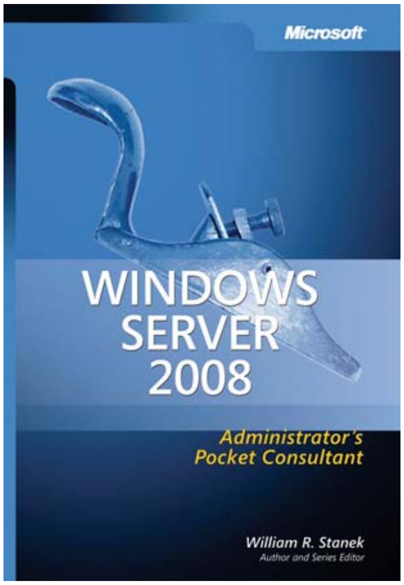

Windows Server® 2008 Administrator’s Pocket Consultant

William R. Stanek

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Chapter 12

Managing File Systems and Drives

A hard disk drive is the most common storage device used on network workstations and servers. Users depend on hard disk drives to store their word-processing documents, spreadsheets, and other types of data. Drives are organized into file systems that users can access either locally or remotely.

Local file systems are installed on a user's computer and don't require remote network connections to access. The C drive available on most workstations and servers is an example of a local file system. You access the C drive using the file path C:\.

You access remote file systems, on the other hand, through a network connection to a remote resource. You can connect to a remote file system using the Map Network Drive feature of Windows Explorer.

Wherever disk resources are located, your job as a system administrator is to manage them. The tools and techniques you use to manage file systems and drives are discussed in this chapter. Chapter 13, "Administering Volume Sets and RAID Arrays," looks at volume sets and fault tolerance. Chapter 14, "Managing Files and Folders," tells you how to manage files and directories.

Managing the File Services Role

A file server provides a central location for storing and sharing files across the network. When many users require access to the same files and application data, you should configure file servers in the domain. In earlier releases of the Windows Server operating system, all servers were installed with basic file services. With Windows Server 2008, you must specifically configure a server to be a file server by adding the File Services role and configuring this role to use the appropriate role services.

Table 12-1 provides an overview of the role services associated with the File Services role. When you install the File Services role, you may also want to install these optional features:

Windows Server Backup
The new backup utility included with Windows Server 2008.

Storage Manager for SANs
Allows you to provision storage for Storage Area Networks (SANs).

Multipath IO
Provides support for using multiple data paths between a file server and a storage device. Servers use multiple IO paths for redundancy in case of failure of a path and to improve transfer performance.

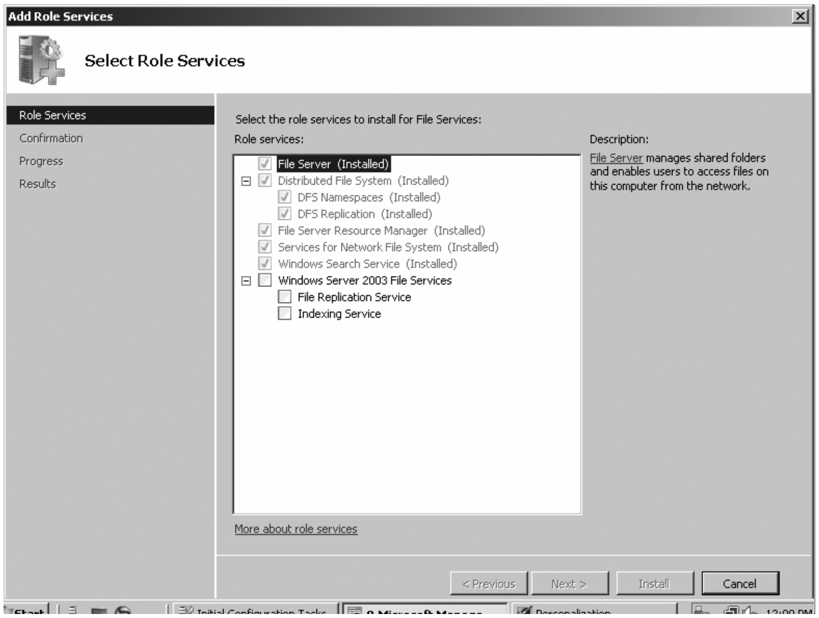
Table 12-1 Role Services for File Servers

Role Service	Description
Share and Storage Management	Installs the Share And Storage Management console and configures the server so that this console can be used. This console allows administrators to manage shared folders and allows users to access shared folders over the network. You can also use this console to configure logical unit numbers (LUNs) in a storage area network (SAN).
Distributed File System (DFS)	Provides tools and services for DFS Namespaces and DFS Replication. DFS Replication is a newer and preferred replication technology. When a domain is running in Windows 2008 Domain Functional Level, domain controllers use DFS Replication to provide more robust and granular replication of the Sysvol.
DFS Namespaces	Allows you to group shared folders located on different servers into one or more logically structured namespaces. Each namespace appears as a single shared folder with a series of subfolders. However, the underlying structure of the namespace can come from shared folders on multiple servers in different sites.
DFS Replication	Allows you to synchronize folders on multiple servers across local or wide area network connections using a multimaster replication engine. The replication engine uses the Remote Differential Compression (RDC) protocol to synchronize only the portions of files that have changed since the last replication. You can use DFS Replication with DFS Namespaces or by itself.
File Server Resource Manager (FSRM)	Installs a suite of tools that administrators can use to better manage data stored on servers. Using FSRM, administrators can generate storage reports, configure quotas, and define file screening policies.
Services for Network File System	Provides a file sharing solution for enterprises with mixed Windows and UNIX environments. When you install Services for Network File System (NFS), users can transfer files between Windows Server 2008 and UNIX operating systems using the NFS protocol.
Windows Search Service	Allows fast file searches of resources on the server from clients that are compatible with Windows Search service. This feature is designed primarily for desktop and small office implementations.
Windows Server 2003 File Services	Provides file services that are compatible with Windows Server 2003. This allows you to use a server running Windows Server 2008 with servers running Windows Server 2003.

File Replication Service (FRS)	Allows you to synchronize folders with file servers that use FRS instead of DFS for replication. Also allows synchronization with Windows 2000 implementations of DFS. If your organization has computers running FRS, you may need to install this role service to ensure compatibility with Windows Server 2008. When a domain is using Windows 2003 Domain Functional Level, domain controllers running Windows Server 2008 use FRS for replication automatically.
Indexing Service	Allows indexing of files and folders for faster searching. Using the related query language, users can find files quickly. You cannot install Indexing Service and Windows Search Service on the same computer.

You can add the File Services role to a server by following these steps:

1. In Server Manager, select the Roles node in the left pane and then click Add Roles. This starts the Add Roles Wizard. If the wizard displays the Before You Begin page, read the Welcome text and then click Next.
2. On the Select Server Roles page, select File Services and then click Next twice.
3. On the Select Role Services page, select one or more role service to install, as shown in Figure 12-1. A summary of each role service is provided in Table 12-1. To allow for interoperability with UNIX, be sure to add Services For Network File System. Click Next.



Select the role services to install for File Services:

Role services:

- ☑ File Server (Installed)
- ☑ Distributed File System (Installed)
  - ☑ DFS Namespaces (Installed)
  - ☑ DFS Replication (Installed)
- ☑ File Server Resource Manager (Installed)
- ☑ Services for Network File System (Installed)
- ☑ Windows Search Service (Installed)
- ☐ Windows Server 2003 File Services
  - ☐ File Replication Service
  - ☐ Indexing Service

Description:

File Server manages shared folders and enables users to access files on this computer from the network.

Figure 12-1 Select the appropriate role services for the file server.

4. A DFS Namespace is a virtual view of shared folders located on different servers. If you are installing DFS Namespaces, you'll have three additional configuration pages:
   - On the Create A DFS Namespace page, set the root name for the first namespace or elect to create a namespace later. The namespace root name should be something that is easy for users to remember, such as CorpData. In a large enterprise, you may need to create separate namespaces for each major division.
   - On the Select Namespace Type page, specify whether you want to create a domain-based namespace or a stand-alone namespace. Domain-based namespaces can be replicated with multiple namespace servers to provide high availability but can only have up to 5,000 DFS folders. Stand-alone namespaces can have up to 50,000 DFS folders but are replicated only when you use failover server clusters and configure replication.
   - On the Configure Namespace page, you can add shared folders to the namespace as well as namespaces that are associated with a DFS folder. Click Add. In the Add Folder To Namespace dialog box, click Browse. In the Browse For Shared Folders dialog box, select the shared folder to add and then click OK. Next, type a name for the folder in the namespace. This name can be the same as the original folder name or a new name that will be associated with the original folder in the namespace. After you type a name, click OK to add the folder and complete the process.

Note You do not have to configure DFS Namespaces at this time. Once you've installed DFS Namespaces, DFS Replication, or both, you can use the DFS Management console to manage the related features. This console is installed and available on the Administrative tools menu. See Chapter 15, "Data Sharing, Security, and Auditing," for more information.

5. With File Server Resource Manager, you can monitor the amount of space used on disk volumes and create storage reports. If you are installing File Server Resource Manager, you'll have two additional configuration pages:
   - On the Configure Storage Usage Monitoring page, you can select disk volumes for monitoring. When you select a volume and then click Options, you can set the volume usage threshold and choose the reports to generate when the volume reaches the threshold value. By default, the usage threshold is 85 percent.
   - On the Set Report Options page, you can select a save location for usage reports. One usage report of each previously selected type is generated each time a volume reaches its threshold. Old reports are not automatically deleted. The default save location is %SystemDrive%\StorageReports. To change the default location, click Browse and then to select the new save location in the Browse For Folder dialog box. You can also elect to receive reports by e-mail. To do this, you must specify the recipient e-mail addresses and the SMTP server to use.

Note You do not have to configure monitoring and reporting at this time. After you've installed FSRM, you can use the File Server Resource Manager console to manage the related features. This console is installed and available on the Administrative tools menu. See Chapter 14 for more information.

6. If you are installing Windows Search Service, you'll see an additional configuration page that allows you to select the volumes to index. Indexing a volume makes it possible for users to search a volume quickly. However, indexing entire volumes can affect service performance, especially if you index the system volume. Therefore, you may only want to index specific shared folders on volumes, which you'll be able to do later on a per-folder basis.

Note You do not have to configure indexing at this time. After you've installed Windows Search Service, you can use the Indexing Options utility in Control Panel to manage the related features.

