How to Measure DEX

EUC Unplugged, April 2024, Scottsdale, US

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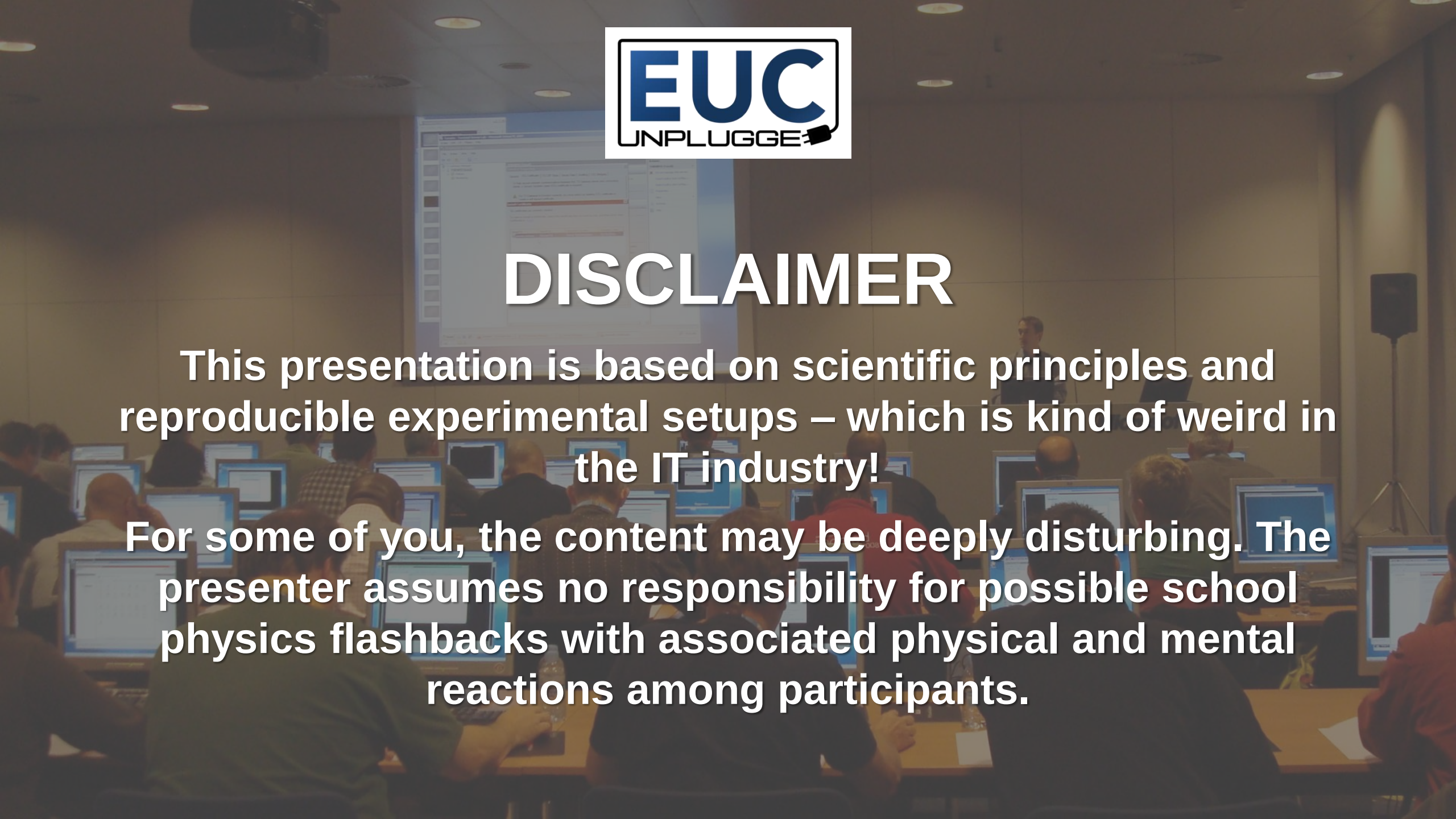

DISCLAIMER

This presentation is based on scientific principles and reproducible experimental setups – which is kind of weird in the IT industry!

For some of you, the content may be deeply disturbing. The presenter assumes no responsibility for possible school physics flashbacks with associated physical and mental reactions among participants.

Benny Tritsch

Dr. Tritsch IT Consulting

EUC Score

Parallels

GO-EUC

TeamRGE
Remoting Graphics Experts

Performance Data Scientist
EUC Documentary Cameraman
MVP | CTP | EUC Expert | NGCA

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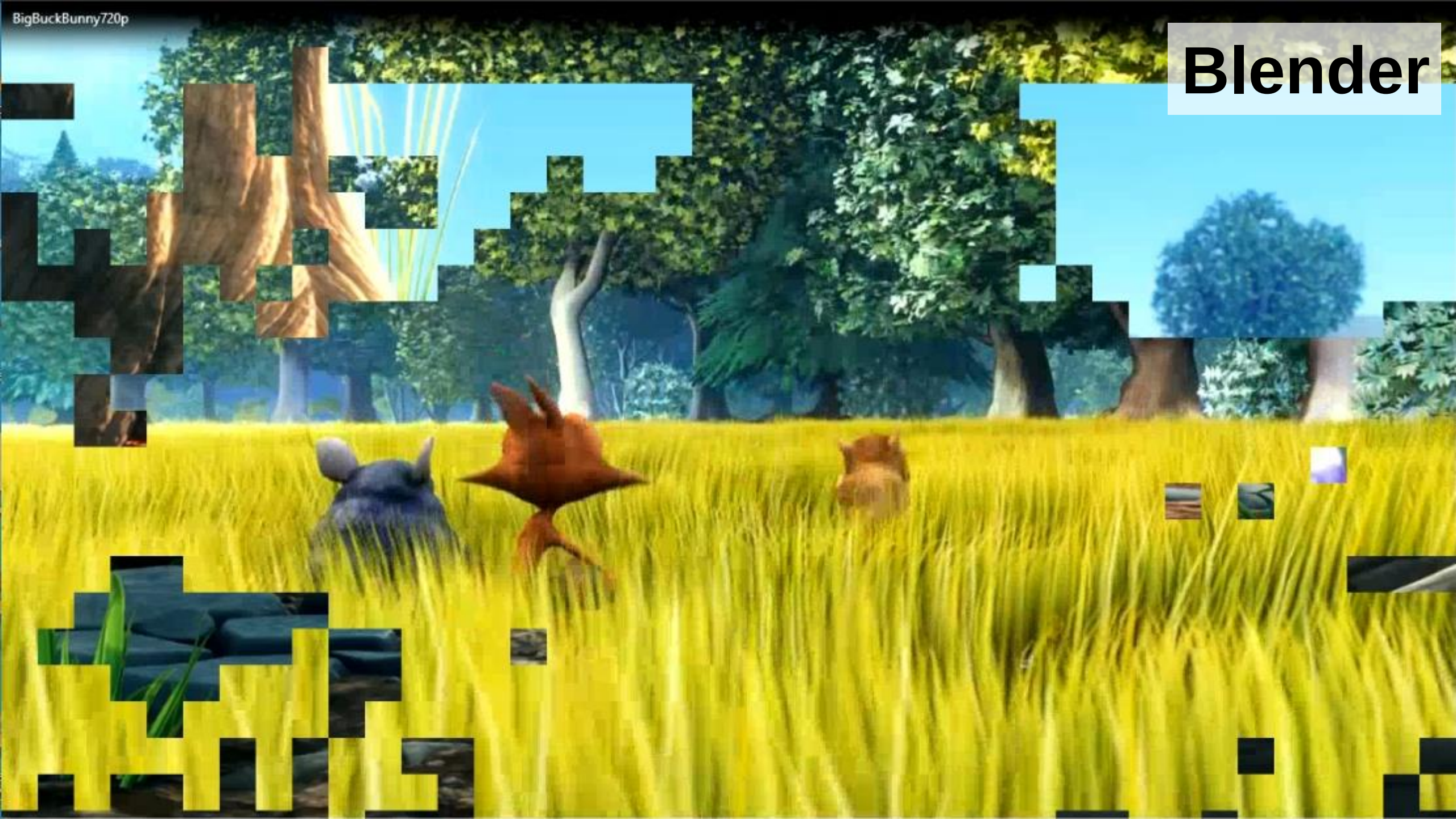
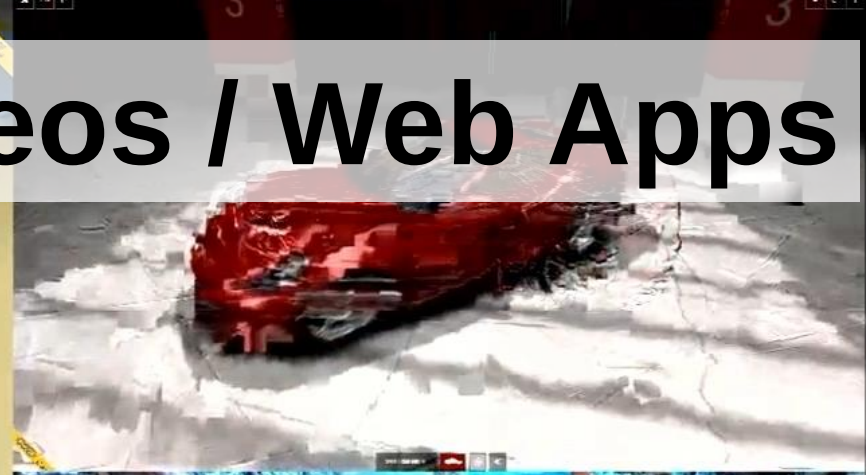
@drtritsch

