Redundant Encoding and Packaging of Live Segmented Media (REaP)

Mile High Video 2023

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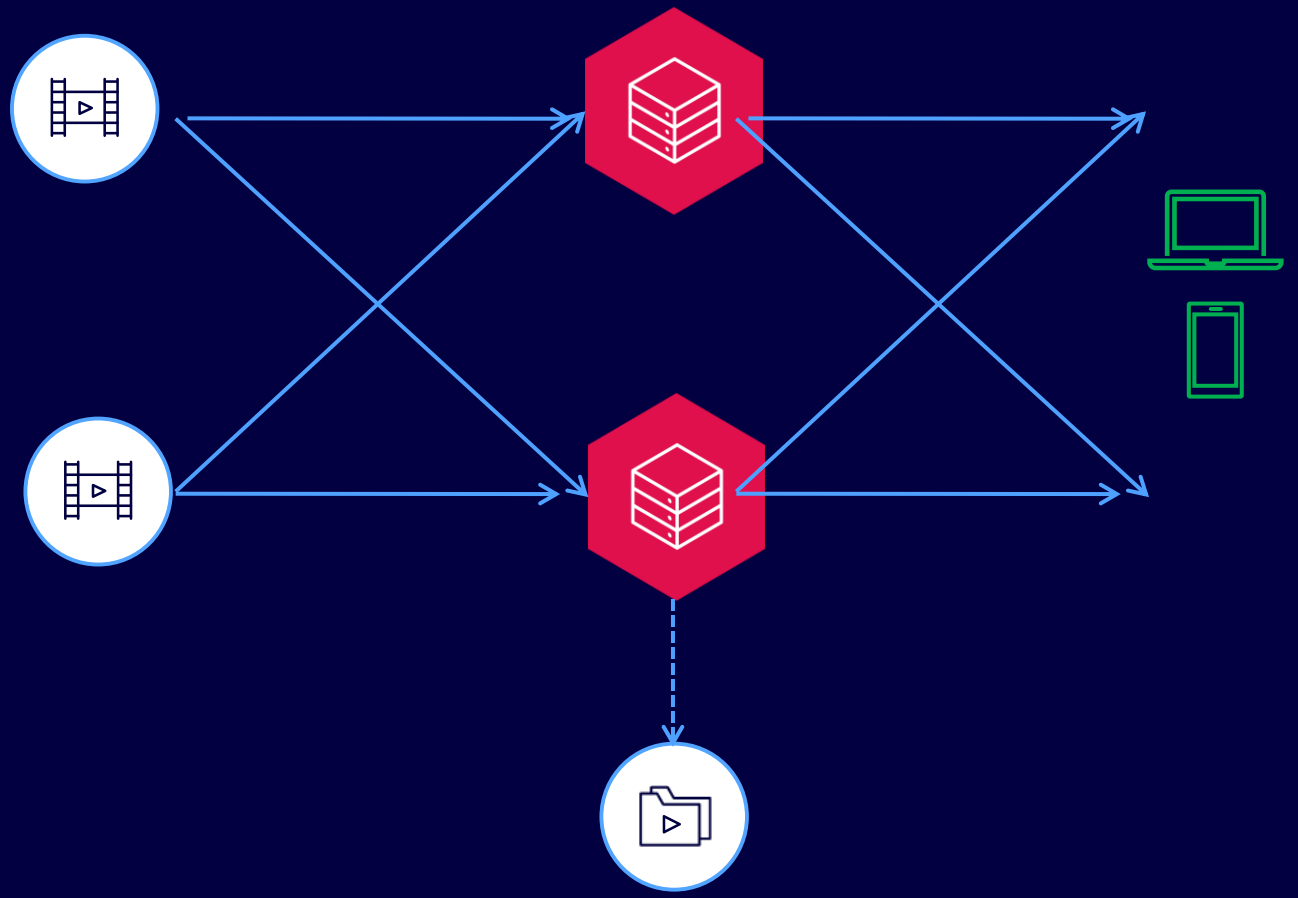


Unified Streaming

REaP History (1)

