

TELECOM
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PARIS-SACLAY



GPAC

CMAF 101

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Paris Video Tech Meetup #3

01/02/2017

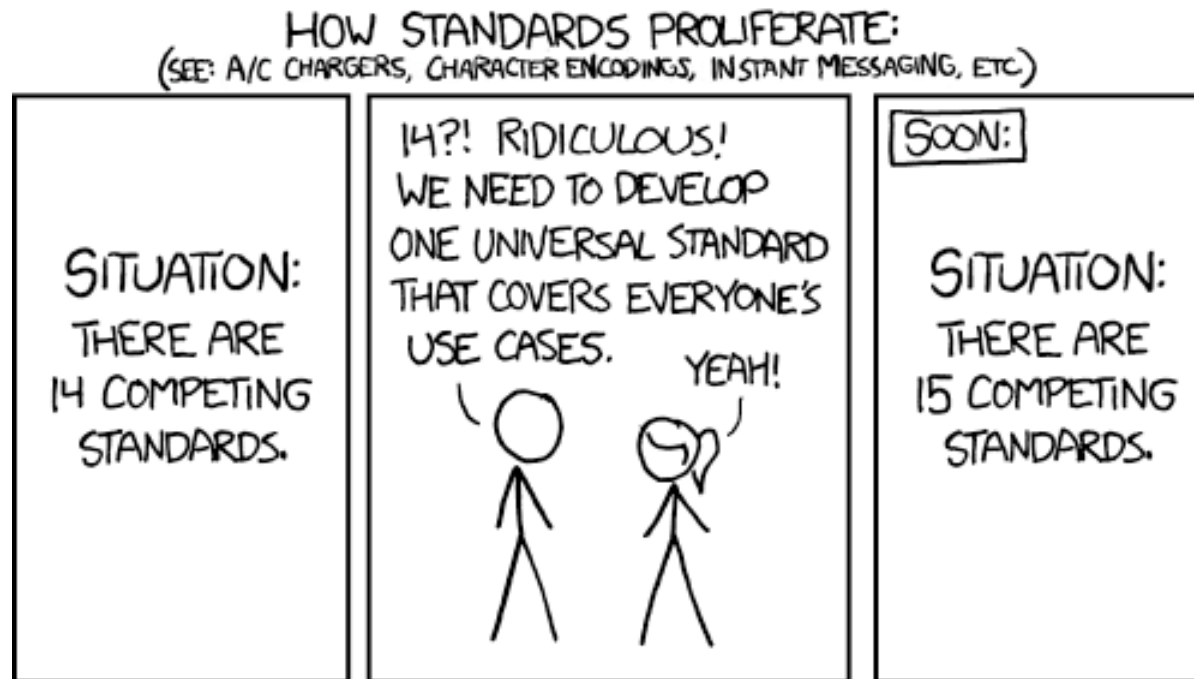


Disclaimer

These are my views/understanding
(based on Jan. 2017 version),
not necessarily the views of the
CMAF group or of the other chairs
or the final standard



Adaptive Streaming Market Fragmentation





CMAF

- **Specification mainly proposed by**
 - Apple
 - Microsoft

- **Defines a Format for Segmented Delivery**
 - To improve cacheability, to reduce CDN costs
 - To reduce deployment complexity, to remove the need for gateways/transformatters



C-MAF: What is a MAF ?

- **MPEG usually makes wide, general-purpose, application-agnostic formats**
 - Ex: Codecs (AVC, HEVC ...) can be used for
 - Broadcast, on-demand, video conferencing systems ...
 - Ex: Containers can be used in many application types
 - MPEG-2 TS is used in DVB, ATSC, HLS, ...
 - MP4 is used as camera files, web streams ...
- **MAF = MPEG Application Format (ISO/IEC 23000, a.k.a. MPEG-A)**
 - Interesting combinations of MPEG standards for dedicated applications

