X-Ways Forensics Version 16.0 SR-4

Test Results for Deleted File Recovery and Active File Listing Tool

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Test Results for Deleted File Recovery and Active File Listing Tool: X-Ways Forensics Version 16.0 SR-4

Contents

Introduction

The Computer Forensics Tool Testing (CFTT) program is a joint project of the Department of Homeland Security (DHS), the National Institute of Justice, and the National Institute of Standards and Technology Law Enforcement Standards Office and Information Technology Laboratory. CFTT is supported by other organizations, including the Federal Bureau of Investigation, the U.S. Department of Defense Cyber Crime Center, U.S. Internal Revenue Service Criminal Investigation Division Electronic Crimes Program, and the U.S. Department of Homeland Security's Bureau of Immigration and Customs Enforcement, U.S. Customs and Border Protection and U.S. Secret Service. The objective of the CFTT program is to provide measurable assurance to practitioners, researchers, and other applicable users that the tools used in computer forensics investigations provide accurate results. Accomplishing this requires the development of specifications and test methods for computer forensics tools and subsequent testing of specific tools against those specifications.

Test results provide the information necessary for developers to improve tools, users to make informed choices, and the legal community and others to understand the tools' capabilities. The CFTT approach to testing computer forensics tools is based on well-recognized methodologies for conformance and quality testing. The specifications and test methods are posted on the CFTT Web site (http://www.cftt.nist.gov/) for review and comment by the computer forensics community.

This document reports the results from testing X-Ways Forensics Version 16.0 SR-4 against the *Active File Identification & Deleted File Recovery Tool Specification Version 1.1*, available at the CFTT Web site (http://www.cftt.nist.gov/DFR-req-1.1-pd-01.pdf).

Test results from other tools can be found on the DHS S&T-sponsored digital forensics Web page, http://www.cyberfetch.org/.

How to Read This Report

This report is divided into four sections. The first section is a high level summary of the results from the test runs. The remaining sections of the report describe the test cases, discuss any noteworthy tool behaviors encountered and provide documentation of test case run details that support the discussion of tool behaviors. Section 2 gives a general description of the test cases. Section 3 discusses test results by file system. Section 4 gives details of the test results for each test case. Please refer to the vendor documentation for guidance on using the tool.

Test Results for Deleted File Recovery Tool

Tool Tested:	X-Ways Forensics
Software Version:	16.0 SR-4
Supplier:	X-Ways AG
Address:	Agrippastr. 37-39
	50676 Cologne
	Germany
Tel:	+49 221-420 486 5
Fax:	+49 3212-123 2029
WWW:	http://www.x-ways.com/

1   Results Summary

The focus of this report is to characterize the observed behavior of the tested tool for the recovery of deleted files based on residual file system metadata remaining after files are deleted. The tool's "Particularly Thorough File System Data Structure Search" feature was not selected for any of the tests. The tool is applied to a set of image files constructed to present a variety of common file deletion scenarios for widely used file systems. If a tool does not completely recover a file this may stem from one or more causes. These factors may include the following:

- The data are no longer present in the image, e.g., overwritten.
- Sufficient meta-data to locate the data is not present or reachable.
- The algorithm implemented by the tool does not use the meta-data that locates the missing data.
- The implementation of the tool algorithm is incorrect.

In many cases, there is no one behavior that is *correct*. A tool designer may choose from different algorithms that each have their own behaviors. The algorithm choices have trade offs for each file layout scenario and file system meta-data characteristics. It may be that no one algorithm is correct all the time. For example, in FAT file systems no meta-data is present to locate more than the first block of the file. The algorithms used to recover files from FAT file systems only recover the deleted file completely when certain conditions prevail on the subject media. The conditions and algorithm success are determined by the specific drive content and file system meta-data characteristics. The test images for each test case are "dd" images of a hard drive from a cleanly shut down system. The tool must operate within the confines of the operating systems and file systems. Because the file systems tested require different algorithms for each file system and therefore produce different results for each file system, results for each file system are discussed individually.

Some general observations follow:

- For the file systems tested, deleted files were recovered from FAT12, FAT16, FAT32, NTFS, exFAT and ext2 file systems. No files were recovered from ext3, ext4 or HSF+ file systems. However, some file names were recovered from ext3 and ext4 file systems.
- File content was always recovered in whole clusters (a cluster is a power of 2 multiple of 512 bytes, e.g., 512, 1024, 2048, 4096, . . .).
- The files recovered by the tool were composed of clusters from one or more sources. All recovered content originated either in a previously deleted file, an existing file or meta-data that had overwritten data from a deleted file (reported as from *an undetermined source*).
- The tool was able to list active files and directories from all file systems tested (FAT, exFAT, NTFS, ext2, ext3, ext4 and HFS+ file systems).
- Non-Latin character file names, e.g., 北京.txt, were displayed correctly for both recovered and active files.

Each file system type has different metadata structures. This leads to different tool behaviors for each file system type. Observed file system specific tool behaviors include:

1.1 FAT
- Recovered file names do not always match the content of the associated recovered file, especially when a deleted file is overwritten.
- Recovered files that were fragmented at time of deletion are often recovered with fragments from multiple files or from active files.
- If no deleted files or meta-data have been overwritten, then intact deleted contiguous files were completely recovered. Intact fragmented files were recovered with content from multiple files or with content from active files.
- If some deleted files and meta-data have been overwritten then most intact deleted files were recovered. For files with intact meta-data but partial or complete overwriting of the file data, a recovered file may have content from multiple files, active files or meta-data from newer files (that has overwritten the deleted file).
- Intact deleted files within deleted directories were recovered.
- Names of the deleted files were recovered from the meta-data for both Latin character (e.g., a–z) and non-Latin character (e.g., ß, ç, ö, я, ю, ﺵ, 美国）file names. Long file names, if available, are reported. If no long file name was ever recorded for the file, then the DOS 8.3 file name, e.g., ALCOR.TXT for XALCOR.TXT, is reported with an underscore, "_", replacing the first character of the file name. If metadata for the long file name is overwritten, then the file system generated DOS 8.3 file name is reported e.g., _ETELG~1.TXT for betelgeuse.txt.
- Files deleted via the recycle bin were recovered along with recycle bin artifacts. Files from FAT16 and FAT32 file systems were recovered twice.

- Reported size of the original deleted file matches the size of the named recovered file.
- Reported MAC times of the named recovered file matches the original deleted file MAC times.
- Since last access time is not tracked for FAT file systems, only the last access data is reported.
- Deleted shortcut .lnk files were recovered.
- Active shortcut .lnk files were listed.
- All active files and directories were listed.

1.2 ExFat

- No intact files were recovered from a deleted subdirectory.
- The modified and accessed MAC times reported for files recovered was as expected.
- If no deleted files or meta-data have been overwritten, then most intact deleted files, both contiguous and fragmented, were completely recovered. Files deleted from a subdirectory were not recovered.
- If some deleted files and meta-data has been overwritten then most intact deleted files were recovered. For files with intact meta-data but partial or complete overwriting of the file data, a recovered file may have content from multiple files, active files or meta-data from newer files (that has overwritten the deleted file).
- Deleted files within deleted directories were not always recovered.
- Names of the deleted files were recovered from the meta-data for both Latin character (e.g., a–z) and non-Latin character (e.g., ß, ç, ö, я, ю, ش, 美国）file names.
- Recovery of files deleted via the recycle bin was not tested.
- Reported size of the original deleted file matches the size of the named recovered file.
- Active special objects were listed including shortcut .lnk files.
- All active files and directories were listed.

1.3 NTFS

- If no deleted files or meta-data have been overwritten, then intact deleted files, both contiguous and fragmented, were completely recovered.
- If some deleted files and meta-data has been overwritten then most intact deleted files were recovered. For files with intact meta-data but partial or complete overwriting of the file data, a recovered file may have content from multiple files or active files.
- Deleted files within deleted directories were recovered.
- Intact deleted files contained within the MFT and files in compressed directories were recovered.
- Names of the deleted files were recovered from the meta-data for both Latin character (e.g., a–z) and non-Latin character (e.g., ß, ç, ö, я, ю, ش, 美国）file names.

- Files deleted via the recycle bin were recovered along with recycle bin artifacts.
- Reported size of the original deleted file matches the size of the named recovered file.
- Reported MAC times of the named recovered file matches the original deleted file MAC times.
- Deleted special objects were recovered including alternate data stream, shortcut .lnk files and symbolic links.
- Active special objects were listed including alternate data stream, shortcut .lnk files and symbolic links.
- All active files and directories were listed.

1.4 Ext

- Files were recovered only from the ext2 file system; no files were recovered from either ext3 or ext4 file systems.
- If no deleted files or meta-data have been overwritten, then intact deleted files, both contiguous and fragmented, were completely recovered.
- If some deleted files and meta-data has been overwritten then most intact deleted files were recovered. For files with intact meta-data but partial or complete overwriting of the file data, a recovered file may have content from multiple files, active files or meta-data from newer files (that has overwritten the deleted file).
- Deleted files within deleted directories were recovered.
- Names of deleted files were not always recovered for ext2, ext3 and ext4 file systems. For the ext2 file system, when a file name was recovered it was usually not associated with the recovered data. Two objects were usually returned: an empty file with the name of the deleted file, e.g., *Bellatrix.txt*, and an object with a tool-generated name, e.g., *FileInInode#13,* with the content of the deleted file. Other times, one object was returned, the named deleted file with its contents. The names of deleted folders were recovered for ext2, ext3 and ext4 file systems. A tool generated file name was assigned to each recovered file recovered without a name.
- Files deleted via the recycle bin were recovered along with recycle bin artifacts.
- Reported size of the original deleted file matches the size of the named recovered file.
- Reported MAC times of the recovered file matches the expected MAC times for the deleted file.
- Hard links and symbolic links were not recovered for ext2 file systems; ext3 and ext4 file systems were not tested.
- Active special objects were listed including hard links and symbolic links for ext2, ext3 and ext4 file systems.
- All active files and directories were listed for ext2, ext3 and ext4 file systems.

1.5 HFS+

Active files and directories were listed, but no files were recovered from HFS+ file systems.

A discussion of specific tool behavior is in Section 3, with test details presented in Section 4.

2 Test Case Descriptions

The following is a list of the basic test cases and the test objective:

DFR-01.   Recover one non-fragmented file.
DFR-02.   Recover file with two fragments.
DFR-03.   Recover file with multiple fragments.
DFR-04.   Recover several non-fragmented files with non-Latin character file names.
DFR-05.   Recover two fragmented files.
DFR-06.   Recover one large file.
DFR-07.   Recover one overwritten file.
DFR-08.   Recover several overwritten files.
DFR-09.   Recover large number of files, no overwriting.
DFR-10.   Recover large number of files, with some overwriting.
DFR-11.   Recover from one directory.
DFR-12.   Recover from more than one directory.
DFR-13.   Recover chaotic file system activity.
DFR-14.   Recover other file system object.
DFR-15.   List one of each file system object.
DFR-16.   List a large number of files.
DFR-17.   List deep file paths.

Each test case is repeated at least four times to characterize the tool's behavior for different file system families. These include FAT, exFAT, NTFS and ext. The NTFS and exFAT images contain a single partition. The FAT and ext images each contain three partitions. Each partition has the same pattern of files created and deleted for a given test case. The FAT and ext cases (three partitions) have three times as many files as the NTFS and exFAT cases (one partition). The FAT images contain a FAT-12, a FAT-16 and a FAT-32 partition. The FAT partitions were created on a Windows Vista system. Some partitions marked as FAT-12 in the partition table, appear to have a FAT table that is actually FAT-16 (this did not significantly affect test results). The NTFS images were also created on a Microsoft Windows Vista system. The ext partitions were created on a Fedora Linux system. The exFAT partition and HFS+ partitions were created on a Mac running Snow Leopard, OSX Version 10.6.

The test images are available at: http://www.cfreds.nist.gov/dfr-test-images.html and the layout of the test images is documented in: http://www.cfreds.nist.gov/dfr-images/setup-july-10-2012.pdf.

Except for test case DFR-01, the size of all deleted files is a multiple of 512. The deleted file in test case DFR-01 is 712 bytes.

Within this document, test cases are sometimes referred to as a scenario or a test scenario. Also, a test case name sometimes includes the file system family name if a discussion only applies to a particular file system family, e.g., if a discussion only applies to DFR-01 for the NTFS file system DFR-01 may be referred to as DFR-NTFS-01 (or just NTFS-01). The two HSF+ test cases are referred to as DFR-OSX-01 and DFR-OSX-04.

Some of the test cases are repeated with some variation to introduce additional data block layout scenarios. These include the following:

- DFR-01-recycle – Similar to DFR-01 with a change to how the file is deleted. Instead of deleting the file directly, the file is moved to the recycle bin and then the bin is emptied.
- DFR-05-braid – Create two fragmented files such that the data blocks are intertwined and then delete both files.
- DFR-05-nest – Create two fragmented files such that the data blocks of one file surround the data blocks of the other file and then delete both files.
- DFR-07-one – Create a deleted file partially overwritten by an active file.
- DFR-07-two – Starting with the image of 07-one, delete the active file so that two deleted files have claim to the same data.
- DFR-NTFS-11-MFT – Similar to DFR-11, but all files are kept to 512 bytes so that the data is stored within the MFT. This scenario only applies to NTFS.
- DFR-NTFS-11-Compress -- Similar to DFR-NTFS-11, but the file system has the *compress* option turned on. This scenario only applies to NTFS.
- DFR-OSX-01 & DFR-OSX-04 – There is no metadata left after a file is deleted from an HFS+ file system so only one case (DFR-OSX-01) is needed to demonstrate that no files are recovered and one case (DFR-OSX-04) is used to demonstrate the ability to list (non-Latin character) file names.

