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The Shortcut Guide™ To

Managing Disk Fragmentation

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Chapter 4: The Business Need for Defragmentation

Chapter 1 explored how disks work. They used to be large, expensive, slow, and have very limited capacity. Today, that has all changed. Modern disk storage is inexpensive and provides nearly infinite storage capacity for a small investment. Modern laptop and desktop computers routinely have a terabyte or more of storage, a capacity that was unheard of on even the largest systems 10 years ago. Such capacity comes with a reasonable price tag and maintains very high performance if properly maintained.

Disk operation is not all paradise, though. There are many issues to consider when operating disks. None of them should prevent you from using disk storage. However, they should be taken into account when implementing and operating any disk-reliant system. These issues can include:

- Disk lifetime—How long will each disk drive work before it fails?
- Throughput—How quickly is data getting from the storage system to the computer?
- Redundancy—Is the system truly redundant and fault tolerant?
- Fragmentation—Is the disk system operating at optimum efficiency?

Then, in Chapter 2, we explored one problem, disk fragmentation, in great detail. In a nutshell, bits of a file get scattered all over a disk. This makes reading the file more difficult for the hardware to accomplish, decreasing the efficiency of disks and slowing disk throughput. When critical files or often-used files become fragmented, the impact can be profound.

Fragmentation is a problem that can actually result from a number of causes. Unfortunately, these causes include normal daily operation of a disk. Over time, disks will become fragmented. There are preventative measures that we can take, and many that are designed right into our modern operating and file systems. But these measures only delay the inevitable.

Chapter 3 divided the problems caused by fragmentation into three categories:

- Performance
- Backup and restore or data integrity
- Stability

Each of these is a key driver in the return on investment (ROI) for every computer system in an organization. Certainly a system's performance and stability directly affect the productivity of that system and anyone who relies on it. For example, if a user's desktop computer is unstable, the user's performance rapidly degrades. Extending that to a server, now the performance of every user who relies on that server is degraded. All these detrimental system complications quickly add up to significant loss, whether directly observed (for example, system downtime, data loss) or more subtle but just as real (for example, small degradation over time).

We then explored a decision-making process for selecting and implementing a defragmentation solution. This process was based largely on technical criteria, as the intended audience of Chapter 3 is the IT department, including the IT implementer and the IT manager. However, that process often includes, and in many cases is owned by, the IT department's business decision maker (BDM). The BDM needs a different set of criteria because their needs and responsibilities have a different focus from the implementer's. Those BDM decision-making needs are the subject of this chapter.

> 🕮 You should review Chapter 3 thoroughly either before or after reading this chapter. They go hand in hand to provide a complete picture of the selection and implementation process. Although some of the content will be similar or duplicate, other content will be unique and prove very useful to understand the problem and solution from more than one viewpoint.

In this chapter, we will examine the fragmentation problem as a business problem. First, we'll spend some time looking at fragmentation as a business risk. Although previous sections described the on-disk technical details, we'll look at the impact to users, systems, and the business. Once we've seen what kind of impact fragmentation can have, we'll take a look at how best to justify a solution to the problem. The best way to do this is with case studies. We'll examine examples of other companies that have successfully mitigated the fragmentation problem and use that data to help justify our own solution. Then we'll provide a strategy for selecting a defragmentation solution. Previous chapters examined this same problem from a technical perspective, but we'll examine the problem from a business standpoint. For example, the technical solution may not account for an ROI calculation as part of the solution. However, from a business perspective, if the solution isn't worth more than the problem, we may not fix it at all.

Understanding the Investment

As we saw in Chapter 3, there are a number of problems caused by disk fragmentation. As previously mentioned, we divided the problems caused by fragmentation into three categories. Let's briefly recap these categories and explore how they apply to our ROI decision-making process.

> 🕮 For more technical details about how fragmentation impacts these categories, see Chapter 3.

