WAVE Update

October 22-26, 2018

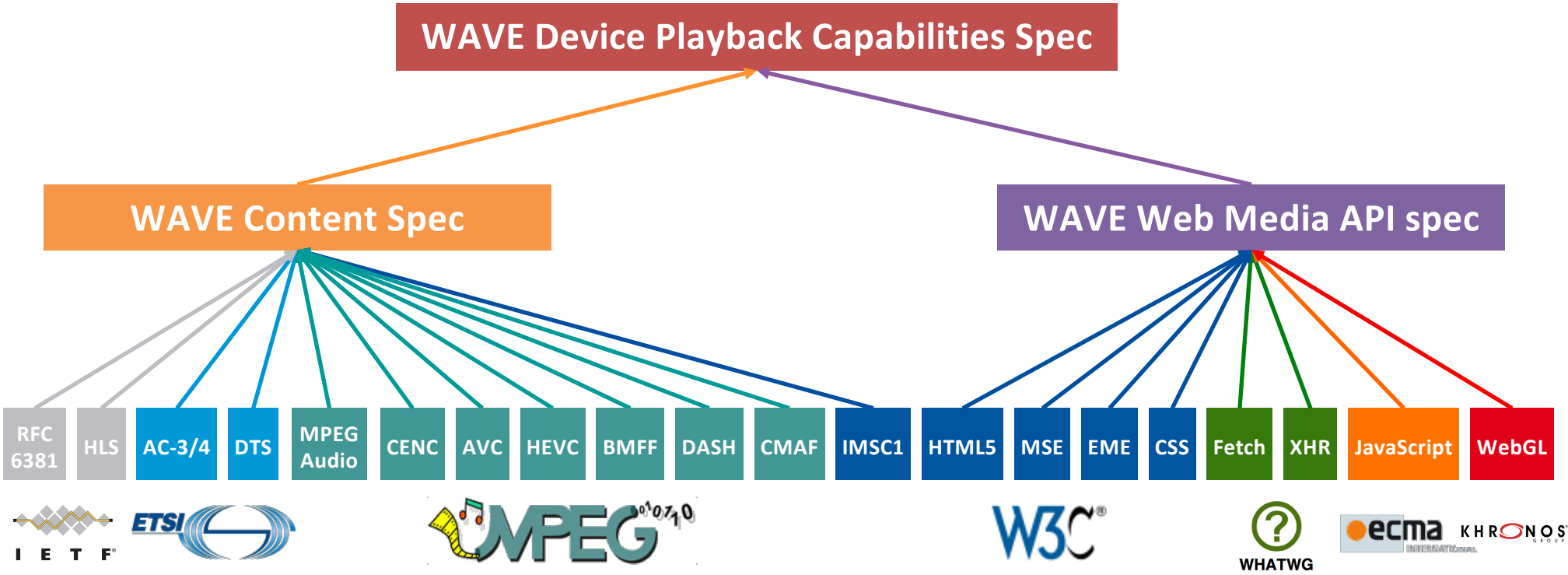
W3C TPAC 2018 | Lyon

Supporting a fragmented OTT world

- Fragmentation impacts content providers and device makers:
  - Multiple streaming formats (HLS, HDS, DASH, Smooth)
  - Multiple device types from laptops to phones to gaming consoles
  - Inconsistent device performance capabilities
  - Inconsistent device compliance to industry specifications
- The result:
  - Content providers: Increased cost to prepare, store and support OTT
  - Device makers: Increased test and support costs for devices
  - Consumers: Glitchy media experience

WAVE
WEB APPLICATION VIDEO ECOSYSTEM

WAVE bridges media standards & web standards



WAVE
WEB APPLICATION VIDEO ECOSYSTEM

Current WAVE Membership

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

*Company names in **bold** are members of the WAVE Steering Committee.*

WAVE
WEB APPLICATION VIDEO ECOSYSTEM

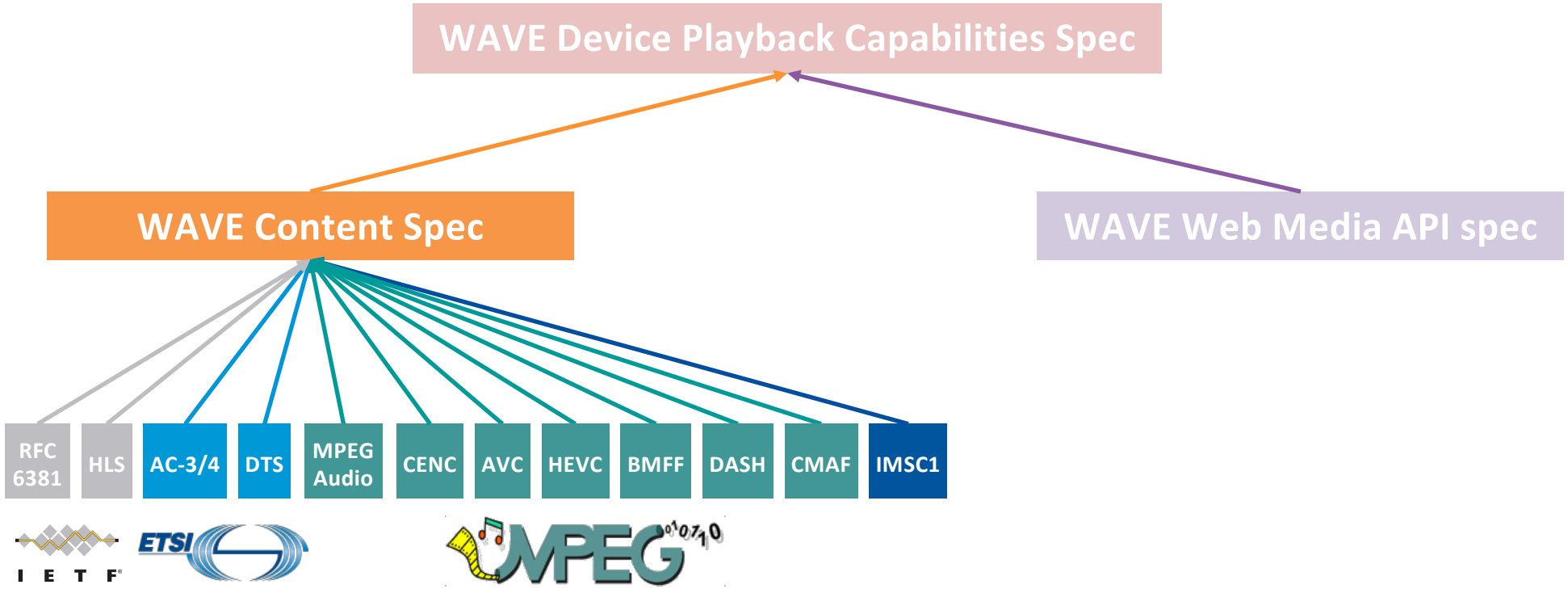
Current WAVE Membership – many also W3C members!

