WAVE Overview

Part 1: CMAF and the WAVE Content Specification

Presentation to the W3C Media and Entertainment Interest Group

June 5, 2018

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Agenda

- CTA Web Application Video Ecosystem (WAVE)
- ISO IEC Common Media Application Format (CMAF)
- The WAVE Content Specification, 2018 Edition
- Discussion

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CTA Web Application Video Ecosystem (WAVE)

An industry effort to address web media encoding, playback and platform issues utilizing global standards.

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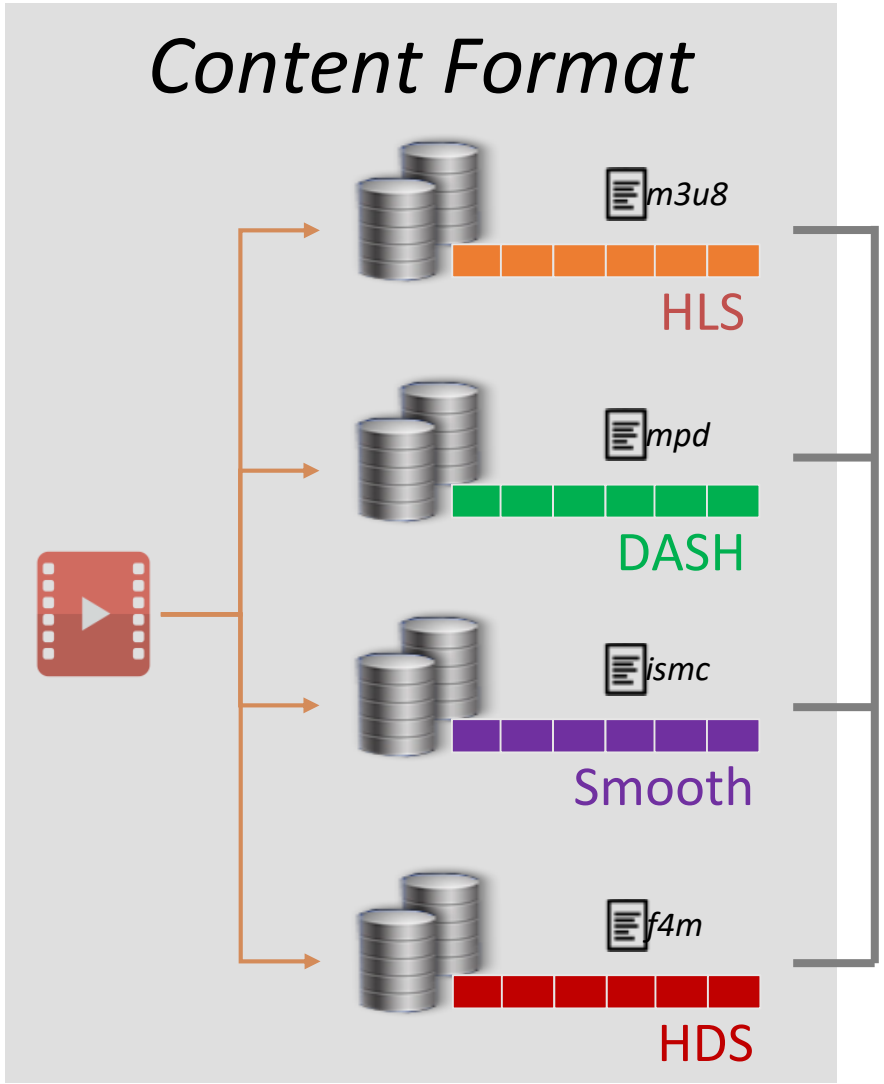
Web Media Encoding, Playback and Platform Issues



Each “asset” copied to multiple media formats

- different video codecs
- different audio codecs
- Regional frame rates

Cost to content creators and distributors

Inefficiencies in content delivery networks (CDNs)