Performance

When a computer's disk is fragmented, more read-and-write operations are required to manipulate the same amount of data, and these operations become more complex as the data is further fragmented. Over time, most disks become fragmented. This means that over time, system performance can degrade as a result of slowly escalating fragmentation. Depending on the severity of the degradation and the amount of time that the symptoms took to manifest, it may take time before fragmentation is perceptible to a user. Let's look at each problem individually because, even though they usually have a common root cause, the approach and remediation to each can be very different. And so can the cost to repair each type of problem.

User-Perceived Performance Issues

IT and Help desk staff encounter user-perceived performance issues frequently under the generic complaint of, "My system used to be fast, but now it takes forever to do anything." There are numerous potential causes of such problems, and disk fragmentation is one of them.

When the IT department receives performance complaints, they usually have a standard set of tasks and tools that they use to help improve the overall performance of the system. These often include actions such as:

- Rebooting the computer
- Emptying the Web browser cache
- Deleting files in the Temp directory
- Defragmenting the hard drive using the built-in Windows defragmentation utility
- Scanning for viruses and malware
- Running Windows Update to apply any outstanding patches
- Uninstalling all user-installed applications
- Re-imaging the system as a brute-force fix

Fortunately for many users, one or more of these steps usually results in some measurable system improvement. As a result, the user stops complaining and the IT group closes out the ticket. Although this might seem like a good thing, there are a number of flaws with this strategy. The primary flaw is the implementation of these steps. They are usually done as one combined suite of problem-solving steps. If the computer becomes acceptably performant (or is "fixed), there is no way to determine which step was responsible.

In addition, almost all these steps are one-off performance improvement tasks. None are effective in improving the system's performance permanently or repeatedly except the Windows Update task, which is virtually never going to improve the system's performance anyway.

The cost of responding to this complaint is significant. The loss of productivity is the most obvious concern, because the slower the user's computer, the less efficient the user is at performing computer-intensive tasks. Between the time the performance loss is recognized and the problem is reported to IT, the user generally spends some time complaining about it to coworkers and management. Once reported, the IT staff might take several hours to run their suite of repair tasks and restore the system to a "usable" state. All these are significant money and time drains on your resources.

Less-Perceived Performance Issues

System slowdowns are often not very obvious to users. Consider a system that degrades its performance at a rate of 1% per hour compared to 1% per week. The former system would have a significantly slower response after just a few days. The latter might never be detected by a user until some time-critical task was performed or until they used another system that did not have the same performance issue. Many users never notice long-term system degradation at all or simply attribute it to a system getting old. They wrongly assume that computers, like people, get slower as they age. A computer system should perform equally on its first day and after a decade of use. Modern computers don't wear out or degrade like people or older machinery. They either work or they fail.

However, there is a twist. Computers perform properly only when maintained. There are only a few ongoing maintenance tasks that must be run at a regular basis, but they are critical to keeping a computer performing at peak levels. These regular maintenance tasks include:

- **Scanning for and removing malware**. This should be done on a daily basis and is usually also done in real-time by software that remains active on each computer. Although many enterprises maintain firewalls and security gateways, each computer is also usually configured with malware protection for situations where the malware avoids the perimeter defenses.
- **Defragmenting and preventing fragmentation of disks**. This is also done daily and can, depending on the software solution, be done continuously in real-time. This must be done on each computer throughout the enterprise, regardless of its role.

This guide concentrates on the second task, defragmentation. This can be done on a regular or continuous basis to help ensure that there is no performance impact to users. Almost all defragmentation software packages have the ability to run at off-hours times on a daily basis. The more advanced packages also contain technologies that both help prevent future fragmentation and defragment continuously in the background. These are very useful as fire-and-forget solutions so that the administrator and the user can feel confident that this problem is addressed with no interaction required.

Example of Fragmentation Performance Impact

Fragmentation is often cited as a detriment to system performance; however, surprisingly few hard facts have been published on the impact of disk fragmentation in a sizeable organization. This chapter will offer several examples of measurable impact through the citation of case studies and other published data. The first example is in the area of performance impact at a worldwide restaurant chain.

