Multimedia content representation

2024/25 Q2

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DAC – UPC

* Part of the material comes from other sources.

Multimedia content

- Life-cycle
- Content architectures
  - Concepts
  - Classification
- Content types
  - Characters
  - Audio
  - Images
  - Video
- Structures and containers
- Metadata

Multimedia content

Life-cycle

- Creation
- Storage
- Processing
- Distribution
- (Preservation)
- Deletion

Multimedia content

Life-cycle

- Creation
- Storage
- **Processing**
- Distribution
- (Preservation)
- Deletion

Multimedia content: Processing

- ***Use***

- CRUD → (Create) Read Update (Delete)

- Read: Access, “render” (play, reproduce, …)
- Update: Transform, Combine, *Manipulate*
- …

Multimedia content

Life-cycle

- Creation
- Storage
- Processing
- Distribution
- (Preservation)
- Deletion

→ medio físico se puede deteriorar
- formato en qe está guardado puede deprecarse

Elements

- Identification
- Description (Metadata)
- Coding
- Transfer (Comm. protocols)
- Search
- *Business Models*
- Digital Rights Management

- **Information (Formats: Metadata + Resources)**
- **Protocols (Dialogue, Operations)**

Multimedia content

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- **Content architectures**
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Content architectures

- *Monomedia vs. Multimedia*
- *Monomedia content types*

- Classification: Based on what?

- Concepts to consider:
  - Captured/Scanned vs. Synthetized
  - Space, time, … (dimensions)
  - Human senses: hearing, vision, ...
  - ...

Content architectures

- A first simple classification:
  - Characters
  - Audio
  - Image
  - Video

Content architectures

- Classification: Based on what?
- Concepts to consider:
  - …
- EXERCISE:
  - What other digital content types, apart from characters, audio, image, video?
  - Main standards?

Digital content types

EXERCISE

- Other content/concepts:
  - PDF
  - Ejecutable
  - Excel
  - 3D

Content architectures

- Classification – “Other things”:
  - 3D !
  - Computational data / Databases / Application specific information (“Applications”!)
  - Scalar numbers
  - Bio-signals

    (“perpendicular”?: *according to its use”)*
  - Games, virtual/augmented reality
  - Software? e-books? *Document formats*
  - *Structures and containers!*

Content architectures

- Another approach (MIME Content types):
    - application
    - audio
    - example
    - font
    - haptics
    - image
    - message
    - model
    - multipart
    - text
    - video

MIME Content types

- application
- audio
- example
- font
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Characters vs. Text

- Characters: Monomedia
- Text:
  - “Plain” (→ characters)
  - “Rich” (format, structure!)
- Text → Documents!
- Documents:
  - Multimedia structures
  - Logical and physical (layout) structure
    Presentation

- **We focus now on characters**

Characters

- Coding / representation
- Visualization: Fonts, …
- Character Sets:
  - ASCII → ISO 646 → 127 characters
  - ISO 2022: Variable width encoding (7-8 bits bytes). Escape chars → 255characters

    bytes de 7-8 bits
  - **ISO/IEC 8859** (8-bit printable chars encodings): 1 part for different charsets (Latin, Arabic, Hebrew, …)

    8859-1 : one language
    8859-2 : another language
    ⋮
  - UCS (Universal Character Set)
    - ISO/IEC 10646
    - Aligned to **UNICODE**
    - **UTF-x** concept (UTF-7, UTF-8, UTF-16, UTF-32)

Unicode Characters

- A **character** is a symbol that appears in a text
  - letters of the alphabet
  - pictograms (like ©)
  - accents
- Unicode characters are abstract entities:
  - `LATIN CAPITAL LETTER A`
  - `LATIN CAPITAL LETTER A WITH RING ABOVE`
  - `HIRAGANA LETTER SA`
  - `RUNIC LETTER THURISAZ THURS THORN`

Hiragana letter SA

さ

Runic letter Thurisaz Thurs Thorn

ᚦ

Unicode Glyphs

- A **glyph** is a graphical presentation
- A typical example is: Å
- This may represent several characters:
  - `LATIN CAPITAL LETTER A WITH RING ABOVE`
  - `ANGSTROM SIGN`

same character

They belong to two different unicodes

- Or even a sequence of characters:
  - `LATIN CAPITAL LETTER A`
    `COMBINING RING ABOVE`
- Some characters even result in several glyphs

Unicode Code Points

- A **code point** is a unique number assigned to every Unicode character
- Code points are between 0 and 1,114,112
- Only around 100,000 are used today
- The character `HIRAGANA LETTER SA` is assigned the code point 12,373
- Code point 0 through 127 coincide with ASCII
- Some code point are never assigned

Unicode Character Encoding

- A **character encoding** interprets a sequence of bytes as a sequence of code points
- The bytes are first parsed into **code units** → bloques de información en las que se codifica
- Code units have a fixed length
- One or more code units may be required to denote a code point
- Examples are UTF-8, UTF-16, UTF-32 → máximo sólo 1 code unit

2 code units

se codifica en un número múltiplo de 8 hasta 4 code units

UTF-8

- A code unit is a single byte
- A code point is from 1 to 4 code units
- Code units between 0 and 127 directly represent the corresponding code points
- `110XXXXX` indicates that 2 code units are used
- `1110XXXX` indicates that 3 code units are used
- `11110XXX` indicates that 4 code units are used
- The remaining code units looks like `10XXXXXX`

$$11110\underbrace{xxx}_{3} \quad 10\underbrace{xxxxxx}_{+\ 6} \quad 10\underbrace{xxxxxx}_{6} \quad 10\underbrace{xxxxxx}_{6}$$

UTF-8 Example

- 11100011 10000001 10010101
- **1110**0011 **10**000001 **10**010101
- 11000001010101
- 12,373

3055 H

- HIRAGANA LETTER SA

UTF-16

- A code unit consists of 2 bytes
- Code points below 65,536 are in a single code unit
- Higher code points are represented as:
  - `110110XXXXXXXXXX 110111XXXXXXXXXX`

  (after subtracting 65,536)
- This makes sense because Unicode assign no code points between the numbers:

  `1101100000000000 (55,296)`

  and

  `1101111111111111 (57,343)`

UTF-16 Example

“Big-endian byte order” / Character

- 11111110 11111111 00110000 01010101
- 00110000 01010101
- 12,373

3055 H

- HIRAGANA LETTER SA

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Audio/Sound

- One dimension
- “Speech” or not. Frequency ranges
- Natural (recorded) or generated
- Structured (“symbols”)

- Coding and compression formats

- Oído humano: 20 - 20000 Hz
- voz humana: 300 - 3000 Hz

Audio standards (1/2)

- Telephony/Speech:
  - PCM (Pulse Code Modulation). Logarithmic.
  - G.7xx - GSM
- Music:
  - CD-DA (Compact Disc – Digital Audio). Linear PCM.
    → 1,411 Mbps (CD-ROM x1)
  - DVD-Audio → 9,216 Mbps
  - Music specific: MIDI (Musical Instrument Digital Interface)
- Broadcasting/video:
  - Based on human hearing (perception)
  - MPEG-1 Layer III (**mp3**)
  - MPEG-2 **AAC** (Advanced Audio Coding)

Audio standards (2/2)

- Open Source (*xiph.org* Foundation):
  - *Lossy:*
    - **Vorbis**: ('00) Competing with mp3/AAC
    - **Opus** (mainly authored by Mozilla and Skype):
      - RFC 6716 (2012)
      - Updated in RFC 8251 (2017)
  - *Lossless:*
    - FLAC (Free Lossless Audio Codec), 2001
- Vendors:
  - Lossless:
    - ALAC (Apple Lossless Audio Codec):
      - 2004, open source in 2011

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Images

- 2 dimensions
- Still images

- **Raster**/Pixels/Bitmap vs. **Vector**
- (Capture/Scanning vs. Synthesis)

Images

- 2 dimensions
- Still images

- **Raster**/Pixels/Bitmap vs. **Vector**
- (Capture/Scanning vs. Synthesis)

