

“On date, time, location and other metadata in MP4/MOV files”

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1 Introduction

During writing software to change dates in MP4/MOV files I had a lot of moments that I thought: how is this data stored? There are a lot of special cases that have probably grown during the development and merging with other standards. This document (for now) focuses on the atoms/boxes where metadata is stored. The idea behind this document to make things more clear and explain some of the knotty terminology with things often meaning the same (or not).

About this *webpage design*: there is none. I am currently updating this information in an HTML file that I edit MS Word, with the main aim to also make it printable on A4/letter format. There are Excel tables linked in this document that I want to ‘keep on the page’. I realise that it looks sub-optimal in a browser... Please resize the browser to a small width, or you can view the pdf version [index.pdf](#).

MP4 or Quicktime? What name to use: The MP4 format is based on the Quicktime format[1] but from here I will call it MP4 format since this has become more general.

2 Dates and data in MP4 files

This whole exercise started with the annoyance of having MP4 files wrongly dated because of wrong time-setting on the recording device and also by noticing strange sorting behavior during sorting in Google Photos and other applications. Simply, the first distinction is between the operating system file attributes (time created, modified, last opened) and the data stored within the MP4 file.

3 Atoms that contain metadata

3.1 Metadata atom

The ‘meta’ atom, full name ‘metadata atom’ is one container where metadata is stored in an MP4/MOV file. It can be either a so-called ‘full atom’ with version and flag bytes added, or a non-full atom without the latter two. The size of the atom is variable and depends on all the data inside of it (child atoms).

| Metadata atom | | | |
|---------------|---------|---------|----------|
| Variable | # Bytes | Type | Values |
| Size | 4 | uint32 | variable |
| Type | 4 | uint32 | 'meta' |
| Version | 1 | | 1 |
| Flags | 3 | 3 bytes | |

Position in file. The path of metadata atom can be either \moov\meta or \moov\udta\meta, or both. No more than one atom is allowed in each path. The metadata atom can also be present in :[trak ?].

The meta atom contains many childatoms and data stored in keys. I will not describe the structure of each separate atom inside as this has been often described elsewhere, e.g. (1) and references therein. The idea of this document is to show the structure of the atoms using data from real-life examples in illustrations such as in Table 1. In the top-line the hexadecimal byte values are shown and below descriptive information.

Table 1: Example of metadata atom that has no ‘keys’ section. (file had no metadata before, metadata inserted by Windows property editor). Note that metadata atom is a **full-atom** here. File:[2]

| | | | | | |
|-------------------------|-------------|-------------|-------------------|------------------|--|
| Metadata atom | 00 00 00 C0 | 6D 65 74 61 | 00 00 00 00 | 00 00 00 00 | |
| | size | type meta | v | flags | |
| Metadata handler atom | 00 00 00 21 | 68 64 6C 72 | 00 00 00 00 | 00 00 00 00 | 6D 64 69 72 00 00 00 00 00 00 00 00 00 00 00 00 00 00 |
| | size | type hdlr | v | flags | predefined=0 handler type mdir Reserved=0 Reserved=0 Reserved=0 Name |
| Metadata Item List Atom | 00 00 00 93 | 69 6C 73 74 | | | |
| | size | type ilst | | | |
| Metadata Item Atom | 00 00 00 2E | A9 77 72 74 | | | |
| | size | type @wrt | | | |
| Value atom | 00 00 00 26 | 64 61 74 61 | 00 00 00 01 | 00 00 00 00 | 57 6E 20 63 6F 6D 70 6F 73 65 72 ... |
| | size | type data | type indicator DF | locale indicator | type=1: string Wn composer1/c... |
| Metadata Item Atom | 00 00 00 19 | 74 6D 70 6F | | | |
| | size | type tmpo | | | |
| Value atom | 00 00 00 11 | 64 61 74 61 | 00 00 00 15 | 00 00 00 00 | 00 |
| | size | type data | type indicator DF | locale indicator | type=\$15=21: big-endian signed int in 1,2,3 or 4 bytes |
| Metadata Item Atom | 00 00 00 20 | A9 6E 61 6D | | | |
| | size | type @nam | | | |
| Value atom | 00 00 00 18 | 64 61 74 61 | 00 00 00 01 | 00 00 00 00 | 57 69 6E 54 69 74 6C 65 |
| | size | type data | type indicator DF | locale indicator | type=1: string "WinTitle" |
| Metadata Item Atom | 00 00 00 24 | A9 63 6D 74 | | | |
| | size | type @cmt | | | |
| Value atom | 00 00 00 1C | 64 61 74 61 | 00 00 00 01 | 00 00 00 00 | 57 69 6E 20 43 6F 6D 6D 65 6E 74 73 |
| | size | type data | type indicator DF | locale indicator | type=1: string "Win Comments" |