Consider a case study written by Joel Shore in 2007 entitled, "Diskeeper Keeps the Food Coming at Ruby Tuesday." In this case study, Shore explored the impact that disk fragmentation has in this worldwide organization of more than 900 restaurants. With such a disperse organization, a lack of centralized IT assets is almost guaranteed. In addition, the likelihood of advanced user knowledge at each restaurant, or even in each region, cannot be assumed. Thus, there is no IT staff to perform regular speed-up or system maintenance tasks. However, Ruby Tuesday identified defragmentation as a requirement for all their systems worldwide to help ensure ongoing system performance.

As a result of the lack of local IT staff, one of the key drivers to their solution selection was that they required a hands-off solution—that is, the solution just work with zero input or decision-making by the user. After they purchased and implemented their solution, Ruby Tuesday estimated that they potentially saved $2.1 million per year by keeping the systems performing at peak level.

Data Integrity

Fragmentation does not just have an effect on the system's performance. There is also an impact on the integrity of the data that the system stores and processes. As a system's disk becomes fragmented (whether slowly over time or rapidly due to significant data throughput), the number of discrete read-and-write operations necessary to manage the data increases. Each operation is an opportunity for the disk to fail and puts a little more strain on the mechanics of the drive.

Consider your car. If you keep your car at peak performance, it is less likely to break down. Regularly changing the oil means that the engine encounters less friction and requires less effort to move the car. If the oil gets dirty and old, the engine has to work harder because there's resistance. Harder work means shorter life for engine components, and as a result, you're more likely to encounter a breakdown or mechanical failure.

Although disk drives aren't nearly as reliant on this type of upkeep, there is a measurable difference between a well-maintained drive and one that has had no maintenance. A drive that has severe fragmentation works very hard to read and write data compared with a similar drive without fragmentation. Less work means less likelihood of failure, which means increased data availability and integrity.

Unfortunately, data integrity issues usually do not provide advanced warning. They usually manifest when a user tries to access data and the file is missing or corrupt. At that point, the best alternative is usually restoring from a backup or looking for a copy (for example, a recent copy sent via email). Once this initial data integrity issue is recognized, most administrators will immediately take steps to verify the integrity of other data and proactively mitigate any other data integrity issues (for example, get a complete backup of the data, repair the drive, and so on).

Data Recovery Services

There are a number of data recovery companies in business today. These companies specialize in recovering data from failed computer hard drives. They often charge anywhere from a few hundred to a few thousand dollars for their service depending on the quantity of data, the age of the drive, the level of damage to the drive, and other factors.

Before you are in a situation where you need this kind of service, you should consider performing regular data backups. If you have a reliable backup copy of your data, you are less likely to need this unreliable and expensive service. This is especially true for irreplaceable data such as photographs and email conversations which may be difficult or impossible to recreate.

Stability

Within the context of fragmentation, data integrity and stability are very similar. If the system's data integrity begins to fail, the stability will also fail. This is because the computer's operating system (OS) is really just made up of data on the hard drive, just like any other data. If the data begins to become compromised, as discussed earlier, the system's stability will decrease.

The symptoms of an unstable Windows system vary widely but can include:

- Random system hanging or halting
- Periodic crash dump or "blue screen" error messages
- Irregular application error messages, often not corresponding to any specific action
- Noises from the hard drive (almost any noise from a hard drive is a sign of trouble)
- Poor system performance, often including moments where the system pauses for a moment
- Random system reboot or shutdown events

As you can see, some of these symptoms are very severe. In many cases, they can have a profound impact on the system's usability and on the user's confidence in the system. If you've ever lost several hours worth of work when a system unexpectedly crashed, you can relate to this problem.