Redundant live encoding with failover support

A/B Watermarking

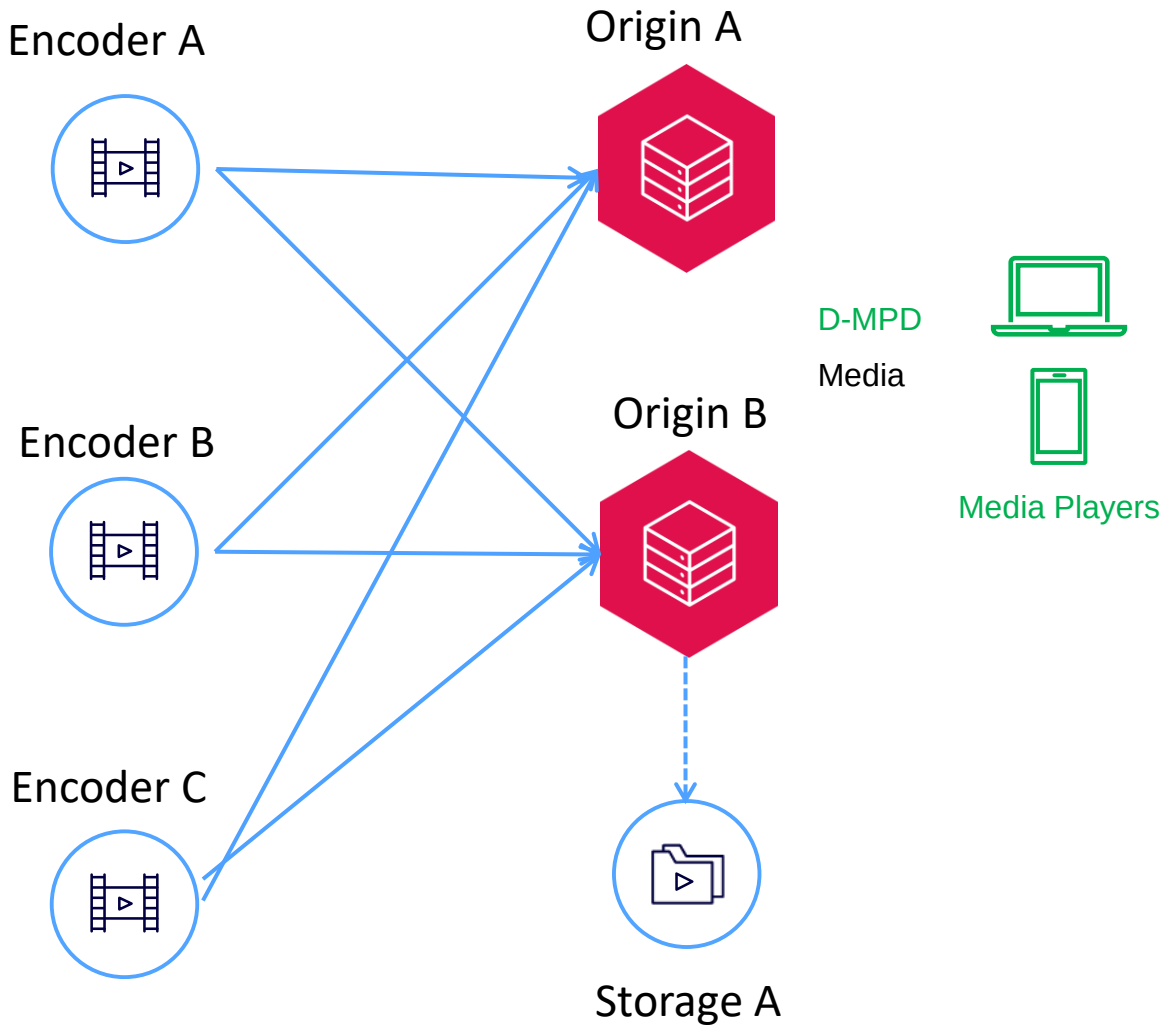
Distributed ABR encoder with multiple codecs, distributed ladders

3rd Party metadata
(e.g. timed text, programme & splice point information)

live timelines preserved in MP4 archives (replay & live2Vod)

Cloud storage access and content repurposing

Smooth Streaming and Azure live Media



REaP History (2)
Encoder Sync workshop

Unified Streaming Platform

Redundant live encoding

Redundant packaging with distributed origins

Live Media Ingest between encoders and origins

Archiving and CMAF storage of 24x7 live archives

~ 100 attendees from broadcast and cloud computing industries

~ follow up is planned in July this year

https://sites.google.com/view/encodersyncworkshop/home

REaP History (3)
MPEG Standardisation

Unified Streaming Platform

Moving Picture Experts Group (MPEG)

