



Qualcomm

# INTEROPERABILITY FOR INTERNET TV SERVICES

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Mile High Video, Denver

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# OUTLINE

Problems and Challenges

Selected Standardisation efforts

- DASH-IF
- Low-Latency DASH
- CMAF and CTA WAVE
- DVB-I
- 3GPP enTV, 5G and Hybrid Services

Summary

# SOME OBJECTIVES AND APPROACHES

## Objectives

- Enabling broadcast-grade linear TV service on the Internet
- Making media service more personalized, interactive and immersive
- Enabling monetization of media services
- Making services accessible on many different devices and platforms
- Ensuring an end-to-end work flow with all enablers is in place

## Approaches:

- Interoperability programs
- Identifying commercial Demand
- Global standards and ecosystems
- End-to-end workflows and ecosystems
- Supporting implementations by test, open source, conformance and reference tools



# DASH-IF

# CONTINUING TO SUPPORT DASH ADOPTION ...

Founded in 2012 after MPEG-DASH completion, DASH-IF addresses

- Interoperability
- Promotion
- Supporting other SDOs and our members

for interoperable deployment of massively scalable Internet Streaming Services

Charter Members



Associate Members



Contributor Members



# TOOLS CREATED AROUND DASH-IF IOPS

DASH-IF creates guidelines referred to as Interoperability Points (IOPs)

In order to support the deployment of DASH-IF IOPs, DASH-IF Interoperability Group maintains tools:

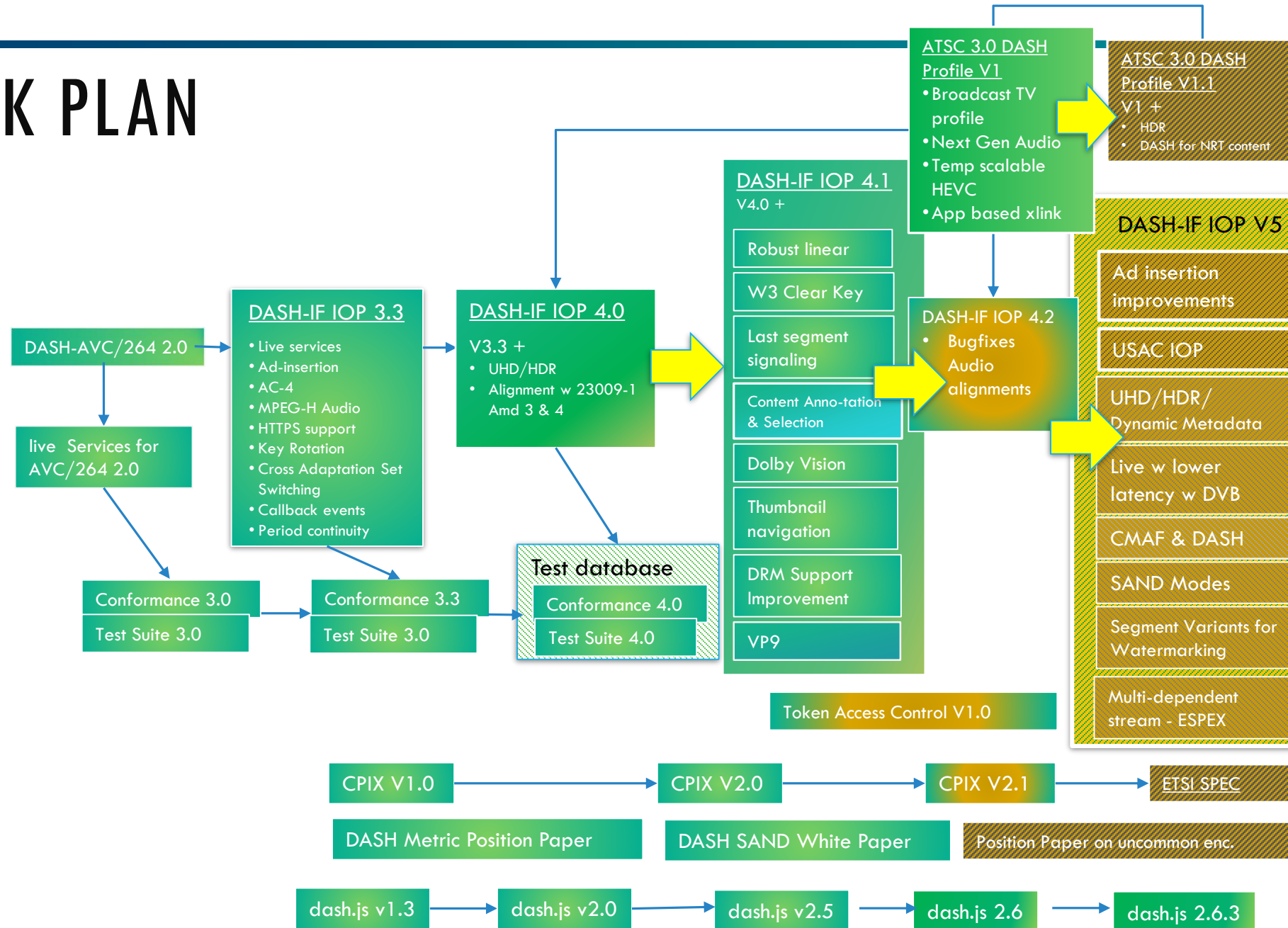
- Documentation of the Interoperability Points
  - V5.0 will be significantly revised both in terms of structuring and publishing
- Test Cases backing the Interoperability Points
- Test Vectors for Test Cases hosted on DASH-IF and Akamai servers
- Conformance Software hosted on DASH-IF web site
- Reference Player delivered as open source player → dash.js
- Open Source Work Flow for Content Generation
- DASH Identifiers Repository

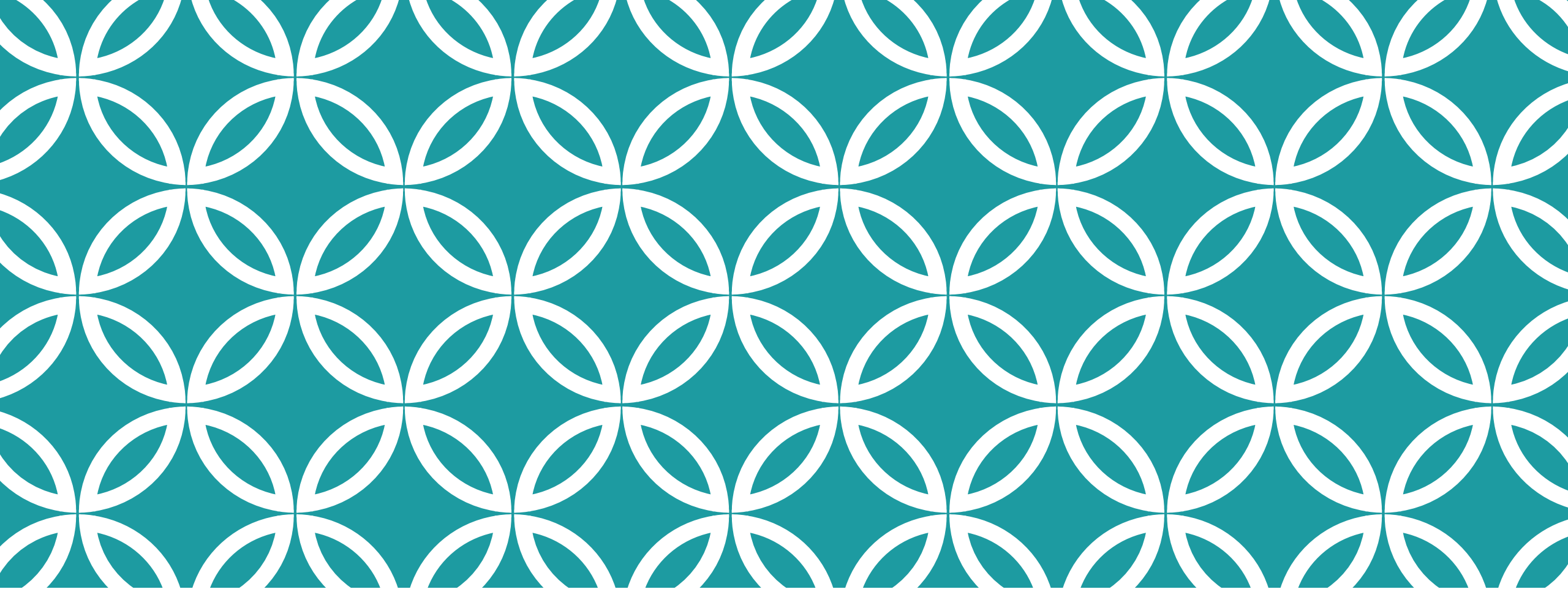
Recent activity: Feature-based development supported by a data base of features, test cases and test vectors

All documentation and tools are publicly available and no fees are attached.

