BRIGHTCOVE

Content Steering: a Standard for Multi-CDN Streaming

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L3 tutorials
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MULTI-CDN DELIVERY

ESSENTIAL FOR

- Multi-region delivery
- Better scale
- Improved reliability / failover
- Improved QOE

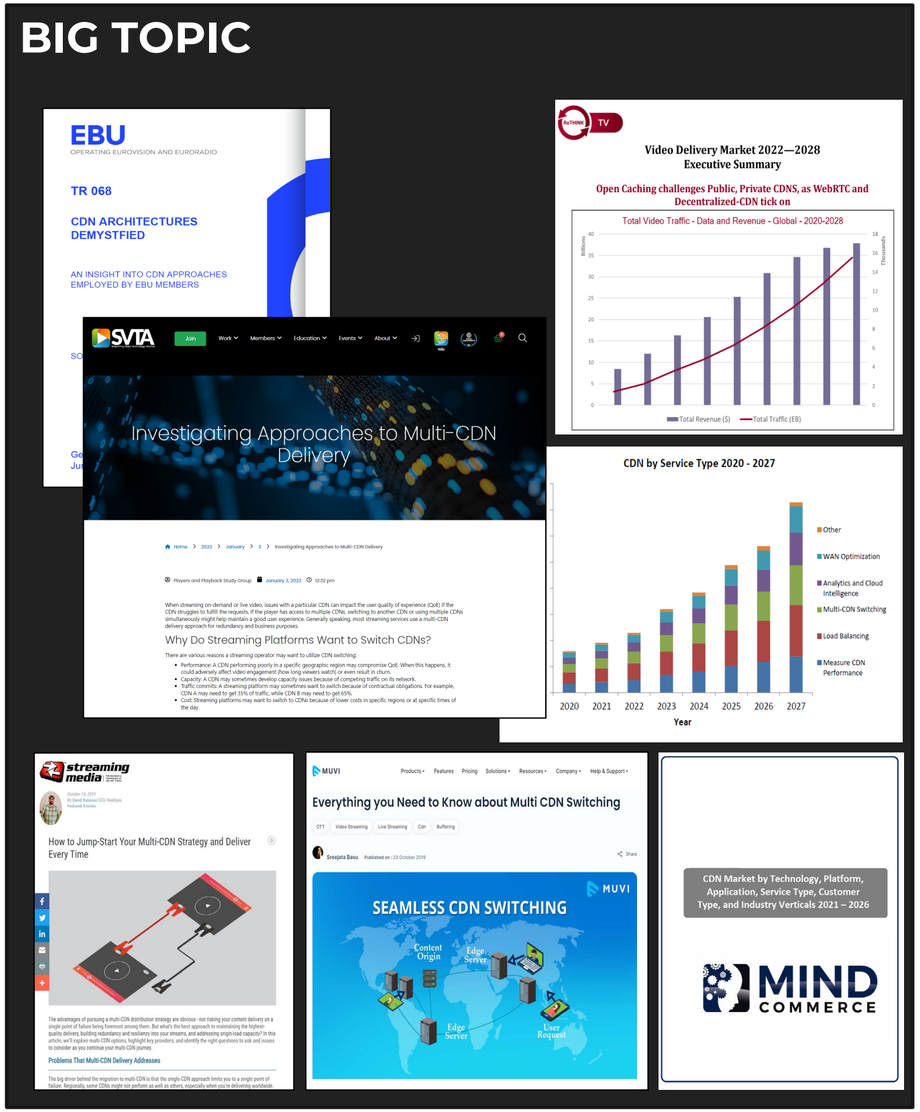
NOT TRIVIAL TO IMPLEMENT

- Many approaches proposed over last decade

Architecture	Pros	Cons
DNS-based	This is the simplest of all solutions since the source video URL always remains constant.	Switch delay is more time-consuming, ranging from 300 seconds to even five minutes in case of CDN failures. This can immensely hamper the user QoE.
On-the-fly manifest rewrite	Better user experience due to midstream switching eliminating the need for hard refresh during video playback. No matter the volume of simultaneous session resets, this method reduces the chances of a cascade effect that may hamper the video workflow.	