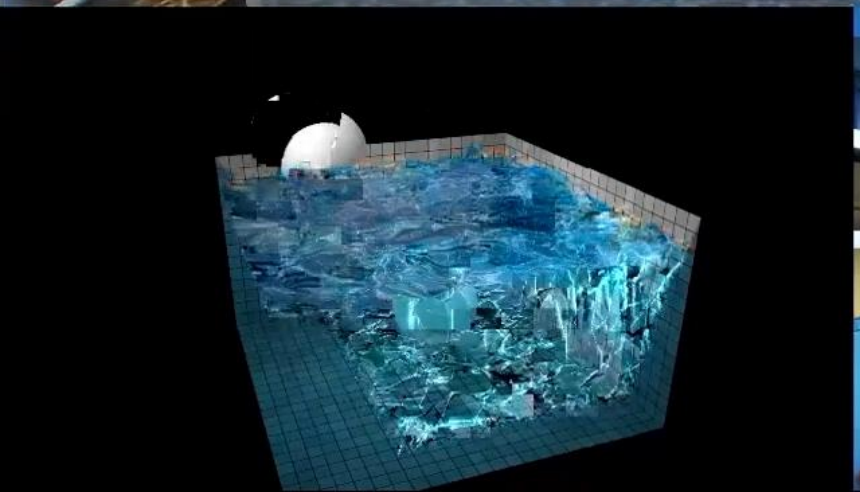
“Back off man, I’m a scientist!”
Bill Murray, Ghostbusters, 1984


Gartner defines DEX as a strategy that focuses on employees, their experience, and their use of technology


BigBuckBunny720p
Blender

Videos / Web Apps





HTML5 Web App

PDF Scroll

Remoting Protocol Features

Remoting protocols run on top of the Internet Protocol (IP), using Transmission Control Protocol (TCP), User Datagram Protocol (UDP) or a combination a TCP and UDP for different aspects of remoting. While older remoting protocols only used TCP, the modern ones use UDP for the graphics remoting aspect.

TCP is a connection-oriented protocol providing high reliability through error checking, congestion control and a built-in mechanism that rearranges data packets in the order specified. It also guarantees that all data remains intact in the packets transferred. But all this makes TCP relatively heavy-weight, significantly reducing graphics remoting performance on low bandwidth and high latency/packet loss networks.

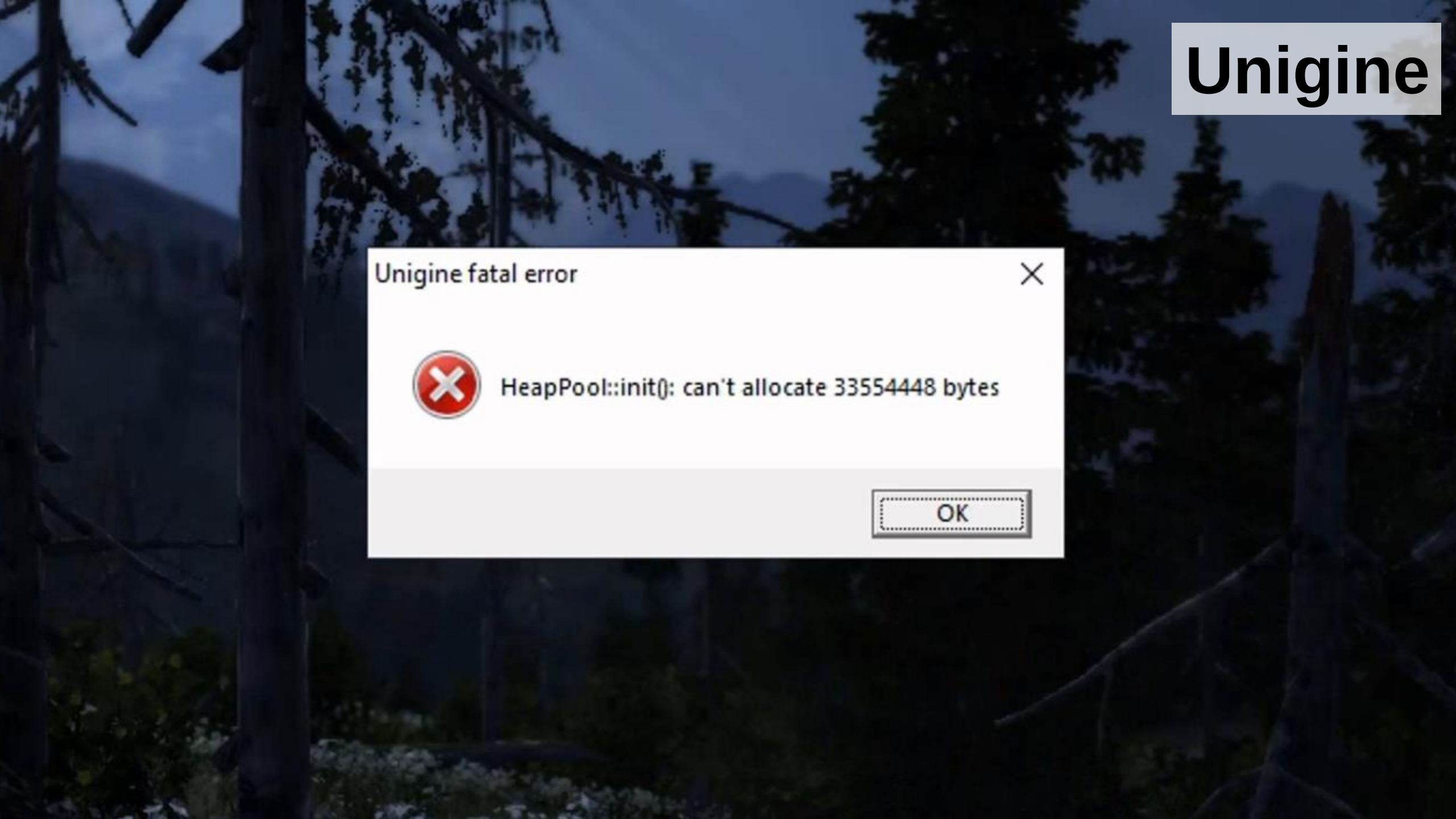
U[illegible] is a c[illegible]ne[illegible]onles[illegible]

