

ACTIVE@ UNDELETE 7.0

USER GUIDE

COPYRIGHT

Copyright © 2007, LSOFT TECHNOLOGIES INC. All rights reserved. No part of this documentation may be reproduced in any form or by any means or used to make any derivative work (such as translation, transformation, or adaptation) without written permission from LSOFT TECHNOLOGIES INC.

LSOFT TECHNOLOGIES INC. reserves the right to revise this documentation and to make changes in content from time to time without obligation on the part of LSOFT TECHNOLOGIES INC. to provide notification of such revision or change.

LSOFT TECHNOLOGIES INC. provides this documentation without warranty of any kind, either implied or expressed, including, but not limited to, the implied warranties of merchantability and fitness for a particular purpose. LSOFT may make improvements or changes in the product(s) and/or the program(s) described in this documentation at any time.

All technical data and computer software is commercial in nature and developed solely at private expense. As the User, or Installer/Administrator of this software, you agree not to remove or deface any portion of any legend provided on any licensed program or documentation contained in, or delivered to you in conjunction with, this User Guide.

LSOFT.NET logo is a trademark of LSOFT TECHNOLOGIES INC.

Other brand and product names may be registered trademarks or trademarks of their respective holders.

CONTENTS

1. Product Overview	4
About Active@ UNDELETE 7.0	4
System Requirements.....	4
2. Getting Started	5
Application Views and Windows	5
Application Preferences	10
3. Using Active@ UNDELETE 7.0	15
Restore Partitions	15
Recover Files and Folders	21
Using Scan Results.....	28
4. Active@ UNDELETE Tools.....	37
Disk Image	37
Working with a Corrupted RAID System.....	41
Virtual Partition (Logical Drive Clone)	42
Preview Image Files	43
Hardware Diagnostic File.....	44
Hex Editor	45
5. Knowledge Base.....	56
Understanding the File System: FAT.....	60
Understanding The File System: NTFS	75
Understanding The File Recovery Process	86
Step by Step with examples.....	87
The Partition Recovery Process.....	94
Other Partition Recovery Topics.....	95
Appendix	105
Toolbar Commands Reference.....	105
Symbols and Icons.....	108
Toolbars and Menus	109
Recovery Tips	114
Troubleshooting.....	114
Frequently Asked Questions.....	114
Online Help and Technical Support.....	114
Glossary.....	115

1. PRODUCT OVERVIEW

This chapter gives an overview of Active@ UNDELETE 7.0 and requirements for running the utility.

ABOUT ACTIVE@ UNDELETE 7.0

Active @ UNDELETE is a software application designed to help you restore your lost data from deleted files, folders or even partitions. With Active@ UNDELETE, you can:

- Recover deleted files and folders
- Detect deleted partitions and restore them or recover data from them
- Create a Disk Image for safe data restoration
- Perform an Advanced Scan and organize the result using Document View and Recovery Toolkit
- Write recovered data from files and folders directly to a CD or Data DVD, avoiding dangerous hard drive activity
- Perform batch file recovery, using Recovery Toolkit
- Restore data from damaged RAID-system drives
- Edit disk content with the advanced Hex Editor tool
- Preview image files before restoring

SYSTEM REQUIREMENTS

The following system specifications are required:

- Windows 2000, Windows 2003, Windows XP, WinPE, Windows Vista operating system
- Pentium processor or compatible
- 6 MB available on hard disk
- 64 MB of RAM or more
- Internet Explorer 4 or later, Mozilla Firefox 1.0 or later
- CD/DVD burner (recommended)
- Mouse or other pointing device

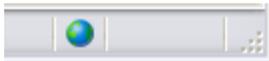
2. GETTING STARTED

Active@ UNDELETE is designed to explore and browse all data storage devices on your computer in different ways to find and recover lost data. All information in the application is organized in tabbed views that provide easy access to information for different purposes.

To familiarize yourself with the Active@ UNDELETE 7.0 workspace, read the following topics in this guide:

- Application Views and Windows
- Application Preferences
- Toolbars and Menus (see *Appendix*)

For online help or to check for updates, an Internet connection is required. You can view the availability and status of your Internet connection with the status bar icon, shown below.



APPLICATION VIEWS AND WINDOWS

All information in the application is organized in tabbed views. Four of the main views are:

- Recovery Explorer
- Document View
- Recovery Toolbox View
- Log View

To browse through each of these views, click on each tab in turn. You may also open a view from the View menu.

To close the current view at any time, press CTRL+F4. To open any closed view, select it from the View menu.

The status bar, at the bottom of the workspace shows the current status of the application or status of the activity in progress. When Active@ UNDELETE is idle and ready to perform an operation, the status displays "Ready".

To toggle the status bar on and off, click View > Status Bar.

Note When you run Active@ UNDELETE, the application gathers information about disks and partitions available to the system. During this preliminary operation, the status bar displays "Initializing..." and application prevents most other operations from starting. Application Log View shows detailed information about the initialization stage.

Application Views and Windows

Many views display lists and hierarchy trees and use symbols to indicate the status of drives, devices, folders and other items. For descriptions of these symbols, see *Symbols and Icons* in the Appendix.

To modify the information displayed in columns in a table list, right-click any column header and select or clear columns from context menu. If you click More... in the context menu, the Choose Columns dialog box appears.

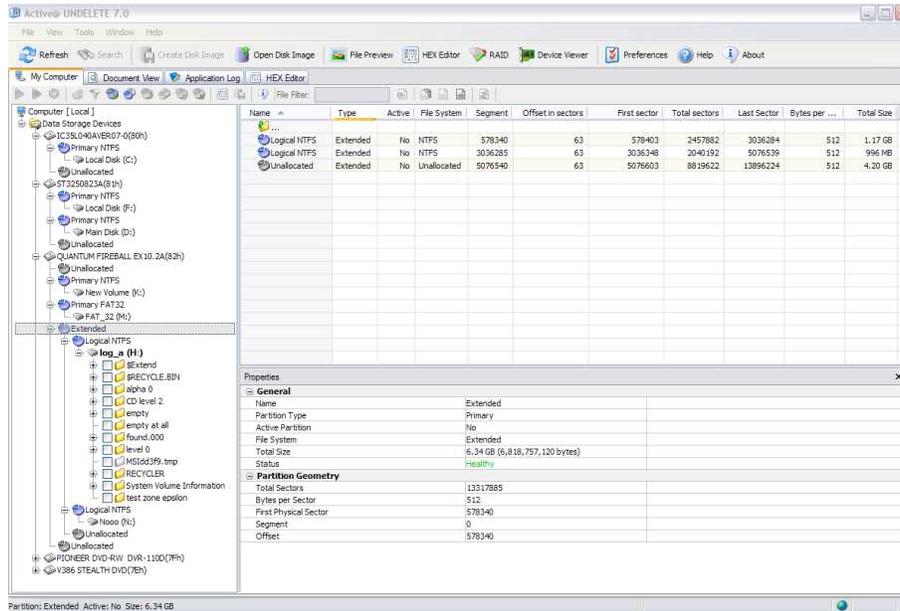
RECOVERY EXPLORER VIEW

The main view in Active@ UNDELETE is Recovery Explorer View. The view tab label displays "My Computer".

This is the default view that you see after the application starts. The left panel is the Tree pane. It displays the hierarchical structure of all drives, devices, folders and files of the scanned Logical Drive, Virtual RAID and opened Disk Image. Scan Results appear here if you scan a device. To collapse a node in this tree, click the minus sign (-) next to the node name or double-click a node. To expand a node, click the plus sign (+) next to the node name or double-click a node.

When you select a node in the hierarchy tree, details of the selected node appear in the List pane and Properties panel.

Recovery Explorer View



The List Pane displays the sub elements of the selected node. To make the list easier to read, you may do the following:

- To sort the list by a column in ascending order, click the column header. The column is highlighted.
- To sort the same column in descending order, click the column header a second time.
- To show a list that is reduced in size by a filter, select one of the preset options in the File Filter toolbar.

When you select items in the List pane, details of the selected item appear in the Properties panel.

To perform an action on any node in either the Tree pane or the List pane, select the node and choose a command from the View or Tools menus. You may also choose a command from the toolbar or from the right-click context menu.

To add an item to the Recovery Toolbox, select the check box next to the item.

The Properties panel displays default properties for each selected item in Tree or List panes. Updates to these properties appear dynamically along with commands and activities performed in the workspace. To toggle the Properties Pane on and off click View > Properties Pane.

Note You can create a custom filter for tree and list items. For more information see *File Filter Toolbar* in the Appendix.

DOCUMENT VIEW

The Document View displays all files detected after a logical drive scan. The left pane displays a list of items. To make the list easier to read, you may group these items by:

- Extension
- Application
- File Type

When you select an item in the left pane, all detected files that match the selected criteria appear in the right pane. To make this list easier to read, you may do the following:

- To sort the list by a column in ascending order, click the column header.
- To sort the list by the same column in descending order, click the column header a second time.
- To show a list that is reduced in size by a filter, select one of the preset options in the File Filter toolbar.
- To add an item to the Recovery Toolbox, select the check box next to the item.

Note You can create a custom filter for this list. For more information see *File Filter Bar* in the Appendix.

RECOVERY TOOLBOX VIEW

The Recovery Toolbox is a tool that allows files selected from various other views (for example Recovery Explorer, Document View or Search Result) to be recovered at once to the same specified destination. The recovery destination may be a different Hard Disk or a CD or Data DVD. In the recovery destination, each recovered file retains a copy of its original folder hierarchy. When you select the check box next to a file or folder in Recovery Explorer view, Document View or Search Results View, the selected item is copied to the Recovery Toolbox along with its path information. Similarly, if you clear a check box next to a file or folder in another view, the item is removed from the Recovery Toolbox.

In the Recovery Toolbox, the Space Indicator panel displays available space on recovery destination drive or CD/DVD along with the amount of free space required to recover all selected files.

To clear all selected check boxes in all views, click Clear Recovery Toolbox.

Note Including path information is optional. For more information, see *Recovery* in Application Preferences, in this chapter.

LOG VIEW

This log screen monitors each action taken by the application and displays messages, notifications and other service information. Use the messages in this screen to observe and further understand the flow of the recovery process.

We recommend that you attach a copy of the log file to all requests made to our technical support group. The entries in this file will help us resolve certain issues.

To prepare a log file, turn on Display Trace Events and Write Log on Disk options in the Preferences dialog box.

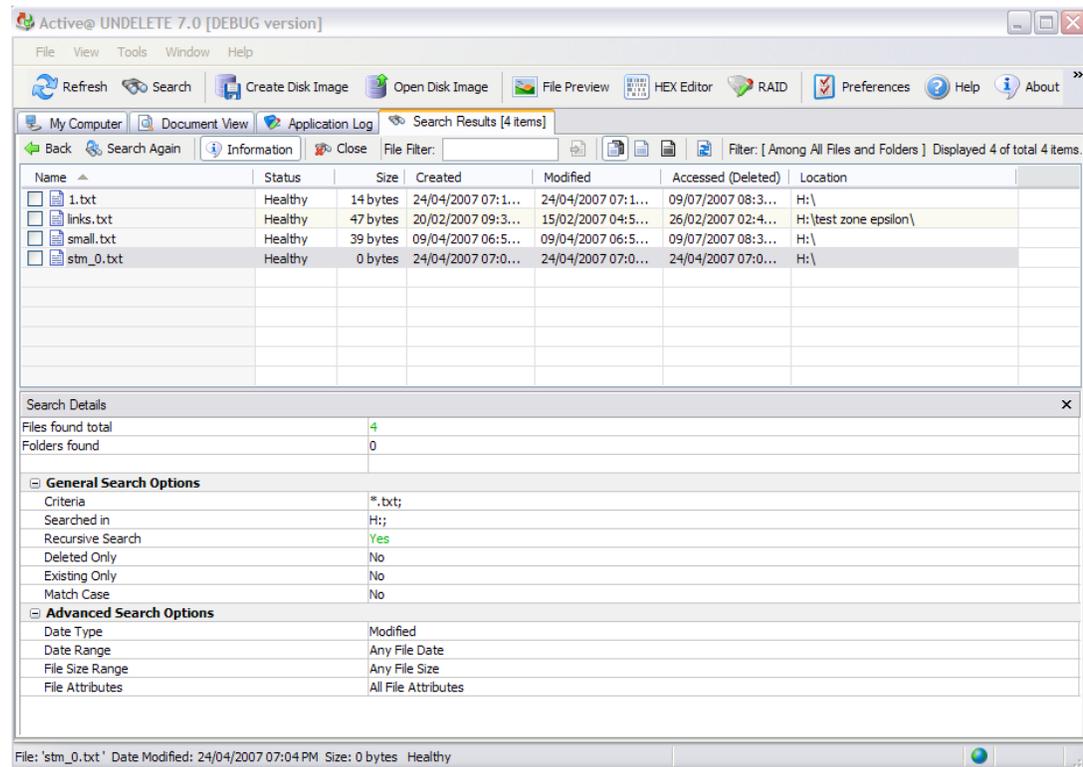
It is best to save the log file to a physical disk that is different from the disk that holds the deleted data. By doing this, you reduce the risk of writing over the data that you are trying to recover.

For information on setting log file options, see *Application Preferences* in this chapter.

SEARCH RESULTS VIEW

The Search Results view appears after you perform a Search for Files and Folders. The top panel displays the results of the search in a list.

Search Results View



To make this list easier to read, you may do the following:

- To sort the list by a column in ascending order, click the column header.
- To sort the list by the same column in descending order, click the column header a second time.
- To show a list that is reduced in size by a filter, select one of the preset options in the File Filter toolbar.

To add an item to the Recovery Toolbox, select the check box next to the item.

To recover an item in this list, right-click the item and choose Recover from the context menu.

To preview an item, select it and click File Preview.

The Search Details panel shows the statistics and criteria of the search that was recently performed. To show or hide this panel, click Information.

To change search criteria and repeat the search at the same location, click Search Again.

To close the Search Results view and discard all information, click Close.

Note: For information about how to start a search, see *Search for Files and Folders* in Chapter 3. Using Active@ UNDELETE 7.0.

Note: You can create a custom filter for this list. For more information see *File Filter Bar* in the Appendix.

APPLICATION PREFERENCES

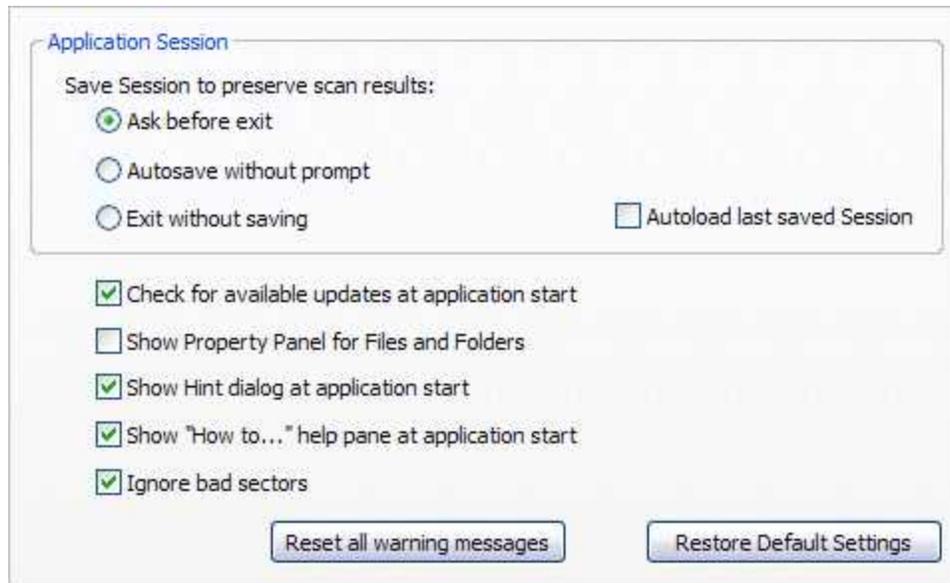
You can change many of the settings that affect the application's behavior in the Preferences dialog box.

To open the Preferences dialog box, do one of the following:

- From the **Tools** menu, select **Preferences**
- In the Application toolbar, click **Preferences**

A description of the tabs in this page follows below.

GENERAL



To set General options:

1. You may set default activities that happen when the application starts or exits:
 - To show a warning before saving the current session when you exit, click **Ask before exit**.
 - To save the session without a warning when you exit, select **Autosave without prompt**.
 - To exit each time without saving, select **Exit without saving**.
 - To load the previous session data each time you start, select the **Autoload last saved session** check box.

2. To connect to the Active@ UNDELETE site and check for application updates each time you start, select the **Check for available updates** check box.
3. To display the property panel each time you start, select the **Show Property Panel for Files and Folders** check box.
4. To show hints about the application each time you start, select the **Show Hint dialog at application start** check box.
5. To automatically skip over bad sectors when scanning the disk or recovering files, select the **Ignore bad sectors** check box.
6. To discard all custom General settings and restore defaults, click **Restore default settings**.

RECOVERY

The screenshot shows a settings dialog with two sections. The first section, 'File and Folder Recovery', contains a text field for 'Default path to recover:' with the value 'd:\temp' and an ellipsis button. Below it are three checkboxes: 'Replace invalid file name symbols with the symbol:' (checked) with a text field containing an underscore, 'Allow to recover to the same drive (containing original data)' (unchecked), and 'Open destination folder, when recovery is complete' (checked). The second section, 'Partition restore', contains a checked checkbox for 'Backup Partition Information' and a 'File name:' text field with an ellipsis button.

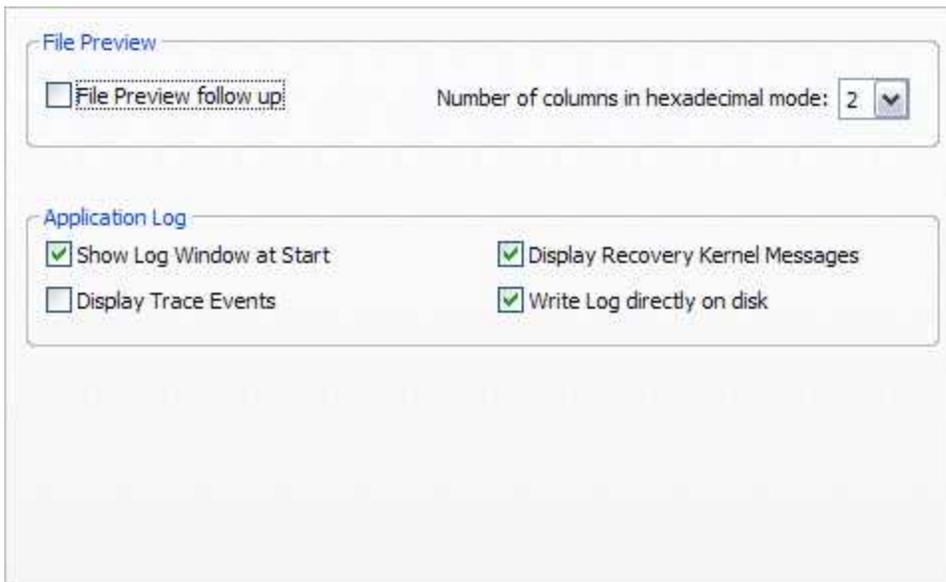
To set Recovery options:

1. To set the default path to the folder where you will save recovered files, enter the path in the **Default path to recover** field. You may also click the ellipsis button (...) and navigate to this folder.
2. To automatically replace invalid characters in a recovered file name:
 - a. Select the **Replace invalid file name symbols** check box.
 - b. Enter a valid character in the field. The standard character is underscore (_).
3. To save recovered files and folders on the same drive as the source data, select the **Allow to recover to the same drive** check box.
4. To open the destination folder after you recover files and folders, select the **Open destination folder** check box.

5. To automatically skip over bad sectors when recovering a file, select the **Ignore bad sectors** check box.
6. When you restore a partition, to automatically save a backup file before you restore:
 - a. Select the **Backup Partition Information** check box.
 - b. Enter the path and the default file name for the backup file in the **File name field**. You may also click the ellipsis button (...) and navigate to the folder and then enter the file name.

Note: We strongly recommend that you do not write recovered files and folders to the same hard drive as the source data.

TOOLS



To set Tools options:

1. In File Preview:
 - To attempt to preview an image file each time you select a new file, select the **File Preview follow-up** check box. To attempt to preview an image file manually each time, clear this check box.
 - To show non-image files in the image viewer in hexadecimal mode, from the **Number of columns in hexadecimal mode** drop-down list, select the number of columns.
2. In Application Log:
 - To show the Application Log view when you start, select the **Show Log Window at Start** check box.

- To record all system events in the log, select the **Display Trace Events** check box.
- To show recovery messages from the system, select the **Display Recovery Kernel Messages** check box.
- To automatically write the log to a file, select the **Write log on disk** check box.

Note: If you display all system trace events in the application log, the log file will quickly become very large.

HEX EDITOR

Hex Editor uses a simple, low-level disk viewer which displays information in binary and text modes at the same time. You can use this view to analyze the contents of data storage structure elements.

The Data Inspector is part of the Hex Editor and displays whatever is currently under the cursor. It does so in ten different formats. This may help you interpret data as displayed in Hex Editor.



To set Hex Editor options:

1. To show the Status pane by default, select the **Show Status pane** check box.
2. To show the Info pane by default, select the **Show Info pane** check box.
3. To display the current address offset in Hexadecimal format, select the **Hexadecimal address** check box. To display the current address offset in decimal format, clear the **Hexadecimal address** check box.
4. To set the font size, choose a size from the **Font size** drop-down list.

5. In **Data Inspector**, select the check box next to all the formats of values that you want to display. Clear the check box next to formats that you do not want to display.

RECOVERY TOOLBOX

The screenshot shows the 'RECOVERY TOOLBOX' application preferences dialog box. It is divided into two main sections. The first section, titled 'Selected files path organizing:', contains two radio button options: 'Ignore file path' (which is unselected) and 'Reconstruct full path for selected folder' (which is selected). The second section, titled 'CD - DVD burner options', contains several checked options: 'Finalize Media (No further writing)', 'Dynamic Power Control (OPC)', 'Erase rewritable media before writing', 'Buffer Under Run Error Proof', and 'Eject disk after burning'. There is also a text input field for 'Cache buffer size, Mb:' with the value '20' entered.

To set Recovery Toolbox options:

1. To display the file path of selected files, select **Reconstruct Full Path**. To leave the path information blank, select **Ignore file path**.
2. In CD – DVD burner options:
 - To allow no further writing to CD or DVD media after restoring files, select the **Finalize Media** check box.
 - To wipe erasable media before writing restored files, select the **Erase rewritable media** check box.
 - To set the cache buffer size, enter a size in the **Cache buffer size** field.
 - To monitor and maintain the quality of disc writing (newer disc writers) select the **Dynamic Power Control (OPC)** check box.
 - To prevent buffer under run errors when writing to CD/DVD, select the **Buffer Under RuN Error Proof** check box.
 - To eject the CD/DVD after burning, select the **Eject disk after burning** check box.

3. USING ACTIVE@ UNDELETE 7.0

Note: Not every deleted file can be recovered. To be successful, it is important to try every method available.

RESTORE PARTITIONS

If you cannot see partitions on your device, or if you know that partitions are missing, you may scan a device to find partitions first.

If you can see partitions on your device, you may skip ahead to *Recover Files and Folders*.

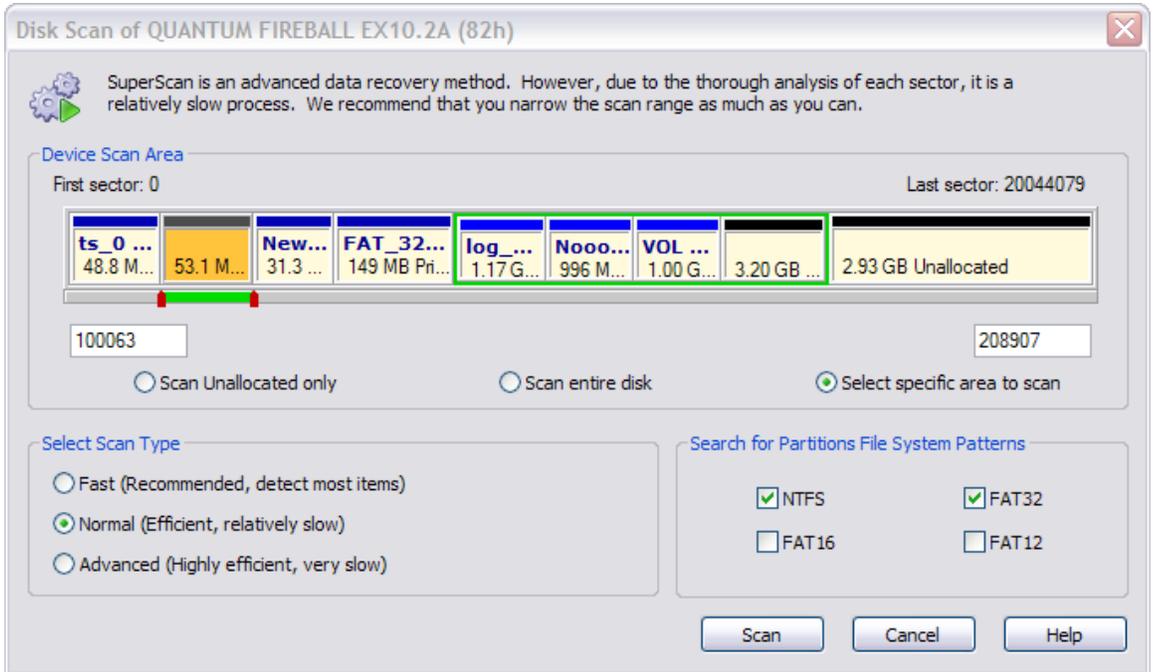
SCAN A PHYSICAL DEVICE FOR DELETED PARTITIONS

A physical device is an installed hard disk, Flash card, external USB disk or any device that holds data. You may scan a device two ways:

- Scan for deleted partitions.
- Scan for files by signature.

SCAN FOR DELETED PARTITIONS

You can locate existing and deleted partitions on a physical device.



To scan a physical device for deleted partitions:

1. In the **Recovery Explorer** tree, select a device node under **Data Storage Devices**. Details of the selected node appear in the List pane.
2. To open the **Disk Scan** dialog box, do one of the following:
 - In the Recovery Explorer Toolbar, click **Default Scan**.
 - Right-click the selected device and click **Scan > Deleted Partitions** from the context menu.
3. In the **Disk Scan** dialog box, you may:
 - Select specific areas to scan or you may scan the entire disk.
 - If you select specific areas to scan, use sliders or exact numbers to set boundaries of scan area.
 - Set the scan type to **Fast**, **Normal** or **Advanced**.
 - Search for default patterns, or you may select specific patterns to search for.
4. Click **Scan**. The **Processing...** dialog box appears.
5. To display scanning events and progress details, click **Details**.
6. To terminate the scan process, click **Stop** at any time. Results may be not accurate or complete.
7. After the scan completes or terminates, a **Scan Results** branch appears in the Recovery Explorer tree.

Note: If you stop a device scan before it has completed, you may resume the scan from the point at which it was terminated.

You may use nodes in the Scan Results branch for further actions. For more information, see *Using Scan Results* later in this chapter.

SCAN FOR FILES BY SIGNATURE

You can locate current and deleted files by their unique file signature on a physical device.