Rewriting the manifest can sometimes bring about errors. Midstream switching is not completely seamless, and takes time for the server to understand that a particular CDN is unavailable.
Server-side	It is a relatively simple CDN switching method to implement since changes happen in the server itself that is easier for the operator to control.	Page loading may take some time, adding to delays. Since CDN switching is based on the collective data from many clients, it does necessarily consider the unique conditions of the actual clients.
Client-side	QoS data is almost accurate as it is fetched based on individual clients' local and real-time performance metrics. Seamless midstream CDN switching is possible.	It is a complex procedure to implement when built in-house due to the code complexity of the algorithms that requires detailed planning.

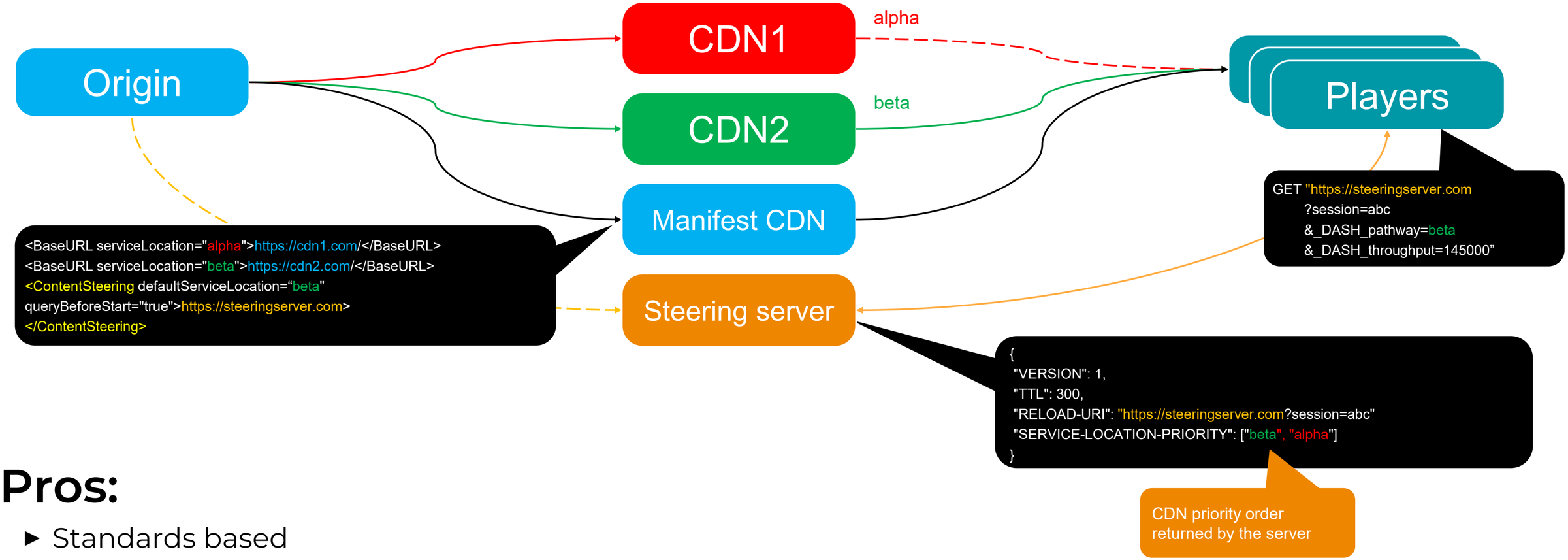
https://www.svta.org/2023/01/03/investigating-approaches-to-multi-cdn-delivery/