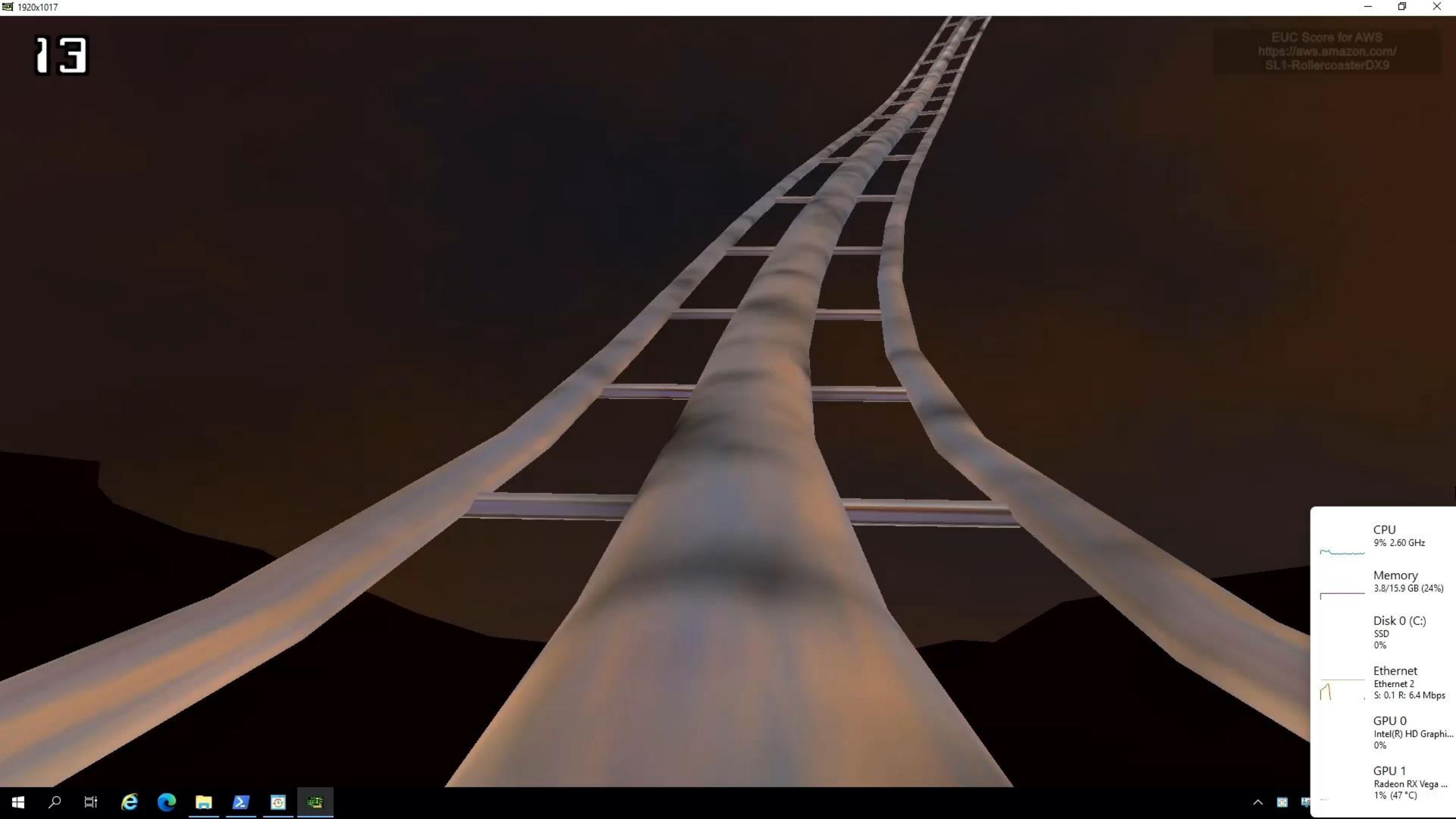
But there is more to a remoting protocol, in particular when it comes to extensibility. The concept of virtual channels provides a way to establish separate streams of data communication while taking advantage of the remote session communication already established. Many remoting protocols use virtual channels to add functions that allow a strict separation from the core features or are not yet specified in the protocol. They represent a platform that future developments can be based on without having to modify the communication methods between host and clients. Examples for virtual channel use cases are joint client and server clipboards or redirecting print jobs to local client printers.

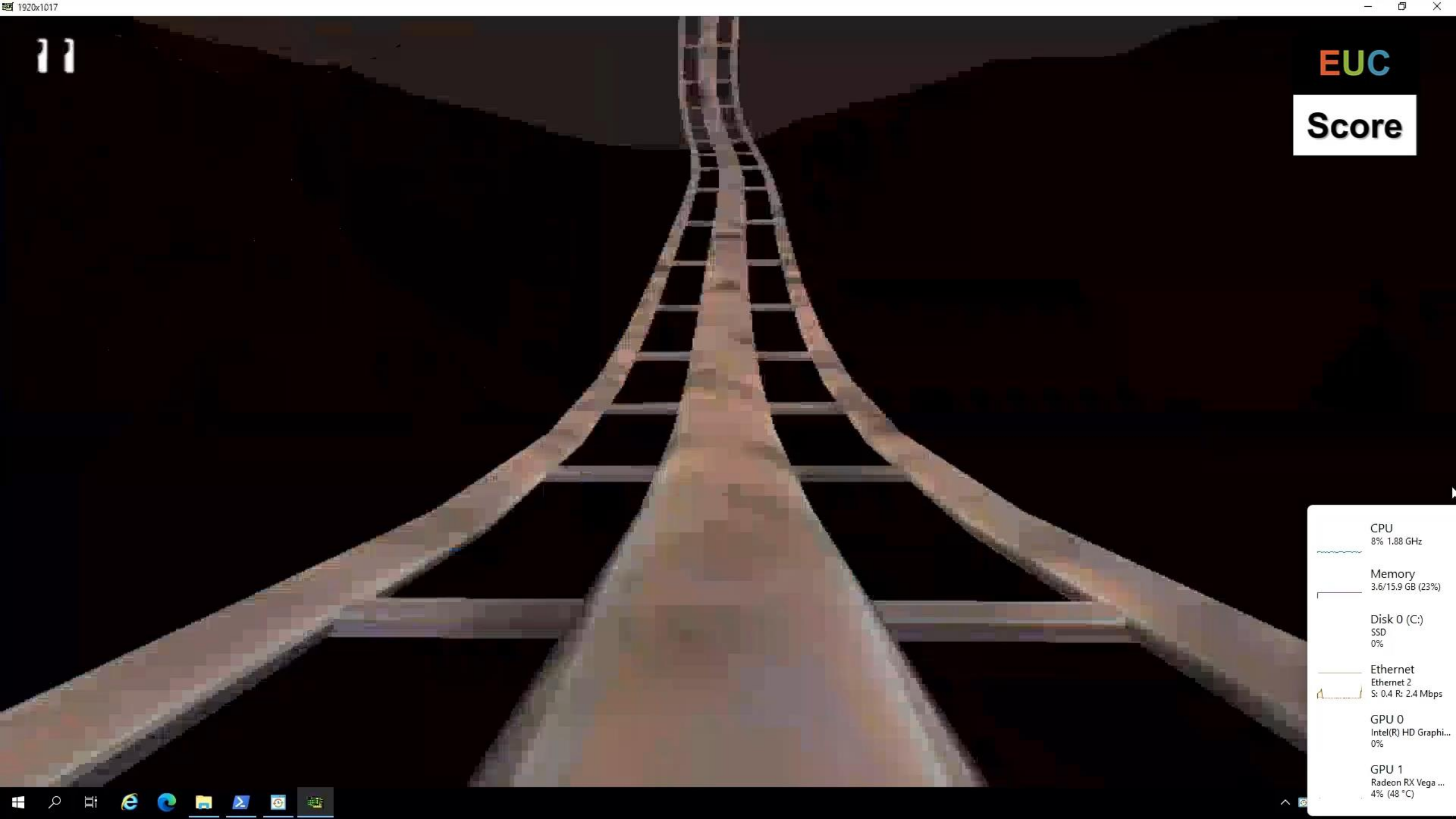
Other notable remoting protocol features include bi-directional audio transmission, client side [illegible]

Client Side Rendering versus Host Side Rendering

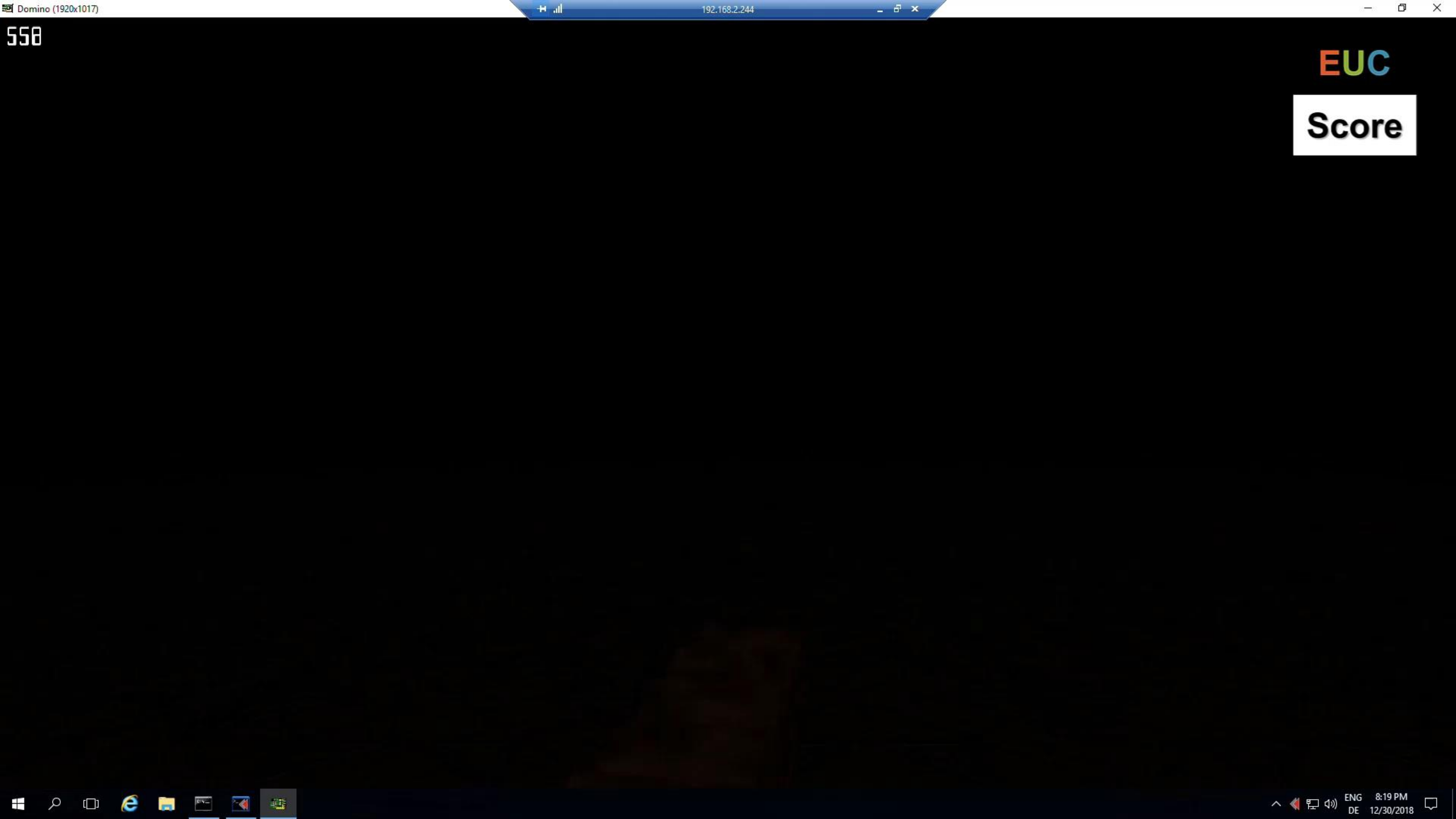
In a graphics remoting environment, the Windows desktop including its applications is rendered in a


