mhv/2024

ACM MILE HIGH VIDEO

Standards based OTT A/B Watermarking at Scale

MHV2024 – Day 1

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Unified Streaming, Amsterdam, The Netherlands

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Unified Streaming

VARNISH SOFTWARE

Forensic Watermarking

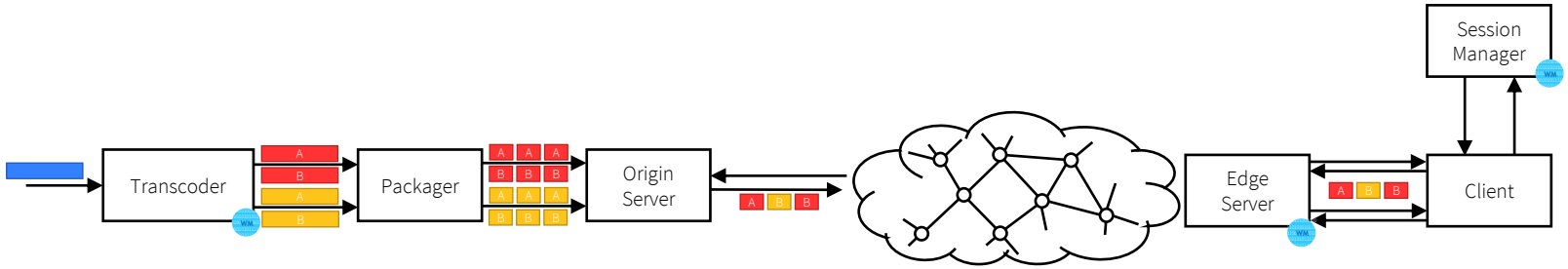
Unique identifier embedded within each content copy for the purpose of tracking individual copies to deter unauthorized redistribution.

Market drivers:

- Premium VOD
- Live Sports

Major industry trend = server-side watermarking

- Trade-off between cache overhead and watermarking
- No integration on the client side needed



Reference: DASH-IF Webinar – February 10, 2023: Server-Side Watermarking DASH-IF End-to-End Architecture

DASH-IF Forensic A/B Watermarking Specification

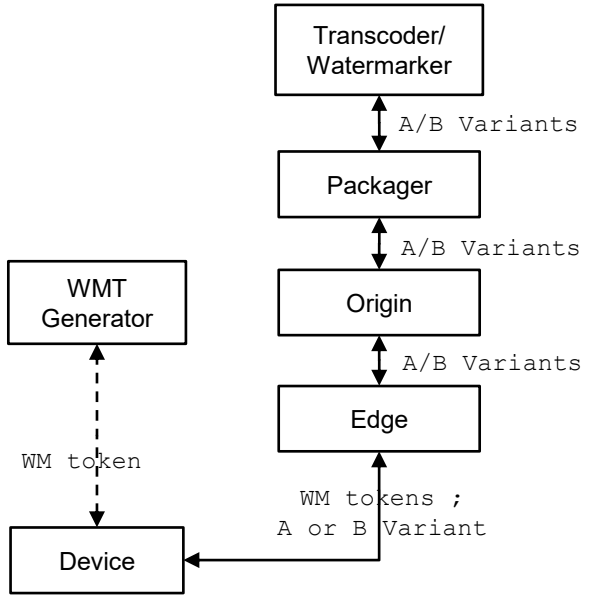
- April 6th, **2021 - First proposal of Watermarking Pace Info.**
- March 3rd , **2022 – 1st Community Review** on DASH-IF Forensic. A/B Watermarking.
- March 3rd, 2
- February 2nd , **2023 – 2nd Community Review** on DASH-IF Forensic. A/B Watermarking.
- **August 28th, 2023 – ETSI Public version:** ETSI TS 104 002 Publicly Available Specification (PAS); DASH-IF Forensic A/B Watermarking version 1.1.1 8-2023. An interoperable watermarking integration schema.

DASH-IF Forensic A/B Watermarking Specification

End-to-end architecture that impacts encoder / packager / edge / device

Straightforward A/B routing logic at the Edge

- Watermark token containing a unique A/B pattern transmitted to the Edge by the device
- Explicit metadata stream (`WMPaceInfo` metadata) from the encoder to the edge to signal which WMID bit is associated to a given egress segment