Storage costs

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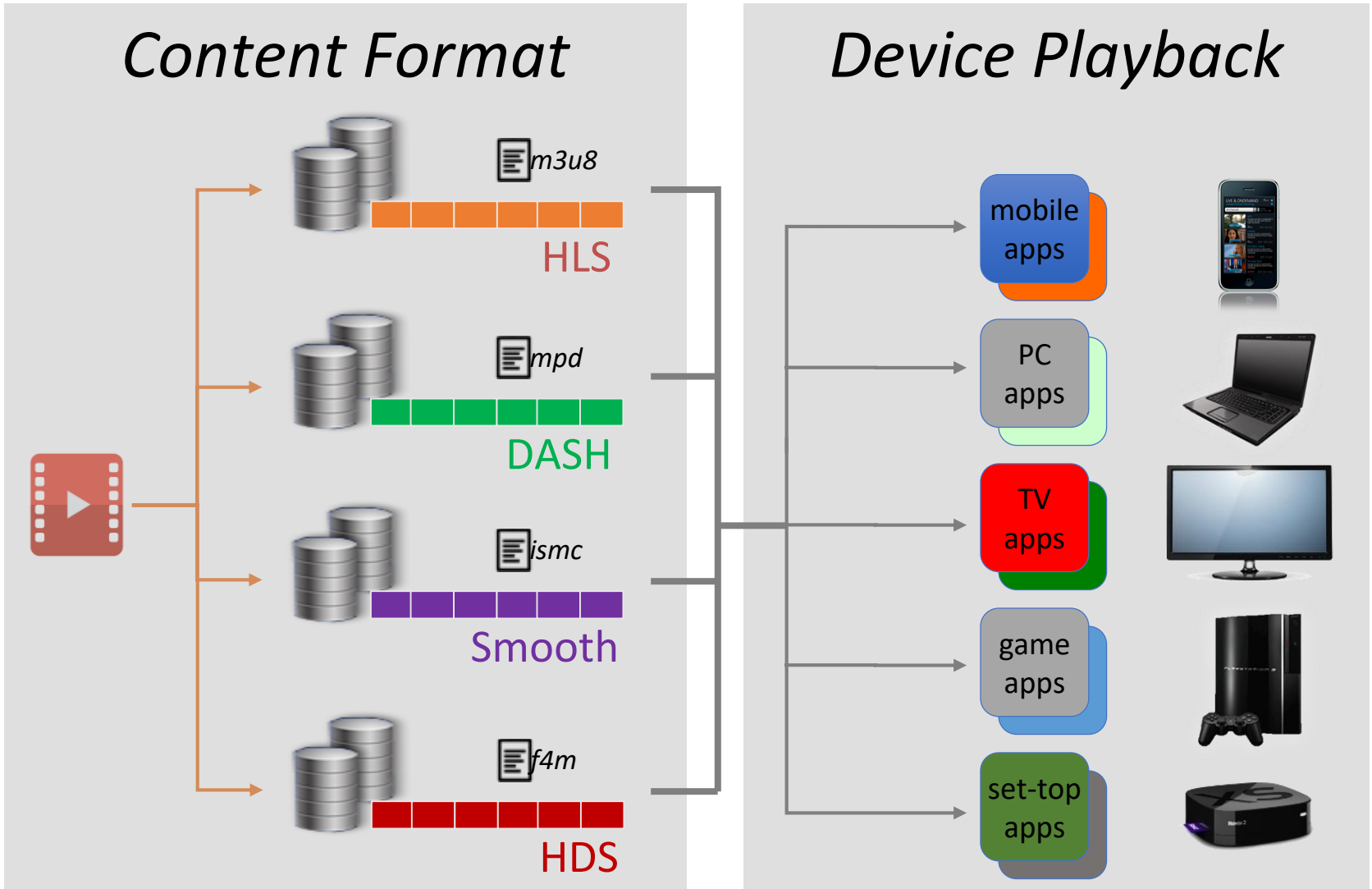
Web Media Encoding, Playback and Platform Issues



- Switching bitrate glitches
- Codec incompatibility
- Scaling display issues
- Partial profile support
- Long-term playback instability
- Audio discontinuities
- Request protocol deficiencies
- Memory problems
- CPU weakness
- Variable HDR support
- Unknown capabilities
- Ad splicing problems

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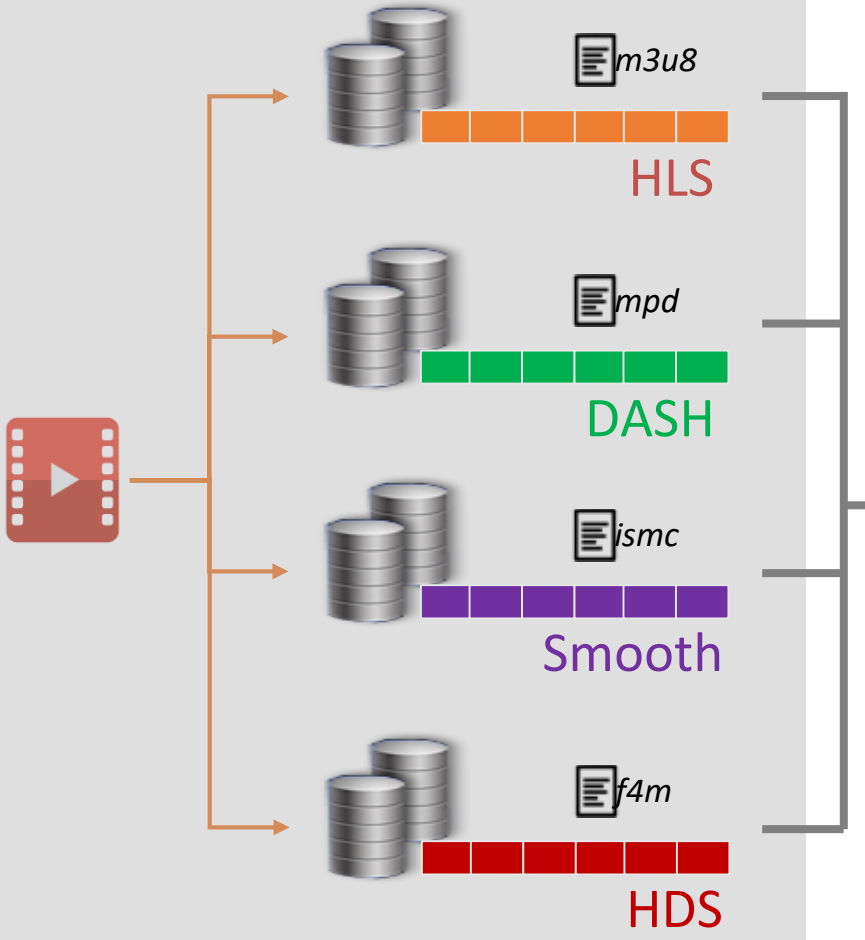
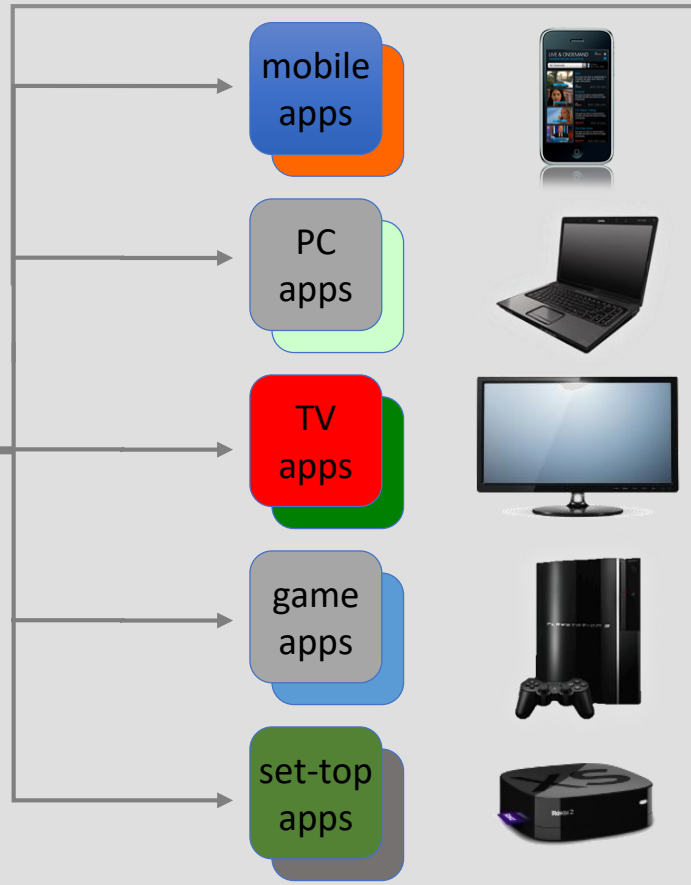
Web Media Encoding, Playback and Platform Issues