Adobe Systems
AGP
Akamai
Amazon
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

*Company names in **bold** are members of the WAVE Steering Committee.*

WAVE
WEB APPLICATION VIDEO ECOSYSTEM

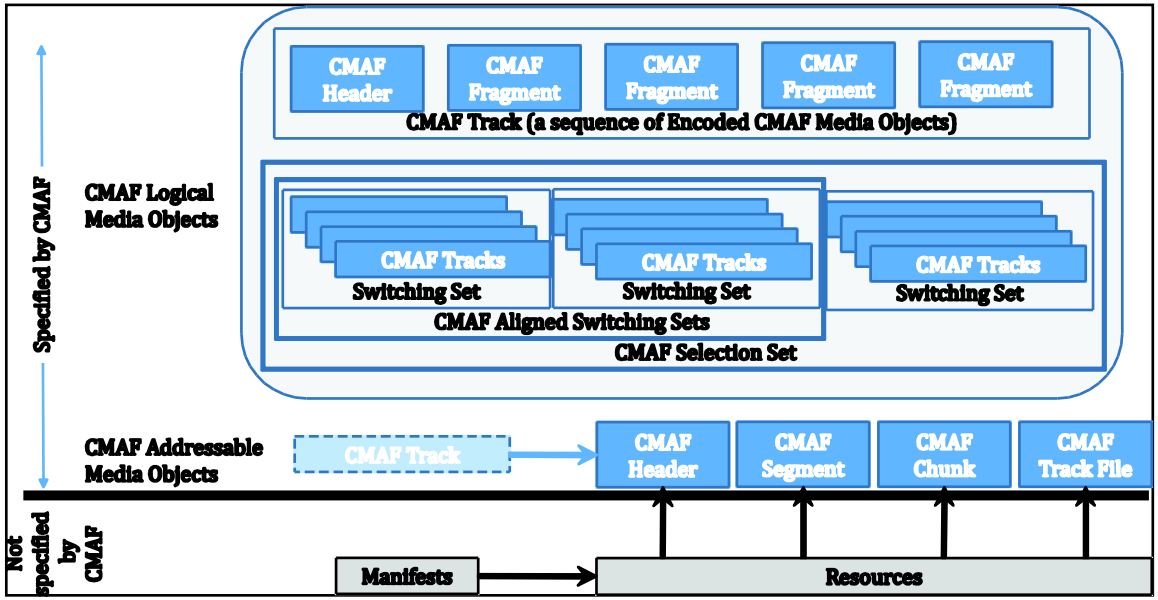
Content Specification



WAVE
WEB APPLICATION VIDEO ECOSYSTEM

What is the Common Media Application Format (CMAF)?

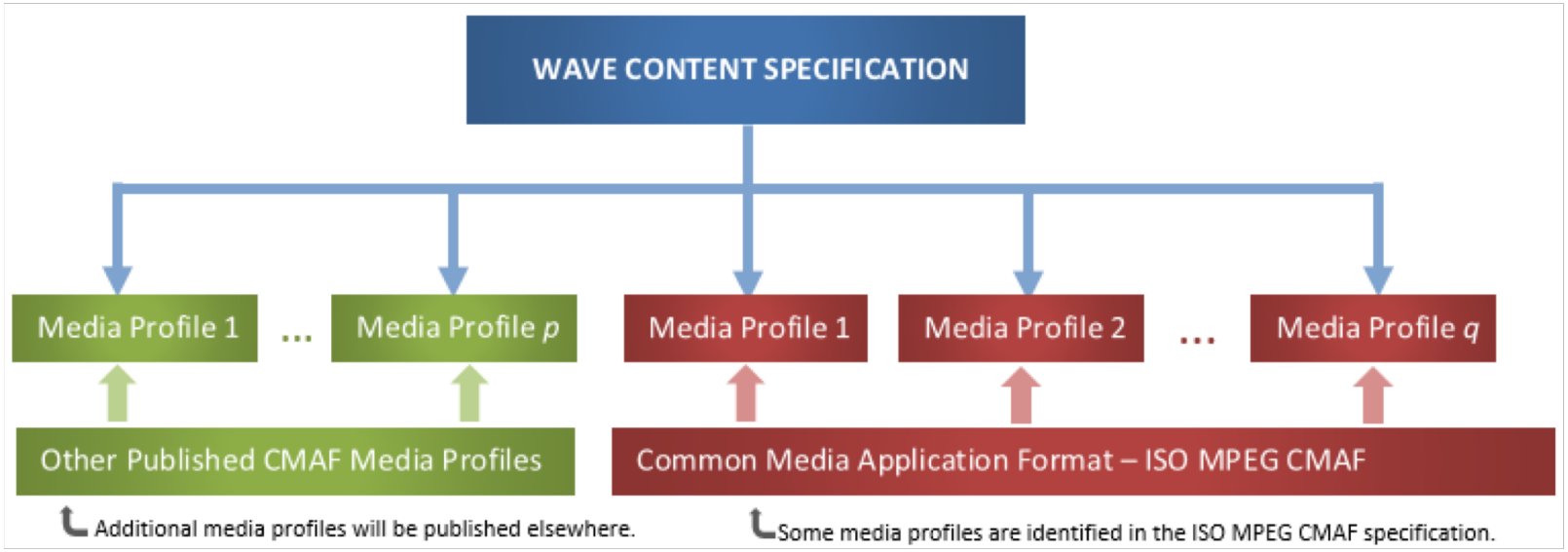
- CMAF is:
  - Standardization and codification of existing best practices…
  - …for fragmented MP4 delivery in common use with DASH…
  - …with some enhancements for low latency delivery.
- Apple added CMAF to HLS as a segment format & committed to client compatibility in 2016.
- Other companies across the industry began to adopt CMAF early in 2017.
- CMAF was published as ISO/IEC spec in January 2018.



