Forensic study of YAFFS2 filesystem

(Study)

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Chapter 1 : Understanding the YAFFS2 Filesystem

In the world of embedded systems and mobile devices, data storage must be reliable, efficient, and adaptable to hardware constraints. The YAFFS2 (Yet Another Flash File System version 2) filesystem emerged as a response to the unique challenges posed by NAND flash memory — a common non-volatile storage medium in many embedded platforms.

1.1 History of YAFFS and YAFFS2

YAFFS was initially developed in 2002 by Charles Manning of Aleph One Ltd, specifically designed to work with NAND flash memory.

> ***NAND Flash*** *is a high-density, block-based, non-volatile memory used primarily for data storage. It's efficient and inexpensive, but requires careful management due to block erasure limits, bad blocks, and write constraints — challenges that YAFFS2 handles through its flash-aware architecture.*

While other filesystems at the time, such as JFFS and JFFS2, were aimed at NOR flash, they did not handle the characteristics of NAND well — especially its susceptibility to bit errors, bad blocks, and the need for wear leveling.

YAFFS introduced a fresh approach by managing NAND-specific features natively, providing better performance and reliability for embedded applications. As NAND technology evolved, larger page sizes and out-of-band (OOB) data requirements became more prevalent. To support these changes, YAFFS2 was introduced.

YAFFS2 extended the original design with:

- Support for larger page sizes (e.g., 2KB, 4KB)
- Checkpointing to reduce mount time
- Efficient handling of metadata and deleted files
- Versioning and object-based data representation

Unlike traditional file systems, YAFFS2 directly interfaces with the raw flash device, using its own wear leveling, error handling, and garbage collection algorithms.

1.2 Uses and Applications

YAFFS2 has seen widespread adoption in a range of embedded and mobile devices, particularly in the early days of smartphones and IoT systems. Its key advantages — low overhead, simplicity, and robustness — made it a preferred choice for:

- **Android devices (pre-ext4 era)**
  Many early Android phones used YAFFS2 before transitioning to ext4 and F2FS.
- **Routers and network appliances**
  Devices like OpenWrt-based routers often use YAFFS2 to store firmware and configurations.
- **Industrial control systems**
  Robust and minimalistic, YAFFS2 fits the needs of devices with tight memory and performance constraints.
- **Custom embedded Linux platforms**
  Developers can integrate YAFFS2 into their kernel to take full control over how data is stored and managed on NAND.

Despite newer filesystems gaining popularity, YAFFS2 remains relevant in scenarios where direct flash access, full control over wear and error handling, and minimal dependencies are crucial.

Chapter 2 : The Philosophy and Core Principles of YAFFS2

YAFFS2 is more than just a filesystem adapted to NAND flash — it embodies a design philosophy built around simplicity, efficiency, and robustness, tailored specifically for the limitations and strengths of raw NAND memory. Understanding its core principles is key to grasping both its behavior and the forensic challenges it presents.

2.1 Designed for NAND, Not Adapted to It

Unlike filesystems retrofitted to work on flash storage, YAFFS2 was designed from the ground up for NAND flash. NAND has characteristics that make it fundamentally different from block devices like hard drives or SSDs, including:

- **No random write access** — data must be written in pages and erased in blocks.
- **Presence of bad blocks** — NAND flash can have faulty sectors from the factory.
- **Bit errors over time** — requiring error correction (ECC) mechanisms.
- **Finite write/erase cycles** — making wear leveling critical.

YAFFS2 acknowledges these constraints and builds a structure that embraces them rather than hiding them.

2.2 Object-Based Storage Model

YAFFS2 uses an object-based model, where every file, directory, symlink, or special node is represented as an object with a unique ID. This structure is flat and simple:

- Each object is associated with a header chunk (metadata)
- Data is stored in data chunks, numbered sequentially
- Chunks are written append-only — changes result in new chunks, not overwrites

This model makes versioning, recovery, and forensic analysis inherently more feasible compared to traditional filesystems that overwrite data.

2.3 Append-Only Write Strategy

To mitigate flash wear and avoid complex metadata rewrites, YAFFS2 uses an append-only strategy:

- New data or metadata is always written to a new location
- Old chunks are marked obsolete and cleaned later by garbage collection
- This approach prevents in-place updates and reduces the risk of corruption during power failures

This also means deleted or previous versions of files often remain accessible on the flash until cleaned, a key opportunity for forensic recovery.

2.4 No Reliance on Traditional File Allocation Tables

YAFFS2 does not maintain a central file allocation table. Instead, it reconstructs the file structure during mounting by scanning the flash for object headers and data chunks. To improve boot speed, it optionally uses a checkpointing mechanism to store a snapshot of the state.

This decentralization:

- Reduces corruption risks
- Simplifies recovery from partial writes
- Makes it easier to analyze the structure at a low level

2.5 Minimal Dependencies, Maximum Portability

YAFFS2 is written in clean, portable C and does not depend on a specific kernel interface beyond what's needed to talk to MTD (Memory Technology Device) layers. This makes it:

- Lightweight enough for constrained embedded systems

- Portable across architectures and Linux kernel versions
- Open to customization for specific hardware or reliability needs

2.6 Resume

YAFFS2's philosophy reflects a deep understanding of raw NAND flash — it does not attempt to hide its nature but instead builds a system that respects and leverages it. Its object-based model, append-only writes, and simplicity result in a filesystem that is both efficient in embedded contexts and rich in recoverable forensic data. These characteristics form the foundation upon which specialized tools, such as the one presented in this project, can operate effectively.

Chapter 3 : Core Concepts of the YAFFS2 Filesystem

YAFFS2 (Yet Another Flash File System 2) is tailored for NAND flash memory and relies on a simple, robust structure built from low-level units. Understanding these building blocks is essential for analyzing or recovering data from YAFFS2 images.

3.1 What is a Page ?

A page is the smallest writable unit in NAND flash memory. In YAFFS2, a page consists of:

- Main Data Area: where user or metadata content is stored (e.g., 2048 or 4096 bytes).
- Spare Area / Out-of-Band (OOB): additional bytes (e.g., 64 or 128 bytes) used for metadata, error correction codes (ECC), and YAFFS-specific tags.

Example: A typical page might be 2048 bytes + 64 bytes OOB.

3.2 What is a Chunk ?

In YAFFS2 terminology, a chunk is essentially a page of NAND, including both the data and the OOB part.
Each chunk serves a specific purpose:

- It contains either metadata (about a file or directory)
- Or it contains actual file data

Chunks are append-only and written sequentially.

3.2.1 Data Part of a Chunk

The data part (main area) of a chunk:
Can contain file content (raw bytes)
Or, in the case of object headers, it contains a YAFFS Object Header structure, which includes:

- Object type (file, dir, symlink, etc.)
- Object ID
- Parent ID
- File name
- File size (for files)
- Permissions and types
- Timestamps

This metadata is critical for reconstructing the filesystem hierarchy during mount or analysis.

3.2.2 OOB Part of a Chunk (Tags / Spare Area)

The Out-of-Band (OOB) area contains YAFFS tags, which provide crucial management metadata. These fields

may include:

- Chunk ID: data chunk number within a file (starts at 0)
- Object ID: links the chunk to a specific file or directory
- Sequence number: helps determine write order (important for versioning)
- Validity flags
- ECC or error correction codes (used by the NAND controller or YAFFS itself)

YAFFS stores enough metadata in this area to allow :

- Efficient mounting (checkpointing)
- Detection of deleted or stale chunks
- Recovery from partial writes or power loss

3.3 What is an Erase block ?

The Erase block is the smallest unit of memory that can be erased at once on NAND flash.

In contrast:

A page (or chunk) is the smallest unit you can read or write.

But you cannot erase individual pages — you must erase a whole block of pages at once.

Typical values :

Page_Size	OOB_Size	Erase_Block	Total Pages per Block	
2048 bytes	64 bytes	128 pages	128	← I will use this one
4096 bytes	128 bytes	64 pages	64	

So, a typical NAND block might be:

2048 B/page × 128 pages = 256 KB per erase block

The Erase block matters for the Garbage Collection and Wear.

YAFFS2 must erase entire blocks to reclaim space.

It marks pages as obsolete and eventually erases the whole block during garbage collection.

As a consequence, old data may survive in blocks that haven’t been erased yet.

My forensic tool will scan all pages, including those marked obsolete, because they're only erased in full blocks.

Chapter 4 : Structures

4.1 Structural Organization of YAFFS2

The structural organization depends of NAND characteristics.

We can found :

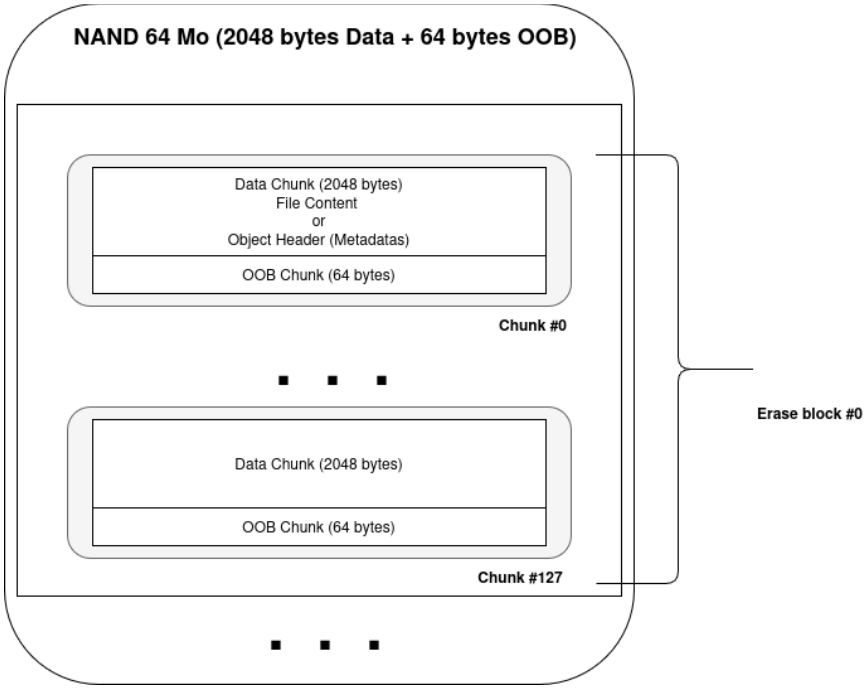
- 2048 bytes page_size and 64 bytes oob_size,
- 4096 bytes page_size and 128 bytes oob_size,
- 512 bytes page_size and 16 bytes oob_size,
- 8192 bytes page_size and 224 bytes oob_size,
- 16384 bytes page_size and 448 bytes oob_size

In this document, I will detail the organization of a YAFFS2 file system with the following characteristics :

- page_size = 2048 bytes
- oob_size = 64 bytes
- erase_block = 128 pages

But the others have exactly the same structure.

Here is the structure :



We clearly find the following concepts:

- Erase block (128 pages in this case),
- Chunk containing:
  - a Data / Metadata section
  - an Out Of Band (OOB or spare — both terms are used) section

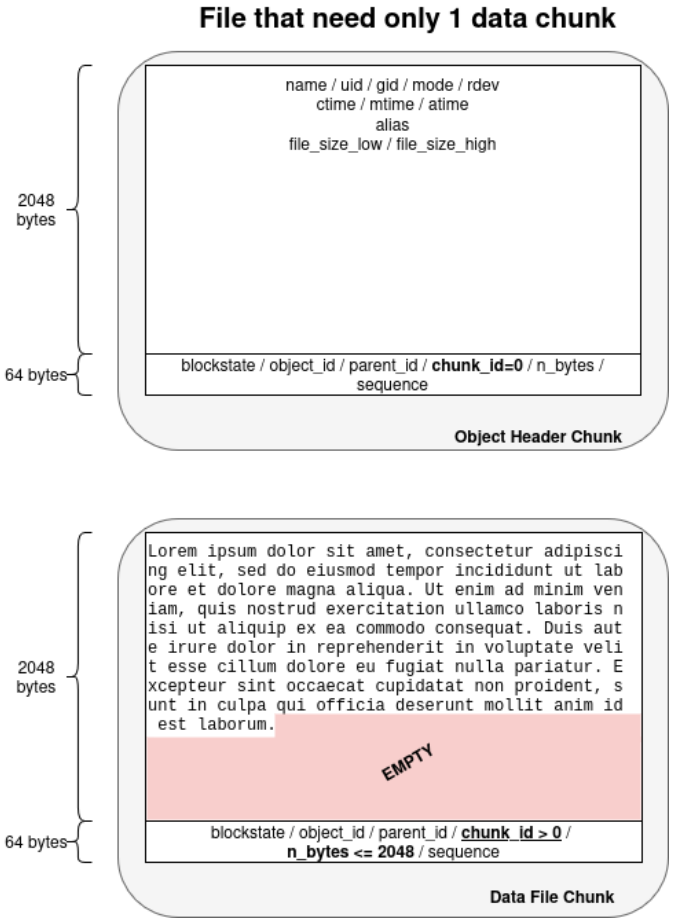
Concerning encoding, the actual on-flash data is almost always stored in little-endian, because:

- YAFFS2 is primarily used on ARM-based embedded systems, which are predominantly little-endian.
- The YAFFS2 reference implementation (from Aleph One) assumes little-endian when writing object headers and chunk metadata.
- Most commercial NAND controllers and MTD subsystems expect little-endian data layouts.

