



Technical Overview of File Services

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Abstract

Microsoft® Windows® server technologies deliver a low total cost of ownership (TCO) and reliable file services that are essential to enterprise computing infrastructures. Windows Server 2003 delivers an exciting set of customer-focused improvements in file services, especially for those using Windows NT® Server 4.0 to provide file services. This technical overview discusses improvements in Windows Server 2003 File Services and covers the following: core infrastructure file service innovations, new features, and improved management tools aimed at lowering the TCO associated with managing servers.

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Introduction

Microsoft® Windows® Server technologies deliver low total cost of ownership (TCO) and reliable file services that are essential to enterprise computing infrastructures. Windows Server 2003 delivers an exciting set of customer-focused improvements in file services, especially for those using Windows NT® Server 4.0 to provide file services. This technical overview discusses improvements in Windows Server 2003 File Services and covers the following: core infrastructure file service innovations, new features and improved management tools aimed at lowering the TCO associated with managing servers.

Key Improvements

As a result of listening closely to customer feedback, Microsoft has built important improvements to file services in the Windows Server 2003 product line. These improvements focus on three key areas:

- **Improved Infrastructure Services.** Improved infrastructure services provide more flexibility with storage options and file delivery. As new storage topologies and applications have become more popular in the past 5 years [for example, storage area networks (SANs)], it has been a struggle to get different components of a solution to work well together. New standardized infrastructure services in Windows Server 2003 help to streamline the development of core server management and file services.
- **Enhanced End User Experience.** Windows Server 2003, used in conjunction with Microsoft Windows XP, delivers seamless access to network data and files. It also strengthens the safety net for end users who save files on network shares, even from non-Windows XP clients.
- **Lower TCO.** Improved manageability in Windows Server 2003 leads to a lower total cost of ownership. This is accomplished by using improved Web-based management tools, as well as more extensive command line tools that enable the use of scripts to manage remote or local file servers.

What's In This Article

Topics covered in this article include:

- [New Features and Improvements](#)
- [Benefits](#)
- [Improved Infrastructure Services Virtual Disk Service](#)
- [Volume Shadow Copy Service](#)
- [Distributed File System](#)
- [Shadow Copy Restore](#)
- [Offline Files Improvements](#)
- [WebDAV Redirector](#)
- [Command-line Tools](#)
- [Automated System Recovery](#)
- [Chkdsk](#)

- [Disk Defragmenter](#)

New Features and Improvements

The Windows Server 2003 family provides many enhancements to the file system infrastructure. The features and descriptions listed in the following table provide a general overview of what's new and improved in File Services for Windows Server 2003.

Enhanced File System Features

Feature	Description
Shadow Copy Restore (Previous Versions)	<p>Shadow Copy Restore (Previous Versions) provides point-in-time copies for network folders. Users can easily access previous versions of their files through the Windows Explorer by right-clicking on a file or folder. Using Shadow Copies, a Windows Server 2003-based file server will efficiently and transparently maintain a set of previous versions of all files on the file server.</p>
Enhanced Distributed File System (DFS)	<p>DFS helps businesses deliver highly available file services at a low total cost of ownership. DFS can be used to create one logical file system out of multiple physical systems, making your environment easier for users to use and more efficient in terms of equipment utilization. With DFS you can create a single directory tree that includes multiple file servers and file shares in a group, division, or enterprise that allows users to easily find files or folders distributed across the network. This single directory tree (logical namespace) can contain more than 5000 shared folders, located on different servers across an enterprise.</p> <p>Using the Active Directory® service, DFS shares can also be published as volume objects and administration can be delegated.</p> <p>In Windows Server 2003, DFS now offers a closest site selection capability where DFS uses Active Directory site metrics to route a client to the closest available file server for a given path. Plus, a single Windows Server 2003 system can host multiple DFS roots.</p>
DFS File Replication Services (FRS)	<p>FRS enables businesses to achieve a low TCO, just like with DFS, by ensuring that data stays synchronized. FRS works in conjunction with DFS by replicating data on file shares, automatically maintaining synchronization between copies across multiple servers.</p> <p>A new feature in Windows Server 2003, the DFS Microsoft Management Console (MMC) user interface allows configuration of replication topologies. The FRS service itself also has new features—compression of replication traffic and the ability to damp unnecessary replication traffic.</p>
Enhanced Encrypting File	<p>Windows Server 2003 strengthens the security of your file services with enhanced EFS. EFS complements other access controls providing an added</p>