Table 2: Example of metadata atom that has a ‘keys’ section. Note that metadata atom is a **non-full-atom** here. File: [3]

| | | | | | |
|-------------------------|-------------|-------------|-------------------|---|--|
| Metadata atom | 00 00 xx xx | 6D 65 74 61 | | | |
| | size | type meta | | | |
| Metadata handler atom | 00 00 00 22 | 68 64 6C 72 | 00 00 00 00 | 00 00 00 00 | 6D 64 74 61 00 00 00 00 00 00 00 00 00 00 00 00 00 00 |
| | size | type hdlr | v | flags | predefined=0 handler type mdtA Reserved=0 Reserved=0 Reserved=0 |
| Metadata Item Keys Atom | 00 00 00 93 | 68 65 79 73 | 00 00 00 00 | | |
| | size | type keys | v | flags | entry_count |
| Key value 1 | 00 00 00 28 | 6D 64 74 61 | 63 6F 6D 2E | 61 70 70 6C 65 2E 71 75 69 63 6B 74 69 6D ... | key_name (Apple calls it key_value) com.apple.quicktime.creationdate |
| Key value 2 | 00 00 00 21 | 64 61 74 61 | 63 6F 6D 2E | 61 70 70 6C 65 2E 71 75 69 63 6B 74 69 6D ... | key_name com.apple.quicktime.model |
| Key value 3 | 00 00 00 24 | A9 6E 61 6D | 63 6F 6D 2E | 61 70 70 6C 65 2E 71 75 69 63 6B 74 69 6D ... | key_name com.apple.quicktime.location.ISO6709 |
| Metadata Item List Atom | 00 00 00 xx | 69 6C 73 74 | | | |
| | size | type ilst | | | |
| Metadata Item Atom | 00 00 00 30 | 00 00 00 01 | | | |
| | size | type =key 1 | | | |
| Value atom | 00 00 00 28 | 64 61 74 61 | 00 00 00 01 | 46 52 1A 41 | 32 30 31 34 2D 30 37 2D 30 35 54 ... |
| | size | type data | type indicator DF | locale indicator | type=1: string 2014-07-05T13:02:04+0200 |
| Metadata Item Atom | 00 00 00 21 | 00 00 00 02 | | | |
| | size | type =key 2 | | | |
| Value atom | 00 00 00 19 | 64 61 74 61 | 00 00 00 01 | 46 52 1A 41 | 69 50 68 6F 6E 65 20 35 73 |
| | size | type data | type indicator DF | locale indicator | type=1: string iPhone 5s |
| Metadata Item Atom | 00 00 00 32 | 00 00 00 03 | | | |
| | size | type =key 3 | | | |
| Value atom | 00 00 00 2A | 64 61 74 61 | 00 00 00 01 | 46 52 1A 41 | 2B 34 33 2E 36 35 32 31 2B 30 30 ... |
| | size | type data | type indicator DF | locale indicator | type=1: string +43.6521+003.3638+148.202/ |

3.2 User data atom

A User Data Atom whose immediate parent is a movie atom contains data relevant to the movie as a whole. A User Data Atom whose parent is a track atom contains information relevant to that specific track. A QuickTime movie file may contain many user data atoms, but only one User Data Atom is allowed as the immediate child of any given movie atom or track atom.

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The series of atoms inside a User Data Atom is also referred to as 'user data list'. Each data element in the user data list contains size and type information along with its data. An example is shown in Table 3.