For details refer to <http://dashif.org> → Interoperability

# WORK PLAN

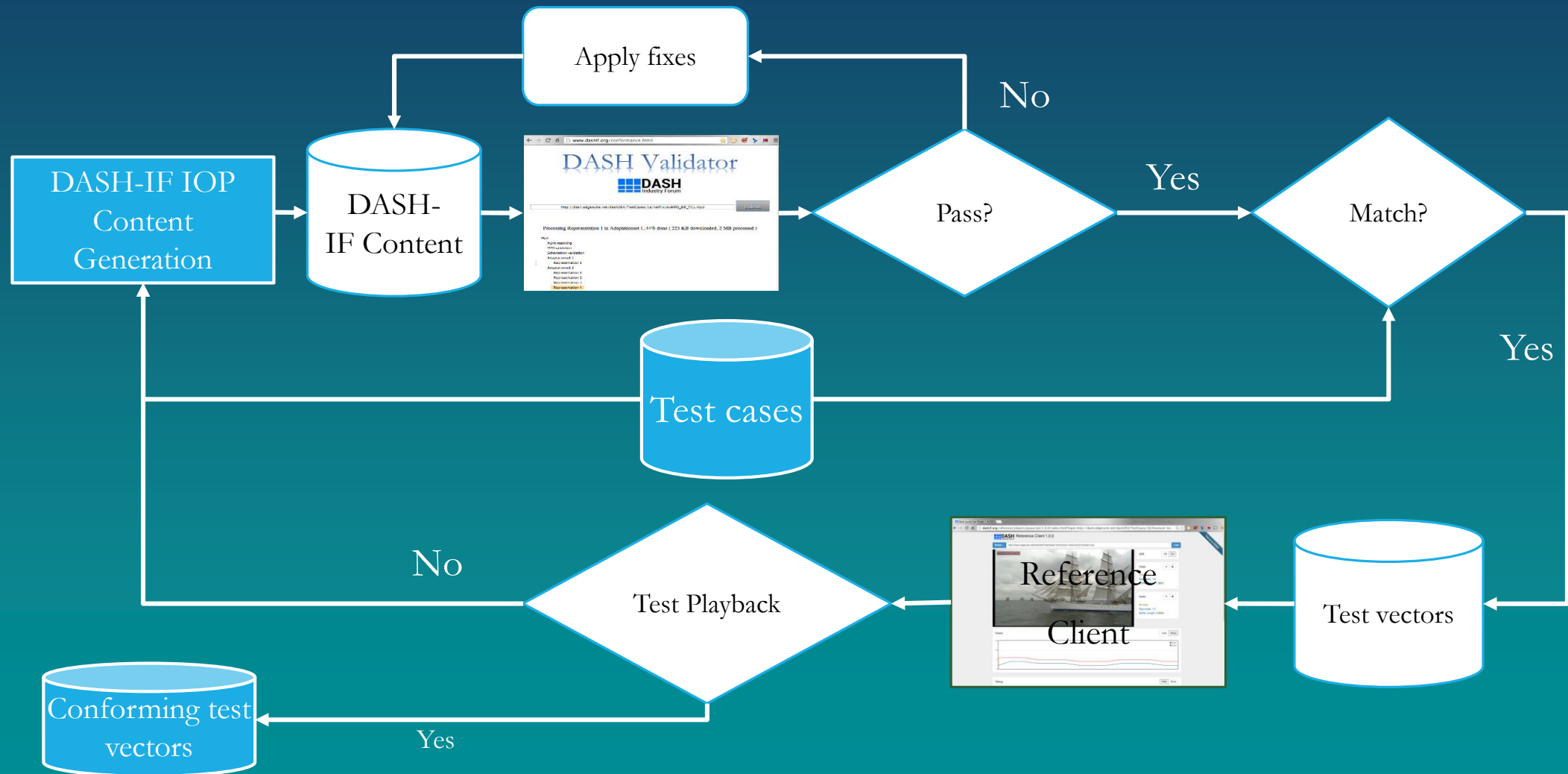




# DASH-IF TOOLS AND PROCESSES



# TEST VECTOR GENERATION HIGH-LEVEL FRAMEWORK AND DASH-IF ASSETS



# TO ADDRESS SCALABILITY: DASH-IF TEST ASSET DATA BASE

A database and UI hosted on  
an Amazon EC2 instance

Multiple levels of user  
authorization

- Public viewing of assets
- DASH-IF users for updating dataset
- Master-level user

The screenshot displays the DASH-IF Test Assets UI in a web browser. The browser's address bar shows the URL `testassets.dashif.org:8080/index.html#testvector/list`. The page features a dark blue sidebar on the left with navigation links: "Feature Groups", "Features", "Testcases", "Testvector" (which is highlighted), "List", "FAQ / Help", and "Login". The main content area has a header with the "DASH Industry Forum" logo and a hamburger menu icon. Below the header, the "Testvector List" section includes a "Select columns:" dropdown menu currently set to "Testvector , Feature Group , Fe", and three buttons: "Copy", "CSV", and "Excel". A table with five columns is displayed below: "Testvector", "Feature Group", "Feature", "Testcase", and "URL". The table contains five rows of data, all of which are identical. Each row shows a "Testvector" value, a "Feature Group" of "Standard Definition", a "Feature" of "Dynamic Segment Offering with MPD Update", a "Testcase" of "Test Case 1", and a "URL" of `http://vm2.dashif.org/livesim-dev/periods`.

| Testvector | Feature Group       | Feature                                  | Testcase    | URL                                       |
|------------|---------------------|--|-------------|---|
|            | Standard Definition | Dynamic Segment Offering with MPD Update | Test Case 1 | http://vm2.dashif.org/livesim-dev/periods |
|            | Standard Definition | Dynamic Segment Offering with MPD Update | Test Case 1 | http://vm2.dashif.org/livesim-dev/periods |
|            | Standard Definition | Dynamic Segment Offering with MPD Update | Test Case 1 | http://vm2.dashif.org/livesim-dev/periods |
|            | Standard Definition | Dynamic Segment Offering with MPD Update | Test Case 1 | http://vm2.dashif.org/livesim-dev/periods |
|            | Standard Definition | Dynamic Segment Offering with MPD Update | Test Case 1 | http://vm2.dashif.org/livesim-dev/periods |

# CONFORMANCE

## Validation of

- MPD
  - Representations
  - Interactions MPD/Representations
- According to ISO/IEC 23009-1 and DASH-IF IOP

No elementary stream

## Source Git

- Frontend: <https://github.com/Dash-Industry-Forum/Conformance-Software>
- Backend: <https://github.com/Dash-Industry-Forum/Conformance-and-reference-source>

<https://dashif.org/conformance.html>

The screenshot shows the DASH Validator web application. At the top, the title "DASH Validator" is displayed in a large, blue, serif font, with the DASH Industry Forum logo to its right. Below the title, a subtitle reads "Validation (Conformance check) of ISO/IEC 23009-1 MPEG-DASH MPD and Segments". A text input field contains the URL "http://dash.edgesuite.net/dash264/TestCases/1a/qualcomm/1/MultiRate.mpd". To the right of the input field is a blue "Submit" button, followed by an "or" separator, a "Choose File" button, and the text "No file chosen". Below this, there is a checkbox labeled "MPD conformance only". The status "Conformance test completed" is shown. Below that, the profiles are listed: "Profiles: urn:mpeg:dash:profile:isoff-on-demand:2011, http://dashif.org/guidelines/dash264". A link for "Feature list" is provided. At the bottom, a table shows the validation results for different representations. The first row shows "on 1" and "entation validation success". The second row shows "on 2" and "entation validation success". The third row shows "on 3" and "entation validation success". The fourth row shows "on 1" and "entation validation success".

| Representation | Validation Result           |
|----------------|-----------------------------|
| on 1           | entation validation success |
| on 2           | entation validation success |
| on 3           | entation validation success |
| on 1           | entation validation success |

# WHAT IS THE REFERENCE CLIENT?

A player which can play back the DASH-IF IOP test vectors and which illustrates best practices in doing so.

The client is written in JavaScript and makes use of the W3C Media Source Extensions and Encrypted Media Extensions to the VideoElement.

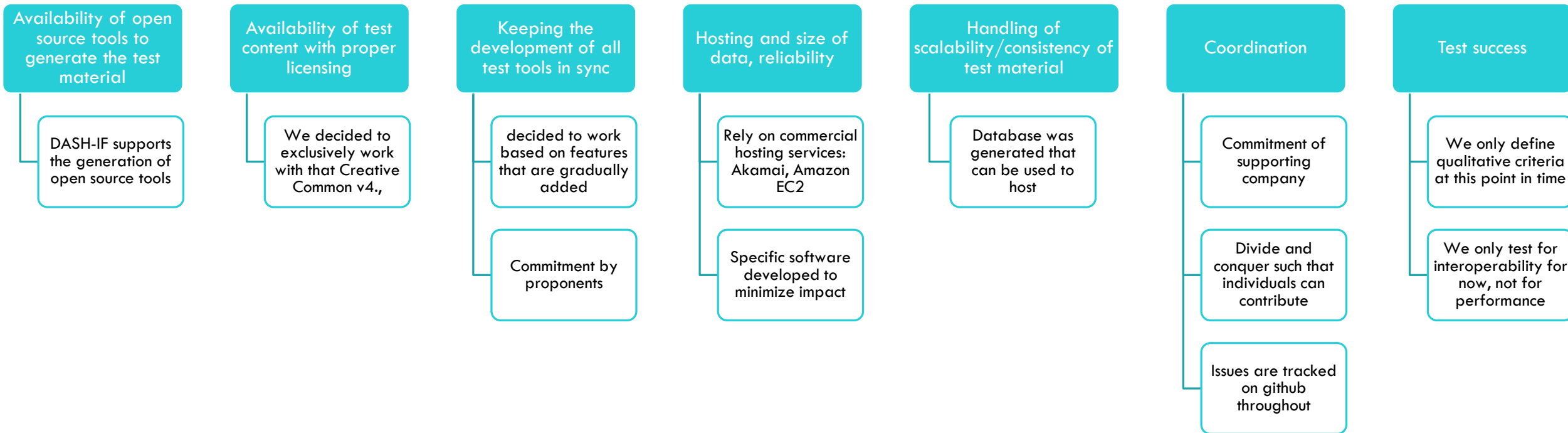
Current client works on Chrome v30+, IE11 under Win8.1, Edge under Win10, Safari under Yosemite, Firefox 39+.

It is an open-source project on Github - <https://github.com/Dash-Industry-Forum/dash.js/>

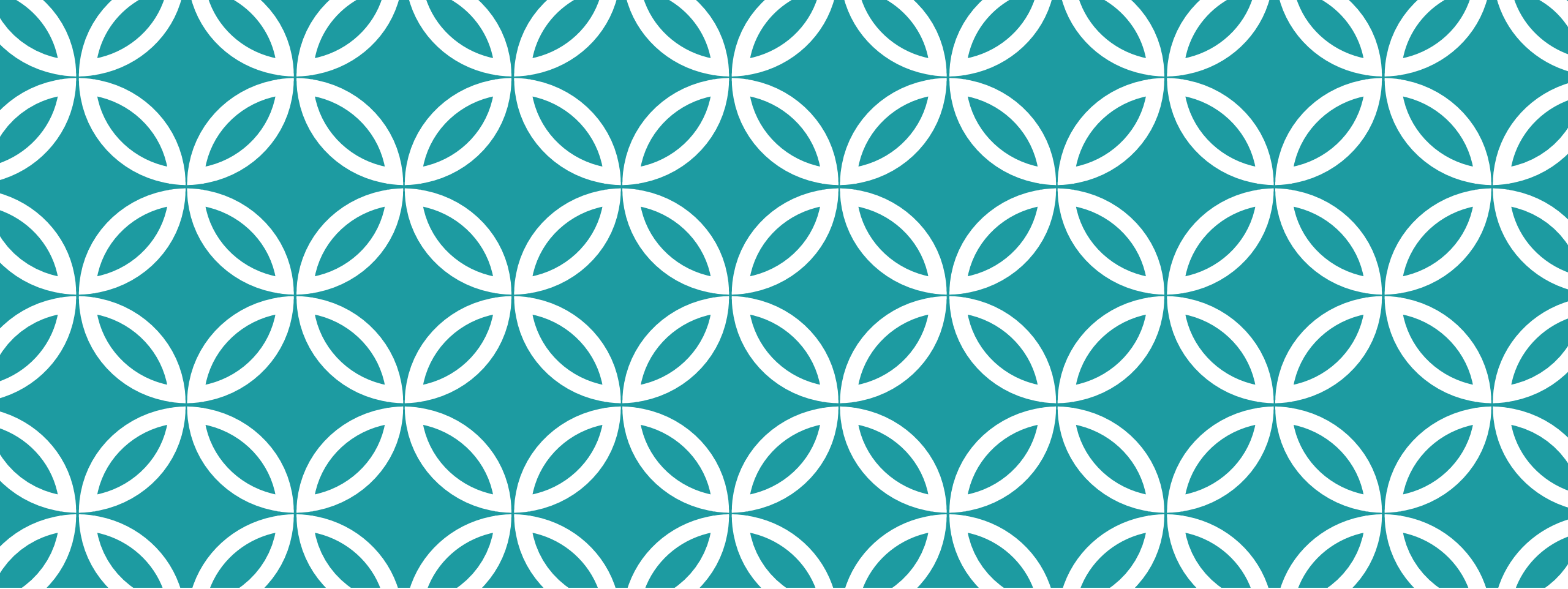
Project has been underway approximately four years.

There have been 80 different collaborators to the code to date.





