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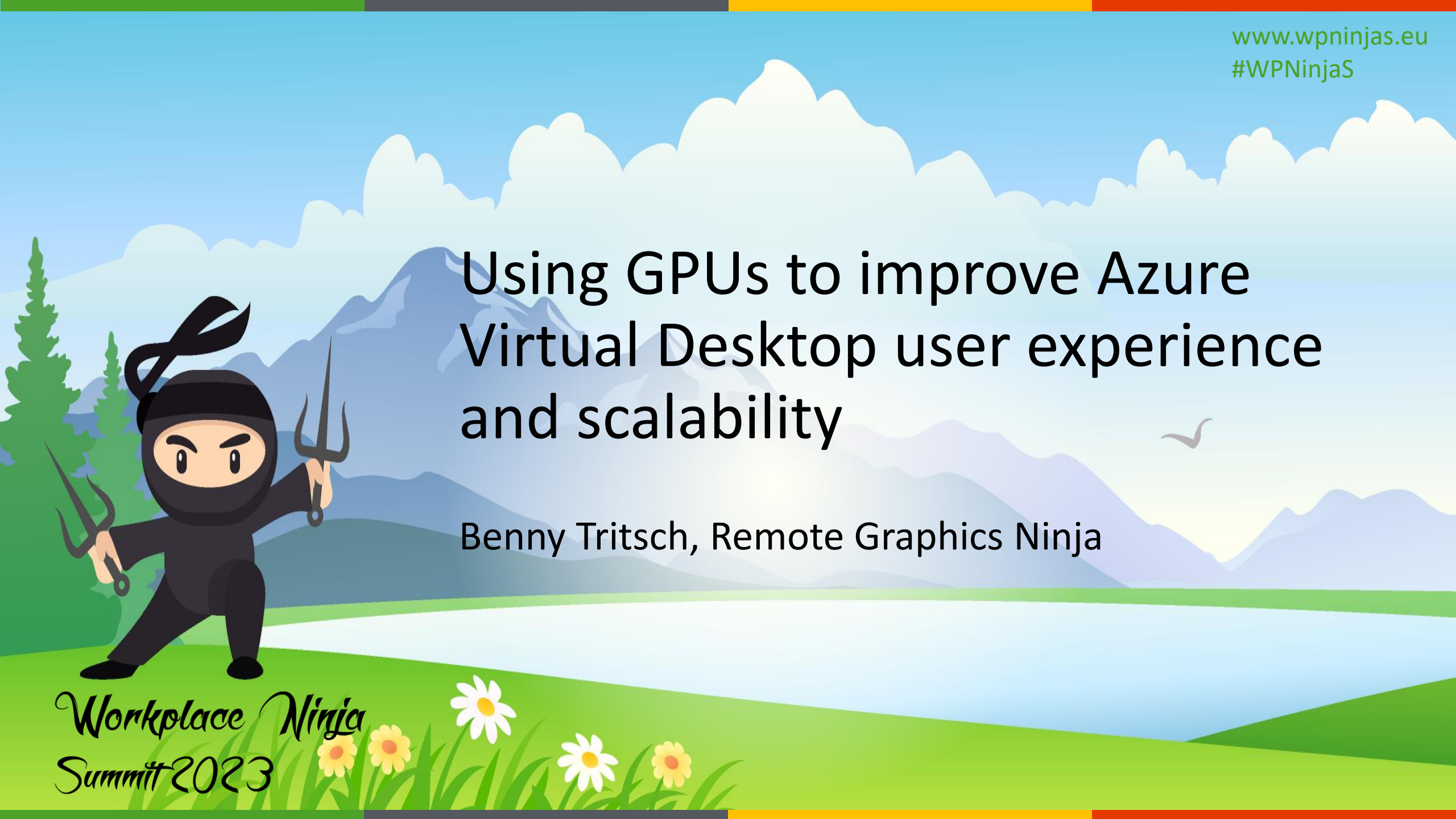
Using GPUs to improve Azure Virtual Desktop user experience and scalability

