LCEVC x264 Report: 1080p VMAF/Subjective Quality

Jan Ozer, July, 2020

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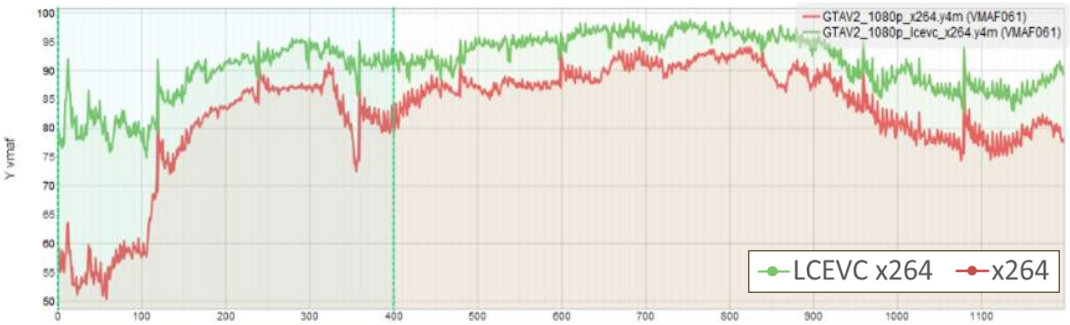
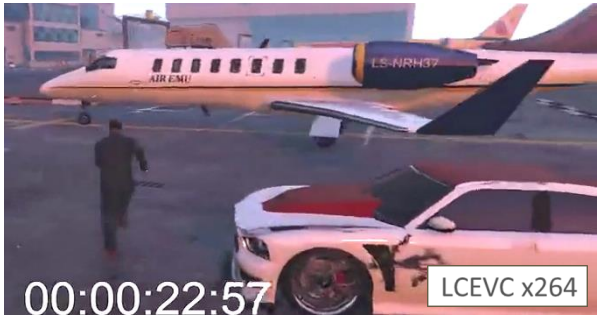
Overview





V-NOVA engaged Jan Ozer (dba Doceo Publishing) to evaluate the quality achievable with LCEVC enhancement when applied to multiple base layer codecs.

The first set of formal tests compared LCEVC with a base layer of x264 (LCEVC x264) to native x264. This analysis evaluated quality four different ways.

This report summarizes the findings from this analysis.

- **Via Objective Quality Metrics: VMAF comparisons** computed using FFmpeg with Rate Distortion Curves and BD-Rate stats computed in Excel. For reference, BD-Rates also computed for PSNR, SSIM, MS-SSIM.
- **File by file subjective evaluations** using the MSU VQMT result plot as a guide (upper left) and frame grabs on lower quality frames (upper right)
- **Subjective Mean Opinion Score (MOS)** comparisons performed by GB Tech. Additional details available in separate report in the Appendix.
- **Crowd-sourced subjective assessment** performed by Subjectify

Executive Summary of the results

- On 33 tested clips across 5 content genres at 1080p resolution, **LCEVC x264 outperformed x264 on VMAF and subjective MOS, with BD-Rates respectively of -42.3% and -44.8%** (i.e. LCEVC x264 achieves the same quality as x264 with less than 60% of the x264 bitrate). VMAF scores showed the highest correlation to 'ground-truth' MOS subjective scoring vs other objective metrics
- **LCEVC x264 showed more robustness than x264:** x264 at lower data rates often scored <4 in the MOS scale (41% of the total votes were ≤4) due to visible impairments like blocking artifacts or flickering, while LCEVC x264 showed more robustness, scoring 5 and above in 99% of the cases. When bandwidth constrained, LCEVC x264 tended to soften the image which was typically not perceived by the viewers as an annoying impairment, and was often ignored.
- **Results were consistent across content genres:** BD-Rate-VMAF ranges from -30% (for eGames) to -49% (various), BD-Rate-MOS ranges from -40% (eGames) to -53% (movies)
- **Subjective evaluation of the lowest quality frames confirmed the greater robustness of LCEVC x264**. As visible in the frame grabs, in several instances (e.g., GTAV2, BBB, Zoolander) the blockiness and other artifacts in x264 are much more noticeable than LCEVC x264.
- **Further crowd-sourced subjective analysis performed by Subjectify.us confirmed the above results,** with viewers significantly preferring LCEVC x264 vs x264 at the same bitrates and at 80% of the bitrate vs x264 (full bitrate)
- **LCEVC x264** (veryslow preset for the base layer) **encodes 2.5x faster than x264 (veryslow preset).** On decoding, at same bitrate LCEVC consumes lower voltage and about the same power of x264; comparing the same approximate quality, LCEVC playback is more efficient in both power and voltage.

Test Coordinator

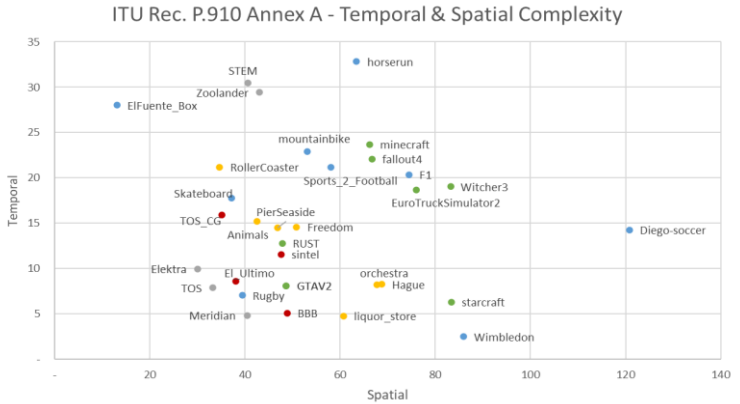
Ozer is a leading expert on H.264, H.265, and VP9 encoding for live and VOD production, the computation and use of video quality metrics, and encoding with FFmpeg. Ozer is a contributing editor to *Streaming Media Magazine*, where he reviews codecs, on-premise and cloud encoders, and ancillary tools like QoE and QoS monitoring services.

Ozer blogs at www.streaminglearningcenter.com, and is the author of over 20 streaming and video-related books, including *Video Encoding by the Numbers: Eliminate the Guesswork from your Streaming Video*, and *Learn to Produce Videos with FFmpeg: In Thirty Minutes or Less*. His books have consistently garnered five-star reviews on Amazon and have been adopted as textbooks by multiple colleges and universities.

Methodology: Test Clips & Data Rates

Test clips

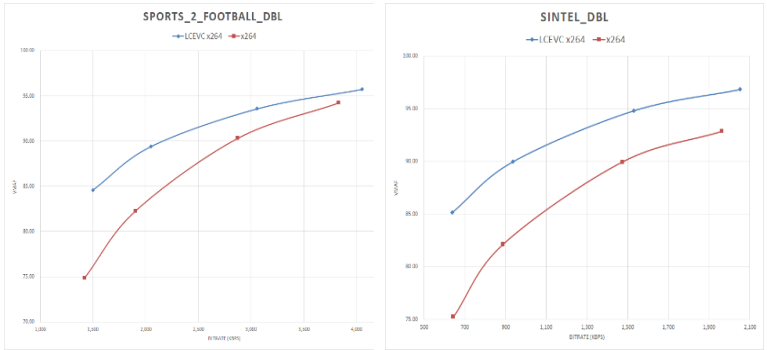
Doceo supplied 33 test clips from a range of sources in multiple genres including animations, games, movies, sports, and various. As shown above, the clips represented an extensive range of temporal and spatial complexity. Clips are presented in Appendix I.



Data rates

Various bitrates were used for each clip that focus on the most relevant use cases employed by streaming services (e.g., high-motion football clip between 1.5 - 4 Mbps (left), easier Sintel animation between 0.6-2 Mbps (right)).

For this reason, the VMAF and MOS scores should be relevant to most use cases. The exception were several gaming clips where the VMAF score was lower to reflect that gaming platforms typically cap the bitrate at around 6 Mbps.