Use Cases and Requirements document based on input

Call For Proposals in January 2022, responses in April 2022

Joint Response from DASH-IF with several companies

Based on generalized DASH-IF live media ingest,
mainly emphasizing
the use of DASH-IF and CMAF

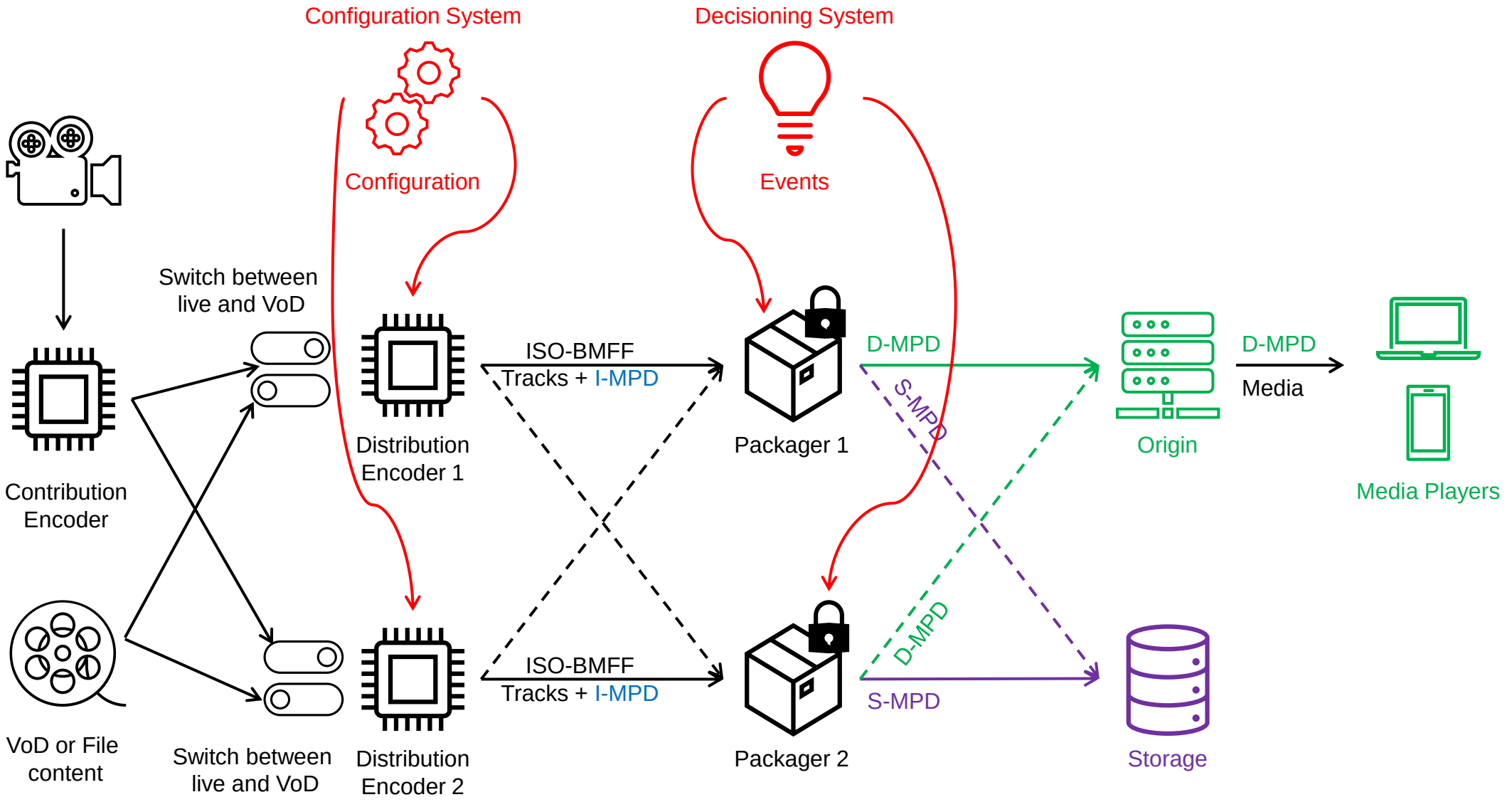
Currently in the CD (comitee draft stage),
the QR code links to both
The latest draft and the
use case and requirements

Use Cases Reqs.