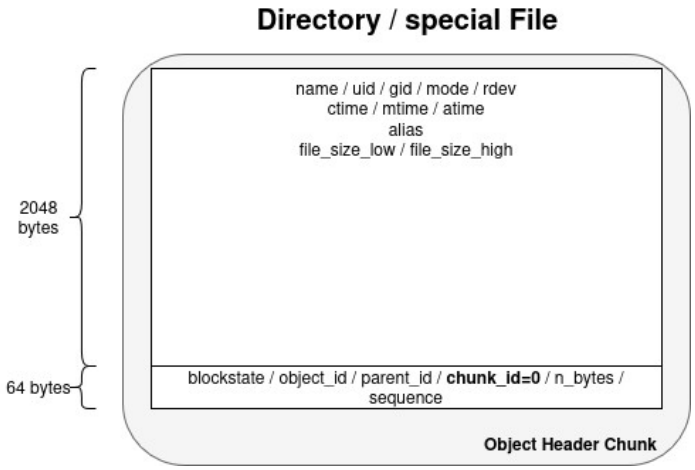
4.2 Detailed Structural Organization

Here are different cases we can encounter in YAFFS2

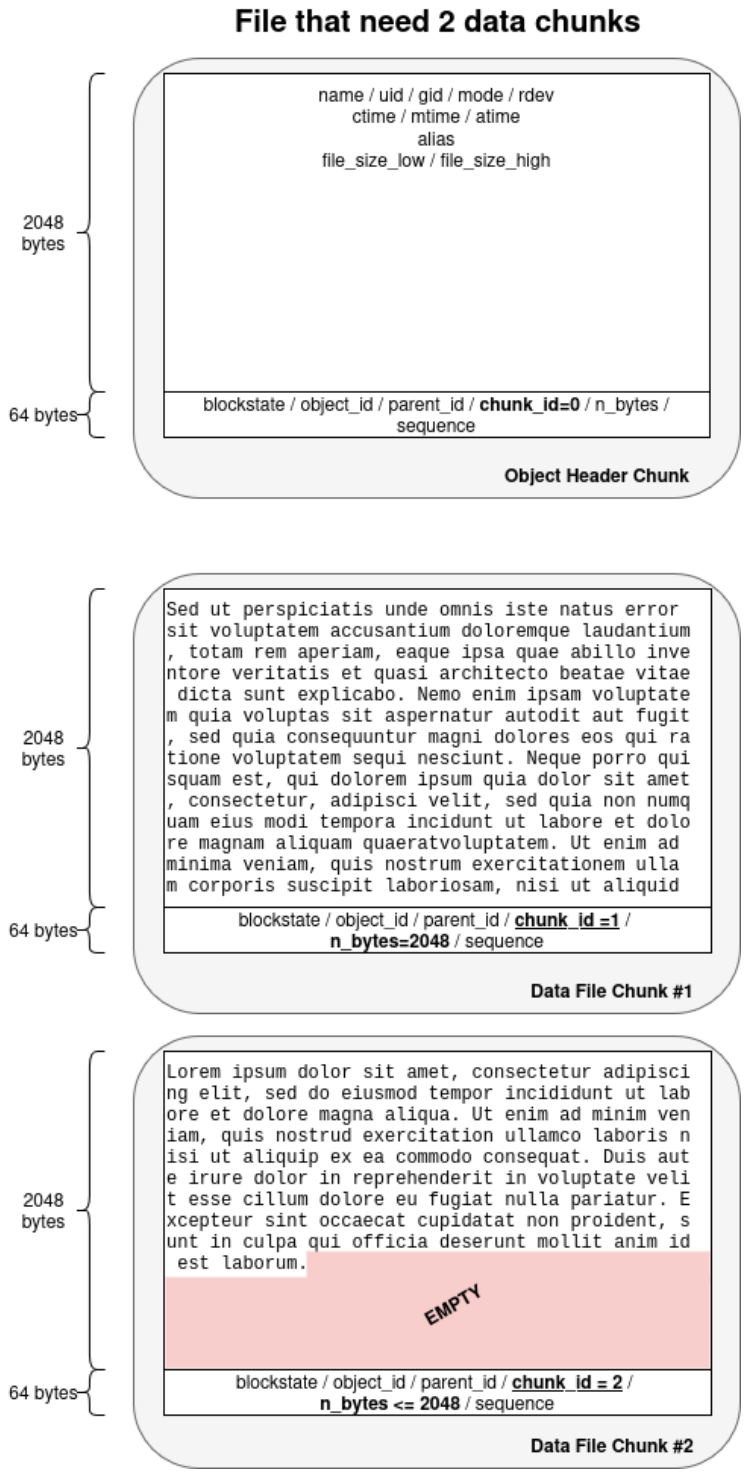
4.2.1 A simple file with size < 2048 bytes (only 1 data chunk is used)



4.2.2 A directory, a special file (e.g bloc device, char device, socket, named pipe, ect.)



4.2.3 A bigger file (almost 2 chunks of data)



There is no documentation that precisely details the positions of the various fields, so I had to consult the YAFFS2 driver source code, specifically the `yaffs_guts.h` file.

4.3 OOB Part

Note: Some fields did not seem particularly relevant to me, so I was able to omit certain ones. However, here is what this block contains:

Field	Position	Length	Description
blockstate	1	1	If this byte is equal to `0xFF`, the chunk is valid. For any other value, the chunk will be marked as unusable.
sequence_number	2	4	This is an incremental number per object_id/chunk_id. Since YAFFS2 does not overwrite an existing block but writes a new one, some blocks may have the same object_id/chunk_id. The sequence_number, which keeps increasing for the same file (object_id), is used to select the most recent version. If multiple blocks share the same object_id/chunk_id, the one with the highest sequence_number should be chosen.
object_id	6	4	This is the ID of each object. An "object" refers to: a directory, or a file, or a special file. This field carries two pieces of information: - The most significant byte (1 byte): 0: 'YAFFS_OBJECT_TYPE_UNKNOWN', 1: 'YAFFS_OBJECT_TYPE_FILE', 2: 'YAFFS_OBJECT_TYPE_SYMLINK', 3: 'YAFFS_OBJECT_TYPE_DIRECTORY', 4: 'YAFFS_OBJECT_TYPE_HARDLINK', 5: 'YAFFS_OBJECT_TYPE_SPECIAL', - The less significant bytes (3 bytes) : the object_id
chunk_id	10	4	This information allows proper re-sequencing of the data chunks within a file. **Note**: chunk_id carries two pieces of information: – If its most significant byte is 8, it indicates that the Data Part contains metadata. In this case, the concept of parent_id is introduced, which equals the chunk_id with its most significant byte removed. – If this byte is 0, then the Data Part contains actual data.
n_bytes	14	2	Number of bytes of data present in the Data Part.

4.4 Data Part

4.4.1 Data Part of type header

There is no special parsing concerning that kind of Data Part, but as it can have less or egal than 2048 bytes, the real size is specified in the n_bytes field in the OOB Part.

Example : if n_bytes = 5 → the data size will be 5

« 12345 » is encoded 0x30 0x31 0x32 0x33 0x34 0x35 0x00 0x00 ….. from the start of the Data Part.

Note : this time the data are encoded in big-endian.

4.4.2 Data Part of type header

Note: Some fields did not seem particularly relevant to me, so I was able to omit certain ones. However, here is what this block contains:

I apply these constants :

- MXNMLN : Max name length = 254 bytes
- MXALLN : Max alias length = 160 bytes

Field	Position	Length	Description
junk0	0	10	/
name	10	MXNMLN	File name
junk1	MXNMLN+10	4	/
yst_mode	MXNMLN+14	4	File mode (permissions + kind of object) e.g. -rwxr-xr-x for a file drwxrwxr-x for a directory lrwxrwxrwx for a symlink brw-rw-rw- for a bloc device crw-rw-rw- for a char device srw------ for a unix socket prw-rw---- for named pipe This field carries 2 pieces of information : - the object type (most significant byte) - the permissions (less significant bytes)
yst_uid	MXNMLN+18	4	Owner uid
yst_gid	MXNMLN+22	4	Group uid
yst_atime	MXNMLN+26	4	Access time (epoch second format)
yst_mtime	MXNMLN+30	4	Modify time (epoch second format)
yst_ctime	MXNMLN+34	4	Create time (epoch second format)
file_size_low	MXNMLN+38	4	Low 32 bits of file size
equiv_id	MXNMLN+42	4	Used for hard links, specifies the object ID of the file to be hardlinked to.
alias	MXNMLN+46	MXALLN	Aliases are for symlinks only
yst_rdev	MXNMLN+MXALLN+46	4	Stuff for block and char devices (equivalent of stat.st_rdev in C)
win_ctime1	MXNMLN+MXALLN+50	4	Appears to be for timestamp stuff for WinCE
win_ctime2	MXNMLN+MXALLN+54	4	Appears to be for timestamp stuff for WinCE
win_atime1	MXNMLN+MXALLN+58	4	Appears to be for timestamp stuff for WinCE
win_atime2	MXNMLN+MXALLN+62	4	Appears to be for timestamp stuff for WinCE
win_mtime1	MXNMLN+MXALLN+66	4	Appears to be for timestamp stuff for WinCE
win_mtime2	MXNMLN+MXALLN+70	4	Appears to be for timestamp stuff for WinCE

inb.shad_obj_id	MXNMLN+MXALLN+74	4	???
inb.is_shrink	MXNMLN+MXALLN+78	4	???
file_size_high	MXNMLN+MXALLN+82	4	High 32 bits of file_size
reserved	MXNMLN+MXALLN+86	1	???
shadows_obj	MXNMLN+MXALLN+87	4	???
is_shrink	MXNMLN+MXALLN+91	4	???

Chapter 5 : Operating Procedure

Now that my environment is set up and operational, and in order to understand how the YAFFS2 file system works, I will proceed as follows:

- Boot the virtual image up to the mounting of /mnt/disk
- Erase the simulated NAND and then flash it using the blank YAFFS2 image
- Mount the /mnt/yaffs partition
- Iterate:
  - perform a single modification on the file system
  - take a snapshot of the entire YAFFS2 partition

Then, knowing what operations had been performed (file creation, move, deletion, truncation, etc.), I analyzed each snapshot.

Moreover, to simulate orphans, (I cannot reproduce that case so I imagine data chunks without metadata) :

- I copy a data chunk with chunk_id=1 and put it in the last two empty chunk of the filesystem,
- I modify the object_id in the last two chunk with 513 and modify chunk_id=1 for the first one and chunk_id=2 for the second.

I've then :

Object ID	Chunk ID	Particularity
513	1	Data = 'test9'
513	2	Data = 'test8'

5.1 How YAFFS2 manage creations

5.1.1 Object creation

Here is a very detailed example that extract and explain all fields.

The example consists of a file creation named 'test1.txt' in the root directory / (object_id=1).