BIG TOPIC



HLS/DASH CONTENT STEERING

General concept

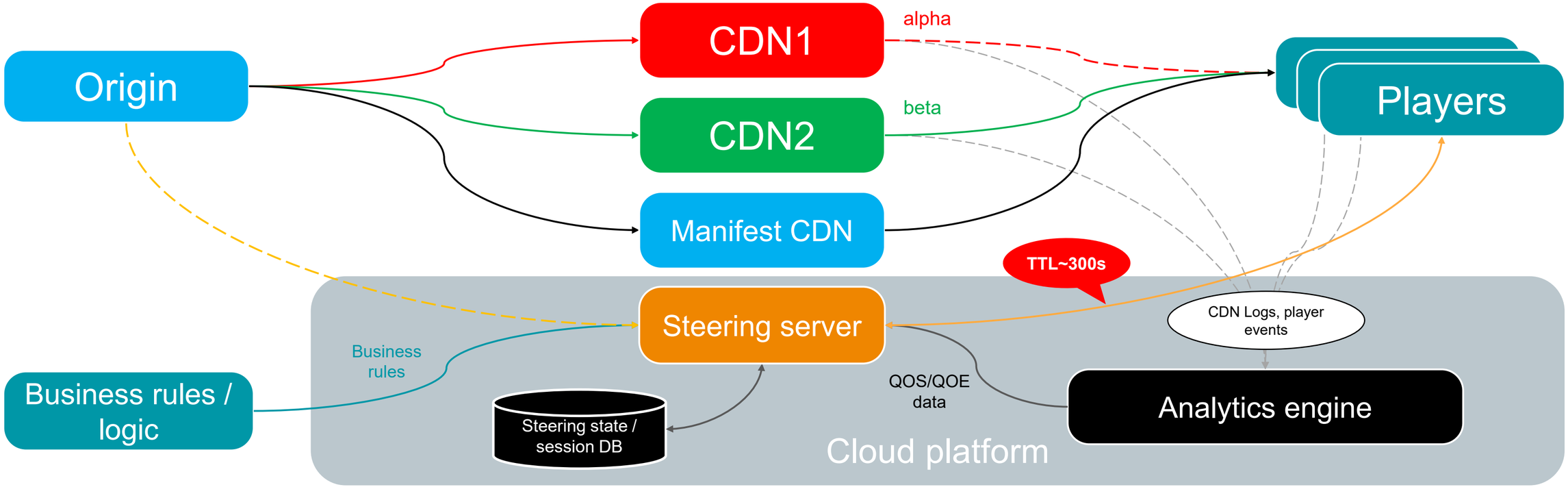


Pros:

- Standards based
- The same steering protocol & server is used for both HLS and DASH
- Simple integration – no need to patch players!
- Backwards compatible
- Complements the existing BaseURL redundancy / failover behavior mechanisms