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

WAVE
WEB APPLICATION VIDEO ECOSYSTEM

WAVE Content Spec and Published CMAF Media Profiles



- CMAF presentations can be constructed from a variety of codecs – the binding to the CMAF container format is called a "Media Profiles".
- CMAF defines 1) CMAF bindings for a variety of MPEG codecs, 2) extensibility for bindings outside MPEG.
- WAVE has an objective process to qualify Media Profiles for the WAVE Content Specification
  - Market relevance, MSE compatibility, and schedule for availability of test tools / test content.
  - WAVE's adoption of new Media Profiles is an ongoing process.

WAVE
WEB APPLICATION VIDEO ECOSYSTEM

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 these video Media Profiles. Additional media profiles are likely to be added in an amendment prior to the 2019 edition of the WAVE Content Specification.

WAVE
WEB APPLICATION VIDEO ECOSYSTEM

WAVE Content Spec 2018 - Audio Profiles

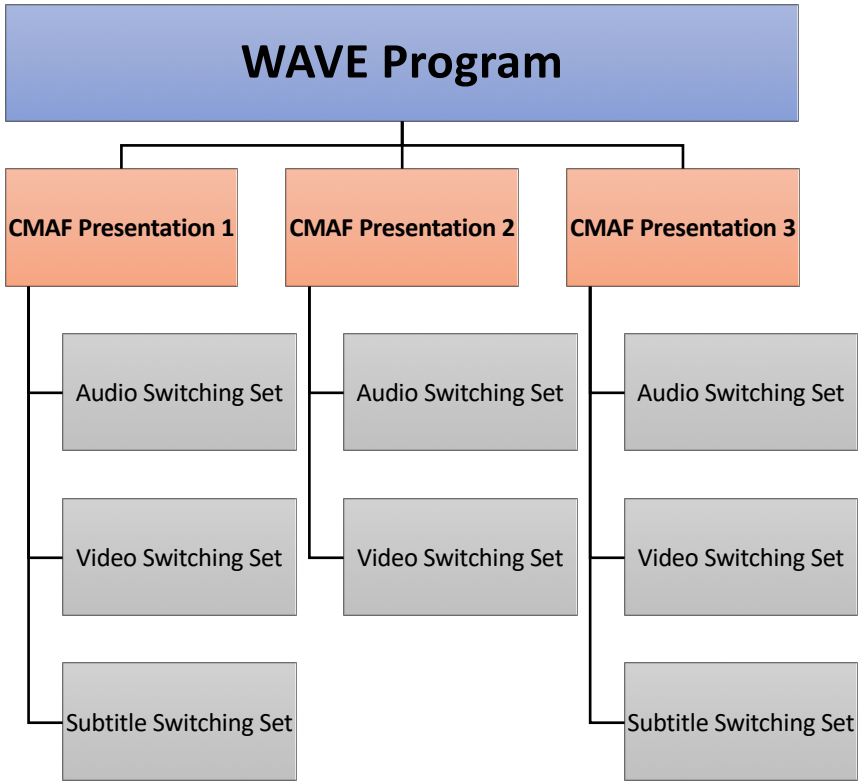
- Some organizations outside MPEG are publishing bindings specifications for CMAF.
- ETSI is publishing CMAF bindings specs for Dolby and DTS audio codecs.
- Other organizations have suggested they will publish CMAF bindings in 2018.
- The WAVE Content Specification also includes both IMSC1 Text and Image CMAF bindings.

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
DTS-HD	DTS-HD	DTS, DTS-HD	n.a.	dtsc, dtse, dtsh	'dts1'	[DTS-HD]
AC-3 and Enhanced 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

WAVE
WEB APPLICATION VIDEO ECOSYSTEM

WAVE Programs and Live Linear Content

- *WAVE Program*: Defined as a sequence of one or more CMAF Presentations.
  - Why? Because live linear content with ad insertions may require multiple CMAF Presentations (unlike VOD).
- A WAVE Program can (optionally) conform to a WAVE *Splice Constraint Profile*.
- The *Baseline Splice Constraint Profile* is:
  - Encoding constraints to enable continuous rendering of sequential Switching Sets in WAVE Programs
  - Intended for most existing adaptive streaming Players in the market today.
- WAVE will publish new, more advanced Splice Constraint Profiles as new devices enter the market.