Content Format



Device Playback



Reference Platform

- Distributors need consistent app behavior across platforms
- WAVE testing needs neutral, well-known reference platform
- Each device platform has different video features, APIs and semantics.

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WAVE - Web Application Video Ecosystem

- WAVE addresses global media interop issues by defining interop points based on global standards, targeting desktop and embedded browsers – laptops, phones, tables, smart TVs, media sticks and set-top boxes.
- Encoding issues are being worked on by the Content Specification Task Force, published in the WAVE content specification, based on profiles of the new ISO IEC CMAF specification.
- Playback issues are being worked on by the Device Playback Capabilities Task Force, in the upcoming Device Playback Capabilities specification.
- Platform issues are being addressed by the HTML5 API Task Force, in the published Web Media API Snapshot spec, as well as the upcoming Web Media Application Developers Guidelines and the Web Media Porting specification.

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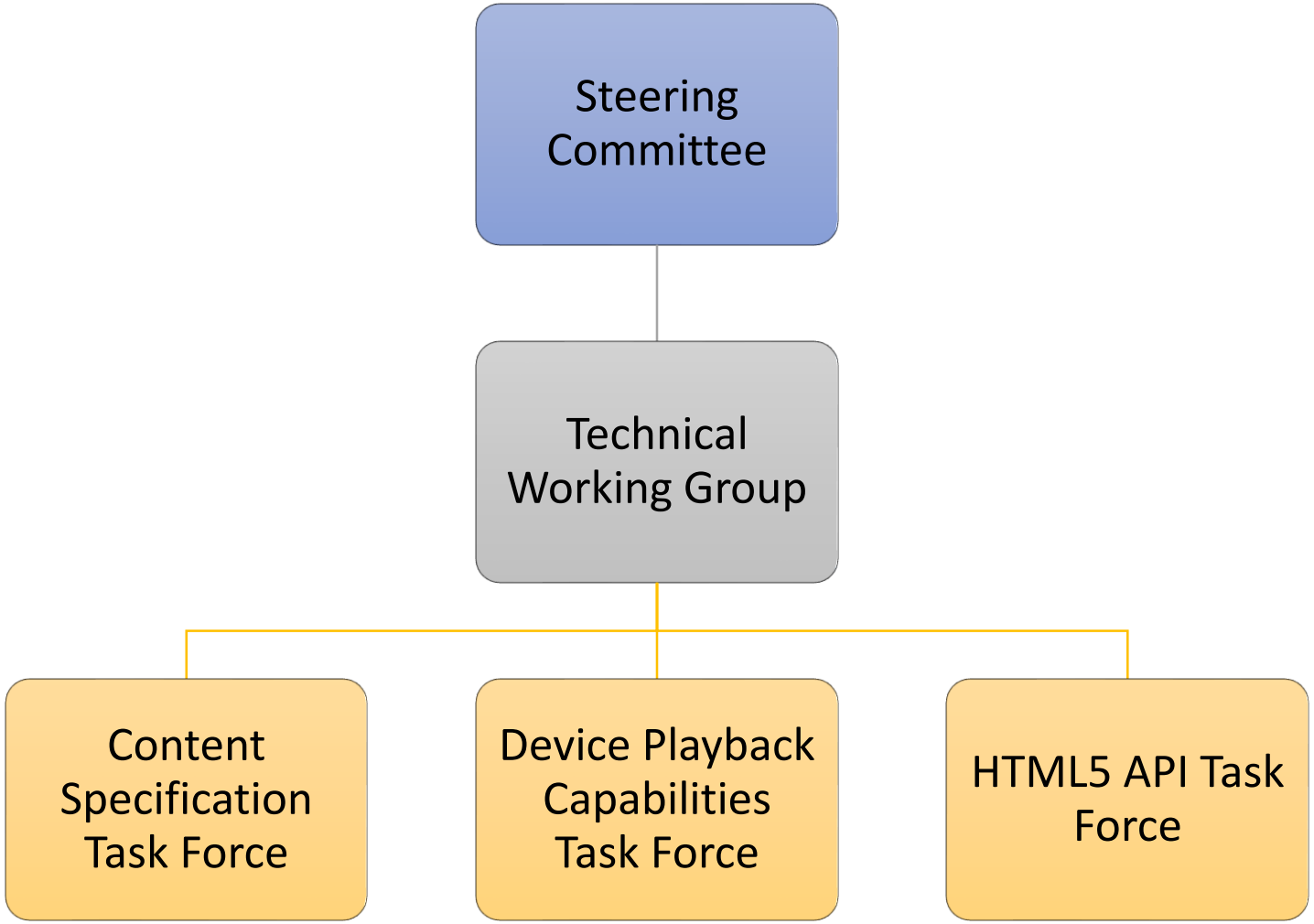
WAVE Organization