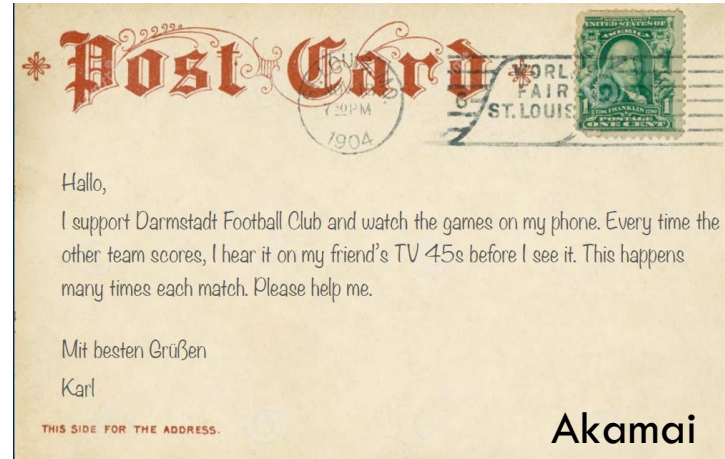
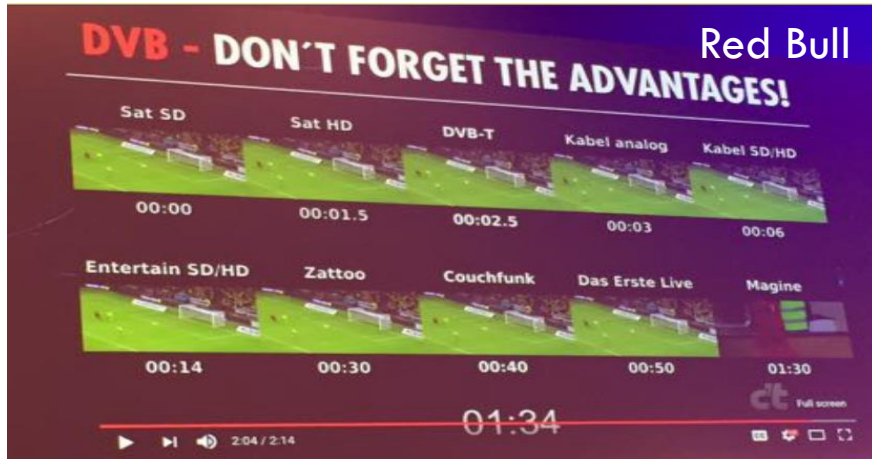
# ADDRESSING COMPLEXITY



# LOW-LATENCY DASH



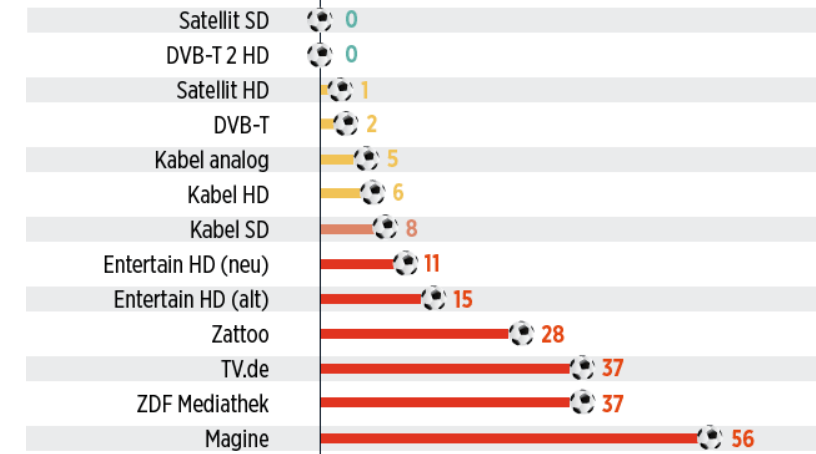
# REMEMBER 2017 WORKSHOP



## Verzögerungen beim TV-Signal

Angaben in Sekunden

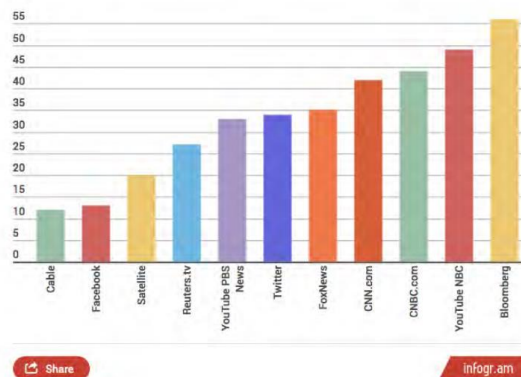
**TOR**



## Live Stream Latency

- Data taking during Nov 16 presidential debates in the US.
- Good opportunity to compare latency as the event was carried by most major broadcasters.

## Debate Streaming Latency



## Adios 45s!

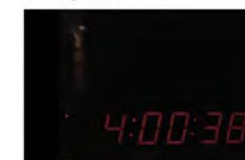
MSL 4.0 Low Latency HLS



56:20



Low latency WebRTC

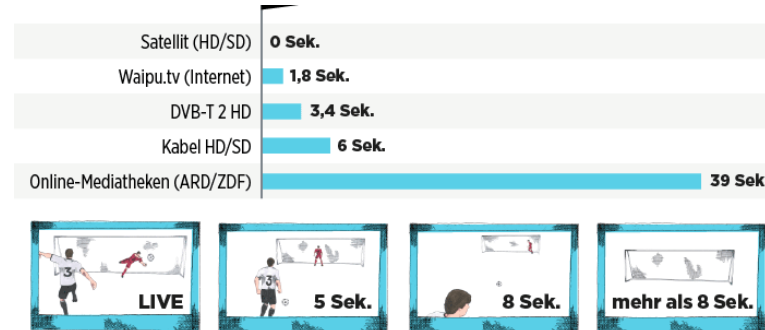


00:38





# AND THERE WAS THE WORLD CUP 2018



info.BILD.de





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# KEY PERFORMANCE INDICATORS

## Latency:

- End-to-End Latency (EEL): The latency for an action that is captured by the camera until its visibility on the remote screen.
- Encoding+Distribution Latency (EDL): The latency of the linear playout output (which typically serves as input to distribution encoder(s)) to the screen

## Startup Delay

- Live Edge Start-up Delay (LSD): The time between a user action (service access or service join) and the time until the first media sample of the service is perceived by the user when joining at the live edge
- Seek Start-up Delay (SSD): The time between a user action (service access or service join) and the time until the first media sample of the service is perceived by the user when seeking to a time shift buffer.

Adjusting the above parameters may impact certain other performance aspects as those document below.

- Compression Efficiency
- Network Efficiency and Scalability
- Robustness to Bandwidth Variations and Errors
- Lower layer protocol changes needed

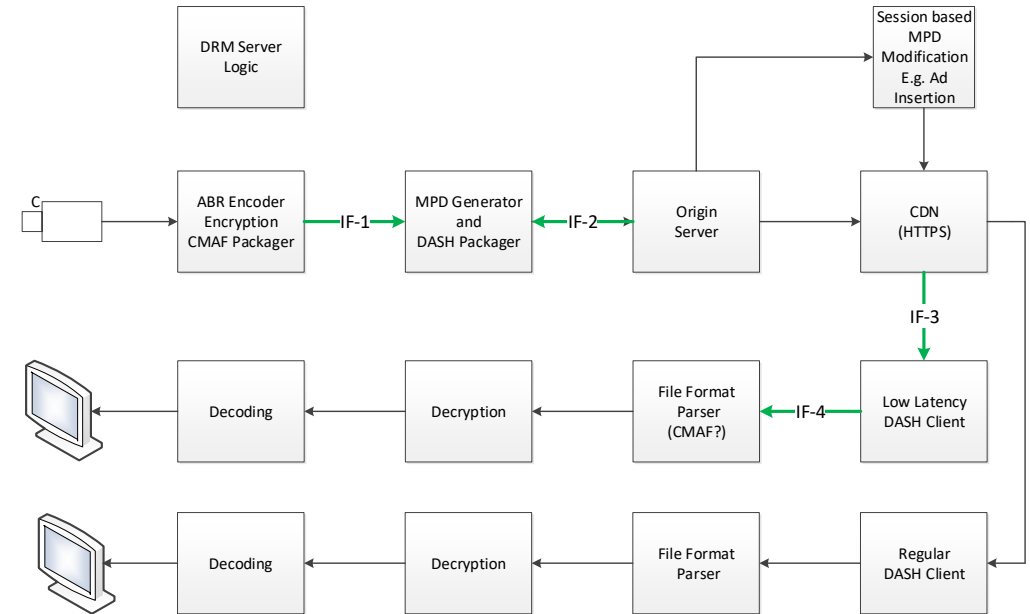
# STATUS OF THE WORK IN DASH-IF AND DVB

## DVB

- Completion of use cases (together with DASH-IF) and Commercial Requirements for Low-Latency DASH
  - Encoder to Screen Latency of 3.5 seconds
  - Live Edge Start-up Delay in the order of 1 second or less
  - presentation of a media time at a specific wall-clock time within 500ms tolerance
  - updated DVB-DASH specification shall be completed by Q4/2018
- Technical work started in collaboration with DASH-IF

## DASH-IF

- In the progress of drafting guidelines for Low-Latency DASH
- Context of real service operation issues: Program changes, ad insertion, operational problems, scalability
- Guidelines include
  - Interface between Encoder and DASH Packager assuming CMAF packaging
  - DASH Packager Operation including MPD generation and MPD updates, as well as segment generation
  - Client Implementation Guidelines and requirements: buffers, ABR logic, etc.
- Development of test, reference and conformance tools



# SELECTED TECHNOLOGY OVERVIEW AND SOME ISSUES

## HTTP Chunked Transfer Encoding of partially available files

- possible with CDNs today as long as they are configured for low latency streaming

## Multiple Movie Fragments per Segment → CMAF Chunking

- Supported in MSE
- However,
  - has not been tested on legacy clients in HbbTV
  - significant percentage of clients fail to play segments with multiple movie fragments
- What should the chunk duration be: 1 frame, 320ms? Experiments necessary
- What about sparse tracks such as subtitle? Clarifications/bug fixes needed in MPEG file format

## Signaling early availability in MPD

- Supported by DASH MPD, but required some clarification → Cor.3 in MPEG

## Using @duration and \$Number\$ for now

- We identified an issue with Segment Timeline which requires the duration of the Segment to be known to announce

## Accelerated playback in the device to address both low latency and fast startup

- Generally supported in MSE, but is it tested? Not supported in common TV Set decoder APIs → CTA WAVE
- What are the implications of applying this to the user perception