System (EFS)	level of protection for your data. EFS runs as an integrated system service, making it easy for you to manage, difficult to attack, and transparent to the user.
Volume Shadow Copy Service	A shadow copy of a storage volume is a point-in-time copy of the original entity. The shadow copy is typically used by a backup application to back up files that are made to appear static, even though they are really changing. And if created on a storage area network (SAN), the shadow copy can be transported to another server for backup, testing, or data mining.
Virtual Disk Service (VDS)	VDS implements a single, uniform interface for managing disks. Each hardware vendor writes a VDS “provider” that translates general purpose VDS APIs into specific instructions for their hardware. With this abstraction layer provided by VDS, Windows Server 2003 gives customers a more robust set of solutions, including greater flexibility for making long-term investment decisions regarding SANs and other storage options.
Command-line Interface	Administrators gain powerful new command-line utilities for many disk management tasks in Windows Server 2003, including: the ability to grow basic disks, perform various disk and RAID configurations, shadow copy management, and file system tuning.
Increased CHKDSK Performance	Because the NTFS file system has always been a true journaled file system, CHKDSK operations are rarely required. If in the unlikely event a disk does need to be checked (less than 1 percent of unplanned outages require such checking), CHKDSK performs 20% to 38% faster than in Windows 2000.
Higher Performance Defragmentation Tool	The Windows defragmenter tool can increase disk availability and performance by optimizing files on a volume. Defragmentation in Windows Server 2003 is faster and more efficient than it was in Windows 2000. Plus, it supports online defragmentation of the Master File Table (MFT) and can defragment NTFS volumes with any cluster size.
Content Indexing	Content indexing is a fast, easy, and secure way for users to search for information locally or on the network. Users can search in files that use different formats and languages, either through the Search command on the Start menu, or through HTML pages viewed in a browser.
Automated System Recovery (ASR)	A new feature in Windows Server 2003, ASR improves productivity by enabling one-step restore of the operating system, system state, and hardware configuration in disaster recovery situations.
Remote Document	A new feature in Windows Server 2003, remote document sharing increases

Sharing (WebDAV)	'connectedness' to your business through the WebDAV redirector. With the WebDAV redirector, clients can access files on Web repositories through file system calls.
GUID Partition Table (GPT)	<p>Windows XP 64-Bit Edition and the 64-bit versions of Windows Server 2003, Enterprise Edition and Datacenter Edition support a new disk partitioning style, the GPT.</p> <p>Unlike master boot record (MBR) partitioned disks, data critical to platform operation is located in partitions instead of unpartitioned or hidden sectors. In addition, GPT partitioned disks have redundant primary and backup partition tables for improved partition data structure integrity.</p>
New Support for Anti-virus Products	Protecting your resources from malicious code delivered by viruses is a key component for providing secure and reliable file services. Windows Server 2003 enhances the already robust anti-virus support for Windows Server by providing new kernel APIs that enable higher performance and reliability from third party anti-virus products. In addition, there is now a Windows Hardware Quality Lab (WHQL) test suite and driver certification process for anti-virus file system filter drivers.

Benefits

The Windows Server 2003 family provides the following file system benefits:

Benefit	Description
Increased Dependability	Windows Server 2003 ensures higher reliability with new features such as Automated System Recovery (ASR), making it easier to recover your system, back up your files, and maintain maximum availability.
Greater Productivity	Windows Server 2003 delivers an enhanced file system infrastructure, making it easier to use, secure, and store files and other essential resources. Users benefit by always being able to access the resources they need, including quickly recovering files without costly assistance from an IT helpdesk.
Enhanced Connectivity	Windows Server 2003 provides new and enhanced features, like remote document sharing, that improve connectivity within and across the organization.

