Emmy Tutorial 1: Introduction to MPEG DASH

March 2, 2022

Thomas Stockhammer (Qualcomm Incorporated)
DASH-IF Interoperability WG Chair
Co-editor of MPEG-DASH ISO/IEC 23009-1 1st to 5th edition
Today’s agenda

- Chronical Matters and Anecdotes (getting old)
- The core principles of DASH
- What is new in the 5th edition
- DASH-IF Interoperability Guidelines v5
- Tools
- What’s next to come
- DASH Deployments
- Thank you

Presenter
Dr. Thomas Stockhammer
Director, Technical Standards
Qualcomm Europe, Inc.

Leading and driving among others
- DVB: 5G TF, DVB-I
- MPEG: MPEG-I, CMAF and DASH
- 3GPP: XR over 5G, 5G Video, 5GMS
- DASH-IF: Interop WG, Test
- ETSI: 5G Broadcast
- CTA WAVE: CMAF Device PB, Test
The history - why a standard?
History

CFP Completed April 2010 in Dresden – the Volcano Eyjafjallajökull meeting

INTERNATIONAL ORGANISATION FOR STANDARDISATION
ORGANISATION INTERNATIONALE DE NORMALISATION
ISO/IEC JTC1/SC29/WG11
CODING OF MOVING PICTURES AND AUDIO

ISO/IEC JTC1/SC29/WG11
MPEG2010/M 17875
July 2010, Geneva, Switzerland

MPEG and 3GPP Meetings in 2010/2011:

- Geneva, July 2010 => CD
- Erlangen, August 2010
- Paris, September 2010
- Guangzhou, October 2010
- Barcelona, November 2010
- San Francisco, December 2010
- Berlin, January 2011
- Daegu, January 2011 => DIS
- Sanya, February 2011
- Geneva, March 2011
- San Diego, April 2011
- Berlin, June 2011
- Torino, July 2011 => FDIS

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<table>
<thead>
<tr>
<th>Status</th>
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<tr>
<td>Input</td>
<td>All Systems</td>
<td>Reply to CFP on HTTP Streaming: 3GPP Adaptive HTTP Streaming</td>
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The Standards

Based on these efforts and collaboration, MPEG and 3GPP developed jointly the work and published the specifications as:

- TS 26.247: 3GPP Dynamic Adaptive Streaming over HTTP (3GP-DASH)
- ISO/IEC 23009-1: Dynamic Adaptive Streaming over HTTP: Media presentation description and Segment formats

Since then:
- 5 editions of DASH part 1 are completed
- The DASH standard has 8 parts
- DASH is adopted by many organizations

