

Implementing Hard Drives

Chapter 12



Overview

- **In this chapter, you will learn how to**
 - Explain the partitions available in Windows
 - Discuss hard drive formatting options
 - Partition and format hard drives
 - Maintain and troubleshoot hard drives

Hard Drive Partitions

Partitioning

- **Process of electronically subdividing the physical hard drives**
 - Windows assigns them names such as C: or D:
 - A hard drive must have at least one partition
 - Partitioning enables you to organize a drive according to your personal taste



- **One physical drive**
 - One or more partitions

- **Three kinds of partitions:**
 - Basic disks (uses master boot record)
 - Older style
 - Readable by other utilities
 - Dynamic disks
 - Proprietary Microsoft style
 - GUID partition table (GPT)
 - Newer scheme that replaces the MBR

Master Boot Record (MBR)

- **The first sector of an MBR hard drive contains the master boot record (MBR).**
- **MBR is a small amount of data that contains the partition table.**
- **Partition table describes the number and size of partitions on the disk.**
 - MBR partition tables support up to four partitions.
 - Instructions in the master boot record use this table to determine which partition contains the active operating system.

Master Boot Record (MBR) (continued)

1. The master boot record looks for a partition with an operating system.

2. The partition table tells the master boot record where to look.

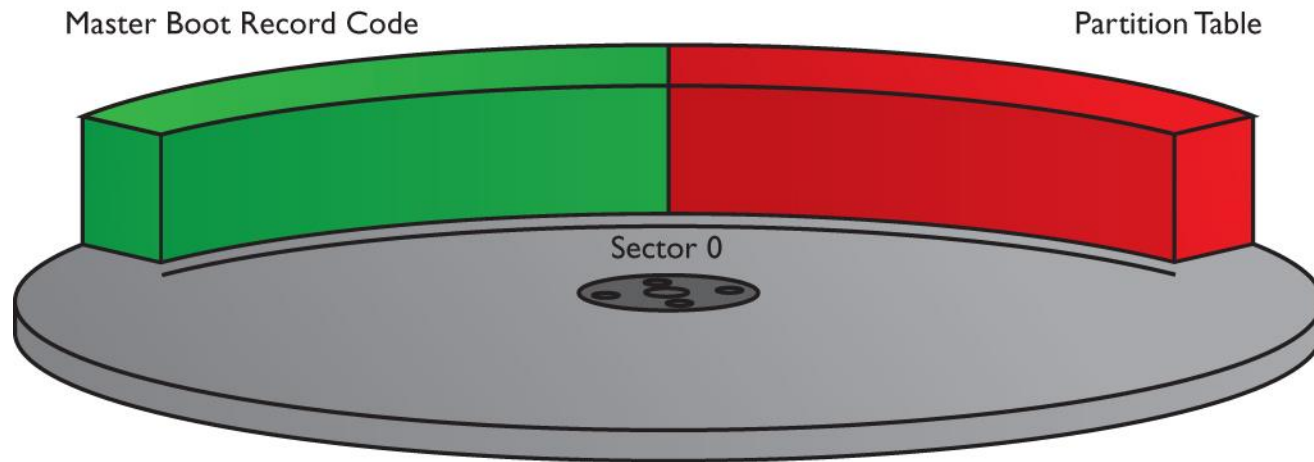


Figure 1: The master boot record

Master Boot Record (MBR) (*continued*)

- **After the MBR locates the appropriate partition, the partition boot sector loads the OS on that partition.**
 - The partition boot sector stores information important to its partition, such as the location of the OS boot files.

Master Boot Record (MBR) (continued)

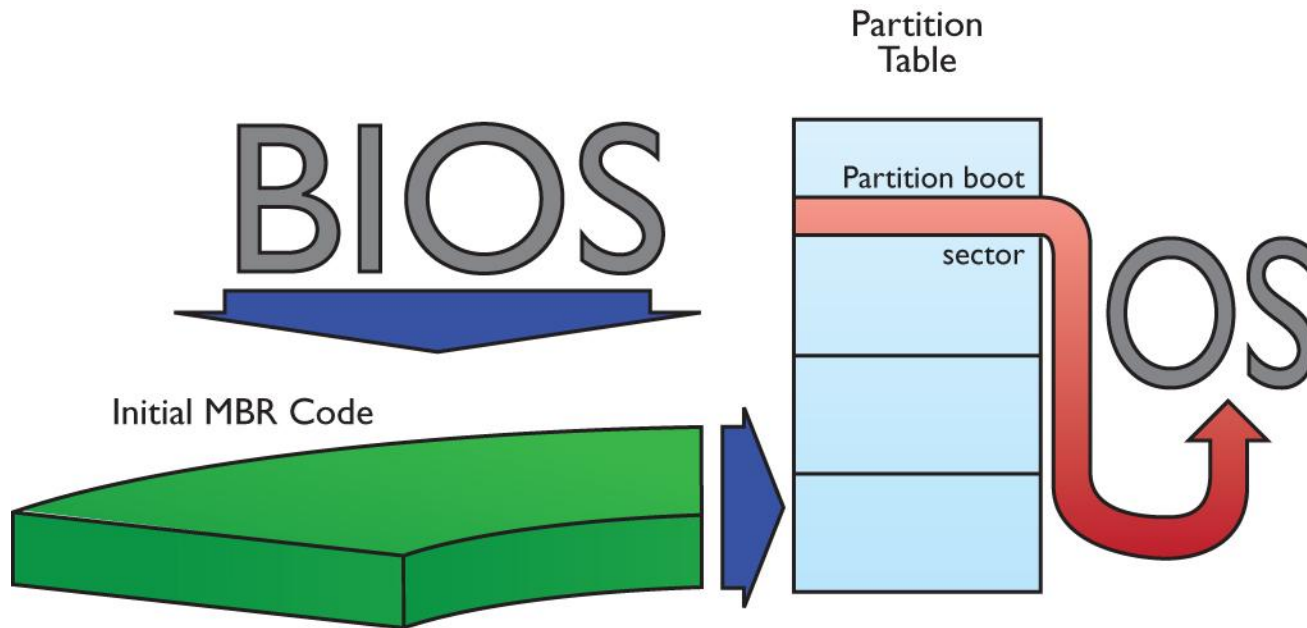


Figure 2: Using the master boot record to boot an OS

Master Boot Record (MBR) (*continued*)

- **MBR partition tables support two types of partitions: primary partitions and extended partitions:**
 - Primary partitions are designed to support bootable operating systems—only one can be active.
 - Extended partitions are not bootable.
 - A single MBR disk may have up to four primary partitions or three primary partitions and one extended partition.

Master Boot Record (MBR) (continued)

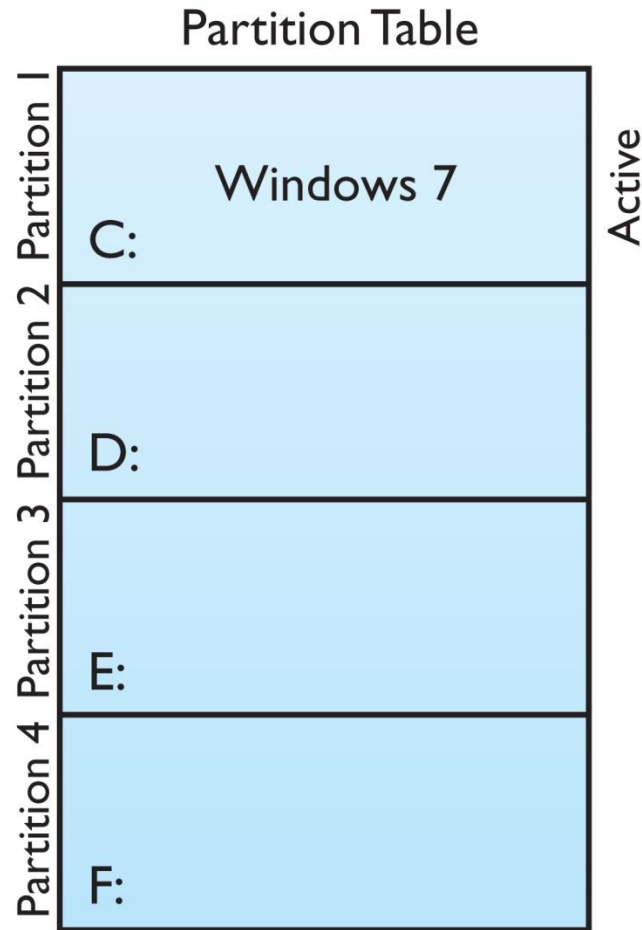


Figure 3: The active partition containing Windows

Master Boot Record (MBR) (*continued*)

- **Every primary partition on a single drive has a special setting stored in the partition table called active that determines the active partition.**
 - The MBR finds the active partition and boots the operating system on that partition. Only one partition can be active at a time because you can run only one OS at a time.

Master Boot Record (MBR) (*continued*)

- **To control multiboot setups, a bootloader can be used.**
 - When the computer boots, the boot-manager software yanks control from the MBR and asks which OS you wish to boot.
 - Once a partition is set as active, the partition boot sector loads the operating system.
 - GRUB is a popular free bootloader found in Linux.

Master Boot Record (MBR) (*continued*)

```
GNU GRUB version 1.99-18ubuntu1

Ubuntu, with Linux 3.2.0-20-generic-pae
Ubuntu, with Linux 3.2.0-20-generic-pae (recovery mode)
Memory test (memtest86+)
Memory test (memtest86+, serial console 115200)
Windows 7 (loader) (on /dev/sda1)

Use the ↑ and ↓ keys to select which entry is highlighted.
Press enter to boot the selected OS, 'e' to edit the commands
before booting or 'c' for a command-line.
```

Figure 4: GRUB in action

Master Boot Record (MBR) (*continued*)

- **With a four-partition limit, an MBR disk is limited to four drive letters if using only primary partitions—an extended partition overcomes this limit.**
 - An extended partition can contain multiple logical drives, each of which can get a drive letter.
 - A logical drive works like a primary partition, except that you cannot boot from it.

Master Boot Record (MBR) (continued)

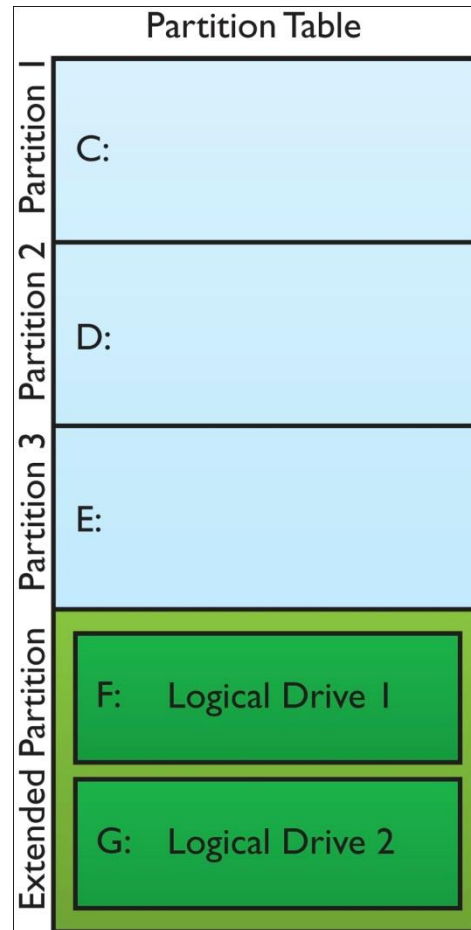


Figure 5: An extended partition containing multiple logical drives

Dynamic Disks

- **New since Windows 2000**
- **Partitions referred to as volumes**
- **Enable spanned volumes over multiple drives**
- **Enable use of software-based RAID**
 - The RAID levels you can use depend on the version of Windows used.
 - Only higher-end editions of each version (XP, Vista, and 7) use dynamic disks (Professional, Business, Ultimate, and Enterprise editions).
- **Not limited to 4 volumes**

Dynamic Disks (*continued*)

Volume	Windows XP Professional	Windows Vista Business/Ultimate/Enterprise	Windows 7 Professional/Ultimate/Enterprise	Windows Server 2008/Server 2008 R2
Simple	X	X	X	X
Spanned	X	X	X	X
Striped	X	X	X	X
Mirrored			X	X
RAID 5				X

Table 1: Dynamic Disk Compatibility

GUID Partition Table

- **The globally unique identifier partition table (GPT) follows some of the same principles as the MBR scheme, but many limits have been overcome.**
 - While MBR drives are limited to four partitions, a GPT drive can have an almost unlimited number of primary partitions (Microsoft has limited Windows to 128 partitions).
 - MBR partitions have a limit of 2.2 TB—but GPT is only limited to a size in zettabytes.
 - GPT partitioning supports LBA right out of the box—MBR schemes require the BIOS to see them as CHS values.

GUID Partition Table (continued)

- **GPT is arranged by LBA instead of sectors.**
 - LBA 0 is the protective MBR.

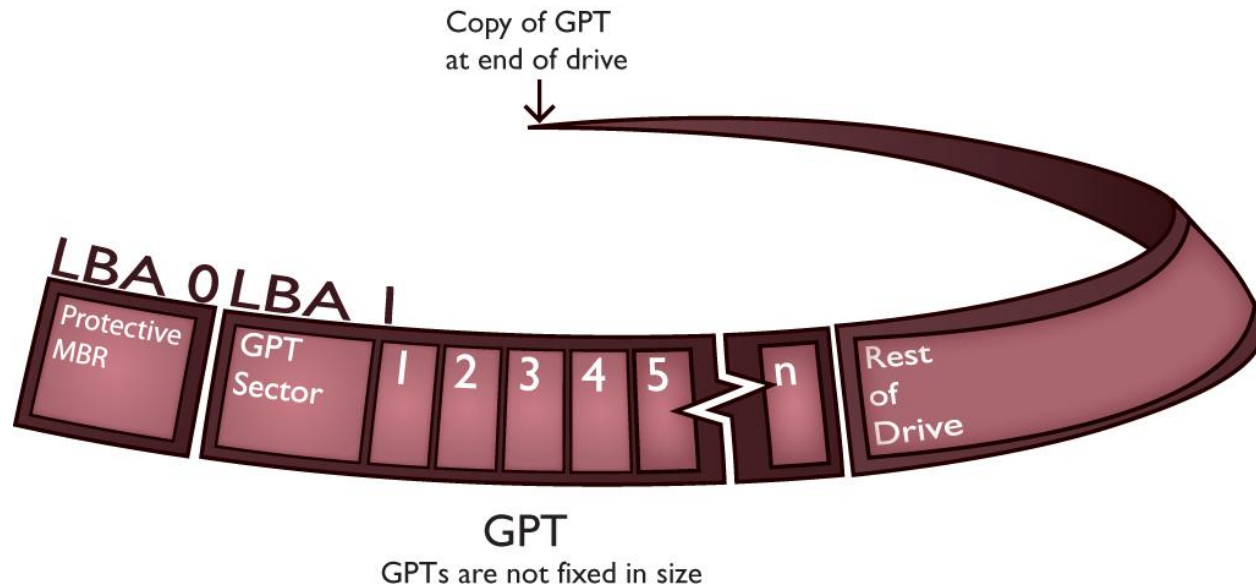


Figure 6: GUID partition table

Other Partition Types

- **Hidden partition**
 - A primary partition that is hidden from the OS, often used for backup purposes—sometimes called a factory recovery partition
- **Swap partition**
 - Only found on Linux and BSD systems. Similar to a page file, but instead it has a dedicated partition.

When to Partition

- **When installing a new OS**
- **When adding a new hard drive**
- **Older Versions of Windows used the FDISK program**
- **Newer versions use Disk Management**
- **Linux uses FDISK (not the same as Windows) or other tools, like GParted**
- **Later versions of Windows can resize partitions by expanding them with available free space (XP/Vista/7) or shrink (Vista/7) partitions**

When to Partition (*continued*)

```
MS-DOS Version 6
Fixed Disk Setup Program
(C)Copyright Microsoft Corp. 1983 - 1993

      FDISK Options

Current fixed disk drive: 1

Choose one of the following:

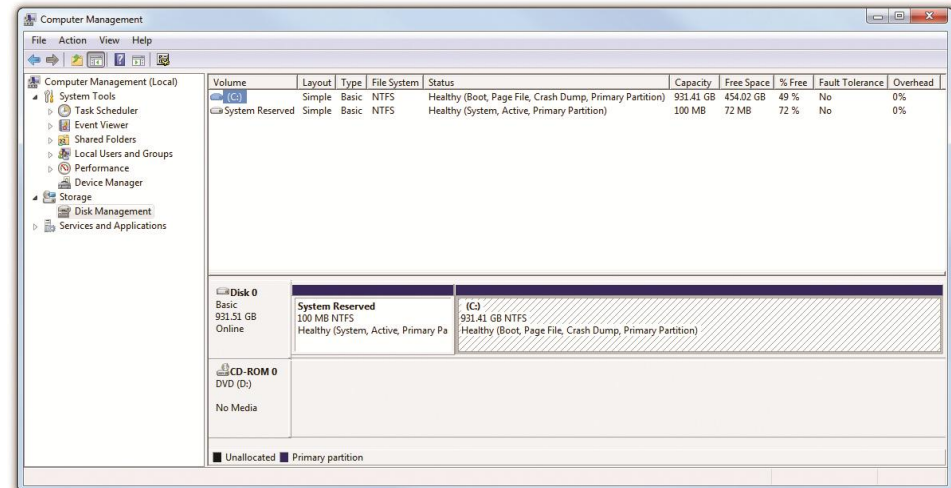
1. Create DOS partition or Logical DOS Drive
2. Set active partition
3. Delete partition or Logical DOS Drive
4. Display partition information

Enter choice: [1]

Press Esc to exit FDISK
```

Figure 7: FDISK

Figure 8: Windows 7 Disk Management tool in Computer Management



Partition Naming Problems

- **Drive structures on an MBR or GPT disk are called partitions, regardless of which operating system is used—XP follows this convention.**
- **Dynamic disks (Microsoft proprietary) use volumes—not partitions.**
- **In Windows Vista and 7, they are called partitions during installation but volumes in Disk Management.**

Partition Naming Problems (continued)

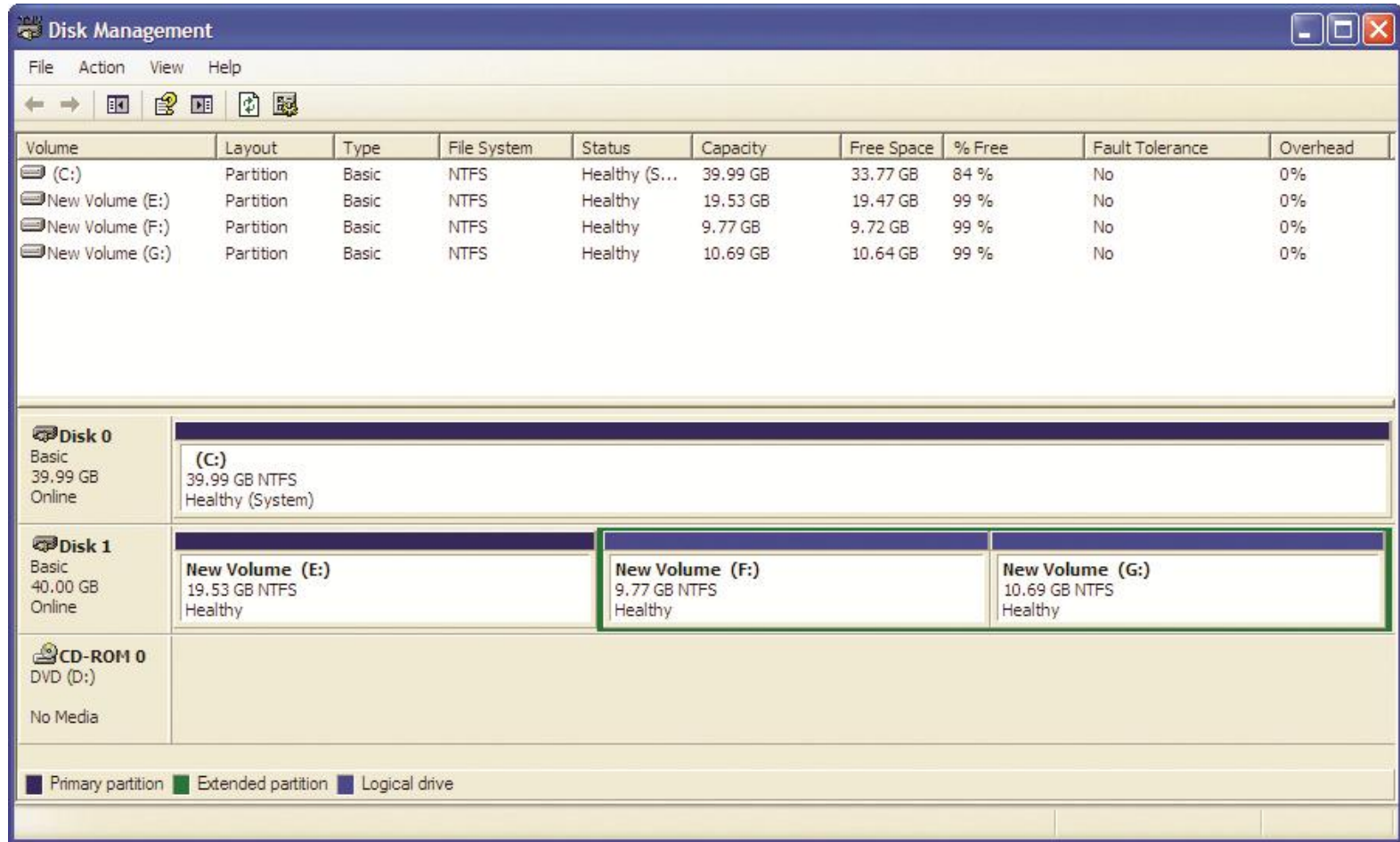


Figure 9: Windows XP very clearly showing primary and extended partitions and logical drives in the extended partition