Continuous Rendering for a continuous user experience

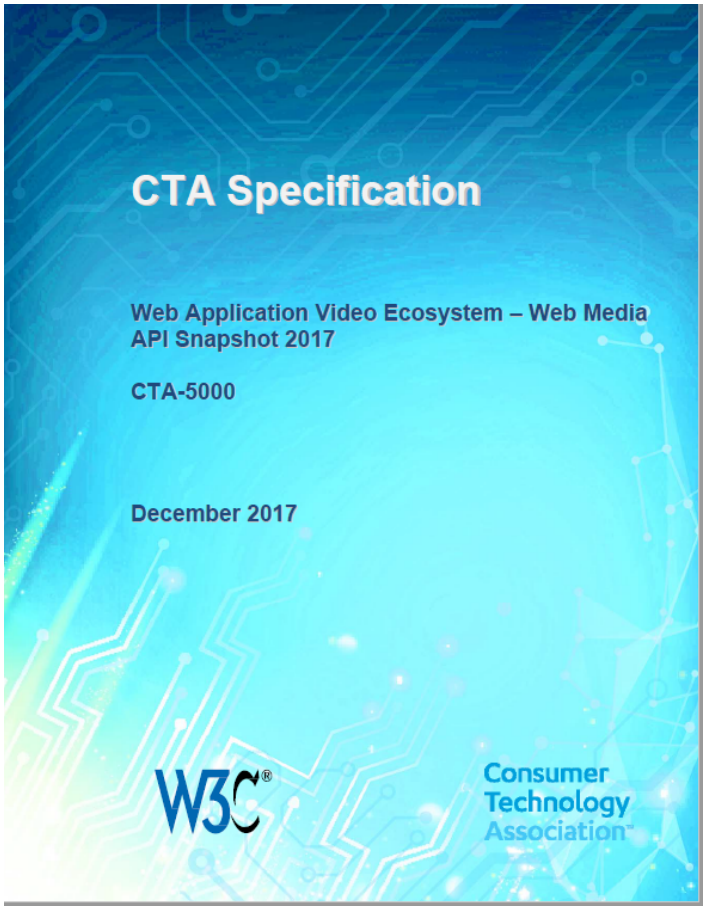
WAVE
WEB APPLICATION VIDEO ECOSYSTEM

The WAVE Content Specification

Download WAVE specifications in PDF format at:

https://cta.tech/WAVE

*This is a **free** download.*



WAVE
WEB APPLICATION VIDEO ECOSYSTEM

Content

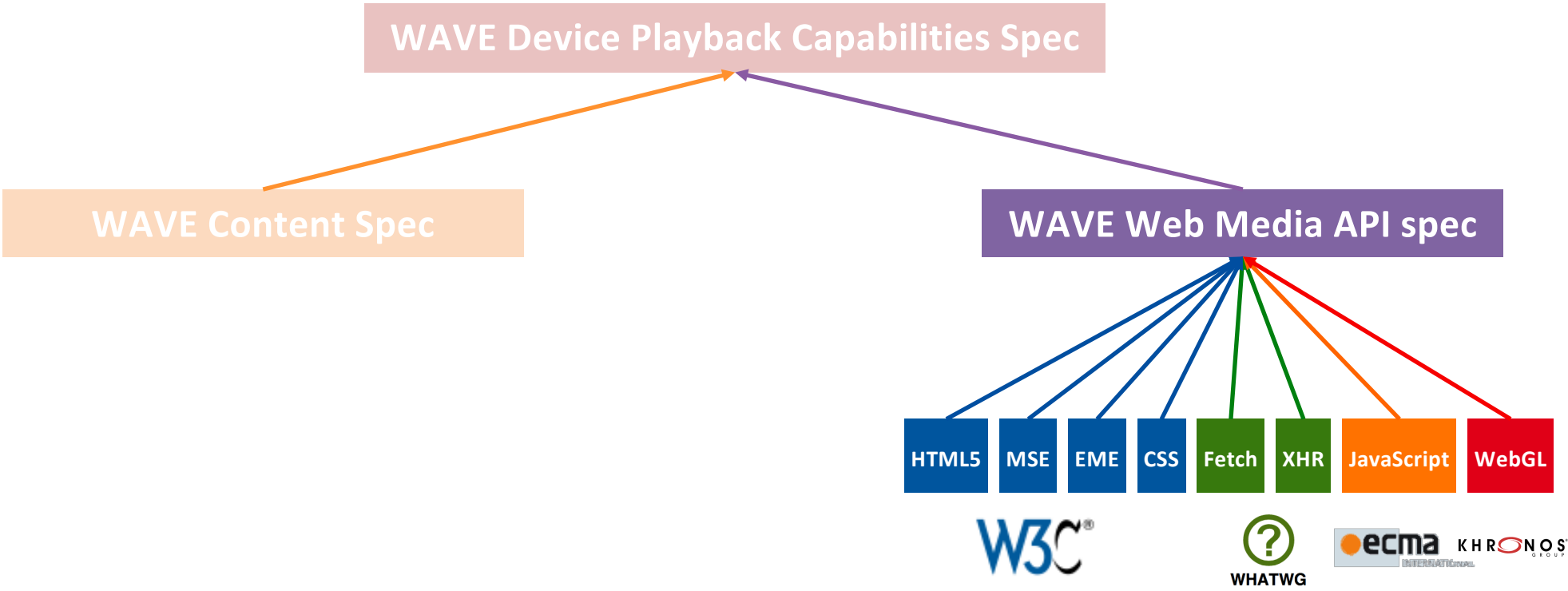
Device Playback Capabilities

HTML5 Reference Platform

HTML5 API Task Force

WAVE
WEB APPLICATION VIDEO ECOSYSTEM

HTML5 API Specification



WAVE
WEB APPLICATION VIDEO ECOSYSTEM

HTM5 API Task Force: Work Plan

- **Web Media API Community Group:**
  - w3.org/community/webmediaapi/

1. **Annual Web Media API spec**
   - define baseline web APIs to support media web apps.
2. **Guidelines for media web app developers**
3. **Identify gaps in current web APIs**
   - work with W3C Working Groups to update web standards.

WAVE
WEB APPLICATION VIDEO ECOSYSTEM

Web Media API Snapshot

W3C Community Group Final Report

Web Media API Snapshot 2017

Final Community Group Report 20 December 2017

Latest editor's draft:
https://w3c.github.io/webmediaapi/

Editors:
David Evans, British Broadcasting Corporation
Mark Vickers, Comcast

Participate:
GitHub w3c/webmediaapi
File a bug
Commit history

Abstract

This specification lists the Web APIs to support media web apps that are supported across all four of the most widely used user agent code bases at the time of publication. This specification should be updated at least annually to keep pace with the evolving Web platform. We encourage manufacturers to develop products that support the APIs in the most recent version of Web Media API Snapshot. This specification is comprised of references to existing specifications in W3C and other specification groups. The target devices will include any device that runs a modern HTML user agent, including televisions, game machines, set-top boxes, mobile devices and personal computers.