3 Discussion of Test Results

Test data was prepared for all scenarios with the following file systems: FAT (FAT12, FAT16 & FAT32), NTFS, exFAT and ext (ext2, ext3 & ext4). Test data for two scenarios was prepared for HFS+ file systems using combinations of journaling and case sensitivity (OSX, OSXC, OSXJ & OSXCJ).

This section discusses the following characteristics of the tool behavior for various file deletion scenarios:

- Recovered content
- Reported file size
- Reported MAC times
- Recovered file names
- File system unique objects
- Listing active files

3.1 How to read this section

The subsections that follow present the tool behaviors that were observed in testing by file deletion scenario. For more details on the results presented in each subsection see the corresponding subsection in Section 4.

3.2 File System Support

Files were recovered from FAT, exFAT, NTFS and ext2 file systems, but no files were recovered from ext3, ext4 or HFS+ file systems. The design of these file systems seem to not allow complete recovery of any files, i.e., the tool cannot recover any files for these file systems from the file system meta-data. However, some file names were recovered from ext3 and ext4 file systems.

3.3 Scenarios where no files were overwritten

For nine test cases that have no files overwritten, the following observations were made:

3.3.1 FAT

Of the 819 intact deleted files with metadata, 792 were fully recovered. Of the 27 files not completely recovered, 24 involved fragmented files with the recovered file containing content from multiple files and 18 contained content from active files.

3.3.2 exFAT

Of the 273 files deleted, 270 were fully recovered. The three files not recovered were in a subdirectory.

3.3.3 NTFS

Of the 273 intact deleted files, all were fully recovered.

3.3.4 Ext

Of the 273 intact deleted files from the ext2 file system, 271 files were fully recovered. For the ext2, ext3 and ext4 file systems, most, but not all file names were recovered. For the ext2 file system, two objects were usually returned: an empty file with the name of the deleted file, e.g., *Bellatrix.txt*, and an object with a tool-generated name, e.g., *FileInInode#13,* with the content of the deleted file. Other times, one object was returned, the named deleted file with its contents. No files were recovered from the ext3 or ext4 file systems.

3.4 Scenarios with Deleted Directories

Two scenarios, case 11 and case 12, investigate recovery of deleted files within deleted directories along with recovery of the file names and the directory names. The first scenario, case 11, is constructed with nothing overwritten; the second scenario, case 12, is constructed with some files and directory metadata overwritten.

3.4.1 FAT (Directories)

For case FAT-11, all deleted files were recovered and all deleted directories were identified. For case FAT-12, 9 of 27 intact files were fully recovered, and 18 files were partially recovered containing blocks from two or more files. Of the 9 deleted directories, 6 were identified.

3.4.2 ExFAT (Directories)

For case XFAT-11, none of the deleted files were recovered, but the deleted directory was identified. For case XFAT-12, 2 of 3 deleted directories were identified. 3 of 9 deleted files were completely recovered.

3.4.3 NTFS (Directories)

For case NTFS-11, all deleted files were completely recovered and the deleted directory was identified. For case NTFS-12, 9 of 9 intact deleted files were completely recovered. 2 of 3 deleted directories were identified.

3.4.4 EXT (Directories)

No files were recovered from the ext3 or ext4 partitions. For case EXT-11, all deleted files were recovered from the ext2 partition with file names intact. The deleted directory was identified from each partition (ext2, ext3 and ext4). For case EXT-12, all nine intact deleted files from the ext2 file system were completely recovered. Six were recovered with file names intact. Three were recovered without file names. File names were recovered for 3 of 12 deleted files from the ext4 partition. Eight of the nine deleted directory names were recovered (3 of 3 from ext2, 3 of 3 from ext3 and 2 of 3 from ext4).

3.5 Scenarios with some files overwritten

For seven test cases that have some overwritten files, the following observations were made:

3.5.1 FAT

- 2,894 files were deleted, 1,118 files were intact with metadata, 102 files were overwritten with metadata left behind after file deletion.

- Of 1,222 recovered files, 885 files were accurately recovered. Of the 337 remaining files recovered, 297 had content from multiple files, 197 had content from active files, and 81 had content from an undetermined source.

3.5.2 ExFAT
- 965 files were deleted, 376 files were intact with metadata, 31 files were overwritten with metadata left behind.
- Of 400 recovered files, 371 files were accurately recovered. Of the 30 other recovered objects, 18 contained data from more than one file, 16 had data from active files and 18 contained data from an undermined source.

3.5.3 NTFS
- 965 files were deleted, 370 files were intact with metadata, 563 files were overwritten with metadata left behind.
- Of 406 recovered files, 374 files were accurately recovered. Of the 32 other recovered objects, 24 contained data from more than one file, and 24 contained data from active files.

3.5.4 EXT
- 2,869 files were deleted, 1,225 files were intact with metadata, 990 files were overwritten with metadata left behind. The files were deleted from an ext2, an ext3 and an ext4 partition. Files were only recovered from the ext2 partition.
- Of 406 recovered files, 372 files were accurately recovered. Of the 34 remaining files recovered, 29 had content from multiple files, 24 had content from active files, and 17 had content from an undetermined source. For the ext2, ext3 and ext4 file systems, some file names were recovered. For the ext2 file system, two objects were usually returned: an empty file with the name of the deleted file, e.g., *Bellatrix.txt*, and an object with a tool-generated name, e.g., *FileInInode#13,* with the content of the deleted file. Other times, one object was returned, the named deleted file with its contents.

3.6 Reported File Size for Recovered Files
For file systems FAT, exFAT and NTFS, if a file name was recovered, the tool reports the original file size corresponding to the recovered file name. For ext2 file systems a file size is reported even though a file name might not be recovered. The reported file size matches the size of the original file (the original file is identified by the recovered file content). Nothing was recovered for ext3 or ext4 file systems. It should be noted that for overwritten files the reported file size may be misleading in that the recovered content may be from a different file.

3.7 Recovered MAC Times
This section discusses the observed MAC time characteristics displayed for test case DFR-01. The reader is reminded that the operating system replaces the *ctime* meta-data with the time of file deletion for ext file systems.

3.7.1 FAT

- The *access times* and *modify/last written times* were correct. Note the automatically generated expected values in the CFTT layout document are off by one hour. The times match if adjusted from Coordinated Universal Time (UTC) to Eastern Daylight Time (EDT). This is a known problem in some Linux versions where an inappropriate Daylight Saving Time (DST) adjustment is applied. This is an issue with the test data, not with the tested tool.
- Only last access date reported (FAT does not track last access time, only the last access date).

3.7.2 ExFAT

All times matched the expected values.

3.7.3 NTFS

All times matched the expected values. All times were reported in UTC.

3.7.4 Ext

For the ext2 file system, the *modify times* and *access times* matched expected values. No *ctime* was reported, but the file *delete time* was reported. For ext3 and ext4 file systems, the *access* and *delete times* matched expected values, no *ctime* was reported, but the *modify time* value reported was the same as the *delete time.*

3.8 Non-Latin Character File Names

Non-Latin character file names for recovered files were displayed correctly for FAT, ExFAT, NTFS and ext file systems.

3.9 Deletion Through Recycle Bin

Files deleted via empting the recycle bin (or *trash* on some file systems) were recovered for NTFS and ext2 file systems along with recycle bin artifacts. For FAT file systems, two copies of deleted files from FAT16 and FAT32 were recovered. One with the original file name and an additional copy with a generated file name, e.g., Bellatrix.txt was also recovered as _rqcrfk5.txt. No files were recovered from ext3 or ext4 file systems. Recovery of files deleted through the recycle bin was not tested for exFAT file systems.

3.10 Special NTFS Situations

Files were recovered from a compressed NTFS file system and from within the Master File Table (MFT).

3.11 Listing Special Objects (Links, Alternate Data Streams, etc.)

The tool was able to list all file system special objects for FAT, exFAT, NTFS, ext2, ext3 and ext4 file systems.

3.12 Recovering Special Objects (Links, Alternate Data Streams, etc.)

The tool was able to recover some file system specific objects:

3.12.1 FAT

Deleted files and shortcut .lnk files were recovered.

3.12.2 ExFAT

Recovering special objects was not tested for ExFAT file systems.

3.12.3 NTFS

Alternate data streams, shortcut .lnk files and symbolic links from NTFS file systems were recovered, however the files that the alternate data streams were attached to were not recovered.

3.12.4 Ext

 Deleted files were recovered from ext2 file systems, but no hard links or symbolic links. The ext3 and ext4 file systems were not tested.

3.13 Mac File Systems HFS+ File Recovery

No files were recovered from HFS+ file systems. OS X removes all file metadata when a file is deleted, although some journal metadata may remain for journaling file systems (OSXJ and OSXCJ).

3.14 Listing Active Files

The tool was able to list all files and directories for ext2, ext3, ext4, FAT, NTFS, exFAT, and HFS+ file systems.

4 Test Result Details

The test results are presented in a series of tables. Most of the tables either give a summary of the deleted files and metadata created for each test case or the table gives a summary of what the tool recovered. For some test cases, additional tables are provided to give details about individual files deleted and recovered within a test case.

4.1 How to read this section

This section provides the details for the discussions in Section 3 of this report. The data discussed in subsections of Section 3 are in the corresponding subsections of this section (Section 4). The remainder of this subsection explains the tables that summarize the test results. The data presented in this subsection are examples only. The actual results are presented in the other subsections.

The two most important tables are the "Available Metadata and File Block Summary" and "Recovered File Analysis Summary." The metadata table describes the state of the deleted files and residual meta-data and identifies the limits for what can be recovered. The analysis table describes how accurate the tool actually recovered known content.

The main summary tables and the information contained within are as follows:

Available Metadata and File Block Summary							
Case	Deleted	Intact/Meta	Partial/Meta	None/meta	Intact/None	Partial/None	None/None
ntfs-07	5	1	0	2	0	0	2

The **Available Metadata and File Block Summary** gives a one row summary of the file blocks and meta-data available for recovery for a testcase.

- Case: The test case identifier.
- Deleted: The number of files created and then deleted.
- Intact/Meta: The number of files with no blocks overwritten and metadata available. All these files should be recoverable.
- Partial/Meta: The number of files with some, but not all, blocks overwritten and metadata available. However, only independently allocated blocks are counted.
- None/Meta: The number of files with all blocks overwritten, but metadata available. For NTFS file systems, data blocks from small files may be contained within the MFT and are incorrectly counted here.
- Intact/None: The number of files with no blocks overwritten and metadata overwritten.
- Partial/None: The number of files with some, but not all, blocks overwritten and metadata overwritten.
- None/None: The number of files with all blocks and metadata overwritten.

The table above indicates five files deleted, but only one file intact with metadata. Two files are completely overwritten, but have some metadata available. The files could still be within the MFT and hence recoverable.

Recovered File Analysis Summary												
Case	Del	Rec	SS	First	Full	Match	Sigma	Multi	Other	Active	Seq	Over	Ovf
ntfs-07	5	3	2	3	1	2	0	0	0	0	0	4	1

The **Recovered File Analysis Summary** gives a one-row summary of the files recovered for a test case.
- Case: The test case identifier.
- Del: The number of deleted files. The notation k/j means k files created in j directories.
- Rec: The number of files recovered by the tool. This should be at least as many as the **Intact/Meta** value from the table above.
- SS: The number of deleted files that contributed blocks to the recovered files. This will be discussed below when we have more data from the example.
- First: The number of recovered files that contain the first block of the deleted file.

- Full: The number of recovered files that are complete and accurate with no extra blocks.
- Match: The number of recovered files with a correctly matching name.
- Sigma: The number of recovered files with a recovered name that matches except for the first character. This is an artifact of some deleted files on FAT file systems where the Greek ISO representation of the letter sigma (σ) replaces the first character of the file name to indicate a deleted file.
- Multi: The number of files with blocks from two or more deleted files. In other words, files with blocks of data from different files recovered together into one recovered file.
- Other: The number of files recovered with unrecognized data blocks. This is usually the case when a file is partially overwritten with file system metadata.
- Active: The number of recovered files that include data blocks from active (not deleted) files.
- Seq: The number of recovered files with data blocks out of sequence.
- Over: The number of files that are overwritten in the test case.
- Ovf: The number of files that the tool reports as overwritten.

The next three tables are an analysis within a single test case of each file deleted and each file recovered by the tool under test. These tables are only provided for a few test cases because of the amount of data that would be generated if these tables were provided for each test case.

Deleted File Details					
Case	File	Size	Bytes	Residue	Meta
ntfs-07	Bunda.txt	8	4096	0	none
	Castor.txt	8	4096	0	none
	Duhr.TXT	8	4096	0	meta
	Furud.txt	15	7680	15	meta
	Grumium.txt	1	512	0	meta

Each row of the **Deleted File Details** table describes each deleted file.

- Case: The test case identifier. The field is left blank after the first file for the remaining files of the test case.
- File: The name of the deleted file.
- Size: The number of 512 byte blocks allocated to the file.
- Bytes: The number of bytes allocated to the file.
- Residue: The number of data blocks not overwritten, i.e., the number of data blocks available for recovery.
- Meta: Either *none* or *meta* indicating the absence or presence of file metadata.

