

S9884 USER EXPERIENCE IS KEY TO VDI SUCCESS, COLOR ACCURACY IS THE KEY TO USER EXPERIENCE

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SESSION TARGET

Why is it key to choose the right protocol to get the best user experience

- CITRIX PROTOCOL OVERVIEW
- PROTOCOL/CODEC USAGE SCENARIOS
- IMAGE QUALITY HUMAN EYE & SSIM MEASUREMENT FOR H.264
- BANDWIDTH COMPARISON FOR VIDEO USE CASE
- VDI ON SCALE TESTING
- WRAP-UP

PROTOCOL & CODECS

Citrix XenDesktop 7.18

Video Codec Policy	Region	Visual Quality	CODECS USED	HW ENC*
Do Not Use	Region optimized	Medium	Static: JPEG (90) + 2D/MDRLE Video: Adaptive JPEG (10-65)	No
For Entire Screen	Entire Screen	Medium	H.264 4:2:0	Yes
For act. changing regions	Region optimized	Medium	Static: JPEG (90) + 2D/MDRLE Video: H.264 4:2:0	Yes
H.264+TextOptimization*	Entire Screen	Medium	H.264 4:2:0 + Lossless Text	No
For Entire Screen	Entire Screen	Build To Lossless	H.264 4:2:0 during activity, 2D/MDRLE when stationary	Yes
For Entire Screen	Entire Screen	Visual lossless: Medium	H.264 4:4:4	Yes
For Entire Screen (H.265)	Entire Screen	Medium	H.265 4:2:0	Yes
For act. changing regions (H.265)	Region optimized	Medium	Static: JPEG (90) + 2D/MDRLE Video: H.265 4:2:0	Yes
For act. changing regions (H.265)	Entire Screen	Build To Lossless	H.265 4:2:0 during activity, 2D/MDRLE when stationary	Yes

* no policy available for TextOpt

* videocodec (H.264/H.265) part via NVENC

CODECS & USE CASE

What to use when...

Bitmap (JPG, RLE)	H.264	H.265
• 2DRLE/MDRLE for text/crisp areas, JPEG for photographic imagery • „Build to Lossless“ and „Always Lossless“ policies for pixel perfect quality • Many compression policies (Image quality, color depth, etc.) • Can utilize client side bitmap cache • No hardware encoding (NVENC) • Very bandwidth efficient for static content ➡ Office VDI usage	YUV 4:2:0 • Good compression and visual quality • Hardware encoding (NVENC) • Chroma subsampling yields blurred text • Bandwidth efficient for video/moving images ➡ 3D VDI usage YUV 4:4:4 • Very good visual quality • Hardware encoding (NVENC) • No chroma subsampling • Great for sharp graphics as well as text • Increase in bandwidth ➡ 3D VDI usage with high color accuracy requirements	YUV 4:2:0 • Better compression at same visual quality or same quality at lower bandwidth (compared to H.264) • Requires hardware encoding (NVENC) • No CPU encoding as it would be too cost intensive (~8xCPU load compared to H.264) • Requires specific endpoint capabilities to decode H.265. Use 3rd party tools like DXVAChecker to see if your endpoint is capable ➡ 3D VDI usage in low bandwidth scenarios

CODECS & USE CASE

What to use when...

Mixed Mode (Video and Bitmap)

Adaptive Display / Selective H.264/H.265

- „Hybrid“: Use the best available codec for a specific screen „region“
- Leverages hardware encoding H.264/H.265 (NVENC) for video regions (a.k.a. „Selective H.264“). If HW encoding not available, software H.264 encoding is used.
- Very good image quality for static content (Bitmap) and low bandwidth requirement for moving images/video (H.264/H.265)

➡ Office VDI usage with multimedia content

H.264/H.265 / Build to Lossless (NEW with 7.18)

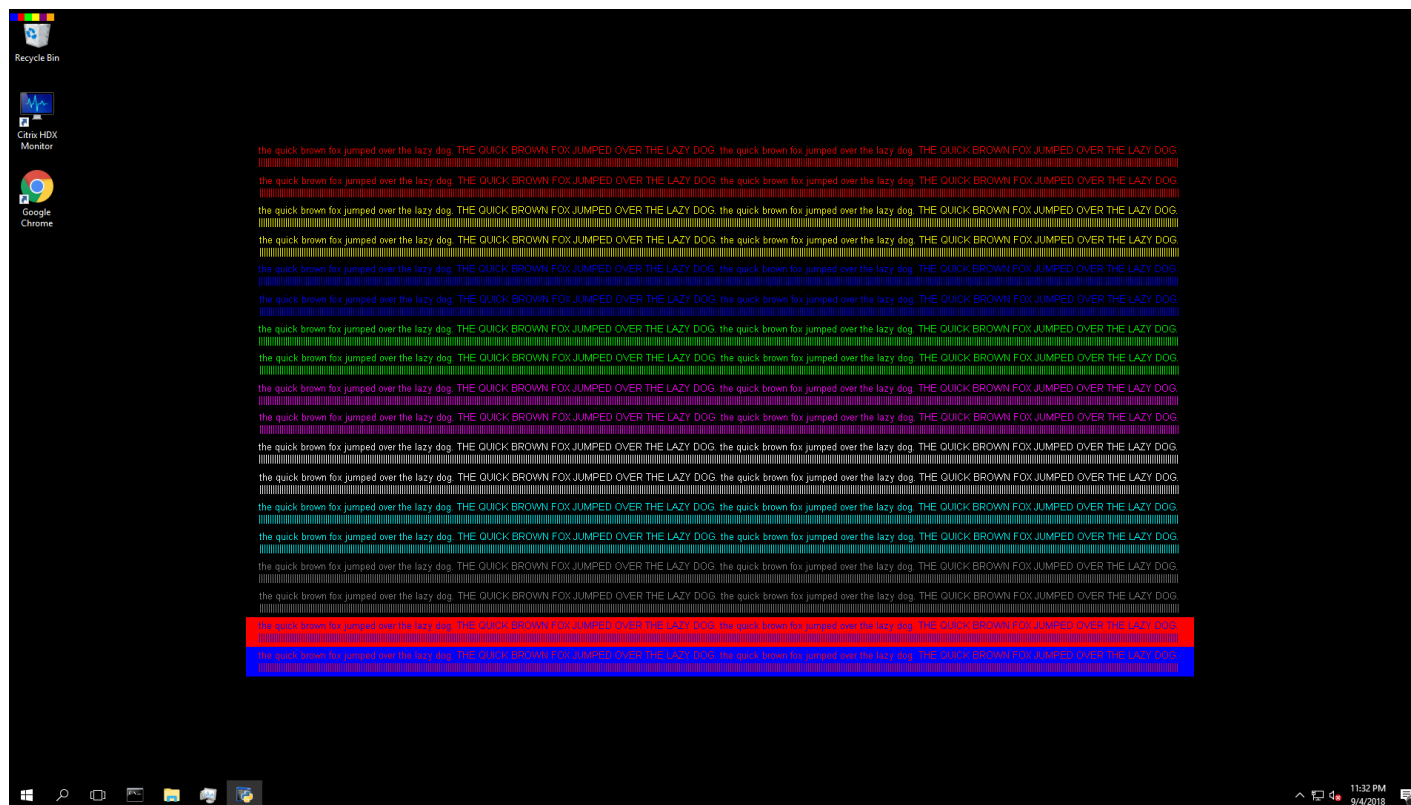
- Hardware encoding (NVENC) for video codec usage
- „Sharpening“ effect when changing from moving to static content but pixel perfect quality
- Chroma subsampling less problematic as it is used only for moving images/video

