# Windows IT Pro

## One Less Fire: Automating System Performance and Reliability

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I n the universal catalog of IT woes, fragmented hard disks on client computers is just one of those things that has to be dealt with. IT teams that are able to stay ahead of fragmentation can free themselves up and move on to other important tasks. However, failure to stay on top of the fragmentation issue can lead to a multitude of problems.

File fragmentation is a serious problem. As a disk gets more fragmented the workload on the operating system and hardware increases. It becomes more difficult for applications to read and write data, file corruption becomes a distinct possibility, the user experience is negatively affected due to system performance issues, and the reliability of the computer is endangered. Let's look at the impact of disk defragmentation on your users.

## Applications

The most common impact that fragmented drives can have on applications is a slowdown in read and write times for files being used by the application. This is especially true of applications that work with large files, such as image editing and video creation tools, but the slowdown can be noticeable with even standard office automation applications, especially as disks become more crowded with data. (For more information, please download the whitepaper, "The Impact of Disk Fragmentation," available at http://www.windowsitpro.com/cluster/docs/products/1/2/Diskeeper.whiteppr.final.pdf). Playback of video or music can be interrupted or delayed by the problems of reading fragmented files. Badly fragmented disks can even have problems simply loading applications at all as the executables and DLLs that make up the application can be fragmented and scattered physically all over the hard drive.

End users can also experience increased load times and, in the worst cases, the application can actually time out or lock up when it is unable to load. The IT help desk generally receives these problems when users say something like, "there is something wrong with my computer." These problems can be very time-consuming to solve, often because the problem is first thought to be caused by a corrupted application and not a fragmented hard drive. As a result, the IT staff often wastes significant time trying to diagnose these problems.

## System Performance

A quick look at the Windows Task Manager Processes tab will show you the hundreds of millions of I/O bytes read and written, even after the computer has only been running for a short time and when the disk is not fragmented. Disks that are fragmented make much more I/O work, which can create I/O bottlenecks. When a disk is fragmented, the system has more trouble reading and writing files when the disk does not allow the files to be written contiguously, or when existing files are scattered throughout the disk. IT departments rarely use the Windows performance tools such as Perfmon on desktop computers, but doing so enables the user to determine just what impact disk fragmentation has on the performance of the computer by monitoring the performance counters in the PhysicalDisk object.  This is not to suggest that you need to constantly monitor the system performance using Perfmon, but by having baseline information you can diagnose system issues as they occur.

You can use the following Perfmon counters to monitor the performance impact that file fragmentation has on a client computer system:

Avg. Disk Queue Length
Avg. Disk Red Queue Length
Avg. Disk Write Queue Length
Avg. Disk sec/Read
Avg. Disk sec/Transfer
Avg. Disk sec/Write
Split IO/Sec

These counters are all specifically related to how data is moved on the hard drives. By comparing baseline (non-fragmented disk) data to the data returned by a fragmented system, you can get a direct corroboration of the additional overhead being incurred due to disk fragmentation.

## Data Security

File fragmentation affects data security in at least three ways. The first is that it makes data backup more difficult, especially when run as a background task, due to the additional work the hard drives must do and the additional chance that the file may be corrupted. Fragmented files simply take longer to back up than contiguous files, and with the narrow window of opportunity inherent in a traditional daily backup process, delays in accessing and reading files mean that some files won't get the security of regular backup.

The second affect on security is the integrity of the files themselves. Severely fragmented files tend to be more susceptible to data corruption than contiguous files and forcing the operating system to write fragmented files increases the chance the data will be corrupted. Certain types of applications, such as desktop database products like Microsoft Access and Filemaker, are likely to encounter additional problems in maintaining uncorrupted data files on severely fragmented hard drives.

The third security issue is that removing data from hard drives necessitates that all of the disk sectors containing data be scrubbed. Significant disk fragmentation makes removing data that much more difficult.