Unigine
Unigine fatal error
HeapPool::init(): can't allocate 33554448 bytes
OK


1920x1017
13
EUC Score for AWS
https://aws.amazon.com/
SL1-RollercoasterDX9
CPU
9% 2.60 GHz
Memory
3.8/15.9 GB (24%)
Disk 0 (C:)
SSD
0%
Ethernet
Ethernet 2
S: 0.1 R: 6.4 Mbps
GPU 0
Intel(R) HD Graphi...
0%
GPU 1
Radeon RX Vega ...
1% (47 °C)

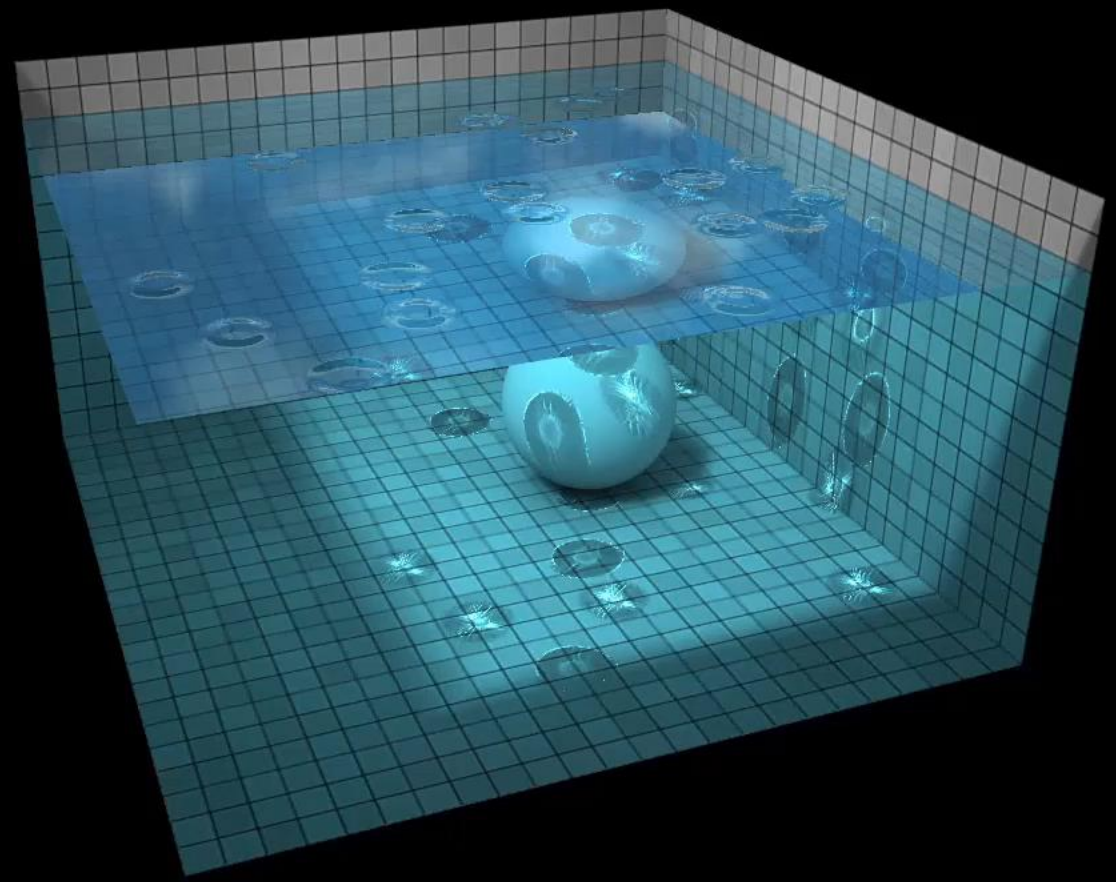

1920x1017
EUC
Score
CPU
8% 1.88 GHz
Memory
3.6/15.9 GB (23%)
Disk 0 (C:)
SSD
0%
Ethernet
Ethernet 2
S: 0.4 R: 2.4 Mbps
GPU 0
Intel(R) HD Graphi...
0%
GPU 1
Radeon RX Vega ...
4% (48 °C)

Coral_Reef_1080p


Domino (1920x1017)
192.168.2.244
558
EUC
Score
ENG
DE
8:19 PM
12/30/2018

WebGL Water

Not secure | madebyevan.com/webgl-water/



WebGL Water

Made by Evan Wallace

This demo requires a decent graphics card and up-to-date drivers. If you can't run the demo, you can still see it on YouTube.

Interactions:

- Draw on the water to make ripples
- Drag the background to rotate the camera
- Press SPACEBAR to pause and unpause
- Drag the sphere to move it around
- Press the L key to set the light direction
- Press the G key to toggle gravity

Features:

- Raytraced reflections and refractions
- Analytic ambient occlusion
- Heightfield water simulation *
- Soft shadows
- Caustics (see this for details) **

* requires the OES_texture_float extension
** requires the OES_standard_derivatives extension

Tile texture from zooboing on Flickr

Views

CPU 100%

60 Seconds 0%

Disk 100 KB/sec

0

Network 1 Mbps

0

Memory 100 Hard Faults/sec

0

Task Manager

File Options View

Processes Performance Users Details

CPU
88% 2.60 GHz

Memory
1.7/4.0 GB (43%)