Command Strings

x264

```
ffmpeg -i input.mp4 -r 30 -c:v libx264 -b:v 1000k -bufsize 2000k -g 60.0 -keyint_min 60 -maxrate 1000k -preset veryslow -sc_threshold 0 -threads 1 -tune psnr output.ts
```

LCEVC x264

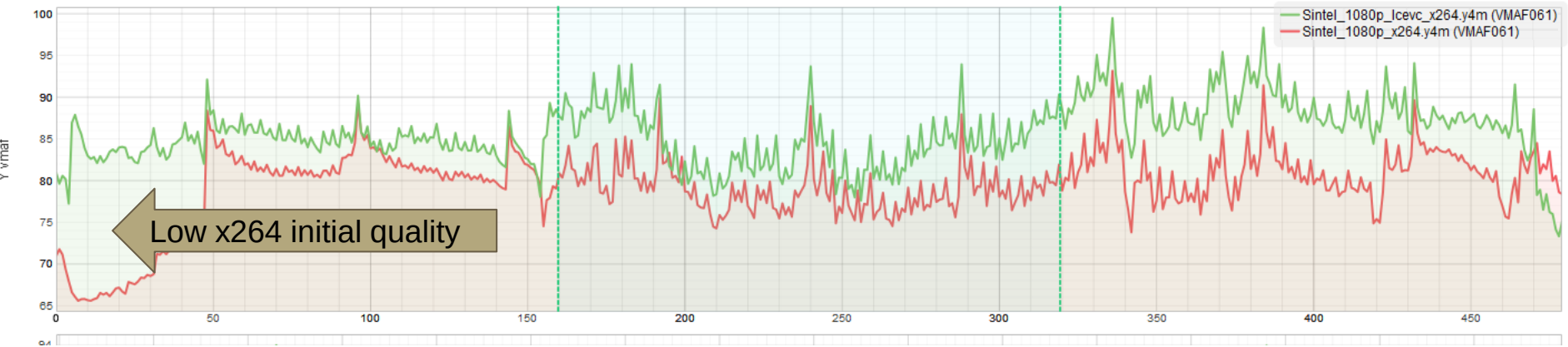
```
ffmpeg -i input.mp4 -c:v lcevc_h264 -base_encoder x264 -r 30 -g 60 -b:v 1000k  -eil_params "preset=veryslow;threads=1;scenecut=0;deterministic=1;lcevc_tune=vmaf;min-keyint=60" output_LCEVC.mp4
```

We tested with a modified build of FFmpeg version 4.2.2 that adds support for LCEVC enhancement. We used a beta version (3.0.bffe), of the LCEVC libraries from V-Nova. After agreeing on the command strings, V-Nova produced all files with spot verification by Doceo to ensure that the proper script was applied.

Initial tests included both CBR and CRF-based encoding, but we produced final results using single-pass CBR encoding as the most practical for a live encoding scenario.

We modified encoding strings for the applied quality analysis. Clips encoded for VMAF measurements were tuned accordingly (see above), for SSIM/MS-SSIM were encoded using `lcevc_tune ssim`, while clips encoded for subjective comparisons were tuned for maximum visual quality (i.e., `lcevc_tune` not specified).

Testing Philosophy



Care was taken to ensure the fairest possible comparison. For example, we observed that files encoded using x264 CBR encoding would often start with a few seconds of lower quality video as shown in the first few seconds of the clip above (see also plot on page 2).

This 2-3 seconds of comparatively low quality could unfairly influence subjective ratings based upon 20-second clips while proving irrelevant for a 2-hour movie. To eliminate this issue, we concatenated each clip to encode it twice and then extracted the second clip for subjective and metric analysis.

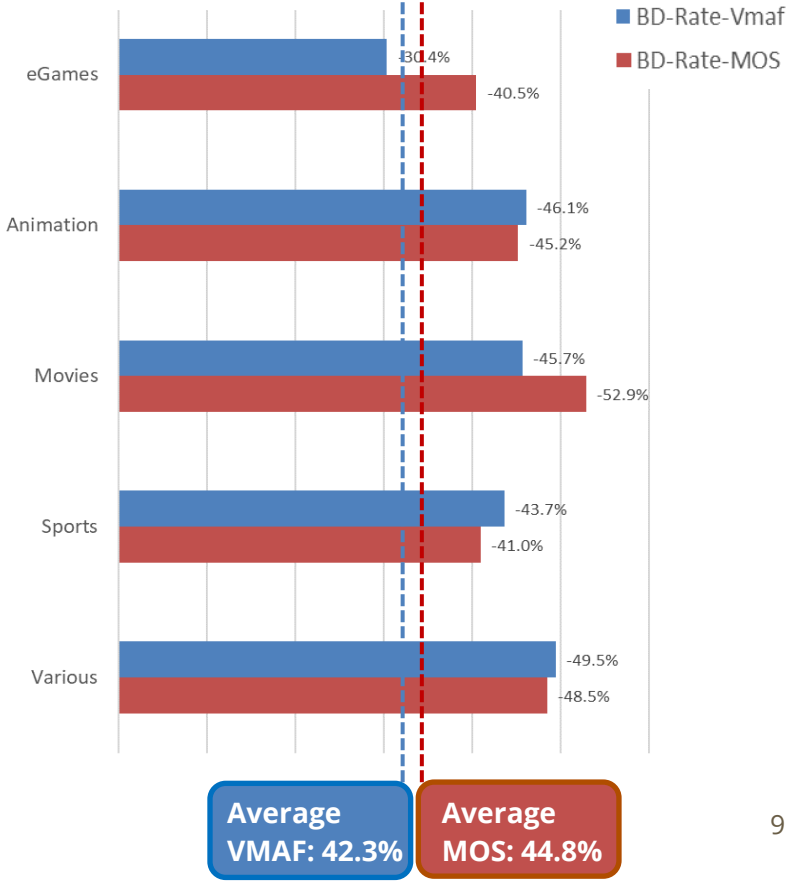
Significant Findings (Page 1)

The significant findings of this report are:

- VMAF scores (blue) and subjective MOS BD-Rate scores (red) show that when encoding 1080p files to relevant bitrates, ***LCEVC x264 is able to produce the same visual quality as x264 at about 60% of the data rate.***
- When encoding 1080p files to relevant distribution bitrates, VMAF scores have a higher correlation to MOS subjective scoring, while other metrics (e.g., SSIM, PSNR) are much less correlated