- **Vector graphics**:
  - Geometric objects
    (lines, polygons, circles, ellipses, curves, …)

Vector graphics formats

Standards:

- CGM. Computer Graphics Metafile. (File format / container). ISO/IEC 8632. `image/cgm`
- SVG. Scalable Vector Graphics. XML based. W3C (May include raster graphics). `image/svg+xml`
- SVG 2 (2018)
- …

Proprietary:

- Adobe Illustrator. `application/illustrator`
- CorelDRAW. `application/coreldraw`
- Encapsulated PostScript (EPS). `application/postscript`
- …

Images

- 2 dimensions
- Still images

- **Raster**/Pixels/Bitmap vs. **Vector**
- (Capture/Scanning vs. Synthesis)

- **Raster images:**
  - Bits per pixel (“depth”)
  - Formats/Standards

Image (compression) formats

ISO standards:

- JPEG. ISO/IEC 10918 / ITU-T T.81 ('92 → '94) `image/jpeg`
- JPEG2000. ISO/IEC 15444 ('01 → '19). `image/jpeg2000`
- JPEG XR. eXtended Range. ISO/IEC 29199 / ITU-T T.83x ('09 → '20). `image/vnd.ms-photo, image/jxr`
- JPEG XT. eXTensions (compatible). ISO/IEC 18477 Includes HDR (High Dynamic Range)
- JPEG XL (better image quality and compression ratios)
- Other JPEG formats …
- **`https://jpeg.org/`**

Image formats - JPEG

JPEG
JPEG
JPEG
2000
JPEG
AI
JPEG
AIC
JPEG
LS
JPEG
Pleno
JPEG
Systems
JPEG
Trust
JPEG
XL
JPEG
XR
JPEG
XS
JPEG
XT

- `https://jpeg.org/`

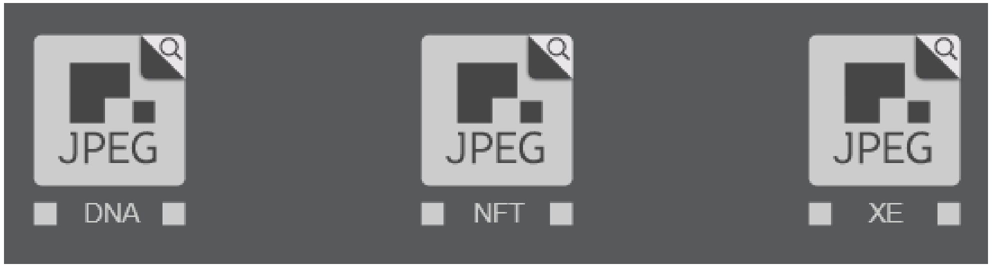

Image formats - JPEG

Engineering “Emmy” prize in 2019

https://www.iso.org/news/ref2441.html

- htt g/

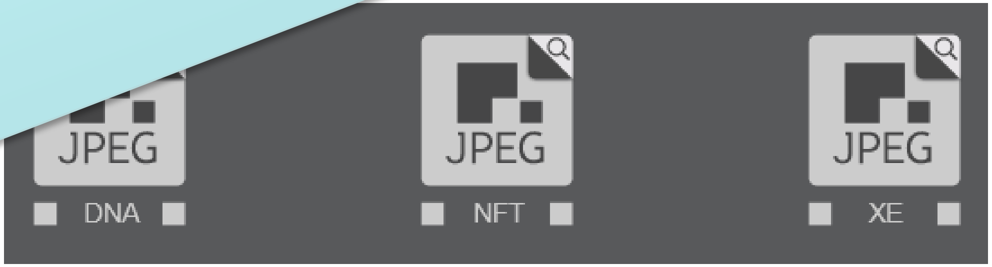

Image formats

“Professional” use:

- DPX. Digital Picture Exchange. ANSI/SMPTE standard (268M-2003 (268M-1994), 268-1:2014, 268-2:2018) `image/dpx`

- “RAW”: raw image formats.

- ISO 12234-2, Tag Image File Format / Electronic Photography (TIFF/EP), 2001

Image formats

“Individual” use:

- BMP. Microsoft Windows bitmap, 1986. `image/bmp`
- GIF. Graphics Interchange format. CompuServe, 1987 Patents expired 2003. `image/gif`
- WebP. Google. 2010. Based on VP8 (video). Smaller files but concerns on image quality. Also *container.* `image/webp`
- BPG (Better Portable Graphics), 2014. `image/bpg`
- …

Not so popular:

- FLIF (Free Lossless Image Format), 2015. `image/flif`

Image file formats / containers

(not clear diferentiation "format" / "file format" !!!)

- JFIF. JPEG File Interchange Format
- PNG. Portable Network Graphics. Donated to W3C ('96) (Informational) RFC 2083 ('97), ISO/IEC 15948 ('04) **Datastream** (lossless) & Associated **file** format. `image/png`
- TIFF. Tagged Image File Format. Adobe(v.6,1992) `image/tiff`
- …

(New/future) Image formats

FROM VIDEO FORMATS:

- AVIF (*AV1 Image File Format*): Image File Format of *AV1*, from Alliance for Open Media (AOMedia) (2019)

- HEIF (*High Efficiency Image File Format*): Image File Format of *HEVC* (High Efficiency Video Coding), specified in *MPEG-H* part 12 (ISO/IEC 23008-12) (1st in 2017, Ed.2 2022, Ed.3 in 2025). Based on *ISOBMFF*

- HEIC (*High Efficiency Image Coding*): A specific implementation of HEIF using the *HEVC* codec (“HEVC in HEIF”). Mainly supported by Apple

- WebP: Based on *VP8*. Includes a *RIFF*-based container. From Google (2010). Web-oriented

(New/future) Image formats

Next-Generation JPEG Image Coding:

- JPEG-XL (JPEG XL image coding system): ISO/IEC 18181

  Web-oriented. JPEG-1 backwards compatible

  Parts

  1: Core coding system (2024, *2022 version withdrawn*)

  2: File format (2024)

  3: Conformance testing (2022, *under revision*)

  4: Reference software (2022)

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Video

- 3 dimensions (2D + time)
- “Moving images”
- Animation = “moving vector graphics”
- Capture vs. Synthesis
- Series of “frames” (raster images)
  → Frames per second
- Compression/Coding

- 3D video!

Animation (“moving vector graphics”)

- Motion controlled by vectors rather than pixels
- Scalable Vector Graphics (SVG) for still vector graphics
- SVG2 allows animation: With JavaScript, f.e.
- Synchronized Multimedia Integration Language (**SMIL**). Version 3.0 December 2018 (W3C)
- SMIL:
  - write interactive multimedia presentations
  - describe temporal behaviour

Video compression formats

- Color: RGB → luma + chroma (2); subsampling
- TV: ITU-R Rec. 601 (1982!)
- Pure sequence of images (spatial compression):
  - M-JPEG, M-JPEG2000
- MPEGs (+ temporal compression; I-, P- & B-frames)
- Others:

Video compression formats

- Color: RGB → luma + chroma (2); subsampling
- TV: ITU-R Rec. 601 (1982!)
- Pure sequence of images (spatial compression):
  - M-JPEG, M-JPEG2000
- **MPEGs** (+ temporal compression; I-, P- & B-frames)

Video compression formats

- **MPEGs** (+ temporal compression; **I**-, P- & B-frames):
  - MPEG-1 (ISO/IEC 11172) ("CD-ROM")
  - MPEG-2 (ISO/IEC 13818 / ITU-T H.262) ("DVD")
  - MPEG-4 part 2 "visual" (objects) (ISO/IEC 14496) (ASF profile compatible with H.263)
  - **AVC, Advanced Video Coding (MPEG-4 part 10 / H.264)** ("Web")
  - HEVC, …
  - *(H.261, H.263; transmission, videoconferencing)*

HEVC (High Efficiency Video Coding)

- Video compression standard after AVC (MPEG-4)
- ISO/IEC 23008-2 MPEG-H / ITU-T H.265
- Improvement over MPEG-4 AVC:

  - Double data compression for the same quality, or
  - better quality for the same bit rate
- High resolutions:

  Ultra HD TV 8K support (up to 8192 × 4320)

HEVC (High Efficiency Video Coding)

- Video compression standard after AV MPEG-4)
- ISO/IEC 23008-2 **MPEG-H** / IT
- Improvement over MP
  - Double dat or
  - bett
- H

  2 × 4320)

Engineering "Emmy" prize in 2017

https://www.emmys.com/news/awards-news/engineering-awards-170927

HEVC (High Efficiency Video Coding)

- Video co pression standard after AV MPEG-4)
- ISO/IEC MPEG-H / IT
- Impro
  - or
- H
)

"Emmy"

7

ards-

E

https://www.emmys.