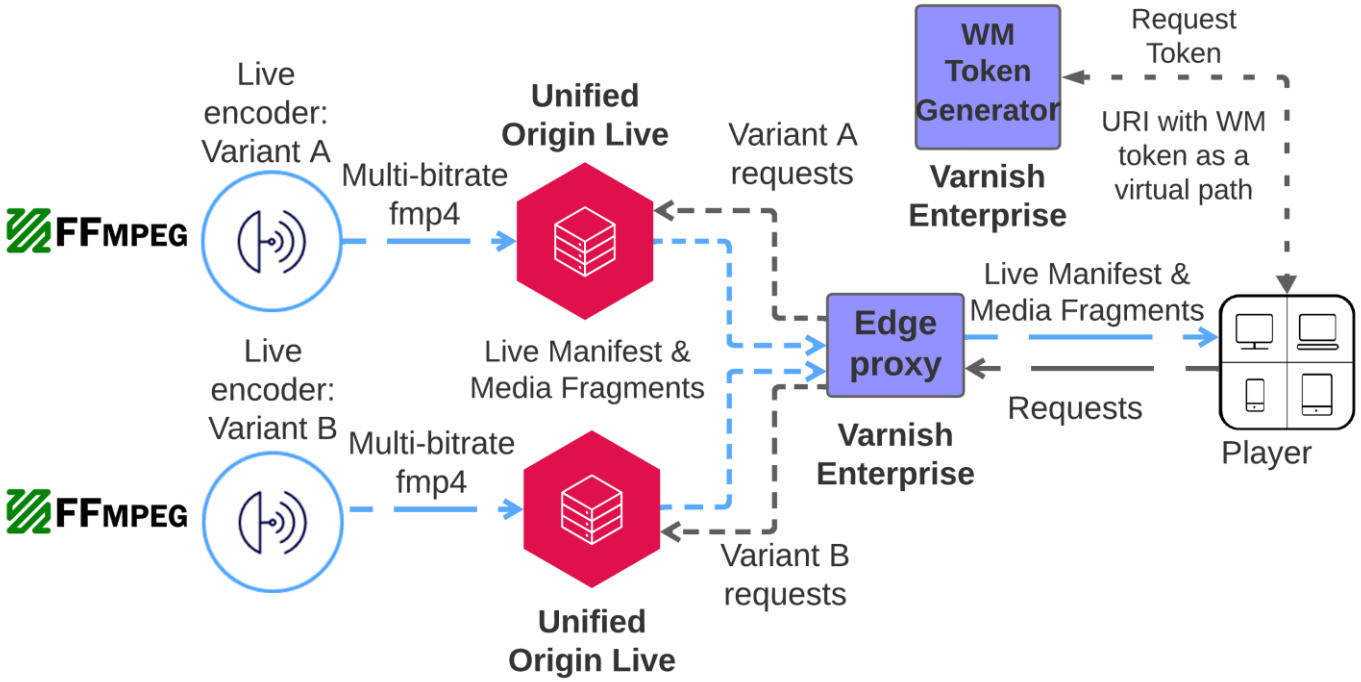


Reference: DASH-IF Webinar – February 10, 2023: Server-Side Watermarking DASH-IF End-to-End Architecture

A/B Delivery Framework architecture

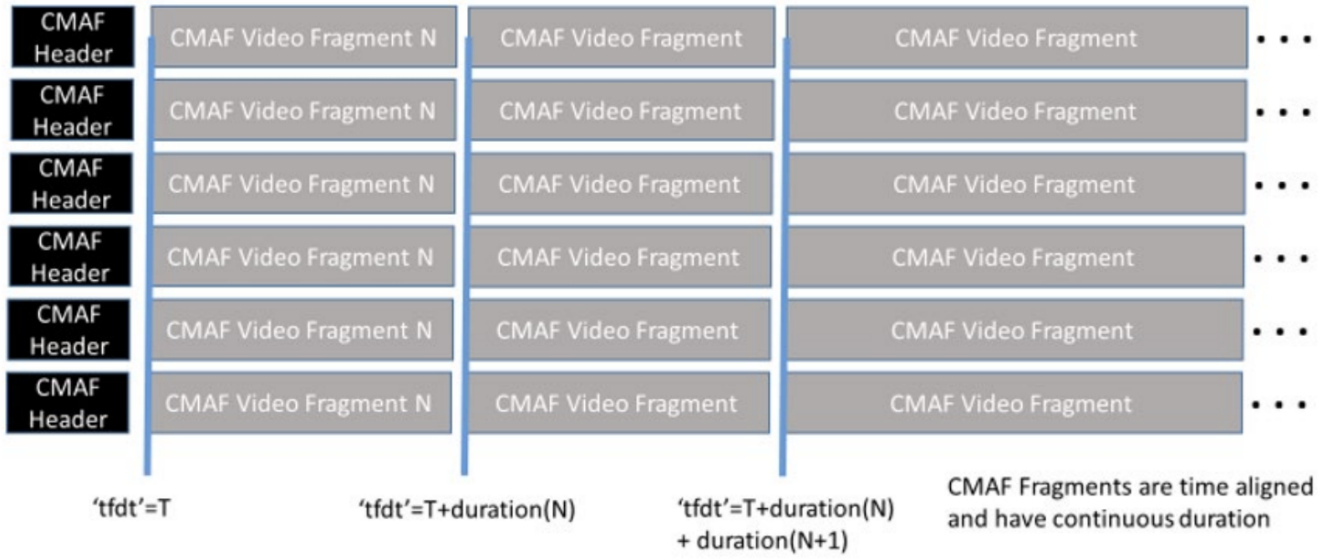
Requirements

- CMAF Live ingest.
- ISO/IEC JCT 1 SC29 WG 3, Text of ISO/IEC CD 23009-9 Redundant encoding and packaging for segmented live media (REAP).
- DASH Segment Template number
- Real-time processing of media workflow.



