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MSU Cloud Video Transcoding Benchmark 2020 Methodology

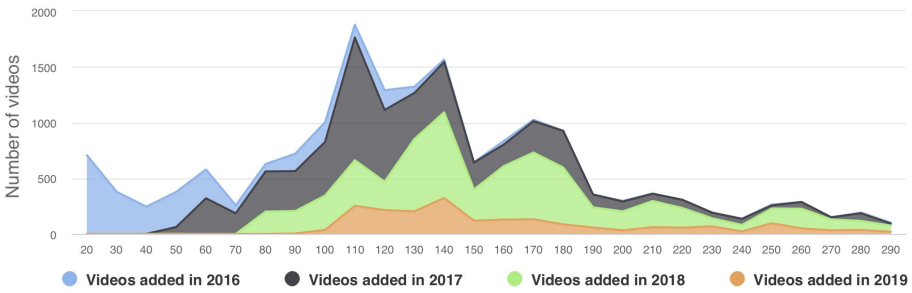
Outline

- Video selection
- Encoding presets selection
- Encoding time
- Sequence-based comparison
- Quality measure
- Encoders score calculation
  - Special cases
- Calculation of overall score (BSQ-rate)
- Appendix
  - Encoding settings
  - Sequence-based options

Video selection (1)

- Test video set is chosen from MSU video collection (15000+ videos)
  - All videos have high bitrate, they were generated by real users and downloaded from different resources (Vimeo, xiph.org, etc)
  - All videos have an appropriate license (CCBY)
- All videos are in YUV420P (name in ffmpeg), SDR, 8-bit

Year	# FullHD videos	# FullHD samples	# 4K videos	# 4K samples	Total # of videos	Total # of samples
2016	3	7	882	2902	885	2909
2017	1996	4738	1544	4561	3540	9299
2018	4342	10330	1946	5503	6288	15833
2019	4945	12402	2091	6016	7036	**18418**



Bitrate distribution of video sequences from MSU video set by year

Video selection (3)

- For this comparison 15 videos were chosen (including 3 UGC videos), then they were encoded into h.264-lossless since some cloud encoding services don't support raw .yuv files.
- The complete list is as follows (UGC is highlighted in green):

christmas_cats_1920x1080_25.mp4	construction_site_1920x1080_30.mp4	crowd_run_1920x1080_50.mp4	football_1920x1080_30.mp4	blue_hair_1920x1080_30.mp4
hard_rock_1920x1080_25.mp4	kindergarten_interview_1920x1080_30.mp4	park_mobile_1920x1080_24.mp4	pyranha_rafting_1920x1080_24.mp4	stone_1920x1080_30.mp4
street_musician_1920x1080_24.mp4	summer_of_adventure_1920x1080_30.mp4	tennis_vlog_1440x1080_30.mp4	wedding_party_1920x1080_24.mp4	the_forest_1920x1080_30.mp4

Encoding presets selection

- This year we chose to use default encoding parameters of each tested service
- Encoding standards tested: H.264, HEVC
- We ran encodes at 3 resolutions with 7 intersecting bitrates
- See appendix for exact presets

Bitrate, kbps	Resolution		
	480p	720p	1080p
75	+		
120	+		
250	+	+	
500	+	+	
750	+	+	
1000	+	+	+
2000	+	+	+
4000		+	+
6000		+	+
8000			+
10000			+
12000			+

Encoding time

- This year we introduced time measurements into cloud service comparison
- We started the clock when the encoding task was finalized and sent to the service and stopped it when we received a webhook for this task ending
- We ran all tasks twice and chose the shortest time, which gave us a rough estimate of the time required to encode a sequence
- To better estimate the stability of services we ran test encodes (same video, 3 resolutions 1 bitrate each) each 10 minutes for a week thus obtaining the data seen in the “encoding time deviation” plot in the report

Sequence-based comparison

- Other names:
  Context Aware Encoding, Per-Title Encoding, etc
- This sub-comparison is aimed at assessing the quality of automatic encoding option selection of different services
- Service fully supports sequence-based encoding when it can produce both a resolution ladder and a bitrate ladder
- Service partially supports sequence-based encoding when it can only select a bitrate for a set resolution / quality parameter (i.e. QVBR for AWS Elemental MediaConvert)
- See appendix for resolution-parameter ladder used for partially supporting services

Quality measure

- Main metric of the comparison: YUV-SSIM
  - YUV-SSIM is computed as the weighted average of SSIM values for each channel individually
    - (4 * Y-SSIM + V-SSIM + U-SSIM) / 6
- Other used metrics: Y-VMAF (v0.6.3), Y-SSIM, U-SSIM, V-SSIM, YUV-PSNR, Y-PSNR, U-PSNR, V-PSNR
- Metrics calculation: via MSU VQMT 12 http://compression.ru/video/quality_measure/video_measurement_tool.html