➡ 3D VDI usage with high color accuracy requirements and low bandwidth

IMAGE QUALITY COMPARISON

COMPARISON H.264

YUV4:2:0 and YUV4:4:4 (Reference Image)



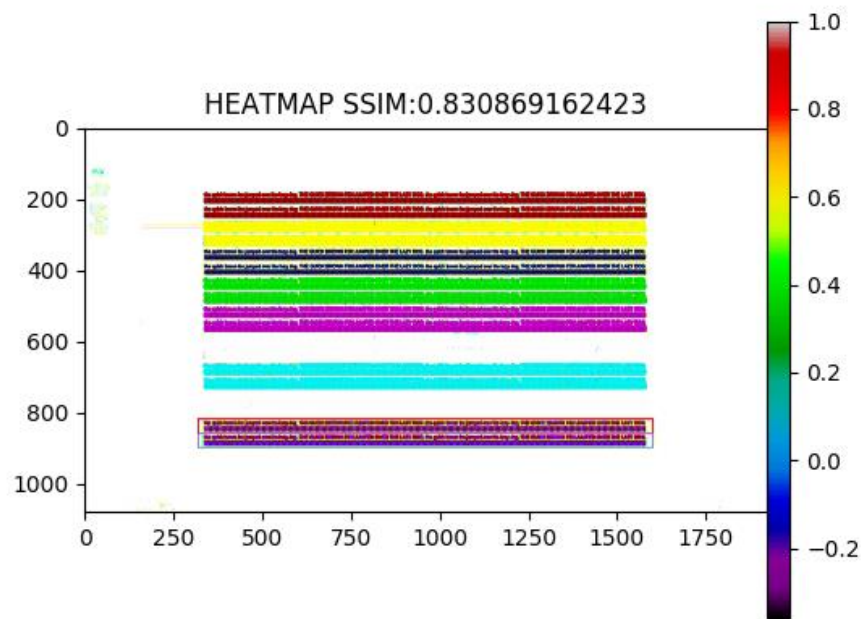
COMPARISON H.264

YUV4:2:0 and YUV4:4:4



H.264 (STATIC TEXT)