Partition Naming Problems (continued)

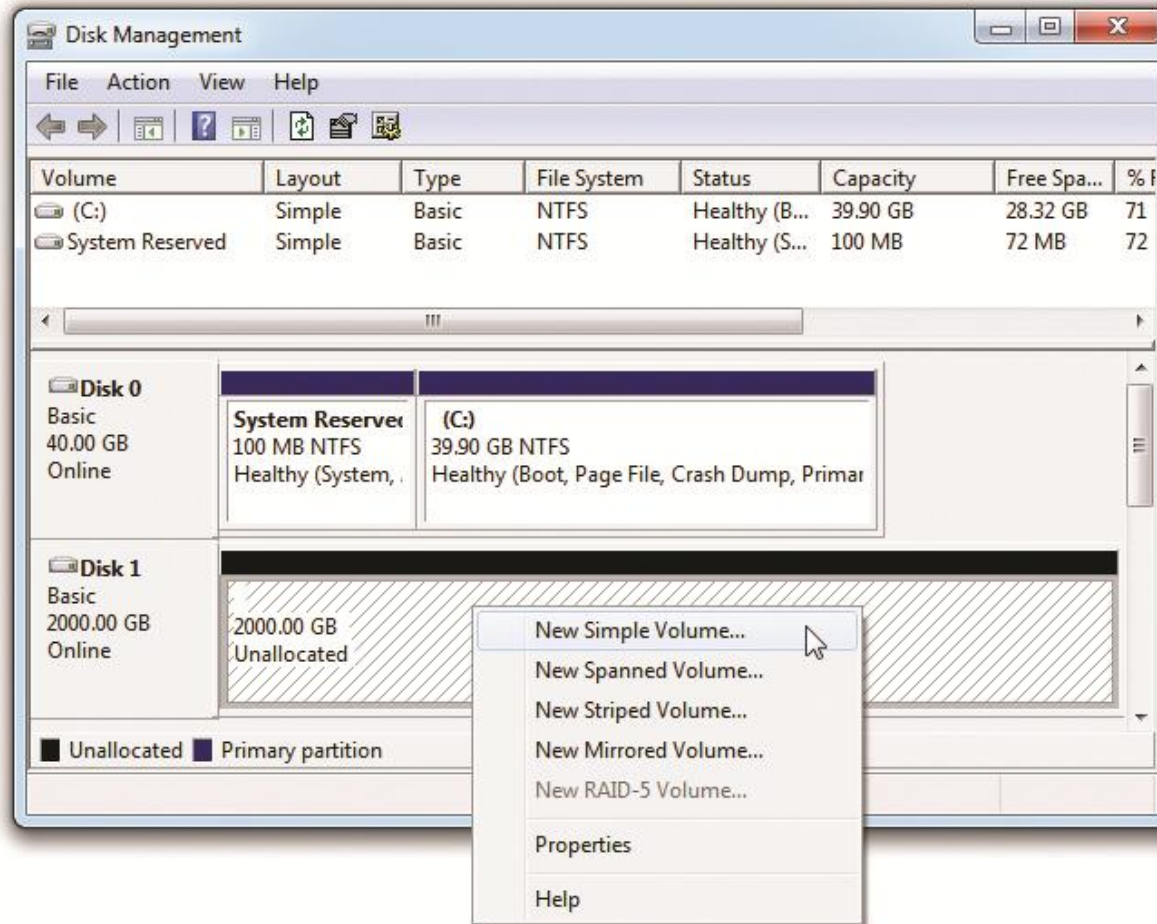


Figure 10: New volume option

Hard Drive Formatting

- **Formatting** configures a partition to hold files and folders suitable to the OS.
- **Two major functions of formatting:**
 - Creates a file system
 - Creates a root directory

File Systems

- **Windows supports four different file systems**
 - FAT (often called FAT16)
 - FAT32
 - FAT64
 - NTFS

File Allocation Table (FAT)

- **File allocation table (FAT)** keeps track of the sectors that store the various parts of a file
- **16-bit FAT (FAT16)** uses 4 hexadecimal digits to number the sectors
 - 0000 thru FFFF
- **FAT is like a two-column spreadsheet**
 - Column one numbers the sectors
 - Column two contains the status of the sector
 - Bad sectors = FFF7
 - Good sectors = 0000
- **Format creates the FAT and then writes to and reads from each sector to see if it is good**

File Allocation Table (FAT) *(continued)*


0000	
0001	
0002	
0003	
0004	
0005	
0006	
	
FFF9	
FFFA	
FFFB	
FFFC	
FFFD	
FFFF	
FFFF	

Figure 11: 16-bit FAT

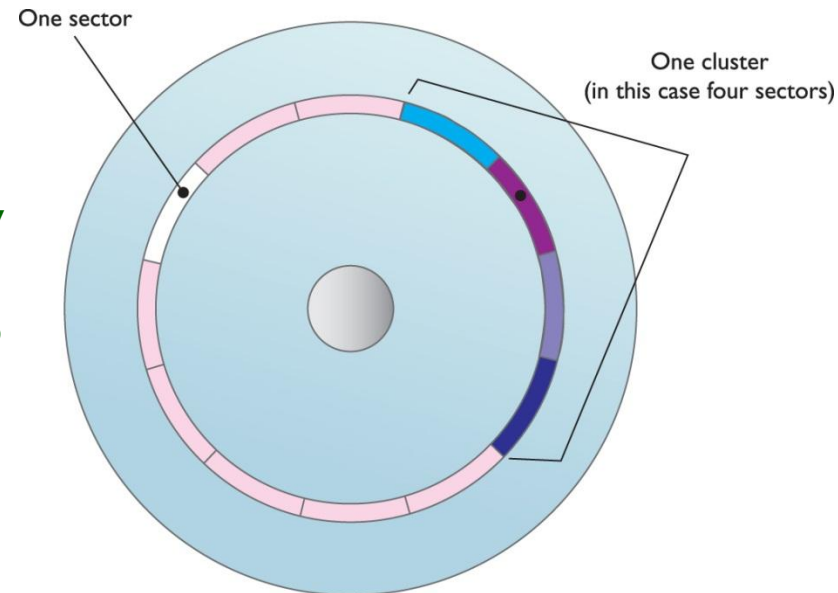
FAT Limitations

- **16 bits can address only 64 K (2^{16}) sectors**
- **Sector sizes limited to 512 bytes**
- **64 K × 512 bytes = 32 MB max. size in early drives**
 - What to do to increase capacity?
- **Solution was **clustering**, enabling partition sizes up to 2 GB**

Clustering

- **Clustering** combines a set of contiguous sectors and treats them as a single unit
- Called a **cluster** or **file allocation unit**
 - Instead of numbering the sectors, clusters were numbered
 - Allowed partition sizes up to 2 GB
- **Size of cluster increases with the size of the partition**

Figure 12: Cluster versus sector



Clustering (*continued*)

If FDISK makes a partition this big:	You'll get this many sectors/cluster:
16 to 127.9 MB	4
128 to 255.9 MB	8
256 to 511.9 MB	16
512 to 1023.9 MB	32
1024 to 2048 MB	64

Table 2: FAT16 Cluster Sizes

How FAT Works

- **Windows looks for the first cluster marked 0000 (good and available)**
- **If the file fits in that cluster, *FFFF* is put in the status column**
- **If the file is larger than the cluster, Windows finds the next open cluster**
 - That open cluster's number is put in the first status field to know where to link
 - Process continues until the file is fully stored
 - Last cluster's status field is marked *FFFF* (end-of-file)

Examples of FAT Storage

Cluster	Status
3ABB	0000
3ABC	0000
3ABD	FFF7
3ABE	0000
3ABF	0000
3AC0	0000
3AC1	0000
3AC2	0000
3AC3	0000
3AC4	0000
3AC5	0000
3AC6	0000
3AC7	0000

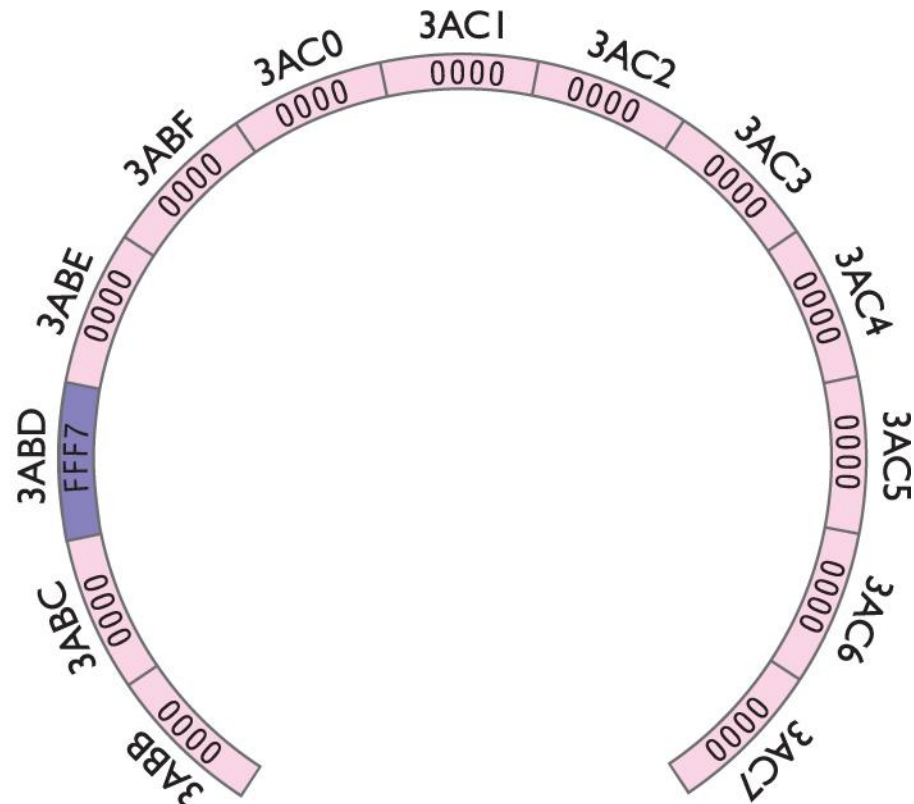


Figure 13: The initial FAT

Examples of FAT Storage *(continued)*

Cluster	Status
3ABB	3ABC — MOM.TXT
3ABC	0000
3ABD	FFF7
3ABE	0000
3ABF	0000
3AC0	0000
3AC1	0000
3AC2	0000
3AC3	0000
3AC4	0000
3AC5	0000
3AC6	0000
3AC7	0000

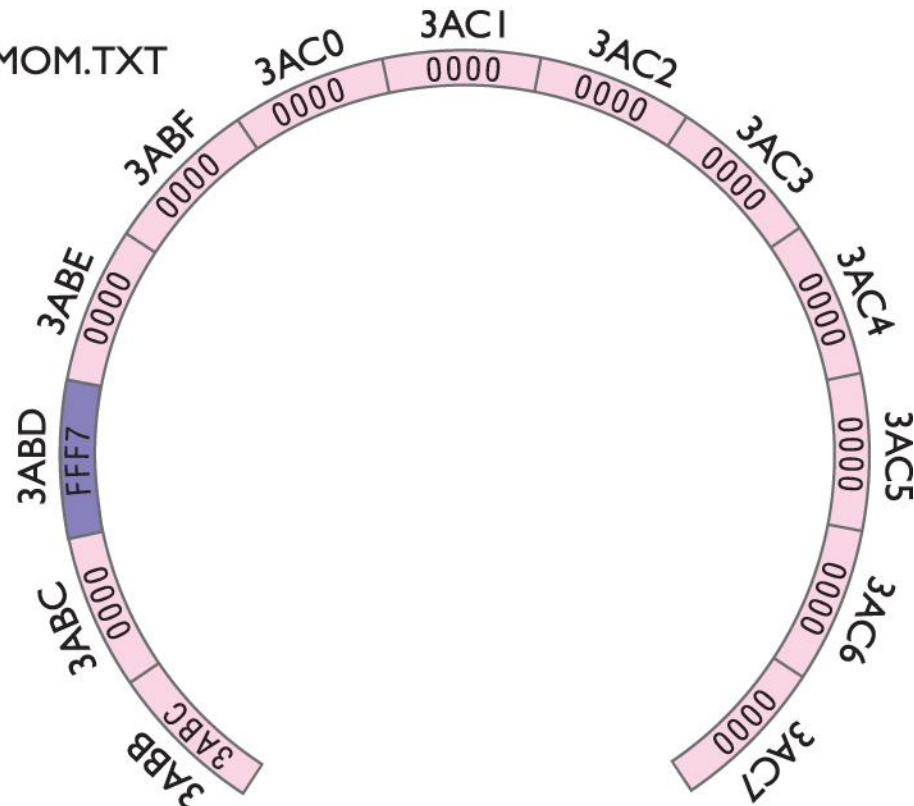


Figure 14: The first cluster used

Examples of FAT Storage *(continued)*

Cluster	Status
3ABB	3ABC
3ABC	3ABE
3ABD	FFF7
3ABE	0000
3ABF	0000
3AC0	0000
3AC1	0000
3AC2	0000
3AC3	0000
3AC4	0000
3AC5	0000
3AC6	0000
3AC7	0000

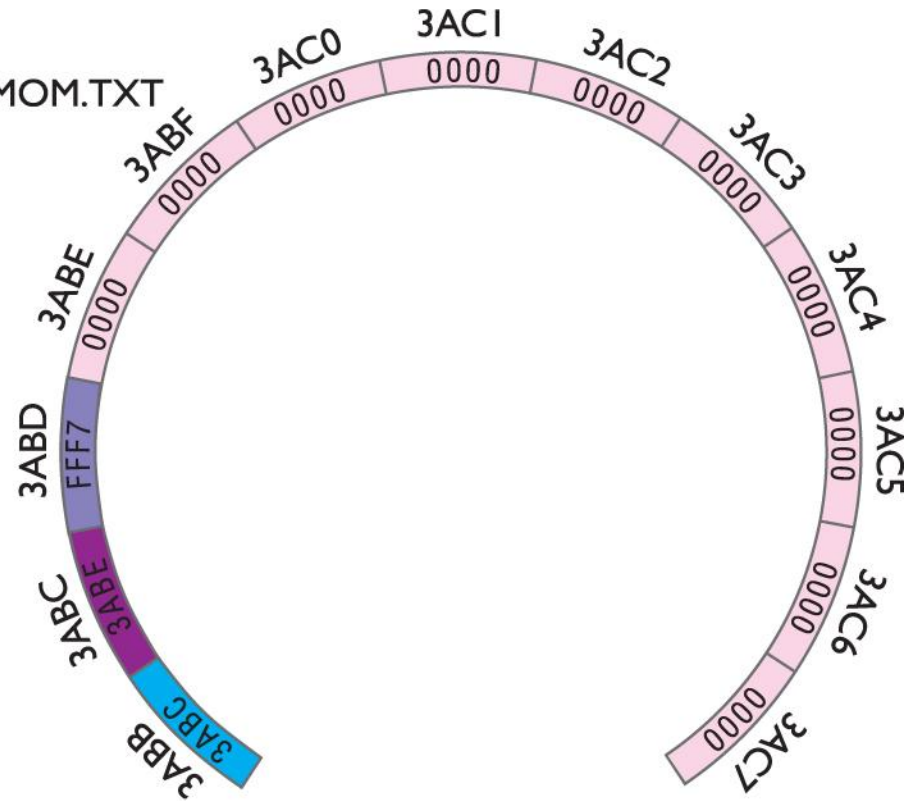


Figure 15: The second cluster used

Examples of FAT Storage *(continued)*

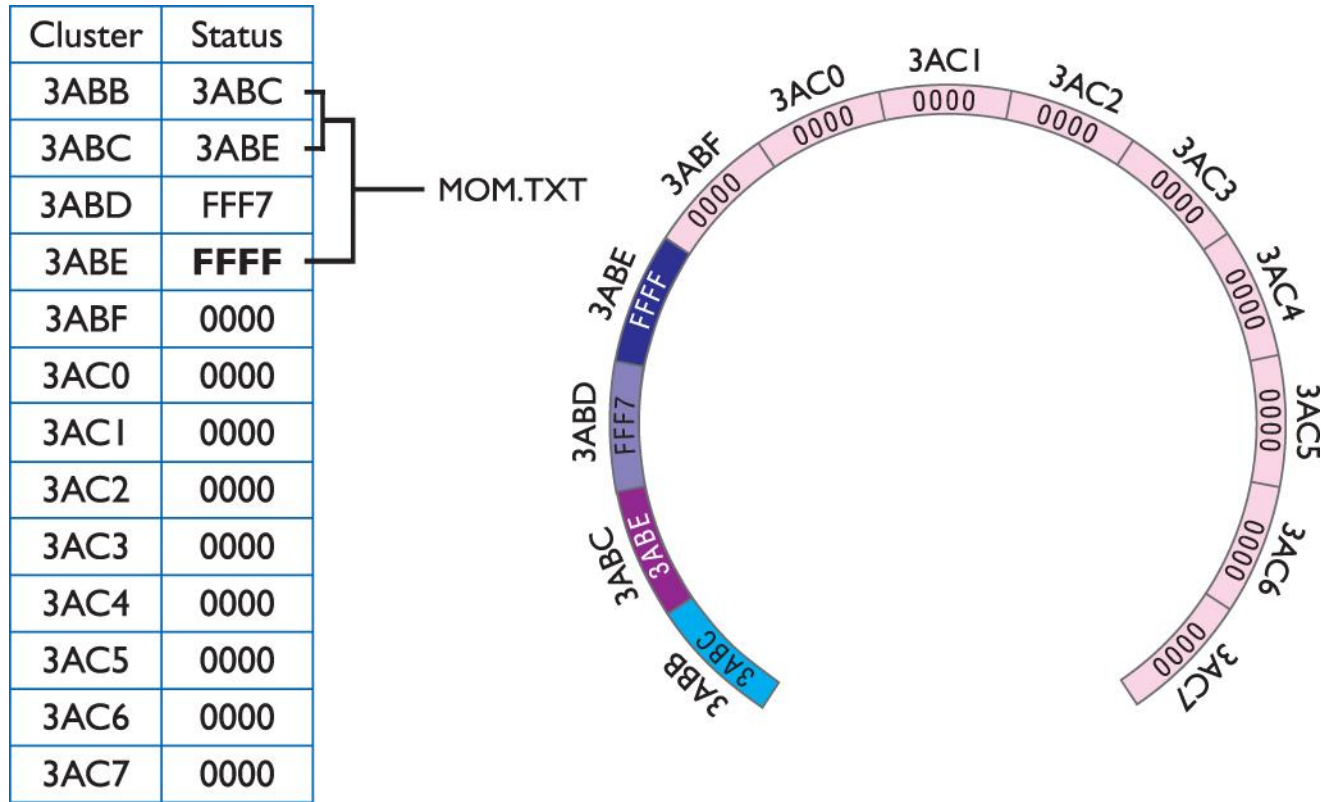


Figure 16: End of file reached

Fragmentation

- **Fragmentation** occurs when files are spread across clusters (not contiguous).
 - Individual files are broken into pieces that fit into a sector or cluster.
 - The pieces are stored on the hard drive but may not be stored in contiguous clusters.
- **Fragmentation slows down the system during hard drive reads and writes.**
- **Programs such as Disk Defragmenter can be used to defragment files, folders, or both.**