Improved Infrastructure Services

Windows Server 2003 contains many improvements in the way it manages and uses local storage. These improvements include:

Improved File System Infrastructure

- Virtual Disk Service (VDS)
- Volume Shadow Copy Service (VSS)
- Distributed File System

Enhanced End User Experience

- Shadow Copy Restore
- Offline Files improvements
- WebDAV Redirector improvements

Lower Total Cost of Ownership: Improved Manageability

- Command-line tools
- Automated System Recovery

Better Utilities Improve Performance and Availability

- Chkdsk
- Disk Defragmenter

Improved File System Infrastructure

Virtual Disk and Volume Shadow Copy Services are key elements of the improved file system infrastructure in Windows Server 2003.

Virtual Disk Service (VDS)

Whereas Volume Shadow Copy Service (see below) provides an important building block for managing data on disks, the Virtual Disk Service (VDS) provides an important new set of command-line utilities and management applications for managing the disks themselves.

In Windows 2000, each storage area network (SAN) hardware vendor provided its own proprietary set of APIs for managing their hardware. This makes it challenging to develop uniform SAN-management software. Windows Server 2003 addresses this issue with VDS. VDS implements a single, uniform interface for managing disks. Each hardware vendor writes a VDS "provider" that translates the general purpose VDS APIs into specific instructions for their hardware. With this abstraction layer provided by VDS, Windows Server 2003 gives customers a more robust set of solutions, including greater flexibility for making long-term investment decisions regarding SANs and other storage options.

Management applications no longer need to take into account the specific hardware being targeted. Instead, by developing applications that target VDS, the next generation of Windows disk management applications will be able to manage any hardware that has a VDS provider.

There is an immediate benefit from the VDS architecture: Microsoft has implemented VDS providers for basic and dynamic disks. This brings functionality to basic disks, such as online growth, that formerly applied only to dynamic disks. See Figure 1 below for an illustration of Virtual Disk Service.