CMAF Transcoding component

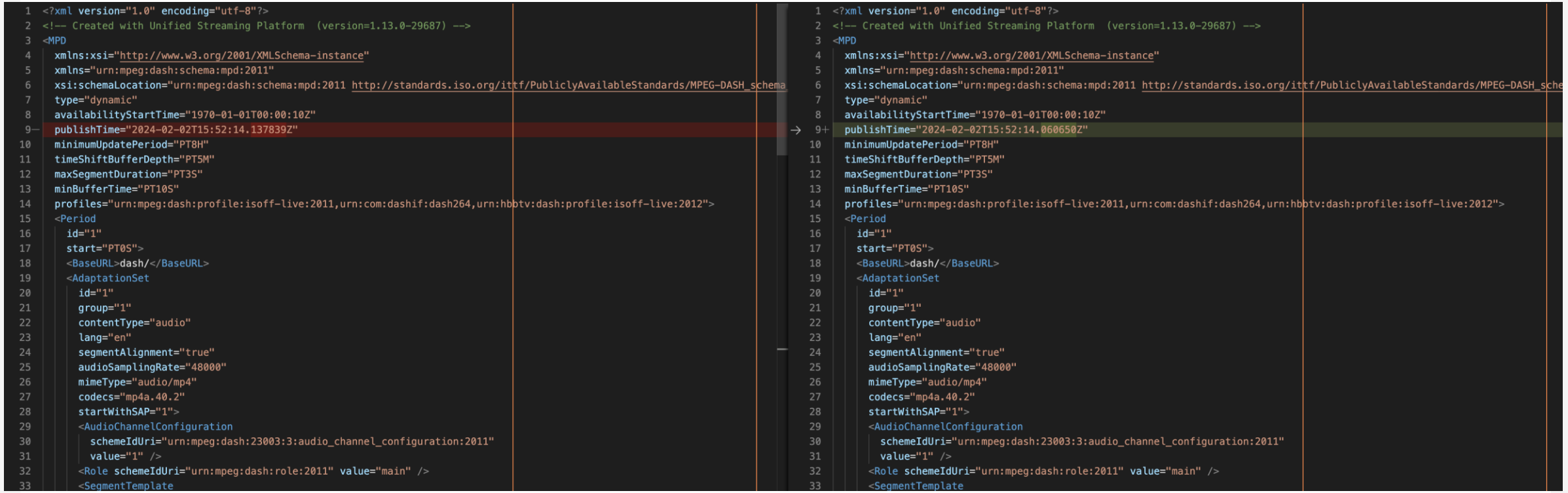
- Bitrate alignment
- Same segment duration
- Segment boundary alignment
- Interchangeable segments
- Audio & timed text is also transcoded



Source: https://cdn.cta.tech/cta/media/media/resources/standards/pdfs/cta-5001-c_final.pdf

ISO/IEC 23000-19:2020, (24-27)

DASH MPD A/B Variant example



```
<?xml version="1.0" encoding="utf-8"?>
<!-- Created with Unified Streaming Platform  (version=1.13.0-29687) -->
<MPD
  xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
  xmlns="urn:mpeg:dash:schema:mpd:2011"
  xsi:schemaLocation="urn:mpeg:dash:schema:mpd:2011 http://standards.iso.org/ittf/PubliclyAvailableStandards/MPEG-DASH_schema
  type="dynamic"
  availabilityStartTime="1970-01-01T00:00:10Z"
  publishTime="2024-02-02T15:52:14.137839Z"
  minimumUpdatePeriod="PT8H"
  timeShiftBufferDepth="PT5M"
  maxSegmentDuration="PT3S"
  minBufferTime="PT10S"
  profiles="urn:mpeg:dash:profile:isoff-live:2011,urn:com:dashif:dash264,urn:hbbtv:dash:profile:isoff-live:2012">
  <Period
    id="1"
    start="PT0S">
    <BaseURL>dash/</BaseURL>
    <AdaptationSet
      id="1"
      group="1"
      contentType="audio"
      lang="en"
      segmentAlignment="true"
      audioSamplingRate="48000"
      mimeType="audio/mp4"
      codecs="mp4a.40.2"
      startWithSAP="1">
      <AudioChannelConfiguration
        schemeIdUri="urn:mpeg:dash:23003:3:audio_channel_configuration:2011"
        value="1" />
      <Role schemeIdUri="urn:mpeg:dash:role:2011" value="main" />
      <SegmentTemplate
```

```
<?xml version="1.0" encoding="utf-8"?>
<!-- Created with Unified Streaming Platform  (version=1.13.0-29687) -->
<MPD
  xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
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  publishTime="2024-02-02T15:52:14.060650Z"
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  timeShiftBufferDepth="PT5M"
  maxSegmentDuration="PT3S"
  minBufferTime="PT10S"
  profiles="urn:mpeg:dash:profile:isoff-live:2011,urn:com:dashif:dash264,urn:hbbtv:dash:profile:isoff-live:2012">
  <Period
    id="1"
    start="PT0S">
    <BaseURL>dash/</BaseURL>
    <AdaptationSet
      id="1"
      group="1"
      contentType="audio"
      lang="en"
      segmentAlignment="true"
      audioSamplingRate="48000"
      mimeType="audio/mp4"
      codecs="mp4a.40.2"
      startWithSAP="1">
      <AudioChannelConfiguration
        schemeIdUri="urn:mpeg:dash:23003:3:audio_channel_configuration:2011"
        value="1" />
      <Role schemeIdUri="urn:mpeg:dash:role:2011" value="main" />
      <SegmentTemplate
```

A Variant

B Variant

WM Token Generator

- WM Token was used in **direct mode**
- JWT Token as the WM Token:
  - WM version: **wmver-label**
  - WM technology vendor: **wmvnd-label**
  - Length of WM pattern: **wmpatlen:** 10 bits fixed length
- JWT token was generated using Varnish Enterprise VMOD.
- WM Token is used as a virtual path for each request to the Edge.

