
AWS
re:Invent
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MNE304

Formula 1 case study: F1TV with AWS media and edge services

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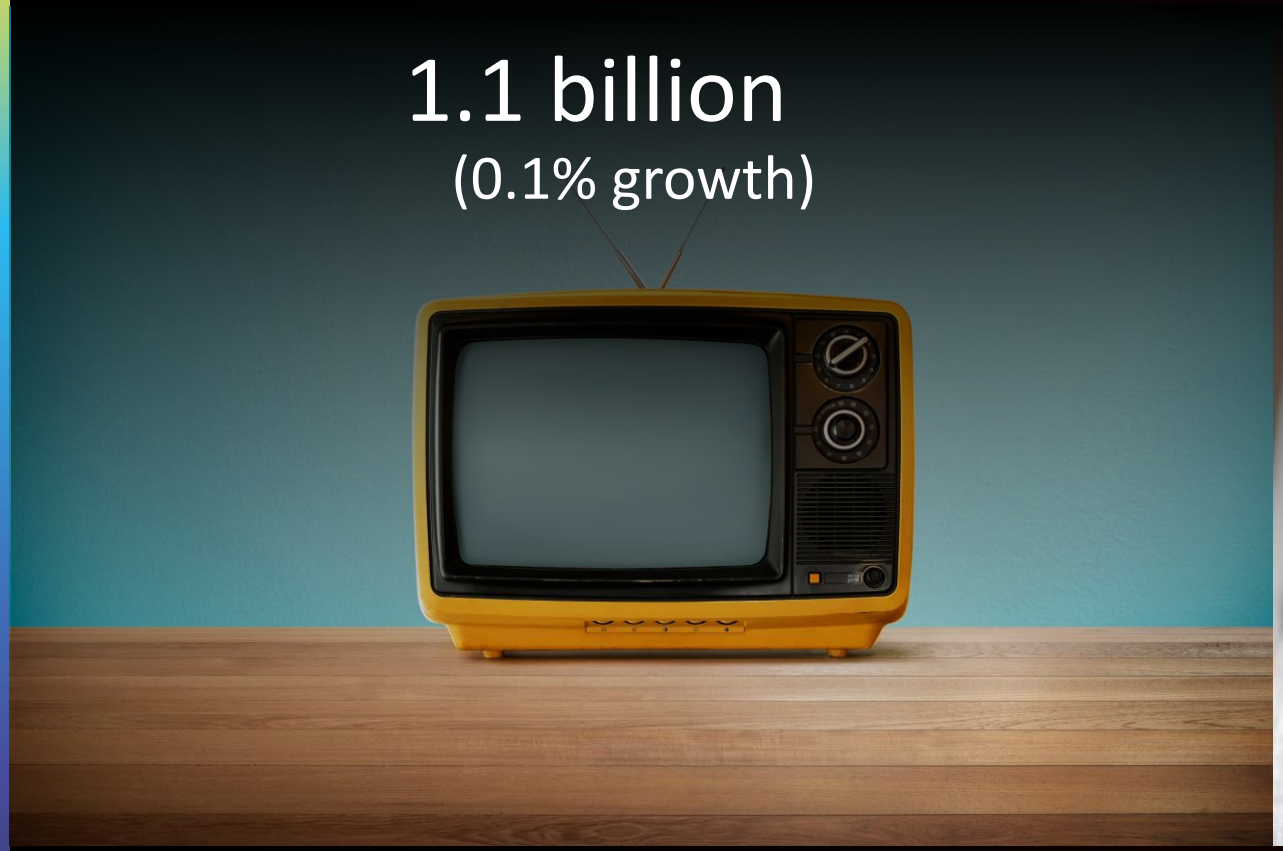
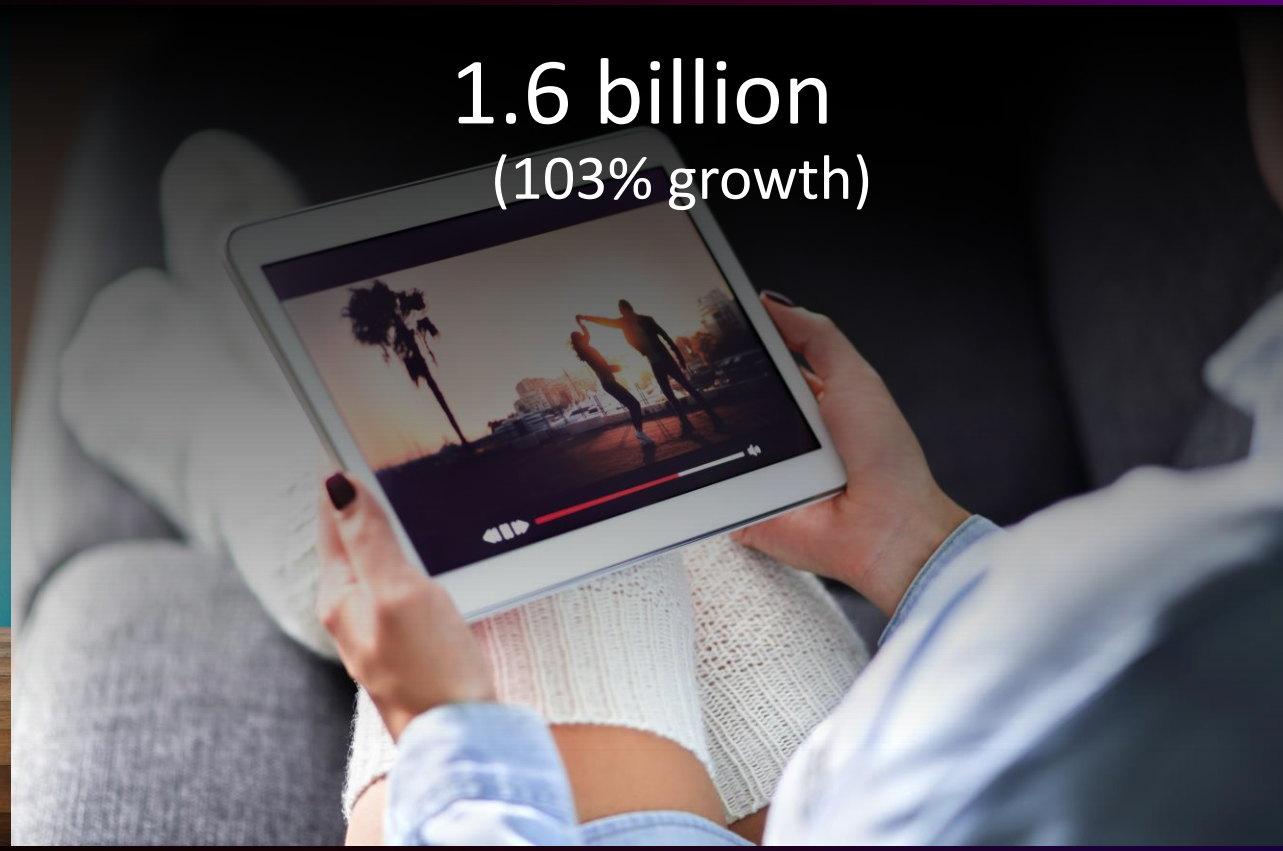
Agenda

- Online video streaming today
- F1TV journey with AWS
- Media processing AWS Elemental services
- Delivering global scale video streaming events with Amazon CloudFront
- Secure media delivery at the edge