YUV4:2:0



YUV4:4:4

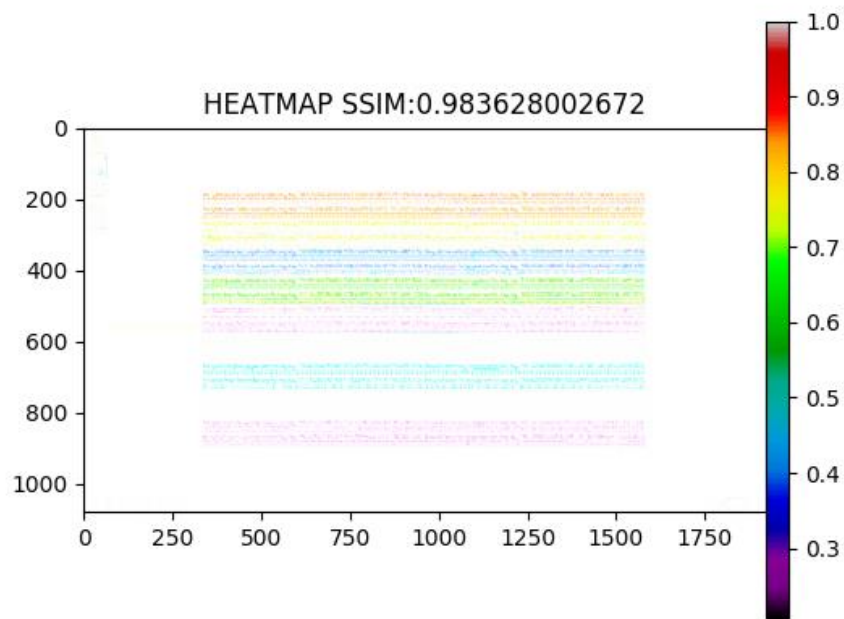


IMAGE QUALITY

Static Text

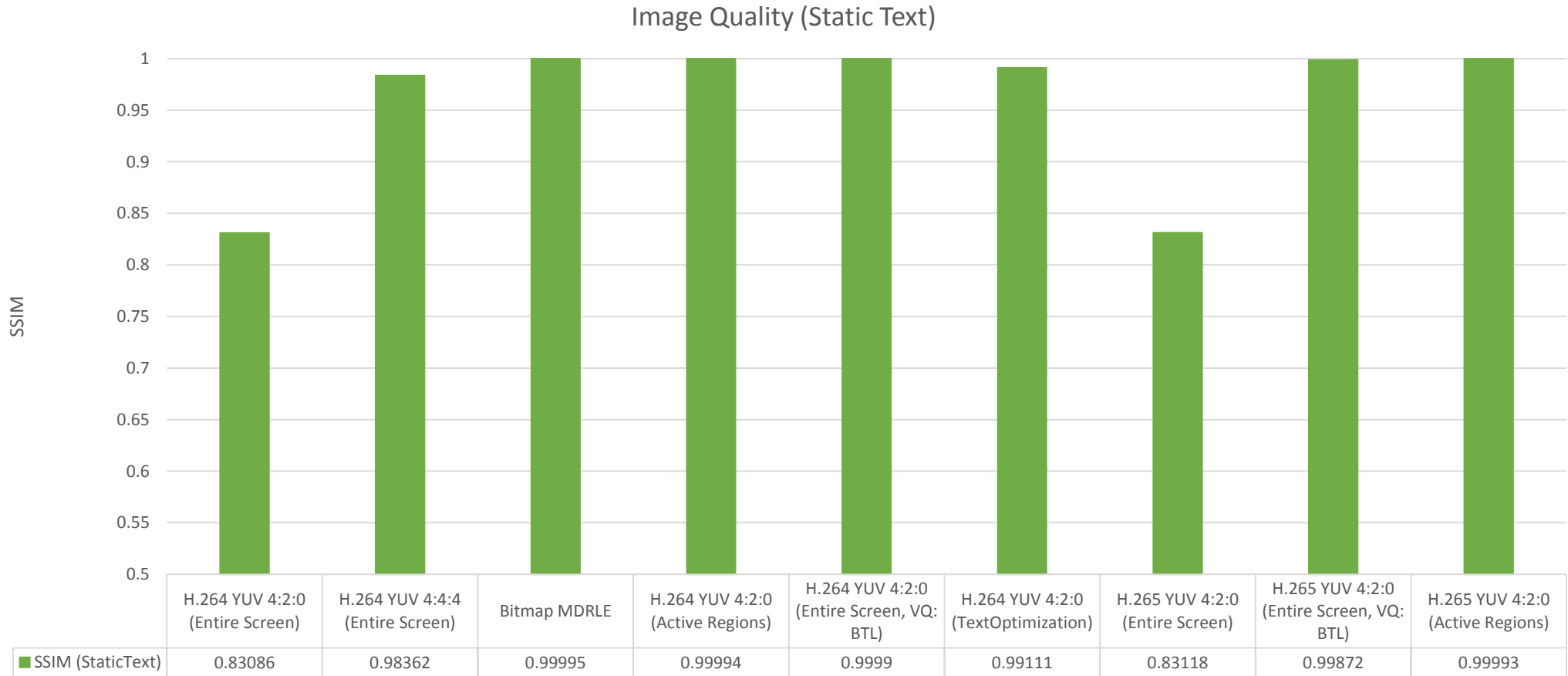
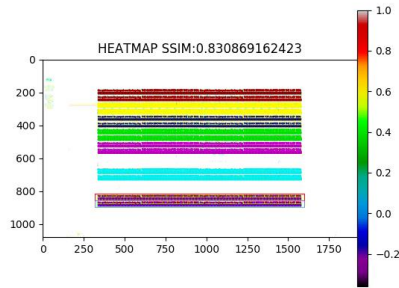


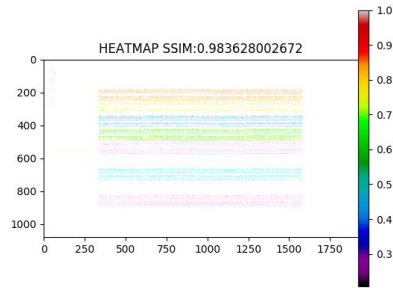
IMAGE QUALITY

Heatmaps

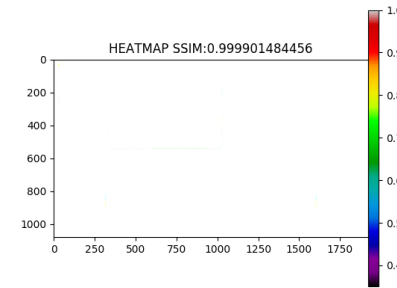
H264 YUV 4:2:0
(Entire Screen)



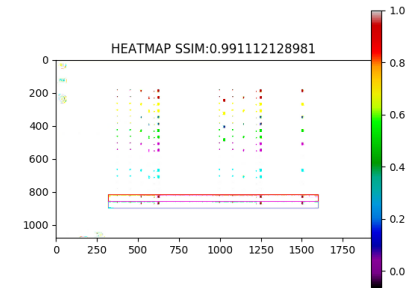
H264 YUV 4:4:4:
(Entire Screen)



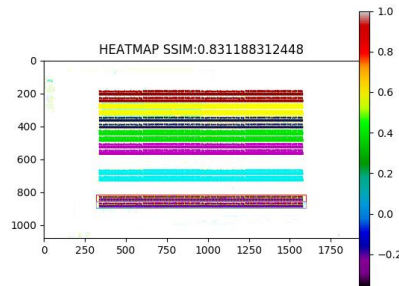
H264 YUV 4:2:0
(BTL)



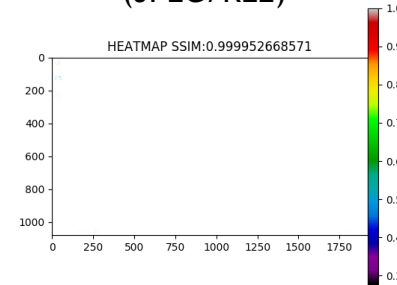
H264 YUV 4:2:0
(TextOptimization)



H265 YUV 4:2:0
(Entire Screen)