Encoders score calculation

- Averaging of per-frame metrics results for the whole video — simple mean (average) value
- Quadratic interpolation of RD-curves
- Reference encoder — AWS Elemental MediaConvert

- Results are averaged across all testing videos: simple mean (average) value, for speed and for quality

Calculation of overall score

Bitrate for the same quality rate (BSQ-rate)

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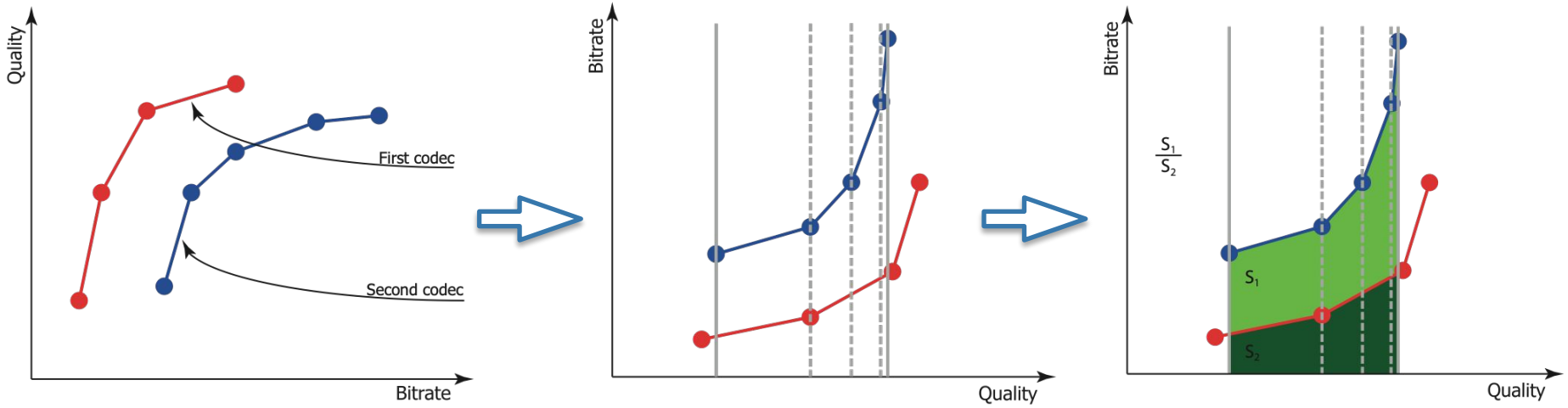
1. Compute the average bitrate ratio for a fixed quality is to invert the axes of the bitrate/quality graph
2. Average the interval over which the quality axis is chosen. The averaging is only over overlapping segments
3. Calculation of the area under the curves in the chosen interpolation segment and determination of their ratio