MHV: Emmy MPEG-DASH
<table>
<thead>
<tr>
<th>Year</th>
<th>Edition</th>
<th>Title</th>
<th>Authors</th>
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<tbody>
<tr>
<td>2011</td>
<td>1</td>
<td>ISO/IEC 23009-1 Media Presentation Description and Segment Formats</td>
<td>Thomas Stockhammer and Per Fröjdh</td>
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<td>Thomas Stockhammer, Per Fröjdh</td>
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<td>3</td>
<td>ISO/IEC 23009-1:2014 AMD 1 Extended profiles and time synchronization</td>
<td>Thomas Stockhammer, Alex Giladi</td>
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<td>2014</td>
<td>4</td>
<td>23009-1:2014 AMD 2 Spatial Relationship Description, Generalized URL parameters and other extensions</td>
<td>Emmanuel Thomas, Sylvain Kervadec, Cyril Concolato</td>
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<tr>
<td>2014</td>
<td>5</td>
<td>23009-1:2014 AMD 3 Authentication, Access Control and multiple MPDs</td>
<td>Thomas Stockhammer, Alexander Giladi</td>
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<td>2014</td>
<td>6</td>
<td>23009-1:2014 AMD 4 Segment Independent SAP Signalling, MPD chaining and other extensions</td>
<td>Thomas Stockhammer, Iraj Sodagar, Alex Giladi</td>
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<td>2015</td>
<td>7</td>
<td>23009-1 3rd edition Media presentation description and segment formats</td>
<td>Thomas Stockhammer</td>
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<td>2016</td>
<td>8</td>
<td>23009-1 3rd edition AMD 1 on device information and other extension</td>
<td>Ali C. Begen, Thomas Stockhammer</td>
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<td>2019</td>
<td>9</td>
<td>23009-1 4th edition</td>
<td>Iraj Sodagar, Thomas Stockhammer, Mike Dolan</td>
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<td>2020</td>
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<td>Thomas Stockhammer, Mike Dolan</td>
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<td>Iraj Sodagar, Thomas Stockhammer</td>
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<td>23009-1 4th edition AMD 2 Preroll, nonlinear playback and other extensions</td>
<td>Ye-Kui Wang, Iraj Sodagar</td>
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<tr>
<td>2023</td>
<td>13</td>
<td>23009-1 5th edition AMD Extended Dependent Random Access Representations and other extensions</td>
<td>Thomas Stockhammer and Christian Timmerer</td>
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<tr>
<td>2017</td>
<td>15</td>
<td>23009-2 2nd edition DASH Conformance and reference software</td>
<td>Emmanuel Thomas</td>
</tr>
<tr>
<td>2017</td>
<td>16</td>
<td>23009-2 AMD 1 Conformance vectors and reference software for SRD, SAND and Server Push</td>
<td>Yuriy Reznik, Kilroy Hughes, Thomas Stockhammer</td>
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<tr>
<td>2020</td>
<td>17</td>
<td>23009-2 3rd edition</td>
<td>Thomas Stockhammer, Alex Giladi</td>
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<td>23009-3 3rd edition DASH Implementation Guidelines</td>
<td>Alex Giladi and Yasser Syed</td>
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<tr>
<td>2013</td>
<td>22</td>
<td>ISO/IEC 23009-4 Segment encryption and authentication</td>
<td>Mary-Luc Champel, Emmanuel Thomas</td>
</tr>
<tr>
<td>2018</td>
<td>23</td>
<td>23009-4 2nd edition Segment encryption and authentication</td>
<td>Mary-Luc Champel</td>
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<td>2017</td>
<td>24</td>
<td>23009-5 Server and Network Assisted DASH</td>
<td>Viswanathan (Vishy) Swaminathan, Kevin Streeter, Imed Bouzazi, and Franck Denoual</td>
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<td>23009-5 AMD 1 Improvements on SAND messages</td>
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<td>26</td>
<td>23009-6 DASH with Server Push and WebSockets</td>
<td>Ali C. Begen, Iraj Sodagar, Alex Giladi</td>
</tr>
<tr>
<td>2022</td>
<td>27</td>
<td>23009-8 AMD 1 URL customization other extensions</td>
<td>Iraj Sodagar</td>
</tr>
</tbody>
</table>
A few others on standards development

Jean Le Feuvre

Dave Singer

DF /QC colleagues
Mark Watson and Mike Luby

Harry Piles and Paul Higgs – the masters of the XML

Waqar Zia for all of his work on conformance and reference software

The colleagues from DVB and OIPF/HbbTV

The Korean gang who made MASH into DASH

Youngkwon and Leonardo

And many many more
Some Fundamentals of DASH
## Core Principles of DASH

<table>
<thead>
<tr>
<th>CDN and Cache friendly</th>
<th>Stateless Server</th>
<th>Client-driven</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low manifest traffic (small size and low update frequency)</td>
<td>Carrying ISO BMFF and CMAF</td>
<td>Late Binding</td>
</tr>
<tr>
<td>Works with HTML-5 and MSE</td>
<td>HLS Convergence</td>
<td>Live and On-Demand</td>
</tr>
</tbody>
</table>
Manifest
- Timeline
- Resource Addresses
- HTTP
- Codecs
- Variants
- DRM Server license
- Operational information

Encode each media type at multiple bitrates => track

Split each track into small segments

Make each segment addressable via an HTTP-URL

Client makes decision on which segment to download

Client acquires a license for encrypted content

Client splices and synchronizes for playback

Encrypt each segment

Split each track into small segments

Make each segment addressable via an HTTP-URL

Client makes decision on which segment to download

Client acquires a license for encrypted content

Client splices and synchronizes for playback

Encrypt each segment
What is **specified** – and what is **not**?