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WAVE Membership (as of April 2018)

Adobe Systems
AGP
Akamai
Amazon.com
Apple
AT&T
AwoX
BAMTech Media
BBC Research & Dev.
BitRouter
Brazilian Soc. of TV Eng.
Brightcove
Cable Television Labs
castLabs
CBS Interactive
Charter Communications
Cisco Systems
Comcast Cable
Cox Communications
Discovery Communications
Disney/ABC/ESPN
Dolby Laboratories
Ericsson
Eurofins Digital Testing
Facebook
Fraunhofer
Google
Home Box Office (HBO)
Huawei Device Co.
Intel Corporation
JR Consulting
JW Player
LG Electronics
Martin Freeman Consulting
Microsoft Corporation
MPAA
Motion Picture Laboratories
Mux
Nagravision
Nathan Zerbe LLC
Nat'l Assoc. of Broadcasters
Netflix
Nevelex Corporation
Opera Software
P Thomsen Consulting
Qualcomm Incorporated
RK Entertainment Technology Consulting
Samsung Electronics
Showtime Networks
Sky
Solekai Systems
Sony Electronics
SpireSpark International
Starz
Streaming Video Alliance
TBT
Toshiba
TP Vision
Turner Broadcasting System
UltraViolet / DECE
Verance Corporation
Verimatrix
Verizon
Viacom
Vizio
WJR Consulting
World Wide Web Consortium
WWE
Xperi/DTS

*Steering Committee members in **bold***

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WAVE Current & Future Publications

PUBLISHED

- “Web Application Video Ecosystem – Content Specification”, April 2018, https://members.cta.tech/ctaWAVE
- “Web Media API Snapshot 2017”, Draft Community Group Report 13 February 2018, https://w3c.github.io/webmediaapi/

PENDING

- “Event Messages in WAVE” (white paper)
- “Web Application Video Ecosystem (WAVE) Device Playback Capabilities”
- “Web Media Application Developer Guidelines”
- “Web Media Porting Specification”

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ISO IEC Common Media Application Format (CMAF)

The WAVE Content Specification is derived from the ISO/IEC standard, “Common media application format (CMAF) for segmented media”.

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What is CMAF?

The Common Media Application Format (CMAF) defines the container that holds the audio and video content. It is not another media presentation format, like Dynamic Adaptive Streaming over HTTP (DASH) or HTTP Live Streaming (HLS).

CMAF is a codification and standardization of existing fragmented MP4 best practices, with some enhancements.

CMAF is a manifest independent encoding suitable for DASH and HLS, and designed with both on-demand and live linear streaming in mind.

ISO/IEC 23000-19, Information technology — Coding of audio-visual objects — Part 19: Common media application format (CMAF) for segmented media. https://www.iso.org/standard/71975.html