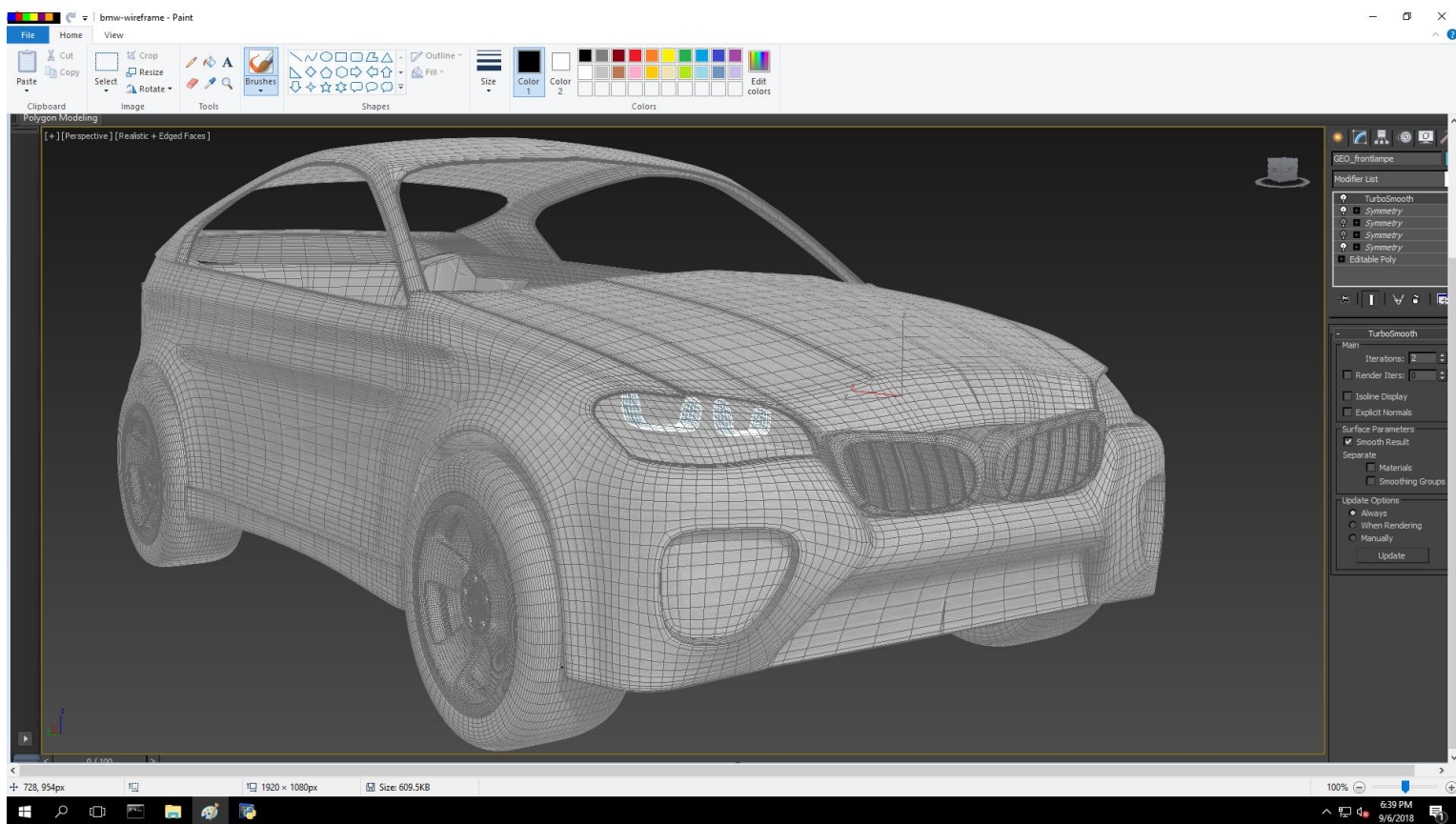


Bitmap Encoding
(JPEG/RLE)



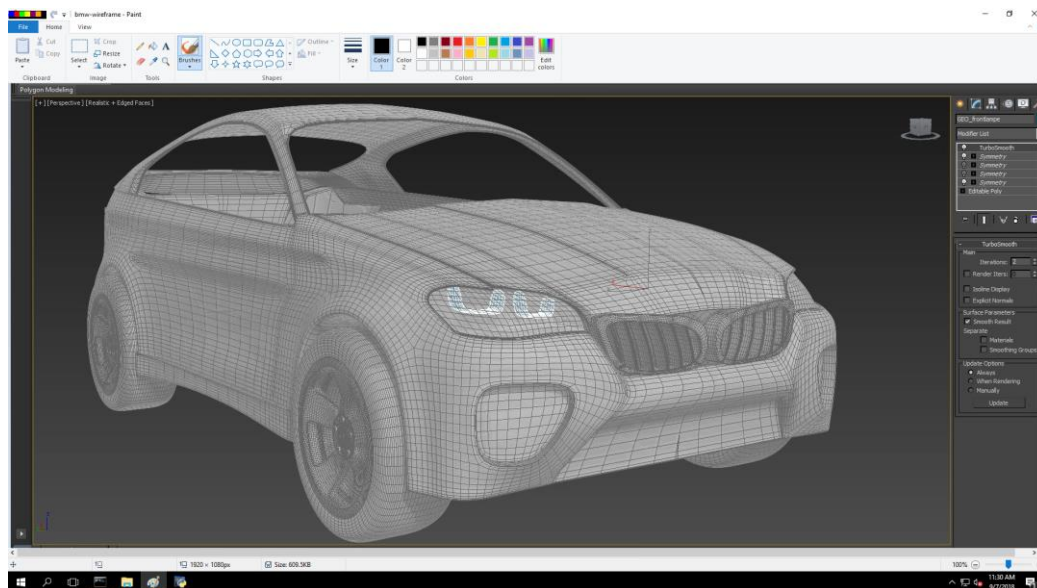
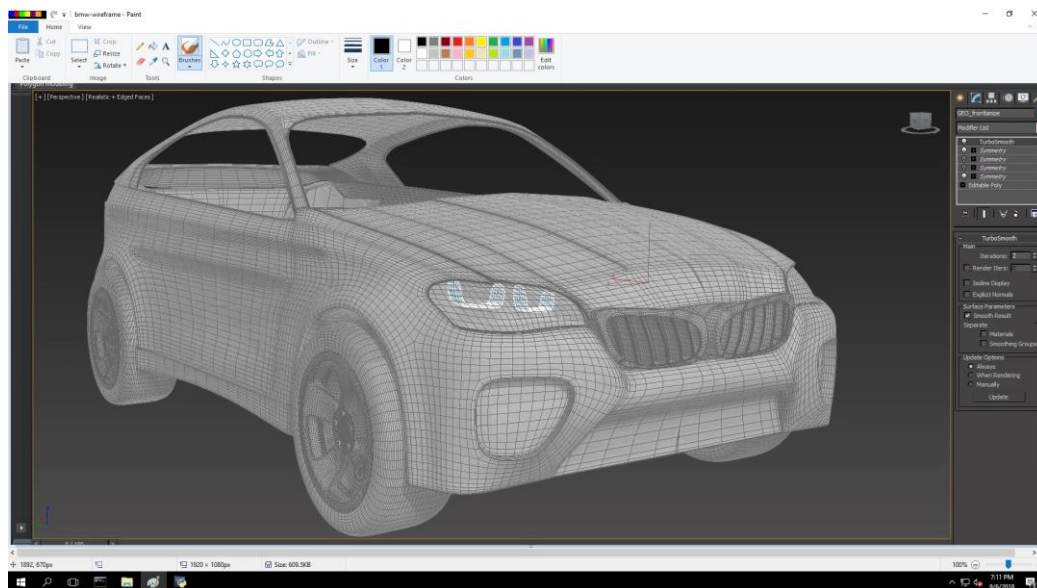
COMPARISON H.264

YUV4:2:0 and YUV4:4:4 (Reference Image)



