nd, 3rd ...). The Logical Cluster Number (LCN) is the starting address of the space and the Run Length is the length of the allocation in clusters. Each entry in the Extent List is a fragment. When a user wants to access a file each fragment's information is transferred to the disk controller. In many cases a file will be in thousands of pieces so there are thousands of entries in the Extent List. A MFT record is only 1KB in size, so when files are very fragmented the MFT record needs to be extended as well, with chained pointers connecting all of the pieces. Obviously, it takes less time and resources to transfer a single contiguous entry for a file. Fragmented files can take 15-20 times longer to access than a contiguous file of the same size.

Each file fragment is mapped to the physical disk by the disk controller. A contiguous file will require fewer physical I/O to the disk than the same file in 50 fragments. This means fewer disk I/O and better throughput when files are contiguous.

Benefits from Disk Optimization

Disk optimization is beneficial when the server is undergoing the kind of activity that produces file and free space fragmentation. This activity includes: file creation, file deletion, file extension and file truncation. Over time, this kind of activity chops the free space on the disk into smaller and smaller pieces. As the free space fragmentation increases the file system struggles to allocate contiguous space, and that's when file fragmentation accelerates. Free space fragmentation is the origin of file fragmentation.

File and free space fragmentation manifest themselves in a number of ways that adversely affect server performance. The symptom users notice most is sluggish performance. When systems need to deal with fragmented files they need to use additional memory and CPU resources as well. These resources are then unavailable to users. Systems accessing badly fragmented files usually suffer from slow file access and poor system response. Application launches are slower and, in severe cases, apps can hang or crash. System boot and shutdown can also be affected by fragmentation as well as the time it takes users to login to a server.

Historically we have seen all sorts of servers benefit from disk optimization.

File Servers- Based on the kinds of activity described above it is understandable that volatile file servers would benefit from optimization. File create/delete/extend/truncate activity trashes a disk very quickly with a corresponding decrease in performance. File servers, by their very nature, are subject to this kind of activity.

Application Servers- Like file servers, application servers that host transaction-based apps are another example. Any applications that process transactions that are later subject to modification or deletion are candidates for optimization.

Database Servers- Database servers benefit from optimization in two ways. First, optimization sees the database as a single file and tries to make it logically contiguous. Secondly, database log files are notorious for fragmenting since they grow over time due to discrete logging events. Optimization makes the log files contiguous.

Web Servers- Web servers where content is dynamic in nature also suffer from fragmentation. Large image files take longer to load when they are fragmented. Updates to blogs, news, videos and other changing elements that are part of a website are all victimized by fragmentation.

PerfectDisk defragments files at the file system level to provide the fastest possible read/write access to the file. It also consolidates the free space for the volume which slows down re-fragmentation. When the file system can find contiguous free space there is less fragmentation.

Disk optimization is an extra step you can take to maintain your computing environment. For example, some clients will periodically want full system backups of their systems on some scheduled basis. Disk optimization dramatically shortens backup time which means less system downtime. Should a system restore be needed, restoration of contiguous files from disk or tape is faster. In some instances, PerfectDisk has saved clients a full day of backup time.

System troubleshooting is another area where disk optimization is an asset. When problems are encountered system administration personnel need to investigate the possible source of the problem which can be a time-consuming process. File and free space fragmentation are often the culprits in performance-related problems. Proactive disk optimization removes fragmentation as a source of I/O related problems.

Disk optimization can be done on a scheduled basis or it can run unobtrusively in the background when it detects the system is idle. In this mode, the disk is optimized using excess system resources with no impact on users. When system activity increases the disk optimization process stops.

Disk Optimization and Virtual Servers

Virtualized Windows servers behave in the same manner as physical servers. When file and free space fragmentation are problems on physical servers it only affects the applications running on that machine. When file and free space fragmentation are problems on virtual servers it can affect all of the virtual machines on the physical host. An ESX physical host has a finite amount of resources. As fragmentation creates, excessive I/O on one virtual machine it can impact the performance of the other virtual machines on the same host.

Recent testing showed optimizing the Windows Server guest systems in a VMware environment minimized resource overload and improved overall performance. Data capture was done using VMware's vscsiStats utility¹ which counts and sorts all I/O coming through the storage stack. Using the same disks where one set was fragmented and the other optimized, the results were impressive.