Recovered File Content Analysis										
Case	Content	Name	Size	First	Blocks	Tail	Src	Shift	Seq	Other
dfr-ntfs-07	Grumium.txt	Grumium.txt	512	1	0	0	1	0	0	0
	Furud.txt	Duhr.TXT	4,096	1	7	0	1	0	0	0
	Furud.txt	Furud.txt	7,680	1	14	0	1	0	0	0

Each row of the **Recovered File Content Analysis** table describes each recovered file.

- Case: The test case identifier. The field is left blank after the first file for the remaining files of the test case.
- Content: The file name of the file that was the source of the first recovered data block of the recovered object.
- Name: The name assigned to the recovered object by the tool under test.
- Size: The value reported by the tool under test as the size of the original deleted file.
- First: The number of initial file blocks included in the recovered object.
- Blocks: The number of non-initial blocks included in the recovered object.
- Tail: The number of partial sector blocks included in the recovered object.
- Src: The number of files contributing to the recovered file.
- Shift: The number of times there is a shift to a new data source (i.e., the number of files in addition to the first that contributed data to the recovered object).
- Seq: The number of times a there is a break in the sequence of blocks within the recovered object.
- Other: The number of unidentified blocks included in the recovered object.

Some observations about this example follow:
- **Grumium.txt** is recovered from the NTFS MFT since the file is small and contained within the MFT there are no independently allocated file blocks to be reported in the **Available Metadata and File Block Summary** table**.**
- **Duhr.TXT** was completely overwritten by **Furud.txt** and so the recovered object named **Duhr.TXT** actually contains content from the overwriting file.
- Also note that even though three files were recovered, only two of the deleted files contributed data blocks to the recovered objects. Hence the value two in the **SS** column in the **Available Metadata and File Block Summary** table**.**

Recovered File Content Block Details		
Case	Name	Recovered Content
dfr-ntfs-07	Duhr.TXT	Furud.txt(8 of 15)
	Furud.txt	Furud.txt(15 of 15)
	Grumium.txt	Grumium.txt(1 of 0)

Each row of the **Recovered File Content Block Details** table describes the source of recovered file content.

- Case: The test case identifier. The field is left blank after the first file for the remaining files of the test case.
- Name: The name of the recovered object.
- Recovered Content: A list of data sources included in the recovered object. Each entry is accompanied with the number of blocks included in the recovered object and the size of the source object. The recovered object **Duhr.TXT** is composed of eight blocks from **Furud.txt**, a file fifteen blocks in size.

Deleted File MAC Times				
Case	File	Modify	Access	Create
ntfs-07	Bunda.txt	11/06/11 15:09:59 -0500	11/06/11 15:12:56 -0500	11/06/11 15:09:59 -0500

Deleted File MAC Times				
Case	File	Modify	Access	Create
	Castor.txt	11/06/11 15:09:59 -0500	11/06/11 15:12:56 -0500	11/06/11 15:09:59 -0500
	Duhr.TXT	11/06/11 15:09:59 -0500	11/06/11 15:12:56 -0500	11/06/11 15:09:59 -0500
	Furud.txt	11/06/11 15:36:36 -0500	11/06/11 15:36:36 -0500	11/06/11 15:36:36 -0500
	Grumium.txt	11/06/11 15:36:36 -0500	11/06/11 15:36:36 -0500	11/06/11 15:36:36 -0500

Each row of the **Deleted File Mac Times** table above reports the MAC times in MM/DD/YY HH:MM:SS format for each deleted file.

- Case: The test case identifier. The field is left blank after the first file for the remaining files of the test case.
- Name: The name of the deleted file.
- Modify/Access/Create: The MAC times just before the file is deleted.

Recovered File MAC Times				
Case	File	Modify	Access	Create
dfr-ntfs-07	Grumium.txt	11/06/11 03:36:36PM	11/06/11 03:36:36PM	11/06/11 03:36:36PM
	Duhr.TXT	11/06/11 03:09:59PM	11/06/11 03:12:56PM	11/06/11 03:09:59PM
	Furud.txt	11/06/11 03:36:36PM	11/06/11 03:36:36PM	11/06/11 03:36:36PM

Each row of the **Recovered File Mac Times** table reports the MAC times in MM/DD/YY HH:MM:SS format for each recovered file.

- Case: The test case identifier. The field is left blank after the first file for the remaining files of the test case.
- Name: The name of the deleted file.
- Modify/Access/Create: The MAC times reported by the tool under test.

4.2 File System Support

The following table identifies the file deleted for each partition type.

Case XXX-01 Deleted Files	
Partition	Deleted File
EXT2	Bellatrix.txt
EXT3	Bunda.txt
EXT4	Botein.txt
FAT12	XBEID.TXT
FAT16	Betelgeuse.txt
FAT32	Bellatrix.txt
NTFS	Bunda.txt
OSXJ	Bellatrix.TXT
OSX	Betelgeuse.txt
OSXCJ	Beid.txt
OSXC	xBellatrix.txt
exFAT	Betelgeuse.txt

Each row of the **Recovered File Content Block Details** table below describes the source of recovered file content.

- Case: The test case identifier. The field is left blank after the first file for the remaining files of the test case.

- Name: The name of the recovered object.
- Recovered Content: A list of data sources included in the recovered object. Each entry is accompanied with the number of blocks included in the recovered object and the size of the source object.
-

Recovered File Content Block Details		
Case	**Name**	**Recovered Content**
dfr-ext-01	FileinInode#13	Bellatrix.txt(1 of 1)
dfr-fat-01	Bellatrix.txt	Bellatrix.txt(1 of 1)
	Betelgeuse.txt	Betelgeuse.txt(1 of 1)
	_BEID.TXT	XBEID.TXT(1 of 1)
dfr-ntfs-01	Bunda.txt	Bunda.txt(8 of 8)
dfr-xfat-01	Betelgeuse.txt	Betelgeuse.txt(8 of 8)

-

4.3 Recovered Content (No Overwrites)

This subsection summarizes results for cases with no overwritten files.

The **Available Metadata and File Block Summary** gives a one row summary of the file blocks and meta-data available for recovery for a test case.

- Case: The test case identifier.
- Deleted: The number of files created and then deleted.
- Intact/Meta: The number of files with no blocks overwritten and metadata available. All these files should be recoverable.
- Partial/Meta: The number of files with some, but not all, blocks overwritten and metadata available. However, only independently allocated blocks are counted.
- None/Meta: The number of files with all blocks overwritten, but metadata available. For NTFS file systems, blocks from small files may be contained within the MFT and not counted here.
- Intact/None: The number of files with no blocks overwritten and metadata overwritten.
- Partial/None: The number of files with some, but not all, blocks overwritten and metadata overwritten.
- None/None: The number of files with all blocks and metadata overwritten.

Available Metadata and File Block Summary							
Case	**Deleted**	**Intact/Meta**	**Partial/Meta**	**None/meta**	**Intact/None**	**Partial/None**	**None/None**
fat-01	3	3	0	0	0	0	0
fat-02	3	3	0	0	0	0	0
fat-03	3	3	0	0	0	0	0
fat-05	6	6	0	0	0	0	0
fat-05-braid	6	6	0	0	0	0	0
fat-05-nest	6	6	0	0	0	0	0
fat-06	3	3	0	0	0	0	0
fat-09	780	780	0	0	0	0	0
fat-11	9	9	0	0	0	0	0
xfat-01	1	1	0	0	0	0	0
xfat-02	1	1	0	0	0	0	0
xfat-03	1	1	0	0	0	0	0
xfat-05	2	2	0	0	0	0	0

Available Metadata and File Block Summary							
Case	Deleted	Intact/Meta	Partial/Meta	None/meta	Intact/None	Partial/None	None/None
xfat-05-braid	2	2	0	0	0	0	0
xfat-05-nest	2	2	0	0	0	0	0
xfat-06	1	1	0	0	0	0	0
xfat-09	260	260	0	0	0	0	0
xfat-11	3	3	0	0	0	0	0
ntfs-01	1	1	0	0	0	0	0
ntfs-02	1	1	0	0	0	0	0
ntfs-03	1	1	0	0	0	0	0
ntfs-05	2	2	0	0	0	0	0
ntfs-05-braid	2	2	0	0	0	0	0
ntfs-05-nest	2	2	0	0	0	0	0
ntfs-06	1	1	0	0	0	0	0
ntfs-09	260	260	0	0	0	0	0
ntfs-11	3	3	0	0	0	0	0
ext-01	3	3	0	0	0	0	0
ext-02	3	3	0	0	0	0	0
ext-03	3	3	0	0	0	0	0
ext-05	6	6	0	0	0	0	0
ext-05-braid	6	6	0	0	0	0	0
ext-05-nest	6	6	0	0	0	0	0
ext-06	3	2	1	0	0	0	0
ext-09	780	766	0	0	14	0	0
ext-11	9	9	0	0	0	0	0

The **Recovered File Analysis Summary** gives a one-row summary of the files recovered for a test case.

- Case: The test case identifier.
- Del: The number of deleted files. The notation k/j means k files created in j directories.
- Rec: The number of files recovered by the tool. This should be at least as many as the **Intact/Meta** value from the table above.
- SS: The number of deleted files that contributed blocks to the recovered files. This will be discussed below when we have more data from the example.
- First: The number of recovered files that contain the first block of the deleted file.
- Full: The number of recovered files that are complete and accurate with no extra blocks.
- Match: The number of recovered files with a correctly matching name.
- Sigma: The number of recovered files with a recovered name that matches except for the first character. This is an artifact of some deleted files on FAT file systems where the Greek ISO representation of the letter sigma (σ) replaces the first character of the file name to indicate a deleted file.
- Multi: The number of files with blocks from two or more deleted files. In other words, files with blocks of data from different files recovered together into one recovered file.
- Other: The number of files recovered with unrecognized data blocks. This is usually the case when a file is partially overwritten with file system metadata.
- Active: The number of recovered files that include data blocks from active (not deleted) files.
- Seq: The number of recovered files with data blocks out of sequence.
- Over: The number of files that are overwritten in the test case.

- Ovf: The number of files that the tool reports as overwritten.

Recovered File Analysis Summary													
Case	**Del**	**Rec**	**SS**	**First**	**Full**	**Match**	**Sigma**	**Multi**	**Other**	**Active**	**Seq**	**Over**	**Ovf**
fat-01	3	3	3	3	3	2	1	0	0	0	0	0	0
fat-02	3	3	0	0	0	0	0	3	0	3	0	0	0
fat-03	3	3	0	0	0	0	0	3	0	3	0	0	0
fat-05	6	6	0	0	0	0	0	6	0	6	0	0	0
fat-05-braid	6	6	0	0	0	0	0	6	0	0	0	0	0
fat-05-nest	6	6	0	0	0	0	0	6	0	6	0	0	0
fat-06	3	3	3	3	0	2	1	0	0	0	0	0	0
fat-09	780	780	780	780	780	780	0	0	0	0	0	0	0
fat-11	9/3	9/0	9	9	9	9	0	0	0	0	0	0	0
xfat-01	1	1	1	1	1	1	0	0	0	0	0	0	0
xfat-02	1	1	1	1	1	1	0	0	0	0	0	0	0
xfat-03	1	1	1	1	1	1	0	0	0	0	0	0	0
xfat-05	2	2	2	2	2	2	0	0	0	0	0	0	0
xfat-05-braid	2	2	2	2	2	2	0	0	0	0	0	0	0
xfat-05-nest	2	2	2	2	2	2	0	0	0	0	0	0	0
xfat-06	1	1	1	1	1	1	0	0	0	0	0	0	0
xfat-09	260	260	260	260	260	260	0	0	0	0	0	0	0
xfat-11	3/1	0/0	0	0	0	0	0	0	0	0	0	0	0
ntfs-01	1	1	1	1	1	1	0	0	0	0	0	0	0
ntfs-02	1	1	1	1	1	1	0	0	0	0	0	0	0
ntfs-03	1	1	1	1	1	1	0	0	0	0	0	0	0
ntfs-05	2	2	2	2	2	2	0	0	0	0	0	0	0
ntfs-05-braid	2	2	2	2	2	2	0	0	0	0	0	0	0
ntfs-05-nest	2	2	2	2	2	2	0	0	0	0	0	0	0
ntfs-06	1	1	1	1	1	1	0	0	0	0	0	0	0
ntfs-09	260	260	260	260	260	260	0	0	0	0	0	0	0
ntfs-11	3/1	3/0	3	3	3	3	0	0	0	0	0	0	0
ext-01	3	1	1	1	1	0	0	0	0	0	0	0	0
ext-02	3	1	1	1	1	0	0	0	0	0	0	0	0
ext-03	3	1	1	1	1	0	0	0	0	0	0	0	0
ext-05	6	0	0	0	0	0	0	0	0	0	0	0	0
ext-05-braid	6	2	2	2	2	0	0	0	0	0	0	0	0
ext-05-nest	6	2	2	2	2	0	0	0	0	0	0	0	0
ext-06	3	1	1	1	1	0	0	0	0	0	0	1	0
ext-09	780	260	260	260	260	0	0	0	0	0	0	0	0
ext-11	9/3	3/0	3	3	3	3	0	0	0	0	0	0	0

The next two tables give summary totals by file system.