BD-Rate VMAF vs. BD-Rate MOS

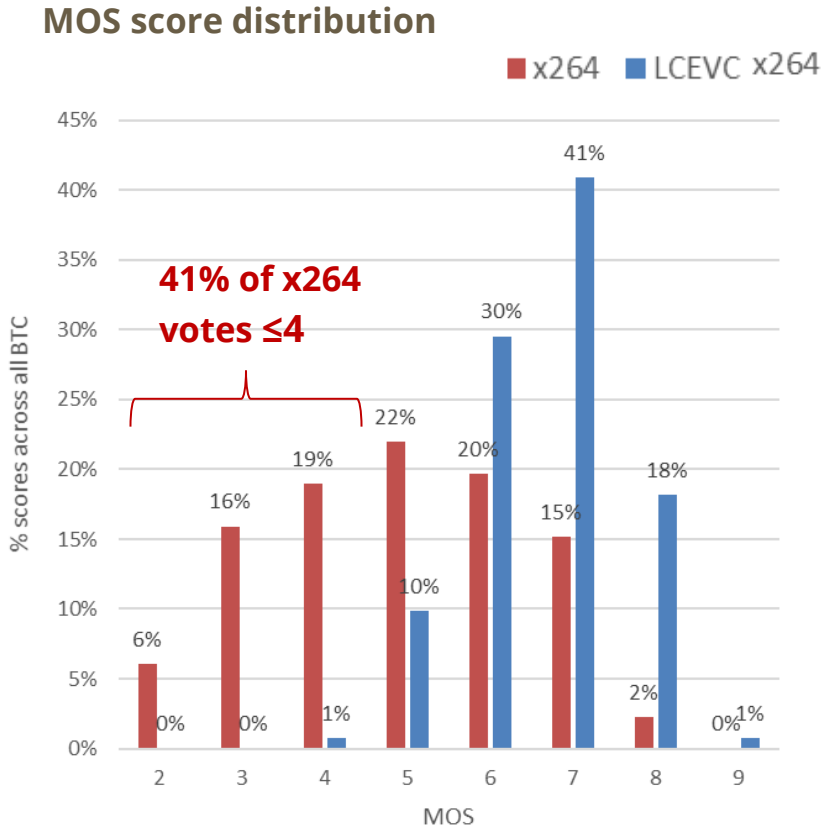
By content category



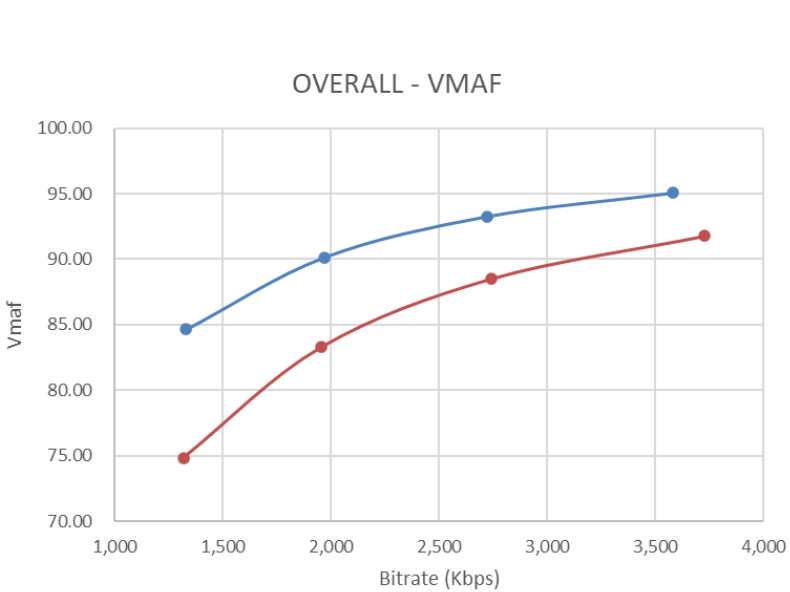
Significant Findings (Page 2)

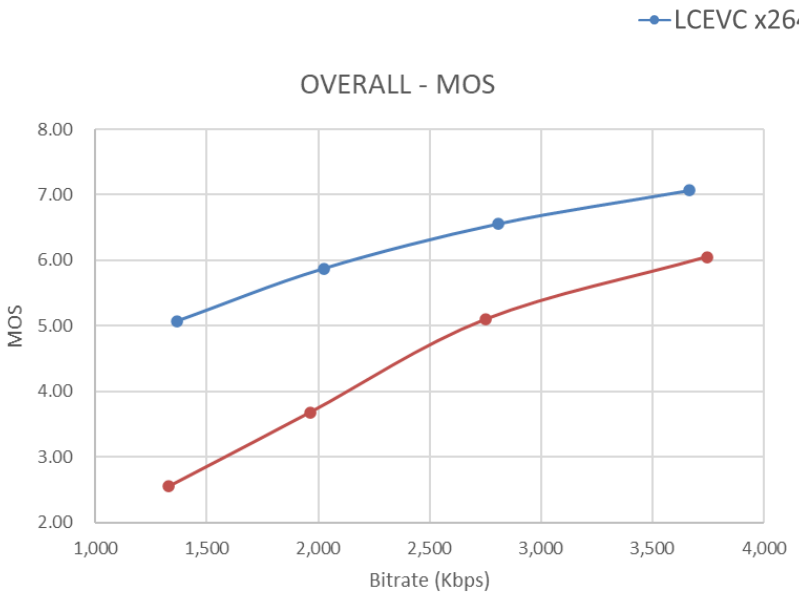
The significant findings of this report are (continued):

- x264 at lower data rates often scored <4 in the MOS scale (41% of the total votes were ≤4) due to ***visible impairments*** like blocking artifacts, and a general instability in the images, like flickering. A viewer commented “there were clearly visible blocks which created a moving mesh impossible to ignore.”
- ***LCEVC x264 showed more robustness***, scoring 5 and above in 99% of the cases. When bandwidth constrained, LCEVC x264 tended to soften the image which is typically not perceived by the naïve viewers as an annoying impairment, and is often ignored.
- At close viewing inspection on still frames and magnification (which was not the focus of this test), x264 is sometime sharper in selected parts, however at higher rates ***LCEVC x264 preserves more details and avoids the perceptible impairments*** often visible with x264 even at higher rates.



VMAF & MOS: Overall RD-curve Performance

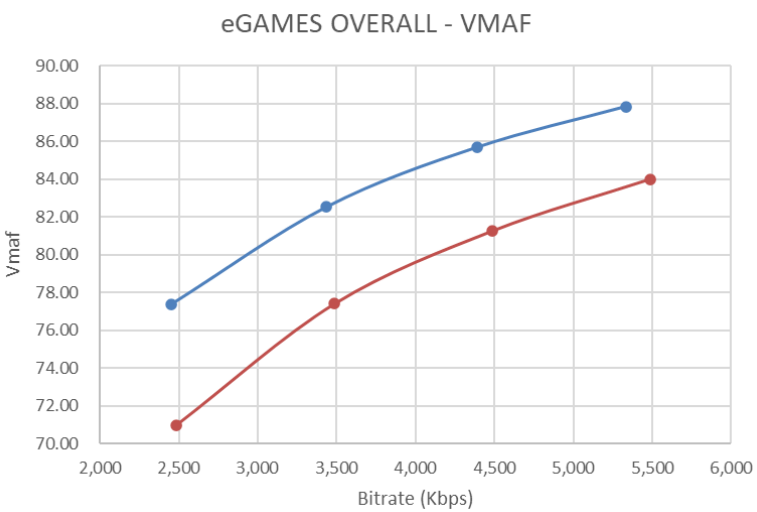


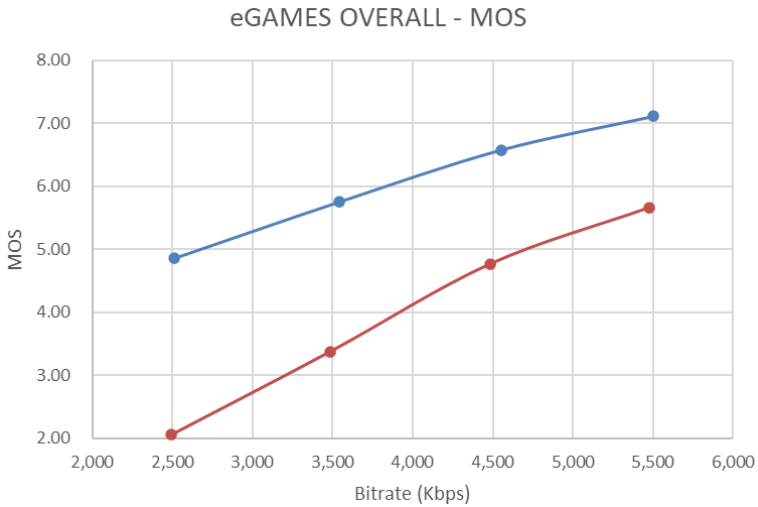


Overall, in VMAF testing, LCEVC x264 proved **42.3%** more efficient than x264 from around 1.1 Mbps through ~3.6 Mbps.