Problems with patents!!!

Video compression formats

- **MPEGs** (+ temporal compression; I-, P- & B-frames):
  - MPEG-1 (ISO/IEC 11172)
  - MPEG-2 (ISO/IEC 13818 / ITU-T H.262)
  - MPEG-4 part 2 “visual” (objects) (ISO/IEC 14496) (ASF profile compatible with H.263)
  - AVC (MPEG-4 part 10 / H.264)
  - HEVC, …

- **Others**:
  - VP8 (Google) 2010. Open Source. RFC6386
  - VP9 → **AV1** **(Alliance for Open Media)** ***(royalty-free)***

Still more compression possible?

- AVC (H.264) → HEVC (H.265) → ??

Still more compression possible?

- AVC (H.264) → HEVC (H.265) → ??

VVC: **Versatile Video Coding**

- Developed in MPEG Committees (JVET)
- MPEG-I: ISO/IEC 23090 / H.266
  Coded Representation of Immersive Media

→ **Part 3: VVC (published 2021,**
3rd Ed., 2024, AMDs)

→ Part 12: Immersive video (FDIS 2nd Ed., 2025)

→ Part 4: Immersive audio (FDIS 2025)
… 39 parts already!

Still more compression possible?

- AVC (H.264) → HEVC (H.265) → ??

VVC: **Versatile Vid**

- Developed in M
- MPEG

Cod   Media

→   021,

MDs)

→ P   mersive video (FDIS 2nd Ed., 2025)

→ Par   4: Immersive audio (FDIS 2025)

… 39 parts already!

Patents: MPEG LA +
Media Coding Industry
Forum (MC-IF)

→ Licensement

Patents? Licenses?

- New standard in MPEG → MPEG-5 !!

  Essential Video Coding

- Objective: solve the need for a “licensing-friendly” video codec that would facilitate the timely availability of clear and transparent Type 2 licensing terms, with HEVC-level quality.

- ISO/IEC 23094. No new algorithms! (**2020**, *Amendments and new parts*)

MPEG Other video codings

- ISO/IEC 23094-1:
  Essential Video Coding (EVC)

- ISO/IEC 23094-2: Low Complexity Enhancement Video Coding (LCEVC)

- Future:
  - (Video) coding for machines
  - Lenslet video coding
  - …

Multimedia content

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  - Audio
  - Images
  - Video
- **Structures and containers**
- Metadata

Structures and containers

- *Structures → Documents*

llevar cosas juntas

- Containers → Multimedia containers
- Files → File formats
- Information ("film" example):
  - Audio streams
  - Video streams
  - Synchronization info
  - Metadata
  - Complementary info: subtitles, chapters, …
- Parts:
  "chunks", "atoms", "packets", "segments", …
  contain the "payload" (data)

Multimedia containers

- **Proprietary**
  - Microsoft/IBM: RIFF (Resource Interchange FF)
  - Microsoft: ASF, AVI, …
  - Adobe: Flash video, …
- **Open**
  - Matroska (.mkv) [*Very much used for video*]
  - Google: WebM (VP8+Vorbis for HTML5). (Based on Matroska)
    (***Now***: VP9+Opus)
  - Xiph.org: ogg (Theora+Vorbis for HTML5)
  - …

WebP uses RIFF as container
WAV, AVI, etc. are derived from RIFF

Multimedia containers

- **Standard**
  - DVD Forum: VOB
  - 3GP * (mobile)
  - MJ2 * (Motion JPEG 2000)
  - MPEG-2 TS --> Transform Stream
  - MP4 * (MPEG-4 Parts 14 & 15)
  - MXF (Material eXchange Format), SMPTE (TV broadc.)
  - MPEG-21 *
  - HEIF*(High Efficiency Image File Format), ISO/IEC 23008-12

* *Based on ISO base media file format (ISOBMFF)*

↳ mecanismo genérico de contenedor estandarizado por ISO se
se puede particularizar para casos concretos.

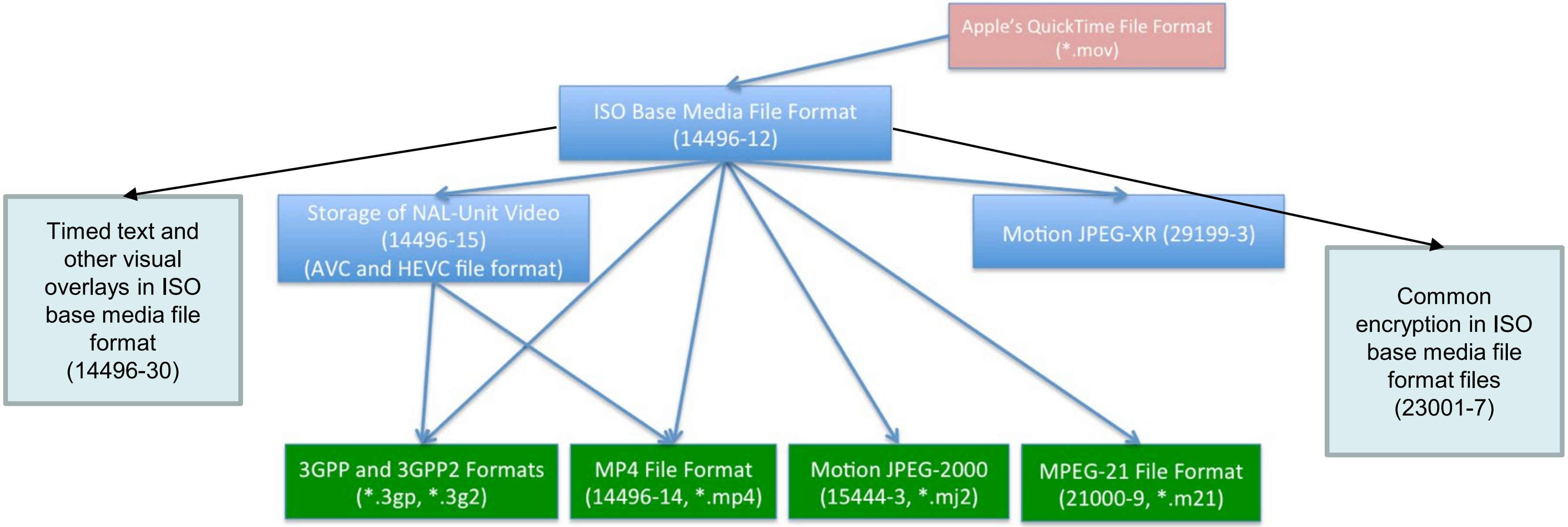
Multimedia containers

- ISO base media file format (ISOBMFF)
  - Format for different bitstreams
  - Specified in JPEG2000 and MPEG-4
  - Based on Apple Quick Time container
  - Specific extensions going on