Available Metadata and File Block Summary							
Case	**Deleted**	**Intact/Meta**	**Partial/Meta**	**None/meta**	**Intact/None**	**Partial/None**	**None/None**
fat	819	819	0	0	0	0	0
xfat	273	273	0	0	0	0	0
ntfs	273	273	0	0	0	0	0
ext	819	804	1	0	14	0	0
Totals	2184	2169	1	0	14	0	0

Recovered File Analysis By File System													
Type	**Del**	**Rec**	**SS**	**First**	**Full**	**Match**	**Sigma**	**Multi**	**Other**	**Active**	**Seq**	**Over**	**Ovf**
FAT	819	819	795	795	792	793	2	24	0	18	0	0	0
ExFAT	273	270	270	270	270	270	0	0	0	0	0	0	0
NTFS	273	273	273	273	273	273	0	0	0	0	0	0	0
ext	819	271	271	271	271	3	0	0	0	0	0	1	0
Totals	2184	1633	1609	1609	1606	1339	2	24	0	18	0	1	0

4.4 Scenarios with Deleted Directories

For details about directories, refer to test cases DFR-11 (above) and test case DFR-12 (below).

4.5 Recovered Content (Overwrites)

This subsection summarizes results for cases than involve overwriting some files and metadata. The degree of overwriting can be gauged from the **Available Metadata and File Block Summary table.**

Available Metadata and File Block Summary							
Case	Deleted	Intact/Meta	Partial/Meta	None/meta	Intact/None	Partial/None	None/None
fat-07	15	6	0	3	0	0	6
fat-07-one	9	3	0	2	0	0	4
fat-07-two	6	0	0	2	0	0	4
fat-08	74	32	2	9	7	1	23
fat-10	2340	780	0	0	0	0	1560
fat-12	36	27	0	0	0	9	0
fat-13	414	270	0	84	0	0	60
xfat-07	5	3	0	0	0	0	2
xfat-07-one	3	1	0	1	0	0	1
xfat-07-two	2	0	0	1	0	0	1
xfat-08	25	13	0	1	1	0	10
xfat-10	780	260	0	0	0	0	520
xfat-12	12	9	0	0	0	3	0
xfat-13	138	90	3	25	0	0	20
ntfs-07	5	1	0	2	0	0	2
ntfs-07-one	3	1	0	2	0	0	0
ntfs-07-two	2	0	0	2	0	0	0
ntfs-08	25	13	3	9	0	0	0
ntfs-10	780	260	0	497	0	0	23
ntfs-12	12	9	0	0	0	3	0
ntfs-13	138	87	0	48	0	0	3
ext-07	15	6	1	2	0	0	6
ext-07-one	9	3	0	3	0	0	3
ext-07-two	6	0	0	3	0	0	3
ext-08	49	20	0	6	3	4	16
ext-10	2340	896	1	860	12	0	571
ext-12	36	30	0	0	1	3	2
ext-13	414	270	19	95	1	1	28

The **Recovered File Analysis Summary** gives a one-row summary of the files recovered for a test case.

- Case: The test case identifier.
- Del: The number of deleted files. The notation k/j means k files created in j directories.
- Rec: The number of files recovered by the tool. This should be at least as many as the **Intact/Meta** value from the table above.
- SS: The number of deleted files that contributed blocks to the recovered files. This will be discussed below when we have more data from the example.
- First: The number of recovered files that contain the first block of the deleted file.

- Full: The number of recovered files that are complete and accurate with no extra blocks.
- Match: The number of recovered files with a correctly matching name.
- Sigma: The number of recovered files with a recovered name that matches except for the first character. This is an artifact of some deleted files on FAT file systems where the Greek ISO representation of the letter sigma (σ) replaces the first character of the file name to indicate a deleted file.
- Multi: The number of files with blocks from two or more deleted files. In other words, files with blocks of data from different files recovered together into one recovered file.
- Other: The number of files recovered with unrecognized data blocks. This is usually the case when a file is partially overwritten with file system metadata.
- Active: The number of recovered files that include data blocks from active (not deleted) files.
- Seq: The number of recovered files with data blocks out of sequence.
- Over: The number of files that are overwritten in the test case.
- Ovf: The number of files that the tool reports as overwritten.

Recovered File Analysis Summary												
Case	Del	Rec	SS	First	Full	Match	Sigma	Multi	Other	Active	Seq	Over	Ovf
fat-07	15	9	6	8	6	5	1	0	0	0	0	9	0
fat-07-one	9	6	3	5	3	3	0	0	0	1	0	6	0
fat-07-two	6	3	0	0	0	0	0	0	0	3	0	6	0
fat-08	74	42	36	31	30	18	12	5	0	0	0	35	0
fat-10	2340	780	780	780	780	780	0	0	0	0	0	1560	0
fat-12	36/9	27/0	9	9	9	9	0	18	3	0	0	9	0
fat-13	414	355	66	57	57	57	0	274	78	193	0	144	0
xfat-07	5	3	3	3	3	3	0	0	0	0	0	2	0
xfat-07-one	3	2	1	1	1	1	0	0	1	0	0	2	0
xfat-07-two	2	1	0	0	0	0	0	0	0	1	0	2	0
xfat-08	25	13	13	13	13	13	0	0	0	0	0	11	0
xfat-10	780	260	260	260	260	260	0	0	0	0	0	520	0
xfat-12	12/3	3/0	3	3	3	3	0	0	0	0	0	3	0
xfat-13	138	118	90	90	90	90	0	18	17	15	0	48	0
ntfs-07	5	3	2	3	2	2	0	0	0	0	0	4	0
ntfs-07-one	3	2	1	2	1	1	0	0	0	0	0	2	0
ntfs-07-two	2	1	0	0	0	0	0	0	0	1	0	2	0
ntfs-08	25	13	11	12	10	10	0	1	0	0	0	12	0
ntfs-10	780	260	260	260	260	260	0	0	0	0	0	520	0
ntfs-12	12/3	9/0	9	9	9	9	0	0	0	0	0	3	0
ntfs-13	138	118	92	92	92	92	0	23	0	23	0	51	0
ext-07	15	3	2	2	2	0	0	1	0	0	0	9	0
ext-07-one	9	2	1	1	1	0	0	1	1	0	0	6	0
ext-07-two	6	1	0	0	0	0	0	1	1	1	0	6	0
ext-08	49	13	10	11	10	0	0	1	1	0	0	26	0
ext-10	2340	260	260	260	260	0	0	0	0	0	0	1432	0
ext-12	36/9	9/0	9	9	9	6	0	0	0	0	0	5	0
ext-13	414	118	90	90	90	0	0	25	14	23	0	143	0

The next two tables give summary totals by file system.

Available Metadata and File Block Summary							
Case	Deleted	Intact/Meta	Partial/Meta	None/meta	Intact/None	Partial/None	None/None
fat	2894	1118	2	100	7	10	1657
xfat	965	376	3	28	1	3	554

Available Metadata and File Block Summary							
Case	Deleted	Intact/Meta	Partial/Meta	None/meta	Intact/None	Partial/None	None/None
ntfs	965	371	3	560	0	3	28
ext	2869	1225	21	969	17	8	629
Totals	7693	3090	29	1657	25	24	2868

Recovered File Analysis By File System													
Type	Del	Rec	SS	First	Full	Match	Sigma	Multi	Other	Active	Seq	Over	Ovf
FAT	2894	1222	900	890	885	872	13	297	81	197	0	1769	0
ExFAT	965	400	370	370	370	370	0	18	18	16	0	588	0
NTFS	965	406	375	378	374	374	0	24	0	24	0	594	0
ext	2869	406	372	373	372	6	0	29	17	24	0	1627	0
Totals	7693	2434	2017	2011	2001	1622	13	368	116	261	0	4578	0

4.6 Reported File Size for Recovered Files

This subsection summarizes reported size for recovered metadata.

The **Available Metadata and File Block Summary** gives a one row summary of the file blocks and meta-data available for recovery for a testcase.

- Case: The test case identifier.
- Deleted: The number of files created and then deleted.
- Intact/Meta: The number of files with no blocks overwritten and metadata available. All these files should be recoverable.
- Partial/Meta: The number of files with some, but not all, blocks overwritten and metadata available. However, only independently allocated blocks are counted.
- None/Meta: The number of files with all blocks overwritten, but metadata available. For NTFS file systems, blocks from small files may be contained within the MFT and not counted here.
- Intact/None: The number of files with no blocks overwritten and metadata overwritten.
- Partial/None: The number of files with some, but not all, blocks overwritten and metadata overwritten.
- None/None: The number of files with all blocks and metadata overwritten.

Available Metadata and File Block Summary							
Case	Deleted	Intact/Meta	Partial/Meta	None/meta	Intact/None	Partial/None	None/None
fat-01	3	3	0	0	0	0	0
fat-07	15	6	0	3	0	0	6
fat-11	9	9	0	0	0	0	0
xfat-01	1	1	0	0	0	0	0
xfat-07	5	3	0	0	0	0	2
xfat-11	3	3	0	0	0	0	0
ntfs-01	1	1	0	0	0	0	0
ntfs-07	5	1	0	2	0	0	2
ntfs-11	3	3	0	0	0	0	0
ext-01	3	3	0	0	0	0	0
ext-07	15	6	1	2	0	0	6
ext-11	9	9	0	0	0	0	0

The **Recovered File Analysis Summary** gives a one-row summary of the files recovered for a test case.

- Case: The test case identifier.

- Del: The number of deleted files. The notation k/j means k files created in j directories.
- Rec: The number of files recovered by the tool. This should be at least as many as the **Intact/Meta** value from the table above.
- SS: The number of deleted files that contributed blocks to the recovered files. This will be discussed below when we have more data from the example.
- First: The number of recovered files that contain the first block of the deleted file.
- Full: The number of recovered files that are complete and accurate with no extra blocks.
- Match: The number of recovered files with a correctly matching name.
- Sigma: The number of recovered files with a recovered name that matches except for the first character. This is an artifact of some deleted files on FAT file systems where the Greek ISO representation of the letter sigma (σ) replaces the first character of the file name to indicate a deleted file.
- Multi: The number of files with blocks from two or more deleted files. In other words, files with blocks of data from different files recovered together into one recovered file.
- Other: The number of files recovered with unrecognized data blocks. This is usually the case when a file is partially overwritten with file system metadata.
- Active: The number of recovered files that include data blocks from active (not deleted) files.
- Seq: The number of recovered files with data blocks out of sequence.
- Over: The number of files that are overwritten in the test case.
- Ovf: The number of files that the tool reports as overwritten.

Recovered File Analysis Summary													
Case	Del	Rec	SS	First	Full	Match	Sigma	Multi	Other	Active	Seq	Over	Ovf
fat-01	3	3	3	3	3	2	1	0	0	0	0	0	0
fat-07	15	9	6	8	6	5	1	0	0	0	0	9	0
fat-11	9/3	9/0	9	9	9	9	0	0	0	0	0	0	0
xfat-01	1	1	1	1	1	1	0	0	0	0	0	0	0
xfat-07	5	3	3	3	3	3	0	0	0	0	0	2	0
xfat-11	3/1	0/0	0	0	0	0	0	0	0	0	0	0	0
ntfs-01	1	1	1	1	1	1	0	0	0	0	0	0	0
ntfs-07	5	3	2	3	2	2	0	0	0	0	0	4	0
ntfs-11	3/1	3/0	3	3	3	3	0	0	0	0	0	0	0
ext-01	3	1	1	1	1	0	0	0	0	0	0	0	0
ext-07	15	3	2	2	2	0	0	1	0	0	0	9	0
ext-11	9/3	3/0	3	3	3	3	0	0	0	0	0	0	0

Each row of the **Deleted File Details** table describes each deleted file.

- Case: The test case identifier. The field is left blank after the first file for the remaining files of the test case.
- File: The name of the deleted file.
- Size: The number of 512 byte blocks allocated to the file.
- Bytes: The number of bytes allocated to the file.
- Residue: The number of data blocks not overwritten, i.e., the number of data blocks available for recovery.

- Meta: Either *none* or *meta* indicating the absence or presence of file metadata.