In subjective trials, LCEVC x264 proved even better, with a consistent advantage over x264 of **44.8%**

VMAF & MOS: eGames



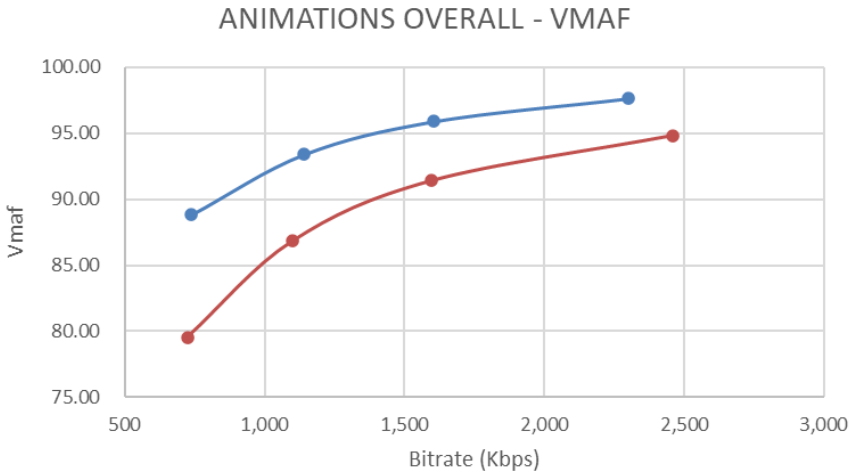


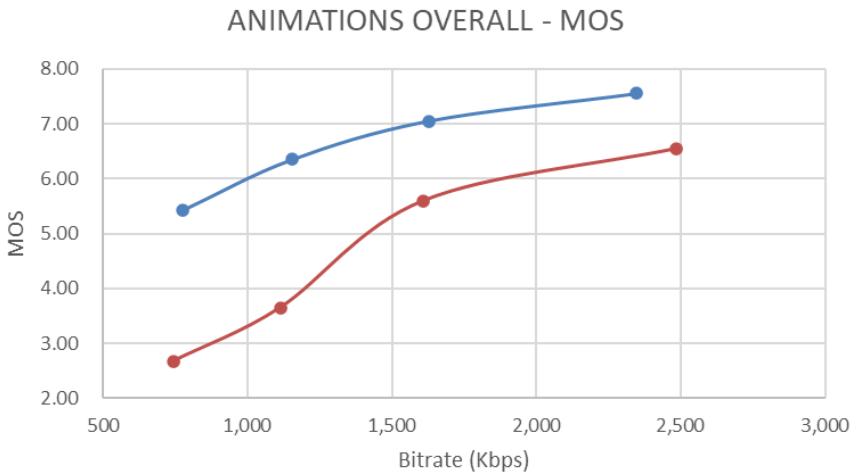
eGames performance compared the quality of eight computer games like Minecraft, Grand Theft Auto, and Witcher3, all encoded at 60 fps.

In VMAF scoring, LCEVC x264 was consistently superior to x264 through data rates ranging from 2.5 Mbps to 5.5 Mbps and produced the same quality as x264 at a **30.4%** lower data rate.

In subjective trials, LCEVC x264 particularly excelled at lower bitrates (but still relevant VMAF ranges) though x264 caught up slightly at higher bitrates. Nonetheless, throughout the tested range, LCEVC's MOS scoring showed a very significant **40.5%** advantage over x264.

VMAF & MOS: Animation



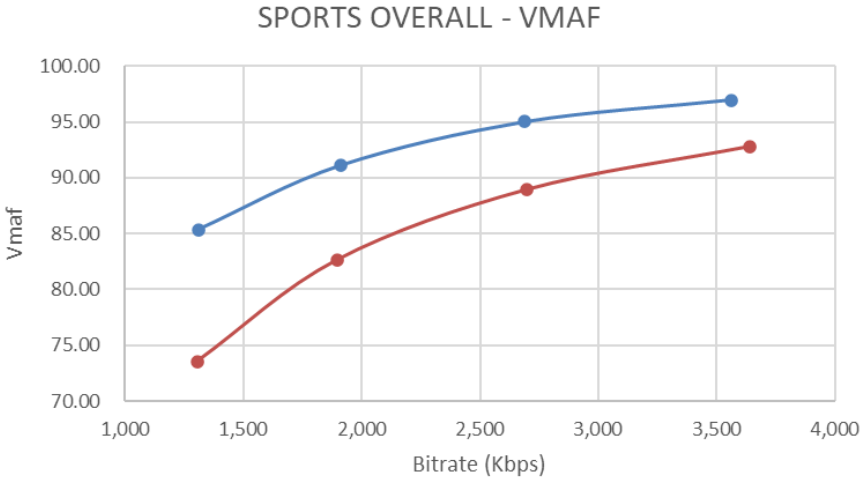


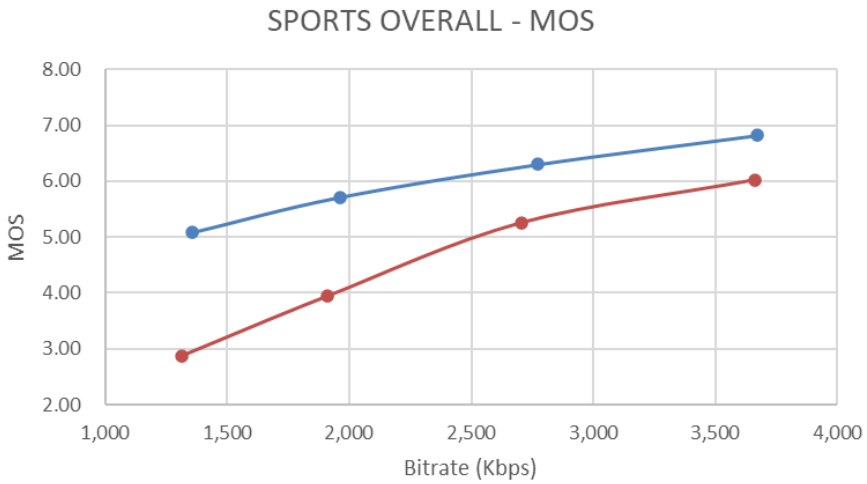
Animated clips included Big Buck Bunny, Sintel, character generated sequences from Tears of Steel, and Spanish cartoon El Ultimo.

In VMAF scoring, LCEVC x264 was consistently superior to x264 through data rates ranging from 700 kbps to 2.5 Mbps and produced the same quality as x264 at a **46.1%** lower data rate.

In subjective trials, LCEVC x264 outperformed x264 very significantly at lower data rates with x264 narrowing the gap at around 1600 kbps. Overall, through the tested range, LCEVC's MOS scoring showed a very significant **45.2%** advantage over x264.

VMAF & MOS: Sports



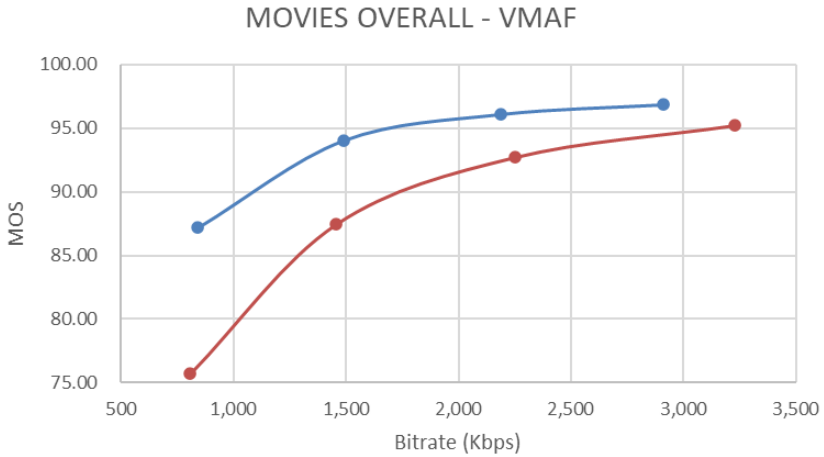


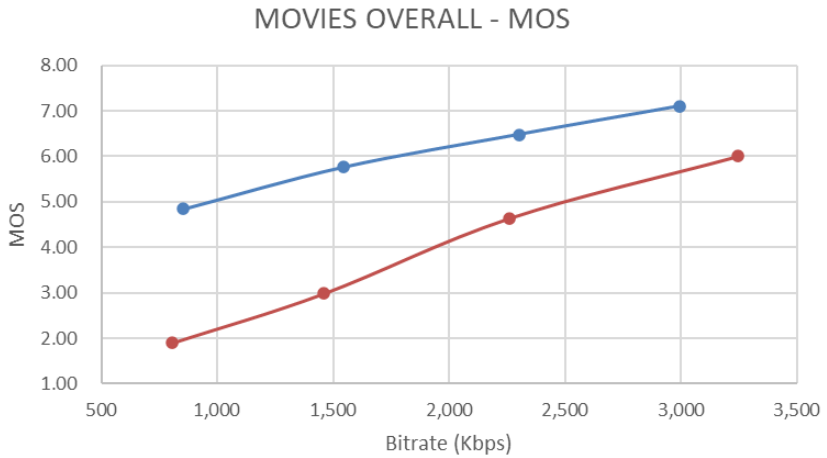
Sports included multiple test videos showing basketball, football, soccer, skateboarding, horse racing, tennis, Formula 1, rugby, and running.