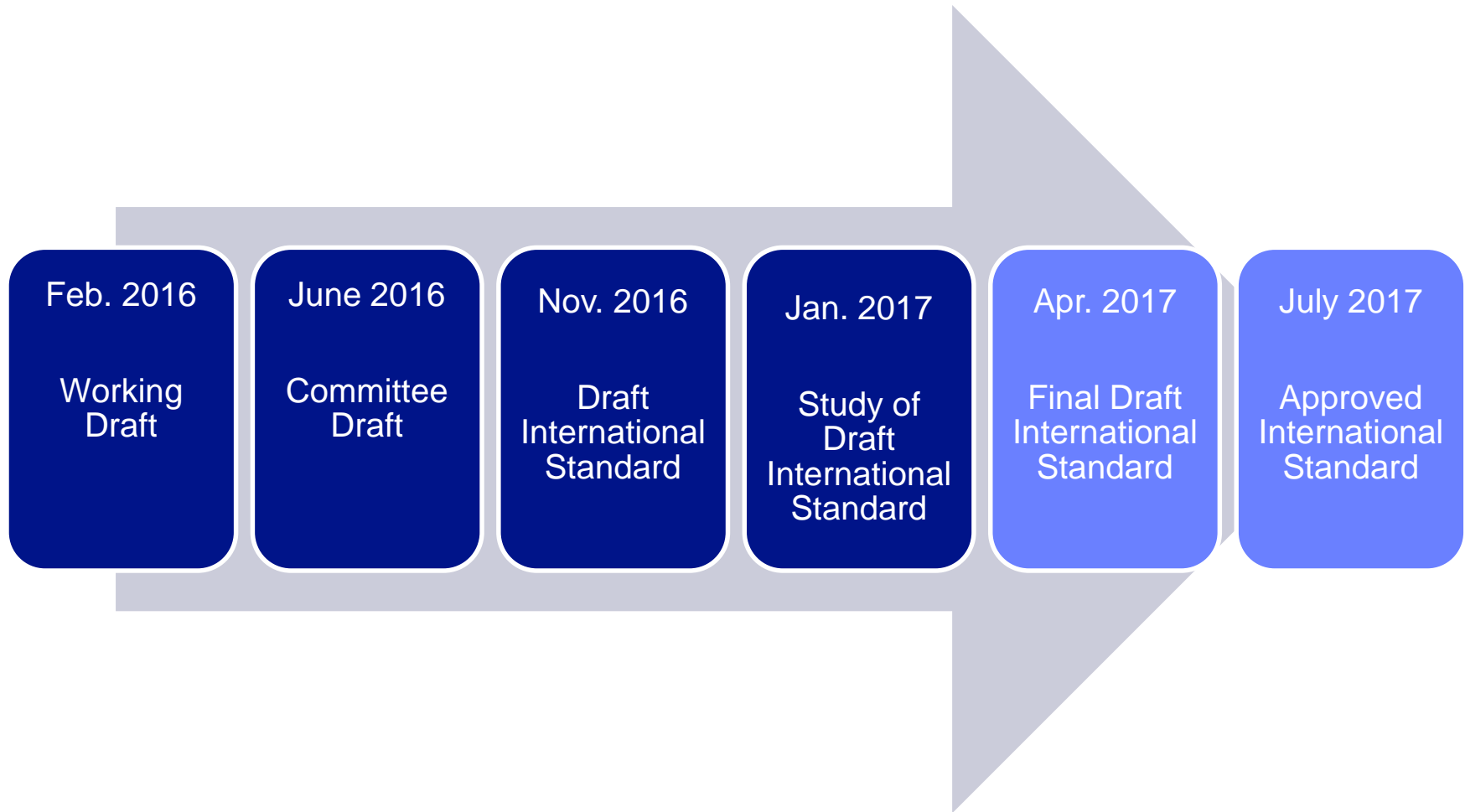


Lots of MAFs

ISO/IEC 23000-2: Music player	application format
ISO/IEC 23000-3: Photo player	application format
ISO/IEC 23000-4: Musical slide show	application format
ISO/IEC 23000-5: Media streaming	application format
ISO/IEC 23000-6: Professional archival	application format
ISO/IEC 23000-7: Open release access	application format
ISO/IEC 23000-8: Portable video player	application format
ISO/IEC 23000-9: Digital Multimedia Broadcasting	application format
ISO/IEC 23000-10: Video surveillance	application format
ISO/IEC 23000-11: Stereoscopic video	application format
ISO/IEC 23000-12: Interactive music	application format
ISO/IEC 23000-13: Augmented reality	application format
ISO/IEC 23000-15: Multimedia preservation	application format
ISO/IEC 23000-16: Publish/Subscribe	application format
ISO/IEC 23000-17: Multiple Sensorial Media	application format
ISO/IEC 23000-18: Media Linking	application format
ISO/IEC 23000-19: Common media	application format
ISO/IEC 23000-20: Omni-directional Media	application format

CMAF Development Timeline

A very fast standardization pace



The CMAF Specification

■ Covered

- Media Format: choice of MP4 / CENC & constraints
- Media Profiles: choice of codecs (AAC, AVC, HEVC) & constraints
- Presentation Profiles: set of Media Profiles

■ Not covered

- No new ISOBMFF features, no new boxes
 - Content should play in existing players
- No new manifest format
- No specific player behavior

■ Not completed

- Encryption modes: CBC vs. CTR
 - CMAF only fully useful today for non-protected content



First time reading the CMAF spec: Why is it so complex?