Table 3: Example of user data atom that also contains a meta data atom. File: [4]

| | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
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| User data atom | 00 00 01 CA | 75 64 74 61 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | size | type | udta | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| User data Item Atom | 00 00 00 10 | 53 44 4C 4E | 53 45 51 5F | 50 4C 41 59 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| User data Item Atom | 00 00 00 10 | 73 6D 72 64 | SEQ_PLAY | 54 52 55 45 | 42 4C 55 45 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| User data Item Atom | 00 00 00 1E | A9 78 79 7A | TRUEBLUE | 00 12 15 C7 | 2B 35 30 2E | 39 36 37 38 | 2D 31 31 34 | 2E 30 36 39 | 30 2F | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| User data Item Atom | 00 00 00 1A | 73 6D 74 61 | size | 18 | 15 C7 | 2B 35 30 2E | 39 36 37 38 | 2D 31 31 34 | 2E 30 36 39 | 30 2F | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| User data Item Atom | 00 00 00 1A | 73 6D 74 61 | type | 18 | 15 C7 | 2B 35 30 2E | 39 36 37 38 | 2D 31 31 34 | 2E 30 36 39 | 30 2F | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Metadata atom | 00 00 00 97 | 6D 65 74 61 | saut | 00 00 00 00 | 00 00 00 0E | 73 61 75 74 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | size | type | meta | v | flags | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Metadata handler atom | 00 00 00 20 | 68 64 6C 72 | v | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 6D 64 69 72 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 00 00 00 00 | 0 |

A User Data Atom can also be the container of a Meta Data Atom as is shown in Table 3. Now, an important part that is *different* from the data inside the Meta Data Atom (that also can contain atomtypes starting with ©) is the following:

All user data list entries whose type begins with the © character (ASCII 169) are defined to be international text. These list entries must contain a list of text strings with associated language codes. By storing multiple versions of the same text, a single user data text item can contain translations for different languages. The list of text strings uses a small integer atom format, which is identical to the QuickTime atom format, except that it uses 16-bit values for size and type instead of 32-bit values. **The first value is the size of the string, including the size and type***, and the second value is the language code for the string.

What is meant is probably the following: In the 'Quicktime atom format' (Table 3c) the data is stored in a Value Atom with type 'data' including a 4-byte type indicator (1 for string) and a 4-byte locale indicator. When you reshuffle the bytes of the User Data Item Atom you can place the data in a 'pseudo' Value Atom like in (Table 3b).

***The first value is the size of the string, including the size and type:** type indicator is 1 by definition, type of atom is 'data' by definition.

| | | | | |
|---------|------------------------|-----------------------|------|--|
| Content | Publisher | WM/Publisher | - | |
| | Content provider | WM/ContentDistributor | - | |
| | Media created | <i>cannot be set</i> | - | |
| | Encoded by | WM/EncodedBy | - | |
| | Author URL | WM/AuthorURL | - | |
| | Promotion URL | WM/PromotionURL | - | |
| | Copyright | <i>cannot be set</i> | - | |
| | Parental rating | WM/ParentalRating | - | |
| | Parental rating reason | <i>cannot be set</i> | - | |
| | Composers | - | ©wrt | |
| | Conductors | WM/Conductor | - | |
| | Period | WM/Period | - | |
| | Mood | WM/Mood | - | |
| | Part of set | - | disk | |
| | Initial key | WM/InitialKey | - | |
| | Beats-per-minute | - | tmpo | |
| | Protected | <i>cannot be set</i> | - | |

Information is not easy to find. The data can be stored in various types that are indicated by a type enumeration (like well-know types in the meta atom).

I cannot find this information as you would expect it on the Microsoft website. Although many 'keys' that are used in the Xtra atom (e.g. WM/Composer) are described in the WMF Attribute list (3) including a type enumeration (WMT_ATTR_DATATYPE enumeration); part of this enumeration is as follows: WMT_TYPE_DWORD = 0, WMT_TYPE_STRING = 1, WMT_TYPE_BINARY = 2 etc. However, this is not the enumeration used in the Xtra atom.

The actual enumeration used I found in Exiftool source code (4) and in an Xtrabox Java script (5), and is shown in Table 6. As noted in (4), an implementation has existed in a branch of mp4v2 but has been removed. This is discussed in (6).