ETSI TS 104 002 V1.1.1

Table 1: Integer Claim key values for the WM token

==========

Claim label Integer key

---

wmver-label 300

wmvnd-label 301

wmpatlen-label 302

wmsegduration-label 303

wmpattern-label 304

wmid-label 305

wmopid-label 306

wmkeyver-label 3078

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WMPaceInfo

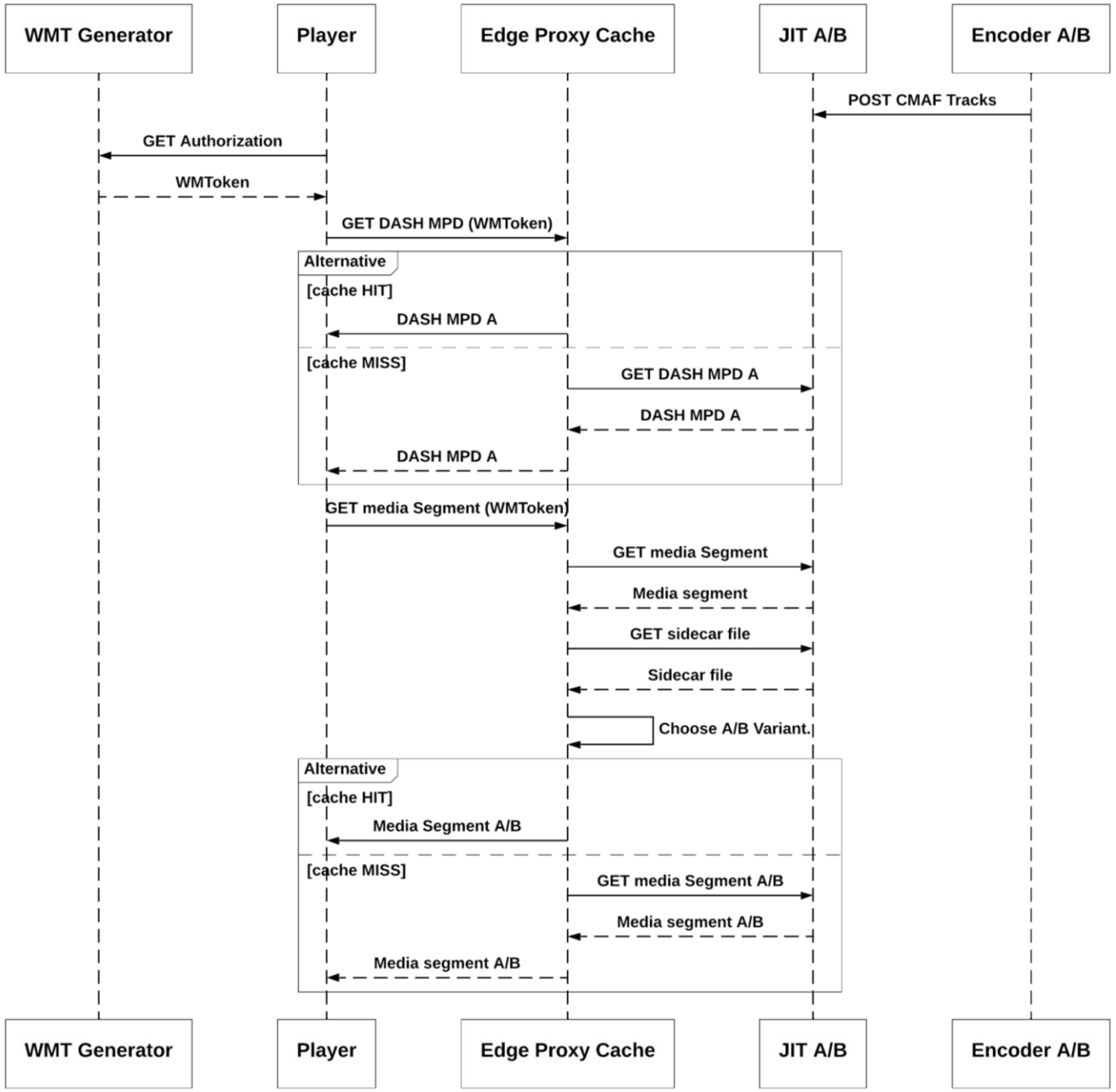
WMPaceInfo Data: **Synthetically generated by the JIT**

- variant
- position

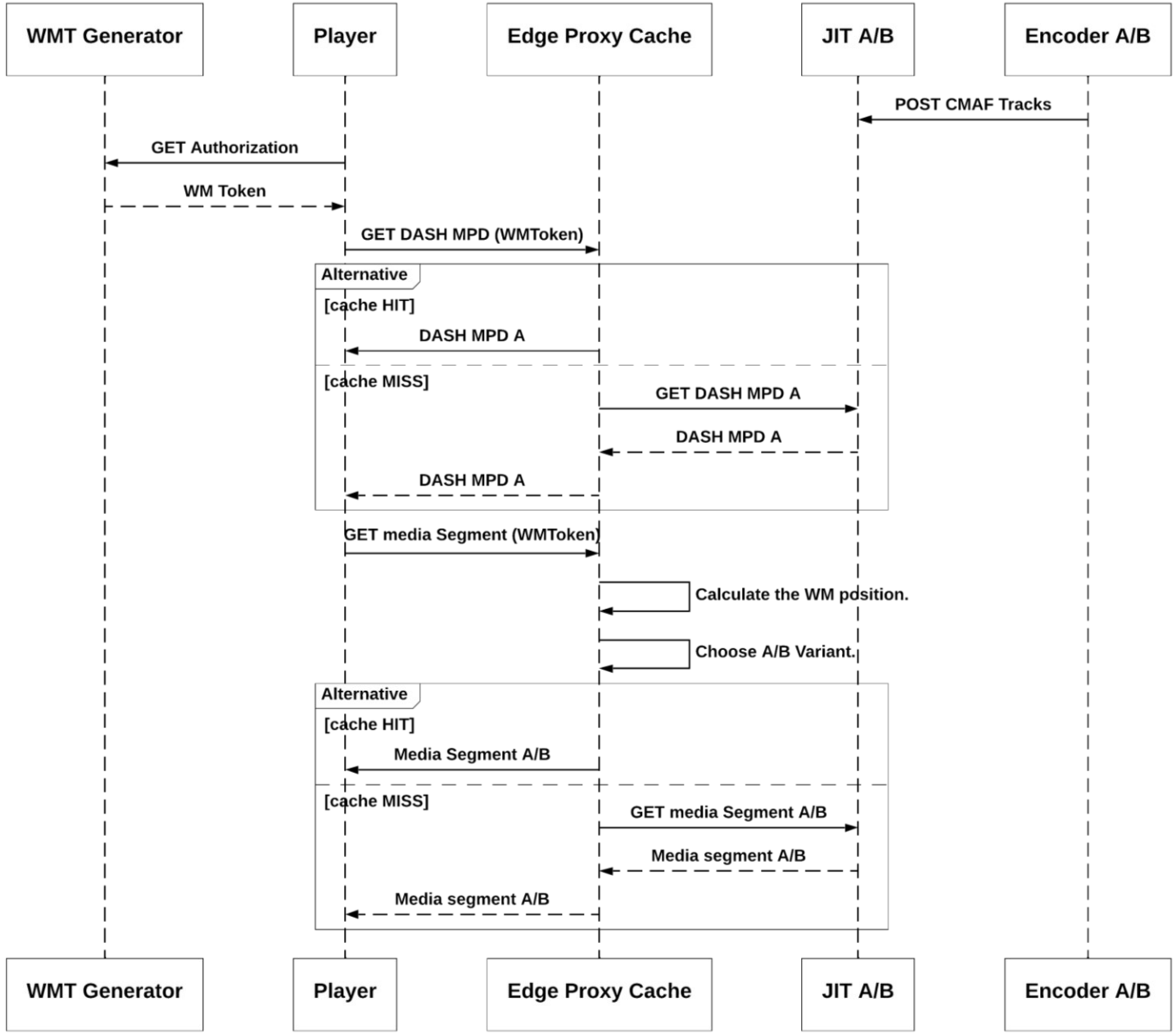
WMPaceInfo delivery:

- Sidecar file as JSON object
- HTTP response header
- Calculated at the Edge server – Name scheme

WMPaceInfo: Side-car File approach



WMPaceInfo: Name Scheme approach



Name Scheme delivery implementation using Varnish

- Multi-thread based processing
- HTTP Routing and Header manipulation
- Independent client request/response from backend fetch
- Implement using Varnish Configuration Language

Example calculation of WMPaceInfo *position* at the Edge

http://localhost/ingress.isml/dash/ingress-video=500000-**888789591**.m4s

position-wm = mod(integer(url-segment-number), str.len(wm-pattern));
variant-a-b = str.substr(wm-pattern, 1, std.integer(position-wm));

http://localhost/**ingress-a**/ingress.isml/dash/ingress-video=500000-888789591.m4s
http://localhost/**ingress-b**/ingress.isml/dash/ingress-video=500000-888789591.m4s

Media Delivery

- HTTP based media delivery
- Discrete Files for WMPaceInfo acquisition
- Same URL for A/B presentations
- Cache keys – Unique cacheable objects for A/B presentations

- Generate A/B sequence in content delivery component is introduced based on a smart edge cache using Varnish Enterprise with a specific caching logic.

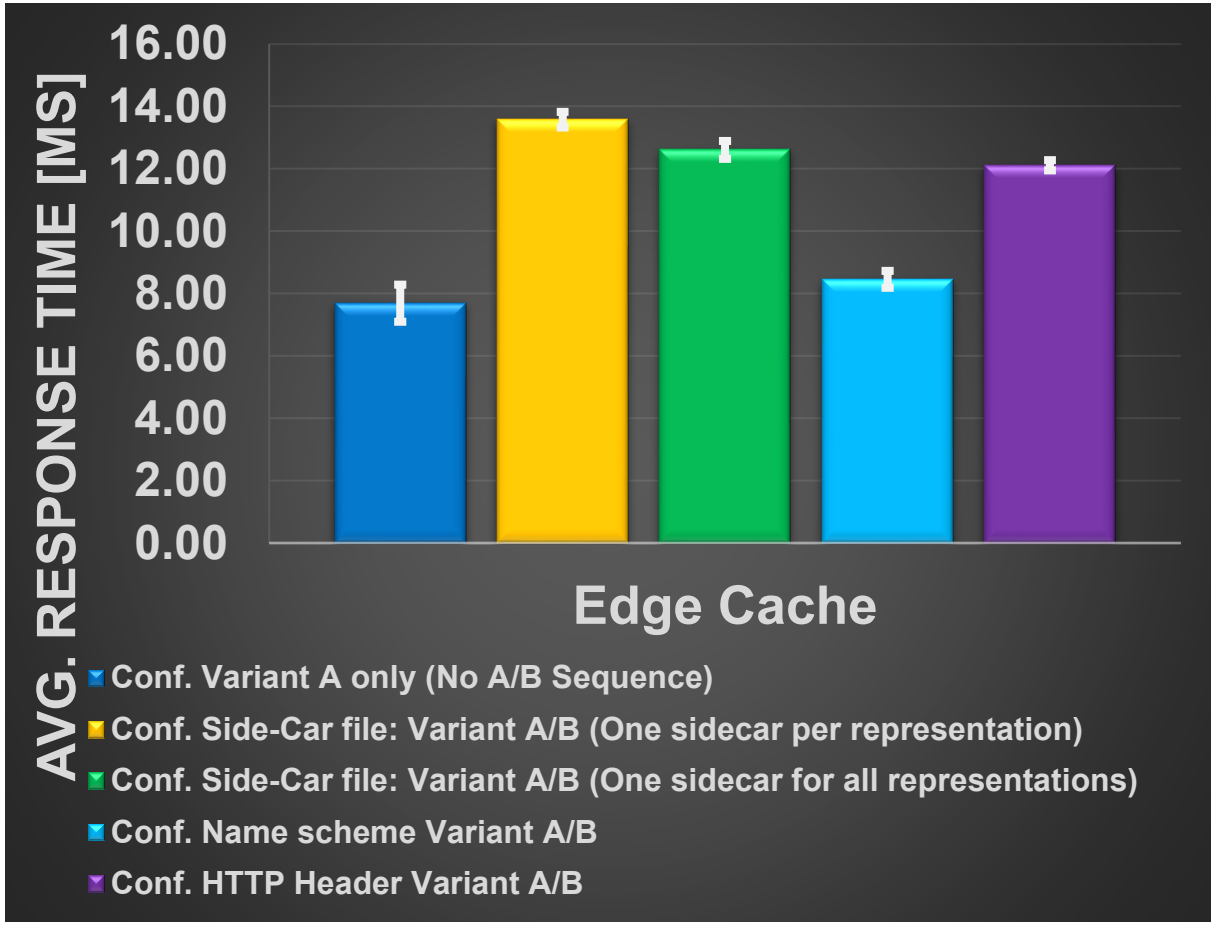
Example test cases

- Enabled Live streaming with A/B sequencing
- Media player requests all A/B representations in parallel when new media segments are available
- Cache not loaded

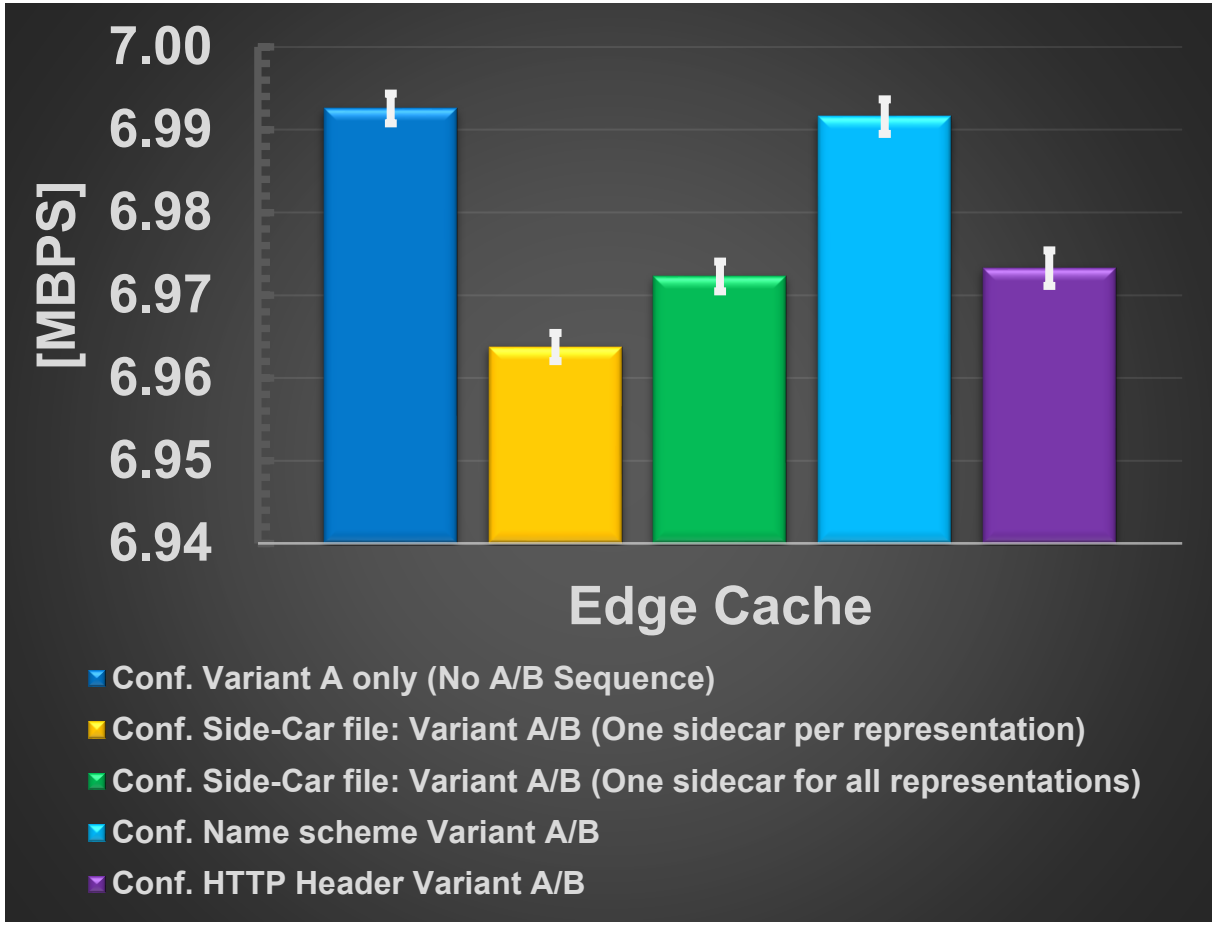
- Media source:
  - **8 video** AVC1 CMAF **tracks**: [100, 150, 300, 500, 1000, 1500, 2500, 3500] kbps
  - **1 audio** AAC CMAF **tracks**:
    - 64 kbps
- Media egress:
  - DASH
  - 1.92 seconds of segment duration

Cache not loaded

Avg. response time [ms]