Video services landscape

Video subscriptions growth predictions by 2025*





Omdia TV & Online Video Intelligence Service

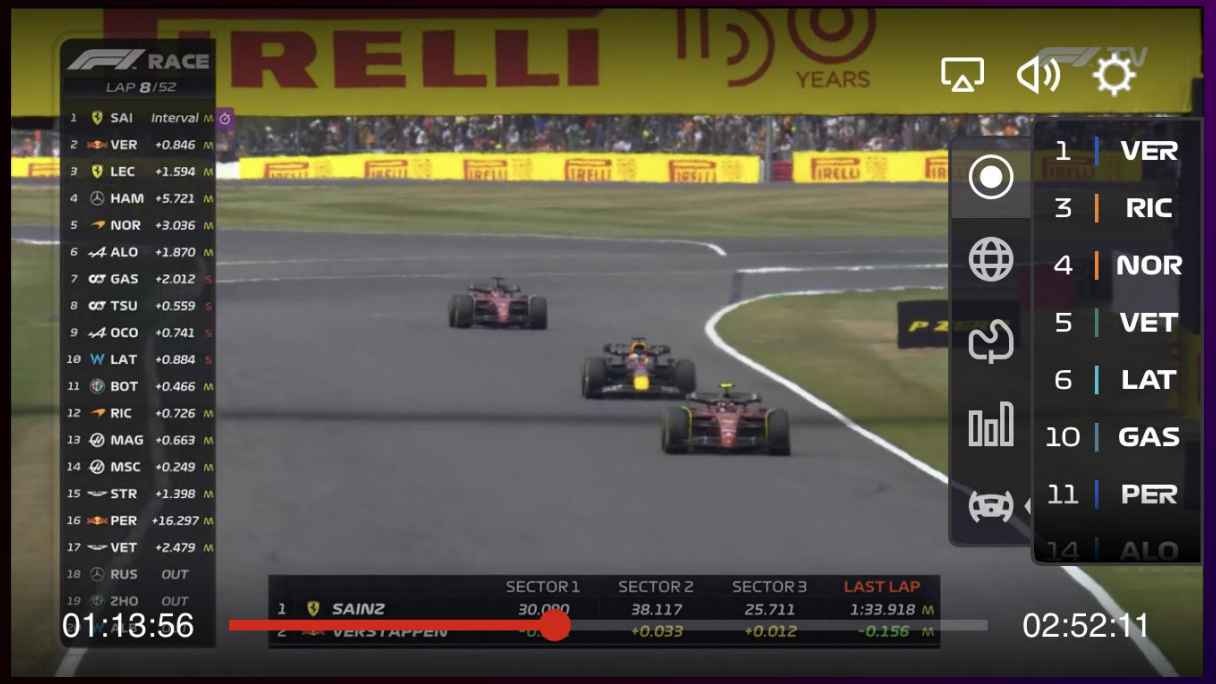
Viewing experiences are changing

Traditional content

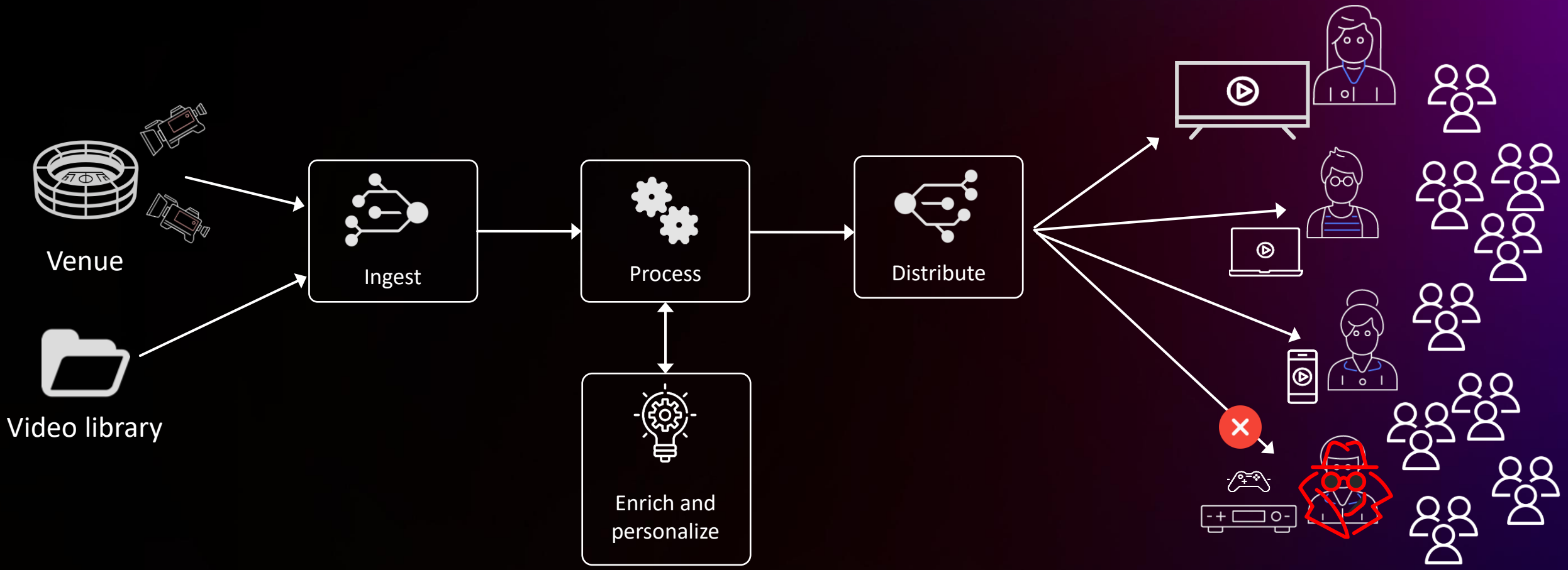
Passive experience

Interactive watching experience

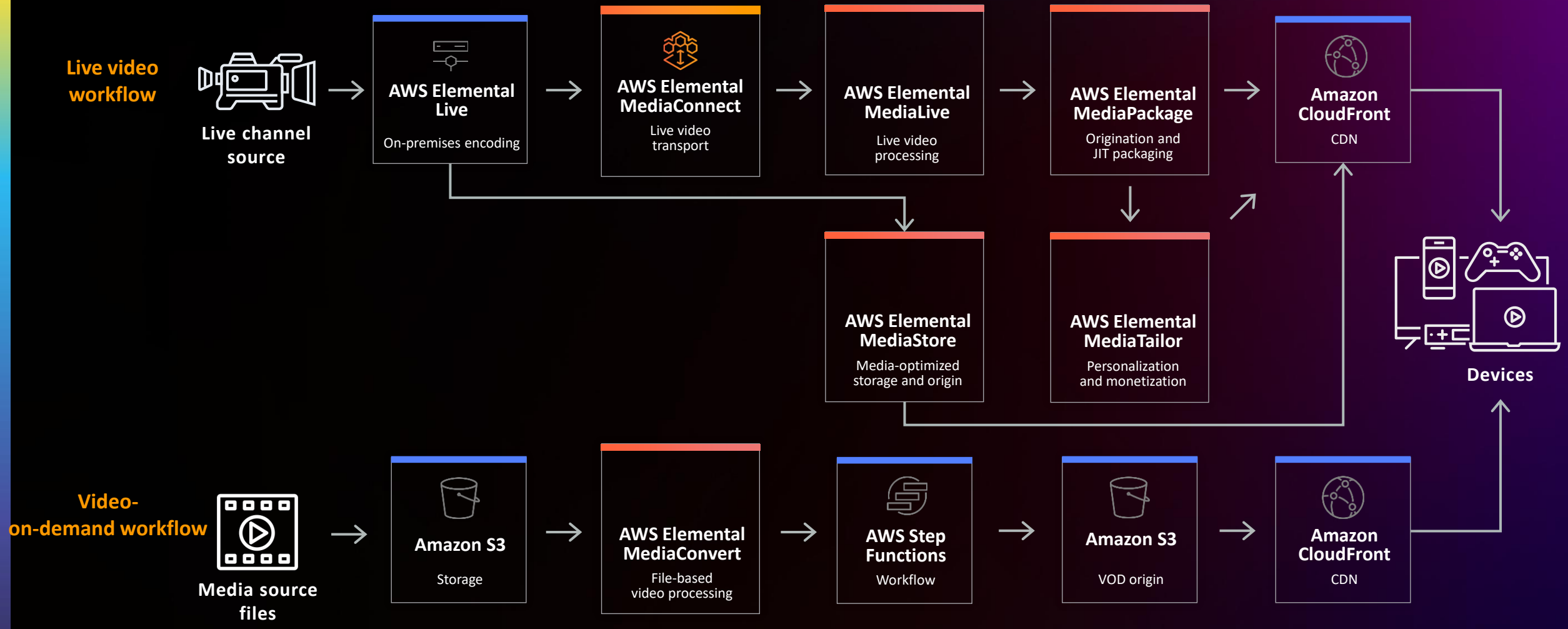
Engaging and personalized video streaming services



What makes online video streaming work?



Overview of AWS Media Services



F1’s digital products

Formula 1

- Web, iOS, Android

F1TV

- Web, iOS, tvOS, Android, Google TV, Fire Tablet, Fire TV
- 115 F1TV Access Territories
- 85 F1TV Pro Territories
- 6 Languages