Fragmented File

- Takes longer for system to piece together and can impact performance

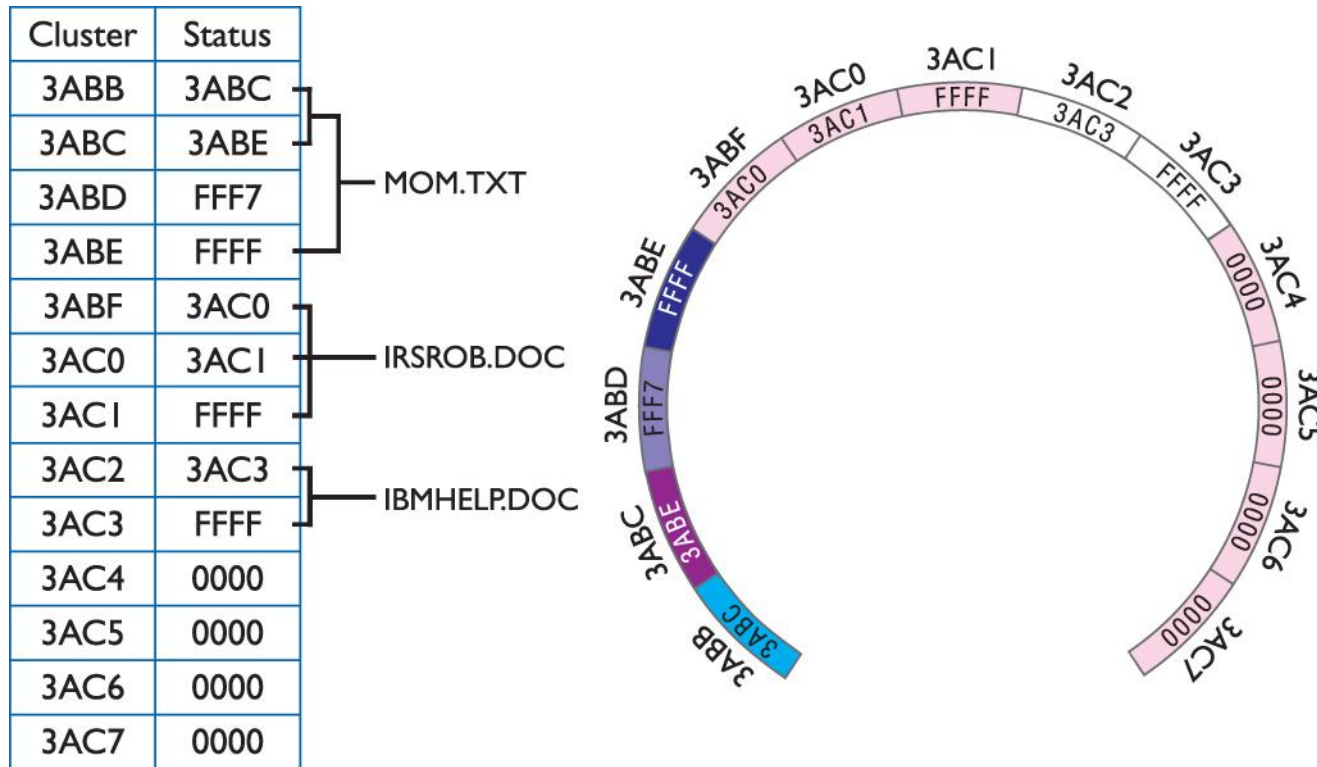


Figure 17: Three files saved

Fragmented File (*continued*)

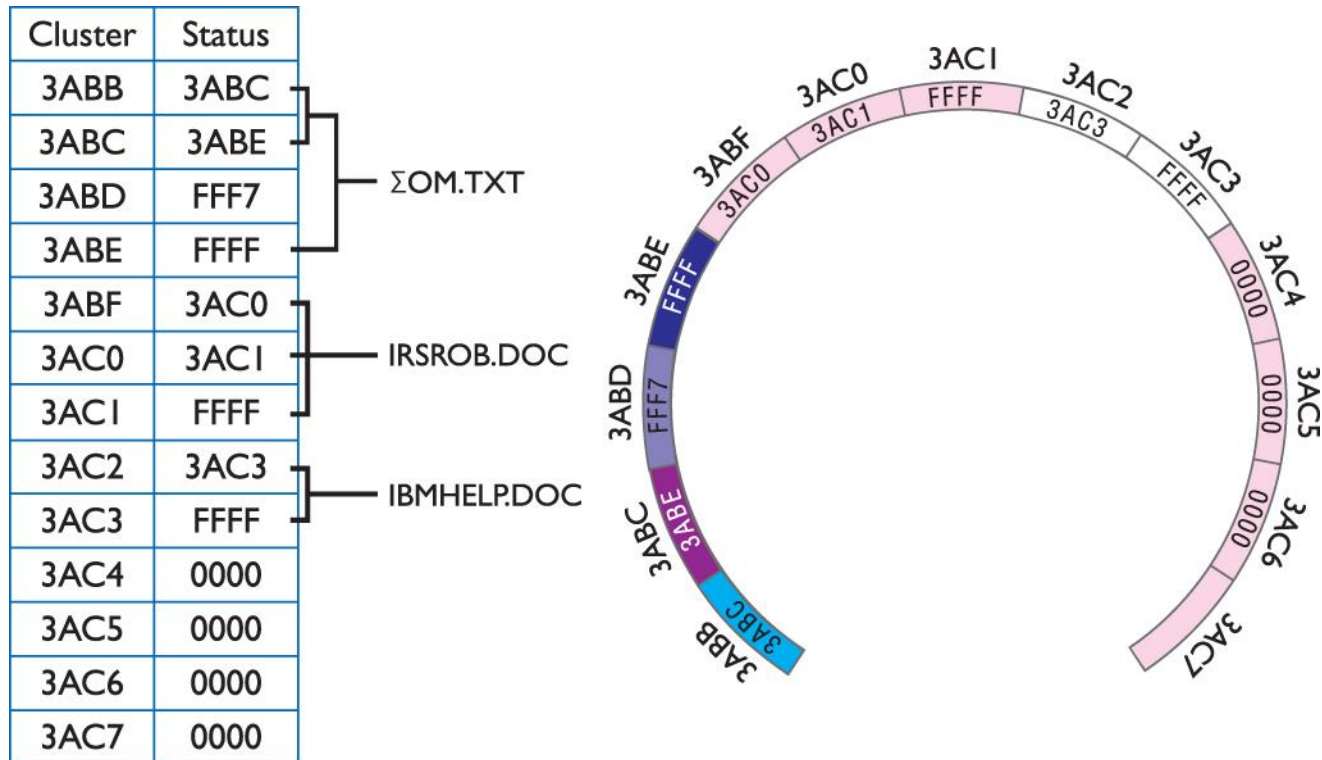


Figure 18: The mom.txt file erased

Fragmented File (continued)

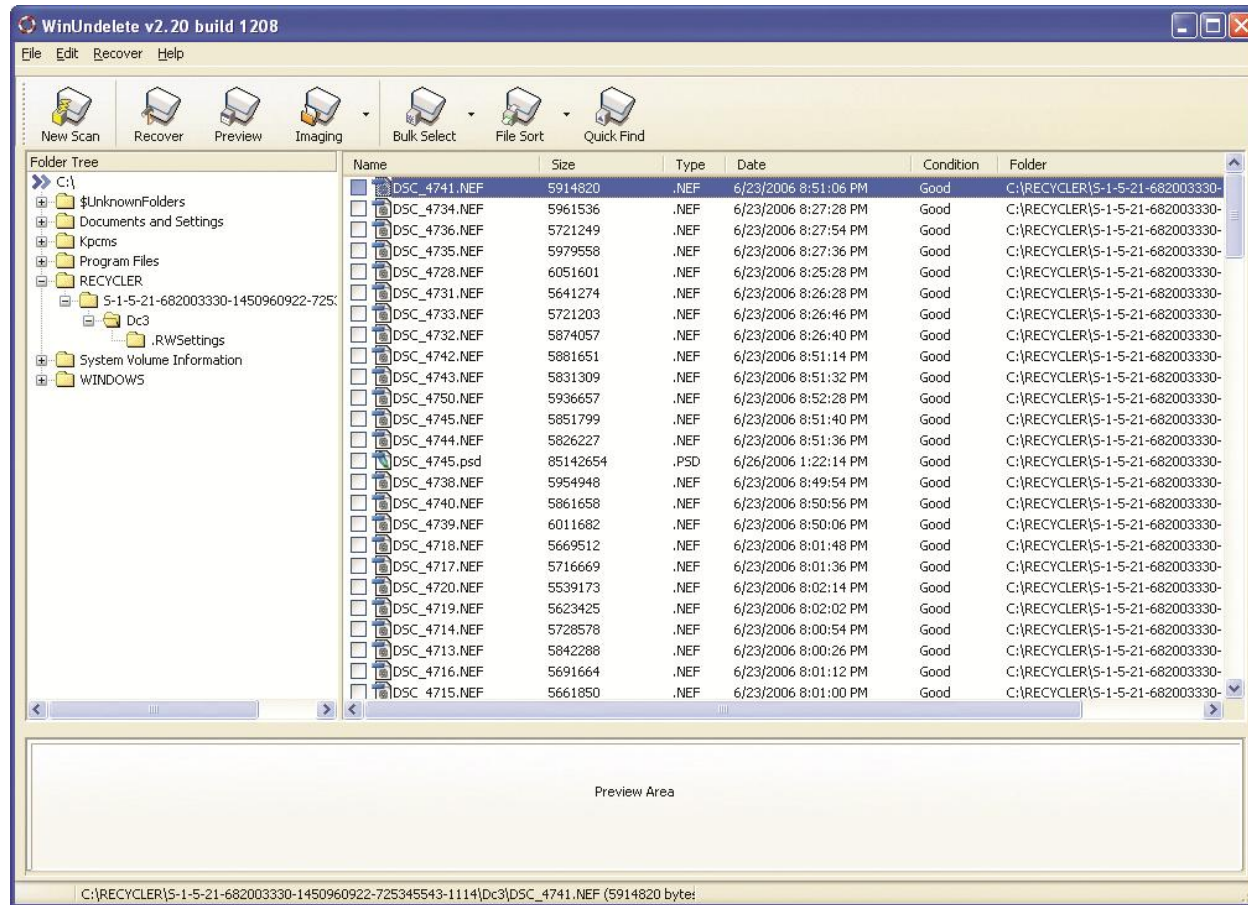


Figure 19: WinUndelete in action

Fragmented File (*continued*)

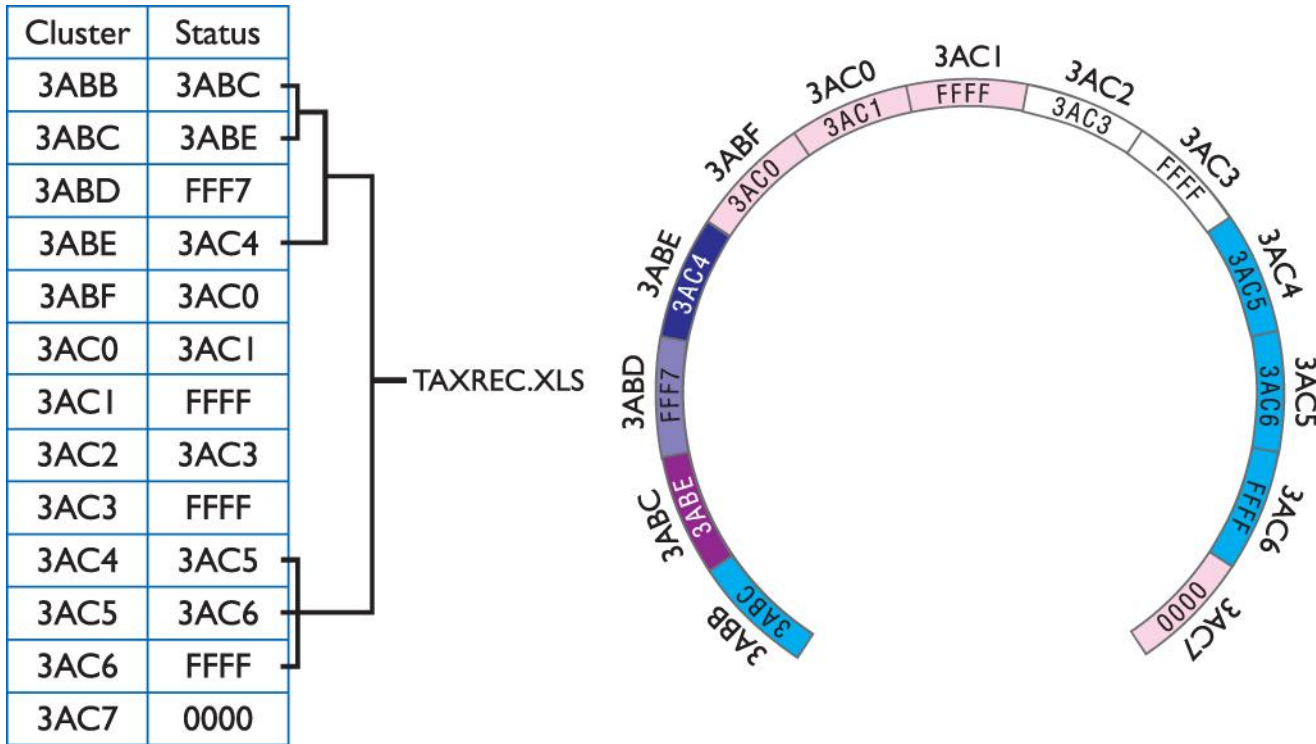


Figure 20: The taxrec.xls file fragmented

Disk Defragmenter

- Can defragment disk

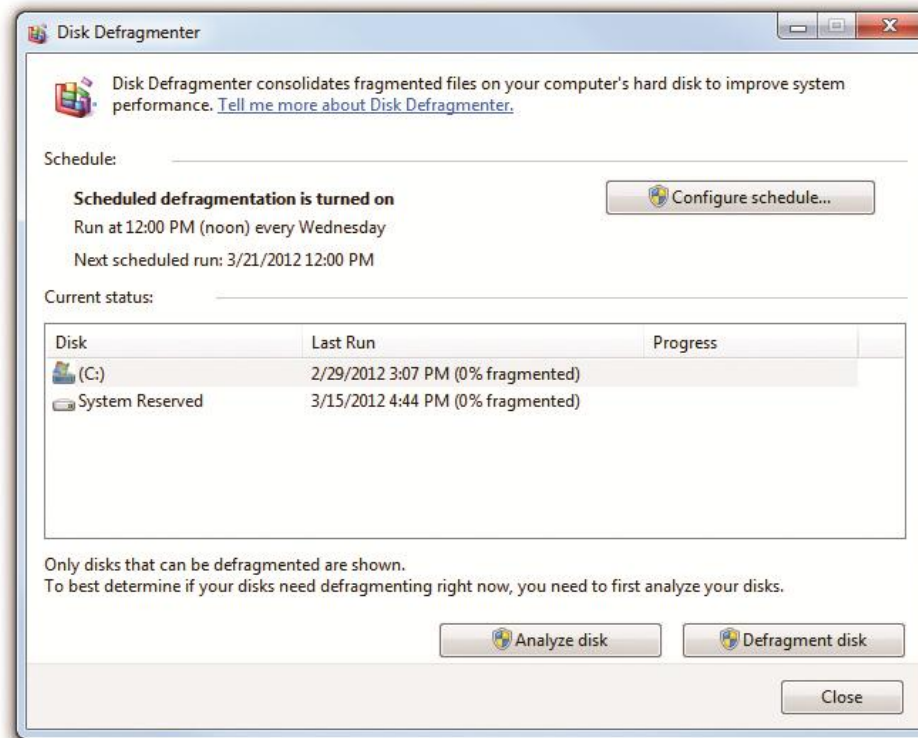


Figure 21: Windows Disk Defragmenter

FAT32

- **FAT32** was introduced with Windows 95 OSR2 (OEM Service Release 2)
- **Supports partitions up to 2 terabytes**
- **Uses 32 bits to describe each cluster**
- **Allows the use of small clusters**
- **Can still become fragmented**

FAT32 (*continued*)

Drive Size	Cluster Size
512 MB or 1023 MB	4 KB
1024 MB to 2 GB	4 KB
2 GB to 8 GB	4 KB
8 GB to 16 GB	8 KB
16 GB to 32 GB	16 KB
>32 GB	32 KB

Table 3: FAT32 Cluster Sizes

NTFS

- **File system of choice today**
- **Six major improvements and refinements**
 - Redundancy
 - Security
 - Compression
 - Encryption
 - Disk quotas
 - Cluster sizing

NTFS Improvements

- **NTFS structure provides redundancy**
 - Uses an enhanced file allocation table called the master file table (MFT)
 - NTFS keeps a backup copy in the middle of the disk
- **Security**
 - Provides file and folder access control
 - Uses Access Control List (ACL) to restrict or grant access

NTFS Improvements (continued)

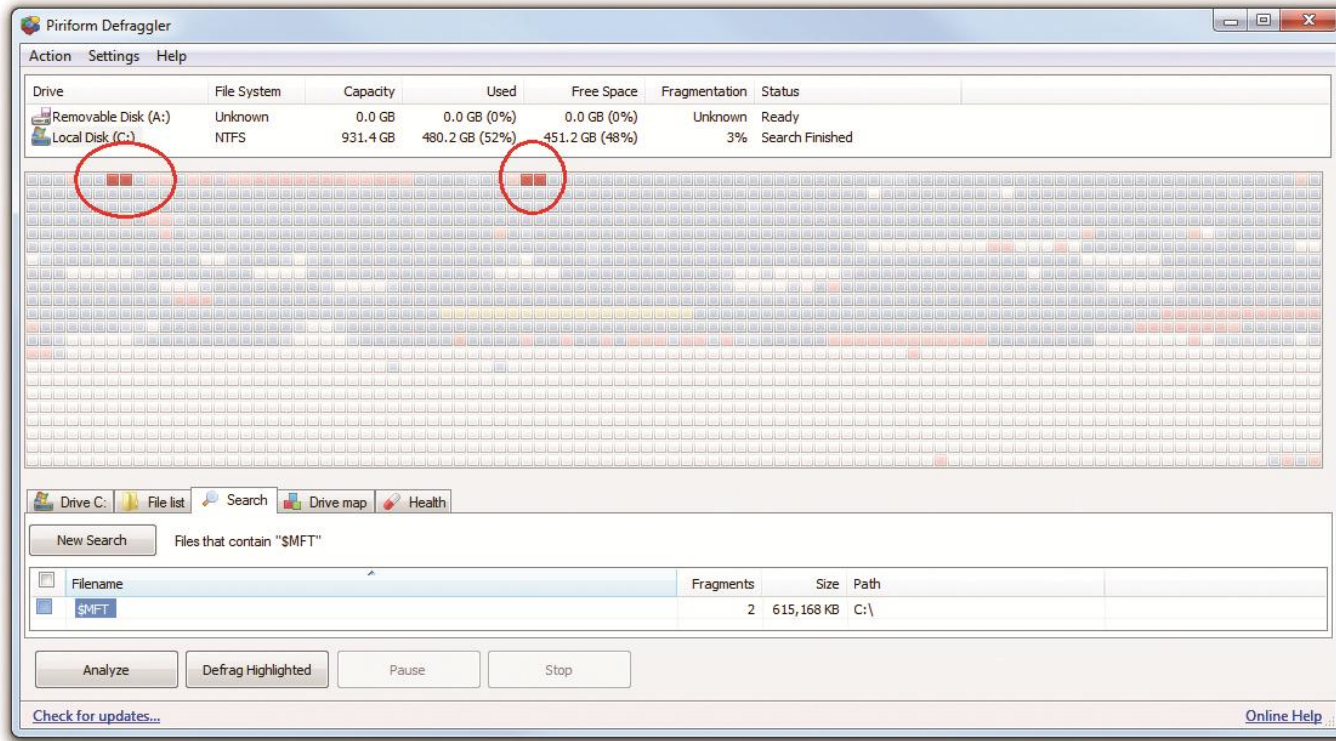


Figure 22: The NTFS MFT appears in a defragmenter program as the highlighted red blocks.