Luckily, system instability stemming from fragmentation usually has some early indicators. Most systems don't just suddenly stop working as result of excess disk fragmentation. There will usually be one or more of the previously mentioned symptoms that worsen or become more frequent over time until they are addressed or the system completely fails. This can allow an IT professional to step in early and mitigate the problem before it becomes catastrophic (for example, making a data backup, defragmenting the disk).

The early indicators are both a blessing and a curse. Regardless, the problem needs to be addressed. Luckily, you can make a smart investment to fix this problem before it manifests itself. The next section discusses exactly how you can justify the investment and ensure that your systems remain reliable and your data remains intact.

Justifying the Investment

At this point in our series on disk fragmentation issues, you should understand many of the problems that fragmentation creates or exacerbates. You are probably looking to implement a solution immediately. Chapter 3 covered the technical aspects of implementing a solution. But as a BDM, you need different data. You need to understand the ROI to justify the spending to stockholders, management, ownership, and so on. In many organizations, you are required to write a formal justification for spending this amount of money. You may also need to create a change control justification for your IT department before they will deploy a change across all computers. This section helps you create this type of content.

We will examine the justification for our purchase in the same three categories that we've been using to describe the problem: performance, data integrity, and stability. For each section, we'll look at case studies of companies that have realized quantifiable improvements in these areas. These case studies often overlap, providing improvements in two or all three categories. However, there is usually one area that stands out more than the others.

A Note on Case Studies

This section uses case studies to justify a business decision. In most instances, these case studies have been commissioned by companies that distribute or sell defragmentation solutions such as Diskeeper Corporation. Regardless of the source of the research or the funding behind it, this document will continue to examine the fragmentation problem and solutions without bias to any particular vendor or solution.

Performance

As we saw earlier in this chapter, higher performance often directly leads to more effective workers and faster processes. When computer performance is at its peak, we realize efficiencies across a variety of assets. People get their work done faster (and spend less time complaining about slow computers), process-intensive, or throughput-intensive tasks run faster, system backups run faster, and so on.

Improving Employee Productivity

We already understand that increased employee productivity is a benefit to any organization. There are many examples of improving employee productivity through disk defragmentation. One great example that was previously mentioned is the restaurant chain Ruby Tuesday. This chain has restaurants around the world, which presents IT challenges, as there is rarely a technician at the restaurant. The computers at each restaurant must be self-sufficient and require little external maintenance over time.

As we learned earlier, all computer systems encounter disk fragmentation over time as part of the normal operation of the system. Ruby Tuesday identified that the ongoing fragmentation of their systems was causing each computer to slowly lose performance, which resulted in their ordering and billing processes (the processes that required the computers) to slow. Because the success and profitability of restaurants often depend largely on their efficiency, Ruby Tuesday focused on identifying the cause of the system slowdown.

In addition to the system's decreasing performance, the risk of having a hard drive fail prematurely is significant. Consider the difficulty and cost of replacing a hard drive in a remote restaurant where there is no IT presence and no trained personnel locally. Computers might be down for days or weeks, or entire computers might need to be delivered and replaced (again, with trained personnel). This results in a very high cost whenever a system fails.

Ruby Tuesday calculated that a loss of 30 seconds of productivity per hour due to computer performance issues in a restaurant open 12-hours a day resulted in an annual potential revenue loss of $2.1 million (May 2007). That is a significant loss of revenue in any organization, and in a restaurant chain where competition is high and profit margins are thin, this can make an enormous difference in the company's success.

One choice that Ruby Tuesday made was to implement a hands-off disk defragmentation solution. The solution they chose ran automatically with no user input. Although the deployment, results and configuration could be centrally managed by the centralized IT department, the daily operations were completely automated. This kept the long-term operating costs low and ensured that local staff at each restaurant did not need to be trained in IT operations (another costly investment considering the employee attrition at most chain restaurants).