Deleted File Details					
Case	File	Size	Bytes	Residue	Meta
fat-01	Bellatrix.txt	1	712	1	meta
	Betelgeuse.txt	1	712	1	meta
	XBEID.TXT	1	712	1	meta
fat-07	Bellatrix.txt	8	4096	0	none
	Betelgeuse.txt	8	4096	0	none
	Canopus.txt	8	4096	0	none
	Capella.txt	8	4096	0	meta
	Deneb.txt	8	4096	0	meta
	Denebola.TXT	8	4096	0	meta
	Fomalhaut.TXT	16	8192	16	meta
	FumAlSamakah.txt	16	8192	16	meta
	Gemma.TXT	8	4096	8	meta
	Giauzar.txt	8	4096	8	meta
	Graffias.TXT	8	4096	8	meta
	XBEID.TXT	8	4096	0	none
	XCAPH.TXT	8	4096	0	none
	XDUBHE.TXT	8	4096	0	none
	XFURUD.TXT	16	8192	16	meta
fat-11	Capella.txt	16	8192	16	meta
	Elnasl.txt	16	8192	16	meta
	Maaz.txt	16	8192	16	meta
	Nunki.txt	16	8192	16	meta
	Rastaban.txt	16	8192	16	meta
	Rukbat.txt	16	8192	16	meta
	Sadatoni.txt	16	8192	16	meta
	Thuban.txt	16	8192	16	meta
	Tyl.txt	16	8192	16	meta
xfat-01	Betelgeuse.txt	8	4396	8	meta
xfat-07	Betelgeuse.txt	1	512	0	none
	Capella.txt	1	512	0	none
	Deneb.txt	1	512	1	meta
	Fomalhaut.TXT	2	1024	2	meta
	Gemma.TXT	1	512	1	meta
xfat-11	Adhil.txt	4	2048	4	meta
	Alpheratz.txt	4	2048	4	meta
	Mirach.txt	4	2048	4	meta
ntfs-01	Bunda.txt	8	4296	8	meta
ntfs-07	Bunda.txt	8	4096	0	none
	Castor.txt	8	4096	0	none
	Duhr.TXT	8	4096	0	meta
	Furud.txt	15	7680	15	meta
	Grumium.txt	1	512	0	meta
ntfs-11	Sheliak.txt	4	2048	4	meta
	Sulafat.txt	4	2048	4	meta
	Vega.txt	4	2048	4	meta
ext-01	Bellatrix.txt	1	712	1	meta
	Botein.txt	1	712	1	meta
	Bunda.txt	1	712	1	meta
ext-07	Bellatrix.txt	8	4096	0	none
	Botein.txt	8	4096	0	none
	Bunda.txt	8	4096	0	none
	Canopus.txt	8	4096	0	none
	Castor.txt	8	4096	0	none
	Chort.txt	8	4096	0	none
	Denebola.TXT	8	4096	0	meta
	Diadem.TXT	8	4096	6	meta
	Duhr.TXT	8	4096	0	meta
	FumAlSamakah.txt	16	8192	16	meta
	Furud.txt	16	8192	16	meta
	Giauzar.txt	6	3072	6	meta

Deleted File Details					
Case	File	Size	Bytes	Residue	Meta
	Gomeisa.txt	8	4096	8	meta
	Grumium.txt	6	3072	6	meta
	fornax.txt	16	8192	16	meta
ext-11	Adhil.txt	16	8192	16	meta
	Alpheratz.txt	16	8192	16	meta
	Betelguese.txt	16	8192	16	meta
	Mintaka.txt	16	8192	16	meta
	Mirach.txt	16	8192	16	meta
	Rigel.txt	16	8192	16	meta
	Sheliak.txt	16	8192	16	meta
	Sulafat.txt	16	8192	16	meta
	Vega.txt	16	8192	16	meta

Each row of the **Recovered File Content Analysis** table describes each recovered file.

- Case: The test case identifier. The field is left blank after the first file for the remaining files of the test case.
- Content: The file name of the file that was the source of the first recovered data block of the recovered object.
- Name: The name assigned to the recovered object by the tool under test.
- Size: The value reported by the tool under test as the size of the original deleted file.
- First: The number of initial file blocks included in the recovered object.
- Blocks: The number of non-initial blocks included in the recovered object.
- Tail: The number of partial sector blocks included in the recovered object.
- Src: The number of files contributing to the recovered file.
- Shift: The number of times there is a shift to a new data source (i.e., the number of files in addition to the first that contributed data to the recovered object).
- Seq: The number of times a there is a break in the sequence of blocks within the recovered object.
- Other: The number of unidentified blocks included in the recovered object.

Recovered File Content Analysis										
Case	Content	Name	Size	First	Blocks	Tail	Src	Shift	Seq	Other
dfr-fat-01	Bellatrix.txt	Bellatrix.txt	712	1	0	1	1	0	0	0
	Betelgeuse.txt	Betelgeuse.txt	712	1	0	1	1	0	0	0
dfr-fat-07	Fomalhaut.TXT	Fomalhaut.TXT	8,192	1	15	0	1	0	0	0
	FumAlSamakah.txt	FumAlSamakah.txt	8,192	1	15	0	1	0	0	0
	Gemma.TXT	Deneb.txt	4,096	1	7	0	1	0	0	0
	Gemma.TXT	Gemma.TXT	4,096	1	7	0	1	0	0	0
	Giauzar.txt	Giauzar.txt	4,096	1	7	0	1	0	0	0
	Graffias.TXT	Graffias.TXT	4,096	1	7	0	1	0	0	0
dfr-fat-11	Nunki.txt	Nunki.txt	8,192	1	15	0	1	0	0	0
	Tyl.txt	Tyl.txt	8,192	1	15	0	1	0	0	0
	Capella.txt	Capella.txt	8,192	1	15	0	1	0	0	0
	Rastaban.txt	Rastaban.txt	8,192	1	15	0	1	0	0	0
	Maaz.txt	Maaz.txt	8,192	1	15	0	1	0	0	0
	Thuban.txt	Thuban.txt	8,192	1	15	0	1	0	0	0
	Sadatoni.txt	Sadatoni.txt	8,192	1	15	0	1	0	0	0
	Elnasl.txt	Elnasl.txt	8,192	1	15	0	1	0	0	0
	Rukbat.txt	Rukbat.txt	8,192	1	15	0	1	0	0	0
dfr-xfat-01	Betelgeuse.txt	Betelgeuse.txt	4,396	1	7	1	1	0	0	0
dfr-xfat-07	Fomalhaut.TXT	Fomalhaut.TXT	1,024	1	1	0	1	0	0	0
	Gemma.TXT	Gemma.TXT	512	1	0	0	1	0	0	0

Recovered File Content Analysis										
Case	Content	Name	Size	First	Blocks	Tail	Src	Shift	Seq	Other
	Deneb.txt	Deneb.txt	512	1	0	0	1	0	0	0
dfr-ntfs-01	Bunda.txt	Bunda.txt	4,296	1	7	1	1	0	0	0
dfr-ntfs-07	Grumium.txt	Grumium.txt	512	1	0	0	1	0	0	0
	Furud.txt	Duhr.TXT	4,096	1	7	0	1	0	0	0
	Furud.txt	Furud.txt	7,680	1	14	0	1	0	0	0
dfr-ntfs-11	Vega.txt	Vega.txt	2,048	1	3	0	1	0	0	0
	Sheliak.txt	Sheliak.txt	2,048	1	3	0	1	0	0	0
	Sulafat.txt	Sulafat.txt	2,048	1	3	0	1	0	0	0
	Rigel.txt	Rigel.txt	8,192	1	15	0	1	0	0	0
	Betelguese.txt	Betelguese.txt	8,192	1	15	0	1	0	0	0
	Mintaka.txt	Mintaka.txt	8,192	1	15	0	1	0	0	0

4.7 Recovered MAC Times

The MAC times are as reported by the **stat** command from a Linux environment (MM/DD/YY HH:MM:SS + or – HHMM) for ext, fat and NTFS. The MAC times for the exFAT cases are as reported by the **stat** command from an OS X environment. The file delete times are as reported by the Windows **dir** command.

Note that for the FAT dates and times the **stat** times reported as the actual MAC times should be adjusted by adding one hour.

Also note that the operating system replaces the *ctime* meta-data with the time of file deletion for ext file systems. Therefore the expected *ctime* value is the deletion time and not the *ctime* value just before file deletion. Otherwise the expected value for a recovered MAC time is the MAC time just before file deletion.

Each row of the **Deleted File Mac Times** table reports the MAC times in MM/DD/YY HH:MM:SS format for each deleted file just before the file is deleted.

- Case: The test case identifier. The field is left blank after the first file for the remaining files of the test case.
- Name: The name of the deleted file.
- Modify/Access/Create: The MAC times just before the file is deleted.

Deleted File MAC Times				
Case	File	Modify	Access	Create
ext-01	Bellatrix.txt	02/29/00 13:13:00 -0500	01/02/99 03:03:00 -0500	10/09/11 13:10:19 -0400
	Botein.txt	02/29/00 13:15:00 -0500	01/02/99 03:05:00 -0500	10/09/11 13:10:20 -0400
	Bunda.txt	02/29/00 13:14:00 -0500	01/02/99 03:04:00 -0500	10/09/11 13:10:20 -0400
fat-01	Bellatrix.txt	02/29/00 13:13:00 -0500	01/01/99 23:00:00 -0500	12/25/11 13:02:24 -0500
	Betelgeuse.txt	02/29/00 13:12:00 -0500	01/01/99 23:00:00 -0500	12/25/11 13:02:24 -0500
	XBEID.TXT	02/29/00 13:11:00 -0500	01/01/99 23:00:00 -0500	12/25/11 13:02:23 -0500
ntfs-01	Bunda.txt	02/29/00 13:14:00 -0500	01/02/99 03:04:00 -0500	02/03/12 10:12:59 -0500
xfat-01	Betelgeuse.txt	02/29/00 13:12:00	01/2/99 03:02:00	10/16/2011 09:57:49

The File Delete Times table reports the time the file was deleted for ext file systems. These times are the expected values recovered for *ctime* for the ext file systems.

File Delete Times (ext)		
Case	Operation	File Delete Time
ext-01	delete	Bellatrix.txt
ext-01	delete time	Sun Oct 9 13:12:59 EDT 2011
ext-01	delete	Bunda.txt
ext-01	delete time	Sun Oct 9 13:13:00 EDT 2011
ext-01	delete	Botein.txt
ext-01	delete time	Sun Oct 9 13:13:00 EDT 2011

Each row of the **Recovered File Mac Times** table reports the MAC times in MM/DD/YY HH:MM:SS format for each recovered file.

- Case: The test case identifier. The field is left blank after the first file for the remaining files of the test case.
- Name: The name of the deleted file.
- Modify/Access/Create: The MAC times reported by the tool under test.

Recovered File MAC Times				
Case	File	Modify	Access	Create
dfr-ext-01	Botein.txt	10/09/2011 13:13:00	01/02/1999 03:05:00	10/09/2011 13:13:00
	Bellatrix.txt	none	none	none
	FileInInode#13	02/29/2000 13:13:00	01/02/1999 03:03:00	10/09/2011 13:12:59
	Bunda.txt	10/09/2011 13:13:00	01/02/1999 03:04:00	10/09/2011 13:13:00
dfr-fat-01	?BEID.TXT	02/29/2000 14:11:00	01/02/1999	12/25/2011 14:02:23
	Bellatrix.txt	02/29/2000 14:13:00	01/02/1999	12/25/2011 14:02:24
	Betelgeuse.txt	02/29/2000 14:12:00	01/02/1999	12/25/2011 14:02:24
dfr-ntfs-01	Bunda.txt	02/29/2000 13:14:00	01/02/1999 03:04:00	02/03/2012 10:12:59
dfr-xfat-01	Betelgeuse.txt	02/29/2000 13:12:00	01/02/1999 03:02:00	10/16/2011 09:57:49

4.8 Non-Latin Character File Names

The **Recovered File Analysis Summary** gives a one-row summary of the files recovered for a test case.
- Case: The test case identifier.
- Del: The number of deleted files. The notation k/j means k files created in j directories.
- Rec: The number of files recovered by the tool. This should be at least as many as the **Intact/Meta** value from the table above.
- SS: The number of deleted files that contributed blocks to the recovered files. This will be discussed below when we have more data from the example.
- First: The number of recovered files that contain the first block of the deleted file.
- Full: The number of recovered files that are complete and accurate with no extra blocks.
- Match: The number of recovered files with a correctly matching name.
- Sigma: The number of recovered files with a recovered name that matches except for the first character. This is an artifact of some deleted files on FAT file systems

where the Greek ISO representation of the letter sigma (σ) replaces the first
character of the file name to indicate a deleted file.

- Multi: The number of files with blocks from two or more deleted files. In other
  words, files with blocks of data from different files recovered together into one
  recovered file.
- Other: The number of files recovered with unrecognized data blocks. This is
  usually the case when a file is partially overwritten with file system metadata.
- Active: The number of recovered files that include data blocks from active (not
  deleted) files.
- Seq: The number of recovered files with data blocks out of sequence.
- Over: The number of files that are overwritten in the test case.
- Ovf: The number of files that the tool reports as overwritten.

Recovered File Analysis Summary													
Case	Del	Rec	SS	First	Full	Match	Sigma	Multi	Other	Active	Seq	Over	Ovf
ext-04	36	12	12	12	12	0	0	0	0	0	0	0	0
fat-04	36	36	36	36	36	0	0	0	0	0	0	0	0
ntfs-04	12	12	12	12	12	0	0	0	0	0	0	0	0
xfat-04	12	12	12	12	12	0	0	0	0	0	0	0	0

Each row of the **Recovered File Content Block Details** table describes the source of
recovered file content.

- Case: The test case identifier. The field is left blank after the first file for the
  remaining files of the test case.
- Name: The name of the recovered object.
- Recovered Content: A list of data sources included in the recovered object. Each
  entry is accompanied with the number of blocks included in the recovered object
  and the size of the source object.