To scan for files by signature:

1. In the **Recovery Explorer** tree, select a device node under **Data Storage Devices**. Details of the selected node appear in the List pane.
2. To open the **Low Level Disk Scan** dialog box, do one of the following:
 - From the Recovery Explorer toolbar, click **Advanced Scan**.
 - Right-click the selected device and click **Scan > Low Level** from the context menu
3. In the **Low Level Disk Scan** dialog box, you may:
 - Select specific areas to scan or you may scan the entire disk.
 - If you select specific areas to scan, use sliders or exact numbers to set boundaries of scan area.
 - Select **Options** to add or remove file signatures to search for.
4. Click **Scan**. The **Processing...** dialog box appears.
5. To display scanning events and progress details, click **Details**.
6. To terminate the scan process, click **Stop** at any time. Results may be not accurate or complete.
7. After the scan completes or terminates, a **Scan Results** branch appears in the Recovery Explorer tree.

Note: If you stop a device scan before it has completed, you may resume the scan from the point at which it was terminated.

You may use nodes in the Scan Results branch for further actions. For more information, see *Using Scan Results* later in this chapter.

FILTER DETECTED PARTITIONS BY CERTAINTY

After you complete a scan, detected partitions are listed in order of their certainty status based on attributes and validation level. To make a long list of partitions easier to read, remove partitions with status Bad and lower using a filter.

To filter detected partitions:

1. In the **Scan Results** node, select a device node with detected partitions.
2. To open the **Filter Detected Partition** dialog box, do one of the following:
 - From the Recovery Explorer toolbar, click **Filter DeviceScan Results**.
 - Right-click the partition and click **Filter...** from the context menu.
3. In the **Filter Detected Partition** dialog box, do the following:
 - a. To filter any file systems, select the **Any File Systems** check box.

- b. To specify file systems to filter, select **Specify File Systems** and select the check box next to all file systems to include.
 - c. To reduce the size of the partition list, select the check box only next to the status settings that you want to display.
 - d. To display any size of partition, click **Any Size**.
 - e. To restrict the size of partition to display, click **Specify Size Range, KB** and enter the lowest and highest partition size.
 - f. To set advanced filter options, click **Advanced** and indicate each FAT or NTFS attribute in the **Advanced Filtering** dialog box appears.
4. Click **OK**.
 5. Press **Set Defaults** in the **Filter Detected Partition** dialog box to cancel partition filtering.

EDIT OR CLONE DETECTED PARTITIONS

It may be necessary for you to edit detected partition attributes directly when some attributes are detected incorrectly or need adjustments.

Any detected partition can be cloned (virtually copied) before manually altering partition attributes and properties. We recommend that you edit the clone rather than directly edit the original partition. Any detected partition can be cloned as many times as you want.

To clone detected partitions:

1. Select a detected partition in the Recovery Explorer tree.
2. To clone the selected partition, do one of the following:
 - From the Recovery Explorer toolbar, click **Clone Partition**.
 - Right-click the selected partition and click **Clone** from the context menu.

To edit the boot sector template in detected partitions:

1. Select a detected partition in the Recovery Explorer tree.
2. To open the **Edit Boot Sector Template** dialog box, do one of the following:
 - From the Recovery Explorer toolbar, click **Edit Partition**.
 - Right-click the selected partition and click **Edit Partition** from the context menu.
3. In the **Edit Boot Sector Template** dialog box, edit the Primary or Copy Boot sectors separately or simultaneously by entering values in designated fields.

RESTORE PARTITIONS

We recommend that you restore a partition with a certainty status of "Acceptable" or higher).

Before you restore a partition, you may clone or edit the partition directly to adjust its properties.

Here are some rules to follow when restoring a partition:

1. Assigning a drive letter.

- Be aware of the location of executable files or files required by the operating system. Many MS-DOS and Windows programs refer to a specific drive letter when describing a path to executable files.
- Drives A: and B: are usually reserved for floppy disk drives, but you can assign these letters to removable drives if the computer does not have a floppy disk drive.
- Hard disk drives in the computer receive letters C through Z, while mapped network drives are assigned drive letters in reverse order (Z through B).

2. Setting the partition as active.

- You may set only a primary partition as active. You cannot set a logical drive (an extended partition) as active.
- To set a partition as active, the partition must have an MBR (Master Boot Record) as the first sector.
- A computer can only have one active partition per disk.
- The name commonly used for the partition that contains the startup files is the boot partition. The name commonly used for the partition that contains the operating system files is the system partition.
- The system partition can never be part of a striped volume, spanned volume, or RAID-5 volume
- The system partition must be a primary partition that has been marked as active for startup purposes. It must be located on the disk that the computer accesses when starting up the system.
- There can be only one active system partition on a disk at a time.
- You may have multiple basic disks and each disk can have one active partition, however the computer will only start from one specific disk. If you want to use another operating system, you must first mark its system partition as active before restarting the computer.
- You cannot mark an existing dynamic volume as active. However, you can convert a basic disk containing the active partition to a dynamic disk. After the disk is converted, the partition becomes a simple volume that is active. If the active partition is not the current system or boot partition it becomes a simple volume and loses its entry in the partition table, so it can no longer be active.

3. Creating an extended partition.

- A computer can only have one extended partition per physical disk device.
- You cannot create an extended partition on a disk if it already has four primary partitions.

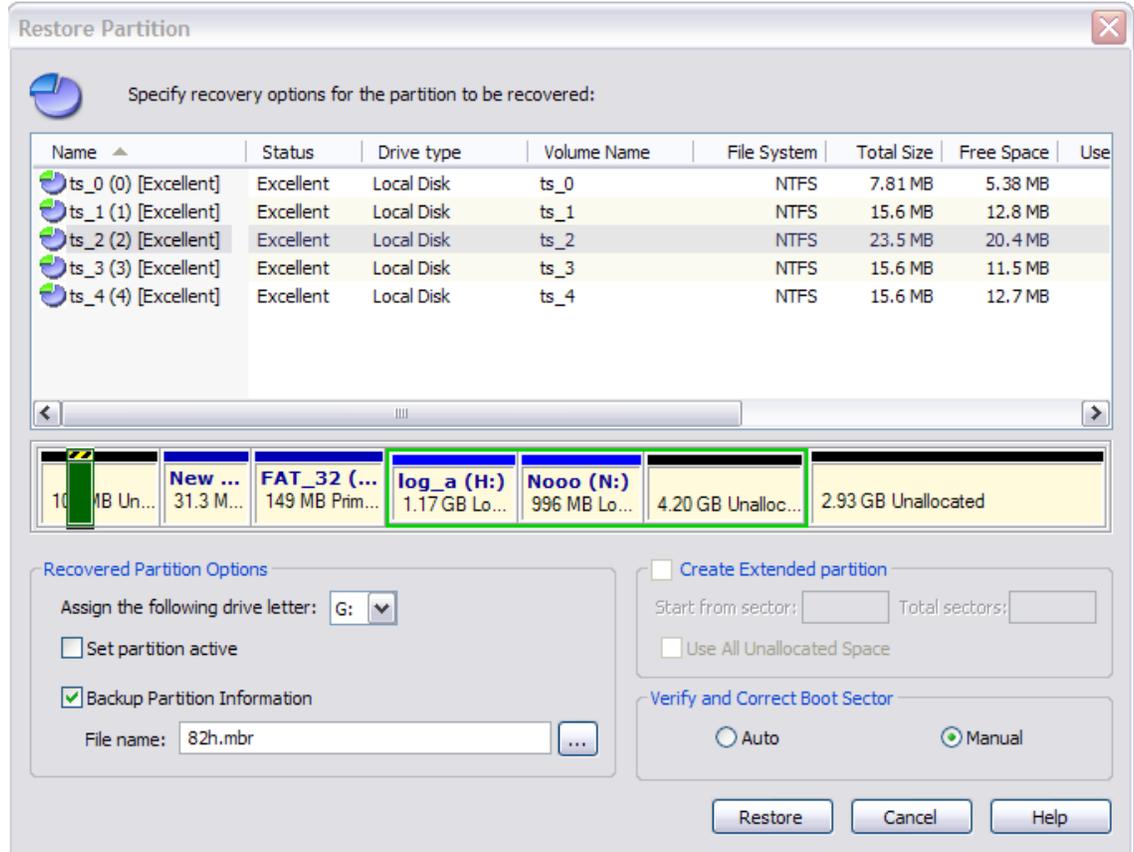
To restore a detected partition:

1. Select a detected partition in the Recovery Explorer tree.

Restore Partitions

- To open the **Restore Partition** dialog box, do one of the following:
 - From the Recovery Explorer toolbar, click **Restore Partition**.
 - Right-click the selected partition and choose **Restore Partition** from the context menu.

Restore Partition Dialog Box



- In the **Restore Partition** dialog box, specify options for recovery:
 - To select a different partition from the Device Scan without exiting this dialog, select one from the list. The selected partition appears on the device map, showing its relative position and size.
 - A selected partition that appears on the device map with a green border fits the unallocated space and can be recovered.
 - If the selected partition appears with a red highlight, then this partition overlaps with an existing partition and cannot be restored.
 - To assign a drive letter to the recovered partition, select a letter from the **Assign the following drive letter** drop-down list.
 - To set this partition as active, select the **Set partition active** check box.
 - To save partition information to a file for safety or for reference, select the **Backup Partition Information** check box and enter the path and file name in the **File name** field. To browse to the folder and record the path, click the ellipsis button (...).

- To create an extended partition, select the **Create Extended partition** check box.
- To automatically verify and correct the boot sector, select **Auto**.
- To verify and correct boot sectors records manually in a dialog box, select **Manual**.

RECOVER FILES AND FOLDERS

After you can see partitions on a device, the UNDELETE process consists of two stages.

- Stage 1 – Scan a logical drive
- Stage 2 – Search for deleted files and folders
- Stage 3 - Recover deleted files and folders

SCAN A LOGICAL DRIVE

Scanning logical drives is a required step for recovering files and folders – during the scan all deleted (and existing) file and folders are detected. There are two ways to scan a drive or a partition:

- Quick Scan – quick and sufficient in most scenarios.
- Low Level Scan - where files will be detected by a unique file signature.

QUICK SCAN

Quick Scan results are displayed in folders under the scanned drive node in Recovery Explorer and, optionally, in Document View.

To Quick Scan a logical drive:

1. In the Recovery Explorer tree pane or in the list pane, select a logical drive.
2. To open the **Scan Logical Drive** dialog box, do one of the following:
 - From the Recovery Explorer toolbar, click **Default Scan**.
 - Right-click the selected logical drive and click **Scan** from the context menu.
3. Choose **Quick Scan**.
4. To collect scan results in the Document View, select the **Show scan results in Document View** check box.
5. Click **Scan!** The **Processing...** dialog box appears.
6. To display scanning events and progress details, click **Details**.
7. To terminate the scan process, click **Stop** at any time. Results may be not accurate or complete.
8. After the scan completes, if you chose to show scan results in the Document View, the **Document View** appears.

9. To view hierarchical folders under the scanned drive node, select the **My Computer** tab. The Recovery Explorer view appears. The node label for the logical drive that was scanned is emphasized in bold.

For help with locating files in the Document View, see *Application Views and Windows* in Chapter 2. Getting Started.

LOW LEVEL SCAN

Low Level Scan results are displayed under a Scan Results node in Recovery Explorer. All found files are grouped by their file extension.

You may rescan logical drives as many times you want. All previous results will be lost and each scan result may vary.

A Low Level Scan is a more complex process and will take more time than a Quick Scan. You may save Low Level Scan results in a separate file and reuse the results in a new session.

To Low Level Scan a physical device or a logical drive:

1. In the Recovery Explorer tree pane or in the list pane, select a physical device or a logical drive.
2. To open the **Scan Logical Drive(s)** dialog box, do one of the following:
 - From the Recovery Explorer toolbar, click **Default Scan**.
 - Right-click the selected logical drive and click **Scan** from the context menu.
3. Choose **Low Level Scan**.
4. To modify list of file signatures to be searched:
 - g. Click **Options**. The **Select File Signatures** dialog box appears.
 - h. To restrict the search parameters, clear the check box next to each file type that you do not want to search for.
 - i. Click **OK**.
5. View the list of file signatures that will be reported in the **File Signatures** text box.
6. Click **Scan!** The **Processing...** dialog box appears.
7. To display scanning events and progress details, click **Details**.
8. To terminate the scan process, click **Stop** at any time. Results may be not accurate or complete.
9. After the scan completes, scan results appear in a **Scan Results** node in Recovery Explorer.

To save Low Level Scan results:

1. Under the **Scan Results** node, right-click a scanned logical drive and click **Save Scan Result** from the context menu. The **Save Scan Result** dialog box appears.
2. Browse to the folder where you want to save the file.

Search for deleted Files and Folders (Optional)

3. In **File name**, you may use the suggested file name, or you may change it.
4. Click **Save**.

WARNING: Save a scan results file to a physical drive that is different from the drive that contains the original files.

After you have completed your scan, continue with Stage 2.

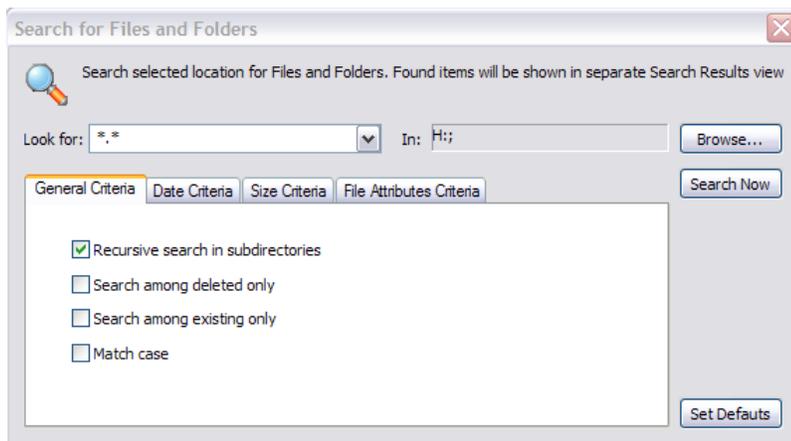
SEARCH FOR DELETED FILES AND FOLDERS (OPTIONAL)

To help you find deleted files in a long list of files from a scanned drive, you may search the list with specific search criteria and review results in a Search Results View.

To search a scanned drive for deleted Files and Folders:

1. Select a scanned Logical Drive or scanned Detected Partition.
2. To open the **Search for Files and Folders** dialog box, do one of the following:
 - From the main toolbar, click **Search**.
 - Right-click the selected item and click **Search** from the context menu.

Search for Files and Folders Dialog Box



3. In the **Look for** field, enter the text, along with wildcard symbols or regular expressions, for which you intend to search.
4. The search path appears in the **In** field. To change the search path, click **Browse...** and select the drive.
5. To set options in the **General Criteria** tab:
 - To search the root level of the drive and all sub folders, select the **Recursive search in subdirectories** check box. To search only the root folder, clear this check box.
 - To display only files that are deleted or damaged, select the **Search among deleted only** check box.
 - To display only files that are not deleted, select the **Search among existing only** check box.

- To display files that match upper and lower case letters in the **Look for** field, select the **Match case** check box.
- 6. To display files by a specified date, in the **Date Criteria** tab, in the **Date Type** drop-down list, choose a type and select a date range.
- 7. To display files by a specified file size, in the **Size Criteria** tab, select **Small**, **Medium** or **Large**, or specify the size range in KB.
- 8. To display files based on file attributes, in the File Attributes Criteria tab, click **Selected Attributes Only** and select the check box next to all attributes that you want to search for.
- 9. To change all settings back to default settings, click **Set Defaults**.
- 10. Click **Search Now**. The **Processing...** dialog box appears.
- 11. To display disk image events and progress details, click **Details**.
- 12. To terminate the disk image process, click **Stop** at any time. Results may be not accurate or complete.
- 13. After the search is complete, a **Search Results** view appears.

You may repeat a search many times and refine the search criteria for better results.

Note: The search pattern wildcard symbols use the same pattern that you use when searching in Windows.

The asterisk (*) in the pattern means that at this place can be zero or any other symbol. For example:

- * - all files on the drive or in the folder
- *.TXT - all files with "TXT" extension
- My*.* - all files starting with "My"
- MyFile.txt - search for the file named "MyFile.txt"

For information about the Search Results view, see *Application Views and Windows* in Chapter 2. Getting Started.

You may use File Filter to improve search results. For more information see *File Filter Toolbar* in the Appendix.

RECOVER FILES

Recovering deleted files and folders is one of essential features of Active@ UNDELETE. There are two main methods for recovering detected files and folders:

- **Recover from application views.** Recovery Explorer, Document View and Search Result Views display files, which you can recover directly from the view.
- **Recover using the Recovery Toolbox.** You may collect files and folders in the Recovery Toolbox from various sources and recover them all at once.

WARNING: Save recovered files or folders onto a different drive from where the original damaged or deleted files or folders exist.

RECOVER FROM APPLICATION VIEWS

You may recover damaged or deleted files and folders directly from Recovery Explorer, Document View and Search Result View.

To recover files from views:

1. In the view list, click a file or folder to select it.
2. You may select multiple files or folders.
 - To select consecutive files or folders in a list, select the first item and press **SHIFT** while you select the last item.
 - To select non-consecutive files or folders, select the first item and press **CTRL** while you select each other item.
3. To open the **File and Folder Recovery** dialog box, do one of the following:
 - From the Recovery Explorer toolbar, click **Recover Files and Folders**.
 - Right-click selected files and click **Recover** from the context menu.
4. In the **File and Folder Recovery** dialog box, specify the destination path to save recovered files and other options and click **Recover**. The **Processing...** dialog box appears.
5. To display recovery events and progress details, click **Details**.
6. To terminate the recovery process, click **Stop** at any time. Results may be not accurate or complete.

RECOVER USING THE RECOVERY TOOLBOX

You can select files from different views in the Active@ UNDELETE workspace and collect them in the Recovery Toolbox. To select files, select the check box next to the file name in Recovery Explorer, Document View or Search Results view. To remove files from the Recovery Toolbox, clear the check box in these three views.

You may recover the collection of files and folders in the Recovery Toolbox all at once. There are two methods for recovering files:

- Recover files to a hard disk.
- Recover files to a CD or DVD.

To recover files to a hard disk:

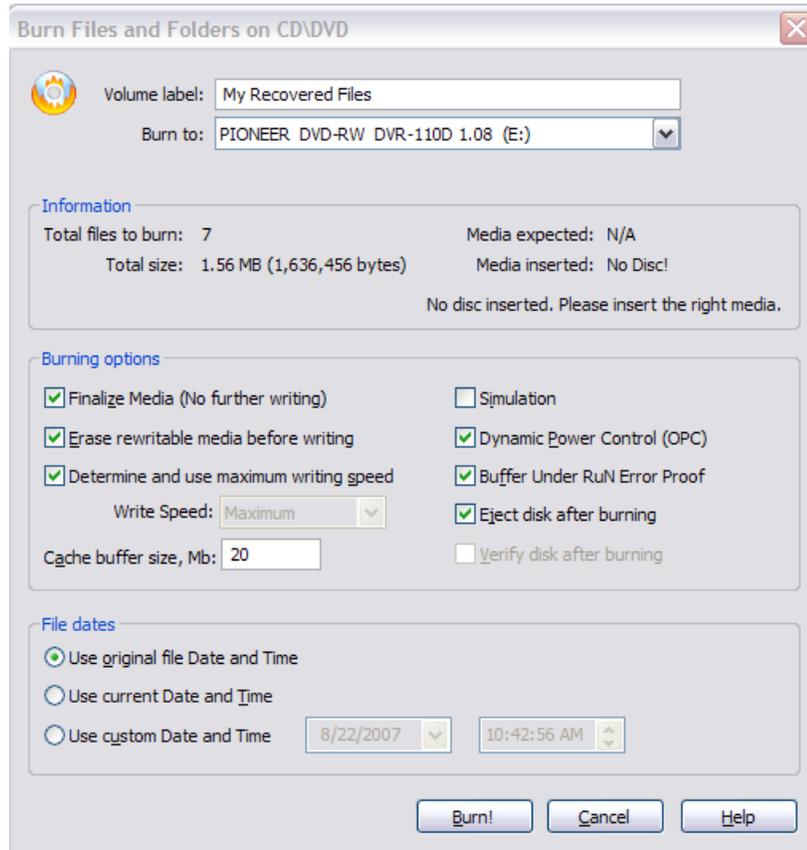
1. To collect files in the **Recovery Toolbox**, select the check box next to the file name or folder name in **Recovery Explorer** view, **Document View** or in **Search Result** view. Folder hierarchy for selected files are preserved in the **Recovery Toolbox**.
2. Select the **Recovery Toolbox** tab.
3. Click **Recover all items in Recovery Toolbox**. The **File and Folder Recovery** dialog box appears.
4. In **Destination path**, enter the path to the folder where you want to save recovered files. To browse to the folder and record the path in this field, click the ellipsis button (...).

5. To use the same file name for each recovered file, click **Use original file names**.
6. To rename each file, click **Rename files to** and enter a file name prefix. Each file will be named with this prefix and a sequential number.
7. If you are writing recovered files back to the same folder where the original files were, you might encounter existing files with the same name. Decide what to do in each case in **If file already exist**.
8. To automatically replace invalid characters in a recovered file name:
 - j. Select the **Replace invalid file name symbols** check box.
 - k. Enter a valid character in the field. The standard character is underscore (_).
9. To save recovered files and folders on the same drive as the source data, select the **Allow to recover to the same drive** check box.
10. To display the destination folder after recovery, select the **Browse destination folder after recovery completes** check box.
11. Click **Recover**. The **Processing...** dialog box appears.
12. To display recovery events and progress details, click **Details**.
13. To terminate the recovery process, click **Stop** at any time. Results may be not accurate or complete.
14. If you chose to display the destination folder after recovery, the destination folder appears.

To recover files to a CD or DVD:

1. To collect files in the **Recovery Toolbox**, select the check box next to the file name or folder name in **Recovery Explorer** view, **Document View** or in **Search Result** view. Folder hierarchy for selected files are preserved in the **Recovery Toolbox**.
2. Select the **Recovery Toolbox** tab.
3. Click **Burn**. The **Burn Files and Folder on CD\DVD** dialog box appears.

Burn Files and Folders on CD\DVD Dialog Box



4. To change the volume label on the CD, enter the label in **Volume label**.
5. To select another burning device, choose it in the **Burn to** drop-down list.
6. To burn an ISO image:
 - a. In the **Burn to** drop-down list, choose **ISO Image**. The **ISO File Name** field appears.
 - b. Enter the path to the folder where the ISO image will be created. To browse to the folder, click the ellipsis button (...).
7. Specify burning options and file date preferences.
8. Click **Burn!** The **Processing...** dialog box appears.
9. To display recovery events and progress details, click **Details**.
10. To terminate the recovery process, click **Stop** at any time. Results may be not accurate or complete. The disk will likely be unreadable, if you stop.

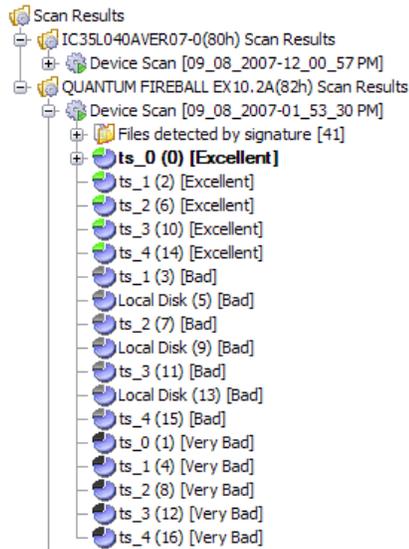
For a description of burning options in the Recovery Toolbox, see *Application Preferences* in Chapter 2. Getting Started.

USING SCAN RESULTS

The information in this chapter can be used for either a physical device scan or for a logical drive or partition scan.

After you have completed a device scan, a Scan Results branch appears in the Recovery Explorer tree. Detected partitions are listed in order of their certainty.

Scan Results Display Order of Certainty



There are 12 attributes that define a partition. In some cases, the application cannot be certain that the found item actually is a partition. The rating in the order of certainty depends on how many attributes are found and what condition they are in.

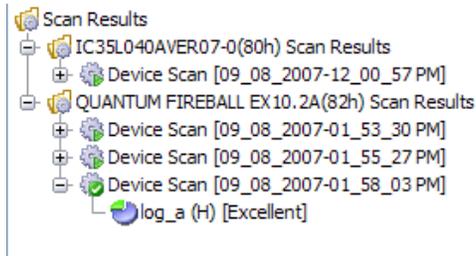
You may perform the following actions on partitions in the Scan Results branch:

- Stop and Resume a Scan
- Save and Load Scan Results
- Restore Scan Results

STOP AND RESUME A SCAN

To stop a physical device scan at any time, press Stop. After you stop a scan, a Scan Results branch appears in the Recovery Explorer tree.

Example Stopped Scan Results



The example above shows how incomplete scan results are indicated. An icon appears next to each node in the Scan Results branch.

-  - Device scan was terminated and can be resumed
-  - Device scan was completed

To resume a terminated scan:

1. Select a device scan result under the **Scan Results** branch.
2. To resume the scan, do one of the following:
 - From the Recovery Explorer toolbar, click **Resume Device Scan**.
 - Right-click the selected device scan and click **Resume Scan** from the context menu.

SAVE AND LOAD SCAN RESULTS

It can take a long time to run a Default Disk Scan or a Low Level Disk Scan. Because you are dealing with a large volume of information, you might not be able to review all the data in one session.

So that you do not have to scan a partition again, you can save and re-use valuable scan results. You can save entire Scan Results branch or make separate save for each Disk Scan or all scan set for particular device.

Scan results are saved with the file extension SCANINFO.

WARNING: Save a scan results file to a physical drive that is different from the drive that contains the original files.

To save scan results:

1. To save the entire **Scan Results** branch, select the branch.
2. To save a device node, select it under **Scan Results**.
3. Right-click the selected node and click **Save Scan Result** from the context menu. The **Save Scan Result** dialog box appears with the default path and a suggested file name.
4. To change the file path, browse to a different folder.
5. To change the file name, enter a name in the **File name** field.
6. Click **Save**.

To load saved scan results:

7. To open the **Load Scan Results** dialog box, do one of the following:
 - From the **File** menu, click **Open > Scan Result...**
 - Right-click the logical drive node and click **Load Scan Result** from the context menu.
 - If there is a **Scan Results** branch in the Recovery Explorer tree, right-click the **Scan Results** branch or right-click a **Scan Results** node and click **Load Scan Result** from the context menu.
8. Browse to the folder that contains the scan result file and select the file.
9. Click **Open**.

The data from the scan results file appears in a Scan Results node in the Recovery Explorer tree.

REMOVE SCAN RESULTS

Data in the Scan Results branch is copied from the original physical device. You may remove any node – including detected partitions - from the Scan Results branch without harming the data on the original physical device.

To remove scan results:

1. To remove the entire **Scan Results** branch, select the branch.
2. To remove a device node, select it under **Scan Results**.
3. Right-click the selected node and click **Remove Scan Result** from the context menu.

The selected node is removed from the Recovery Explorer tree.

4. ACTIVE@ UNDELETE – ENTERPRISE EDITION

Active@ UNDELETE Network Edition allows application ("Client") to connect to the remote computer ("Server") by using Active@ Remote Recovery Agent and:

- Scan drives and devices
- Search for Files and Folders
- Preview deleted Files
- Recover deleted Files and Folders on remote machine and much more...

The remote computer must be running the Active@ Remote Recovery Agent to let the host computer to get access to its file structure. After establishing the connection, you can navigate through drives and folders of the remote computer in the same way that it works for a local computer.