7. When you've completed all the optional pages, click Next. You'll see the Confirm Installation Options page. Click Install to begin the installation process. When Setup finishes installing the server with the features you've selected, you'll see the Installation Results page. Review the installation details to ensure that all phases of the installation completed successfully.

If the File Services role is installed already on a server and you want to install additional services for a file server, you can add role services to the server using a similar process. In Server Manager, expand the Roles node and then select the File Services node. In the main pane, the window is divided into several panels. Scroll down until you see the Role Services panel and then click Add Role Services. You can then follow the previous procedure starting with step 3 to add Role Services.

Adding Hard Disk Drives

Before you make a hard disk drive available to users, you'll need to configure it and consider how it'll be used. With Microsoft Windows Server 2008, you can configure hard disk drives in a variety of ways. The technique you choose depends primarily on the type of data you're working with and the needs of your network environment. For general user data stored on workstations, you might want to configure individual drives as stand-alone storage devices. In that case, user data is stored on a workstation's hard disk drive, where it can be accessed and stored locally.

Although storing data on a single drive is convenient, it isn't the most reliable way to store data. To improve reliability and performance, you might want a set of drives to work together. Windows Server 2008 supports drive sets and arrays using redundant array of independent disks (RAID) technology, which is built into the operating system.

Physical Drives

Whether you use individual drives or drive sets, you'll need physical drives. Physical drives are the actual hardware devices that are used to store data. The amount of data a drive can store depends on its size and whether it uses compression. Typical drives have capacities of 100 gigabytes (GB) to 500 GB. Many drive types are available for use with Windows Server 2008, including Small Computer Systems Interface (SCSI), Parallel ATA (PATA), and Serial ATA (SATA).

The terms SCSI, PATA, and SATA designate the interface type used by the hard disk drives. This interface is used to communicate with a drive controller. SCSI drives use SCSI controllers, PATA drives use PATA controllers, and so on. When setting up a new server, you should give considerable thought to the drive configuration. Start by choosing drives or storage systems that provide the appropriate level of performance. There really is a substantial difference in speed and performance among various drive specifications.

You should consider not only the capacity of the drive but also the following:

Rotational speed
A measurement of how fast the disk spins

Average seek time
A measurement of how long it takes to seek between disk tracks during sequential input/output (I/O) operations

Generally speaking, when comparing drives that conform to the same specification, such as Ultra320 SCSI or SATA II, the higher the rotational speed (measured in thousands of rotations per minute) and the lower the average seek time (measured in milliseconds, or msecs), the better. As an example, a drive with a rotational speed of 15,000 RPM will give you 45 percent to 50 percent more I/O per second than the average 10,000 RPM drive, all other things being equal. A drive with a seek time of 3.5 msec will give you a 25 percent to 30 percent response time improvement over a drive with a seek time of 4.7 msec.

Other factors to consider include the following:

Maximum sustained data transfer rate
A measurement of how much data the drive can continuously transfer

Mean time to failure (MTTF)
A measurement of how many hours of operation you can expect to get from the drive before it fails

Nonoperational temperatures
Measurements of the temperatures at which the drive fails

Most drives of comparable quality will have similar transfer rates and MTTF. For example, if you compare Ultra320 SCSI drives with a 15,000 RPM rotational speed, you will probably find similar transfer rates and MTTF. For example, the Maxtor Atlas 15K II has a maximum sustained data transfer rate of up to 98 megabytes per second (MBps). The Seagate Cheetah 15K.4 has a maximum sustained data transfer rate of up to 96 MBps. Both have a MTTF of 1.4 million hours. Transfer rates can also be expressed in gigabits per second (Gbps). A rate of 1.5 Gbps is equivalent to a data rate of 188 MBps, and 3.0 Gbps is equivalent to 375 MBps. Sometimes you'll see a maximum external transfer rate (per the specification to which the drive complies) and an average sustained transfer rate. The average sustained transfer rate is the most important factor. The Seagate Barracuda 7200 SATA II drive has a rotational speed of 7,200 RPM and an average sustained transfer rate of 58 MBps. With an average seek time of 8.5 msec and an MTTF of 1 million hours, the drive performs comparably to other 7,200 RPM SATA II drives. However, most Ultra320 SCSI drives perform better and are better at multi-user read/write operations, too.

Temperature is another important factor to consider when you're selecting a drive—but it's a factor few administrators take into account. Typically, the faster a drive rotates, the hotter it will run. This is not always the case, but it is certainly something you should consider when making your choice. For example, 15K drives tend to run hot, and you must be sure to carefully regulate temperature. Both the Maxtor Atlas 15K II and the Seagate Cheetah 15K.4 can become nonoperational at temperatures of 70°C or higher (as would most other drives).

Preparing a Drive for Use

After you install a drive, you'll need to configure it for use. You configure the drive by partitioning it and creating file systems in the partitions, as needed. A partition is a section of a physical drive that functions as if it were a separate unit. After you create a partition, you can create a file system in the partition.

Two partition styles are used for disks: Master Boot Record (MBR) and GUID Partition Table (GPT). x86-based computers use the MBR partition style. MBR contains a partition table that describes where the partitions are located on the disk. With this partition style, the first sector on a hard disk contains the master boot record and a binary code file called the master boot code that's used to boot the system. This sector is unpartitioned and hidden from view to protect the system.

With the MBR partitioning style, disks support volumes of up to 4 terabytes and use one of two types of partitions—primary and extended. Each MBR drive can have up to four primary partitions or three primary partitions and one extended partition. Primary partitions are drive sections that you can access directly for file storage. You make a primary partition accessible to users by creating a file system on it. Unlike primary partitions, you can't access extended partitions directly. Instead, you can configure extended partitions with one or more logical drives that are used to store files. Being able to divide extended partitions into logical drives allows you to divide a physical drive into more than four sections.

x64-based computers running 64-bit versions of Windows use the GPT partition style. The key difference between the GPT partition style and the MBR partition style has to do with how partition data is stored. With GPT, critical partition data is stored in the individual partitions and redundant primary and backup partition tables are used for improved structure integrity. Additionally, GPT disks support volumes of up to 18 exabytes and up to 128 partitions. Although underlying differences exist between the GPT and MBR partitioning styles, most disk-related tasks are performed in the same way.

Using Disk Management

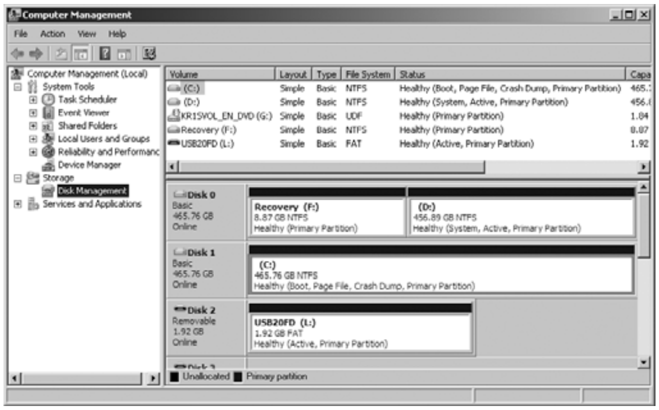
You'll use the Disk Management snap-in for the Microsoft Management Console (MMC) to configure drives. Disk Management makes it easy to work with the internal and external drives on a local or remote system. Disk Management is included as part of the Computer Management console and the Server Manager console. You can also add it to custom MMCs. In Computer Management and in Server Manager, you can access Disk Management by expanding the Storage node and then selecting Disk Management.

Regardless of whether you are using Computer Management or Server Manager, Disk Management has three views: Disk List, Graphical View, and Volume List. With remote systems you're limited in the tasks you can perform with Disk Management. Remote management tasks you can perform include viewing drive details, changing drive letters and paths, and converting disk types. With removable media drives, you can also eject media remotely. To perform more advanced manipulation of remote drives, you can use the DISKPART command-line utility.

> **Note** Before you work with Disk Management, you should know several things. If you create a partition but don't format it, the partition will be labeled as Free Space. If you haven't assigned a portion of the disk to a partition, this section of the disk is labeled Unallocated.

In Figure 12-2, the Volume List view is in the upper-right corner and the Graphical View is in the lower-right corner. This is the default configuration. You can change the view for the top or bottom pane as follows:

- To change the top view, select View, choose Top, and then select the view you want to use.
- To change the bottom view, select View, choose Bottom, and then select the view you want to use.
- To hide the bottom view, select View, choose Bottom, and then select Hidden.



Volume	Layout	Type	File System	Status	Capa
(C:)	Simple	Basic	NTFS	Healthy (Boot, Page File, Crash Dump, Primary Partition)	465.
(D:)	Simple	Basic	NTFS	Healthy (System, Active, Primary Partition)	456.
KR1SVOL_EN_DVD (G:)	Simple	Basic	UDF	Healthy (Primary Partition)	1.84
Recovery (F:)	Simple	Basic	NTFS	Healthy (Primary Partition)	8.87
USB20FD (L:)	Simple	Basic	FAT	Healthy (Active, Primary Partition)	1.92

Disk 0
Basic
465.76 GB
Online

Recovery (F:)
8.87 GB NTFS
Healthy (Primary Partition)

(D:)
456.89 GB NTFS
Healthy (System, Active, Primary Partition)

Disk 1
Basic
465.76 GB
Online

(C:)
465.76 GB NTFS
Healthy (Boot, Page File, Crash Dump, Primary Partition)

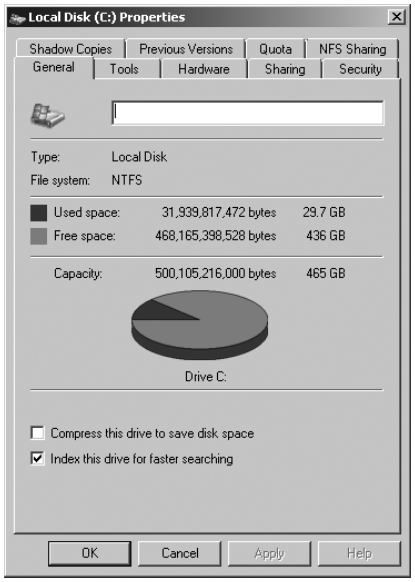
Disk 2
Removable
1.92 GB
Online

USB20FD (L:)
1.92 GB FAT
Healthy (Active, Primary Partition)

Figure 12-2 In Disk Management the upper view provides a detailed summary of all the drives on the computer and the lower view provides an overview of the same drives by default.