F1 Live Timing

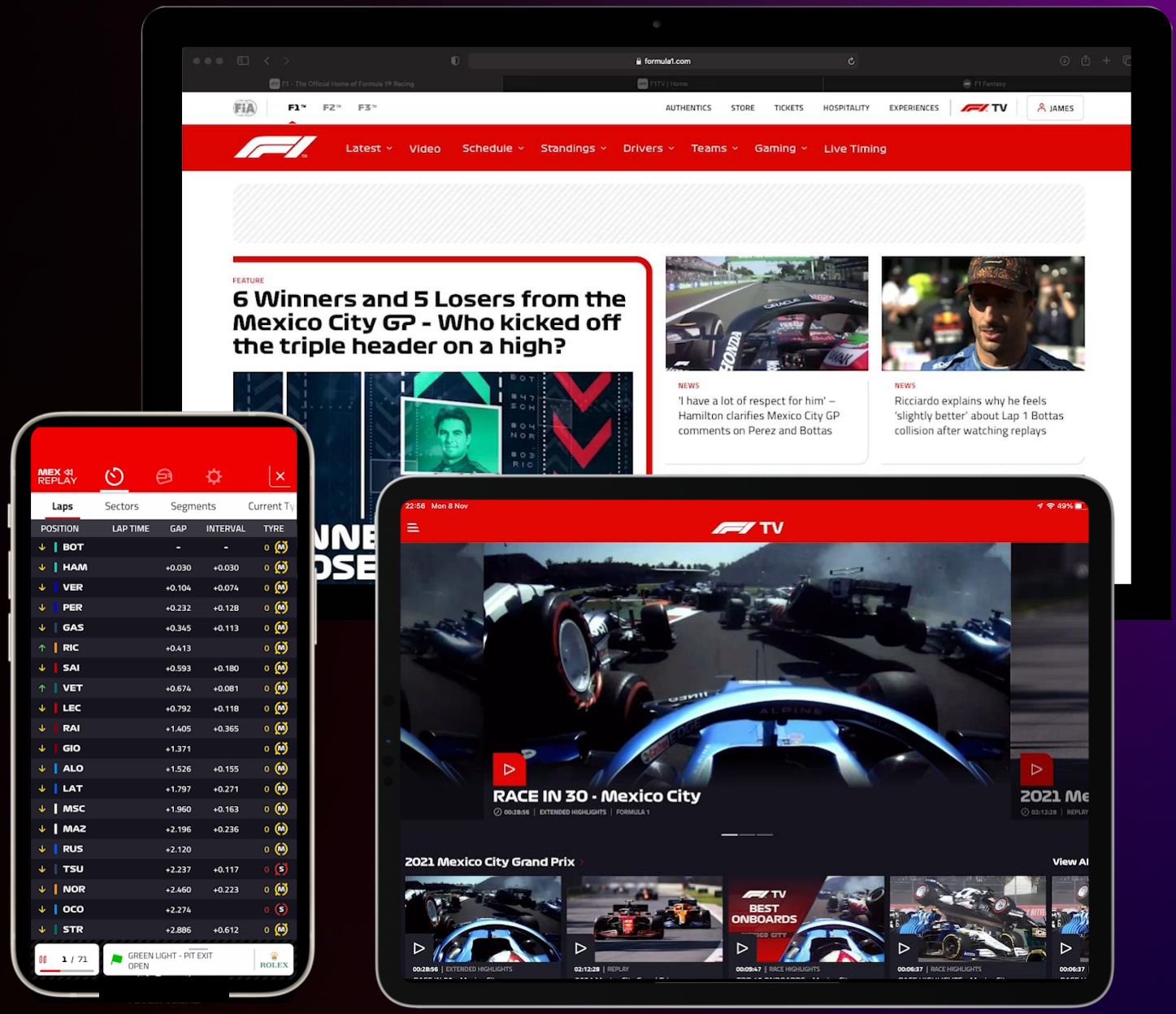
- Web, iOS, Android

F1 Fantasy

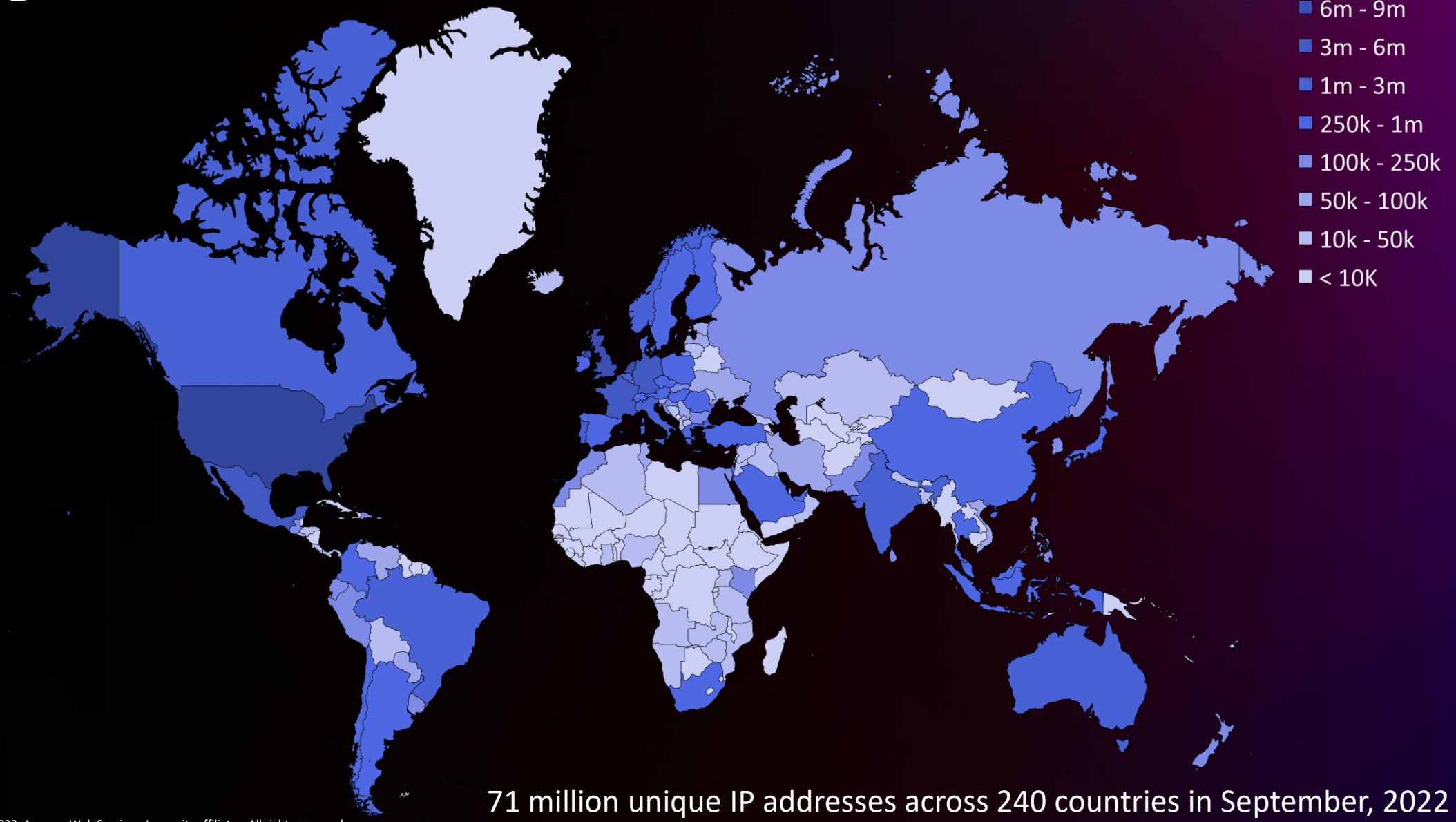
- Web

F1 Race Guide

- iOS, Android



F1’s global audience



71 million unique IP addresses across 240 countries in September, 2022

RACE IN 30 - Japan

00:29:53 | EXTENDED HIGHLIGHTS | F1

PLAY

JOLYON P
ANALYSIS

00:40:37 | ANALYSIS

PLAY

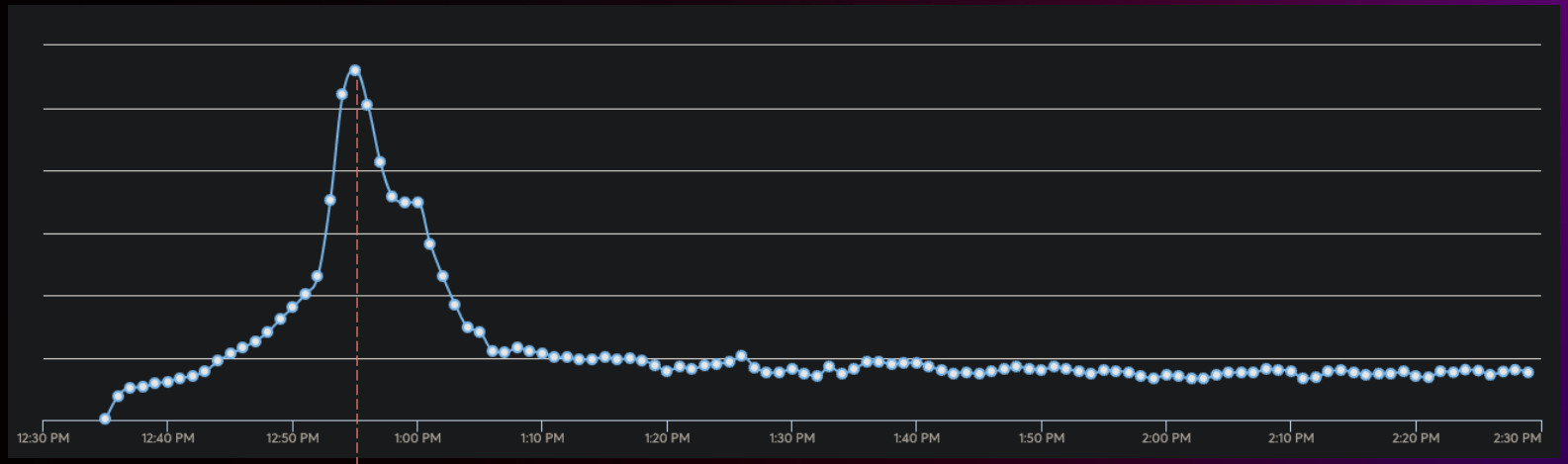
JOLYON PALMER'S ANALYSIS - Japan

TOP 10 ONBOARDS - Japan

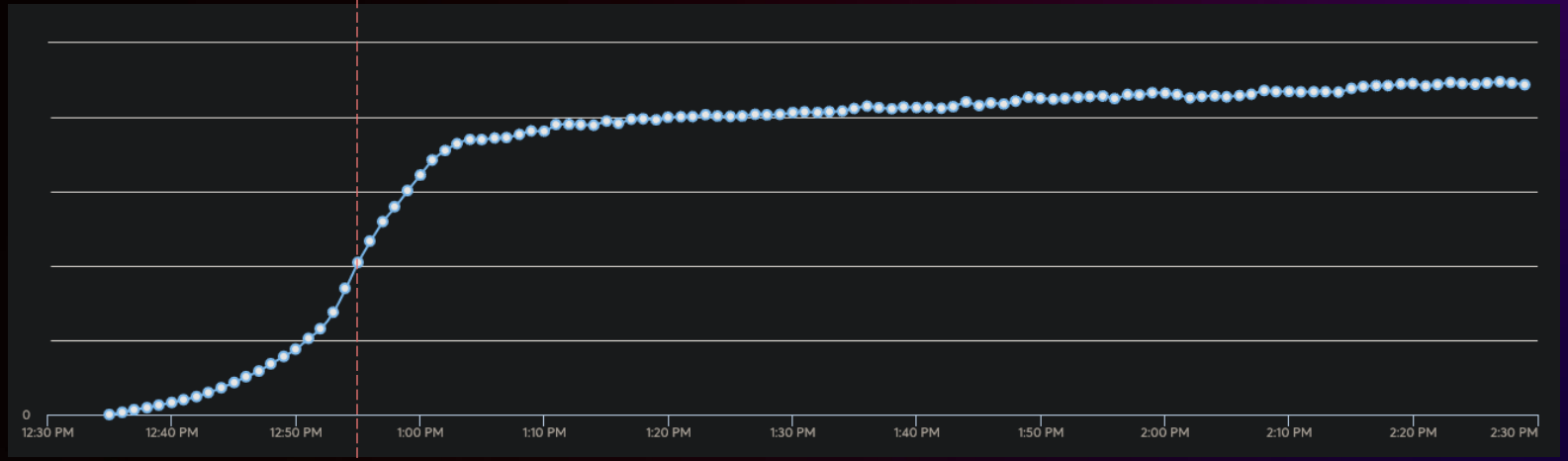
When lights go out

- In the 10 mins prior
  - Play requests served > peak concurrent users
  - 40% of all requests during the race are handled
- In the 2 mins prior to opening sequence
  - 30% of peak viewers join
- At lights out
  - Concurrent users reaches 76% of peak

Video Play Requests



Concurrent Viewers



Opening Sequence

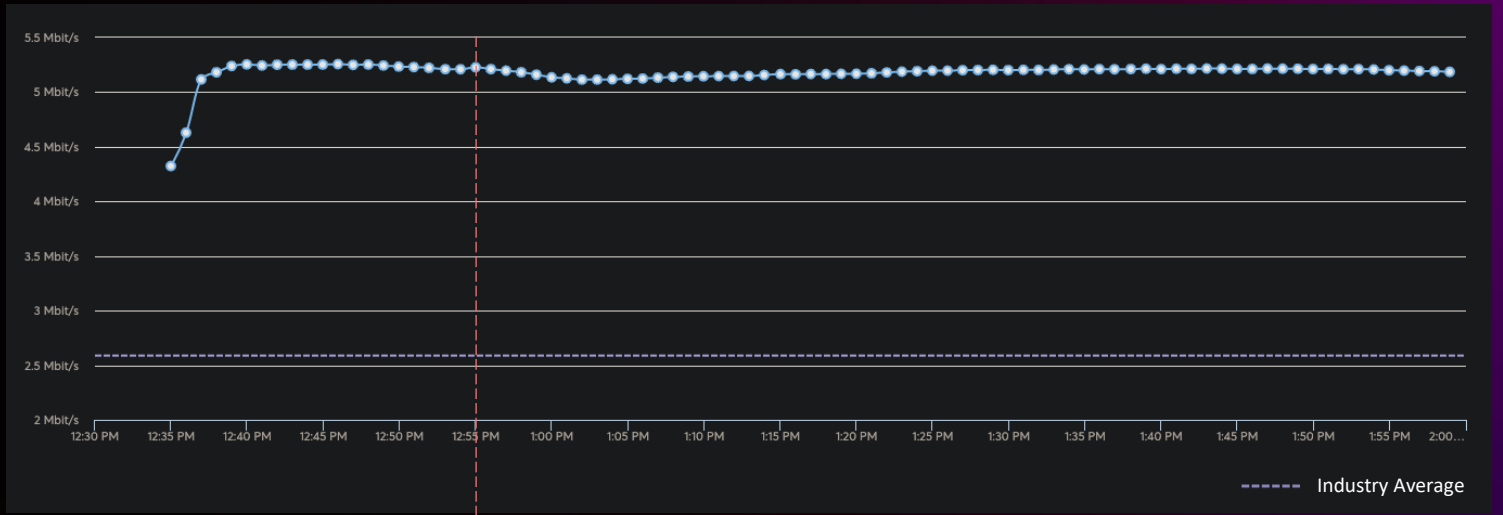
Hungarian Grand Prix 2022

Global Video QoS Metrics

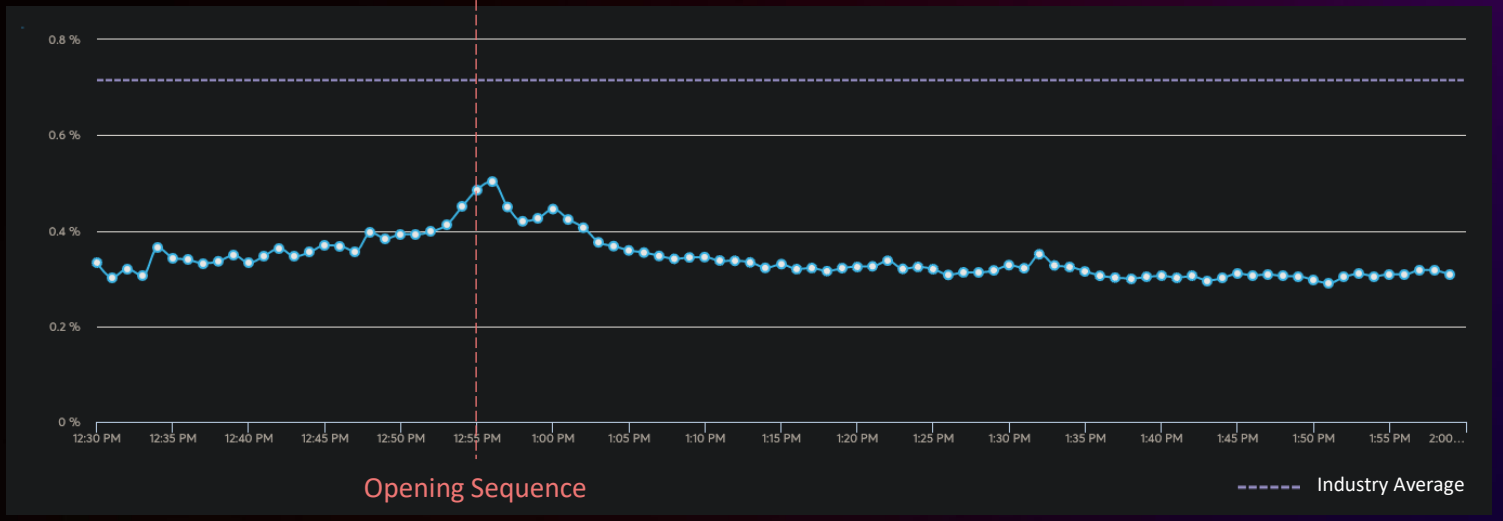
Consistently ahead of industry averages for QoS metrics