In VMAF scoring, LCEVC x264 proved **43.7%** more efficient than x264 at data rates ranging from around 1.2 Mbs to 3.5 Mbps.

As seen in other genres, LCEVC x264 particularly excelled at lower bitrates with x264 catching up slightly at higher bitrates. Overall, LCEVC's MOS scoring showed that LCEVC was **41.0%** more efficient than x264.

VMAF & MOS: Movie



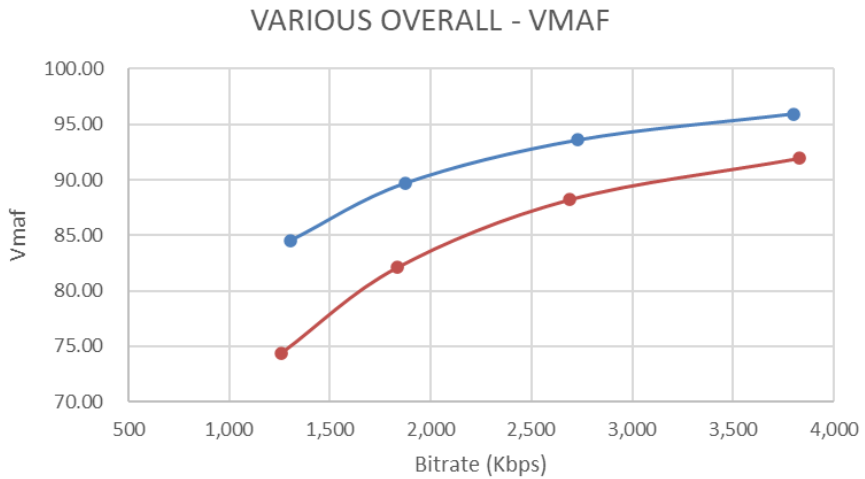


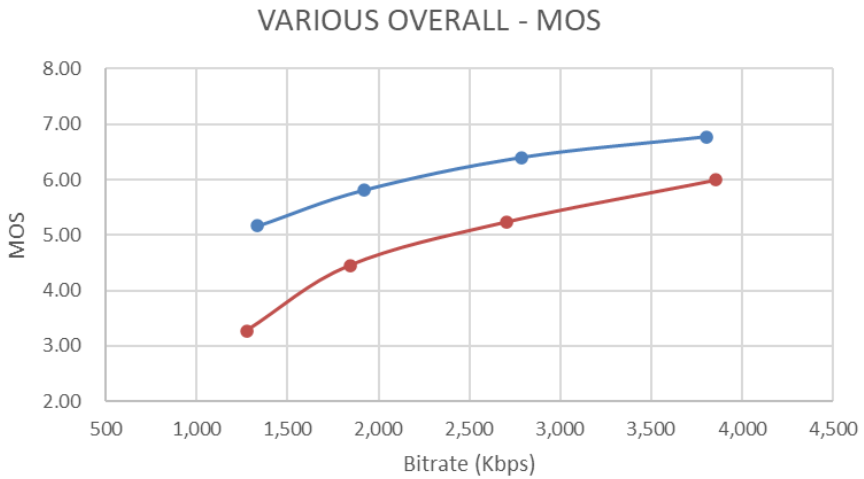
This genre included clips from Elektra, Meridian, STEM, actor-dominated scenes from Tears of Steel and the runway sequence from Zoolander 1 encoded at a range of frame rates.

In VMAF scoring, LCEVC x264 was **45.7%** more efficient than x264 through data rates ranging from ~750 kbps to ~3.3 Mbps and VMAF scores ranging from 76 to 96.

In subjective trials, LCEVC x264 proved **52.9%** more efficient than x264, the most significant margin in the test group.

VMAF & MOS: Various





This category included a wide range of clips that presented unique encoding challenges like excessive detail or ultra-high motion.
In VMAF scoring, LCEVC x264 proved **49.5%** more efficient than x264 from around 1.1 Mbps through ~3.8 Mbps.

In subjective trials, LCEVC proved even better, with a consistent advantage over x264 of **48.4%**

Frames Analysis: Overview

In this analysis we look beyond the scores and examine the lowest quality frames from two videos in each genre. We choose the two by selecting the videos where LCEVC x264 exhibited the best and worst MOS advantage over x264.

Then we identified the lowest quality frame in each clip and the same frame from the other clip. Full results in the Appendix, presented with the source clip first, then x264, then LCEVC x264.

Many of the lowest quality frames show only minor issues. However, in several instances (GTAV2, BBB, Zoolander), the blockiness and other artifacts in x264 are much more noticeable than LCEVC x264 – examples in the following pages.

			BD-rate LCEVC vs x264 (negative = LCEVC better)	
#	Type	video_name	Vmaf	MOS
1	eGames	EuroTruckSimulator2	Worst	-17.9%
2	eGames	fallout4	-25.7%	-23.7%
3	eGames	GTAV	-29.4%	-31.4%
4	eGames	GTAV2	Best	-65.0%
5	eGames	minecraft	-26.7%	-28.1%
6	eGames	RUST	-33.0%	-46.9%
7	eGames	starcraft	-30.5%	-59.7%
8	eGames	WITCHER3	-22.7%	-51.0%
9	Animation	BBB	Best	-58.3%
10	Animation	EL_ULTIMO	-65.9%	-42.2%
11	Animation	sintel	-36.9%	-40.7%
12	Animation	TOS_CG	Worst	-39.7%
13	Movies	Elektra	-52.3%	-52.5%
14	Movies	Meridian	-35.3%	-54.4%
15	Movies	STEM	-40.1%	-52.7%
16	Movies	TOS	Best	-57.9%
17	Movies	Zoo	Worst	-47.3%
18	Sports	horserun	Best	-57.0%
19	Sports	mountainbike	-22.3%	-41.8%
20	Sports	Skateboard	-34.0%	-50.1%
21	Sports	Sports_2_Football	Worst	-11.5%
22	Sports	Rugby	-51.4%	-49.5%
23	Sports	Soccer-Diego	-36.2%	-17.8%
24	Sports	F1AroundCorner	-45.8%	-48.7%
25	Sports	ElFuente_Box	-37.8%	-54.2%
26	Sports	Wimbledon	-100.0%	-37.8%
27	Various	Animals	-34.0%	-33.1%
28	Various	Freedom	-37.1%	-54.1%
29	Various	Hague	-47.4%	-61.8%
30	Various	liquor_store	Best	-71.8%
31	Various	orchestra	-47.3%	-55.1%
32	Various	PierSeaside	Worst	-9.8%
33	Various	RollerCoaster	-35.5%	-53.4%
Total			**-40.7%**	**-44.8%**

Frame analysis: BBB (animations)

Frame analysis: GTAV2 (eGames)

x264 – Lowest quality frame

LCEVC x264 - Equivalent

Frame analysis: Zoolander (movie)