Viewing Detailed Information

From the Disk Management window, you can get more detailed information on a drive section by right-clicking it and then selecting Properties from the shortcut menu. When you do this, you see a dialog box much like the one shown in Figure 12-3. This is the same dialog box that you can open from Windows Explorer (by selecting the top-level folder for the drive and then selecting Properties from the File menu).



Type: Local Disk

File system: NTFS

■ Used space: 31,939,817,472 bytes 29.7 GB

■ Free space: 468,165,398,528 bytes 436 GB

Capacity: 500,105,216,000 bytes 465 GB

☐ Compress this drive to save disk space

☑ Index this drive for faster searching

Figure 12-3 The General tab of the Properties dialog box provides detailed information about a drive.

Installing and Checking for a New Drive

Hot swapping is a feature that allows you to remove devices without shutting off the computer. Typically, hot-swappable drives are installed and removed from the front of the computer. If your computer supports hot swapping of drives, you can install drives to the computer without having to shut down. After you do this, open Disk Management, and select Rescan Disks from the Action menu. New disks that are found are added as basic disks. If a disk that you've added isn't found, reboot.

If the computer doesn't support hot swapping of drives, you must turn the computer off and then install the new drives. Then you can scan for new disks as described previously. If you are working with new disks that have not been initialized—meaning they don't have disk signatures—Disk Management will start the Initialize And Convert Disk Wizard as soon it starts up and detects the new disks.

You can use the Initialize And Convert Disk Wizard to initialize the disks by following these steps:

1. Click Next to exit the Welcome page. On the Select Disks To Initialize page, the disks you added are selected for initialization automatically, but if you don't want to initialize a particular disk, you can clear the related option.
2. Click Next to display the Select Disks To Convert page. This page lists the new disks as well as any nonsystem or boot disks that can be converted to dynamic disks. The new disks aren't selected by default. If you want to convert the disks, select them and then click Next.
3. The final page shows you the options you've selected and the actions that will be performed on each disk. If the options are correct, click Finish. The wizard then performs the designated actions. If you've elected to initialize a disk, the wizard writes a disk signature to the disk. If you've elected to convert a disk, the wizard converts the disk to a dynamic disk after writing the disk signature.

If you don't want to use the Initialize And Convert Disk Wizard, you can close it and use Disk Management instead to view and work with the disk. In the Disk List view, the disk will be marked with a red exclamation point icon, and the disk's status will be listed as Not Initialized. You can then right-click the disk's icon and select Initialize Disk. Confirm the selection (or add to the selection if more than one disk is available for initializing) and then click OK to start the initialization of the disk. Conversion to a dynamic disk would then proceed as discussed in "Converting a Basic Disk to a Dynamic Disk."

Understanding Drive Status

Knowing the drive status is useful when you install new drives or troubleshoot drive problems. Disk Management shows the drive status in the Graphical View and Volume List views. Table 12-2 summarizes the most common status values.

Table 12-2 Common Drive Status Values

Status	Description	Resolution
Online	The normal disk status. It means the disk is accessible and doesn't have problems. Both dynamic disks and basic disks display this status.	The drive doesn't have any known problems. You don't need to take any corrective action.
Online (Errors)	I/O errors have been detected on a dynamic disk.	You can try to correct temporary errors by right-clicking the disk and choosing Reactivate Disk. If this doesn't work, the disk might have physical damage or you might need to run a thorough check of the disk.
Offline	The disk isn't accessible and might be corrupted or temporarily unavailable. If the disk name changes to Missing, the disk can no longer be located or identified on the system.	Check for problems with the drive, its controller, and cables. Make sure that the drive has power and is connected properly. Use the Reactivate Disk command to bring the disk back online (if possible).
Foreign	The disk has been moved to your computer but hasn't been imported for use. A failed drive brought back online might sometimes be listed as Foreign.	Right-click the disk and choose Import Foreign Disks to add the disk to the system.
Unreadable	The disk isn't accessible currently, which can occur when disks are being rescanned. Both dynamic and basic disks display this status.	With FireWire/USB card readers, you might see this status if the card is unformatted or improperly formatted. You might also see this status after the card is removed from the reader. Otherwise, if the drives aren't being scanned, the drive might be corrupted or have I/O errors. Right-click the disk and choose Rescan Disk (on the Action menu) to try to correct the problem. You might also want to reboot the system.

Unrecognized	The disk is of an unknown type and can't be used on the system. A drive from a non-Windows system might display this status.	If the disk is from another operating system, don't do anything. You can't use the drive on the computer, so try a different drive.
Not Initialized	The disk doesn't have a valid signature. A drive from a non-Windows system might display this status.	If the disk is from another operating system, don't do anything. You can't use the drive on the computer, so try a different drive. To prepare the disk for use on Windows Server 2008, right-click the disk and choose Initialize Disk.
No Media	No media has been inserted into the CD-ROM or removable drive, or the media has been removed. Only CD-ROM and removable disk types display this status.	Insert a CD-ROM, a floppy disk, or a removable disk to bring the disk online. With FireWire/USB card readers, this status is usually (but not always) displayed when the card is removed.

Working with Basic and Dynamic Disks

Windows Server 2008 supports two types of disk configurations:

Basic
The standard disk type used in previous versions of Windows. Basic disks are divided into partitions and can be used with previous versions of Windows.

Dynamic
An enhanced disk type for Windows Server 2008 that you can update without having to restart the system (in most cases). Dynamic disks are divided into volumes and can be used only with Windows 2000 and later releases of Windows.

Note You can't use dynamic disks on portable computers or with removable media.

Using Basic and Dynamic Disks

When you convert to Windows Server 2008, disks with partitions are initialized as basic disks. When you install Windows Server 2008 on a new system with unpartitioned drives, you have the option of initializing the drives as either basic or dynamic.

Basic drives support the standard fault-tolerant features. You can use basic drives to maintain existing spanning, mirroring, and striping configurations and to delete these configurations. However, you can't create new fault-tolerant drive sets using the basic disk type. You'll need to convert to dynamic disks and then create volumes that use mirroring or striping. The fault-tolerant features and the ability to modify disks without having to restart the computer are the key capabilities that distinguish basic and dynamic disks. Other features available on a disk depend on the disk formatting.

You can use both basic and dynamic disks on the same computer. The catch is that volume sets must use the same disk type. For example, if you have mirrored drives C and D that were created under Windows NT 4.0, you can use these drives under Windows

Server 2008. If you want to convert C to the dynamic disk type, you must also convert D. To learn how to convert a disk from basic to dynamic, see "Changing Drive Types" on page 12xxx.

You can perform different disk configuration tasks with basic and dynamic disks. With basic disks, you can do the following:

- Format partitions and mark them as active
- Create and delete primary and extended partitions
- Create and delete logical drives within extended partitions
- Convert from a basic disk to a dynamic disk

With dynamic disks, you can do the following:

- Create and delete simple, striped, spanned, mirrored, and RAID-5 volumes
- Remove a mirror from a mirrored volume
- Extend simple or spanned volumes
- Split a volume into two volumes
- Repair mirrored or RAID-5 volumes
- Reactivate a missing or offline disk
- Revert to a basic disk from a dynamic disk (requires deleting volumes and reloading)

With either disk type, you can do the following:

- View properties of disks, partitions, and volumes
- Make drive letter assignments
- Configure security and drive sharing

Special Considerations for Basic and Dynamic Disks

Whether you're working with basic or dynamic disks, you need to keep in mind three special types of drive sections:

Active
The active partition or volume is the drive section for system cache and startup. Some devices with removable storage may be listed as having an active partition.

Boot
The boot partition or volume contains the operating system and its support files. The system and boot partition or volume can be the same.

Crash Dump
The partition to which the computer attempts to write dump files in the event of a system crash. By default, dump files are written to the *%SystemRoot%* folder, but can be located on any desired partition or volume.

Page File
A partition containing a paging file used by the operating system. Because a computer can page memory to multiple disks, according to the way virtual memory is configured, a computer can have multiple page file partitions or volumes.

System
The system partition or volume contains the hardware-specific files needed to load the operating system. The system partition or volume can't be part of a striped or spanned volume.

Note Windows Server 2008 supports two key CPU architectures: x86 and x64. On an x86-based computer, you can mark a partition as active using Disk Management. In Disk Management, right-click the primary partition you want to mark as active, and then select Mark Partition As Active. You can't mark dynamic disk volumes as active. When you convert a basic disk containing the active partition to a dynamic disk, this partition becomes a simple volume that's active automatically.

Changing Drive Types

Basic disks are designed to be used with previous versions of Windows. Dynamic disks are designed to let you take advantage of the latest Windows features. Only computers running Windows 2000 or later releases of Windows can use dynamic disks. However, you can use dynamic disks with other operating systems, such as UNIX. To do this, you need to create a separate volume for the non-Windows operating system. You can't use dynamic disks on portable computers.

Windows Server 2008 provides the tools you need to convert a basic disk to a dynamic disk and to change a dynamic disk back to a basic disk. When you convert to a dynamic disk, partitions are changed to volumes of the appropriate type automatically. You can't change these volumes back to partitions. Instead, you must delete the volumes on the dynamic disk and then change the disk back to a basic disk. Deleting the volumes destroys all the information on the disk.

Converting a Basic Disk to a Dynamic Disk

Before you convert a basic disk to a dynamic disk, you should make sure that you don't need to boot the computer to other versions of Windows. Only computers running Windows 2000 and later releases of Windows can use dynamic disks.

With MBR disks, you should also make sure that the disk has 1 MB of free space at the end of the disk. Although Disk Management reserves this free space when creating partitions and volumes, disk management tools on other operating systems might not. Without the free space at the end of the disk, the conversion will fail.

With GPT disks, you must have contiguous, recognized data partitions. If the GPT disk contains partitions that Windows doesn't recognize, such as those created by another operating system, you can't convert to a dynamic disk.

With either type of disk, the following holds true:

- You can't convert drives that use sector sizes larger than 512 bytes. If the drive has large sector sizes, you'll need to reformat before converting.
- You can't use dynamic disks on portable computers or with removable media. You can only configure these drives as basic drives with primary partitions.
- You can't convert a disk if the system or boot partition is part of spanned, striped, mirrored, or RAID-5 volume. You'll need to stop the spanning, mirroring, or striping before you convert.
- You shouldn't convert a disk if it contains multiple installations of the Windows operating system. If you do, you might be able to start the computer only using Windows Server 2008.
- You can convert disks with other types of partitions that are part of spanned, striped, mirrored, or RAID-5 volumes. These volumes become dynamic volumes of the same type. However, you must convert all drives in the set together.