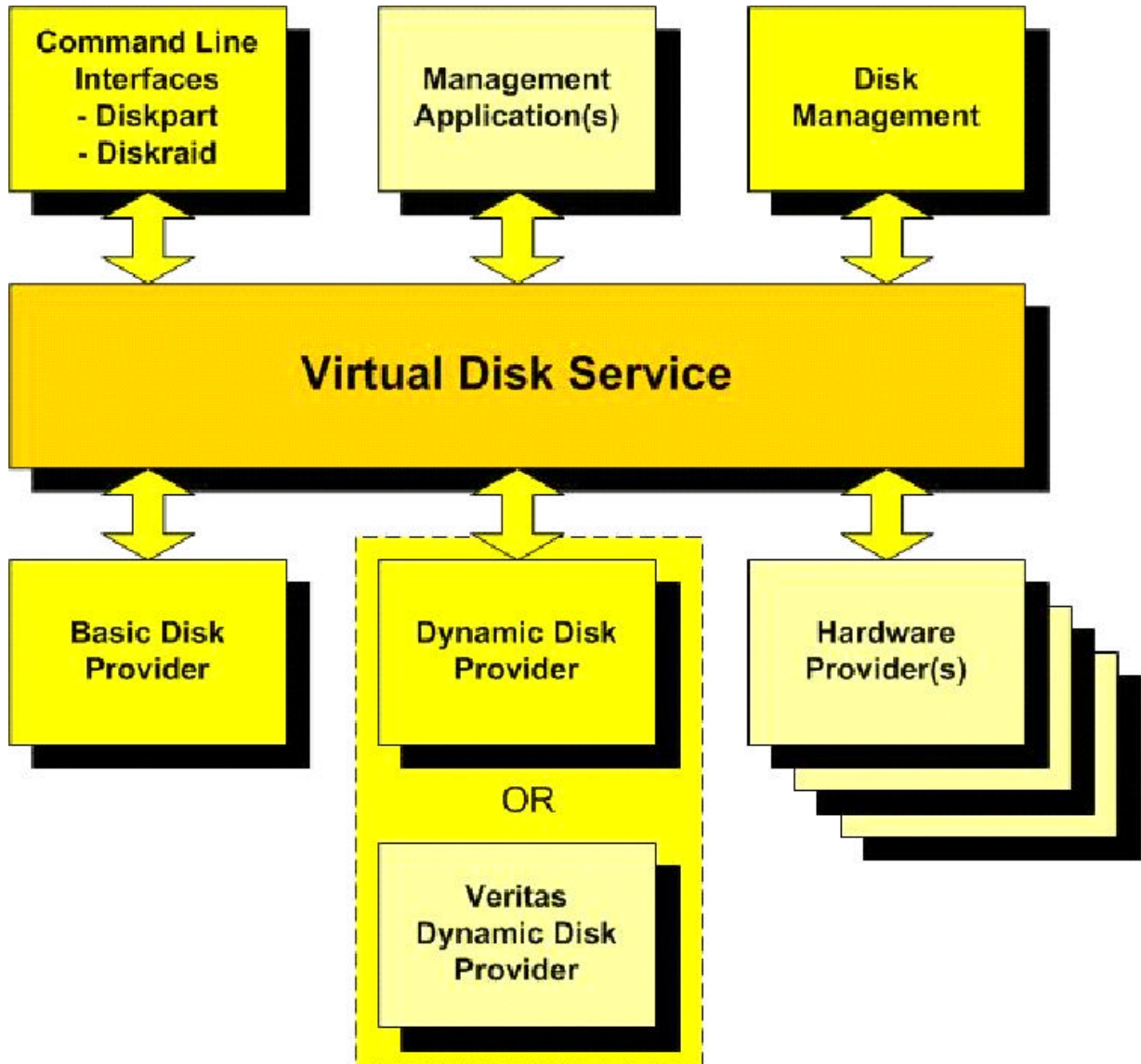


Figure 1. Virtual Disk Service schema

Volume Shadow Copy Service (VSS)

Volume Shadow Copy Service (VSS) is a general infrastructure for creating point-in-time copies of data on a volume. These are generally referred to as 'snapshots'. The goal of VSS is to provide an efficient, robust, and useful mechanism for the next generation of data management applications.

Scenarios Enabled by VSS

You can take advantage of the following three key scenarios when using the Volume Shadow Copy Service.

- **Shadow Copies for Backup**

One set of applications that use VSS are backup applications. Using Windows 2000, you either had to stop activity on your server during the backup process, or live with the side effects of an online backup: inconsistent data and open files that could not be backed up. With Windows Server 2003, online backups result in consistent data, and files that are open during the backup are never a problem.

VSS accomplishes this by facilitating communications between the following three important entities to ensure a high-fidelity backup and easy restore process.

- **Requestors**—These are applications, such as backup or storage management, that request a point-in-time copy of data or a shadow copy.
- **Writers**—These are the components of an application which advertise and protect data. For example, Active Directory, and other application servers will have writers that advertise their data, location, and method of backup and restore. Writers differentiate VSS from other shadow copy or snapshot solutions. Applications are involved in the shadow copy process in VSS to guarantee high-fidelity, consistent shadow copies.
- **Providers**—Providers expose the mechanism for hardware- or software-based shadow copies. Many storage hardware vendors are writing providers for their storage arrays. Windows Server 2003 comes with a software provider.

Figure 2 below shows how requestors, writers, and providers interact.

- **Shadow Copy Transport**

Shadow Copy Transport gives storage administrators the ability to easily transport data on a Storage Area Network (SAN). For example, suppose that you need to make a production database available for data mining, backup, or testing. With VSS, you can create a shadow copy, export it on the SAN, and simply import it on a second server located on the SAN. In this way, you can transport multi-terabyte volumes on your SAN in minutes. The only requirement is that you have a provider from your storage array vendor.

For a Flash demonstration of Virtual Disk Service and Volume Shadow Copy Service, see: <http://www.microsoft.com/windowsserver2003/evaluation/demos/default.mspx>

- **Shadow Copy Restore**

Shadow Copy Restore enables users to see point-in-time copies of content in network folders. For more information, see Shadow Copy Restore in the Enhanced End User Experience section below.

For a Flash demonstration of Shadow Copy Restore, see:

<http://www.microsoft.com/windowsserver2003/evaluation/demos/default.mspx>

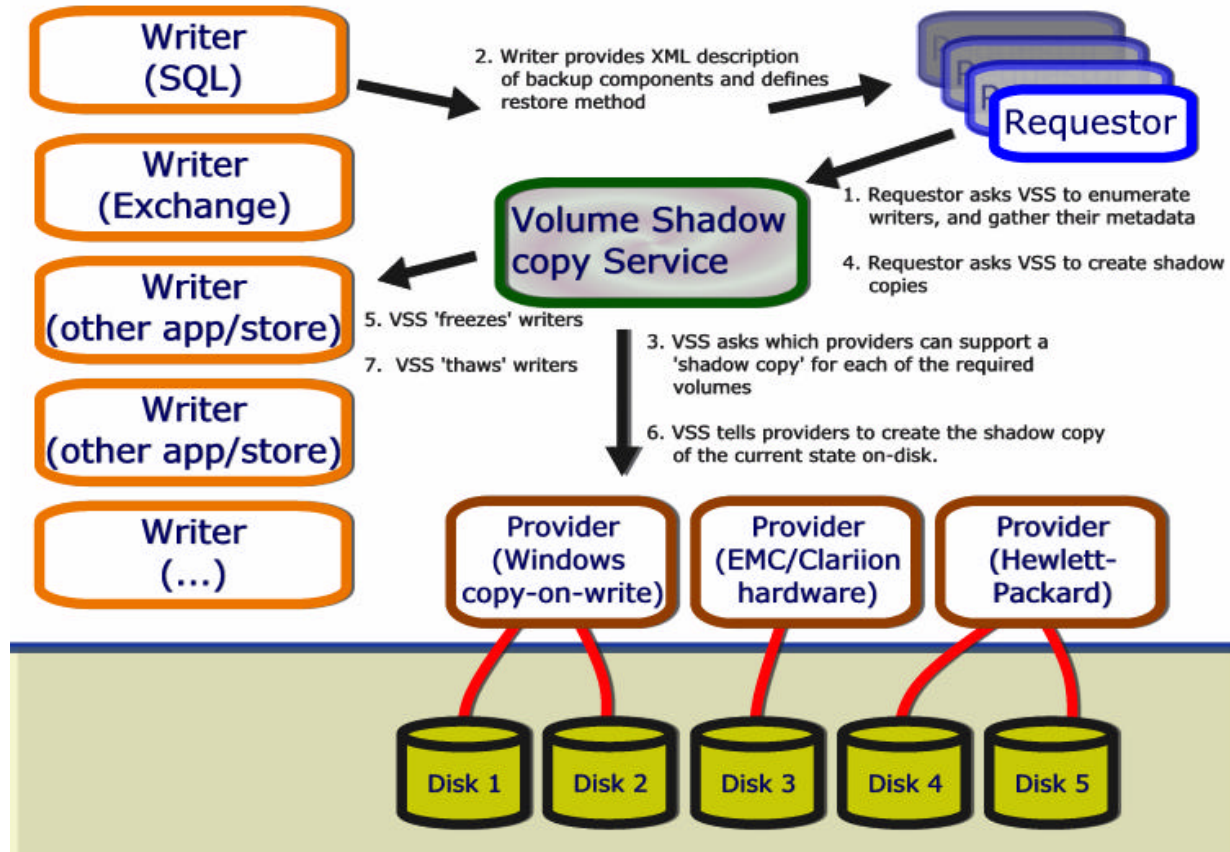


Figure 2. Using Volume Shadow Copy Service—How requestors, writers, and providers interact

Important An important thing to note about the built-in Windows shadow copy provider is that it uses a "copy-on-write" algorithm to provide shadow copies in the most space-efficient way possible. For example, if you have three gigabytes (GB) of data on a volume, Windows Server 2003 does not copy all three GB when you create a shadow copy. Instead, Windows Server 2003 simply makes copies of the original data on the volume as applications make changes.

Distributed File System

Windows Server 2003 contains improvements to the Distributed File System (DFS). DFS is a powerful feature for managing federated file servers. It provides the following capabilities:

- **Service layer.** DFS provides a service layer by separating the names that clients use to access files on the network, from the names of the actual servers that host the files.
- **Scalability.** DFS improves scalability by enabling you to balance the client workload among multiple servers.
- **Reliability.** DFS improves reliability by transparently redirecting client requests to a different server in the event of a failure. DFS uses the File Replication Service (FRS) to automatically synchronize replicas.

DFS Roots and DFS Junctions. The fundamental concepts of DFS are DFS roots and DFS links:

- A DFS root is a server, or a set of servers, that clients go to first when trying to access a file. These servers are typically spread across sites in a domain.
- A DFS link is a reference from the logical directory to a physically shared folder on a server located anywhere in an enterprise that can handle the file request.