*Media Presentation on HTTP Server*

*Segment*

*Media Presentation Description (XML)*

*Resources located by HTTP-URLs*

*HTTP/1.1*

*HTTP Access Client*

*DASH Access Engine*

*Media Engines*

*DASH Client*

---

MHV: Emmy MPEG-DASH

19
Data Model

MHV: Emmy MPEG-DASH
Mapping to DASH

  <Period duration="PT0H3M1.638" start="PT0S">
    <AdaptationSet>
      <ContentComponent contentType="video" id="1" />
      <Representation bandwidth="4190760" codecs="avc1.640028" height="1080" id="1" mimeType="video/mp4" width="1920">
        <BaseURL>car-20120827-89.mp4</BaseURL>
        <SegmentBase indexRange="674-1149" />
        <Initialization range="0-673" />
      </Representation>
      <Representation bandwidth="2073921" codecs="avc1.4d401f" height="720" id="2" mimeType="video/mp4" width="1280">
        <BaseURL>car-20120827-88.mp4</BaseURL>
        <SegmentBase indexRange="708-1183" />
        <Initialization range="0-707" />
      </Representation>
      <Representation bandwidth="100000" codecs="avc1.4d4015" height="444" id="5" mimeType="video/mp4" width="256">
        <BaseURL>car-20120827-150.mp4</BaseURL>
        <SegmentBase indexRange="671-1146" />
        <Initialization range="0-670" />
      </Representation>
    </AdaptationSet>
  </Period>
</MPD>
DASH MANIFEST FOR LIVE

Key issue for reducing latency is the reduction of segment duration w/o losing scalability

HLS Manifest states what is available on the server and only provides information on the past, which results in the following

1. Client sending uplink requests for Manifest prior to each Segment request
2. A full new manifest needs to be delivered for each new Segment (which also grows over time, so short Segments and Late Binding are more difficult to realize)
3. The manifest needs to be parsed and processed by client for every request
4. For each new segment, a new Manifest needs to be written on the server

DASH MPD provides information of the past and permits promises for the future

- If used properly, several or all of the above can be mitigated or at least reduced
- Functions to support this:
  - Templates in URLs and predictive segment availability times ➔ small manifests and lower segment sizes
  - Flexible MPD validity expiration mechanisms ➔ MPD updates only when necessary
  - Time-synchronized server and client ➔ no requests are necessary
SEGMENT ADDRESSING

```
<Representation mimeType="video/mp4"
    frameRate="24"
    bandwidth="1558322"
    codecs="avc1.4d401f" width="1277" height="544">
  <SegmentList duration="10">
    <Initialization sourceURL="http://cdn.bitmovin.net/bbb/video-1500/init.mp4"/>
    <SegmentURL media="http://cdn.bitmovin.net/bbb/video-1500/segment-0.m4s"/>
    <SegmentURL media="http://cdn.bitmovin.net/bbb/video-1500/segment-1.m4s"/>
    <SegmentURL media="http://cdn.bitmovin.net/bbb/video-1500/segment-2.m4s"/>
    <SegmentURL media="http://cdn.bitmovin.net/bbb/video-1500/segment-3.m4s"/>
    <SegmentURL media="http://cdn.bitmovin.net/bbb/video-1500/segment-4.m4s"/>
  </SegmentList>
</Representation>
```

```
<Representation mimeType="video/mp4"
    frameRate="24"
    bandwidth="1558322"
    codecs="avc1.4d401f" width="1277" height="544">
  <SegmentTemplate media="http://cdn.example.net/bbb/segment-$Number$.m4s"
    initialization="http://cdn.example.net/bbb//init.mp4"
    startNumber="0"
    timescale="24"
    duration="48"/>
</Representation>
```
ADVANCED CLIENT

