Comparing Remote Desktop Protocols: Perceived User Experience Across RDP, HDX, and Blast

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End User Computing Tech

Bernhard Tritsch

Germany

Dr. Tritsch IT Consulting

He/Him/His

23 years in the program

MVP

Most Valuable Professionals

NERDIO VALUED PROFESSIONAL

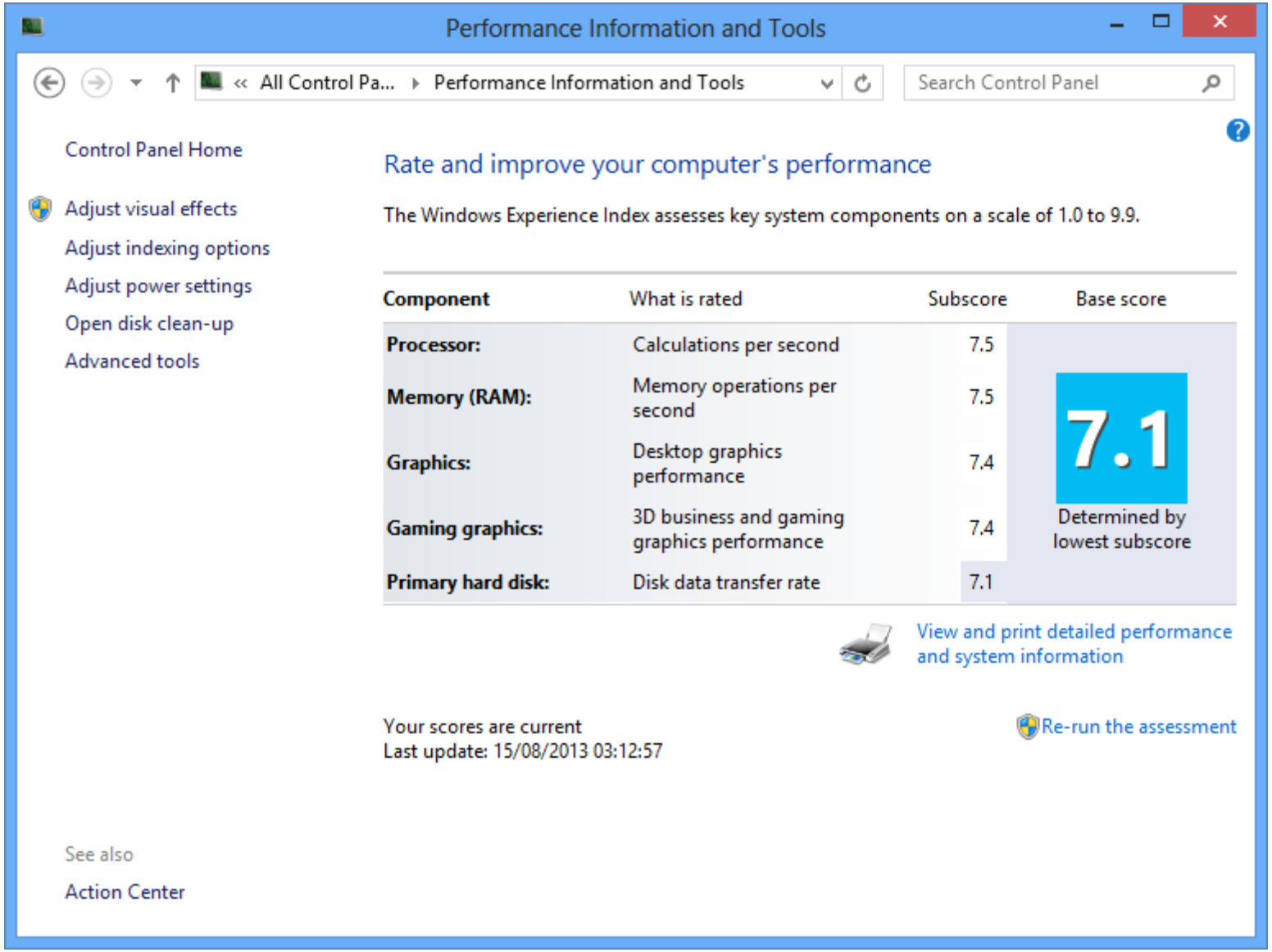
VIPP Very Important Parallels Professional

Parallels

Table of Content

Scoring versus measuring perceived user experience

How to Score Test Results?



Protocol Characteristics

Microsoft SxS RDP

- Independent update lifecycle
- Reverse connect model
- Enhanced security model
- Cloud-native integration
- Advanced transport flexibility
- Modular networking stack
- Built-in diagnostics and telemetry
- Tight integration with RDP Agent framework

Citrix HDX

- Built on ICA
- High-definition user experience focus
- Intelligent redirection (client-side or server-side rendering)
- Adaptive compression
- Network optimization
- Adaptive Transport TCP/UDP
- Multimedia & graphics optimization
- Device & peripheral redirection
- Session Reliability
- Dynamic adaptation to changing conditions
- Extensive feature ecosystem
- Configurable via policies

Omnissa Blast (Extreme)

- High-performance display protocol
- Transport flexibility TCP/UDP
- Codec-based streaming (H.264, HVEC/H265, AV1, BlastCodec) w/ GPU offload
- Adaptive image quality & bandwidth optimization
- Multimedia & graphics optimization
- Broad client & device support
- Strong security model
- Modular components (transport + codec)
- Unified access & simplified connectivity (single port)

RDP Perf Counters

\RemoteFX Network(*)\Current TCP Bandwidth	TCP Bandwidth detected in bits per second (bps)
\RemoteFX Network(*)\Current TCP RTT	Average TCP round-trip time (RTT) detected in ms
\RemoteFX Network(*)\Current UDP Bandwidth	UDP Bandwidth detected in bits per second (bps)
\RemoteFX Network(*)\Current UDP RTT	Average UDP round-trip time (RTT) detected in ms
\RemoteFX Network(*)\Loss Rate	Loss percentage
\RemoteFX Network(*)\Retransmission Rate	Percentage of packets that have been retransmitted
\RemoteFX Network(*)\TCP Received Rate	Rate in bps at which data is received over TCP
\RemoteFX Network(*)\TCP Sent Rate	Rate in bps at which data is sent over TCP
\RemoteFX Network(*)\UDP Received Rate	Rate in bps at which data is received over UDP
\RemoteFX Network(*)\UDP Sent Rate	Rate in bps at which data is sent over UDP

RDP Perf Counters

\RemoteFX Graphics(*)\Graphics Compression ratio	Ratio of bytes encoded to bytes input
\RemoteFX Graphics(*)\Average Encoding Time	Average frame encoding time
\RemoteFX Graphics(*)\Frame Quality	Quality of the output frame
\RemoteFX Graphics(*)\Input Frames/second	Number of sources frames
\RemoteFX Graphics(*)\Output Frames/second	Number of frames sent to the client
\RemoteFX Graphics(*)\Source Frames/second	Number of frames composed by source

\RemoteFX Graphics(*)\Frames Skipped/second – Insufficient Client Resources

\RemoteFX Graphics(*)\Frames Skipped/second – Insufficient Network Resources

\RemoteFX Graphics(*)\Frames Skipped/second – Insufficient Server Resources

Citrix HDX Perf Counters

\ICA Session(Console (UserName))\EDT bandwidth available (bps)

\ICA Session(Console (UserName))\Input Session Bandwidth

\ICA Session(Console (UserName))\Output Session Bandwidth

\ICA Session(Console (UserName))\Input Session Compression

\ICA Session(Console (UserName))\Output Session Compression

\ICA Session(Console (UserName))\Latency - Last Recorded

\ICA Session(Console (UserName))\Latency - Session Average

\ICA Session(Console (UserName))\EDT RTT

\ICA Graphics(<n>)\BitRate - Current

\ICA Graphics(<n>)\Frame Rate - Current FPS

\ICA Graphics(<n>)\Frame Rate - Input FPS

\ICA Graphics(<n>)\Frame Rate - Target FPS

\ICA Graphics(<n>)\Thinwire Average Input FPS

\ICA Graphics(<n>)\Thinwire Average Output FPS

\ICA Graphics(<n>)\Thinwire Bandwidth Estimate (bps)

\ICA Graphics(<n>)\Thinwire Latency Estimate (ms)

Omnissa Blast Perf Counters

\Horizon Blast Session Counters(Session ID: n; (main))\Estimated Bandwidth (Uplink)

\Horizon Blast Session Counters(Session ID: n; (main))\Instantaneous Transmitted Bytes over TCP

\Horizon Blast Session Counters(Session ID: n; (main))\Instantaneous Transmitted Bytes over UDP

\Horizon Blast Session Counters(Session ID: n; (main))\Instantaneous Received Bytes over TCP

\Horizon Blast Session Counters(Session ID: n; (main))\Instantaneous Received Bytes over UDP

\Horizon Blast Session Counters(Session ID: n; (main))\Packet Loss (Uplink)

\Horizon Blast Session Counters(Session ID: n; (main))\Jitter (Uplink)

\Horizon Blast Session Counters(Session ID: n; (main))\RTT

\Horizon Blast Session Counters(Session ID: n; (main))\Automatic Reconnect Count

\Horizon Blast Imaging Counters(Session ID: n; Channel: Imaging; (main))\Frames per second

\Horizon Blast Imaging Counters(Session ID: n; Channel: Imaging; (main))\Dirty frames per second

\Horizon Blast Imaging Counters(Session ID: n; Channel: Imaging; (main))\FBC Rate

\Horizon Blast Imaging Counters(Session ID: n; Channel: Imaging; (main))\Poll Rate

\Horizon Blast Imaging Counters(Session ID: n; Channel: Imaging; (main))\Outbound Bandwidth (Kbps)