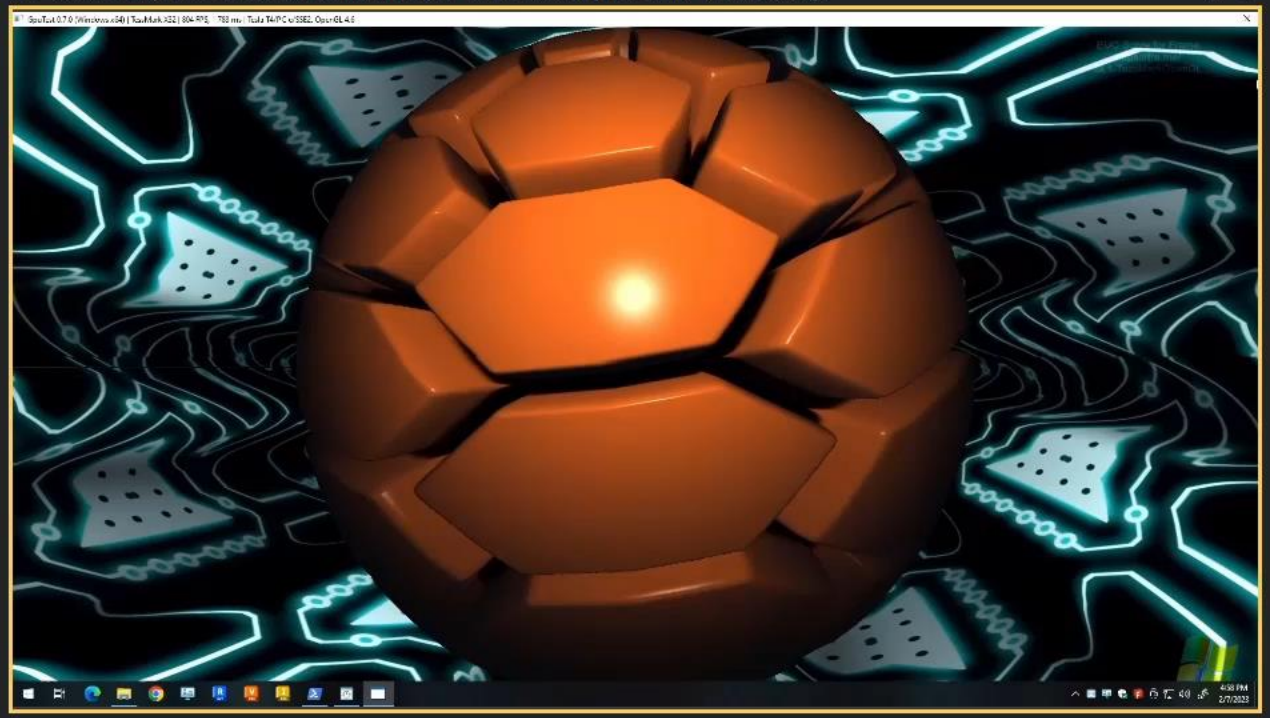
Ethernet
S: 16.0 Kbps R: 16.0 Kbps

Fewer details | Open Resource

WebGL Water - Pro... Task Manager Resource Monitor

ENG DE 5:37 PM 1/6/2021

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

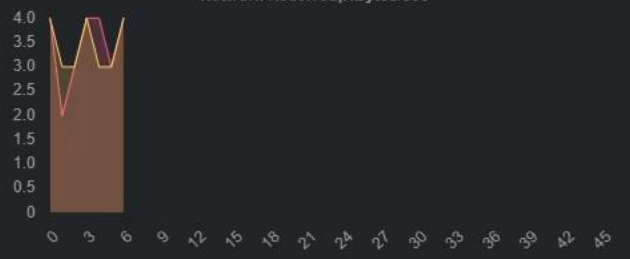


SL1-TessMarkOpenGL on Azure NC4asT4 v3 | HP t640 w/o GPU | FRP8 UDP (10ms latency)

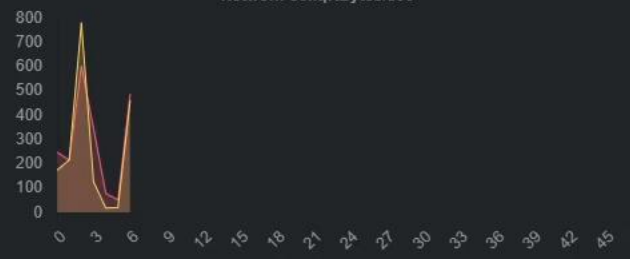
CPU|%

Memory|MBytes

Network Received|KBytes/sec



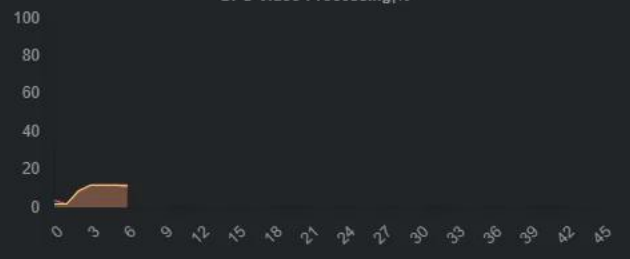
Network Sent|KBytes/sec



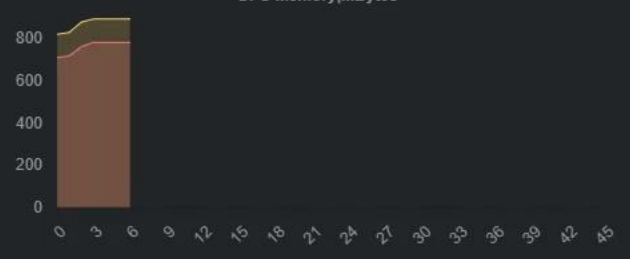
GPU 3D|%

GPU Video Decode|%

GPU Video Processing|%



GPU Memory|MBytes

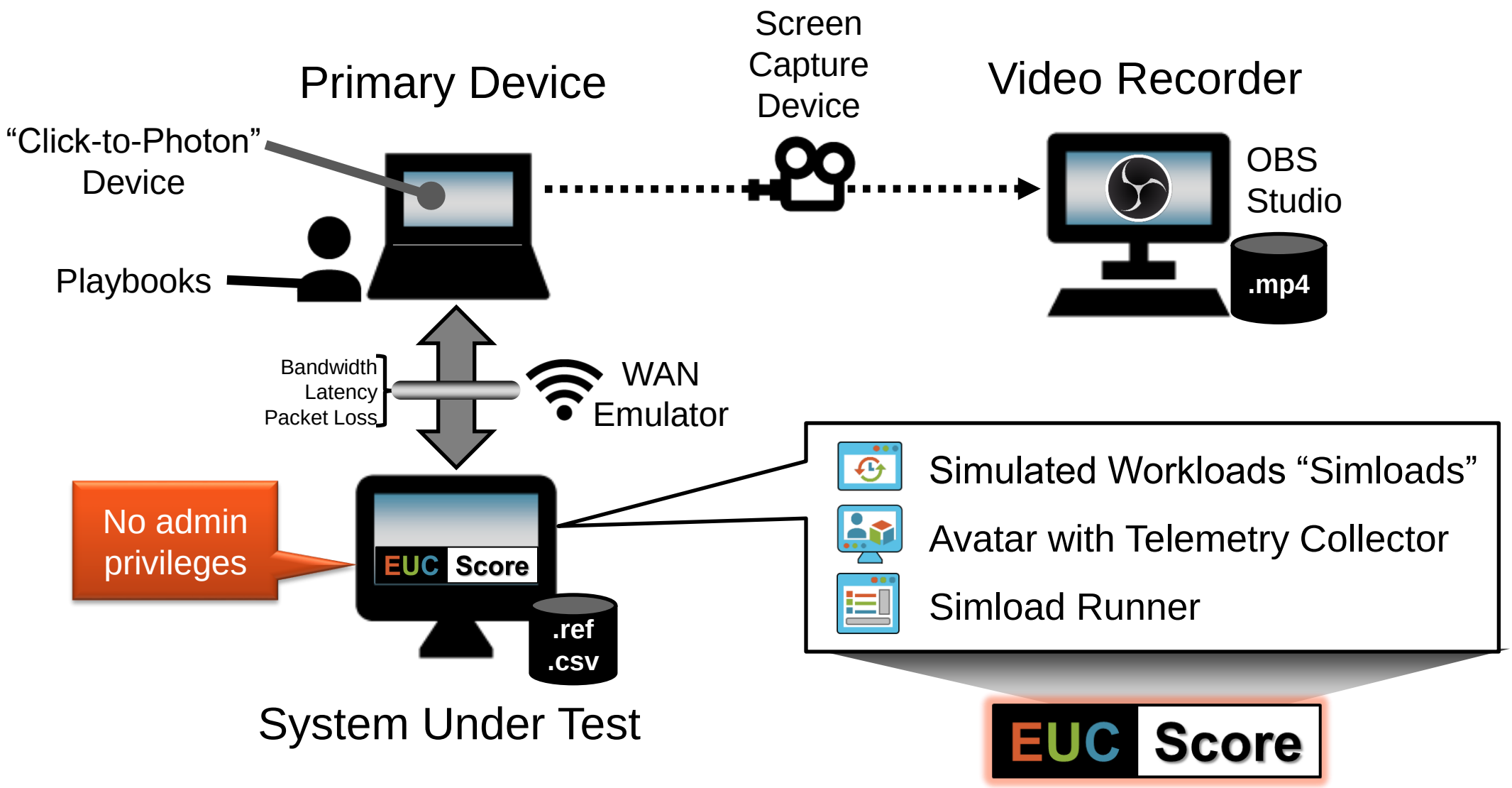


00:00:07 00:00:45 Help Report

Some EUC Score Sync Player Clips

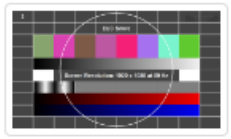
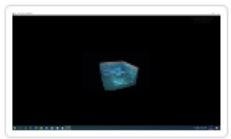
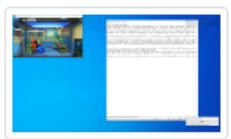
- BLENDER on CAD/CAM Workstation – HDX LAN vs HDX WAN
- WMPlayer on CAD/CAM Workstation – HDDX LAN vs RDP LAN
- INVENTOR on CAD/CAM Workstation – HDX LAN vs HDX WAN
- SOLIDWORKS on Azure AVD – Large versus Small GPU
- CATIA on Azure AVD – Large versus Small GPU
- EUC Score Results