Chunk	Part	Fields (little-endian except ASCII)		Explanation	Description
Chunk #1 **OBJ = 257 CHUNK_ID= 0**	Data	name	test1.txt ...		File « test1.txt » creation
		yst_mode	\xa4 \x81 \x00 \x00	0x**8**1a4 : 0x**8** → it's a file 0x1a4 → (644)o → rw-r--r--	
		yst_uid	\x00 \x00 \x00 \x00	Uid = 0	

		yst_gid	\x00 \x00 \x00 \x00	Gid = 0	
		yst_atime	\x3b \x12 \x37 \x68	0x6837123b → (1748439611)d 28 mai 2025 15:40:11	
		yst_mtime	\x3b \x12 \x37 \x68	0x6837123b → (1748439611)d 28 mai 2025 15:40:11	
		yst_ctime	\x3b \x12 \x37 \x68	0x6837123b → (1748439611)d 28 mai 2025 15:40:11	
		file_size_low	\x00 \x00 \x00 \x00	0 byte	
		alias	\xff	NA	
		yst_rdev	\x00 \x00 \x00 \x00	NA	
		file_size_high	\x00 \x00 \x00 \x00	0x0000 → 0 byte	
	OOB	blockstate	\xff	→ Good Chunk	
		sequence_number	\x01 \x10 \x00 \x00	0x00001001 → (4097)d	
		object_id	\x01 \x01 \x00 \x10	0x**1**0000101 → 0x**1** → the chunk represents a file 0x0000101 → object_id= 257	
		chunk_id	\x01 \x00 \x00 \x80	0x**8**0000001 : 0x**8** → header chunk implies chunk_id=0 0x0000001 → **parent_id=1 → in root directory**	
		n_bytes	\x00 \x00	0x0000 → 0 byte	
Chunk #2 **OBJ = 257 CHUNK_ID= 1**	Data	test1\x00\x00...		Data = « test1 »	Filling « test1.txt » with « test1 » string
	OOB	blockstate	\xff	→ Good Chunk	
		sequence_number	\x01 \x10 \x00 \x00	0x00001001 → (4097)d	
		object_id	\x01 \x01 \x00 \x00	0x**0**0000101 → 0x**0** → the chunk represents data 0x101 → object_id= 257	
		chunk_id	\x01 \x00 \x00 \x00	0x**0**0000001 : 0x**0** → data chunk 0x0000001 → chunk_id=1	
		n_bytes	\x05 \x00	0x0005 → 5 bytes	
Chunk #3 **OBJ = 257 CHUNK_ID= 0**	Data	name	test1.txt ...		Update « test1.txt » metadata
		yst_mode	\xa4 \x81 \x00 \x00	0x**8**1a4 : (0x**8**)h → it's a file (0x1a4)h → (644)o → rw-r--r--	
		yst_uid	\x00 \x00 \x00 \x00	Uid = 0	
		yst_gid	\x00 \x00 \x00 \x00	Gid = 0	
		yst_atime	\x3b \x12 \x37 \x68	0x6837123b → (1748439611)d 28 mai 2025 15:40:11	
		yst_mtime	\x3b \x12 \x37 \x68	0x6837123b → (1748439611)d 28 mai 2025 15:40:11	
		yst_ctime	\x3b \x12 \x37 \x68	0x6837123b → (1748439611)d 28 mai 2025 15:40:11	
		file_size_low	\x05 \x00 \x00 \x00	0x00000005 → 5 bytes	
		alias	\xff	NA	
		yst_rdev	\x00 \x00 \x00 \x00	NA	
		file_size_high	\x00 \x00 \x00 \x00	0x00000000 → 0 byte	
	OOB	blockstate	\xff	→ Good Chunk	
		sequence_number	\x01 \x10 \x00 \x00	0x00001001 : (4097)d	
		object_id	\x01 \x01 \x00 \x10	0x**1**0000101 → 0x**1** → the chunk represents a file	

			0x0000101 → object_id= 257	
		chunk_id \x01 \x00 \x00 \x80	0x**8**0000001 : 0x**8** → header chunk 0x0000001 → chunk_id=1	
		n_bytes \x50 \x00	0x0005 → 5 bytes	
Chunk #4 **OBJ = 1** **CHUNK_ID= 0**	Data	name		Update parent directory = root directory /
		yst_mode \xed \x41 \x00 \x00	0x**4**1ed : (0x**4**)h → it's a directory (0x1ed)h → (755)o → rwxr-xr-x	
		yst_uid \x00 \x00 \x00 \x00	Uid = 0	
		yst_gid \x00 \x00 \x00 \x00	Gid = 0	
		yst_atime \x32 \x12 \x37 \x68	0x68371232 → (1748439602)d 28 mai 2025 15:40:02	
		yst_mtime \x3b \x12 \x37 \x68	0x6837123b → (1748439611)d 28 mai 2025 15:40:11	
		yst_ctime \x3b \x12 \x37 \x68	0x6837123b → (1748439611)d 28 mai 2025 15:40:11	
		file_size_low \xff \xff \xff \xff	0xffffffff → NA bytes	
		alias \xff	NA	
		yst_rdev \x00 \x00 \x00 \x00	NA	
		file_size_high \xff \xff \xff \xff	0xffffffff → NA byte	
	OOB	blockstate \xff	→ Good Chunk	
		sequence_number \x01 \x10 \x00 \x00	0x00001001 : (4097)d	
		object_id \x01 \x00 \x00 \x30	0x**3**0000001 → 0x**3** → the chunk represents a directory 0x0000001 → object_id= 1	
		chunk_id \x00 \x00 \x00 \x80	0x**8**0000000 : 0x**8** → header chunk 0x0000000 → chunk_id=0	
		n_bytes \x00 \x00	0x0000 → 0 byte	

Resume:

Object ID	Chunk ID	Particularity	Description
257	0	uid / gid / mode / rdev / atime / mtime / ctime / size = 0 / parent_id	Empty file creation
257	1		File filling
257	0	File size = 5	Update file metadata
1 *(reserved)*	0	Update mtime and ctime	Update parent Directory

Note #1 : as you can see, `object_id` carries 2 pieces of information :

- most significant byte → object type (1:File, 2:Symlink, 3:Directory, 4:Hardlink, 5:Special)
- less significant bytes → `object_id`

Note #2 : the field named `chunk_id` carries 2 pieces of information :

- most significant byte → chunk type (0x8 : Header Chunk / 0x0 : Data Chunk)
  - if « Header Chunk », that means that the data chunk contains metadata
  - if « Data Chunk », that means that the data chunk contains only data.
- less significant bytes → `chunk_id` in case of Data Chunk / `parent_id` in case of Header Chunk

Note #3 : The field named yst_mode carries 2 pieces of information :

- most significant byte → the file type (1: Regular File, 2: Symlink, 3:Directory, 4:Hardlink, 5: Char device, 6: Block device, 7:Named pipe, 8: Socket)
- less significant bytes → the permissions (owner:rwx / group:rwx / other:rwx)

5.1.2 Directory creation

Suppose we have the creation of the new directory dir3 like that : /..../dir2/dir3
We will have new chunk filled as this :

Object ID	Chunk ID	Particularity	Description
dir3 obj_id	0	uid / gid / mode / rdev / atime / mtime / ctime / size = 0 / parent_id	“dir3” creation
parent obj_id	0	Update mtime and ctime	Update dir2
...	0	Update mtime and ctime	...
1	0	Update mtime and ctime	Update root Directory

5.1.3 Link creation

YAFFS created a link exactly as it creates an empty file : everythink is the same, except that “alias” field contains the reference (in string) to the target file.

5.1.4 Special file creation

YAFFS works exactly the same as a “normal” file creation. The only difference occurs in the “yst_rdev” field.

5.2 How YAFFS2 manage modifications

5.2.1 Object renaming

We will have new chunk filled as this :

Object ID	Chunk ID	Particularity	Description
file obj_id	0	Name → new_name	Update file metadata
parent obj_id	0	Update mtime and ctime	Update parent obj_id
...	0	Update mtime and ctime	...
1	0	Update mtime and ctime	Update root Directory /

We found this procedure for every kind of object (file, directory, special file).

Note : in the NAND, it already exists chunk with same `object_id` and `chunk_id`, but when YAFFS create new chunk, it takes care to create `sequence_number` higher.
This mechanism make old chunk obsolete.

5.2.2 File truncate

We may have new chunks. “May have” because, when a file is composed of N data chunks, only the last one concerned by the truncation is re-created with correct data and correct size.

Object ID	Chunk ID	Particularity	Description
file obj_id	>last_one<	New data	Update last file data chunk
file obj_id	0	Update file size, ctime, mtime	Update file metadata
parent obj_id	0	Update mtime and ctime	Update parent obj_id
...	0	Update mtime and ctime	...
1	0	Update mtime and ctime	Update root Directory /

Note : In the NAND, it already exists chunk with same object_id and chunk_id, but when YAFFS create new chunk, it takes care to create sequence_number higher.

This mechanism make old chunk obsolete, so reusable by the garbage collector (concept not detailed in that document).

5.3 How YAFFS2 manage deletions

Remember the file creation an filling :

Object ID	Chunk ID	Particularity	Description
257	0	uid / gid / mode / rdev / atime / mtime / ctime / size = 0 / parent_id	Empty file creation
257	1		File filling
257	0	File size = 5	Update file metadata
parent obj_id	0	Update mtime and ctime	Update parent Directory
...	0	Update mtime and ctime	...
1	0	Update mtime and ctime	Update parent Directory

When this object is deleted, we have new chunks used and filled with :

Object ID	Chunk ID	Particularity	Description
257	0	Name = ‘**unlinked**’, file_size = 0, parent_id = **3** (unlinked)	Update file metadata
257	0	Name = ‘**deleted**’, file_size = 0, parent_id = **4** (deleted)	Update file metadata
parent obj_id	0	Update mtime and ctime	Update parent Directory
...	0	Update mtime and ctime	...
1	0	Update mtime and ctime	Update parent Directory

Note : Here are special parent Id :

- 1: 'YAFFS_OBJECTID_ROOT',
- 2: 'YAFFS_OBJECTID_LOSTNFOUND',
- 3: 'YAFFS_OBJECTID_UNLINKED',
- 4: 'YAFFS_OBJECTID_DELETED',

During deletion, the file name the parent_id and the timestamps where changed.
First, the file is renamed in ‘unlinked’ and associated to reserved object_id 3.
Then, the file is renamed in ‘deleted’ and associated to reserved object_id 4.

Chapter 6 : Forensic tool

As we have seen, the philosophy of YAFFS2 is to write on new chunk every time there is anything modified on the filesystem.
I can take advantage of that paradigm to restore, and version even deleted objects.
My forensic tool must have several goals :

1. list almost all objects in a YAFFS filesystem (even renamed, truncated, deleted, and orphans),
2. restore all of the above objects as much as possible,
3. forensic analyze chunks (Data Part and Oob Part),

Furthermore, it needs to have the ability to manage :

- different page_size and oob_size and encoding (little / big endian) → if I can auto-detect those parameters, it will be best
- fine selection object_id :
  - either with a exhaustive list,
  - and/or a range,
- fine selection version_id :
  - either with a exhaustive list,
  - and/or a range,
- a timestamp to restore the filesystem as it was at this time,
- restore owners (root user only),
- restore permissions (root user only),
- a directory in which the restoration will put objects,
- several debug levels (0: normal, 1:base, 2:verbose)