To convert a basic disk to a dynamic disk, follow these steps:

1. In Disk Management, right-click a basic disk that you want to convert, either in the Disk List view or in the left pane of the Graphical View. Then select Convert To Dynamic Disk.
2. In the Convert To Dynamic Disk dialog box, select the check boxes for the disks you want to convert. If you're converting a spanned, striped, mirrored, or RAID-5 volume, be sure to select all the basic disks in this set. You must convert the set together. Click OK to continue.
3. The Disks To Convert dialog box shows the disks you're converting. The buttons and columns on this dialog box contain the following information:

Name
Shows the disk number.

Disk Contents
Shows the type and status of partitions, such as boot, active, or in use.

Will Convert
Specifies whether the drive will be converted. If the drive doesn't meet the criteria, it won't be converted, and you might need to take corrective action, as described previously.

Details
Shows the volumes on the selected drive.

Convert
Starts the conversion.

1. To begin the conversion, click Convert. Disk Management warns you that after you finish the conversion you won't be able to boot previous versions of Windows from volumes on the selected disks. Click Yes to continue.
2. Disk Management will restart the computer if a selected drive contains the boot partition, system partition, or a partition in use.

Changing a Dynamic Disk Back to a Basic Disk

Before you can change a dynamic disk back to a basic disk, you must delete all dynamic volumes on the disk. After you do this, right-click the disk and select Convert To Basic Disk. This changes the dynamic disk to a basic disk; you can then create new partitions and logical drives on the disk.

Reactivating Dynamic Disks

If the status of a dynamic disk displays as Online (Errors) or Offline, you can often reactivate the disk to correct the problem. You reactivate a disk by following these steps:

1. In Disk Management, right-click the dynamic disk you want to reactivate, and then select Reactivate Disk. Confirm the action when prompted.
2. If the drive status doesn't change, you might need to reboot the computer. If this still doesn't resolve the problem, check for problems with the drive, its controller, and the cables. Also make sure that the drive has power and is connected properly.

Rescanning Disks

Rescanning all drives on a system updates the drive configuration information on the computer. Rescanning can sometimes resolve a problem with drives that show a status of Unreadable. You rescan disks on a computer by selecting Rescan Disks from Disk Management's Action menu.

Moving a Dynamic Disk to a New System

An important advantage of dynamic disks over basic disks is that you can easily move them from one computer to another. For example, if after setting up a computer, you decide that you don't really need an additional hard disk, you can move it to another computer where it can be better used.

Windows Server 2008 greatly simplifies the task of moving drives to a new system. Before moving disks, you should follow these steps:

1. Open Disk Management on the system where the dynamic drives are currently installed. Check the status of the drives and ensure that they're marked as healthy. If the status isn't healthy, you should repair partitions and volumes, as necessary, before you move the disk drives.

   Note Drives with BitLocker Drive encryption cannot be moved using this technique. BitLocker Driver Encryption wraps drives in a protected seal so that any offline tampering is detected and results in the disk being unavailable until an administrator unlocks it.

2. Check the hard disk subsystems on the original computer and the computer to which you want to transfer the disk. Both computers should have identical hard disk subsystems. If they don't, the Plug and Play ID on the system disk from the original computer won't match what the destination computer is expecting. As a result, the destination computer won't be able to load the right drivers, and boot might fail.

3. Check whether any dynamic disks that you want to move are part of a spanned, extended, or striped set. If they are, you should make a note of which disks are part of which set and plan on moving all disks in a set together. If you are moving only part of a disk set, you should be aware of the consequences. For spanned, extended, or striped volumes, moving only part of the set will make the related volumes unusable on the current computer and on the computer to which you are planning to move the disks.

When you are ready to move the disks, following these steps:

1. On the original computer, start Computer Management. Then, in the left pane, select Device Manager. In the Device List, expand Disk Drives. This shows a list of all the physical disk drives on the computer. Right-click each disk that you want to move and then select Uninstall. If you are unsure which disks to uninstall, right-click each disk and select Properties. In the Properties dialog box, click the Volumes tab and then choose Populate. This shows you the volumes on the selected disk.
2. Next, select the Disk Management node in Computer Management on the original computer. Right-click each disk that you want to move and then select Remove Disk.
3. After you perform these procedures, you can move the dynamic disks. If the disks are hot-swappable and this feature is supported on both computers, remove the disks from the original computer and then install them on the destination computer. Otherwise, turn off both computers, remove the drives from the original computer, and then install them on the destination computer. When you're finished, restart the computers.
4. On the destination computer, access Disk Management and then select Rescan Disks from the Action menu. When Disk Management finishes scanning the disks, right-click any disk marked Foreign and then click Import. You should now be able to access the disks and their volumes on the destination computer.

Note In most cases, the volumes on the dynamic disks should retain the drive letters that they had on the original computer. However, if a drive letter is already used on the destination computer, a volume receives the next available drive letter. If a dynamic volume previously did not have a drive letter, it does not receive a drive letter when moved to another computer. Additionally, if automounting is disabled, the volumes aren't automatically mounted and you must manually mount volumes and assign drive letters.

Using Basic Disks and Partitions

When you install a new computer or update an existing computer, you'll often need to partition the drives on the computer. You partition drives using Disk Management.

Partitioning Basics

In Windows Server 2008, a physical drive using MBR partition style can have up to four primary partitions and one extended partition. This allows you to configure MBR drives in one of two ways: using one to four primary partitions, or using one to three primary partitions and one extended partition. A primary partition can fill an entire disk, or you can size it as appropriate for the workstation or server you're configuring. Within an extended partition, you can create one or more logical drives. A logical drive is simply a section of a partition with its own file system. Generally, you use logical drives to divide a large drive into manageable sections. With this in mind, you might want to divide a 600 GB extended partition into three logical drives of 200 GB each. Physical disks with GPT partition style can have up to 128 partitions.

After you partition a drive, you format the partitions to assign drive letters. This is a high-level formatting that creates the file system structure rather than a low-level formatting that sets up the drive for initial use. You're probably very familiar with the C drive used by Windows Server 2008. Well, the C drive is simply the designator for a disk partition. If you partition a disk into multiple sections, each section can have its own drive letter. You use the drive letters to access file systems in various partitions on a physical drive. Unlike MS-DOS, which assigns drive letters automatically starting with the letter C, Windows Server 2008 lets you specify drive letters. Generally, the drive letters C through Z are available for your use.

Note The drive letter A is usually assigned to the system's floppy disk drive. If the system has a second floppy disk drive, the letter B is assigned to it, so you can use only the letters C through Z. Don't forget that CD-ROMs, Zip drives, and other types of media drives need drive letters as well. The total number of drive letters you can use at one time is 24. If you need additional volumes, you can create them using drive paths.

Using drive letters, you can have only 24 active volumes. To get around this limitation, you can mount disks to drive paths. A drive path is set as a folder location on another drive. For example, you could mount additional drives as E:\Data1, E:\Data2, and E:\Data3. You can use drive paths with basic and dynamic disks. The only restriction for drive paths is that you mount them on empty folders that are on NTFS drives.

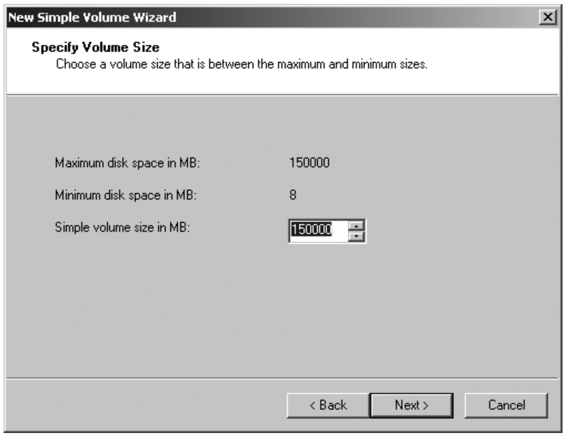
To help you differentiate between primary partitions and extended partitions with logical drives, Disk Management color-codes the partitions. For example, primary partitions might be color-coded with a dark-blue band and logical drives in extended partitions might be color-coded with a light-blue band. The key for the color scheme is shown at the bottom of the Disk Management window. You can change the colors in the View Settings dialog box by choosing Settings on the Disk Management View menu.

Creating Partitions and Simple Volumes

Windows Server 2008 simplifies the Disk Management user interface by using one set of dialog boxes and wizards for both partitions and volumes. The first three volumes on a basic drive are created automatically as primary partitions. If you try to create a fourth volume on a basic drive, the remaining free space on the drive is converted automatically to an extended partition with a logical drive of the size you designate by using the new volume feature it created in the extended partition. Any subsequent volumes are created in the extended partitions and logical drives automatically.

In Disk Management, you create partitions, logical drives, and simple volumes by following these steps:

1. In Disk Management's Graphical view, right-click an unallocated or free area and then choose New Simple Volume. This starts the New Simple Volume Wizard. Read the Welcome page and then click Next.
2. The Specify Volume Size page, shown in Figure 12-4, specifies the minimum and maximum size for the volume in megabytes (MB) and lets you size the volume within these limits. Size the partition in MB in the Simple Volume Size field and then click Next.



Specify Volume Size

Choose a volume size that is between the maximum and minimum sizes.

Maximum disk space in MB: 150000

Minimum disk space in MB: 8

Simple volume size in MB: 150000

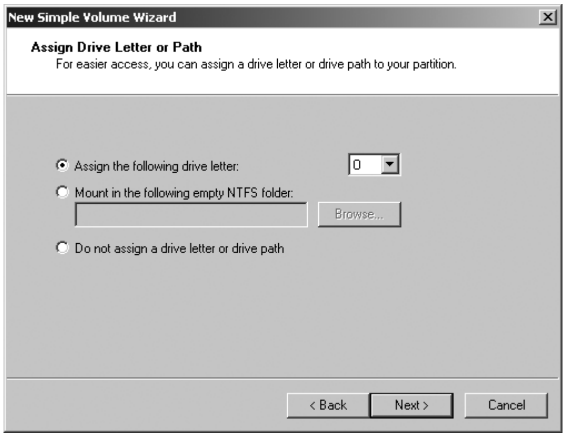
Figure 12-4 Set the size of the volume on the Specify Volume Size page.