NTFS Improvements (*continued*)

- **Compression**
 - Enables files and folders to be compressed to save space—Windows Explorer displays filenames for compressed files in blue.
- **Encrypting file system (EFS)**
 - Enables files and folders to be encrypted and unreadable to anyone without the key
 - Essentially has **integrated security**
- **Files and folders can be encrypted or compressed**

NTFS Improvements (continued)

- **Disk quotas**
 - Can control how users can use space
 - Set on a per-drive basis
- **Cluster sizes**
 - Can adjust cluster sizes
 - Rare to do so
 - NTFS supports 16 TB minus 64-KB partitions
 - MBR limited to 2 TB so have to go to dynamic disk for full capacity

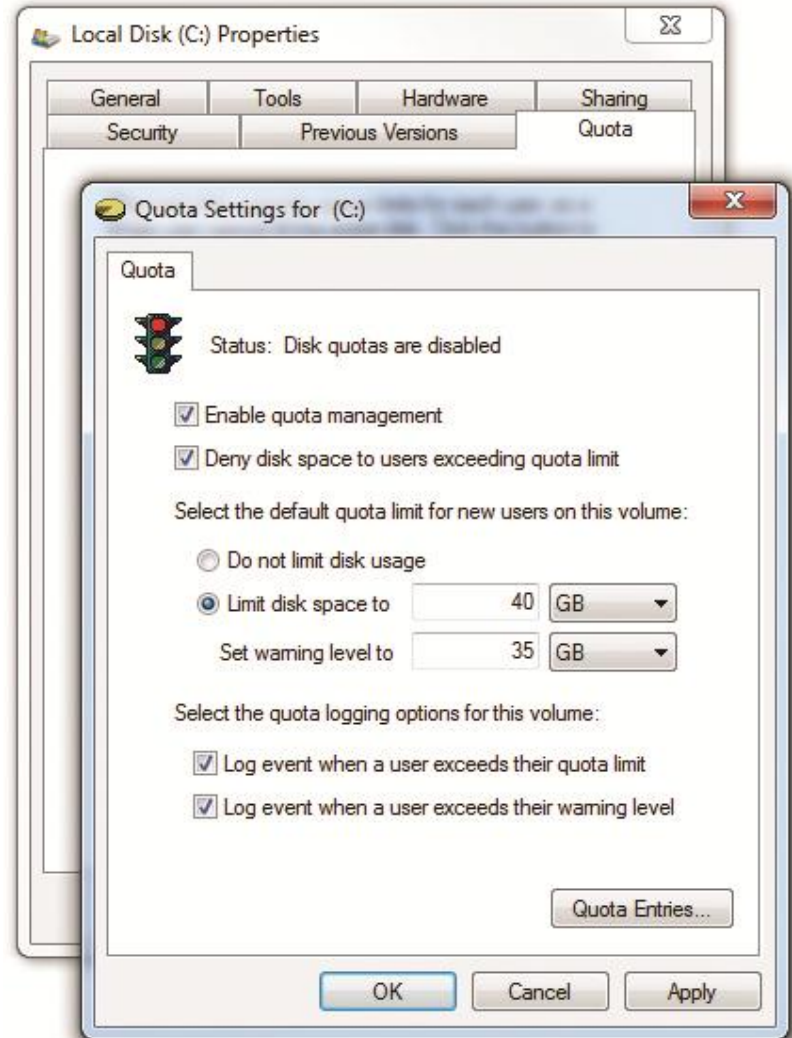


Figure 23: Hard drive quotas in Windows 7

NTFS Improvements (*continued*)

Drive Size	Cluster Size	Number of Sectors
512 MB or less	512 bytes	1
513 MB to 1024 MB (1 GB)	1024 bytes (1 KB)	2
1025 MB to 2048 MB (2 GB)	2048 bytes (2 KB)	4
2049 MB and larger	4096 bytes (4 KB)	8

Table 4: NTFS Cluster Sizes

FAT64

- **FAT64**

- Today's USB drives are considerably larger, so the file system becomes an issue.
- FAT32 does not work on drives larger than 2 TB and limits file size to 4 GB.
- exFAT (or FAT64), breaks the 4-GB file-size barrier, supporting files up to 16 exabytes (EB) and a theoretical partition limit of 64 zettabytes (ZB).
- The exFAT file system extends FAT32 from 32-bit cluster entries to 64-bit cluster entries in the file table, making file structures and storage more efficient.

FAT64 (*continued*)

- **FAT64 (continued)**
 - Like FAT32, FAT64 does not have NTFS features (encryption, compression, etc.).
 - Microsoft introduced exFAT in Windows 7, but Windows Vista with SP1 also supports exFAT. Microsoft has enabled Windows XP support for exFAT with a special download.

FAT64 (continued)

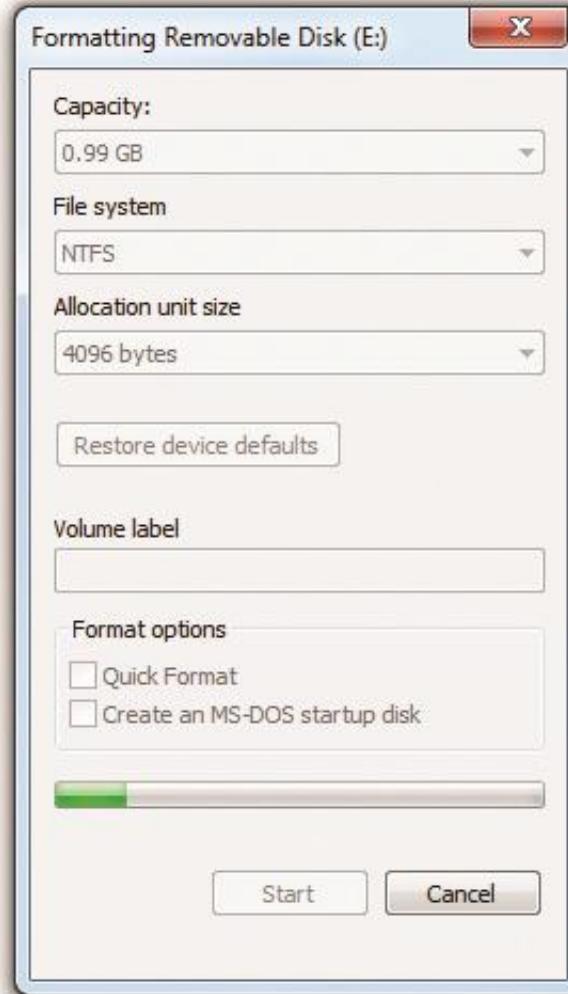


Figure 24: Formatting a thumb drive in Windows 7

The Partitioning and Formatting Process

Bootable Media

- **Any removable media that has a bootable OS installed**
 - Floppy, CD-ROM, USB thumb drive
 - All Windows and Linux installation CDs are bootable
 - Common to create bootable media with tools added

Partitioning and Formatting with the Installation Disc

- **The partitioning and formatting tools differ between Windows XP and Windows Vista/7.**
 - Windows XP has a text-based installation tool.
 - Windows Vista and Windows 7 use a graphical tool.
 - The process of setting up drives is nearly identical.

Partitioning and Formatting with the Installation Disc (*continued*)

- **Partitioning During Windows XP Installation**

- One primary partition is the most common way to set up a hard drive—one large active C: drive
- Text mode of Windows installation has tools to create partitions
 - Can create single partition or multiple partitions—primary and extended
 - Can set size of partitions
 - Can format partitions. Quick formatting does not check drive quality. Regular formatting will try to write and then read from each sector. Bad sectors will be marked.

Partitioning and Formatting with the Installation Disc (*continued*)

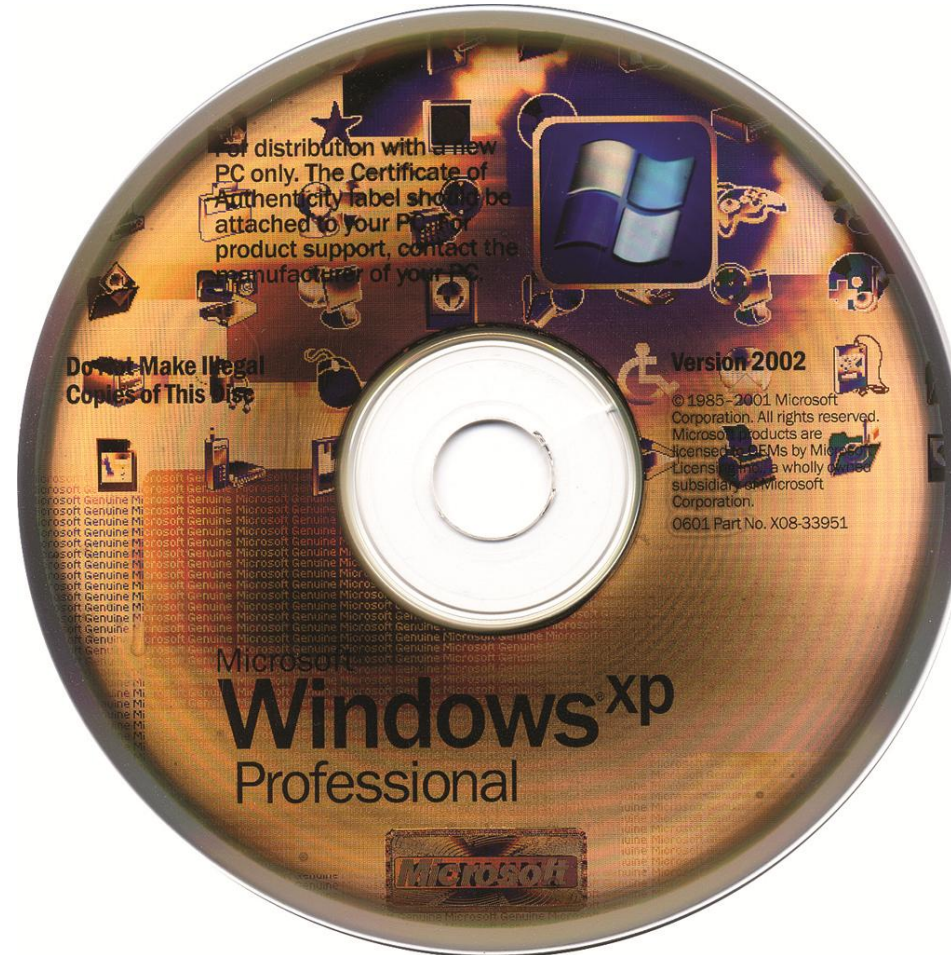


Figure 25: Windows installation CD

Partitioning and Formatting with the Installation Disc (*continued*)

```
Windows XP Professional Setup

Welcome to Setup.

This portion of the Setup program prepares Microsoft(R)
Windows(R) XP to run on your computer.

• To set up Windows XP now, press ENTER.
• To repair a Windows XP installation using
  Recovery Console, press R.
• To quit Setup without installing Windows XP, press F3.

ENTER=Continue  R=Repair  F3=Quit
```

Figure 26: Welcome to Setup

Partitioning and Formatting with the Installation Disc (*continued*)

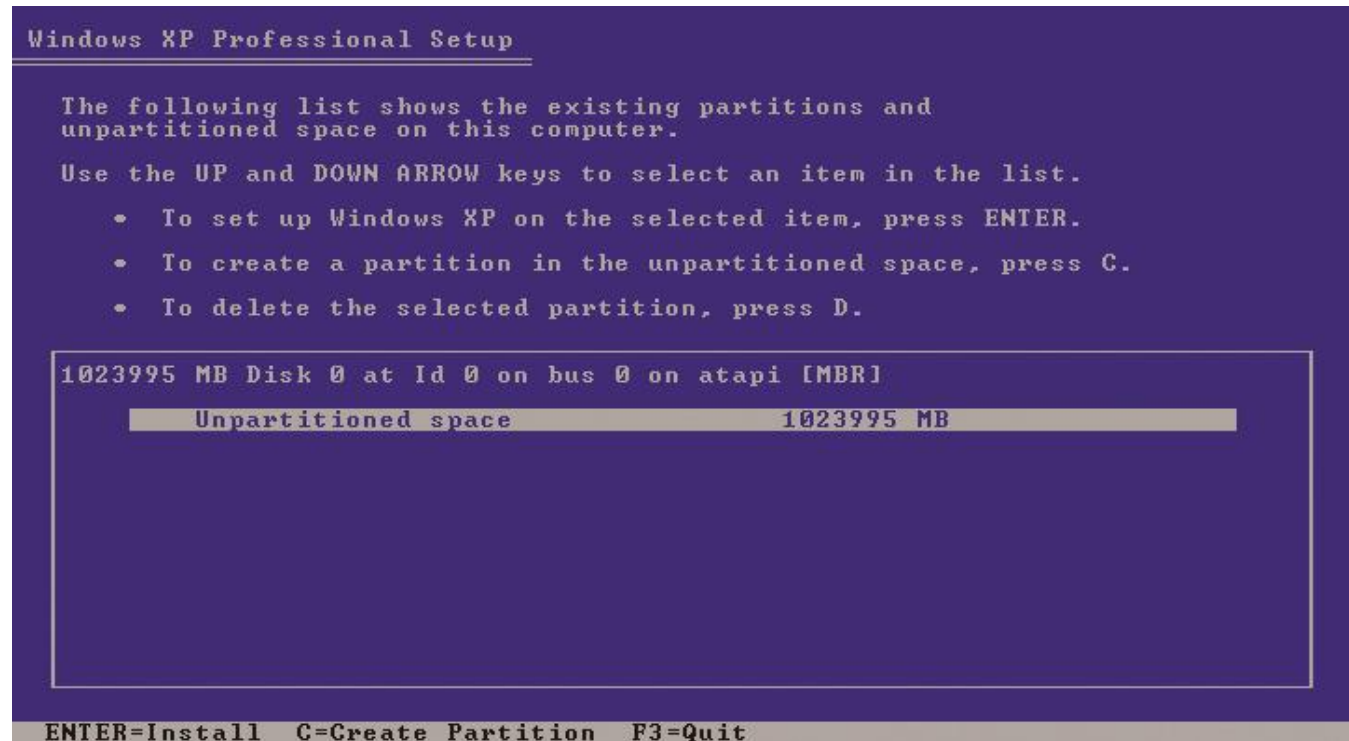


Figure 27: Partitioning screen

Partitioning and Formatting with the Installation Disc (*continued*)

```
Windows XP Professional Setup

You asked Setup to create a new partition on
1023995 MB Disk 0 at Id 0 on bus 0 on atapi [MBR].

• To create the new partition, enter a size below and
  press ENTER.

• To go back to the previous screen without creating
  the partition, press ESC.

The minimum size for the new partition is      8 megabytes (MB).
The maximum size for the new partition is 1023987 megabytes (MB).
Create partition of size (in MB): 1023987
```

ENTER=Create ESC=Cancel

Figure 28: Setting partition size

Partitioning and Formatting with the Installation Disc (*continued*)

```
Windows XP Professional Setup

The following list shows the existing partitions and
unpartitioned space on this computer.

Use the UP and DOWN ARROW keys to select an item in the list.

• To set up Windows XP on the selected item, press ENTER.
• To create a partition in the unpartitioned space, press C.
• To delete the selected partition, press D.

1023995 MB Disk 0 at Id 0 on bus 0 on atapi [MBR]
C: Partition1 [New <Raw>]          340989 MB < 340989 MB free>
  Unpartitioned space              683006 MB

ENTER=Install  D=Delete Partition  F3=Quit
```

Figure 29: A newly created partition along with unpartitioned space

Partitioning and Formatting with the Installation Disc (*continued*)

```
Windows XP Professional Setup

A new partition for Windows XP has been created on
1023995 MB Disk 0 at Id 0 on bus 0 on atapi [MBR].

This partition must now be formatted.

From the list below, select a file system for the new partition.
Use the UP and DOWN ARROW keys to select the file system you want,
and then press ENTER.

If you want to select a different partition for Windows XP,
press ESC.

Format the partition using the NTFS file system <Quick>
Format the partition using the NTFS file system

ENTER=Continue  ESC=Cancel
```

Figure 30: Format screen

Partitioning and Formatting with the Installation Disc (*continued*)

```
Windows XP Professional Setup

You asked Setup to delete the partition

  E:  Partition3 [New <Raw>]           340989 MB < 340989 MB free>
on 1023995 MB Disk 0 at Id 0 on bus 0 on atapi [MBR].

• To delete this partition, press L.
  CAUTION: All data on this partition will be lost.

• To return to the previous screen without
  deleting the partition, press ESC.

L=Delete  ESC=Cancel
```

Figure 31: Option to delete partition

Partitioning and Formatting with the Installation Disc (*continued*)

- **Partitioning During Windows Vista/7 Installation**
 - The partitioning and formatting process in Vista/7 installations differs from the Windows XP process primarily in looks (it's graphical)—not in function.
 - The most common partitioning and formatting option is a single C: partition, making it active, and formatting it as NTFS. Note that Windows 7 creates two partitions, a 100-MB System Reserved partition and the C: partition.

Partitioning and Formatting with the Installation Disc (*continued*)

- **Partitioning During Windows Vista/7 Installation (continued)**
 - If you want to do any custom partitioning or delete existing partitions, you click on Drive options (advanced) in the “Where do you want to install Windows?” dialog box.
 - To create a new partition, click the New button and specify the size.
 - Windows Vista and Windows 7 can read FAT and FAT32 drives, but they won't install to a FAT partition by default.

Partitioning and Formatting with the Installation Disc (*continued*)



Figure 32: Starting the Windows 7 installation

Partitioning and Formatting with the Installation Disc (*continued*)

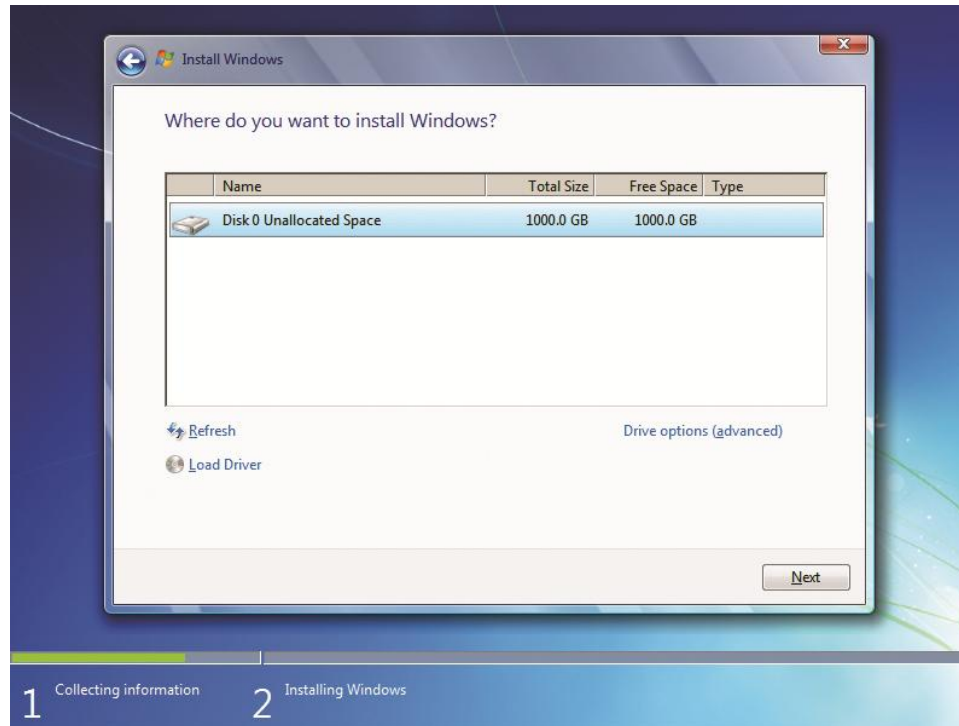


Figure 33: Where do you want to install Windows?