Windows Server 2003 includes an important reliability enhancement for DFS—the capability of a single server to host multiple DFS roots. In Windows 2000, you could not have multiple DFS roots on a single server. As a consequence, a larger number of servers running Windows 2000 are required to host multiple DFS roots. In Windows Server 2003, this restriction is removed. In addition, Windows 2000 clustered stand-alone DFS servers could host only one DFS root, while Windows Server 2003 allows for the hosting of multiple DFS roots.

Windows Server 2003 also improves the behavior of DFS when you set up replicas that span multiple sites. In Windows 2000, DFS would give priority to targets within the same site as the client, and if there were no link targets within the same site, it would pick any random link target in any other site for the client's request. This is not the most efficient algorithm.

For example: If your company has sites in Redmond, Silicon Valley, and Tasmania, and your client computer is trying to access a link in Silicon Valley, the client computer will failover to any targets in Redmond or Tasmania when all of the link targets on the Silicon Valley site are unavailable, regardless of communication costs. Windows Server 2003, on the other hand, uses the site costing information in Active Directory to choose between off-site targets to satisfy a client request.

In this example, DFS would see from Active Directory that it is more expensive to communicate from Silicon Valley to Tasmania than from Silicon Valley to Redmond, and it would correspondingly redirect the Silicon Valley client to the Redmond target which is configured to be closest in the Active Directory sites.

Other File Serving Improvements

Windows Server 2003 contains many other file serving improvements:

- Improved Common Internet File System (CIFS) Throughput (especially on multiprocessor servers)
- Increased scalability for DFS (including a reduced memory footprint and faster startup/configuration)
- Better diagnostic tools for FRS
- Better disk space and network bandwidth management for FRS

Enhanced End User Experience

Shadow Copy Restore, and improvements to Offline Files and WebDAV Redirector combine to provide an enhanced user experience.

Shadow Copy Restore

Studies have shown that human error causes over one third of all data loss. Windows Server 2003 includes a new feature to address this problem: shadow copies.

A shadow copy is a previous version of a file. Using shadow copies, a Windows Server 2003-based file server will efficiently and transparently maintain a set of previous versions of all files on the file server. Clients use a separate add-on program, which is included on the Windows Server 2003 CD and integrates seamlessly with the client machine, to view the previous versions.

Shadow copies are a low-cost way to recover from many file-impacting accidents caused by human error, such as accidentally deleting, corrupting, or editing a file.

While shadow copies cannot replace your current backup solution—for example, shadow copies cannot protect you from data loss due to media failures—shadow copies should reduce the number of times you need to restore data from tape. You can recover data from a shadow copy instead. Figure 3 below illustrates how easy it is to work with a shadow copy.