Recovered File Content Block Details		
Case	Name	Recovered Content
dfr-ext-04	FileinInode#12	Naan.txt3(8 of 8)
	FileinInode#14	Pakora.txt3(8 of 8)
	FileinInode#16	Seoul.txt3(8 of 8)
	FileinInode#19	Walnut.txt3(8 of 8)
	FileinInode#21	Hummus.txt3(8 of 8)
	FileinInode#23	Tagine.txt3(8 of 8)
	FileinInode#24	Tea.txt3(8 of 8)
	FileinInode#26	Mitsubishi-k.txt3(8 of 8)
	FileinInode#27	Mitsubishi-h.txt3(8 of 8)
	FileinInode#29	Vessel.txt3(8 of 8)
	FileinInode#30	BeiJing.txt3(8 of 8)
	FileinInode#33	Tokyo.txt3(8 of 8)
dfr-fat-04	Gefäß.txt1	Vessel.txt1(8 of 8)
	Gefäß.txt2	Vessel.txt2(8 of 8)
	Gefäß.txt3	Vessel.txt3(8 of 8)
	北京.txt1	BeiJing.txt1(8 of 8)
	東京.txt1	Tokyo.txt1(8 of 8)
	北京.txt2	BeiJing.txt2(8 of 8)
	東京.txt2	Tokyo.txt2(8 of 8)
	北京.txt3	BeiJing.txt3(8 of 8)
	東京.txt3	Tokyo.txt3(8 of 8)

Recovered File Content Block Details		
Case	Name	Recovered Content
	नान.txt1	Naan.txt1(8 of 8)
	नान.txt2	Naan.txt2(8 of 8)
	नान.txt3	Naan.txt3(8 of 8)
	чай.txt1	Tea.txt1(8 of 8)
	گردو.txt1	Walnut.txt1(8 of 8)
	чай.txt2	Tea.txt2(8 of 8)
	گردو.txt2	Walnut.txt2(8 of 8)
	чай.txt3	Tea.txt3(8 of 8)
	گردو.txt3	Walnut.txt3(8 of 8)
	חומוס.txt1	Hummus.txt1(8 of 8)
	طاجين.txt1	Tagine.txt1(8 of 8)
	پکوڑا.txt1	Pakora.txt1(8 of 8)
	서울.txt1	Seoul.txt1(8 of 8)
	みつびし.txt1	Mitsubishi-h.txt1(8 of 8)
	ミツビシ.txt1	Mitsubishi-k.txt1(8 of 8)
	חומוס.txt2	Hummus.txt2(8 of 8)
	طاجين.txt2	Tagine.txt2(8 of 8)
	پکوڑا.txt2	Pakora.txt2(8 of 8)
	ㅅ ㅇ .txt2	Seoul.txt2(8 of 8)
	みつびし.txt2	Mitsubishi-h.txt2(8 of 8)
	ミツビシ.txt2	Mitsubishi-k.txt2(8 of 8)
	חומוס.txt3	Hummus.txt3(8 of 8)
	طاجين.txt3	Tagine.txt3(8 of 8)
	پکوڑا.txt3	Pakora.txt3(8 of 8)
	ㅅ ㅇ .txt3	Seoul.txt3(8 of 8)
	みつびし.txt3	Mitsubishi-h.txt3(8 of 8)
	ミツビシ.txt3	Mitsubishi-k.txt3(8 of 8)
dfr-ntfs-04	Gefäß.txt	Vessel.txt(4 of 4)
	北京.txt	BeiJing.txt(4 of 4)
	東京.txt	Tokyo.txt(4 of 4)
	नान.txt	Naan.txt(4 of 4)
	чай.txt	Tea.txt(4 of 4)
	گردو.txt	Walnut.txt(4 of 4)
	חומוס.txt	Hummus.txt(4 of 4)
	طاجين.txt	Tagine.txt(4 of 4)
	پکوڑا.txt	Pakora.txt(4 of 4)
	ㅅ ㅇ .txt	Seoul.txt(4 of 4)
	みつびし.txt	Mitsubishi-h.txt(4 of 4)
	ミツビシ.txt	Mitsubishi-k.txt(4 of 4)
dfr-xfat-04	Gefäß.txt	Vessel.txt(6 of 6)
	北京.txt	BeiJing.txt(6 of 6)
	東京.txt	Tokyo.txt(6 of 6)
	नान.txt	Naan.txt(6 of 6)
	чай.txt	Tea.txt(6 of 6)
	گردو.txt	Walnut.txt(6 of 6)
	חומוס.txt	Hummus.txt(6 of 6)
	طاجين.txt	Tagine.txt(6 of 6)
	پکوڑا.txt	Pakora.txt(6 of 6)
	ㅅ ㅇ .txt	Seoul.txt(6 of 6)
	みつびし.txt	Mitsubishi-h.txt(6 of 6)
	ミツビシ.txt	Mitsubishi-k.txt(6 of 6)

4.9 Deletion Through Recycle Bin

The **Available Metadata and File Block Summary** gives a one row summary of the file blocks and meta-data available for recovery for a test case.

- Case: The test case identifier.
- Deleted: The number of files created and then deleted.
- Intact/Meta: The number of files with no blocks overwritten and metadata available. All these files should be recoverable.
- Partial/Meta: The number of files with some, but not all, blocks overwritten and metadata available. However, only independently allocated blocks are counted.
- None/Meta: The number of files with all blocks overwritten, but metadata available. For NTFS file systems, blocks from small files may be contained within the MFT and not counted here.
- Intact/None: The number of files with no blocks overwritten and metadata overwritten.
- Partial/None: The number of files with some, but not all, blocks overwritten and metadata overwritten.
- None/None: The number of files with all blocks and metadata overwritten.

Available Metadata and File Block Summary							
Case	Deleted	Intact/Meta	Partial/Meta	None/meta	Intact/None	Partial/None	None/None
ext-01-recycle	3	3	0	0	0	0	0
fat-01-recycle	3	3	0	0	0	0	0
ntfs-01-recycle	1	1	0	0	0	0	0

The **Recovered File Analysis Summary** gives a one-row summary of the files recovered for a test case.

- Case: The test case identifier.
- Del: The number of deleted files. The notation k/j means k files created in j directories.
- Rec: The number of files recovered by the tool. This should be at least as many as the **Intact/Meta** value from the table above.
- SS: The number of deleted files that contributed blocks to the recovered files. This will be discussed below when we have more data from the example.
- First: The number of recovered files that contain the first block of the deleted file.
- Full: The number of recovered files that are complete and accurate with no extra blocks.
- Match: The number of recovered files with a correctly matching name.
- Sigma: The number of recovered files with a recovered name that matches except for the first character. This is an artifact of some deleted files on FAT file systems where the Greek ISO representation of the letter sigma (σ) replaces the first character of the file name to indicate a deleted file.
- Multi: The number of files with blocks from two or more deleted files. In other words, files with blocks of data from different files recovered together into one recovered file.

- Other: The number of files recovered with unrecognized data blocks. This is usually the case when a file is partially overwritten with file system metadata.
- Active: The number of recovered files that include data blocks from active (not deleted) files.
- Seq: The number of recovered files with data blocks out of sequence.
- Over: The number of files that are overwritten in the test case.
- Ovf: The number of files that the tool reports as overwritten.

Recovered File Analysis Summary												
Case	Del	Rec	SS	First	Full	Match	Sigma	Multi	Other	Active	Seq	Over	Ovf
ext-01-recycle	3	2	1	1	1	0	0	0	1	0	0	0	0
fat-01-recycle	3	7	3	5	3	2	1	0	2	0	0	0	0
ntfs-01-recycle	1	2	1	1	1	0	0	0	1	0	0	0	0

Each row of the **Deleted File Details** table describes each deleted file.

- Case: The test case identifier. The field is left blank after the first file for the remaining files of the test case.
- File: The name of the deleted file.
- Size: The number of 512 byte blocks allocated to the file.
- Bytes: The number of bytes allocated to the file.
- Residue: The number of data blocks not overwritten, i.e., the number of data blocks available for recovery.
- Meta: Either *none* or *meta* indicating the absence or presence of file metadata.

Deleted File Details					
Case	File	Size	Bytes	Residue	Meta
ext-01-recycle	Bellatrix.txt	8	4096	8	meta
	Botein.txt	8	4096	8	meta
	Bunda.txt	8	4096	8	meta
fat-01-recycle	Bellatrix.txt	8	4096	8	meta
	Betelgeuse.txt	8	4096	8	meta
	XBEID.TXT	8	4096	8	meta
ntfs-01-recycle	Bunda.txt	8	4296	8	meta

Each row of the **Recovered File Content Block Details** table describes the source of recovered file content.

- Case: The test case identifier. The field is left blank after the first file for the remaining files of the test case.
- Name: The name of the recovered object.
- Recovered Content: A list of data sources included in the recovered object. Each entry is accompanied with the number of blocks included in the recovered object and the size of the source object.

Recovered File Content Block Details		
Case	Name	Recovered Content
dfr-ext-01-recycle	FileinInode#13	Bellatrix.txt(8 of 8)
	FileinInode#75483	other(1)

Recovered File Content Block Details		
Case	Name	Recovered Content
dfr-fat-01-recycle	Bellatrix.txt	Bellatrix.txt(8 of 8)
	Betelgeuse.txt	Betelgeuse.txt(8 of 8)
	_BEID.TXT	XBEID.TXT(8 of 8)
	_iooncp6.txt	other(2)
	_iqcrfk5.txt	other(2)
	_rooncp6.txt	Betelgeuse.txt(8 of 8)
	_rqcrfk5.txt	Bellatrix.txt(8 of 8)
dfr-ntfs-01-recycle	$I019S2V.txt	other(2)
	$R019S2V.txt	Bunda.txt(8 of 8)

4.10 Special NTFS Situations

The **Available Metadata and File Block Summary** gives a one row summary of the file blocks and meta-data available for recovery for a testcase.

- Case: The test case identifier.
- Deleted: The number of files created and then deleted.
- Intact/Meta: The number of files with no blocks overwritten and metadata available. All these files should be recoverable.
- Partial/Meta: The number of files with some, but not all, blocks overwritten and metadata available. However, only independently allocated blocks are counted.
- None/Meta: The number of files with all blocks overwritten, but metadata available. For NTFS file systems, blocks from small files may be contained within the MFT and not counted here.
- Intact/None: The number of files with no blocks overwritten and metadata overwritten.
- Partial/None: The number of files with some, but not all, blocks overwritten and metadata overwritten.
- None/None: The number of files with all blocks and metadata overwritten.

Available Metadata and File Block Summary							
Case	Deleted	Intact/Meta	Partial/Meta	None/meta	Intact/None	Partial/None	None/None
ntfs-11-compress	3	0	0	3	0	0	0
ntfs-11-mft	3	0	0	3	0	0	0

The **Recovered File Analysis Summary** gives a one-row summary of the files recovered for a test case.

- Case: The test case identifier.
- Del: The number of deleted files. The notation k/j means k files created in j directories.
- Rec: The number of files recovered by the tool. This should be at least as many as the **Intact/Meta** value from the table above.
- SS: The number of deleted files that contributed blocks to the recovered files. This will be discussed below when we have more data from the example.
- First: The number of recovered files that contain the first block of the deleted file.

- Full: The number of recovered files that are complete and accurate with no extra blocks.
- Match: The number of recovered files with a correctly matching name.
- Sigma: The number of recovered files with a recovered name that matches except for the first character. This is an artifact of some deleted files on FAT file systems where the Greek ISO representation of the letter sigma (σ) replaces the first character of the file name to indicate a deleted file.
- Multi: The number of files with blocks from two or more deleted files. In other words, files with blocks of data from different files recovered together into one recovered file.
- Other: The number of files recovered with unrecognized data blocks. This is usually the case when a file is partially overwritten with file system metadata.
- Active: The number of recovered files that include data blocks from active (not deleted) files.
- Seq: The number of recovered files with data blocks out of sequence.
- Over: The number of files that are overwritten in the test case.
- Ovf: The number of files that the tool reports as overwritten.

Recovered File Analysis Summary												
Case	Del	Rec	SS	First	Full	Match	Sigma	Multi	Other	Active	Seq	Over	Ovf
ntfs-11-compress	3/1	3/0	3	3	3	3	0	0	0	0	0	3	0
ntfs-11-mft	3/1	3/0	3	3	3	3	0	0	0	0	0	3	0

Content Analysis									
Case	Content	Name	First	Blocks	Tail	Src	Shift	Seq	Other
dfr-ntfs-11-compress	Sheliak.txt	Sheliak.txt	1	31	0	1	0	0	0
	Sulafat.txt	Sulafat.txt	1	31	0	1	0	0	0
	Vega.txt	Vega.txt	1	31	0	1	0	0	0
dfr-ntfs-11-mft	Sheliak.txt	Sheliak.txt	1	0	0	1	0	0	0
	Sulafat.txt	Sulafat.txt	1	0	0	1	0	0	0
	Vega.txt	Vega.txt	1	0	0	1	0	0	0

Each row of the **Recovered File Content Block Details** table describes the source of recovered file content.

- Case: The test case identifier. The field is left blank after the first file for the remaining files of the test case.
- Name: The name of the recovered object.
- Recovered Content: A list of data sources included in the recovered object. Each entry is accompanied with the number of blocks included in the recovered object and the size of the source object.

Recovered File Content Block Details		
Case	Name	Recovered Content
dfr-ntfs-11-compress	Sheliak.txt	Sheliak.txt(32 of 0)
	Sulafat.txt	Sulafat.txt(32 of 0)
	Vega.txt	Vega.txt(32 of 0)
dfr-ntfs-11-mft	Sheliak.txt	Sheliak.txt(1 of 0)
	Sulafat.txt	Sulafat.txt(1 of 0)

Recovered File Content Block Details		
Case	**Name**	**Recovered Content**
	Vega.txt	Vega.txt(1 of 0)

4.11 Listing Special Objects (Links, Alternate Data Streams, etc.)

The **Objects Created Table** lists by partition each object created for case xxx-15.