Increasing System Longevity

Another example where we realize a monetary gain from higher performing computers is in capital expenditure and asset longevity. A very common reason for replacing computers in an enterprise is in response to users complaining about insufficient system performance. Many organizations have a well-defined longevity requirement for computers, but the user complaints often drive review of, or exceptions to, this process. But the longer a computer is used, the higher the return on that investment becomes. Therefore, we want to use the computer for as long as we possibly can.

Defragmentation helps in this area by improving performance and therefore increasing system longevity. As you saw in previous chapters of this series, the performance between fragmented and defragmented systems can be dramatic. Even a minor change in the usable life of a computer system can be dramatic when you consider several factors:

- The number of similar computers that need replacing
- The hardware cost of replacement
- The operating cost of installing, configuring, and transferring data to the new systems
- The disposal cost of the existing computers

All these factors help us understand that obtaining even a small extension in a computer's usable lifetime is a significant cost-saving measure.

Decreasing Deployment Time

Another area where performance plays an important role is in the deployment of new computer systems. Consider how your organization sets up and configures new and replacement computers. Most likely you use system imaging software that installs images over the network, such as Symantec's Ghost or the built-in imaging software installed with Microsoft Windows Server 2003 and 2008. These processes are dependent on both the disk and network to efficiently transfer an enormous amount of data to the new system. Any improvement to disk throughput will improve the efficiency of the network-based data transfer and therefore improve the system's imaging speed.

One example where defragmentation made a difference in system imaging speed was at the Trinity School in New York City. The school's director of technology, David Alfonso, used a defragmentation solution throughout his data center. One significant improvement he realized was in system imaging, where he saw the time required to load a system image decrease from 25 minutes to 12 minutes. The decrease in disk fragmentation improved local data throughput which, in turn, enabled the imaging software to more thoroughly use available network bandwidth to keep the data stream moving at the highest speed possible. Because the Trinity School images up to 20 systems at a time, the performance improvement helped Alfonso realize an enormous efficiency in this area.

Data Integrity

The cost of losing data can be significant. Consider a few scenarios:

- A bank relies on its database to log customers' transactions and account information. Even a single point of data lost can result in financial catastrophe for the customer and the bank.
- A publicly-traded company loses the work it has done to prepare its mandatory quarterly filings. Whenever a company misses a mandatory filing date, there are significant financial and procedural penalties, including de-listing the company and criminal charges against its officers.
- A research scientist stores unfiled patent documentation on his laptop computer. He also backs up the data to a secured server. If these documents are modified by anyone other than the user, or if the data is destroyed, this significant research investment may be lost.

We could go on for a long time with examples about the cost of data integrity or data loss. But this concept is relatively well understood to most BDMs. Most organizations that rely on data for their core business have implemented data categorization—identifying data that, if lost, has significant impact on the company. This is often called high-value data or high business impact data.

Special precautions are taken to ensure that high-value data is not lost or corrupted. These precautions usually start with regular, verified, and secured data backups. This helps ensure that the data can be recovered in case of loss. Because restoring data from backup can be costly and does not always restore the most current version, most organizations choose to take steps to help prevent the loss in the first place. Often this means that the organizations also employ a data defragmentation solution. This helps with both system stability (explored in the next section) and data integrity.

Stability

System stability directly results in decreased system cost. This concept is applicable to almost any capital asset. As an example, consider your car. It is a capital asset—you paid a significant price for it and expect it to work for many years. You may plan your career and personal life around the fact that you have a car. Of course, these plans most likely depend on the car working properly. Few people purchase a car and make plans based on it working 90% of the time. Even fewer people own a car and expect it to break down during a drive to the hospital or a job interview. In these cases, you might have to pay for a taxi or private car service to get to your destination, which would significantly increase your transportation costs.

The same paradigm applies to computer stability and cost. Unexpected downtime is incredibly expensive in a number of ways. The users' inability to use the system is the most obvious impact. But consider the expense of out-of-warranty repairs to a system. There is also the operations cost of identifying and replacing the failed system. In almost all cases, preventing system downtime is a better investment than repairing the system when it fails.