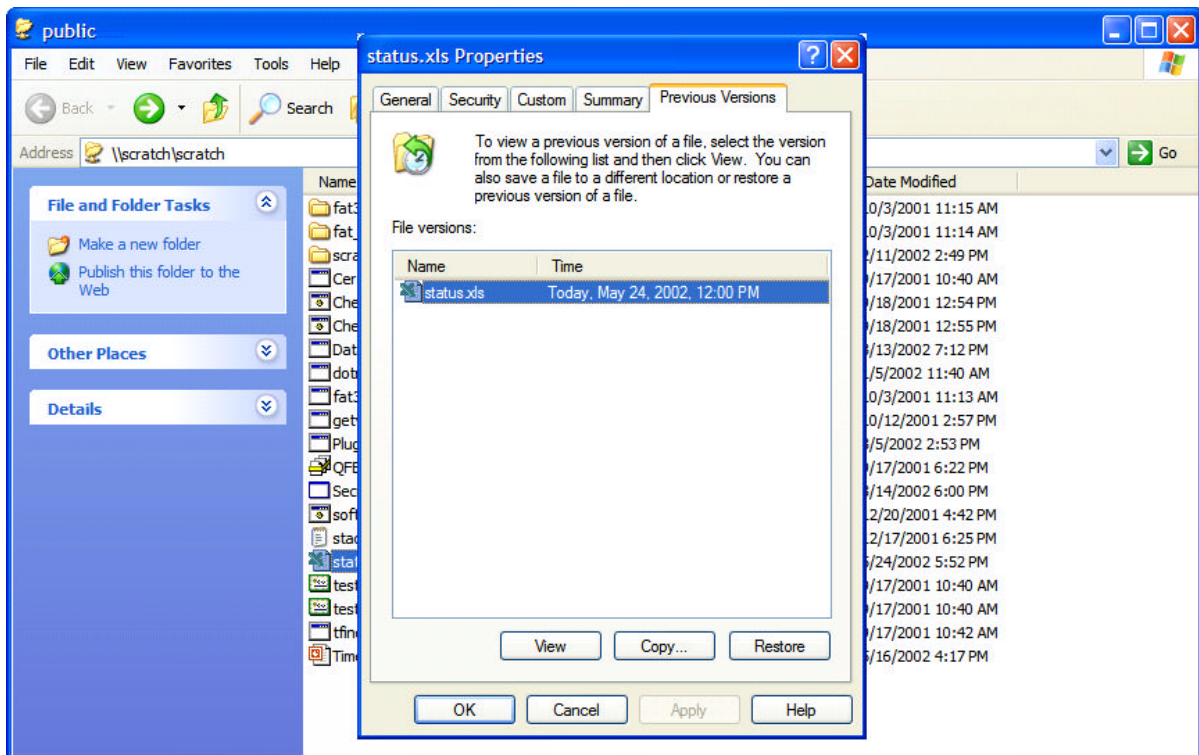


Figure 3. Working with shadow copies

Offline Files Improvements

Windows Server 2003, in conjunction with changes made to the Windows XP client, presents several improvements for file serving. On the client side, Windows XP includes several improvements to Offline Files. This feature, introduced in Windows 2000, lets client machines cache copies of network files and folders on local machines.

There are two types of caching—caching for documents and caching for programs. The server administrator chooses the type of caching used for a network file share.

- **When the client is caching documents**, the operating system will use the copy of the document on the file server, if it is available. However, when the file server is not available, Windows XP will transparently let the user work on the cached copy of the document.

- **When the client is caching programs** and the file server is available, Windows XP will simply check the file server to verify that the cached version of the program is up-to-date. If the program is up-to-date, then Windows XP will execute the cached copy of the program. This offloads work from the file server to the desktop operating system, improving the scalability of the file server.

Improvements to Offline Files are more robust in Windows XP and Windows Server 2003 than in Windows 2000 for additional reasons. For example, with Windows XP, users also can cache files from a Distributed File System (DFS) namespace — an improvement over Windows 2000. Also, Offline Files in Windows XP works better with the Encrypting File System (EFS).

WebDAV Redirector

Web Document Authoring and Versioning (WebDAV) is an industry standard extension to HTTP that allows special-purpose Web publishing tools to update Web content. WebDAV Redirector provides this functionality to all Windows applications. A user can map WebDAV servers to drive letters, or use WebDAV universal naming convention (UNC) names directly, as done today with server message blocks (SMBs) or local files. WebDAV Redirector handles file requests from applications, transparently mapping them via the WebDAV protocol to WebDAV-enabled servers.

Lower Total Cost of Ownership

IT Professionals who are responsible for managing file servers have asked for features that help them deliver services at a reduced cost. Windows Server 2003 includes some important advances that help achieve the objective of lower total cost of ownership.

Command-line Tools

In addition to the Web-based interface, Windows Server 2003 adds three important command-line tools for managing local storage.

- **Diskpart** manages partitions. It lets you create mirrors and stripe sets, extend volumes, and so on.
- **Fsutil** manages advanced NTFS features, such as the USN Journal, hard links, and quotas.
- **Vssadmin** manages Volume Shadow Copy Service.
- **Dfsutil** manages DFS namespaces. It enables script-based administration, troubleshooting and debugging of DFS namespaces and servers.

Automated System Recovery

Another important server management scenario is disaster recovery.

Windows Server 2003 includes Automated System Recovery (ASR) to help with disaster recovery scenarios. ASR can help when you are faced with either the physical destruction of your hardware (for example, in an earthquake or fire), or in the event of a catastrophic hardware failure.

