

# Evaluation of **MPEG-5 Part 2 (LCEVC)** for Gaming Video Streaming Applications

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# Objectives

Evaluation of the new MPEG-5 Low Complexity Enhancement Video Coding (LCEVC) standard on Gaming Content

Comparison of compression efficiency of LCEVC with existing practical implementation of video codec standards H.264/AVC and H.265/HEVC

# High level LCEVC decoding workflow

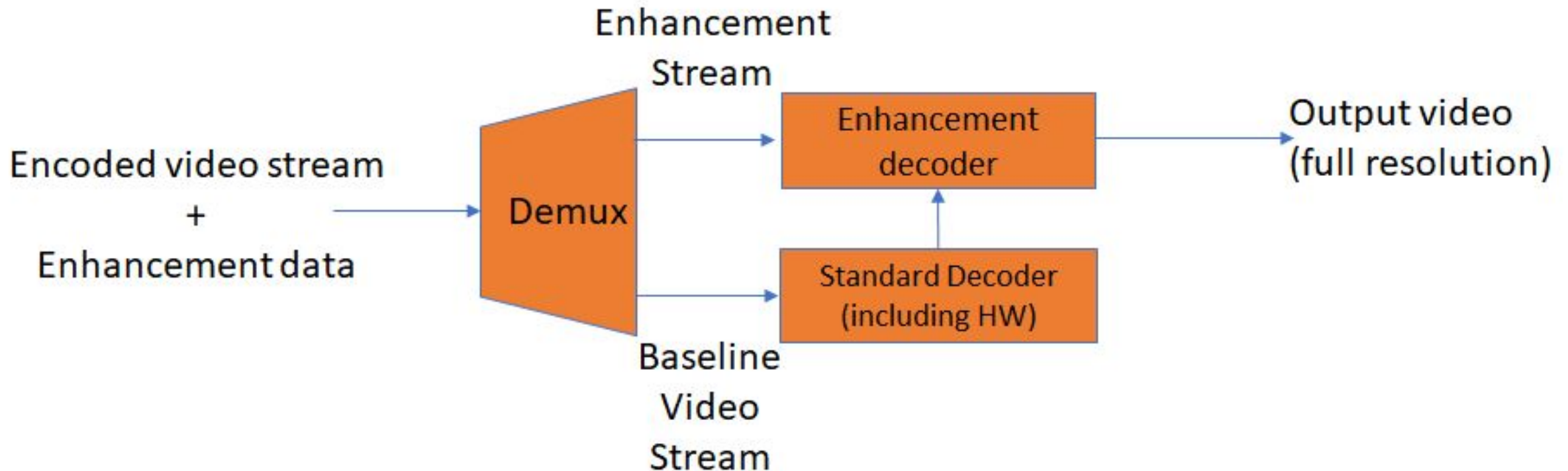
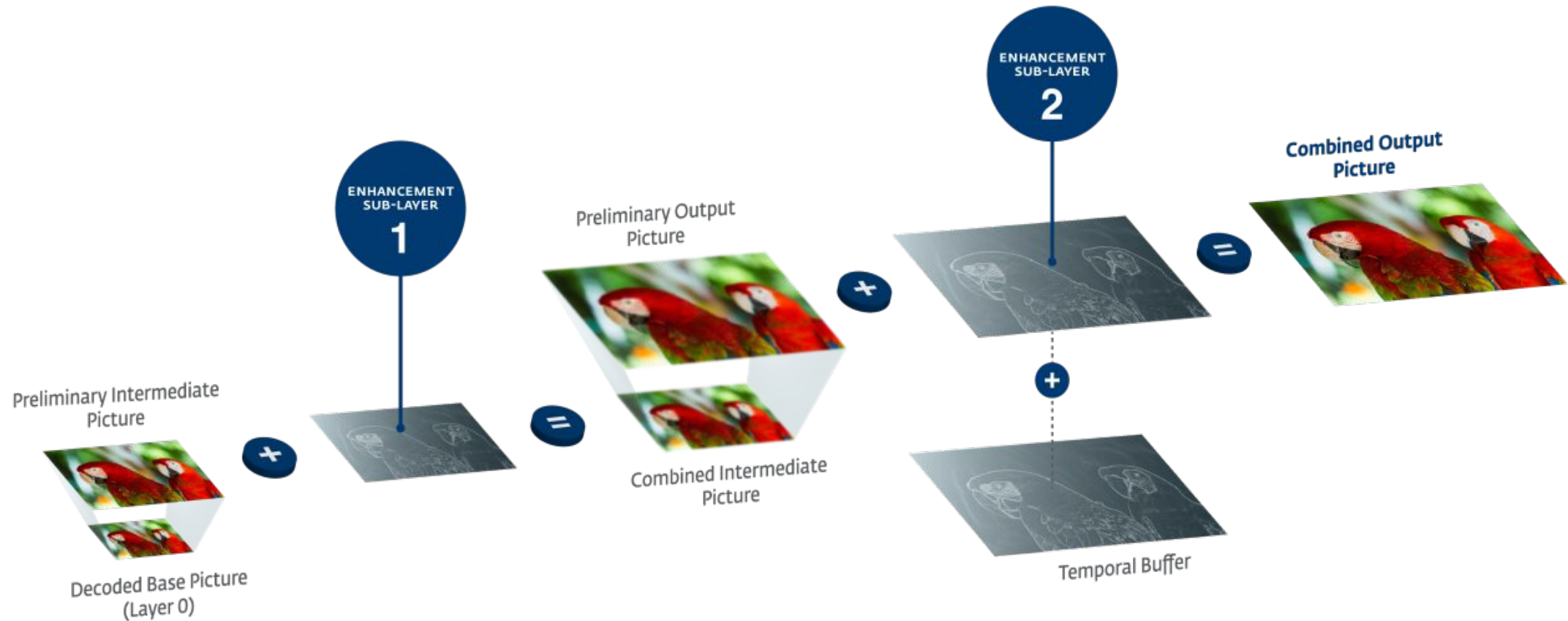