## Discussion on new HTTP variants, for example to support queued requests

# LOW-LATENCY STREAMING

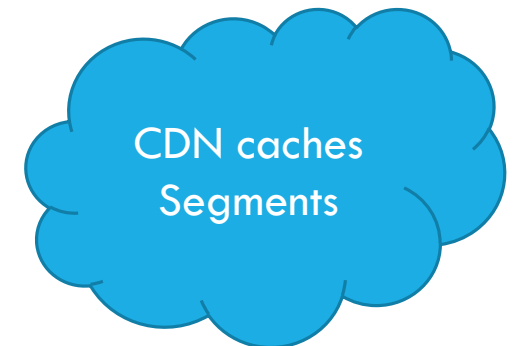
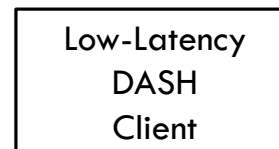
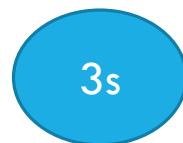
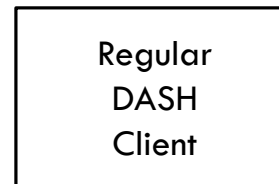
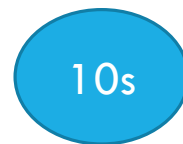
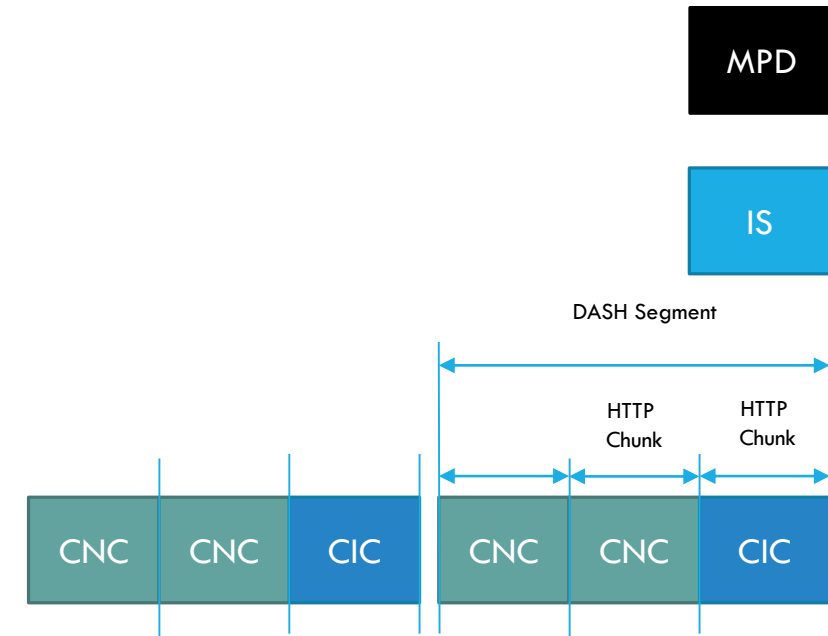
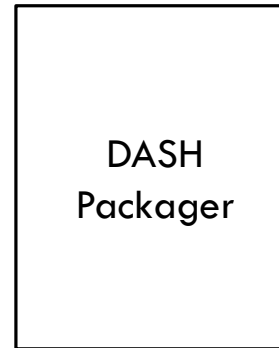
## Encoder



CH = CMAF Header

CNC = CMAF non-initial chunk

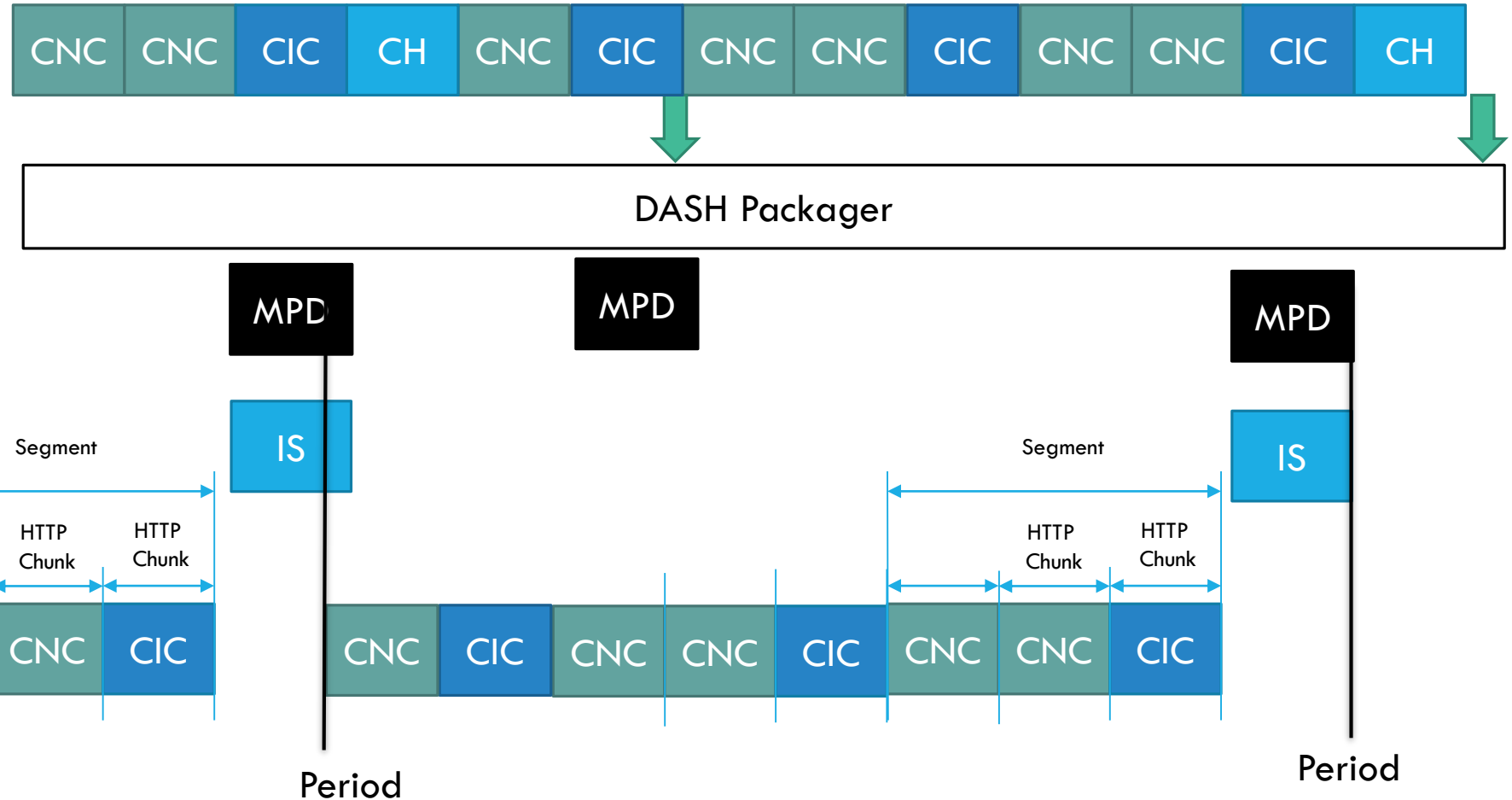
CIC = CMAF initial chunk



# LOW-LATENCY STREAMING AND TRIGGERS

## Triggers:

- Operational or Program Change
- Inband or out-of-band
- Should come with prewarning

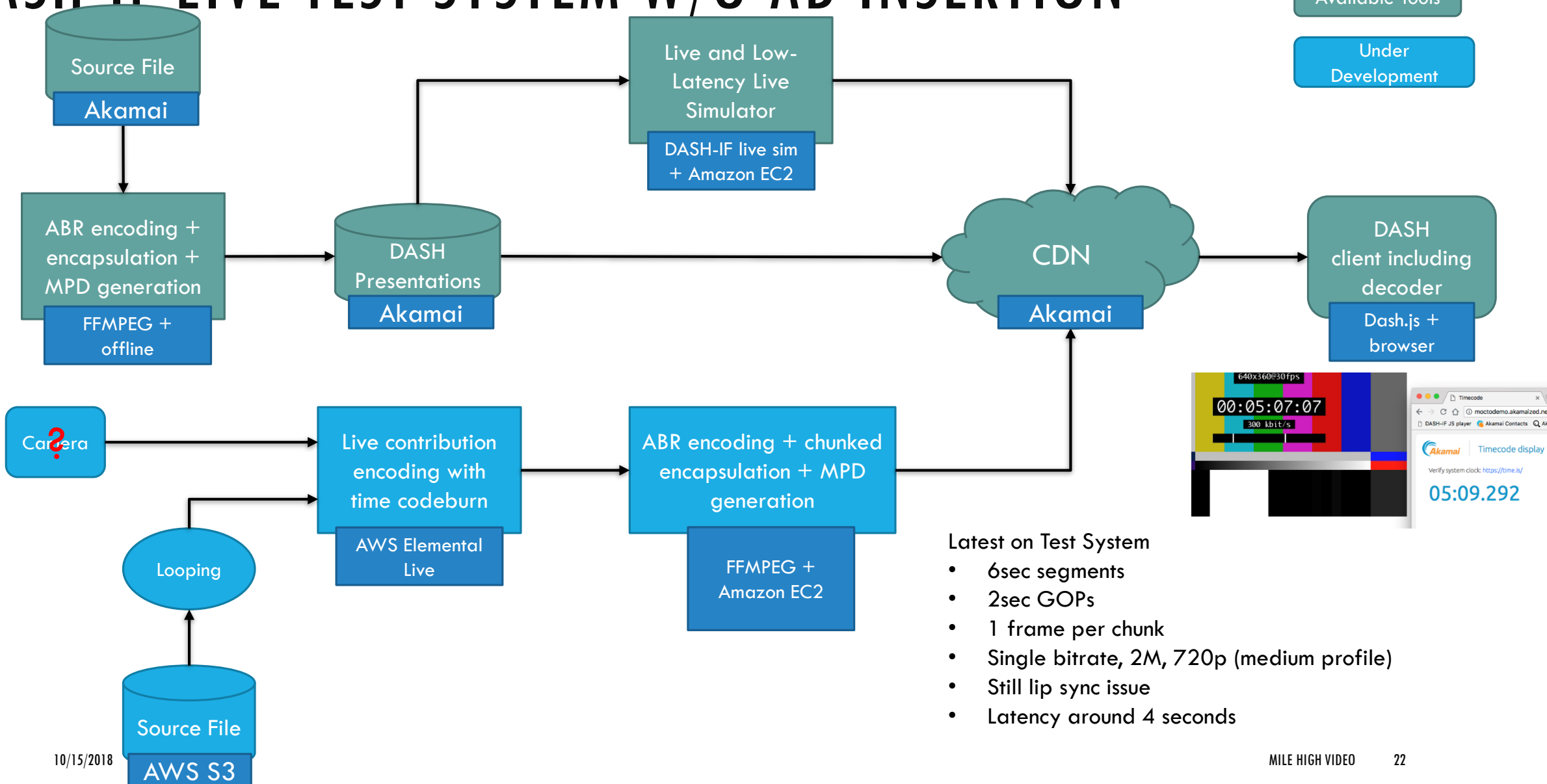


# DASH-IF LIVE TEST SYSTEM W/O AD INSERTION

Tools and  
Hosting

Available Tools

Under  
Development



# ADDING AD INSERTION

Client-Side Ad Insertion

SCTE-35  
Interpreter

DASH  
Client

SCTE-35  
Interpreter

DASH  
Packager

Light Extended  
Live Sim

SCTE-35 in MPD  
(or emsg)

MPD with ad  
prepared  
Segments

SCTE-35  
Interpreter

MPD  
Manipulator  
(Proxy)