Here is the program help

```
usage: yaffs2_parser.py [-h] --image IMAGE [--obj_ids OBJ_IDS [OBJ_IDS …]]
                                           [--obj_id_from OBJ_ID_FROM]
                                           [--obj_id_to OBJ_ID_TO]
                                           [--snapshot SNAPSHOT]
                                           [--name NAME]
                                           [--versions VERSIONS [VERSIONS …]]
                                           [--version_from VERSION_FROM]
                                           [--version_to VERSION_TO]
                                           [--outdir OUTDIR]
                                           [--debug {0,1,2}]
                                           [--last_only]
                                           [--wide]
                                           [--autodetect]
                                           [--autodetect_only]
                                           [--pagesize PAGESIZE]
                                           [--oobsize OOBSIZE]
                                           [--endianness {big,little}]
                                           [--restore_owner]
                                           [--restore_right]
                                           [--remove_path REMOVE_PATH]
```

```
This program is part of my Forensic project
It tries to forensic a YAFFS2 partition and tries to restore as much as possible
  --> even deleted and orphans (data chunk without metadata)
*** If you want to restore blockdevice / chardevice or --restore_owner, run me as root ***

options:
  -h, --help            show this help message and exit
  --image IMAGE         YAFFS2 image to process/analyze
  --obj_ids OBJ_IDS [OBJ_IDS ...]
                        Object_id (list) to retain
  --obj_id_from OBJ_ID_FROM
                        Minimum Object_id to retain
  --obj_id_to OBJ_ID_TO
                        Maximum Object_id to retain
  --snapshot SNAPSHOT   Reconstruct the NAND state at this timestamp (format 'YYYY-MM-DD hh:mm:ss')
  --name NAME           Retain only the file specified
  --versions VERSIONS [VERSIONS ...]
                        Versions (list) to retain
  --version_from VERSION_FROM
                        Minimum Version number to retain
  --version_to VERSION_TO
                        Maximum Version number to retain
  --outdir OUTDIR       Output Directory : if set, restoration will be done / *** for [block|char]devices
requires to be root ***
  --debug {0,1,2}       Debug level : 0 (none), 1 (base), 2 (detailed)
  --last_only           If activated, process only the last file version. The restored files will not contain
object_id and version
  --wide                If activated, wide print (much more informations)
  --autodetect          If activated, auto-detecting pagesize / oobsize / [littel|big]-endian
  --autodetect_only     If activated, auto-detecting pagesize / oobsize / [littel|big]-endian and stop !
  --pagesize PAGESIZE   Pagesize in bytes
  --oobsize OOBSIZE     OOB size in bytes
  --endianness {big,little}
                        Little (default) or big endian
  --restore_owner       If activated, restore owners *** requires to be root ***
  --restore_right       If activated, restore rights
  --remove_path REMOVE_PATH
                        Only for absolute symlink : remove base path
                        e.g. if you have dir1/dir2/dir3/link1 --> /mnt/yaffs/test1.txt
                        --remove_path /mnt/yaffs will remove that string
                        in the targer dir1/dir2/dir3/link1 --> test1.txt
                        then using –outdir /tmp/toto will restore
                        /tmp/toto/dir1/dir2/dir3/link1 --> /tmp/toto/test1.txt

-------------------------------------------------------------------------------------------------------------
-------------
Program    : yaffs2_parser.py
Author     : Hashment
Date       : 30/05/2025

This program can :
   - automatically detect the structure pagesize/oobsize : [(2048, 64), (4096, 128), (512, 16), (8192, 224),
(16384, 448)]
   - show all objects **even deleted** present in the YAFFS2 image such as :
       o files        <--
       o directories  <--
       o symlinks     <--
       o block devices<--
       o unix socket      (shown but not restorable)
   - ultra detailed output (permissions, size, timestamps ctime, atime, mtime)
   - fine select YAFFS2 objects by object_ids, versions (list and/or from-to)
   - fine select YAFFS2 objects by name
   - fine select YAFFS2 objects by timestamp snapshot

Restoration :
```

```
   - everything is restorable (except unix soket) in a specified out directory mentionned with --outdir
   - orphan data is restorable : it represents data chunks without metadata (e.g. name, size, timestamps,
owner ect.)

Debug :
   - very fine debug the YAFFS2 structure (CHUNKS, data_part, oob_part, fields, etc ...)
       -> do not forget to activate --debug 2 for that
       -> do not forget to store output to a debug file or pipe to 'less' or 'more'
```

6.1 List all objects (even renamed, truncated, deleted)

I've proceeded a complex scenario in which I create, move, delete truncate file and directories :

```
[   14.391648] ====[ Mounting /dev/mtdblock1 on /mnt/yaffs ]====
[   14.405895] ====[ Dumping initial on /dev/mtd1 ]====
[   15.134698] ====[ Creating /file1.txt in / ]====
[   20.917990] ====[ Creating chained directories /dir1/dir2/dir3 ]====
[   26.708773] ====[ Creating link /dir1/dir2/dir3/link1 -> ../../../test1.txt ]====
[   32.508219] ====[ Creating named pipe /dir1/dir2/named_pipe ]====
[   38.318230] ====[ Creating block device /dir1/block_device ]====
[   44.111376] ====[ Creating unix socket /dir6/aSocket.sock ]====
[   49.943995] ====[ Moving directory /dir1/dir4/dir5 in /dir1/dir2 ]====
[   55.739753] ====[ Deleting /dir1/dir2/dir5 ]====
[   61.520354] ====[ Renaming /dir1/dir4 in /dir1/dir41 ]====
[   67.313454] ====[ Creating /file2.txt in /dir1/dir41 ]====
[   73.114283] ====[ Creating /dir1/lorem.txt ]====
[   78.919710] ====[ Truncating /dir1/lorem.txt ]====
[   84.725678] ====[ Fin ]====
```

The purpose is to retrieve everything before deletion, rename or truncation.

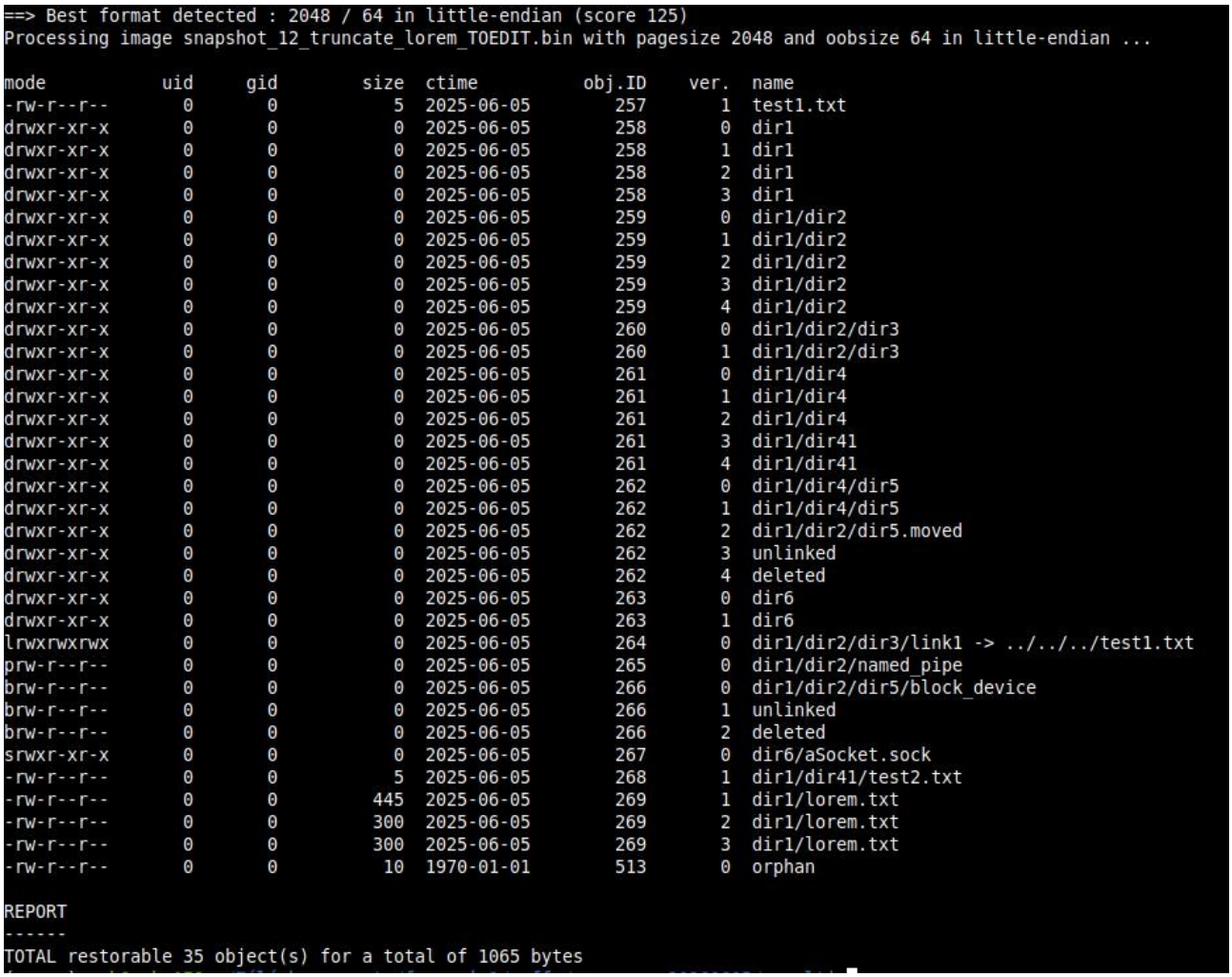
Here is the file tree at the end of these operations :

```
# ls -lR
.:
total 7
drwxr-xr-x    1 0        0             2048 Jun  5 13:26 dir1
drwxr-xr-x    1 0        0             2048 Jun  5 13:26 dir6
drwx------    1 0        0             2048 Jun  5 13:25 lost+found
-rw-r--r--    1 0        0                5 Jun  5 13:25 test1.txt

./dir1:
total 5
drwxr-xr-x    1 0        0             2048 Jun  5 13:26 dir2
drwxr-xr-x    1 0        0             2048 Jun  5 13:26 dir41
-rw-r--r--    1 0        0              300 Jun  5 13:26 lorem.txt

./dir1/dir2:
total 4
drwxr-xr-x    1 0        0             2048 Jun  5 13:25 dir3
prw-r--r--    1 0        0             2048 Jun  5 13:25 named_pipe

./dir1/dir2/dir3:
total 1
lrwxrwxrwx    1 0        0               18 Jun  5 13:25 link1 -> ../../../test1.txt

./dir1/dir41:
total 1
-rw-r--r--    1 0        0                5 Jun  5 13:26 test2.txt

./dir6:
total 2
```

```
srwxr-xr-x    1 0        0            2048 Jun  5 13:26 aSocket.sock

./lost+found:
total 0
```

When I run my forensic program with --autodetect, it shows :

```
$ python yaffs2_parser.py --image snapshot_12_truncate_lorem.bin –autodetect
```



```
==> Best format detected : 2048 / 64 in little-endian (score 125)
Processing image snapshot_12_truncate_lorem_TOEDIT.bin with pagesize 2048 and oobsize 64 in little-endian ...

mode          uid     gid        size  ctime          obj.ID    ver.  name
-rw-r--r--      0       0           5  2025-06-05        257       1  test1.txt
drwxr-xr-x      0       0           0  2025-06-05        258       0  dir1
drwxr-xr-x      0       0           0  2025-06-05        258       1  dir1
drwxr-xr-x      0       0           0  2025-06-05        258       2  dir1
drwxr-xr-x      0       0           0  2025-06-05        258       3  dir1
drwxr-xr-x      0       0           0  2025-06-05        259       0  dir1/dir2
drwxr-xr-x      0       0           0  2025-06-05        259       1  dir1/dir2
drwxr-xr-x      0       0           0  2025-06-05        259       2  dir1/dir2
drwxr-xr-x      0       0           0  2025-06-05        259       3  dir1/dir2
drwxr-xr-x      0       0           0  2025-06-05        259       4  dir1/dir2
drwxr-xr-x      0       0           0  2025-06-05        260       0  dir1/dir2/dir3
drwxr-xr-x      0       0           0  2025-06-05        260       1  dir1/dir2/dir3
drwxr-xr-x      0       0           0  2025-06-05        261       0  dir1/dir4
drwxr-xr-x      0       0           0  2025-06-05        261       1  dir1/dir4
drwxr-xr-x      0       0           0  2025-06-05        261       2  dir1/dir4
drwxr-xr-x      0       0           0  2025-06-05        261       3  dir1/dir41
drwxr-xr-x      0       0           0  2025-06-05        261       4  dir1/dir41
drwxr-xr-x      0       0           0  2025-06-05        262       0  dir1/dir4/dir5
drwxr-xr-x      0       0           0  2025-06-05        262       1  dir1/dir4/dir5
drwxr-xr-x      0       0           0  2025-06-05        262       2  dir1/dir2/dir5.moved
drwxr-xr-x      0       0           0  2025-06-05        262       3  unlinked
drwxr-xr-x      0       0           0  2025-06-05        262       4  deleted
drwxr-xr-x      0       0           0  2025-06-05        263       0  dir6
drwxr-xr-x      0       0           0  2025-06-05        263       1  dir6
lrwxrwxrwx      0       0           0  2025-06-05        264       0  dir1/dir2/dir3/link1 -> ../../../test1.txt
prw-r--r--      0       0           0  2025-06-05        265       0  dir1/dir2/named_pipe
brw-r--r--      0       0           0  2025-06-05        266       0  dir1/dir2/dir5/block_device
brw-r--r--      0       0           0  2025-06-05        266       1  unlinked
brw-r--r--      0       0           0  2025-06-05        266       2  deleted
srwxr-xr-x      0       0           0  2025-06-05        267       0  dir6/aSocket.sock
-rw-r--r--      0       0           5  2025-06-05        268       1  dir1/dir41/test2.txt
-rw-r--r--      0       0         445  2025-06-05        269       1  dir1/lorem.txt
-rw-r--r--      0       0         300  2025-06-05        269       2  dir1/lorem.txt
-rw-r--r--      0       0         300  2025-06-05        269       3  dir1/lorem.txt
-rw-r--r--      0       0          10  1970-01-01        513       0  orphan

REPORT
------
TOTAL restorable 35 object(s) for a total of 1065 bytes
```

6.1.1 Auto-detection

It detects correctly the best image format 2048/64/little-endian.

