Multi-Codec DASH Dataset

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Motivation

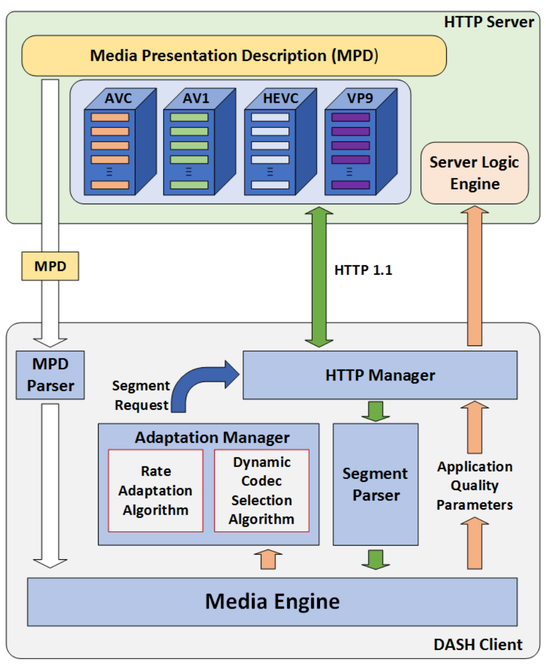
Current situation

- Currently, we are in a situation where we can choose from multiple video codecs such as AVC, HEVC, VP9 and AV1.Every new major video codec has increased coding efficiency significantly compared to its predecessor
- However, not every kind of end user device is supporting all possible codecs. Thus, there is a need to support multiple codecs. We expect that DASH services will have to deal with such situations

Research Goals/Questions

- **Create Multi-codec DASH dataset** comprising AVC, HEVC, VP9, and AV1 in order to enable interoperability testing and experimenting with different adaptation strategies of DASH clients supporting multiple video codecs
- **Research Multi-codec DASH scheme** and its potential to be adopted for HTTP adaptive streaming. Consider possible usage scenarios
- **Present coding performance evaluation of AV1** compared to AVC, HEVC, and VP9 in the context of HTTP adaptive streaming

Multi-codec DASH scheme



Server and client roles in a Multi-codec DASH scheme

Server-side roles

- Compute quality metrics of encoded segments
- Deliver quality metrics to the client
- Analyze clients requests and application quality parameters
- Automatically encode new or remove unused segments, update MPDs

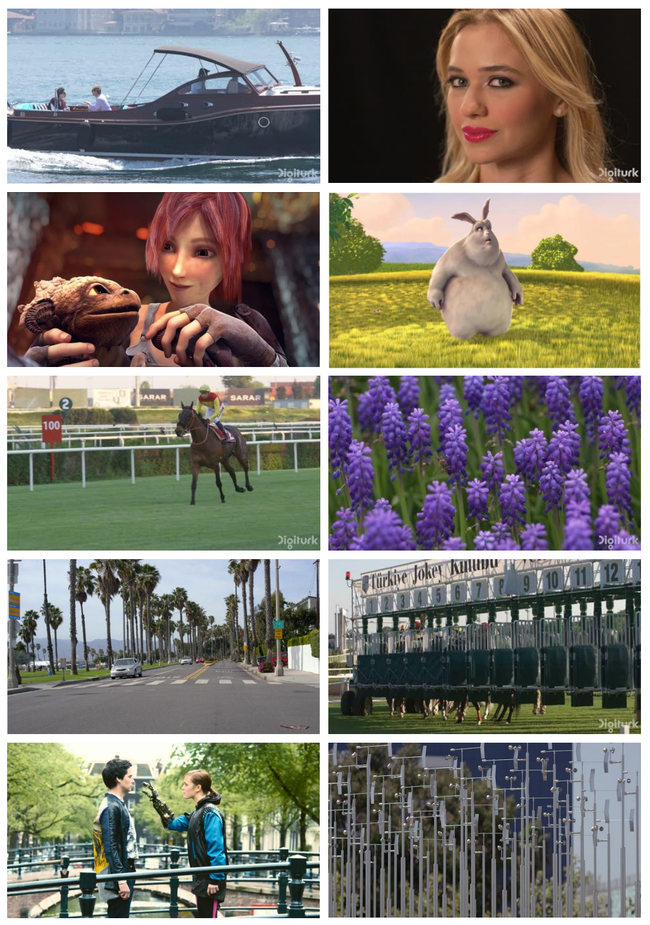
Client-side roles

- Use quality metrics to decide which segments to request
- Send application quality parameters to the server
- Switch between segments encoded with different codecs
- Switch between representations of the video stream