Country	Rebuffering %
Belgium	0.28
Brazil	0.38
Canada	0.27
Finland	0.25
France	0.43
Germany	0.32
Mexico	0.42
Netherlands	0.23
Sweden	0.18
United States	0.26

Video Bitrate

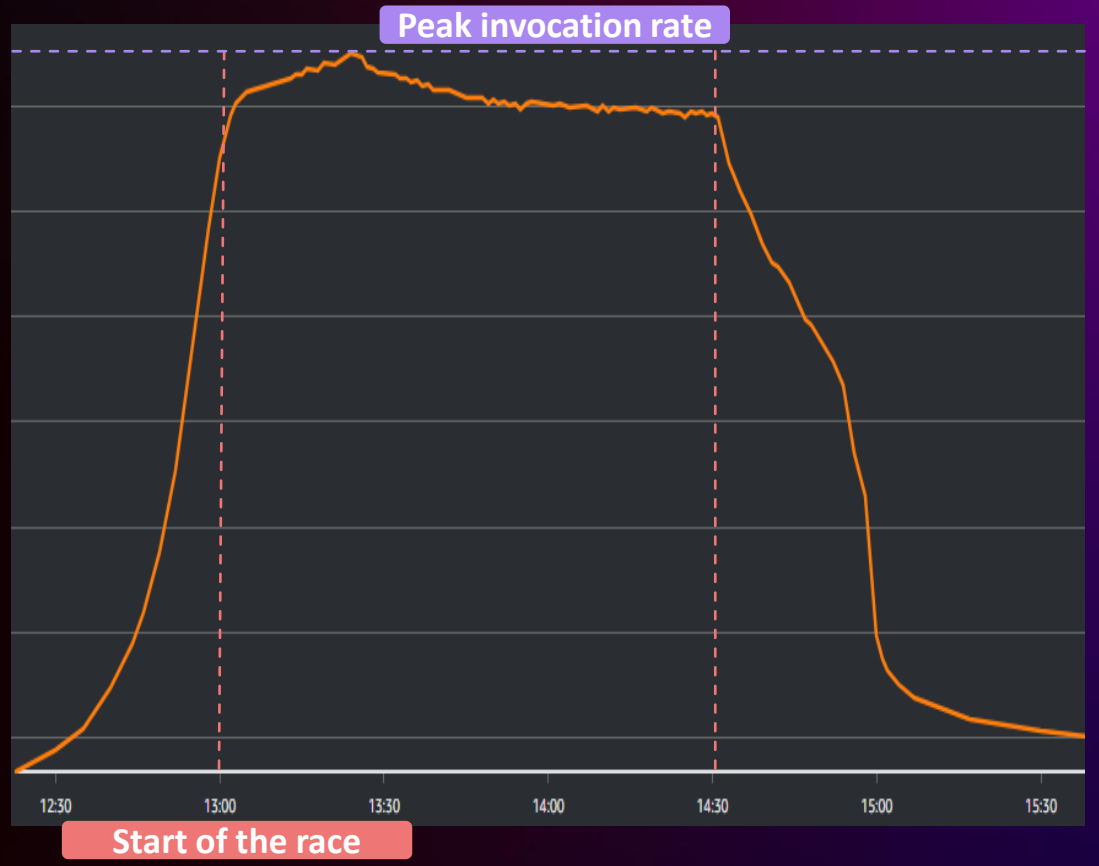


Rebuffering %

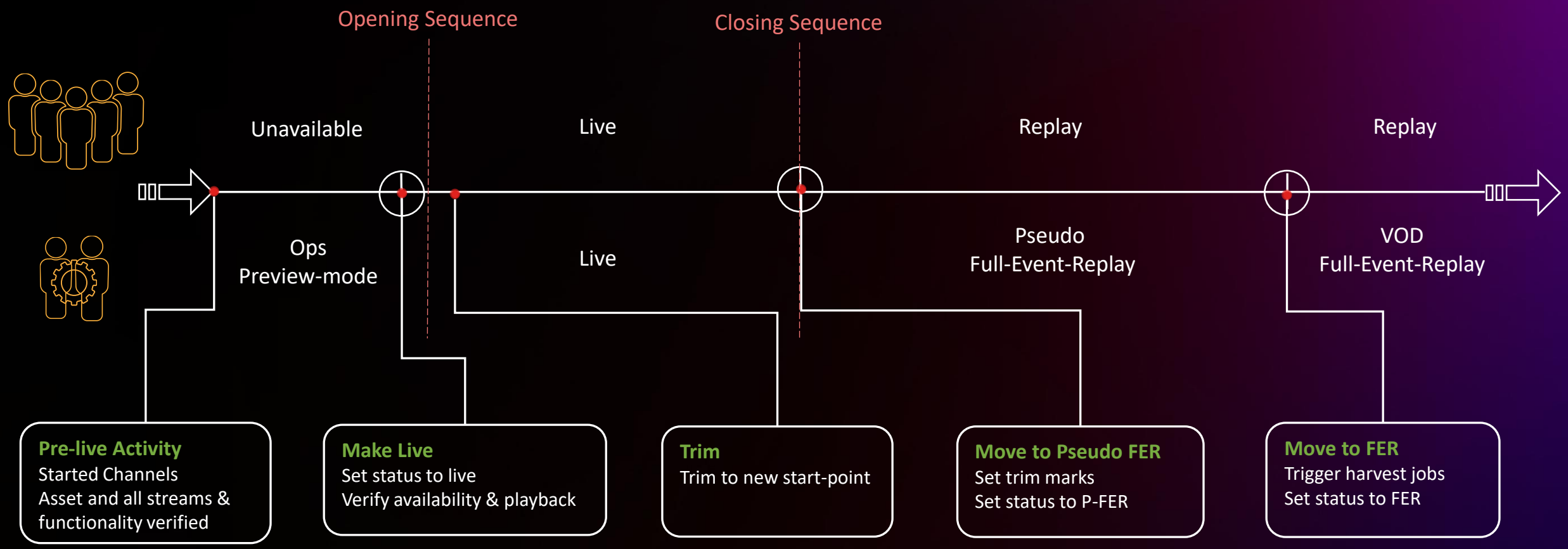


Content protection

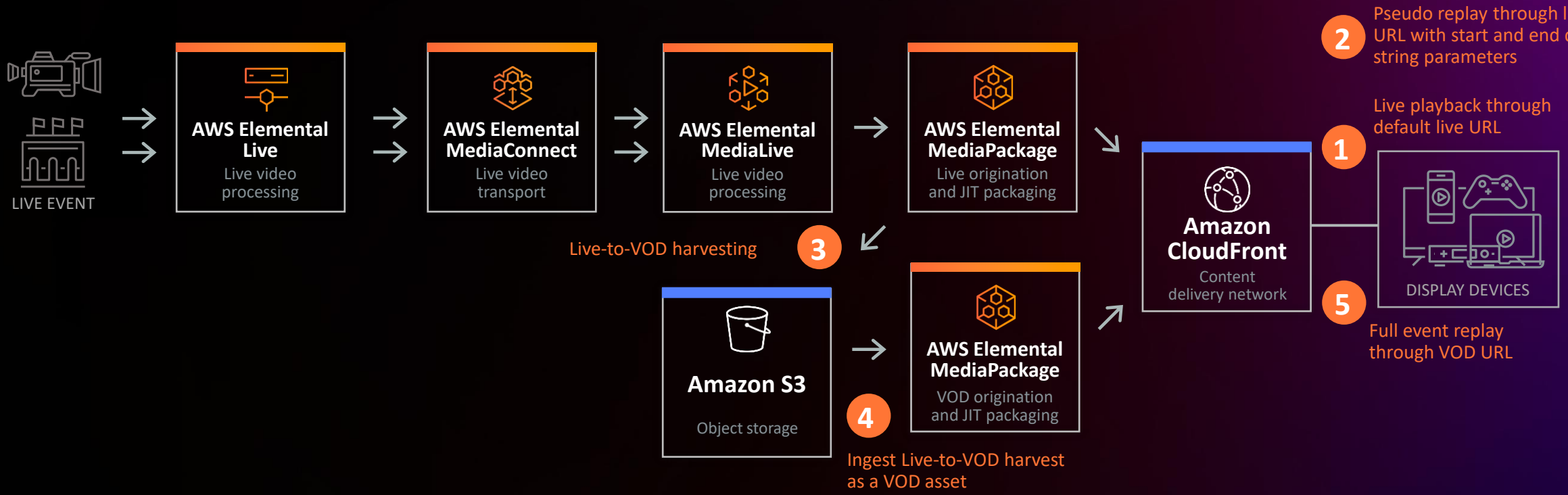
- Stream tokenization and DRM are both employed by F1TV; both processes require per-user executions
- Solution had to be performant and scalable, accounting for massive spike in traffic at the start of session
- F1 worked with the AWS product team on a pre-GA service, now called CloudFront Functions, that allows token validation to happen truly at the edge, with each taking substantially less than 1ms
- We have seen function invocations regularly exceed many tens of millions per minute