Image Source: <https://docs.v-nova.com/v-nova/lcevc/lcevc-sdk-overview>

# LCEVC: Two sublayers of residual data



# LCEVC Advantages

**Improved** video compression efficiency (compared to base codec used at full resolution)

**Reduced** overall encoding complexity

**Backwards compatible** with existing ecosystem of device (no new chipsets needed)

# Source Sequences

## Cloud Gaming Video Dataset (CGDVS)

- 14 reference gaming videos
- 1920x1080
- 60 fps
- 30 seconds

# Screenshots of six sample games used in this work



(a) Bejeweled



(b) Worms



(c) Fortnite



(d) LoL

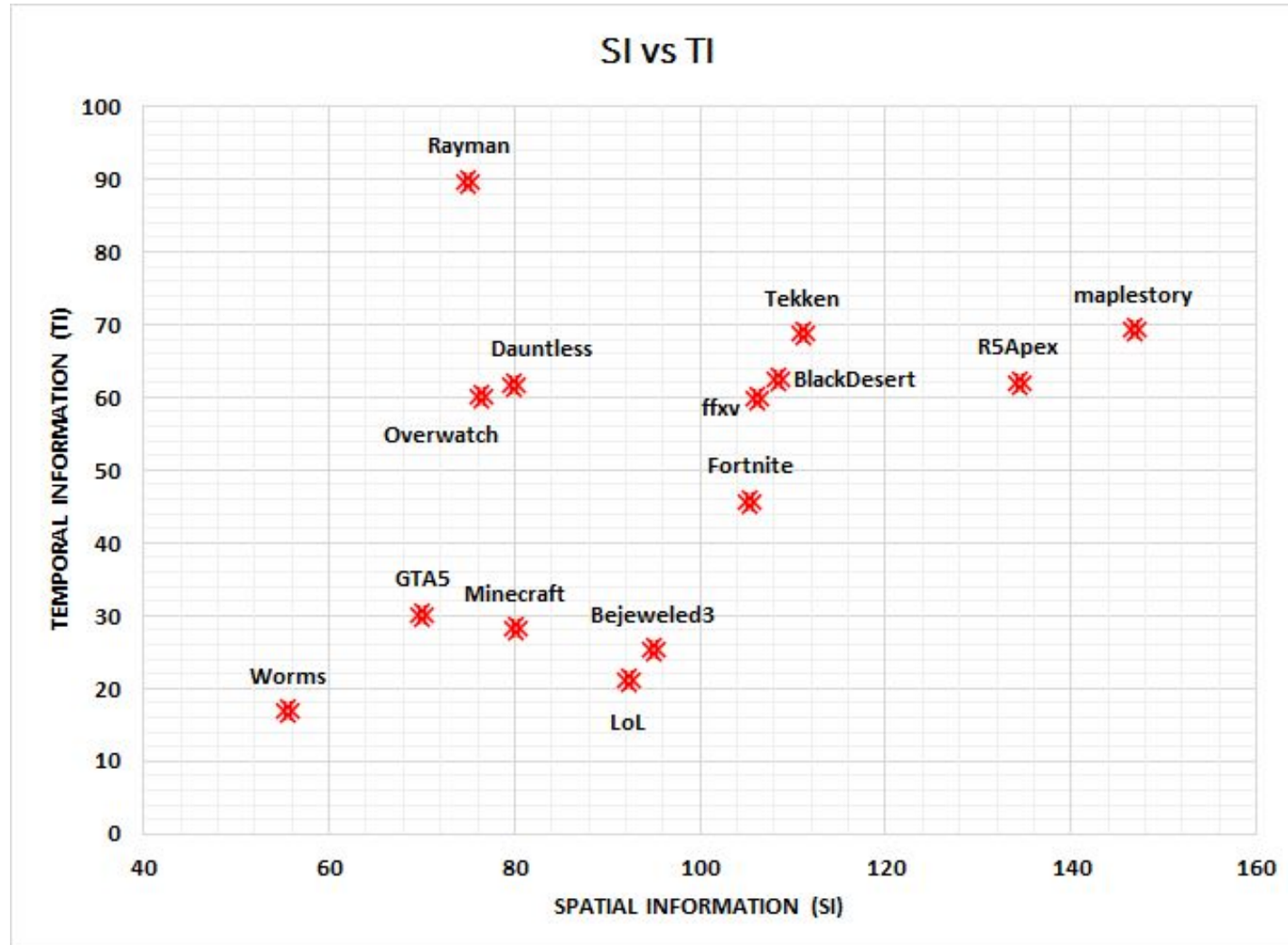


(e) Maplestory



(f) Overwatch

# Spatial Information (SI) vs Temporal Information (TI)





# Encoding Settings Summary

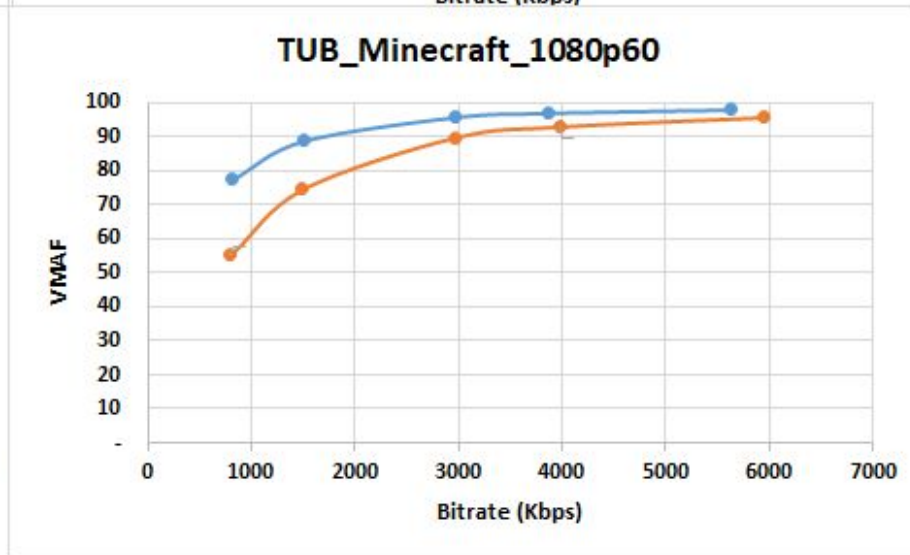
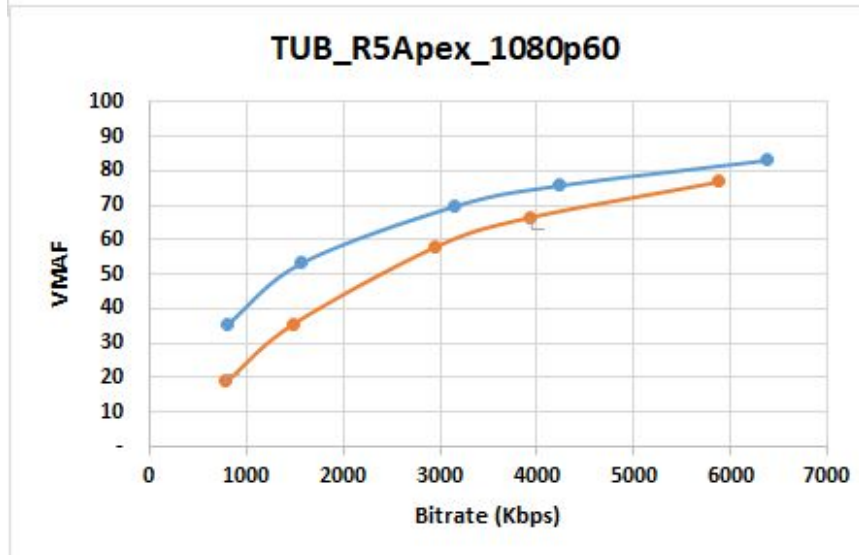
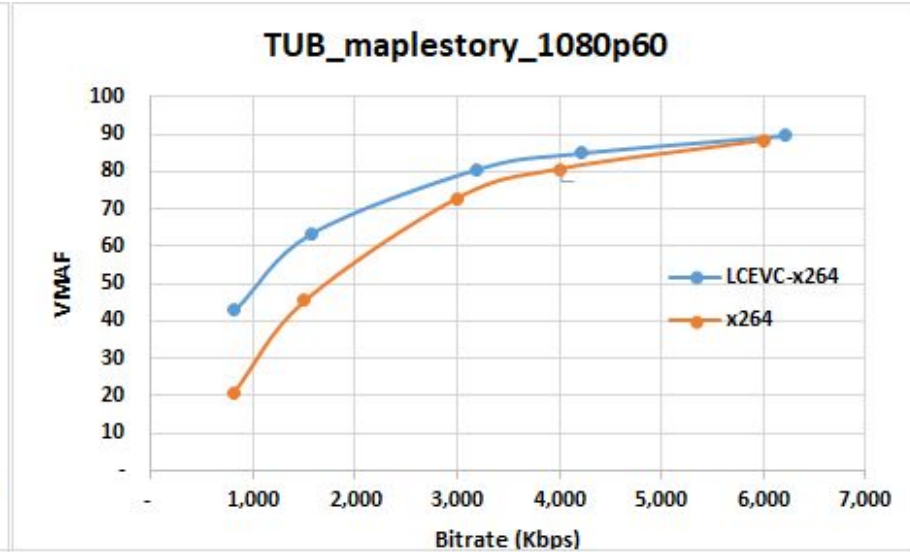
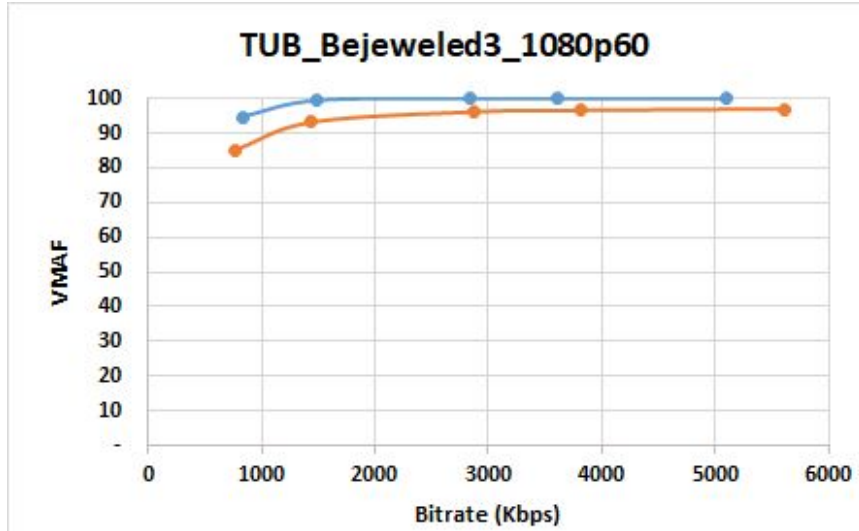
Parameter	Value
Duration	30 sec
Resolution	1080p
Bitrates (kbps)	800, 1500, 3000, 4000, 6000
Frame Rate	60.00
Encoder	FFmpeg
Encoding Mode	CBR
Video Compression Standards	H.264, H.265, LCEVC H.264, LCEVC H.265
Preset	medium and veryfast