<https://www.youtube.com/watch?v=oLxFqzumFrc>



Basic Concept: Segmented Delivery

- **Ability to process parts of a stream independently**
 - At the encoding level: open/closed GoP
 - At the encryption level: encryption metadata
 - At the packaging level: self-contained ISOBMFF data

- **Ability to switch between streams without double-download and double-decode**
 - At the encoding level: time-alignment of closed GoPs
 - At the encryption level: shared encryption parameters
 - At the packaging level: shared ISOBMFF parameters

=> CMAF Fragment



Basic Concept: CMAF Fragment

- **A set of constraints to guarantee**
 - Independent parsing
 - Independent decryption
 - Independent decoding
- **Additional mappings to delivery units for**
 - On-Demand Delivery
 - Live Delivery
 - Low Latency Delivery
- **Remember:**
A CMAF Fragment is not a delivery concept!!!



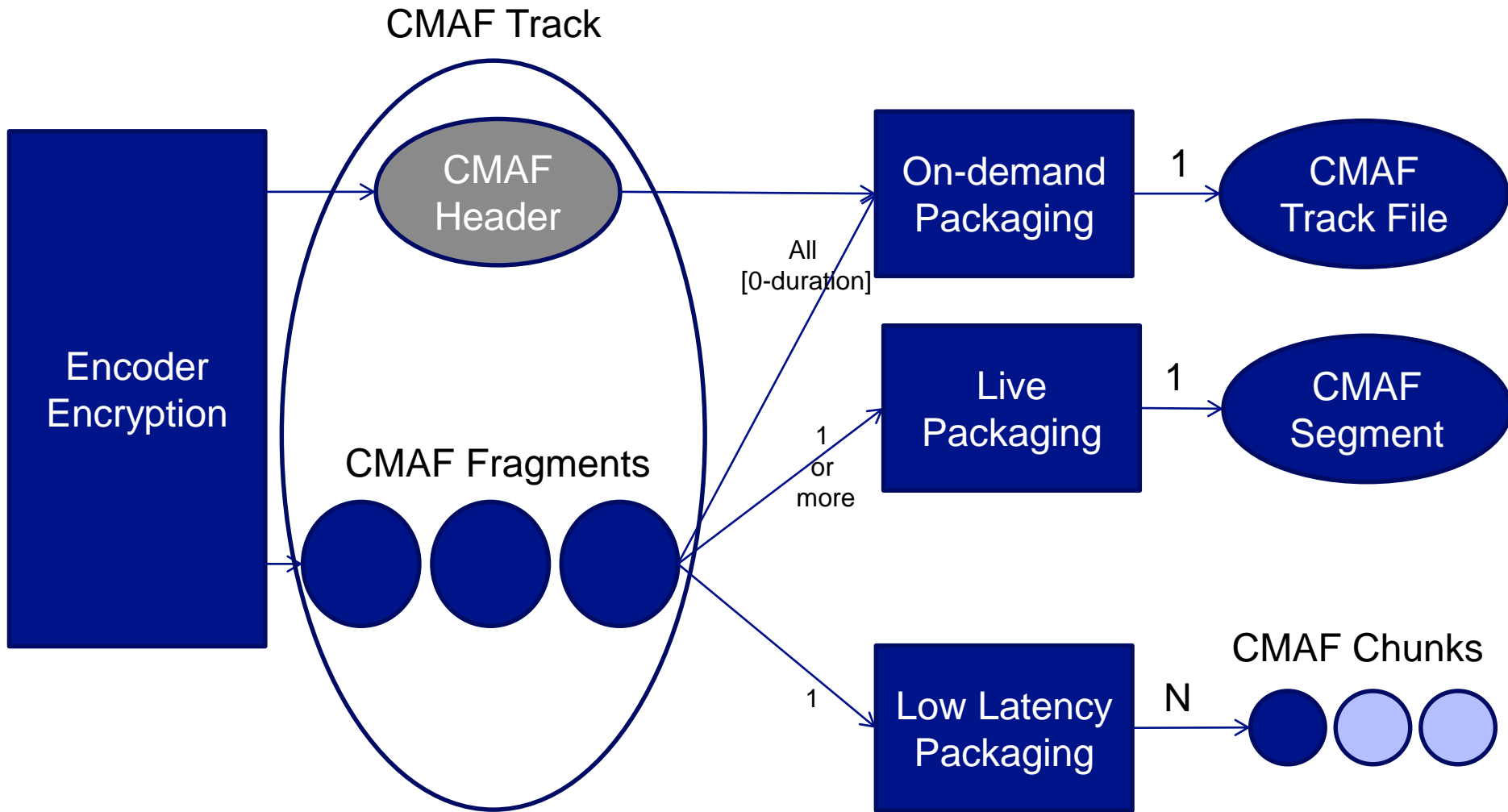


Basic Concept: CMAF Track

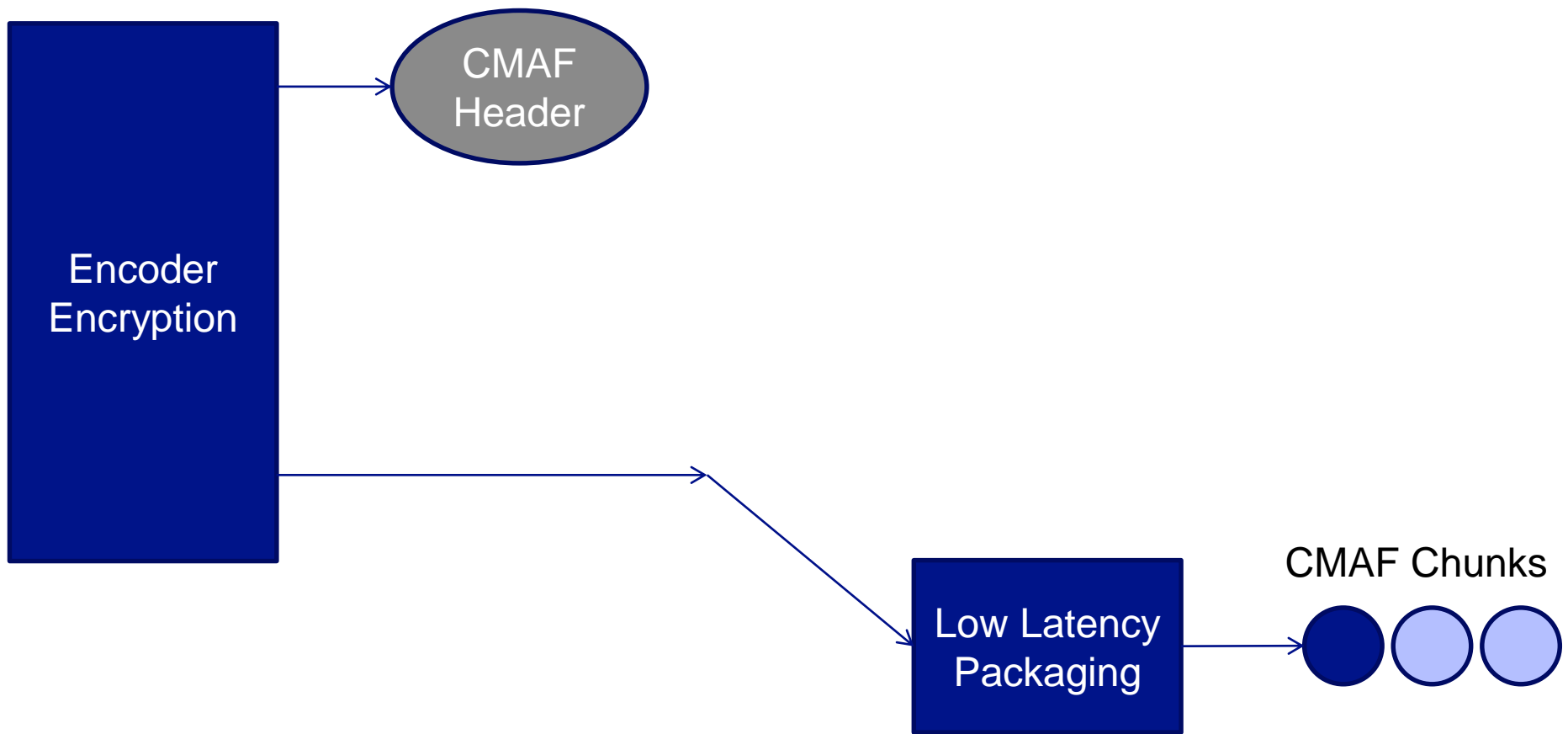
- **Set of contiguous CMAF Fragments**
 - single media type (no multiplex)
- **Associated to a CMAF Header**
- **Remember:**
A CMAF Track is not a delivery concept!!!



