

A Study About Reducing the Costs of Windows Systems

# Hidden IT Costs



Andreas Blaeser • O&O Software GmbH, Berlin • June 2008

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**Costs play a decisive role in today's economic situation. Whereas expenditures in the IT Sector were reaching the sky just a few years ago, they have now become one of the favored areas where business controllers and consultants look to save money. All too often, however, it's just the obvious expenses that are taken into consideration, leaving an enormous savings potential left untouched. This study will explore the high costs arising as a result of fragmentation, and how they can be eliminated and avoided with just a minor investment.**

The magic formula concerning IT expenditures is, without a doubt, TCO –Total Cost of Ownership. This is understood to be the sum of expenditures related to furnishing a workplace with information technology. Over the years, it's been tried, time and time again, to relegate and prioritize these expenditures more precisely. It begins with the purchase of hardware and software. After acquisition, there are the costs of maintenance by IT personnel as well as additional expenditures for software updates and hardware resupply. The final expenditures emerge when the material is put out of operation and needs to be discarded.

It could therefore be concluded that the expenses for operating a PC system far exceed those related to simply acquiring and disposing of it. Alone the cost of labor related to having an IT specialist on hand for correcting a failed software application on a PC system can quickly reach astronomical heights. In addition, virus attacks and other malware are responsible for burdening businesses with enormous costs every year, and these wind up directly into the TCO calculation.

This study will not concern itself with the well-known expenses arising from downtimes, or private surfing and play-

ing by employees during working hours: it will, instead, focus its attention on the hidden, difficult to recognize expenses existing in information technology.

### **The religious war among operating systems**

Business's view of IT expenses has been evolving over the past few years. It's no longer the procurement and administration expenses alone that matter, but increasingly, the cost-benefit ratio of the software itself. This is especially true in the operating systems sector, where the increasing application of Linux has brought about a veritable rivalry to achieve the best TCO. Reports, alternately claiming Windows and Linux as the winner in reducing costs, are published at regular intervals. Administrative expenses play an important role here as well, but the expenses related to everyday work with the operating systems are even more important. The fact that a worker is able to finish his work faster with one of the two operating systems makes its procurement by the company pay off very quickly. Even the increased expenditure caused by changing systems can actually save money under certain conditions.

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## Cutting costs on the job has a multiplying effect

It should also be understood that improving the efficiency of a company employee has an even greater impact on savings than reducing administrative expenses. This can be traced to the fact that administrative expenses can already be reduced by using modern software. In addition, cuts in administration expenses affect relatively few employees, namely the IT personnel. Increasing the productivity of every employee, on the other hand, results in a significant multiplying factor. This will have, in a relatively short time, a positive effect on the cost factor and earn increasing attention from not only the IT department, but by the company management as well.

## Fragmentation of data occurs on every PC workstation

There are, however, even further expenses arising, on every workstation, that have a multiplying effect: e.g., in the choice of operating system and the additional software that's needed to be applied. These costs, however, are not visible. They are hidden and conceal themselves mostly behind the technical characteristics of a system or software. In the following sections, we will highlight one such cost factor: fragmentation of data on hard disks. Many are aware of this phenomenon and know what to do against it, but do they also know how high the costs caused by fragmentation really are? Here's a little hint before we get started: the costs are dramatically higher than one might think.

The interesting and decisive thing about fragmentation of data is that it always and inevitably turns up on every workstation. It makes no difference what kind of operating system or software is being used. Fragmentation is part of the process of saving data, and therefore remains unavoidable. There is, however, a suitable counter measure: periodic de-

fragmentation with a software developed specifically for this purpose. How easily and effectively this software can be applied will also be treated in a later section.