MPD with ads

Segments

DASH  
Client

Server-Side Ad Insertion

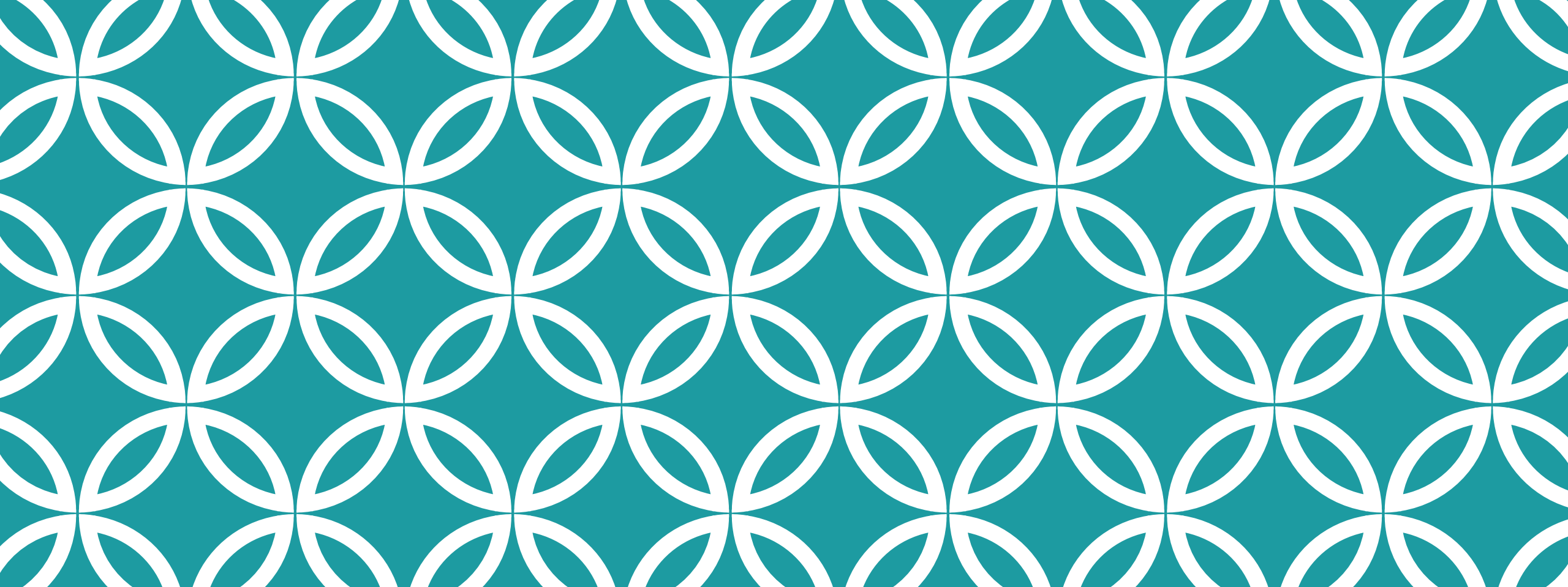
Origin

Test Streams  
and Test Cases

Live Sim  
Extensions  
Tobbe may  
be interested

Carriage of  
SCTE-35

New work  
Functionality  
should be  
defined

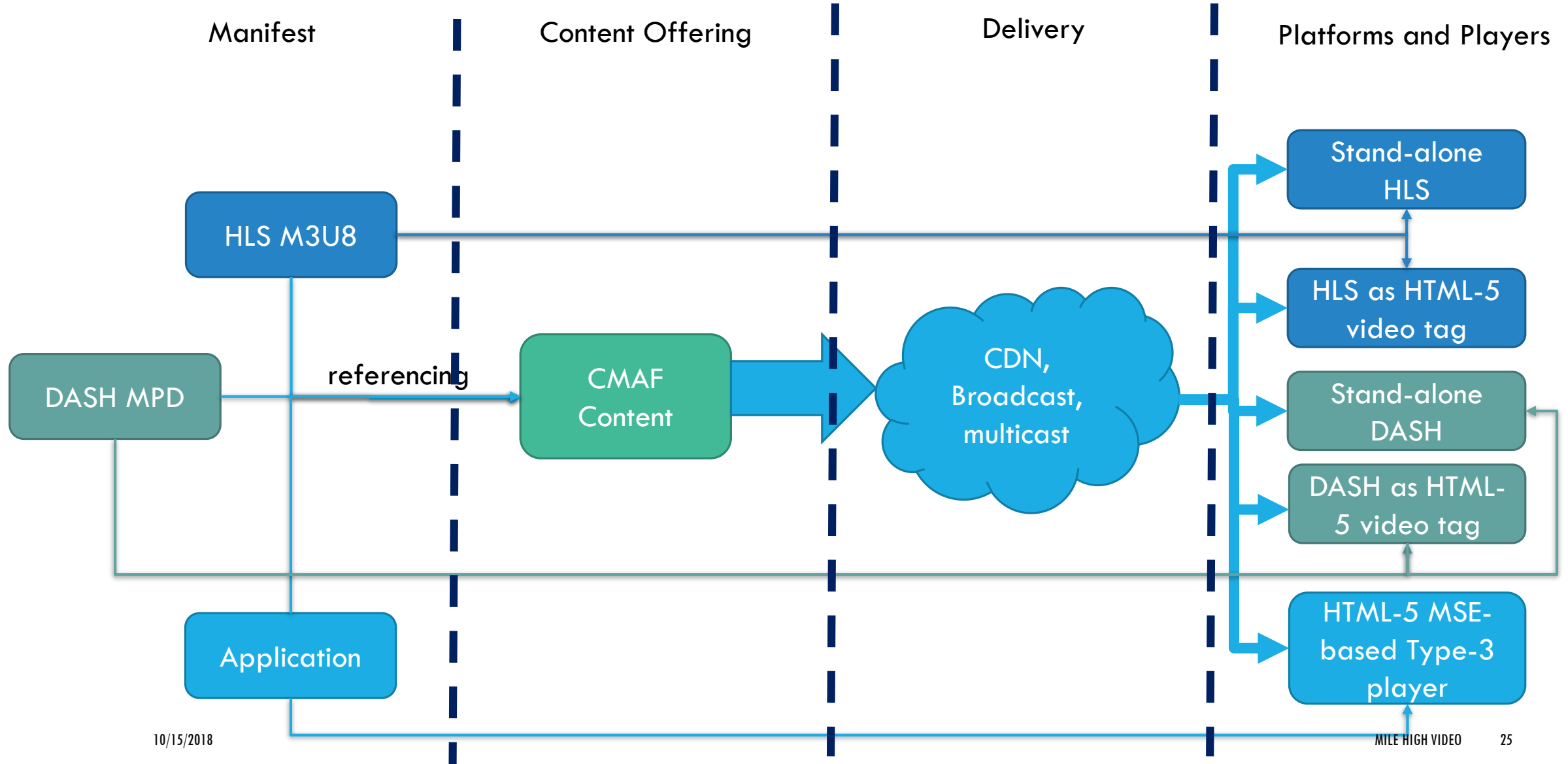


CMAF AND CTA WAVE

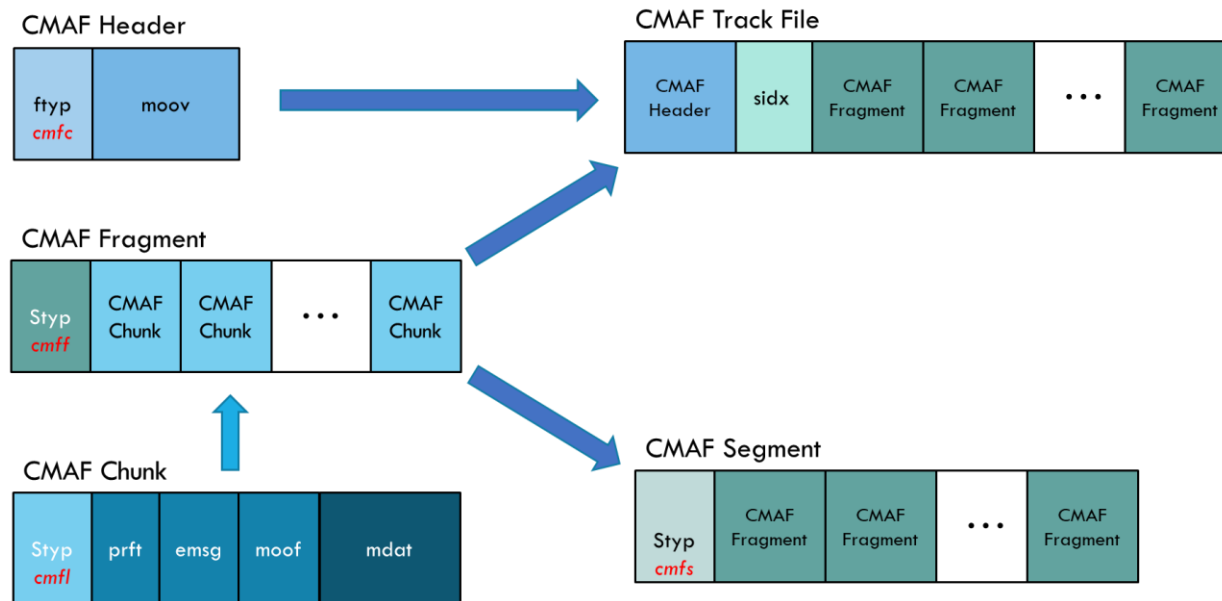




# DIFFERENT PLAYERS – SINGLE ENCODING AND COMMON DELIVERY



# DASH-IF AND CMAF



Gradually move segment formats to be CMAF conforming

However, we need to check very carefully on conformance between DASH and CMAF

Common conformance suite for content to identify issues

Work with the industry to fully align the two technologies

Update CMAF to add relevant DASH functionalities

Multistream

Period concept and splicing

Events

And and and

# COMMERCIAL OTT VIDEO ISSUES: WAVE SOLUTION

## Content Specification

Content Specification based upcoming ISO MPEG Common Media Application Format (CMAF), compatible with DASH and HLS.