CONNECT TO ACTIVE@ REMOTE RECOVERY AGENT

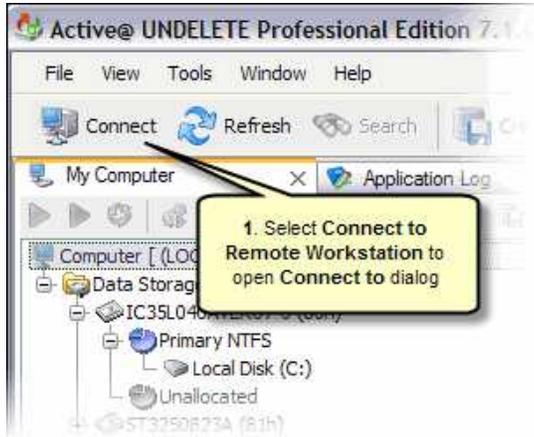
If you are using the Active@ UNDELETE Enterprise Edition you be able to connect to Active@ Remote Recovery Agent to recover files on (from) remote computer. Active@ Recovery Agent is a small utility that provides recovery features over a network environment.

The computer that you want to connect to must have Active@ Remote Recovery Agent running with status **Enabled**. After you establish connection through the network, then you can scan and browse the Files and Folders of the remote computer and select them for recovery. You can recover files locally (copy recovered files from remote computer to the one where Active@ UNDELETE is running) or remotely, e.g. recovered files will be stored on a computer where they were actually recovered.

ESTABLISH THE CONNECTION TO REMOTE COMPUTER

1. Open **Connect to Active@ Remote Recovery Agent** dialog in one of the following ways:
 - From the **Files** menu choose **Connect...** command.
 - From the Recovery Explorer toolbar, click **Connect** button.

Connect to Active@ Remote Recovery Agent



2. In Connect to Active@ Remote Recovery Agent dialog do the follows:
 - Select a workstation from a drop-down list of network neighborhood computer names or
 - Type a computer name or computer IP address or a name into the combo box text field and press [Enter] to connect.
3. Click **Connect** button to establish connection with Active@ Remote Recovery Agent on computer you selected. Once connection is set, you will be able to see Physical Disks and Drives of remote computer ready to be scanned for deleted Files and Folders.

Note:

Click **Browse for Computer** button, located on the right side of the neighborhood computers drop-down list, to find and choose computer outside of workgroup or domain;

Click **Options...** button to change connection options. See *Remote Recovery options* for details.

WARNING: If the remote computer has **Active@ Remote Recovery Agent** protected with a password, you will need to specify the same password in Remote Recovery Options to be able to make connection. If the password you enter matches the password defined for **Active@ Remote Recovery Agent** the connection will be established.

ACTIVE@ RECOVERY AGENT OVERVIEW

The **Active@ Remote Recovery Agent** provides unique ability (as a "server") to let **Active@ UNDELETE** application (act as a "client") to do remote scan, search, recover and other operations with remote computers.

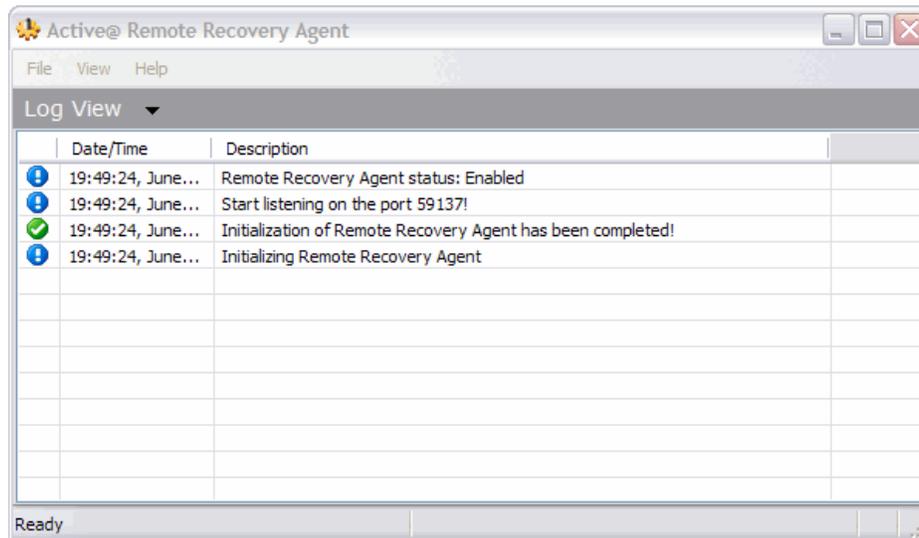
This is very simple to use **Active@ Remote Recovery Agent**: run it as an application (you can keep it as open window or minimize it, - in that case you can access the application at any time in "System Tray" area).

Active@ Remote Recovery Agent has a few options that you can use to configure the application in appropriate manner. See *Remote Recovery options* for details.

USING ACTIVE@ REMOTE RECOVERY AGENT

To start the application from the Windows click **Start** button, click **Programs > LSoft Technologies**. Click **Remote Recovery Agent** from the programs menu.

When it starts, the window shown below appears:



In this Log View screen, transaction information is shown, along with a brief description of each activity.

The Active@ Remote Recovery Agent window can be minimized to small icon in "System Tray" as shown below:



This icon changes, according to different activity states of the application. Usually the icon flashes when the status changes.

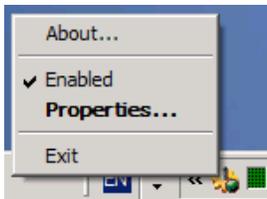
SYSTEM TRAY ICON ACTIVITY STATES

-  Application in **Disabled** state. It cannot receive and response on any request from Active@ UNDELETE Client.
-  Application in **Enabled** state. It ready to receive and response on any request from Active@ UNDELETE Client.
-  Application in **Connected** state. It currently on line with Recovery Toolkit Client and processing scanning, recovery and other commands from the client.
-  This icon indicates, that **Active@ Remote Recovery Agent** processing requests from **Active@ UNDELETE Client**. Usually it flashes also when change the status.

To let Active@ UNDELETE ("client") to connect to **Active@ Remote Recovery Agent** its status should be set to **Enable** mode. It can be done in either ways:

- Click **File > Enable** in command toolbar.
- Right-click the **Remote Recovery Agent** icon in the SysTray. Click **Enable** from the context menu.

By right click on this icon, gives an access to context menu, where you can choose to restore window, **Enable\Disable** or **Exit** application.



REMOTE RECOVERY OPTIONS

The Active@ Remote Recovery Agent allow specifying following settings:

The screenshot shows a configuration window with three main sections:

- Connection Options:**
 - Port number, used to establish Remote Recovery: 59137
 - Port number, used to RPC calls: 59139
 - Enable Remote Recovery Agent at Start
- Authorization:**
 - Use password for connection validation
 - Password: [masked]
- Log View Options:**
 - Show service messages in Log View
 - Auto-save log entries

Buttons at the bottom right: Set Defaults, Apply

CONNECTION OPTIONS

Port Number

The number of the communication port reserved for the TCP connection between **Active@ Recovery Agent** and **Active@ UNDELETE**. After applying changes, **Active@ Recovery Agent** is restarted immediately.

WARNING: If you have firewall activated, make sure that ports numbers you selected are not blocked.

Enable Active@ Remote Recovery Agent at Start.

With this check box selected, **Active@ Recovery Agent** allows connection with **Active@ UNDELETE** as soon as the agent starts.

AUTHORIZATION

Use password for connection validation

With this check box selected, the connection request from the client is password protected and validated against the matching password entered in **Active@ Recovery Agent**.

LOGVIEW OPTIONS

Show service messages in Log View

Display traces events with high details

Auto-save log entries

With this option on, all events will be saved in log file on disk, by default, in directory where Active@ Recovery Agent is installed.

5. ACTIVE@ UNDELETE TOOLS

DISK IMAGE

With Active@ UNDELETE you can create a raw Disk Image of logical drives and part of or a whole physical data storage device. A raw Disk Image contains an exact, sector-by-sector copy of a single partition or disk.

A raw Disk Image consists of two files: a configuration file and data file (or files). The configuration file describes the disk or partition geometry and keeps the image description. This file has the .DIM extension. When verifying or exploring a raw image, select this file.

The raw Disk Image data files have numerical extensions starting from .001 added to the whole image name.

Here is an example: If you save a raw disk image with the name MyImage, the application creates a file named MyImage.dim. This is the configuration file. Data is stored in a file named MyImage.dim.001. If more than one file is created, the next file is named MyImage.dim.002, and so on.

The data file can be split in several files – chunks that can be useful if you want to save the Disk Image on a CD or Data DVD.

WHEN TO USE DISK IMAGE

Raw disk images are very helpful in a data recovery. Here are some reasons why a raw disk image can be used for data recovery:

- Data recovery technologies are based on searching the unused space on a partition for traces of deleted, lost or damaged files and folders. So-called "unused space" on a partition is not recognized by the file system and is not saved to a regular disk image. However, this space does contain valuable data information and it is saved to a raw disk image.
- The uncompressed raw disk image file contains a sequence of sectors that is unchanged from the original. There are no headers or other application-specific identifiers added. As a result, the raw disk image can be viewed by any data rescue software as a mirror of your drive. If the integrity of the data on your live disk is questionable, you may want to experiment with the data on the partition image instead.
- If file size is an issue, a compressed raw image may be used. Active@ Undelete is an example of data recovery software which can work with both compressed and uncompressed raw images.
- Raw images have no regard for the file system type. During the raw disk image recording process, all sectors are backed up. An image of any partition can be restored by using Active@ Disk Image software.

Disk Image

- If you want the data from a file to be restored from the disk image to the same exact location as they were before, then use a raw disk image. A regular image saves all current data but restores files to different sectors, allowing the partition to shrink or grow, depending on the size of the replaced file. In a regular situation, you should not be concerned about partition size. If the partition size is important, however, a raw image is the solution.

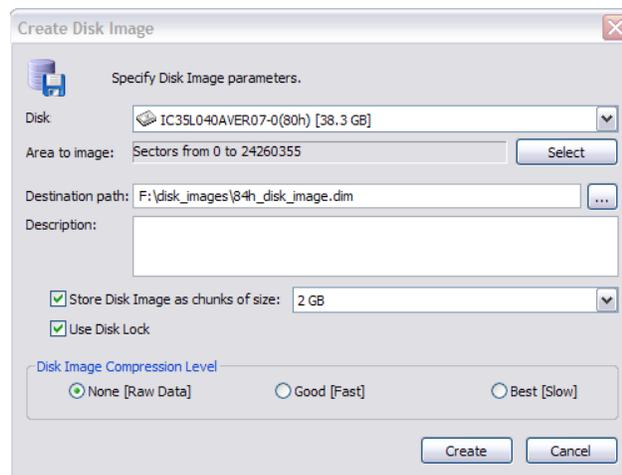
CREATE A DISK IMAGE

Using Active@ UNDELETE you can create a Disk Image of a logical Drive or a Physical Device.

To create a Disk Image:

1. In Recovery Explorer, select a logical drive, a partition or a physical device.
2. To open the **Create Disk Image** dialog box, do one of the following:
 - From the Tools menu, choose Disk Image > Create.
 - From the Recovery Explorer toolbar, click **Create Disk Image**.
 - Right-click the selected item and click Create Disk Image from the context menu.

Create Disk Image Dialog Box



3. In the Create Disk Image dialog box, do the following:
 - To change the selected disk, choose one from the **Disk** drop-down list.
 - To specify an area to image, click **Select**. The **Select Disk Area** dialog box appears. Indicate the first and last sectors and click **OK**.
 - Enter the path to the destination folder in **Destination path**. To browse to the path, click the ellipsis button (...). If the disk image is saved in chunks, all chunk files will be created in the same folder.
 - Enter a brief description about this disk image for future reference.

- To split the disk image into files of a specific size, select the **Store Disk Image as chunks of size** check box and select the size from the drop-down list.
 - To lock the selected disk and prevent any read or write activity during the disk image, select the **Use Disk Lock** check box.
 - Indicate the disk compression level. To make the disk image compatible with any third party applications, choose None [Raw Data].
4. Click **Create**. The **Processing...** dialog box appears.
 5. To display disk image events and progress details, click **Details**.
 6. To terminate the disk image process, click **Stop** at any time. Results may be not accurate or complete. The disk image will likely be unreadable, if you stop.

Note: The file extension for a Disk Image configuration file is .DIM by default.

Important: The Destination Path for a Disk Image file must always be on another drive.

File systems such as FAT16 and FAT32 do not support file sizes larger than 2GB and 4GB respectively. With these file systems it is not possible to create a Disk Image file for a drive as it is likely to grow larger than the size limit. The solution in this case is to do one of the following:

- Use a Destination Path drive that is formatted using Windows NT, Windows 2000, Windows XP and using NTFS
- Create a Disk Image that is split into chunks of an appropriate size, keeping within the limits set by the file system

OPEN A DISK IMAGE

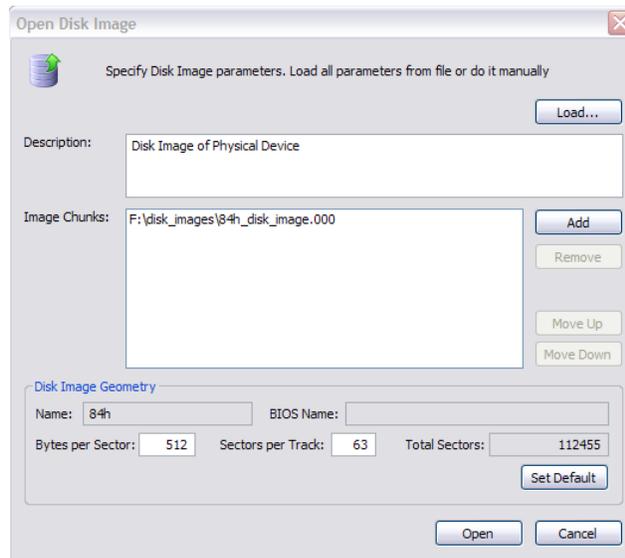
You may open a Disk Image to browse for files and folders or to scan for deleted files and folders.

To open a Disk Image file:

1. To open the **Open Disk Image** dialog box, do one of the following:
 - From the **Tools** menu, choose **Disk Image > Open...**
 - From the main toolbar, click **Open Disk Image**.

Disk Image

Open Disk Image Dialog Box



2. In the **Open Disk Image** dialog box, click **Load** and select the .DIM (Disk Image Configuration) file.
3. If the .DIM file does not exist, to add a binary file click **Add** and select the image chunk files.
4. To change the order of a file in the list, select it and click either **Move Up** or **Move Down**.
5. If you are opening a disk image from a .DIM file, values in Disk Image Geometry appear.
6. If you are opening a disk image from binary files, click Set Default. values in Disk Image Geometry appear.
7. Click **Open**. A node appears in Recovery Explorer.

You may perform all tasks on this node that are applicable for a drive, a device or a partition.

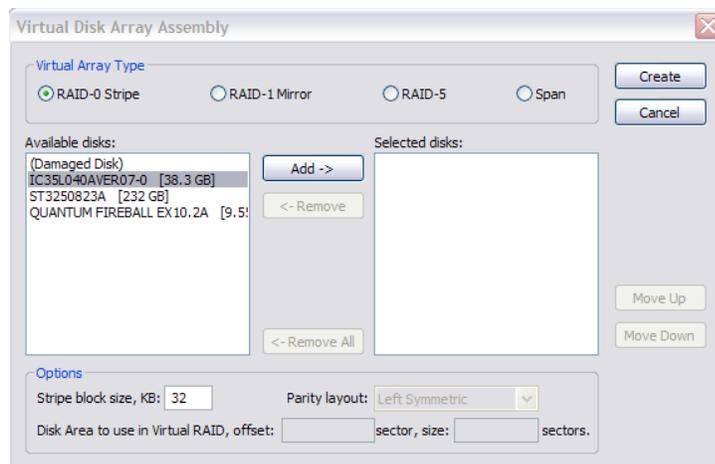
WORKING WITH A CORRUPTED RAID SYSTEM

If you have a corrupted RAID configuration and one or more drives in the array are damaged, you can combine the healthy drives together with the damaged drives in a virtual disk array. If the damaged drives are inaccessible, you can substitute a "dummy" drive as a replacement. Active@ UNDELETE simulates the RAID assembly and you can scan this virtual array as a logical device.

To create a Virtual Disk Array:

- To open the **Virtual Disk Array Assembly** dialog box, do one of the following:
 - From the Tools menu, choose **Virtual Disk Array (RAID)**.
 - From the main toolbar, click **RAID**.

Virtual Disk Array Assembly Dialog Box



- Specify the virtual array type.
- To select disks, do one of the following:
 - Double-click a disk in the **Available disks** list to move it to the **Selected disks** list.
 - Click a disk in the **Available disks** list to select it. To move it to the **Selected disks** list, click **Add**.
- To change the order of a disk in the **Selected disks** list, select it and click **Move Up** or **Move Down**.
- To remove a disk from the **Selected disks** list, do one of the following:
 - Double-click a disk in the **Selected disks** list.
 - Click a disk in the **Selected disks** list. To remove it, click **Remove**.
- To remove all disks from the **Selected disks** list, click **Remove All**.

Virtual Partition (Logical Drive Clone)

7. In **Stripe block size**, specify the stripe block size in kilobytes (Stripe and RAID-5 arrays only).
8. If RAID5 is recognized, select a parity layout from the **Parity layout** drop-down list.
9. In some cases, you may be able to specify **Disk Area to use in Virtual RAID**. To do so, enter the first sector and the area size in sectors.
10. Click **Create**. The **Processing...** dialog box appears.
11. To display creation events and progress details, click **Details**.
12. To terminate the creation process, click **Stop** at any time. Results may be not accurate or complete.
13. If a virtual disk array is created successfully, a new node appears in Recovery Explorer tree.
14. If a virtual disk array is not created, or if it is created with errors, return to step 1 and try again with different disks, or with a different disk order and RAID options.

Parity Layout Choices for RAID5 Array

Left Synchronous				Left Asynchronous				Right Synchronous				Right Asynchronous			
0	5	6	P	0	3	6	P	P	5	6	11	P	3	6	9
1	4	P	11	1	4	P	9	0	P	7	10	0	P	7	10
2	P	7	10	2	P	7	10	1	4	P	9	1	4	P	11
P	3	8	9	P	5	8	11	2	3	8	P	2	5	8	P

VIRTUAL PARTITION (LOGICAL DRIVE CLONE)

A virtual logical partition is a copy (a clone) of a logical drive using a defined geometry that emulates a real logical drive or partition. If you have a logical drive that is recognized by Windows, and you cannot access the data in that drive, you may be able to gain access to your data by creating a virtual partition copy.

To create a Virtual Partition:

1. In **Recovery Explorer**, select a logical drive or a partition and do one of the following:
 - From the Recovery Explorer toolbar, click **Clone Partition**.
 - Right-click the selected item and click **Clone Drive Info** from the context menu.
2. A partition copy appears under the corresponding physical device item.

You can execute all tasks applicable to a logical drive on this drive copy, including Modify Partition command.

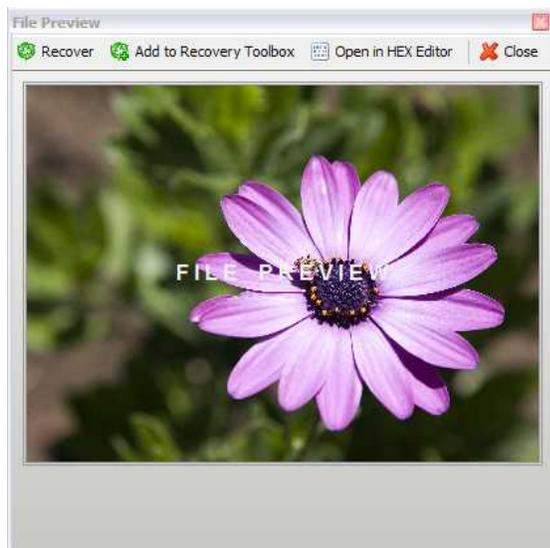
To alter the properties of a virtual drive, do one of the following:

1. Select a Virtual Partition item.
2. To open the **Edit Boot Sector Template** dialog box, do one of the following:
 - From the Recovery Explorer toolbar, click **Edit Partition**.
 - Right-click the selected item and click **Modify Partition** from the context menu.
3. In the **Edit Boot Sector Template** dialog box, make changes to **Boot Sector Primary** and **Boot Sector Copy** separately or simultaneously.
4. Click **Save**.

PREVIEW IMAGE FILES

File Preview allows you to view the contents of an image file (jpg, bmp, gif, png etc.) before you recover the file.

File Preview Dialog Box



Preview files are shown in a separate window.

To open the File Preview dialog box from any view, do one of the following:

- Double-click an image file.
- Right-click an image file and click **File Preview** from the context menu.

- Select an image file and click **File Preview** from the main toolbar.

To recover a file from the File Preview dialog box, do one of the following:

- Click **Recover**.
- Right-click anywhere in the preview window and click **Recover** from the context menu.
- To add the preview file to Recovery Toolbox, click **Add to Recovery Toolbox**. You may recover this file along with all other files in Recovery Toolbox.

Note: If the preview file is not an image file, it appears in hexadecimal and text mode.

To open a preview file in Hex Editor, do one of the following:

- Click **Open in Hex Editor**.
- Right-click anywhere in the preview window and click **Open in Hex Editor** from the context menu.

Note: To change File Preview options, open the Preferences dialog box. For more information, see *Application Preferences* in Chapter 2, Getting Started.

HARDWARE DIAGNOSTIC FILE

If you want to contact our technical support staff for help with file recovery, a file that contains a summary of your local devices is helpful. Active@ UNDELETE allows you to create a summary listing file in XML format. This data format is "human-readable" and can help our technical support staff analyze your computer configuration or point out disk failures.

To create a hardware diagnostic file:

1. From the **File** menu, click **Save Hardware Info As...**

Note: To save time when contacting our technical support staff, we highly recommend that you provide us with a hardware diagnostic file.

HEX EDITOR

OVERVIEW

Hex Editor is advanced tool for viewing and editing sectors of Physical Disks, Partitions and contents of any file type.

Hex Editor uses a simple, low-level disk viewer which displays information in binary and text modes at the same time. You can use this view to analyze the contents of data storage structure elements such as:

- Hard disk drives
- Floppy drives
- Partitions
- Files
- Other objects

To open any of these items in the editor:

1. In the Active@ UNDELETE Recovery Explorer tree pane or file pane select an item.
2. Do one of the following:
 - From the **Edit** menu, click **Open In Hex Editor**.
 - Right-click the item and click **Open In Hex Editor** from the context menu.

Hex Editor shows detailed information about the selected object in the information panel on the left side of the view. The right panel displays the binary and text view of the file.

After the Hex Editor view appears, you may browse through the content of the open item using the scroll bar, keyboard arrows or the mouse wheel.

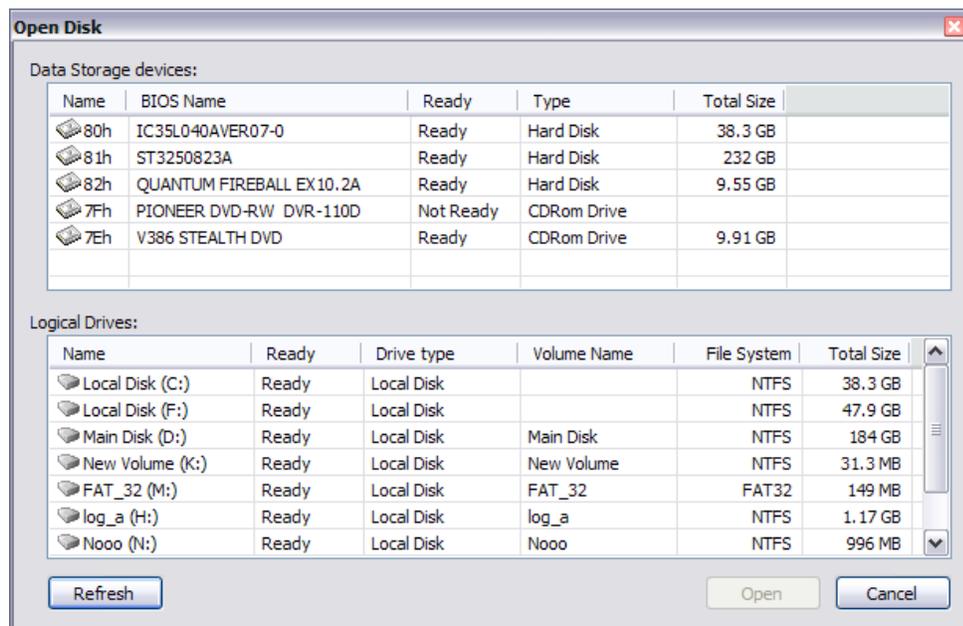
Click either the binary area or the text area to focus on it. You may also use the Tab keyboard key to switch the focus between hexadecimal and text modes.

OPEN OBJECTS FOR EDITING

You can open a physical disk, a logical drive and partitions or a file from any of the application views (for example, Recovery Explorer view or Documents view).

From the Hex Editor view, to open a disk for editing:

1. From the Hex Editor toolbar, click **Open Disk**. The **Open Disk** dialog box appears.



2. Select a physical disk or a logical drive.
3. Click **Open**. The selected object appears in Hex Editor.

WARNING: As with any advanced tool, use “advanced caution” with Hex Editor. Changes that you make may affect disk structure integrity. You must be certain that the changes you make are in line with correct data structures before you save changes.

SUBJECT NAVIGATION AND INFORMATION

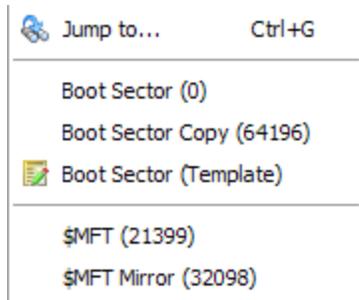
After you have opened an object with Hex Editor, you may navigate by scrolling block by block, or by “jumping” directly to specific addresses. You may jump to disk system records, such as the boot sector (primary and copy) or partition table. In a file’s cluster chain list, you may jump to the first cluster of a continuous cluster chunk when working with a file.

To open the Navigate menu, do one of the following:

- In the Hex Editor toolbar, open the **Navigate** drop-down menu.
- Right-click in the editor pane and open the **Navigate** submenu in the context menu.

The selections that appear depend on the type of object that you are editing.

Example Navigate Menu Selections



NAVIGATE A PHYSICAL DISK

To navigate to the disk system records of a physical disk, open the Navigate menu.

To open the Navigate menu, do one of the following:

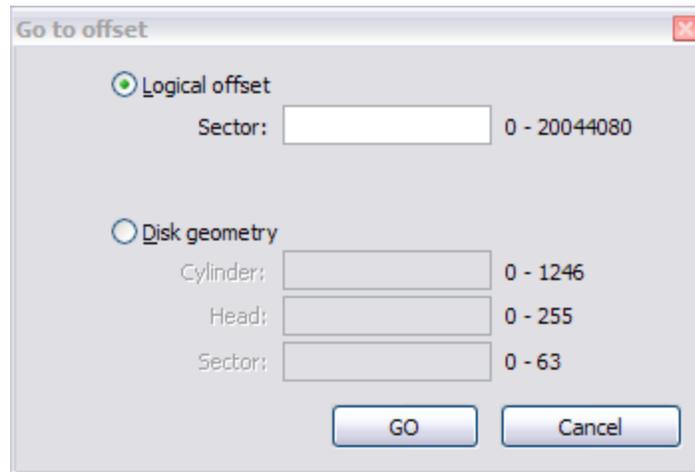
- In the Hex Editor toolbar, open the **Navigate** drop-down menu.
- Right-click in the editor pane and open the **Navigate** submenu in the context menu.

Note: To open the disk system record in a template dialog, select menu item marked with icon and the word **Template**. For more information about templates, see *Editing using Templates*, later in this chapter.

To navigate to a particular area on a physical disk:

1. To open the **Go to offset** dialog box, do one of the following:
 - From the **Navigate** menu, click **Jump To...**
 - Right-click in the editor pane and choose **Navigate > Jump To...** from the context menu.