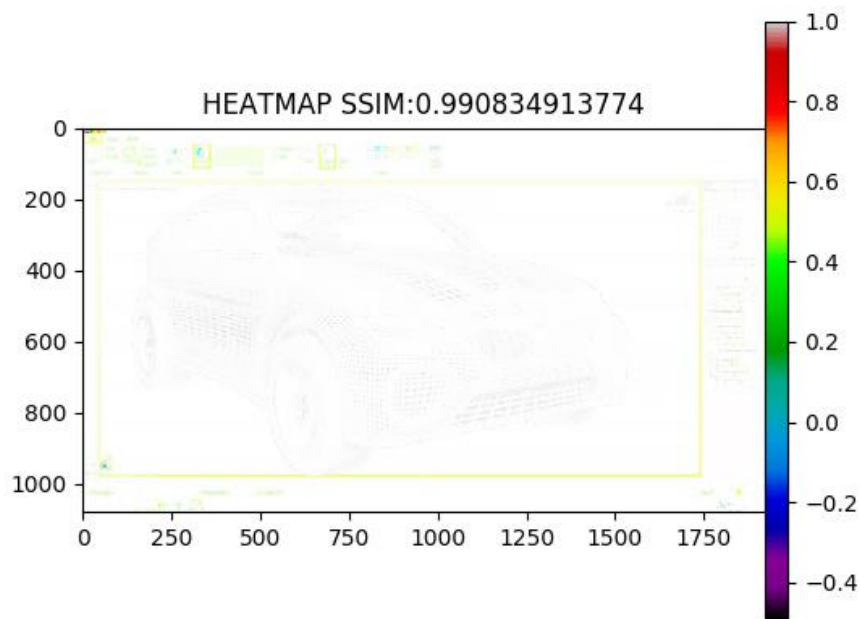
COMPARISON H.264

YUV4:2:0 and YUV4:4:4



H.264 (WIREFRAME)

YUV4:2:0



YUV4:4:4

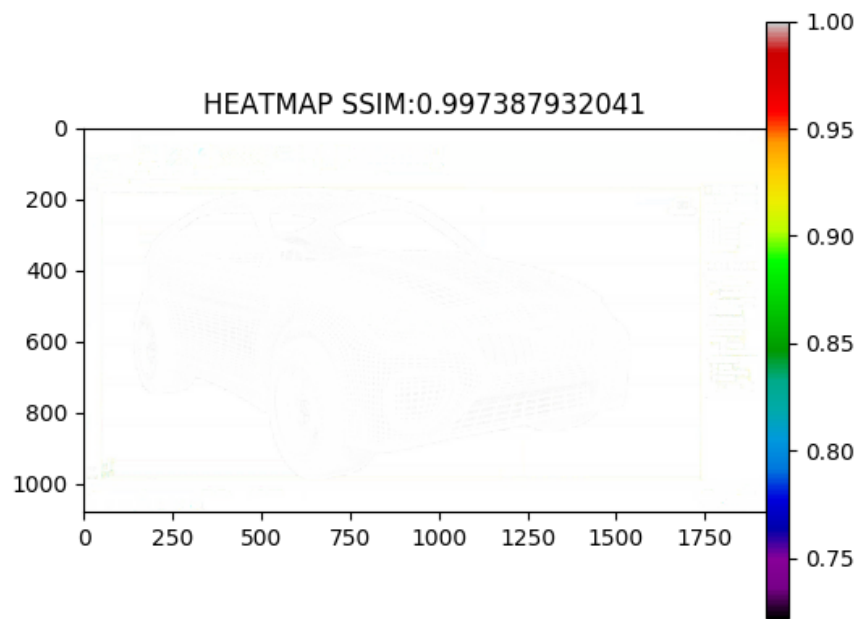
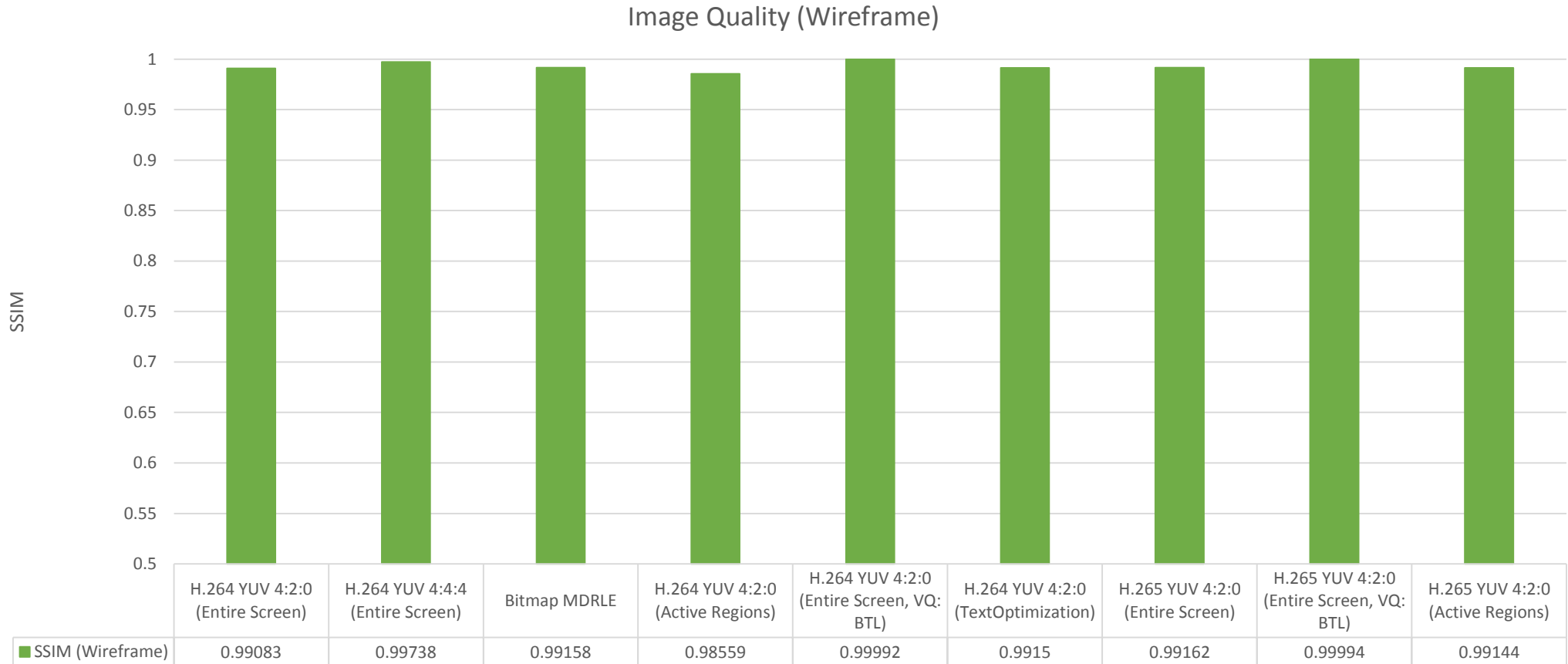