  - Object oriented structure
  - “Box” → File Type Box
  - Supports streaming

ISO base media file format

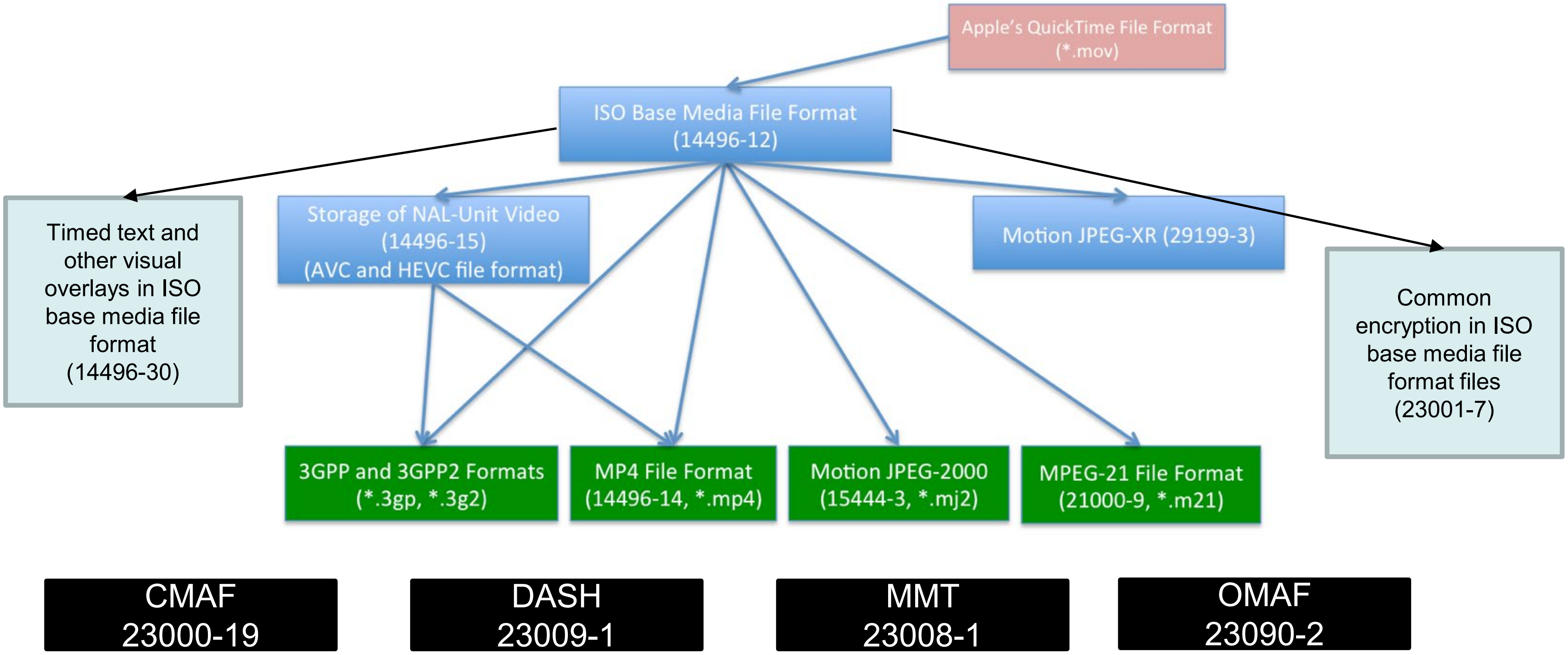
- Relationship with other standards:



Apple's QuickTime File Format (*.mov)
ISO Base Media File Format (14496-12)
Timed text and other visual overlays in ISO base media file format (14496-30)
Storage of NAL-Unit Video (14496-15) (AVC and HEVC file format)
Motion JPEG-XR (29199-3)
Common encryption in ISO base media file format files (23001-7)
3GPP and 3GPP2 Formats (*.3gp, *.3g2)
MP4 File Format (14496-14, *.mp4)
Motion JPEG-2000 (15444-3, *.mj2)
MPEG-21 File Format (21000-9, *.m21)

ISO base media file format

- Relationship with other standards:



Apple's QuickTime File Format (*.mov)

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Timed text and other visual overlays in ISO base media file format (14496-30)

Storage of NAL-Unit Video (14496-15) (AVC and HEVC file format)

Motion JPEG-XR (29199-3)

Common encryption in ISO base media file format files (23001-7)

3GPP and 3GPP2 Formats (*.3gp, *.3g2)

MP4 File Format (14496-14, *.mp4)

Motion JPEG-2000 (15444-3, *.mj2)

MPEG-21 File Format (21000-9, *.m21)

CMAF 23000-19

DASH 23009-1

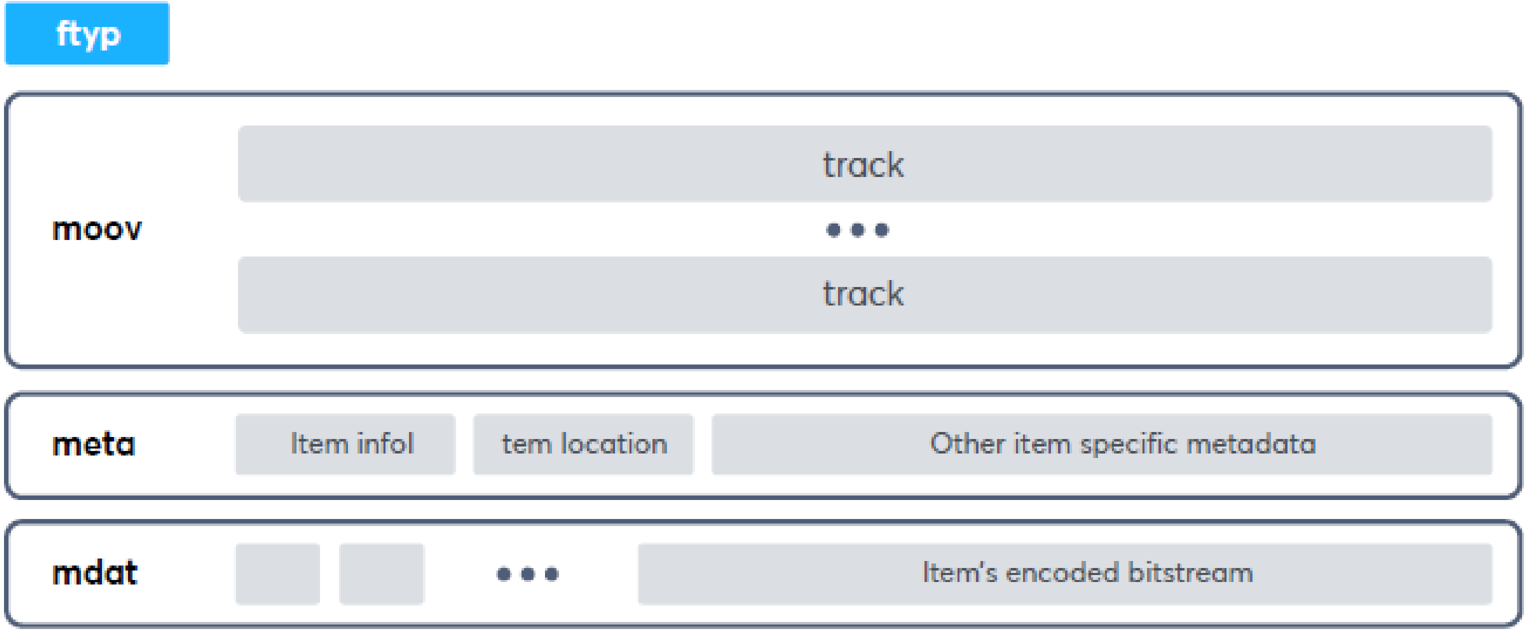
MMT 23008-1

OMAF 23090-2

ISO Base Media File Format

- Boxes structure:

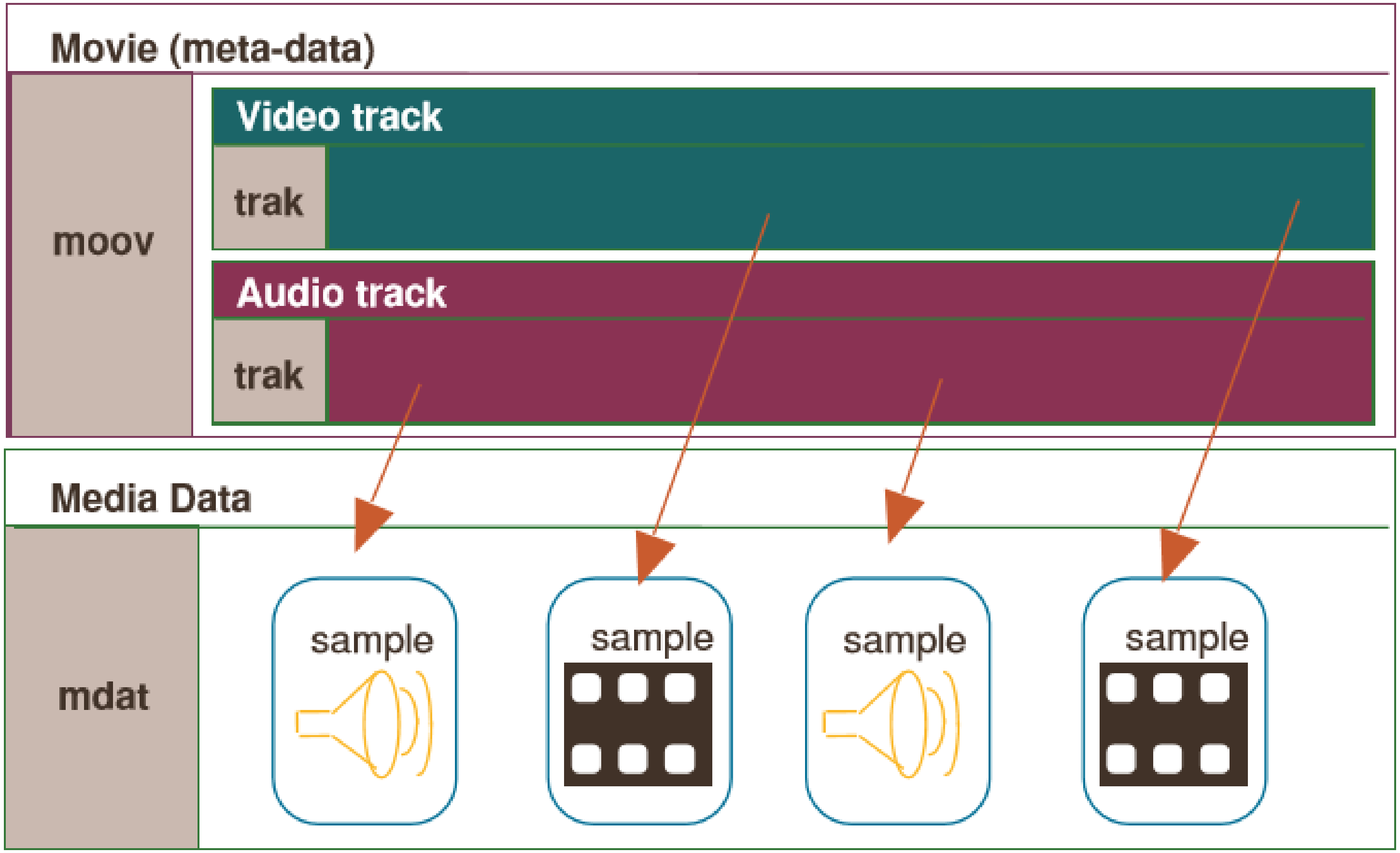
ftyp*: FileTypeBox,* ***moov****: Movie Box,* ***mdat****: Media Data Box*



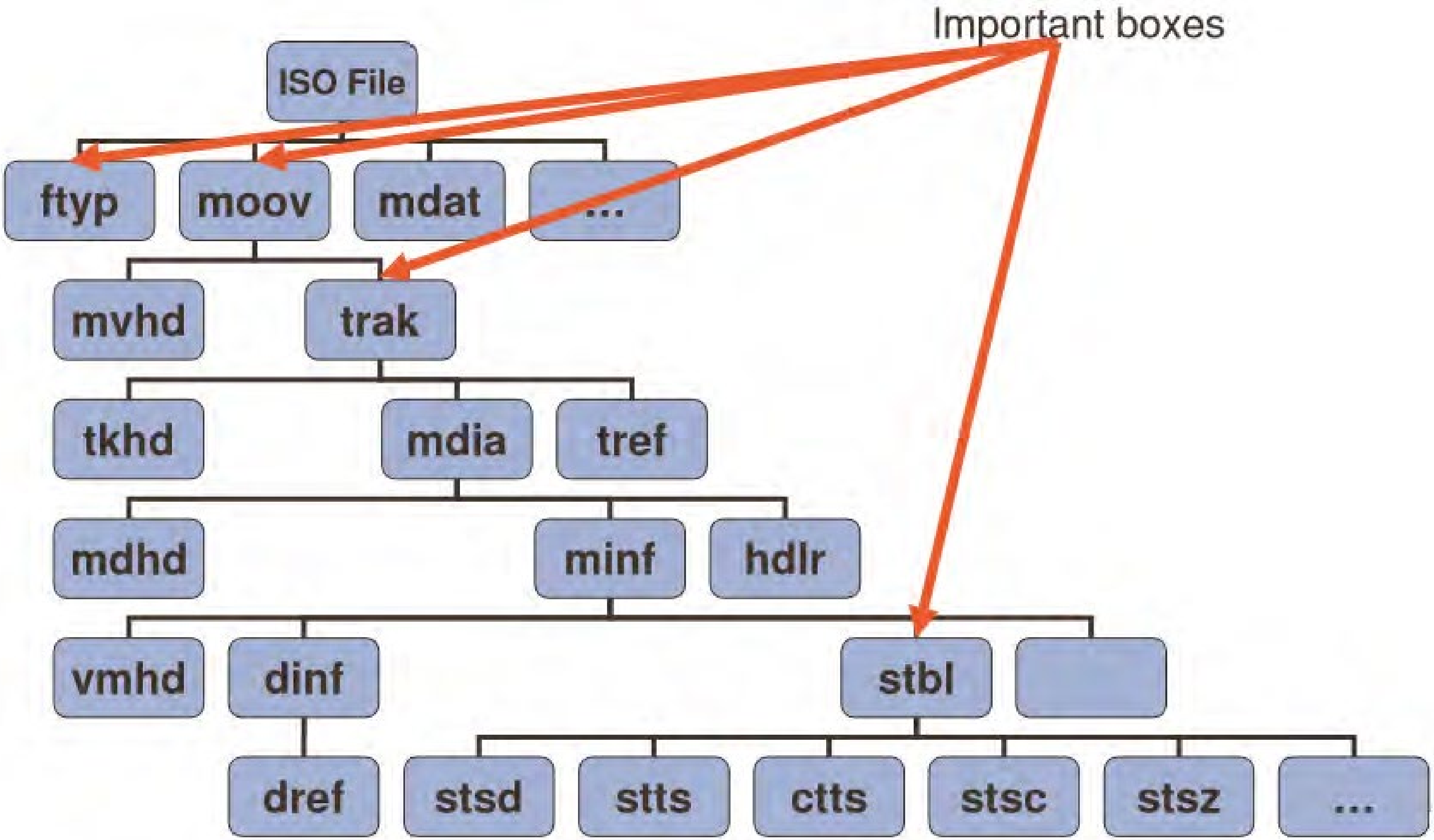
Source: "Ultimate Guide to Container Formats", by Armin Trattnig

ISO Base Media File Format

- Example for a movie:

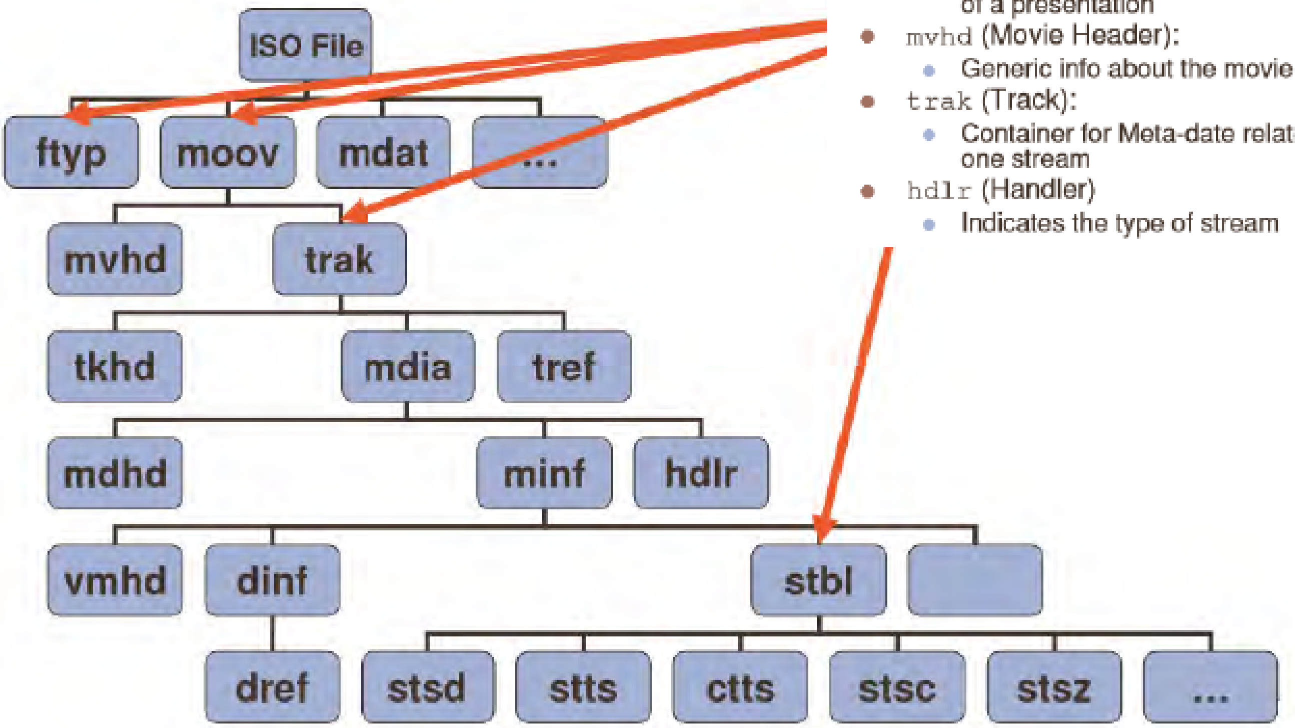


ISO Base Media File Format



ISO Base Media File Format

TYPICAL STRUCTURE



- `ftyp` (File Type): 1 per file
  - File type
  - File version
  - Compatibility with other ISO files
- `mdat` (Media Data):
  - Contains the media data
  - A file may have several, non contiguous
- `moov` (Movie):
  - Unique container for the metadata of a presentation
- `mvhd` (Movie Header):
  - Generic info about the movie
- `trak` (Track):
  - Container for Meta-date related to one stream
- `hdlr` (Handler)
  - Indicates the type of stream
- `dinf/dref` (Data Information/Data Reference)
  - Indicates the location of the data (current file or remote file)
- `stbl` (Sample Table)
  - Contains the meta data related to samples, sample per sample
- `stsd` (Sample Description)
  - Contains the decoder configuration for the elementary stream
- `stts` (Sample To Time)
  - DTS for each sample
  - Use a predictive coding scheme
- `stsz` (Sample To Size)
  - Size of each sample, run-length coded

ISO Base Media File Format

- **MPEG Systems File Format Subgroup wins Technology & Engineering Emmy® Award 2021**

- Recognized with an Award for their 20 years of work on the ISO Base Media File Format (ISOBMFF), first standardized in 1999 as part of the MPEG-4 Systems specification, and is now in its 6th edition as ISO/IEC 14496-12. It is the structural specification under the widely used and supported MP4 and 3GP file formats.

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- **Metadata**

Metadata

- “Data over data”
- “Data over multimedia resources/content”
- Example: Images

Metadata example

Definir elementos qe necesita una imagen JPEG sin tener qe procesar la imagen.

JPSearch Core Metadata Schema

- Identifier -> mínima descripción de un archivo multimedia
- Title
- Description
- OriginalImageIdentifier
- Keyword
- CreationDate
- ModifiedDate
- RightsDescription
- Source
- CollectionLabel
- PreferenceValue
- Rating
- RegionOfInterest
- Modifiers
- Creators
- Publisher
- GPSPositioning
- Width
- Heigth

Metadata example

JPSearch Core Metadata Schema

- Identifier
- Title
- Description
- OriginalImageIdentifier
- Keyword
- CreationDate
- ModifiedDate
- RightsDescription
- Source
- CollectionLabel
- PreferenceValue
- Rating
- RegionOfInterest
- Modifiers
- Creators
- Publisher
- GPSPositioning
- Width
- Height

EXERCISE: What is missing? What should be out?

Metadata example

EXERCISE

Metadata - components

- **Schema** (categories of information)
- **Vocabulary** (specific ‘words' or ‘values’)
- **Conceptual model** (relationships between the information and concepts in a resource)
- **Content standard** (describe how specific information should be entered within metadata schema categories)
- **Encoding** (the way the metadata is presented, e.g. XML)

Metadata - components

- **Schema** (categories of information)
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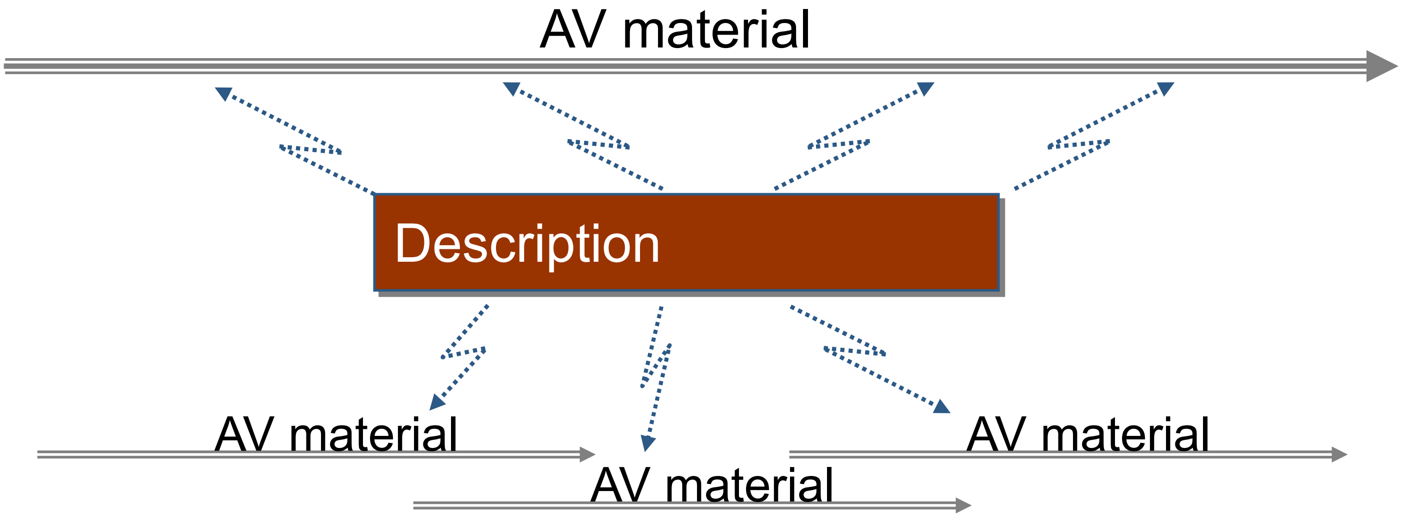
Metadata - Schemas

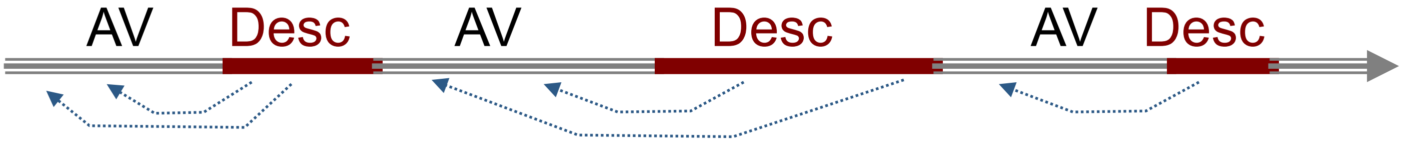
- Classification concepts:
  - *What is described*: audio, video, places, images, artistic images, books, …
  - *Application environment*: education, libraries, museums, archives, web, …
  - *Objective*: administration, description, search, interchange, preservation, …
- “Embedded” or not