Objects Created for ext-15		
Step	**Operation**	**Files in Partition EXT2**
1	create	Adhara-X2.txt
1	link	Adhara-hard-link-X2.txt->Adhara-X2.txt
1	create	.hidden-X2.txt
1	create	Dschubba-X2.txt
1	link	Dschubba-symbolic-link-X2.txt=>Dschubba-X2.txt
1	mkdir	Aquila-dir-X2
1	create	Altair-FileInDir-X2
1	link	Aquila-sym-linkToDir-X2=>Aquila-dir-X2
Step	Operation	Files in Partition EXT3
1	create	Betelgeuse-X3.txt
1	link	Betelgeuse-hard-link-X3.txt->Betelgeuse-X3.txt
1	create	.hidden-X3.txt
1	create	Electra-X3.txt
1	link	Electra-symbolic-link-X3.txt=>Electra-X3.txt
1	mkdir	Cygnus-dir-X3
1	create	Deneb-FileInDir-X3
1	link	Cygnus-sym-linkToDir-X3=>Cygnus-dir-X3
Step	Operation	Files in Partition EXT4
1	create	Canopus-X4.txt
1	link	Canopus-hard-link-X4.txt->Canopus-X4.txt
1	create	.hidden-X4.txt
1	create	Mintaka-X4.txt
1	link	Mintaka-symbolic-link-X4.txt=>Mintaka-X4.txt
1	mkdir	Lyra-dir-X4
1	create	Vega-FileInDir-X4
1	link	Lyra-sym-linkToDir-X4=>Lyra-dir-X4

The **Special Objects Listed** table identifies each object and attributes reported by the tested tool.

Special Objects Listed for dfr-ext-15	
Attributes	**Object**
Active	Adhara-hard-link-X2.txt
Active	Adhara-X2.txt
Active	Altair-FileInDir-X2
Active.Folder	Aquila-dir-X2
Active	Aquila-sym-linkToDir-X2
Active	Betelgeuse-hard-link-X3.txt
Active	Betelgeuse-X3.txt
Active	Canopus-hard-link-X4.txt
Active	Canopus-X4.txt
Active.Folder	Cygnus-dir-X3
Active	Cygnus-sym-linkToDir-X3
Active	Deneb-FileInDir-X3
Active	Dschubba-symbolic-link-X2.txt
Active	Dschubba-X2.txt
Active	Electra-symbolic-link-X3.txt
Active	Electra-X3.txt
Active	.hidden-X2.txt
Active	.hidden-X3.txt
Active	.hidden-X4.txt

Special Objects Listed for dfr-ext-15	
Attributes	**Object**
Active.Folder	Lyra-dir-X4
Active	Lyra-sym-linkToDir-X4
Active	Mintaka-symbolic-link-X4.txt
Active	Mintaka-X4.txt
Active	Vega-FileInDir-X4

The **Objects Created Table** lists by partition each object created for case xxx-15.

Objects Created for fat-15		
Step	**Operation**	**Files in Partition FAT12**
1	create	Adhara-file-FAT12.txt
1	link	Adhara-shortcut-FAT12.txt->Adhara-file-FAT12.txt
1	create	ReadOnly-FAT12.txt
1	create	Archive-FAT12.txt
1	create	System-FAT12.txt
1	create	Hidden-FAT12.txt
1	create	NotIndexed-FAT12.txt
Step	Operation	Files in Partition FAT16
1	create	Betelgeuse-file-FAT16.txt
1	link	Betelgeuse-shortcut-FAT16.txt->Betelgeuse-file-FAT16.txt
1	create	ReadOnly-FAT16.txt
1	create	Archive-FAT16.txt
1	create	System-FAT16.txt
1	create	Hidden-FAT16.txt
1	create	NotIndexed-FAT16.txt
Step	Operation	Files in Partition FAT32
1	create	Canopus-file-FAT32.txt
1	link	Canopus-shortcut-FAT32.txt->Canopus-file-FAT32.txt
1	create	ReadOnly-FAT32.txt
1	create	Archive-FAT32.txt
1	create	System-FAT32.txt
1	create	Hidden-FAT32.txt
1	create	NotIndexed-FAT32.txt

The **Special Objects Listed** table identifies each object and attributes reported by the tested tool.

Special Objects Listed for dfr-fat-15	
Attributes	**Object**
Active	Adhara-file-FAT12.txt
Active	Adhara-shortcut-FAT12.lnk
Active	Archive-FAT12.txt
Active	Archive-FAT16.txt
Active	Archive-FAT32.txt
Active	Betelgeuse-file-FAT16.txt
Active	Betelgeuse-shortcut-FAT16.lnk
Active	Canopus-file-FAT32.txt
Active	Canopus-shortcut-FAT32.lnk
Active	Hidden-FAT12.txt
Active	Hidden-FAT16.txt
Active	Hidden-FAT32.txt
Active	NotIndexed-FAT12.txt
Active	NotIndexed-FAT16.txt
Active	NotIndexed-FAT32.txt
Active	ReadOnly-FAT12.txt

Special Objects Listed for dfr-fat-15	
Attributes	**Object**
Active	ReadOnly-FAT16.txt
Active	ReadOnly-FAT32.txt
Active	System-FAT12.txt
Active	System-FAT16.txt
Active	System-FAT32.txt

The **Objects Created Table** lists by partition each object created for case xxx-15.

Objects Created for ntfs-15		
Step	**Operation**	**Files in Partition NTFS**
1	create	shortcut-file.txt
1	create	hard-file.txt
1	create	symbolic-file.txt
1	create	stream-file.txt
1	link	shortcut-shortcut.lnk->shortcut-file.txt
1	link	hard-link.txt->hard-file.txt
1	link	symbolic-link.txt->symbolic-file.txt
1	ads	stream-file.txt+Brahmaputra.txt
1	create	ReadOnly-ntfs.txt
1	create	Archive-ntfs.txt
1	create	System-ntfs.txt
1	create	Hidden-ntfs.txt
1	create	NotIndexed-ntfs.txt

The **Special Objects Listed** table identifies each object and attributes reported by the tested tool.

Special Objects Listed for dfr-ntfs-15	
Attributes	**Object**
Active	Archive-ntfs.txt
Active	Brahmaputra.txt
Active	hard-file.txt
Active	hard-link.txt
Active	Hidden-ntfs.txt
Active	NotIndexed-ntfs.txt
Active	ReadOnly-ntfs.txt
Active	shortcut-file.txt
Active	shortcut-shortcut.lnk
Active	stream-file.txt
Active	symbolic-file.txt
Active	symbolic-link.txt
Active	System-ntfs.txt

The **Objects Created Table** lists by partition each object created for case xxx-15.

Objects Created for xfat-15		
Step	**Operation**	**Files in Partition exFAT**
1	create	Adhara-file-XFAT.txt
1	link	Adhara-shortcut-XFAT.txt->Adhara-file-XFAT.txt
1	create	ReadOnly-XFAT.txt
1	create	Archive-XFAT.txt
1	create	System-XFAT.txt
1	create	Hidden-XFAT.txt
1	create	NotIndexed-XFAT.txt

The **Special Objects Listed** table identifies each object and attributes reported by the tested tool.

Special Objects Listed for dfr-xfat-15	
Attributes	**Object**
Active	Adhara-file-XFAT.txt
Active	Adhara-shortcut-XFAT.lnk
Active	Archive-XFAT.txt
Active	Hidden-XFAT.txt
Active	NotIndexed-XFAT.txt
Active	ReadOnly-XFAT.txt
Active	System-XFAT.txt

4.12 Recover Special Objects (Links, Alternate Data Streams, etc.)

The **Objects Created Table ext-14** lists by partition each object created for case ext-14.

Objects Created for ext-14		
Step	**Operation**	**Files in Partition EXT2**
1	mkdir	far-X4
1	create	Canopus-target-local-rmTarget-X4.txt Canopus-target-remote-rmTarget-X4.txt
1	link	Canopus-near-rmTarget-X4.txt->Canopus-target-local-rmTarget-X4.txt
1	link	far-X4/Canopus-far-rmTarget-X4.txt->Canopus-target-remote-rmTarget-X4.txt
1	create	Castor-target-local-rmLink-X4.txt Castor-target-remote-rmLink-X4.txt
1	link	Castor-near-rmLink-X4.txt->Castor-target-local-rmLink-X4.txt
1	link	far-X4/Castor-far-rmLink-X4.txt->Castor-target-remote-rmLink-X4.txt
1	create	Capella-target-local-rmBoth-X4.txt Capella-target-remote-rmBoth-X4.txt
1	link	Capella-near-rmBoth-X4.txt->Capella-target-local-rmBoth-X4.txt
1	link	far-X4/Capella-far-rmBoth-X4.txt->Capella-target-remote-rmBoth-X4.txt
1	create	Mintaka-target-local-rmTarget-X4.txt Mintaka-target-remote-rmTarget-X4.txt
1	link	Mintaka-near-rmTarget-X4.txt=>Mintaka-target-local-rmTarget-X4.txt
1	link	far-X4/Mintaka-far-rmTarget-X4.txt=>Mintaka-target-remote-rmTarget-X4.txt
1	create	Mizar-target-local-rmLink-X4.txt Mizar-target-remote-rmLink-X4.txt
1	link	Mizar-near-rmLink-X4.txt=>Mizar-target-local-rmLink-X4.txt
1	link	far-X4/Mizar-far-rmLink-X4.txt=>Mizar-target-remote-rmLink-X4.txt
1	create	Mimosa-target-local-rmBoth-X4.txt Mimosa-target-remote-rmBoth-X4.txt
1	link	Mimosa-near-rmBoth-X4.txt=>Mimosa-target-local-rmBoth-X4.txt
1	link	far-X4/Mimosa-far-rmBoth-X4.txt=>Mimosa-target-remote-rmBoth-X4.txt
1	mkdir	Leo-target-local-rmTarget-X4 Libra-target-local-rmLink-X4 Lynx-target-local-rmBoth-X4
1	create	Regulas-target-local-rmTarget-X4
1	create	Vega-target-local-rmLink-X4
1	create	Elvashak-target-local-rmBoth-X4
1	mkdir	Leo-target-remote-rmTarget-X4 Libra-target-remote-rmLink-X4 Lynx-target-remote-rmBoth-X4
1	create	Regulas-target-remote-rmTarget-X4
1	create	Vega-target-remote-rmLink-X4
1	create	Elvashak-target-remote-rmBoth-X4
1	link	Leo-near-rmTarget-X4=>Leo-target-local-rmTarget-X4
1	link	far-X4/Leo-far-rmTarget-X4=>Leo-target-remote-rmTarget-X4
1	link	Libra-near-rmLink-X4=>Libra-target-local-rmLink-X4
1	link	far-X4/Libra-far-rmLink-X4=>Libra-target-remote-rmLink-X4
1	link	Lynx-near-rmBoth-X4=>Lynx-target-local-rmBoth-X4
1	link	far-X4/Lynx-far-rmBoth-X4=>Lynx-target-remote-rmBoth-X4
2	delete	Canopus-target-local-rmTarget-X4.txt Canopus-target-remote-rmTarget-X4.txt
2	delete	Castor-near-rmLink-X4.txt Castor-far-rmLink-X4.txt
2	delete	Capella-target-local-rmBoth-X4.txt Capella-target-remote-rmBoth-X4.txt Capella-near-rmBoth-X4.txt Capella-far-rmBoth-X4.txt
2	delete	Mintaka-target-local-rmTarget-X4.txt Mintaka-target-remote-rmTarget-X4.txt

Objects Created for ext-14		
Step	**Operation**	**Files in Partition EXT2**
2	delete	Mizar-near-rmLink-X4.txt Mizar-far-rmLink-X4.txt
2	delete	Mimosa-target-local-rmBoth-X4.txt Mimosa-target-remote-rmBoth-X4.txt Mimosa-near-rmBoth-X4.txt Mimosa-far-rmBoth-X4.txt
2	delete	Leo-target-local-rmTarget-X4 Leo-target-remote-rmTarget-X4
2	delete	Libra-near-rmLink-X4 Libra-far-rmLink-X4
2	delete	Lynx-target-local-rmBoth-X4 Lynx-target-remote-rmBoth-X4 Lynx-near-rmBoth-X4 Lynx-far-rmBoth-X4
Step	Operation	Files in Partition EXT3
Step	Operation	Files in Partition EXT4

The **Objects Created Table fat-14** lists by partition each object created for case FAT-14.

Objects Created for fat-14		
Step	**Operation**	**Files in Partition FAT12**
1	create	fat12-file-df.txt
1	create	fat12-file-dl.txt
1	create	fat12-file-db.txt
1	link	fat12-shortcut-df.lnk->fat12-file-df.txt
1	link	fat12-shortcut-dl.lnk->fat12-file-dl.txt
1	link	fat12-shortcut-db.lnk->fat12-file-db.txt
2	delete	fat12-file-db.txt
2	delete	fat12-file-df.txt
2	delete	fat12-shortcut-db.lnk
2	delete	fat12-shortcut-dl.lnk
Step	Operation	Files in Partition FAT16
1	create	fat16-file-df.txt
1	create	fat16-file-dl.txt
1	create	fat16-file-db.txt
1	link	fat16-shortcut-df.lnk->fat16-file-df.txt
1	link	fat16-shortcut-dl.lnk->fat16-file-dl.txt
1	link	fat16-shortcut-db.lnk->fat16-file-db.txt
2	delete	fat16-file-db.txt
2	delete	fat16-file-df.txt
2	delete	fat16-shortcut-db.lnk
2	delete	fat16-shortcut-dl.lnk
Step	Operation	Files in Partition FAT32
1	create	fat32-file-df.txt
1	create	fat32-file-dl.txt
1	create	fat32-file-db.txt
1	link	fat32-shortcut-df.lnk->fat32-file-df.txt
1	link	fat32-shortcut-dl.lnk->fat32-file-dl.txt
1	link	fat32-shortcut-db.lnk->fat32-file-db.txt
2	delete	fat32-file-db.txt
2	delete	fat32-file-df.txt
2	delete	fat32-shortcut-db.lnk
2	delete	fat32-shortcut-dl.lnk

The **Objects Created Table ntfs-14** lists by partition each object created for case NTFS-14.