IMAGE QUALITY

Wireframe



BANDWIDTH COMPARISON (VIDEO)

BANDWIDTH COMPARISON

Video playback scenario

The screenshot displays a Windows 10 desktop environment. A video player window titled 'splash' is open, showing a scene from 'Fantastic Beasts and Where to Find Them - Trailer 3.mpd'. The video player has a yellow text overlay that reads '1408x592 window size'. Below the video, another yellow text overlay reads '2:30min duration'. To the right of the video player, the Windows Task Manager is open, showing the 'Performance' tab. The 'Processes' list shows 'Splash (32 bit)' using 58% CPU and 26% memory. The 'Performance' section shows 'GPU' usage at 3% and 'Network' usage at 0%. The 'Virtual Channel Display mode' section shows 'HDX' and 'Thinwire' settings. The 'Real-Time Statistics' section shows 'CPU time used by encoder: 6%' and 'Memory used by encoder: 358 MB'. The 'Total Statistics' section shows 'Total bandwidth usage: 1491.0 Mb' and 'Total frames send to client: 85289'.

1408x592 window size

2:30min duration

Win10 with 1920x1200 resolution, 2vCPUs@3.5GHz, P40-1B profile

BANDWIDTH COMPARISON

Video playback @ 30fps

CODEC	Visual Quality	Encoder CPU	Total FPS	MB transfered
Bitmap JPG/RLE	Medium	7%	3693	355MB
H.264 YUV420	Medium	2%	3736	220MB
H.264 YUV444	Medium	3%	3728	655MB
H.264/Bitmap*	Medium	7%	3698	205MB
H.264	Build To lossless	5%	3642	195MB
H.264 TextOpt	Medium	23%	3448	160MB
H.265 YUV420	Medium	2%	3766	180MB
H.265/Bitmap*	Medium	8%	3721	185MB
H.265	Build To Lossless	5%	3796	175MB

*Adaptive Display (active changing regions)

BANDWIDTH COMPARISON

Video playback @ 30fps

CODEC	Visual Quality	Encoder CPU	Total FPS	MB transfered
Bitmap JPG/RLE	High	8%	3633	610MB
H.264 YUV420	High	2%	3719	210MB
H.264 YUV444	High	4%	3716	690MB
H.264/Bitmap*	High	5%	3671	215MB
H.264	Build To lossless	5%	3642	195MB
H.264 TextOpt	High	22%	3508	160MB
H.265 YUV420	High	3%	3780	185MB
H.265/Bitmap*	High	7%	3627	175MB
H.265	Build To Lossless	5%	3796	175MB

*Adaptive Display (active changing regions)

