

# Data Storage and Data Migration

Reto Kromer • AV Preservation by reto.ch

## Open-Source Tools and Resources for Audio-Visual Archives

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# Summary

- data storage
- data migration

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# Data Migrations

## 2014

- our internal archive from LTO-4 to LTO-6 (5.7 PB)

## 2014–2021

- many migrations for clients

## 2021

- our internal archive from LTO-6 to LTO-8

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# Magnetic Tape

- in use since the 1950s by IT
- cartridges are always on polyester base (old open reels can be on triacetate base)

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## Packaging

- open reel
- cassette
- cartridge

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## Recording

- linear or diagonally
- analogue or digital

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## LTO

- Linear Tape-Open
- answer from the IT industry to the bank and insurance sector
- in 2000 LTO-1
- currently LTO-9
- currently Fujifilm, Hewlett Packard Enterprise, IBM, Quantum and SONY Group form the LTO Consortium

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## LTO-8

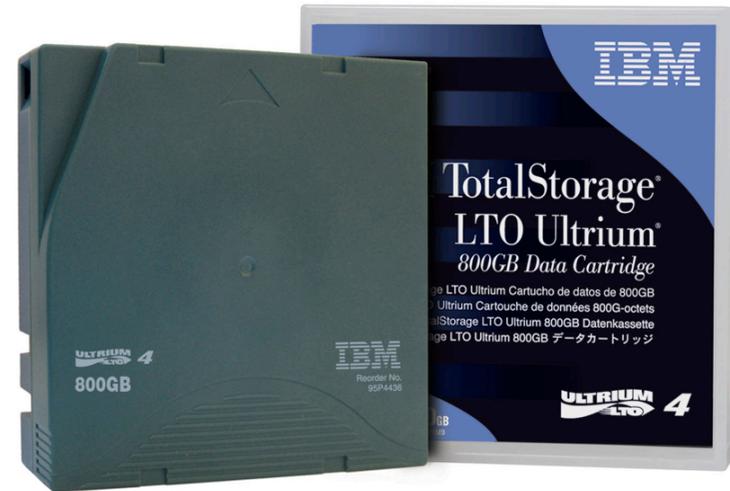
- only one-generation backward reading capabilities
- format M8 = LTO-7 cartridges formatted as LTO-8
- M8 can be used on LTO-8 drives only

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## LTO-9

- LTO-9 drives manufactured by IBM only
- LTO-9 cartridges manufactured by Fujifilm and Sony Group only
- only one-generation backward reading capabilities
- backward reading capabilities for regular LTO-8 (L8), but not M8

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## Formatting

### TAR

- from LTO-1 to LTO-4 only possibility
- still possible possible today

### LTFS

- possible (and recommended) since LTO-5

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## TAR

- standard TAR
  - bloc size
  - number of archives per cartridge
  - archives needing more than one cartridge
- TAR with a proprietary data encoding (e.g. BRU, Retrospect)

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# LTFS

- different versions
- almost one implementation per vendor, but...  
... "lufs" and "mklufs" common commands
- lossless compression (default) or uncompressed data
- unencrypted (default) or encrypted data

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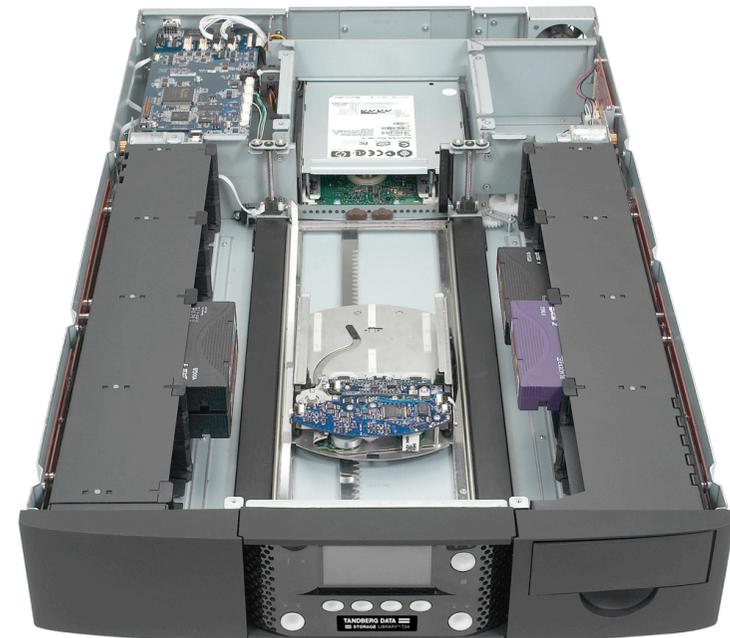
# Drive

- internal or external unit
- library

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## Storage of the Tapes

- in a tape library
- on a shelf
- in a fire-proved cabinet

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## Software

- proprietary or open source
- graphical user interface (GUI) and/or command-line interface (CLI)

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## Plan the Next Migration

- file naming
- barcodes
- checksums
- write the full index to the cartridge
- technical metadata
- code to retrieve the files

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## #1: Film

### FILM

- FILM\_DPX/Film\_nnnnnn.dpx
- Film\_PCM.wav
- Film\_ProRes.mov
- Film\_H264.mp4

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## #2: Video

### VIDEO

- Video\_YUV422.mkv
- Video\_ProRes.mov
- Video\_H264.mp4

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## Longterm

- storage of the cartridges
- three copies...
  - ... in geographically distant locations
- data integrity check
- data migration
- availability of LTO desks

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## Reading

Reto Kromer: **On the Bright Side of Data Migrations**, in «IASA Journal», n. 49 (December 2018), IASA, p. 18–22

→ [retokromer.ch/publications/IASA\\_49.html](http://retokromer.ch/publications/IASA_49.html)

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## read | script | write

script to modify

- container
- codec
- both container and codec
- metadata
- filename

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## #1: ProRes-born Content

### from:

- ProRes stored in a QuickTime (.mov) container

### to:

- ProRes stored in a Matroska (.mkv) container

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## Update the Container

→ read file from source LTO

→ demultiplex file

- ProRes 422, 10 bit [yuv422p10le]
- ProRes 4444, 10 bit [yuv444p10le or yuva444p10le] or 12 bit [yuv444p12le]

→ multiplex file

→ write file to destination LTO

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SMPTE RDD 36:2015

### SMPTE REGISTERED DISCLOSURE DOCUMENT

## Apple ProRes Bitstream Syntax and Decoding Process



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## #2: Video

### from:

- AVI / 8-bit and 10-bit uncompressed
- MOV / 8-bit and 10-bit uncompressed
- MP4 / 8-bit and 10-bit uncompressed

### to:

- Matroska / FFV1

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## Container and Codec

- read file from source LTO
- demultiplex file
- decode file
  - $Y'CbCr$ , 4:2:2, 8 bit, «raw» [uyvy422]
- encode file
- multiplex file
- write file to destination LTO

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## Container and Codec

- read file from source LTO
- demultiplex file
- decode file
  - $Y'CbCr$ , 4:2:2, 10 bit, «raw» [yuv422p10le]
- encode file
- multiplex file
- write file to destination LTO

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## #3: Filename

### from:

- Title\_YUV422.mkv

### to:

- Title\_YCbCr422\_9d5084b5b0a08d5022b39e0e75241d12.mkv

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