In Windows 2000, recovering from a disaster is a long, manual process, which includes:

- Acquiring new hardware
- Installing a basic version of Windows
- Manually configuring the storage hardware to match the pre-disaster configuration
- Installing your restore software

- Restoring the operating system settings
- Restoring the application settings
- Restoring the application data

The goal of ASR is to quickly and automatically bring a non-bootable machine to a state where you can run a restore program to recover data. ASR will configure the new storage to the same specifications as the pre-disaster storage; it will also restore the operating system, all applications, and settings.

As opposed to the lengthy, manual process faced in recovering from a disaster, when using Windows 2000 or an earlier version Windows operating system, ASR in Windows Server 2003 presents the administrator with an easy solution.

ASR in Windows Server. The process for recovering a system using ASR in Windows Server 2003 is as follows:

- Boot from a Windows Server CD and choose Automated System Recovery.
- Provide access to the backup media and an pre-prepared ASR floppy.
- Take a long break—You'll come back to a working machine with the operating system and all applications properly configured.

To use ASR, you have to prepare an ASR backup before running this process. An ASR backup is a regular system backup, plus the creation of an ASR floppy disk. This disk contains important configuration information about your storage system, (for example, the number and size of your partitions), as well as information on how to restore the backup that you just created.

What makes ASR work is a small amount of bootstrap code in the Windows setup program. If you boot from the CD and press the F8 key when prompted, you will enter the ASR bootstrap program. The ASR code in Windows setup knows how to read the ASR floppy disk to reconfigure the storage system. The ASR version of Windows setup will then install just enough of the operating system to run a restore program. ASR can then automatically invoke the restore program to restore the rest of the data from your ASR backup.

Microsoft provides a complete ASR solution in Windows Server 2003, which is fully extensible by third-party vendors offering backup solutions.

Better Utilities Improve Performance and Availability

Windows Server 2003 contains enhancements to key utilities.

Chkdsk

Windows Server 2003 includes improvements in chkdsk performance that began with Windows 2000. Independent testing by E Testing labs verifies that chkdsk on Windows Server 2003 is between 140% to over 1200% faster than on Windows NT® Server 4.0; and 20% to 38% faster than Windows 2000 (on volumes with millions of files). Please refer to the [e-Testing Labs Report](#) for a complete comparison of chkdsk performance on three Windows-based operating systems.

Beyond these improvements in chkdsk performance, remember that one of the goals of the NTFS file system is to minimize the number of incidents in which it is required to run chkdsk. NTFS is a fully journaled file system: it uses write-ahead logging (the same technique used in most databases) to ensure that its metadata is consistent, even after a crash. Chkdsk is required only when the hardware fails and corrupts the NTFS metadata.

Disk Defragmenter

Windows Server 2003 also includes improvements to Disk Defragmenter. Microsoft has improved the defragmentation engine to improve performance. In Windows Server 2003, the disk defragmenter can also defragment the NTFS Master File Table (MFT).

Summary

The Windows Server 2003 family builds on the foundation of Windows 2000 with new features and improvements that drive down the total cost of ownership. These file features together with improved storage management functionality strengthen the dependability of your core infrastructure. Employees can be more productive due to less downtime and easy retrieval of files and resources. Finally, Windows Server 2003 will allow everyone in your organization to stay better connected and take full advantage of the emerging platform for XML Web Services.

Related Links

See the following resources for further information:

- [What's New in File and Print Services for Windows Server](http://www.microsoft.com/windowsserver2003/evaluation/overview/technologies/fileandprint.mspix) at <http://www.microsoft.com/windowsserver2003/evaluation/overview/technologies/fileandprint.mspix>
- [Introducing the Windows Server Family](http://www.microsoft.com/windowsserver2003/evaluation/overview/family.mspix) at <http://www.microsoft.com/windowsserver2003/evaluation/overview/family.mspix>
- [What's New in Storage Management](http://www.microsoft.com/windowsserver2003/evaluation/overview/technologies/storage.mspix) at <http://www.microsoft.com/windowsserver2003/evaluation/overview/technologies/storage.mspix>
- [Windows 2000 File and Print Services](http://www.microsoft.com/windows2000/technologies/fileandprint/default.asp) at <http://www.microsoft.com/windows2000/technologies/fileandprint/default.asp>

For the latest information about Windows Server 2003, see the [Windows Server 2003 Web site](http://www.microsoft.com/windowsserver2003/default.mspix) at <http://www.microsoft.com/windowsserver2003/default.mspix>.