The goal of this Web Media API Community Group specification is to transition to the W3C Recommendation Track for standards development.

- **First annual API Snapshot published 20 December 2017:** https://www.w3.org/2017/12/webmediaapi.html
  - Lists key APIs supported in 2017 in all major HTML code bases.
  - CTA-W3C agreement to co-publish this spec.
  - Plan to propose Community Group spec as a W3C standards track spec
  - CTA WAVE released a test suite for all listed APIs based on W3C API tests (https://webapitests2017.ctawave.org).
  - Test suite will enable manufacturers to test that their HTML support is up-to-date!
  - Web Media API Snapshot 2018 to be published in December, 2018.

WAVE
WEB APPLICATION VIDEO ECOSYSTEM

The WAVE Web Media API Snapshot 2017

Download WAVE specifications in PDF format at:

https://cta.tech/WAVE

*This is a **free** download.*

WAVE
WEB APPLICATION VIDEO ECOSYSTEM

Web Media Application Developer Guidelines

W3C Community Group Draft Report

Web Media Application Developer Guidelines 2018

Draft Community Group Report 22 August 2018

Latest editor's draft:
https://w3c.github.io/webmediaguidelines

Editors:
Joel Korpi (AppNexus)
Thasso Griebel (CastLabs)
Jeff Burtoft (former editor) (Microsoft)

Participate:
GitHub w3c/webmediaguidelines
File a bug
Commit history
Pull requests

Abstract

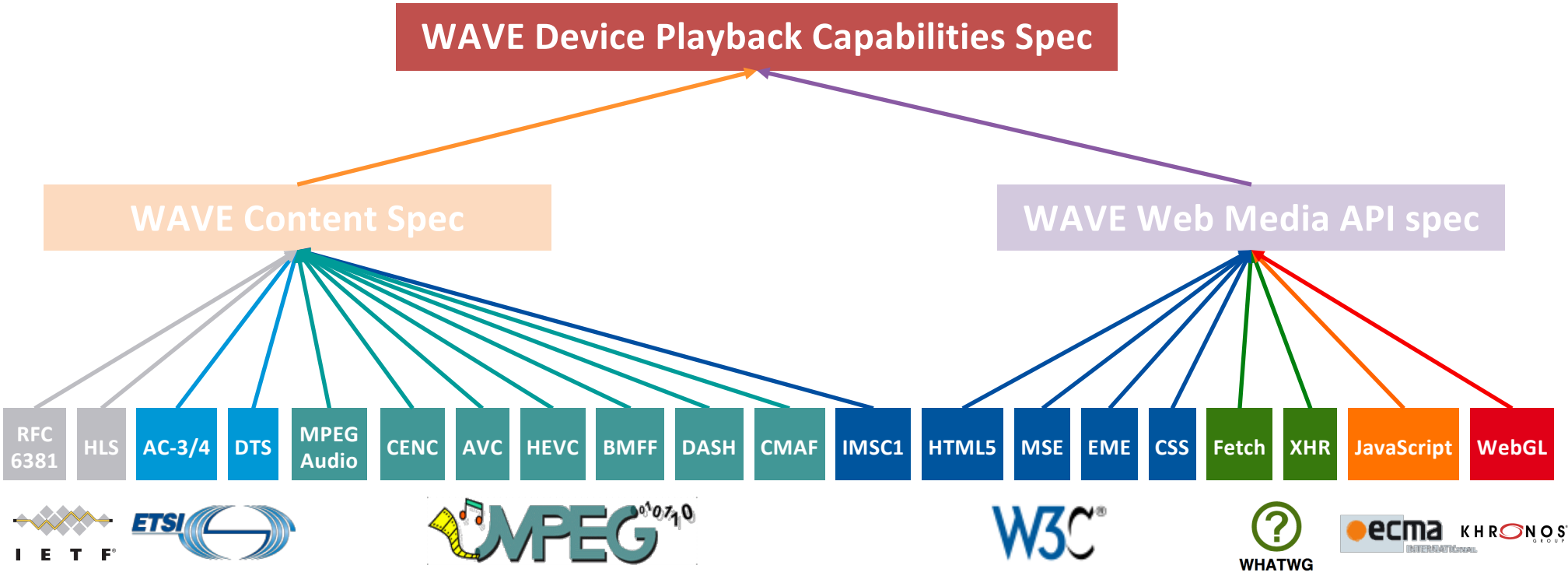
This specification is a companion guide to the Web Media API spec. While the Web Media API spec is targeted at device implementations to support media web apps in 2018, this specification will outline best practices and developer guidance for implementing web media apps. This specification should be updated at least annually to keep pace with the evolving Web platform. The target devices will include any device that runs a modern HTML user agent, including televisions, game machines, set-top boxes, mobile devices and personal computers.

The goal of this Web Media API Community Group specification is to transition to the W3C Recommendation Track for standards development.