## The hard disk – storage place of all data

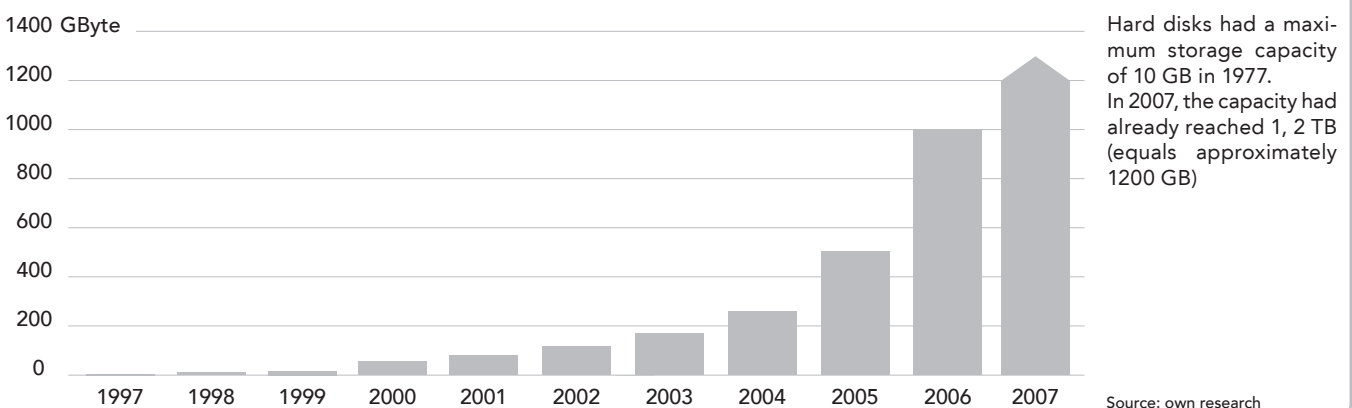
All data that need to be permanently saved must be deposited on a secondary storage volume. These are normally hard disks, CD-ROMs or also DVD-ROMs. Lately USB-Sticks, various Memory-Cards and Solid State Disks have been added to the list. The hard disk remains, however, the standard volume for saving data. All operating systems and programs are accessed from it, and all data are also stored on it. This is true whether we're talking about a local workstation computer or a central data server in a company. Data always need to be read and written.

The hard disk, along with the CD-Rom and DVD drives, is among the last mechanical components of an up to date computer system. Even when a computer has any number of rapid processors and micro chips, its speed will always depend on the speed of the hard disk.

The capacity of a present day hard disk is 120 times larger than it was almost 10 years ago (see Figure 1). The speed of data processing has also increased enormously, though not to the same extent. The speed of a hard disk is limited by its mechanism and, therefore, by the laws of physics. Deciding factors here are the number of turns per minute, and the average access time needed for reading and writing the data.

The data are stored contiguously, which not only considerably increases the speed for accessing, but prevents even further fragmentation from occurring.

Figure 1: Progress of Hard Disk Capacity



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Figure 2: Hard Disk Storage of Data

The files are not stored contiguously, which leads to the data being read more slowly. There is also a strong possibility that further fragmentation will occur very quickly, which will then slow down the entire system.



The data are stored contiguously, which not only considerably increases the speed for accessing, but prevents even further fragmentation from occurring.



## Fragmentation is unavoidable

All data are written on the hard disk in concentric tracks. Each of these tracks has a particular storage capacity so that very large files must be split among multiple tracks. In order to read such a split file, one track after the other has to be approached. This next track should normally be located very close to the first one, in order to minimize the time needed for repositioning the read/write head every time it accesses the necessary file.

This sounds very simple in theory, but in practice it is nearly impossible. The operating system cannot know in advance where certain files in differing size and number should be stored. Every file will be treated and saved by itself. The main objective of the operating system is the secure and fastest possible saving of data, so that no data will be lost if a system crashes. Doing this, however, forces the optimal positioning of files to be obstructed. What should happen if files are changed afterwards or even deleted? Their original storage location will then be released by the operating system and used for other files. This causes so-called fragmented files to develop over a certain period of time. What emerges is that the data of a file are not saved contiguously, but spread throughout the entire hard disk (see also Figure 2).

The consequence of all this is that the reading – as well as writing – of a hard disk takes longer because the read/write head must be repositioned for every single data fragment. This mechanical process thereby influences the overall performance of a PC system and is the source for considerable losses in speed and efficiency.