- Constant Bitrate Encoding achieved by *-minrate* and *-maxrate* parameters
- Medium preset used for x264 and LCEVC x264 and veryfast used for x265 and LCEVC x265

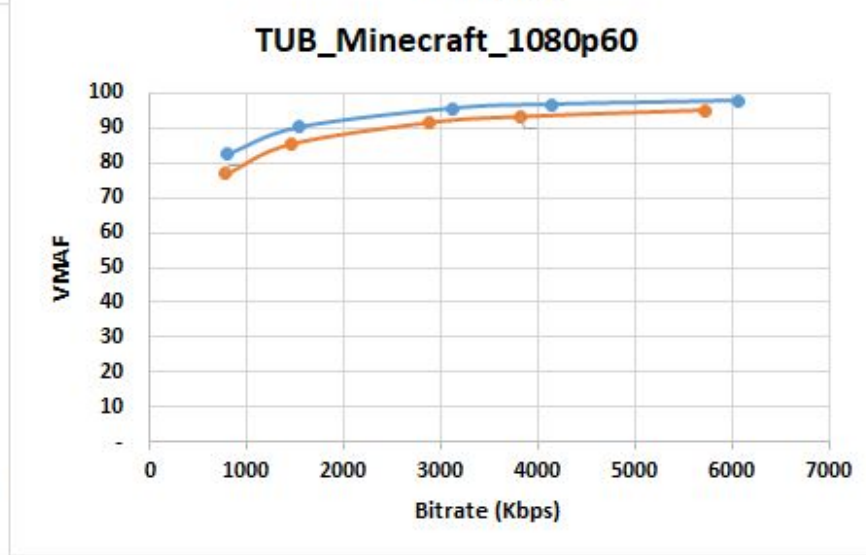
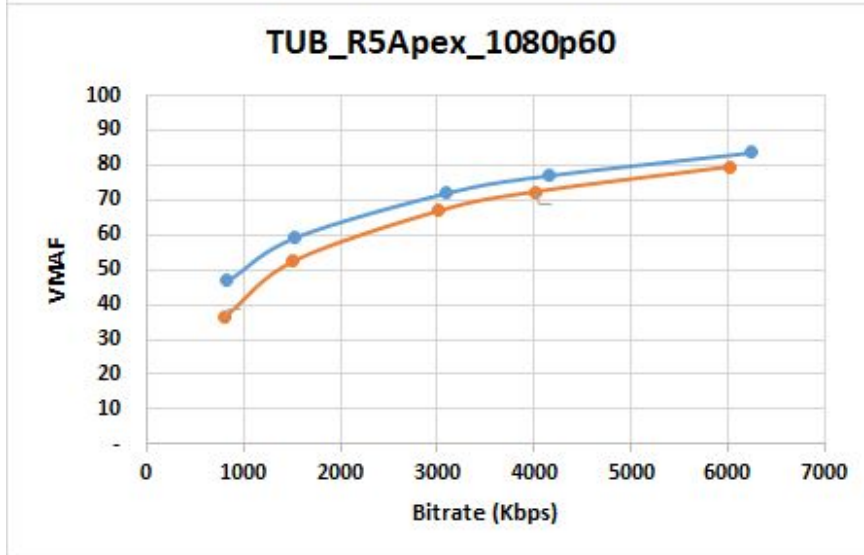
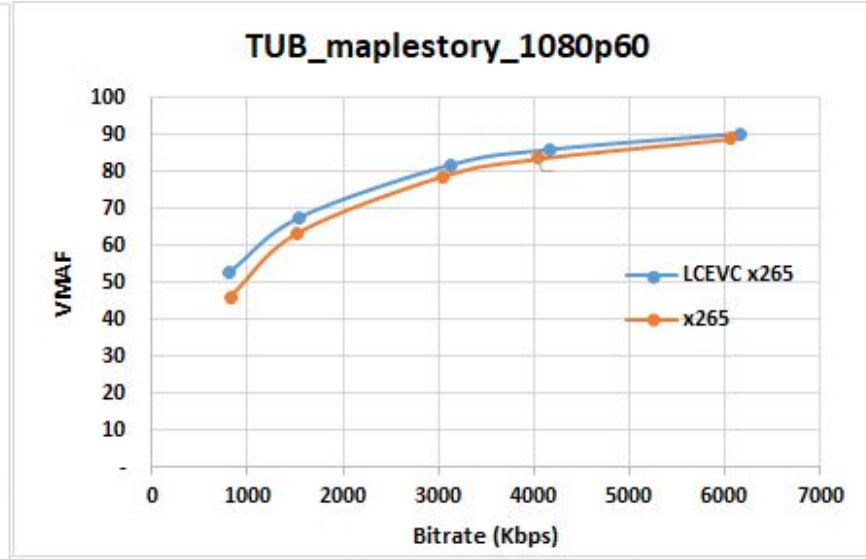
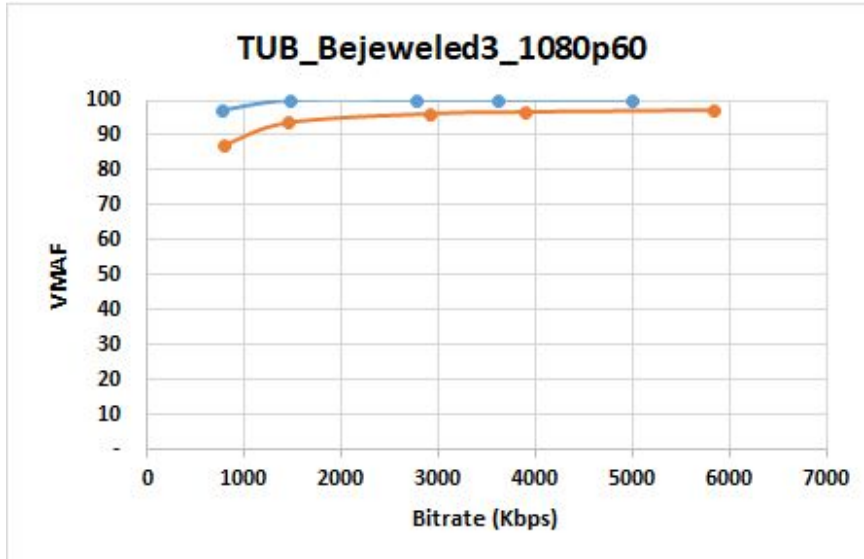
# Results

# Quality-BR curves

# X264 vs LCEVC-x264



# X265 vs LCEVC-x265



**BD-BR**

# x264 vs LCEVC\_x264 (medium preset)

Game	BD-Rate-VMAF (%)	BD-Rate-PSNR (%)
TUB_Bejeweled3_1080p60	-69.02%	NaN
TUB_BlackDesert_1080p60	-42.15%	-19.66%
TUB_Dauntless_1080p60	-40.15%	-28.00%
TUB_ffxv_1080p60	-41.57%	-27.68%
TUB_Fortnite_1080p60	-41.56%	-15.96%
TUB_GTA5_1080p60	-43.02%	-6.97%
TUB_LoL_TF_1080p60	-41.87%	NaN
TUB_maplestory_1080p60	-30.56%	15.04%
TUB_Minecraft_1080p60	-48.53%	14.28%
TUB_Overwatch_2_1080p60	-43.77%	-24.47%
TUB_R5Apex_1080p60	-36.74%	-7.61%
TUB_RaymanLegd_1080p60	-39.69%	-17.91%
TUB_Tekken_1080p60	-42.93%	-31.93%
TUB_Worms_1080p60	-28.35%	NaN
<b>Total BD-BR Savings</b>	<b>-42.14%</b>	<b>-13.72%</b>