<InbandEventStream MPD Validity Expiration>

<Representation mimeType="video/mp4"
    frameRate="24"
    bandwidth="1558322"
    codecs="avc1.4d401f" width="1277" height="544">
    <SegmentTemplate media="http://example.net/video/segment-0Time$.m4s"
                     initialization="http://example.net/video/segment-0/init.mp4"
                     timescale="24">
    <SegmentTimeline>
        <S t="0" d="40" r="5"/>
    </SegmentTimeline>
</SegmentTemplate>
</Representation>

Segment-0
Segment-48
Segment-92
......
<Represntation id="3" width="1920" height="1080" frameRate="25/1" bandwidth="800000" codecs="avc1.4D4028">
  <SegmentTemplate timescale="25" media="multiperiod_video_1_2_\$Number\$.mp4?m=1521455401" initialization="multiperiod_video_1_2_init.mp4?m=1521455401" startNumber="19" presentationTimeOffset="51">
    <SegmentTimeline>
      <S t="901" d="50" r="14"/>
    </SegmentTimeline>
  </SegmentTemplate>
</Representation>

</AdaptationSet>

<AdaptationSet mimeType="audio/mp4" segmentAlignment="0" lang="en">
  <Representation id="4" bandwidth="99605" audioSamplingRate="48000" codecs="mp4a.40.2">
    <SegmentTemplate timescale="48000" media="multiperiod_audio_1_5_\$Number\$.mp4?m=1521455401" initialization="multiperiod_audio_1_5_init.mp4?m=1521455401" startNumber="19" presentationTimeOffset="96320">
      <SegmentTimeline>
        <S t="1730624" d="96256"/>
        <S t="1826600" d="95232"/>
        <S t="1922112" d="96256" r="2"/>
        <S t="2210880" d="95232"/>
        <S t="2306112" d="96256" r="2"/>
        <S t="2594880" d="95232"/>
        <S t="2690112" d="96256" r="2"/>
        <S t="2978880" d="95232"/>
        <S t="3074112" d="96256"/>
      </SegmentTimeline>
    </SegmentTemplate>
  </Representation>
</AdaptationSet>
Segment Index is a binary description of accessible units (Fragments/Segments) the Representation provides an accurate bitrate over time profile. It can be used by the client for optimized request scheduling.

```xml
<Representation bandwidth="4190760" codecs="avc1.640028" height="1080" id="1" mimeType="video/mp4" width="1920">
  <BaseUrl>car-20120827-89.mp4</BaseUrl>
  <SegmentBase indexRange="674-1149">
    <Initialization range="0-673" />
  </SegmentBase>
</Representation>
```
To avoid combinatorial complexity or useless downloads, tracks are offered individually on cloud.

Client selects relevant tracks and synchronizes playout.

**Audio Selection Set**
- English AAC stereo CMAF Switching Set (single Track)
- French AAC stereo CMAF Switching Set (single Track)
- English multichannel CMAF Switching Set (single Track)
- French multichannel CMAF Switching Set (single Track)

**Subtitle Selection Set**
- English WebVTT description CMAF Switching Set (single Track)
- English TTML description CMAF Switching Set (single Track)
- French WebVTT dub CMAF Switching Set (single Track)
- French TTML dub CMAF Switching Set (single Track)

**Video Selection Set**
- SD Media Profile CMAF Switching Set (multiple Tracks)
- HD Media Profile CMAF Switching Set (multiple Tracks)
- UHD10 Media Profile CMAF Switching Set (multiple Tracks)
MULTITRACK MODEL

Content

Media Type Video
Media Type Audio
Media Type Subtitle
Media Type Application

Asset Description
Multiple Media Types
Application-based Selection
Automated System-based Selection
Dynamic Switching

Target Version 1 (Adaptation Set)
Target Version 2 (Adaptation Set)
Target Version 3 (Adaptation Set)