## System Reliability

Disk fragmentation has a negative impact on system reliability across the board. From bootup to shutdown, a fragmented drive can cause problems with almost any system-level action in Windows. Remember that the Windows operating system constantly uses the disk-based page file. This means that reliable disk operation is critical to reliable system operation.

Fragmentation issues with the page file can cause "out of virtual memory" errors and can cause data loss, while a heavily fragmented Master File Table (the file allocation table used by NTFS) can slow the already extended boot process of a Windows computer. And since fragmentation doesn't get better on its own—instead getting much worse as the disk stores more data—these associated problems also continue to get worse.

Lastly, file fragmentation decreases the life of your hard drives.  Disk head movement is increased by the need to access data contained in fragmented files. The more disk head movement, the less mean time between failure (MTBF) will be experienced, shortening the life of the hard drive. Disk defragmentation, though it might be

envisioned as physically working the disks harder, actually increases the MTBF because of the overall reduction in the amount of disk head movement necessary to perform file access on unfragmented drives.

## Choosing a Defragging Tool

So now that we've established that a good defragmentation tool is a necessary part of a stable, reliable computing enterprise, let's talk about what you need in the tool you select for your environment.

## Performance

As hard disks keep getting bigger and bigger, it becomes more important for a good defragmentation tool to be able to completely defragment and optimize a hard drive quickly and effectively. The various defragmentation tools on the market do this in different ways. Some only defragment files, others offer disk optimization or manage free space, and still others offer more of a complete disk management system, giving the end user the ability to configure the type of defragmentation that is run.

It is also important to consider the performance of the defragmenter in different situations. Disks with a lot of free space are relatively easy to defragment, but as the drives fill up, defragmenting becomes more complex. A tool that works effectively when there is 50 percent free space on a drive may not run so well when the drive has only 20 percent space available. Some defragmenters have been known to fail with an insufficient drive space error when there seems to be a reasonable amount of free space. Others slow to a crawl and affect other applications. Be sure to check on the defragmenting software's performance under less-than-ideal conditions.

## Accuracy and Reliability

It may sound obvious, but it is critical that any defragmenting tool be accurate in its activities and reliable in its performance. Once you start reorganizing data on a hard drive, a minor error in data placement can cause major problems. Once again, judge your software choice by its capabilities on severely fragmented drives that are fairly full. The goal is to have a product that provides consistent, repeatable results. You should never be concerned that your defragmentation tool is the source of a problem.

## Defragmenting Effects

The ways in which the defragmentation process affects

overall system performance is an important consideration when choosing a defragging tool. The one exception to this if is you are planning to run scheduled defragmentation on the client computers only during off hours when the system isn't being used for any other activities. However, scheduled defragmentation still requires, minimally, management overhead to ensure that there are no conflicts with the established scheduled times. At the bottom line, the defragmentation tool should be able to be run transparently to the console user as a background task.

The defragmentation tool should be a well-written background application, adding a minimal amount of system overhead when foreground actions are being done and taking full advantage of system idle time. This does not mean that defragmentation shouldn't be able to be run as a foreground application in the event that a system really needs to have its drives defragmented, since there might be an occasional need to do just that. The tool should be able to take full advantage of the system resources available to it and cooperate well with other applications and user interactions if necessary.

## Disk and Volume Support

Your defragmentation tool should support all of the disk and volume options available on a Windows computer, such as volume sets, mirrored drives, RAID arrays, etc. It should also be compatible Windows services such as VSS (Volume Shadow Services) and backup services. The tool should also have support for the Microsoft recommended boot time disk cleanup activities, such as MFT and page file defragging and directory consolidation. Given the common use of multiple hard drives in workstations, as well as servers, the ability to defragment multiple volumes simultaneously is worth having.

## Enterprise Support

Ideally, you want a single tool that can be used throughout your enterprise. Although this paper focuses on the client side of the equation, the optimum choice is an application available for all of the Windows computers in your enterprise, both client and server. Support for automated installation of the proper version of the software, depending upon the target computer, should be included. This support should include the 64-bit versions of the Windows client and server operating systems, too.