Build a Single-User DEX Test Lab



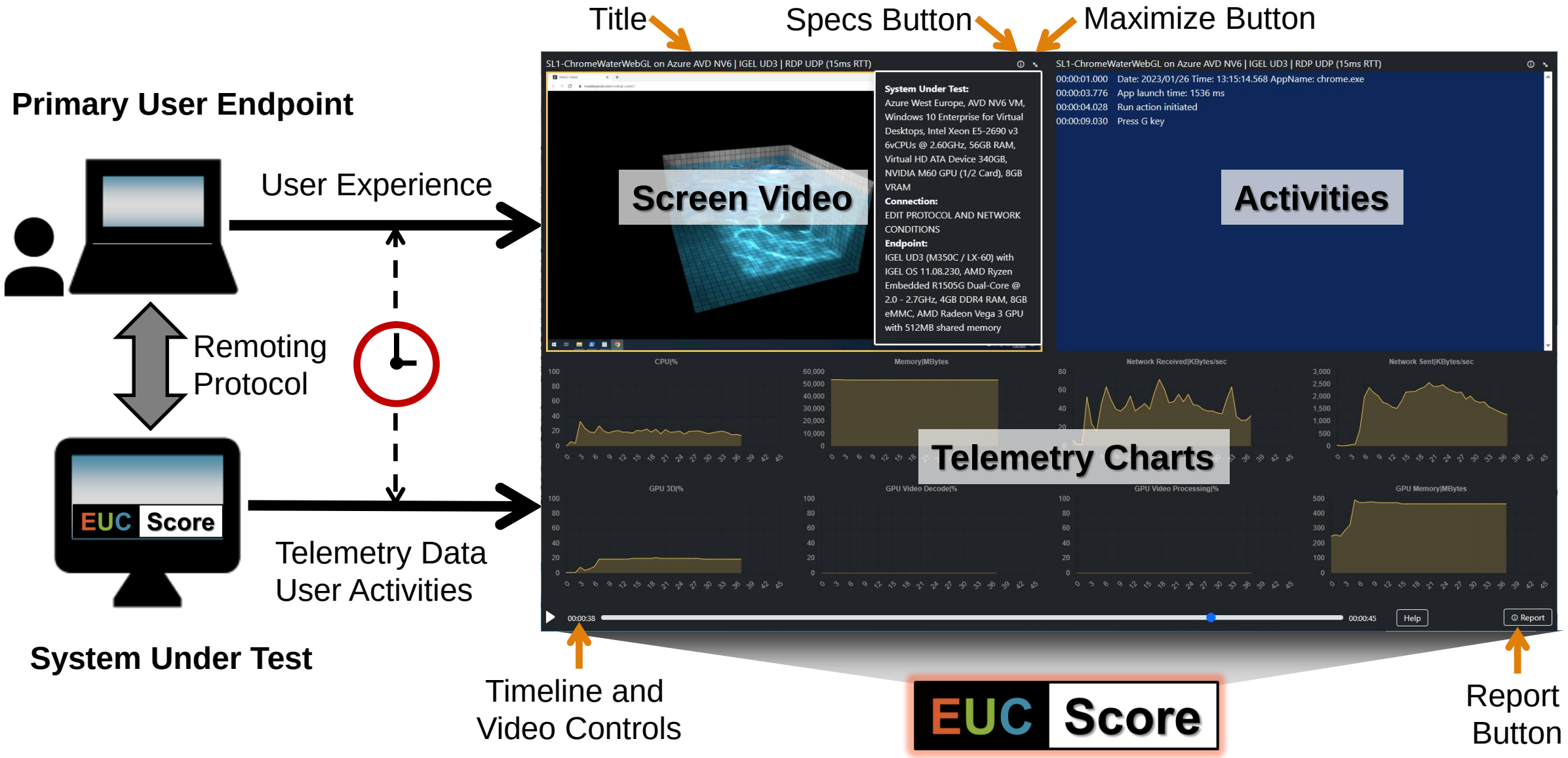
EUC Score Simload Gallery: https://eucscore.com/gallery.html

https://eucscore.com/gallery.html

Thumbnail	Simload Type	Description
	**System**	**SL0-TestScreen** Open a test pattern screen and save system information.
	**Primary** Base	**SL1-NotepadEdit** Open Microsoft Notepad and start writing a novel with random type speed.
	**Primary** Base	**SL1-WordpadScroll** Open local DOCX file with PNG images in Wordpad and randomly move pages up and down every second.
	**Primary** JPEGView	**SL1-JPEGViewStatic** Open JEPG image in JEPG View. **NOTE**: This is the most basic Simload as it includes neither animations nor user interactions.
	**Primary** JPEGView	**SL1-JPEGViewAnim** Open animated GIF image in JEPG View.
	**Primary** WMPlayer	**SL1-WMPlayer480pWMV** Open local 480p WMV video in Windows Media Player, switch from windowed to fullscreen mode.
	**Persona** Base	**SL2-Base** **Foreground**: SL3-AppDialog **Background**: SL1-JPEGViewAnim

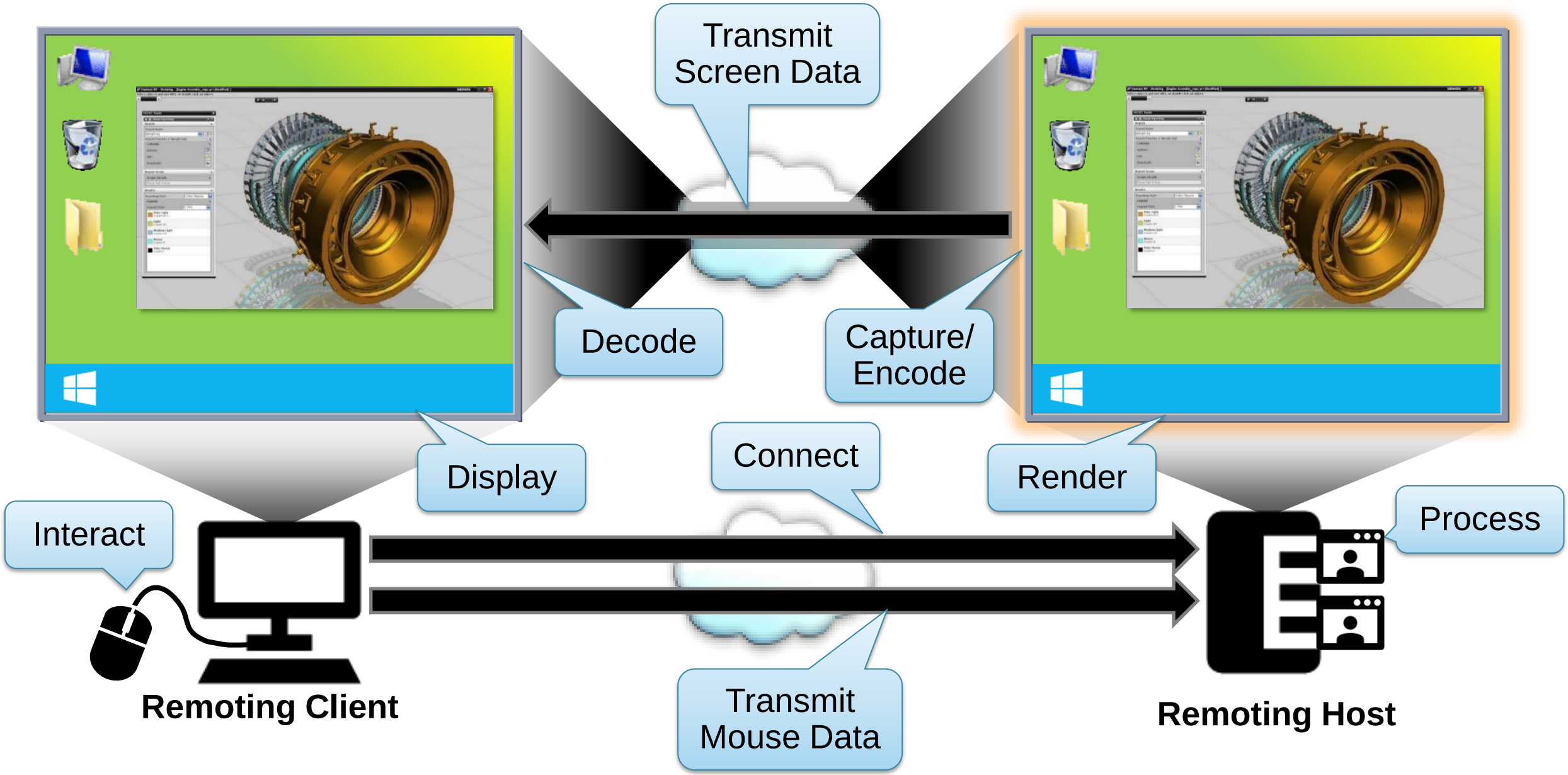
+ custom or manual Simloads with real user playbooks

Visual Data Analytics – Sync Player



Glossary – Screen Artifacts / Anomalies

- Block boundary – mosaicking, pixelating, quilting, checkerboarding
- Tiling, striping – rendering each section of an image grid, a tile, or a stripe separately
- Smear artifact – grime, smudge, airbrush effect
- Blurriness – out of focus, fuzziness, unsharpness
- Color artifacts – false colors, color bleeding, color lookup table errors
- Mosquito noise – edge busyness
- Ringing – echoing, ghosting
- Choppy – laggy, jumpy, jerky
- Floating – illusory motion in certain regions while the surrounding areas remain static
- Jitter – loss of transmitted data between network devices, irregular movement, variation, unsteadiness
- Flickering – fine-grain flickering and coarse-grain flickering, irregular or unsteady moves
- Slow motion – action appears to be slowed down
- Video stuttering (“micro stutters”) – irregular delays between frames
- Freeze frames – a single frame in a video sequence forming a motionless image