Relation content / description

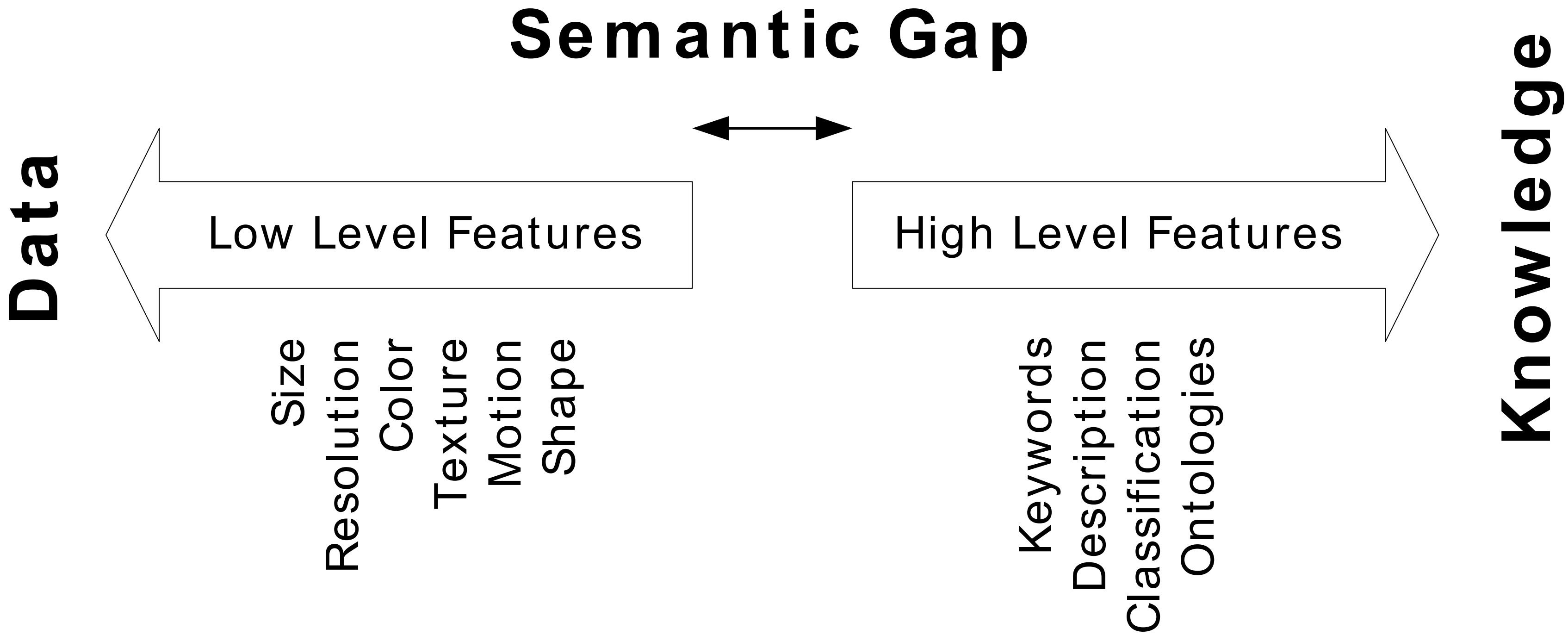
- Description may be separated from the content



- Description may be embedded in the content



Multimedia Metadata
Low level vs. High level features



Semantic Gap

Data

Low Level Features

Size

Resolution

Color

Texture

Motion

Shape

High Level Features

Keywords

Description

Classification

Ontologies

Knowledge

Dublin Core (DC)

- One of most used schemas.
- Objective: “Set of 'core' metadata properties”
  for a basic description of resources
  (simple and compound).
- Generic: “Lowest common denominator”.
  Basic interoperability between
  “digital collections”.
- Official standard: ISO 15836.
- Extension and adaptation mechanism:
  - **“Qualifier”**
  - **Extension**

Dublin Core (DC)

Element	Definition	Record A – a painting	Record B – a digital image
Title	Name by which the resource is formally known	Mona Lisa, La Gioconda	Mona Lisa, La Gioconda
Creator	An entity primarily responsible for making the content of the resource	Leonardo da Vinci	Leonardo da Vinci
Subject	The topic of the content of the resource	Woman, Portrait, Renaissance	Woman, Portrait, Renaissance
Description	An account of the content of the resource	Three-quarter portrait of a Florentine woman in front of a landscape	Three-quarter portrait of a Florentine woman in front of a landscape
Publisher	An entity responsible for making the resource	Musée du Louvre	[owner of digital collection]
Contributor	An entity responsible for making contributions to the content of the resource	N/A	Jane Smith [digital photographer]
Date	A date associated with an event in the life cycle of the resource	1500s	2002-10-30

Dublin Core (DC)

Type	The nature or genre of the content of the resource (e.g. sound, text, still image)	Still Image	Still Image
Format	The physical or digital manifestation of the resource (e.g. book, JPEG, PDF)	Oil painting	JPEG file
Identifier	An unambiguous reference to the resource within a given context	No.779 [museum inventory number]	2002_0054.jpg
Source	A reference to a resource from which the present resource is derived	N/A	Louvre No.779 [museum inventory number]
Language	A language of the intellectual content of the resource	N/A	N/A
Relation	A reference to a related resource	N/A	Record A
Coverage	The extent or scope of the content of the resource	77cm x 53cm	158KB
Rights	Information about rights held in and over the resource	Not in copyright	© [owner of digital collection]

Metadata - Schemas

- General:
  - **XMP** (eXtensible Metadata Platform): ISO 16684 (Ed.2 ‘19). Originated in Adobe. Different serializations
- Images:
  - **Exif** (Exchangeable image file format)
    - Photo cameras; In JPEG, TIFF, …
  - **JPSearch**
  - **JPOnto** (JPEG): LinkedData and Ontology
  - **VRA** (Virtual Resources Association) **Core**
    - Cultural or art images
- Audiovisual:
  - **MPEG-7** (Multimedia Content Description Interface)
  - **ID3** (Metadata container. Normally for MP3 audio)

Metadata - Schemas

- TV:
  - **P/Meta** (EBU), **EBUCore** (EBU)
  - **PBCore** (Public Broadcasting Metadata Diccionary)
  - **SMPTE** (Society of Motion Picture Technical Experts):
    - **Data Diccionary**
    - **MXF** (Material Exchange Format)