"Go to Offset Dialog Box for a Physical Disk



- To jump to an exact sector (address) offset, select **Logical offset** and enter the exact sector value in the **Sector** field.
- To specify disk geometry, select Disk Geometry and enter the number of cylinders, heads and sectors in the appropriate fields. To help you enter these values, the minimum and maximum values appear to the right of each field.

NAVIGATE A LOGICAL DRIVE

To navigate to disk system records of a logical drive, open the Navigate menu.

To open the Navigate menu, do one of the following:

- In the Hex Editor Toolbar, open the **Navigate** drop-down menu.
- Right-click in the editor pane and open the **Navigate** submenu in the context menu.

Note: To open the disk system record in a template dialog, select menu item marked with icon and the word **Template**. For more information about templates, see *Editing using Templates*, later in this chapter.

To navigate to a particular area on a logical drive:

- To open the **Go to offset** dialog box, do one of the following:
 - From the **Navigate** menu, click **Jump To...**
 - Right-click in the editor pane and choose **Navigate > Jump To...** from the context menu.

"Go to Offset" Dialog Box for a Logical Drive

- To jump to an exact offset, select **Logical Offset** and enter the exact value in sectors or clusters. To help you enter these values, the minimum and maximum values appear to the right of each field.

NAVIGATE THE CLUSTER CHAINS OF A FILE

File Cluster Chain

To help navigate through the content of open files, file cluster information is displayed at the left side of the editor under the object description. You can select any cluster in this list jump immediately to that cluster or simply scroll through the list to view selected cluster content.

To navigate to a particular area of a file:

- To open the **Go to offset** dialog box, do one of the following:
 - From the **Navigate** menu, click **Jump To...**
 - Right-click in the editor pane and choose **Navigate > Jump To...** from the context menu.
- To jump to an exact offset, select **Logical Offset** and enter the exact value in sectors. To help you enter these values, the minimum and maximum values appear to the right of the field.
- To navigate through files cluster chain blocks (continuous file clusters) click **File Cluster Chain**.

Hex Editor

Example File Cluster Chain List

File Cluster Chain ×			
Offset	First Cluster	Last Cluster	Total Clusters
0	82327	83849	1523

DATA INSPECTOR

Data Inspector is a small table window that provides the service of “inspecting” (or interpreting) data currently selected in the edit pane. The Data Inspector table lets you view the type of data you have selected. This may help you interpret data as displayed in Disk Hex Editor.

The Data inspector window disappears when you click on another area in the explorer, and appears again when you return to the Hex Editor.

There are ten types to choose from.

Example Data Inspector Table

Data Inspector	
EB 52 90 4E 54 46 53 20	
Signed 8bit	-21
Unsigned 8bit	235
Signed 16bit	21227
Unsigned 16bit	21227
Signed 32bit	1318081259
Unsigned 32bit	1318081259
Signed 64bit	2329282760189956843
Binary	11101011
Float	1.210677e+009
Double	5.75029834011922e-153

To open the Data Inspector:

1. Right-click in the edit panel and choose Data Inspector from the context menu.

To change the way Data Inspector displays information:

1. Right-click anywhere in the Data Inspector window.
2. To show or hide any of the types displayed in Data Inspector:
 - Select **Show**.
 - Clear the check mark next to a type that you want to hide.
 - Select a cleared type to show it.
3. To change the way that values are displayed, in the context menu, choose one of:
 - **Octal view**
 - **Hexadecimal view**
 - **Decimal view**
4. To hide Data Inspector, choose **Hide** from the context menu.

EDITING WITH HEX EDITOR

Hex Editor allows you to edit the content of a selected part of an opened object. By default, Hex Editor shows content of an object in **Read Only** mode that prevents accidental modifications. In **Edit** mode, you can change content of the opened file or disk and all modifications are stored in memory.

Changes are written to the drive when you click **Save**.

To toggle between Read Only and Edit modes, do one of the following:

- From the Hex Editor Toolbar, choose **Edit > Allow Edit content**.
- Right-click in the edit pane and choose **Allow Edit content** from the context menu.

When you copy selected text from the edit pane to the clipboard, you may store it there in one of three formats:

- **Binary** – hexadecimal representation of selected data
- **Text** – text representation of selected data
- **Display** – formatted hexadecimal and text representation of selected data (as it appears in the editor)

EDITING USING TEMPLATES

You can edit Disk System Records (MFT, Boot sector etc.) by using specially designed forms. The system record that appears in the Navigate menu may be different, depending on the type of object that you have opened in the Hex Editor.

To open a system record in the template dialog, do one of the following:

- In the Hex Editor toolbar, choose **Navigate > [system record] (Template)**.
- Right-click in the editor pane and choose **Navigate To > [system record] (Template)** from the context menu.

Example Partition Table Template Dialog Box

Partition Table, 0 sector ✖

MBR: 33 C0 8E D0 BC 00 7C FB 50 07 50 1F FC BE 1B 7C BF 1B 06 50 57 B9 E5 01 F3 A4 CB BD BE 07 B1 04

Disk Index: 05 2B 29 D2

Partition Table Entry #1

Active partition: 00

Start head: 1

Start sector: 1

Start cylinder: 13

Operating system [hex]: 07

End head: 254

End sector: 63

End cylinder: 16

Sectors before partition: 208908

Partition size in sectors: 64197

Partition Table Entry #2

Active partition: 00

Start head: 0

Start sector: 1

Start cylinder: 17

Operating system [hex]: 0B

End head: 254

End sector: 63

End cylinder: 35

Sectors before partition: 273105

Partition size in sectors: 305235

Partition Table Entry #3

Active partition: 00

Start head: 0

Start sector: 1

Start cylinder: 36

Operating system [hex]: 05

End head: 254

End sector: 63

End cylinder: 864

Sectors before partition: 578340

Partition size in sectors: 13317885

Partition Table Entry #4

Active partition: 00

Start head: 0

Start sector: 0

Start cylinder: 0

Operating system [hex]: 00

End head: 0

End sector: 0

End cylinder: 0

Sectors before partition: 0

Partition size in sectors: 0

Signature (55 AA): 55 AA

Set Defaults
Save
Cancel

To change any value in the template dialog box, select the field and type a new value.

The pencil icon () beside a field indicates that value has been changed.

Hex Editor

To discard all changes and restore all values to fields in the dialog box, click **Reset**.

To save all changes made in the dialog box, click **Save**.

WARNING Saving incorrect values might render the partition useless. You may not undo changes that you make in this dialog box.

Example Boot Sector Template Dialog Box

Review and modify content of Primary and Copy Boot Sectors. It is recommended to do changes only in memory (Leave 'Save changes on disk' unchecked).

Boot Sector Primary Boot Sector Copy

JMP instruction [hex]: EB 52 90

System ID: NTFS

Bytes per Sector: 512

Sectors per Cluster: 2

Reserved Sectors: 0

Media descriptor [hex]: F8

Sectors per Track: 63

Heads: 255

Hidden Sectors: 63

Total Sectors: 2040191

Start #MFT: 340032

Start #MFT Mirror: 510047

Clusters per MFT rec [hex]: 01

Clusters per index block [hex]: 04

Serial number [hex]: D4 34 64 CC 7E 64 CC FC

Signature (55 AA): 55 AA

Edit Primary and Copy sectors synchronously

Reset Save Cancel

The fields that appear may vary, depending on the type of file system (FAT, FAT32 or NTFS).

You can edit the primary and copy of the boot sector record simultaneously. To do so, switch back and forth between Boot Sector Primary and Boot Sector Copy to compare field values. Select Boot Sector Primary and type a value into a field and then select Boot Sector Copy and type a value into the same field.

The pencil icon () beside a field indicates that value has been changed.

The caution icon () beside a field indicates that the value in the Boot Sector Primary is different from the same field in Boot Sector Copy.

To discard all changes and restore all values to fields in the dialog box, click **Reset**.

To save all changes made in the dialog box, click **Save**.

WARNING Saving incorrect values might render the boot sector useless. You may not undo changes that you make in this dialog box.

SAVING CHANGES

Unless stated otherwise, all modifications made in the Hex Editor are stored in memory.

Changes are written to the drive when you click **Save**.

HEX EDITOR PREFERENCES

There are several options available in Hex Editor.

To set Hex Editor options:

1. From the Hex Editor toolbar, click **Options**. The **Preferences** dialog box appears.
2. In **Editor Window Options**:
 - To hide the status bar at the bottom of the edit pane, clear the **Show Status pane** check box. To show the status bar, select this check box.
 - To hide the Info pane on the left side of the workspace, clear the **Show Info pane** check box. To show the Info pane, select this check box.
 - To display text in hexadecimal offset format, select the **Hexadecimal address** check box. To display text in decimal format, clear this check box.
 - To change the font size in the edit pane, select a font size from the **Font size** drop-down list.
3. In **Data Inspector**:
 - To show a format type, select the check box next to the type name. To hide a format type, clear the check box next to the type name.

File Cluster Chain

To help navigate through the content of open files, file cluster information is displayed at the left side of the editor under the object description. You can select any cluster in this list jump immediately to that cluster or simply scroll through the list to view selected cluster content.

6. KNOWLEDGE BASE

This chapter describes some basic concepts that might help when unerasing data.

HARDWARE AND DISK ORGANIZATION

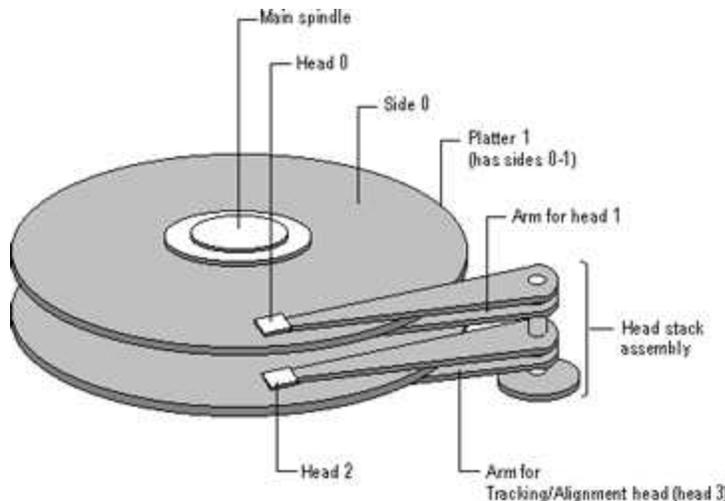
Here you can get some information about HDDs (Hard Disk Drives) and low-level disk organization:

- Hard Disk Drive Basics
- Master Boot Record (MBR)
- Partition Table

HARD DISK DRIVE BASICS

Each hard disk consists of platters, with rings on both sides of each platter. These rings are called tracks. Sections within each track are called sectors. A sector is the smallest physical storage unit on a disk. A sector is almost always 512 bytes in size.

Hard disk with two platters



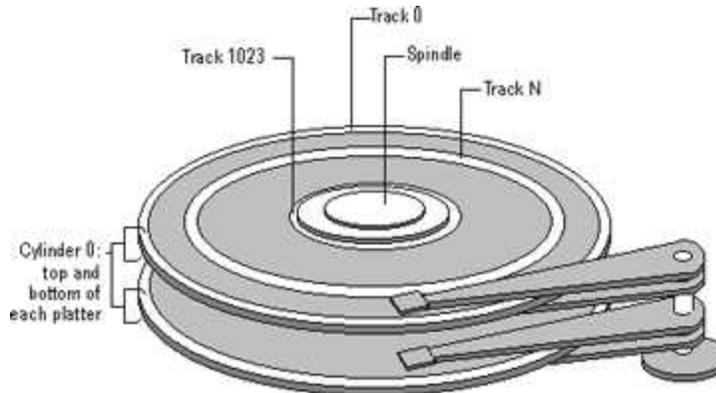
The structure of older hard drives (for example, prior to Windows 95) refers to a cylinder/ head/ sector notation. All current disks use a translation factor to make their actual hardware layout appear continuous.

TRACKS AND CYLINDERS

On a hard disk, data is stored in thin, concentric bands. A drive head, while in one position can read or write a circular ring, or band called a track. There can be more than a thousand tracks on a 3.5-inch hard disk.

Tracks are a logical rather than a physical structure, and are established when the disk is low-level formatted. Track numbers start at 0, and track 0 is the outermost track of the disk. The highest numbered track is next to the spindle. If the disk geometry is being translated, the highest numbered track would typically be 1023.

A hard disk showing track 0, a track in the middle of the disk, and track 1023



A cylinder consists of the set of tracks that are at the same head position on each disk. In the picture above, cylinder 0 is the four tracks at the outermost edge of the sides of the platters. If the disk has 1024 cylinders (which would be numbered 0-1023), cylinder 1023 consists of all of the tracks at the innermost edge of each side.

Most disks used in personal computers today rotate at a constant angular velocity. The tracks near the outside of the disk are less densely populated with data than the tracks near the center of the disk. Thus, a fixed amount of data can be read in a constant period of time, even though the speed of the disk surface is faster on the tracks located further away from the center of the disk.

Modern disks reserve one side of one platter for track positioning information, which is written to the disk at the factory during disk assembly. It is not available to the operating system. The disk controller uses this information to fine tune the head locations when the heads move to another location on the disk. When a side contains the track position information, that side cannot be used for data. Thus, a disk assembly containing two platters has three sides that are available for data.

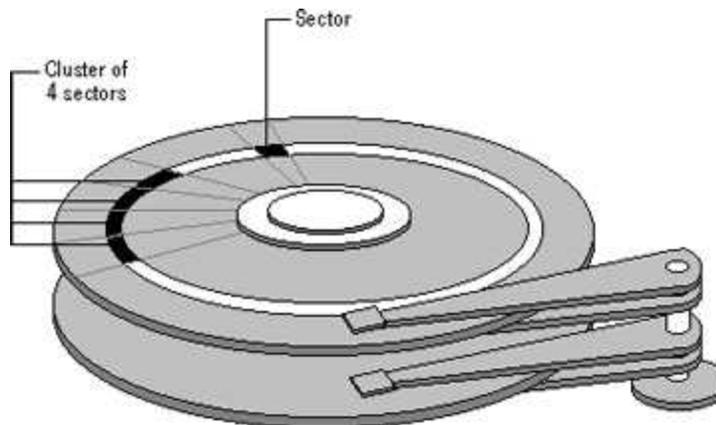
SECTORS AND CLUSTERS

Each track is divided into sections called sectors. A sector is the smallest physical storage unit on the disk.

Each track has the same number of sectors, which means that the sectors are packed much closer together on tracks near the center of the disk.

The picture below shows sectors on a track. You can see that sectors closer to the spindle are closer together than those on the outside edge of the disk. The disk controller uses the sector identification information stored in the area immediately before the data in the sector to determine where the sector itself begins.

Hard disk showing sectors on a track



As a file is written to the disk, the file system allocates the appropriate number of clusters to store the file's data. For example, if each cluster is 512 bytes and the file is 800 bytes, two clusters are allocated for the file. Later, if you update the file to, for example, twice its size (1600 bytes), another two clusters are allocated.

If contiguous clusters (clusters that are next to each other on the disk) are not available, the data are written elsewhere on the disk and the file is considered to be fragmented. Fragmentation is a problem when the file system must search several different locations to find all the pieces of the file you want to read. The search causes a delay before the file is retrieved. A larger cluster size reduces the potential for fragmentation, but increases the likelihood that clusters will have unused space.

Using clusters larger than one sector reduces fragmentation, and reduces the amount of disk space needed to store the information about the used and unused areas on the disk.

MBR (MASTER BOOT RECORD)

The Master Boot Record, created when you create the first partition on the hard disk, is probably the most important data structure on the disk. It is the first sector on every disk. The location is always track (cylinder) 0, side (head) 0, and sector 1.

The Master Boot Record contains the Partition Table for the disk and a small amount of executable code. On x86-based computers, the executable code examines the Partition Table, and identifies the system partition. The Master Boot Record then finds the system partition's starting location on the disk, and loads a copy of its Partition Boot Sector into memory. The Master Boot Record then transfers execution to executable code in the Partition Boot Sector.

Note Although there is a Master Boot Record on every hard disk, the executable code in the sector is used only if the disk is connected to an x86-based computer and the disk contains the system partition.

Figure below shows a hex dump of the sector containing the Master Boot Record. The figure shows the sector in two parts. The first part is the Master Boot Record, which occupies the first 446 bytes of the sector. The disk signature (FD 4E F2 14) is at the end of the Master Boot Record code. The second part is the Partition Table.

Physical Sector: Cyl 0, Side 0, Sector 1

Hardware and Disk Organization

```

00000000: 00 33 C0 8E D0 BC 00 7C - 8B F4 50 07 50 1F FB FC .3.....|...P.P..
00000010: BF 00 06 B9 00 01 F2 A5 - EA 1D 06 00 00 BE BE 07 .....
00000020: B3 04 80 3C 80 74 0E 80 - 3C 00 75 1C 83 C6 10 FE ...<.t.<.u.....
00000030: CB 75 EF CD 18 8B 14 8B - 4C 02 8B EE 83 C6 10 FE .u.....L.....
00000040: CB 74 1A 80 3C 00 74 F4 - BE 8B 06 AC 3C 00 74 0B .t.<.t.....<.t.
00000050: 56 BB 07 00 B4 0E CD 10 - 5E EB F0 EB FE BF 05 00 V.....^.....
00000060: BB 00 7C B8 01 02 57 CD - 13 5F 73 0C 33 C0 CD 13 ..|...W..._s.3...
00000070: 4F 75 ED BE A3 06 EB D3 - BE C2 06 BF FE 7D 81 3D Ou.....}.|=
00000080: 55 AA 75 C7 8B F5 EA 00 - 7C 00 00 49 6E 76 61 6C U.u.....|..Inval
00000090: 69 64 20 70 61 72 74 69 - 74 69 6F 6E 20 74 61 62 id partition tab
000000A0: 6C 65 00 45 72 72 6F 72 - 20 6C 6F 61 64 69 6E 67 le.Error loading
000000B0: 20 6F 70 65 72 61 74 69 - 6E 67 20 73 79 73 74 65 operating syste
000000C0: 6D 00 4D 69 73 73 69 6E - 67 20 6F 70 65 72 61 74 m.Missing operat
000000D0: 69 6E 67 20 73 79 73 74 - 65 6D 00 00 80 45 14 15 ing system...E..
000000E0: 00 00 00 00 00 00 00 00 - 00 00 00 00 00 00 00 .....
000000F0: 00 00 00 00 00 00 00 00 - 00 00 00 00 00 00 00 .....
00000100: 00 00 00 00 00 00 00 00 - 00 00 00 00 00 00 00 .....
00000110: 00 00 00 00 00 00 00 00 - 00 00 00 00 00 00 00 .....
00000120: 00 00 00 00 00 00 00 00 - 00 00 00 00 00 00 00 .....
00000130: 00 00 00 00 00 00 00 00 - 00 00 00 00 00 00 00 .....
00000140: 00 00 00 00 00 00 00 00 - 00 00 00 00 00 00 00 .....
00000150: 00 00 00 00 00 00 00 00 - 00 00 00 00 00 00 00 .....
00000160: 00 00 00 00 00 00 00 00 - 00 00 00 00 00 00 00 .....
00000170: 00 00 00 00 00 00 00 00 - 00 00 00 00 00 00 00 .....
00000180: 00 00 00 00 00 00 00 00 - 00 00 00 00 00 00 00 .....
00000190: 00 00 00 00 00 00 00 00 - 00 00 00 00 00 00 00 .....
000001A0: 00 00 00 00 00 00 00 00 - 00 00 00 00 00 00 00 .....
000001B0: 00 00 00 00 00 00 00 00 - FD 4E F2 14 00 00 .....N.....

                                80 01 ..
000001C0: 01 00 06 0F 7F 96 3F 00 - 00 00 51 42 06 00 00 00 ....•.?...QB....
000001D0: 41 97 07 0F FF 2C 90 42 - 06 00 A0 3E 06 00 00 00 A.....,B...>....
000001E0: C1 2D 05 0F FF 92 30 81 - 0C 00 A0 91 01 00 00 00 .-.....0.....
000001F0: C1 93 01 0F FF A6 D0 12 - 0E 00 C0 4E 00 00 55 AA .....N..U.

```

IMPORTANT Viruses Can Infect the Master Boot Record.

Many destructive viruses damage the Master Boot Record and make it impossible to start the computer from the hard disk. Because the code in the Master Boot Record executes before any operating system is started, no operating system can detect or recover from corruption of the Master Boot Record. You can use, for example, the DiskProbe program on Windows NT Workstation Resource Kit CD to display the Master Boot Record, and compare it to the Master Boot Record shown above. There are also utilities on the Microsoft Windows Resource Kits that enable you to save and restore the Master Boot Record.

PARTITION TABLE

The Master Boot Record contains the Partition Table for the disk and a small amount of executable code for the boot start. The location is always the first sector on the disk.

The first 446 (0x1BE) bytes are MBR itself, the next 64 bytes are the Partition Table, and the last two bytes in the sector are a signature word for the sector and are always 0x55AA.

UNDERSTANDING THE FILE SYSTEM: FAT

The FAT (File Allocation Table) file system is a simple file system originally designed for small disks and simple folder structures. The FAT file system is named for its method of organization, the file allocation table, which resides at the beginning of the volume. To protect the volume, two copies of the table are kept, in case one becomes damaged. In addition, the file allocation tables and the root folder must be stored in a fixed location so that the files needed to start the system can be correctly located.

A volume formatted with the FAT file system is allocated in clusters. The default cluster size is determined by the size of the volume. For the FAT file system, the cluster number must fit in 16 bits and must be a power of two.

FAT PARTITION BOOT SECTOR

The Partition Boot Sector contains information that the file system uses to access the volume. On x86-based computers, the Master Boot Record use the Partition Boot Sector on the system partition to load the operating system kernel files.

The table below describes the fields in the Partition Boot Sector for a volume formatted with the FAT file system.

Byte Offset (in hex)	Field Length	Sample Value	Description
00	3 bytes	EB 3C 90	Jump instruction.
03	8 bytes	MSDOS5.0	OEM Name in text
0B	25 bytes		BIOS Parameter Block
24	26 bytes		Extended BIOS Parameter Block
3E	448 bytes		Bootstrap code
1FE	2 bytes	0x55AA	End of sector marker

The table below describes BIOS Parameter Block and Extended BIOS Parameter Block Fields

Byte Offset (in hex)	Field Length	Sample Value	Description
0x0B	WORD	0x0002	Bytes per Sector. The size of a hardware sector. For most disks in use in the United States, the value of this field is 512.
0x0D	BYTE	0x08	Sectors Per Cluster. The number of sectors in a cluster. The default cluster size for a volume depends on the volume size and the file system.
0x0E	WORD	0x0100	Reserved Sectors. The number of sectors from the Partition Boot Sector to the start of the first file allocation table, including the Partition Boot Sector. The minimum value is 1. If the value is greater than 1, it means that the bootstrap code is too long to fit completely in the Partition Boot Sector.
0x10	BYTE	0x02	Number of file allocation tables (FATs). The number of copies of the file allocation table on the volume. Typically, the value of this field is 2.
0x11	WORD	0x0002	Root Entries. The total number of file name entries that can be stored in the root folder of the volume. One entry is always used as a Volume Label. Files with long filenames use up multiple entries per file. Therefore, the largest number of files in the root folder is typically 511, but you will run out of entries sooner if you use long filenames.
0x13	WORD	0x0000	Small Sectors. The number of sectors on the volume if the number fits in 16 bits (65535). For volumes larger than 65536 sectors, this field has a value of 0 and the Large Sectors field is

Byte Offset (in hex)	Field Length	Sample Value	Description
			used instead.
0x15	BYTE	0xF8	Media Type. Provides information about the media being used. A value of 0xF8 indicates a hard disk.
0x16	WORD	0xC900	Sectors per file allocation table (FAT). Number of sectors occupied by each of the file allocation tables on the volume. By using this information, together with the Number of FATs and Reserved Sectors, you can compute where the root folder begins. By using the number of entries in the root folder, you can also compute where the user data area of the volume begins.
0x18	WORD	0x3F00	Sectors per Track. The apparent disk geometry in use when the disk was low-level formatted.
0x1A	WORD	0x1000	Number of Heads. The apparent disk geometry in use when the disk was low-level formatted.
0x1C	DWORD	3F 00 00 00	Hidden Sectors. Same as the Relative Sector field in the Partition Table.
0x20	DWORD	51 42 06 00	Large Sectors. If the Small Sectors field is zero, this field contains the total number of sectors in the volume. If Small Sectors is nonzero, this field contains zero.
0x24	BYTE	0x80	Physical Disk Number. This is related to the BIOS physical disk number. Floppy drives are numbered starting with 0x00 for the A disk. Physical hard disks are numbered starting with 0x80. The value is typically 0x80 for hard disks, regardless of how many physical disk drives exist, because the value is only relevant if the device is the startup disk.
0x25	BYTE	0x00	Current Head. Not used by the

Byte Offset (in hex)	Field Length	Sample Value	Description
			FAT file system.
0x26	BYTE	0x29	Signature. Must be either 0x28 or 0x29 in order to be recognized by Windows NT.
0x27	4 bytes	CE 13 46 30	Volume Serial Number. A unique number that is created when you format the volume.
0x2B	11 bytes	NO NAME	Volume Label. This field was used to store the volume label, but the volume label is now stored as special file in the root directory.
0x36	8 bytes		FAT16 System ID. Either FAT12 or FAT16, depending on the format of the disk.

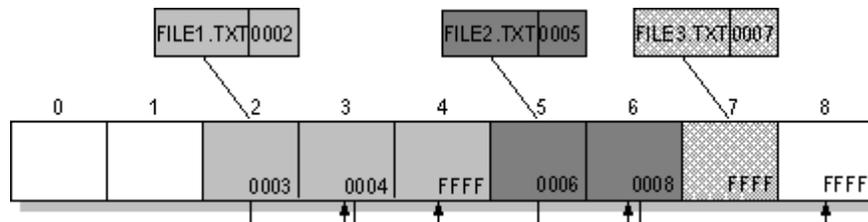
For more detailed information see resource kits on Microsoft's web site <http://www.microsoft.com/windows/reskits/webresources/default.asp> or Microsoft Developers Network (MSDN) <http://msdn.microsoft.com>

FILE ALLOCATION SYSTEM

The FAT file allocation system is named for its method of organization, the file allocation table, which resides at the beginning of the volume. To protect the volume, two copies of the table are kept, in case one becomes damaged. In addition, the file allocation tables must be stored in a fixed location so that the files needed to start the system can be correctly located.

The file allocation table contains the following types of information about each cluster on the volume (see example below for FAT16):

Three files



This picture shows three files. The file File1.txt is a file that is large enough to use three clusters. The second file, File2.txt, is a fragmented file that also requires three clusters. A small file, File3.txt, fits completely in one cluster. In each case, the folder structure points to the first cluster of the file.