## Device Playback Requirements

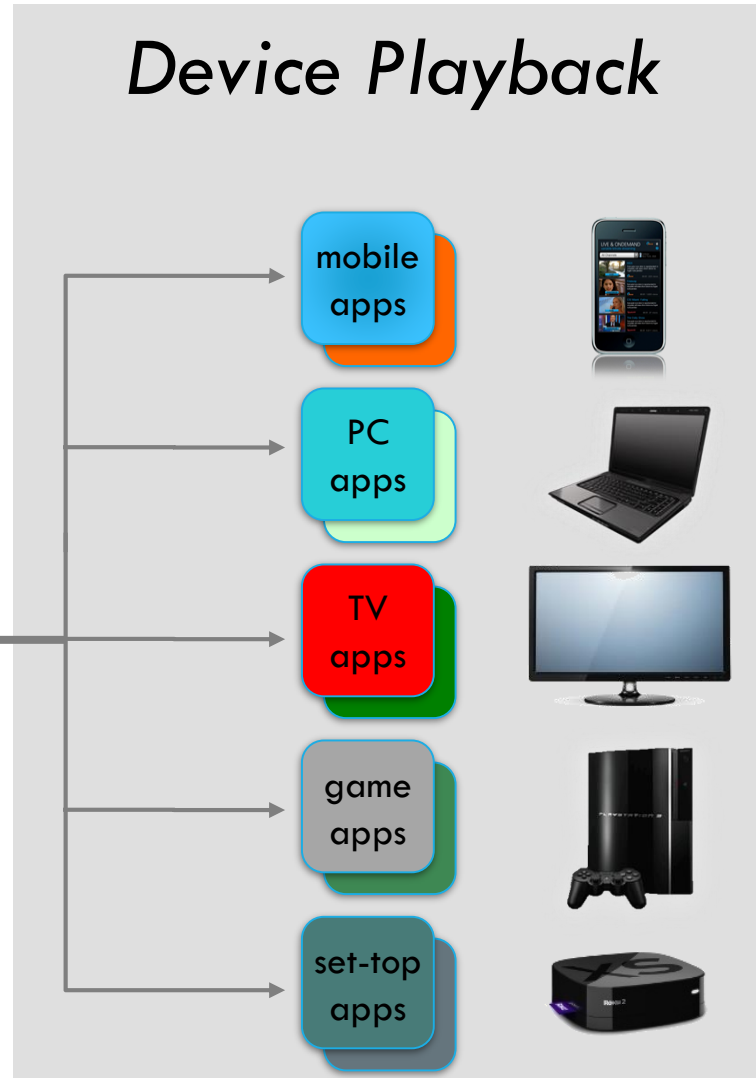
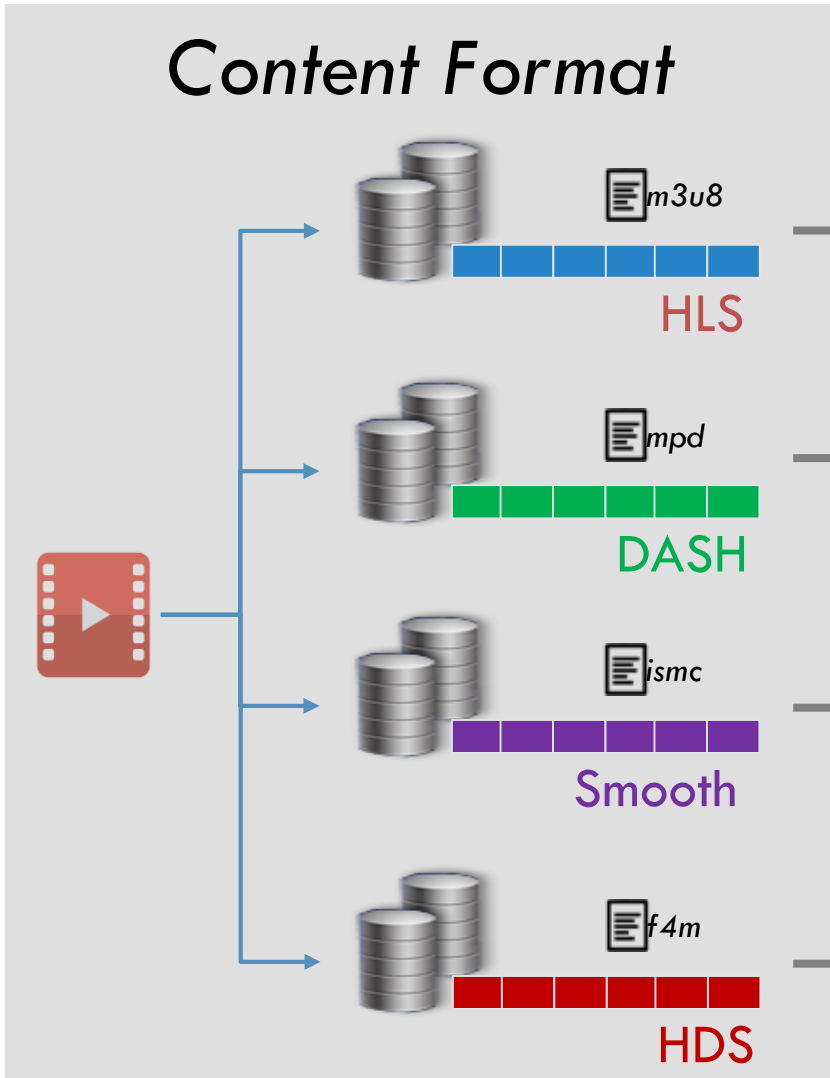
Testable requirements covering the most common device playback interoperability issues.

## HTML5 Reference Platform

Reference application framework based on HTML5 providing functional guidelines for playback interoperability.

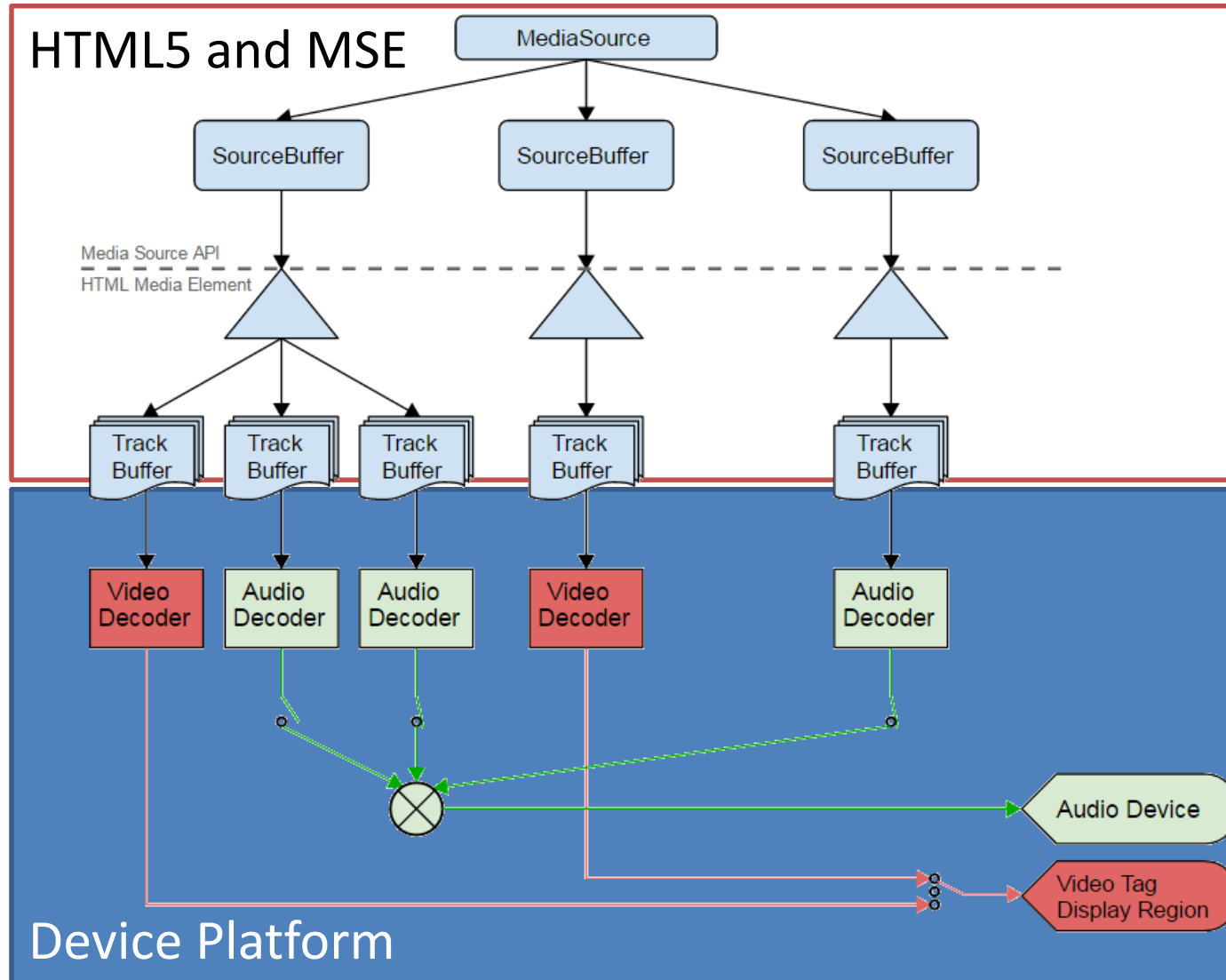


# COMMERCIAL OTT VIDEO ISSUES: DEVICE PLAYBACK ISSUES



- 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

# Connection to HTML5 & MSE



## HTML5 and MSE

- Provide APIs for applications to playback WAVE content
- Extend APIs to ensure more consistent and richer user experience

## Device Playback Platform:

- Ensuring that WAVE content can be “played” consistently when using “MSE-like” APIs for different use cases and applications.
- Use HTML5 as reference and test platform, not excluding other platforms

# DEVICE PLAYBACK

One of the key missing pieces for consistent Internet TV Services

## Media Source Extension

- This specification extends HTMLMediaElement [HTML51] to allow JavaScript to generate media streams for playback.
- Allowing JavaScript to generate streams facilitates a variety of use cases like adaptive streaming and time shifting live streams.

## ByteStream Format for ISO BMFF

- <https://www.w3.org/TR/mse-byte-stream-format-isobmff/>
- This specification defines a Media Source Extensions<sup>TM</sup> [MEDIA-SOURCE] byte stream format specification based on the ISO Base Media File Format.

For MSE being used, the results of using the API need to fulfill highest-quality requirements

```
var ms = new MediaSource();
video.src = window.URL.createObjectURL(ms);
ms.addEventListener('sourceopen', onMediaSourceOpen);

function onMediaSourceOpen() {
    sourceBuffer = ms.addSourceBuffer('video/mp4; codecs="avc1.4d401f"');
    sourceBuffer.addEventListener('updateend', nextSegment);

    GET(initUrl, appendToBuffer);

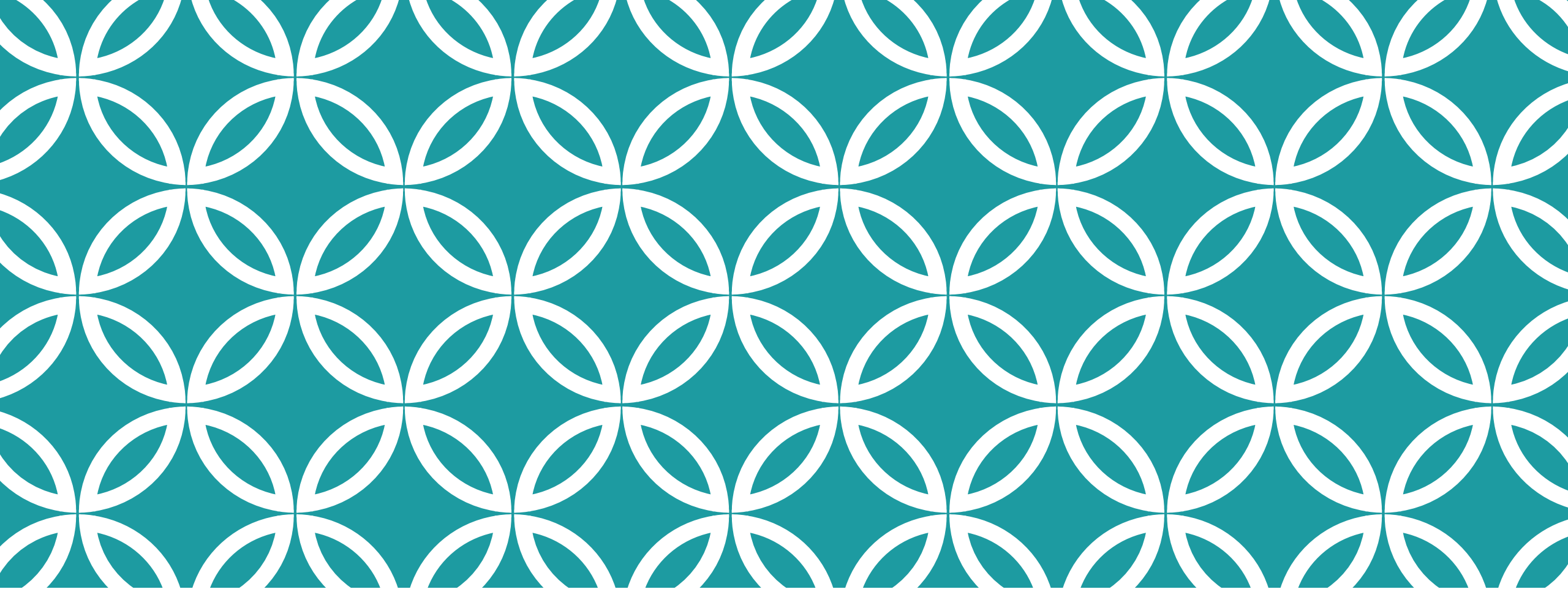
    video.play();
}

function nextSegment() {
    var url = templateUrl.replace('$Number$', index);
    GET(url, appendToBuffer);
    index++;
    if (index > numberOfChunks) {
        sourceBuffer.removeEventListener('updateend', nextSegment);
    }
}

function appendToBuffer(videoChunk) {
    if (videoChunk) {
        sourceBuffer.appendBuffer(new Uint8Array(videoChunk));
    }
}
```