On average, across all the virtual machines tested, the PerfectDisk results showed:

- A 28% reduction in total I/O. Optimization produces fewer I/O across the storage stack, reducing VMware overhead.
- A 12x increase in really large I/O. If fewer I/O are produced for the same work then many I/O are larger which is desirable.
- A 49% reduction in slow I/O. Fewer and larger I/O map better to the physical disk resulting in fewer disk accesses which improves disk latency²
- A 58% improvement in sequential I/O. Optimization with free space consolidation makes contiguous file creation easier.
- A 28% improvement in throughput. The difference in elapsed time to perform the identical tests was better with the optimized disks.

¹ vscsiStats comes with VMware and is useful utility for analyzing I/O related performance issues

² VMware says I/O taking more than 30ms to complete constitutes a disk latency problem. The PerfectDisk optimized disks reduced the number of I/O taking more than 30ms by almost half. Optimization sends fewer and larger I/O to the disk controller which means data can be mapped to disk with less physical disk I/O. As a result, I/O complete faster.

Environments

Anyone using Windows operating systems on servers or workstations will encounter file and free space fragmentation, guaranteed. To demonstrate this take a brand new disk and install Windows Server, some security software, a couple of applications and PerfectDisk so you have a way to look at the disk. A PerfectDisk analysis will show you have a couple thousand fragmented files and the free space is in hundreds or thousands of pieces; and this is before you do any work. Fragmentation is inherent in using Windows and as we have described it, with system use the problem compounds itself until it has an impact on performance and user response.

Fragmentation is application agnostic and it occurs in all industries from banking and manufacturing to transportation and government. A medical imaging vendor offers PerfectDisk with their turnkey systems delivered to doctor's offices and hospitals. Digitized medical images are very large files and prone to fragmentation. PerfectDisk keeps the images contiguous and the consolidated free space slows re-fragmentation. The contiguous images are accessed faster and save physicians time.

An e-commerce site that supports the online ordering system for a national pizza chain uses PerfectDisk to help it maintain an order rate of 20-100 orders per second. The high order creation, update and deletion rate demanded a solution that could keep the disk in optimal performance condition.

A printing company allows its customers to upload files and images to be printed and found that this could kill their file servers when the uploads got too fragmented. PerfectDisk resolved the issue.

In an effort to automate medical records a major hospital uses a Form Fast application that was causing major fragmentation with a corresponding performance hit. PerfectDisk maintains contiguous files and free space mitigating the problem.

Disk optimization works well with applications and other software utilities. It also works well with both direct attached storage and SAN technologies. PerfectDisk is currently working with a variety of SAN's and customers are using it with these platforms:

- EMC Clariions
- EMC VNX
- EMC VMAX
- HP EVA 6000, HP P4000
- Dell EqaulLogic PS5000 and PS6500
- NetApp/IBM
- Oracle/Pillar

Summary

There are many advantages to implementing an optimization solution for your environment. Performance and productivity improves. Savings are realized by reducing administrative costs, backup times, electrical power consumption and more. Today's computing is about speed. Everyone wants instant access to their data and the web. To make this possible, Raxco offers the tools that give companies an edge; to make and keep things faster on its server systems. PerfectDisk optimization software provides unparalleled administration, unbeatable performance and a solution that saves time and money.

15-Point PerfectDisk Quick Guide

1. File and free space fragmentation are inevitable on all Windows operating systems
2. Fragmentation is caused by file creation/deletion/extension and truncation
3. Fragmentation slows file read/write times
4. Disk optimization reorganizes the files as the Windows file system sees the file; the disk controller decides where the file goes on the disk
5. Fragmentation affects all kinds of servers
6. Fragmentation symptoms include slow boot and shutdown, slow application launches, slow logins, application hangs and crashes and overall sluggish performance
7. Fragmentation impacts virtual servers as well as physical servers
8. Optimization delivers the fastest possible read/write times
9. Optimization speeds up backups and AV scans
10. Optimization saves troubleshooting time
11. Optimization reduces VMware overhead and disk latency while improving sequential I/O and throughput
12. Optimization provides excellent disk space utilization
13. Optimization can run in the background with no impact on users
14. Optimization works with direct-attached storage and SANs
15. Optimization saves time and money