Benny Tritsch, Remote Graphics Ninja



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water
IT Security & Defense

About Benny Tritsch

Focus

EUC Evangelist and Chief Scientist

From

Dr. Tritsch IT Consulting, Germany

My Blog

https://eucscore.com

Certifications

Microsoft MVP, Citrix CTP, VMware vExpert, NVIDIA NGCA, Parallels VIPP

Hobbies

EUC benchmarking and building the EUC Score toolset for the community

Contact

info@eucscore.com

Agenda

Thank you, Ruben Spruijt, for running many of the tests and Frame for providing Azure resources

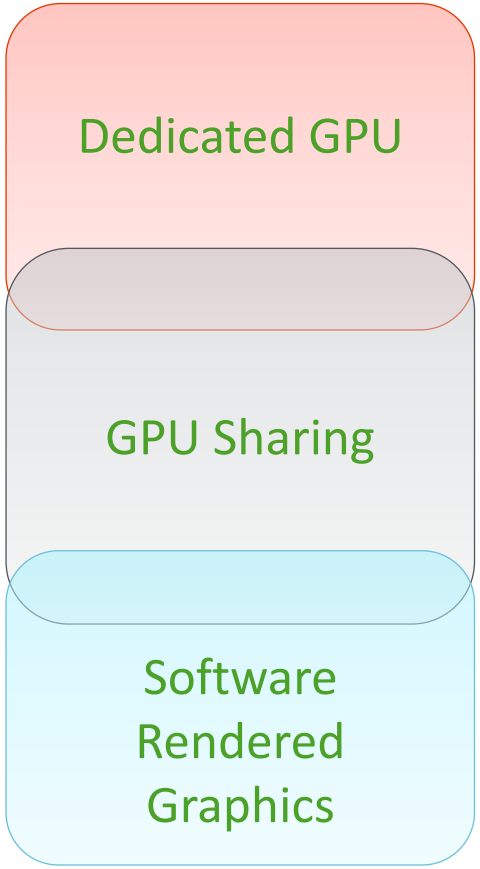
Key takeaways:

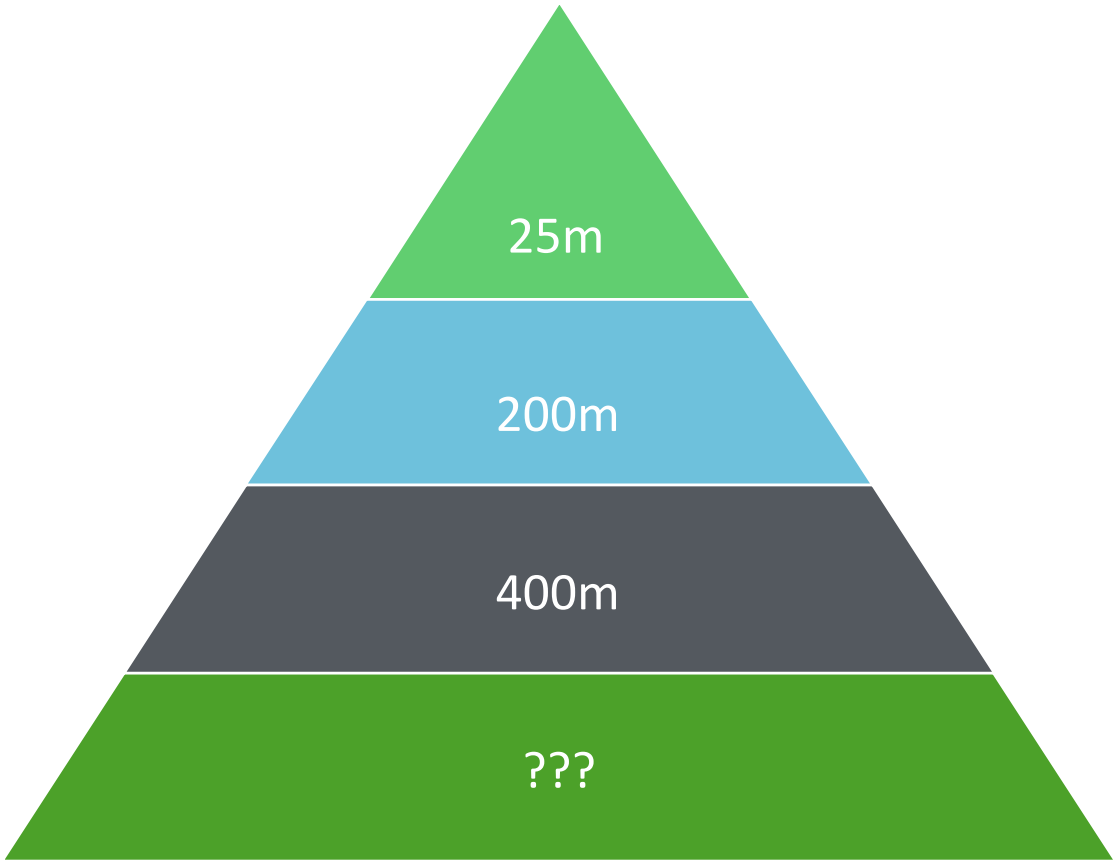
- **GPU intro, how GPUs improve app performance, and GPU-accelerated remoting**
- **Reproducible performance tests of GPU-accelerated Azure VM types**
- **Show difference between Azure VMs with and without GPU**