CONTENT STEERING SERVER

Direct implementation

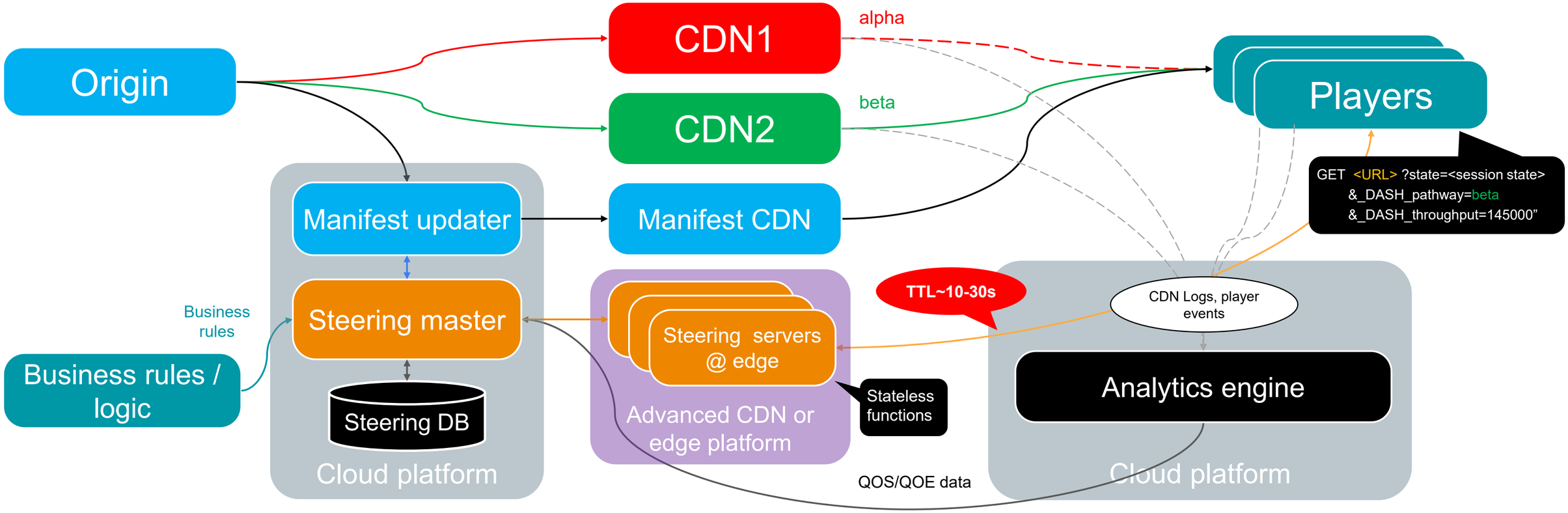


Challenges / tradeoffs:

- TTL time: 300s default is too long! Suitable for basic CDN load balancing. Not suitable for QOE optimizations.
- Scalability: the steering server should be at least as scalable as manifest CDN!
- Costs: reducing TTL will increase number of requests and traffic to the steering server!