Delivering CMAF Fragments: Hypothetical ways of forming delivery units



Real CMAF Chunk Production



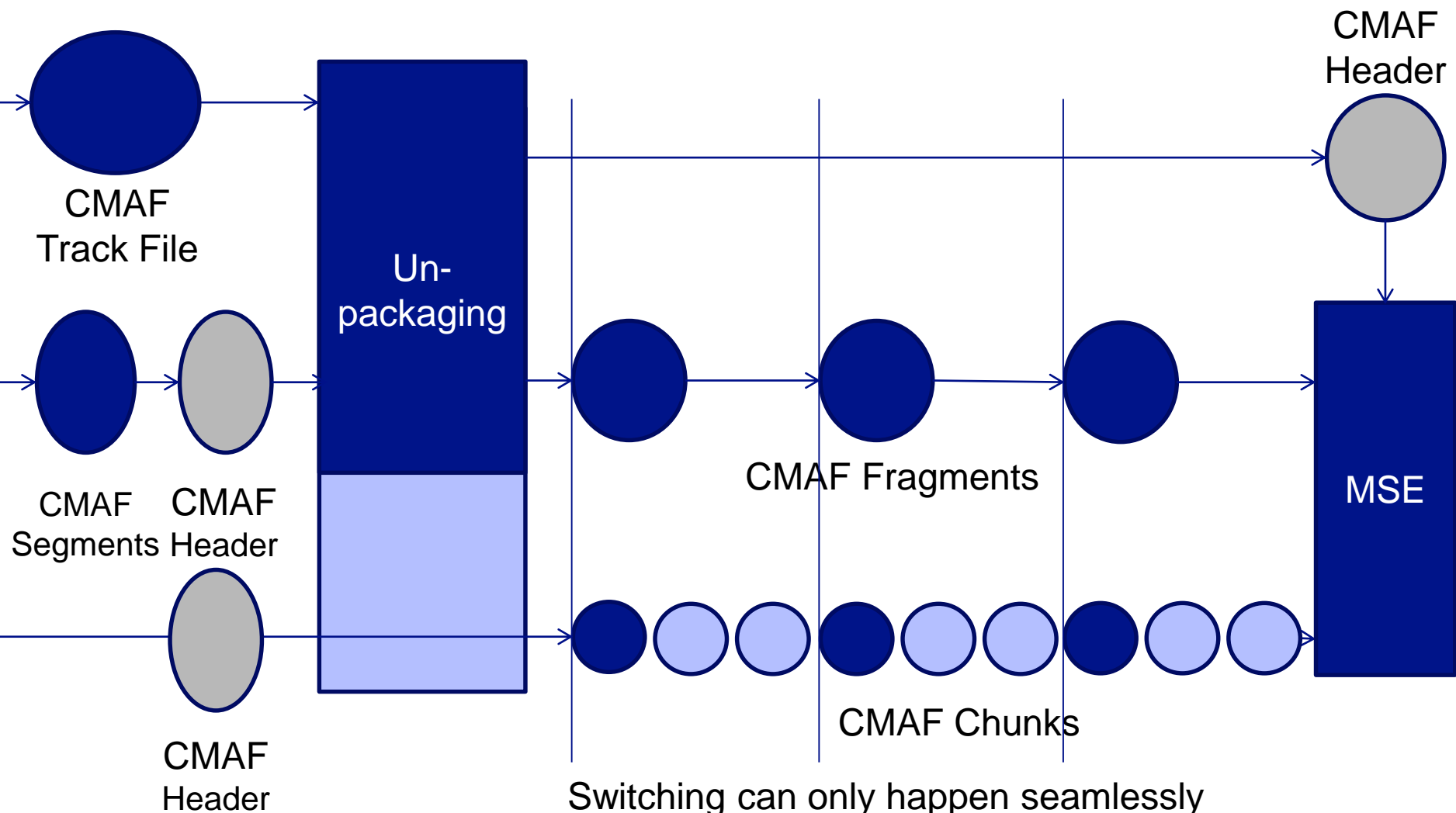
CMAF Resources

- **Manifests will typically provide URLs to**
 - CMAF Track Files
 - Or CMAF Header + CMAF Segments
 - Or CMAF Header + CMAF Chunks

- **CMAF Resource Signaling via ISOBMFF brands**
 - 'cmfc' (general CMAF compatibility)
 - 'cmfs' (CMAF segment compatibility)
 - 'cmfl' (CMAF Chunks compatibility)