Encoded Representation 1
Encoded Representation 2
Encoded Representation 3
DETAILS ON TIMING MODEL ACROSS PERIODS

<table>
<thead>
<tr>
<th>Element or Attribute Name</th>
<th>Use</th>
</tr>
</thead>
<tbody>
<tr>
<td>SegmentTemplate</td>
<td>M1,2,3</td>
</tr>
<tr>
<td>@presentationTimeOffset</td>
<td>OD1,2,3 0</td>
</tr>
<tr>
<td>@eptDelta</td>
<td>OD1,2,3</td>
</tr>
<tr>
<td>@pdDelta</td>
<td>OD1,2,3</td>
</tr>
</tbody>
</table>

Restrictions needed – see later
ISO/IEC 23009-1:2021(X)
ISO/IEC JTC 1/SC 29/WG 3
Date: 2021-10-04

Information technology — Dynamic adaptive streaming over HTTP (DASH) — Part 1: Media presentation description and segment formats

FDIS stage

The 5th edition
5th Edition Extensions

- DASH profile for using Common Media Application Format (CMAF) are added;
- the concept Resynchronization is added in order to identify stream access points in Segments;
- MPD patching is updated to support explicit MPD updates of smaller size, not only as inband messages;
- a client processing model for Event Streams and Timed Metadata tracks is introduced;
- Extensions are added to content protection for efficient signalling and to support robustness levels.
- A descriptor is added in order to describe the minimum required device output protection security.
- More flexible bandwidth signalling is provided to signal variable bitrate encoding.
DASH Profiles for CMAF content
Constraints – Documenting the obvious

Segment and Representation Constraints

- Mapping of CMAF Resources to DASH Manifest Signaling according to diagram
- Mapping of CMAF internal parameters to MPD

Adaptation Set Constraints

- Signaling of internal parameters to MPD Adaptation Set parameters for different media type
- Content Protection Signaling

Period Constraints

- One or multiple CMAF Presentations, differentiated by a Subset
- Timeline Mapping of media presentation (presentation time offset)

Multi-Period and Media Presentation Constraints

- Detailed sequencing requirements, only overlaps, no gaps
- Core Profile: Video Adaptation Set shall be exactly the Period duration
- Extended Profile: Video Adaptation Set may overlap at the Period end
Resync – Chunk Signaling

- signaling the existence of Resynchronization Points in a Media Segment with additional information that permits to easily locate the Resync Point.

<table>
<thead>
<tr>
<th>NL 0</th>
<th>Cardinality</th>
<th>Specification</th>
<th>Constraints</th>
<th>Description</th>
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<tr>
<td>styp</td>
<td>0/1</td>
<td>ISO/IEC 14496-12</td>
<td>DASH/CMAF constraints</td>
<td>Segment Type</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Signalling compatibility to CMAF Chunk</td>
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<tr>
<td>prft</td>
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<td>ISO/IEC 14496-12</td>
<td>DASH/CMAF constraints</td>
<td>Producer Reference Time</td>
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<td>DASH/CMAF constraints</td>
<td>Event Message</td>
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<tr>
<td>free</td>
<td>+</td>
<td>ISO/IEC 14496-12</td>
<td>none</td>
<td>free box</td>
</tr>
<tr>
<td>skip</td>
<td>+</td>
<td>ISO/IEC 14496-12</td>
<td>none</td>
<td>skip box</td>
</tr>
<tr>
<td>moof</td>
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<td>DASH/CMAF constraints</td>
<td>Movie Fragment box and the boxes it contains</td>
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<tr>
<td>mdat</td>
<td>1</td>
<td>ISO/IEC 14496-12</td>
<td>DASH/CMAF constraints</td>
<td>Media Data container for media samples</td>
</tr>
</tbody>
</table>

MHV: Emmy MPEG-DASH
Resynchronization

Use cases

- Low latency streaming and fast access to the service
- Fast channel acquisition in broadcast services
- Low latency streaming and resynchronization after losses or buffer underruns
- Fast down-switching in low duration buffer cases
- Fast and efficient seeking to time