- **Ready for review:** https://w3c.github.io/webmediaguidelines/
- Lists best practices for building media web apps.
  - Use cases including VOD & Live
  - Media Playback Methods
  - Content Encoding Guidelines
  - Web App Structure
- No test suite

WAVE
WEB APPLICATION VIDEO ECOSYSTEM

Device Playback Capabilities Specification



WAVE
WEB APPLICATION VIDEO ECOSYSTEM

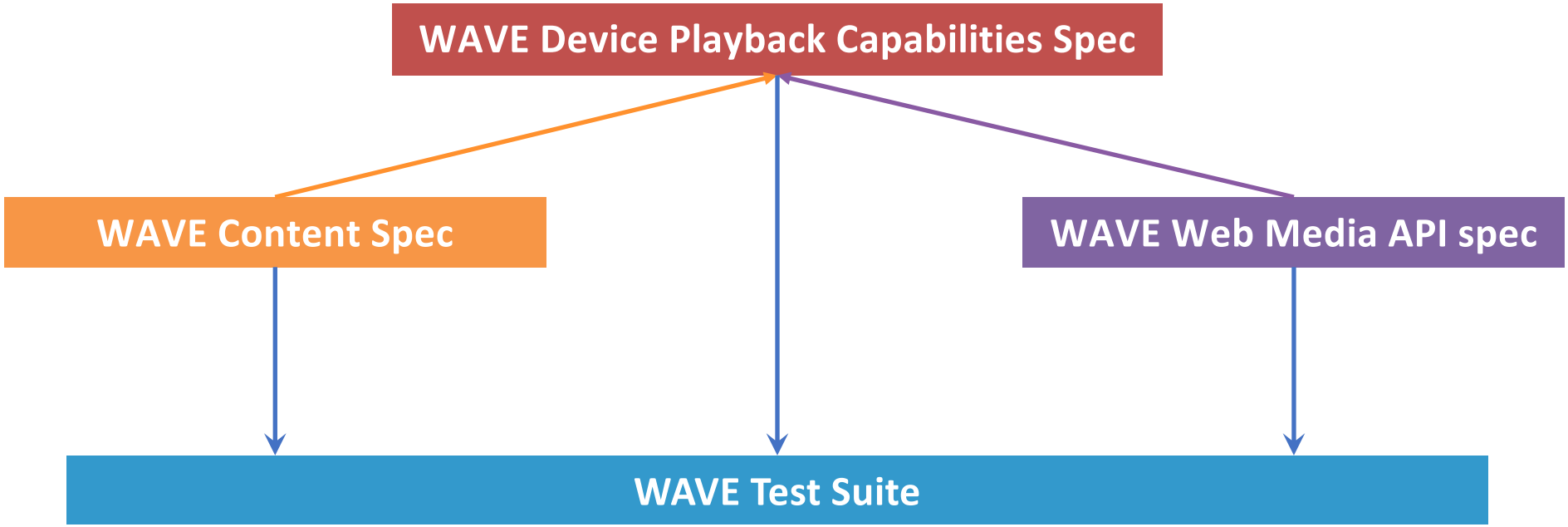
OTT Device Performance Challenges

- Ad splicing problems
- Regional profiles (50/60Hz)
- Request protocol deficiencies
- Unknown codec capabilities
- Unknown rendering capabilities
- Partial profile support
- Codec incompatibility
- Long-term playback instability
- Late Binding Synchronization
- Audio discontinuities
- Glitches when switching bitrate
- Memory problems
- Limited processing power
- Long start-up delay
- Performance monitoring
- DRM support
- Variable HDR support
- Scaling display issues

DPCTF Specification Objectives

- Provide testable requirements for device performance challenges
- Provide capability code points for WAVE content
- Enable the qualification of existing platforms for their WAVE content playback capabilities
- Generate a forward-looking specification for advanced media playback requirements, including new codecs and experiences
- Prioritize challenges and address the highest priority items first

WAVE Test Suite



WAVE
WEB APPLICATION VIDEO ECOSYSTEM

Questions addressed with the WAVE Test Suite

Given a content stream,

1. *Does it comply to WAVE Content Spec requirements?*

Given a device,

2. *Does the device meet Device Playback Capabilities Spec requirements?*
3. *If HTML5, does the device comply to WAVE HTML5 API requirements?*

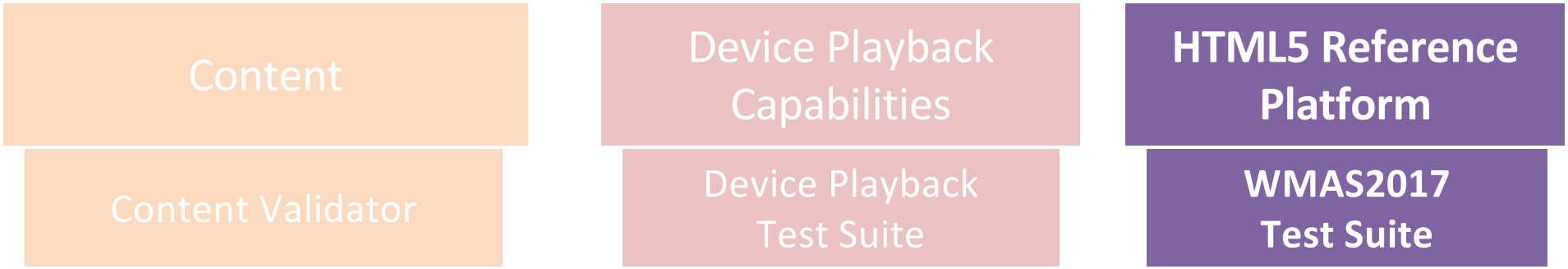
WAVE
WEB APPLICATION VIDEO ECOSYSTEM

WAVE Approach to Test

- Compliance program (not certification or “logo” program)
- Partner with other groups where possible (e.g. DASH-IF, W3C)
  - Extend existing test efforts
  - Some new WAVE use cases lead to new tests
- WAVE arranges for the creation of new test material as needed
  - Cooperate with partner groups
  - Avoid hard ‘forks’ of existing open source tests
  - Continue licensing agreements on existing projects
  - Currently using “free, open source” model