Objects Created for ntfs-14		
Step	**Operation**	**Files in Partition NTFS**
1	create	shortcut-file-df.txt
1	create	hard-file-df.txt
1	create	symbolic-file-df.txt
1	create	stream-file-df.txt
1	link	shortcut-shortcut-df.lnk->shortcut-file-df.txt
1	link	hard-link-df.txt->hard-file-df.txt

Objects Created for ntfs-14		
Step	**Operation**	**Files in Partition NTFS**
1	link	symbolic-link-df.txt->symbolic-file-df.txt
1	create	stream-file-df.txt+Volga.txt
1	create	shortcut-file-dl.txt
1	create	hard-file-dl.txt
1	create	symbolic-file-dl.txt
1	create	stream-file-keep.txt
1	link	shortcut-shortcut-dl.lnk->shortcut-file-dl.txt
1	link	hard-link-dl.txt->hard-file-dl.txt
1	link	symbolic-link-dl.txt->symbolic-file-dl.txt
1	create	stream-file-keep.txt+Watauga.txt
1	create	shortcut-file-db.txt
1	create	hard-file-db.txt
1	create	symbolic-file-db.txt
1	create	stream-dir.txt
1	link	shortcut-shortcut-db.lnk->shortcut-file-db.txt
1	link	hard-link-db.txt->hard-file-db.txt
1	link	symbolic-link-db.txt->symbolic-file-db.txt
1	create	stream-dir.txt+Nile.txt
2	delete	shortcut-file-db.txt
2	delete	shortcut-file-df.txt
2	delete	shortcut-shortcut-db.lnk
2	delete	shortcut-shortcut-dl.lnk
2	delete	hard-file-db.txt
2	delete	hard-file-df.txt
2	delete	hard-link-db.txt
2	delete	hard-link-dl.txt
2	delete	symbolic-file-db.txt
2	delete	symbolic-file-df.txt
2	delete	symbolic-link-db.txt
2	delete	symbolic-link-dl.txt
2	delete	stream-dir.txt
2	delete	stream-file-df.txt

The **Available Metadata and File Block Summary** gives a one row summary of the file blocks and meta-data available for recovery for a test case.

- Case: The test case identifier.
- Deleted: The number of files created and then deleted.
- Intact/Meta: The number of files with no blocks overwritten and metadata available. All these files should be recoverable.
- Partial/Meta: The number of files with some, but not all, blocks overwritten and metadata available. However, only independently allocated blocks are counted.
- None/Meta: The number of files with all blocks overwritten, but metadata available. For NTFS file systems, blocks from small files may be contained within the MFT and not counted here.
- Intact/None: The number of files with no blocks overwritten and metadata overwritten.
- Partial/None: The number of files with some, but not all, blocks overwritten and metadata overwritten.
- None/None: The number of files with all blocks and metadata overwritten.

Available Metadata and File Block Summary							
Case	**Deleted**	**Intact/Meta**	**Partial/Meta**	**None/meta**	**Intact/None**	**Partial/None**	**None/None**

Available Metadata and File Block Summary							
Case	Deleted	Intact/Meta	Partial/Meta	None/meta	Intact/None	Partial/None	None/None
ext-14	10	4	0	1	0	0	1
fat-14	12	9	0	0	3	0	0
ntfs-14	15	11	0	4	0	0	0

The **Recovered File Analysis Summary** gives a one-row summary of the files recovered for a test case.

- Case: The test case identifier.
- Del: The number of deleted files. The notation k/j means k files created in j directories.
- Rec: The number of files recovered by the tool. This should be at least as many as the **Intact/Meta** value from the table above.
- SS: The number of deleted files that contributed blocks to the recovered files. This will be discussed below when we have more data from the example.
- First: The number of recovered files that contain the first block of the deleted file.
- Full: The number of recovered files that are complete and accurate with no extra blocks.
- Match: The number of recovered files with a correctly matching name.
- Sigma: The number of recovered files with a recovered name that matches except for the first character. This is an artifact of some deleted files on FAT file systems where the Greek ISO representation of the letter sigma (σ) replaces the first character of the file name to indicate a deleted file.
- Multi: The number of files with blocks from two or more deleted files. In other words, files with blocks of data from different files recovered together into one recovered file.
- Other: The number of files recovered with unrecognized data blocks. This is usually the case when a file is partially overwritten with file system metadata.
- Active: The number of recovered files that include data blocks from active (not deleted) files.
- Seq: The number of recovered files with data blocks out of sequence.
- Over: The number of files that are overwritten in the test case.
- Ovf: The number of files that the tool reports as overwritten.

Recovered File Analysis Summary													
Case	Del	Rec	SS	First	Full	Match	Sigma	Multi	Other	Active	Seq	Over	Ovf
ext-14	10	10	2	2	2	0	0	0	0	8	0	2	0
fat-14	12	12	6	6	6	6	0	0	6	0	0	0	0
ntfs-14	15	12	8	8	8	7	0	2	2	2	0	4	0

Content Analysis									
Case	Content	Name	First	Blocks	Tail	Src	Shift	Seq	Other
dfr-ext-14	Elvashak-target-local-rmBoth-X4	Elvashak-target-local-rmBoth-X4	1	7	0	1	0	0	0
	Elvashak-target-remote-rmBoth-X4	Elvashak-target-remote-rmBoth-X4	1	7	0	1	0	0	0
	Capella-target-local-rmBoth-X4.txt	FileinInode#16	1	7	0	1	0	0	0
	Capella-target-remote-rmBoth-X4.txt	FileinInode#17	1	7	0	1	0	0	0
	Mintaka-target-local-rmTarget-X4.txt	FileinInode#18	1	7	0	1	0	0	0

Content Analysis									
Case	Content	Name	First	Blocks	Tail	Src	Shift	Seq	Other
	Mintaka-target-remote-rmTarget-X4.txt	FileinInode#19	1	7	0	1	0	0	0
	Mimosa-target-local-rmBoth-X4.txt	FileinInode#24	1	7	0	1	0	0	0
	Mimosa-target-remote-rmBoth-X4.txt	FileinInode#25	1	7	0	1	0	0	0
	Regulas-target-local-rmTarget-X4	Regulas-target-local-rmTarget-X4	1	7	0	1	0	0	0
	Regulas-target-remote-rmTarget-X4	Regulas-target-remote-rmTarget-X4	1	7	0	1	0	0	0
dfr-fat-14	fat12-file-db.txt	fat12-file-db.txt	1	7	0	1	0	0	0
	fat12-file-df.txt	fat12-file-df.txt	1	7	0	1	0	0	0
	Unknown	fat12-shortcut-db.lnk	0	0	0	1	0	0	1
	Unknown	fat12-shortcut-dl.lnk	0	0	0	1	0	0	1
	fat16-file-db.txt	fat16-file-db.txt	1	7	0	1	0	0	0
	fat16-file-df.txt	fat16-file-df.txt	1	7	0	1	0	0	0
	Unknown	fat16-shortcut-db.lnk	0	0	0	1	0	0	1
	Unknown	fat16-shortcut-dl.lnk	0	0	0	1	0	0	1
	fat32-file-db.txt	fat32-file-db.txt	1	7	0	1	0	0	0
	fat32-file-df.txt	fat32-file-df.txt	1	7	0	1	0	0	0
	Unknown	fat32-shortcut-db.lnk	0	0	0	1	0	0	1
	Unknown	fat32-shortcut-dl.lnk	0	0	0	1	0	0	1
dfr-ntfs-14	Nile.txt	Nile.txt	1	7	0	1	0	0	0
	Volga.txt	Volga.txt	1	7	0	1	0	0	0
	hard-file-db.txt	hard-link-db.txt	1	7	0	1	0	0	0
	shortcut-file-db.txt	shortcut-file-db.txt	1	7	0	1	0	0	0
	shortcut-file-df.txt	shortcut-file-df.txt	1	7	0	1	0	0	0
	Unknown	shortcut-shortcut-db.lnk	0	0	0	1	0	0	1
	Unknown	shortcut-shortcut-dl.lnk	0	0	0	1	0	0	1
	stream-file-df.txt	stream-file-df.txt	1	7	0	1	0	0	0
	symbolic-file-db.txt	symbolic-file-db.txt	1	7	0	1	0	0	0
	symbolic-file-df.txt	symbolic-file-df.txt	1	7	0	1	0	0	0
	Unknown	symbolic-link-db.txt	0	0	0	0	0	0	0
	Unknown	symbolic-link-dl.txt	0	0	0	0	0	0	0

Each row of the **Recovered File Content Block Details** table describes the source of recovered file content.

- Case: The test case identifier. The field is left blank after the first file for the remaining files of the test case.
- Name: The name of the recovered object.
- Recovered Content: A list of data sources included in the recovered object. Each entry is accompanied with the number of blocks included in the recovered object and the size of the source object. The recovered object

Recovered File Content Block Details		
Case	Name	Recovered Content
dfr-ext-14	Elvashak-target-local-rmBoth-X4	Elvashak-target-local-rmBoth-X4(8 is active)
	Elvashak-target-remote-rmBoth-X4	Elvashak-target-remote-rmBoth-X4(8 is active)
	FileinInode#16	Capella-target-local-rmBoth-X4.txt(8 of 8)
	FileinInode#17	Capella-target-remote-rmBoth-X4.txt(8 of 8)
	FileinInode#18	Mintaka-target-local-rmTarget-X4.txt(8 is active)
	FileinInode#19	Mintaka-target-remote-rmTarget-X4.txt(8 is active)
	FileinInode#24	Mimosa-target-local-rmBoth-X4.txt(8 is active)
	FileinInode#25	Mimosa-target-remote-rmBoth-X4.txt(8 is active)
	Regulas-target-local-rmTarget-X4	Regulas-target-local-rmTarget-X4(8 is active)

Recovered File Content Block Details		
Case	**Name**	**Recovered Content**
	Regulas-target-remote-rmTarget-X4	Regulas-target-remote-rmTarget-X4(8 is active)
dfr-fat-14	fat12-file-db.txt	fat12-file-db.txt(8 of 8)
	fat12-file-df.txt	fat12-file-df.txt(8 of 8)
	fat12-shortcut-db.lnk	other(1)
	fat12-shortcut-dl.lnk	other(1)
	fat16-file-db.txt	fat16-file-db.txt(8 of 8)
	fat16-file-df.txt	fat16-file-df.txt(8 of 8)
	fat16-shortcut-db.lnk	other(1)
	fat16-shortcut-dl.lnk	other(1)
	fat32-file-db.txt	fat32-file-db.txt(8 of 8)
	fat32-file-df.txt	fat32-file-df.txt(8 of 8)
	fat32-shortcut-db.lnk	other(1)
	fat32-shortcut-dl.lnk	other(1)
dfr-ntfs-14	Nile.txt	Nile.txt(8 of 8)
	Volga.txt	Volga.txt(8 of 8)
	hard-link-db.txt	hard-file-db.txt(8 of 8)
	shortcut-file-db.txt	shortcut-file-db.txt(8 of 8)
	shortcut-file-df.txt	shortcut-file-df.txt(8 of 8)
	shortcut-shortcut-db.lnk	other(1)
	shortcut-shortcut-dl.lnk	other(1)
	stream-file-df.txt	stream-file-df.txt(8 of 8)
	symbolic-file-db.txt	symbolic-file-db.txt(8 of 8)
	symbolic-file-df.txt	symbolic-file-df.txt(8 of 8)
	symbolic-link-db.txt	
	symbolic-link-dl.txt	

4.13 Mac File Systems HFS+ File Recovery

No files were recovered from HFS+ file systems. The tool was able to list all active files and directories.

4.14 Listing Active Files

The **Active Files and Folders Listed** table summarizes by file system the active files and folders listed by the tested tool.

- Case: The test case identifier.
- Files Active: The number of active files.
- Files Listed: The number of files that the tested tool listed. This should match the value in the Files Active column.
- Folders Active: The number of active folders (directories).
- Folders Listed: The number of folders (directories) that the tested tool listed. This should match the value in the Folders Active column.

Active Files and Folders Listed				
Case	**Files Active**	**Files Listed**	**Folders Active**	**Folders Listed**
dfr-ext-16	3066	3066	27	27
dfr-ext-17	135	135	135	135
dfr-fat-16	3066	3066	27	27
dfr-fat-17	135	135	135	135
dfr-ntfs-16	1022	1022	9	9
dfr-ntfs-17	45	45	45	45
dfr-xfat-16	1022	1022	9	9
dfr-xfat-17	45	45	45	45

The **Active Files and Folders Omitted from Listing** table by test case the active files and folders not listed by the tested tool.

- Case: The test case identifier.
- Diffs: The number of omitted files and folders along with the names of the first few omitted items.

Active Files and Folders Omitted from Listing	
Case	Diffs
dfr-ext-16	0 Files
dfr-ext-17	0 Files
dfr-fat-16	0 Files
dfr-fat-17	0 Files
dfr-ntfs-16	0 Files
dfr-ntfs-17	0 Files
dfr-xfat-16	0 Files
dfr-xfat-17	0 Files