## Fragmentation of free disk space

It's not only the fragmentation of files which cause a decrease in performance. The fragmentation of the free disk space itself can also lead to considerable losses in system velocity. This form of fragmentation is also known as free space fragmentation and is brought about by the deletion of files leaving gaps between files.

These gaps are filled by operating systems with new files. Once again, we see that the operating system is not doing its best at finding the right place to deposit files, since newly created files might be immediately fragmented. This is especially the case with larger files. That's why it's not only important to consider the defragmentation of files when defragmenting a file system, but the combination of files as well, so that the gaps between them can be closed. This is the only way to correct a free space fragmentation and avoid an immediate new fragmentation of files. The latter would quickly lead to a renewed degradation of performance and significantly reduce the success of the defragmentation.

## Hidden costs as a result of fragmentation

Now that the technical foundations have been explained, through the use of concrete calculation fields, we can turn our attention to the costs arising from fragmentation.

It has already been mentioned that the hard disk constitutes a mechanical component of a computer system. All data will be written and read upon it. This occurs with the use of a read/write head, which is moved with very low speed and very high speed above the platter (magnetic disk). Every physical read or write process occurs in two steps:

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1. The positioning of the hard disk head over the relevant area of the magnetic disk
2. The subsequent reading or writing of the data

The time needed for the first step is defined as the mean access time of a hard disk. On modern hard disks, this is approximately 12 milliseconds. To generalize, one could speak of an average of around 8 milliseconds. The time for the second step actually refers to the reading or writing of data, and the subsequent transfer onto the computer is called the data transfer rate. This occurs at a rate between 50 and 100 MByte per second, which means we can speak of an average of 75 MByte per second.

### Time is lost as a result of increased access time

To simplify things, let's say that it's not the actual reading or writing of data that requires any time, but the positioning of the hard disk head that makes all the difference. This reduces the calculation of decreased velocity on the average access time needed for accessing a sector on a hard disk.

This allows us to conclude that a file deposited on a continuous region of the hard disk will be read within the average access time. If this same file were split between two sectors, however, the amount of time needed for accessing would be doubled because two independent regions would now have to be read. Taking it one step further, a file split into ten segments would correspondingly take ten times longer. This calculation can be arbitrarily extended for however many segments or fragments a file possesses: the higher the number of fragments, the longer the access time needed for reading and writing.

Let's now consider what happens when particular files with an ideal total loading time of one second are deposited on the hard disk contiguously, and in one big piece.

These can be program files from the Microsoft Office family (Word, Excel, Outlook and Access), but also normal data files such as letters, documents, table calculations or also databases.

If 100 of these files are loaded on one day, the user would have to wait 100 seconds for the end of the loading process. Let's now say that instead of existing in one block, these files are deposited on two blocks of the hard disk, which means a doubled amount of time needed for loading.

The user is now forced to wait 200 seconds for these files, a time span 100 seconds longer than before. This time increase has to be multiplied when considering Servers because here as well, so many files have to be read and written daily that, just as with workstations, a bottleneck develops. The following observation can therefore be made about Servers.

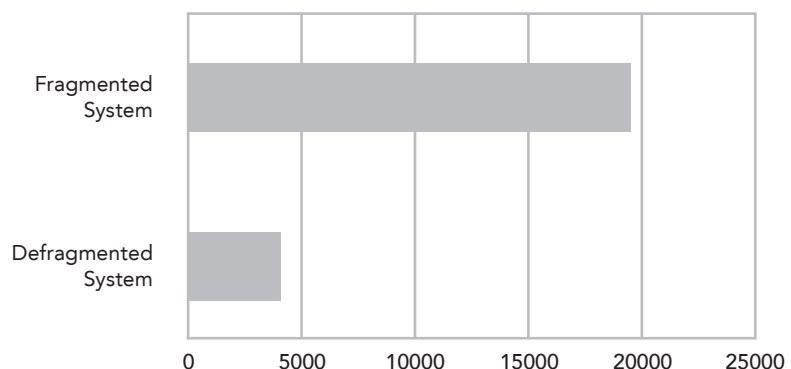
### Lost working hours increase costs

These nearly 2 minutes a day don't sound very dramatic at first, but when we imagine a company with 500 employees working on PC systems, we arrive at a total of 50,000 seconds a day, lost as a result of defragmentation alone. That turns out to be 13.8 hours a day. Put another way, almost two workers a day will be needed to make up for this loss of time.