The application should be available to be remotely

installed using push technology so that IT does not need to physically visit every machine in the enterprise. Upgrades should also be able to be deployed without requiring IT interaction with each computer.

## Support for Group Policy

Group policy support is critical for any enterprise application installed across the board, either via direct integration with existing Active Directory groups or through the ability to be used with AD groups created specifically for defragmentation management policies. The application should support management and configuration via the Group Policy interface. This enables the IT staff to configure defragmentation as appropriate for each defined group of clients.

## Centralized Management

As with any enterprise application, your defragmentation tool should have a centralized management interface enabling individual instances of the application to be monitored and controlled from a central location. This is important to note because tools such as the built-in Windows defrag are available to the user yet there is no way for the IT administrator to determine if that built-in tool is being used or the results of its use. At the very least, the tool should enable you to generate detailed reports on the activity of the defragmentation software on each computer, along with automatic generation of alerts for systems that do not meet your pre-defined criteria for successful defragmentation. A centralized database containing the reporting information that can be accessed from any authorized location on the network can also be an excellent addition.

The management interface should be clear and easy to use, not requiring the user or administrator to master any concepts that they are not already comfortable with. Information should be displayed in an easy-to-understand format and the interface should be customizable to the needs of the user.

## Windows Vista Defragmentation Tool

As with Windows XP and Windows 2000 Workstation before it, Windows Vista ships with a defragmentation tool as one of the system utilities. This defines the importance of having defragmentation available to the end user, but the tool in Vista doesn't go very far in solving the problems that a fragmented hard drive brings.

The built-in tool provides an adequate stopgap for a user not willing to invest in a better third-party tool and who is willing to spend the time running the defragger on each drive on their computer. Though the built-in defragger comes installed with a pre-configured defragmentation schedule, there is no management available, nor is there any way for IT to track the use of the defragger tool.

Though the use of the Vista defragmentation tool can be scheduled, there is no way of knowing if defragmentation has actually been run. If end users turn off the computer or stop the defragger from running due to perceived interference with foreground tasks, the computer remains unprotected from the perils of fragmented drives.

Very often the built-in defragger is only run when the user sees a perceptible decrease in the disk performance of their computer. This means that the tool is being used when the computer is at its worst, with a huge number of fragmented files and often not much remaining disk space. At this point there is no subtle way to run the defragger; it's going to need all of the resources available to clean up the hard drive, assuming it can even do so.

## Why Use Diskeeper?

With 21 years of experience building disk defragmentation tools, Diskeeper 2007 represents the current state-of-the art in disk defragmentation technology. Diskeeper solves the problems that disk fragmentation causes on Windows computers and offers support for all Windows environments, from the single-user home computer to the largest corporate enterprise. With Diskeeper 2007, Diskeeper brings major new technical improvements to all 2007 versions of the software.

The first and most noticeable technical improvement in Diskeeper 2007 is the inclusion of InvisiTasking™ technology. InvisiTasking affords true, real-time, on-the-fly disk defragmentation that goes beyond previous attempts at simple I/O throttle approaches to background on-the-fly defragmentation techniques. The technology of InvisiTasking takes a more proactive approach to utilizing system resources. It checks to see what resources are available to the application to assure that the foreground application's performance is not affected, and gives the user a truly transparent background defragging experience. Using this technology means that it is no longer necessary to explicitly schedule after-hours disk defragmentation runs.

InvisiTasking also allows for real-time defragmentation to occur. This means that file fragmentation is automatically

corrected as it happens, minimizing the fragmentation that occurs with new file creation and file writing. The process is automatic and requires no user intervention. In addition, InvisiTasking runs with no negative impact on system performance or resources, regardless of its workload.

