ISOBMFF@DVB
“Beyond TS” Workshop

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Overview

• ISOBMFF, standards and statuses
• ISOBMFF basic concepts
• Types and usages of ISOBMFF files
• On-going works
• How to extend the ISOBMFF ?
• ISO Base Media File Format, formally known as:
  – 14496-12 (MPEG) and 15444-12 (JPEG)
  – identical text, for historical reasons

• Core specification for several formats, freely available
  – 5th edition about to be published integrating
    • AMD1:2013 (files with brand iso7)
    • COR1:2013 (item location)
    • AMD2:2014 (timed text)
    • COR2:2014 (timed text, sidx)
    • AMD3:2015 (fonts, files with brand iso8)
    • COR3:2015 (fragments)
    • AMD4 (iso9, audio, language, SAP)
ISOMBFF: standards and statuses (2/2)

- MPEG-defined extension specifications
  - Carriage of MPEG-4 Systems data in ISOBMFF
    - 14496-14:2003 (strictly speaking the MP4 FF, iods box)
  - Carriage of NAL-unit structured video in ISOBMFF (AVC, HEVC, ...)
  - Carriage of MPEG-21 assets
    - 21000-9:2005
  - Carriage of TTML and WebVTT in ISOBMFF
    - 14496-30:2014
- Other extensions: 3GPP, F4V, ...
**ISOBMFF: conformance and reference software**

- **Conformance bit streams**
  - ISO/IEC 14496-4
  - Some streams are freely available
    - See [http://standards.iso.org/ittf/PubliclyAvailableStandards/](http://standards.iso.org/ittf/PubliclyAvailableStandards/)
  - More are welcome

- **Software**
  - ISO/IEC 14496-5
  - Reference software, freely available
    - C, ISO Licence
    - Read/Write MP4 files
  - Contributions are welcome

- **Intent to remove technologies from standard (corrigendum)**
  - If no bitstream
  - And no reference software
ISO BMFF: Logical Structure

• A file
  – Contains
    • Timed data in tracks of a movie
    • Other data (untimed) in items
    • Or a combination of both
  – Defines a common timeline for all tracks to be synchronized

• A track
  – Corresponds to a specific media type (codec).
  – Is associated to a single decoder (except for scalable codecs).
  – May be linked, grouped or alternative to other tracks
  – May have associated untimed data in items
  – May be encrypted
  – Is decomposed into samples

• A sample
  – Represents contiguous data used by a decoder at given times (DTS, CTS)
  – Has properties (size, position, random access, decoder configuration...)
  – May be described in terms of sub-samples
  – May be associated to other similar samples in sample groups
  – May have sample-specific auxiliary information

• An item
  – Represents data consumed as a whole and valid for the entire duration of the movie.
  – Has properties (type, position, size ...)
### ISO BMFF: Separation of data

<table>
<thead>
<tr>
<th>Movie Media Data</th>
<th>Video track information</th>
<th>Audio track information</th>
</tr>
</thead>
<tbody>
<tr>
<td>Track header</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Track header</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Movie header**

- Sample
- Sample frame
- Sample
- Sample frame
ISOBMFF: Physical Structure

• Data is stored in a basic structure called box
  – No data outside of a box

• Each box has length, type (4 printable chars), possibly version and flags, and data
  – Extensible format:
    • Unknown boxes can be skipped (syntactically)

• Header information is a hierarchical set of boxes (typically ‘moov’ or ‘meta’)

• Media data is stored unstructured, in boxes (mainly ‘mdat’, or ‘idat’) in the same file as the header or may be stored in a separate file
Typical Box Hierarchy (1 track)

ISO File

ftyp

moov

mvhd

trak

iods

tkhd

mdia

... 

mdhd

minf

hdlr

vmhd

dinf

stbl

... 

dref

stsd

stts

stsz

... 

mdat

... 

Data not box-structured
Typical Box Hierarchy (Untimed)
ISOBMFF:

File Types & Usages (1/2)

• Plain Files
  – Simple recording of timed data (data first, header last)
  – ISOBMFF Tools: mdat, moov, ...