CONTENT STEERING @ EDGE

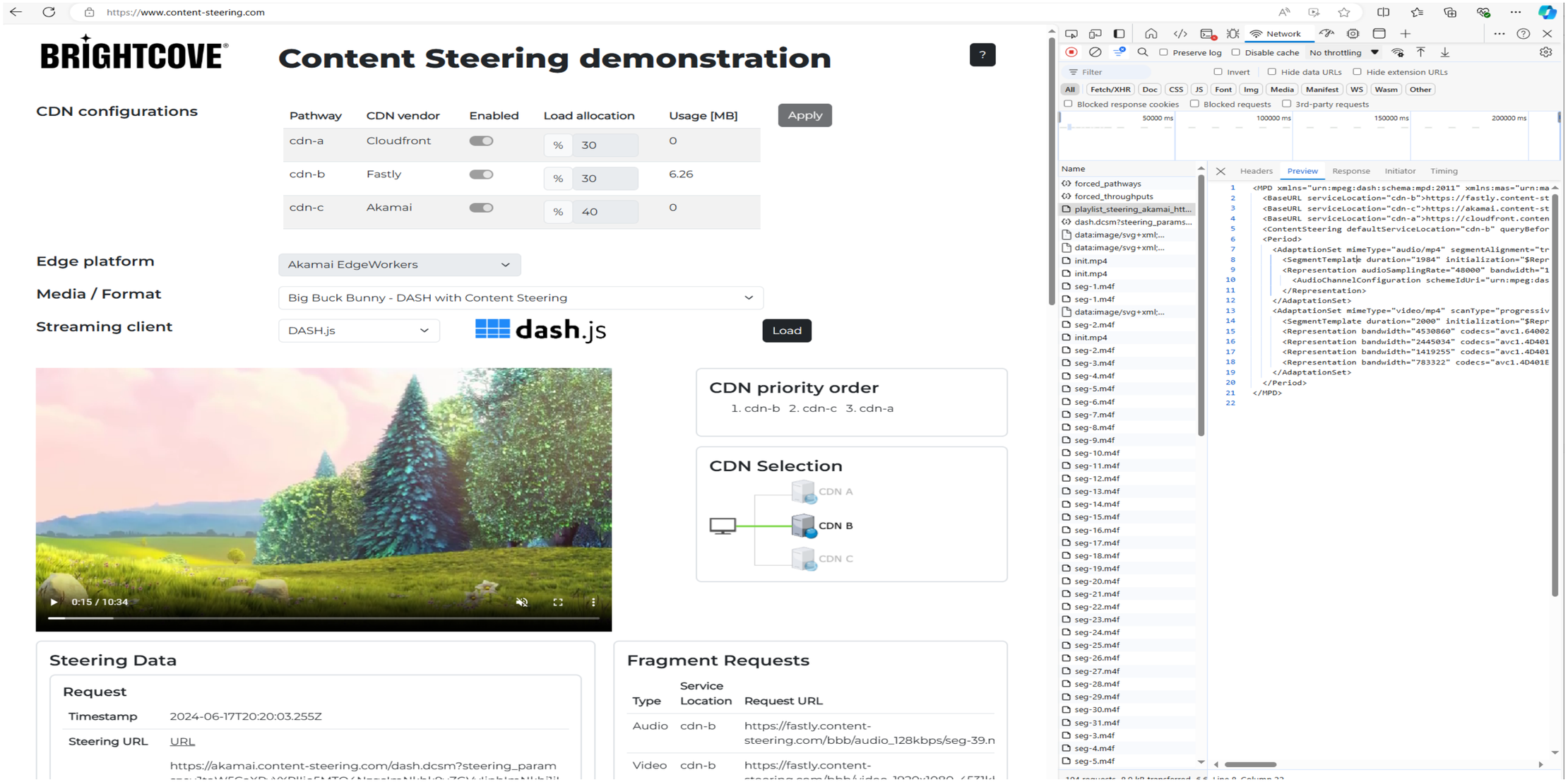
Edge-based implementation



Advantages:

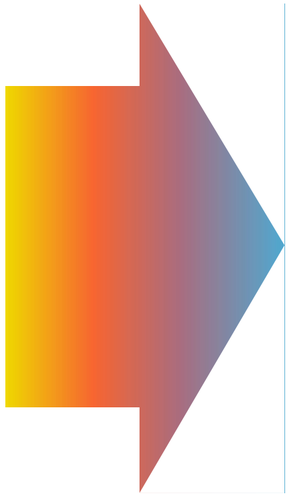
- TTL can be much smaller – comparable to player buffer delay
- Enables QOE optimizations, faster switching / failover, more precise load-balancing.
- Scales well. Multiple CDNs or platforms can be used for redundancy.

TECHNOLOGY DEMONSTRATION



PERFORMANCE STUDY
Methodology

- Systems compared:
  - CDN A/B/C – single-CDN systems
  - CDN A+B+C – multi-CDN system with content steering
- Testing orchestration
  - Over 150 proxies utilized
  - Broad spread of geo locations
  - Using K6, and several VPN networks
- Volumes
  - 0ver 8000 sessions
  - Over 1300 of playback hours
  - Over 1.3TB of media data delivered
- Protocols & clients:
  - DASH, DASH.js client
  - HLS, HLS.js client
- Steering servers, analytics
  - Brightcove



www.testbed.content-steering.com

Playback statistics

Volume

System	CDN A + B + C + Content Steering	CDN A	CDN B	CDN C
Video views	4838	2766	2923	3031
Seconds played	2908810	1656690	1748420	1828050
Traffic [GB]	545.73 CDN-A: 174.67 [32.01%] CDN-B: 157.20 [28.80%] CDN-C: 213.87 [39.19%]	452.98	413.86	476.68

QoS

System	CDN A + B + C + Content Steering	CDN A	CDN B	CDN C
Throughput [Mbps]	246.47	127.48	60.63	128.55
Throughput SD [Mbps]	361.61	227.22	179.56	245.00
Latency [ms]	45.30	98.61	257.50	90.35
Latency SD [ms]	151.54	172.27	434.51	295.02
CDN switches	127	0	0	0

QoE

System	CDN A + B + C + Content Steering	CDN A	CDN B	CDN C
Start time [ms]	798.53	973.07	1667.90	1018.01
Re-buffering ratio [%]	0.03	0.54	5.57	0.54
Re-buffering events [#/session]	0.06	0.19	7.04	0.11
Video bitrate [Mbps]	5.66	5.74	4.28	5.86
Resolution [lines]	1059	1038	840	1060
Rendition switches [#/session]	0.12	0.58	0.40	0.31