WAVE
WEB APPLICATION VIDEO ECOSYSTEM

WAVE HTML5 API Test Suite



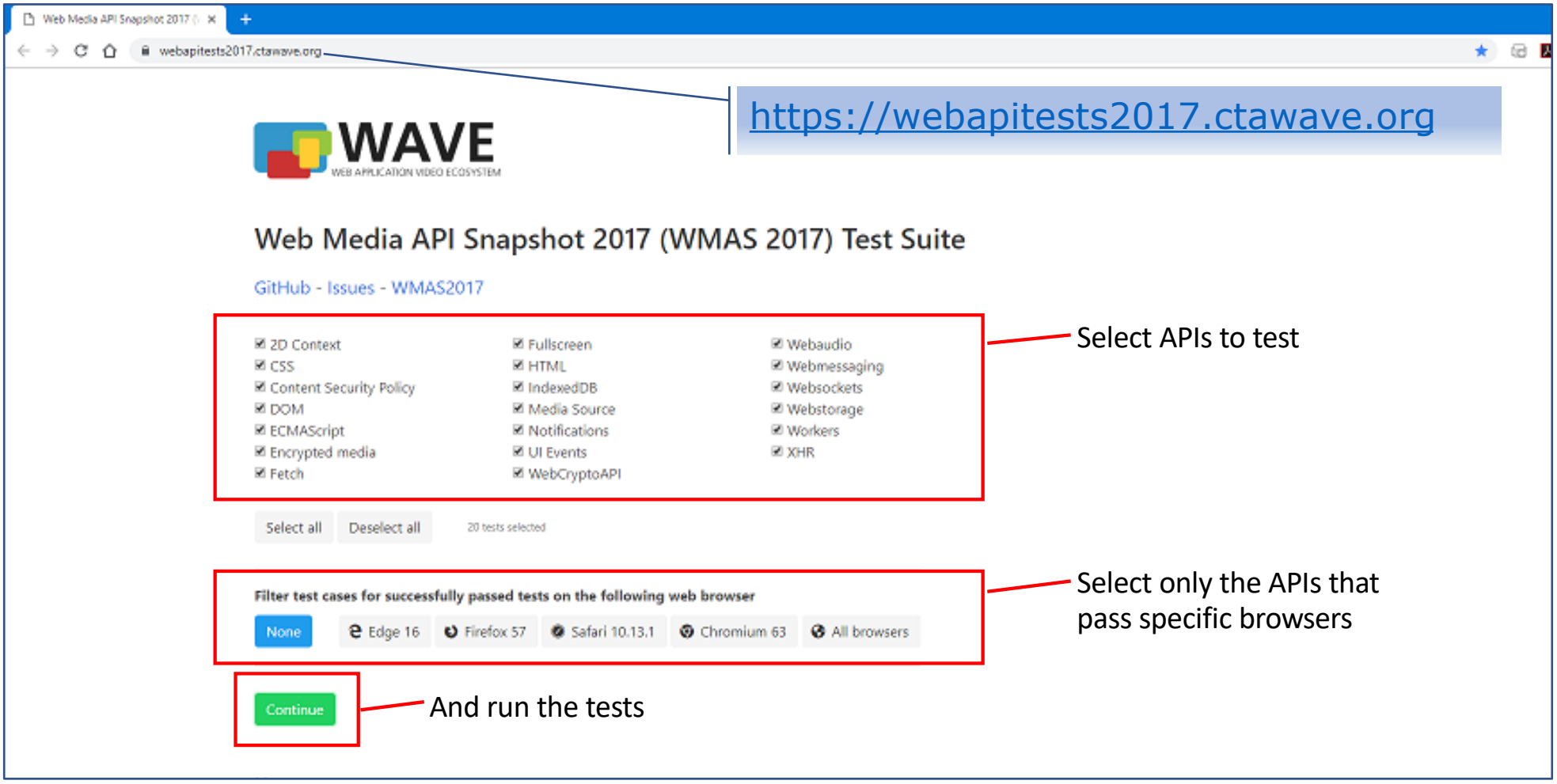
- Based on W3C Web Platform Tests under agreement with W3C
- Verifies API under certain assumptions
- Published and available now

WAVE
WEB APPLICATION VIDEO ECOSYSTEM

WMAS2017 Test Suite – Assumptions

- Based on Web Media API Snapshot 2017 (WMAS2017) specification
- Modified to run on general-purpose *and* embedded systems
  - E.g., laptops/tablets/phones *and* smart TVs/media sticks/STBs
- Targets APIs that pass on the four main browser codebases (Chromium, Edge, Gecko, WebKit; using CanIUse.com)
- Verified on:
  - Downloadable browsers (cf. codebases)
  - Three embedded systems (smart TV, media stick, gaming console)

WAVE
WEB APPLICATION VIDEO ECOSYSTEM



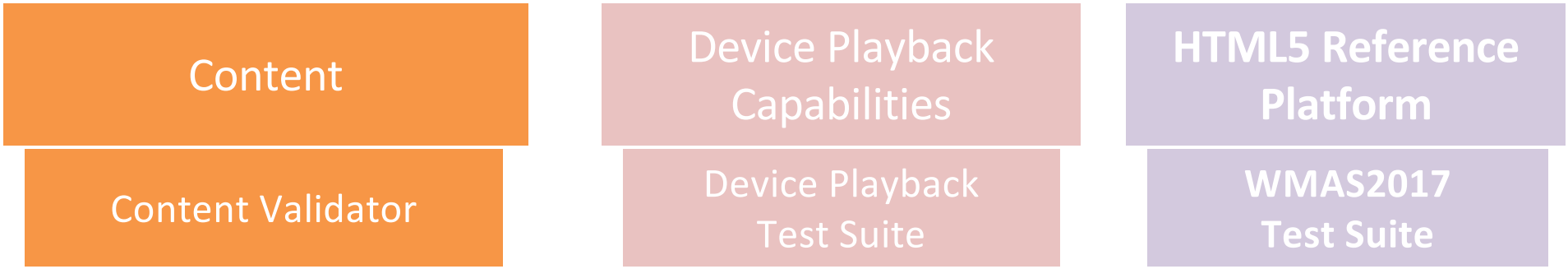
WAVE
WEB APPLICATION VIDEO ECOSYSTEM

WAVE Test Material – HTML5 API Reference Platform

- Web Media API Snapshot 2017 Test Suite
  - Test drive live (unblock port 8050)
    - https://webapitests2017.ctawave.org/
  - Open Source version (for porting to e.g. smart TVs)
    - https://github.com/cta-wave/WMAS2017
  - Issues list *(public—if you encounter a bug or need a feature)*
    - https://github.com/cta-wave/WMAS2017/issues