# x265 vs LCEVC\_x265 (veryfast preset)

Game	BD-Rate-VMAF (%)	BD-Rate-PSNR (%)
TUB_Bejeweled3_1080p60	-86.74%	NaN
TUB_BlackDesert_1080p60	-33.25%	41.30%
TUB_Dauntless_1080p60	-26.42%	21.44%
TUB_ffxv_1080p60	-21.73%	45.70%
TUB_Fortnite_1080p60	-27.94%	45.95%
TUB_GTA5_1080p60	-30.61%	NaN
TUB_LoL_TF_1080p60	-51.78%	NaN
TUB_maplestory_1080p60	-14.91%	NaN
TUB_Minecraft_1080p60	-36.86%	NaN
TUB_Overwatch_2_1080p60	-32.08%	35.20%
TUB_R5Apex_1080p60	-25.40%	68.84%
TUB_RaymanLegd_1080p60	-37.84%	18.22%
TUB_Tekken_1080p60	-26.17%	17.15%
TUB_Worms_1080p60	-46.84%	NaN
<b>Total BD-BR Savings</b>	<b>-35.61%</b>	<b>36.73%</b>



# BD-BR Savings (VMAF)

Game	BD-Rate-VMAF (%)			
	x264 vs LCEVC_x264	x265 vs LCEVC_x265	x265 vs LCEVC_x264	x264 vs x265
TUB_Bejeweled3_1080p60	-69.02%	-86.74%	-70.92%	-37.79%
TUB_BlackDesert_1080p60	-42.15%	-33.25%	0.60%	-50.04%
TUB_Dauntless_1080p60	-40.15%	-26.42%	4.34%	-51.99%
TUB_ffxv_1080p60	-41.57%	-21.73%	-4.68%	-47.16%
TUB_Fortnite_1080p60	-41.56%	-27.94%	-2.51%	-51.47%
TUB_GTA5_1080p60	-43.02%	-30.61%	-6.60%	-50.07%
TUB_LoL_TF_1080p60	-41.87%	-51.78%	-42.61%	-28.81%
TUB_maplestory_1080p60	-30.56%	-14.91%	0.20%	-45.80%
TUB_Minecraft_1080p60	-48.53%	-36.86%	-22.98%	-51.00%
TUB_Overwatch_2_1080p60	-43.77%	-32.08%	3.33%	-54.91%
TUB_R5Apex_1080p60	-36.74%	-25.40%	-4.54%	-48.32%
TUB_RaymanLegd_1080p60	-39.69%	-37.84%	-5.17%	-46.33%
TUB_Tekken_1080p60	-42.93%	-26.17%	-2.81%	-52.56%
TUB_Worms_1080p60	-28.35%	-46.84%	-36.66%	-31.56%
<b>Total BD-BR Savings</b>	<b>-42.14%</b>	<b>-35.61%</b>	<b>-13.64%</b>	<b>-46.27%</b>

Note: x264 and LCEVC\_x264 are for videos encoded using medium preset, while x265 and LCEVC\_x265 results are for videos encoded using veryfast preset.