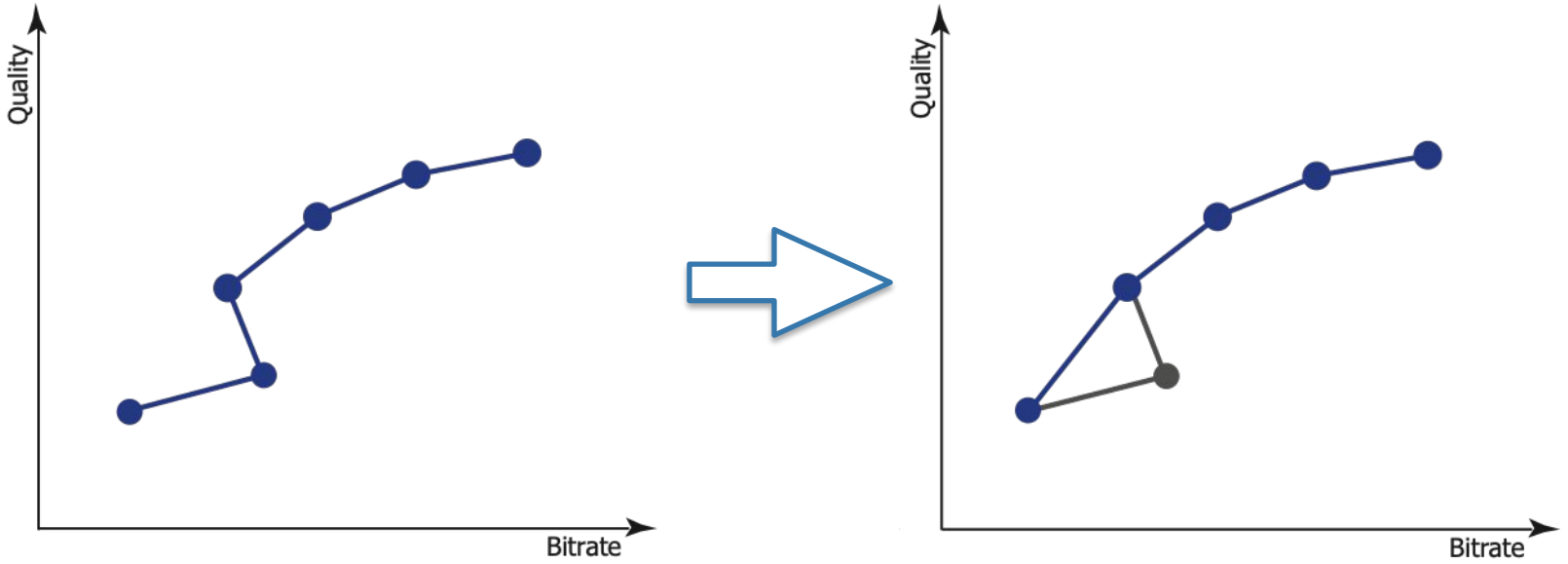
$$BSQ - rate = \frac{S1}{S2}$$



Encoders score calculation

Special cases

Non-monotonic RD curve: outliers are excluded before the interpolation

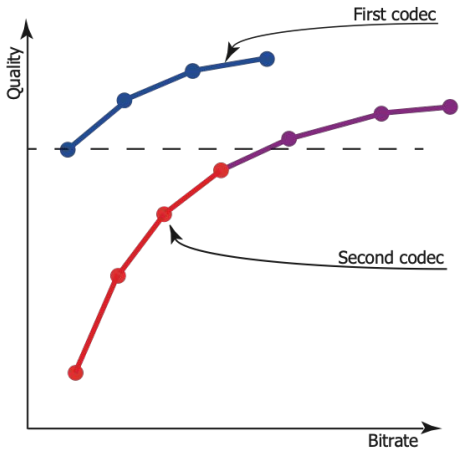


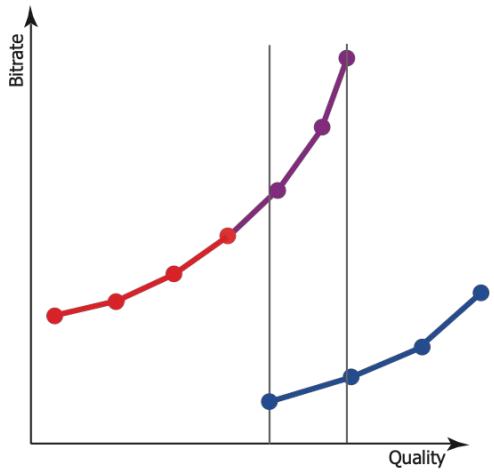
Encoders score calculation

Special cases

Non-overlapping RD curves: additional measurements are made at lower/higher bitrates

- Reference encoder is measured on lower bitrates
- For comparison of two non-reference encoders: lower bitrates for leaders are measured until the intersection





Purple part of the curve - additionally measured bitrates to reach the intersection

Appendix / Encoding settings

- In this section we provide the settings used in our comparison
- Here we provide only the encoding settings, all other settings (input/output/container info) are omitted
- The only settings changing between encodes are **`{bitrate}`** and **`{height}`** and they are set in accordance to the table shown earlier

Appendix / Encoding settings

AWS Elemental MediaConvert

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H.264

```
{
    "VideoDescription": {
        "ScalingBehavior": "DEFAULT",
        "TimecodeInsertion": "DISABLED",
        "AntiAlias": "ENABLED",
        "Sharpness": 50,
        "CodecSettings": {
            "Codec": "H_264",
            "H264Settings": {
                "InterlaceMode": "PROGRESSIVE",
                "NumberReferenceFrames": 3,
                "Syntax": "DEFAULT",
                "Softness": 0,
                "GopClosedCadence": 1,
                "GopSize": 90,
                "Slices": 1,
                "GopBReference": "DISABLED",
                "SlowPal": "DISABLED",
                "SpatialAdaptiveQuantization": "ENABLED",
                "TemporalAdaptiveQuantization": "ENABLED",
                "FlickerAdaptiveQuantization": "DISABLED",
                "EntropyEncoding": "CABAC",
                "FramerateControl": "INITIALIZE_FROM_SOURCE",
                "RateControlMode": "VBR",
                "CodecProfile": "MAIN",
                "Telecine": "NONE",
                "MinIInterval": 0,
                "AdaptiveQuantization": "HIGH",
                "CodecLevel": "AUTO",
                "FieldEncoding": "PAFF",
                "SceneChangeDetect": "ENABLED",
                "QualityTuningLevel": "SINGLE_PASS",
                "FramerateConversionAlgorithm": "DUPLICATE_DROP",
                "UnregisteredSeiTimecode": "DISABLED",
                "GopSizeUnits": "FRAMES",
                "ParControl": "INITIALIZE_FROM_SOURCE",
                "NumberBFramesBetweenReferenceFrames": 2,
                "RepeatPps": "DISABLED",
                "DynamicSubGop": "STATIC",
                "Bitrate": {bitrate}
            }
        },
        "AfdSignaling": "NONE",
        "DropFrameTimecode": "ENABLED",
        "RespondToAfd": "NONE",
        "ColorMetadata": "INSERT",
        "Height": {height}
    }
}
```