3. On the Assign Drive Letter Or Path page, shown in Figure 12-5, specify whether you want to assign a drive letter or path and then click Next. The following options are available:

   Assign The Following Drive Letter
   Choose this option to assign a drive letter. Then select an available drive letter in the selection list provided. By default, Windows Server 2008 selects the lowest available drive letter and excludes reserved drive letters as well as those assigned to local disks or network drives.

   Mount In The Following Empty NTFS Folder
   Choose this option to mount the partition in an empty NTFS folder. You must then type the path to an existing folder or click Browse to search for or create a folder to use.

   Do Not Assign A Drive Letter Or Drive Path
   Choose this option if you want to create the partition without assigning a drive letter or path. If you later want the partition to be available for storage, you can assign a drive letter or path at that time.



Assign Drive Letter or Path

For easier access, you can assign a drive letter or drive path to your partition.

● Assign the following drive letter: O

○ Mount in the following empty NTFS folder:

○ Do not assign a drive letter or drive path

Figure 12-5 On the Assign Drive Letter Or Path page, assign the drive designator or choose to wait until later.

> **Note** You don’t have to assign volumes a drive letter or a path. A volume with no designators is considered to be unmounted and is for the most part unusable. An unmounted volume can be mounted by assigning a drive letter or a path at a later date. See “Assigning, Changing, or Removing Drive Letters and Paths” on page 12xxx.

4. On the Format Partition page, shown in Figure 12-6, determine whether and how the volume should be formatted. If you want to format the volume, choose Format This Volume With The Following Settings and then configure the following options:

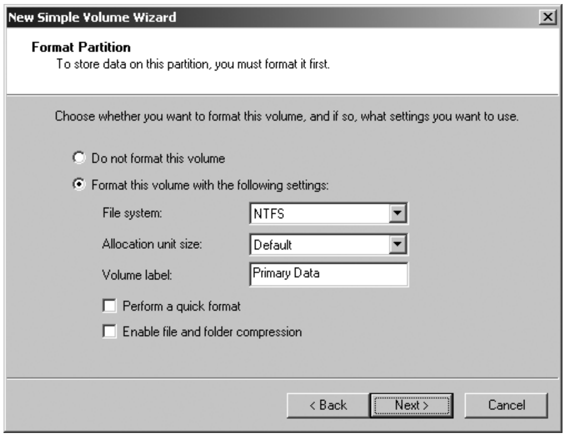
   File System
   Sets the file system type as FAT, FAT32, or NTFS. NTFS is selected by default in most cases. If you create a file system as FAT or FAT32, you can later convert it to NTFS with the Convert utility. You can’t, however, convert NTFS partitions to FAT or FAT32.

   Allocation Unit Size
   Sets the cluster size for the file system. This is the basic unit in which disk space is allocated. The default allocation unit size is based on the size of the volume and, by default, is set dynamically prior to formatting. To override this feature, you can set the allocation unit size to a specific value. If you use many small files, you might want to use a smaller cluster size, such as 512 or 1024 bytes. With these settings, small files use less disk space.

   Volume Label
   Sets a text label for the partition. This label is the partition’s volume name and by default is set to New Volume. You can change the volume label at any time by right-clicking the volume in Windows Explorer, choosing Properties, and typing a new value in the Label field provided on the General tab.

   Perform A Quick Format
   Tells Windows Server 2008 to format without checking the partition for errors. With large partitions, this option can save you a few minutes. However, it’s usually better to check for errors, which enables Disk Management to mark bad sectors on the disk and lock them out.

Enable File And Folder Compression
Turns on compression for the disk. Built-in compression is available only for NTFS. Under NTFS, compression is transparent to users and compressed files can be accessed just like regular files. If you select this option, files and directories on this drive are compressed automatically. For more information on compressing drives, files, and directories, see "Compressing Drives and Data" on page 12xxx.



Format Partition
To store data on this partition, you must format it first.

Choose whether you want to format this volume, and if so, what settings you want to use.

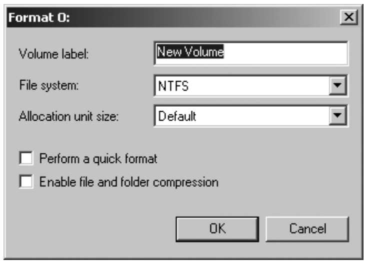
○ Do not format this volume
● Format this volume with the following settings:
File system: NTFS
Allocation unit size: Default
Volume label: Primary Data
☐ Perform a quick format
☐ Enable file and folder compression

Figure 12-6 Set the formatting options for the partition on the Format Partition page.

5. Click Next, confirm your options, and then click Finish.

Formatting Partitions

Formatting creates a file system in a partition and permanently deletes any existing data. This is a high-level formatting that creates the file system structure rather than a low-level formatting that initializes a drive for use. To format a partition, right-click the partition and then choose Format. This opens the Format dialog box shown in Figure 12-7.



Volume label: New Volume
File system: NTFS
Allocation unit size: Default
☐ Perform a quick format
☐ Enable file and folder compression

Figure 12-7 Format a partition in the Format dialog box by specifying its file system type and volume label.

You use the formatting fields as follows:

Volume Label
Specifies a text label for the partition. This label is the partition's volume name.

File System
Specifies the file system type as FAT, FAT32, or NTFS. FAT is the file system type supported by MS-DOS and Microsoft Windows 3.1, Windows 95, Windows 98, and Windows Me. NTFS is the native file system type for Microsoft Windows NT and later releases of

Windows. "Windows Server 2008 File Structures" on page 13XXX tells you more about NTFS and the advantages of using it with Windows Server 2008.

Allocation Unit Size
Specifies the cluster size for the file system. This is the basic unit in which disk space is allocated. The default allocation unit size is based on the size of the volume and is set dynamically prior to formatting. To override this feature, you can set the allocation unit size to a specific value. If you use lots of small files, you might want to use a smaller cluster size, such as 512 or 1024 bytes. With these settings, small files use less disk space.

Perform A Quick Format
Tells Windows Server 2008 to format without checking the partition for errors. With large partitions this option can save you a few minutes. However, it's more prudent to check for errors, which allows Disk Management to mark bad sectors on the disk and lock them out.

Enable File And Folder Compression
Turns on compression for the disk. Built-in compression is available only for NTFS. Under NTFS, compression is transparent to users and compressed files can be accessed just like regular files. If you select this option, files and directories on this drive are compressed automatically. For more information on compressing drives, files, and directories, see "Compressing Drives and Data" on page 12xxx.

When you're ready to proceed, click OK. Because formatting a partition destroys any existing data, Disk Management gives you one last chance to abort the procedure. Click OK to start formatting the partition. Disk Management changes the drive's status to reflect the formatting and the percentage of completion. When formatting is complete, the drive status will change to reflect this.

Managing Existing Partitions and Drives

Disk Management provides many ways to manage existing partitions and drives. Use these features to assign drive letters, delete partitions, set the active partition, and more. In addition, Windows Server 2008 provides other utilities to carry out common tasks such as converting a volume to NTFS, checking a drive for errors, and cleaning up unused disk space.

Assigning Drive Letters and Paths

You can assign drives one drive letter and one or more drive paths, provided that the drive paths are mounted on NTFS drives. Drives don't have to be assigned a drive letter or path. A drive with no designators is considered to be unmounted, and you can mount it by assigning a drive letter or path at a later date. You need to unmount a drive before moving it to another computer.

Windows cannot modify the drive letter of system, boot, or page file volumes. To change the drive letter of a system or boot volume, you'll need to edit the Registry as described in Microsoft Knowledge Base article 223188 (*http://support.microsoft.com/kb/223188/en-us)*. Before you can change the drive letter of a page file volume, you may need to move the page file to a different volume.

To manage drive letters and paths, right-click the drive you want to configure in Disk Management, and then choose Change Drive Letter And Paths. This opens the dialog box shown in Figure 12-8. You can now do the following:

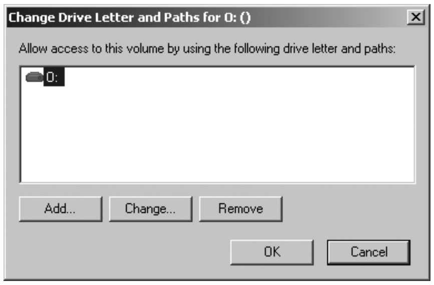
Add a drive path
Click Add, select Mount In The Following Empty NTFS Folder, and then type the path to an existing folder or click Browse to search for or create a folder.

Remove a drive path
Select the drive path to remove, click Remove, and then click Yes.

Assign a drive letter
Click Add, select Assign The Following Drive Letter, and then choose an available letter to assign to the drive.

Change the drive letter
Select the current drive letter, and then click Change. Select Assign The Following Drive Letter, and then choose a different letter to assign to the drive.

Remove a drive letter
Select the current drive letter, click Remove, and then click Yes.



Change Drive Letter and Paths for O: ()

Allow access to this volume by using the following drive letter and paths:

O:

Figure 12-8 You can change the drive letter and path assignment in the Change Drive Letter And Paths dialog box.

Note If you try to change the letter of a drive that's in use, Windows Server 2008 displays a warning. You'll need to exit programs that are using the drive and try again or allow Disk Management to force the change by clicking Yes when prompted.

Changing or Deleting the Volume Label

The volume label is a text descriptor for a drive. With FAT and FAT32, the volume label can be up to 11 characters in length and can include spaces. With NTFS, the volume label can be up to 32 characters in length. Additionally, although FAT and FAT32 don't allow you to use some special characters, including * / \ [ ] : ; | = , . + " ? < >, NTFS does allow you to use these special characters.

Because the volume label is displayed when the drive is accessed in various Windows Server 2008 utilities, such as Windows Explorer, it can provide information about a drive's contents. You can change or delete a volume label using Disk Management or Windows Explorer.

Using Disk Management, you can change or delete a label by following these steps:

1. Right-click the partition, and then choose Properties.
2. On the General tab of the Properties dialog box, type a new label for the volume in the Label text box or delete the existing label. Click OK.

Using Windows Explorer, you can change or delete a label by following these steps:

1. Right-click the drive icon and then choose Properties.
2. On the General tab of the Properties dialog box, type a new label for the volume in the Label text box or delete the existing label. Click OK.

Deleting Partitions and Drives

To change the configuration of an existing drive that's fully allocated, you might need to delete existing partitions and logical drives. Deleting a partition or a drive removes the associated file system, and all data in the file system is lost. So before you delete a partition or a drive, you should back up any files and directories that the partition or drive contains.

Note To protect the integrity of the system, you can't delete the system or boot partition. However, Windows Server 2008 will let you delete the active partition or volume if it is not designated as boot or system. Always check to ensure that the partition or volume you are deleting doesn't contain important data or files.