Partitioning and Formatting with the Installation Disc (*continued*)

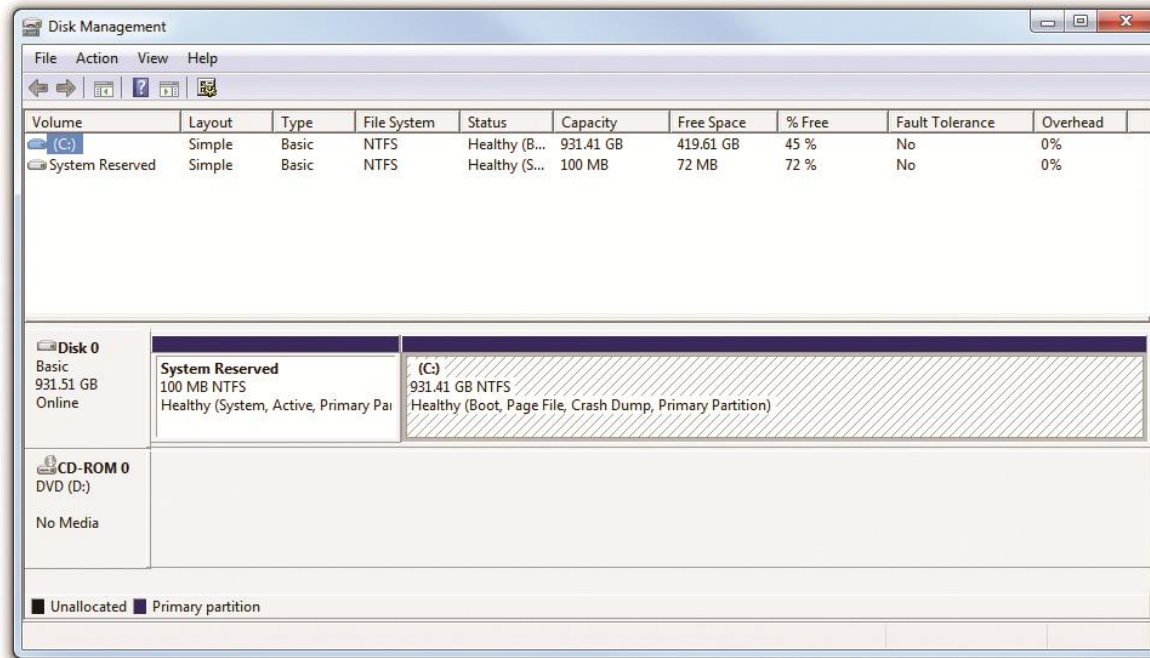


Figure 34: Disk Management showing the default partitions in Windows 7

Partitioning and Formatting with the Installation Disc (*continued*)

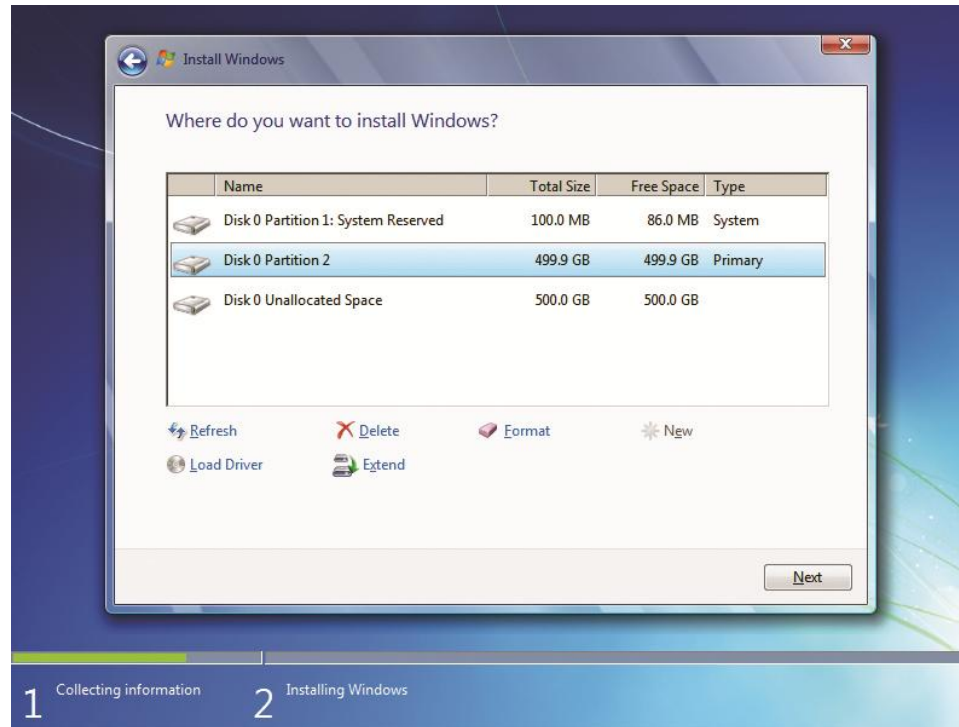


Figure 35: New 499-GB partition with 100-MB System Reserved partition and unallocated space

Disk Management

- **Disk Management—primary tool for partitioning and formatting drives after installation**
- **Part of computer management**
- **The Microsoft Management Console (MMC) snap-in can be accessed directly with diskmgmt.msc**

Disk Management (*continued*)

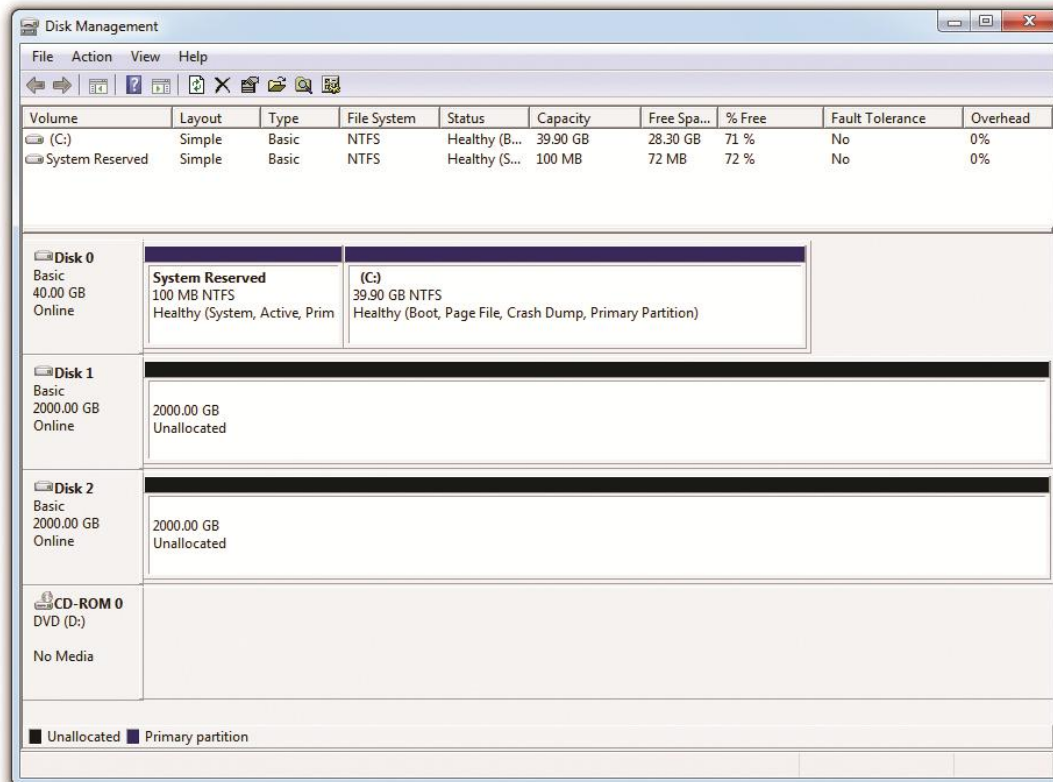


Figure 36: Disk Management

Disk Management (*continued*)

- **Disk initialization**

- Includes special information placed on a hard drive that identifies the hard drive and membership in different types of arrays
- To initialize a disk, right-click the icon and select Initialize.
- All drives must be initialized before you can use them.
- In Windows 7 you will get the option to select MBR or GPT as a partition style.

Disk Management (*continued*)

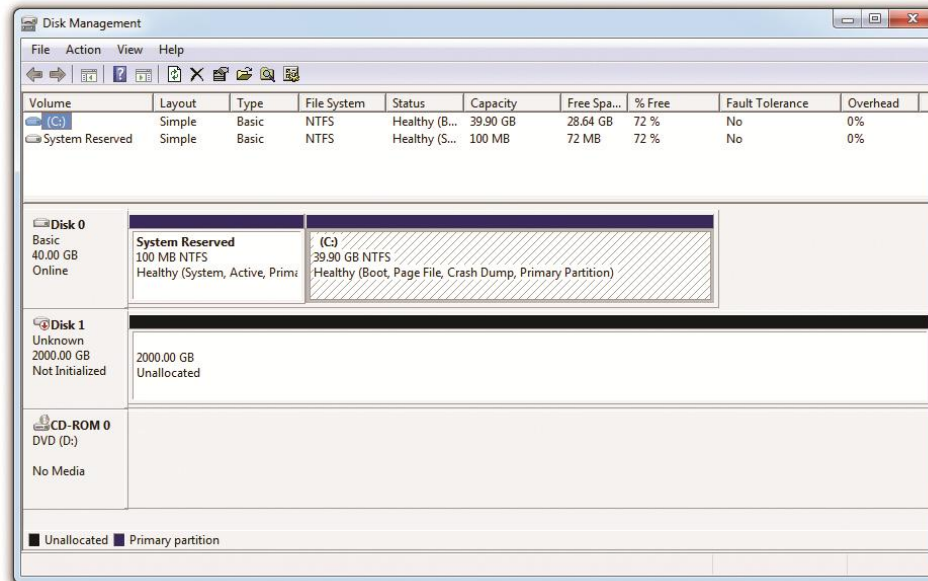


Figure 37: Unknown drive in Disk Management

Disk Management (*continued*)

- **You can view the status of a drive in Disk Management:**
 - Healthy: just what it sounds like
 - Unallocated: space with no partition
 - Active: potentially bootable partition
 - Foreign drive: unknown dynamic disk
 - Formatting: drive is in the process of being formatted
 - Failed: indicates a drive has died or a drive has been part of a RAID array that's now broken
 - Online: normal, working drive
 - Offline: corrupted drive or problem with communicating with drive

Disk Management (*continued*)

- **Creating partitions and volumes in Disk Management:**
 - To create partitions or volumes, right-click the unallocated part of the drive and select New Partition in Windows XP or New Simple Volume in Windows Vista/7.
 - Disk Management runs the New Partition Wizard or the New Simple Volume Wizard.
 - In Windows XP, you'll be asked to select a primary partition or an extended partition. After that, you will specify the partition or volume size.

Disk Management (*continued*)

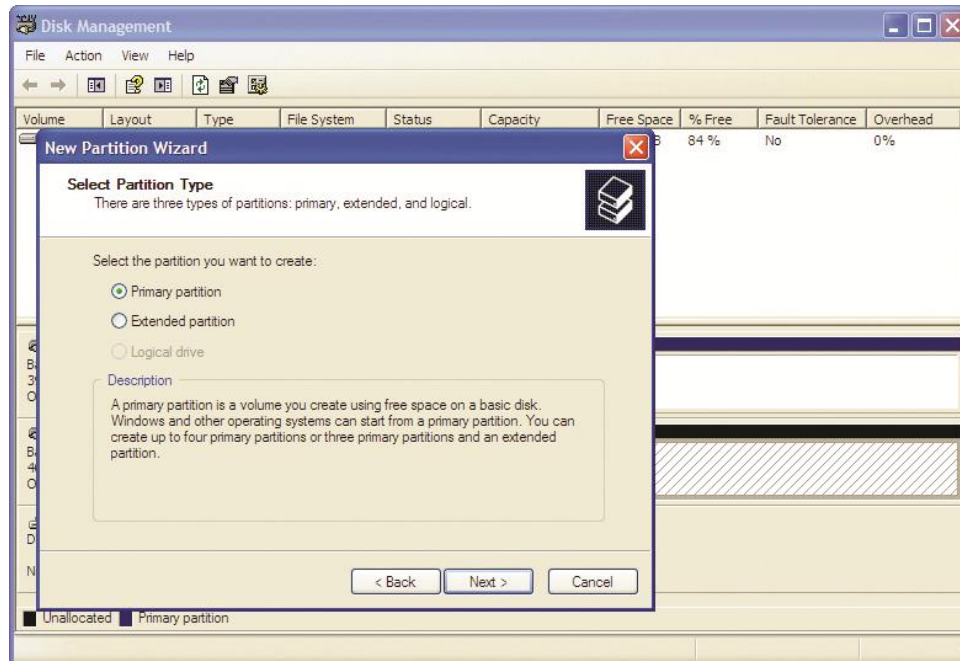


Figure 38: The New Partition Wizard in Windows XP at the Select Partition Type dialog box

Disk Management (*continued*)

- **Creating partitions and volumes in Disk Management (continued):**
 - Because Windows Vista and Windows 7 don't give you the option to specify whether you want primary or extended partitions, you'll go straight to the sizing screen.
 - Specify partition or volume size and click Next. You will choose whether you want to assign a drive letter to the partition or volume, mount it as a folder to an existing partition or volume, or do neither.

Disk Management (*continued*)

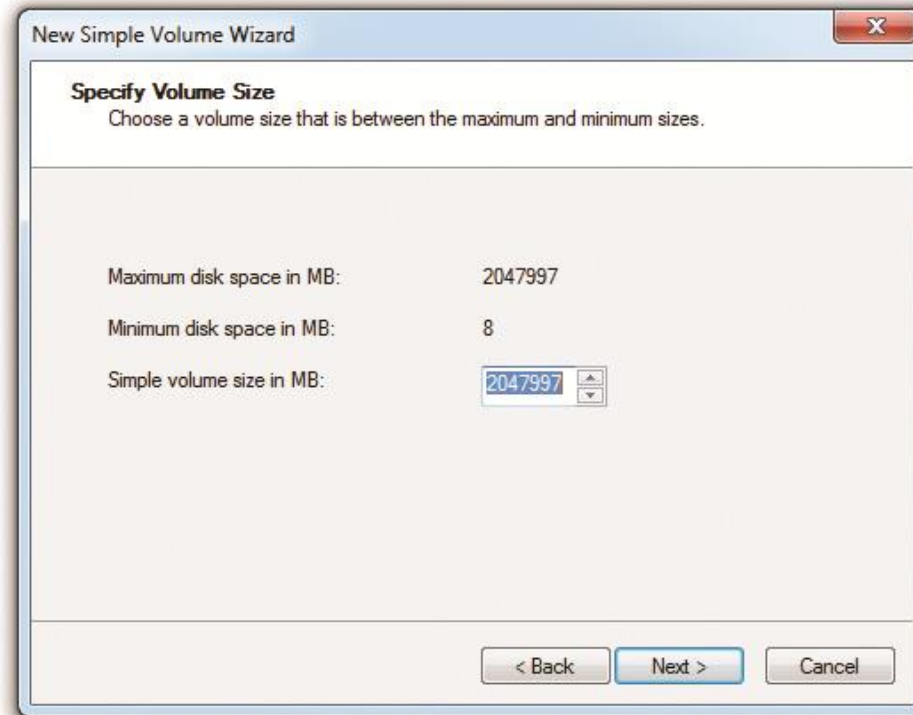


Figure 39: Specifying the simple volume size in the New Simple Volume Wizard

Disk Management (*continued*)

- **Creating partitions and volumes in Disk Management (continued):**
 - Note that Windows Vista and Windows 7 do not enable you to specify whether you want a primary or extended partition when you create a volume. The first three volumes you create will be primary partitions. Every volume thereafter will be a logical drive in an extended partition.

Disk Management (*continued*)

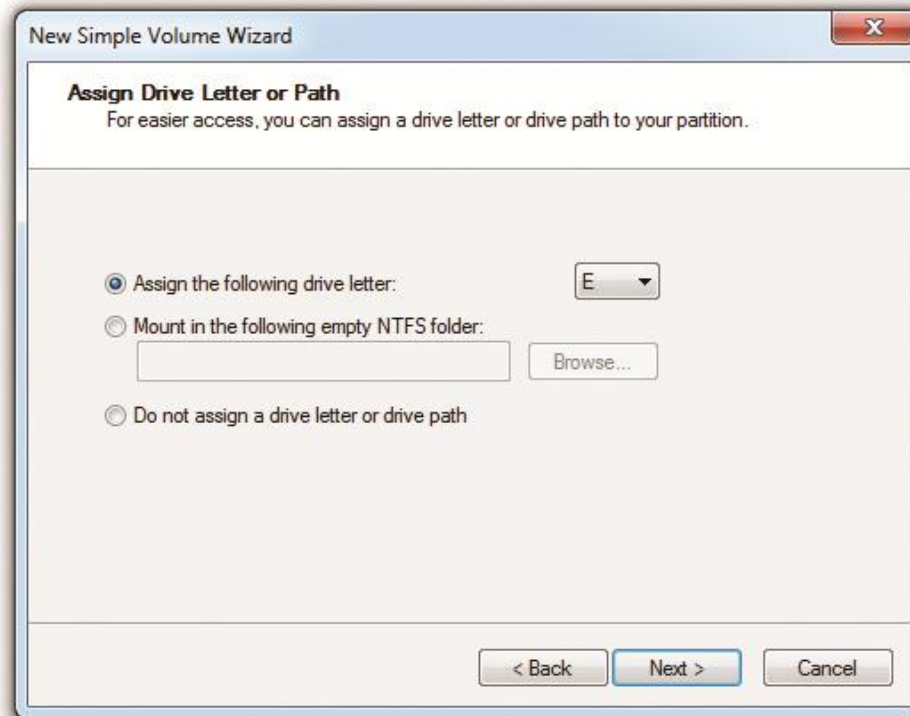


Figure 40: Assigning a drive letter to a partition

Disk Management (*continued*)

- **Formatting—the last screen asks for the format type**
 - If the partition is less than 4 GB, you can choose FAT, FAT32, or NTFS.
 - If the partition is 4 GB to 32 GB, you can choose FAT32 or NTFS.
 - If the partition is > 32 GB, you can choose only NTFS. While FAT32 supports partitions up to 2 TB, Microsoft supports FAT32 partitions only up to 32 GB.