CD Text

REaP Flow

Unified Streaming Platform



REaP Goals

Unified Streaming Platform

a) Interchangeable Live Media Ingest and stream announcement (ingest) from more than on encoder

b) Interchangeable segments from an origin, player, packager or encoder

c) Interchangeable MPD’s or HLS playlists from different sources (origin)

d) Efficient cloud storage access and archiving of live segmented media

e) Failover support for entities (encoders/packagers) failing and rejoining again

f) Support workflows for live and live with dynamic ad insertion

g) Support workflows with DRM and content protection

h) Mixing file and live inputs

REaP Assumptions

Unified Streaming Platform

a) Common contribution signalling with timing information (e.g. MPEG-2 TS, ST 2110, SDI)

b) Timing information in contribution can be mapped back to a time relative to Unix Epoch by configuration of synchronization time stamp (offset)

c) Approximate clock synchronization withing +- 100 ms of different distributed entities

d) Cross transmission is possible from multiple encoders to multiple packagers/origins

e) Focusses on the Streaming head end and ISO Base Media File Format and CMAF type formats, i.e. formats based on fragmented MP4 are deployed

f) Distributed workflow with distributed encoders, packagers, origins, CDN's and player possibly in multiple regions and different data centers

REaP Contributions

Unified Streaming Platform

a) I-MPD: Using the 23009-1 MPEG-DASH for announcing a set of streams to be posted a priori to enable live media ingestion use cases and distributed encoder synchronization. I-MPD adds constraints to MPEG-DASH MPD but no new elements are defined (so far).

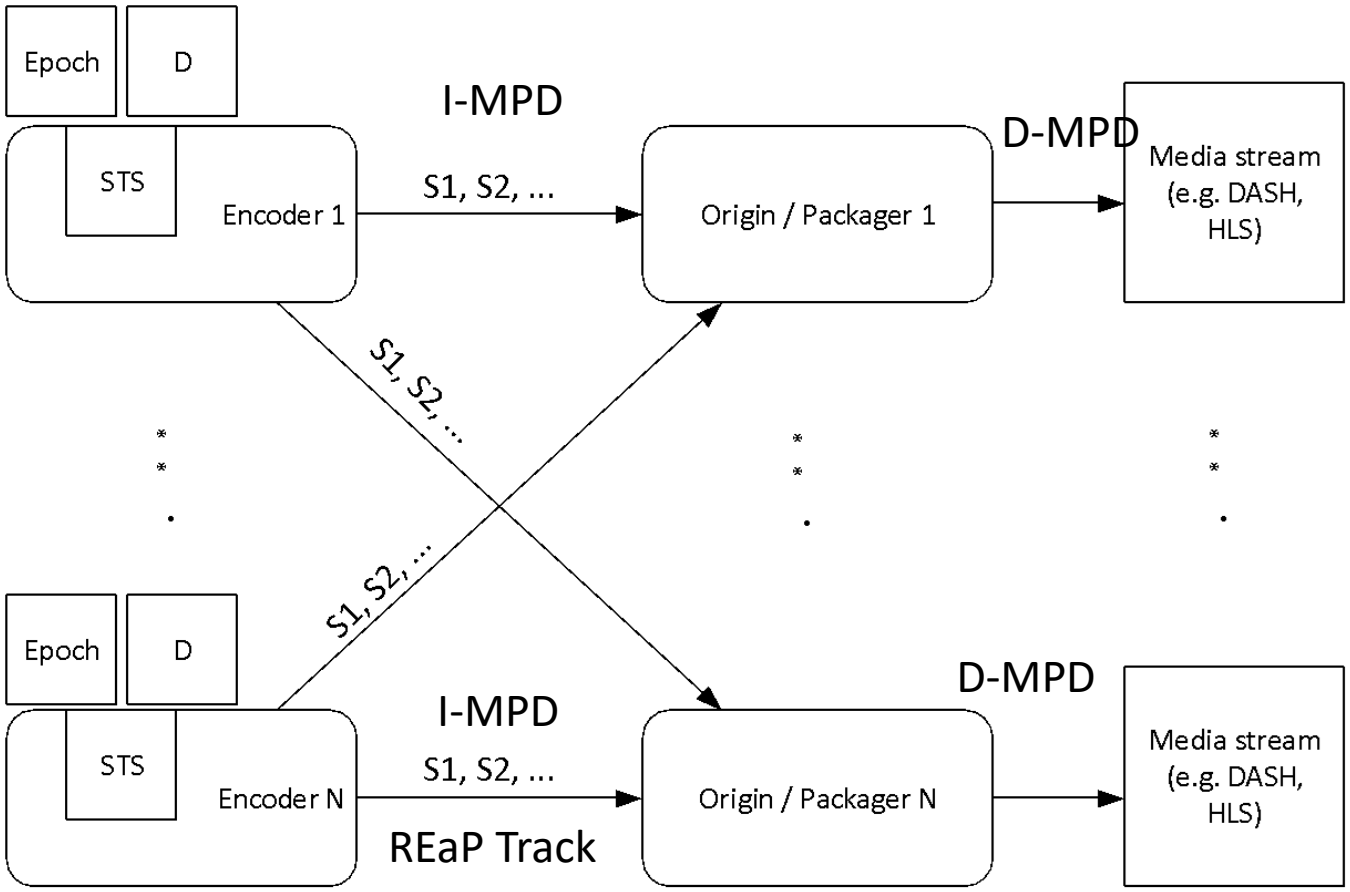
b) REeP media segment and track format: REaP adds some additional constraints and relaxations to DASH segments, CMAF fragments and CMAF tracks to enable generation of segments that are interchangeable, main aspects include using a **common anchor** 1-1-1970 (excluding leap seconds), and an aligned and comment segmentation strategy.