Table 6: Type enumeration of Xtra values

| Const Name | Decimal | Hexadecimal |
|----------------------|---------|-------------|
| MP4_XTRA_BT_UNICODE | 8 | \$8 |
| MP4_XTRA_BT_INT64 | 19 | \$13 |
| MP4_XTRA_BT_FILETIME | 21 | \$15 |
| MP4_XTRA_BT_GUID | 72 | \$48 |

Table 7: Example of an Xtra atom

| | | | |
|-----------|-------------------------------|-----------------------------|---|
| Xtra atom | 00 00 03 14 size 788 | 58 74 72 61 type Xtra | |
| Key 1 | 00 00 00 2D key_size 45 | 00 00 00 13 key_name_len | 57 4D 2F 53 68 61 72 65 64 55 73 65 72 52 61 74 69 6E 67 key_name WM/SharedUserRating |
| Value 1 | 00 00 00 0E value_size | 00 13 val_type | 19 00 00 00 00 00 00 00 value |
| Key 2 | 00 00 00 28 key_size 43 | 00 00 00 08 key_name_len | 57 4D 2F 53 75 62 54 69 74 6C 65 00 00 00 01 key_name WM/SubTitle |
| Value 1 | 00 00 00 14 value_size | 00 08 val_type | 4D 00 79 00 53 00 75 00 62 00 74 00 00 00 value M . y . S . u . b . t . . . |
| Key 3 | 00 00 00 3F key_size 63 | 00 00 00 08 key_name_len | 57 4D 2F 43 61 74 65 67 6F 72 79 00 00 00 02 key_name WM/Category |
| Value 1 | 00 00 00 14 value_size | 00 08 val_type | 4D 00 79 00 54 00 61 00 67 00 31 00 00 00 value M . y . T . a . g . 1 . . . |
| Value 2 | 00 00 00 14 value_size | 00 08 val_type | 4D 00 79 00 54 00 61 00 67 00 32 00 00 00 value M . y . T . a . g . 2 . . . |
| Key 4 | 00 00 00 27 key_size | 00 00 00 07 key_name_len | 57 4D 2F 4D 6F 6F 64 00 00 00 01 key_name WM/Mood |
| Value 1 | 00 00 00 14 value_size | 00 08 val_type | 4D 00 79 00 4D 00 6F 00 6F 00 64 00 00 00 value M . y . M . o . o . d . . . |

3.4 EXIF tag data in general

The next section will be about the Nikon NCTG atom that contains data stored in an EXIF format. Therefore first this section, because this is more general and will also exist in other atoms.

EXIF data is stored using a tag and then the data, like this:

| | | | |
|-----|----------|-------|------|
| tag | val_type | count | data |
|-----|----------|-------|------|

In this section the tag is not discussed, only how the value is stored and how to read it.

Like in the other containers of data, EXIF also works with a type enumeration. I call these enumerators 'val_type' to keep consistency, but they are specific to EXIF and also introduce the "rational", which is a fraction of two 4-byte integers stored inside an 8-byte variable (7). This enumeration is shown in Table 8.

The 2-byte 'type' is always followed by a 2-byte 'count'. In structures described until now, the length of the total data is usually indicated by one value. In case EXIF data you have to find this by multiplying:

BytesToRead=(# bytes specified by 'val_type' enumerator) x ('count').

As regards the 'tag'. EXIF data is stored using tags that are very specific for each case. So when inside an NCTG atom the tag 1 can mean the 'Make of the camera' while in a completely other case it can mean 'depth under sea level'. The example shown in the next section will demonstrate how this works.

Table 8: EXIF data type enumeration (7)

| Enumerator | Format | # bytes | Comment |
|------------|-------------------|---------|--|
| 1 | unsigned byte | 1 | |
| 2 | ascii strings | 1 | |
| 3 | unsigned short | 2 | |
| 4 | unsigned long | 4 | |
| 5 | unsigned rational | 8 | "rational" is fractional value, first (u)int32 is numerator, 2nd (u)int32 is denominator |
| 6 | signed byte | 1 | |
| 7 | undefined | 1 | |
| 8 | signed short | 2 | |
| 9 | signed long | 4 | |
| 10 | signed rational | 8 | |
| 11 | single float | 4 | |
| 12 | double float | 8 | |

3.5 Nikon NCTG atom

The Nikon tags are stored in an EXIF format (see 3.4). As described, for EXIF you need specific tables to find the meaning of each tag. They are just stored as numbers and can mean anything in every different case.