Transmit
Screen Data
Decode
Capture/
Encode
Display
Connect
Render
Interact
Process
Transmit
Mouse Data
Remoting Client
Remoting Host

Science of DEX: Performance Influencers

“Remoting Protocol Stack”

Host System
“VM Type”

Client Device
“Endpoint”

GPUs

Network

Science of DEX: Network Factors

The richer the graphics, the more bandwidth it will take

Bandwidth

Data transfer rate of a network connection

Latency

Delay; amount of time to traverse a system

Packet Loss

Discarding of data packets (in percent)

Latency: It's Einstein's Fault…

40,000km ≈ 25,000mi

~130ms

Speed of light

c ≈ 300,000km/sec

186,000mi/sec

VF%	Cable
74–79	Cat-7 twisted pair
77	RG-8/U
67	optical fiber
65	RG-58A/U
65	Cat-6A twisted pair
64	Cat-5e twisted pair
58.5	Cat-3 twisted pair

Minimum velocity factors for network cables

Science of DEX: Human Timings

Nervous System

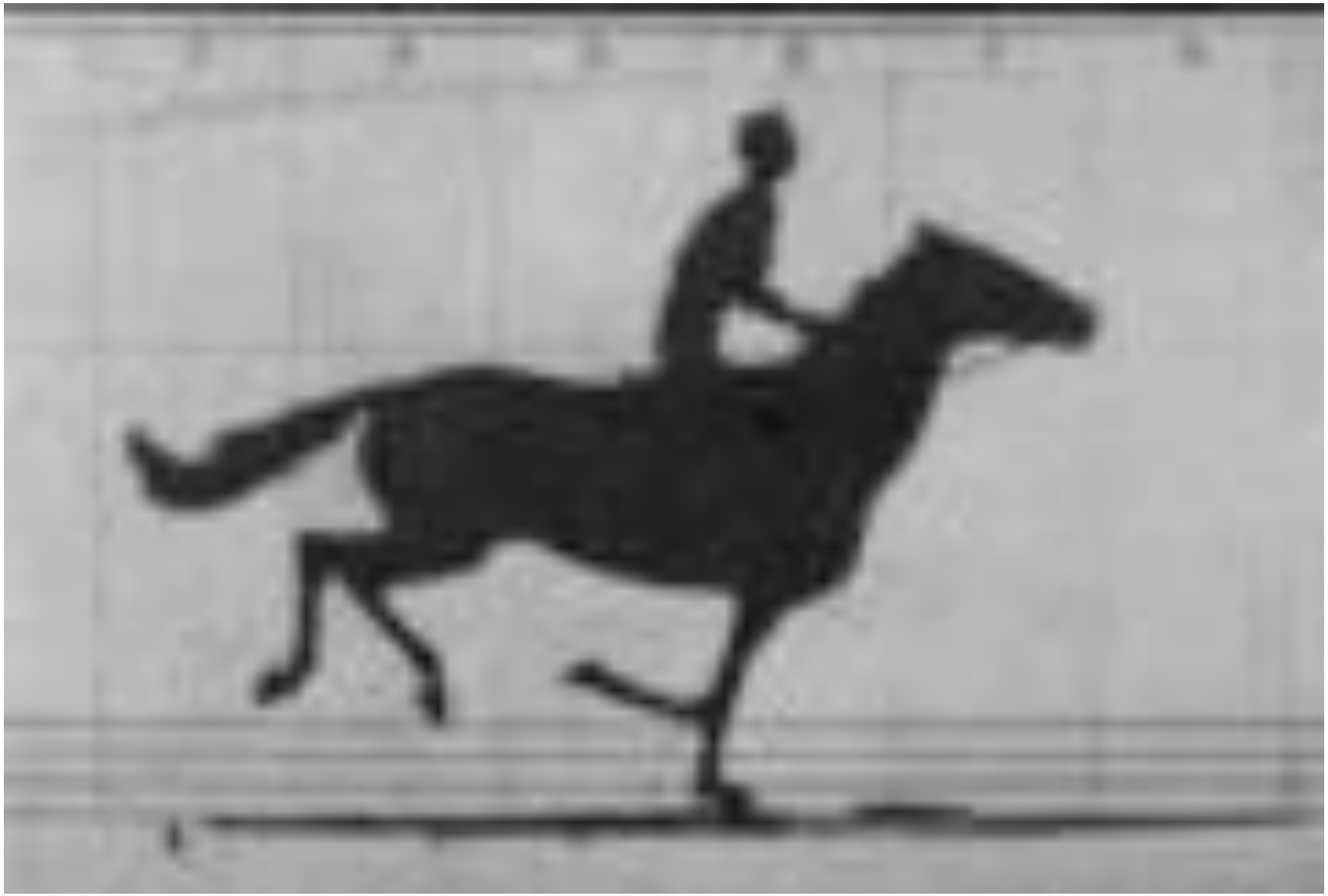
- Speed of nerve impulse is 120 meters per second
- Human response time is 150-300ms (varies with age)
- Equals to 15,000 – 30,000 km of fiber cables

Visual System

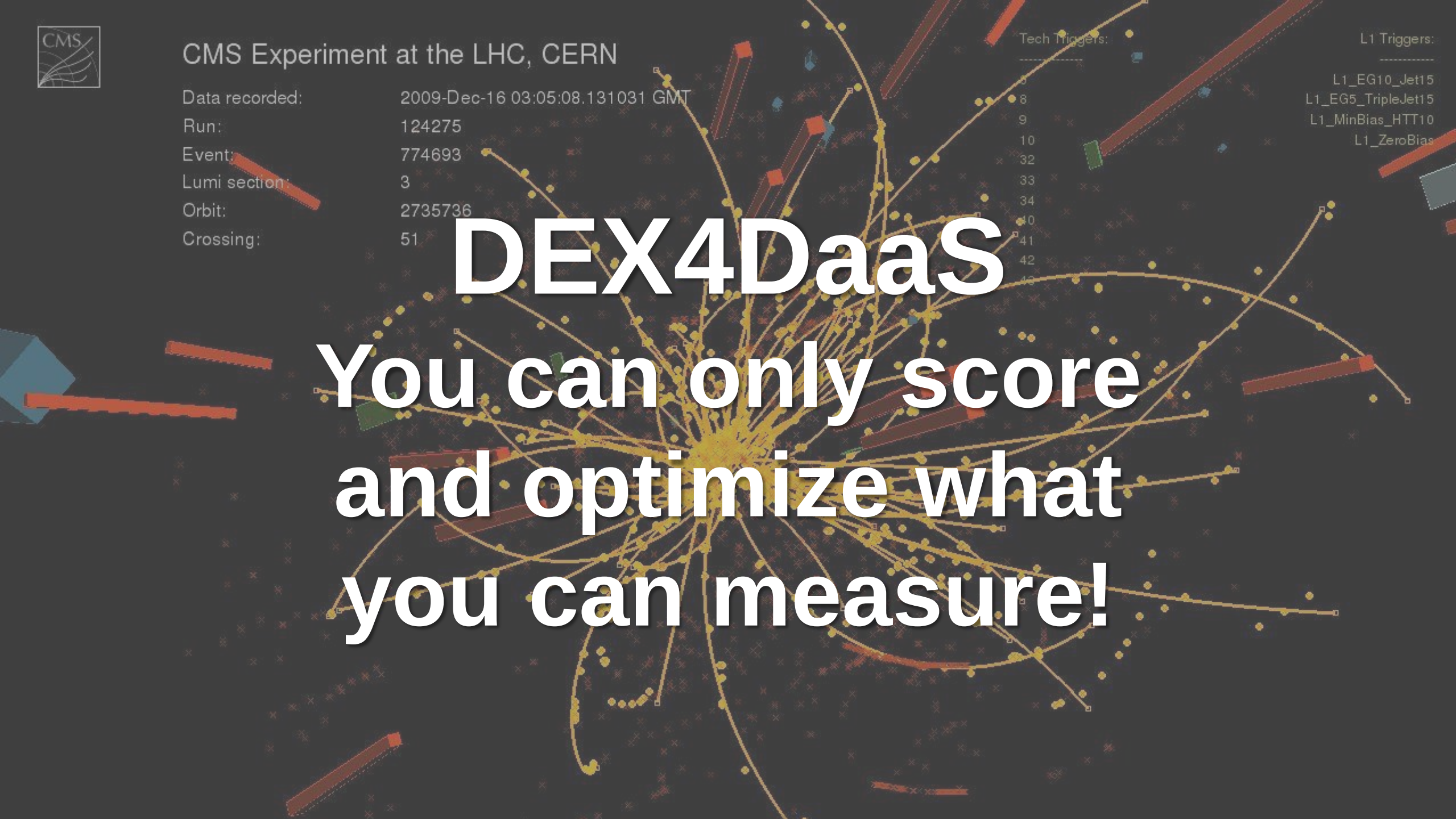
- 24 to 30 frames per second are required for video or motion
- Most desktop monitors' refresh rate is 60 Hz (=16ms)
- Eye blink: 100-150ms
- The brain can process visual data from a single image in 13ms
- Flicker up to 500 Hz