For example, the Plantronics Corporation conducted a small internal study. They compared the stability of desktop computers before and after running disk defragmentation software. Everything else remained the same—the system workload, the hardware and software configurations, and so on. When the system was defragmented, the users consistently reported that their systems were more reliable and performed better than before the defragmentation. Technical reasons aside (see Chapter 2 for the reasons), the system stability improved both the perception and reality of the system's reliability.

A similar case study comes from the Web hosting company CrystalTech, where disk fragmentation was decreasing system performance so severely that customers complained and some systems had to be taken offline for maintenance to defragment the disks. Similar to Plantronics, the implementation of a defragmentation solution improved both the real and perceived performance and uptime of the systems.

A more technical and less user-oriented case study was conducted by *Windows IT Pro* magazine in June 2007. When the researchers intentionally fragmented certain key components of the system, there was a significant decrease in system stability. However, as soon as they used a defragmentation solution to address the problem, the stability issues were resolved.

Cost-Benefit Analysis Summary

We've seen that disk fragmentation can be a significant problem. This isn't just a technical problem—it is also a financial problem as well as a business problem. Fragmentation can have a significant monetary impact on any organization. And its impact is not just a minor nuisance; it can significantly impact the entire business, even if the business is not technology-focused (as we saw with the Ruby Tuesday case). As we've explored, there is a wide span of problems that disk fragmentation causes and you should understand the necessity for a solution in your company. The next section describes how to choose the solution that's best for you and integrate it in your company.

How to Make Your Decision

You've looked at the available defragmentation solutions. You've decided on a default defragmentation method and potential exceptions. You have an idea of how many computers will receive the software and how it will be deployed. Now you need to make your purchase and use it.

The remaining phases of the purchasing process are fairly straightforward. These are common to any software evaluation decision:

- Preselection
- Test
- Purchase
- Deployment

Let's take a brief look at each of these phases from a BDM's perspective.

This section is similar to the identically-titled section in Chapter 3. Although much of the data is the same, it has been customized to be more useful from a business point of view instead of a technical implementation viewpoint.

Preselection

Now that you've identified the needs of your organization, take a look at the solutions available. There are a number of ways that you can find out information about the features of the software packages:

- Read marketing literature from the software developer
- Review industry-provided case studies
- Check software reviews from other corporate users, IT managers, and BDMs
- Visit the company's Web site
- Ask the manufacturer to have a sales representative contact you
- Network to find others who use the same software and ask them their opinions

The desired result of this work is that you'll have one or two solutions that you believe will work best for your needs. There may be a long list of potential solutions, but using these methods against the decision criteria we developed earlier should help bubble the best candidate to the top. Once that happens, we can examine the best candidate through testing.

Test

Testing any significant IT investment is a critical step in the selection process. No matter how much research you perform, you should see it work before you commit to the solution.

The BDM rarely performs any hands-on tests. But this person does need to ensure that the tests are being carried out by the IT team and that the data being gathered can be used to make a trustworthy business decision.

> 🕮 The testing instructions in Chapter 3 are extensive and should provide a solid foundation for any testing process.

The results that you receive from the IT team doing the testing should include answers to the following questions:

- Does the software perform the functions that it advertises?
- Does it address the three categories of issues discussed in this guide?
- Is the software reasonably easy to deploy and manage?
- Did the software affect any other business software or systems? Were there any conflicts?
- Was the software tested in the manner it would be implemented on production systems (in real-time, on a schedule designed for production systems, etc.)?

These answers will not necessarily provide a complete picture of the solution or drive you towards a single product. Instead, the test results should be balanced with other decision-making criteria that apply to any IT purchase such as price, supportability, and long-term value.