In fact it tries all combinations :

- 2048 bytes page_size and 64 bytes oob_size :
  - little-endian
  - big-endian
- 4096 bytes page_size and 128 bytes oob_size :
  - little-endian
  - big-endian
- 512 bytes page_size and 16 bytes oob_size :
  - little-endian
  - big-endian
- 8192 bytes page_size and 224 bytes oob_size :
  - little-endian

- big-endian
- 16384 bytes page_size and 448 bytes oob_size :
  - little-endian
  - big-endian

For each combination, it calculates a heuristic score. This one is calculated as this : It takes the first 1000 chunks and data/oob parse them. Then it checks the values obtained (object_id, chunk_id, file_size, uid, gid, rdev, mode, timestamps, ect).
Every time an extracted value is plausible, it increase a count that gives a final score.
The configuration with best score play the game.

6.1.2 Explore file tree

We can see that files, directories, named pipe, socket, , block device are well detected (type , owner, permission, size).

6.1.3 Analyze of rename, truncate, delete objects

It shows all as expected :

- object 266 (named pipe) was automatically deleted when we delete /dir1/dir2/dir5 (because it was inside)
  → restoring object_id=266 and version=0 can restore the deleted block device.
- object 261 (directory) was named initially /dir1/dir4 then it was renamed in /dir1/dir41
  → restoring object_id=261 and one of version 0,1,2 can restore the deleted directory.
- object 269 (file) was truncated. It has initially a 445 bytes size then it was truncated to 300 bytes.
  → restoring object_id=269 and version=1 can restore initial file.

6.1.4 --wide parameter

Moreover, if we activate --wide parameter, we can have more detailed information :

```
$ python yaffs2_parser.py --image snapshot_12_truncate_lorem.bin --autodetect --wide
```

```
==> Best format detected : 2048 / 64 in little-endian (score 125)
Processing image snapshot_12_truncate_lorem_TOEDIT.bin with pagesize 2048 and oobsize 64 in little-endian ...

  obj.ID    ver.  parentId  name                                    mode        size    uid    gid    ctime                 atime                 mtime                 sequence    offset  sha1sum
     257       1         1  test1.txt                               -rw-r--r--        5      0      0  2025-06-05 15:25:40   2025-06-05 15:25:40   2025-06-05 15:25:40       4097      2112  b444ac06613fc8d63795be9ad0beaf55011936ac
     258       0         1  dir1                                    drwxr-xr-x        0      0      0  2025-06-05 15:25:45   2025-06-05 15:25:45   2025-06-05 15:25:45       4097      6336  da39a3ee5e6b4b0d3255bfef95601890afd80709
     258       1         1  dir1                                    drwxr-xr-x        0      0      0  2025-06-05 15:25:45   2025-06-05 15:25:45   2025-06-05 15:25:45       4097     23232  da39a3ee5e6b4b0d3255bfef95601890afd80709
     258       2         1  dir1                                    drwxr-xr-x        0      0      0  2025-06-05 15:26:26   2025-06-05 15:25:45   2025-06-05 15:26:26       4097     63360  da39a3ee5e6b4b0d3255bfef95601890afd80709
     258       3         1  dir1                                    drwxr-xr-x        0      0      0  2025-06-05 15:26:38   2025-06-05 15:25:45   2025-06-05 15:26:38       4097     80256  da39a3ee5e6b4b0d3255bfef95601890afd80709
     259       0       258  dir1/dir2                               drwxr-xr-x        0      0      0  2025-06-05 15:25:45   2025-06-05 15:25:45   2025-06-05 15:25:45       4097      8448  da39a3ee5e6b4b0d3255bfef95601890afd80709
     259       1       258  dir1/dir2                               drwxr-xr-x        0      0      0  2025-06-05 15:25:45   2025-06-05 15:25:45   2025-06-05 15:25:45       4097     21120  da39a3ee5e6b4b0d3255bfef95601890afd80709
     259       2       258  dir1/dir2                               drwxr-xr-x        0      0      0  2025-06-05 15:25:57   2025-06-05 15:25:45   2025-06-05 15:25:57       4097     33792  da39a3ee5e6b4b0d3255bfef95601890afd80709
     259       3       258  dir1/dir2                               drwxr-xr-x        0      0      0  2025-06-05 15:26:14   2025-06-05 15:25:45   2025-06-05 15:26:14       4097     48576  da39a3ee5e6b4b0d3255bfef95601890afd80709
     259       4       258  dir1/dir2                               drwxr-xr-x        0      0      0  2025-06-05 15:26:20   2025-06-05 15:25:45   2025-06-05 15:26:20       4097     59136  da39a3ee5e6b4b0d3255bfef95601890afd80709
     260       0       259  dir1/dir2/dir3                          drwxr-xr-x        0      0      0  2025-06-05 15:25:45   2025-06-05 15:25:45   2025-06-05 15:25:45       4097     10560  da39a3ee5e6b4b0d3255bfef95601890afd80709
     260       1       259  dir1/dir2/dir3                          drwxr-xr-x        0      0      0  2025-06-05 15:25:51   2025-06-05 15:25:45   2025-06-05 15:25:51       4097     29568  da39a3ee5e6b4b0d3255bfef95601890afd80709
     261       0       258  dir1/dir4                               drwxr-xr-x        0      0      0  2025-06-05 15:25:45   2025-06-05 15:25:45   2025-06-05 15:25:45       4097     12672  da39a3ee5e6b4b0d3255bfef95601890afd80709
     261       1       258  dir1/dir4                               drwxr-xr-x        0      0      0  2025-06-05 15:25:45   2025-06-05 15:25:45   2025-06-05 15:25:45       4097     19008  da39a3ee5e6b4b0d3255bfef95601890afd80709
     261       2       258  dir1/dir4                               drwxr-xr-x        0      0      0  2025-06-05 15:26:14   2025-06-05 15:25:45   2025-06-05 15:26:14       4097     46464  da39a3ee5e6b4b0d3255bfef95601890afd80709
     261       3       258  dir1/dir41                              drwxr-xr-x        0      0      0  2025-06-05 15:26:14   2025-06-05 15:25:45   2025-06-05 15:26:14       4097     61248  da39a3ee5e6b4b0d3255bfef95601890afd80709
     261       4       258  dir1/dir41                              drwxr-xr-x        0      0      0  2025-06-05 15:26:32   2025-06-05 15:25:45   2025-06-05 15:26:32       4097     71808  da39a3ee5e6b4b0d3255bfef95601890afd80709
     262       0       261  dir1/dir4/dir5                          drwxr-xr-x        0      0      0  2025-06-05 15:25:45   2025-06-05 15:25:45   2025-06-05 15:25:45       4097     14784  da39a3ee5e6b4b0d3255bfef95601890afd80709
     262       1       261  dir1/dir4/dir5                          drwxr-xr-x        0      0      0  2025-06-05 15:26:03   2025-06-05 15:25:45   2025-06-05 15:26:03       4097     38016  da39a3ee5e6b4b0d3255bfef95601890afd80709
     262       2       259  dir1/dir2/dir5.moved                    drwxr-xr-x        0      0      0  2025-06-05 15:26:03   2025-06-05 15:25:45   2025-06-05 15:26:03       4097     44352  da39a3ee5e6b4b0d3255bfef95601890afd80709
     262       3         3  unlinked                                drwxr-xr-x        0      0      0  2025-06-05 15:26:20   2025-06-05 15:25:45   2025-06-05 15:26:20       4097     54912  da39a3ee5e6b4b0d3255bfef95601890afd80709
     262       4         4  deleted                                 drwxr-xr-x        0      0      0  2025-06-05 15:26:20   2025-06-05 15:25:45   2025-06-05 15:26:20       4097     57024  da39a3ee5e6b4b0d3255bfef95601890afd80709
     263       0         1  dir6                                    drwxr-xr-x        0      0      0  2025-06-05 15:25:45   2025-06-05 15:25:45   2025-06-05 15:25:45       4097     16896  da39a3ee5e6b4b0d3255bfef95601890afd80709
     263       1         1  dir6                                    drwxr-xr-x        0      0      0  2025-06-05 15:26:09   2025-06-05 15:25:45   2025-06-05 15:26:09       4097     42240  da39a3ee5e6b4b0d3255bfef95601890afd80709
     264       0       260  dir1/dir2/dir3/link1 -> ../../../test1.txt lrwxrwxrwx        0      0      0  2025-06-05 15:25:51   2025-06-05 15:25:51   2025-06-05 15:25:51       4097     27456  da39a3ee5e6b4b0d3255bfef95601890afd80709
     265       0       259  dir1/dir2/named_pipe                    prw-r--r--        0      0      0  2025-06-05 15:25:57   2025-06-05 15:25:57   2025-06-05 15:25:57       4097     31680  da39a3ee5e6b4b0d3255bfef95601890afd80709
     266       0       262  dir1/dir2/dir3/block_device             brw-r--r--        0      0      0  2025-06-05 15:26:03   2025-06-05 15:26:03   2025-06-05 15:26:03       4097     35904  da39a3ee5e6b4b0d3255bfef95601890afd80709
     266       1         3  unlinked                                brw-r--r--        0      0      0  2025-06-05 15:26:03   2025-06-05 15:26:03   2025-06-05 15:26:03       4097     50688  da39a3ee5e6b4b0d3255bfef95601890afd80709
     266       2         4  deleted                                 brw-r--r--        0      0      0  2025-06-05 15:26:03   2025-06-05 15:26:03   2025-06-05 15:26:03       4097     52800  da39a3ee5e6b4b0d3255bfef95601890afd80709
     267       0       263  dir6/aSocket.sock                       srwxr-xr-x        0      0      0  2025-06-05 15:26:09   2025-06-05 15:26:09   2025-06-05 15:26:09       4097     40128  da39a3ee5e6b4b0d3255bfef95601890afd80709
     268       1       261  dir1/dir41/test2.txt                    -rw-r--r--        5      0      0  2025-06-05 15:26:32   2025-06-05 15:26:32   2025-06-05 15:26:32       4097     69696  109f4b3c50d7b0df729d299bc6f8e9ef9066971f
     269       1       258  dir1/lorem.txt                          -rw-r--r--      445      0      0  2025-06-05 15:26:38   2025-06-05 15:26:38   2025-06-05 15:26:38       4097     78144  cd36b370758a259b34845084a6cc38473cb95e27
     269       2       258  dir1/lorem.txt                          -rw-r--r--      300      0      0  2025-06-05 15:26:43   2025-06-05 15:26:38   2025-06-05 15:26:43       4097     84480  60acccecac6e1cc29957ae0b03b8e9033fd08882d
     269       3       258  dir1/lorem.txt                          -rw-r--r--      300      0      0  2025-06-05 15:26:43   2025-06-05 15:26:38   2025-06-05 15:26:43       4097     86592  60acccecac6e1cc29957ae0b03b8e9033fd08882d
     513       0         1  orphan                                  -rw-r--r--       10      0      0  1970-01-01 01:00:01   1970-01-01 01:00:00   1970-01-01 01:00:01       8193  69201792  455bcd5917c990aa6cb6ef04028dbeaac5a176ce

REPORT
------
TOTAL restorable 35 object(s) for a total of 1065 bytes
```

Note #1 : All timestamps were there, and as I put 5 seconds between each filesystem operation, we can see clearly different ctimes.
Note #2 : I've added a sha1sum for the data part of each object (there is the same checksum for all directory or special files). We can see different sha1sum for object_id 269 (/dir1/lorem.txt) that was truncated.