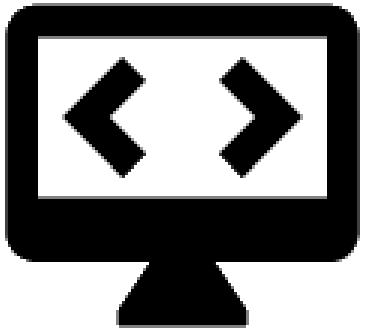
Auditory System

- Range of human hearing is 20 to 20,000 Hz
- Decibel (dB) measures the force of the sound wave (0-120dB, log.)
- Minimal time interval between two sounds is 3-30ms
- Interaural: 10-20µs



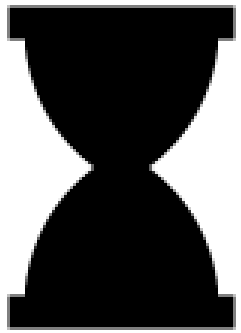
The Horse in Motion by Eadweard Muybridge
"Sallie Gardner“ running at a 1:40 gait over the Palo Alto track, on 19th June 1878


CMS Experiment at the LHC, CERN
Data recorded: 2009-Dec-16 03:05:08.131031 GMT
Run: 124275
Event: 774693
Lumi section: 3
Orbit: 2735736
Crossing: 51
Tech Triggers:
8
9
10
32
33
34
41
42
L1 Triggers:
L1_EG10_Jet15
L1_EG5_TripleJet15
L1_MinBias_HTT10
L1_ZeroBias
DEX4DaaS
You can only score and optimize what you can measure!



Boot and logon duration

Measure boot time + logon time + user session load time. This is the time from turning on the endpoint device to the moment when the user can start interacting with the desktop or the published application. (Citrix: Session Launch Diagnostics, Time to first byte - TTFB)

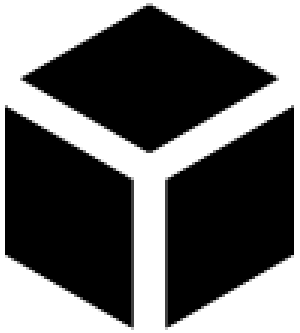


Application and content load time

Measure the amount of time it takes for a user mode application to start, to initialize fully, and potentially open data files from the storage system before the user interface becomes ready for user input.

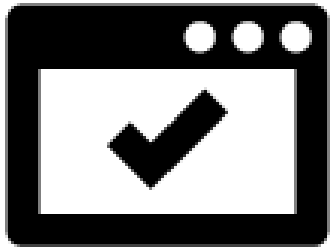
User input delay (“Lag”)

(System Response Time, Interactivity Time) Measure the amount of time that passes between user input (= user-initiated triggers) and the corresponding appearance of graphics primitives or user interface elements, also referred to as responsiveness, lag or latency. In case of a remote desktop connection, the network's round-trip time (RTT) may play a significant role for the user input delay.



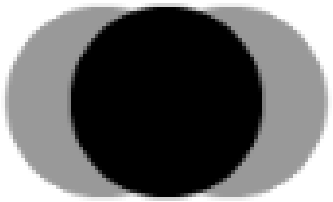
Graphics APIs supported

Detect incompatibilities when running graphics applications using the DirectX, OpenGL, Vulkan and WebGL APIs.



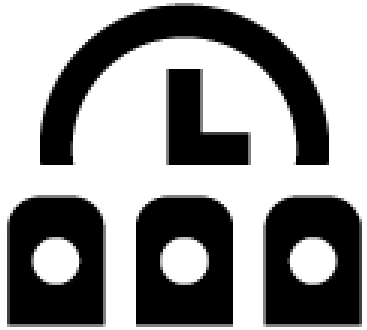
Media formats supported

Detect incompatibilities when opening media files, such as MP4, MPEG, MOV, WMV or AVI.



Distortion of media

Measure media and screen output quality, identify out-of-sync media streams (= lack of cross-media synchronicity) and detect image, animation, and audio/video compression and decompression artifacts and anomalies, such as grains, color loss, blocking, tiling, pixelating, blurring, flickering, and noise.

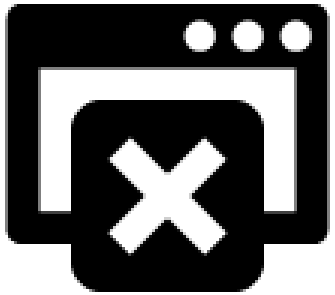


Screen refresh rate

Measure the number of times per second that the desktop or application is able to draw or refresh consecutive images on the screen of the endpoint device, expressed in frames per second (fps) or Hertz (Hz). In remote desktop scenarios, the frame rate on the sender side and on the receiver side both contribute to the overall perceived frame rate.

Endpoint specs and quality

Ensure that the physical endpoint device is reliable and that input and output devices connected to it are working properly in the context of a remote desktop connection. Examples are screens, keyboard, mouse, USB devices or printers. For the screens, determine the resolution (number of pixels and density) as well as the visual dimensions diagonally in inches or centimeters.



Application stability

Detect application hangs, freezes, crashes or unhandled exceptions.

Session availability and resilience

Detect user session hangs/disconnects/reconnects.

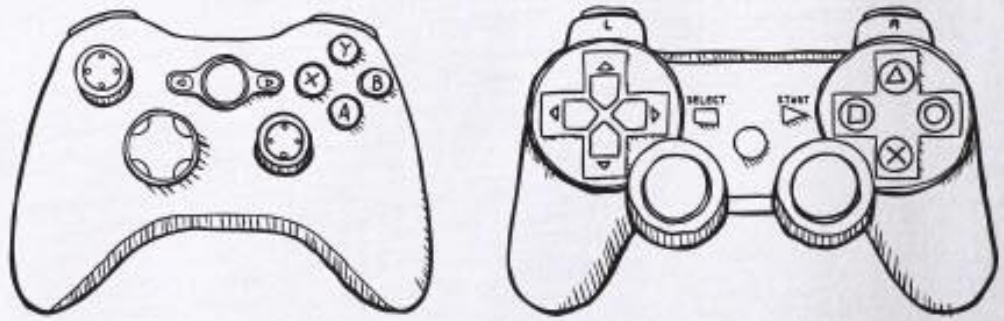
Science of EUC – DEX Quality Criteria

	**Boot and logon duration**	Measure boot time + logon time + user session load time until it is ready for user interaction
	**Application and content load time**	Measure time from user starting an application until the content appears and the application is ready for user input
	**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 media files, such as MP4, MPEG, MOV, WMV or AVI
	**Distortion of media**	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 (frames per second = fps)
	**Endpoint specs and quality**	Determine the number of pixels and density as well as the screen's visual dimensions – frame buffer requirements grow with resolution and screen number
	**Application stability**	Detect application hangs, freezes, crashes or unhandled exceptions
	**Session availability and resilience**	Detect user session hangs, disconnects and reconnects

Science of DEX: Personas

	Persona Name	Rendering	IT Workforce	Description
	**Task Worker**	CPU	25-80%	Well-defined, repetitive, and delineated tasks, using a limited number of applications
	**Information Worker**	CPU or shared GPU	25-80%	Find facts quickly, create documents, edit, write & process information
	**Knowledge Worker**	High-end CPU or shared GPU	10-50% ~400m	Tasks include accessing the Internet, using email, and creating complex documents, presentations, and spreadsheets
	**Power User**	Shared GPU or dedicated GPU	5-50% ~200m	People who use multiple compute, network and graphics-intensive applications
	**CAD/CAM Professional Designer**	Dedicated GPU	5-25% ~25m	People who use graphically-intense applications for computer-aided design (CAD) and computer-aided manufacturing (CAM)

VIDEO GAMES DON'T MAKE US VIOLENT



LAG DOES

Call to Action

If you want to learn more about the science of EUC Score projects, send an email to

info@eucscore.com

EUC Score

https://eucscore.com
https://eucscore.com/results

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

EUC Score Links

- Home page: https://eucscore.com/
- Test Methodology: https://eucscore.com/methodology.html
- Toolset documentation: https://eucscore.com/docs/index.html
- Simload Gallery: https://eucscore.com/gallery.html
- Test Results (Sync Player): https://eucscore.com/results
- Terminology (Glossary): https://eucscore.com/terminology.html
- Lab Equipment: https://eucscore.com/equipment.html

Thank You

Benny Tritsch | info@eucscore.com | @drtritsch