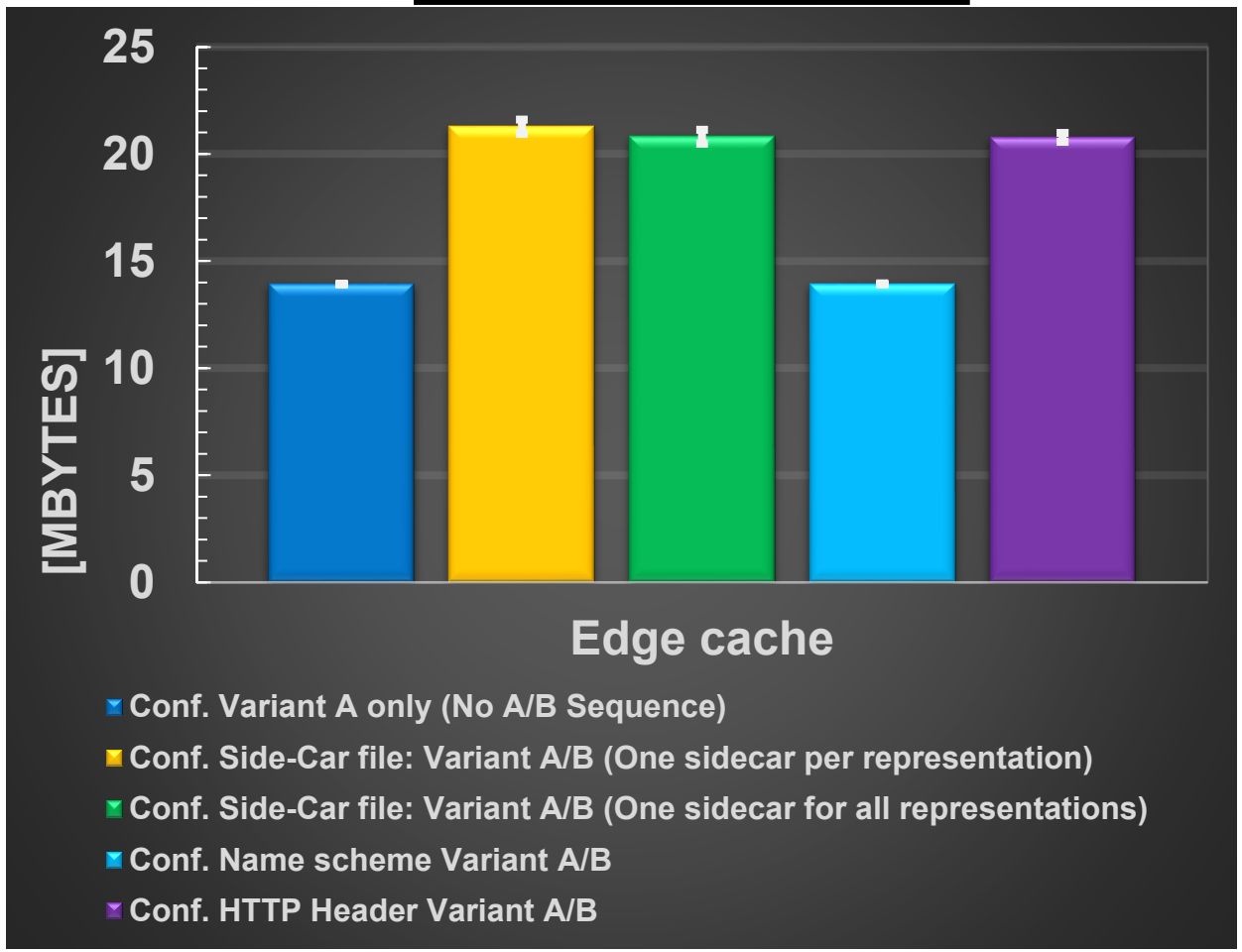


Avg. Throughput [Mbps]