You can delete a primary partition, a volume, or a logical drive by following these steps:

1. In Disk Management, right-click the partition, volume, or drive you want to delete, and then choose Explore. Using Windows Explorer, move all the data to another volume or verify an existing backup to ensure that the data was properly saved.
2. In Disk Management, right-click the partition, volume, or drive again and select Delete Partition, Delete Volume, or Delete Logical Drive as appropriate.
3. Confirm that you want to delete the selected item by clicking Yes.

Deleting an extended partition differs slightly from deleting a primary partition or a logical drive. To delete an extended partition, follow these steps:

1. Delete all the logical drives on the partition following the steps listed in the previous procedure.
2. Select the extended partition area itself and delete it.

Converting a Volume to NTFS

Windows Server 2008 provides a utility for converting FAT volumes to NTFS. This utility, Convert (Convert.exe), is located in the %*SystemRoot*% folder. When you convert a volume using this tool, the file and directory structure is preserved and no data is lost. Keep in mind, however, that Windows Server 2008 doesn't provide a utility for converting NTFS to FAT. The only way to go from NTFS to FAT is to delete the partition by following the steps listed in the previous section and then to recreate the partition as a FAT volume.

The Convert Utility Syntax

Convert is a command-line utility run at the command prompt. If you want to convert a drive, use the following syntax:

```
convert volume /FS:NTFS
```

where *volume* is the drive letter followed by a colon, drive path, or volume name. For example, if you wanted to convert the D drive to NTFS, you'd use the following command:

```
convert D: /FS:NTFS
```

The complete syntax for Convert is shown here:

```
convert volume /FS:NTFS [/V] [/X] [/CvtArea:filename] [/NoSecurity]
```

The options and switches for Convert are used as follows:

volume	Sets the volume to work with
/FS:NTFS	Converts to NTFS
/V	Sets verbose mode
/X	Forces the volume to dismount before the conversion (if necessary)
/CvtArea: *filename*	Sets name of a contiguous file in the root directory to be a placeholder for NTFS system files
/NoSecurity	Removes all security attributes and makes all files and directories accessible to the group Everyone

The following sample statement uses Convert:

```
convert C: /FS:NTFS /V
```

Using the Convert Utility

Before you use the Convert utility, determine whether the partition is being used as the active boot partition or a system partition containing the operating system. With Intel x86 systems, you can convert the active boot partition to NTFS. Doing so requires that the system gain exclusive access to this partition, which can be obtained only during startup. Thus, if you try to convert the active boot partition to NTFS, Windows Server 2008 displays a prompt asking if you want to schedule the drive to be converted the next time the system starts. If you click Yes, you can restart the system to begin the conversion process.

Tip Often you will need to restart a system several times to completely convert the active boot partition. Don't panic. Let the system proceed with the conversion.

Before the Convert utility actually converts a drive to NTFS, the utility checks to see whether the drive has enough free space to perform the conversion. Generally, Convert needs a block of free space that's roughly equal to 25 percent of the total space used on the drive. For example, if the drive stores 200 GB of data, Convert needs about 50 GB of free space. If the drive doesn't have enough free space, Convert aborts and tells you that you need to free up some space. On the other hand, if the drive has enough free space, Convert initiates the conversion. Be patient. The conversion process takes several minutes (longer for large drives). Don't access files or applications on the drive while the conversion is in progress.

You can use the */CvtArea* option to improve performance on the volume so that space for the MFT is reserved. This option helps to prevent fragmentation of the MFT. How? Over time, the MFT might grow larger than the space allocated to it. The operating system must then expand the MFT into other areas of the disk. Although the Disk Defragmenter utility can defragment the MFT, it cannot move the first section of the MFT, and it is very unlikely there will be space after the MFT because this will be filled by file data.

To help prevent fragmentation in some cases, you might want to reserve more space than the default (12.5 percent of the partition or volume size). For example, you might want to increase the MFT size if the volume will have many small or average-sized files rather than a few large files. To specify the amount of space to reserve, you can use FSUtil to create a placeholder file equal in size to that of the MFT you want to create. You can then convert the volume to NTFS and specify the name of the placeholder file to use with the */CvtArea* option.

In the following example, you use FSUtil to create a 1.5 GB (1,500,000,000 bytes) placeholder file named Temp.Txt:

```
fsutil file createnew c:\temp.txt 1500000000
```

To use this placeholder file for the MFT when converting drive C to NTFS, you would then type the following command:

```
convert c: /fs:ntfs /cvtarea:temp.txt
```

Notice that the placeholder file is created on the partition or volume that is being converted. During the conversion process, the file will be overwritten with NTFS metadata and any unused space in the file will be reserved for future use by the MFT.

Resizing Partitions and Volumes

Windows Server 2008 doesn't user Ntldr and Boot.ini to load the operating system. Instead, Windows Server 2008 has a pre-boot environment in which Windows Boot Manager is used to control startup and load the boot application you've selected. Windows Boot Manager also finally frees the Windows operating system from its reliance on MS-DOS so that you can use drives in new ways. With Windows Server 2008, you can extend and shrink both basic and dynamic disks. You can use either Disk Management or DiskPart to extend and shrink volumes. You cannot shrink or extend striped volumes.

In extending a volume, you convert areas of unallocated space and add them to the existing volume. For spanned volumes on dynamic disks, the space can come from any available dynamic disk, not only those on which the volume was originally created. Thus you can combine areas of free space on multiple dynamic disks and use those areas to increase the size of an existing volume.

Caution Before you try to extend a volume, be aware of several limitations. First, you can extend simple and spanned volumes only if they are formatted and the file system is NTFS. You can't extend striped volumes. You can't extend volumes that aren't formatted or that are formatted with FAT or FAT32. Additionally, you can't extend a system or boot volume, regardless of its configuration.

You can shrink a simple volume or a spanned volume by following these steps:

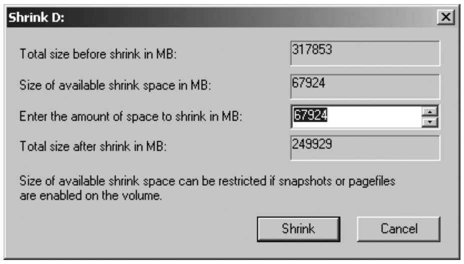
1. In Disk Management, right-click the volume that you want to shrink and then select Shrink Volume. This option is available only if the volume meets the previously discussed criteria.
2. In the field provided in the Shrink dialog box shown in Figure 12-9, enter the amount of space to shrink. The Shrink dialog box provides the following information:

   Total Size Before Shrink In MB
   Lists the total capacity of the volume in MB. This is the formatted size of the volume.

   Size Of Available Shrink Space In MB
   Lists the maximum amount by which the volume can be shrunk. This doesn't represent the total amount of free space on the volume; rather, it represents the amount of space that can be removed, not including any data reserved for the master file table, volume snapshots, page files, and temporary files.

   Amount of Space To Shrink In MB
   Lists the total amount of space that will be removed from the volume. The initial value defaults to the maximum amount of space that can be removed from the volume. For optimal drive performance, you'll want to ensure that the drive has at least 10 percent of free space after the shrink operation.

   Total Size After Shrink In MB
   Lists what the total capacity of the volume in MB will be after the shrink. This is the new formatted size of the volume.



Total size before shrink in MB: 317853

Size of available shrink space in MB: 67924

Enter the amount of space to shrink in MB: 67924

Total size after shrink in MB: 249929

Size of available shrink space can be restricted if snapshots or pagefiles are enabled on the volume.

Figure 12-9 Specify the amount of space to shrink from the volume.

3. Click Shrink to shrink the volume.

You can extend a simple volume or a spanned volume by following these steps:

1. In Disk Management, right-click the volume that you want to extend and then select Extend Volume. This option is available only if the volume meets the previously discussed criteria and free space is available on one or more of the system's dynamic disks.
2. In the Extend Volume Wizard, read the introductory message and then click Next.
3. On the Select Disks page, select the disk or disks from which you want to allocate free space. Any disks currently being used by the volume will automatically be selected. By default, all remaining free space on those disks will be selected for use.
4. With dynamic disks, you can specify the additional space that you want to use on other disks by performing the following tasks:
    - Click the disk and then click Add to add the disk to the Selected list box.
    - Select each disk in the Selected list box and in the Select The Amount Of Space In MB list box, specify the amount of unallocated space to use on the selected disk.
5. Click Next, confirm your options, and then click Finish.

Repairing Disk Errors and Inconsistencies

Windows Server 2008 includes feature enhancements that reduce the amount of manual maintenance you must perform on disk drives. The following enhancements have the most impact on the way you work with disks:

- Transaction NTFS
- Self-Healing NTFS

Transactional NTFS allows file operations on an NTFS volume to be performed transactionally. This means programs can use a transaction to group together sets of file and registry operations so that all of them succeed or none of them succeed. While a transaction is active, changes are not visible outside of the transaction. Changes are committed and written fully to disk only when a transaction is completed successfully. If a transaction fails or is incomplete, the program rolls back the transactional work to restore the file system to the state it was in prior to the transaction.

Transactions that span multiple volumes are coordinated by the Kernel Transaction Manager (KTM). The KTM supports independent recovery of volumes if a transaction fails. The local resource manager for a volume maintains a separate transaction log and is responsible for maintaining threads for transactions separate from threads that perform the file work.

Traditionally, you have had to use the Check Disk tool to fix errors and inconsistencies in NTFS volumes on a disk. Because this process can disrupt the availability of Windows systems, Windows Server 2008 uses Self-Healing NTFS to protect file systems without having to separate maintenance tools to fix problems. Because much of the self-healing process is enabled and performed automatically, you may only need to manually perform volume maintenance when you are notified by the operating system that a problem cannot be corrected automatically. If such an error occurs, Windows Server 2008 will notify you about the problem and provide possible solutions.

Self-Healing NTFS has many advantages over Check Disk, including the following:

- Check Disk must have exclusive access to volumes, which means system and boot volumes can only be checked when the operating system starts up. On the other hand, with Self-Healing NTFS, the file system is always available and does not need to be corrected offline (in most cases).
- Self-Healing NTFS attempts to preserve as much data as possible if corruption occurs and reduces failed file system mounting that previously could occur if a volume was known to have errors or inconsistencies. During restart, Self-Healing NTFS repairs the volume immediately so that it can be mounted.
- Self-Healing NTFS reports changes made to the volume during repair through existing Chkdsk.exe mechanisms, directory notifications, and update sequence number (USN) journal entries. This feature also allows authorized users and administrators to monitor repair operations through Verification, Waiting For Repair Completion, and Progress Status messages.
- Self-Healing NTFS can recover a volume if the boot sector is readable but does not identify an NTFS volume. In this case, you must run an offline tool that repairs the boot sector and then allow self-healing NTFS to initiate recovery.