- **Introduction into GPU virtualization**
- **Overview and use cases of GPU-accelerated VMs in Azure**
- **Testing AVD VMs with GPUs**
- **Analyzing the test result**
- **Summary and recommendations**

Enterprise VM Categories

- **Designers**
- **Power Users**
- **Knowledge Workers**
- **Task Workers**

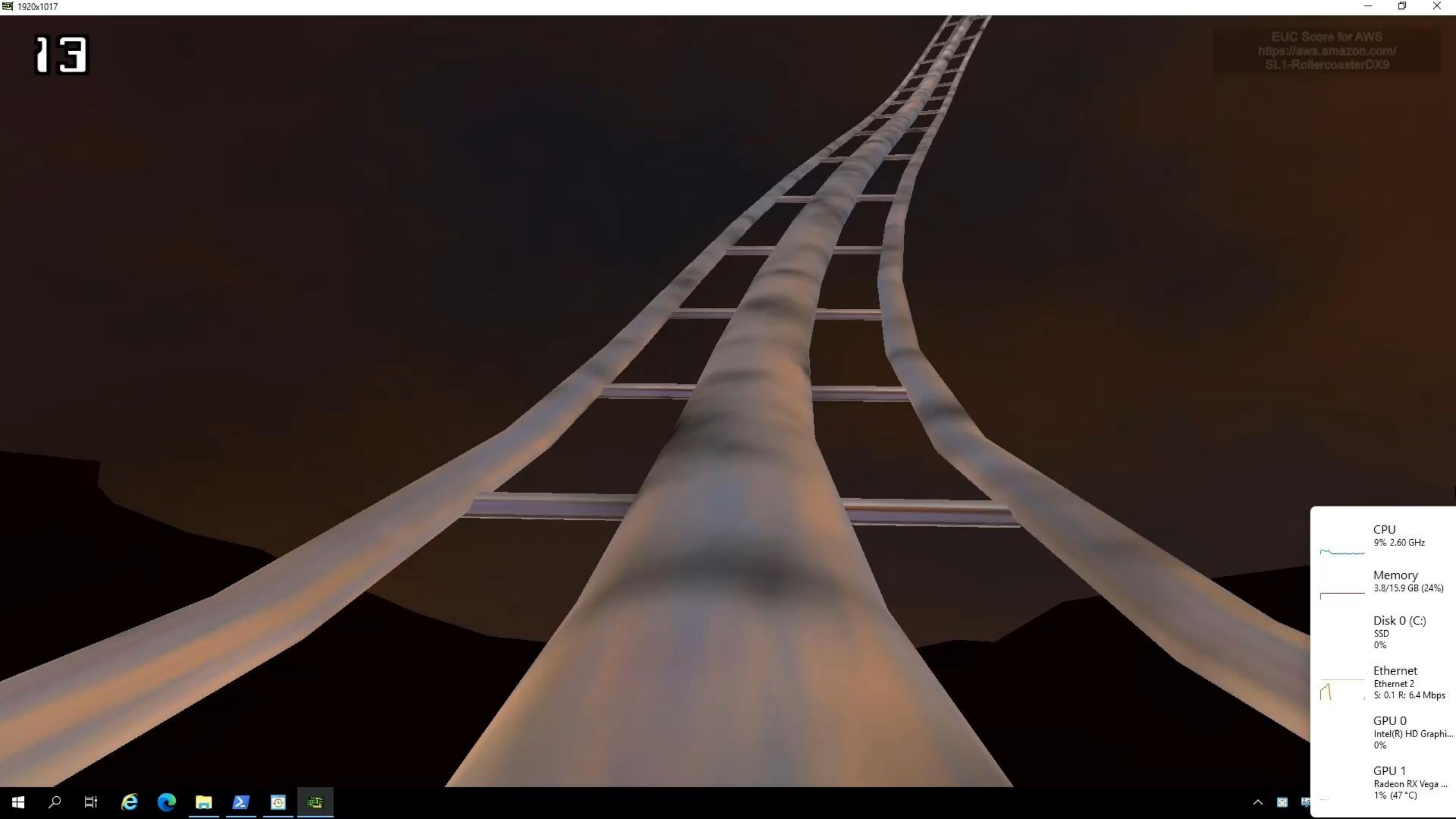