Diskeeper's Intelligent File Access Acceleration Sequencing Technology (I-FAAST™) version 2.0 is an upgrade of the 1.0 version of this technology found in earlier versions of Diskeeper. I-FAAST adapts the layout of files on the hard drive to accommodate the user and application access patterns that it detects. By working with the other defragmentation technologies found in Diskeeper, I-FAAST is able to maximize the performance of the most commonly accessed files. While I-FAAST is an automated process, the user now has the option to explicitly select files to be processed by I-FAAST.

## Enterprise Issues

For the corporate IT user, integrating new software into the existing enterprise is a key factor in making a purchasing decision. This is especially true for applications installed on every computer. Let's look at the most important requirements for the corporate IT user.

## Deployment

Getting applications onto every computer in the enterprise is a time-consuming and expensive task in most organizations. This means that the ability to remotely deploy and configure is essential in any enterprise application. Diskeeper 2007 Administrator includes the PushInstall technology to allow any business version of Diskeeper to be remotely installed and configured on any workstation or server in the enterprise. The installations can be immediate or scheduled and allow for the software to be installed at off times or whenever the IT staff deems it appropriate. The same technology can be used to push upgrades out to existing Diskeeper installations on any computer, simplifying the update process and guaranteeing that the IT staff is aware of which version of Diskeeper is currently running on all of their managed systems.

With Diskeeper 2007 Administrator, Diskeeper 2007, Diskeeper 10, and Diskeeper 9 versions of the software are all supported, allowing enterprises running earlier versions of Windows NT and Windows 98 to still be included in the enterprise disk fragmentation protection scheme.

Also, installing Diskeeper 2007 on a running system does not require that the system be rebooted to complete the installation. Diskeeper can also be included in any system images used to deploy new hardware, preconfigured and ready to run in the chosen configuration. While the built-in defragger can also be configured in a system image, the issue of managing the defragger is still important.

## Management

Diskeeper 2007 Administrator offers detailed management control of your Diskeeper installations with policy based client management that makes use of Active Directory. The policies can be applied to existing AD groups or to new groups created specifically for Diskeeper. All business versions of Diskeeper since Diskeeper 9 can be managed from the Administrator interface. It is a .NET application and works with any existing Microsoft SQL Server database or with the Microsoft SQL Server Desktop Engine (MSDE). MSDE is included with the shipping product and can be installed on any Windows workstation or server.

Automated email alerts can be configured through the management interface to alert the administrator to current or potential problems relating to disk fragmentation on the Diskeeper clients. These alerts can be on issues that might develop into problems or actual application failures. Disk capacity warnings can also be generated to let the administrator know when disk space is starting to become an issue on client or server computers. Diskeeper Administrator uses policy-based management, making use of the already configured Active Directory groups already in use for systems management. The administrator can also create newly defined custom groups for use with the Administrator tool to allow for more detailed grouping than might have already existed within the Active Directory.

License management is also provided to assure the administrator that there are sufficient licenses of the Diskeeper products to protect all critical computers. Diskeeper 2007 Administrator is capable of managing the Enterprise Server, Server, ProPremier and Professional versions of Diskeeper 2007. Multiple iterations of the Administrator can be installed on the network, all reading and writing data to the same (or multiple) SQL database. This is a useful feature in a large distributed environment, which can't be duplicated by the built-in tool.

## Reporting

Reporting is an important part of any management infra-structure. The ability to generate reports on the status and condition of each computer is critical to keeping IT aware of what is happening on the network. Diskeeper 2007 Administrator includes an easy-to-use report gen-eration interface that allows the administrator to create custom reports on individual or multiple systems run-ning Diskeeper. These reports, which can be auto-gener-ated and emailed to any recipient on a scheduled basis, include system status, system settings, disk free space, alert status, and license management.