Disk Management (*continued*)

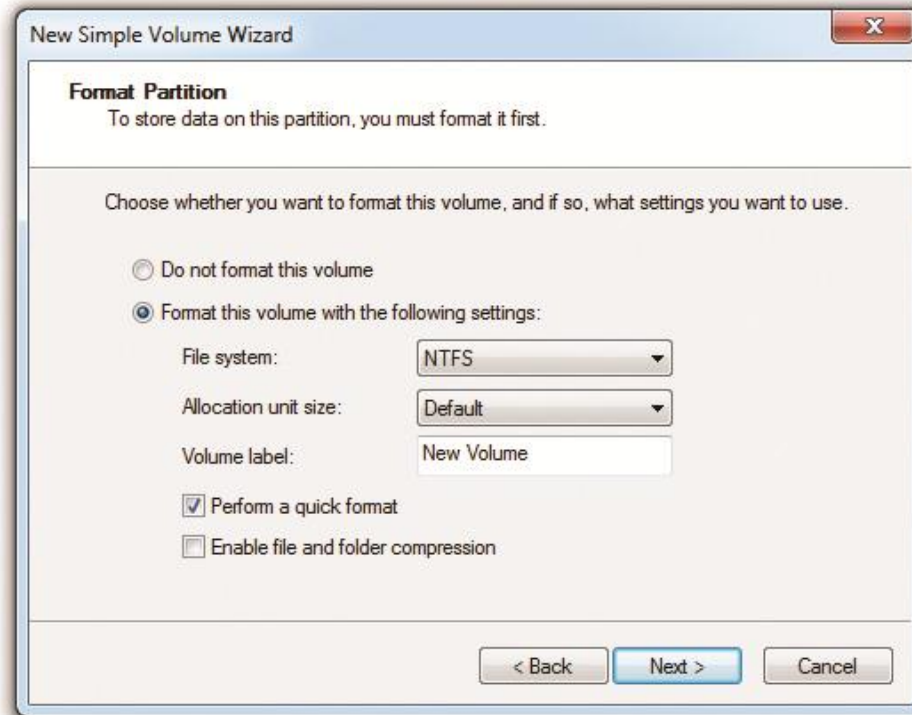


Figure 41: Choosing a file system type

Disk Management (*continued*)

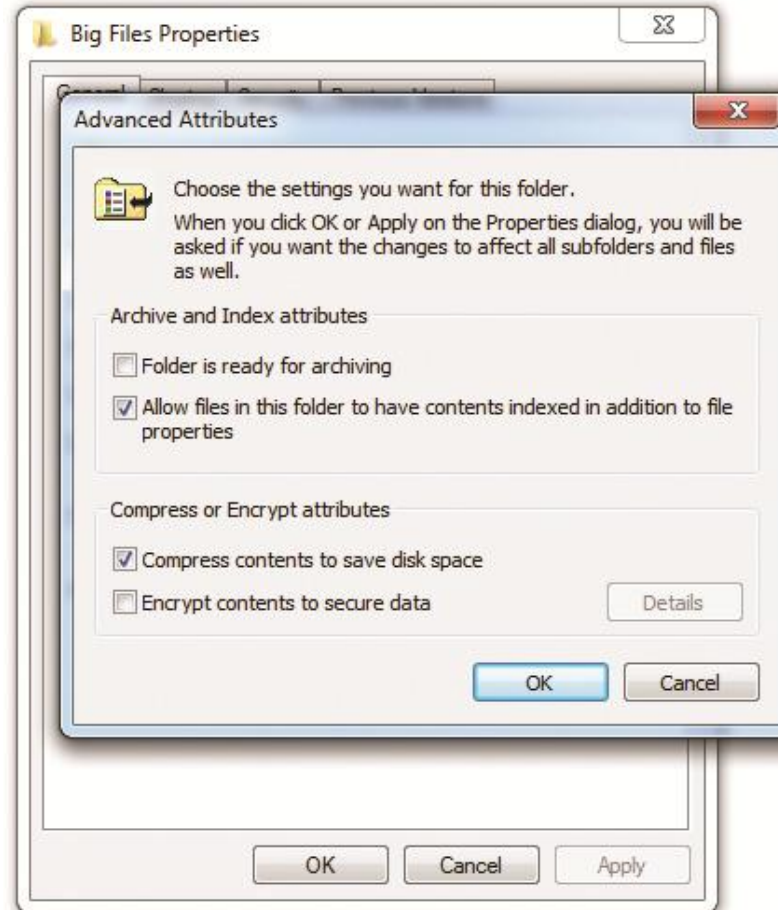


Figure 42: Turning on compression

Dynamic Disks

- **Windows 2000 and newer OSs use the Disk Management tool to offer an improved kind of disk partition called a *dynamic disk*.**
 - Regular drives are called basic disks.
 - A dynamic disk enables you to enlarge partitions without first deleting the partitions or losing data.

Dynamic Disks (continued)

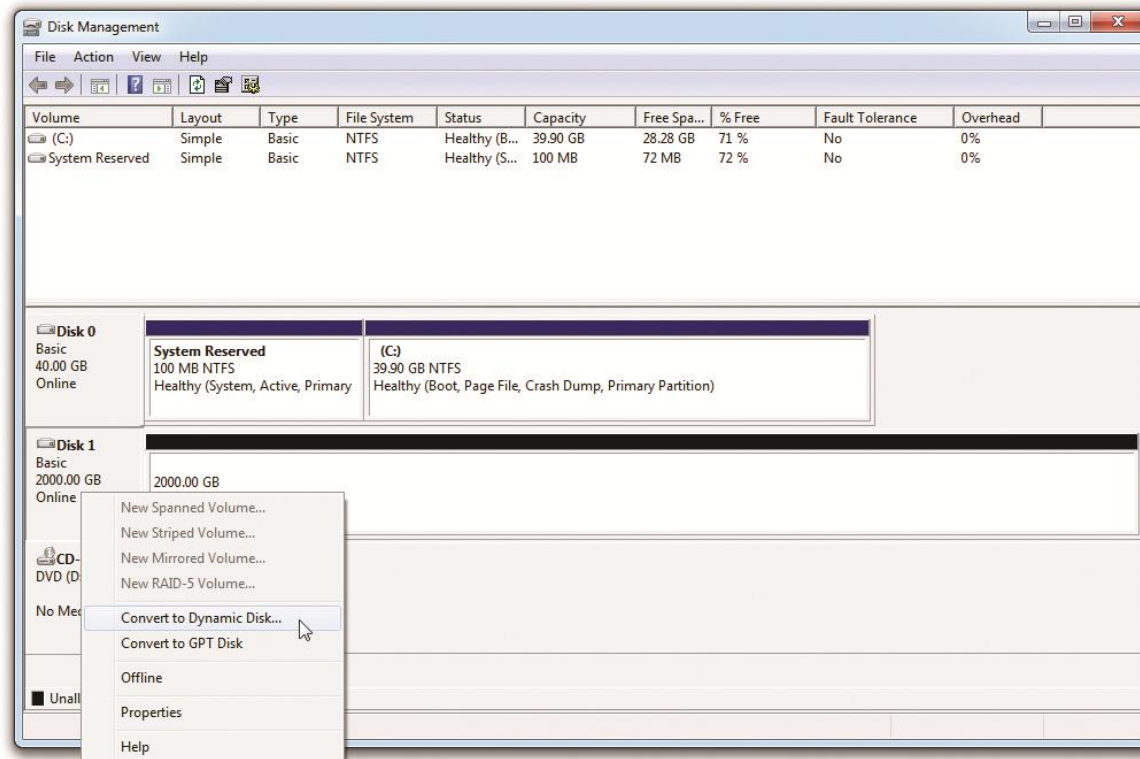


Figure 43: Converting to a dynamic disk

Dynamic Disks (*continued*)

- **Dynamic disks do not contain primary and extended partitions. Instead, they are divided into volumes. Dynamic disks support several types of volumes:**
 - Simple volume—acts just like a primary partition
 - Spanned volume—spans a volume across multiple physical disks
 - Extend a volume—extends a partition on a single drive, but only into unallocated space

Dynamic Disks (continued)

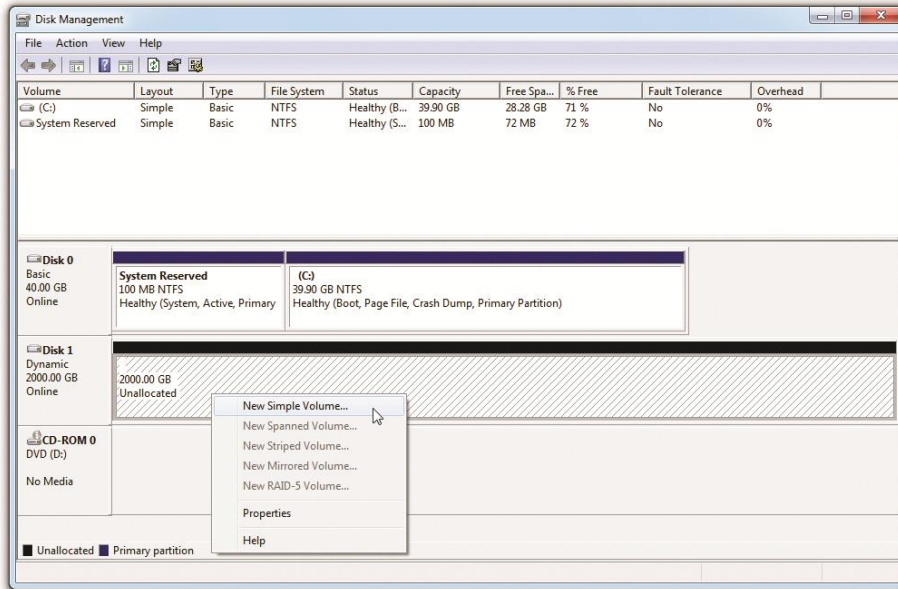
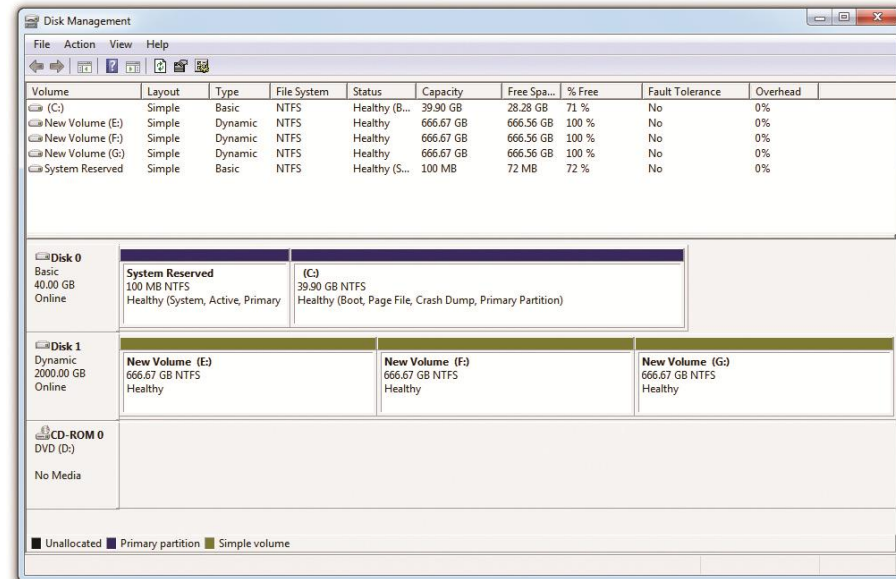


Figure 44: Selecting to open the New Simple Volume Wizard

Figure 45: Simple volumes



Dynamic Disks (continued)

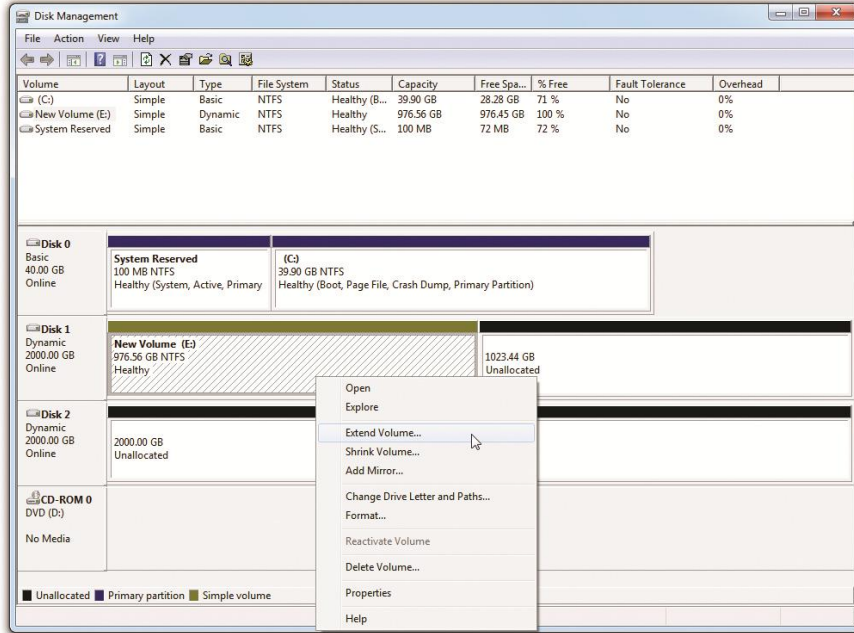
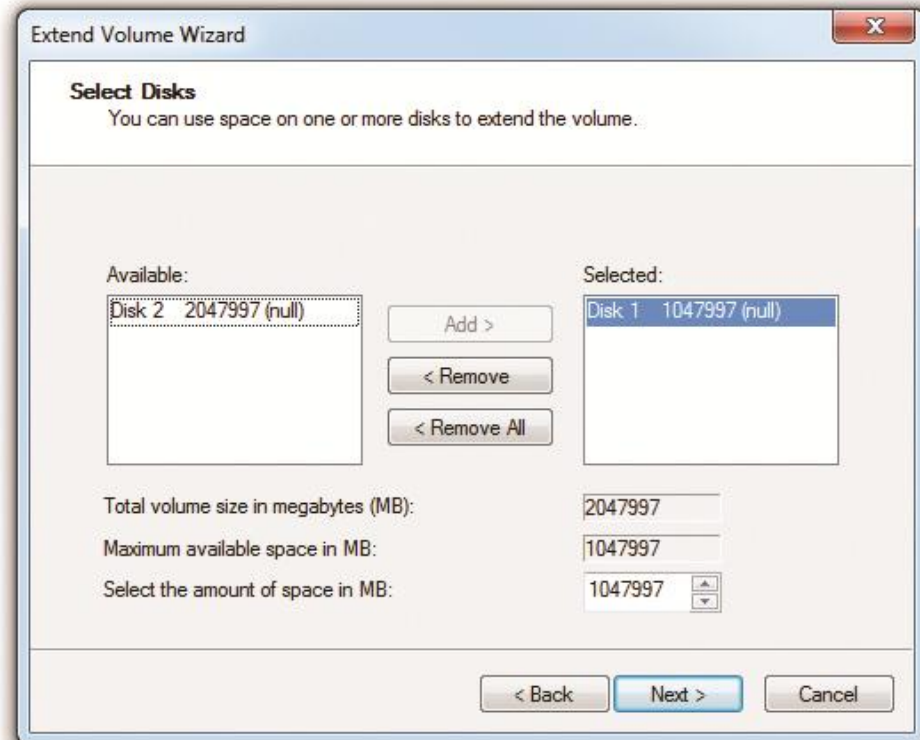


Figure 46: Selecting the Extend Volume option

Figure 47: The Extend Volume Wizard



Dynamic Disks (continued)

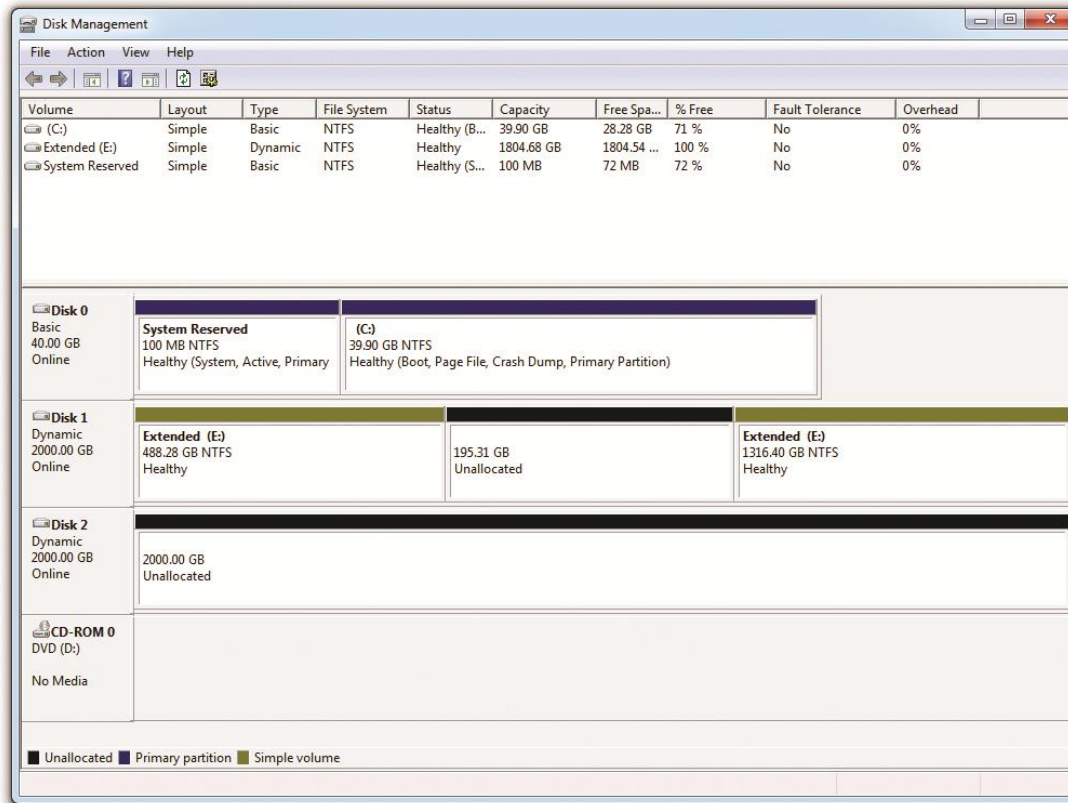


Figure 48: Extended volume

Dynamic Disks (*continued*)

- **Dynamic disk volumes (continued):**
 - Striped volume—two or more dynamic disks that spread out blocks of each file across multiple disks. All the disks make up a striped set. This is a RAID 0 array.
 - Mirrored volume—Windows 7 Professional, Enterprise, and Ultimate editions can create a mirror set with two drives for data redundancy. Mirrors are RAID 1.