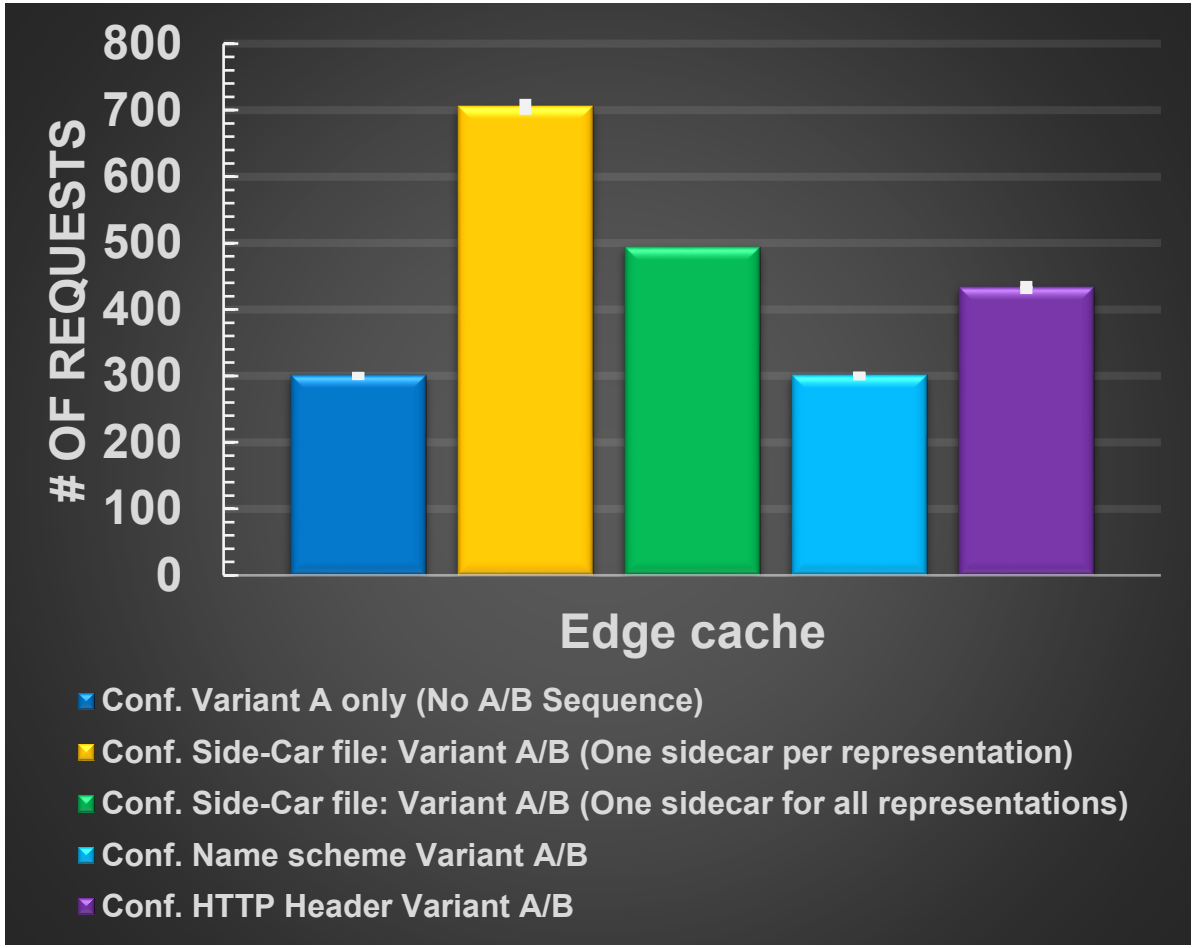


Cache not loaded

Cache size [MB]

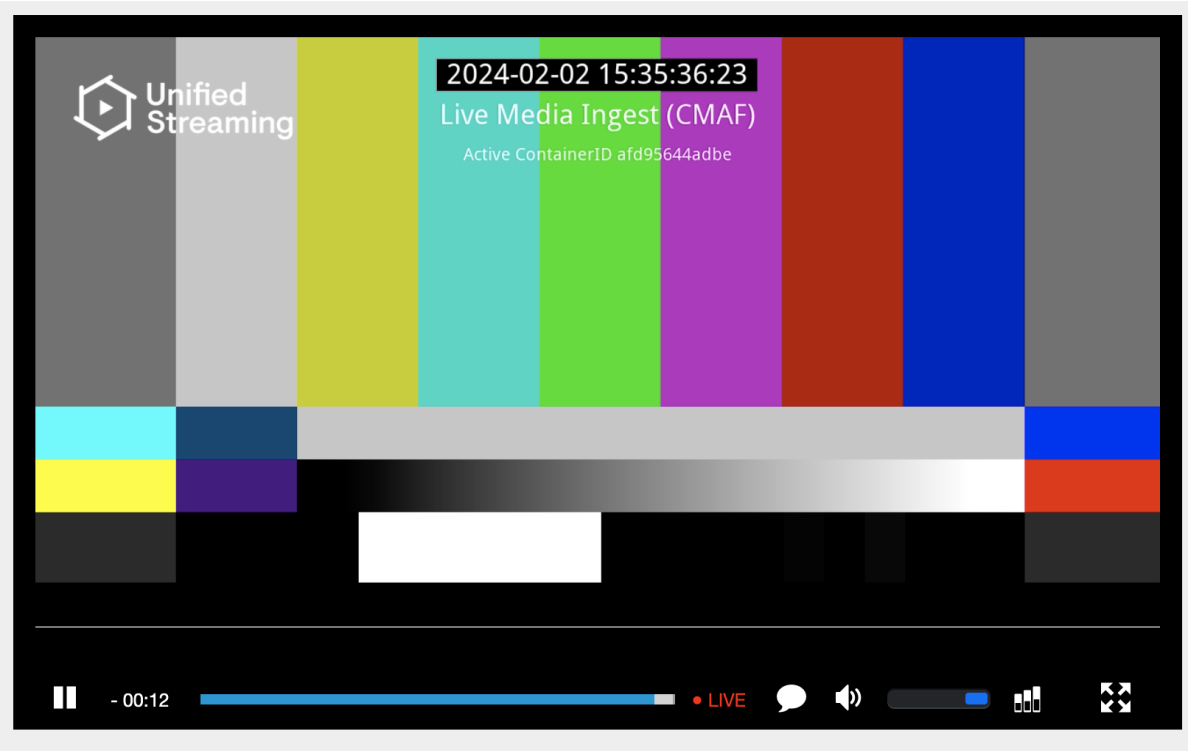


Backend requests



Live demo example

A Live stream



B Live stream

Summary

- Media delivery framework for A/B sequence to a broad range of devices.
- Authoring component of two live CMAF ingests with a burned container ID, with segment and bit-rate alignment.
- HTTP Delivery component with an optimized caching approach.
- PoC using Varnish Enterprise and Unified Origin was implemented and evaluated.
- Framework evaluation showed low response time overhead, reduced backend traffic, and a relative decrease in cache size.
- An efficient way to produce unique streams to clients at scale
- Next steps we are looking to deploy this on a larger scale and in production.

Questions?

Thank you!

For any questions, feel free to contact me at:

roberto at unified-streaming.com

https://doi.org/10.1145/3638036.3640251

https://github.com/unifiedstreaming/watermarking-dash-if-demo

Unified Streaming


Unified Streaming

Testing environment: EC2 c5n.xlarge

Compute	Value
vCPUs	4
Memory (GiB)	10.5
Memory per vCPU (GiB)	2.62
Physical Processor	Intel Xeon Platinum 8124M
Clock Speed (GHz)	3
CPU Architecture	x86_64

Networking	Value
Network Performance (Gbps)	Up to 25

Storage	Value
EBS Optimized	true
Max Bandwidth (Mbps) on (EBS)	4750
Max Throughput (MB/s) on EBS	593.75
Max I/O Operations/second (IOPS)	20000
Baseline Bandwidth (Mbps) on (EBS)	1150
Baseline Throughput (MB/s) on EBS	143.75
Baseline I/O Operations/second (IOPS)	6000

https://docs.aws.amazon.com/AWSEC2/latest/UserGuide/compute-optimized-instances.html