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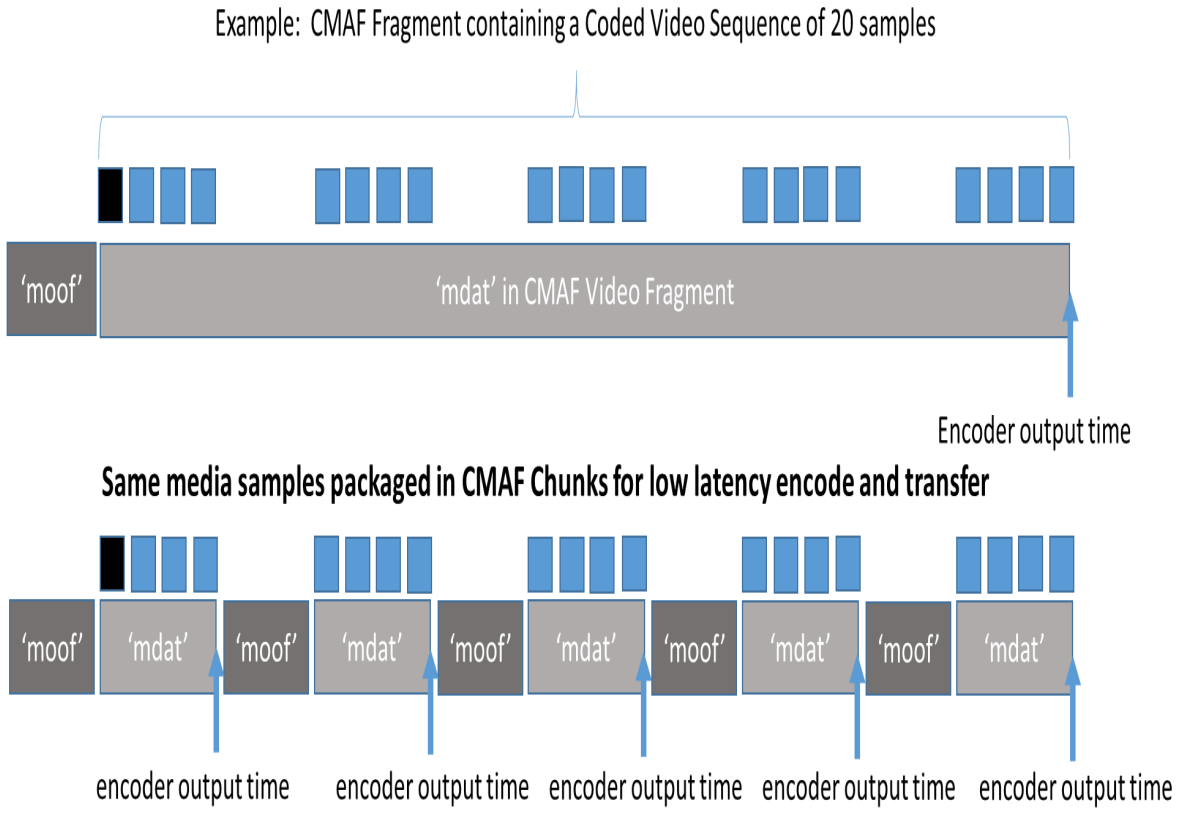
Manifest independent live-linear and on-demand encoding

Common Media Application Format – ISO MPEG CMAF

- An 18-month Apple-Microsoft co-development activity. January 2015, Microsoft and Apple shared the idea of a common media format between HLS and DASH in individual meetings with 8 companies.
- Proposed at MPEG's 114th meeting in San Diego in Feb 2016.
- Requirements submitted by: Adobe, Akamai, Apple, BBC, Cisco, Comcast, DTG, Ericsson, Fraunhofer, iStreamPlanet, LG Electronics, Microsoft, MLBAM, Qualcomm, Samsung, Starz, Telecom Italia, Turner, Verimatrix, WWE.
- Draft specification submitted by: Apple, Microsoft, MLBAM, Cisco, Akamai and Comcast.
- Became a published ISO/IEC spec January 2018.



CMAF was designed with live linear streaming, content protection and ad signaling in mind.