Dynamic Disks (continued)

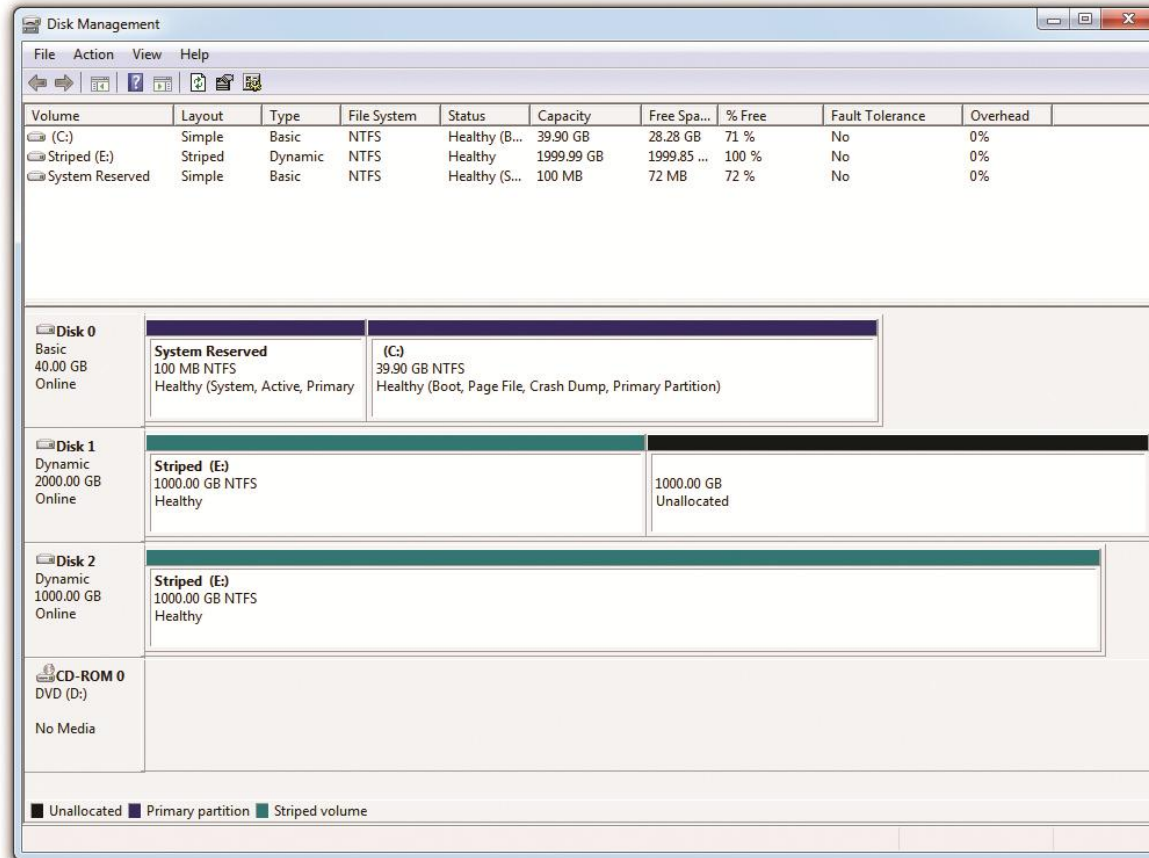


Figure 49: Two striped drives

Dynamic Disks (continued)

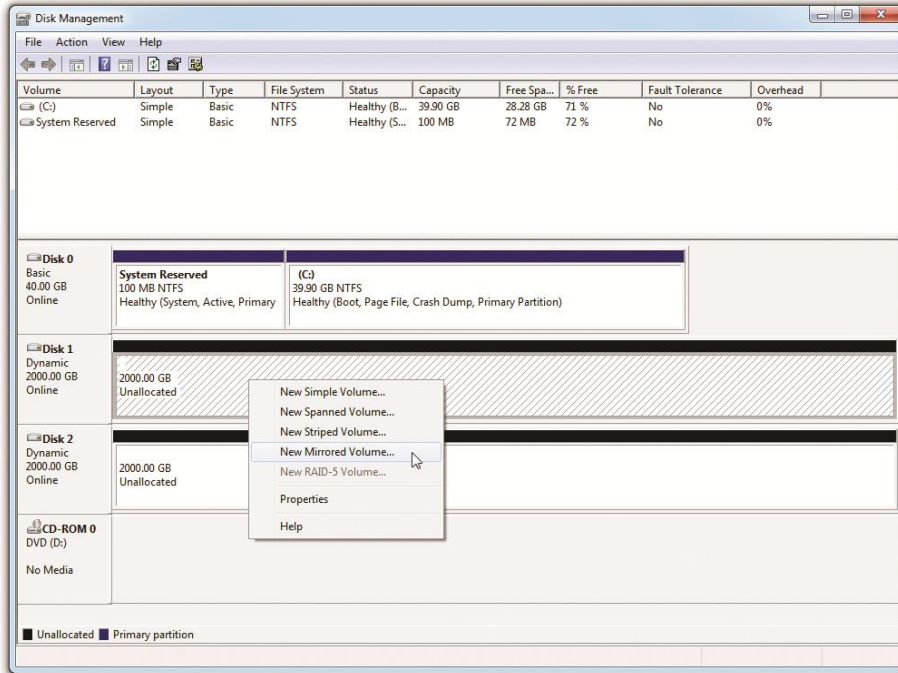
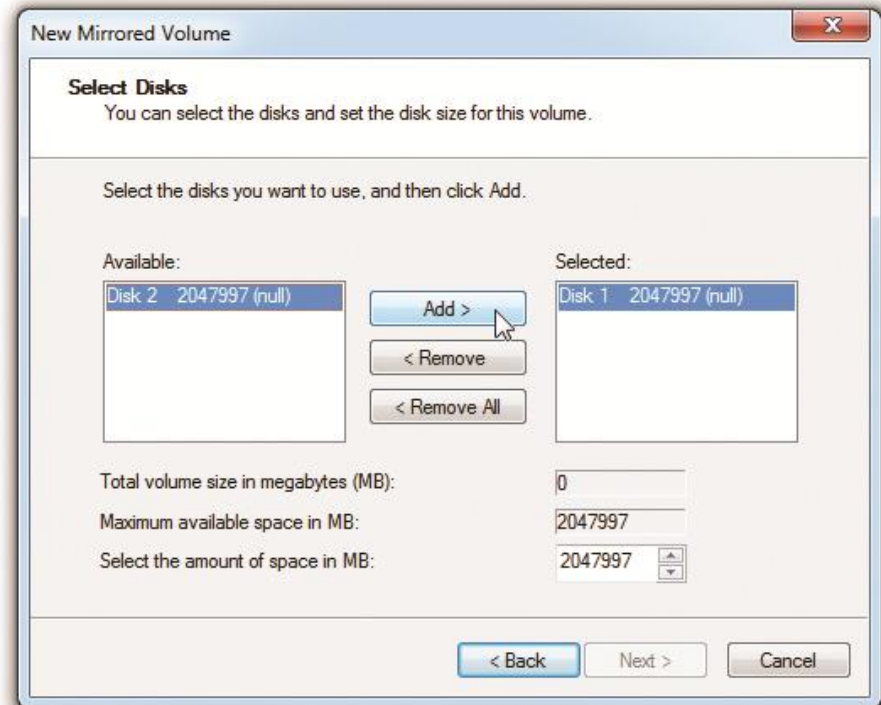


Figure 50: Selecting a new mirror

Figure 51: Selecting drives for the array



Dynamic Disks (*continued*)

- **Dynamic disk volumes (continued):**
 - Striped volume with parity—Disk Management enables you to create a RAID 5 array that uses three or more disks to create a robust solution for storage.
 - This applies to all the professional versions of Windows XP, Windows Vista, and Windows 7.
 - However, for those operating systems, you can make the array only on a Windows Server machine that you access remotely across a network.

Mount Point

- **While partitions and volumes can be assigned a drive letter, D: through Z:, they can also be mounted as a folder on another drive, also known as a mount point.**
 - This enables you to use your existing folders to store more data than can fit on a single drive or partition/volume.

Mount Point (continued)

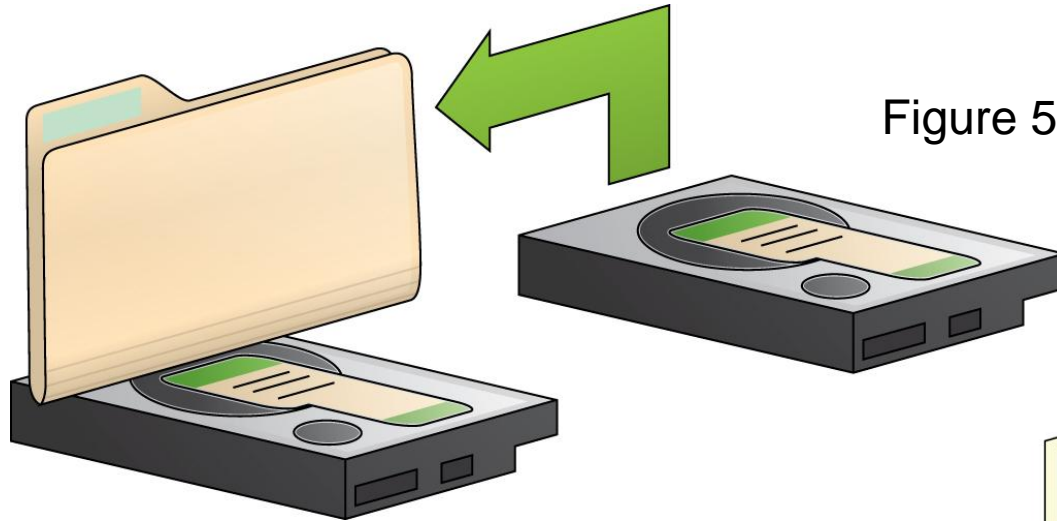
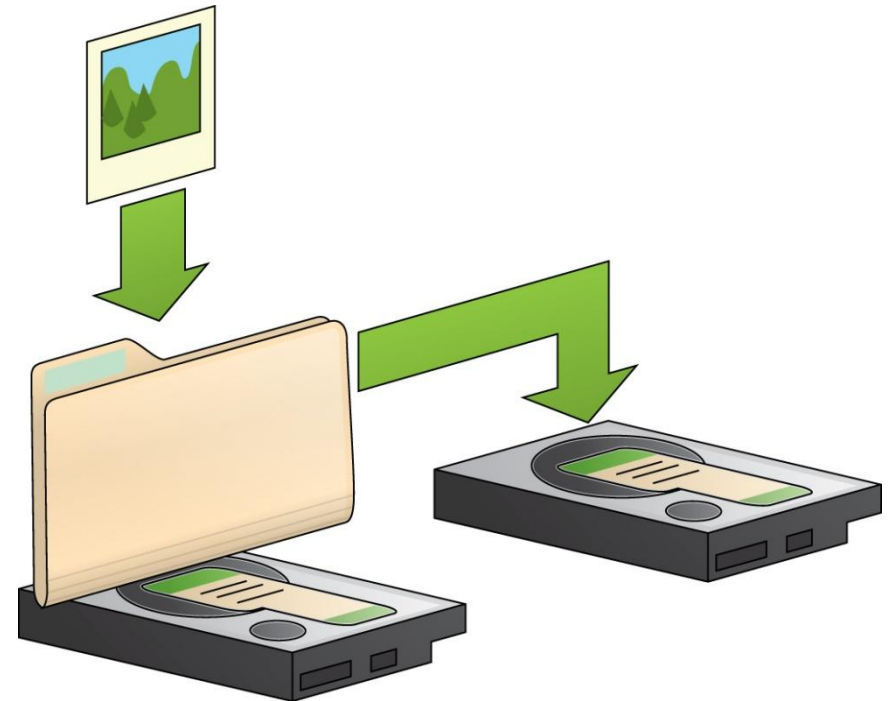


Figure 52: Mounting a drive as a folder

Figure 53: Adding photos to the mounted folder stores them on the second hard drive.



Mount Point (*continued*)

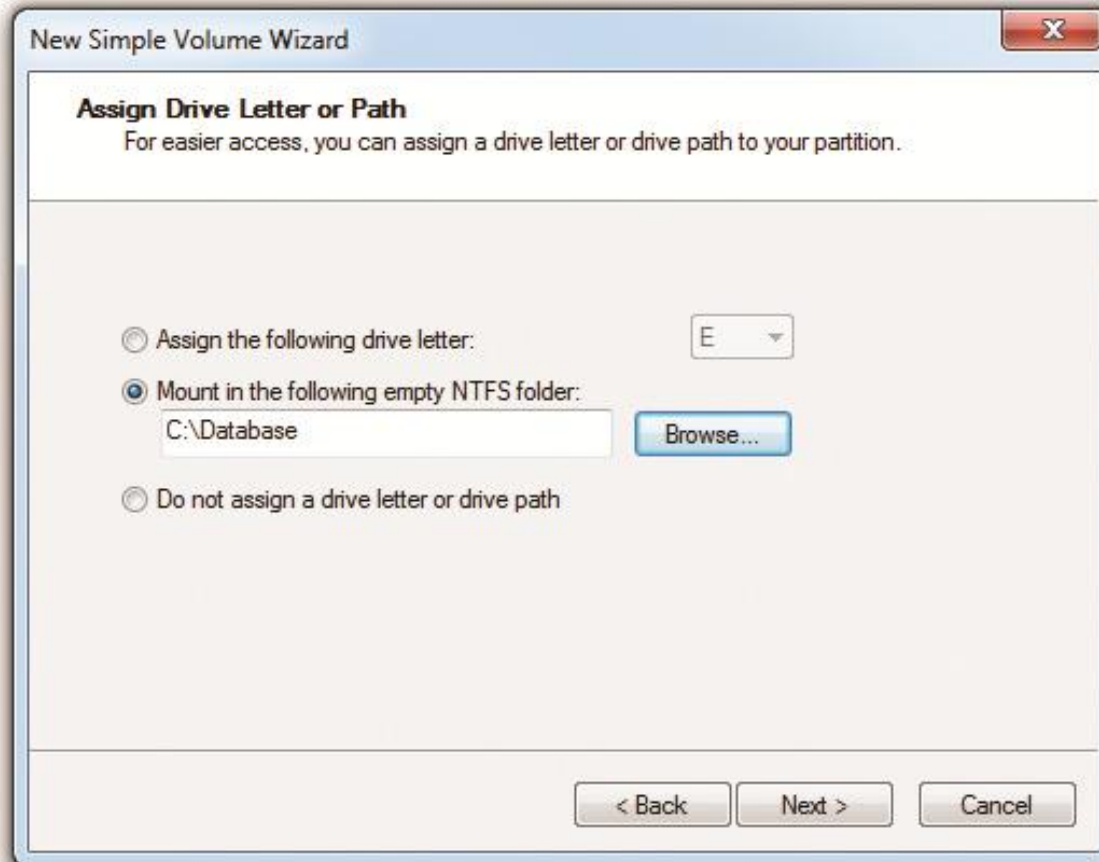


Figure 54: Choosing to create a mounted volume

Formatting a Partition

- Can format in **Windows Explorer**
- Can format in **Computer/Disk Management**

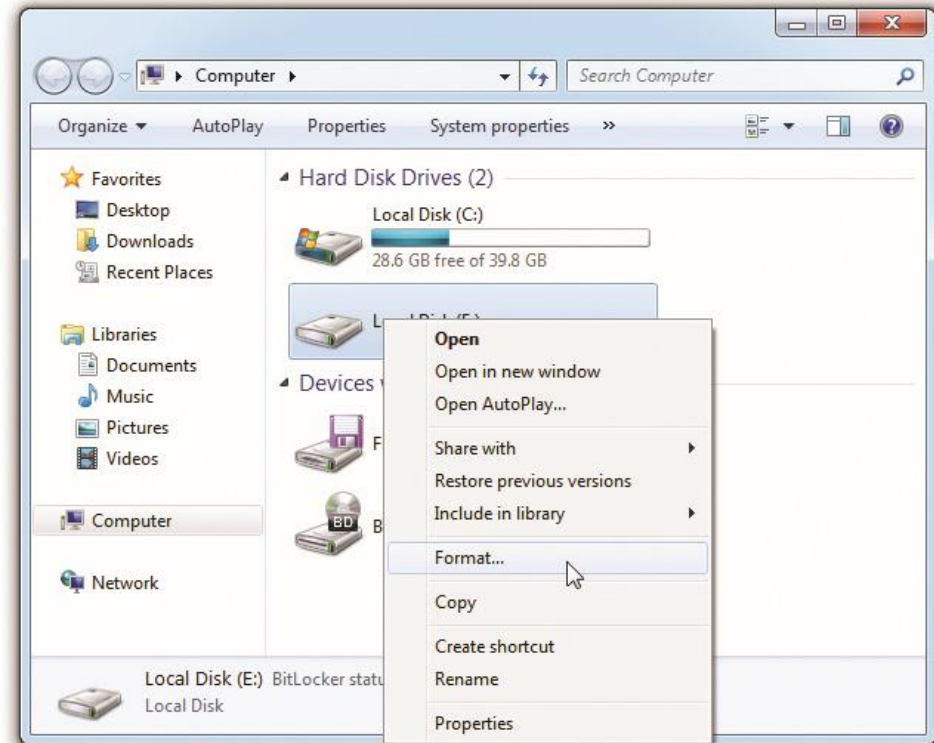


Figure 55: Choosing Format in Computer

Maintaining and Troubleshooting Hard Drives

Error-checking

- **Error-checking** scans for bad clusters on hard drives
- Often referred to by old name of ScanDisk or Run command of **CHKDSK**
 - Also checks for invalid filenames and tries to fix them
 - Looks for lost clusters or chains that do not have a filename associated with them and deletes them
 - Checks the links between parent and child folders
 - Launched via error-checking tools from Windows Explorer

Error-checking (*continued*)

- **Can check the drive**
- **Can be set to fix errors automatically**
- **Can scan for and recover bad sectors**

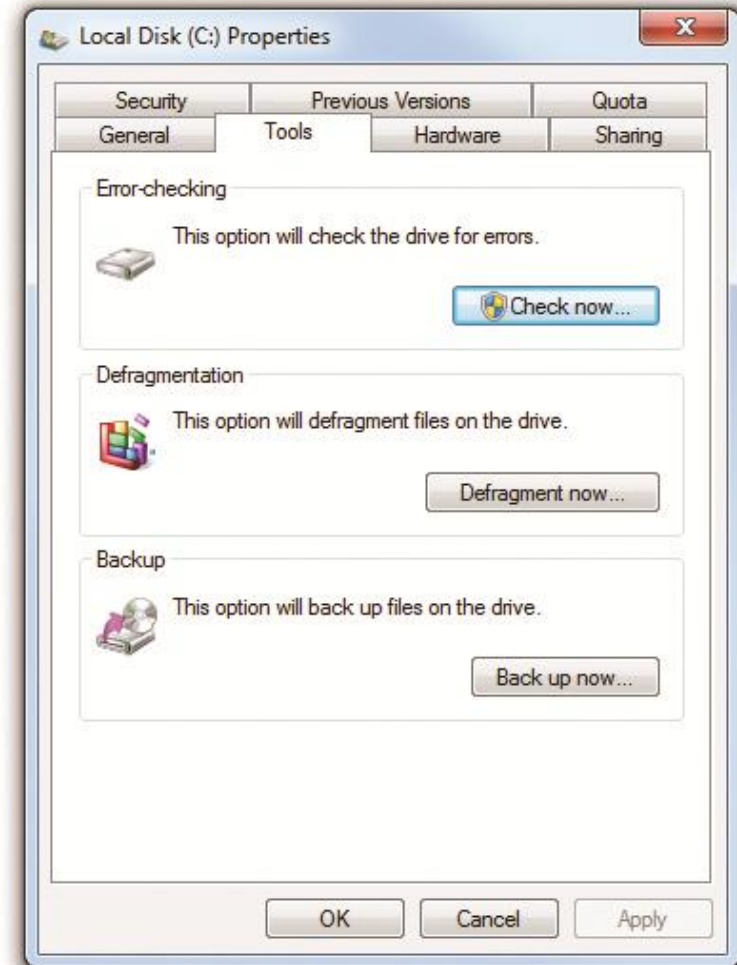


Figure 56: The Tools tab in the Properties dialog box

Error-checking (*continued*)

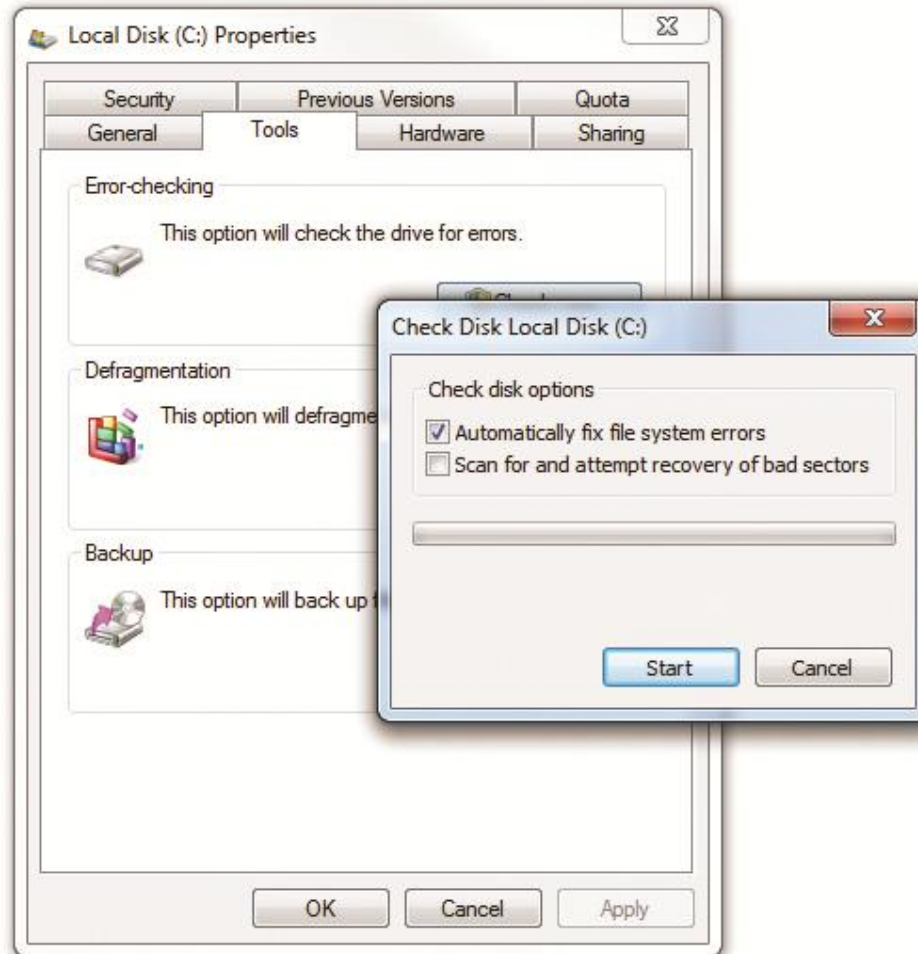


Figure 57: Check Disk options

Defragmentation

- **Disk Defragmenter**
 - Consider using regularly (monthly or weekly)
 - Will slow down system while running
 - If not done, system will slow down due to fragmentation
 - Can be scheduled
 - Called **DEFRAG** by many techs and by CompTIA