In 2008, according to the German Bureau of Statistics, the average cost of labor in industry was € 28,70 an hour.

Figure 3: Effect of Fragmentation on the Booting Process

At the start of a Windows XP-System, read and write accesses are being run on approx. 3900 files having a total size of over 70 MByte. The graphic shows that with a fragmented system, almost five times as many data fragments must be read and written. This will significantly slow down not only the booting process, but all work with the system as well.



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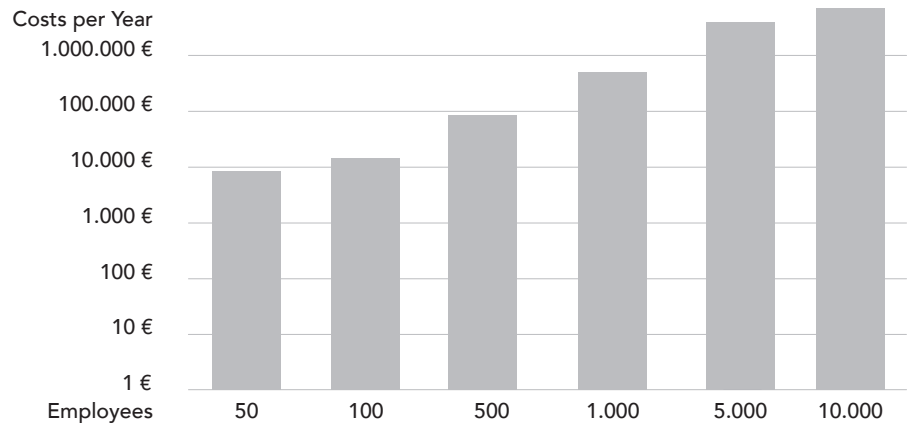
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Figure 4: Costs as a Result of Fragmentation

Average costs of 174.27€ per workplace, per year, end up totaling a considerable amount. The graphic reveals these costs to companies with differing numbers of employees.

Through the periodic application of O&O Defrag, these costs can be so reduced, that the price of acquisition amortizes within just a few weeks.

The cost axis was scaled logarithmically.



Based on these hourly costs, our sample company loses € 396,06 a day. Taking an average of 220 working days a year, the annual costs amount to € 87.133,20 or € 174.27 per workstation. It should be emphasized here that these expenses will definitely not turn up in any TCO calculation, so the costs we mention can truly be described as hidden. In our example, we can claim them as costs for personnel.

## Reducing costs with O&O Defrag

These expenses can, however, be avoided – through defragmenting a computer on a regular basis. Along with the option of automatic defragmentation on a regular basis, O&O Defrag also allows you to run a defragmentation in the background during the working day, without the user noticing it. O&O Defrag is able to single-handedly control all aspects of the defragmentation. It additionally features an integrated function for consolidating free disk space, which lets you totally eliminate free space fragmentation.

Let's take another look at the company we used in the example: an O&O Defrag license for 500 computers, including control over a network, costs € 5.649,00. To this figure, we're going to calculate two eight-hour working days needed for an administrator to test and install O&O Defrag on all the computers. Allowing for the previously mentioned, average hourly cost of labor, this results in additional costs of € 459,20. All together, this makes a total of € 6.108,20 for 500 workstations, and comes down to an expense of € 12,22 per workstation.

Applying this amount to the expenses caused by fragmentation - € 174,27 on every workstation per year - the acquisition of O&O Defrag will already pay itself off after only 14,26 work days (when calculated using the previously mentioned figure of 220 workdays per year). The bottom line is that the company will now save over € 162 per year and workstation!