## Client-Side Issues

Disk defragmentation is as much of a problem for client computers as it has ever been, even in environments that primarily rely on network storage. Just about every office automation application creates temporary files when used, sometimes by the dozens or even hundreds. Web brows-ers are particularly bad offenders, as any examination of the temp directories used by the browser will show. And in most small businesses and many medium-sized busi-nesses, local file storage is still heavily used, meaning that all of these computers can see benefits, sometimes significant, by an aggressive use of disk defragmentation software.

The issues that tend to most often affect the user experi-ence are those surrounding system performance. These include slow-loading applications, files that are slow to open, and an overall decrease in the apparent speed of the computer, all of which can be attributed to disk fragmentation problems. In many cases, using the built-in defragmentation tool can make the user experience unbearable while the tool is running. Tests have shown that simple file copy tasks or file open tasks can take as much as 150 percent longer when the built-in defragger is running. Performance hits like this tend to frustrate end users, encouraging them to walk away form their work or even stop the tool from running, neither of which are desirable outcomes.

Diskeeper 2007 offers two advantages to the end user. The first is the benefit of InvisiTasking, which results in no impact on end-user actions while Diskeeper is running. The technology allows the application to evaluate what, if any, resources are available to it in the context of ongoing user activities. This evaluation permits Diskeeper to keep itself out of the way of the user experience, preventing users from experiencing any change in their system when doing disk-based I/O. From the end user's point of view,

this difference from the built-in software alone is suffi-cient to justify its use in most cases.

The second is I-FAAST. Once configured, or allowed to make its own determinations, a system running Diskeeper 2007 can actually show improved file access performance. This is true not only for a system running the built-in defragmenter but also those that are running no defragmenting software at all. This is because of the file layout optimizations that Diskeeper is performing using I-FAAST, making data access faster on the system than on an un-optimized drive. This performance benefit can be derived by simply enabling the default configura-tion of I-FAAST to be used or by allowing users to desig-nate their most-used files for I-FAAST optimization.

Additional features that Diskeeper has developed include the boot-time defragmentation of MFT and page files, automatic directory consolidation, which speeds up the operations of applications like anti-virus scanners, and the FragShield™ technology which helps prevent page files and MFTs from getting fragmented in the first place. None of these features is available in the built-in defrag-ger in any version of Windows Vista and they all bring tangible benefits to the end user.

## Test Results

Now let's look at actual performance results when using Diskeeper 2007 and the built-in tools in Windows XP and Windows Vista.

## Methodology

A 60GB test volume was created on a separate physical disk from the system volume. The fragmentation / file numbers on the volume were as follows:

- 50,000 files
          20,000 fragmented files
- 5,000 directories
          1,500 fragmented directories
- 30 percent free space

Utilities were used for the creation of files and frag-mented files / directories. The volume was imaged using Acronis TrueImage 10.0 for reuse throughout the com-parison.

Between all trials, the volume was restored from backup (located on a second physical volume) using Acronis 10.0, and the system rebooted to flush memory usage.

Additionally, the 'target volume' of PCMark05 for use in its Hard Disk Drive-specific trials was set to the 60GB test volume.

For the PCMark05 benchmark trials, the System suite was run to provide the full PCMark05 Score. This is comprised of 11 tests, which run the gamut of system performance:

- HDD – XP Startup
- Physics and 3D
- 2D – Transparent Windows
- 3D – Pixel Shader
- Web Page Rendering
- File Decryption
- 2D – Graphics Memory – 64 lines
- HDD – General Usage
- Multithreaded Test 1
- Multithreaded Test 2
- Multithreaded Test 3

For the timed copy trials, a 2GB file was created using CF10.exe and stored on the system volume. Using a batch file, the 2GB file was copied 6 times to the 60GB test volume, being deleted between each copy. The total time to copy the 2GB file 6 times was then recorded, using TestAids.exe. As noted previously, the 60GB test volume was restored to its original state between each trial.

During the DK 2007 Automatic PCMark05 benchmark trials, Automatic defragmentation was started on the test volume and the GUI closed.

During XP Pro built-in defragmenter timed copy job and PCMark05 benchmark trials, copies and benchmarks were begun precisely when defragmentation started, during manual defragmentation.