6.1.5 --obj_ids and --obj_id_from and --obj_id_to

These parameters allow the user to select a list of object_id and/or a range of objects if specifying _from and to.

6.1.6 --versions and --version_from and --version_to

These parameters allow the user to select a list of version and/or a range of versions if specifying _from and to.

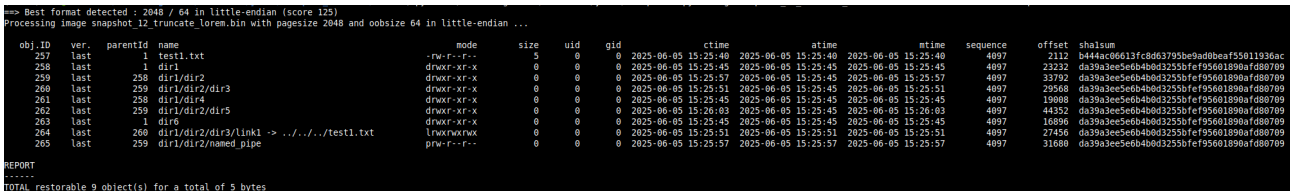
6.1.7 --last_only

This option alow the user to select only the last instance of the filesystem.

6.2 Snapshot

Let's try the snapshot parameter :

```
$ python yaffs2_parser.py --image snapshot_12_truncate_lorem.bin --autodetect --wide --snapshot='2025-06-05 15:26:03'
```



We can see that we have a snapshot of the filesystem at this time.

Of course, everything visible is restorable.

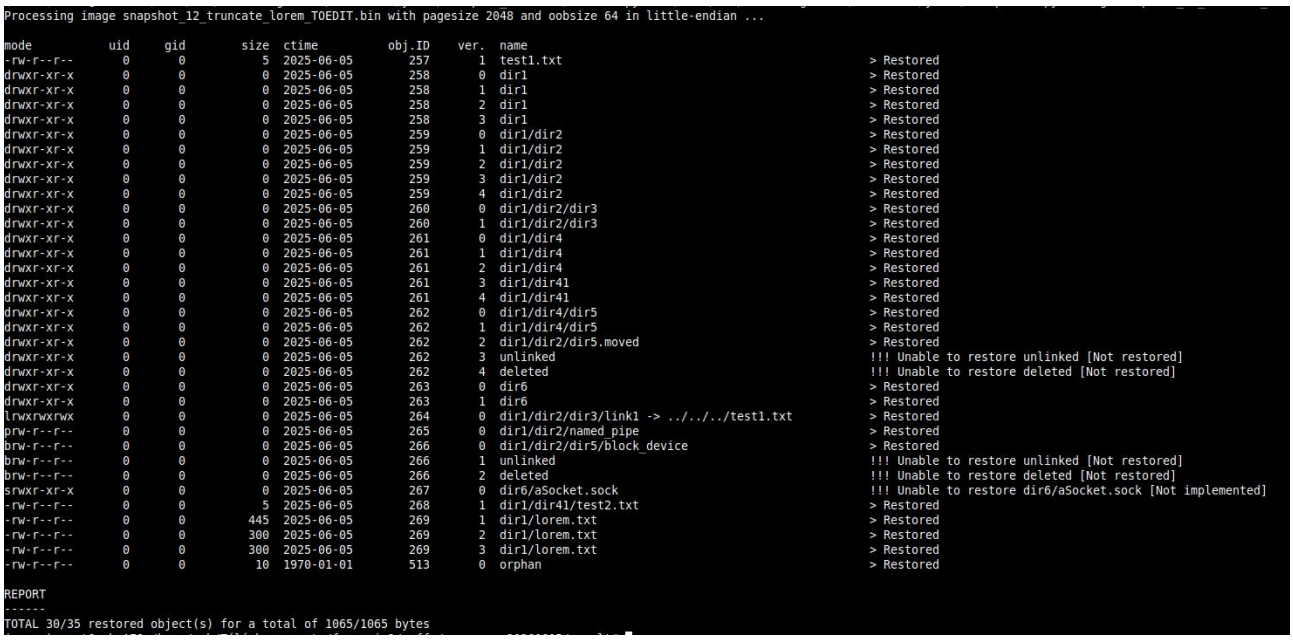
6.3 Restore

6.3.1 Object restoration

If I want to restore the snapshot, I just add `--outdir` parameter with a specified directory :

For full demonstration, I ran as root and without `--snapshot` activated.

```
$ python yaffs2_parser.py --image snapshot_12_truncate_lorem.bin --autodetect --outdir /tmp/toto
```



and here is what I get in /tmp/toto directory :

```
$  ls -lR /tmp/toto
/tmp/toto:
total 16
drwxr-xr-x 5 root root 4096 juin   8 16:24 dir1
drwxr-xr-x 2 root root 4096 juin   8 16:24 dir6
-rwxr-xr-x 1 root root   10 juin   8 16:24 orphan.o513.v0
-rwxr-xr-x 1 root root    5 juin   8 16:24 test1.txt.o257.v1

/tmp/toto/dir1:
total 24
drwxr-xr-x 5 root root 4096 juin   8 16:24 dir2
drwxr-xr-x 3 root root 4096 juin   8 16:24 dir4
drwxr-xr-x 2 root root 4096 juin   8 16:24 dir41
-rwxr-xr-x 1 root root  445 juin   8 16:24 lorem.txt.o269.v1
-rwxr-xr-x 1 root root  300 juin   8 16:24 lorem.txt.o269.v2
-rwxr-xr-x 1 root root  300 juin   8 16:24 lorem.txt.o269.v3

/tmp/toto/dir1/dir2:
total 12
drwxr-xr-x 2 root root 4096 juin   8 16:24 dir3
drwxr-xr-x 2 root root 4096 juin   8 16:24 dir5
drwxr-xr-x 2 root root 4096 juin   8 16:24 dir5.moved
prw-r--r-- 1 root root    0 juin   8 16:24 named_pipe.o265.v0

/tmp/toto/dir1/dir2/dir3:
total 0
lrwxrwxrwx 1 root root 19 juin   8 16:24 link1 -> /tmp/toto/test1.txt

/tmp/toto/dir1/dir2/dir5:
total 0
brw-r--r-- 1 root root 11, 0 juin   8 16:24 block_device.o266.v0

/tmp/toto/dir1/dir2/dir5.moved:
total 0

/tmp/toto/dir1/dir4:
total 4
drwxr-xr-x 2 root root 4096 juin   8 16:24 dir5

/tmp/toto/dir1/dir4/dir5:
total 0

/tmp/toto/dir1/dir41:
total 4
-rwxr-xr-x 1 root root 5 juin   8 16:24 test2.txt.o268.v1

/tmp/toto/dir6:
total 0
```

Note #1 : The restored link seems to be broken, it's normal because as you can see, restored files are suffixed with their object_id and version.

Note #2 : An impossible restoration is a unix socket. Because it needs a running program to create an unix socket. When the filesystem is "sleeping", the unix socket would not have existence.

For a correct symlink restoration, activate the `--last_only` parameter. Then restored files will have no suffixes.

6.3.2 Owner restoration

Only root can full restore owner in objects. With the current user (if not root), the command will produce an error and the file was not restored.

For that, the `--restore_owner` parameter need to be added.

```
$ python yaffs2_parser.py --image snapshot_12_truncate_lorem.bin --autodetect --snapshot='2025-06-05 15:26:03'
--outdir /tmp/toto --restore_owner
```

6.3.3 Right restoration

By default, restores files and directory were done with user umask.

But, if you want to restore the exact rights, just add `--restore_right` parameter.

```
$ python yaffs2_parser.py --image snapshot_12_truncate_lorem.bin --autodetect --snapshot='2025-06-05 15:26:03'
--outdir /tmp/toto –restore_right
```

6.4 Forensic

When adding `--debug 2` parameter, the forensic program works in forensic mode.

→ it details a lot of information :

6.4.1 Auto-detect

The program will show detailed information about the auto-detect algorithm :

```
Auto-detecting NAND parameters ...
    testing format 2048+64 in little-endian -> Score : 125
    testing format 2048+64 in big-endian -> Score : 0
    testing format 4096+128 in little-endian -> Score : 21
    testing format 4096+128 in big-endian -> Score : 0
    testing format 512+16 in little-endian -> Score : 39
    testing format 512+16 in big-endian -> Score : 0
    testing format 8192+224 in little-endian -> Score : 1
    testing format 8192+224 in big-endian -> Score : 0
    testing format 16384+448 in little-endian -> Score : 1
    testing format 16384+448 in big-endian -> Score : 0
==> Best format detected : 2048 / 64 in little-endian (score 125)
Processing image snapshot_12_truncate_lorem.bin with pagesize 2048 and oobsize 64 in little-endian ...
```