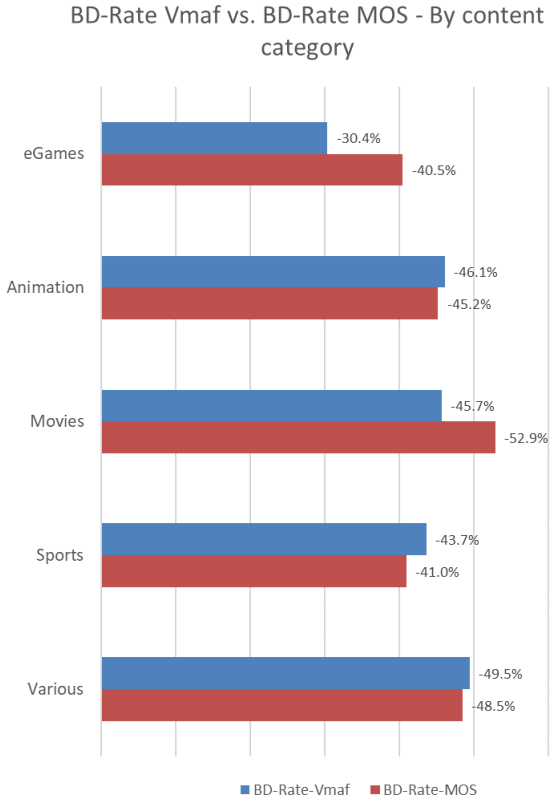
x264 – Equivalent

LCEVC x264 – Lowest quality frame

BD-Rate VMAF/MOS for Individual Clips

The chart shows BD-Rate scores for all the 5 genres. VMAF ratings ranged from a low of 30.4% (eGames) to 49.5% (Various) while MOS ranged from 40.5% (eGames) to 52.9% (Movies).

The table shows BD-Rate scores for all individual clips. VMAF ratings ranged from a low of 21.3% (EuroTrackSim2) to 100% (Wimbledon/Liquor Store) while MOS ranged from 10.1% (Pier Seaside) to 71.8% (Liquor Store).



			BD-rate LCEVC vs x264 (negative = LCEVC better)	
#	Type	video_name	Vmaf	MOS
1	eGames	EuroTruckSimulator2	-21.3%	-17.9%
2	eGames	fallout4	-28.3%	-23.7%
3	eGames	GTAV	-30.4%	-31.4%
4	eGames	GTAV2	-41.7%	-65.0%
5	eGames	minecraft	-29.4%	-28.1%
6	eGames	RUST	-33.8%	-46.9%
7	eGames	starcraft	-33.5%	-59.7%
8	eGames	WITCHER3	-24.5%	-51.0%
9	Animation	BBB	-44.6%	-58.3%
10	Animation	EL_ULTIMO	-65.3%	-42.2%
11	Animation	sintel	-37.6%	-40.7%
12	Animation	TOS_CG	-37.0%	-39.7%
13	Movies	Elektra	-52.7%	-52.5%
14	Movies	Meridian	-44.4%	-54.4%
15	Movies	STEM	-40.0%	-52.7%
16	Movies	TOS	-51.3%	-57.9%
17	Movies	Zoo	-40.1%	-47.3%
18	Sports	horserun	-34.7%	-57.0%
19	Sports	mountainbike	-26.1%	-41.5%
20	Sports	Skateboard	-33.2%	-50.9%
21	Sports	Sports_2_Football	-23.7%	-11.5%
22	Sports	Rugby	-50.7%	-49.5%
23	Sports	Soccer-Diego	-39.9%	-17.8%
24	Sports	F1AroundCorner	-48.0%	-48.7%
25	Sports	ElFuente_Box	-36.7%	-54.1%
26	Sports	Wimbledon	-100.0%	-37.8%
27	Various	Animals	-34.2%	-33.1%
28	Various	Freedom	-37.8%	-54.1%
29	Various	Hague	-50.8%	-61.8%
30	Various	liquor_store	-100.0%	-71.8%
31	Various	orchestra	-47.0%	-55.1%
32	Various	PierSeaside	-41.1%	-10.1%
33	Various	RollerCoaster	-35.4%	-53.4%
	eGames		**-30.4%**	**-40.5%**
	Animation		**-46.1%**	**-45.2%**
	Movies		**-45.7%**	**-52.9%**
	Sports		**-43.7%**	**-41.0%**
	Various		**-49.5%**	**-48.5%**
	Total		**-42.3%**	**-44.8%**

BD-Rates across all metrics

To complement VMAF and assess how LCEVC x264 performs across widely used objective measurements, we calculated three other metrics:

- PSNR
- SSIM
- MS-SSIM

Like VMAF, MS-SSIM shows a 33% BD-rate benefit in favor of LCEVC x264, while PSNR and SSIM show a positive BD-Rate (i.e., in favour of x264), which is NOT correlated to subjective observations.

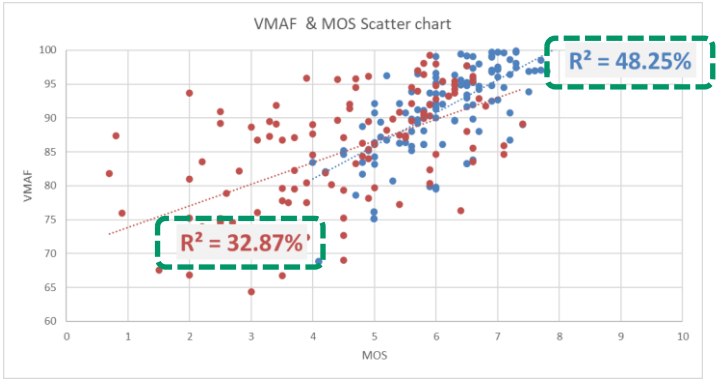
Next page show metrics correlation with 'ground-truth' MOS.