\Horizon Blast Imaging Counters(Session ID: n; Channel: Imaging; (main))\Inbound Bandwidth (Kbps)

\Horizon Blast Imaging Counters(Session ID: n; Channel: Imaging; (main))\Out Queueing time (us)

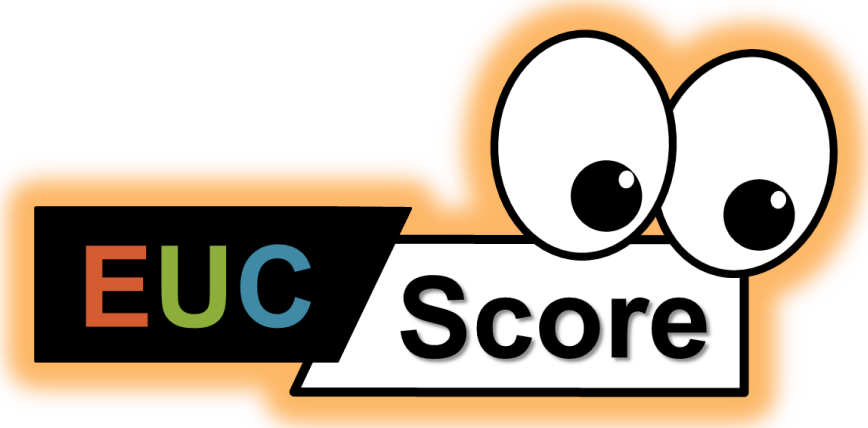

What? No Score for User Experience?

From a User's Perspective: Quality Criteria

Boot and logon duration	Measure boot time + logon time + user session load time until it is ready for user interaction. Includes identity management and authentication methods.
Application and content load time	Measure time from user starting an application until the content appears and the application is ready for user input, including access to the storage system.
User input delay ("Lag")	Measures responsiveness of graphical elements after user-initiated triggers = "time from mouse click to screen update" (lag, latency, system response time).
Graphics APIs supported	Detect incompatibilities when running graphics applications using the DirectX, OpenGL, Vulkan and WebGL APIs.
Media formats supported	Detect incompatibilities when opening and playing media files, such as MP4, MPEG, MOV, WMV or AVI.
Distortion of media	Measure media and screen output quality. Detect image, animation, and audio/video compression and decompression artifacts and anomalies.
Screen refresh rate	Measure the number of times per second that the desktop or application can draw consecutive images on the screen and in the host frame buffer (frames per sec = fps).
Endpoint specs and quality	Determine the screens' number of pixels, density, and visual dimensions – frame buffer requirements grow with resolution and screen number. Detect periphery incompatibilities.
Application reliability and stability	Detect application hangs, freezes, crashes or unhandled exceptions. Measure consistency, dependability and robustness of applications.
Session consistency and resilience	Check if user state is preserved across subsequent sessions. Measure session disruptions, hangs, disconnects/reconnects, availability, timeouts and redundancy.

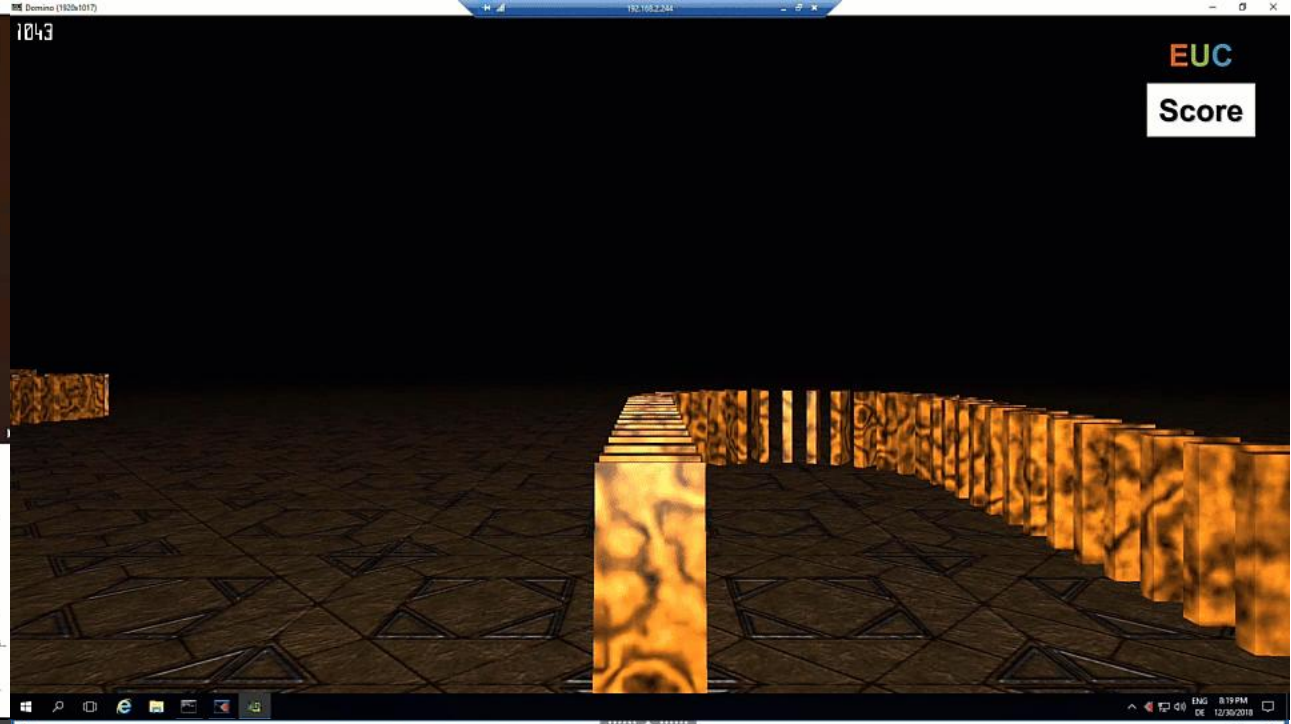
Distortions – Common VDI Screen Artifacts

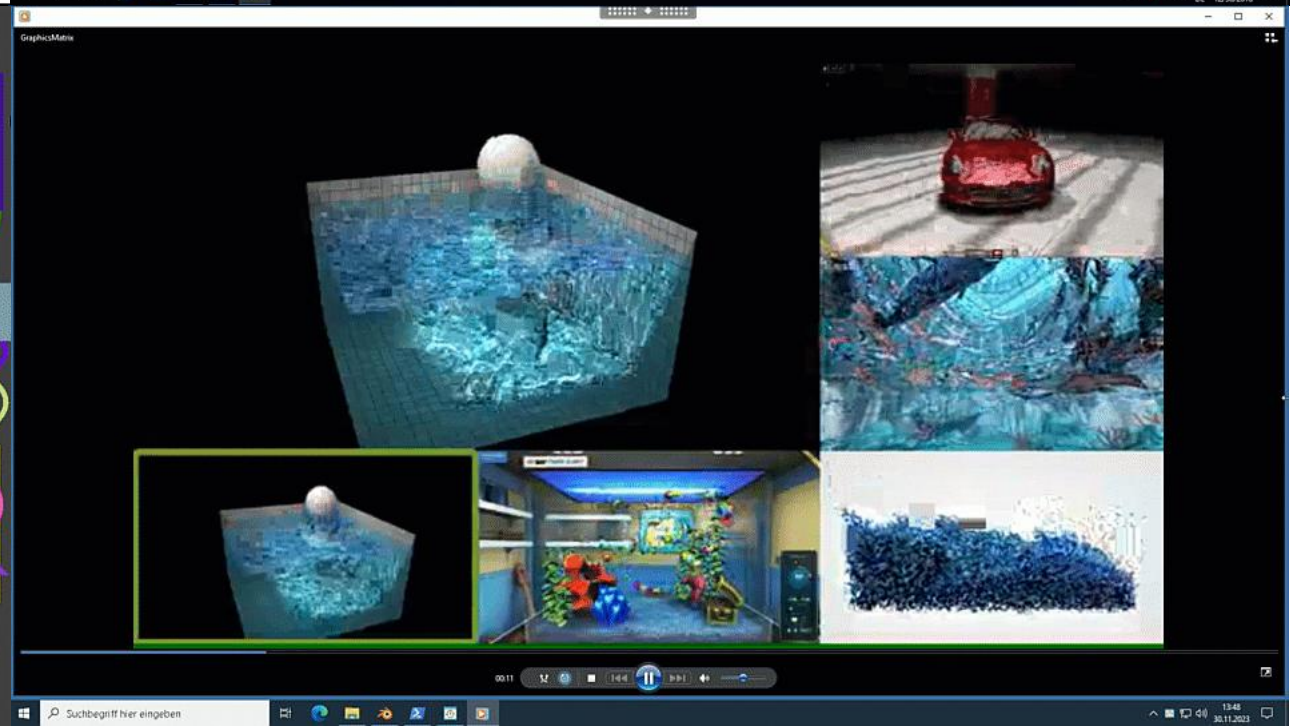
- **Stuttering**: A visual or playback artifact where the screen output appears to skip, jump, or hesitate, making the motion look non-smooth, jerky, or choppy, despite potentially high frame rates.
- **Flickering**: Rapid, unwanted, and often periodic fluctuations in brightness, luminosity, or color intensity. It appears as flashing, strobing, or horizontal dark bands that move across the screen.
- **Frame Freezing**: A single frame forming a motionless screen image. The screen temporarily stops updating or jumps forward suddenly. Network latency or jitter causes new frames to arrive late or out of order.
- **Block Artifacts**: Square blocks appear across the screen, especially when things move quickly. This is caused by low bandwidth. The encoder reduces image quality to keep movement smooth.
- **Tiling Artifacts**: Visual distortions where the image appears to be broken up into small squares or rectangular blocks. This happens because modern video codecs (like H.264, HEVC, AV1) break frames into smaller rectangular blocks—or "tiles"—and compress them separately to save data.
- **Stripe Artifacts**: A visual distortion characterized by persistent or intermittent horizontal or vertical lines or bands that do not belong to the original scene. The effect occurs particularly in areas with lots of motion or detail.
- **Interlacing Artifacts**: Different fields of video don't align correctly, creating horizontal lines.
- **Blurriness**: Text or UI elements appear soft and small fonts become hard to read. A possible reason is progressive refinement where the remoting protocol is sending a low-quality frame first. Later the frame is updated with a sharper version when bandwidth allows. Under constrained conditions, the refinement may never arrive.
- **Smearing**: A smearing artifact caused by a lost keyframe is a video corruption issue where previous visual information fails to update. When the "reference frame" (keyframe) is lost or corrupted, the decoder continues applying motion data to old, outdated image data. Smearing may also be caused by restricted bandwidth where the encoder prioritizes motion but reduces temporal accuracy.
- **Screen Update Errors**: Parts of the screen stop updating while others continue. Some remoting protocols update the screen in regions. If some regions fail to transmit (due to packet loss), they freeze while others continue updating.
- **Mosquito Noise**: A video compression artifact that appears as a shimmering, buzzing, or blotchy distortion concentrated around the sharp edges of objects in a video. It is most commonly associated with MPEG-based compression methods, such as H.264.
- **Empty Regions**: Sections of the screen show black boxes or placeholders. When parts of an encoded frame are lost or corrupted, the client displays empty regions to avoid drawing outdated content.