VDI ON SCALE TESTING

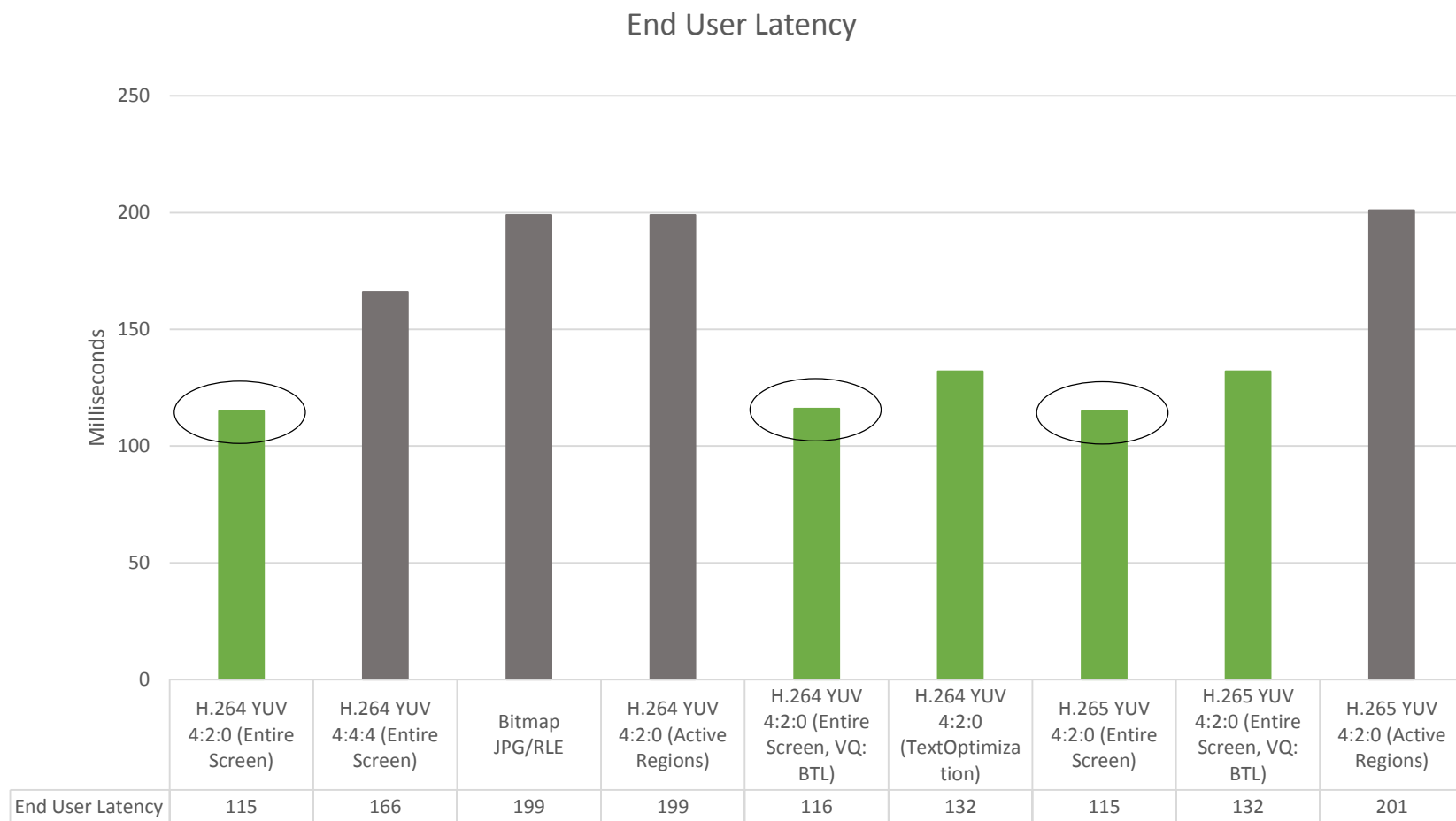
24 VMs ON 1 TESLA P40

TEST SYSTEM

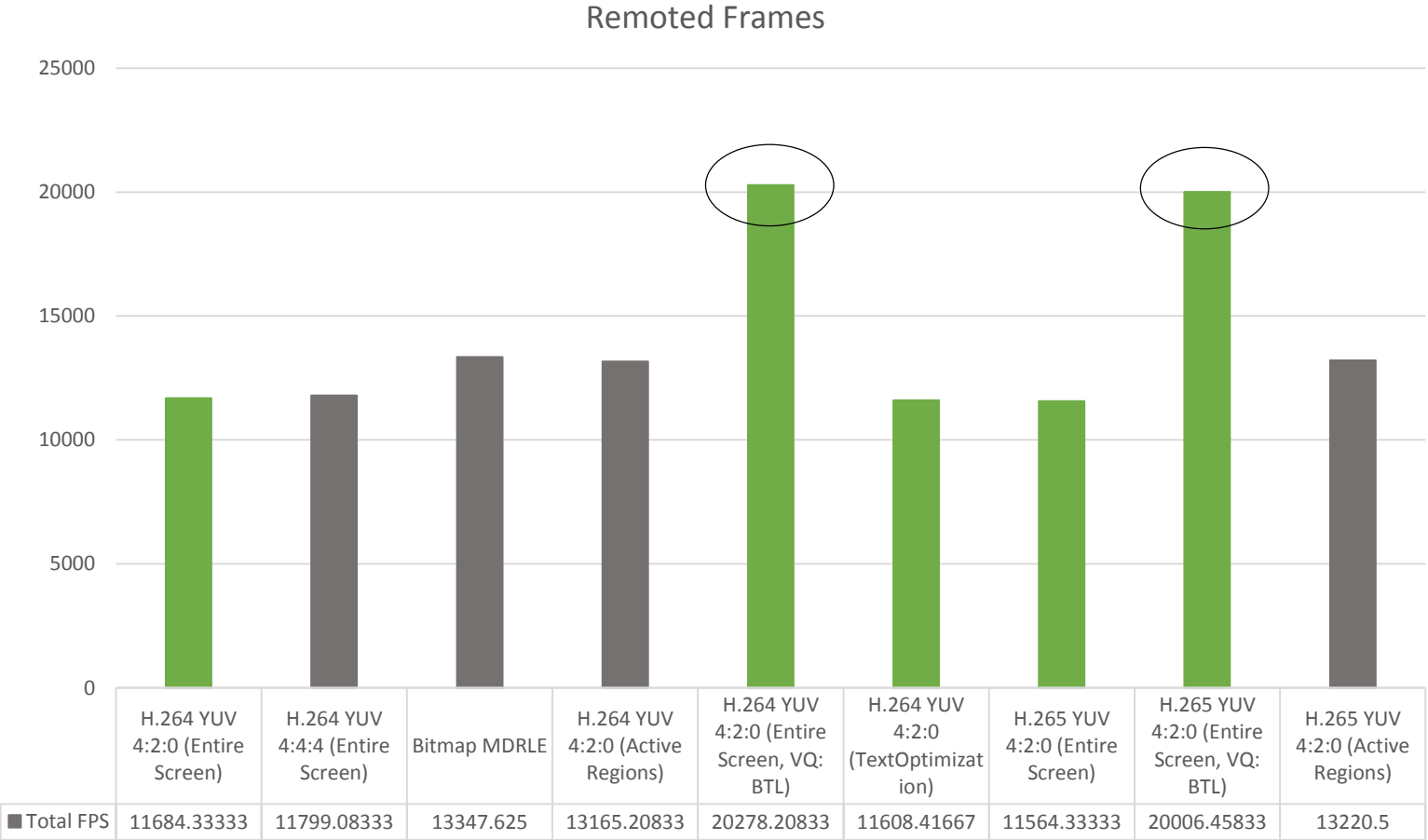
Configuration Details

Host Configuration	VDI Configuration
Cisco UCS C240 M5	vCPU - 4
Intel Xeon Gold 6154 @ 3.00 GHz	vRAM - 4096 MB
VMware ESXi 6.7	NIC - 1 (E1000)
Number of CPUs: 36 (2 x 18)	Hard Disk - 40 GB
Memory: 768 GB	vGPU - P40-1B
Storage: All-Flash SAN (iSCSI)	Virtual Hardware - vmx-14
Hyperthreading, Turbo boost	FRL enabled - Yes
Power Setting: High Performance	VDI agent - CITRIX XenDesktop 7.18
GPU: 1 x P40	CITRIX HDX
GPU Scheduling Policy - Best Effort	Number of Screens - 2
NVIDIA vGPU Driver 6.2 390.72	Screen Resolution - 1920 x 1080

END USER LATENCY (CLICK TO PHOTON)