# High Complexity Games - Fortnite



# High Complexity Games - Tekken

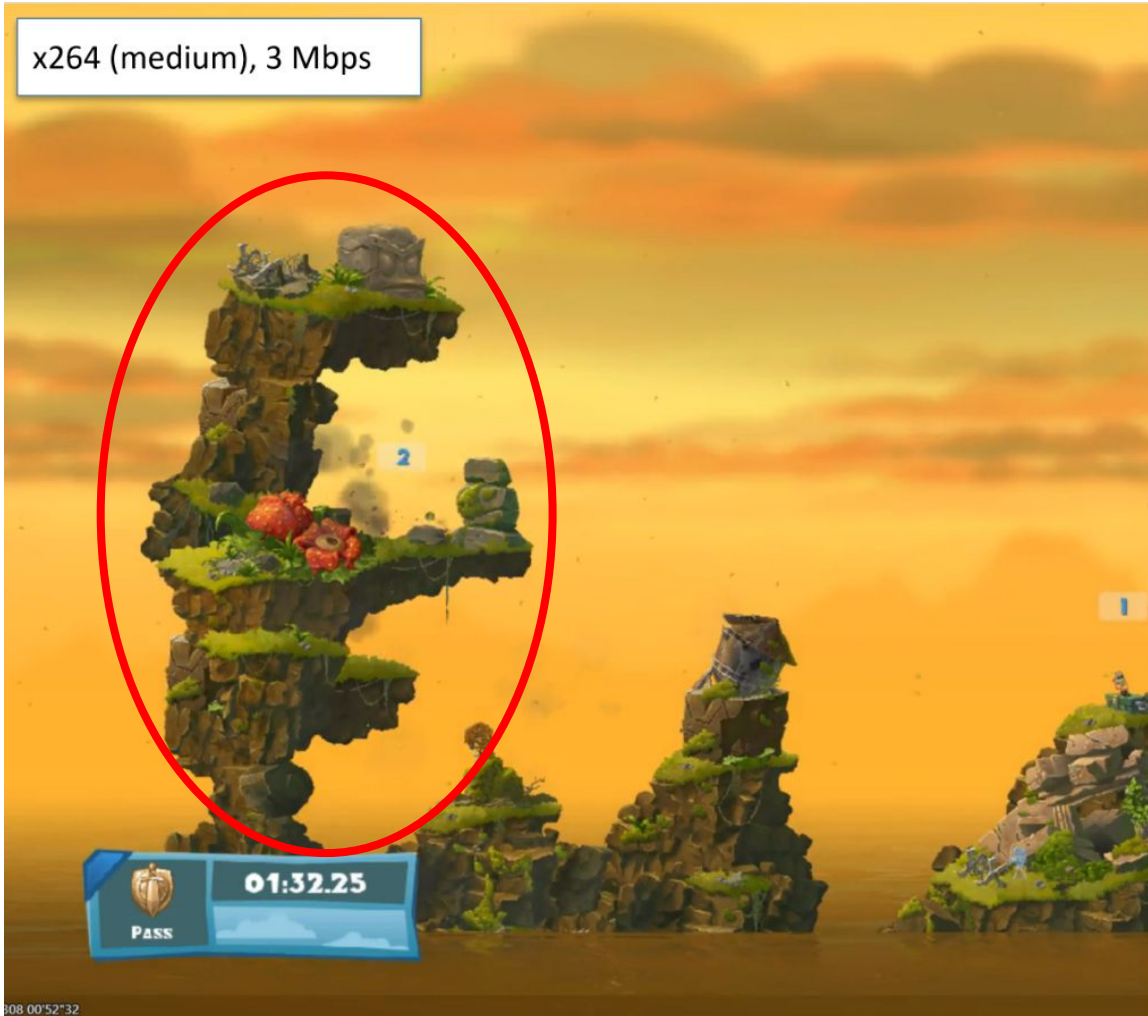


# Low Complexity Games - LoL



# Low Complexity Games - Worms

x264 (medium), 3 Mbps



LCEVC x264 (medium), 3 Mbps



# LCEVC demo: search 'V-Nova' in app stores

## Credentials:

User name: **LCEVC\_Gaming**

Pwd: **Gaming2021**



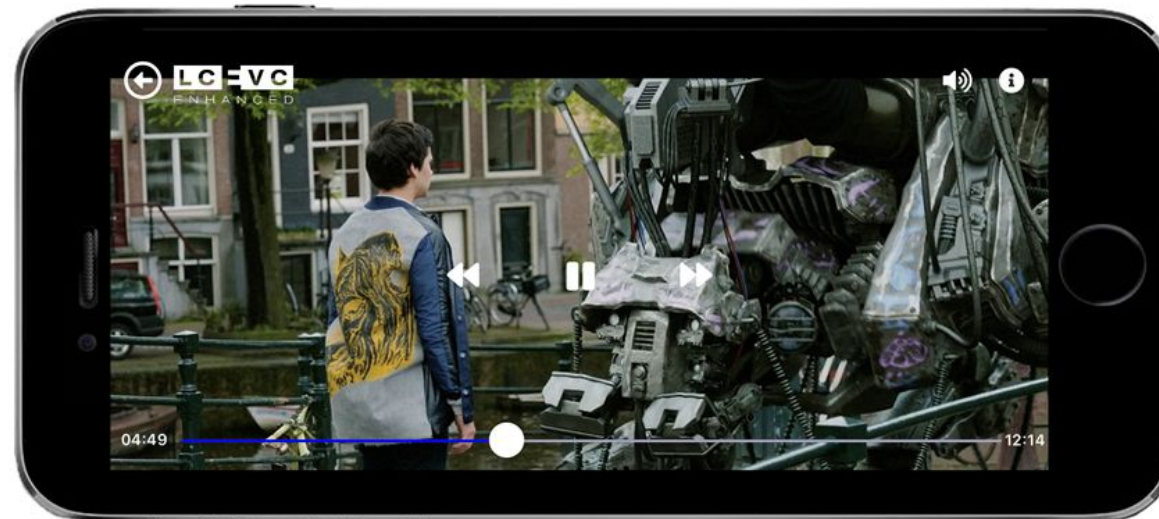
Download on the  
Windows Store



Download on the  
App Store



GET IT ON  
Google Play



# Encoding Speed

x264 (medium) --> LCEVC x264 (medium) is 1.7-2x faster

x265 (veryfast) --> LCEVC x265 (veryfast) is 1.2-1.3x faster

*Note:* This is a rough estimate based on few sample videos encoding on a Laptop. More detailed results will be calculated later