• Progressive Files
  – Progressive download and playback (Header first, data last and interleaved)
  – ISOBMFF Tools: storage using chunk offsets

• Fragmented Files
  – Files for long-running recording sessions (multiple blocks of header and data)
  – ISOBMFF Tools: Movie fragments
Structure of a fragmented file

<table>
<thead>
<tr>
<th>moov</th>
<th>Video track</th>
<th>Audio track</th>
</tr>
</thead>
<tbody>
<tr>
<td>trak</td>
<td>trex</td>
<td>trak</td>
</tr>
<tr>
<td>trex</td>
<td></td>
<td>trex</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>mdat</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image1" alt="Movie fragment" /></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>moof</th>
<th>traf</th>
<th>trun</th>
</tr>
</thead>
<tbody>
<tr>
<td>trun</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>mdat</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image2" alt="Movie fragment" /></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>moof</th>
<th>traf</th>
<th>trun</th>
</tr>
</thead>
<tbody>
<tr>
<td>trun</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>mdat</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image3" alt="Movie fragment" /></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>moof</th>
<th>traf</th>
<th>trun</th>
</tr>
</thead>
<tbody>
<tr>
<td>trun</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>mdat</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image4" alt="Movie fragment" /></td>
</tr>
</tbody>
</table>
ISOBMFF:

**File Types & Usages (2/2)**

- **Segmented Files**
  - Self-contained fragments stored in separate files for HTTP streaming
  - ISOBMFF Tools: Initialization vs. Media Segments, indexing

- **Streamable files**
  - Protocol-specific instructions to create streams from files
  - ISOBMFF Tools: hint tracks (RTP, FLUTE, ...)

- **Stream recording files**
  - Recording of protocol-specific packets into files for replay
  - ISOBMFF Tools: reception hint tracks (RTP, MPEG-2 TS)

- **Packaging files**
  - Storage of related timed or untimed data (e.g. JPEG or XML + audio/video)
  - ISOBMFF Tools: ‘meta’
Dual Headed File: Timed and Untimed data

File
- ftyp
- moov
  - mvhd
  - trak
    - tkhd
    - mdia
  - tref
    - mdhd
    - minf
    - hdlr
- mdat
- hdlr
- meta
  - iinf
  - iloc
  - ipro
    - sinf
- vmhd
- dinf
  - stbl
    - stbl
    - dref
    - stsd
    - stts
    - ctts
    - stsc
    - stsz
    - …
Identifying ISOBMFF files

• Extension not sufficient
  – mp4, m4a, m4s, 3gp ...

• Magic number: ‘ftyp’/‘styp’
  – brands
    • Compatible brand: “claim and permission”
    • Major brand: “best use”
  – “isom”, “avc1”, “isoX” (X=2…9), “mp41”, “mp71”, ...

• MIME types and codecs (RFC 6381)
  – “video/mp4”: if it contains visual data
  – “audio/mp4”: otherwise, if it contains audio,
  – “application/mp4”: otherwise (in particular metadata, …)
  – “codecs” sub-parameter
    • Comma-separated list of track information
    • Uses the sample entry 4cc: “avc1”, “mp4a”, “stpp”,
    • Additional codec-specific information (profiles, levels …)
  – “profiles” sub-parameter
On-going developments

- **Layered HEVC**
  - Scalable, multiview, ...

- **Sample Variants**
  - Multiple versions of each sample
  - Instructions to reconstruct a unique stream

- **Image File Format**
  - Storage of HEVC still images or image collections (short animations, multispectral, ...)
Extending the ISOBMFF

(1/3)

• Easy extensions
  – New codec for temporal data for which you own the sample format (e.g. Opus in MP4)
  – New sample groups for (codec-specific) annotation of samples (e.g. HEVC CRA/BLA)
  – New sample auxiliary data, for (codec-specific) per-sample data (e.g. init vector, …)
  – New untimed data format (e.g. EXIF, XMPP …)
Extending the ISOBMFF

2/3

• Harder extensions
  – Beware of backwards compatibility!
  – Only if all other options have been exhausted

  – Extending existing boxes
    • Use versioning and/or flags

  – New boxes (almost always the wrong option!)
    • Check for name clashes (www.mp4ra.org)
    • Define box syntax and semantics
    • Choose box location and cardinality
      – Timed/Untimed information
      – File level, segment level, movie level, track level, sample level, ...
    • Define new brand if it implies behavior changes/incompatibilities
Extending the ISOBMFF

(3/3)

• Process recommendations
  – Inform/discuss on mp4-sys mailing list, by liaisons or by attending the meetings,
  – Register non-MPEG code points with registration authority
Summary

• **Successful file format**
  – Very versatile: from editing to HTTP streaming
  – Very extensible (codecs, usages, …)
  – Some problems (“Beyond MP4” experiment)

• “The” Solution beyond TS ?
  – Check broadcast-specific requirements (tune-in, compression, …) -> adopt the format or extend the format
Thank you

QUESTIONS ?