Client Processing Resync and Restart

- Finding the box structure within the Segment
- Finding a proper Resynchronization Point including with all relevant information that are needed to start parsing and decoding
- Finding the earliest presentation time that is presented
- Processing of Event messages, if applicable
- Obtaining all decryption relevant information, if applicable
- Start decoding on elementary stream level
# Content Protection

<table>
<thead>
<tr>
<th>Element or Attribute Name</th>
<th>Use</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>ContentProtection</td>
<td></td>
<td>specifies information regarding a content protection or encryption scheme used to encrypt and/or protect the associated Representation(s)</td>
</tr>
<tr>
<td>@schemeldUri</td>
<td>M</td>
<td>identifies a content protection or encryption scheme.</td>
</tr>
<tr>
<td>@value</td>
<td>O</td>
<td>provides additional information specific to the content protection or encryption scheme. For example, it may provide information such as DRM version, encryption mode, etc. For details, refer to 5.8.4.1.6.</td>
</tr>
<tr>
<td>@ref</td>
<td>O</td>
<td>If present, makes this a referencing content protection descriptor that inherits from a “source” content protection descriptor which is identified by the equivalent value of @refld attribute. For details, refer to 5.8.4.1.3. The attribute shall not be present if the @refld attribute is present.</td>
</tr>
<tr>
<td>@refld</td>
<td>O</td>
<td>specifies an identifier of this descriptor. The identifier shall be unique within an MPD. The attribute shall not be present if the @ref attribute is present.</td>
</tr>
<tr>
<td>@robustness</td>
<td>OD</td>
<td>specifies the robustness level required for this content protection scheme for accessing content represented by the associated Representation(s). For more details refer to 5.8.4.1.2 and 5.8.4.1.6. If not present, then the lowest robustness level for the identified content protection scheme applies.</td>
</tr>
</tbody>
</table>
DASH-IF
Who we are?
http://www.dashif.org

- DASH Industry Forum (DASH-IF) was founded in 2012 to promote and catalyze the adoption of MPEG-DASH and help transition it from a specification into a real business.

- With more than 80 members, DASH-IF represents a large footprint of the ecosystem, including service providers, content delivery network operators and broadcasters, as well as technology providers in different domains, and connects the dots in an otherwise fragmented world of internet streaming services.

- DASH-IF also serves as the point of contact for other standards organizations when introducing new DASH-based distribution means.
How do we operate?

We try to be lean, agile, flexible and open …

- Weekly or bi-weekly calls in working groups and active task forces. Two annual f2f meetings.
- Development of specifications, guidelines, liaison based on work items and github issues.
- Publication of guidelines through DASH-IF web page: http://www.dashif.org
- Community Reviews for public
- PAS Agreement with ETSI established to publish specifications.
- Commissioning and sponsoring of conformance, reference and test tools

We try to be lean, agile, flexible and open …
Interoperability – v5
DASH-IF IOP Guidelines
12 parts: https://dashif.org/guidelines/iop-v5/

Part 1: Overview, Architecture and Interfaces
Part 2: Core Principles and CMAF Mapping
Part 3: DASH On-Demand Services
Part 4: DASH Live and Low Latency Services
Part 5: Ad Insertion and Content Replacement
Part 6: Content Protection and Security
Part 7: Video
Part 8: Audio
Part 9: Text
Part 10: Events
Part 11: Additional Technologies
Part 12: Conformance and Reference Software
Low-Latency Streaming with Chunking