Start playback session

System: CDN A + B + C + Content Steering

Media / Format: Big Buck Bunny - DASH

Streaming client: DASH.js — Load

CDN A + B + C + Content Steering

Pathway	Target load allocation
cdn-a	34 %
cdn-b	33 %
cdn-c	33 %

PERFORMANCE STUDY

Performance in different regions

Playback statistics

All Continents | France | All Streaming protocols

Volume

System	CDN A + B + C + Content Steering	CDN A	CDN B	CDN C
Video views	272	148	177	138
Seconds played	164962	89936	107333	82577
Traffic [GB]	27.23 CDN-A: 0.48 [1.77%] CDN-B: 26.29 [96.52%] CDN-C: 0.47 [1.71%]	16.33	23.18	13.02

QoS

System	CDN A + B + C + Content Steering	CDN A	CDN B	CDN C
Throughput [Mbps]	312.89	186.37	165.64	142.39
Throughput SD [Mbps]	454.87	264.07	293.98	203.92
Latency [ms]	16.70	22.97	19.31	26.29
Latency SD [ms]	62.32	52.98	67.23	65.49
CDN switches	2	0	0	0

QoE

System	CDN A + B + C + Content Steering	CDN A	CDN B	CDN C
Start time [ms]	399.94	376.24	642.87	391.55
Re-buffering ratio [%]	0.00	0.00	0.00	0.00
Re-buffering events [#/session]	0.00	0.00	0.00	0.00
Video bitrate [Mbps]	5.63	4.90	5.67	5.68
Resolution [lines]	1056	967	1061	1053
Rendition switches [#/session]	0.01	0.01	0.01	0.04

Playback statistics

All Continents | India | All Streaming protocols

Volume

System	CDN A + B + C + Content Steering	CDN A	CDN B	CDN C
Video views	131	114	109	104
Seconds played	71299	63462	56869	56957
Traffic [GB]	13.09 CDN-A: 2.28 [17.40%] CDN-B: 0.87 [6.66%] CDN-C: 9.94 [75.94%]	17.22	14.14	15.13

QoS

System	CDN A + B + C + Content Steering	CDN A	CDN B	CDN C
Throughput [Mbps]	45.99	36.65	8.27	47.27
Throughput SD [Mbps]	41.11	37.36	12.24	41.25
Latency [ms]	73.20	139.79	583.60	57.69
Latency SD [ms]	191.72	221.82	1838.23	141.54
CDN switches	7	0	0	0

QoE

System	CDN A + B + C + Content Steering	CDN A	CDN B	CDN C
Start time [ms]	1223.16	1724.05	3875.79	1676.91
Re-buffering ratio [%]	0.14	0.22	4.68	1.81
Re-buffering events [#/session]	0.24	0.31	4.90	0.36
Video bitrate [Mbps]	5.42	5.29	3.81	5.65
Resolution [lines]	1036	996	783	1053
Rendition switches [#/session]	0.59	1.18	0.83	0.27

- Improvements depend on:
  - Diversity of performance of CDNs used in the mix
  - The more diverse it is the more QOE/QOS gains are achievable
  - This translates to geographic reach: the wider it is the more important is multi-CDN and QOE-based steering

PERFORMANCE STUDY

QOS/QOE gains

Playback statistics

All Continents | Hong Kong | All Streaming protocols

Volume

System	CDN A + B + C + Content Steering	CDN A	CDN B	CDN C
Video views	134	139	133	131
Seconds played	75908	76232	69627	75343
Traffic [GB]	14.51 CDN-A: 0.76 [5.27%] CDN-B: 0.33 [2.26%] CDN-C: 13.42 [92.48%]	22.81	17.31	20.33

QoS

System	CDN A + B + C + Content Steering	CDN A	CDN B	CDN C
Throughput [Mbps]	53.21	36.88	10.23	47.57
Throughput SD [Mbps]	41.09	42.13	17.14	42.69
Latency [ms]	39.71	205.77	645.35	91.53
Latency SD [ms]	127.28	258.43	430.34	204.69
CDN switches	6	0	0	0

QoE

System	CDN A + B + C + Content Steering	CDN A	CDN B	CDN C
Start time [ms]	1275.35	1918.46	3581.55	1768.08
Re-buffering ratio [%]	0.04	0.04	4.30	0.07
Re-buffering events [#/session]	0.04	0.20	8.17	0.21
Video bitrate [Mbps]	5.61	4.79	3.49	5.50
Resolution [lines]	1058	919	745	1025
Rendition switches [#/session]	0.24	2.29	0.61	1.24