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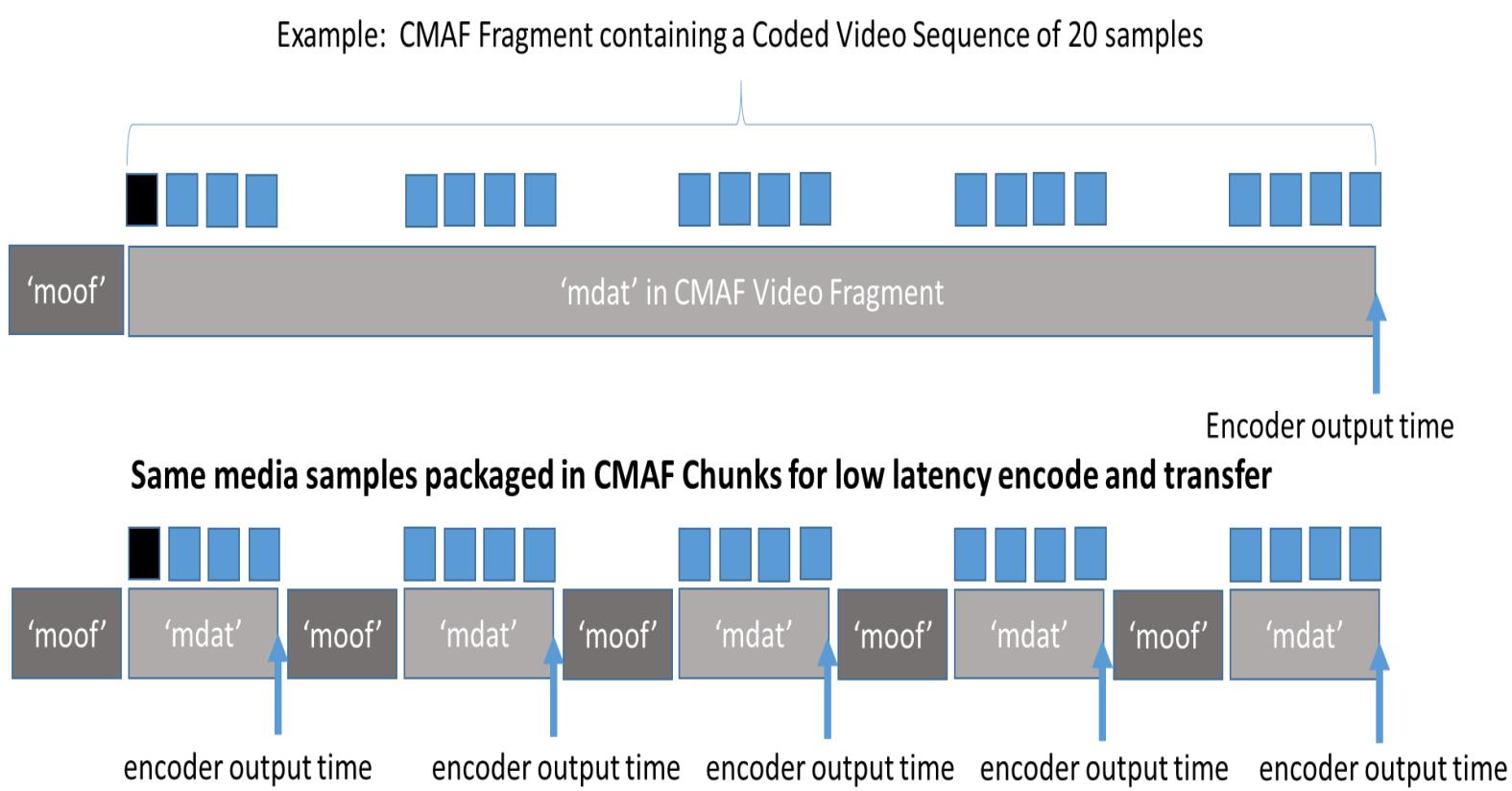
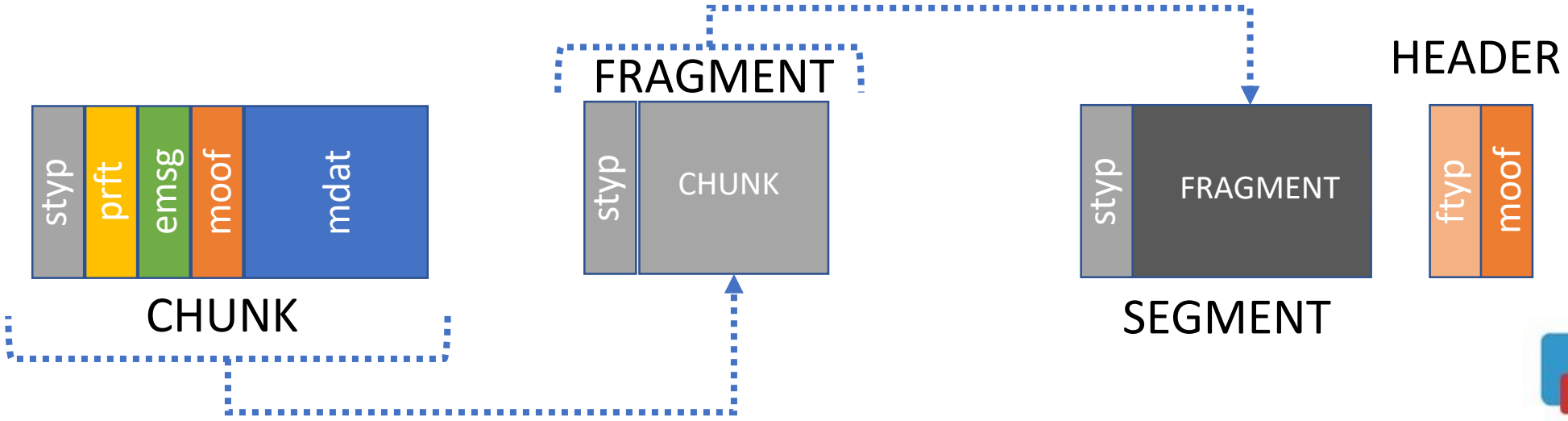
CMAF Media Object Box Tables - Components





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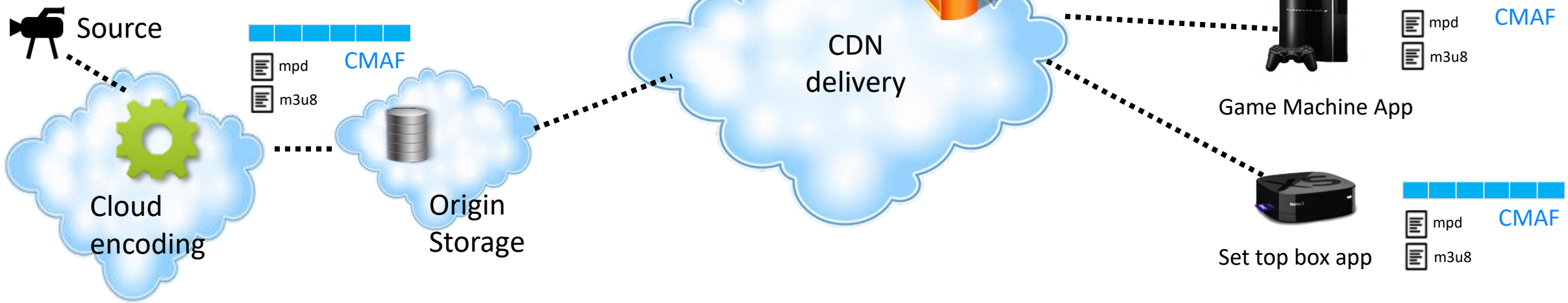
Industry standard manifest (m3u8) — HTTP Live Streaming (HLS) - Apple published in IETF

Industry standard manifest (mpd) — Dynamic Adaptive Streaming over HTTP - ISO MPEG DASH

- June 15, 2016 Apple announced HLS would support CMAF.
- Now the top two adaptive delivery manifest formats - DASH and HLS - support the same content packaging

1) DASH, HLS with CMAF reduce storage and packaging costs,
2) improve edge caching efficiency - very important for live linear streaming,
3) and enable device interoperability.