Encoder

- CNC = CMAF non-initial chunk
- CIC = CMAF initial chunk
- CH = CMAF Header

Many technical details are in DASH-IF IOP v5 http://www.dashif.org/guidelines

Service Description

DASH Packager

CDN stores Segments

10s

3s

Regular DASH Client

Low-Latency DASH Client

Segments

HTTP Chunk

HTTP Chunk

DASH Segment

MhV: Emmy MPEG-DASH
Chunked Segment Distribution

ENCODER

CDN

PLAYER

MHV: Emmy MPEG-DASH
MPEG DASH supporting work

- As part of ISO/IEC 23009-1 4th and 5th edition
- Producer Reference Time in MPD and segments
  - Enables media encoding including wall-clock anchor times
  - Permits DASH client to determine, monitor and control latency.
- Service Description
  - Addresses service provider's influence on DASH client operation
  - Target Latencies, Playback Control
- Updates on Event Processing
- DASH Profile for CMAF Content
- Resynchronization
  - Enables chunk signaling
  - Enables fast downswitching and random access
Advantages of Chunked Segments

• Legacy Player Support with the same content/infra
• CDN friendly: Cacheability and Scalability
• Decoupling of latency from segment duration
• Reuse or Automatic support of existing DVB-DASH
  • Codecs and formats
  • Common Encryption
  • Ad Insertion
  • Events
• Standards-based and promise for convergence
• Works also with ABR Multicast and Broadcast
TEST PLAYER FOR CHUNK-ENCODED CHUNK-TRANSFERED DASH (v4.3.0)

Enter the mpd to test: https://cmstatfakamaized.net/cmaf/ve-uill/2006300/akamibjout.mpd

Target latency in seconds: 3
Maximum catch-up rate (%): 5

Latency estimate: 4.556 secs
Buffer level: 4.523 secs
Startup time: 2.1 secs
Playback rate: 1
Current representation: 1920x1080, 29.97 fps, 6000 kbps
Example 2: DASH-IF Ad Insertion Architecture
Other highlights

Content Protection
- MPEG CMAF format protected by MPEG CENC
- Support of key rotation
- Enhanced Clear Key Content Protection (ECCP)
- DASH-IF XML schema with elements related to content protection

Audio/Video/Text
- Addition of CMAF Profiles
- Codecs Registration for DASH: https://dashif.org/codecs/introduction/

Updates to Ingest specifications
- Encoder synch based on epoch lock
- Manifest description/restriction for CMAF ingest
- Encoder input loss and last segment signaling
- MPEG-B part 18 support and other improvements signaling emsg and timed metadata
- Example reference implementation (e.g., FFmpeg)
- Segment per post, several other media restrictions usage of common encryption
- Deprecate some smooth legacy (mfra, Streams(), etc.)
More than just specs: Test, Reference and Conformance
Dash.js by Numbers

261 Github watchers
4.2k Github Stars
1500 Github forks
159 Github contributors
1100 Github projects that use dash.js
42 releases
What’s next?
MPEG and DASH-IF

MPEG Amd.1
- Alternative MPD Events for Server Guided Ad Insertion
- Nonlinear playback
- Addressable Resource Index Track
- DASH Period Event

DASH-IF
- Content Steering
- Low-Latency and Fast Joining using Addressable Resync Representations
- Server Guided Ad Insertion
- Server-based Watermarking
- DASH and webRTC streaming

Input from other organizations
- CTA WAVE and CMAF
- 3GPP, 5G-MAG, DVB and ATSC
ARI Track

• The ARI Track is time-aligned with the tracks of the CMAF Switching Set.
• The ARI Track documents properties of all tracks of the CMAF Switching Set
• One sample represents a CMAF chunk in a time-aligned manner.
• The sample contains detailed information for the chunk in each of the tracks in the switching set
  • size, timing, SAP types, quality, predictive bitrate into the future
• This track may even be used to carry for example Events or Producer Reference time for the Media Presentation.
• A client may use the Track for fast random access, optimized scheduling, variable bitrate streaming.
• The ARI Track may also be used by network entities to predict bitrate
ARI Track in live mode

Encoder

CNC CNC CIC CNC CNC CIC CH

CNC CNC CIC CNC CNC CIC

DASH Packager

CNC CNC CIC CNC CNC CIC

DASH Segment

HTTP Chunk

HTTP Chunk

ARI Track

2 1

3 2 1

Delay

Chunking

Segments

Time-Shift
Addressable Resync Representation

Issues:
- If in low-latency operation, client may need to down-switch
- When joining, client may have to wait for segment boundary
- In seek mode, the segment duration determines the frequency