c) D-MPD/Media playlist: Constraints and guidelines on MPEG-DASH MPD to enable distributed packager synchronization

d) S-MPD: Constraints and formats to enable archiving and track storage of live content in distributed cloud storage. S-MPD is based on MPEG-DASH 23009-1, but includes additional constraints to enable the storage.

e) Strategy and Workflow for Redundant Encoding and Packaging using standardized interfaces

REaP Workflow Example

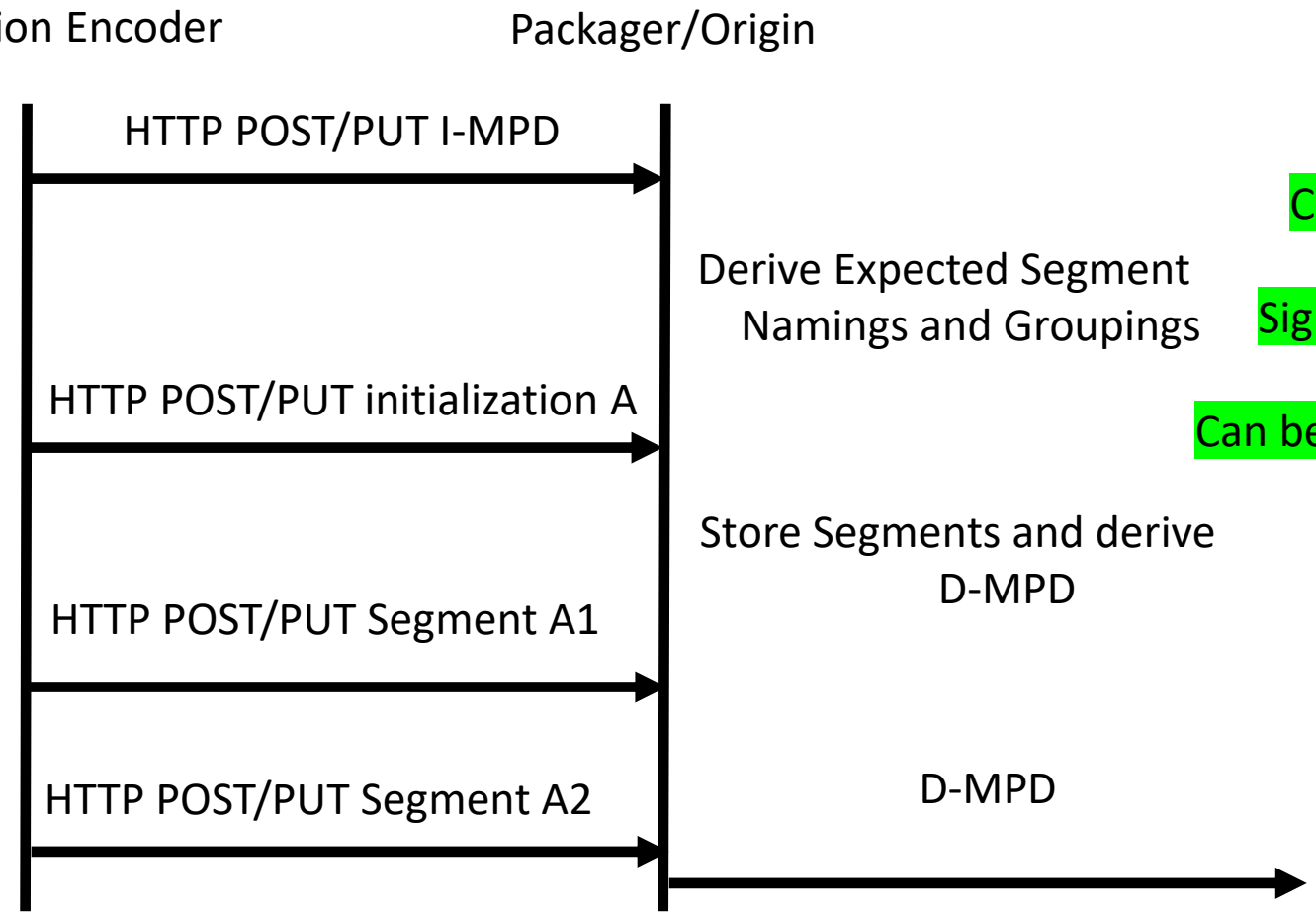


- Epoch – a common time reference.
- D – segment duration.
- STS – Synchronization Time Stamp (to map between input and output)

REaP I-MPD

Unified Streaming Platform

DASH-IF Live media Ingest
https://dashif-documents.azurewebsites.net/Ingest/master/DASH-IF-Ingest.html



I-MPD is a DASH MPD