Understanding the File System: FAT

For more detailed information see resource kits on Microsoft's web site <http://www.microsoft.com/windows/reskits/webresources/default.asp> or Microsoft Developers Network (MSDN) <http://msdn.microsoft.com>

FAT ROOT FOLDER

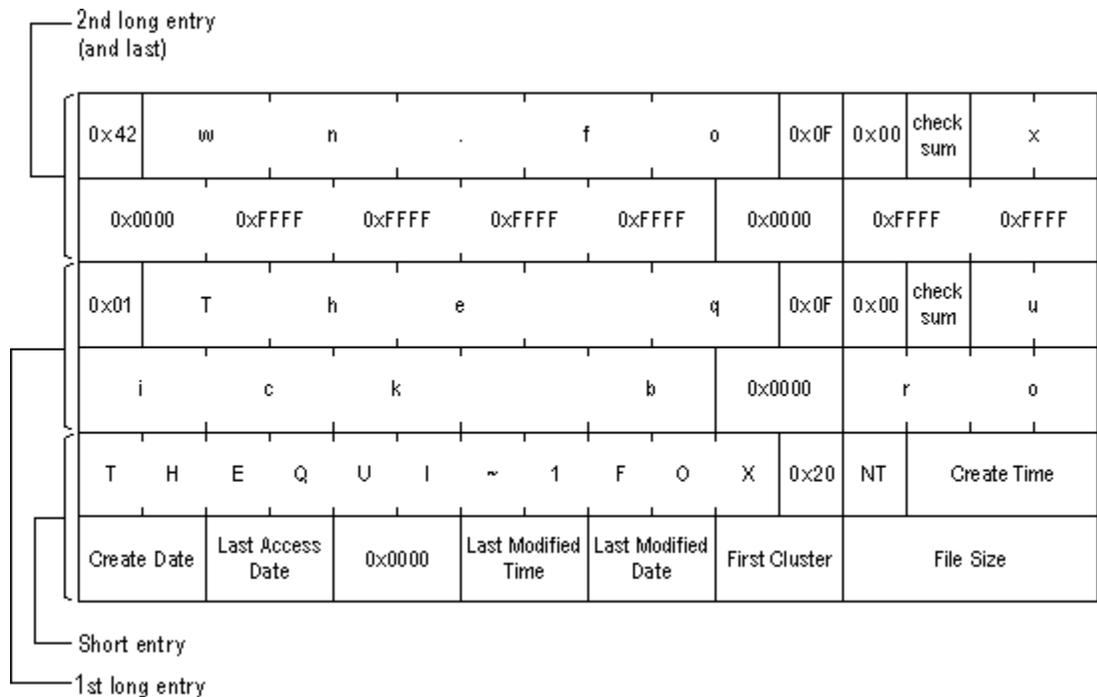
The root folder contains an entry for each file and folder on the root. The only difference between the root folder and other folders is that the root folder is on a specified location on the disk and has a fixed size (512 entries for a hard disk, number of entries on a floppy disk depends on the size of the disk). See Folder Structure topic for details about folder organization.

For more detailed information see resource kits on Microsoft's web site <http://www.microsoft.com/windows/reskits/webresources/default.asp> or Microsoft Developers Network (MSDN) <http://msdn.microsoft.com>

FAT FOLDER STRUCTURE

Folders have set of 32-byte Folder Entries for each file and subfolder contained in the folder (see example figure below).

Long File Name Folder Entry Example



The Folder Entry includes the following information:

- Name (eight-plus-three characters)
- Attribute byte (8 bits worth of information, described later in this section)
- Create time (24 bits)
- Create date (16 bits)
- Last access date (16 bits)

- Last modified time (16 bits)
- Last modified date (16 bits.)
- Starting cluster number in the file allocation table (16 bits)
- File size (32 bits)

There is no organization to the FAT folder structure, and files are given the first available location on the volume. The starting cluster number is the address of the first cluster used by the file. Each cluster contains a pointer to the next cluster in the file, or an indication (0xFFFF) that this cluster is the end of the file.

See File Allocation System for details.

The information in the folder is used by all operating systems that support the FAT file system. In addition, Windows NT can store additional time stamps in a FAT folder entry. These time stamps show when the file was created or last accessed and are used principally by POSIX applications.

Because all entries in a folder are the same size, the attribute byte for each entry in a folder describes what kind of entry it is. One bit indicates that the entry is for a subfolder, while another bit marks the entry as a volume label.

Normally, only the operating system controls the settings of these bits. A FAT file has four attributes bits that can be turned on or off by the user — archive file, system file, hidden file, and read-only file.

FILENAMES ON FAT VOLUMES

Beginning with Windows NT 3.5, files created or renamed on FAT volumes use the attribute bits to support long filenames in a way that does not interfere with how MS-DOS or OS/2 accesses the volume. Whenever a user creates a file with a long filename, Windows creates an eight-plus-three name for the file. In addition to this conventional entry, Windows creates one or more secondary folder entries for the file, one for each 13 characters in the long filename. Each of these secondary folder entries stores a corresponding part of the long filename in Unicode. Windows sets the volume, read-only, system, and hidden file attribute bits of the secondary folder entry to mark it as part of a long filename. MS-DOS and OS/2 generally ignore folder entries with all four of these attribute bits set, so these entries are effectively invisible to these operating systems. Instead, MS-DOS and OS/2 access the file by using the conventional eight-plus-three filename contained in the folder entry for the file.

The Long File Name Example above shows all of the folder entries for the file Thequi~1.fox, which has a long name of The quick brown.fox. The long name is in Unicode, so each character in the name uses two bytes in the folder entry. The attribute field for the long name entries has the value 0x0F. The attribute field for the short name is 0x20.

FAT32 FEATURES

The following topics describe the FAT32 file system.

- File System Specifications
- Boot Sector and Bootstrap Modifications

- FAT Mirroring
- Partition Types

File System Specifications

FAT32 is a derivative of the File Allocation Table (FAT) file system that supports drives with over 2GB of storage. Because FAT32 drives can contain more than 65,526 clusters, smaller clusters are used than on large FAT16 drives. This method results in more efficient space allocation on the FAT32 drive.

The largest possible file for a FAT32 drive is 4GB minus 2 bytes.

The FAT32 file system includes four bytes per cluster within the file allocation table. Note that the high 4 bits of the 32-bit values in the FAT32 file allocation table are reserved and are not part of the cluster number.

Modifications to Boot Sector

Modifications	Description
Reserved Sectors	FAT32 drives contain more reserved sectors than FAT16 or FAT12 drives. The number of reserved sectors is usually 32, but can vary.
Boot Sector Modifications	Because a FAT32 BIOS Parameter Block (BPB), represented by the BPB structure, is larger than a standard BPB, the boot record on FAT32 drives is greater than 1 sector. In addition, there is a sector in the reserved area on FAT32 drives that contains values for the count of free clusters and the cluster number of the most recently allocated cluster. These values are members of the BIGFATBOOTFSINFO structure which is contained within this sector. These additional fields allow the system to initialize the values without having to read the entire file allocation table.
Root Directory	The root directory on a FAT32 drive is not stored in a fixed location as it is on FAT16 and FAT12 drives. On FAT32 drives, the root directory is an ordinary cluster chain. The A_BF_BPB_RootDirStrtClus member in the BPB structure contains the number of the first cluster in the root directory. This allows the root directory to grow as needed. In addition, the BPB_RootEntries member of BPB is ignored on a FAT32 drive.
Sectors Per FAT	The A_BF_BPB_SectorsPerFAT member of BPB is always zero on a FAT32 drive. Additionally, the A_BF_BPB_BigSectorsPerFat and A_BF_BPB_BigSectorsPerFatHi members of the updated BPB provide equivalent information for FAT32 media.

BPB (FAT32)

The BPB for FAT32 drives is an extended version of the FAT16/FAT12 BPB. It contains identical information to a standard BPB, but also includes several extra fields for FAT32 specific information.

This structure is implemented in Windows OEM Service Release 2 and later.

```
A_BF_BPB_STRUC
  A_BF_BPB_BytesPerSector  DW ?
  A_BF_BPB_SectorsPerCluster  DB ?
  A_BF_BPB_ReservedSectors  DW ?
  A_BF_BPB_NumberOfFATs  DB ?
  A_BF_BPB_RootEntries  DW ?
  A_BF_BPB_TotalSectors  DW ?
  A_BF_BPB_MediaDescriptor  DB ?
  A_BF_BPB_SectorsPerFAT  DW ?
  A_BF_BPB_SectorsPerTrack  DW ?
  A_BF_BPB_Heads  DW ?
  A_BF_BPB_HiddenSectors  DW ?
  A_BF_BPB_HiddenSectorsHigh  DW ?
  A_BF_BPB_BigTotalSectors  DW ?
  A_BF_BPB_BigTotalSectorsHigh  DW ?
  A_BF_BPB_BigSectorsPerFat  DW ?
  A_BF_BPB_BigSectorsPerFatHi  DW ?
  A_BF_BPB_ExtFlags  DW ?
  A_BF_BPB_FS_Version  DW ?
  A_BF_BPB_RootDirStrtClus  DW ?
  A_BF_BPB_RootDirStrtClusHi  DW ?
  A_BF_BPB_FSInfoSec  DW ?
  A_BF_BPB_BkUpBootSec  DW ?
  A_BF_BPB_Reserved  DW 6 DUP (?)
A_BF_BPB_ENDS
```

BPB Members

Member Name	Description
A_BF_BPB_BytesPerSector	The number of bytes per sector.
A_BF_BPB_SectorsPerCluster	The number of sectors per cluster.
A_BF_BPB_ReservedSectors	The number of reserved sectors, beginning with sector 0.
A_BF_BPB_NumberOfFATs	The number of File Allocation Tables.
A_BF_BPB_RootEntries	This member is ignored on FAT32 drives.
A_BF_BPB_TotalSectors	The size of the partition, in sectors.

Understanding the File System: FAT

Member Name	Description
A_BF_BP_BPB_MediaDescriptor	The media descriptor. Values in this member are identical to standard BPB.
A_BF_BP_BPB_SectorsPerFAT	The number of sectors per FAT.
Note This member will always be zero in a FAT32 BPB. Use the values from A_BF_BP_BPB_BigSectorsPerFat and A_BF_BP_BPB_BigSectorsPerFatHi for FAT32 media.	
A_BF_BP_BPB_SectorsPerTrack	The number of sectors per track.
A_BF_BP_BPB_Heads	The number of read/write heads on the drive.
A_BF_BP_BPB_HiddenSectors	The number of hidden sectors on the drive.
A_BF_BP_BPB_HiddenSectorsHigh	The high word of the hidden sectors value.
A_BF_BP_BPB_BigTotalSectors	The total number of sectors on the FAT32 drive.
A_BF_BP_BPB_BigTotalSectorsHigh	The high word of the FAT32 total sectors value.
A_BF_BP_BPB_BigSectorsPerFat	The number of sectors per FAT on the FAT32 drive.
A_BF_BP_BPB_BigSectorsPerFatHi	The high word of the FAT32 sectors per FAT value.
A_BF_BP_BPBExtFlags	Flags describing the drive. Bit 8 of this value indicates whether or not information written to the active FAT will be written to all copies of the FAT. The low 4 bits of this value contain the 0-based FAT number of the Active FAT, but are only meaningful if bit 8 is set. This member can contain a combination of the following values.
Value	Description
BGBPB_F_ActiveFATMsk	Mask for low four bits. (000Fh)
BGBPB_F_NoFATMirror	Mask indicating FAT (0080h) mirroring state. If set, FAT mirroring is disabled. If clear, FAT mirroring is enabled.
	Bits 4-6 and 8-15 are reserved.
A_BF_BP_BPB_FS_Version	The file system version number of the FAT32 drive. The high byte represents the major version, and the low byte represents the minor version.
A_BF_BP_BPB_RootDirStrtClus	The cluster number of the first cluster in the FAT32 drive's root directory.
A_BF_BP_BPB_RootDirStrtClusHi	The high word of the FAT32 starting cluster number. A_BF_BP_BPB_FSInfoSec The sector

Member Name	Description
	number of the file system information sector. The file system info sector contains a BIGFATBOOTFSINFO structure. This member is set to 0FFFFh if there is no FSINFO sector. Otherwise, this value must be non-zero and less than the reserved sector count.
A_BF_BPB_BkUpBootSec	The sector number of the backup boot sector. This member is set to 0FFFFh if there is no backup boot sector. Otherwise, this value must be non-zero and less than the reserved sector count.
A_BF_BPB_Reserved	Reserved member.

BIGFATBOOTFSINFO (FAT32)

Contains information about the file system on a FAT32 volume. This structure is implemented in Windows OEM Service Release 2 and later.

```

BIGFATBOOTFSINFO  STRUC
    bfFSInf_Sig DD ?
    bfFSInf_free_clus_cnt DD ?
    bfFSInf_next_free_clus DD ?
    bfFSInf_resvd DD 3 DUP (?)
BIGFATBOOTFSINFO  ENDS

```

BIGFATBOOTFSINFO Members

Member Name	Description
bfFSInf_Sig	The signature of the file system information sector. The value in this member is FSINFOSIG (0x61417272L).
bfFSInf_free_clus_cnt	The count of free clusters on the drive. Set to -1 when the count is unknown.
bfFSInf_next_free_clus	The cluster number of the cluster that was most recently allocated.
bfFSInf_resvd	Reserved member.

FAT MIRRORING

On all FAT drives, there may be multiple copies of the FAT. If an error occurs reading the primary copy, the file system will attempt to read from the backup copies. On FAT16 and FAT12 drives, the first FAT is always the primary copy and

Understanding the File System: FAT

any modifications will automatically be written to all copies. However, on FAT32 drives, FAT mirroring can be disabled and a FAT other than the first one can be the primary (or "active") copy of the FAT.

Mirroring is enabled by clearing bit 0x0080 in the `extdpb_flags` member of a FAT32 Drive Parameter Block (DPB) structure.

Mirroring	Description
When Enabled (bit 0x0080 clear)	With mirroring enabled, whenever a FAT sector is written, it will also be written to every other FAT. Also, a mirrored FAT sector can be read from any FAT. A FAT32 drive with multiple FATs will behave the same as FAT16 and FAT12 drives with multiple FATs. That is, the multiple FATs are backups of each other.
When Disabled (bit 0x0080 set)	With mirroring disabled, only one of the FATs is active. The active FAT is the one specified by bits 0 through 3 of the <code>extdpb_flags</code> member of DPB. The other FATs are ignored. Disabling mirroring allows better handling of a drive with a bad sector in one of the FATs. If a bad sector exists, access to the damaged FAT can be completely disabled. Then, a new FAT can be built in one of the inactive FATs and then made accessible by changing the active FAT value in <code>extdpb_flags</code> .

DRIVE PARAMETER BLOCK (FAT32)

The DPB was extended to include FAT32 information. Changes are effective for Windows 95 OEM Service Release 2 and later.

```
DPB STRUC
    dpb_drive DB ?
    dpb_unit DB ?
    dpb_sector_size DW ?
    dpb_cluster_mask DB ?
    dpb_cluster_shift DB ?
    dpb_first_fat DW ?
    dpb_fat_count DB ?
    dpb_root_entries DW ?
    dpb_first_sector DW ?
    dpb_max_cluster DW ?
    dpb_fat_size DW ?
    dpb_dir_sector DW ?
    dpb_reserved2 DD ?
    dpb_media DB ?
#ifdef NOTFAT32
    dpb_first_access DB ?
#else
```

```

    dpb_reserved DB ?
endif
    dpb_reserved3 DD ?
    dpb_next_free DW ?
    dpb_free_cnt DW ?
ifndef NOTFAT32
    extdpb_free_cnt_hi DW ?
    extdpb_flags DW ?
    extdpb_FSInfoSec DW ?
    extdpb_BkUpBootSec DW ?
    extdpb_first_sector DD ?
    extdpb_max_cluster DD ?
    extdpb_fat_size DD ?
    extdpb_root_clus DD ?
    extdpb_next_free DD ?
endif
DPB ENDS

```

DBP Members

Member Name	Description
dpb_drive	The drive number (0 = A, 1 = B, and so on).
dpb_unit	Specifies the unit number. The device driver uses the unit number to distinguish the specified drive from the other drives it supports.
dpb_sector_size	The size of each sector, in bytes. dpb_cluster_mask The number of sectors per cluster minus 1.
dpb_cluster_shift	The number of sectors per cluster, expressed as a power of 2.
dpb_first_fat	The sector number of the first sector containing the file allocation table (FAT).
dpb_fat_count	The number of FATs on the drive.
dpb_root_entries	The number of entries in the root directory.
dpb_first_sector	The sector number of the first sector in the first cluster.
dpb_max_cluster	The number of clusters on the drive plus 1. This member is undefined for FAT32 drives.
dpb_fat_size	The number of sectors occupied by each FAT. The value of zero indicates a FAT32 drive. Use the value in extdpb_fat_size instead.
dpb_dir_sector	The sector number of the first sector containing the root directory. This member is undefined for

Member Name	Description
	FAT32 drives.
dpb_reserved2	Reserved member. Do not use.
dpb_media	Specifies the media descriptor for the medium in the specified drive.
reserved	Reserved member. Do not use.
dpb_first_access	Indicates whether the medium in the drive has been accessed. This member is initialized to -1 to force a media check the first time this DPB is used.
dpb_reserved3	Reserved member. Do not use.
dpb_next_free	The cluster number of the most recently allocated cluster.
dpb_free_cnt	The number of free clusters on the medium. This member is 0FFFFh if the number is unknown.
extdpb_free_cnt_hi	The high word of free count.
extdpb_flags	Flags describing the drive. The low 4 bits of this value contain the 0-based FAT number of the Active FAT. This member can contain a combination of the following values.
Value	Description
BGBP_B_F_ActiveFATMsk (000Fh)	Mask for low four bits. Do not mirror active FAT to inactive FATs.
BGBP_B_F_NoFATMirror (0080h)	Bits 4-6 and 8-15 are reserved.
extdpb_FSInfoSec	The sector number of the file system information sector. This member is set to 0FFFFh if there is no FSINFO sector. Otherwise, this value must be non-zero and less than the reserved sector count.
extdpb_BkUpBootSec	The sector number of the backup boot sector. This member is set to 0FFFFh if there is no backup boot sector. Otherwise, this value must be non-zero and less than the reserved sector count.
extdpb_first_sector	The first sector of the first cluster.
extdpb_max_cluster	The number of clusters on the drive plus 1.
extdpb_fat_size	The number of sectors occupied by the FAT.
extdpb_root_clus	The cluster number of the first cluster in the root directory.
extdpb_next_free	The number of the cluster that was most recently allocated.

FAT32 PARTITION TYPES

The following table displays all valid partition types and their corresponding values for use in the Part_FileSystem member of the s_partition structure.

Value	Description
PART_UNKNOWN (00h)	Unknown
PART_DOS2_FAT (01h)	12-bit FAT
PART_DOS3_FAT (04h)	16-bit FAT. Partitions smaller than 32MB.
PART_EXTENDED (05h)	Extended MS-DOS Partition
PART_DOS4_FAT (06h)	16-bit FAT. Partitions larger than or equal to 32MB.
PART_DOS32 (0Bh) 32-bit FAT	Partitions up to 2047GB.
PART_DOS32X (0Ch)	Same as PART_DOS32 (0Bh), but uses Logical Block Address Int 13h extensions.
PART_DOSX13 (0Eh)	Same as PART_DOS4_FAT (06h), but uses Logical Block Address Int 13h extensions.
PART_DOSX13X (0Fh)	Same as PART_EXTENDED (05h), but uses Logical Block Address Int 13h extensions.

S_PARTITION (FAT32)

Note Values for head and track are 0-based. Sector values are 1-based. This structure is implemented in Windows OEM Service Release 2 and later.

```
s_partition STRUC
    Part_BootInd DB ?
    Part_FirstHead DB ?
    Part_FirstSector DB ?
    Part_FirstTrack DB ?
    Part_FileSystem DB ?
    Part_LastHead DB ?
    Part_LastSector DB ?
    Part_LastTrack DB ?
    Part_StartSector DD ?
    Part_NumSectors DD ?
s_partition ENDS
```

s_partition Members

Member Name	Description
Part_BootInd	Specifies whether the partition is bootable or not. This value could be set to PART_BOOTABLE (80h), or PART_NON_BOOTABLE(00h). The first partition designated as PART_BOOTABLE is the boot partition. All others are not. Setting multiple partitions to PART_BOOTABLE will result in boot errors.
Part_FirstHead	The first head of this partition. This is a 0-based number representing the offset from the beginning of the disk. The partition includes this head.
Part_FirstSector	The first sector of this partition. This is a 1-based, 6-bit number representing the offset from the beginning of the disk. The partition includes this sector. Bits 0 through 5 specify the 6-bit value; bits 6 and 7 are used with the Part_FirstTrack member.
Part_FirstTrack	The first track of this partition. This is an inclusive 0-based, 10-bit number that represents the offset from the beginning of the disk. The high 2 bits of this value are specified by bits 6 and 7 of the Part_FirstSector member.
PartFileSystem	Specifies the file system for the partition. The following are acceptable values:
Value	Description
PART_UNKNOWN(00h)	Unknown.
PART_DOS2_FAT(01h)	12-bit FAT.
PART_DOS3_FAT(04h)	16-bit FAT. Partition smaller than 32MB.
PART_EXTENDED(05h)	Extended MS-DOS Partition.
PART_DOS4_FAT(06h)	16-bit FAT. Partition larger than or equal to 32MB.
PART_DOS32(0Bh)	32-bit FAT. Partition up to 2047GB.
PART_DOS32X(0Ch)	Same as PART_DOS32(0Bh), but uses Logical Block Address Int 13h extensions.
PART_DOSX13(0Eh)	Same as PART_DOS4_FAT(06h), but uses Logical Block Address Int 13h extensions.
PART_DOSX13X(0Fh)	Same as PART_EXTENDED(05h), but uses Logical Block Address Int 13h extensions.
Part_LastHead	The last head of the partition. This is a 0-based number that represents the offset from the beginning of the disk. The partition includes the head specified by this member.
Part_LastSector	The last sector of this partition. This is a 1-based,

Member Name	Description
	6-bit number representing offset from the beginning of the disk. The partition includes the sector specified by this member. Bits 0 through 5 specify the 6-bit value; bits 6 and 7 are used with the Part_LastTrack member.
Part_LastTrack	The last track of this partition. This is a 0-based, 10-bit number that represents offset from the beginning of the disk. The partition includes this track. The high 2 bits of this value are specified by bits 6 and 7 of the Part_LastSector member.
Part_StartSector	Specifies the 1-based number of the first sector on the disk. This value may not be accurate for extended partitions. Use the Part_FirstSector value for extended partitions.
Part_NumSectors	The 1-based number of sectors in the partition.

UNDERSTANDING THE FILE SYSTEM: NTFS

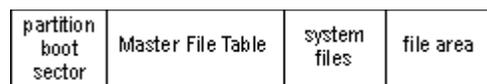
The Windows NT file system (NTFS) provides a combination of performance, reliability, and compatibility not found in the FAT file system. It is designed to quickly perform standard file operations such as read, write, and search — and even advanced operations such as file-system recovery — on very large hard disks.

Formatting a volume with the NTFS file system results in the creation of several system files and the Master File Table (MFT), which contains information about all the files and folders on the NTFS volume.

The first information on an NTFS volume is the Partition Boot Sector, which starts at sector 0 and can be up to 16 sectors long. The first file on an NTFS volume is the Master File Table (MFT).

The following picture illustrates the layout of an NTFS volume when formatting has finished.

Formatted NTFS Volume



The NTFS file system includes security features required for file servers and high-end personal computers in a corporate environment. The NTFS file system also supports data access control and ownership privileges that are important for the integrity of critical data. While folders shared on a Windows NT computer are assigned particular permissions, NTFS files and folders can have permissions assigned whether they are shared or not. NTFS is the only file system on Windows NT that allows you to assign permissions to individual files.

The NTFS file system has a simple, yet very powerful design. Basically, everything on the volume is a file and everything in a file is an attribute, from the data

attribute, to the security attribute, to the file name attribute. Every sector on an NTFS volume that is allocated belongs to some file. Even the file system metadata (information that describes the file system itself) is part of a file.

For more detailed information see resource kits on Microsoft's web site <http://www.microsoft.com/windows/reskits/webresources/default.asp> or Microsoft Developers Network (MSDN) <http://msdn.microsoft.com>.

This chapter covers information about NTFS. Topics covered are listed below:

- NTFS Partition Boot Sector
- NTFS Master File Table (MFT)
- NTFS File Types
- NTFS Data Integrity and Recoverability

NTFS PARTITION BOOT SECTOR

The table below describes the boot sector of a volume formatted with NTFS. When you format an NTFS volume, the format program allocates the first 16 sectors for the boot sector and the bootstrap code.

NTFS Boot Sector

Byte Offset	Field Length	Field Name
0x00	3 bytes	Jump Instruction
0x03	LONGLONG	OEM ID
0x0B	25 bytes	BPB
0x24	48 bytes	Extended BPB
0x54	426 bytes	Bootstrap Code
0x01FE	WORD	End of Sector Marker

On NTFS volumes, the data fields that follow the BPB form an extended BPB. The data in these fields enables Ntldr (NT loader program) to find the master file table (MFT) during startup. On NTFS volumes, the MFT is not located in a predefined sector, as on FAT16 and FAT32 volumes. For this reason, the MFT can be moved if there is a bad sector in its normal location. However, if the data is corrupted, the MFT cannot be located, and Windows NT/2000 assumes that the volume has not been formatted.

The following example illustrates the boot sector of an NTFS volume formatted while running Windows 2000. The printout is formatted in three sections:

- Bytes 0x00– 0x0A are the jump instruction and the OEM ID (shown in bold print).
- Bytes 0x0B–0x53 are the BPB and the extended BPB.
- The remaining code is the bootstrap code and the end of sector marker (shown in bold print).

NTFS Partition Boot Sector

```

Physical Sector: Cyl 0, Side 1, Sector 1
00000000: EB 52 90 4E 54 46 53 20 - 20 20 20 00 02
08 00 00 .R.NTFS ..... 00000010: 00 00 00 00 00
F8 00 00 - 3F 00 FF 00 3F 00 00 00 .....?....?..
00000020: 00 00 00 00 80 00 80 00 - 4A F5 7F 00 00
00 00 00 .....J..... 00000030: 04 00 00 00 00
00 00 00 - 54 FF 07 00 00 00 00 .....T.....
00000040: F6 00 00 00 01 00 00 00 - 14 A5 1B 74 C9
1B 74 1C .....t..t. 00000050: 00 00 00 00 FA
33 C0 8E - D0 BC 00 7C FB B8 C0 07 .....3.....|....
00000060: 8E D8 E8 16 00 B8 00 0D - 8E C0 33 DB C6
06 0E 00 .....3..... 00000070: 10 E8 53 00 68
00 0D 68 - 6A 02 CB 8A 16 24 00 B4 ..S.h..hj....$.
00000080: 08 CD 13 73 05 B9 FF FF - 8A F1 66 0F B6
C6 40 66 ...s.....f...@f 00000090: 0F B6 D1 80 E2
3F F7 E2 - 86 CD C0 ED 06 41 66 0F .....?.....Af.
000000A0: B7 C9 66 F7 E1 66 A3 20 - 00 C3 B4 41 BB
AA 55 8A ..f..f. ...A..U. 000000B0: 16 24 00 CD 13
72 0F 81 - FB 55 AA 75 09 F6 C1 01 .$.r...U.u....
000000C0: 74 04 FE 06 14 00 C3 66 - 60 1E 06 66 A1
10 00 66 t.....f`.f...f 000000D0: 03 06 1C 00 66
3B 06 20 - 00 0F 82 3A 00 1E 66 6A ....f;. ....fj
000000E0: 00 66 50 06 53 66 68 10 - 00 01 00 80 3E
14 00 00 .fP.Sfh.....>... 000000F0: 0F 85 0C 00 E8
B3 FF 80 - 3E 14 00 00 0F 84 61 00 .....>.....a.
00000100: B4 42 8A 16 24 00 16 1F - 8B F4 CD 13 66
58 5B 07 .B..$.fx[. 00000110: 66 58 66 58 1F
EB 2D 66 - 33 D2 66 0F B7 0E 18 00 fXfX.-f3.f.....
00000120: 66 F7 F1 FE C2 8A CA 66 - 8B D0 66 C1 EA
10 F7 36 f.....f..f....6 00000130: 1A 00 86 D6 8A
16 24 00 - 8A E8 C0 E4 06 0A CC B8 .....$.
00000140: 01 02 CD 13 0F 82 19 00 - 8C C0 05 20 00
8E C0 66 .....f 00000150: FF 06 10 00 FF
0E 0E 00 - 0F 85 6F FF 07 1F 66 61 .....o....fa
00000160: C3 A0 F8 01 E8 09 00 A0 - FB 01 E8 03 00
FB EB FE ..... 00000170: B4 01 8B F0 AC
3C 00 74 - 09 B4 0E BB 07 00 CD 10 .....<.t.....
00000180: EB F2 C3 0D 0A 41 20 64 - 69 73 6B 20 72
65 61 64 .....A disk read 00000190: 20 65 72 72 6F
72 20 6F - 63 63 75 72 72 65 64 00 error occurred.
000001A0: 0D 0A 4E 54 4C 44 52 20 - 69 73 20 6D 69
73 73 69 ..NTLDR is missi 000001B0: 6E 67 00 0D 0A
4E 54 4C - 44 52 20 69 73 20 63 6F ng...NTLDR is co
000001C0: 6D 70 72 65 73 73 65 64 - 00 0D 0A 50 72
65 73 73 mpressed...Press 000001D0: 20 43 74 72 6C
2B 41 6C - 74 2B 44 65 6C 20 74 6F Ctrl+Alt+Del to
000001E0: 20 72 65 73 74 61 72 74 - 0D 0A 00 00 00
00 00 00 restart..... 000001F0: 00 00 00 00 00
00 00 00 - 83 A0 B3 C9 00 00 55 AA .....U.