Defragmentation (*continued*)

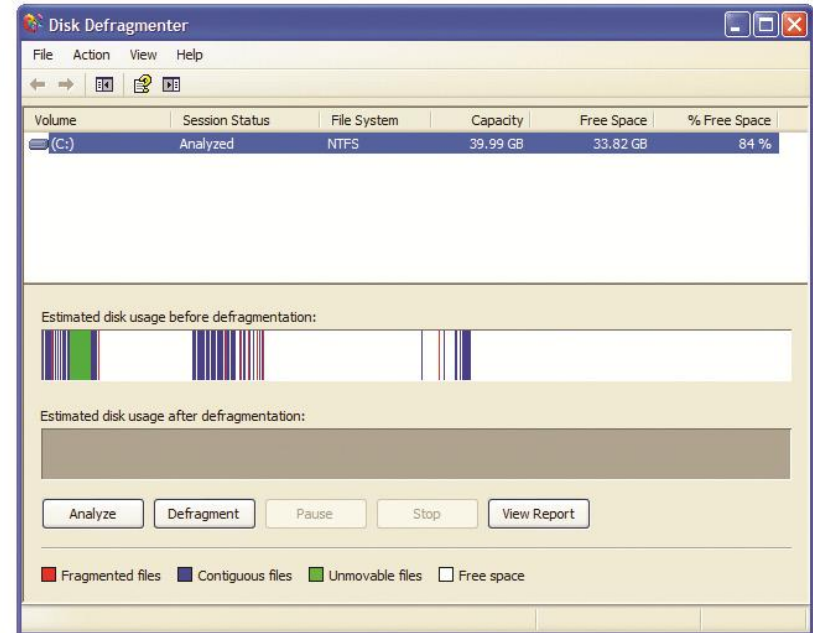
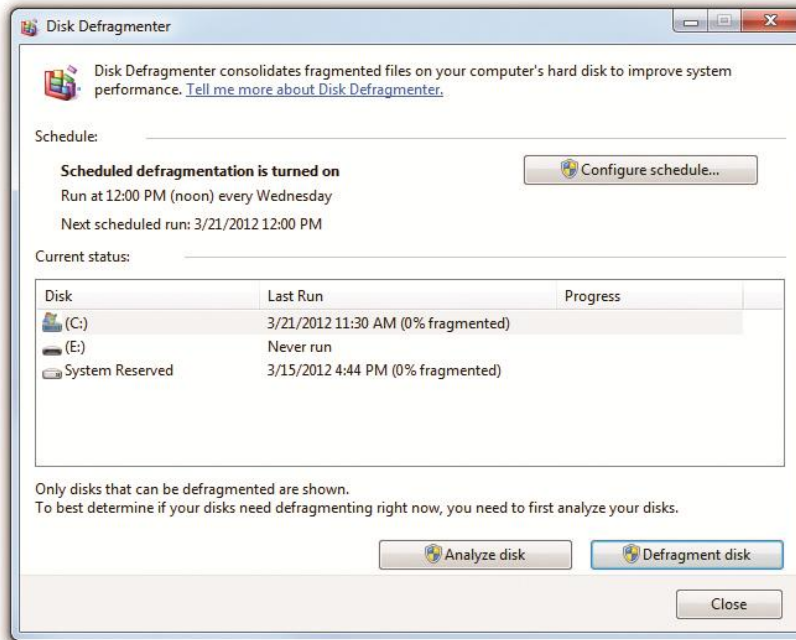


Figure 58: Disk Defragmenter in Windows 7 (left) and Windows XP

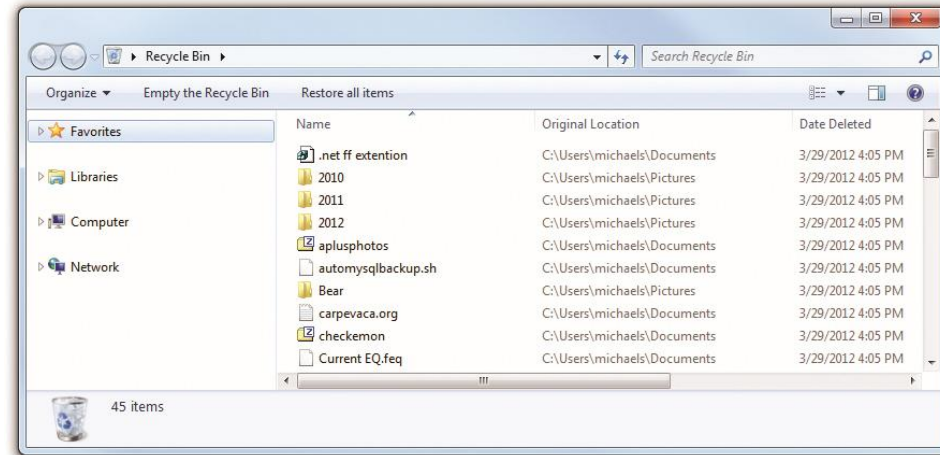
Defragmentation (*continued*)

- **Windows 7 automatically defragments disks once a week.**
 - You can adjust the schedule or even turn it off.
- **Don't defrag solid-state drives (SSDs), as they do not require it.**
 - You could damage them by defragging them, or at least reduce their useful life.
 - Windows 7 disables scheduled defrag for SSDs.

Disk Cleanup

- **Allows you to purge system of unneeded files**
 - Files in the Recycle Bin
 - Temporary Internet files
 - Downloaded program files
 - Temporary files

Figure 59: Mike's Recycle Bin



Disk Cleanup (*continued*)

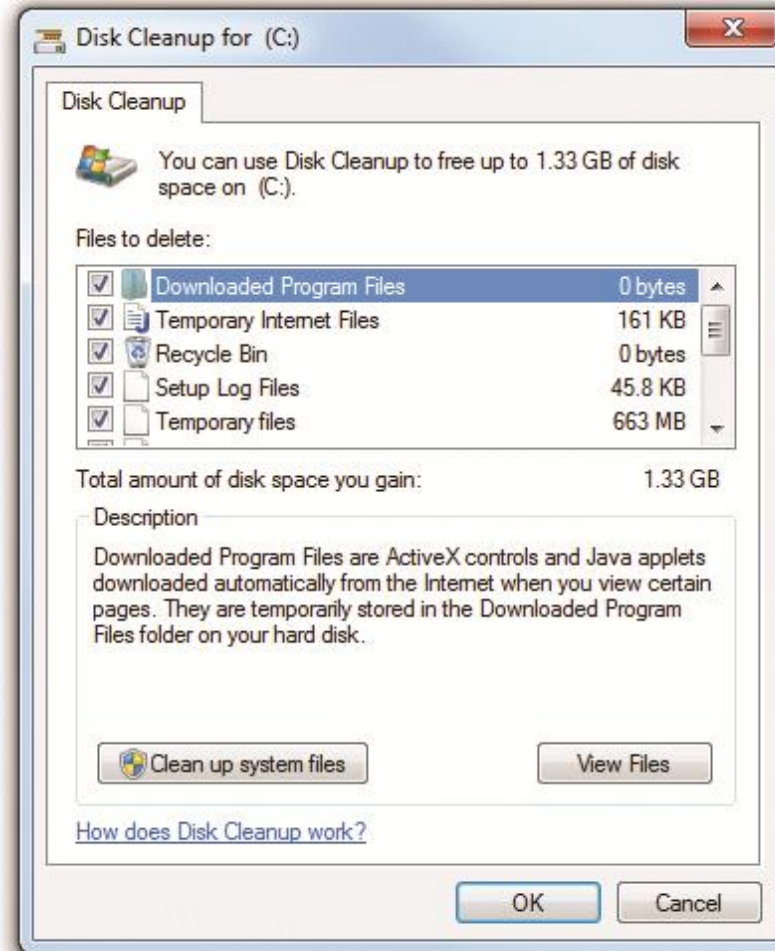


Figure 61: Disk Cleanup

Troubleshooting Hard Drive Implementation

- **Four broad categories of hard drive failures:**
 1. Installation errors
 2. Data corruption
 3. Dying hard drives
 4. RAID Issues

Troubleshooting Installation

- **Connectivity**
 - Hard drive error
 - No fixed disks present
 - HDD controller failure
 - No boot device available
 - Drive not found
- **Solutions include**
 - Checking the cables to make sure they connect properly
 - Reseating the hard drive controller (if an expansion card)
 - Using autodetection in CMOS
 - Checking the jumper settings
 - Some PATA drives are incompatible on the same controller

Troubleshooting Installation (*continued*)

- **CMOS**

- CMOS configuration mismatch
- No boot device available
- Drive not found
- Missing OS
- Solutions
 - Always run autodetect in CMOS
 - Always select LBA

Troubleshooting Installation (continued)

• Partitions

- Failing to partition
 - Invalid drive specification error
- Making the wrong size or type of partition

Figure 62: The “Trying to recover lost allocation unit” error

```
A:\>format C:/s
WARNING: ALL DATA ON NON-REMOVABLE DISK
DRIVE C: WILL BE LOST!
Proceed with Format (Y/N)?y

Formatting 30709.65M
Trying to recover lost allocation unit 37,925
```

• Format

- Failing to format
 - Drive is not accessible
 - Invalid media type
- “Trying to recover lost allocation unit” indicates the drive is dying

Troubleshooting Corruption

- **Data corruption**

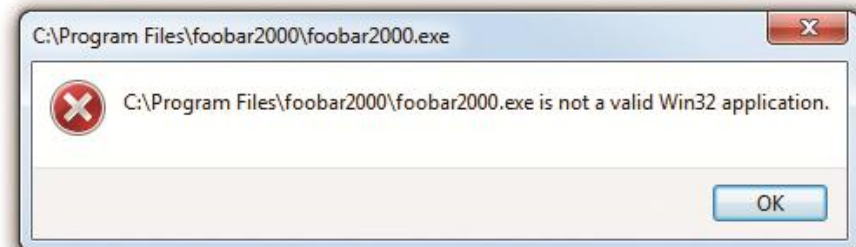
- Caused by many things such as power surges, accidental shutdowns, viruses, and more

- Show up as

- File is missing or corrupt
- Download location information is damaged
- Unable to load file
- Cannot find command.com
- Error loading operating system
- Invalid boot.ini

- Try running error-checking utility

Figure 63: A corrupted data error



Troubleshooting Corruption (continued)

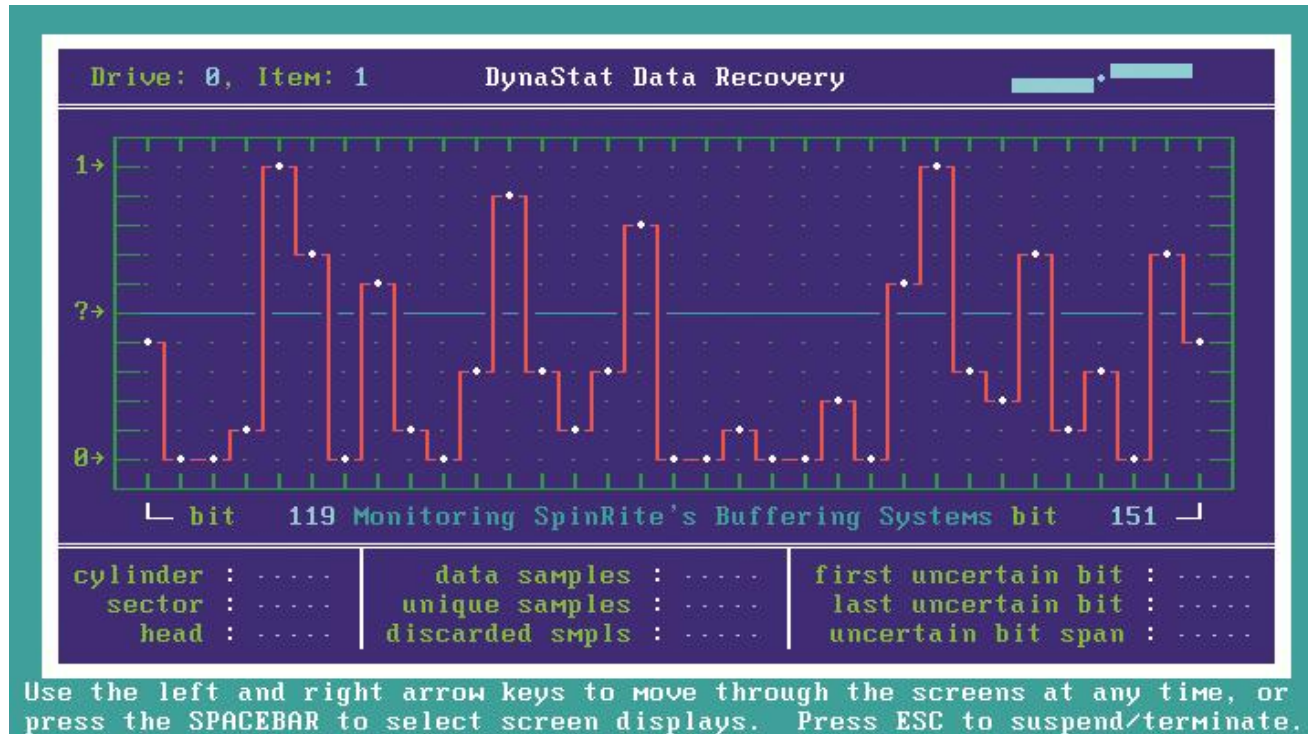


Figure 64: SpinRite at work

Troubleshooting Corruption (*continued*)

- **Corrupted data on bad sectors**
 - The built-in error correction code (ECC) checks the drive for bad sectors
 - Disk checkers can be used to fix problems pertaining to corrupted data
 - Windows will give you error messages with read/write failures. Good hard drives don't fail to read or write. Only dying ones have these problems.

Troubleshooting Dying HDD

- **Dying hard drive**

- The following sounds indicate a drive about to die
 - Continuous high-pitched squeal
 - Series of clacks, a short pause, and then more clacks
 - Continuous grinding or rumbling
- Boot drive issue would show up as “no boot device present”
- Second drives simply do not show up

RAID Issues

- **Drive problems in a RAID array are almost identical to those seen on an individual drive.**
- **If the configuration firmware doesn't recognize one of the drives, first check to make sure the drives are powered and that they are connected to the proper connections.**
 - This is especially true of motherboards with onboard RAID that require you to use only certain special RAID connectors.

RAID Issues (*continued*)

- **When one of the drives in a RAID array fails, several things can happen depending on the type of array and the RAID controller.**
 - With RAID 0, the effect is a critical stop error, or a Blue Screen of Death (BSOD). On reboot, the computer will fail to boot or you'll get a message that the OS can't be found. You will normally lose all data.
 - With all other RAID levels, you will get a notification of the drive failure, and performance will suffer. You usually won't lose data, but you must replace the failed drive.

RAID Issues (*continued*)

- **“RAID Not Found” errors will vary greatly depending on the make and model of hardware RAID or if you used software RAID**
 - A properly functioning hardware RAID array will always show up in the configuration utility.
 - If an existing array stops working and you enter the configuration utility only to find the array is gone, this points to either dead drives or faulty controllers.
 - In either case they must be replaced. If the array is gone but you can still see the drives, then the controller may have broken the array on its own.

Beyond A+

- **Third-party partition tools enable you to create, change, and delete partitions without destroying the data:**
 - PartitionMagic
 - VCOM's Partition Commander
 - GParted
 - Free (open source) license
 - Linux only

Beyond A+ (continued)

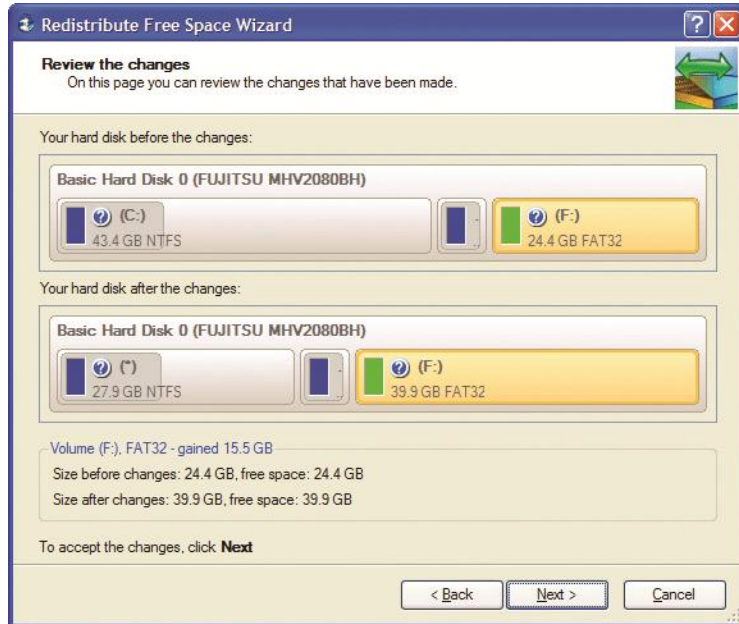


Figure 65: Partition Commander

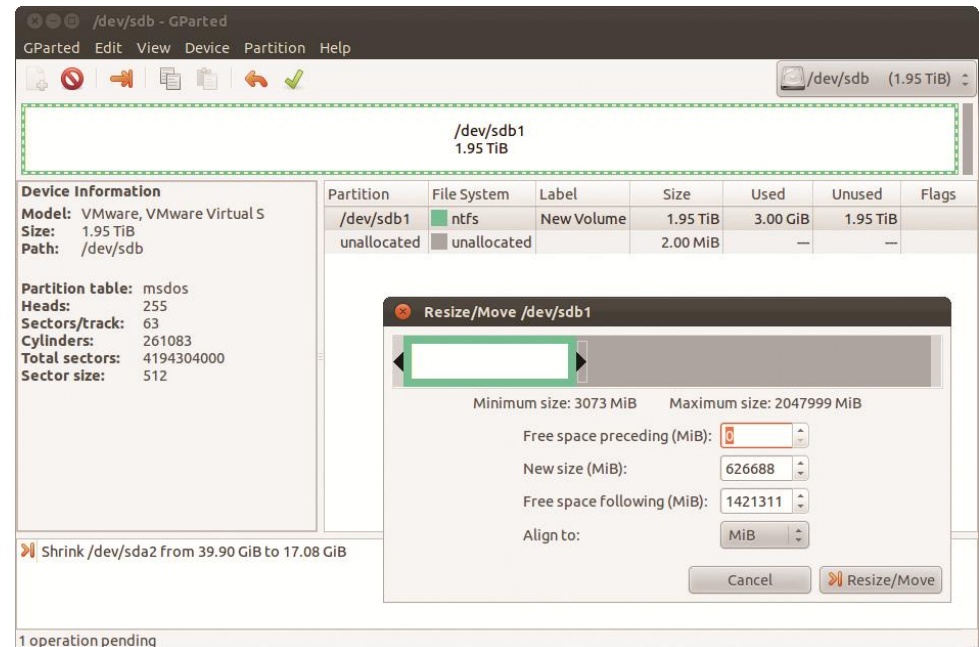


Figure 66: GParted in action