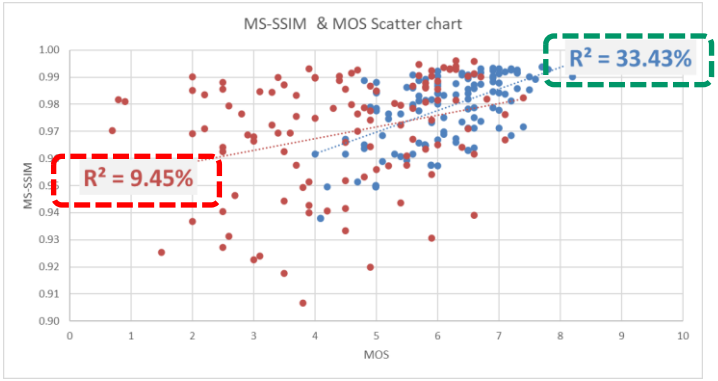
			BD-rate LCEVC vs x264 (negative = LCEVC better)				
#	Type	video_name	Psnr	Vmaf	SSIM	MS-SSIM	MOS
1	eGames	EuroTruckSimulator2	74.1%	-21.3%	12.4%	-24.9%	-17.9%
2	eGames	fallout4	34.4%	-28.3%	-4.0%	-32.9%	-23.7%
3	eGames	GTAV	26.7%	-30.4%	-3.6%	-32.4%	-31.4%
4	eGames	GTAV2	100.0%	-41.7%	26.2%	-31.6%	-65.0%
5	eGames	minecraft	12.2%	-29.4%	-22.9%	-43.7%	-28.1%
6	eGames	RUST	83.6%	-33.8%	9.9%	-48.2%	-46.9%
7	eGames	starcraft	100.0%	-33.5%	71.9%	-18.3%	-59.7%
8	eGames	WITCHER3	-5.5%	-24.5%	-30.0%	-50.8%	-51.0%
9	Animation	BBB	38.6%	-44.6%	13.8%	-15.2%	-58.3%
10	Animation	EL_ULTIMO	74.0%	-65.3%	38.4%	12.3%	-42.2%
11	Animation	sintel	29.6%	-37.6%	17.2%	-21.9%	-40.7%
12	Animation	TOS_CG	3.4%	-37.0%	-0.4%	-28.6%	-39.7%
13	Movies	Elektra	96.7%	-52.7%	100.0%	-32.9%	-52.5%
14	Movies	Meridian	88.9%	-44.4%	53.9%	-17.5%	-54.4%
15	Movies	STEM	-15.7%	-40.0%	-11.9%	-34.5%	-52.7%
16	Movies	TOS	6.3%	-51.3%	4.1%	-28.7%	-57.9%
17	Movies	Zoo	-20.9%	-40.1%	-18.8%	-38.4%	-47.3%
18	Sports	horserun	-15.2%	-34.7%	-16.9%	-32.3%	-57.0%
19	Sports	mountainbike	34.6%	-26.1%	22.7%	-11.1%	-41.5%
20	Sports	Skateboard	11.2%	-33.2%	-9.1%	-40.1%	-50.9%
21	Sports	Sports_2_Football	44.3%	-23.7%	39.9%	-11.1%	-11.5%
22	Sports	Rugby	-18.4%	-50.7%	-35.7%	-56.0%	-49.5%
23	Sports	Soccer-Diego	31.5%	-39.9%	-54.8%	-100.0%	-17.8%
24	Sports	F1AroundCorner	13.5%	-48.0%	-18.2%	-51.1%	-48.7%
25	Sports	ElFuente_Box	-31.7%	-36.7%	-13.2%	-28.8%	-54.1%
26	Sports	Wimbledon	10.8%	-100.0%	-20.5%	-62.4%	-37.8%
27	Various	Animals	14.1%	-34.2%	-1.2%	-22.5%	-33.1%
28	Various	Freedom	0.3%	-37.8%	-9.5%	-40.6%	-54.1%
29	Various	Hague	63.5%	-50.8%	36.9%	-18.8%	-61.8%
30	Various	liquor_store	12.4%	-100.0%	-12.0%	-34.0%	-71.8%
31	Various	orchestra	50.9%	-47.0%	3.4%	-39.1%	-55.1%
32	Various	PierSeaside	45.0%	-41.1%	4.8%	-24.1%	-10.1%
33	Various	RollerCoaster	-6.3%	-35.4%	-2.8%	-26.9%	-53.4%
	eGames		**53.2%**	**-30.4%**	**7.5%**	**-35.3%**	**-40.5%**
	Animation		**36.4%**	**-46.1%**	**17.3%**	**-13.4%**	**-45.2%**
	Movies		**31.1%**	**-45.7%**	**25.5%**	**-30.4%**	**-52.9%**
	Sports		**8.9%**	**-43.7%**	**-11.8%**	**-43.7%**	**-41.0%**
	Various		**25.7%**	**-49.5%**	**2.8%**	**-29.4%**	**-48.5%**
	Total		**29.9%**	**-42.3%**	**5.2%**	**-32.9%**	**-44.8%**

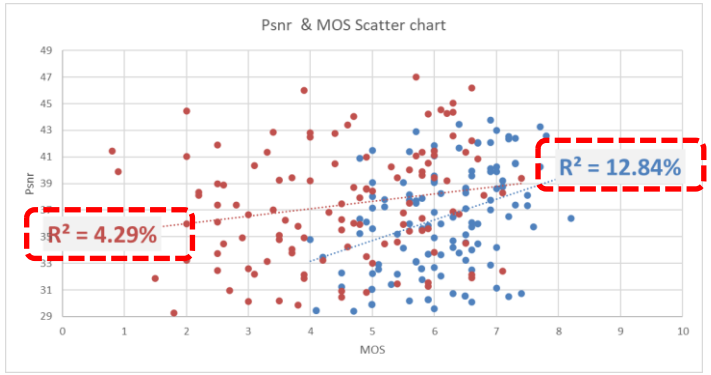
Metrics correlation with “ground-truth” MOS

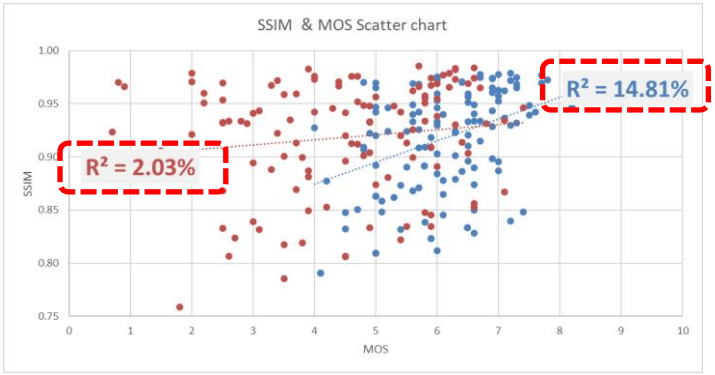
VMAF is the metric with the highest correlation with MOS for both codecs, **MS-SSIM** is second best for LCEVC

PSNR and SSIM have no/extremely low correlation with MOS for both codecs









LCEVC enhances x264 encoding speed by 2.5-2.7x

Encoding speed: command lines used

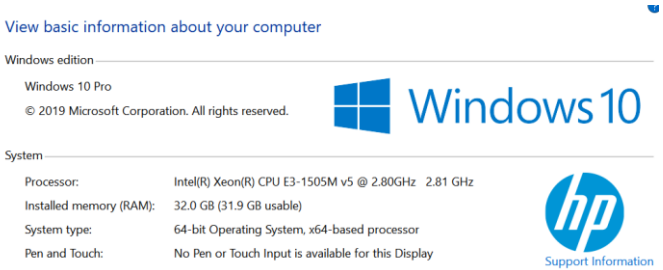
x264

```
ffmpeg -i input.mp4 -r 30 -c:v libx264 -b:v 1000k -bufsize 2000k -maxrate 1000k  -g 60.0 -keyint_min 60 -preset veryslow -sc_threshold 0 output.ts
```

LCEVC x264

```
ffmpeg -i input.mp4 -c:v lcevc_h264 -base_encoder x264 -r 30 -g 60 -b:v 1000k  -eil_params "preset=veryslow;scenecut=0;lcevc_tune=vmaf;min-keyint=60" output_LCEVC.ts
```

Encoding platform used



Encoding speed results

1080p, 1 Mbps

Encoding time in Seconds	x264	LCEVC	LCEVC Savings
Meridian	137	51	62.8%
Football	158	65	*58.9%*

Frames per second	x264	LCEVC	
Meridian	13	35	*2.7x*
Football	11	28	2.5x

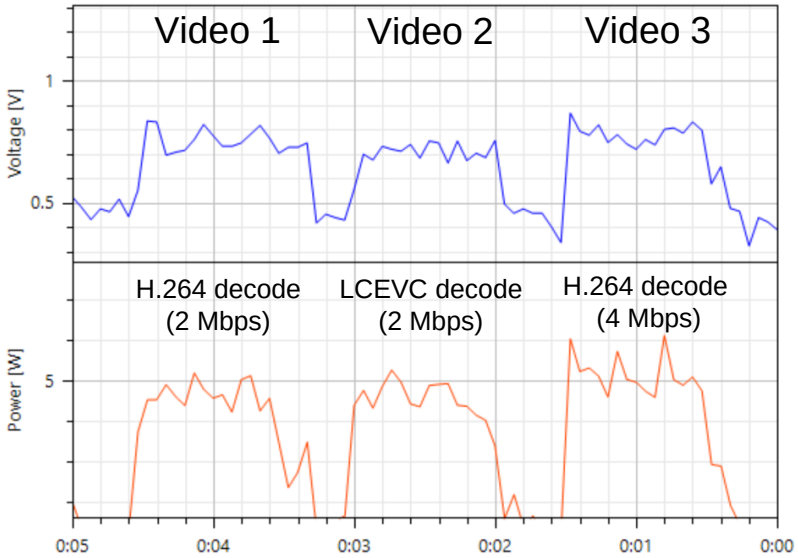
Decoder power drain

Most mobile platforms use hardware-accelerated H.264 playback to reduce battery consumption while playing H.264-encoded videos. With LCEVC, decoding the H.264 base-layer is also hardware accelerated, though decoding the enhancement layer is not.