```

The following table describes the fields in the BPB and the extended BPB on NTFS volumes. The fields starting at 0x0B, 0x0D, 0x15, 0x18, 0x1A, and 0x1C match those on FAT16 and FAT32 volumes. The sample values correspond to the data in this example.

BPB Fields on NTFS

Byte Offset	Field Length	Sample Value	Field Name
0x0B	WORD	0x0002	Bytes Per Sector
0x0D	BYTE	0x08	Sectors Per Cluster
0x0E	WORD	0x0000	Reserved Sectors
0x10	3 BYTES	0x000000	always 0
0x13	WORD	0x0000	not used by NTFS
0x15	BYTE	0xF8	Media Descriptor
0x16	WORD	0x0000	always 0
0x18	WORD	0x3F00	Sectors Per Track
0x1A	WORD	0xFF00	Number Of Heads
0x1C	DWORD	0x3F000000	Hidden Sectors
0x20	DWORD	0x00000000	not used by NTFS
0x24	DWORD	0x80008000	not used by NTFS
0x28	LONGLONG	0x4AF57F0000000000	Total Sectors
0x30	LONGLONG	0x0400000000000000	Logical Cluster Number for the file \$MFT
0x38	LONGLONG	0x54FF070000000000	Logical Cluster Number for the file \$MFTMirr
0x40	DWORD	0xF6000000	Clusters Per File Record Segment
0x44	DWORD	0x01000000	Clusters Per Index Block
0x48	LONGLONG	0x14A51B74C91B741C	Volume Serial Number
0x50	DWORD	0x00000000	Checksum

PROTECTING THE BOOT SECTOR

Because a normally functioning system relies on the boot sector to access a volume, it is highly recommended that you run disk scanning tools such as Chkdsk regularly, as well as back up all of your data files to protect against data loss if you lose access to a volume.

NTFS MFT (MASTER FILE TABLE)

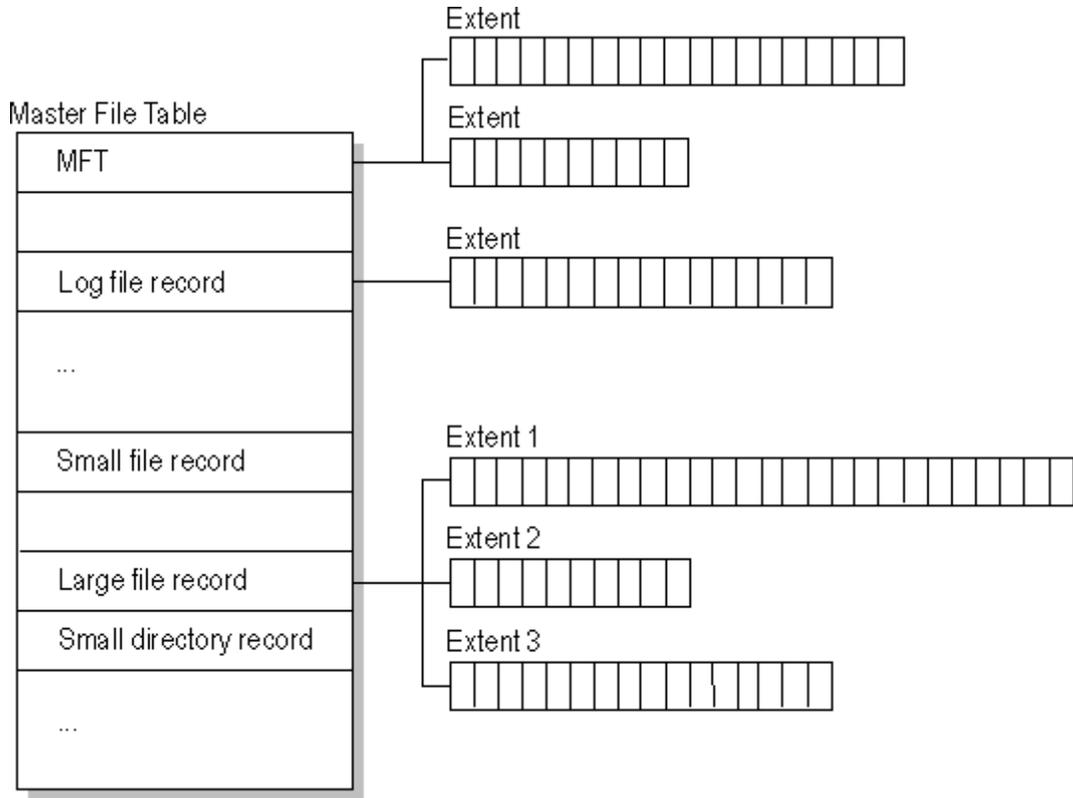
Each file on an NTFS volume is represented by a record in a special file called the master file table (MFT). NTFS reserves the first 16 records of the table for special information. The first record of this table describes the master file table itself, followed by a MFT mirror record. If the first MFT record is corrupted, NTFS reads the second record to find the MFT mirror file, whose first record is identical to the first

record of the MFT. The locations of the data segments for both the MFT and MFT mirror file are recorded in the boot sector. A duplicate of the boot sector is located at the logical center of the disk.

The third record of the MFT is the log file, used for file recovery. The log file is discussed in detail later in this chapter. The seventeenth and following records of the master file table are for each file and directory (also viewed as a file by NTFS) on the volume.

The picture below provides a simplified illustration of the MFT structure.

NTSF MFT Structure



The master file table allocates a certain amount of space for each file record. The attributes of a file are written to the allocated space in the MFT. Small files and directories (typically 1500 bytes or smaller), such as the file illustrated in next figure, can entirely be contained within the master file table record.

MTF Record for a Small File or Directory

Standard information	File or directory name	Security descriptor	Data or index	
----------------------	------------------------	---------------------	---------------	--

This design makes file access very fast. Consider, for example, the FAT file system, which uses a file allocation table to list the names and addresses of each file. FAT directory entries contain an index into the file allocation table.

When you want to view a file, FAT first reads the file allocation table and assures that it exists. Then FAT retrieves the file by searching the chain of allocation units assigned to the file. With NTFS, as soon as you look up the file, it's there for you to use.

Directory records are housed within the master file table just like file records. Instead of data, directories contain index information. Small directory records reside entirely within the MFT structure. Large directories are organized into B-trees, having records with pointers to external clusters containing directory entries that could not be contained within the MFT structure.

NTFS FILE TYPES

This section covers the following topics:

- NTFS File Attributes
- NTFS System Files
- NTFS Multiple Data Streams
- NTFS Compressed Files
- NTFS Encrypted Files
- NTFS Sparse Files

NTFS FILE ATTRIBUTES

The NTFS file system views each file (or folder) as a set of file attributes. Elements such as the file's name, its security information, and even its data, are all file attributes. Each attribute is identified by an attribute type code and, optionally, an attribute name.

When a file's attributes can fit within the MFT file record, they are called resident attributes. For example, information such as filename and time stamp are always included in the MFT file record. When all of the information for a file is too large to fit in the MFT file record, some of its attributes are nonresident.

The nonresident attributes are allocated one or more clusters of disk space elsewhere in the volume. NTFS creates the Attribute List attribute to describe the location of all of the attribute records.

The table below lists all of the file attributes currently defined by the NTFS file system. This list is extensible, meaning that other file attributes can be defined in the future.

Attribute Type	Description
Standard Information	Includes information such as timestamp and link count.
Attribute List	Lists the location of all attribute records that do not fit in the MFT record.
File Name	A repeatable attribute for both long and short file

Attribute Type	Description
	names. The long name of the file can be up to 255 Unicode characters. The short name is the 8.3, case-insensitive name for the file. Additional names, or hard links, required by POSIX can be included as additional file name attributes.
Security Descriptor	Describes who owns the file and who can access it.
Data	Contains file data. NTFS allows multiple data attributes per file. Each file typically has one unnamed data attribute. A file can also have one or more named data attributes, each using a particular syntax.
Object ID	A volume-unique file identifier. Used by the distributed link tracking service. Not all files have object identifiers.
Logged Tool Stream	Similar to a data stream, but operations are logged to the NTFS log file just like NTFS metadata changes. This is used by EFS.
Reparse Point	Used for volume mount points. They are also used by Installable File System (IFS) filter drivers to mark certain files as special to that driver.
Index Root	Used to implement folders and other indexes.
Index Allocation	Used to implement folders and other indexes.
Bitmap	Used to implement folders and other indexes.
Volume Information	Used only in the \$Volume system file. Contains the volume version.
Volume Name	Used only in the \$Volume system file. Contains the volume label.

NTFS SYSTEM FILES

NTFS includes several system files, all of which are hidden from view on the NTFS volume. A system file is one used by the file system to store its metadata and to implement the file system. System files are placed on the volume by the Format utility.

Understanding The File System: NTFS

Metadata Stored in the Master File Table

System File	File Name	MFT Record	Purpose of the File
Master file table	\$Mft	0	Contains one base file record for each file and folder on an NTFS volume. If the allocation information for a file or folder is too large to fit within a single record, other file records are allocated as well.
Master file table 2	\$MftMirr	1	A duplicate image of the first four records of the MFT. This file guarantees access to the MFT in case of a single-sector failure.
Log file	\$Log file	2	Contains a list of transaction steps used for NTFS recoverability. Log file size depends on the volume size and can be as large as 4 MB. It is used by Windows NT/2000 to restore consistency to NTFS after a system failure.
Volume	\$Volume	3	Contains information about the volume, such as the volume label and the volume version.
Attribute definitions	\$AttrDef	4	A table of attribute names, numbers, and descriptions.
Root file name index	\$	5	The root folder.
Cluster bitmap	\$Bitmap	6	A representation of the volume showing which clusters are in use.
Boot sector	\$Boot	7	Includes the BPB used to mount the volume and additional bootstrap loader code used if the volume is bootable.
Bad cluster file	\$BadClus	8	Contains bad clusters for the volume.
Security file	\$Secure	9	Contains unique security descriptors for all files within a volume.
Uppcase table	\$Uppcase	10	Converts lowercase characters to matching Unicode uppercase characters.
NTFS extension file	\$Extend	11	Used for various optional extensions such as quotas, reparse point data, and object identifiers.
		12-15	Reserved for future use.

NTFS MULTIPLE DATA STREAMS

NTFS supports multiple data streams, where the stream name identifies a new data attribute on the file. A handle can be opened to each data stream. A data stream, then, is a unique set of file attributes. Streams have separate opportunistic locks, file locks, and sizes, but common permissions.

This feature enables you to manage data as a single unit. The following is an example of an alternate stream:

```
myfile.dat:stream2
```

A library of files might exist where the files are defined as alternate streams, as in the following example:

```
library:file1
      :file2
      :file3
```

A file can be associated with more than one application at a time, such as Microsoft® Word and Microsoft® WordPad. For instance, a file structure like the following illustrates file association, but not multiple files:

```
program:source_file
      :doc_file
      :object_file
      :executable_file
```

To create an alternate data stream, at the command prompt, you can enter commands such as:

```
echo text>program:source_file
more <program:source_file
```

Important When you copy an NTFS file to a FAT volume, such as a floppy disk, data streams and other attributes not supported by FAT are lost.

NTFS COMPRESSED FILES

Windows NT/2000 supports compression on individual files, folders, and entire NTFS volumes. Files compressed on an NTFS volume can be read and written by any Windows-based application without first being decompressed by another program. Decompression occurs automatically when the file is read.

The file is compressed again when it is closed or saved. Compressed files and folders have an attribute of C when viewed in Windows Explorer.

Only NTFS can read the compressed form of the data. When an application such as Microsoft® Word or an operating system command such as copy requests access to the file, the compression filter driver decompresses the file before making it available. For example, if you copy a compressed file from another Windows NT/2000-based computer to a compressed folder on your hard disk, the file is decompressed when read, copied, and then recompressed when saved.

This compression algorithm is similar to that used by the Windows 98 application DriveSpace 3, with one important difference — the limited functionality compresses the entire primary volume or logical volume. NTFS allows for the compression of an

entire volume, of one or more folders within a volume, or even one or more files within a folder of an NTFS volume.

The compression algorithms in NTFS are designed to support cluster sizes of up to 4 KB. When the cluster size is greater than 4 KB on an NTFS volume, none of the NTFS compression functions are available.

Each NTFS data stream contains information that indicates whether any part of the stream is compressed. Individual compressed buffers are identified by “holes” following them in the information stored for that stream. If there is a hole, NTFS automatically decompresses the preceding buffer to fill the hole.

NTFS provides real-time access to a compressed file, decompressing the file when it is opened and compressing it when it is closed. When writing a compressed file, the system reserves disk space for the uncompressed size.

The system gets back unused space as each individual compression buffer is compressed.

NTFS ENCRYPTED FILES (WINDOWS 2000 ONLY)

The Encrypting File System (EFS) provides the core file encryption technology used to store encrypted files on NTFS volumes. EFS keeps files safe from intruders who might gain unauthorized physical access to sensitive, stored data (for example, by stealing a portable computer or external disk drive).

EFS uses symmetric key encryption in conjunction with public key technology to protect files and ensure that only the owner of a file can access it. Users of EFS are issued a digital certificate with a public key and a private key pair. EFS uses the key set for the user who is logged on to the local computer where the private key is stored.

Users work with encrypted files and folders just as they do with any other files and folders. Encryption is transparent to the user who encrypted the file; the system automatically decrypts the file or folder when the user accesses. When the file is saved, encryption is reapplied. However, intruders who try to access the encrypted files or folders receive an “Access denied” message if they try to open, copy, move, or rename the encrypted file or folder.

To encrypt or decrypt a folder or file, set the encryption attribute for folders and files just as you set any other attribute. If you encrypt a folder, all files and subfolders created in the encrypted folder are automatically encrypted. It is recommended that you encrypt at the folder level.

NTFS SPARSE FILES (WINDOWS 2000 ONLY)

A sparse file has an attribute that causes the I/O subsystem to allocate only meaningful (nonzero) data. Nonzero data is allocated on disk, and non-meaningful data (large strings of data composed of zeros) is not. When a sparse file is read, allocated data is returned as it was stored; non-allocated data is returned, by default, as zeros.

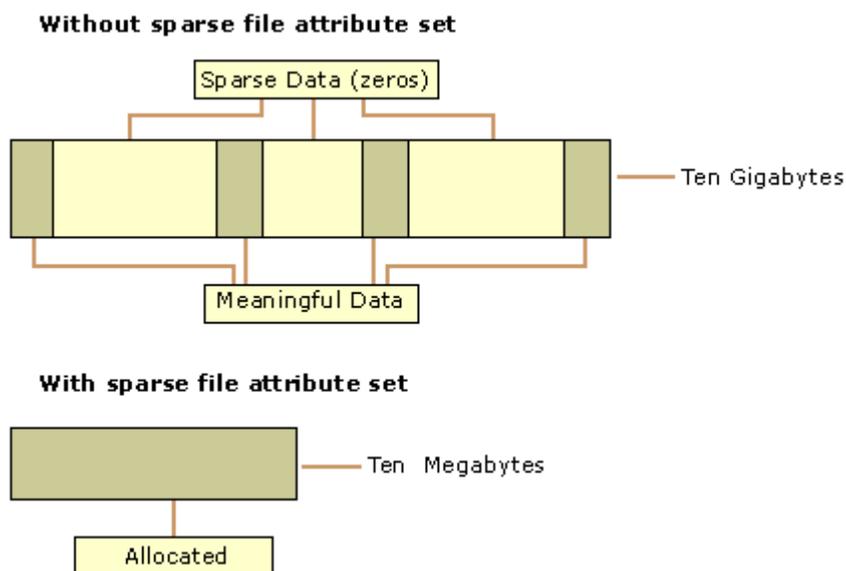
NTFS deallocates sparse data streams and only maintains other data as allocated. When a program accesses a sparse file, the file system yields allocated data as actual data and deallocated data as zeros.

NTFS includes full sparse file support for both compressed and uncompressed files. NTFS handles read operations on sparse files by returning allocated data and sparse data. It is possible to read a sparse file as allocated data and a range of data without retrieving the entire data set, although NTFS returns the entire data set by default.

With the sparse file attribute set, the file system can deallocate data from anywhere in the file and, when an application calls, yield the zero data by range instead of storing and returning the actual data. File system application programming interfaces (APIs) allow for the file to be copied or backed as actual bits and sparse stream ranges. The net result is efficient file system storage and access.

The picture below shows how data is stored with and without the sparse file attribute set.

Windows 2000 Data Storage



Important If either the master boot record (MBR) or boot sector is corrupted, you might not be able to access data on the volume.

RECOVERING DATA WITH NTFS

NTFS views each I/O operation that modifies a system file on the NTFS volume as a transaction, and manages each one as an integral unit. Once started, the transaction is either completed or, in the event of a disk failure, rolled back (such as when the NTFS volume is returned to the state it was in before the transaction was initiated).

To ensure that a transaction can be completed or rolled back, NTFS records the suboperations of a transaction in a log file before they are written to the disk. When a complete transaction is recorded in the log file, NTFS performs the suboperations of the transaction on the volume cache. After NTFS updates the cache, it commits the transaction by recording in the log file that the entire transaction is complete.

Once a transaction is committed, NTFS ensures that the entire transaction appears on the volume, even if the disk fails. During recovery operations, NTFS redoes each

committed transaction found in the log file. Then NTFS locates the transactions in the log file that were not committed at the time of the system failure and undoes each transaction suboperation recorded in the log file.

Incomplete modifications to the volume are prohibited.

NTFS uses the Log File service to log all redo and undo information for a transaction. NTFS uses the redo information to repeat the transaction. The undo information enables NTFS to undo transactions that are not complete or that have an error.

Important NTFS uses transaction logging and recovery to guarantee that the volume structure is not corrupted. For this reason, all system files remain accessible after a system failure. However, user data can be lost because of a system failure or a bad sector.

CLUSTER REMAPPING

In the event of a bad-sector error, NTFS implements a recovery technique called cluster remapping. When Windows 2000 detects a bad-sector, NTFS dynamically remaps the cluster containing the bad sector and allocates a new cluster for the data. If the error occurred during a read, NTFS returns a read error to the calling program, and the data is lost. If the error occurs during a write, NTFS writes the data to the new cluster, and no data is lost.

NTFS puts the address of the cluster containing the bad sector in its bad cluster file so the bad sector is not reused.

Important Cluster remapping is not a backup alternative. Once errors are detected, the disk should be monitored closely and replaced if the defect list grows. This type of error is displayed in the Event Log.

UNDERSTANDING THE FILE RECOVERY PROCESS

The file recovery process can be briefly described as drive or folder scanning to find deleted entries in Root Folder (FAT) or Master File Table (NTFS) then for the particular deleted entry, defining a cluster chain to be recovered and then copying contents of these clusters to the newly created file.

Different file systems maintain their own specific logical data structure, however basically each file system:

- has a list or catalog of file entries, so we can iterate through this list and entries, marked as deleted
- keeps for each entry a list of data clusters, so we can try to find out set of clusters composing the file

After finding out the proper file entry and assembling a set of clusters, composing the file, Active@ UNDELETE reads and copies these clusters to another location.

Not every deleted file can be recovered, however there are some assumptions that are common to all deleted files:

- First, we assume that the file entry still exists (it has not been overwritten with other data). The fewer files that have been created on the drive where the deleted file was resided, increases the chances that space for the deleted file entry has not been used for other entries.

- Second, we assume that the file entry is more-or-less safe to point to the proper place where file clusters are located. In some cases (it has been noticed in Windows XP, on large FAT32 volumes) the operating system damages file entries right after deletion so that the first data cluster becomes invalid and further entry restoration is not possible.
- Third, we assume that the file data clusters are safe (not overwritten with other data). The fewer write operations events on the drive where deleted file resided, the more chances that the space occupied by data clusters of the deleted file has not been used for other data storage.

GENERAL ADVICE AFTER DATA LOSS

DO NOT WRITE ANYTHING ONTO THE DRIVE CONTAINING YOUR IMPORTANT DATA THAT YOU HAVE JUST DELETED ACCIDENTALLY!

Even data recovery software installation can spoil your sensitive data. If the data is really important to you and you do not have another logical drive to install software to, take the whole hard drive out of the computer and plug it into another computer where data recovery software has been already installed or use recovery software that does not require installation, for example recovery software which is capable to run from bootable floppy.

DO NOT TRY TO SAVE ONTO THE SAME DRIVE DATA THAT YOU FOUND AND TRYING TO RECOVER!

When saving recovered data onto the same drive where sensitive data is located, you can intrude in process of recovering by overwriting FAT/MFT records for this and other deleted entries. It is better to save data onto another logical, removable, network or floppy drive.

STEP BY STEP WITH EXAMPLES

This section describes the following functions:

- Disk Scanning for Deleted Entries
- Defining the Chain of Clusters
- Recovering the Chain of Clusters

DISK SCANNING FOR DELETED ENTRIES

Disk Scanning is a process of low-level enumeration of all entries in the Root Folders on FAT12, FAT16, FAT32 or in Master File Table (MFT) on NTFS, NTFS5. The goal is to find and display deleted entries.

In spite of different file/folder entry structure for the different file systems, all of them contain basic file attributes like name, size, creation and modification date/time, file attributes, existing/deleted status, etc...

Given that a drive contains root file table and any file table (MFT, root folder of the drive, regular folder, or even deleted folder) has location, size and predefined

Step by Step with examples

structure, we can scan it from the beginning to the end checking each entry, if it's deleted or not and then display information for all found deleted entries.

Note Deleted entries are marked differently depending on the file system. For example, in FAT any deleted entry, file or folder has been marked with ASCII symbol 229 (0xE5) that becomes first symbol of the structure entry. On NTFS deleted entry has a special attribute in file header that points whether the file has been deleted or not.

EXAMPLE OF SCANNING A FOLDER ON FAT16:

4. Existing folder MyFolder entry (long entry and short entry)

```
0003EE20 41 4D 00 79 00 46 00 6F 00 6C 00 0F 00 09 64 00 AM.y.F.o.l....d.
0003EE30 65 00 72 00 00 00 FF FF FF FF 00 00 FF FF FF FF e.r...YYYY..YYYY
0003EE40 4D 59 46 4F 4C 44 45 52 20 20 20 10 00 4A C4 93 MYFOLDER ..JA"
0003EE50 56 2B 56 2B 00 00 C5 93 56 2B 02 00 00 00 00 00 V+V+..A"V+.....
```

5. Deleted file MyFile.txt entry (long entry and short entry)

```
0003EE60 E5 4D 00 79 00 46 00 69 00 6C 00 0F 00 BA 65 00 aM.y.F.i.l...?e.
0003EE70 2E 00 74 00 78 00 74 00 00 00 00 00 FF FF FF FF ..t.x.t....YYYY
0003EE80 E5 59 46 49 4C 45 20 20 54 58 54 20 00 C3 D6 93 aYFILE TXT .AO"
0003EE90 56 2B 56 2B 00 00 EE 93 56 2B 03 00 33 B7 01 00 V+V+..i"V+..3...
```

6. Existing file Setuplog.txt entry (the only short entry)

```
0003EEA0 53 45 54 55 50 4C 4F 47 54 58 54 20 18 8C F7 93 SETUPLOGTXT .??"
0003EEB0 56 2B 56 2B 00 00 03 14 47 2B 07 00 8D 33 03 00 V+V+....G+..?3..
0003EEC0 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 .....
0003EED0 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 .....
Offset   0 1 2 3 4 5 6 7 8 9 A B C D E F
```

This folder contains 3 entries, one of them is deleted. First entry is an existing folder MyFolder. Second one is a deleted file MyFile.txt Third one is an existing file Setuplog.txt.

First symbol of the deleted file entry is marked with E5 symbol, so Disk Scanner can assume that this entry has been deleted.

EXAMPLE OF SCANNING FOLDER ON NTFS5 (WINDOWS 2000):

For our drive we have input parameters:

- Total Sectors 610406
- Cluster size 512 bytes
- One Sector per Cluster
- MFT starts from offset 0x4000, non-fragmented
- MFT record size 1024 bytes
- MFT Size 1968 records

Thus we can iterate through all 1968 MFT records, starting from the absolute offset 0x4000 on the volume looking for the deleted entries. We are interested in MFT entry 57 having offset $0x4000 + 57 * 1024 = 74752 = 0x12400$ because it contains our recently deleted file "My Presentation.ppt"

Below MFT record number 57 is displayed:

```

Offset 0 1 2 3 4 5 6 7 8 9 A B C D E F
00012400 46 49 4C 45 2A 00 03 00 9C 74 21 03 00 00 00 00 FILE*...?t!.....
00012410 47 00 02 00 30 00 00 00 D8 01 00 00 00 04 00 00 G...0...O.....
00012420 00 00 00 00 00 00 00 00 05 00 03 00 00 00 00 00 .....
00012430 10 00 00 00 60 00 00 00 00 00 00 00 00 00 00 00 .....`.....
00012440 48 00 00 00 18 00 00 00 20 53 DD A3 18 F1 C1 01 H..... SY?.nA.
00012450 00 30 2B D8 48 E9 C0 01 C0 BF 20 A0 18 F1 C1 01 .0+OHeA.A? .nA.
00012460 20 53 DD A3 18 F1 C1 01 20 00 00 00 00 00 00 00 SY?.nA. ....
00012470 00 00 00 00 00 00 00 00 00 00 00 00 02 01 00 00 .....
00012480 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 .....
00012490 30 00 00 00 78 00 00 00 00 00 00 00 00 00 03 00 0...x.....
000124A0 5A 00 00 00 18 00 01 00 05 00 00 00 00 00 05 00 Z.....
000124B0 20 53 DD A3 18 F1 C1 01 20 53 DD A3 18 F1 C1 01 SY?.nA. SY?.nA.
000124C0 20 53 DD A3 18 F1 C1 01 20 53 DD A3 18 F1 C1 01 SY?.nA. SY?.nA.
000124D0 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 .....
000124E0 20 00 00 00 00 00 00 00 0C 02 4D 00 59 00 50 00 .....M.Y.P.
000124F0 52 00 45 00 53 00 7E 00 31 00 2E 00 50 00 50 00 R.E.S.~.1...P.P.
00012500 54 00 69 00 6F 00 6E 00 30 00 00 00 80 00 00 00 T.i.o.n.0...^...
00012510 00 00 00 00 00 00 02 00 68 00 00 00 18 00 01 00 .....h.....
00012520 05 00 00 00 00 00 05 00 20 53 DD A3 18 F1 C1 01 ..... SY?.nA.
00012530 20 53 DD A3 18 F1 C1 01 20 53 DD A3 18 F1 C1 01 SY?.nA. SY?.nA.
00012540 20 53 DD A3 18 F1 C1 01 00 00 00 00 00 00 00 00 SY?.nA.....
00012550 00 00 00 00 00 00 00 00 20 00 00 00 00 00 00 00 .....
00012560 13 01 4D 00 79 00 20 00 50 00 72 00 65 00 73 00 ..M.y. .P.r.e.s.
00012570 65 00 6E 00 74 00 61 00 74 00 69 00 6F 00 6E 00 e.n.t.a.t.i.o.n.
00012580 2E 00 70 00 70 00 74 00 80 00 00 00 48 00 00 00 ..p.p.t.^...H...
00012590 01 00 00 00 00 00 04 00 00 00 00 00 00 00 00 00 .....
000125A0 6D 00 00 00 00 00 00 00 40 00 00 00 00 00 00 00 m.....@.....
000125B0 00 DC 00 00 00 00 00 00 00 DC 00 00 00 00 00 00 .U.....U.....
000125C0 00 DC 00 00 00 00 00 00 31 6E EB C4 04 00 00 00 .U.....lneA....
000125D0 FF FF FF FF 82 79 47 11 00 00 00 00 00 00 00 00 yyy,yG.....
000125E0 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 .....
000125F0 00 00 00 00 00 00 00 00 00 00 00 00 00 00 03 00 .....
.....
00012600 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 .....