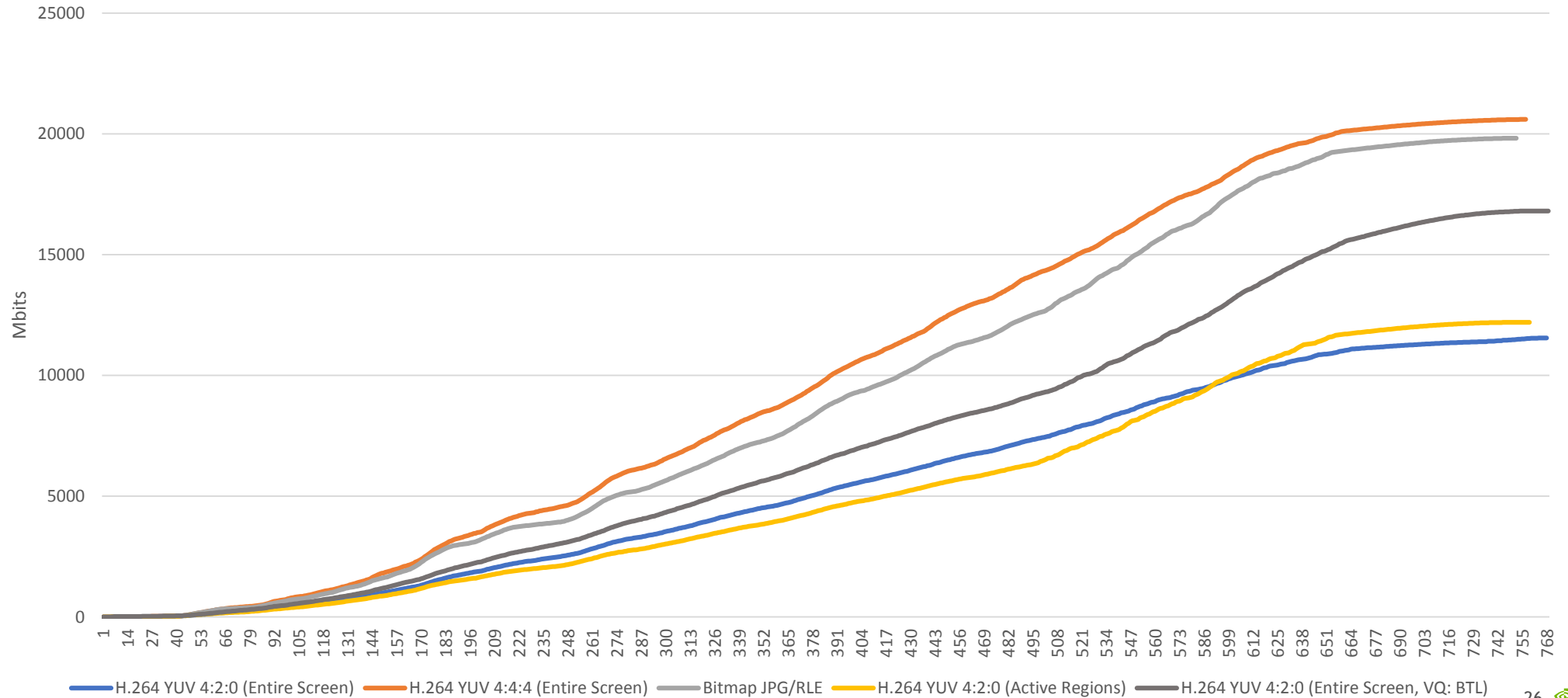


TOTAL REMOTED FRAMES



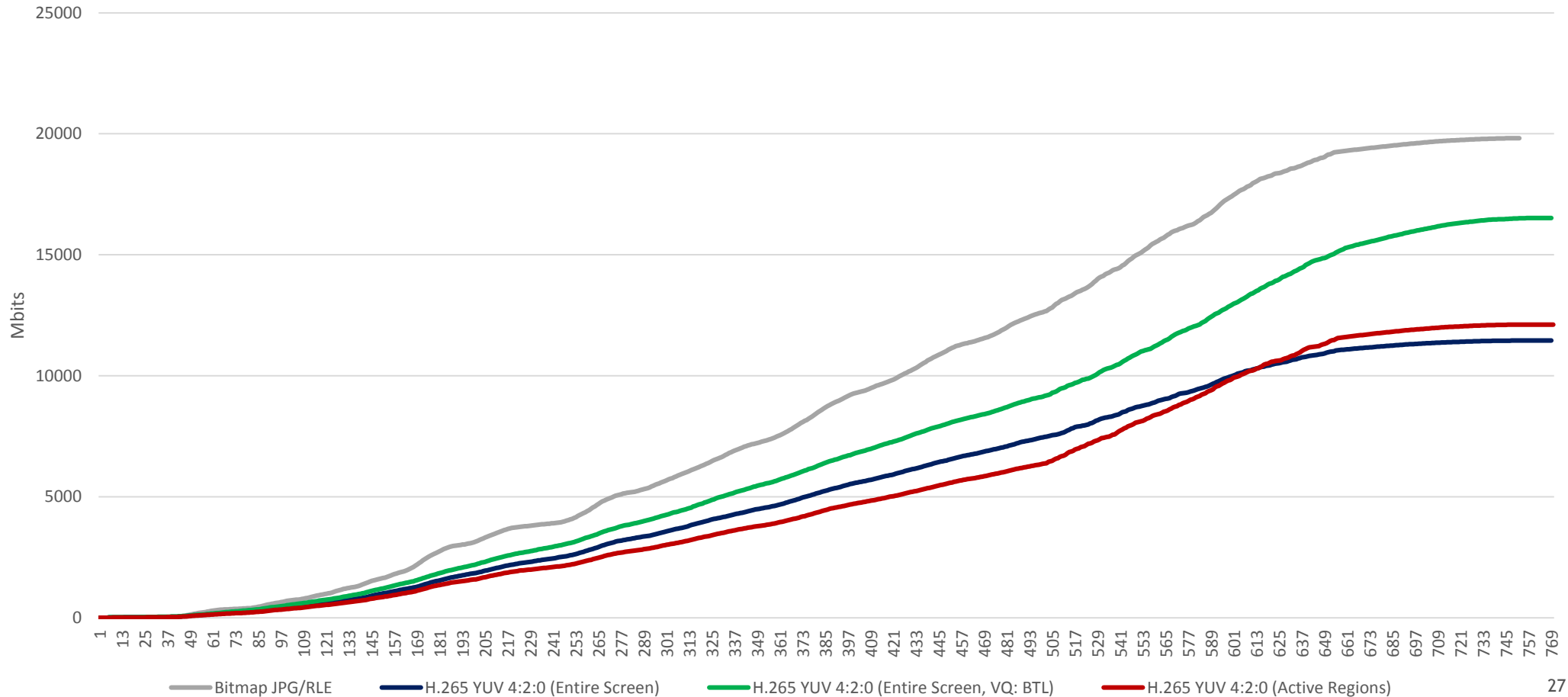
BANDWIDTH H.264

ESX Server - Transmitted Bandwidth (Cumulative Mbits)



BANDWIDTH H.265

ESX Server - Transmitted Bandwidth (Cumulative Mbits)



WRAP-UP

Analyzing the data lead to the following...

- H.264 BTL is a very interesting addition for different use cases. If the users get used to the „sharpening“ effect in their session this is the best possible compromise between visual quality, performance and bandwidth consumption which finally leads to the best achievable **USER EXPERIENCE**
- Bitmap (Thinwire+) is still a good solution for pure office VDI use case, same applies to Mixed Mode(Adaptive Display)
- H.265 leads to slightly reduced bandwidth consumption and is therefore interesting for 3D use cases with limited bandwidth

USEFUL TECHNICAL RESOURCES

Blogs, white papers and everything vGPU

- <http://sschaber.de/blog/>
- <https://www.nvidia.com/object/better-ux.html>
- <https://www.nvidia.com/object/quantifying-impact-of-vgpu-whitepaper.html>
- <https://www.nvidia.com/en-us/design-visualization/solutions/virtualization/resources/>

NVIDIA VIRTUAL GPU RESOURCES



Virtual GPU Test Drive

<https://www.nvidia.com/tryvgpu>



NVIDIA Virtual GPU Website

www.nvidia.com/virtualgpu



NVIDIA Virtual GPU YouTube Channel

<http://tinyurl.com/gridvideos>



Questions? Ask on our Forums

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Q & A