HEVC

```
{
    "VideoDescription": {
        "ScalingBehavior": "DEFAULT",
        "TimecodeInsertion": "DISABLED",
        "AntiAlias": "ENABLED",
        "Sharpness": 50,
        "CodecSettings": {
            "Codec": "H_265",
            "H265Settings": {
                "InterlaceMode": "PROGRESSIVE",
                "NumberReferenceFrames": 3,
                "GopClosedCadence": 1,
                "AlternateTransferFunctionSei": "DISABLED",
                "GopSize": 90,
                "Slices": 1,
                "GopBReference": "DISABLED",
                "SlowPal": "DISABLED",
                "SpatialAdaptiveQuantization": "ENABLED",
                "TemporalAdaptiveQuantization": "ENABLED",
                "FlickerAdaptiveQuantization": "DISABLED",
                "FramerateControl": "INITIALIZE_FROM_SOURCE",
                "RateControlMode": "VBR",
                "CodecProfile": "MAIN_MAIN",
                "Tiles": "ENABLED",
                "Telecine": "NONE",
                "MinIInterval": 0,
                "AdaptiveQuantization": "HIGH",
                "CodecLevel": "AUTO",
                "SceneChangeDetect": "ENABLED",
                "QualityTuningLevel": "SINGLE_PASS",
                "FramerateConversionAlgorithm": "DUPLICATE_DROP",
                "UnregisteredSeiTimecode": "DISABLED",
                "GopSizeUnits": "FRAMES",
                "ParControl": "INITIALIZE_FROM_SOURCE",
                "NumberBFramesBetweenReferenceFrames": 2,
                "TemporalIds": "DISABLED",
                "SampleAdaptiveOffsetFilterMode": "ADAPTIVE",
                "WriteMp4PackagingType": "HEV1",
                "DynamicSubGop": "STATIC",
                "Bitrate": {bitrate}
            }
        },
        "AfdSignaling": "NONE",
        "DropFrameTimecode": "ENABLED",
        "RespondToAfd": "NONE",
        "ColorMetadata": "INSERT",
        "Height": {height}
    }
}
```

Appendix / Encoding settings
Others (1)

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Alibaba ApsaraVideo for Media Processing

H.264	HEVC
{ "Video": { "Codec": "H.264", "Bitrate": **{bitrate}**, "Height": "**{height}**" } }	{ "Video": { "Codec": "H.265", "Bitrate": **{bitrate}**, "Height": "**{height}**" } }

Coconut

"-> mp4:0x**{height}_{bitrate}**k = {destination}\n"	"-> mp4:hevc_0x**{height}_{bitrate}**k = {destination}\n"

Qencode

{ "video_codec": "libx264", "height": "**{height}**", "bitrate": **{bitrate}** }	{ "video_codec": "libx265", "height": "**{height}**", "bitrate": **{bitrate}** }

Appendix / Encoding settings
Others (2)

Tencent Media Processing Service

H.264	HEVC
{ "Codec": "libx264", "Fps": 0, "Height": **{height}**, "Bitrate": **{bitrate}** }	{ "Codec": "libx265", "Fps": 0, "Height": **{height}**, "Bitrate": **{bitrate}** }

Zencoder

{ "height": **{height}**, "video_codec": "h264", "video_bitrate": **{bitrate}** }	{ "height": **{height}**, "video_codec": "hevc", "video_bitrate": **{bitrate}** }

Appendix / Sequence-based options

For the services that only partially support sequence-based encoding we used the following resolution-quality option ladder:

Resolution	AWS QVBR	Coconut quality	Qencode min–max CRFs
1080p	9	4	11–20
720p	8	4	11–20
720p	7	3	21–30
480p	7	3	21–30
360p	7	3	21–30
240p	7	3	21–30

Contact

For any questions about comparison methodology and participation:

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