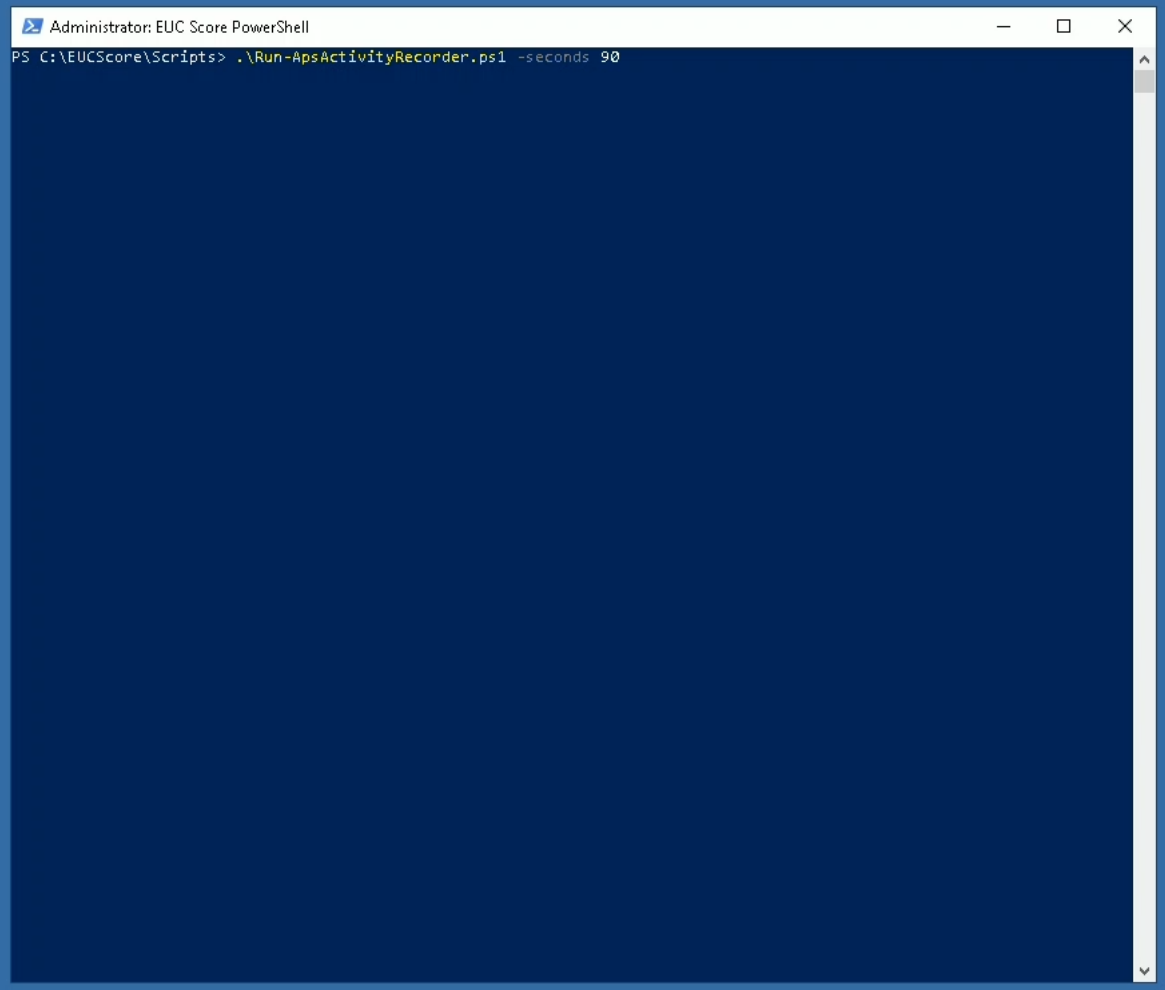


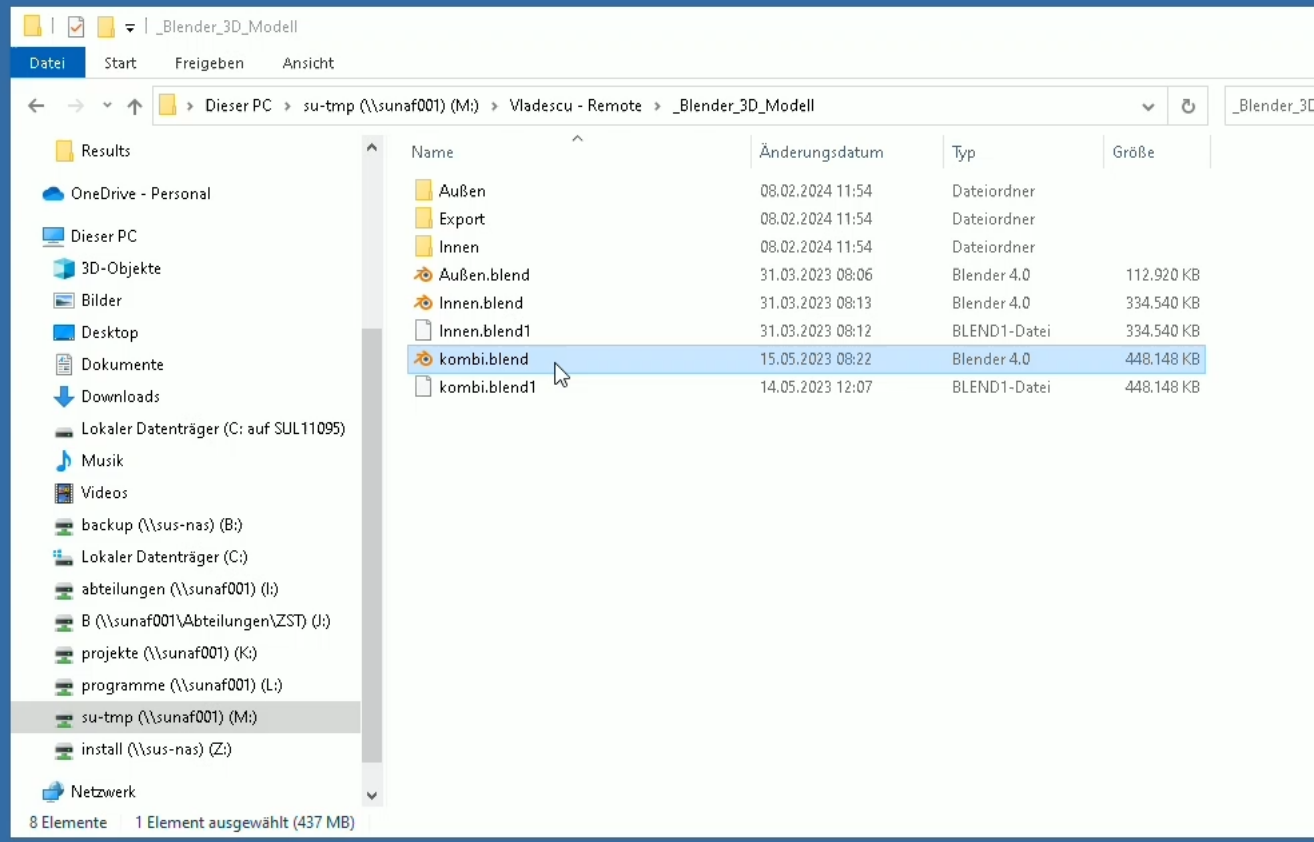
EUC Score measures and quantifies
perceived end-user experience
in Windows remoting and digital workspace environments, both on premises and in the cloud – fast, precise, repeatable and intuitive


10
EUC
Score
CPU
8% 2.39 GHz
Memory
3.6/15.9 GB (23%)
Disk 0 (C:)
SSD
0%
Ethernet
Ethernet 2
S: 0.3 R: 1.3 Mbps
GPU 0
Intel(R) HD Graphi...
0%
GPU 1
Radeon RX Vega ...
6% (48 °C)


1043
EUC
Score


GraphicsMatrix


Administrator: EUC Score PowerShell
PS C:\EUCScore\Scripts> .\Run-ApsActivityRecorder.ps1 -seconds 90