### O&O Defrag amortizes its purchasing cost within just a few weeks

In less than a month, the investment in O&O Defrag will have been amortized: and this is only when taking into account the effects of normal fragmentation and its elimination. There is also an additional advantage in the reduced amount of time needed for creating data images, restoring data, and generally easing the strain on the hard disk, which directly increases the life expectancy of all computers. Had we included all of these factors into the calculation, the purchasing of O&O Defrag would have paid itself off even sooner.

## Why Windows can't help

### The operating system cannot prevent fragmentation

The Windows file system alone has no possibility to counteract fragmentation. The operating system's main concern is with the reading and writing of files, not with placing them in the best position for increasing their access time. To accomplish this, supplementary defragmentation software is required, and this must be used on a regularly basis in order to eliminate the fragmentation that will inevitably reoccur.

\*Suggested Retail Price, May 2008. All prices exclude 19% VAT

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Ever since Windows 2000, Microsoft has been delivering its products with integrated defragmentation software. In many regards, however, this integrated program is insufficient for meeting the daily demands placed upon an efficient computer system. The following will present some of the most frequent problems arising from the day to day work with such integrated software.

## **No automatic defragmentation is possible**

The Windows defragmentation software can only be run manually. The user must personally see to it that a defragmentation is run on a regular basis. When this is not done, successive defragmentation runs will take considerably longer, given that increasing numbers of files have to be processed. In addition, the reduction in performance between two runs will be much higher, thereby inhibiting the overall effectiveness of your system. Fragmentation can occur every time files are changed and results in an immediate slowing down of the system. As stated previously, the only way to avoid this is by running a defragmentation on a regular basis. It was only after Windows Vista that a rudimentary time-scheduling option was implemented, but this offered little room for the user to personally intervene in the process. This limitation resulted in the computer being heavily strained during the process, and made working with it much more difficult.

O&O Defrag, with its time scheduling function and integrated O&O AutoScheduling, allows you to permanently run automatic defragmentation at the push of a button. The user can personally decide if he or she wants to set a schedule for regularly occurring defragmentations. If preferred, he or she can enable the O&O AutoSchedule function to automatically measure the level of fragmentation in the background, and activate a defragmentation accordingly when a certain level is exceeded. Consequently, the highest standard of efficiency can be always guaranteed for the computer system.

## **Straining the computer makes working with it more difficult**

When defragmenting using Windows' own software, it's almost impossible to use the computer due to the strain caused by the process. It should be pointed out that this downtime cancels out, in fact, exceeds any acceleration you gain by defragmenting.

That's why O&O Defrag offers a unique O&O Activity-Guard Technology which constantly measures the workload of the computer, and adjusts the resource availability of O&O Defrag accordingly. This allows the user to continue working without any interference from the defragmentation process. This feature also makes it easier for system administrators

to apply O&O Defrag. An administrator no longer needs to find a special moment for defragmenting a workstation, since O&O Defrag can be run at all times without disturbing a user's ability to work on the computer.

## **The user must possess administrator permissions**

The Windows defragmentation software requires the user to possess administrator permissions in order for it to be run, i.e., the user must possess these permissions. This gives the user complete control over his or her computer, which is not possible in a company due to the security risks that are involved.

O&O Defrag offers various possibilities for avoiding such security risks. Administrators can block users from running it, leaving only the administrator in the position of exercising central authority over the placement of the settings. The administrator may also, however, give users access to O&O Defrag when they're travelling with their notebooks on the road. The program allows for this as well as a number of other possibilities.

## **No remote management possible**

Not being able to exercise remote management when using the Windows defragmentation software is especially problematic for administrators in companies. This forces administrators to run from computer to computer, in order to make sure that they are constantly being defragmented. This kind of "sneaker management" requires, however, a large time expenditure which will wind up reflected in higher costs.

O&O Defrag possesses a central Management Console, with whose help activities and settings can be carried out. All of O&O Defrag's automatic functions can be set here, from the installation over the configuration, up to the refreshing of the software and its settings. A very-own site concept allows for subdividing the computers into groups so that, for example, workstations and servers can be put into two groups. This will allow creating two different schedules for automatic defragmentation. From that point on, no further intervention will be necessary.