```

An MFT Record has a pre-defined structure. It has a set of attributes defining any file of folder parameters.

An MFT Record begins with a standard File Record Header (first bold section, offset 0x00):

- "FILE" identifier (4 bytes)
- Offset to update sequence (2 bytes)
- Size of update sequence (2 bytes)
- \$LogFile Sequence Number (LSN) (8 bytes)
- Sequence Number (2 bytes)
- Reference Count (2 bytes)
- Offset to Update Sequence Array (2 bytes)
- Flags (2 bytes)

Step by Step with examples

- Real size of the FILE record (4 bytes)
- Allocated size of the FILE record (4 bytes)
- File reference to the base FILE record (8 bytes)
- Next Attribute Id (2 bytes)

The most important information for us in this block is the file state: deleted or in-use. If Flags (in red color) field has bit 1 set, it means that file is in-use. In our example it is zero, and this means that the file is deleted.

Starting from 0x48, we have Standard Information Attribute (second bold section):

- File Creation Time (8 bytes)
- File Last Modification Time (8 bytes)
- File Last Modification Time for File Record (8 bytes)
- File Access Time for File Record (8 bytes)
- DOS File Permissions (4 bytes) 0x20 in our case Archive Attribute

Following the standard attribute header, we have File Name Attribute belonging to DOS name space, short file names, (third bold section, offset 0xA8) and again following standard attribute header, we have File Name Attribute belonging to Win32 name space, long file names, (third bold section, offset 0x120):

- File Reference to the Parent Directory (8 bytes)
- File Modification Times (32 bytes)
- Allocated Size of the File (8 bytes)
- Real Size of the File (8 bytes)
- Flags (8 bytes)
- Length of File Name (1 byte)
- File Name Space (1 byte)
- File Name (Length of File Name * 2 bytes)

In our case from this section we can extract file name, "My Presentation.ppt", File Creation and Modification times, and Parent Directory Record number. Starting from offset 0x188, there is a non-resident Data attribute (green section).

- Attribute Type (4 bytes) (e.g. 0x80)
- Length including header (4 bytes)
- Non-resident flag (1 byte)
- Name length (1 byte)
- Offset to the Name (2 bytes)
- Flags (2 bytes)
- Attribute Id (2 bytes)
- Starting VCN (8 bytes)
- Last VCN (8 bytes)

- Offset to the Data Runs (2 bytes)
- Compression Unit Size (2 bytes)
- Padding (4 bytes)
- Allocated size of the attribute (8 bytes)
- Real size of the attribute (8 bytes)
- Initialized data size of the stream (8 bytes)
- Data Runs ...

In this section we are interested in Compression Unit size (zero in our case means non-compressed), Allocated and Real size of attribute that is equal to our file size (0xDC00 = 56320 bytes), and Data Runs (see the next topic).

DEFINING THE CHAIN OF CLUSTERS

To reconstruct a file from a set of clusters, we need to define a chain of clusters. Here are the steps:

1. Scan the drive to locate and identify data.
 - a. One-by-one, go through each file cluster (NTFS) or each free cluster (FAT) that we presume belongs to the file.
 - a. Continue chaining the clusters until the size of the cumulative total of clusters approximately equals the total size of the deleted file. If the file is fragmented, the chain of clusters will be composed of several extents (NTFS), or select probable contiguous clusters and bypass occupied clusters that appear to have random data (FAT).

The location of these clusters can vary depending on file system. For example, a file deleted in a FAT volume has its first cluster in the Root entry; the other clusters can be found in the File Allocation Table. In NTFS each file has a `_DATA_` attribute that describes "data runs". Disassembling data runs reveals extents. For each extent there is a start cluster offset and a number of clusters in extent. By enumerating the extents, the file's cluster chain can be assembled.

The clusters chain can be assembled manually, using low-level disk editors, however it is much simpler using a data recovery utility, like Active@ UNERASER.

DEFINING A CLUSTER CHAIN IN FAT16

In the previous topic, we were examining a sample set of data with a deleted file named `MyFile.txt`. This example will continue with the same theme.

The folder we scanned before contains a record for this file:

```
0003EE60 E5 4D 00 79 00 46 00 69 00 6C 00 0F 00 BA 65 00 aM.y.F.i.l...?e.
0003EE70 2E 00 74 00 78 00 74 00 00 00 00 00 FF FF FF FF ..t.x.t.....yyyy
0003EE80 E5 59 46 49 4C 45 20 20 54 58 54 20 00 C3 D6 93 aYFILE TXT .AO"
0003EE90 56 2B 56 2B 00 00 EE 93 56 2B 03 00 33 B7 01 00 V+V+..i"V+...3..
```

We can calculate size of the deleted file based on root entry structure. Last four bytes are `33 B7 01 00` and converting them to decimal value (changing bytes order),

Step by Step with examples

we get 112435 bytes. Previous 2 bytes (03 00) are the number of the first cluster of the deleted file. Repeating for them the conversion operation, we get number 03 - this is the start cluster of the file.

What we can see in the File Allocation Table at this moment?

```
Offset 0 1 2 3 4 5 6 7 8 9 A B C D E F
00000200 F8 FF FF FF FF FF 00 00 00 00 00 00 00 00 08 00 0yyyyyy.....
00000210 09 00 0A 00 0B 00 0C 00 0D 00 FF FF 00 00 00 00 .....yy....
00000220 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 .....
```

Zeros! And it is good in our case - it means that these clusters are free, i.e. most likely our file was not overwritten by another file's data. Now we have chain of clusters 3, 4, 5, 6 and we are ready to recover it. Some explanations:

- We started looking from offset 6 because each cluster entry in FAT16 takes 2 bytes, our file starts from 3rd cluster, i.e. $3*2=6$.
- We considered 4 clusters because cluster size on our drive is 32 Kb, our file size is 112, 435 bytes, i.e. $3\text{clusters} * 32\text{Kb} = 96\text{Kb}$ plus a little bit more.
- We assumed that this file was not fragmented, i.e. all clusters were located consecutively. We need 4 clusters, we found 4 free consecutive clusters, so this assumption sounds reasonable, although in real life it may be not true.

Note In many cases data cannot be successfully recovered, because the cluster chain cannot be defined. This will occur when another file or folder is written on the same drive as the one where the deleted file is located. Warning messages about this fact will be displayed while recovering data using Active@ UNDELETE.

DEFINING A CLUSTER CHAIN IN NTFS

When recovering in NTFS, a part of DATA attributes called Data Runs provides the location of file clusters. In most cases, DATA attributes are stored in the Master File Table (MFT) record. Finding the MFT record for a deleted file will most likely lead to the location of the cluster's chain.

In example below the DATA attribute is marked with a green color. Data Runs inside the DATA attribute are marked as Bold.

```
Offset 0 1 2 3 4 5 6 7 8 9 A B C D E F
00012580 2E 00 70 00 70 00 74 00 80 00 00 00 48 00 00 00 ..p.p.t._...H...
00012590 01 00 00 00 00 00 04 00 00 00 00 00 00 00 00 00 .....
The File Recovery Process 91
000125A0 6D 00 00 00 00 00 00 00 40 00 00 00 00 00 00 00 m.....@.....
000125B0 00 DC 00 00 00 00 00 00 00 DC 00 00 00 00 00 00 .U.....U.....
000125C0 00 DC 00 00 00 00 00 00 31 6E EB C4 04 00 00 00 .U.....1neA....
000125D0 FF FF FF FF 82 79 47 11 00 00 00 00 00 00 00 00 yyyy,yG.....
```

Decrypting Data Runs

Decrypting data runs can be accomplished using the following steps:

1. First byte (0x31) shows how many bytes are allocated for the length of the run (0x1 in the example case) and for the first cluster offset (0x3 in our case).
 - a. Take one byte (0x6E) that points to the length of the run.

- a. Pick up 3 bytes pointing to the start cluster offset (0xEBC404).
- a. Changing bytes order we get first cluster of the file 312555 (equals 0x04C4EB).
- a. Starting from this cluster we need to pick up 110 clusters (equals 0x6E).
- a. Next byte (0x00) tells us that no more data runs exist.
- a. Our file is not fragmented, so we have the only one data run.
- a. Lastly, check to see if there is enough information (size of the file). Cluster size is 512 bytes. There are 110 clusters, $110 * 512 = 56,320$ bytes. Our file size was defined as 56,320 bytes, so we have enough information now to recover the file clusters.

RECOVERING THE CHAIN OF CLUSTERS

After the cluster chain is defined, the final task is to read and save the contents of the defined clusters to another place, verifying their contents. With a chain of clusters and standard formulae, it is possible to calculate each cluster offset from the beginning of the drive. Formulae for calculating cluster offset vary, depending on file system. Starting from the calculated offset, copy a volume of data equal to the size of the chain of clusters into a newly-created file.

To calculate the cluster offset in a FAT drive, we need to know:

- Boot sector size
- Number of FAT-supported copies
- Size of one copy of FAT
- Size of main root folder
- Number of sectors per cluster
- Number of bytes per sector

NTFS format defines a linear space and calculating the cluster offset is simply a matter of multiplying the cluster number by the cluster size.

RECOVERING CLUSTER CHAIN IN FAT16

This section continues the examination of the deleted file MyFile.txt from previous topics. By now we have chain of clusters numbered 3, 4, 5 and 6 identified for recovering. Our cluster consists of 64 sectors, sector size is 512 bytes, so cluster size is: $64 * 512 = 32,768$ bytes = 32 Kb.

The first data sector is 535 (we have 1 boot sector, plus 2 copies of FAT times 251 sectors each, plus root folder 32 sectors, total 534 occupied by system data sectors).

Clusters 0 and 1 do not exist, so the first data cluster is 2.

Cluster number 3 is next to cluster 2, i.e. it is located 64 sectors behind the first data sector ($535 + 64 = 599$).

Equal offset of 306,668 byte from the beginning of the drive (0x4AE00).

Once the computer is running in this recovery environment, it will help you to see all other files and directories on the drive and allow you to copy data to a safe place on another drive.

PARTITION VISIBILITY

A more serious situation exists if your computer will start and you cannot see a drive partition or physical drive (see Note below). For the partition or physical drive to be visible to the Operating System the following conditions must apply:

- Partition/Drive can be found via Partition Table
- Partition/Drive boot sector is safe

If the above conditions are true, the OS can read the partition or physical drive parameters and display the drive in the list of the available drives.

If the file system is damaged (Root, FAT area on FAT12/FAT16/FAT32, or system MFT records on NTFS) the drive's content might not be displayed and we might see errors like "MFT is corrupted", or "Drive is invalid"... If this is the case it is less likely that you will be able to restore your data. Do not despair, as there may be some tricks or tips to display some of the residual entries that are still safe, allowing you to recover your data to another location.

Partition recovery describes two things:

- Physical partition recovery. The goal is to identify the problem and write information to the proper place on the hard drive so that the partition becomes visible to the OS again. This can be done using manual Disk Editors along with proper guidelines or using recovery software, designed specifically for this purpose. Active@ Partition Recovery software implements this approach.
- Virtual partition recovery. The goal is to determine the critical parameters of the deleted/damaged/overwritten partition and render it open to scanning in order to display its content. This approach can be applied in some cases when physical partition recovery is not possible (for example, partition boot sector is dead) and is commonly used by recovery software. This process is almost impossible to implement manually. Active@ UNDELETE software implements this approach.

Note If your computer has two operating systems and you choose to start in Windows 95/98 or ME, these operating systems cannot see partitions that are formatted for NTFS. This is normal operation for these operating systems. To view NTFS partitions, you must be in a Windows NT/2000/XP environment.

OTHER PARTITION RECOVERY TOPICS

These topics related to the recovery of partitions apply to any file system:

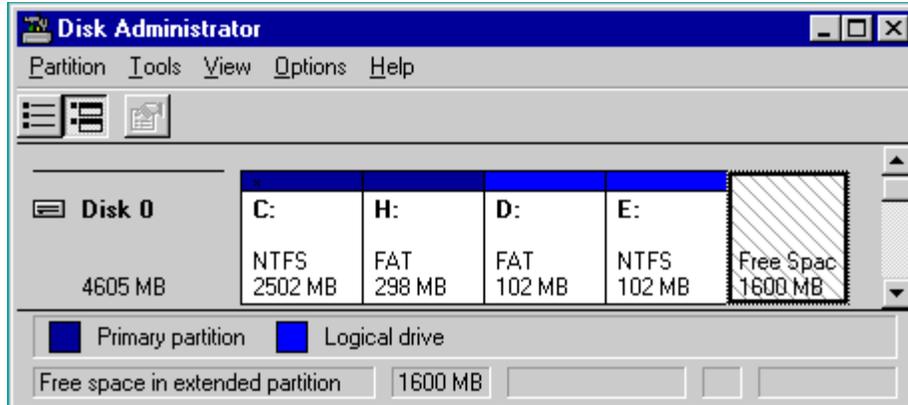
- MBR is Damaged
- Partition is Deleted or Partition Table is Damaged
- Partition Boot Sector is Damaged

Other Partition Recovery Topics

- Missing or Corrupted System Files

For these topics the following disk layout will be used:

Example Disk Info



The figure shows a system with two primary partitions (C:(NTFS) and H:(FAT)) and one extended partition having two logical drives (D: (FAT) and E:(NTFS))

MBR IS DAMAGED

The Master Boot Record (MBR) will be created when you create the first partition on the hard disk. It is very important data structure on the disk. The Master Boot Record contains the Partition Table for the disk and a small amount of executable code for the boot start. The location is always the first sector on the disk.

The first 446 (0x1BE) bytes are MBR itself, the next 64 bytes are the Partition Table, the last two bytes in the sector are a signature word for the sector and are always 0x55AA.

BLANK SCREEN ON STARTUP

For our disk layout we have MBR:

```
Physical Sector: Cyl 0, Side 0, Sector
00000000 33 C0 8E D0 BC 00 7C FB 50 07 50 1F FC BE 1B 7C 3AZ??.|uP.P.u?.|
00000010 BF 1B 06 50 57 B9 E5 01 F3 A4 CB BE BE 07 B1 04 ?..PW?a.o#E??±.
00000020 38 2C 7C 09 75 15 83 C6 10 E2 F5 CD 18 8B 14 8B 8,|.u.??..aoI.<.<
00000030 EE 83 C6 10 49 74 16 38 2C 74 F6 BE 10 07 4E AC i??..It.8,to?..N~
00000040 3C 00 74 FA BB 07 00 B4 0E CD 10 EB F2 89 46 25 <.tu»...?..I.eo%F%
00000050 96 8A 46 04 B4 06 3C 0E 74 11 B4 0B 3C 0C 74 05 -SF.?.<.t.?.<.t.
00000060 3A C4 75 2B 40 C6 46 25 06 75 24 BB AA 55 50 B4 :Au+@?F%.u$»?UP?
00000070 41 CD 13 58 72 16 81 FB 55 AA 75 10 F6 C1 01 74 AI.Xr.?uU?u.oA.t
00000080 0B 8A E0 88 56 24 C7 06 A1 06 EB 1E 88 66 04 BF .Sa?V$C.?.e.?f.?
00000090 0A 00 B8 01 02 8B DC 33 C9 83 FF 05 7F 03 8B 4E ..?..<U3E?y..<N
000000A0 25 03 4E 02 CD 13 72 29 BE 46 07 81 3E FE 7D 55 %.N.I.r)?F.??}?U
000000B0 AA 74 5A 83 EF 05 7F DA 85 F6 75 83 BE 27 07 EB ?tZ?i.U...ou??'.e
000000C0 8A 98 91 52 99 03 46 08 13 56 0A E8 12 00 5A EB S?'R™.F..V.e..Ze
000000D0 D5 4F 74 E4 33 C0 CD 13 EB B8 00 00 00 00 00 00 Oota3AI.e?.....
000000E0 56 33 F6 56 56 52 50 06 53 51 BE 10 00 56 8B F4 V3oVVRP.SQ?...V<o
000000F0 50 52 B8 00 42 8A 56 24 CD 13 5A 58 8D 64 10 72 PR?.BSV$I.ZX?d.r
00000100 0A 40 75 01 42 80 C7 02 E2 F7 F8 5E C3 EB 74 49 .@u.B^C.a?o^AetI
00000110 6E 76 61 6C 69 64 20 70 61 72 74 69 74 69 6F 6E nvalid partition
```

MBR is Damaged

```
000000120 20 74 61 62 6C 65 00 45 72 72 6F 72 20 6C 6F 61 table.Error loa
000000130 64 69 6E 67 20 6F 70 65 72 61 74 69 6E 67 20 73 ding operating s
000000140 79 73 74 65 6D 00 4D 69 73 73 69 6E 67 20 6F 70 ystem.Missing op
000000150 65 72 61 74 69 6E 67 20 73 79 73 74 65 6D 00 00 erating system..
000000160 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 .....
000000170 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 .....
000000180 00 00 00 8B FC 1E 57 8B F5 CB 00 00 00 00 00 00 00 ...<u.W<oE.....
000000190 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 .....
0000001A0 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 .....
0000001B0 00 00 00 00 00 00 00 00 00 00 00 00 00 00 80 01 .....|4.?..^
0000001C0 01 00 07 FE 7F 3E 3F 00 00 00 40 32 4E 00 00 00 ...?>?...@2N...
0000001D0 41 3F 06 FE 7F 64 7F 32 4E 00 A6 50 09 00 00 00 A?..?d2N.|P....
0000001E0 41 65 0F FE BF 4A 25 83 57 00 66 61 38 00 00 00 Ae.??J%?W.fa8...
0000001F0 00 00 00 00 00 00 00 00 00 00 00 00 00 00 55 AA .....U?
```

To simulate what will happen if the first sector has been damaged (by a virus, for example), we will overwrite the first 16 bytes with zeros, as shown below:

```
000000000 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 .....
000000010 BF 1B 06 50 57 B9 E5 01 F3 A4 CB BE BE 07 B1 04 ?..PW?a.oxE??±.
```

We have effectively destroyed the MBR at this point. When we try to restart the computer, we see the hardware testing procedures, and then a blank screen without any messages. This blank screen confirms that the piece of code at the beginning of the MBR could not be executed properly. Error messages cannot be displayed because the MBR cannot be run.

If we boot from a system floppy, however, we can see a hard drive FAT partition and the files on it. We are able to perform standard operations like file copy, program execution and so on. This is possible because only the first part of the MBR has been damaged. The partition table is safe and we can access our drives when we boot from the operating system installed on the other drive.

OPERATING SYSTEM NOT FOUND

In this next scenario, we explore what will happen if the sector signature (last word 0x55AA) has been removed or damaged?

To explore this scenario, we write zeros to the location of sector signature, as shown below:

```
Physical Sector: Cyl 0, Side 0, Sector 1
0000001E0 41 65 0F FE BF 4A 25 83 57 00 66 61 38 00 00 00 Ae.??J%?W.fa8...
0000001F0 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 .....
```

When we try to boot now, we see the "Operating System not found" error message.

When encountering this message on system boot, run Disk Viewer and check the first physical sector on the hard drive to see whether it looks like a valid MBR or not. Here are things to check:

- See if it is filled up with zeros or any other single character.
- Check whether error messages (like you can see above "Invalid partition table"...) are present or not.
- Check whether the disk signature (0x55AA) is present.

The simplest way to repair or re-create the MBR is to run Microsoft's standard utility called FDISK with a parameter /MBR. The command looks like the sample below:

Other Partition Recovery Topics

```
A:\> FDISK.EXE /MBR
```

FDISK is a standard utility included in MS-DOS, Windows 95, 98, ME.

If you have Windows NT / 2000 / XP, you can boot from startup floppy disks or CD-ROM, choose Repair option during setup, and run Recovery Console.

When you are logged on, you can run FIXMBR command to repair the MBR. Another alternative is to use a third party MBR recovery utility or if you've created an MBR backup, repair the damaged MBR by restoring the backup (Active@ Partition Recovery has such capabilities).

RECOVERING DATA IF THE FIRST SECTOR IS BAD OR UNREADABLE

In the Blank Screen simulation, above, we simulated the destroyed first sector scenario. When you try to read the first sector using Disk Viewer/Editor you should get an error message saying that the sector is unreadable. In this case recovery software is unable to help you to bring the hard drive back to the working condition, i.e. physical partition recovery is not possible.

The only thing that can be done is to scan and search for partitions (i.e. perform virtual partition recovery). When something is found - display the data save it to another location. Software, like Active@ File Recovery, Active@ UNERASER for DOS will help you here.

PARTITION IS DELETED OR PARTITION TABLE IS DAMAGED

The information about primary partitions and extended partition is contained in the Partition Table, a 64-byte data structure, located in the same sector as the Master Boot Record (cylinder 0, head 0, sector 1). The Partition Table conforms to a standard layout, which is independent of the operating system. The last two bytes in the sector are a signature word for the sector and are always 0x55AA.

For our disk layout we have Partition Table:

```
Physical Sector: Cyl 0, Side 0, Sector 1
0000001B0 80 01 .....e.
0000001C0 01 00 07 FE 7F 3E 3F 00 00 00 40 32 4E 00 00 00 ...?>?...@2N...
0000001D0 41 3F 06 FE 7F 64 7F 32 4E 00 A6 50 09 00 00 00 A?.?d2N.|P....
0000001E0 41 65 0F FE BF 4A 25 83 57 00 66 61 38 00 00 00 Ae.??J%?W.fa8...
0000001F0 00 00 00 00 00 00 00 00 00 00 00 00 00 00 55 AA .....U?
```

We can see three existing entries and one empty entry:

- Partition 1, offset 0x01BE (446)
- Partition 2, offset 0x01CE (462)
- Partition 3, offset 0x01DE (478)
- Partition 4 - empty, offset 0x01EE (494)

Each Partition Table entry is 16 bytes long, making a maximum of four entries available. Each partition entry has fields for Boot Indicator (BYTE), Starting Head (BYTE), Starting Sector (6 bits), Starting Cylinder (10 bits), System ID (BYTE), Ending Head (BYTE), Ending Sector (6 bits), Ending Cylinder (10 bits), Relative Sector (DWORD), Total Sectors (DWORD).

Partition is Deleted or Partition Table is Damaged

Thus the MBR loader can assume the location and size of partitions. MBR loader looks for the "active" partition, i.e. partition that has Boot Indicator equals 0x80 (the first one in our case) and passes control to the partition boot sector for further loading.

Below, a number of situations are simulated demonstrating events which cause a computer to hang while booting or in a data loss scenario:

Scenario 1. No disk partition has been set to the Active state (Boot Indicator=0x80).

To simulate this scenario, remove the Boot Indicator from the first partition as below:

```
0000001B0 00 01 .....  
0000001C0 01 00 07 FE 7F 3E 3F 00 00 00 40 32 4E 00 00 00 ...?>?...@2N...
```

When we try to boot now, we see an error message like "Operating System not found". This demonstrates a situation where the loader wants to pass control to the active system, and cannot determine which partition is active and contains the system.

Scenario 2. A partition has been set to the Active state (Boot Indicator=0x80) but there are no system files on that partition.

(This situation is possible if we had used FDISK and not selected the correct active partition).

The Loader tries to pass control to the partition, fails, tries to boot again from other devices like the floppy. If it fails to boot again, an error message like "Non-System Disk or Disk Error" appears.

Scenario 3. Partition entry has been deleted.

If the partition entry has been deleted, the next two partitions will move one line up in the partition table, as below:

```
Physical Sector: Cyl 0, Side 0, Sector 1  
0000001B0 80 00 .....€.  
0000001C0 41 3F 06 FE 7F 64 7F 32 4E 00 A6 50 09 00 00 00 A?.?d2N.|P....  
0000001D0 41 65 0F FE BF 4A 25 83 57 00 66 61 38 00 00 00 Ae.??J%?W.fa8...  
0000001E0 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 .....  
0000001F0 00 00 00 00 00 00 00 00 00 00 00 00 00 55 AA .....U?
```

If we try to boot now, the partition previous identified as "second" (FAT) partition becomes the "first" and the loader will try to boot from it. If the operating system does not exist within the partition, the same error messages appear.

Scenario 4. Partition entry has been damaged.

To simulate this situation, write zeros to the location of the first partition entry.

```
Physical Sector: Cyl 0, Side 0, Sector 1  
0000001B0 80 00 .....€.  
0000001C0 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 .....  
0000001D0 41 3F 06 FE 7F 64 7F 32 4E 00 A6 50 09 00 00 00 A?.?d2N.|P....  
0000001E0 41 65 0F FE BF 4A 25 83 57 00 66 61 38 00 00 00 Ae.??J%?W.fa8...  
0000001F0 00 00 00 00 00 00 00 00 00 00 00 00 00 55 AA .....U?
```

If we try to boot now, the MBR loader will try to read and interpret zeros (or other garbage) as partition parameters. The error message will read "Missing Operating System".

Thus, the second step in partition recovery is to run Disk Viewer and to make sure that the proper partition exists in the partition table and has been set as active.

Can Recovery Software Help in the Above Scenarios?

Recovery Software can help in the following ways:

- Discover and suggest you to choose the partition to be active (even FDISK does so).
- Discover and suggest you to choose the partition to be active.
- Perform a free disk space scan to look for partition boot sector or remaining of the deleted partition information in order to try to reconstruct Partition Table entry for the deleted partition.
- Perform all disk space scan to look for partition boot sector or remaining of the damaged partition information in order to try to reconstruct Partition Table entry for the damaged partition entry.

Why is the Partition Boot Sector so Important?

If recovery software finds it, all necessary parameters to reconstruct partition entry in the Partition Table are there. (see Partition Boot Sector topic for details).

What if a Partition Entry was Deleted Then Recreated and Re-formatted?

In this case, instead of the original partition entry we would have a new one and everything would work fine except that later on we could recall that we had some important data on the original partition. If you've created MBR, Partition Table, Volume Sectors backup before the problem (for example, Active@ Partition Recovery and Active@ UNERASER can do this), you can virtually restore it back and look for your data (in case if it has not been overwritten with new data yet). Some advanced recovery tools also have an ability to scan the disk surface and try to reconstruct previously deleted partition information from the remnants of information (i.e. perform virtual partition recovery). However there is no guarantee that you can recover anything.