During Vista built-in defragmenter timed copy job and PCMark05 benchmark trials, defragmentation was scheduled using the defragmenter GUI, and the trials begun when defragmentation commenced.

All trials were run a total of 5 times, and then the highest and lowest values discarded for the purpose of establishing a more accurate median for averaging.

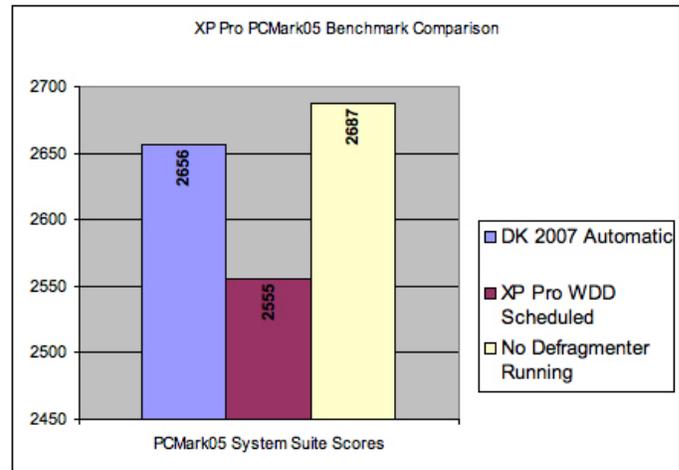The results of the XP Pro PCMark05 benchmark comparison are clear in Figure 1.



**Figure 1.** *XP Pro PCMark05 Benchmark Comparison*

While the system running no defragmentation yielded an average score 31 points greater than that of Diskeeper 2007's Automatic defragmentation process, the gulf between XP Pro's disk defragmenter and the system with no defragmentation is far greater, with the system with no defragmentation 132 points higher than XP Pro on average. From these tests, we can conclude that running a real-time defragmentation tool has a negligible draw on system resources.

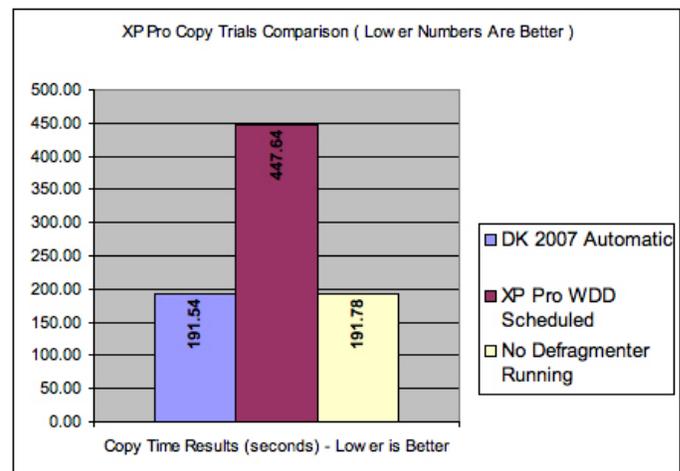In the case of the XP Professional comparison copy trials, the results are graphed in Figure 2.



**Figure 2.** *XP Pro Copy Trials Comparison*

Figure 2 shows that running the XP Professional's built-in disk defragmenter increased the average time to copy the file by 57 percent, resulting in the copy job taking 1.5 times longer to complete.

With Diskeeper 2007 Automatic defragmentation running on the target volume, there is a 0.001 percent variance in the average time the copy job took to complete from trials with no defragmentation occurring whatsoever.