Web Application Video Ecosystem – Content Specification

The WAVE Content Specification is derived from the ISO/IEC standard, “Common media application format (CMAF) for segmented media”, extending it by referencing additional non-MPEG Media Profiles.

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Manifest independent live-linear and on-demand encoding

Common Media Application Format – ISO MPEG CMAF

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CMAF Codec bindings to Global ISO MPEG and non-ISO MPEG Codecs, including new royalty free codecs like AV1 from the Alliance for Open Media.

CMAF Codec bindings or “Media Profiles” with market support will be published annually in the CTA WAVE Content Specification.

CTA WAVE CONTENT SPECIFICATION

Media Profile 1 … Media Profile *p*

Other Published CMAF Media Profiles

Additional media profiles will be published elsewhere.

Media Profile 1 Media Profile 2 … Media Profile *q*

Common Media Application Format – ISO MPEG CMAF

Some media profiles are identified in the ISO MPEG CMAF specification.

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WAVE Content Specification 2018 - Video Profiles

Media Profile Name	*INFORMATIVE* Codec	*INFORMATIVE* Profile	*INFORMATIVE* Level	*INFORMATIVE* Color primaries & matrix coefficients	*INFORMATIVE* Transfer Characteristics	*INFORMATIVE* 'codecs' MIME subparameters	NORMATIVE CMAF Brand	NORMATIVE Normative Reference
HD	AVC	High	4.0	1 (BT.709)	1 (BT.709 OETF)	avc1.640028 avc3.640028	'cfhd'	[CMAF] Table A.1
HHD10	HEVC	Main10 MainTier	4.1	1 (BT.709)	1 (BT.709)	hev1.2.4.L123.B0 hvc1.2.4.L123.B0	'chh1'	[CMAF] Table B.1
UHD10	HEVC	Main10 MainTier 10-bit	5.1	1 (BT.709) 9 (BT.2020)	1 (BT.709 OETF) 14 (BT.2020 OETF)	hev1.2.4.L153.B0 hvc1.2.4.L153.B0	'cud1'	[CMAF] Table B.1
HLG10	HEVC	Main10 MainTier 10-bit	5.1	9 (BT-2020)	18 (BT.2100 Table 5 HLG OETF) 14 (BT.2020 OETF)	hev1.2.4.L153.B0 hvc1.2.4.L153.B0	'clg1'	[CMAF] Table B.1
HDR10	HEVC	Main10 MainTier 10-bit	5.1	9 (BT.2020)	16 (BT.2100 Table 4 PQ EOTF)	hev1.2.4.L153.B0 hvc1.2.4.L153.B0	'chd1'	[CMAF] Table B.1

The 2018 Edition of the WAVE Content Specification includes the following video Media Profiles. Additional media profiles are likely to be added in an amendment prior to the 2019 edition of the WAVE Content Specification – including a CMAF binding for AV-1.

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WAVE Content Spec 2018 - Audio Profiles

- Some organizations outside MPEG have begun publishing bindings specifications for CMAF.
- The first of these organizations is ETSI, which is publishing CMAF bindings specifications for both Dolby and DTS audio codecs.
- Other organization have suggested they will publish CMAF bindings in 2018.
- The WAVE content specification also includes both IMSC1 Text and Image CMAF bindings.
- IMSC1 is being standardized because of its compatibility with EBU_TT_D used in Europe.

Media Profile Name	*INFORMATIVE* Codec Family	*INFORMATIVE* Allowed Codecs or Profiles	*INFORMATIVE* Level	*INFORMATIVE* 'codecs' MIME subparameter	NORMATIVE CMAF Brand	NORMATIVE Normative Reference
AAC Core	AAC	AAC-LC, HE-AAC or HE-AAC v2	2	mp4a.40.2 mp4a.40.5 mp4a.40.29	'caac'	[CMAF] Table A.2
Adaptive AAC Core	AAC	AAC-LC, HE-AAC or HE-AAC v2	2	mp4a.40.2 mp4a.40.5 mp4a.40.29	'caaa'	[CMAF] Table A.2
AAC Multichannel	AAC	AAC-LC, HE-AAC	6	mp4a.40.2 mp4a.40.5 mp4a.40.29	'camc'	[CMAF A1] Table i.2
Enhanced AC-3, including AC-3	AC-3 EAC-3	AC-3 EAC-3	n.a.	ec-3	'ceac'	[EAC3]
AC-4, Single Stream	AC-4	AC-4	3	ac-4.02.01.03	'ca4s'	[AC4]
MPEG-H, Single Stream	MPEG-H	Low Complexity (LC)	3	mhm1.0x0B mhm1.0x0C mhm1.0x0D	'cmhs'	[CMAF A1] Table j.2