Although Self-Healing NTFS is a terrific enhancement, at times you may want to (or may have to) manually check the integrity of a disk. In these cases, you can use Check Disk (Chkdsk.exe) to check for and, optionally, repair problems found on FAT, FAT32, and NTFS volumes. Although Check Disk can check for and correct many types of errors, the utility primarily looks for inconsistencies in the file system and its related metadata. One of the ways Check Disk locates errors is by comparing the volume bitmap to the disk sectors assigned to files in the file system. Beyond this, the usefulness of Check Disk is rather limited. For example, Check Disk can't repair corrupted data within files that appear to be structurally intact.

Running Check Disk from the Command Line

You can run Check Disk from the command line or within other utilities. At a command prompt, you can test the integrity of the E drive by typing the following command:

```
chkdsk E:
```

To find and repair errors that are found in the E drive, use the following command:

```
chkdsk /f E:
```

Note Check Disk can't repair volumes that are in use. If the volume is in use, Check Disk displays a prompt that asks if you want to schedule the volume to be checked the next time you restart the system. Click Yes to schedule this.

The complete syntax for Check Disk is shown here:

```
chkdsk [volume[[path]filename]]] [/F] [/V] [/R] [/X] [/I] [/C] [/L[:size]]
```

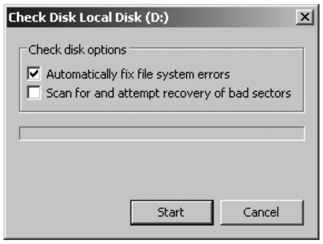
The options and switches for Check Disk are used as follows:

Volume	Sets the volume to work with.
filename	FAT/FAT32 only: Specifies files to check for fragmentation.
/F	Fixes errors on the disk.
/V	On FAT/FAT32: Displays the full path and name of every file on the disk. On NTFS: Displays cleanup messages, if any.
/R	Locates bad sectors and recovers readable information (implies /F).
/L:*size*	NTFS only: Changes the log file size.
/X	Forces the volume to dismount first if necessary (implies /F).
/I	NTFS only: Performs a minimum check of index entries.
/C	NTFS only: Skips checking of cycles within the folder structure.

Running Check Disk Interactively

You can also run Check Disk interactively by using either Windows Explorer or Disk Management. To do that, follow these steps:

1. Right-click the drive and then choose Properties.
2. On the Tools tab of the Properties dialog box, click Check Now.
3. As shown in Figure 12-10, you can now do the following:
    - Check for errors without repairing them. Click Start without selecting either of the check boxes.
    - Check for errors and fix them. Make the appropriate selections in the check boxes to fix file system errors or to recover bad sectors, or both. Then click Start.



☑ Automatically fix file system errors
☐ Scan for and attempt recovery of bad sectors

Figure 12-10 Use Check Disk to check a disk for errors and repair them.

Defragmenting Disks

Any time you add files to or remove files from a drive, the data on the drive can become fragmented. When a drive is fragmented, large files can't be written to a single continuous area on the disk. As a result, the operating system must write the file to several smaller areas on the disk, which means more time is spent reading the file from the disk. To reduce fragmentation, Windows Server 2008 can manually or automatically defragments disks periodically using Disk Defragmenter. The more frequently data is updated on drives, the more often you should run this tool.

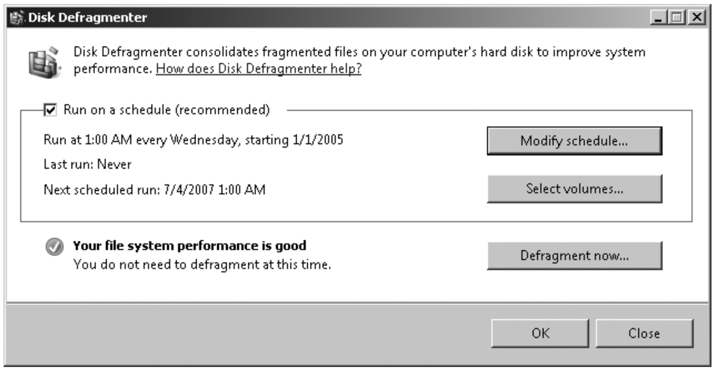
You can manually defragment a disk by following these steps:

1. In Server Manager, select the Storage node and then the Disk Management node. Right-click a drive and then select Properties.
2. On the Tools tab, click Defragment Now.
3. In the Disk Defragmenter dialog box, click Defragment Now.

> **Note** Depending on the size of the disk, defragmentation can take several hours. You can click Cancel Defragmentation at any time to stop defragmentation.

When you enable automatic defragmenation, Windows Server 2008 runs disk defragmenter automatically at 1:00 A.M. every Wednesday. As long as the computer is on at the scheduled run time, automatic defragmentation will occur. You can configure and manage automated defragmentation by following these steps:

1. In Server Manager, select the Storage node and then the Disk Management node. Right-click a drive and then select Properties.
2. On the Tools tab, click Defragment Now. This displays the Disk Defragmenter dialog box, shown in Figure 12-11.



Disk Defragmenter

Disk Defragmenter consolidates fragmented files on your computer's hard disk to improve system performance. How does Disk Defragmenter help?

☑ Run on a schedule (recommended)

Run at 1:00 AM every Wednesday, starting 1/1/2005

Last run: Never

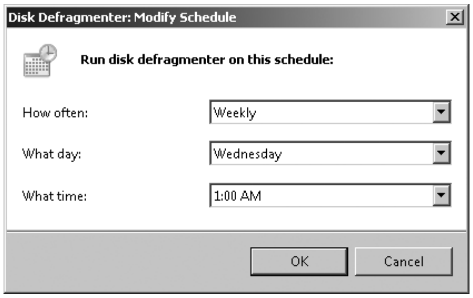
Next scheduled run: 7/4/2007 1:00 AM

Your file system performance is good

You do not need to defragment at this time.

Figure 12-11 Disk Defragmenter analyzes and defragments disks efficiently.

3. To cancel automated defragmentation, clear Run On A Schedule and then click OK twice. Skip the remaining steps.
4. To enable automated defragmentation, select Run On A Schedule. The default or last set run schedule is shown.
5. If you want to modify the run schedule, click Modify Schedule. In the Modify Schedule dialog box, shown in Figure 12-12, set the desired run schedule and then click OK. In the How Often selection list, you can choose Daily, Weekly, or Monthly as the run schedule. If you choose a weekly or monthly run schedule, you'll need to select the run day of the week or month from the What Day selection list. Finally, the What Time selection list lets you set the time of the day that automated defragmentation should occur.



Disk Defragmenter: Modify Schedule

Run disk defragmenter on this schedule:

How often: Weekly

What day: Wednesday

What time: 1:00 AM

Figure 12-12 Set the desired run schedule for automated defragmentation.

6. If you want to manage which disks are defragmented, click Select Volumes. In the Advanced Options dialog box, select which volumes are defragmented. By default, all disks installed within or connected to the computer are defragmented and any new disks are defragmented automatically as well. In the Disks To Defragment list, select the check boxes for disks that should be defragmented automatically and clear the check boxes for disks that should not be defragmented automatically. Click OK.
7. Click OK twice to save your settings.

Compressing Drives and Data

When you format a drive for NTFS, Windows Server 2008 allows you to turn on the built-in compression feature. With compression, all files and directories stored on a drive are automatically compressed when they're created. Because this compression is transparent to users, compressed data can be accessed just like regular data. The difference is that you can store more information on a compressed drive than you can on an uncompressed drive.

Real World

Although compression is certainly a useful feature when you want to save disk space, you can't encrypt compressed data. Compression and encryption are mutually exclusive alternatives for NTFS volumes, which means you have the choice of either using compression or using encryption. You can't use both techniques. For more information on encryption, see "Encrypting Drives and Data" on page 12xxx. If you try to compress encrypted data, Windows Server 2008 automatically decrypts the data and then compresses it. Likewise, if you try to encrypt compressed data, Windows Server 2008 uncompresses the data and then encrypts it.

Compressing Drives

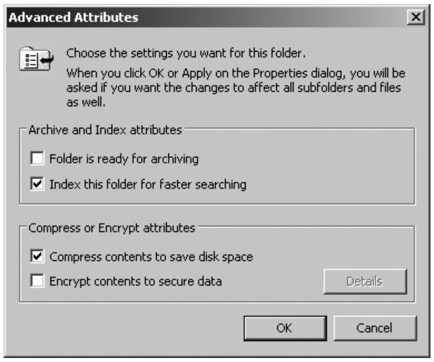
To compress a drive and all its contents, follow these steps:

1. In Windows Explorer or Disk Management, right-click the drive that you want to compress, and then select Properties.
2. Select Compress Drive To Save Disk Space and then click OK.

Compressing Directories and Files

If you decide not to compress a drive, Windows Server 2008 lets you selectively compress directories and files. To compress a file or directory, follow these steps:

1. In Windows Explorer, right-click the file or directory that you want to compress, and then select Properties.
2. On the General tab of the related property dialog box, click Advanced. In the Advanced Attributes dialog box, select the Compress Contents To Save Disk Space check box, as shown in Figure 12-13. Click OK twice.



Advanced Attributes

Choose the settings you want for this folder.

When you click OK or Apply on the Properties dialog, you will be asked if you want the changes to affect all subfolders and files as well.

Archive and Index attributes

☐ Folder is ready for archiving

☑ Index this folder for faster searching

Compress or Encrypt attributes

☑ Compress contents to save disk space

☐ Encrypt contents to secure data

Figure 12-13 With NTFS, you can compress a file or directory by selecting the Compress Contents To Save Disk Space check box in the Advanced Attributes dialog box.

For an individual file, Windows Server 2008 marks the file as compressed and then compresses it. For a directory, Windows Server 2008 marks the directory as compressed and then compresses all the files in it. If the directory contains subfolders, Windows Server 2008 displays a dialog box that allows you to compress all the subfolders associated with the directory. Simply select Apply Changes To This Folder, Subfolders, And Files and then click OK. Once you compress a directory, any new files added or copied to the directory are compressed automatically.