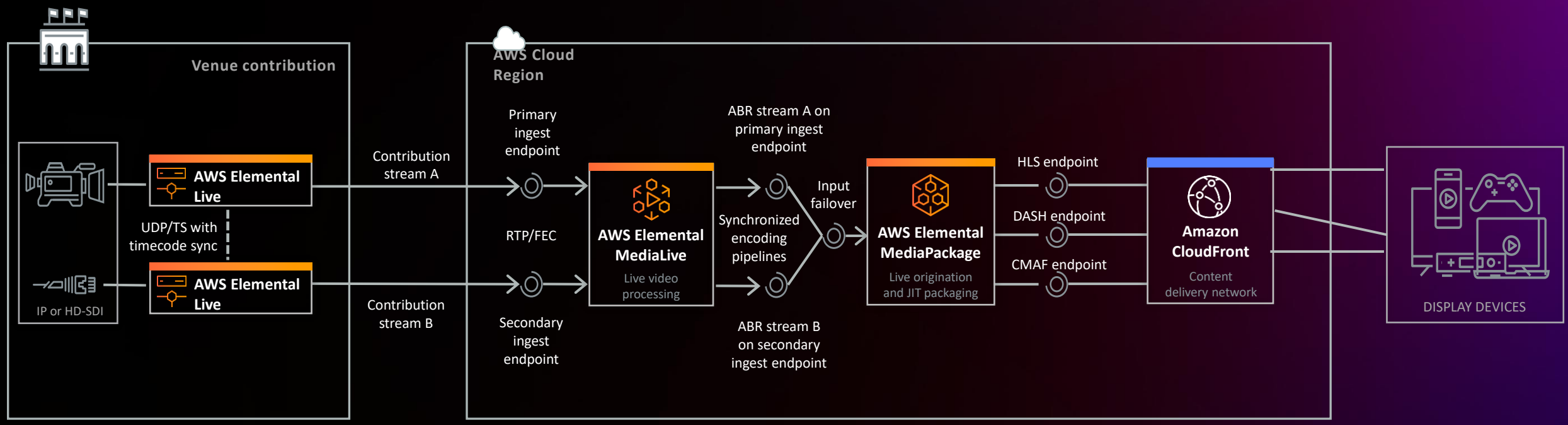
Live Content Lifecycle



Content lifecycle management

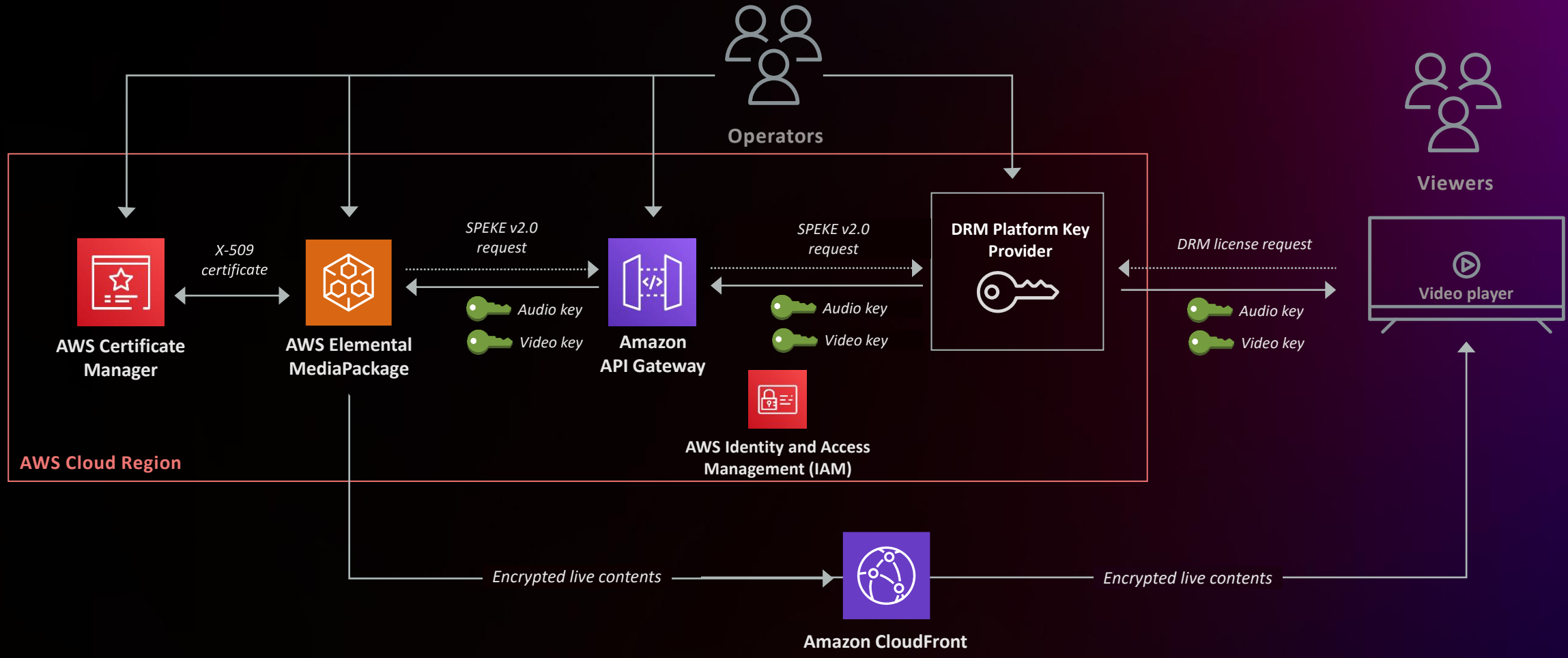


Resilient live workflows

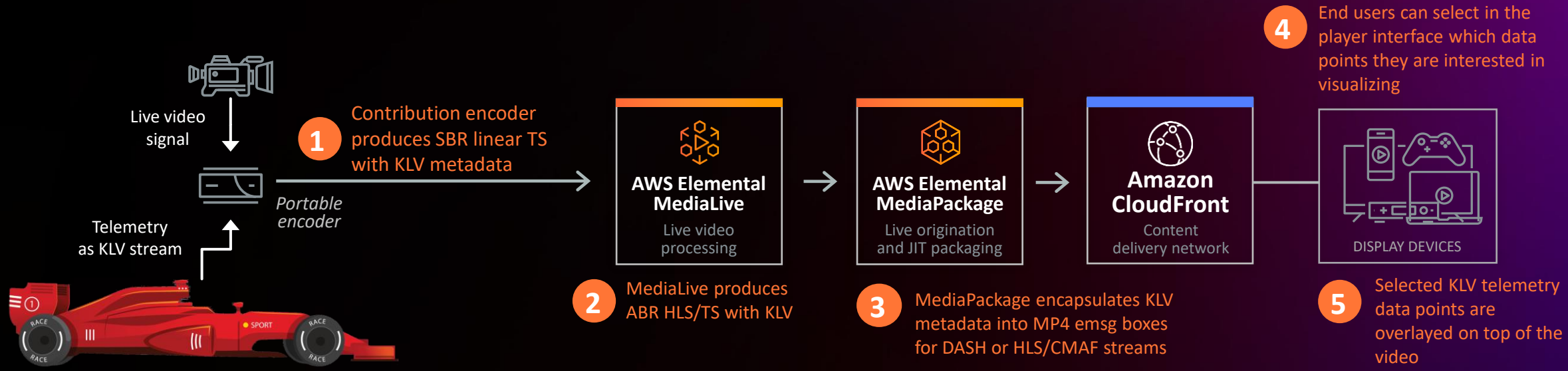


- Redundant ground contribution
- Timecode-synchronized RTP/FEC mezzanine streams
- Two distinct but locked cloud transcoding pipelines
- Aligned HLS ABR renditions, based on input timecode
- Packaging with input failover, transparent to the player
- Single playback URL

Content protection with SPEKE



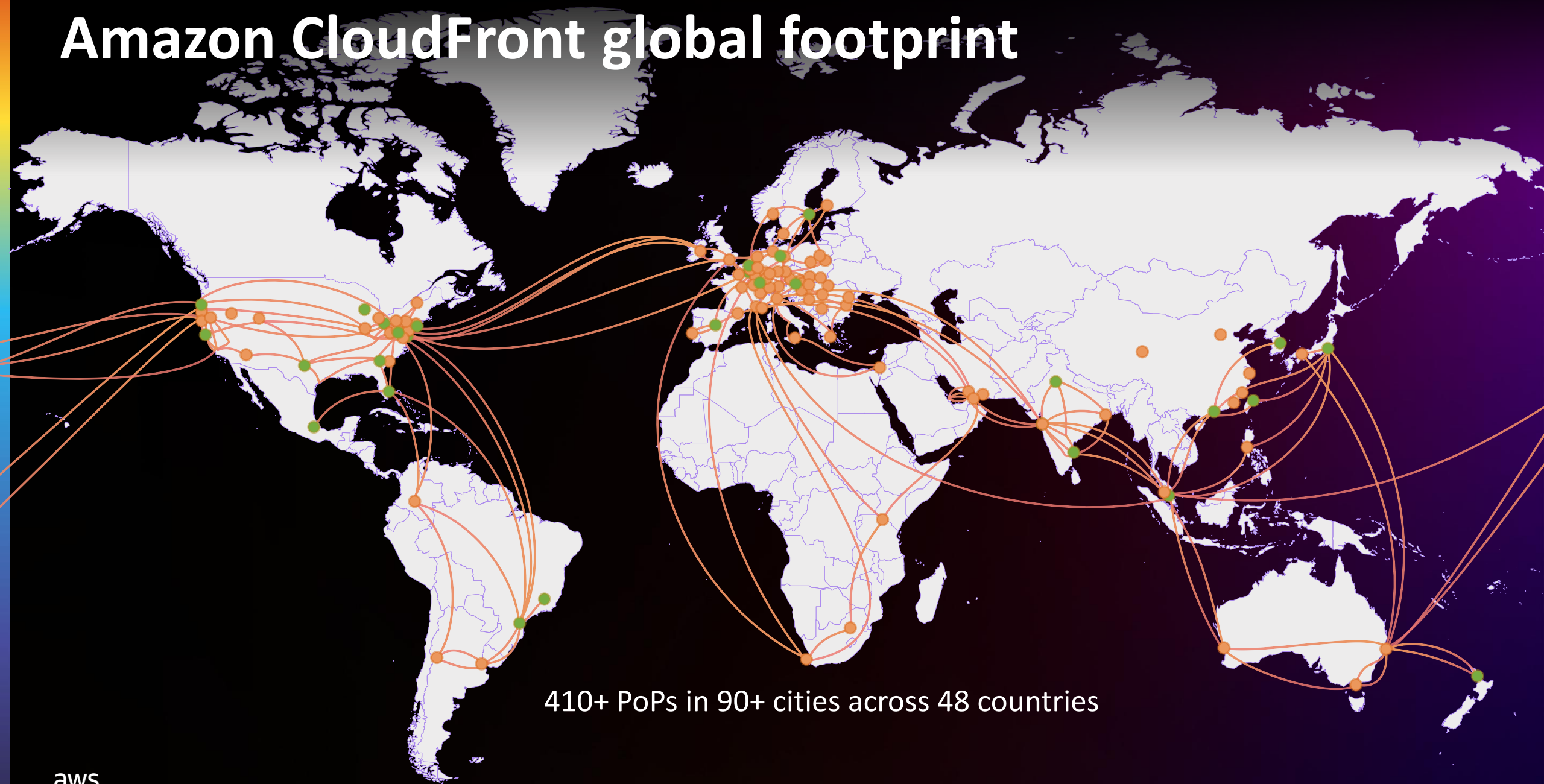
Advanced metadata with KLV



Telemetry data points:
Gear
Speed
Steering
Engine temperature
Fuel tank level
Fuel remaining laps
Tire pressure