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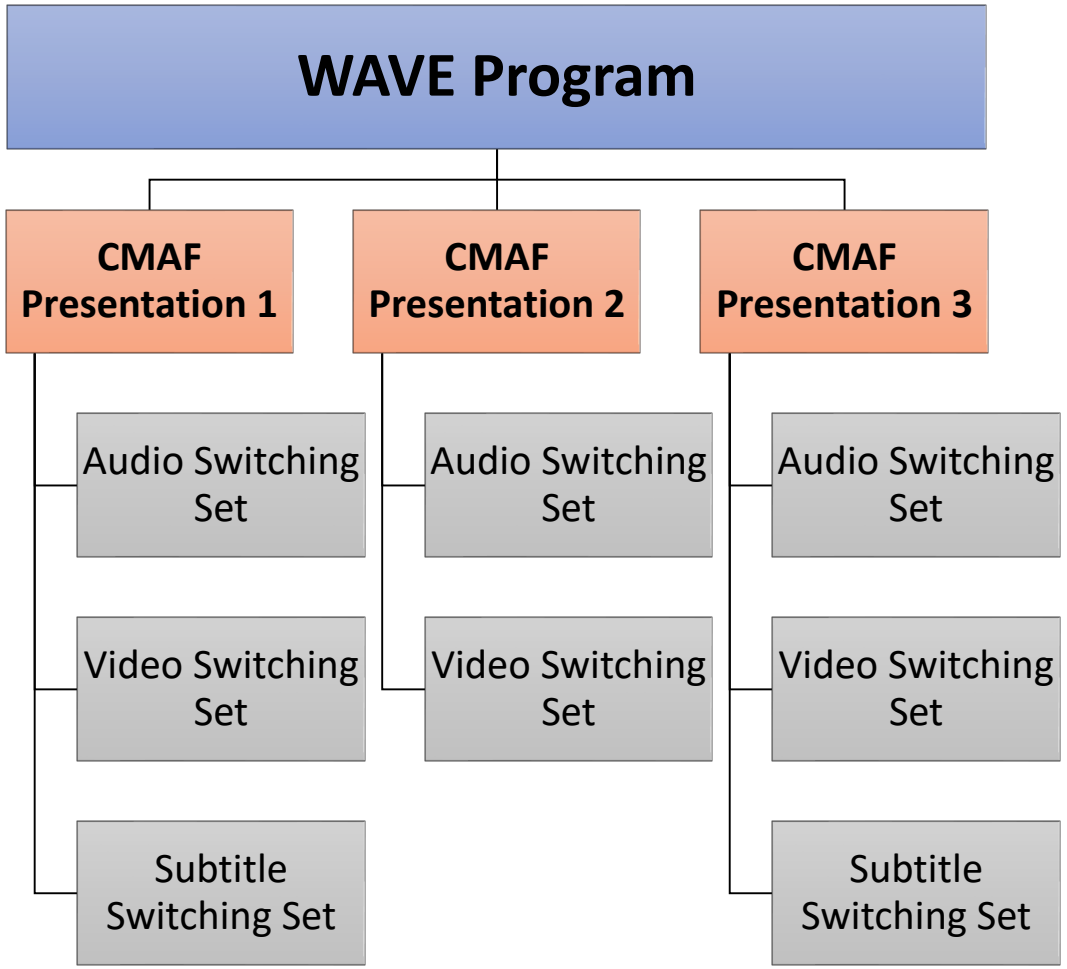
WAVE Programs and Live Linear Content

- Live linear content with ad insertions may require delivering not one but a sequence of CMAF Presentations.
- To address this likelihood, the WAVE content spec defines WAVE programs, which are a sequence of one or more CMAF Presentations.
- When a WAVE Program includes more than one CMAF presentations, it can optionally conform to a WAVE Splice Constraint Profile.
- The 2018 Edition of the WAVE Content Spec defines a Baseline Splice Constraint Profile, encoding constraints intended to allow continuous rendering of Sequential Switching Sets in WAVE Programs on most existing adaptive streaming Players in the market today.
- We anticipate that as new devices enter the market, the more advanced Splice Constraint Profiles will be published by WAVE.



Continuous Rendering for a continuous user experience

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Cross-platform Progressive Web Apps (PWAs)	Web Workers and Web App Manifest – W3C & WHATWG
JavaScript control of adaptive streaming	HTML5 Media Source Extensions (MSE) – W3C
JavaScript interaction with DRM	HTML5 Encrypted Media Extensions (EME) – W3C
Industry standard manifest (m3u8)	HTTP Live Streaming (HLS) - Apple published in IETF
Industry standard manifest (mpd)	Dynamic Adaptive Streaming over HTTP - ISO MPEG DASH
Manifest independent live-linear and on-demand encoding	Common Media Application Format – ISO MPEG CMAF
DRM-Interop encode/decode	Common Encryption for fragmented MP4 - ISO MPEG CENC

Web App Manifest, W3C Working Draft 08 May 2018, www.w3.org/TR/appmanifest/

Web Workers and Web App Manifest – W3C & WHATWG

Media Source Extensions, W3C Recommendation 17 November 2016, http://www.w3.org/TR/media-source/

HTML5 Media Source Extensions (MSE) – W3C

Encrypted Media Extensions, W3C Recommendation 18 September 2017, http://www.w3.org/TR/encrypted-media/

HTML5 Encrypted Media Extensions (EME) – W3C

HTTP Live Streaming (HLS), RFC8216, https://tools.ietf.org/html/rfc8216

HTTP Live Streaming (HLS) - Apple published in IETF

ISO/IEC 23009-1:2014, Information technology – **Dynamic adaptive streaming over HTTP (DASH)** – Part 1: Media presentation description and segment formats, https://www.iso.org/standard/65274.html

Dynamic Adaptive Streaming over HTTP - ISO MPEG DASH

ISO/IEC 23000-19, Information technology — Coding of audio-visual objects — Part 19: **Common media application format (CMAF)** for segmented media. https://www.iso.org/standard/71975.html

Common Media Application Format – ISO MPEG CMAF

ISO/IEC 23001-7:2016, Information technology – MPEG systems technologies – Part 7: **Common encryption** in ISO base media file format files, https://www.iso.org/standard/68042.html

Common Encryption for fragmented MP4 - ISO MPEG CENC

Discussion