O&O Defrag can also be fully integrated, without any problem, into already existing software management systems such as Microsoft SMS or HP OpenView. As a result of its complete conformity to the Windows standards defined by Microsoft, corresponding configurations or even script files can be created for running the program automatically. Management overhead is thereby reduced to an absolute minimum, saving both time and money.

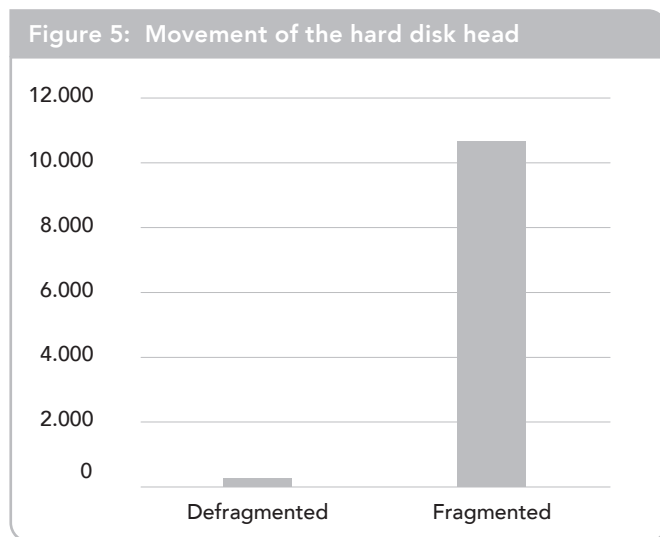


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## Windows defragmentation is just not enough

All in all, Windows defragmentation software can be seen as merely a rudimentary tool, good enough perhaps for the occasional PC user. It makes no sense, however, for daily use by businesses or even by demanding PC users. This is because the aggregated costs associated with manual defragmentation remain too high when compared to commercially available defragmentation software. Products like O&O Defrag not only provide a wider array of necessary functions, they still manage to save money.



## Further advantages to using O&O Defrag

A myriad of problems are caused by defragmentation. The obvious problems posed by the amount of time needed for the reading and writing of data have already been discussed in detail. The following will now throw some light onto a number of additional problems that can arise as a result of fragmentation.

### Less overload of the hard disk mechanism

We frequently hear the following complaint from our clients: running a defragmentation of files on a regular basis puts considerably more strain on the hard disk mechanism than not running one. This is then followed by the conclusion that the computer's life expectancy is reduced as a result of this. This conclusion is totally wrong because, in fact, fragmented files put much more strain on the mechanism than files that are defragmented.

## Consider this short example:

Let's say we have a file that needs to be loaded every time the system boots. We start the computer one time every working day, whereby we can assume that the year has 220 working days. If this file is spread over the hard disk into 50 fragments, every time the file needs to be read, the read/write head will have to be moved into a new position exactly 50 times. Over the course of a year, this will make 11,000 movements of the read/write head for just this one file.

When we now defragment this file, we'd need a total of 50 movements for the reading and one movement for the writing of the defragmented file, which makes a grand total of 51 movements. To this one movement we can now add the read processes that will be conducted over the course of a year. Given that the file can now be read in one process, the head only has to be moved one time to reach the file's position on the hard disk. This results in exactly 220 movements over the course of one year.

We now have a total of 271 movements, including the ones we needed for the defragmentation. We have thereby saved 10.729 movements when compared to the fragmented file – or expressed differently: for a fragmented file, the hard disk head must move approximately 40 times more than it does for a defragmented file.

We can now see clearly that the real strain on the hard disk is caused by fragmented data. A hard disk performing under such strain will suffer higher abrasion, and possibly have its mechanism break down earlier than it would when functioning in a regularly defragmented system. This would be a considerable cost factor as well. The keywords here are the costs for replacing hard disks and the amount of time needed for installing and setting them up.