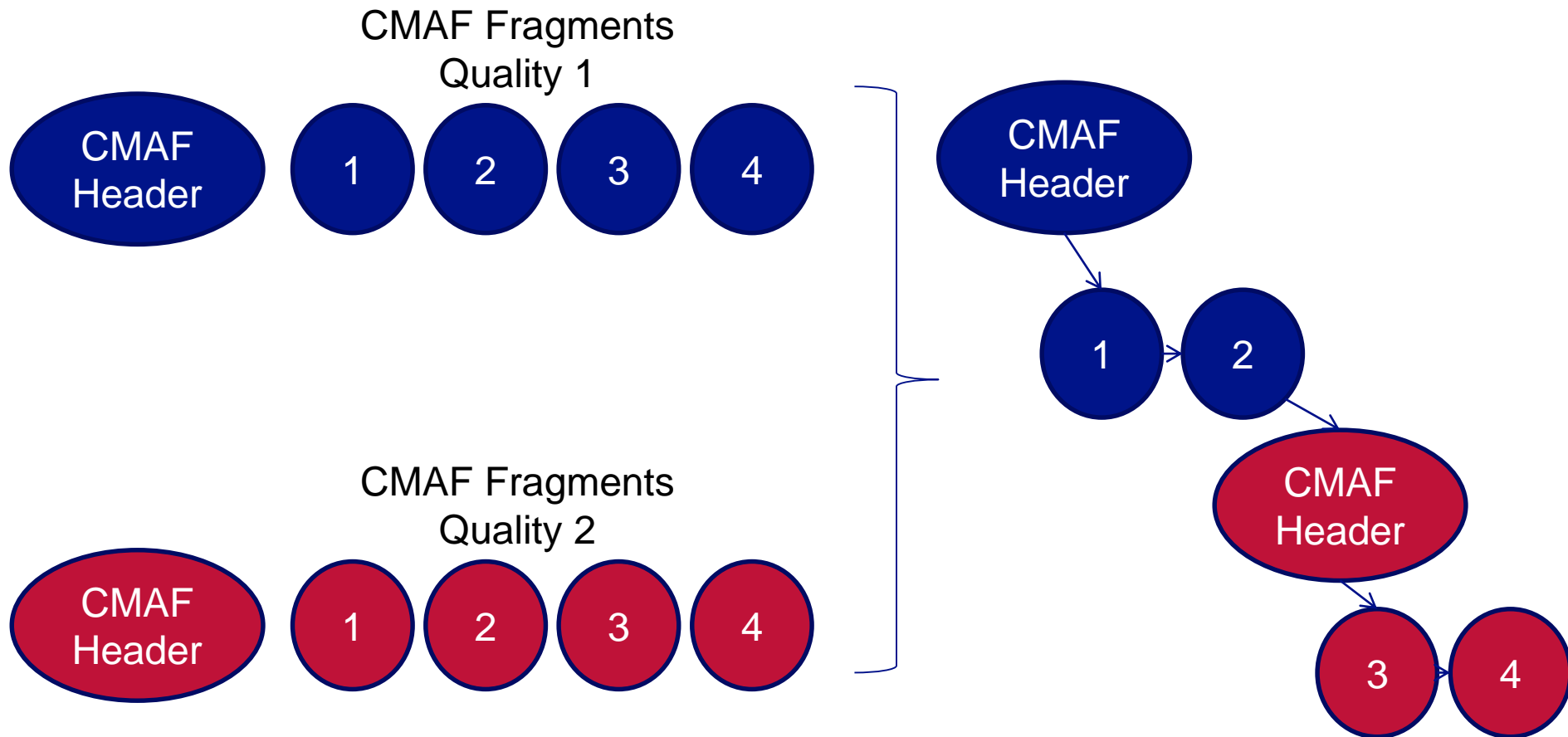


CMAF Content consumption

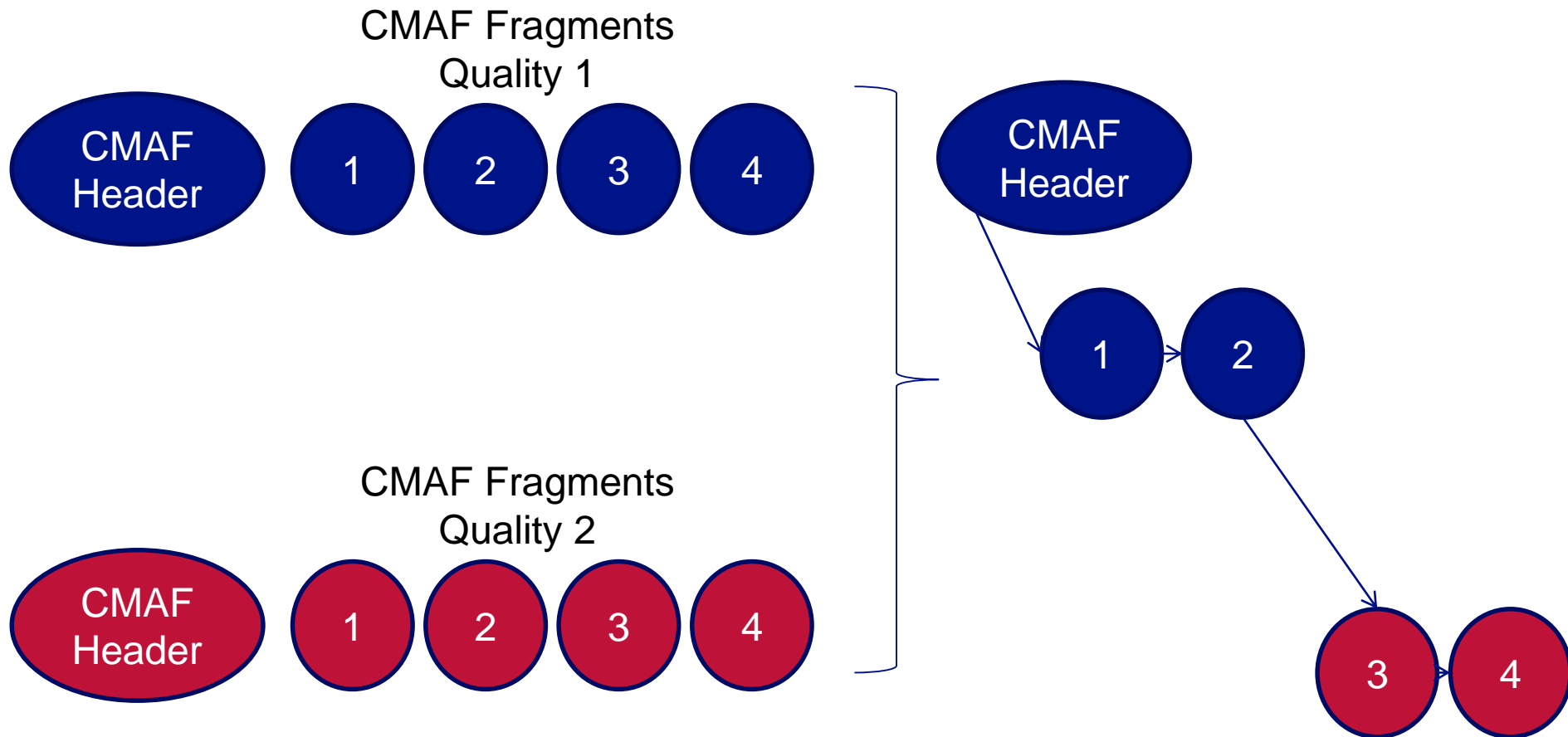


Switching can only happen seamlessly at CMAF Fragment boundaries

Switching with decoder reinitialization



Switching without decoder reinitialization



CMAF Terminology

■ Switching Sets

- Fragments from different Tracks that are switchable from a user perspective (language, aspect, ...)
- Switching Sets Types
 - Switching without pipeline re-initialization
 - Single Initialization Switching Set
 - Switching with pipeline re-initialization
 - Multiple Initialization Switching Set
 - Switching with relaxed constraints (e.g. encryption changes)
 - Aligned Switching Sets