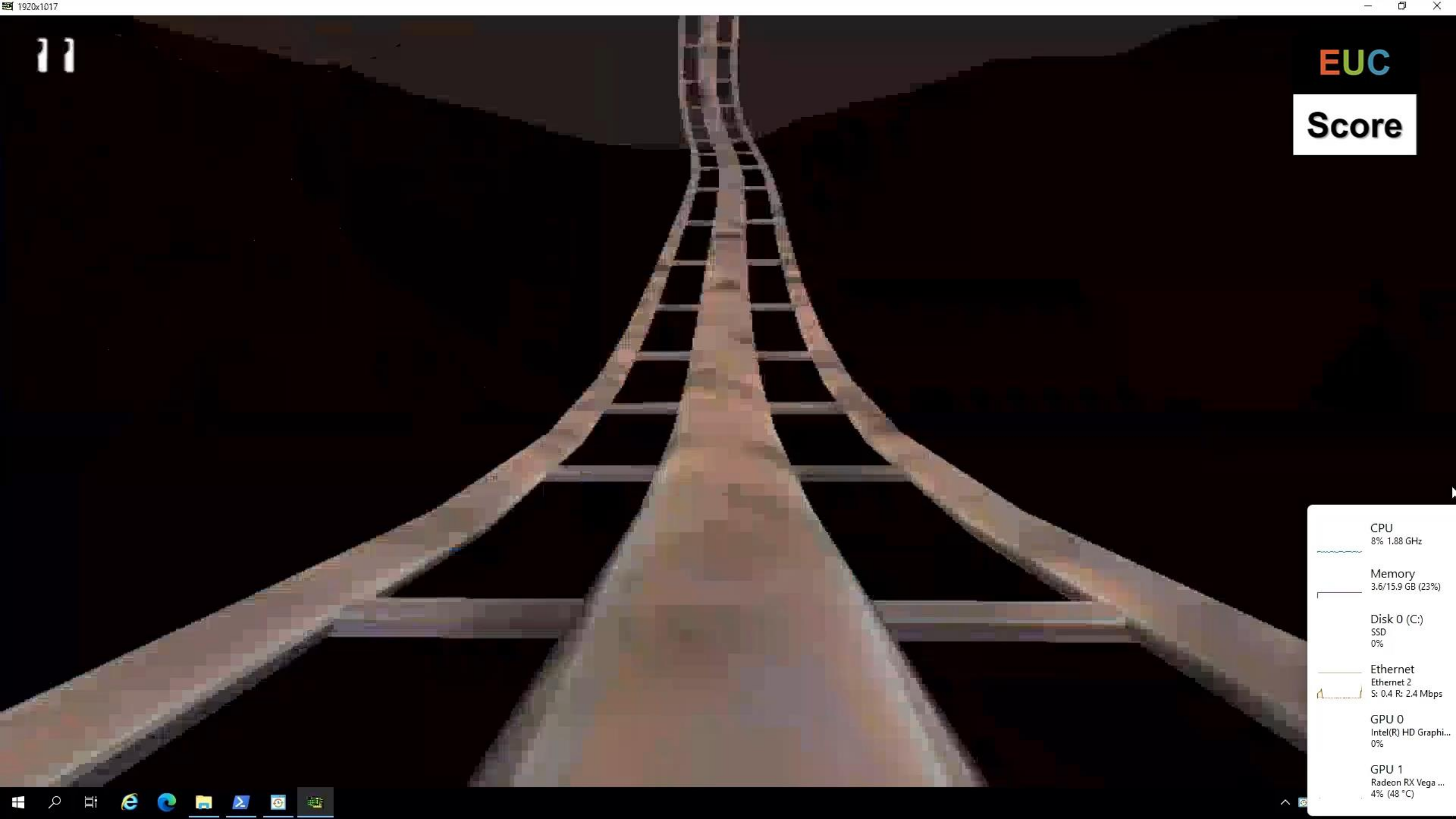


Demos and Video Clips

When things go wrong and unexpected observations

- #1: Striping
- #2: Block Boundary
- #3: Video Smear and Dissolve
- #4: Lost Render Focus
- #5: Latency
- #6: Stuttering Thin Client
- #7: GPU Fail with Fractals


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)