- KLV = Key-Length-Value, a flexible binary metadata storage format optimized for intensive data transport
- KLV metadata messages are synchronized to video frames
- Specific KLV dictionaries per sport can (and should) be created to standardize metadata streams and facilitate player implementations

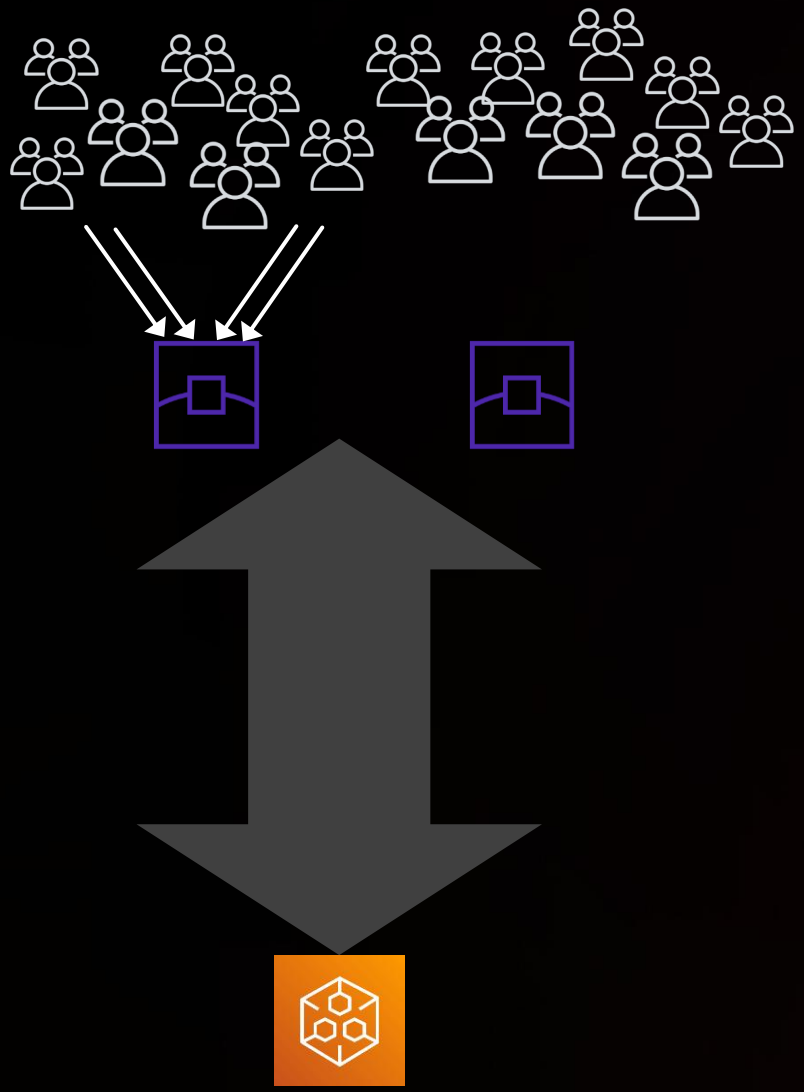
Amazon CloudFront global footprint



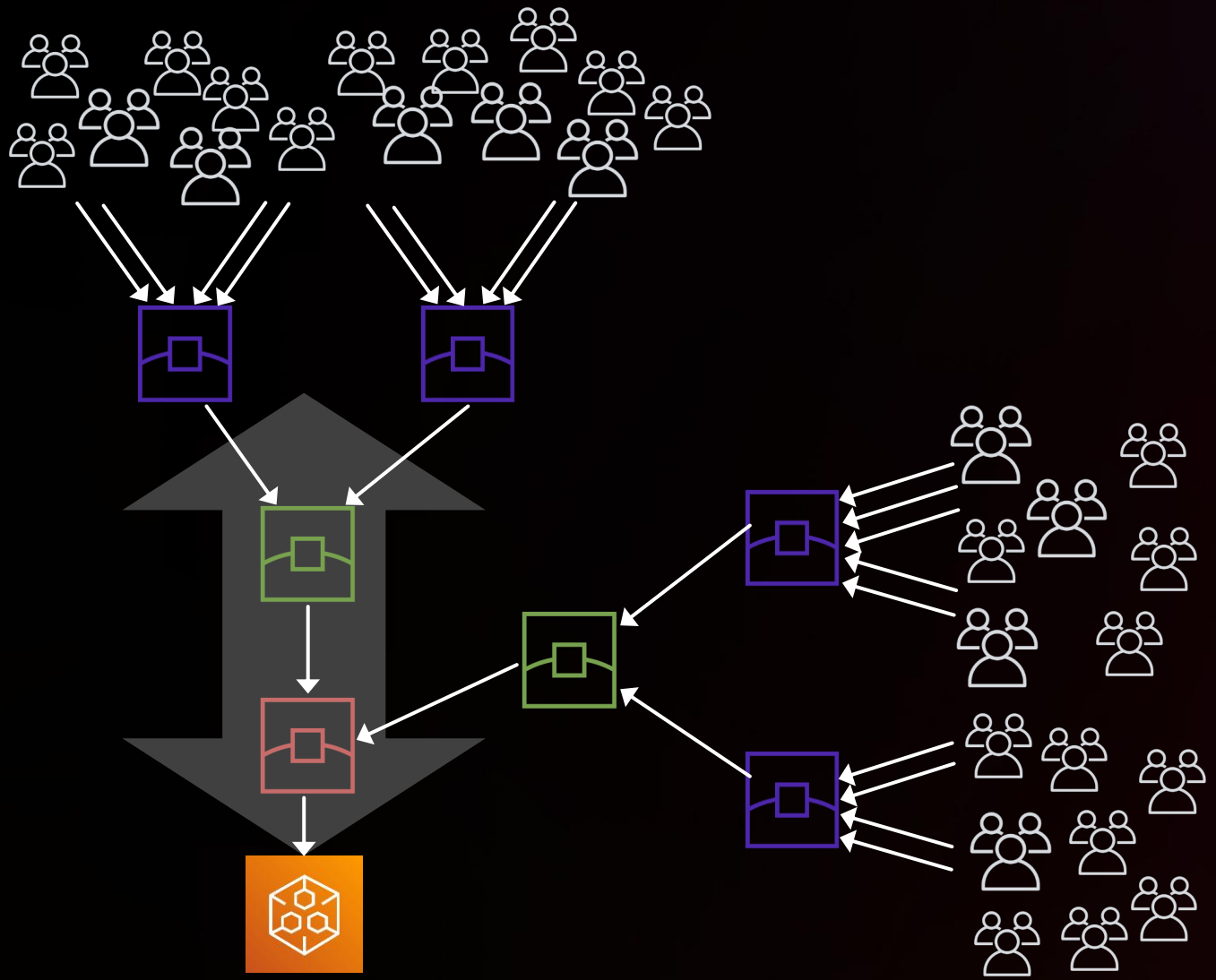
410+ PoPs in 90+ cities across 48 countries