# Conclusion


- In terms of BD-BR analysis using VMAF, LCEVC outperforms both the base codecs, x264 and x265, respectively.
- In terms of BD-BR analysis using PSNR, while LCEVC\_x264 outperforms x264, x265 actually outperforms LCEVC\_x265.
- Initial visual inspection of encoded videos indicates VMAF based savings to be more realistic - formal subjective tests to be conducted.
- In terms of BD-BR using VMAF, LCEVC\_x264 (medium) outperforms x265 (veryfast) in terms of average bitrate savings (13.64%).
- x265 results in almost 46.27% bitrate savings than x264 (considering VMAF)



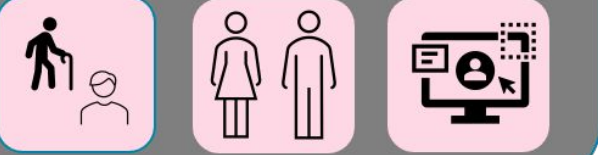
# Ongoing/Future Work

- Extend Comparative Analysis to VP9 and AV1
- Subjective Tests
- Multiple Resolution-BR analysis
- 4K, HDR gaming content

# Subjective Tests Plan

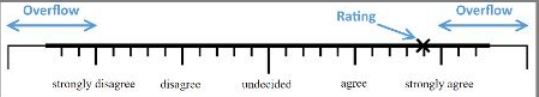
 Pre-questionnaire

Age      Gender      Experience




Instruction for the Test

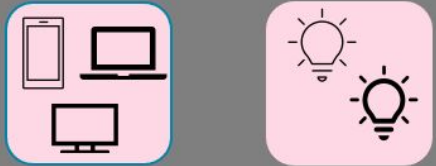
Questionnaire Scale



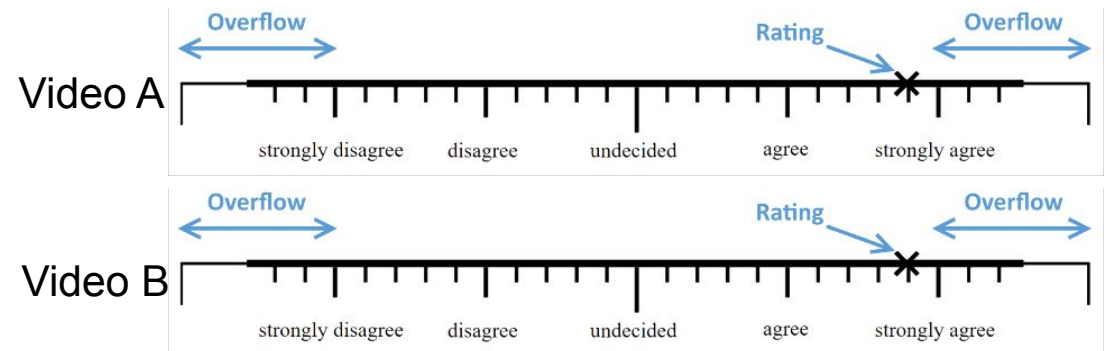
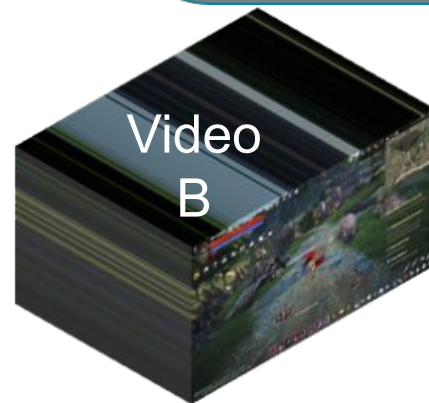
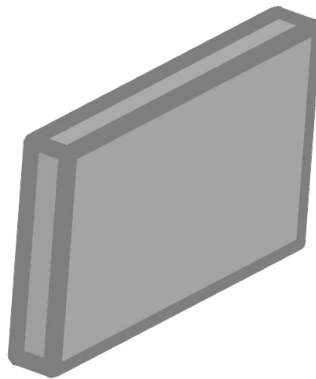
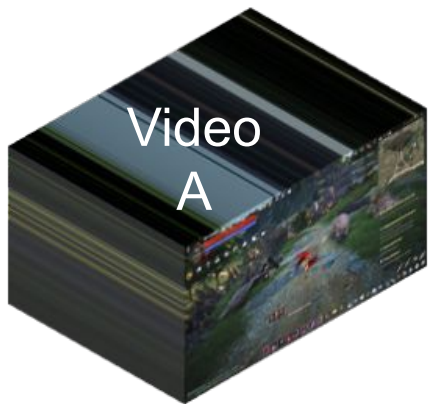
Distance



Device and Environment Setup



Device      Environment



# Acknowledgement

We would like to thank the team at VNOVA, especially Guendalina Cobianchi, Florian Maurer, Lorenzo Ciccarelli, Harry Morgan, Lorenzo Cassina and Simone Ferrara for providing us with the LCEVC SDK releases and help with setting up of the LCEVC encoding commands.

# References

The reference videos can be downloaded from the following link: CGVDS [Reference Videos](#)

The excel files with the VQA and other results and some sample decoded video LCEVC video sequences will be made available. For more information, please check out the following link:

<https://github.com/NabajeetBarman/LCEVC-LiveGaming>