_Blender_3D_Modell
Datei
Start
Freigeben
Ansicht
Dieser PC › su-tmp (\\sunaf001) (M:) › Vladescu - Remote › _Blender_3D_Modell
Results
OneDrive - Personal
Dieser PC
3D-Objekte
Bilder
Desktop
Dokumente
Downloads
Lokaler Datenträger (C: auf SUL11095)
Musik
Videos
backup (\\sus-nas) (B:)
Lokaler Datenträger (C:)
abteilungen (\\sunaf001) (I:)
B (\\sunaf001\Abteilungen\ZST) (J:)
projekte (\\sunaf001) (K:)
programme (\\sunaf001) (L:)
su-tmp (\\sunaf001) (M:)
install (\\sus-nas) (Z:)
Netzwerk
Name
Änderungsdatum
Typ
Größe
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Export 08.02.2024 11:54 Dateiordner
Innen 08.02.2024 11:54 Dateiordner
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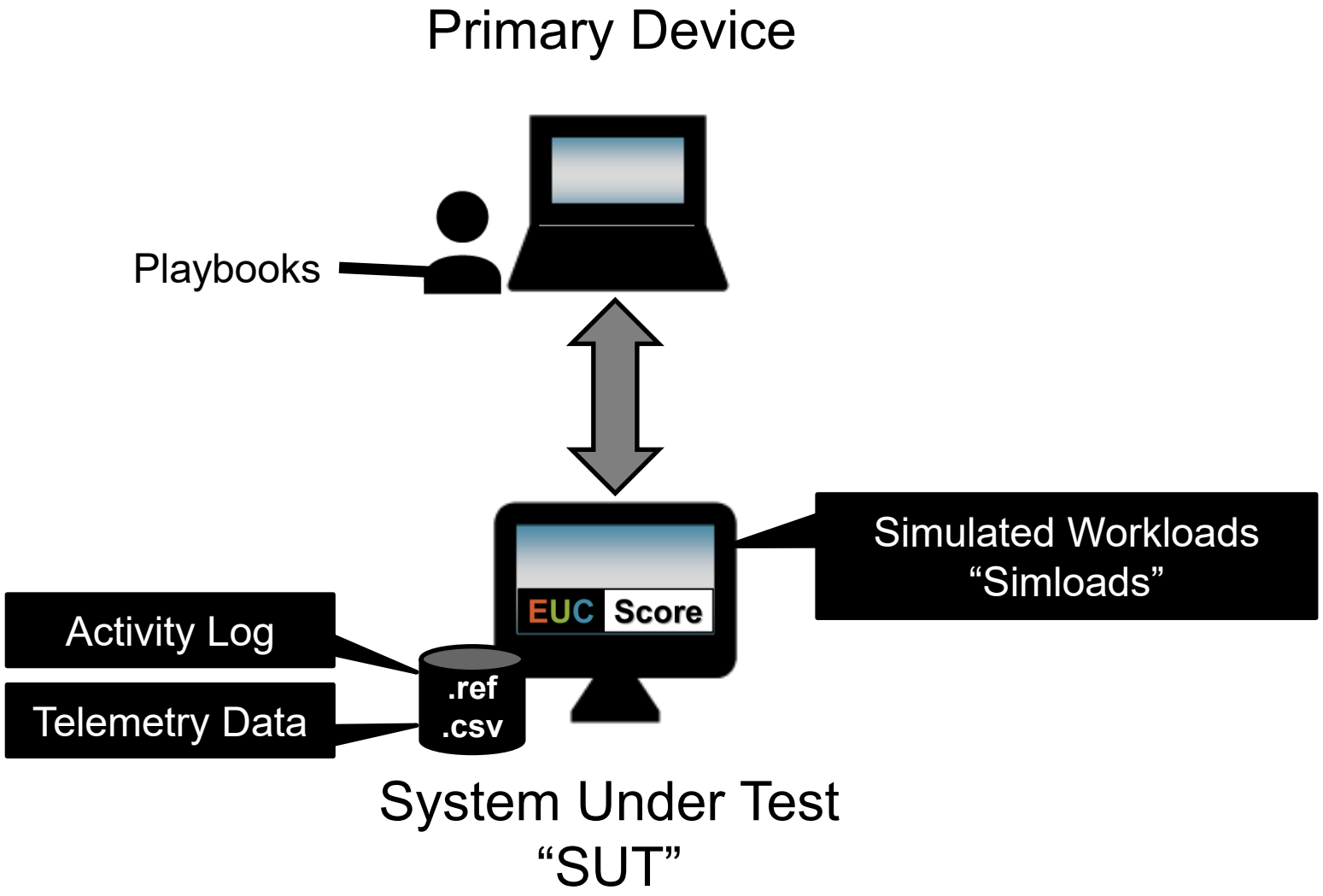
Innen.blend 31.03.2023 08:13 Blender 4.0 334.540 KB
Innen.blend1 31.03.2023 08:12 BLEND1-Datei 334.540 KB
kombi.blend 15.05.2023 08:22 Blender 4.0 448.148 KB
kombi.blend1 14.05.2023 12:07 BLEND1-Datei 448.148 KB
8 Elemente
1 Element ausgewählt (437 MB)

Suchbegriff hier eingeben
13:17
08.02.2024

EUC benchmarking and visualization of test results

End User Computing Tech

A Simple EUC Test Lab



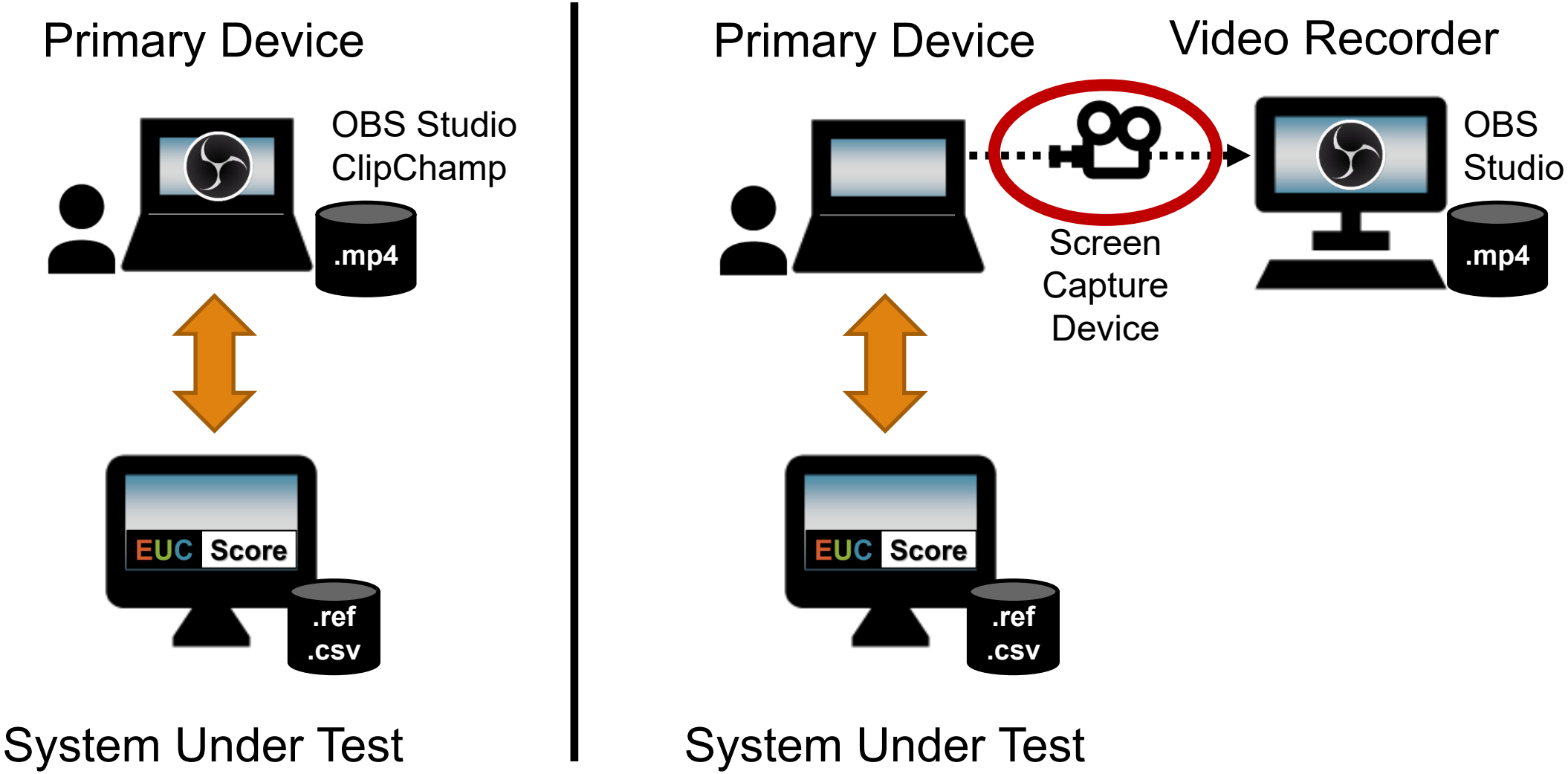
Simulated Workloads – “Simloads”