Constraints on Naming (SegmentTemplate)
Constraints on Timing
Signaling decryption/encryption requirements
Possibly via CPIX
Can be transmitted before Segments are transmitted

REaP Track Format Segmentation

Unified Streaming Platform

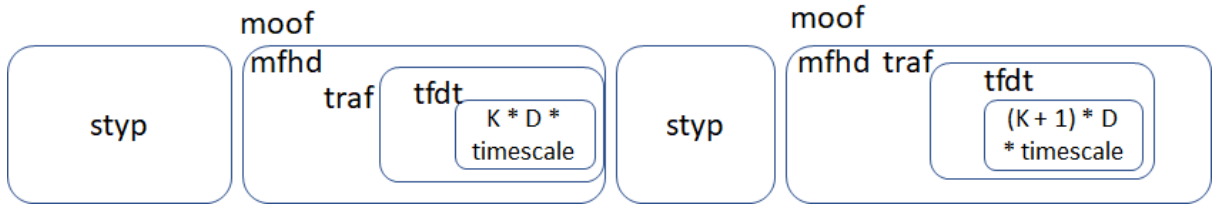
- Output frame time is calculated using:

$$frametime_{out} = frametime_{in} + STS * track\_timescale$$

- The STS (Synchronization Time Stamp) - the difference between the zero time of the input signal and the established time reference, i.e., epoch reference time. By default, STS is zero.
- *track_timescale* is the timescale used by the media track, where timescale is as defined in ISO/IEC 14496-12 in the mdhd (MediaHeader box).
- Synchronization is achieved when encoders calculate the same segment boundaries using:

$$Segmentboundary_K = K * D * track\_timescale$$

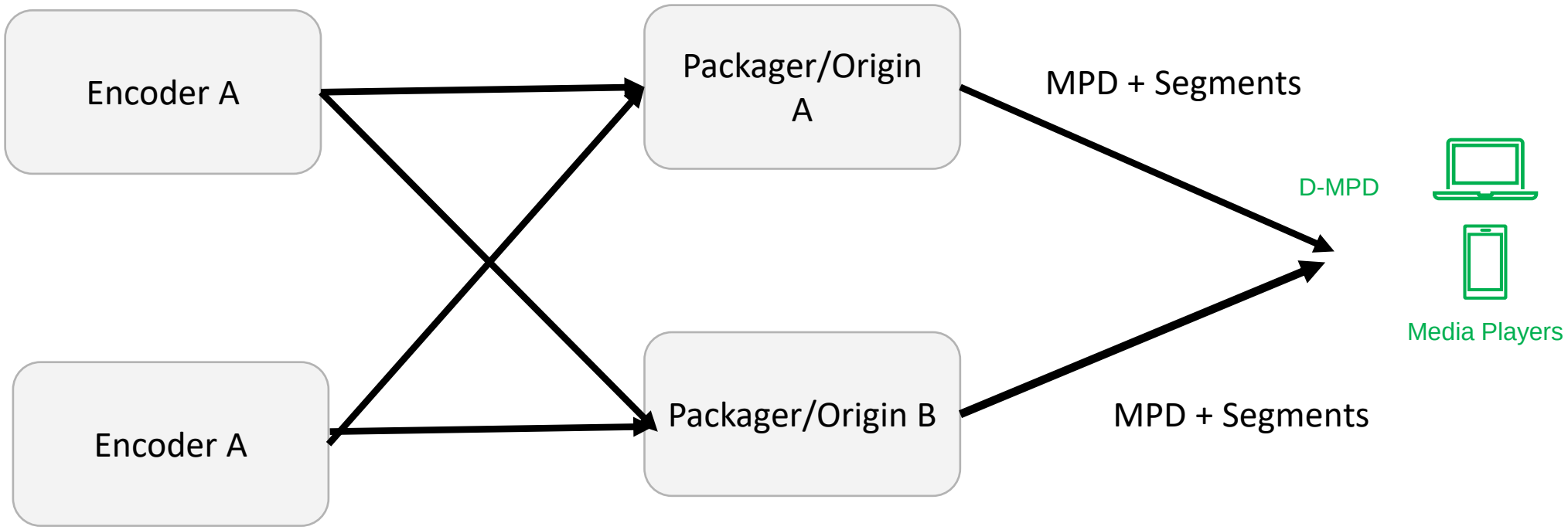
- The segment number is calculated using: $Next\_K = ceil(\frac{now}{D})$
  - *now* is the current wall clock time. *Next_K* is the value of K to compute the next segment boundary.



Timing and segment boundary alignment in the CMAF track, media times are relative to Unix Epoch

REaP D-MPD

Unified Streaming Platform



D-MPD: Enable interchangeable segments and MPD for players and CDN’s

D-MPD and Media playlist Constraints

Unified Streaming Platform

D-MPD

- MPEG-DASH compliant
- Aligned output representations
- Use media time in @publishTime and last modified headers to avoid race conditions
- Epoch relative timings

HLS playlist

- Wrap timestamps using
- Aligned output representations
- #EXT-X-PROGRAM-DATE-TIME to link media time and wall clock time
- Timestamp wrap use to assign
- #X-TIMESTAMP-MAP=MPEGTS:<MPEG-2 time>, LOCAL=YYYY-MM-DDTHH:MM:SS.mmmZ Epoch relative timings