Note If you move an uncompressed file from a different drive, the file is compressed. However, if you move an uncompressed file to a compressed folder on the same NTFS drive, the file isn't compressed. Note also that you can't encrypt compressed files.

Expanding Compressed Drives

You can remove compression from a drive by following these steps:

1. In Windows Explorer or Disk Management, right-click the drive that contains the data you want to expand, and then select Properties.
2. Clear the Compress Drive To Save Disk Space check box and then click OK.

Tip Windows always checks the available disk space before expanding compressed data. You should, too. If less free space is available than used space, you might not be able to complete the expansion. For example, if a compressed drive uses 150 GB of space and has 70 GB of free space available, you won't have enough free space to expand the drive.

Expanding Compressed Directories and Files

If you decide later that you want to expand a compressed file or directory, reverse the process by following these steps:

1. Right-click the file or directory in Windows Explorer.
2. On the General tab of the related Properties dialog box, click Advanced. Clear the Compress Contents To Save Disk Space check box. Click OK twice.

With files, Windows Server 2008 removes compression and expands the file. With directories, Windows Server 2008 expands all the files within the directory. If the directory contains subfolders, you'll also have the opportunity to remove compression from the subfolders. To do this, select Apply Changes To This Folder, Subfolders, And Files when prompted, and then click OK.

> **Tip** Windows Server 2008 also provides command-line utilities for compressing and uncompressing your data. The compression utility is called Compact (Compact.exe). The uncompression utility is called Expand (Expand.exe).

Encrypting Drives and Data

NTFS has many advantages over other file systems that you can use with Windows Server 2008. One of the major advantages is the capability to automatically encrypt and decrypt data using the Encrypting File System (EFS). When you encrypt data, you add an extra layer of protection to sensitive data—and this extra layer acts as a security blanket blocking all other users from reading the contents of the encrypted files. Indeed, one of the great benefits of encryption is that only the designated user can access the data. This benefit is also a disadvantage in that the user must remove encryption before authorized users can access the data.

> **Note** As discussed previously, you can't compress encrypted files. The encryption and compression features of NTFS are mutually exclusive. You can use one feature or the other, but not both.

Understanding Encryption and the Encrypting File System

File encryption is supported on a per-folder or per-file basis. Any file placed in a folder marked for encryption is automatically encrypted. Files in encrypted format can be read only by the person who encrypted the file. Before other users can read an encrypted file, the user must decrypt the file.

Every encrypted file has a unique encryption key. This means that an encrypted file can be copied, moved, and renamed just like any other file—and in most cases these actions don't affect the encryption of the data. (For details, see "Working with Encrypted Files and Folders" on page 12xxx.) The user who encrypted the file always has access to the file, provided that the user's public-key certificate is available on the computer that he or she is using. For this user, the encryption and decryption process is handled automatically and is transparent.

The process that handles encryption and decryption is called the Encrypting File System (EFS). The default setup for EFS allows users to encrypt files without needing special permission. Files are encrypted using a public/private key that EFS automatically generates on a per-user basis.

Encryption certificates are stored as part of the data in user profiles. If a user works with multiple computers and wants to use encryption, an administrator will need to configure a roaming profile for that user. A roaming profile ensures that the user's profile data and public-key certificates are accessible from other computers. Without this, users won't be able to access their encrypted files on another computer.

Security

An alternative to a roaming profile is to copy the user's encryption certificate to the computers that the user uses. You can do this using the certificate backup and restore process discussed in the section of Chapter 15 titled "Backing Up and Restoring Encrypted Data and Certificates." Simply back up the certificate on the user's original computer and then restore the certificate on each of the other computers the user logs on to.

EFS has a built-in data recovery system to guard against data loss. This recovery system ensures that encrypted data can be recovered in the event a user's public-key certificate is lost or deleted. The most common scenario for this is when a user leaves the company and the associated user account is deleted. A manager might have been able to log on to the user's account, check files, and save important files to other folders, but if the user account has been deleted, encrypted files will be accessible only if the encryption is removed or if the files are moved to a FAT or FAT32 volume (where encryption isn't supported).

To access encrypted files after the user account has been deleted, you'll need to use a recovery agent. Recovery agents have access to the file encryption key necessary to unlock data in encrypted files. To protect sensitive data, however, recovery agents don't have access to a user's private key or any private key information.

Windows Server 2008 won't encrypt files without designated EFS recovery agents. Therefore, recovery agents are designated automatically and the necessary recovery certificates are generated automatically as well. This ensures that encrypted files can always be recovered.

EFS recovery agents are configured at two levels:

Domain
The recovery agent for a domain is configured automatically when the first Windows Server 2008 domain controller is installed. By default, the recovery agent is the domain administrator. Through Group Policy, domain administrators can designate additional recovery agents. Domain administrators can also delegate recovery agent privileges to designated security administrators.

Local computer
When a computer is part of a workgroup or in a stand-alone configuration, the recovery agent is the administrator of the local computer by default. Additional recovery agents

can be designated. Further, if you want local recovery agents in a domain environment rather than domain-level recovery agents, you must delete the recovery policy from the group policy for the domain.

You can delete recovery agents if you don't want them to be used. However, if you delete all recovery agents, EFS will no longer encrypt files. One or more recovery agents must be configured for EFS to function.

Encrypting Directories and Files

With NTFS volumes, Windows Server 2008 lets you select files and folders for encryption. When you encrypt files, the file data is converted to an encrypted format that can be read only by the person who encrypted the file. Users can encrypt files only if they have the proper access permissions. When you encrypt folders, the folder is marked as encrypted, but only the files within it are actually encrypted. All files that are created in or added to a folder marked as encrypted are encrypted automatically.

To encrypt a file or directory, follow these steps:

1. Right-click the file or directory that you want to encrypt, and then select Properties.
2. On the General tab of the related Properties dialog box, click Advanced, and then select the Encrypt Contents To Secure Data check box. Click OK twice.

Note You can't encrypt compressed files, system files, or read-only files. If you try to encrypt compressed files, the files are automatically uncompressed and then encrypted. If you try to encrypt system files, you'll get an error.

For an individual file, Windows Server 2008 marks the file as encrypted and then encrypts it. For a directory, Windows Server 2008 marks the directory as encrypted and then encrypts all the files in it. If the directory contains subfolders, Windows Server 2008 displays a dialog box that allows you to encrypt all the subfolders associated with the directory. Simply select Apply Changes To This Folder, Subfolders, And Files and then click OK.

Note On NTFS volumes, files remain encrypted even when they're moved, copied, and renamed. If you copy or move an encrypted file to a FAT or FAT32 drive, the file is automatically decrypted before being copied or moved. Thus, you must have proper permissions to copy or move the file.

Working with Encrypted Files and Folders

Previously, I said that you can copy, move, and rename encrypted files and folders just like any other files. This is true, but I qualified this by saying "in most cases." When you work with encrypted files, you'll have few problems as long as you work with NTFS volumes on the same computer. When you work with other file systems or other computers, you might run into problems. Two of the most common scenarios are:

Copying between volumes on the same computer
When you copy or move an encrypted file or folder from one NTFS volume to another NTFS volume on the same computer, the files remain encrypted. However, if you copy or

move encrypted files to a FAT or FAT32 volume, the files are decrypted before transfer and then transferred as standard files. FAT and FAT32 don't support encryption.

Copying between volumes on a different computer
When you copy or move an encrypted file or folder from one NTFS volume to another NTFS volume on a different computer, the files remain encrypted as long as the destination computer allows you to encrypt files and the remote computer is trusted for delegation. Otherwise, the files are decrypted and then transferred as standard files. The same is true when you copy or move encrypted files to a FAT or FAT32 volume on another computer. FAT and FAT32 don't support encryption.

After you transfer a sensitive file that has been encrypted, you might want to confirm that the encryption is still applied. Right-click the file and then select Properties. On the General tab of the related Properties dialog box, click Advanced. The Encrypt Contents To Secure Data option should be selected.

Configuring Recovery Policy

Recovery policies are configured automatically for domain controllers and workstations. By default, domain administrators are the designated recovery agents for domains and the local administrator is the designated recovery agent for a stand-alone workstation.

Through the Group Policy console, you can view, assign, and delete recovery agents. To do that, follow these steps:

1. Open the Group Policy console for the local computer, site, domain, or organizational unit you want to work with. For details on working with Group Policy, see "Group Policy Management" in Chapter 4, "Automating Administrative Tasks, Policies, and Procedures."
2. Open the Encrypted Data Recovery Agents node in Group Policy. To do this, expand Computer Configuration, Windows Settings, Security Settings, and Public Key Policies and then select Encrypting File System.
3. The right-hand pane lists the recovery certificates currently assigned. Recovery certificates are listed according to who issued them , to whom they are issued, expiration data, purpose, and more
4. To designate an additional recovery agent, right-click Encrypting File System and then select Add Data Recovery Agent. This starts the Add Recovery Agent Wizard, which you can use to select a previously generated certificate that has been assigned to a user and mark it as a designated recovery certificate. Click Next.
5. On the Select Recovery Agents page, click Browse Directory and in the Find Users, Contacts, And Groups dialog box, select the user you want to work with.

Security

Before you can designate additional recovery agents, you must set up a root Certificate Authority (CA) in the domain. Then you must use the Certificates snap-in to generate a personal certificate that uses the EFS Recovery Agent template. The root CA must then approve the certificate request so that the certificate can be used.

6. To delete a recovery agent, select the recovery agent's certificate in the right pane and then press Delete. When prompted to confirm the action, click Yes to permanently and irrevocably delete the certificate. If the recovery policy is empty (meaning that it has no other designated recovery agents), EFS will be turned off so that files can no longer be encrypted.

Decrypting Files and Directories

If you decide later that you want to decrypt a file or directory, reverse the process by following these steps:

1. Right-click the file or directory in Windows Explorer.
2. On the General tab of the related Properties dialog box, click Advanced. Clear the Encrypt Contents To Secure Data check box. Click OK twice.

With files, Windows Server 2008 decrypts the file and restores it to its original format. With directories, Windows Server 2008 decrypts all the files within the directory. If the directory contains subfolders, you'll also have the opportunity to remove encryption from the subfolders. To do this, select Apply Changes To This Folder, Subfolders, And Files when prompted and then click OK.

Tip Windows Server 2008 also provides a command-line utility called Cipher (Cipher.exe) for encrypting and decrypting your data. Typing **cipher** at the command prompt without additional parameters shows you the encryption status of all folders in the current directory.