An example of EXIF data is the NCTG atom. This clearly demonstrates that you need a table to correlate what each tag means. In this case 1 means the make of the camera.

Table 9: Tag enumeration inside an NCTG atom (just parts; outtake of the total list)

| | |
|----------|------------------|
| 1 | Make |
| 2 | Model |
| 3 | Software |
| 17 | CreateDate |
| 18 | DateTimeOriginal |
| 19 | FrameCount |
| 22 | FrameRate |
| 25 | TimeZone |
| 34 | FrameWidth |
| 17859226 | ExposureTime |
| 17859229 | FNumber |
| 17860642 | ExposureProgram |

A real-life example is shown in

Table 10. A simple example is Tag 1. The tag is 1. Lookup-value in Table 9 shows that it is the 'Make'. The val_type is 2, lookup-value in Table 8 shows that it is a string. The count is 6, so 6 characters to read (including \0, so it is a

null-terminated C type string). Strangely, Tag 2 is terminated by two zeros. In a similar way, as a string, the Createdate is stored (Tag 7). Notice that semicolons are use as separators.

An example of a 'rational' is shown in Tag 5. The tag enumerator is \$17 (dec 23), which is not in tables I have found, but it looks like it is also the Framerate. The val_type is 5, a rational that is 8 bytes wide (Table 8). The four-byte numerator is 50000, the four-byte denominator is 1000, so the value is 50.

Table 10: Specific example of an NCTG atom (composed of different tags encountered)

| NCTG atom | 00 00 xx xx | 4E 43 54 47 | size | type | NCTG |
|-----------|-----------------|-------------|-------|-------|---|
| Tag 1 | 00 00 00 01 | 00 02 | 00 06 | count | 4E 49 4B 4F 4E 00 |
| | tag | val_type | | | data |
| | 1=Make | 2 | 6 | | N I K O N . |
| Tag 2 | 00 00 00 02 | 00 02 | 00 0E | count | 43 4F 4F 4C 50 49 58 20 50 39 30 30 00 00 |
| | tag | val_type | | | data |
| | 2=model | 2 | 14 | | C O O L P I X |
| Tag 3 | 00 00 00 03 | 00 02 | 00 16 | count | 43 4F 4F 4C 50 49 58 20 50 39 30 30 20 56 65 72 2E 31 2E 34 31 00 |
| | tag | val_type | | | data |
| | 3=softw. | 2 | 22 | | C O O L P I X P 9 0 0 V e r . 1 . 4 1 . |
| Tag 4 | 00 00 00 13 | 00 04 | 00 02 | count | 00 00 00 4B 00 00 00 00 |
| | tag | val_type | | | data |
| | \$13=framecount | 4 | 2 | | . . . K . . . |
| Tag 5 | 00 00 00 17 | 00 05 | 00 01 | count | 00 00 C3 50 00 00 03 E8 |
| | tag | val_type | | | data |
| | \$17=framerate? | 5 | 1 | | d uint32: 50000 d uint32:1000 |
| Tag 6 | 00 00 00 18 | 00 03 | 00 01 | count | 00 01 |
| | tag | val_type | | | data |
| | \$18=unkn now | 3 | 1 | | 1 |
| Tag 7 | 00 00 00 11 | 00 02 | 00 14 | count | 32 30 31 39 3A 30 38 3A 31 30 20 31 34 3A 34 32 3A 35 34 00 |
| | tag | val_type | | | data |
| | 17=Createdate | 2 | 20 | | 2 0 1 9 : 0 8 : 1 0 1 4 : 4 2 : 5 4 . |

1 https://en.wikipedia.org/wiki/MPEG-4_Part_14#

2 MOV_0234-windowscomments.mp4

3 Apple-Iphone5s.mov

4 Android 6.0.1 - with tags added by Windows Explorer.mp4

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