6.4.2 Chunks

Every chunk was displayed as this :

```
================================================================================================================================================
======
CHUNK #00000000        ||  Object type      YAFFS_OBJECT_TYPE_FILE ( 1)  ||
GOOD Chunk             ++=============================================++            GOOD Chunk

---[ data part ]--- 00000000  01 00 00 00 01 00 00 00   ff ff 74 65 73 74 31 2e  |.........test1.|
size: 2048 bytes    00000010  74 78 74 00 00 00 00 00   00 00 00 00 00 00 00 00  |txt.............|
                    00000020  00 00 00 00 00 00 00 00   00 00 00 00 00 00 00 00  |................|
                    00000030  00 00 00 00 00 00 00 00   00 00 00 00 00 00 00 00  |................|
                    00000040  00 00 00 00 00 00 00 00   00 00 00 00 00 00 00 00  |................|
                    00000050  00 00 00 00 00 00 00 00   00 00 00 00 00 00 00 00  |................|
                    00000060  00 00 00 00 00 00 00 00   00 00 00 00 00 00 00 00  |................|
                    00000070  00 00 00 00 00 00 00 00   00 00 00 00 00 00 00 00  |................|
                    00000080  00 00 00 00 00 00 00 00   00 00 00 00 00 00 00 00  |................|
                    00000090  00 00 00 00 00 00 00 00   00 00 00 00 00 00 00 00  |................|
                    000000a0  00 00 00 00 00 00 00 00   00 00 00 00 00 00 00 00  |................|
                    000000b0  00 00 00 00 00 00 00 00   00 00 00 00 00 00 00 00  |................|
                    000000c0  00 00 00 00 00 00 00 00   00 00 00 00 00 00 00 00  |................|
                    000000d0  00 00 00 00 00 00 00 00   00 00 00 00 00 00 00 00  |................|
                    000000e0  00 00 00 00 00 00 00 00   00 00 00 00 00 00 00 00  |................|
                    000000f0  00 00 00 00 00 00 00 00   00 00 00 00 00 00 00 00  |................|
                    00000100  00 00 00 00 00 00 00 00   00 00 ff ff a4 81 00 00  |................|
                    00000110  00 00 00 00 00 00 00 00   d4 9a 41 68 d4 9a 41 68  |..........Ah..Ah|
                    00000120  d4 9a 41 68 00 00 00 00   ff ff ff ff ff ff ff ff  |..Ah............|
                    00000130  ff ff ff ff ff ff ff ff   ff ff ff ff ff ff ff ff  |................|
                    00000140  ff ff ff ff ff ff ff ff   ff ff ff ff ff ff ff ff  |................|
                    00000150  ff ff ff ff ff ff ff ff   ff ff ff ff ff ff ff ff  |................|
                    00000160  ff ff ff ff ff ff ff ff   ff ff ff ff ff ff ff ff  |................|
                    00000170  ff ff ff ff ff ff ff ff   ff ff ff ff ff ff ff ff  |................|
                    00000180  ff ff ff ff ff ff ff ff   ff ff ff ff ff ff ff ff  |................|
                    00000190  ff ff ff ff ff ff ff ff   ff ff ff ff ff ff ff ff  |................|
                    000001a0  ff ff ff ff ff ff ff ff   ff ff ff ff ff ff ff ff  |................|
```

```
                    000001b0  ff ff ff ff ff ff ff ff   ff ff ff ff ff ff ff ff  |................|
                    000001c0  ff ff ff ff ff ff ff ff   ff ff ff ff 00 00 00 00  |................|
                    000001d0  d4 9a 41 68 00 00 00 00   d4 9a 41 68 00 00 00 00  |..Ah......Ah....|
                    000001e0  d4 9a 41 68 00 00 00 00   00 00 00 00 ff ff ff ff  |..Ah............|
                    000001f0  00 00 00 00 ff ff ff ff   00 00 00 00 00 00 00 00  |................|
                    00000200  ff ff ff ff ff ff ff ff   ff ff ff ff ff ff ff ff  |................|
                    00000210  ff ff ff ff ff ff ff ff   ff ff ff ff ff ff ff ff  |................|
                    00000220  ff ff ff ff ff ff ff ff   ff ff ff ff ff ff ff ff  |................|
                    00000230  ff ff ff ff ff ff ff ff   ff ff ff ff ff ff ff ff  |................|
                    00000240  ff ff ff ff ff ff ff ff   ff ff ff ff ff ff ff ff  |................|
                    00000250  ff ff ff ff ff ff ff ff   ff ff ff ff ff ff ff ff  |................|
                    00000260  ff ff ff ff ff ff ff ff   ff ff ff ff ff ff ff ff  |................|
                    00000270  ff ff ff ff ff ff ff ff   ff ff ff ff ff ff ff ff  |................|
                    00000280  ff ff ff ff ff ff ff ff   ff ff ff ff ff ff ff ff  |................|
                    00000290  ff ff ff ff ff ff ff ff   ff ff ff ff ff ff ff ff  |................|
                    000002a0  ff ff ff ff ff ff ff ff   ff ff ff ff ff ff ff ff  |................|
                    000002b0  ff ff ff ff ff ff ff ff   ff ff ff ff ff ff ff ff  |................|
                    000002c0  ff ff ff ff ff ff ff ff   ff ff ff ff ff ff ff ff  |................|
                    000002d0  ff ff ff ff ff ff ff ff   ff ff ff ff ff ff ff ff  |................|
                    000002e0  ff ff ff ff ff ff ff ff   ff ff ff ff ff ff ff ff  |................|
                    000002f0  ff ff ff ff ff ff ff ff   ff ff ff ff ff ff ff ff  |................|
                    00000300  ff ff ff ff ff ff ff ff   ff ff ff ff ff ff ff ff  |................|
                    00000310  ff ff ff ff ff ff ff ff   ff ff ff ff ff ff ff ff  |................|
                    00000320  ff ff ff ff ff ff ff ff   ff ff ff ff ff ff ff ff  |................|
                    00000330  ff ff ff ff ff ff ff ff   ff ff ff ff ff ff ff ff  |................|
                    00000340  ff ff ff ff ff ff ff ff   ff ff ff ff ff ff ff ff  |................|
                    00000350  ff ff ff ff ff ff ff ff   ff ff ff ff ff ff ff ff  |................|
                    00000360  ff ff ff ff ff ff ff ff   ff ff ff ff ff ff ff ff  |................|
                    00000370  ff ff ff ff ff ff ff ff   ff ff ff ff ff ff ff ff  |................|
                    00000380  ff ff ff ff ff ff ff ff   ff ff ff ff ff ff ff ff  |................|
                    00000390  ff ff ff ff ff ff ff ff   ff ff ff ff ff ff ff ff  |................|
                    000003a0  ff ff ff ff ff ff ff ff   ff ff ff ff ff ff ff ff  |................|
                    000003b0  ff ff ff ff ff ff ff ff   ff ff ff ff ff ff ff ff  |................|
                    000003c0  ff ff ff ff ff ff ff ff   ff ff ff ff ff ff ff ff  |................|
                    000003d0  ff ff ff ff ff ff ff ff   ff ff ff ff ff ff ff ff  |................|
                    000003e0  ff ff ff ff ff ff ff ff   ff ff ff ff ff ff ff ff  |................|
                    000003f0  ff ff ff ff ff ff ff ff   ff ff ff ff ff ff ff ff  |................|
                    00000400  ff ff ff ff ff ff ff ff   ff ff ff ff ff ff ff ff  |................|
                    00000410  ff ff ff ff ff ff ff ff   ff ff ff ff ff ff ff ff  |................|
                    00000420  ff ff ff ff ff ff ff ff   ff ff ff ff ff ff ff ff  |................|
                    00000430  ff ff ff ff ff ff ff ff   ff ff ff ff ff ff ff ff  |................|
                    00000440  ff ff ff ff ff ff ff ff   ff ff ff ff ff ff ff ff  |................|
                    00000450  ff ff ff ff ff ff ff ff   ff ff ff ff ff ff ff ff  |................|
                    00000460  ff ff ff ff ff ff ff ff   ff ff ff ff ff ff ff ff  |................|
                    00000470  ff ff ff ff ff ff ff ff   ff ff ff ff ff ff ff ff  |................|
                    00000480  ff ff ff ff ff ff ff ff   ff ff ff ff ff ff ff ff  |................|
                    00000490  ff ff ff ff ff ff ff ff   ff ff ff ff ff ff ff ff  |................|
                    000004a0  ff ff ff ff ff ff ff ff   ff ff ff ff ff ff ff ff  |................|
                    000004b0  ff ff ff ff ff ff ff ff   ff ff ff ff ff ff ff ff  |................|
                    000004c0  ff ff ff ff ff ff ff ff   ff ff ff ff ff ff ff ff  |................|
                    000004d0  ff ff ff ff ff ff ff ff   ff ff ff ff ff ff ff ff  |................|
                    000004e0  ff ff ff ff ff ff ff ff   ff ff ff ff ff ff ff ff  |................|
                    000004f0  ff ff ff ff ff ff ff ff   ff ff ff ff ff ff ff ff  |................|
                    00000500  ff ff ff ff ff ff ff ff   ff ff ff ff ff ff ff ff  |................|
                    00000510  ff ff ff ff ff ff ff ff   ff ff ff ff ff ff ff ff  |................|
                    00000520  ff ff ff ff ff ff ff ff   ff ff ff ff ff ff ff ff  |................|
                    00000530  ff ff ff ff ff ff ff ff   ff ff ff ff ff ff ff ff  |................|
                    00000540  ff ff ff ff ff ff ff ff   ff ff ff ff ff ff ff ff  |................|
                    00000550  ff ff ff ff ff ff ff ff   ff ff ff ff ff ff ff ff  |................|
                    00000560  ff ff ff ff ff ff ff ff   ff ff ff ff ff ff ff ff  |................|
                    00000570  ff ff ff ff ff ff ff ff   ff ff ff ff ff ff ff ff  |................|
                    00000580  ff ff ff ff ff ff ff ff   ff ff ff ff ff ff ff ff  |................|
                    00000590  ff ff ff ff ff ff ff ff   ff ff ff ff ff ff ff ff  |................|
                    000005a0  ff ff ff ff ff ff ff ff   ff ff ff ff ff ff ff ff  |................|
                    000005b0  ff ff ff ff ff ff ff ff   ff ff ff ff ff ff ff ff  |................|
                    000005c0  ff ff ff ff ff ff ff ff   ff ff ff ff ff ff ff ff  |................|
                    000005d0  ff ff ff ff ff ff ff ff   ff ff ff ff ff ff ff ff  |................|
                    000005e0  ff ff ff ff ff ff ff ff   ff ff ff ff ff ff ff ff  |................|
                    000005f0  ff ff ff ff ff ff ff ff   ff ff ff ff ff ff ff ff  |................|
                    00000600  ff ff ff ff ff ff ff ff   ff ff ff ff ff ff ff ff  |................|
                    00000610  ff ff ff ff ff ff ff ff   ff ff ff ff ff ff ff ff  |................|
                    00000620  ff ff ff ff ff ff ff ff   ff ff ff ff ff ff ff ff  |................|
                    00000630  ff ff ff ff ff ff ff ff   ff ff ff ff ff ff ff ff  |................|
                    00000640  ff ff ff ff ff ff ff ff   ff ff ff ff ff ff ff ff  |................|
                    00000650  ff ff ff ff ff ff ff ff   ff ff ff ff ff ff ff ff  |................|
                    00000660  ff ff ff ff ff ff ff ff   ff ff ff ff ff ff ff ff  |................|
                    00000670  ff ff ff ff ff ff ff ff   ff ff ff ff ff ff ff ff  |................|
                    00000680  ff ff ff ff ff ff ff ff   ff ff ff ff ff ff ff ff  |................|
                    00000690  ff ff ff ff ff ff ff ff   ff ff ff ff ff ff ff ff  |................|
                    000006a0  ff ff ff ff ff ff ff ff   ff ff ff ff ff ff ff ff  |................|
                    000006b0  ff ff ff ff ff ff ff ff   ff ff ff ff ff ff ff ff  |................|
                    000006c0  ff ff ff ff ff ff ff ff   ff ff ff ff ff ff ff ff  |................|
                    000006d0  ff ff ff ff ff ff ff ff   ff ff ff ff ff ff ff ff  |................|
                    000006e0  ff ff ff ff ff ff ff ff   ff ff ff ff ff ff ff ff  |................|
                    000006f0  ff ff ff ff ff ff ff ff   ff ff ff ff ff ff ff ff  |................|
                    00000700  ff ff ff ff ff ff ff ff   ff ff ff ff ff ff ff ff  |................|
                    00000710  ff ff ff ff ff ff ff ff   ff ff ff ff ff ff ff ff  |................|
                    00000720  ff ff ff ff ff ff ff ff   ff ff ff ff ff ff ff ff  |................|
                    00000730  ff ff ff ff ff ff ff ff   ff ff ff ff ff ff ff ff  |................|
                    00000740  ff ff ff ff ff ff ff ff   ff ff ff ff ff ff ff ff  |................|
                    00000750  ff ff ff ff ff ff ff ff   ff ff ff ff ff ff ff ff  |................|
                    00000760  ff ff ff ff ff ff ff ff   ff ff ff ff ff ff ff ff  |................|
                    00000770  ff ff ff ff ff ff ff ff   ff ff ff ff ff ff ff ff  |................|
                    00000780  ff ff ff ff ff ff ff ff   ff ff ff ff ff ff ff ff  |................|
                    00000790  ff ff ff ff ff ff ff ff   ff ff ff ff ff ff ff ff  |................|
                    000007a0  ff ff ff ff ff ff ff ff   ff ff ff ff ff ff ff ff  |................|
                    000007b0  ff ff ff ff ff ff ff ff   ff ff ff ff ff ff ff ff  |................|
                    000007c0  ff ff ff ff ff ff ff ff   ff ff ff ff ff ff ff ff  |................|
                    000007d0  ff ff ff ff ff ff ff ff   ff ff ff ff ff ff ff ff  |................|
                    000007e0  ff ff ff ff ff ff ff ff   ff ff ff ff ff ff ff ff  |................|
                    000007f0  ff ff ff ff ff ff ff ff   ff ff ff ff ff ff ff ff  |................|

                                .......................[ Analyze ].......................
                                junk0                   (0, 10) -> \x01 \x00 \x00 \x00 \x01 \x00 \x00 \x00 \xff \xff
                                 name                    (10, 254) -> \x74 \x65 \x73 \x74 \x31 \x2e \x74 \x78 \x74 \x00 \x00 \
x00 \x00 \x00 \x00 \x00 \x00 \x00 \x00 \x00 \x00 \x00 \x00 \x00 \x00 \x00 \x00 \x00 \x00 \x00 \x00 \x00 \x00 \x00 \x00 \x00 \x00 \
x00 \x00 \x00 \x00 \x00 \x00 \x00 \x00 \x00 \x00 \x00 \x00 \x00 \x00 \x00 \x00 \x00 \x00 \x00 \x00 \x00 \x00 \x00 \x00 \x00 \x00 \
x00 \x00 \x00 \x00 \x00 \x00 \x00 \x00 \x00 \x00 \x
                                junk1                   (264, 4) -> \x00 \x00 \xff \xff
                                yst_mode                (268, 4) -> \xa4 \x81 \x00 \x00
                                yst_uid                 (272, 4) -> \x00 \x00 \x00 \x00
                                yst_gid                 (276, 4) -> \x00 \x00 \x00 \x00
                                yst_atime               (280, 4) -> \xd4 \x9a \x41 \x68
                                yst_mtime               (284, 4) -> \xd4 \x9a \x41 \x68
                                yst_ctime               (288, 4) -> \xd4 \x9a \x41 \x68
                                file_size_low           (292, 4) -> \x00 \x00 \x00 \x00
                                equiv_id                (296, 4) -> \xff \xff \xff \xff
                                 alias                   (300, 160) -> \xff \xff \xff \xff \xff \xff \xff \xff \xff \xff \xff \
xff \xff \xff \xff \xff \xff \xff \xff \xff \xff \xff \xff \xff \xff \xff \xff \xff \xff \xff \xff \xff \xff \xff \xff \xff \xff \
xff \xff \xff \xff \xff \xff \xff \xff \xff \xff \xff \xff \xff \xff \xff \xff \xff \xff \xff \xff \xff \xff \xff \xff \xff \xff \
xff \xff \xff \xff \xff \xff \xff \xff \xff \xff \
                                yst_rdev                (460, 4) -> \x00 \x00 \x00 \x00
                                win_ctime_1             (464, 4) -> \xd4 \x9a \x41 \x68
                                win_ctime_2             (468, 4) -> \x00 \x00 \x00 \x00
                                win_atime_1             (472, 4) -> \xd4 \x9a \x41 \x68
                                win_atime_2             (476, 4) -> \x00 \x00 \x00 \x00
                                win_mtime_1             (480, 4) -> \xd4 \x9a \x41 \x68
                                win_mtime_2             (484, 4) -> \x00 \x00 \x00 \x00
                                inband_shad_obj_id      (488, 4) -> \x00 \x00 \x00 \x00
                                inband_is_shrink        (492, 4) -> \xff \xff \xff \xff
```

```
                                file_size_high          (496, 4) -> \x00 \x00 \x00 \x00
                                reserved                (500, 1) -> \xff
                                shadows_obj             (501, 4) -> \xff \xff \xff \x00
                                is_shrink               (505, 4) -> \x00 \x00 \x00 \x00


result = {'file_size': 0, 'junk0': b'\x01\x00\x00\x00\x01\x00\x00\x00\xff\xff', 'name': 'test1.txt', 'junk1': 4294901760,
'yst_mode': 33188, 'yst_uid': 0, 'yst_gid': 0, 'yst_atime': 1749129940, 'yst_mtime': 1749129940, 'yst_ctime': 1749129940,
'file_size_low': 0, 'equiv_id': 4294967295, 'alias': '', 'yst_rdev': 0, 'win_ctime_1': 1749129940, 'win_ctime_2': 0,
'win_atime_1': 1749129940, 'win_atime_2': 0, 'win_mtime_1': 17491}

+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-
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---[  oob part ]--- 00000800  ff ff 01 10 00 00 01 01   00 10 01 00 00 80 00 00  |................|
size: 64 bytes      00000810  00 00 2a 38 a2 11 04 00   00 00 fb ff ff ff ff ff  |..*8............|
                    00000820  ff ff ff ff ff ff ff ff   c3 ff 03 aa 5a 57 ff ff  |............ZW..|
                    00000830  ff ff ff ff ff ff ff ff   ff ff ff ff ff ff ff ff  |................|

                                ........................[ Analyze ].......................
                                blockstate              (1, 1) -> \xff
                                sequence_number         (2, 4) -> \x01 \x10 \x00 \x00
                                object_id               (6, 4) -> \x01 \x01 \x00 \x10
                                chunk_id                (10, 4) -> \x01 \x00 \x00 \x80
                                n_bytes                 (14, 2) -> \x00 \x00


result = {'obj_type': 1, 'parent_obj_id': 1, 'has_packed_data': True, 'blockstate': 255, 'sequence_number': 4097, 'object_id':
257, 'chunk_id': 0, 'n_bytes': 0, 'obj_type_name': 'YAFFS_OBJECT_TYPE_FILE', 'bs_signif': 'GOOD Chunk', 'file_size': 0}
```