Idea:
- Add dedicated Addressable Resync representations into Adaptation Sets
- In combination with ARI Track, even more advanced operation possible
Content Steering

```xml
xsi:schemaLocation="urn:mpeg:dash:schema:mpd:2011 DASH-MPD.xsd" type="dynamic"
minimumUpdatePeriod="PT30S"
timeShiftBufferDepth="PT30M"
availabilityStartTime="2022-02-25T12:30:00"
minBufferTime="PT4S"
profiles="urn:mpeg:dash:profile:isoff-live:2011">
  <ContentSteering defaultServiceLocation="beta"
queryBeforeStart="true">https://steeringservice.com/app/instance12345</ContentSteering>
  <BaseURL serviceLocation="alpha">https://cdn1.example.com/</BaseURL>
  <BaseURL serviceLocation="beta">https://cdn2.example.com/</BaseURL>
  <Period id="1">
    <AdaptationSet mimeType="video/mp4" codecs="avc1.4D401F"
frameRate="30000/1001" segmentAlignment="true" startWithSAP="1">
      <BaseURL>video/</BaseURL>
      ...
    </AdaptationSet>
  </Period>
</MPD>

{
  "VERSION": 1,
  "TTL": 250,
  "RELOAD-URI": "https://steeringservice.com/instance12345?session=abc"
  "PATHWAY-PRIORITY": ["alpha","beta"]
}
Server Guided Ad Insertion

MHV: Emmy MPEG-DASH
Server Guided Ad Insertion

Instead of complex SCTE-35 logic, simplified Event and processing model
DASH and webRTC

- On March 1st, 2022, DASH-IF published a first report on combining DASH and webRTC-based streaming.
- This report describes use cases made possible by integrating WebRTC Streaming into the DASH workflows as well as the technical considerations that should be taken into account in order to achieve successful integration. The document is primarily informative and information-collecting.
- It serves as a preparation and guidance for future technical work in the context of DASH and webRTC-based Streaming.
- The report was developed by public collaboration under the hospices of DASH-IF in an exploration TF lead by Julia Kenyon and Ali C. Begen.
- Any comments may be submitted through the github issues.
- Based on these recommendations, along with the report, DASH-IF also launched a survey on potential next steps - please respond by April 15, 2022.
Selected other presentations and posters


2. “Session-Based DASH Streaming: A new MPEG standard for customizing DASH streaming per session”, Iraj Sodagar (Tencent America); Alex Giladi (Comcast)

3. “Latest Advances in the Development of the Open-Source Player dash.js”, Daniel Silhavy, Stefan Pham, Stefan Arbanowski, Stephan Steglich (Fraunhofer FOKUS); Bjoern Harrer (Deutsche Telekom AG)

4. Extend CMAF Usage for Large Scale Video Delivery”, Lucas Gregory, Khaled Jerbi, Mickael Raulet, Eric Toullec (ATEME)

5. “Marrying WebRTC and DASH for Interactive Streaming”, Julia Kenyon (Phenix RTS); Thomas Stockhammer (Qualcomm); Ali C. Begen (Ozyegin University / Networked Media); Ofer Shem Tov (Edgecast); Louay Bassbouss, Daniel Silhavy (Fraunhofer FOKUS)
Wrap up
• DASH used in major companies, very much so in Europe.
• Which of the top 10 broadcasters in any country are not using DASH?
• In the US, HLS is still quite dominant, but DASH/HLS convergence accelerates DASH
• Questions about license and royalty fees for DASH seemed to have vanished.
• Significant adoption in application standards: DVB, HbbTV, SCTE, ATSC, 5G, TV 3.0

DASH is a collaborative effort
• Not a single sponsor
• Coordination across SDOs
• Very mature for large scale deployments
• Still full of ideas and innovation
• Please join us in DASH-IF http://dashif.org
Thank you