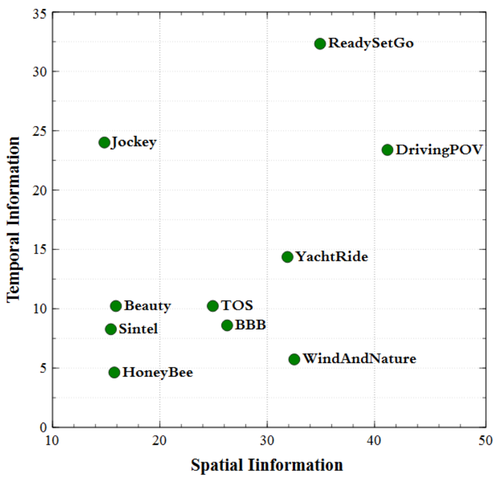
Video sequences

Multi-codec DASH dataset

- Comprises video sequences with minor movements, such as moving head on a fixed black background and sequences with significant movements, such as riding jockeys
- Covers a wide range of different sequence types and genres



Average Spatial information and Temporal information for dataset sequences



#	Bitrate	Resolution	#	Bitrate	Resolution
1	100	256x144	11	4300	1920x1080
2	200	320x180	12	5800	1920x1080
3	240	384x216	13	6500	2560x1440
4	375	384x216	14	7000	2560x1440
5	550	512x288	15	7500	2560x1440
6	750	640x360	16	8000	3840x2160
7	1000	768x432	17	12000	3840x2160
8	1500	1024x576	18	17000	3840x2160
9	2300	1280x720	19	20000	3840x2160
10	3000	1280x720			

Characteristic	Genre	Creator	Frame rate	Resolution	File format	File duration	Sequence duration
BBB	Animation	Blender Foundation	30 fps	3840x2160	mp4	634 sec.	60 sec.
Beauty	Moving head	TUT, Finland	30 fps	3840x2160	y4m	20 sec.	20 sec.
DrivingPOV	Moving cars	Netflix, Inc.	60 fps	4096x2160	y4m	20 sec.	20 sec.
HoneyBee	Nature	TUT, Finland	30 fps	3840x2160	y4m	20 sec.	20 sec.
Jockey	Moving jockey	TUT, Finland	30 fps	3840x2160	y4m	20 sec.	20 sec.
ReadySetGo	Moving horses	TUT, Finland	30 fps	3840x2160	y4m	20 sec.	20 sec.
Sintel	Animation	Blender Foundation	24 fps	4096x1744	y4m	888 sec.	60 sec.
TOS	Composite	Blender Foundation	24 fps	4096x1714	y4m	734 sec.	60 sec.
WindAndNature	Rotating wind vanes	Netflix, Inc.	60 fps	4096x2160	y4m	20 sec.	20 sec.
YachtRide	Moving yacht	TUT, Finland	30 fps	3840x2160	y4m	20 sec.	20 sec.

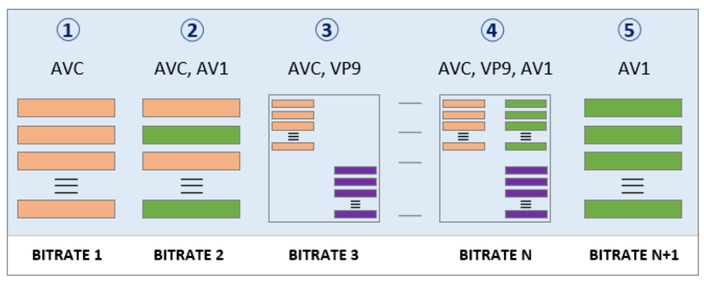
Our dataset is available here: http://dash.itec.aau.at

Multi-codec DASH dataset use cases

Some situations that can lead to the choice of Multi-codec DASH scheme as the delivery strategy for adaptive streaming services

Use case 1

Low bitrate streams are first encoded using fast approach, such as AVC. That allows a streaming system to provide video content to viewers in a short time



Use case 2

Some streams can include segments encoded with different codecs. For example, segments with a large number of motions are encoded by a more efficient codec

Use case 3

Some streams can be encoded in several adaptation sets of segments by two or more codecs. This can happen with bitrate representations which are most frequently transmitted

Use case 4 and 5

Very high bitrates are encoded by the most efficient codecs. This takes a long time but significantly saves bandwidth