PARTITION BOOT SECTOR IS DAMAGED

The Partition Boot Sector contains information, which the file system uses to access the volume. On personal computers, the Master Boot Record uses the Partition Boot Sector on the system partition to load the operating system kernel files. Partition Boot Sector is the first sector of the Partition.

For our first NTFS partition we have boot sector:

```
Physical Sector: Cyl 0, Side 1, Sector 1
000000000 EB 5B 90 4E 54 46 53 20 20 20 20 00 02 01 00 00 e[?NTFS .....
000000010 00 00 00 00 00 F8 00 00 3F 00 FF 00 3F 00 00 00 .....o..?.y.?...
000000020 00 00 00 00 80 00 80 00 3F 32 4E 00 00 00 00 00 ....e.e.?2N.....
000000030 5B 43 01 00 00 00 00 00 1F 19 27 00 00 00 00 00 [C.....'.....
000000040 02 00 00 00 08 00 00 00 10 EC 46 C4 00 47 C4 0C .....iFA.GA.
```

Partition Boot Sector is Damaged

```
000000050 00 00 00 00 00 00 00 00 00 00 00 00 00 00 FA 33 C0 .....u3A
000000060 8E D0 BC 00 7C FB B8 C0 07 8E D8 C7 06 54 00 00 Z??.|u?A.ZOC.T..
000000070 00 C7 06 56 00 00 00 C7 06 5B 00 10 00 B8 00 0D .C.V...C.[...?...
000000080 8E C0 2B DB E8 07 00 68 00 0D 68 66 02 CB 50 53 ZA+Ue..h..hf.EPS
000000090 51 52 06 66 A1 54 00 66 03 06 1C 00 66 33 D2 66 QR.f?T.f....f3Of
0000000A0 0F B7 0E 18 00 66 F7 F1 FE C2 88 16 5A 00 66 8B ....f?n?A?.Z.f<
0000000B0 D0 66 C1 EA 10 F7 36 1A 00 88 16 25 00 A3 58 00 ?fAe.?6...?%.?X.
0000000C0 A1 18 00 2A 06 5A 00 40 3B 06 5B 00 76 03 A1 5B ?...*.Z.@;.[.v.?[
0000000D0 00 50 B4 02 8B 16 58 00 B1 06 D2 E6 0A 36 5A 00 .P?.<.X.±.O?.6Z.
0000000E0 8B CA 86 E9 8A 36 25 00 B2 80 CD 13 58 72 2A 01 <E+eS6%.?€I.Xr*.
0000000F0 06 54 00 83 16 56 00 00 29 06 5B 00 76 0B C1 E0 .T.?V..).[.v.Aa
000000100 05 8C C2 03 D0 8E C2 EB 8A 07 5A 59 5B 58 C3 BE .?A.?ZAeS.ZY[XA?
000000110 59 01 EB 08 BE E3 01 EB 03 BE 39 01 E8 09 00 BE Y.e.?a.e.?9.e...?
000000120 AD 01 E8 03 00 FB EB FE AC 3C 00 74 09 B4 0E BB -.e...ue?~<.t.?>
000000130 07 00 CD 10 EB F2 C3 1D 00 41 20 64 69 73 6B 20 ..I.eoA..A disk
000000140 72 65 61 64 20 65 72 72 6F 72 20 6F 63 63 75 72 read error occur
000000150 72 65 64 2E 0D 0A 00 29 00 41 20 6B 65 72 6E 65 red....).A kerne
000000160 6C 20 66 69 6C 65 20 69 73 20 6D 69 73 73 69 6E l file is missin
000000170 67 20 66 72 6F 6D 20 74 68 65 20 64 69 73 6B 2E g from the disk.
000000180 0D 0A 00 25 00 41 20 6B 65 72 6E 65 6C 20 66 69 ...%.A kernel fi
000000190 6C 65 20 69 73 20 74 6F 6F 20 64 69 73 63 6F 6E le is too discon
0000001A0 74 69 67 75 6F 75 73 2E 0D 0A 00 33 00 49 6E 73 tiguous....3.Ins
0000001B0 65 72 74 20 61 20 73 79 73 74 65 6D 20 64 69 73 ert a system dis
0000001C0 6B 65 74 74 65 20 61 6E 64 20 72 65 73 74 61 72 kette and restar
0000001D0 74 0D 0A 74 68 65 20 73 79 73 74 65 6D 2E 0D 0A t..the system...
0000001E0 00 17 00 5C 4E 54 4C 44 52 20 69 73 20 63 6F 6D ...\\NTLDR is com
0000001F0 70 72 65 73 73 65 64 2E 0D 0A 00 00 00 00 55 AA pressed.....U?
```

Offset 0 1 2 3 4 5 6 7 8 9 A B C D E F

The printout is formatted in three sections:

- Bytes 0x00– 0x0A are the jump instruction and the OEM ID (shown in bold print).
- Bytes 0x0B–0x53 are the BIOS Parameter Block (BPB) and the extended BPB.

This block contains such essential parameters as:

- Bytes Per Sector (WORD, offset 0x0B),
- Sectors Per Cluster (BYTE, offset 0x0D),
- Media Descriptor (BYTE, offset 0x15),
- Sectors Per Track (WORD, offset 0x18),
- Number of Heads (WORD, offset 0x1A),
- Hidden Sectors (DWORD, offset 0x1C),
- Total Sectors (LONGLONG, offset 0x28), etc....
- The remaining code is the bootstrap code (that is necessary for the proper system boot) and the end of sector marker (shown in bold print).

This sector is so important on NTFS, for example, that a duplicate of the boot sector is located on the disk.

Boot Sector for FAT looks different, however its BPB contains parameters similar to the above mentioned. There is no extra copy of this sector stored anywhere, so recovery on FAT is not as convenient as it is on NTFS.

What Will Happen if Partition Boot Sector is Damaged or Bad/Unreadable?

To simulate this scenario, we fill up several lines of the Partition Boot Sector with zeros:

```
000000000 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 .....
000000010 00 00 00 00 00 00 00 00 00 00 00 00 00 00 .....
000000020 00 00 00 00 00 00 00 00 00 00 00 00 00 00 .....
000000030 00 00 00 00 00 00 00 00 00 00 00 00 00 00 .....
000000040 00 00 00 00 00 00 00 00 00 00 00 00 00 00 .....
000000050 00 00 00 00 00 00 00 00 00 00 00 00 00 00 .....
000000060 8E D0 BC 00 7C FB B8 C0 07 8E D8 C7 06 54 00 00 Z???.|u?A.ZOC.T..
```

If we try to boot, we'll see "Non System Disk" or "Disk Error". After we fail to load from it and from floppy, partition becomes unbootable.

Because a normally functioning system relies on the boot sector to access a volume, it is highly recommended that you run disk-scanning tools such as Chkdsk regularly, as well as back up all of your data files to protect against data loss in case you lose access to the volume.

Tools like Active@ Partition Recovery and Active@ UNERASER allow you to create a backup of the MBR, Partition Table and Volume Boot Sectors so that if for some reason the system fails to boot, you can restore your partition information and have access to files and folders on that partition.

What if This Sector is Damaged?

- If we do have backup of the whole disk or MBR/Boot Sectors we can try to restore it from there.
- If we do not have backup, in case of NTFS we could try to locate a duplicate of Partition Boot Sector and get information from there.
- If duplicate boot sector is not found, only virtual partition recovery might be possible if we can determine critical partition parameters such as Sectors per Cluster, etc.

Can I Fix NTFS Boot Sector Using Standard Windows NT/2000/XP Tools?

On NTFS a copy of the boot sector is stored in the middle or at the end of the Volume.

You can boot from startup floppy disks or CD-ROM, choose the Repair option during setup, and run Recovery Console. When you are logged on, you can run the FIXBOOT command to try to fix boot sector.

Can Recovery Software Help in This Situation?

It can backup MBR, Partition Table and Boot Sectors and restore them in case of damage.

It can try to find out duplicate boot sector on the drive and re-create the original one or perform virtual data recovery based on found partition parameters. Some advanced techniques allow assuming drive parameters even if duplicate boot sector is not found (i.e. perform virtual partition recovery) and give the user virtual access to the data on the drive to be able to copy them to the safer location.

MISSING OR CORRUPTED SYSTEM FILES

For the operating system to boot properly, system files are required to be safe. In case of Windows 95 / 98 / ME, these files are msdos.sys, config.sys, autoexec.bat, system.ini, system.dat, user.dat, etc.

In case of Windows NT / 2000 / XP these files are: NTLDR, ntddetect.com, boot.ini, located at the root folder of the bootable volume, Registry files (i.e., SAM, SECURITY, SYSTEM and SOFTWARE), etc.

If these files have been deleted, corrupted or damaged by a virus, Windows will be unable to boot. You'll see error messages like "NTLDR is missing ...".

The next step in the recovery process is to check the existence and safety of system files (you won't be able to check them all, but you must check at least NTLDR, ntddetect.com, boot.ini which cause most problems).

To do it in Windows 95 / 98 / ME, boot in Command Prompt mode, or from a bootable floppy and check the system files in the command line or with a help of third party recovery software.

To do it in Windows NT / 2000 / XP, use the Emergency Repair Process, Recovery Console or third party recovery software.

EMERGENCY REPAIR PROCESS

To proceed with Emergency Repair Process, you need an Emergency Repair Disk (ERD). It is recommended to create an ERD after you install and customize Windows. To create it, use the Backup utility from System Tools. You can use the ERD to repair a damaged boot sector, damaged MBR, repair or replace missing or damaged NT Loader (NTLDR) and ntddetect.com files.

If you do not have an ERD, the emergency repair process can attempt to locate your Windows installation and start repairing your system, but it may not be able to do so.

To run the process, boot from a Windows bootable disk or CD, and choose the Repair option when system suggests you to proceed with installation or repairing. Then press R to run Emergency Repair Process and choose Fast or Manual Repair option. Fast Repair is recommended for most users, Manual Repair - for Administrators and advanced users only.

If the emergency repair process is successful, your computer will automatically restart and you should have a working system

RECOVERY CONSOLE

Recovery Console is a command line utility similar to MS-DOS command line. You can list and display folder content, copy, delete, replace files, format drives and perform many other administrative tasks.

To run Recovery Console, boot from Windows bootable disks or CD and choose the Repair option. When the system suggests you to proceed with installation or

repairing and then press C to run Recovery Console. You will be asked which system you want to log on to and then for the Administrator's password. After you logged on, you can display the drive's contents, check the existence and safety of critical files and, for example, copy them back to restore them if they have been accidentally deleted.

RECOVERY SOFTWARE

Third party recovery software in most cases does not allow you to deal with system files due to the risk of further damage to the system, however you can use it to check for the existence and safety of these files, or to perform virtual partition recovery.

APPENDIX

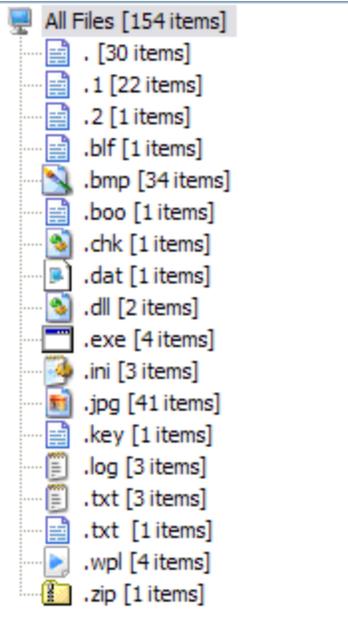
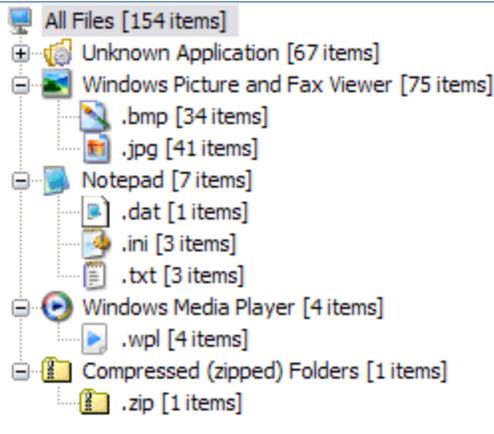
TOOLBAR COMMANDS REFERENCE

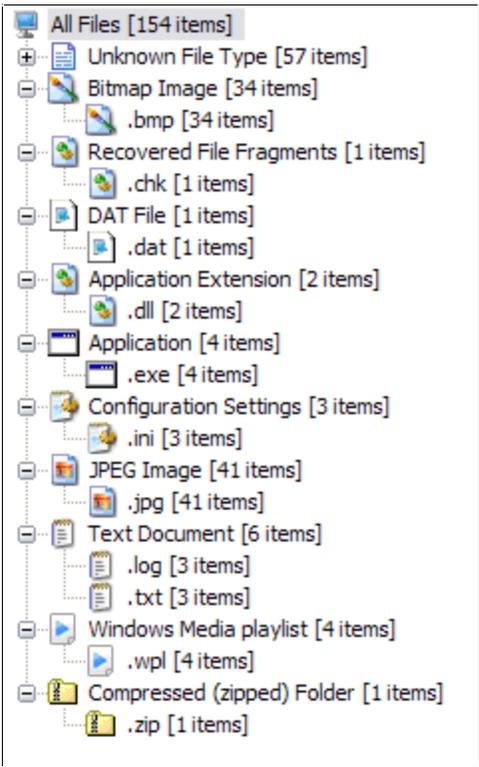
Toolbar commands provide a quick way to execute frequently-used commands.

RECOVERY EXPLORER VIEW

Icon	Command	Description
	Default Scan	Executes default scan for selected item such as Quick Scan for Logical Drive (scan for Files and Folders) and Partition or Physical Device (Scan for Deleted partitions).
	Advanced Scan	Executes advanced scan for Physical Device items – scan for files by its unique signatures. See Scan Physical Device for details.
	Recover	Applies File and Folder recovery for selected items only.
	Resume Device Scan	Resumes deferred scan.
	Filter Device Scan Results	Opens Filter Detected Partitions dialog. Command is applicable only for Device Scan item.
	Clone Partition	Creates virtual copy of selected partition (as well as detected partition) or Logical Drive. See Virtual Partition for details.
	Edit Partition	Opens Edit Boot sector template dialog for selected Detected Partition or Virtual Partition.
	Restore Partition	Starts partition restoration for selected Detected Partition;
	Delete Partition	Removes Detected Partition from Scan Result node;
	Open in Hex Editor	Opens selected item (Physical Device, Partition, Logical Drive or File) in Hex Editor Tool. See Hex Editor for details.
	Create Disk Image	Opens dialog Create Disk Image where selected item is already chosen as a subject of Disk Image.
	Properties	Shows default item properties dialog.

DOCUMENT VIEW

Icon	Command	Description
	Back	Switches back to Recovery Explorer View.
	Group by Extensions	<p>Sort detected files by their file extensions. See picture below.</p> 
	Group by Applications	<p>Sorts detected files by applications associated with the file extensions. See picture below.</p> 
	Group by File Types	Sorts all detected files by registered file types. See picture below.

Icon	Command	Description
		 <p>The screenshot shows a file explorer window with the following contents:</p> <ul style="list-style-type: none"> All Files [154 items] <ul style="list-style-type: none"> Unknown File Type [57 items] <ul style="list-style-type: none"> Bitmap Image [34 items] <ul style="list-style-type: none"> .bmp [34 items] Recovered File Fragments [1 items] <ul style="list-style-type: none"> .chk [1 items] DAT File [1 items] <ul style="list-style-type: none"> .dat [1 items] Application Extension [2 items] <ul style="list-style-type: none"> .dll [2 items] Application [4 items] <ul style="list-style-type: none"> .exe [4 items] Configuration Settings [3 items] <ul style="list-style-type: none"> .ini [3 items] JPEG Image [41 items] <ul style="list-style-type: none"> .jpg [41 items] Text Document [6 items] <ul style="list-style-type: none"> .log [3 items] .txt [3 items] Windows Media playlist [4 items] <ul style="list-style-type: none"> .wpl [4 items] Compressed (zipped) Folder [1 items] <ul style="list-style-type: none"> .zip [1 items]
	Show Drives	In any grouping, toggles source drive on or off.

RECOVERY TOOLBOX

Icon	Command	Description
	Back	Switches back to Recovery Explorer View
	Recover	Advanced scan for physical device items – scans for files by unique signatures. For more information, see <i>Scan a Physical Device</i> in Chapter 3. Using Active@ UNDELETE 7.0.
	Burn	Writes file and folder recovery to a CD or DVD. For more information, see <i>Recover Files to a CD or DVD</i> in Chapter 4. The UNDELETE Process.
	Folders	Toggles the Folders list on and off.
	Preferences	Includes or excludes full file path in recovered file. Also sets CD/DVD burner options.

Icon	Command	Description
		For more information, see <i>Application Preferences</i> in Chapter 2. Getting Started.
	Clear	Removes all items from Recovery Toolbox.

APPLICATION LOG VIEW

Command	Description
Show Service Events	Show or hide low-level system and application kernel messages in the log.
Enable writing log	Enable or disable writing log events directly to the hard disk. By default, location of log file is Application directory.
Clear Log	Remove all log events from the Application Log view.
Save Log As	Save all log events in a log file. Use this command to record log events manually if Enable writing log is disabled.

SYMBOLS AND ICONS

The table below describes the symbols that are used in Active@ UNDELETE

Symbols Used in Explorer Views and File Lists.

Icon	Name	Description
	Root Node	Represents a local or remote computer
	Floppy Drive	
	Logical Drive	Represents a logical drive on one of the detected hard drives.
	CD-ROM Drive	
	Network Drive	Represents a shared network resource
	Folder	Regular file system folder
	Service Folder	This folder contains additional drive scanning results, such as orphan files and folders

Icon	Name	Description
	Deleted Folder	This folder was detected as deleted and available for recovery.
	Destroyed Folder	This folder was detected as completely destroyed - data from this folder is impossible to recover
	File	A common file of any type
	System File	
	Temporary Saved Encrypted File	
	Disk Image Configuration File	Previously created and ready for use
	Deleted File	This file was detected as deleted and available for recovery
	Destroyed File	This file was detected as completely destroyed - data from this file is impossible to recover
	Device Collection	The root element of the detected devices tree on the current computer
	Device	Represents one of the detected devices on the current computer
	Removable Device	Such as a Flash Card or Zip Drive
	Unknown Device	Unspecified device
	Partition	Detected partition on corresponding device
	Unallocated Space	Detected Unallocated space on corresponding device
	Detected Partition	Partition detected after device scan
	Disk Image	Represents an open Disk Image as part of a File System structure

Note A deleted file or folder that appears as a black icon indicates that deleted file or folder has a poor chance of recovery. This may be because it has been partially or completely overwritten.

TOOLBARS AND MENUS

Active @UNDELETE has one main customizable toolbar that displays a set of most-used commands. To customize the appearance of the main toolbar, right-click the toolbar and use the Customize Toolbar dialog box.

Besides the main toolbar, each view may have its own toolbar with commands that are applicable to the specific view.

DROP-DOWN MENU COMMANDS

Menu	Command	Description
File	Open > Session...	Load UNDELETE Session File dialog box. WARNING If you open a saved application session, all intermediate scan results, selections, sorting and filtering in the current session are discarded and cannot be recovered.
	Open > Scan Result...	Load Drive Scan dialog box. WARNING If you open a saved scan result, all current scan information is discarded and cannot be recovered.
	Save Session As...	Save UNDELETE Session File dialog box. Save application log to selected location.
	Save Log As...	Save As dialog box. Save session log to selected location.
	Save Hardware Info As...	Save Hardware Info dialog box. Save hardware diagnostic file to selected location.
	Recent Sessions	The submenu displays a list of recently saved application sessions (maximum 4 items). To load a session, select any of the items WARNING: If you open a saved application session, all intermediate scan results, selections, sorting and filtering in the current session are discarded and cannot be recovered.
	Exit	Close the application. Depending on your Preferences settings: - you may see a prompt to save the current session - the session may be saved automatically - the application may close without saving the current session.
View	Recovery Explorer	Recovery Explorer view opens.

Menu	Command	Description
	Recovery Toolbox	Recovery Toolbox view opens.
	Document View	Document View opens.
	Application Log	Application Log view opens.
	File Preview	File Preview window opens.
	Toolbar > Standard Toolbar	Shows or hides the main application toolbar.
	Toolbar > Customize	Customize Toolbar dialog box.
	Status Bar	Shows or hides the status bar.
	Property Pane	Shows or hides the Property pane in Recovery Explorer view.
	Refresh	Discards all intermediate scan results, selections, sorting and filtering and reloads disk information.
Tools	Disk Image > Create	Create Disk Image dialog box.
	Disk Image > Open	Open Disk Image dialog box.
	Virtual Disk Array	Create Virtual Disk Array dialog box.
	Hex Editor	Hex Editor view opens.
	Preferences	Preferences dialog box. Set and change application preferences.
Window	1. 2. 3. ...	Select a menu item to activate the listed view.
Help	Contents	Application Help view opens.
	How To...	
	Help Online	If your Internet connection is active, your Internet Explorer opens to the Active@ UNDELETE Help web page. This version of online help may be more accurate and up-to-date.
	Check for updates	If your Internet connection is active, the application checks to see if there is a newer version available for download.

Menu	Command	Description
	Undelete Online	If your Internet connection is active, your Internet Explorer opens to the Active@ UNDELETE home page. Online help may be more accurate and up-to-date.
	Technical Support Online	If your Internet connection is active, your Internet Explorer opens to the Active@ UNDELETE Technical Support home page.
	E-Mail to Technical Support	A new mail message opens in your default mail application. The address field contains the mail address to our Technical Support staff. The body of the message contains the application version number and a description of your operating system.
	About Active@ UNDELETE	About Active@ UNDELETE dialog box.

FILE FILTER TOOLBAR

The File Filter toolbar contains commands that can help you organize files in a list.

File Filter Toolbar



By default, the results of a scan contain all files and folders. Use commands in the File Filter toolbar to make a large list of files smaller and easier to read.

You may use the File Filter toolbar in the following views:

- Recovery Explorer View
- Document View
- Search Result Views

The filtered result may be applicable over an entire list (for example, in Search Result View) or within a selected folder (for example in Recovery Explorer view and Document View).

To use the File Filter toolbar:

1. To display an unfiltered list, click Show All Files and Folders.
 - a. To display only existing files and folders, click **Show only existing Files and Folders.**
 - a. To display only deleted files and folders, click **Show only deleted Files and Folders.**

- a. To further reduce the size of a list, enter a pattern in File Filter field and press **ENTER**. The list displays only those files that match the pattern.

USING WILDCARD CHARACTERS IN THE FILE FILTER TOOLBAR

A wildcard character is a keyboard character such as an asterisk (*) or a question mark (?) that is used to represent one or more characters when you are searching for files and folders. Wildcard characters are often used in place of one or more characters when you do not know what the real character is or you do not want to enter the entire name.

Wildcard Character	Example	Description
Asterisk (*)	docum*	Use the asterisk as a substitute for zero or more characters if you are looking for a file that you know what it starts with and you cannot remember the rest of the file name. The example locates all files of any file type that begin with "docum" including documents.txt, document_01.doc and documentum.doc.
	docum*.doc	To narrow the search to a specific type of file, include the file extension. The example locates all files that begin with "docum" and have the file name extension .doc, such as document_01.doc and documentum.doc.
Question mark (?)	doc?.doc	Use the question mark as a substitute for a single character in a file name. In the example, you will locate the file docs.doc or doc1.doc but not documents.doc.
Number sign (#)	doc_###.doc	Use the number sign (also known as the pound or hash sign) as a substitute for a single number in a name. In the example, you will locate the file doc_012.doc or doc_211.doc but not doc_ABS.doc.

RECOVERY TIPS

PROTECT THE DRIVE LOCATION WHERE YOU HAVE ACCIDENTALLY DELETED FILES. Any program that writes data to the disk, even the installation of data recovery software can spoil your sensitive data.

DO NOT SAVE DATA ONTO THE SAME DRIVE THAT YOU FOUND ERASED DATA, WHICH YOU ARE TRYING TO RECOVER! While saving recovered data onto the same drive where sensitive data was located, you can spoil the process of recovering by overwriting table records for this and other deleted entries. It is better to save data onto another logical, removable, network or floppy drive.

IF YOU HAVE AN EXTRA HARD DRIVE, OR OTHER LOGICAL DRIVES THAT ARE BIG ENOUGH, CREATE A DISK IMAGE. A Disk Image is a single-file mirror copy of the contents of your logical drive. Backing up the contents of the whole drive - including deleted data - is a good safety precaution in case of failed recovery. Before you start recovering deleted files, create a Disk Image for this drive.

TROUBLESHOOTING

FREQUENTLY ASKED QUESTIONS

ONLINE HELP AND TECHNICAL SUPPORT

If you are experiencing serious problems using our software, as a registered Active@ UNDELETE customer, you can find up-to-date documentation, instruction and Knowledge Base information on our Web resource.

To open our technical support home page:

1. From the **Help** menu, click **Technical Support Online**.

Note Internet connection is required;

To send an e-mail to our technical support group:

1. From the **Help** menu, click **E-Mail to Technical Support**. A new mail message opens in your default mail application.
 - The address field contains the mail address to our Technical Support staff.
 - The body of the message contains the application version number and a description of your operating system.

2. Add as many details as you find necessary to describe the problem.

Note When sending an e-mail to technical support, it will be helpful to us if you attach a Hardware Info File and an Application Log file. Doing this may shorten our response time.

Other methods to contact our customer service:

- E-mail: support@disk-image.net
- Toll-Free Line: +1 (877) 477-3553
- International Line: +1 (905) 812-8434
- Fax: +1 (416) 352-7561

GLOSSARY

application Active@ UNDELETE is referred to as this throughout this guide.

boot record See MBR.

boot partition Name commonly used for the partition that contains the startup files.

boot sector Part of a hard disc, floppy disc, or similar data storage device that contains code for bootstrapping programs (usually, but not necessarily, operating systems) stored in other parts of the disc.

data storage device See physical device.

disk geometry Set of disk attributes that specify format, partitioning etc. of a disk

drive letter Abstraction at the user level to distinguish one disk or partition from another. For example, the path C:\WINDOWS\ represents a directory WINDOWS on the partition represented by C:.

FAT (File Allocation Table). File that contains the records of every other file and directory in a FAT-formatted hard disk drive. The operating system needs this information to access the files. There are FAT32, FAT16 and FAT versions.

file system Method in which files are named and where they are placed logically for storage and retrieval in a computer. Under scope of this document, one of the Microsoft Windows file systems, such as FAT12, FAT16, FAT32 and NTFS.

logical drive Partitioned space on a physical device.

partition (disk) Hard disk's storage space divided into independent parts.

physical device Device for storing data, that can be connected internally (Hard Drive) or externally (USB Flash card, USB Hard Drive).

physical device geometry see Disk Geometry.

MBR (Master Boot Record). All disks start with a boot sector. When you start the computer, the code in the MBR executes before the operating system is started. The location of the MBR is always track (cylinder) 0, side (head) 0, and sector 1. The MBR contains a file system identifier.

MFT or MFT records (Master File Table). File that contains the records of every other file and directory in an NTFS-formatted hard disk drive. The operating system needs this information to access the files.

system partition Name commonly used for the partition that contains the operating system files.

Virtual RAID Virtual Disk Array. Software layer that sits above assembled physical disks that were part of a hardware RAID system.

volume boot record First sector of a data storage device that has not been partitioned, or the first sector of an individual partition on a data storage device that has been partitioned. It contains code to load and invoke the operating system (or other standalone program) installed on that device or within that partition.