Serving largest scale events with CloudFront

Serving largest scale events with CloudFront

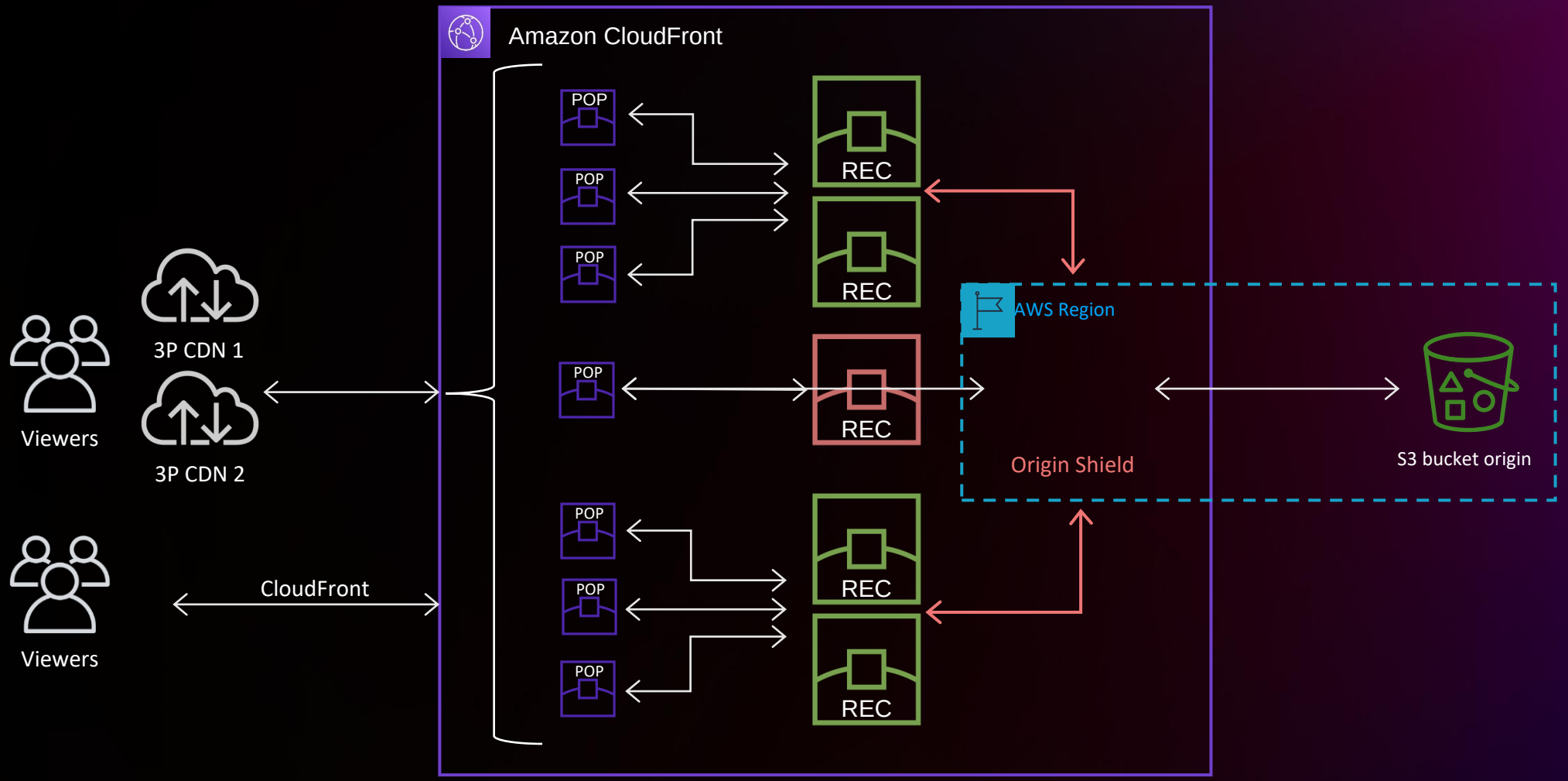


Serving largest scale events



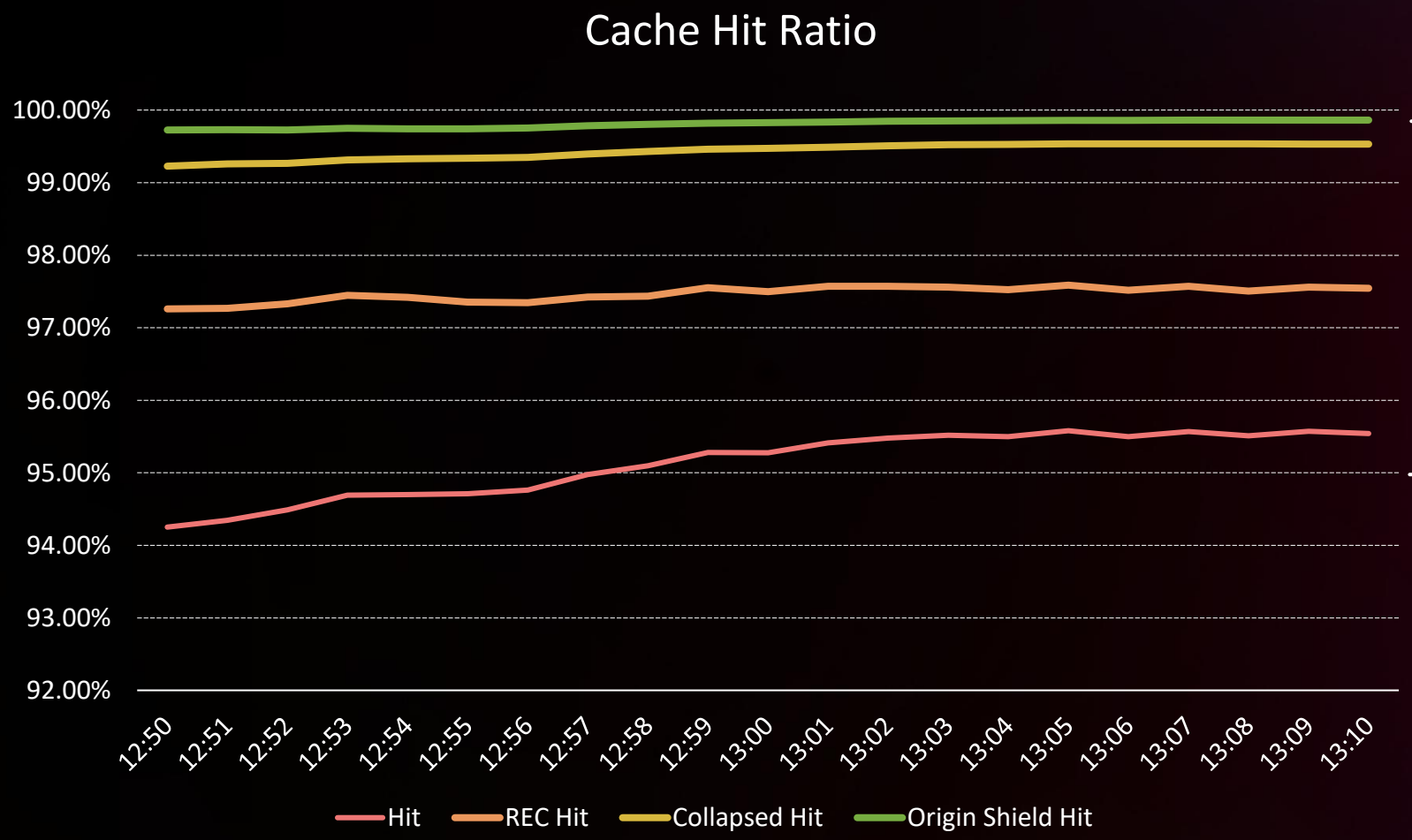
- Dispersing the load through the traffic routing
- Promoting popular objects to L1 cache
- Collapsing requests for simultaneous requests
- Mid-tier regional edge caches
- Origin Shield to maximize origin offload

CloudFront architecture with Origin Shield



PoP = Point of presence
REC = Regional edge cache

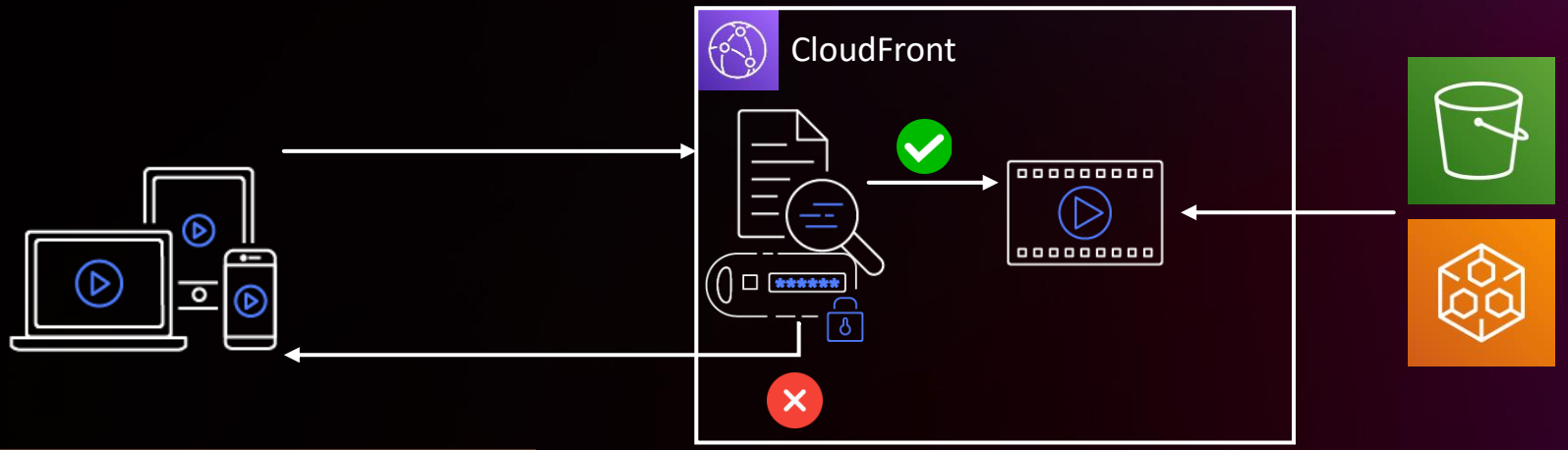
F1TV impact on the origin offload



99.73% – 99.86%

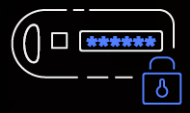
94.25% – 95.57%

Token based access control (*tokenization*)



```
GET /video1/index.m3u8

User-Agent: Chrome.101
Referer: http://video.com
X-sessionId: abcd12
srcIP: 1.5.7.2
```



```
Claims:
User-Agent: Chrome.101
X-sessionId: abcd12
Path: /video1/*
Exp: 1653240758
Signature: iwqjndasnuadsq=
```

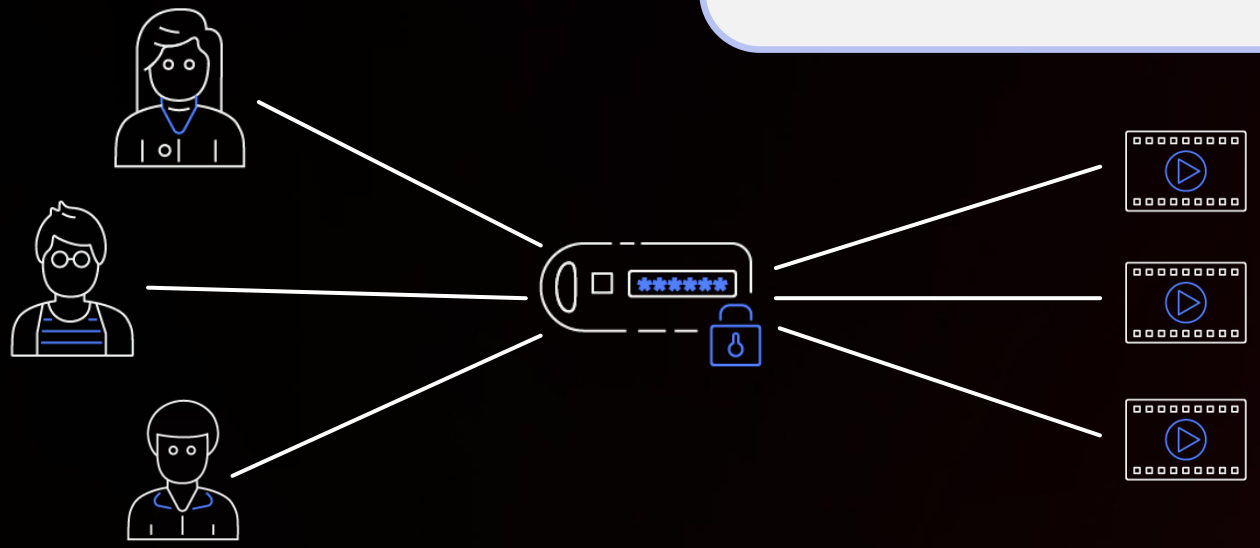
```
Validate signature
Expired?
Claim path covers request URI?
Headers match?
QueryString match?
Source IP match?
Country of origin match?
```

Restricting access considerations

Scoping down access to video assets

- Path pattern unique to video asset
- Challenge with path variance

/v1/master/**b3dae6b[...]cfa640/StreamingTest-HLS**/index.m3u8
/v1/manifest/**b3dae6[...]cfa640/StreamingTest-HLS**/bf18ea59-[...]-b695f1d1270a/2.m3u8
/v1/segment/**b3dae6[...]cfa640/StreamingTest-HLS**/bf18ea59-[...]b695f1d1270a/4/1136351
/out/v1/**df069e9593304746afc28eb0117f2dbd**/index_2_1136317.ts?m=1646863308
/tm/b3dae6b[...]cfa640/bebgiqk6y5etzpgwfswp6jqccyu7c7ve/asset_720_4_4_00007.ts