BD-rate for segments of AV1 compared to AVC, HEVC, and VP9

BD-rate for segments of AV1 compared to AVC, HEVC, and VP9 over the entire bitrate ladder

Sequence	BD-rate		
	AVC	HEVC	VP9
BBB 2 sec.	-1.59 %	12.84 %	0.63 %
BBB 4 sec.	-5.20 %	-0.19 %	-2.95 %
Beauty 2 sec.	-85.51 %	-14.46 %	-37.86 %
Beauty 4 sec.	-62.12 %	-3.05 %	1.04 %
DrivingPOV 2 sec.	-64.26 %	-11.52 %	-9.97 %
DrivingPOV 4 sec.	-64.15 %	-5.29 %	-0.87 %
HoneyBee 2 sec.	-37.11 %	-30.53 %	-24.99 %
HoneyBee 4 sec.	-42.39 %	-29.48 %	-20.91 %
Jockey 2 sec.	-62.44 %	-24.35 %	-14.99 %
Jockey 4 sec.	-60.79 %	-21.83 %	-4.74 %
ReadySetGo 2 sec.	-49.90 %	-18.57 %	-12.76 %
ReadySetGo 4 sec.	-54.23 %	-21.30 %	-12.17 %
Sintel 2 sec.	-26.71 %	-14.47 %	-6.05 %
Sintel 4 sec.	-24.45 %	-13.64 %	-6.97 %
TOS 2 sec.	-22.35 %	-0.80 %	-4.17 %
TOS 4 sec.	-23.36 %	-14.09 %	-7.84 %
WindAndNature 2 sec.	-33.22 %	-21.32 %	-8.96 %
WindAndNature 4 sec.	-43.55 %	-23.72 %	-13.01 %
YachtRide 2 sec.	-52.83 %	-18.11 %	-31.86 %
YachtRide 4 sec.	-55.86 %	-20.90 %	-21.94 %
Average value	**-48.07 %**	**-17.08 %**	**-13.28 %**

BD-rate for segments of AV1 at 3840x2160 compared to AVC, HEVC, and VP9

Sequence	BD-rate		
	AVC	HEVC	VP9
Beauty 2 sec.	—	-50.20 %	-23.42 %
Beauty 4 sec.	—	-46.54 %	-6.71 %
DrivingPOV 2 sec.	-54.09 %	-23.82 %	-20.91 %
DrivingPOV 4 sec.	-49.84 %	-15.82 %	-13.71 %
HoneyBee 2 sec.	—	-51.09 %	-41.32 %
HoneyBee 4 sec.	—	-55.91 %	-48.31 %
Jockey 2 sec.	—	-60.67 %	-22.42 %
Jockey 4 sec.	—	-60.34 %	-22.84 %
ReadySetGo 2 sec.	-63.60 %	-39.25 %	-27.55 %
ReadySetGo 4 sec.	-62.99 %	-35.87 %	-25.30 %
Sintel 2 sec.	-61.77 %	-42.20 %	-12.40 %
Sintel 4 sec.	—	-39.38 %	-12.30 %
TOS 2 sec.	-67.14 %	-44.86 %	-23.89 %
TOS 4 sec.	—	-42.71 %	-29.34 %
WindAndNature 2 sec.	—	-59.04 %	-42.06 %
WindAndNature 4 sec.	—	-58.79 %	-47.63 %
YachtRide 2 sec.	-52.76 %	-31.86 %	-28.59 %
YachtRide 4 sec.	-52.93 %	-31.92 %	-30.44 %
Average value	**-58.14 %**	**-43.90 %**	**-26.62 %**

Quality metrics

- **Weighted Peak Signal-to-Noise Ratio (wPSNR)** for the luminance (Y) and chrominance (UV) components
- PSNR and bitrate is averaged over all frames in each sequence and the **Bjøntegaard-Delta bit-rate (BD-rate)** is calculated from these values over the entire bitrate ladder
- The raw values of **PSNR** and also **SSIM** are part of the dataset and available for further analysis

$$wPSNR = \frac{6 \cdot PSNR_Y + PSNR_U + PSNR_V}{8}$$

Evaluation results

- AV1 codec is able to outperform all the other codecs. **The average gains over AVC are around 48%, 17% compared to HEVC, and 13% compared to VP9.** Gains vary strongly and depend on the individual dataset sequences
- For HEVC, the gains range **from close to zero up to 31%**
- For the high resolution (3840x2160) and high bitrates, the coding gain of AV1 compared to the other codecs is even higher with an average of **roughly 58% compared to AVC, 44% compared to HEVC, and 27% compared to VP9**

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