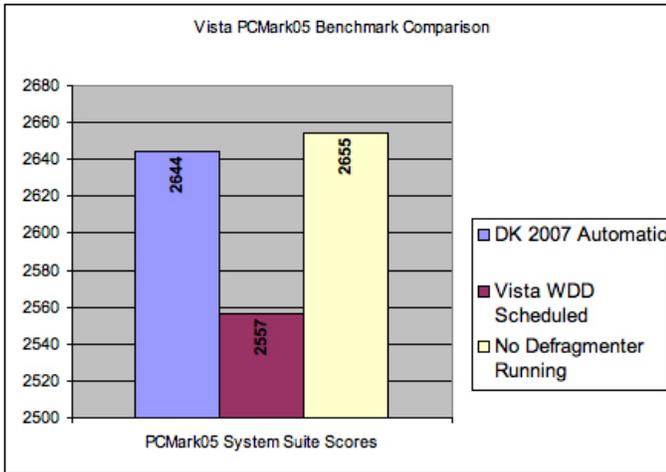Figure 3 shows the results of the Vista PCMark05 benchmark comparisons.



**Figure 3.** *Vista PCMark05 Benchmark Comparison*

While Vista's average system score is 4 percent lower than the average score acquired with no defragmentation occurring on the system, the variance between the scores of no defragmentation and with Diskeeper 2007 Automatic defragmentation occurring is 0.004 percent on average – 0.001 percent of the impact that Vista's built-in defragmenter had on the score.

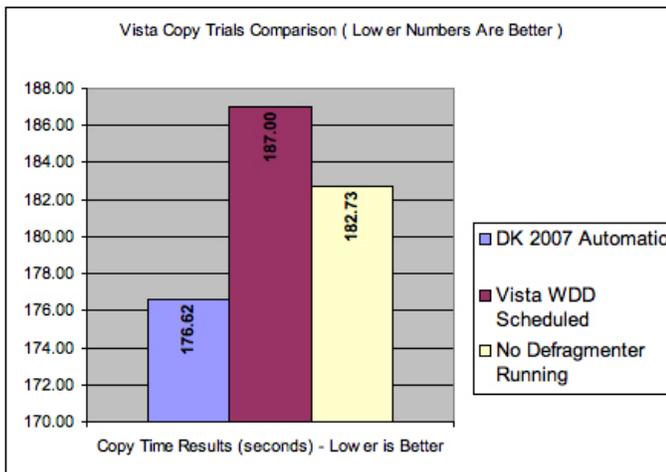Figure 4 represents the results of the copy job comparison run in Windows Vista.



**Figure 4.** *Vista Copy Trials Comparison*

On average, the Windows Vista built-in defragmenter increased by more than 4 seconds the time taken for the copy job to complete. Conversely, with Diskeeper 2007 Automatic defragmentation running, the copy job time decreased dramatically, completing 3 percent faster.

The performance difference between the built-in tool and Diskeeper 2007—in this worst case scenario for Diskeeper—shows that using the built-in tool is likely to cause a noticeable change in system behavior to the end-user. Diskeeper, meanwhile, is much less likely to do so. And when you consider that Diskeeper would be configured to run as an on-going background application when the end-user is not making use of the system, the impact to the end-users workflow will be non-existent.

## Conclusion

It is clear that regular disk defragmentation has many benefits, including better system performance, better user experience, and improved hard disk life being just the most obvious. While the defragger included in Windows Vista can provide some of the benefits of disk defragmentation, Diskeeper 2007 brings the complete package to the table, providing all the benefits that defragging offers in a straightforward easy-to-use package that can be used to bring all its benefits to any end user. More technically astute users can provide additional tuning information to the product to improve their experience even more, but even for the user who chooses to simply install and accept the default configuration, Diskeeper brings benefits that far outweigh its price.

The higher-end versions of Diskeeper include functions that bring even better disk performance to the end-user of the computer, with disk optimizations that result in improved load times for often-used files, meaning that large and complex applications such as video and image editing tools, CAD/CAM, design, and other complex applications load noticeably faster. Users working with large files within those applications, or even with less complex applications, such as Microsoft Excel, will see performance improvement when manipulating those files.

The end result is that the investment in Diskeeper can make users more productive by improving the health, performance, and reliability of their computers and the information stored within them.