WAVE
WEB APPLICATION VIDEO ECOSYSTEM

WAVE Content Validator



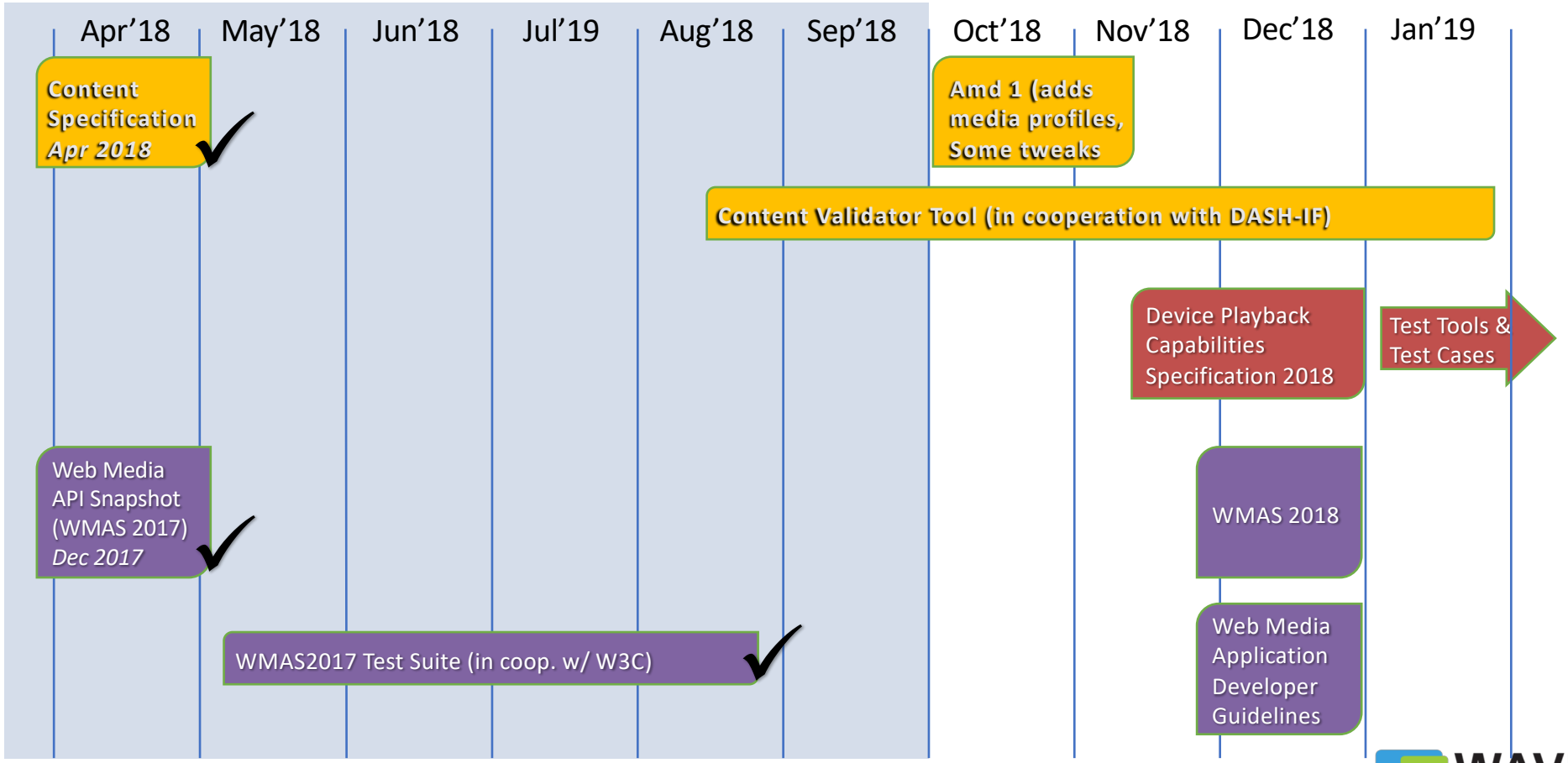
- Based on DASH-IF Content Validator under agreement with DASH-IF
- Verifies CMAF packaging of content
- Does not inspect elementary streams *inside* the CMAF packaged content
- Project under way; should publish Q1 2018

WAVE Content Conformance

- WAVE Content is CMAF Content
- Starting with MPEG-DASH conformance tool
  - “MPEG-DASH format” is *almost* “CMAF format”
- Validation against:
  - ISO-BMFF rules
  - General CMAF rules about segment boxes/CMAF Tracks and Addressable Resources
  - MPD information specific rules for segment boxes (MPD is assumed as manifest for CMAF Presentation)

WAVE
WEB APPLICATION VIDEO ECOSYSTEM

WAVE Roadmap 2018



WAVE
WEB APPLICATION VIDEO ECOSYSTEM

Key Take-Aways

- WAVE supports laptops, phones, and tablets; and embedded systems like smart TVs, media sticks, gaming consoles, and STBs.
- HTML5 APIs incl. MSE/EME are the basis for the preferred common video application environment, but other environments are supported.
- MPEG CMAF and MPEG CENC form the basis for content preparation.
- The WAVE Content and HTML5 API specifications available now
- The HTML5 API test suite is available now
- The DPCTF specification and test suite are coming soon
- WAVE is global in scope and welcomes increased global participation.

How to Get Involved

- Get free WAVE Specifications:

  https://cta.tech/WAVE

- Join the WAVE Project:

  standards@cta.tech *or*

  mbergman@cta.tech (Mike Bergman, CTA)