### Restoring data is made easier

A further problem for fragmented systems is data restoration. This is certainly not a daily problem, but when it happens, a problem with data restoration can have fatal consequences. If a hard disk breaks down as a result of a hardware or software technical problem, this can end up with the hard disk's table of contents being destroyed (for NTFS-file systems, this is the Master File Table). This table of contents is the key to the data. If it's lost, it can generally be restored using special data recovery software such as O&O DiskRecovery. This kind of software searches the entire hard disk for the files and restores them. If these data are contiguous on the hard disk – meaning, defragmented – restoration is very easily accomplished. Merging fragmented files, however, is es-

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entially more difficult, partially even impossible, unless further information about the file system is available.

When breakdowns like this occur, a defragmented file system has instantly paid for itself because the restoration of data is considerably easier, quicker and more successful than with a fragmented file system.

## Creating data images faster

Imaging data is among the most important management assignments. It is normally done on a daily basis so that if a computer breakdown occurs, it will be possible to access the most current database. Data imaging like this will normally be run on servers at night. There are a number of reasons for doing this. For one, the user should not be disturbed by the imaging process, given that the hard disk on the server being imaged will be heavily strained by its being accessed. Furthermore, in order to ensure a consistent status, it's best that data not be altered in any way during an imaging. At best, no other application should be running that might alter the data as a result of its own activity, which is why the administrator requires a special time period for accomplishing this job.

Present day data traffic being what it is, guaranteeing a complete and consistent image of large data volumes has become one of an administrator's most difficult assignments. Ever increasing amounts of data are being stored, edited, or also deleted by users on servers. These constant changes are responsible for a high level of file fragmentation, which again leads to a noticeable decrease in the speed required for the reading and writing of data. It is precisely the reading of all data that's required for creating an image.

Every administrator is thankful when the amount of time needed for creating an image can be shortened. Many are already using software developed for this purpose, ones that restrict the amount of data any user may store. This is supposed to help keep a limit on the volume of the image.

Many administrators are possibly unaware that defragmenting their data would significantly reduce the time needed for any data imaging. These administrators could gain so much valuable time without interrupting the daily workflow or intervening in the system.

## Acceleration of other applications

Aside from data imaging, the running time of other applications would also benefit from the substantial increase in acceleration following regularly scheduled defragmentations. Among these are applications affecting large numbers of files such as

Antivirus-programs, and processes for searching and indexing.

## Conclusion

Hidden costs are, by their very nature, not easy to detect. This is especially true in the ever more complex IT world, where the hiding places are many. We were able to demonstrate how much money gets lost unnoticeably as a result of computer fragmentation – day after day, year after year. The O&O Defrag solution is an economical and quick remedy for avoiding these substantial costs at a minimum of time and effort. It's unfortunate that so many other hidden IT costs cannot be as easily found and corrected. That's why every business should apply defragmentation software that can run automatically and without interfering in the course of a normal working day – otherwise, it's just throwing money away. O&O Defrag pays off – from the moment it's installed on the very first computer!

## About the Author

Andreas Blaeser is employed as E-commerce Manager for the Berlin-based, O&O Software GmbH. Among the products manufactured by O&O, are software for defragmentation and data recovery. He is in charge of sale and distribution of O&O products in the online sector.

## About O&O Software GmbH

O&O Software GmbH has been developing "Tools for Windows" since 1997. These are currently being used in more than 140 countries, and have been translated into a number of languages. Customers include home users, SMEs, public services, and international corporations. The product portfolio includes applications for optimizing performance, data imaging, data recovery and the secure deletion of data. In a number of important tests, O&O products have been judged as being on the technological forefront.

You can learn more by visiting [www.oo-software.com/en/](http://www.oo-software.com/en/) or by contacting us at:

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## Appendix: Savings potential through defragmenting with O&O Defrag across a network

Running a manual defragmentation is impractical and costly for both users and administrators because such a defragmentation has to be controlled locally. The Server Edition of O&O Defrag, on the other hand, can save time and money by being conveniently administered across the entire network of a business. Using it, reductions of the TCO (Total Cost of Ownership) can be achieved regardless of the number of computers, because administrative costs are disproportionate to the number of systems. Under certain conditions, IT personnel lacking the time might tend to neglect maintaining the system properly. This can lead to diminished system performance and with it, reductions in efficiency and productivity.