Playback statistics

All Continents | India | All Streaming protocols

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- Substantial improvements:
  - Up to 30% higher resolution
  - Up to 5x reduction in buffering
  - Up 5x fewer switches

INDUSTRY ADOPTION
Significant momentum

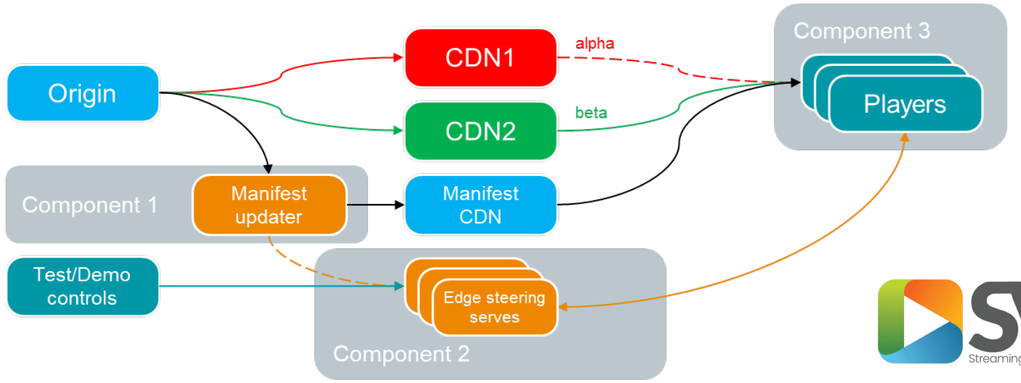
- Players:

Media Player	DASH Content Steering	HLS Content Steering
dash.js	since version 4.5.0	
VIDEO.JS	since version 8.8.0	since version 8.8.0
Shaka Player	since version 4.6.0	since version 4.6.0
ExoPlayer	planned for 2024	planned for 2024
hls.js		since version 1.4.0
AVPlayer		since iOS version 15.0

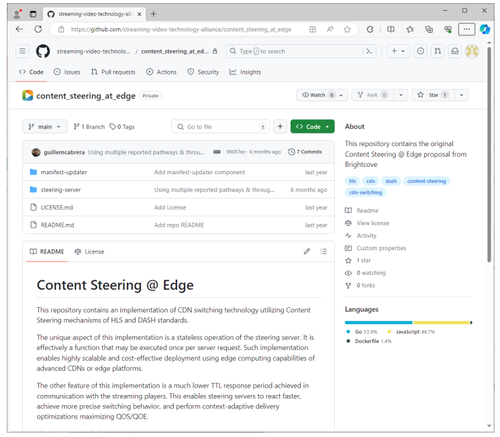
- Packagers & servers:
  - > Brightcove, Synamedia, Google (Shaka)

- Standards & guidelines
  - IETF RFC 8216bis (HLS)
  - ISO/IEC 23009-1 (DASH)
  - ETSI TS 103 998 (DASH-IF Content Steering)

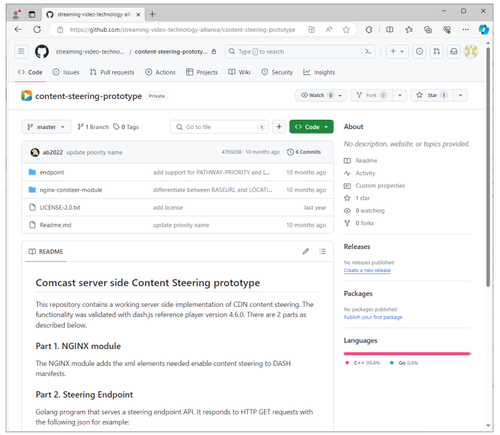
- Open source tools



SVTA Streaming Video Technology Alliance



https://github.com/streaming-video-technology-alliance/content_steering_at_edge



https://github.com/streaming-video-technology-alliance/content-steering-prototype

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THANK YOU