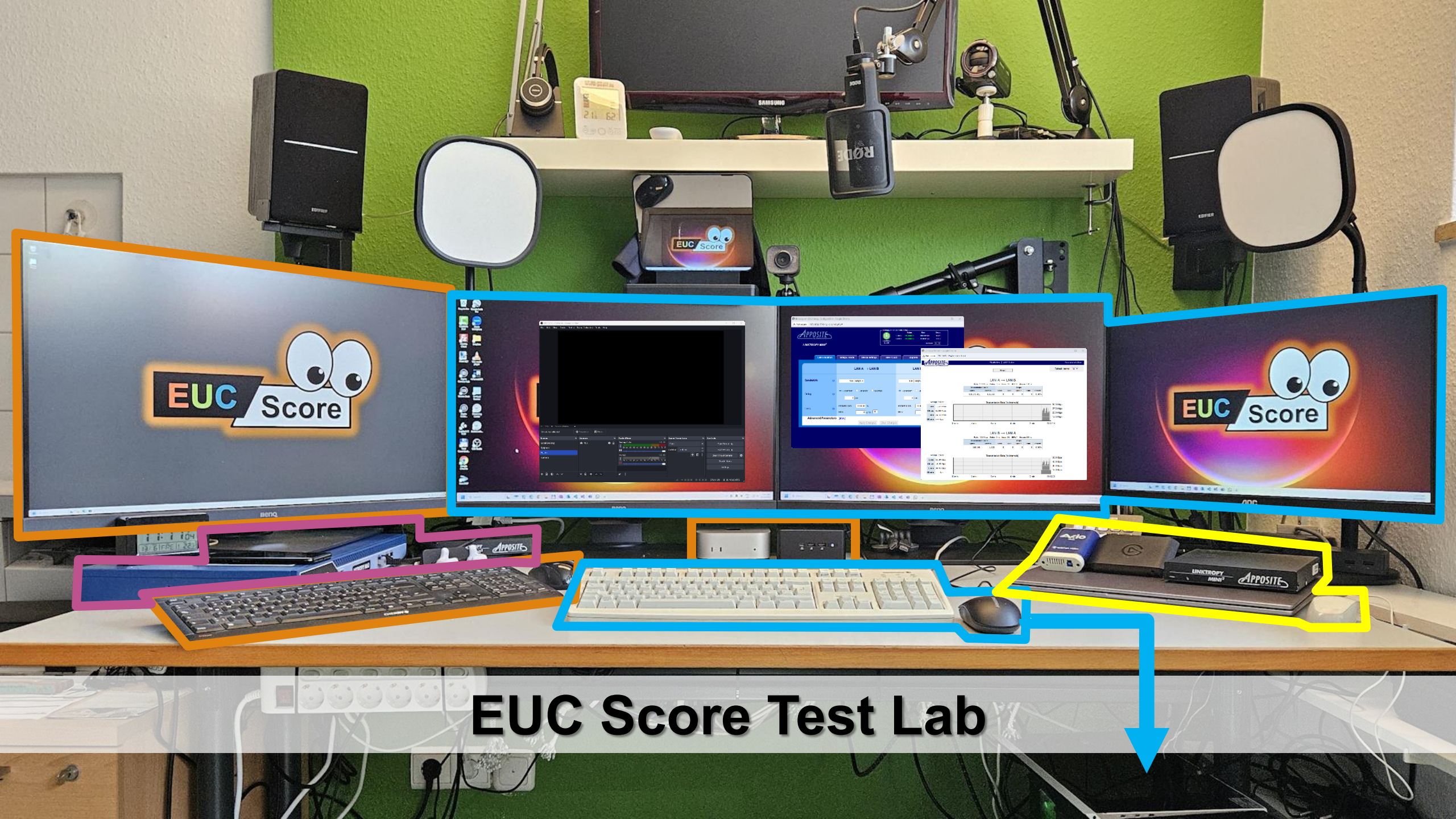
https://eucscore.com/gallery.html

Type		Description
	**Type 1 Primary**	Test run with an application that highlights a specific graphic or multimedia format (GDI, DirectX, OpenGL or video) – may require a pre-installed application.
	**Type 2 Persona**	Sequence of chained or overlayed user activities, orchestrated in such a way they generate the characteristic behavior and consistent load pattern of a predefined interactive user type.
	**Type 3 Score**	Measures predefined system metrics used to produce a number (=score) that represents the performance. Typically, each score Simload is associated with a specific theme.

All Simloads collect activity logs that are stored in the EUCScore\Results folder

Screen Video Recording Options





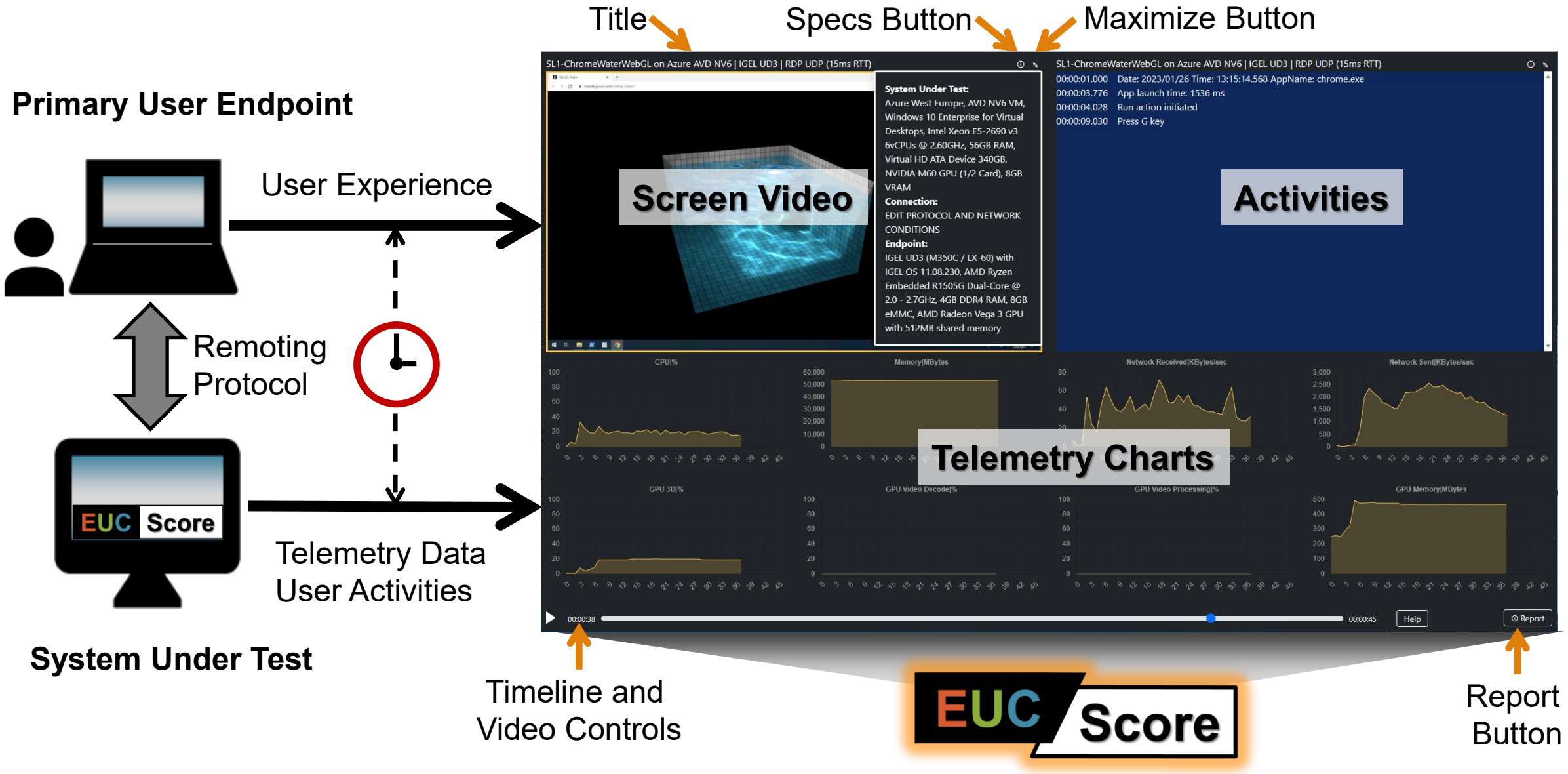
EUC Score Test Lab


60-90 cloud data centers
MAIN R.
DE-CIX
FRANKFURT
Peak (2026): 18.73 Tbit/s
< 10 ms latency
BENCHMARKING
TEST LAB
OBER-RAMSTADT
FRANKENSTEIN
CASTLE
AVD
W365
RDP