Along with providing flexible, sophisticated control and scheduling of defragmentation jobs, network defragmentation software can also be installed and managed across a network. Optimized system performance enables businesses to lower their TCO because system administrators are able to control the network from a central console.

The TCO (Total Cost of Ownership) can be significantly reduced by conversion to a network defragmentation.

The following example compares the administrative costs of a network controlled defragmentation to a manual one. Let's assume that it takes an IT employee at least one working hour to manually defragment one workstation or server. This includes all administrative assignments such as appointment scheduling, going to and from the computer as well as the processing. This manual defragmentation should also be run only once a month. 28,70 Euros an hour would be a conservative estimate of IT and various other personnel costs. Based on this example, the following calculation can be made:

Size of Business	Total Cost of Manual Defragmentation
100 Workstations	2.870 € per Month
500 Workstations	14.350 € per Month
1.000 Workstations	28.700 € per Month

By introducing defragmentation software that is applied

across a network, IT personnel expenses can be significantly reduced. Processes for maintaining the system can be controlled and fully automated, requiring almost no further involvement from an administrator. Beyond that, downtime can be avoided because workstations are no longer blocked the way they are when defragmented and administered manually.

Regardless of the size of the business, administration costs related to a network defragmentation are almost negligible.

O&O Defrag only needs to be configured and have its jobs defined once. Thanks to background defragmentation, there will be no downtime for the workstation's user because all administration is being run in the background.

If we estimate it taking something like five hours to administer a defragmentation across a network, once a month, we come up with the following figures:

Size of Business	Total Cost of Manual Defragmentation
100 Workstations	143,50 € per Month
500 Workstations	143,50 € per Month
1.000 Workstations	143,50 € per Month

Regardless of the size of the company, the IT costs, and therefore the TCO, will be reduced considerably. The numbers prove that it would be foolish, strictly from a TCO point of view, not to apply defragmentation software across a network.

### Extending the life expectancy of PC systems

Most businesses have recognized file fragmentation as a problem. Very few of them, however, are truly aware of the consequences reduced system performance has on IT costs, and the costs for refurbishing hardware, which are ultimately reflected in the net operating profit of their companies.

Fragmentation under Windows 2000/XP/Vista can lead to severe limitations of system performance. This may result in premature or unnecessary purchases of hardware with increased performance.

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Minimal system performance, caused by file fragmentation, can lead to needless investment in new hardware. Regardless of the level of fragmentation, simple optimization strategies may result in using available resources with much greater efficiency. This doesn't, however, correct the real causes of the problem and they'll be sure to resurface on any new hardware. Instead of improving system performance by acquiring new hardware, businesses applying defragmentation software across an entire network would get the most out of their existing material. As a result of serious loss in system performance, many businesses prematurely or unnecessarily purchase new hardware. Using a defragmentation program such as O&O Defrag on their computers, these businesses would achieve increased performance comparable to that gained by any new hardware.

The accruing expenses of refurbishing hardware, along with the costs of new hardware acquisition itself, are tied in with the time expenditure of IT personnel and the ensuing downtime for the systems that need to be adjusted. These must also be considered when calculating expenses.

The possible extension of an optimized system's life expectancy, as a result of defragmentation, has considerable influence on the overall cost of hardware.

Let's assume the price of purchasing a new system to be € 1,500. For our example, an older system would also cost € 1,500. The average service life of the system will be assumed to be 3 years. To simplify matters, we'll ignore any possible value the old system might have. Thanks to frequent defragmentation, we can assume an extended service life of 1 year because the existing hardware resources are now functioning more efficiently. On top of that, the IT personnel costs related to disassembling hardware, system conversion, and setting up the new system can be avoided. A business would therefore save € 500 a year, per workstation, when it delays purchasing new hardware. These savings repeat themselves with every hardware cycle. Added to these savings would be the additional IT personnel costs for converting the system's hardware. Even when using different parameters, the extent of potential savings will be plainly visible.

As a final remark, it should be emphasized that an investment in O&O Defrag also pays off when the time comes for replacing any hardware.