Deployment Guide as a Result of Test

Most organizations overlook one key element of testing that often justifies the entire process. During testing, you have to deploy and redeploy a number of times. And you're documenting the process as you go. A natural result of this work should be a Deployment Guide for the software that you can use in production. This detailed guide will be fully tested and verified before the end of the test process. It is an invaluable document for your deployment staff because they can understand exactly what steps to perform, what results to expect, and how to handle any variances that may occur. And if you're doing a thorough job of testing, this document should require virtually no additional effort.

Once you've completed the testing and combined the results with the other information you have, you should have enough information to decide whether to proceed with the purchase and widespread deployment of the software. But do not be surprised at this point if the project takes a different direction. The results of applied testing sometimes help us draw different conclusions than we had previously thought. For example, you might find that your preselected and tested defragmentation solution conflicts with a disk management application that you use on 25% of your computers. In that case, you would be unable to proceed with the deployment, at least to those affected computers. You might decide not to deploy any defragmentation solution to those computers, to use two defragmentation solutions, or to test your second choice to see if it also has the same issue. But obviously it's better to find this out before you've purchased licenses and begun your widespread deployment.

Purchase

The purchase process will be different for every customer and every software vendor. Virtually every purchase is going to vary to some degree. So providing specific details here isn't really useful. Some software vendors will negotiate bulk pricing, while others will not. Some will accept purchase orders or incremental purchases at the same discount, others will not. You might receive your software funding over time or all at once. The possibilities are endless.

You should ensure that you have ready access to the software. Receiving some number of retail shrink-wrapped packages is one solution. These are effective as known good, clean copies for building system images and performing test installations from local media instead of the network. You should ensure that you have enough on hand in case of problems like the loss of a software deployment server or having to install the software to an isolated or offline system. Some software companies offer alternative methods for software acquisition and storage, such as online libraries or the option to burn their software to CD/DVD on demand. Use whatever method you're comfortable with, as long as you have access to a backup of the software in case of emergency.

Deployment

Great! You've analyzed the market, selected a software package, tested it thoroughly enough to know it works for you, and purchased enough licenses to begin your deployment. Now let's get going!

The section on deployment in Chapter 3 covered the majority of deployment considerations and decision criteria that you make. But by the time you get to this stage, you almost certainly have a very specific deployment strategy, plan, and documentation. Now it is time to execute on your well thought out and documented strategy.

In a perfect world, the deployment is the easiest part of the process. But in reality, issues will arise. Conflicts will come to the surface that weren't detected during testing. Your deployment software might hiccup and miss a hundred users. The new software might conflict with another application that's only deployed on a small number of computers, so you missed it during testing. Regardless of how well you planned, remain flexible and deal with the snags as they arise.

Consider Standardizing and Automating Your Deployments

If your organization does not currently have a standardized deployment strategy, you should consider investigating this option. The benefits to having one are almost too numerous to list but include ensuring IT consistency across the organization, more effectively managing software licenses, and reducing the total cost of ownership (TCO) of systems by reducing the deployment time of a computer from hours or days down to minutes with little or no administrator interaction. Consider reviewing Microsoft's Business Desktop Deployment 2007, which includes both guidance and automated tools and is available for free download.

At the end of the deployment phase, you have your solution installed and running on all the intended computers with the software verified and reporting its status. But deployment isn't really ever complete. New computers come into the environment and require one-off deployments. Old computers require undeployment or reconfiguration. This is part of the ongoing software operation life cycle, but it is the same as any other piece of software.

Summary

Disk fragmentation is a serious problem that affects every business that relies on computer systems. Even companies that don't focus on technology can be severely impacted, but often in less obvious ways. System crashes and errors may be one very apparent symptom of disk fragmentation. Less obvious symptoms are loss of productivity, both employee-based and computer-based.

If it isn't already apparent, let's be very clear: you should evaluate and implement a disk defragmentation solution in your company. It doesn't matter if you have 50 computers or 50,000. Fragmentation is almost certainly causing some negative impact on your organization. You should use the techniques described in this guide to determine the proper solution for your company and then integrate it to all your computers.

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