CHUNK #00000000 : Chunk Number (be careful this is not chunk_id which is a field present in the oob Part)

Object type : YAFFS_OBJECT_TYPE_FILE (1) informs about the chunk type (here a file)

But we can have :

0: 'YAFFS_OBJECT_TYPE_UNKNOWN'

1: 'YAFFS_OBJECT_TYPE_FILE'

2: 'YAFFS_OBJECT_TYPE_SYMLINK'

3: 'YAFFS_OBJECT_TYPE_DIRECTORY'

4: 'YAFFS_OBJECT_TYPE_HARDLINK'

5: 'YAFFS_OBJECT_TYPE_SPECIAL'

GOOD Chunk : indicates that this chunk is not blacklisted by the filesystems

---[data part]--- : the start of the data part (see below)

---[oob part]--- : the start of the oob part (see below)

6.4.2.1 Data Part

```
---[ data part ]--- 00000000  01 00 00 00 01 00 00 00   ff ff 74 65 73 74 31 2e  |..........test1.|
size: 2048 bytes    00000010  74 78 74 00 00 00 00 00   00 00 00 00 00 00 00 00  |txt.............|
                    00000020  00 00 00 00 00 00 00 00   00 00 00 00 00 00 00 00  |................|
                    00000030  00 00 00 00 00 00 00 00   00 00 00 00 00 00 00 00  |................|
                    00000040  00 00 00 00 00 00 00 00   00 00 00 00 00 00 00 00  |................|
                    00000050  00 00 00 00 00 00 00 00   00 00 00 00 00 00 00 00  |................|
                    00000060  00 00 00 00 00 00 00 00   00 00 00 00 00 00 00 00  |................|
                    00000070  00 00 00 00 00 00 00 00   00 00 00 00 00 00 00 00  |................|
                    00000080  00 00 00 00 00 00 00 00   00 00 00 00 00 00 00 00  |................|
                    00000090  00 00 00 00 00 00 00 00   00 00 00 00 00 00 00 00  |................|
                    000000a0  00 00 00 00 00 00 00 00   00 00 00 00 00 00 00 00  |................|
                    000000b0  00 00 00 00 00 00 00 00   00 00 00 00 00 00 00 00  |................|
                    000000c0  00 00 00 00 00 00 00 00   00 00 00 00 00 00 00 00  |................|
                    000000d0  00 00 00 00 00 00 00 00   00 00 00 00 00 00 00 00  |................|
                    000000e0  00 00 00 00 00 00 00 00   00 00 00 00 00 00 00 00  |................|
                    000000f0  00 00 00 00 00 00 00 00   00 00 00 00 00 00 00 00  |................|
                    00000100  00 00 00 00 00 00 00 00   00 00 ff ff a4 81 00 00  |................|
                    00000110  00 00 00 00 00 00 00 00   d4 9a 41 68 d4 9a 41 68  |..........Ah..Ah|
                    00000120  d4 9a 41 68 00 00 00 00   ff ff ff ff ff ff ff ff  |..Ah............|
                    00000130  ff ff ff ff ff ff ff ff   ff ff ff ff ff ff ff ff  |................|
                    00000140  ff ff ff ff ff ff ff ff   ff ff ff ff ff ff ff ff  |................|
[snip]
                    000007b0  ff ff ff ff ff ff ff ff   ff ff ff ff ff ff ff ff  |................|
                    000007c0  ff ff ff ff ff ff ff ff   ff ff ff ff ff ff ff ff  |................|
                    000007d0  ff ff ff ff ff ff ff ff   ff ff ff ff ff ff ff ff  |................|
                    000007e0  ff ff ff ff ff ff ff ff   ff ff ff ff ff ff ff ff  |................|
                    000007f0  ff ff ff ff ff ff ff ff   ff ff ff ff ff ff ff ff  |................|

                                ........................[ Analyze ].......................
                                junk0                   (0, 10) -> \x01 \x00 \x00 \x00 \x01 \x00 \x00 \x00 \xff \xff
                                name                    (10, 254) -> \x74 \x65 \x73 \x74 \x31 \x2e \x74 \x78 \x74 \x00 \x00 ...
                                junk1                   (264, 4) -> \x00 \x00 \xff \xff
                                yst_mode                (268, 4) -> \xa4 \x81 \x00 \x00
                                yst_uid                 (272, 4) -> \x00 \x00 \x00 \x00
                                yst_gid                 (276, 4) -> \x00 \x00 \x00 \x00
                                yst_atime               (280, 4) -> \xd4 \x9a \x41 \x68
                                yst_mtime               (284, 4) -> \xd4 \x9a \x41 \x68
                                yst_ctime               (288, 4) -> \xd4 \x9a \x41 \x68
                                file_size_low           (292, 4) -> \x00 \x00 \x00 \x00
                                equiv_id                (296, 4) -> \xff \xff \xff \xff
                                alias                   (300, 160) -> \xff \xff \xff ...
                                yst_rdev                (460, 4) -> \x00 \x00 \x00 \x00
                                win_ctime_1             (464, 4) -> \xd4 \x9a \x41 \x68
                                win_ctime_2             (468, 4) -> \x00 \x00 \x00 \x00
                                win_atime_1             (472, 4) -> \xd4 \x9a \x41 \x68
                                win_atime_2             (476, 4) -> \x00 \x00 \x00 \x00
                                win_mtime_1             (480, 4) -> \xd4 \x9a \x41 \x68
                                win_mtime_2             (484, 4) -> \x00 \x00 \x00 \x00
                                inband_shad_obj_id      (488, 4) -> \x00 \x00 \x00 \x00
                                inband_is_shrink        (492, 4) -> \xff \xff \xff \xff
                                file_size_high          (496, 4) -> \x00 \x00 \x00 \x00
                                reserved                (500, 1) -> \xff
```

```
                                shadows_obj             (501, 4) -> \xff \xff \xff \x00
                                is_shrink               (505, 4) -> \x00 \x00 \x00 \x00

result = {'file_size': 0, 'junk0': b'\x01\x00\x00\x00\x01\x00\x00\x00\xff\xff', 'name': 'test1.txt', 'junk1': 4294901760,
'yst_mode': 33188, 'yst_uid': 0, 'yst_gid': 0, 'yst_atime': 1749129940, 'yst_mtime': 1749129940, 'yst_ctime': 1749129940,
'file_size_low': 0, 'equiv_id': 4294967295, 'alias': '', 'yst_rdev': 0, 'win_ctime_1': 1749129940, 'win_ctime_2': 0,
'win_atime_1': 1749129940, 'win_atime_2': 0, 'win_mtime_1': 17491}

+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-
+-+-+-
```

We can see 3 parts :

- the hexadecimal dump
- the field extraction (as this)
- the result= → after interpretation

6.4.2.2 OOB Part

```
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-
+-+-+-+-+-+-+-+-

---[  oob part ]--- 00000800  ff ff 01 10 00 00 01 01   00 10 01 00 00 80 00 00  |................|
size: 64 bytes      00000810  00 00 2a 38 a2 11 04 00   00 00 fb ff ff ff ff ff  |..*8............|
                    00000820  ff ff ff ff ff ff ff ff   c3 ff 03 aa 5a 57 ff ff  |............ZW..|
                    00000830  ff ff ff ff ff ff ff ff   ff ff ff ff ff ff ff ff  |................|

                                ........................[ Analyze ]........................
                                blockstate              (1, 1) -> \xff
                                sequence_number         (2, 4) -> \x01 \x10 \x00 \x00
                                object_id               (6, 4) -> \x01 \x01 \x00 \x10
                                chunk_id                (10, 4) -> \x01 \x00 \x00 \x80
                                n_bytes                 (14, 2) -> \x00 \x00


result = {'obj_type': 1, 'parent_obj_id': 1, 'has_packed_data': True, 'blockstate': 255, 'sequence_number': 4097, 'object_id':
257, 'chunk_id': 0, 'n_bytes': 0, 'obj_type_name': 'YAFFS_OBJECT_TYPE_FILE', 'bs_signif': 'GOOD Chunk', 'file_size': 0}
```

We can see 3 parts :

- the hexadecimal dump
- the field extraction (as this)
- the result= → after interpretation