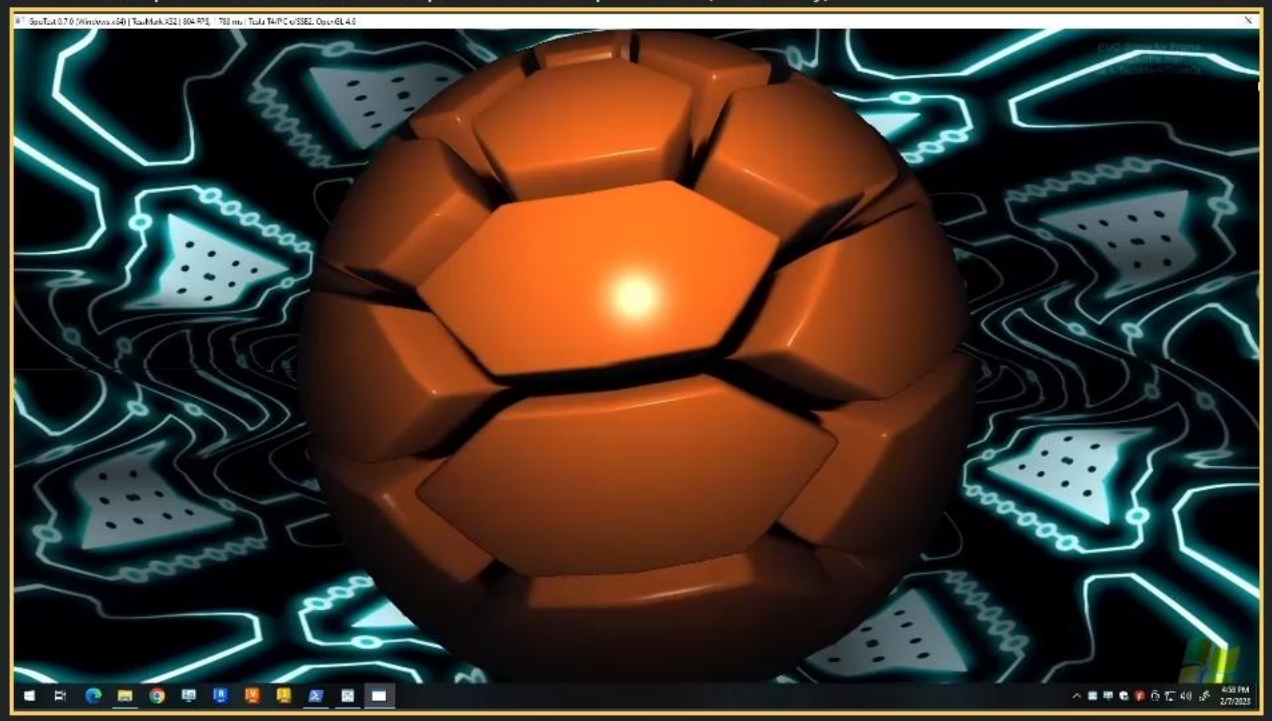
Client Network Settings – WAN Emulator

- **Bandwidth** = data transfer rate in a wired or wireless communication link or the maximum amount of data transmitted over an internet connection in a given amount of time
  - Common values: **100Mbit/s** (LAN), 12Mbit/s, **8Mbit/s**, 4Mbit/s, **2Mbit/s**
- **Latency** = the delay in network communication, also often referred to as round-trip time (RTT)
  - Common values: **0ms**, 20ms, 50ms, **100ms**, **300ms** RTT
- **Packet Loss** = a network packet fails to reach its expected destination, resulting in information loss
  - Common values: **0%**, 0.1%, 0.2%, 1%, **2%**, **5%**

Visual Data Analytics – Sync Player



SL1-TessMarkOpenGL on Azure NC4asT4 v3 | HP t640 w/ GPU | FRP8 UDP (7ms latency)



SL1-TessMarkOpenGL on Azure NC4asT4 v3 | HP t640 w/o GPU | FRP8 UDP (10ms latency)

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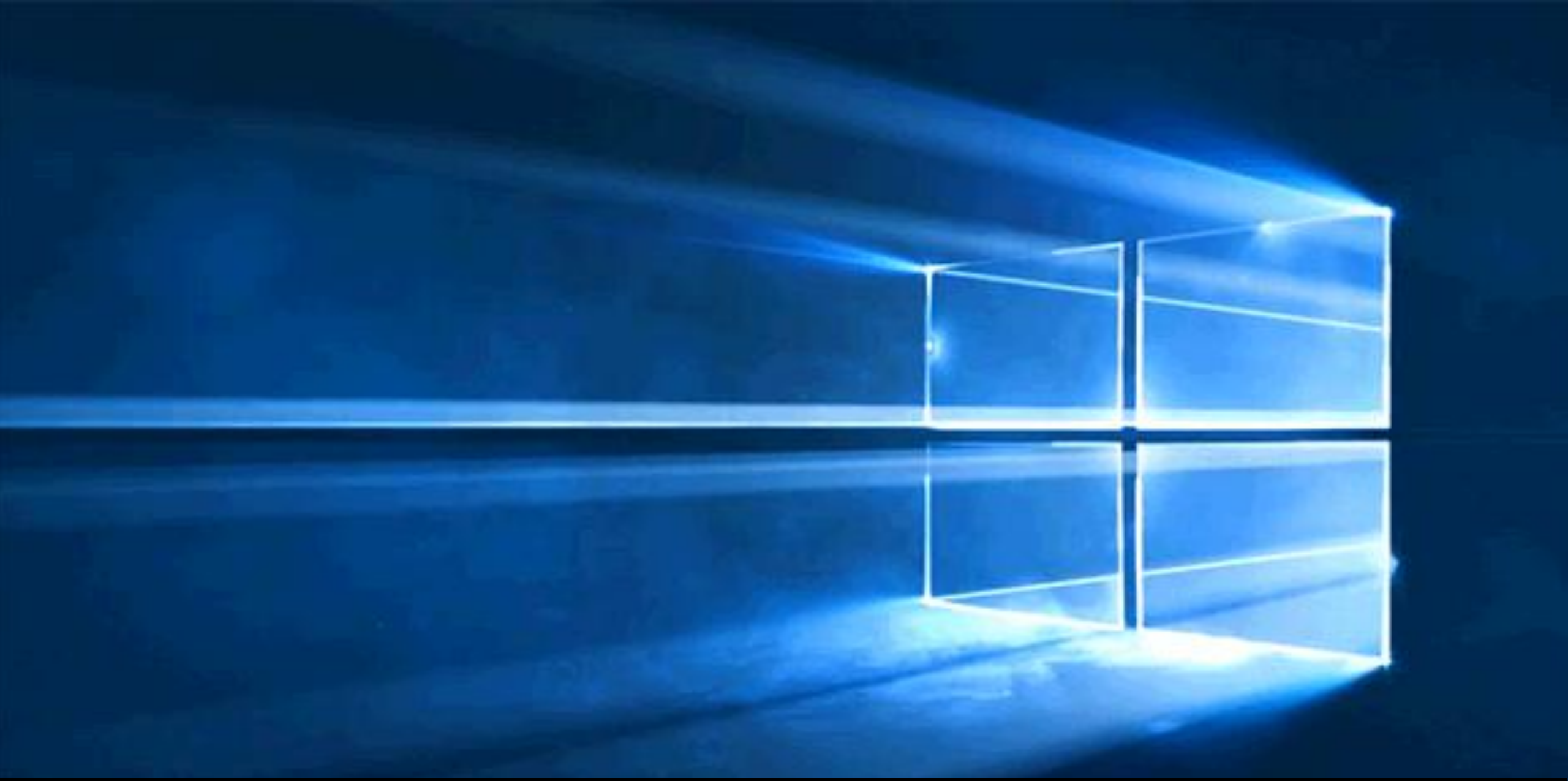


Show Time

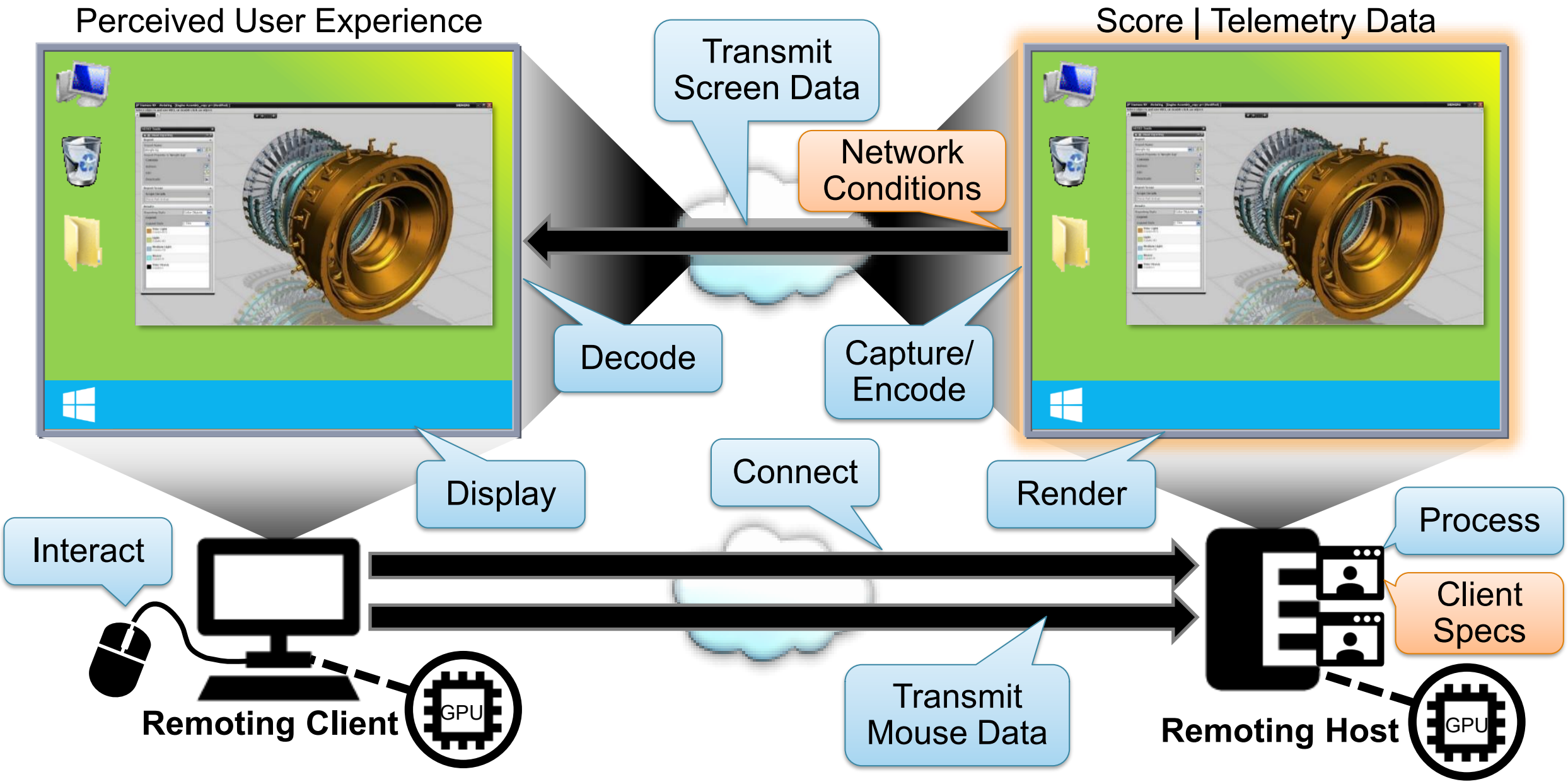
Score Simloads – Noisy Neighbors

Score Simload / VM Type – Noisy Neighbors	App Dialog	App Start	GDI+ Graphics	GDI+ Rectangles	White Noise	IOPS	User Profile Large	User Profile Small
AVD E8ds v5 – 0 Noisy Neighbors	0.30	0.64	5.28	1.15	40.88	3.69	9.65	3.86
AVD E8ds v5 – 4 Noisy Neighbors	0.31	0.75	9.46	2.46	73.96	5.70	9.57	4.18
AVD E8ds v5 – 8 Noisy Neighbors	0.49	1.88	46.21	12.27	252.8	10.80	31.04	15.03