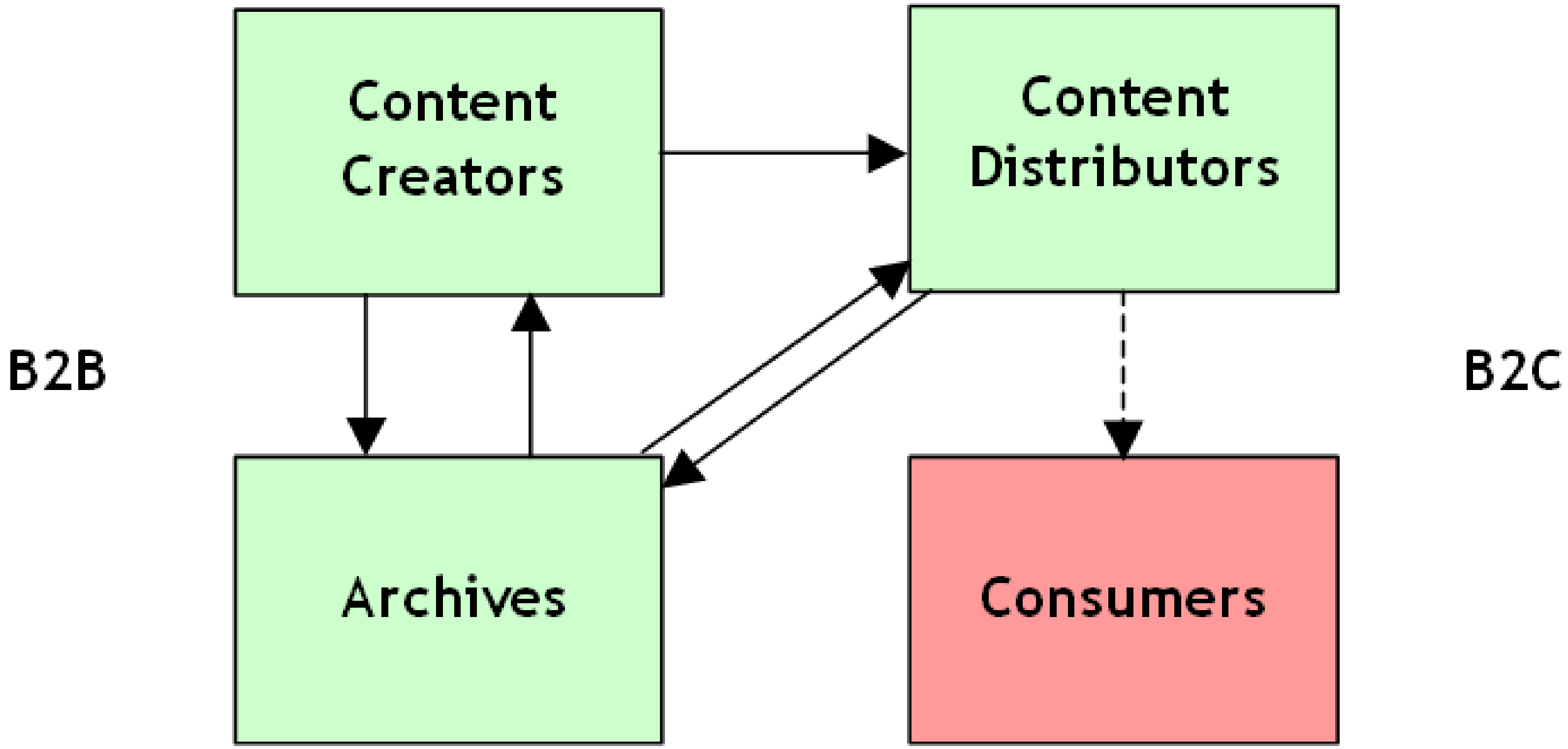
      DMS-1 (Descriptive MD Schema)
    - **BXF** (Broadcast Exchange Format). Protocol.
  - **TV-Anytime**

- Archives:
  - **ISAD(G)** (General International Standard Archival Description)
  - **OAI-PMH** (Open Archives Initiative - Protocol for Metadata Harvesting)

Metadata - EBUCore

- Minimum information needed to describe radio and television content
- "If you can't find it, you don't have it!"
- Creation, management and preservation of material
- Facilitates programme exchanges between broadcasters or between content producers

Metadata - EBUCore



Metadata - EBUCore

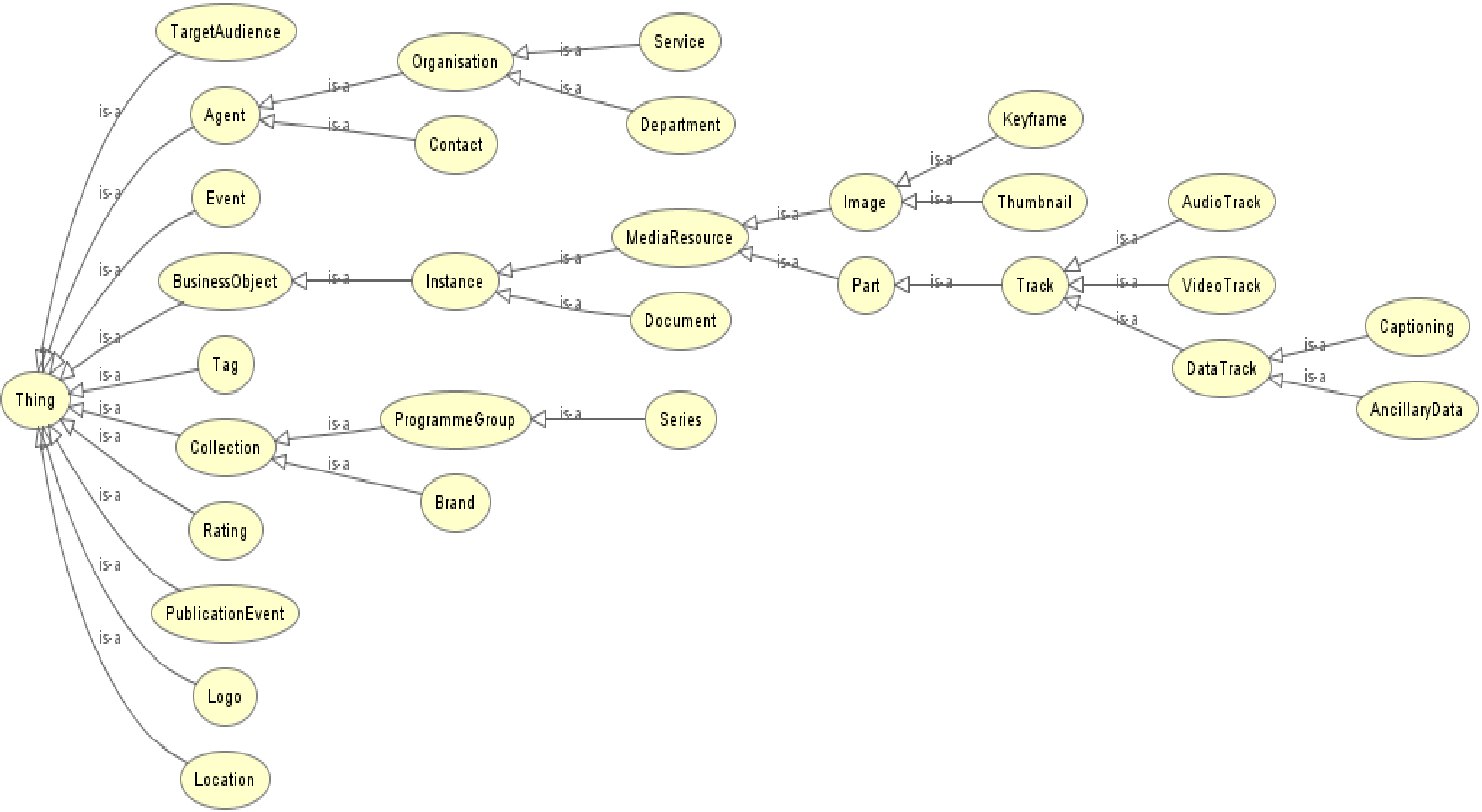
- ***Core Metadata Set Elements (1/2):***
  - Title, Alternative title
  - Creator
  - Subject (topic)
  - Description
  - Publisher
  - Contributor
  - Date (created, issued, modified, digitized, …)
  - Type (genre, target audience, "objectType")
  - …

Dublin Core, but we adapt it for our television specific case.

Metadata - EBUCore

- ***Core Metadata Set Elements (2/2):***
  - Format (technical characteristics):
    Image, Video, Video track, Audio, Audio track, Data, Captioning, Ancilliary data, Signing, Start, End, Duration, Document, Technical attributes, etc.
  - Coverage (time and place aspects)
  - Rights
  - Version
  - Publication history
  - Rating
  - Part
  - Metadata provider
  - Entity

EBUCore – Conceptual Data Model



TargetAudience
Organisation
Service
Agent
Contact
Department
Keyframe
Event
Image
Thumbnail
MediaResource
AudioTrack
BusinessObject
Instance
Part
Track
VideoTrack
Document
Tag
DataTrack
Captioning
Thing
AncillaryData
ProgrammeGroup
Series
Collection
Brand
Rating
PublicationEvent
Logo
Location
is-a