■ CMAF Selection Sets

- Switching Sets where only one of them is displayed

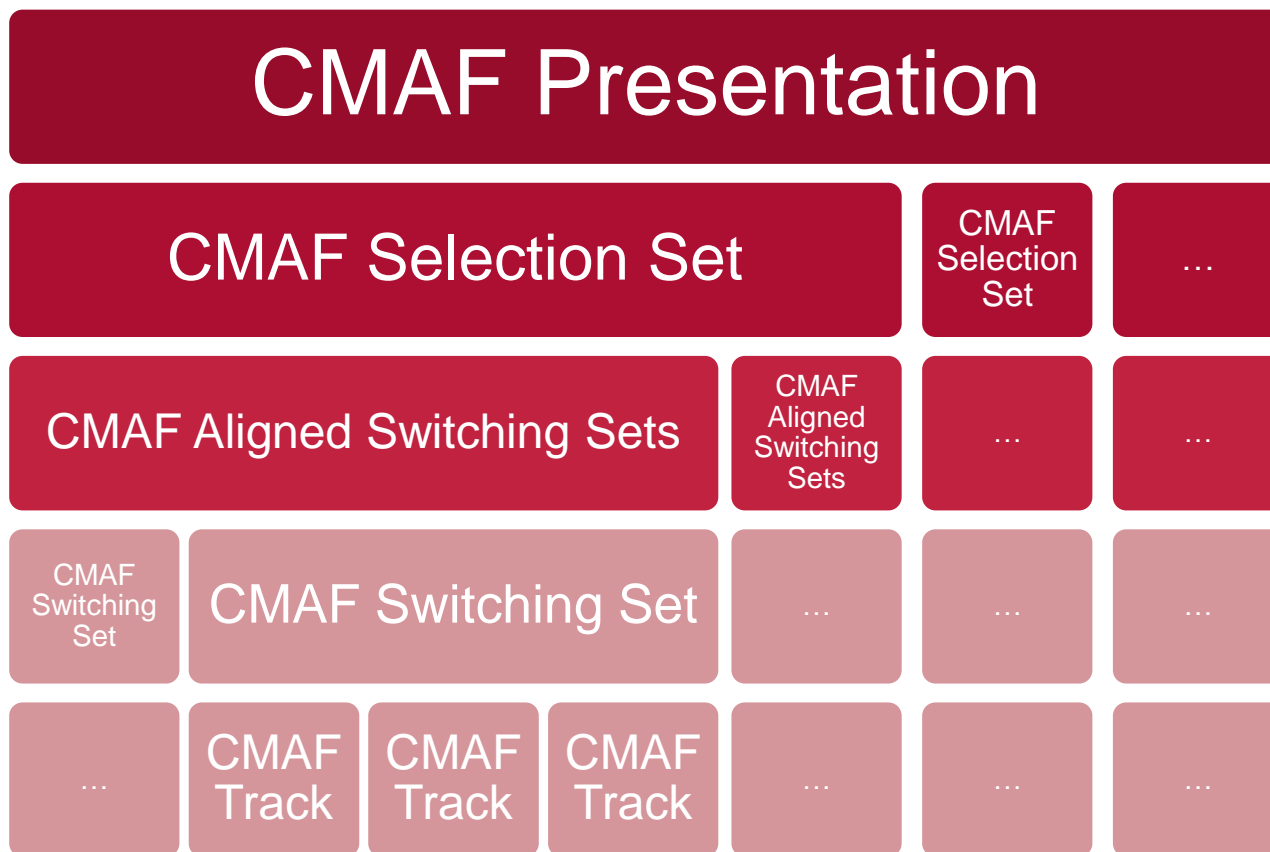
■ CMAF Presentation

- Selection Sets that form a presentation



CMAF Data Model

CMAF Presentation





CMAF Profiles

Media Profiles
Presentation Profiles



AVC-based Video Media Profiles

Media Profile	Cod ec	Pro file	Lev el	Color Coding	Transfer Characteristics	Max Fra me Heig ht	Max Fra me Widt h	Max Fra me Rat e	CMAF File Brand
SD	AVC	Hig h	3.1	BT.709 or BT.601	BT.709 or BT.601 OETF	576	864	60	'cfsd'
HD	AVC	Hig h	4.0	BT.709	BT.709 OETF	1080	1920	60	'cfhd'
HDHF	AVC	Hig h	4.2	BT.709	BT.709 OETF	1080	1920	60	'chdf'



HEVC-base Video Media Profiles

Media Profile	Code c	Profile	Level	Color Coding	Transfer Characteristics	Max Frame Height	Max Frame Width	Max Frame Rate	CMAF File Brand
HHD8	HEVC	Main MainTier	4.1	BT.709	BT.709 OETF	1080	1920	60	'chhd'
HHD10	HEVC	Main10 MainTier	4.1	BT.709	BT.709 OETF	1080	1920	60	'chh1'
UHD8	HEVC	Main8 MainTier	5.0	BT.709	BT.709 OETF	2160	3840	60	'cud8'
UHD10	HEVC	Main10 MainTier 10-bit	5.1	BT.709, BT.2020	BT.709 OETF, BT.2020 OETF	2160	3840	60	'cud1'
HDR10	HEVC	Main10 MainTier 10-bit	5.1	BT-2020	BT.2100 Table 4 PQ EOTF	2160	3840	60	'cpq1'
HLG10	HEVC	Main10 MainTier 10-bit	5.1	BT-2020	BT.2100 Table 5 HLG OETF [note1]	2160	3840	60	'clg1'



Audio Track Profiles

Media Profile	Codec and Profile	Number of channels	Max Sampling Rate	File Brand
AAC Core	AAC-LC, HE-AAC or HE-AAC v2	Mono or Stereo	48 kHz	'caac'
AAC Adaptive	AAC Core for constrained adaptive switching	Mono or Stereo	48 kHz	'caaa'



Subtitle Profiles

Media Profile	Format	Notes	File Brand
WebVTT	WebVTT, Version 1.0	—pending normative reference https://w3c.github.io/webvtt/	'cwt'
TTML IMSC1 Text	Specified in Section 1.1.4	IMSC1 Text Profile	'im1t'
TTML IMSC1 Image	Specified in Section 1.1.5	IMSC1 Image Profile	'im1i'
CEA	CEA-608 and CEA-708	Caption data is embedded in SEI messages in video track; multiple closed caption streams may be present ¹	'ccea'

CMAF Presentation Profiles

- **urn:mpeg:cmaf:presentation_profile:cmfhd:2017**
 - At least 'cfhd'
 - At least 'caac'
 - At least 'im1t'
 - Not encrypted
- **urn:mpeg:cmaf:presentation_profile:cmfhdc:2017**
 - CMFHD but with at least one 'cenc' encrypted media
- **urn:mpeg:cmaf:presentation_profile:cmfhds:2017**
 - CMFHD but with at least one 'cbcs' encrypted media



Thank you. Questions ?