REaP S-MPD and Storage Track File

Unified Streaming Platform

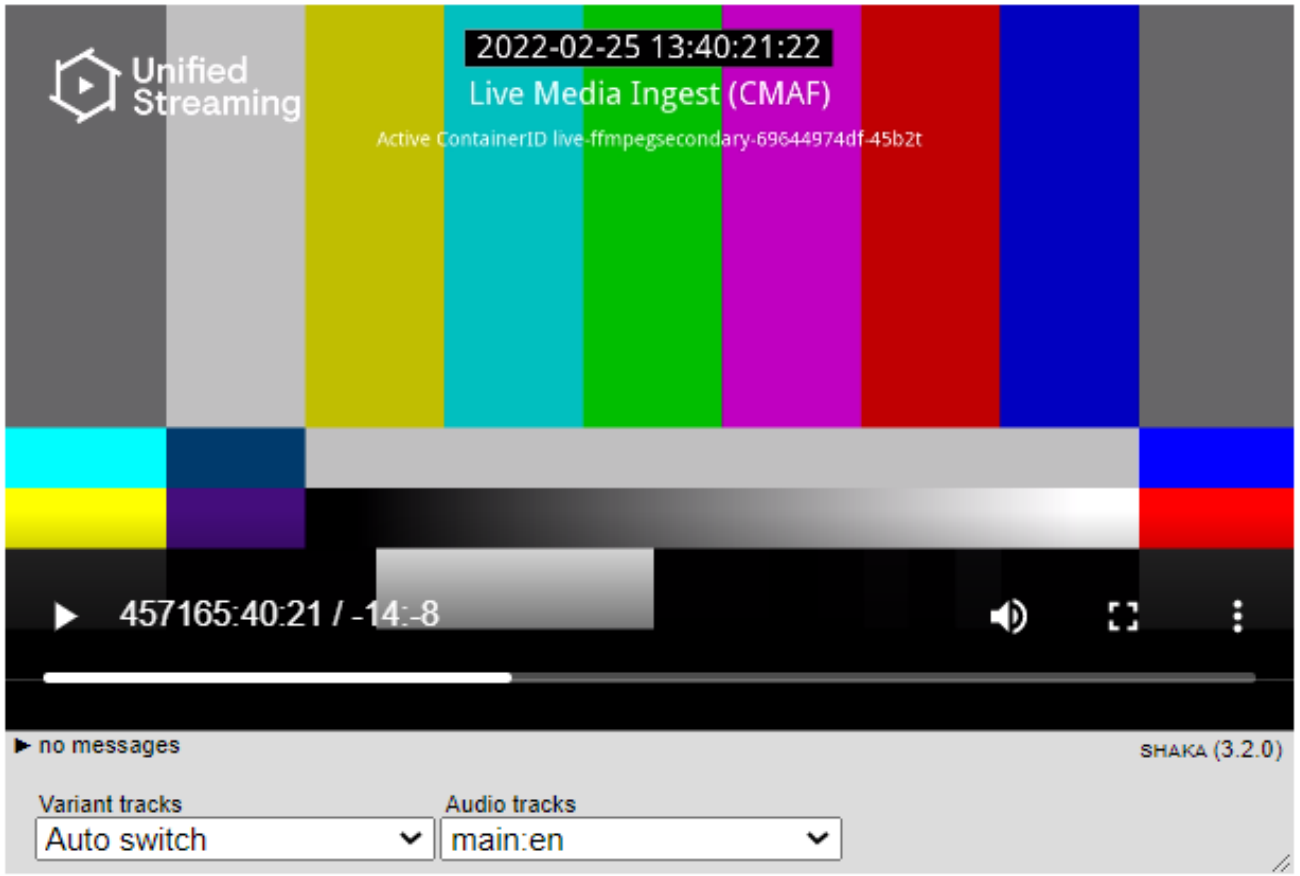
Profiled MPD
for storage

	@profiles	constraints
24x7 live	urn:mpeg:dash:profile:isoff-live:2011	As in clause 8.2
simple live	urn:mpeg:dash:profile:isoff-live:2011	may include SegmentTimeline, may use CMAF profile for DASH
VoD	urn:mpeg:dash:profile:isoff-on-demand:2011	may use CMAF profile for DASH

CMAF track with
interleaved sidx for storing
live archives
Identifiers for storing track
groupings in files stored in
separate files

DASH construct	CMAF construct
MPD ID	CMAF Presentation ID
Period ID	CMAF Presentation ID
AdaptationSet Group ID	Aligned Switching Set ID
AdaptationSet ID	SwitchingSet ID
Representation ID	CMAF track id (not to confuse with track_id)

REaP Demo by USP



REaP: Get Involved

a) New workshop planned for July 2023

b) Specification Review

c) Prototyping, interoperability partner

d) Join the workshop or mailing list

e) Expected completion in 2024

d) Join encoder synch MPEG mailinglist:
https://lists.aau.at/mailman/roster/synched-encoding

Summary

- Use cases and Requirements for new standard/best practice developed via a workshop and in MPEG standards organization and in collaboration with DASH-IF
- Document in CD stage FDIS (standard) expected in 2024
- Storage and Ingest MPD defined with particular structure based on MPEG-DASH
- Additional identifiers in CMAF tracks to enable self contained storage.
- Track archive storage using long duration archive track segments effective for cloud based storag/recording or archiving
- Working draft spec, thus improvements and feedback is still welcome to improve the work.
- Mixing live and file input is considered and discussed
- Open issues include period and discontinuity alignment

Acknowledgements

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- Contributors to the joint DASH-IF proposal, including Khaled Jerbi, Alex Giladi, Mohamed Raad, Guillaume Bichot, Yasser Syed, Thomas Stockhammer, Iraj Sodagar, Phil Maness, Andy Rosen, Cyril Concolato, Xin Wang, Lulin Chen, Laurent Piron
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- Thanks to you all for attending this talk and listening.