# Expected WAVE Specification

| Task Force | Title of Output                                     | Expected date of Publication |
|------------|---|------------------------------|
| HATF       | Web Media API Snapshot 2017                         | NAB 2018                     |
| CSTF       | Content Specification                               | NAB 2018                     |
| DPCTF      | Device Playback Specification                       | Q2 2018                      |
| TCTF       | WAVE Overall Test Approach                          | Q2 2018                      |
| TCTF       | WAVE Test List                                      | Q2 2018                      |
| TCTF       | WAVE Test Specification                             | Q2 2018                      |
| TCTF       | WAVE Test Suite                                     | End 2018                     |
| TCTF       | WAVE Test Tools                                     | End 2018                     |
| HATF       | Web Media Application Developer Guidelines 2017     | Q2 2018                      |
| HATF       | Web Media User Agent Integration Specification 2017 | TBD                          |



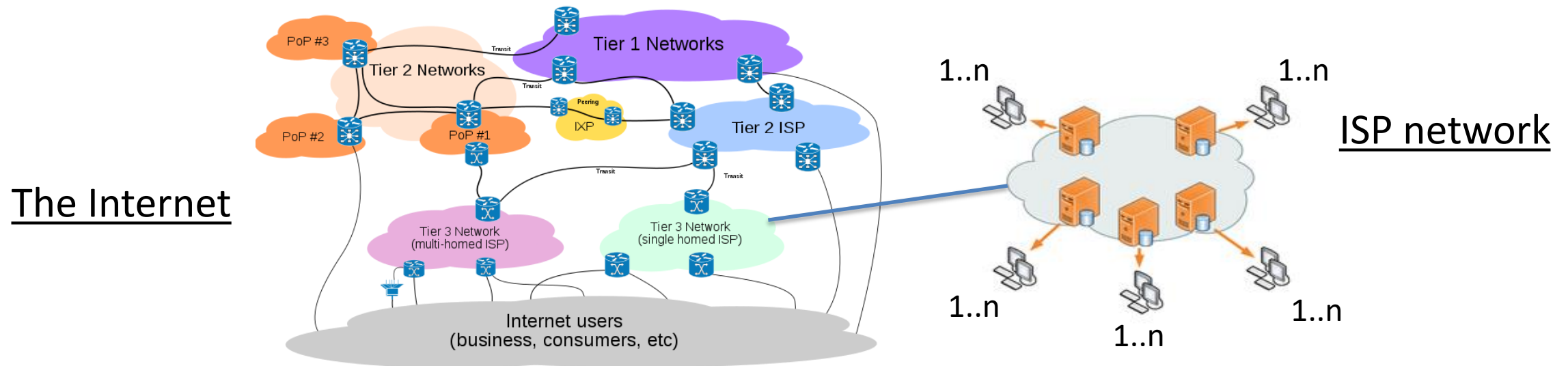
# DVB INTERNET SERVICES (DVB-I)





# DVB-I, the mission...

- DVB-I, where the “I” stands for “Internet”
  - In the context of audio-visual services, “The Internet” is used for “Over-The-Top” (OTT) delivery
  - Well, “The Internet”, as in “CDN overlaid, edge assisted, adaptive delivery, media cloud”



- ...To enable DVB services to be discovered and consumed by devices with basic Internet connectivity, principally a non-managed broadband connection and HTTP access, providing a similar user proposition to that of a DVB broadcast service

# DVB-I – why do we need it all?

A complex ecosystem of platforms, protocol stacks (including ABR), codecs, DRMs, apps, browsers and the devices able to receive and consume video content has taken shape...

- This is probably a bad thing (or at least the down-side of the “good thing”)
  - *Unless You have managed to cut Yourself a nice piece of the cake!*

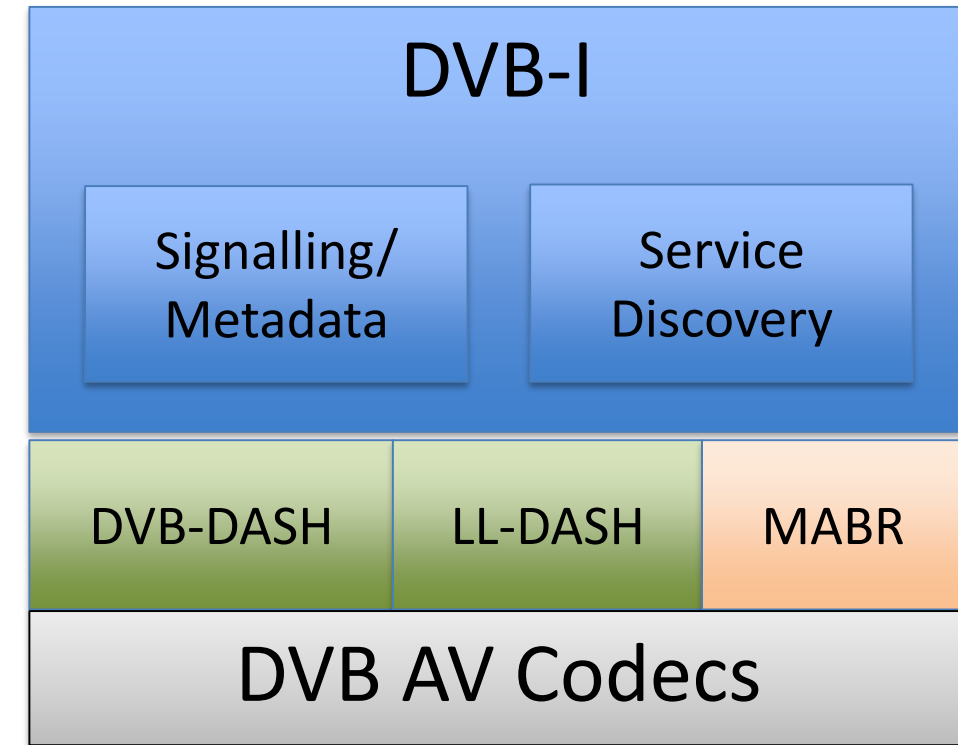


etc...

- Or is this “bad” at all? Maybe it’s just the modern-day media paradigm, the way it was meant to be?
- The “app” ecosystem - a vertical service offered on receiver device platforms where it’s worth providing support
  - Problem for the consumer – inconvenience of switching between apps; obsolescence of app on otherwise perfectly functional receivers
  - Problem for the CE manufacturer – support of multiple solutions for the same function – codecs, ABR solutions, DRM systems, user interface constructs
  - Problem for the broadcaster – how to reach the audience efficiently and reliably?

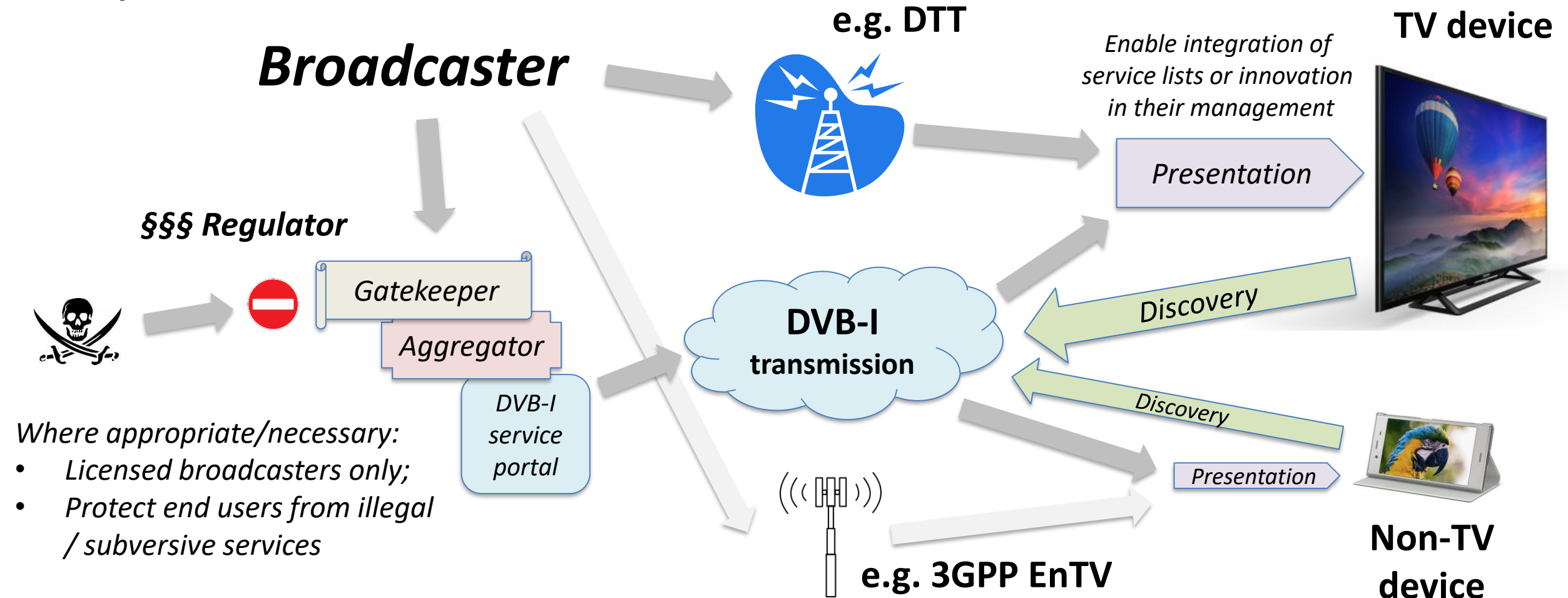
# DVB-I, the vision

- ***Harnessing foundation technologies to provide a complete DVB solution for live OTT delivery:***
  - DVB-DASH (ABR – adaptive bit-rate)
    - ETSI TS 103 285
  - Low-latency DASH (LL-DASH)
    - Technical work started
  - Multicast ABR (MABR) - within suitably capable operator networks
    - Technical work ongoing
    - Reference Architecture published
      - DVB blue book A176
- ***Potential synergies with other ongoing DVB work items:***
  - Targeted Advertising
  - Home Broadcast
- ***Potential liaison activities:***