We used the following tests to compare H.264 and LCEVC battery consumption. The tests involved three video files.

- Video 1 – H.264 @ 2 Mbps
- Video 2 – LCEVC @ 2 Mbps
- Video 3 – H.264 @ 4 Mbps (to match LCEVC quality)

We played these files back on a Zotac Zbox-EN72080v computer with a six-core I7-9750H running Windows 10, measuring voltage and power consumed with the Open Hardware Monitor utility (https://openhardwaremonitor.org/).



As you can see, compared to the 2 Mbps H.264 file, **LCEVC decode consumes lower voltage and about the same power**, so overall, LCEVC decode consumes less battery power. Compared to the 4 Mbps H.264 file, which is the **same approximate quality** as the LCEVC file, **LCEVC playback is more efficient in both power and voltage**.

So, **despite the lack of hardware acceleration for the decode of the enhancement layer, LCEVC playback is slightly more efficient than H.264 playback**.

Subjectify crowd-sourced subjective quality checks

Overview:

Subjectify (http://www.subjectify.us/) is a crowd-sourced cloud service run by Moscow State University. Subjectify recruits and pays testers on the web who watch two videos produced using different codecs or encoding parameters and choose the video with higher quality.

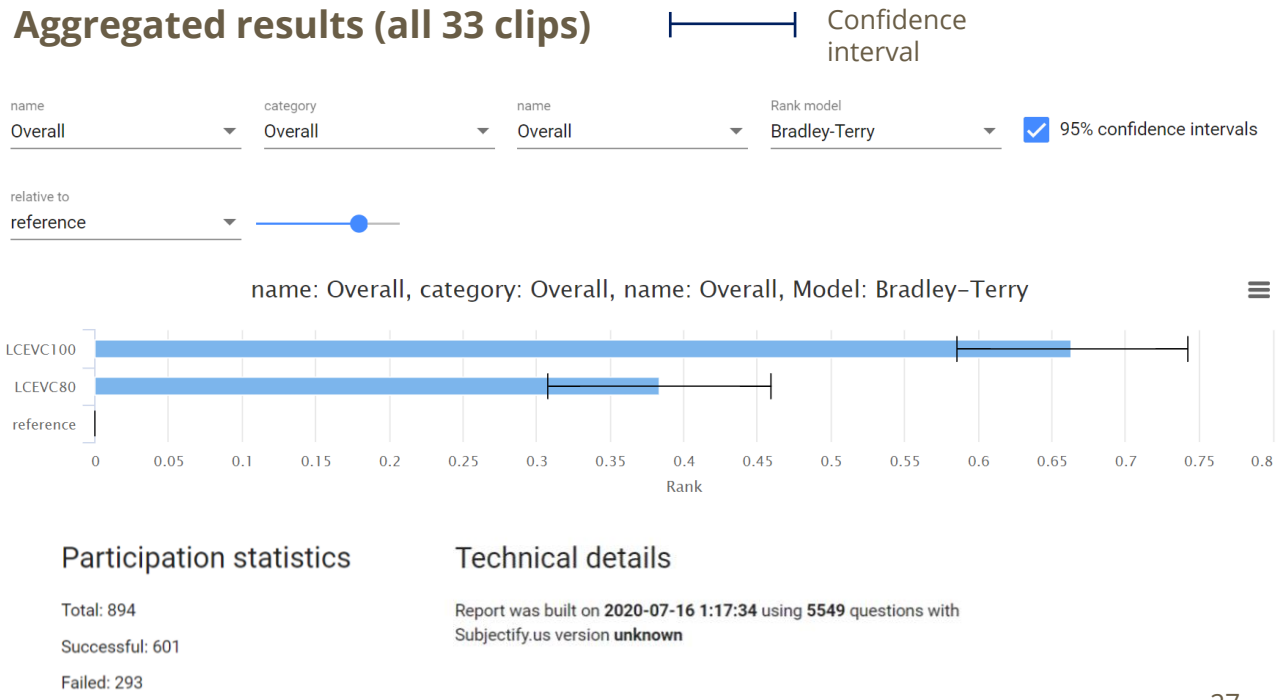
Videos are limited to about 20 seconds in duration, and testers make 10 comparisons in a session, with at least one comparison so obvious that it tests whether the tester is paying attention. If the tester chooses wrong on this question, all results are discarded, and that tester is disqualified from future participation.

- The objective of the Subjectify tests was to confirm that viewers preferred LCEVC videos encoded at the same rate as x264, and at 80% of the x264 bitrate.
- These tests involved the same 33 videos in 5 genres encoded at 1080p resolution.
- The x264 encoded video ('reference') was encoded at a data rate that delivered a VMAF quality of around 85; One LCEVC file was encoded at 100% of x264 bitrate ('LCEVC100') and the other at 80% of x264 bitrate ('LCEVC80').
- Both LCEVC x264 and x264 videos were transcoded to h264 at CRF16 quality for display by the testers.
- Subjectify accumulated over 80 crowd-sourced observations for each clip, for a total of 601 successful participants (i.e., who passed all verification checks) and 5549 answers collected.

Subjectify results (1/2)
LCEVC x264 at 80% of the bitrate outperforms x264

Key findings:

- At 1080p resolution, operators can reduce bitrates by at least 20% and still deliver perceptibly higher quality videos than x264



Subjectify results (2/2): LCEVC80 outperforms x264 consistently across genres

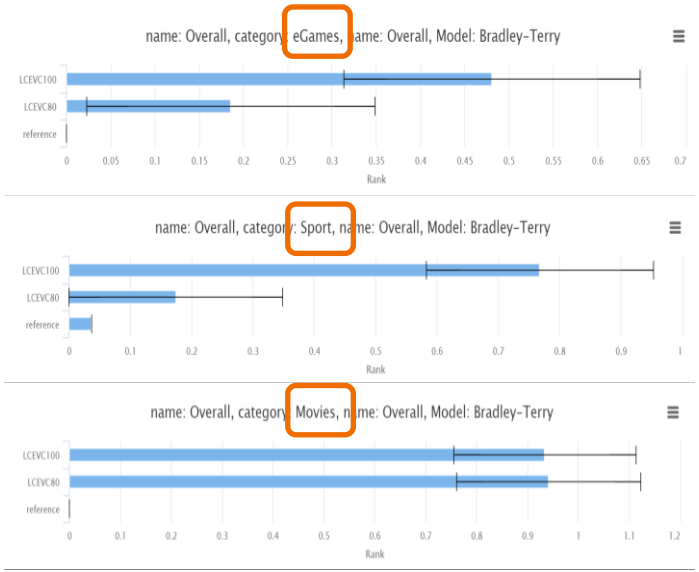
Confidence interval

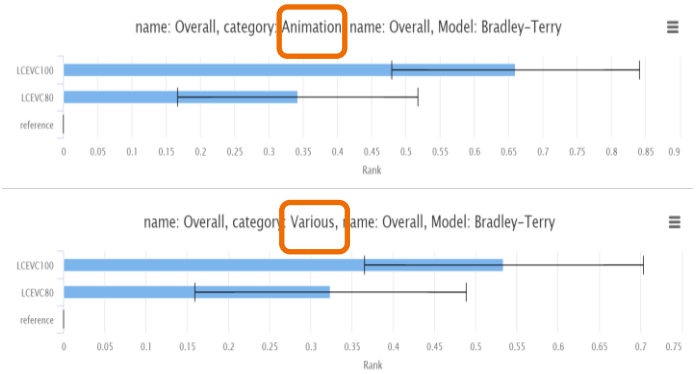
95% confidence intervals

Key findings:

- This result was clear in all tested genres

Results by content genre





Work to Come – Stay tuned

- These findings relate solely to 1080p files. Over the next few weeks, we will work to formulate the ideal LCEVC x264 encoding ladder and measure how it performs against an x264-only ladder
- Further research will explore the VoD use case using uncapped CRF to compute the Convex Hull for LCEVC x264 and x264
- LCEVC's performance when enhancing other codecs (e.g., x265), as well as UHD resolution