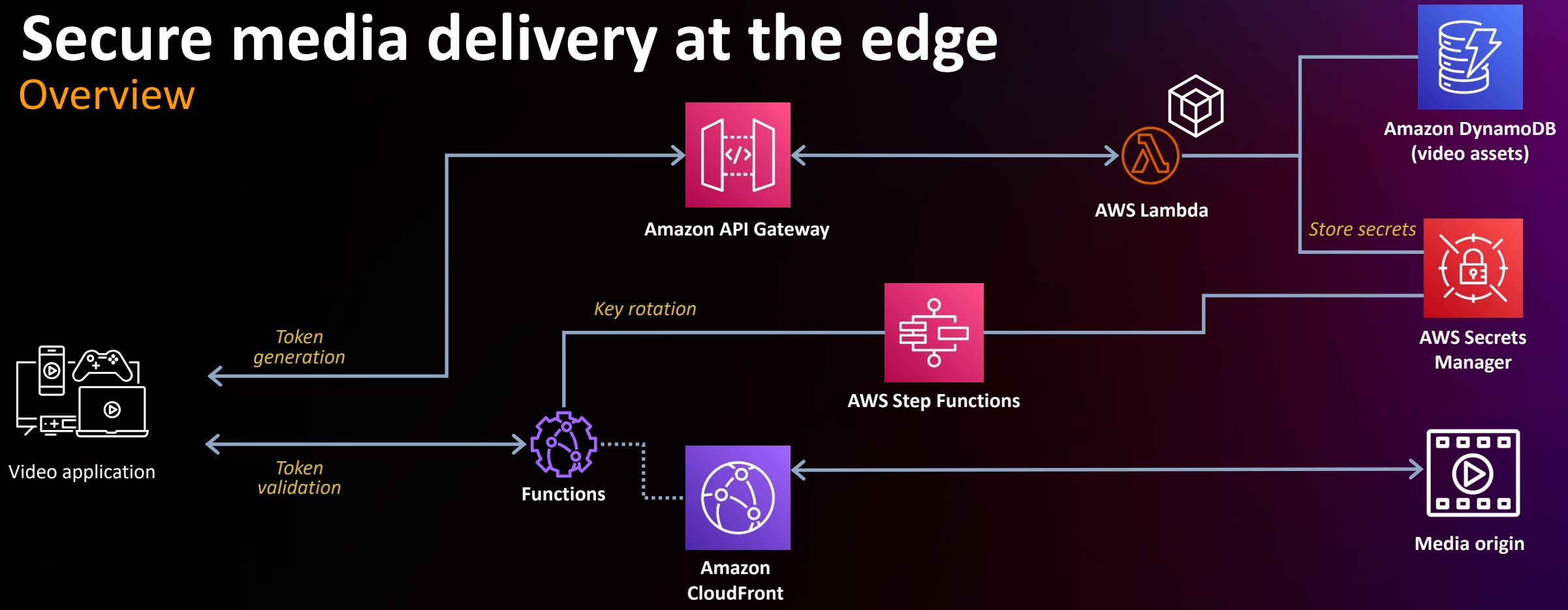


Viewer attributes to limit token usage

- Viewer IP address
- User-Agent
- Referrer
- Session identifier
- Country or region of origin

Secure media delivery at the edge

Overview



Secure Media Delivery at the Edge on AWS

Easy-to-Integrate

An open, extensible path-based token implementation, which comes with zero client-side integration dependencies.

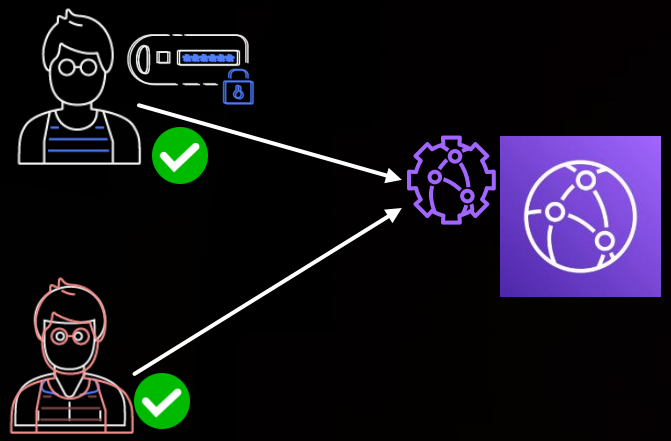
Performance & Scale

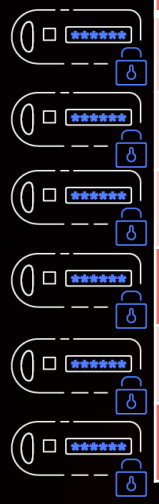
Leveraging CloudFront Functions, token validation can seamlessly scale up to support millions of concurrent requests, with sub-millisecond code execution times.

Powerful Automation

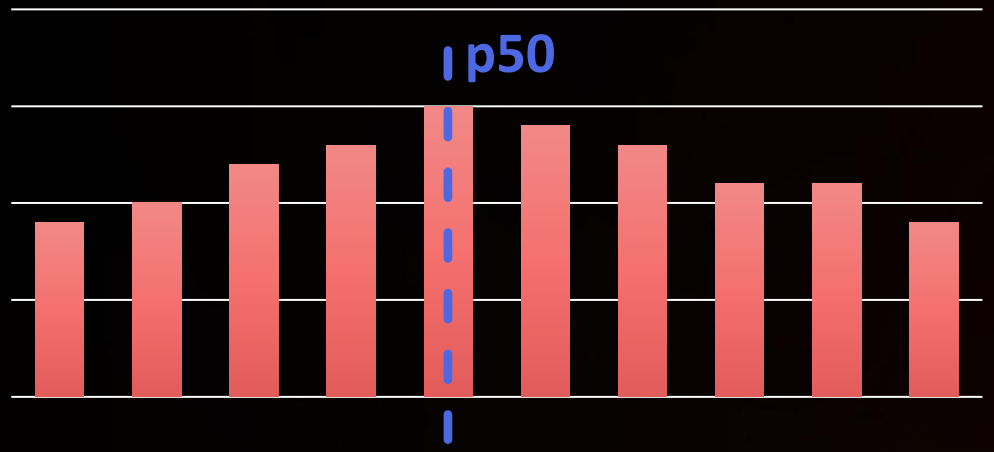
Key rotation and unauthorized session revocation can both be automated, offloading operational dependency from your team.

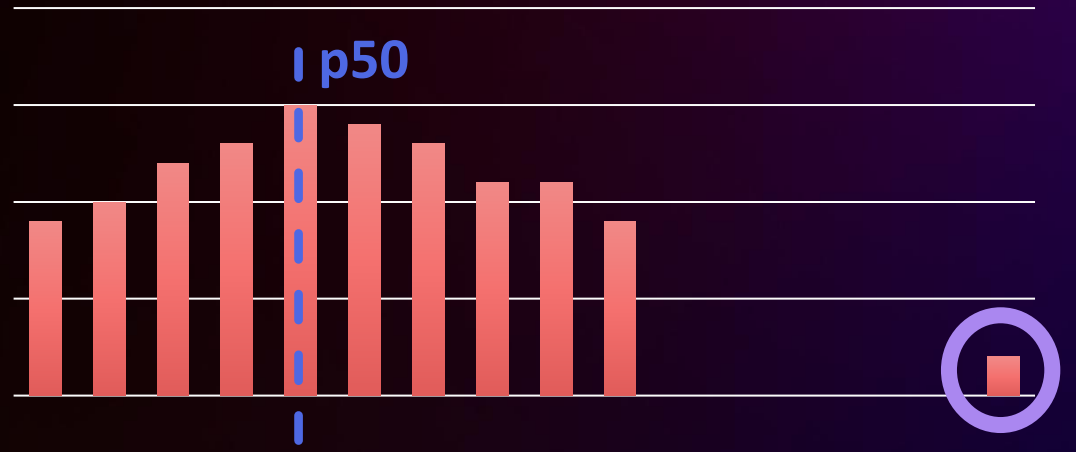
Automatic Session Revocation





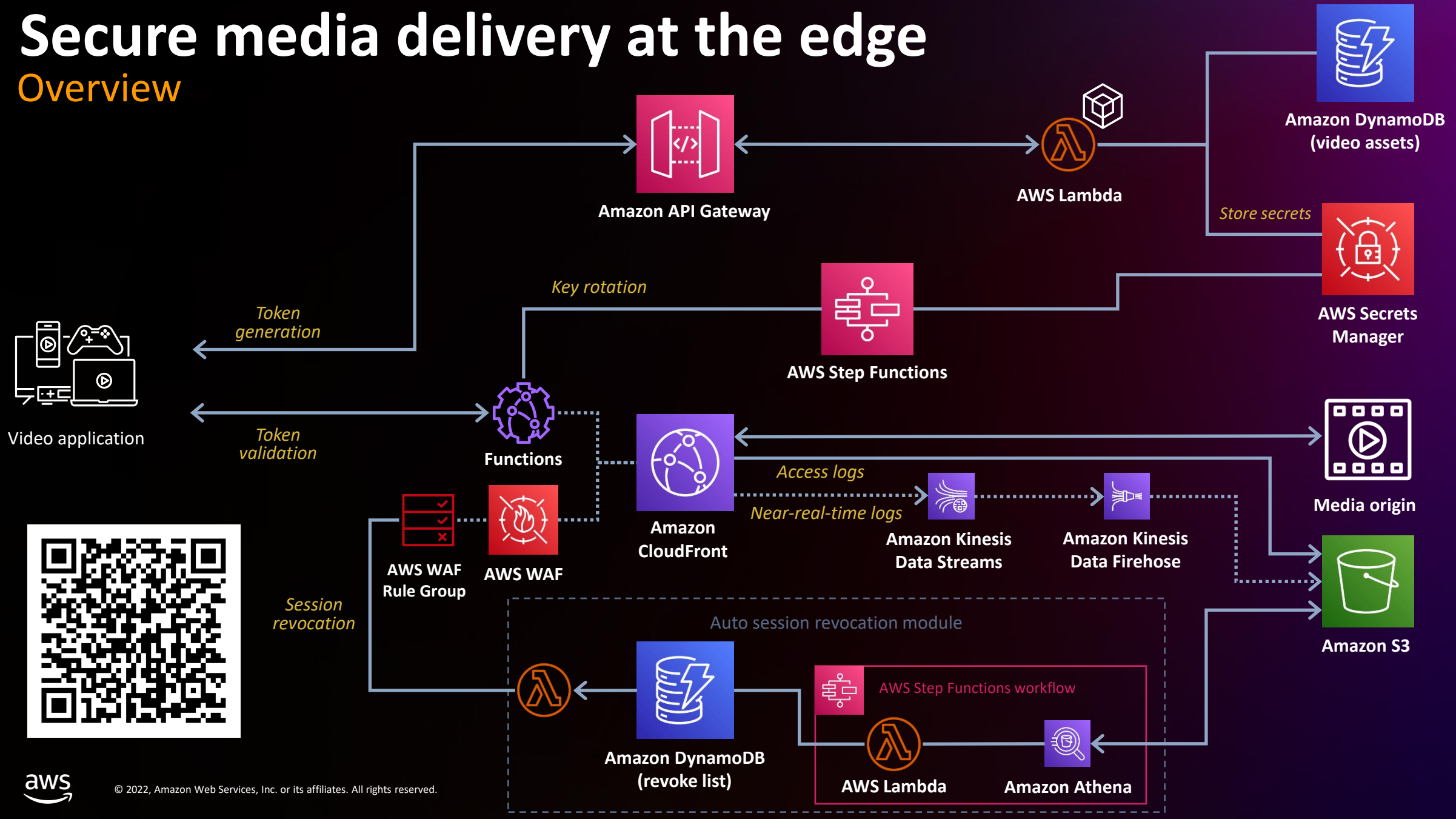
Session ID	Unique user-agents	Unique IPs	Unique Referers	Request rate	Suspicious
3hbSnlnzdo	1	1	1	0.5	No
o7jDNdq584	1	1	1	0.6	No
sWYlTHiJMF	1	1	1	0.6	No
R2cXctK6Sp	**2**	**2**	**2**	**1.1**	**Yes**
lB4ggkdMHq	1	1	1	0.5	No
F4QnWjUy0e	**1**	**2**	**1**	**0.9**	**Yes**





Secure media delivery at the edge

Overview



Thank you!

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