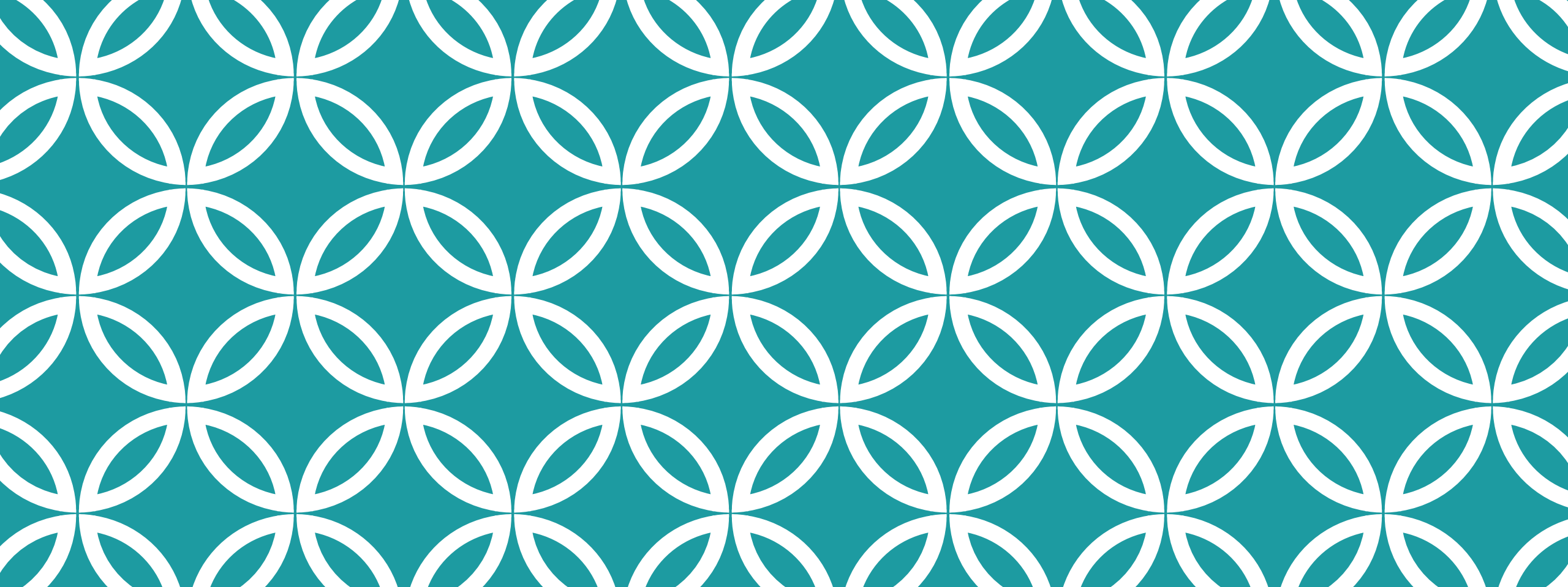
# DVB-I, the vision

- Functional overview; likely roles and elements of the DVB-I specification



# Status of DVB-I

- Commercial Requirements completed, approval by mid August
- Main themes of the into more than 50 CRs
  - Applicability to TVs (w/ & w/o app) and non-TV devices incl. mobile & browser
  - Over-the-top possible, also optimization/management
  - Relying on DVB-DASH for delivery, likely LL-DASH once ready
  - Key concept are Service Lists including Service information, which are semi-static and provide some equivalence to DVB-SI
  - User experience equivalent to DVB-S/T/C/IPTV
  - Services can be 24x7x365 and can be part-time
  - Services can be a mix of live events and VoD Assets, and personalized
  - Hybrid services and devices are considered
  - Trust, security and privacy aspects are considered
  - Expected to have a receiver profile for a minimum-to-implement features for FTA services
  - And many more ...
- Considered a starting point to replicate broadcast experience
- Technical work expected to start in fall 2018



# 3GPP ENTV, 5G AND HYBRID SERVICES



# STATUS

Rel-14 enTV is completed with key features:

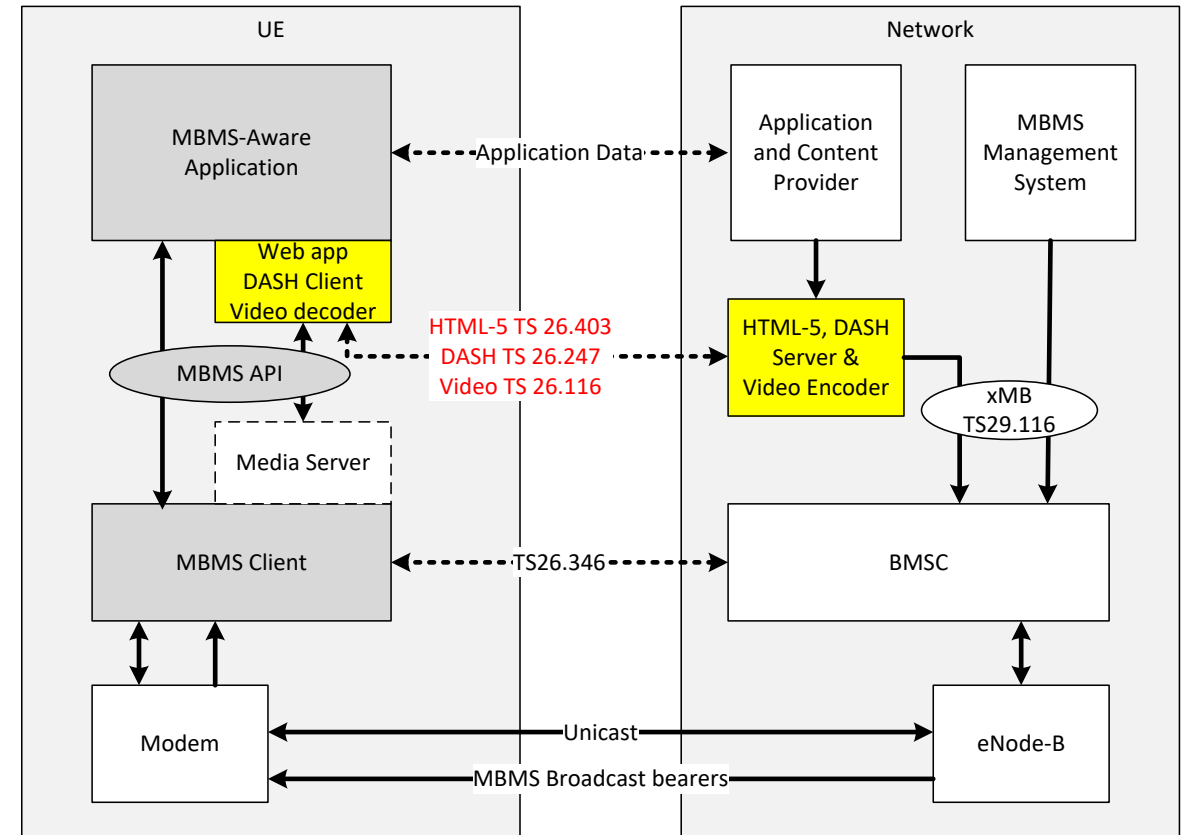
- Transport-only service
- Receive only services
- Standardized xMB interface
- MBMS-APIs
- Radio enhancements

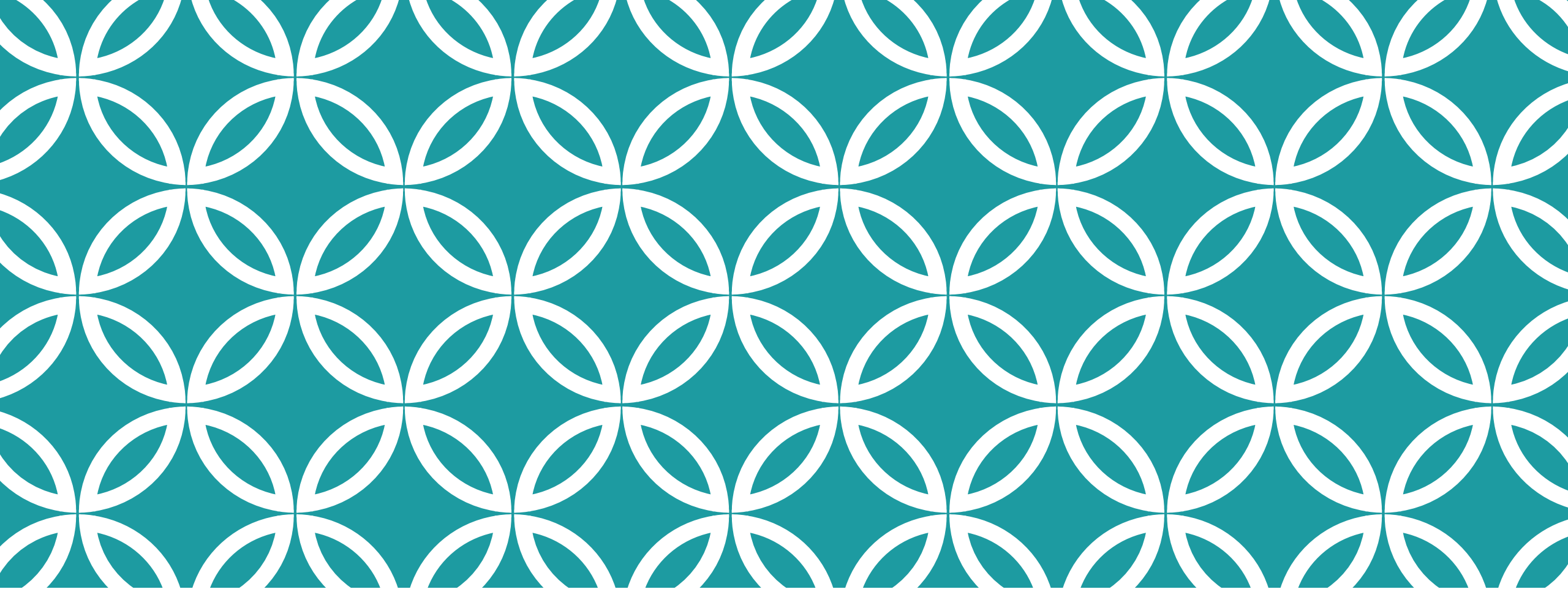
## 5G

- Rel-15: Increase throughput and reduce latency
- Broadcast is expected to be addressed only at later stage
- enTV is the baseline for standalone system
- Radio optimization combining broadcast and unicast

## Hybrid Services

- Enhancing vertical broadcast services by interactive unicast
- Broadcast is a transport optimization by offloading popular content





# SUMMARY



# SUMMARY

Moving TV Services to the Internet is a major opportunity, but we consistency for reach and quality

Standards remain relevant for the Internet world, but different approaches necessary

No longer vertical services, but individual enablers that are well tested

APIs, testing, reference implementations, modular designs

JOIN THE EFFORTS