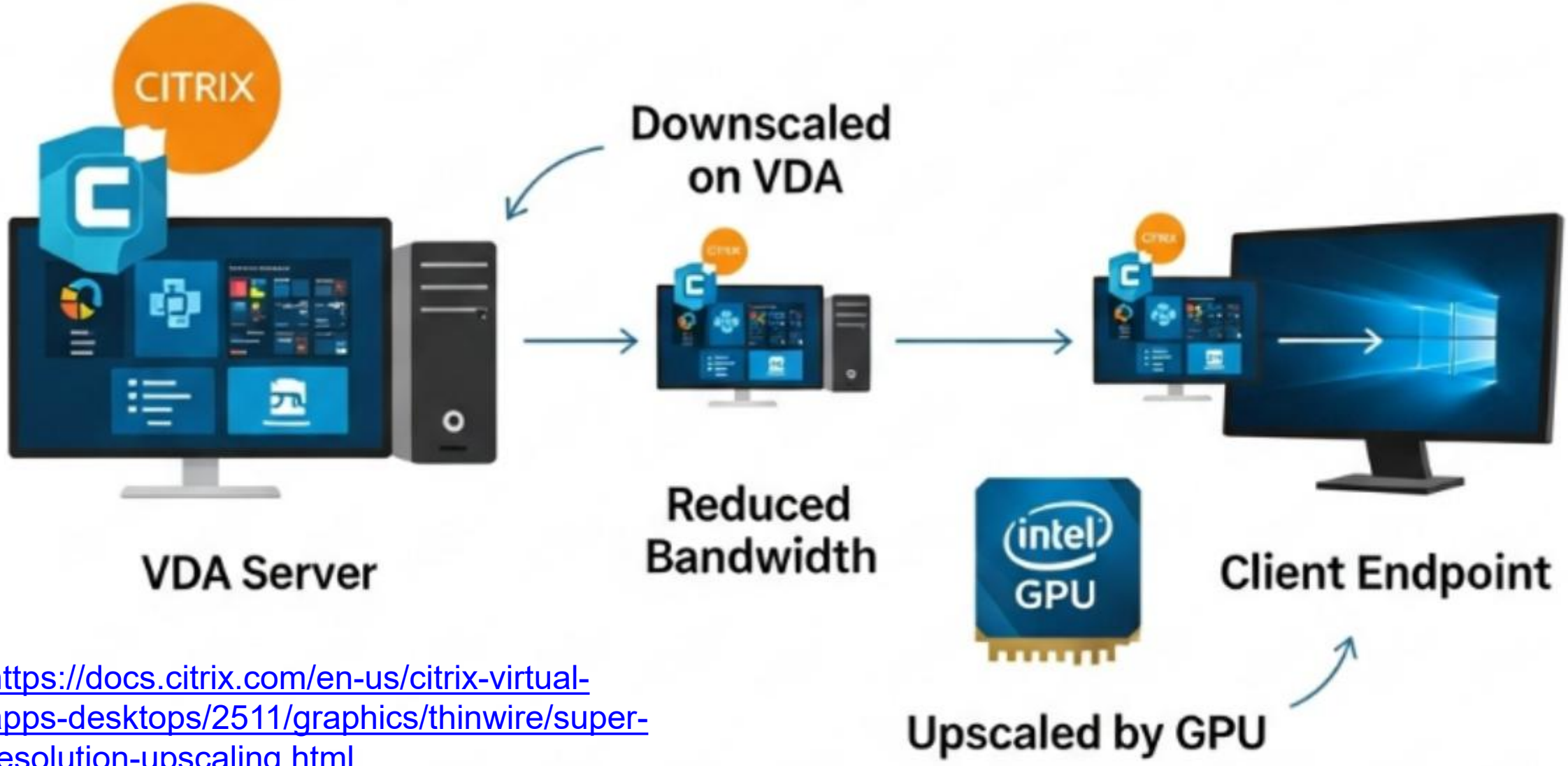
HDX Graphics Super Resolution Upscaling

End User Computing Tech

EUC in a Nutshell

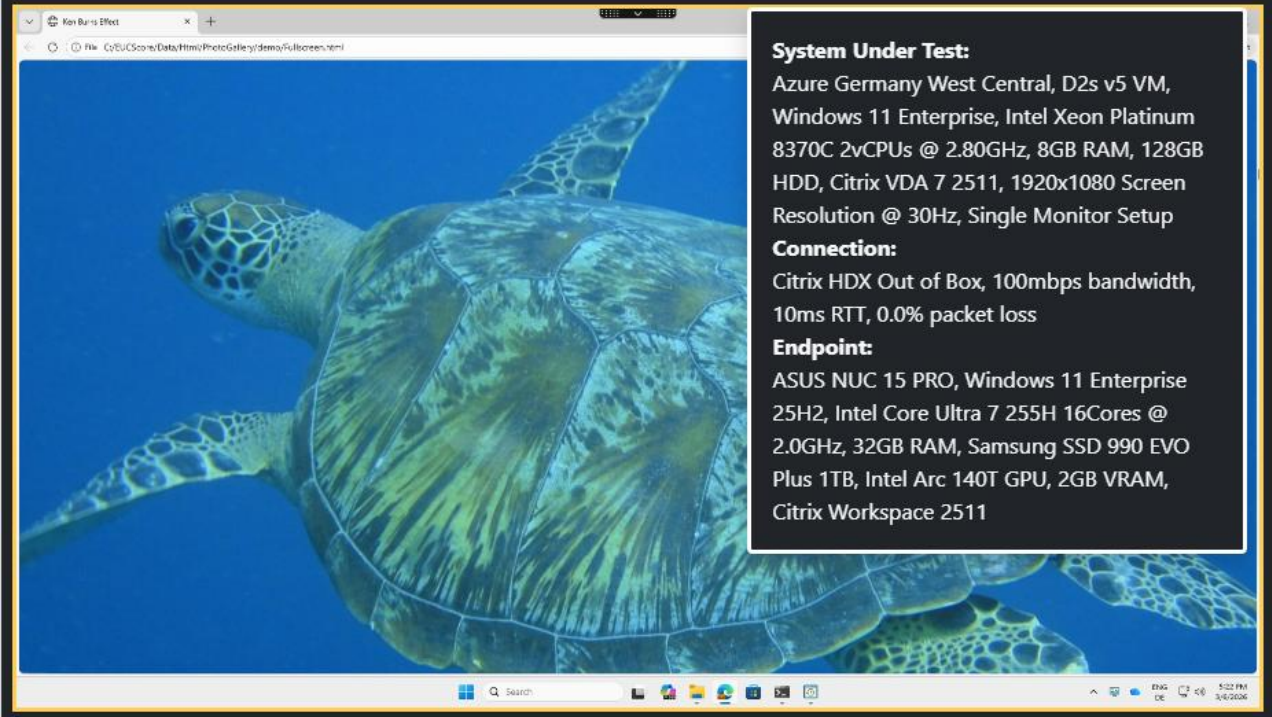


HDX Graphics Super Resolution Upscaling



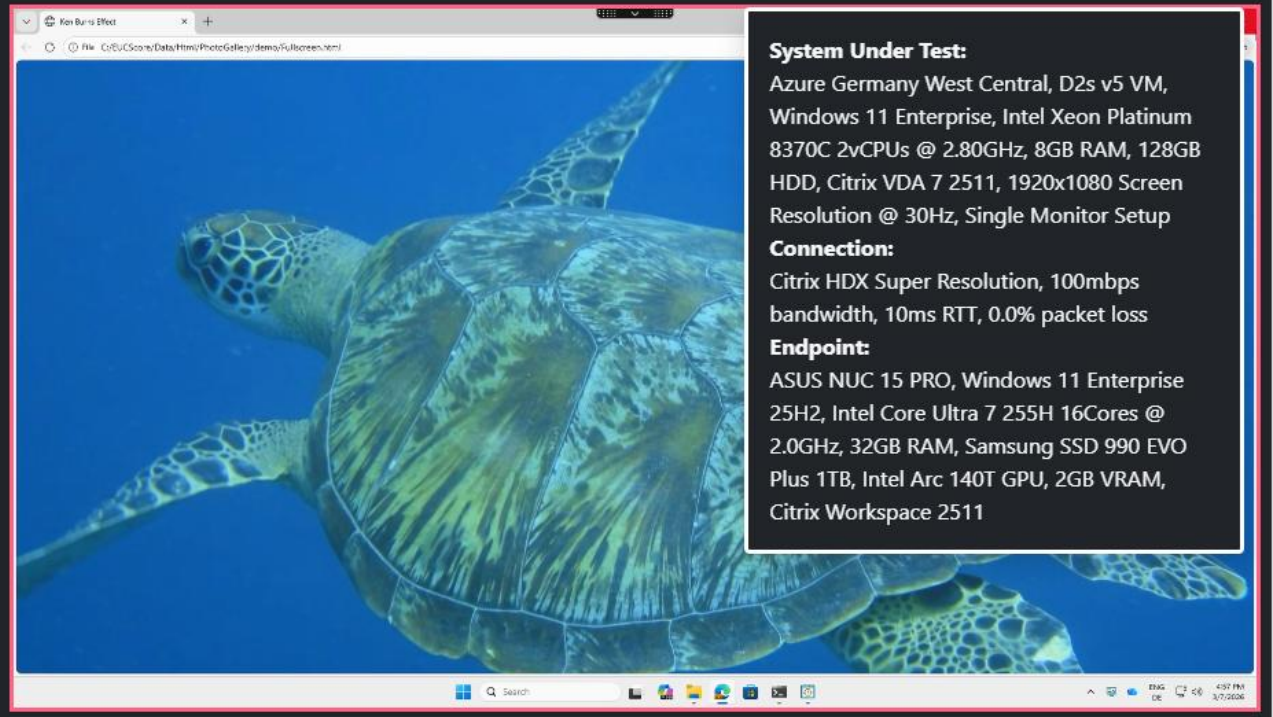
https://docs.citrix.com/en-us/citrix-virtual-apps-desktops/2511/graphics/thinwire/super-resolution-upscaling.html

SL1-MSEdgePhotoGalleryJS on Azure D2s v5 | 2 vCPUs (Intel) | HDX OOB (100mbps, 10ms RTT, 0.0%)



System Under Test:
Azure Germany West Central, D2s v5 VM, Windows 11 Enterprise, Intel Xeon Platinum 8370C 2vCPUs @ 2.80GHz, 8GB RAM, 128GB HDD, Citrix VDA 7 2511, 1920x1080 Screen Resolution @ 30Hz, Single Monitor Setup
Connection:
Citrix HDX Out of Box, 100mbps bandwidth, 10ms RTT, 0.0% packet loss
Endpoint:
ASUS NUC 15 PRO, Windows 11 Enterprise 25H2, Intel Core Ultra 7 255H 16Cores @ 2.0GHz, 32GB RAM, Samsung SSD 990 EVO Plus 1TB, Intel Arc 140T GPU, 2GB VRAM, Citrix Workspace 2511

SL1-MSEdgePhotoGalleryJS on Azure D2s v5 | 2 vCPUs (Intel) | HDX SuperRes2 (100mbps, 10ms RTT, 0.0%)



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Citrix HDX Super Resolution, 100mbps bandwidth, 10ms RTT, 0.0% packet loss
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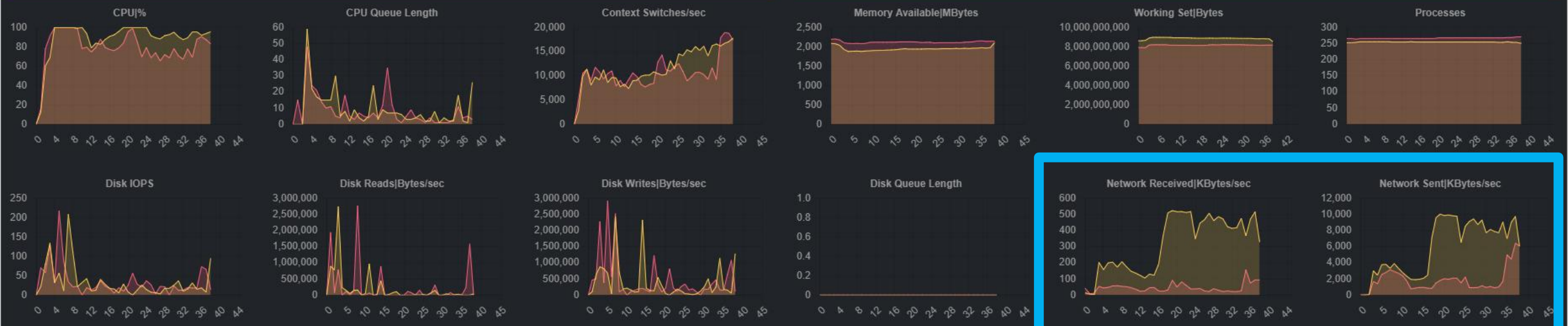

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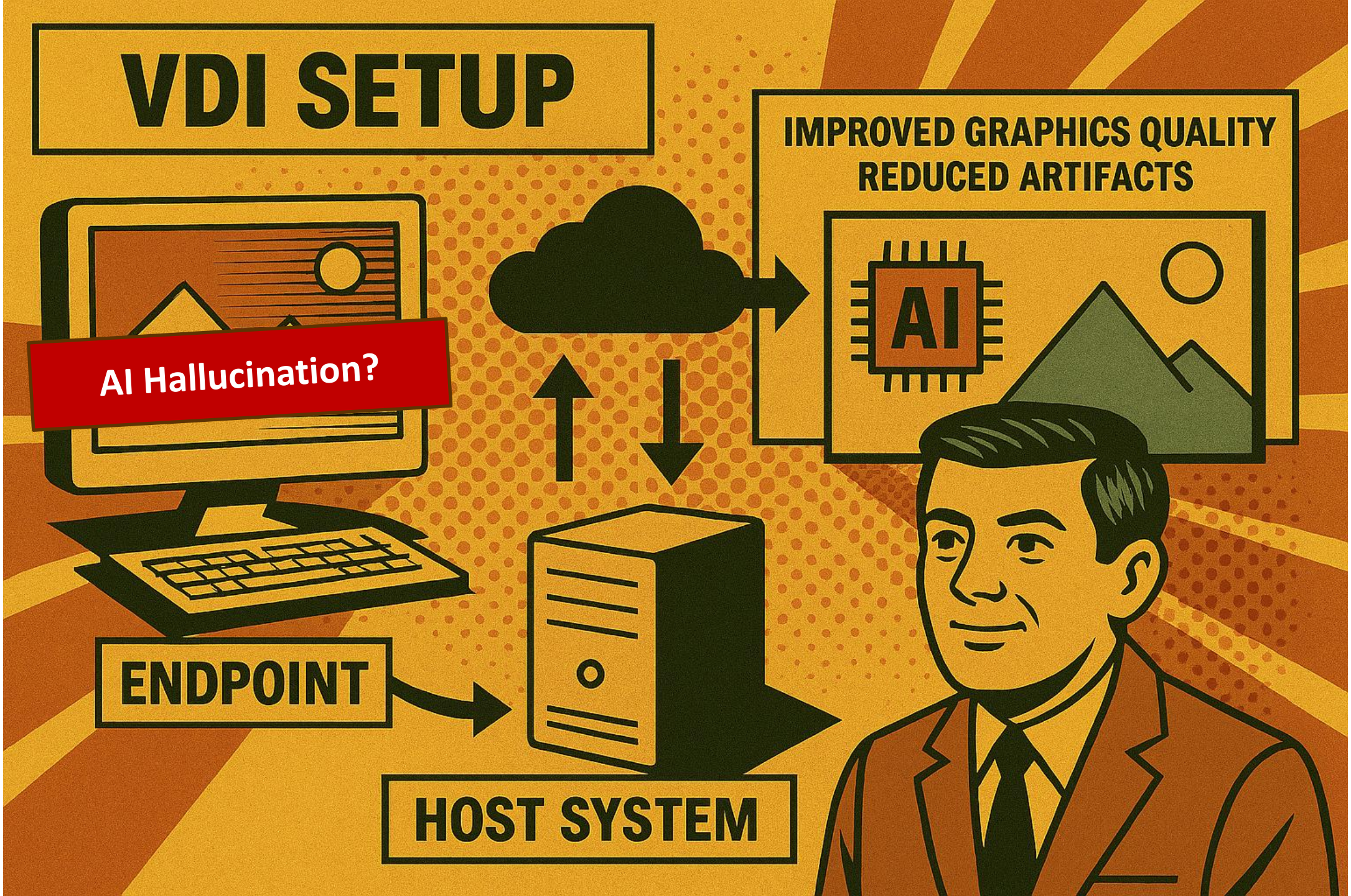
VDI SETUP
IMPROVED GRAPHICS QUALITY
REDUCED ARTIFACTS
AI
AI Hallucination?
ENDPOINT
HOST SYSTEM

Conclusions

Why Perceived User Experience May Suck

- Virtual machine specification
  CPU, RAM, GPU, storage
- Network constraints
  bandwidth, latency, packet loss
- Endpoint device specification and remoting client software

Conclusions

Remoting Protocols – there is no winner!

- Microsoft constantly improves **RDP** (silent updates)
- Omnissa **Blast** performance is better than expected
- Out-of-Box **HDX** prioritizes screen refresh rate over image quality

EUC Infrastructure – endpoints, management, automation & monitoring

- Remoting client software for various endpoint types are becoming increasingly important (“like local”)
- Management consoles are a key differentiator (e.g., add-on products)

The Future

- Remoting protocols using client resources (GPUs, NPUs)

Call to Action

If you want to learn more about EUC Score, send me an email

info@eucscore.com

EUC Score

https://eucscore.com

NOTE: The EUC Score toolset is free for community benchmarking tests when the results are made freely available to the public

https://eucscore.com/freeware/index.html

EUC SCORE

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EUC Score Freeware

https://eucscore.com/freeware/

Last update: May 4, 2026

EUC Score Base Installation Package v26.04 - includes Primary Base Simloads, 2 Personas, 10 Score Simloads, an activity recorder, Simload Runner, and some supplementary tools	Download
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- Lab Equipment: https://eucscore.com/equipment.html

Bedankt voor mij

Tack för mig

Thank you

میرے لئے شکریہ

Tak for mig

Takk fyrir mig

Takk for meg

Danke für mich

Merci pour moi

Gracias por mi

Kiitos minulle