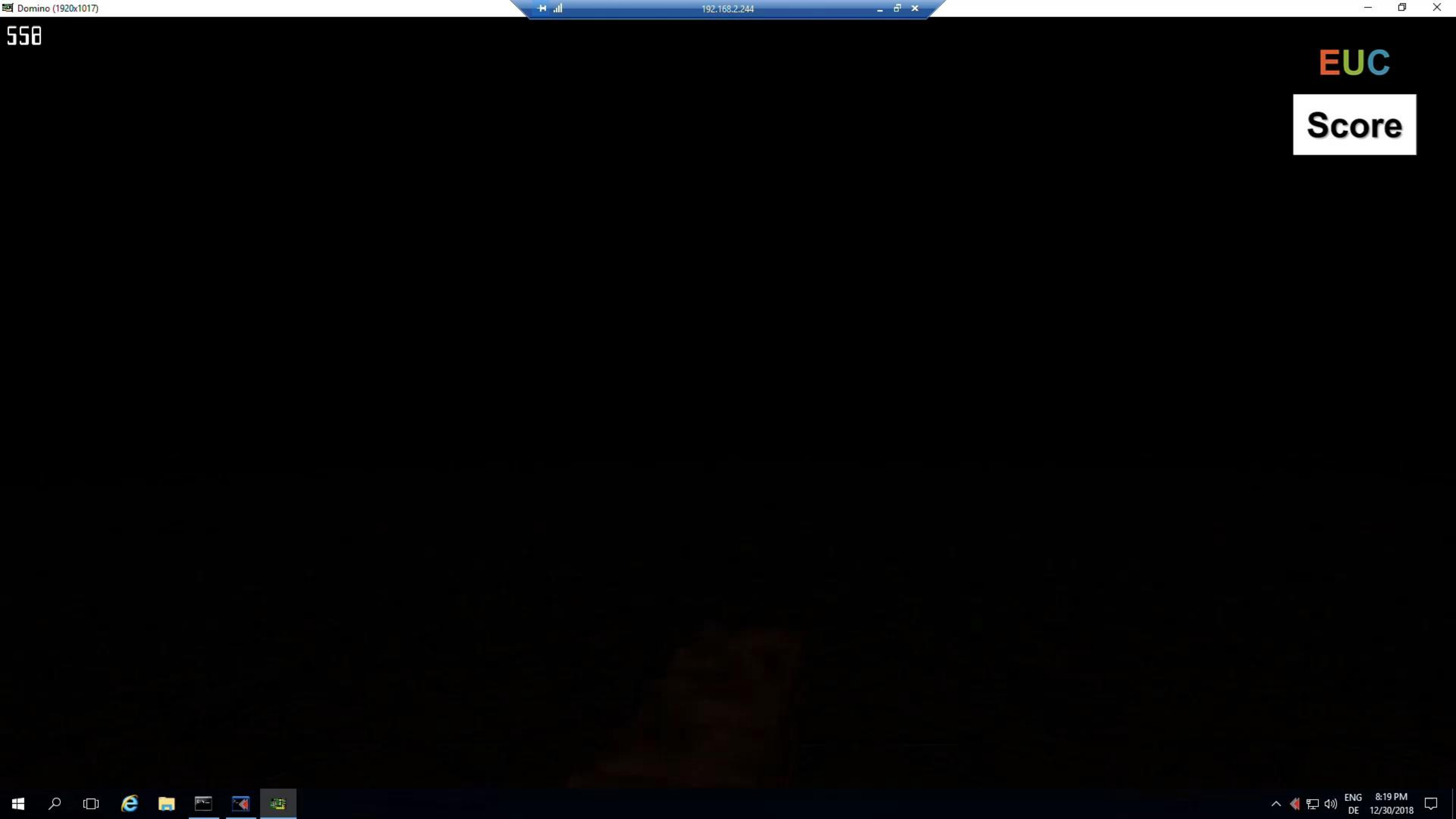
192.168.2.132

Coral_Reef_1080p

EUC

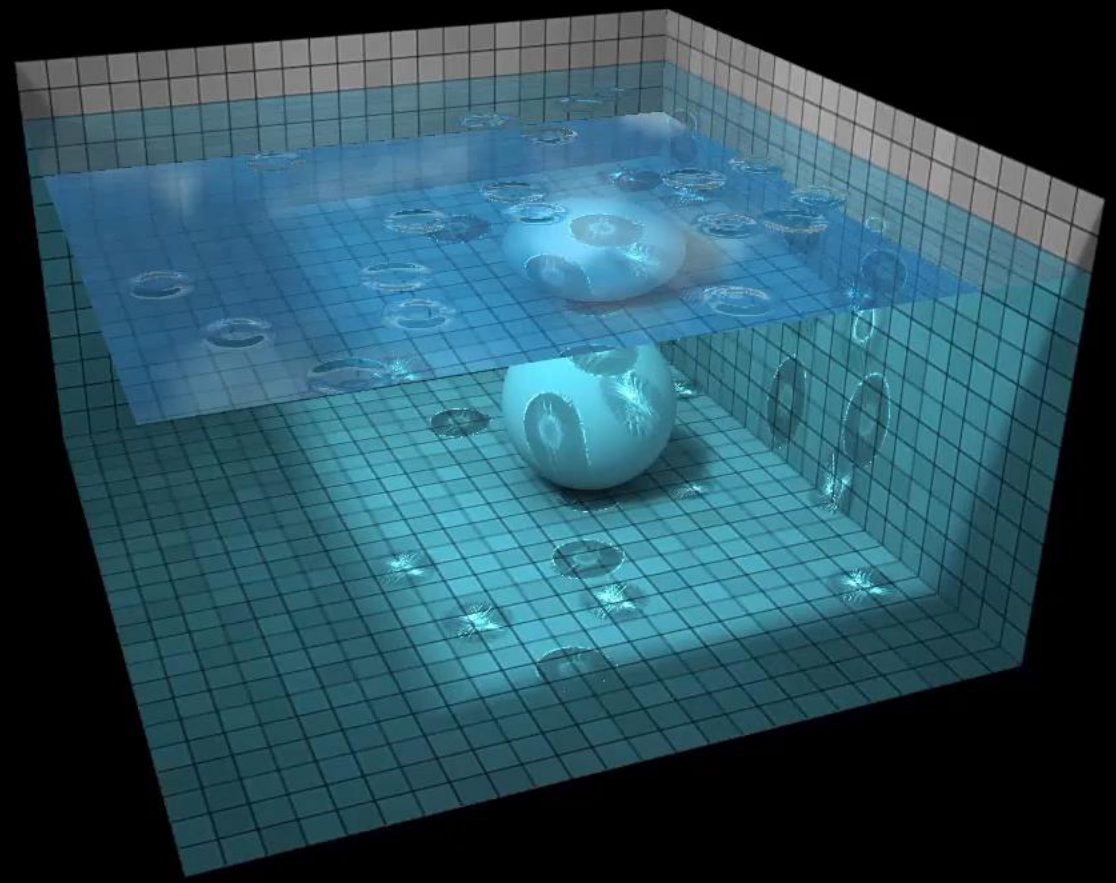
Score

ENG
DE
7:36 PM
9/23/2016


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%)

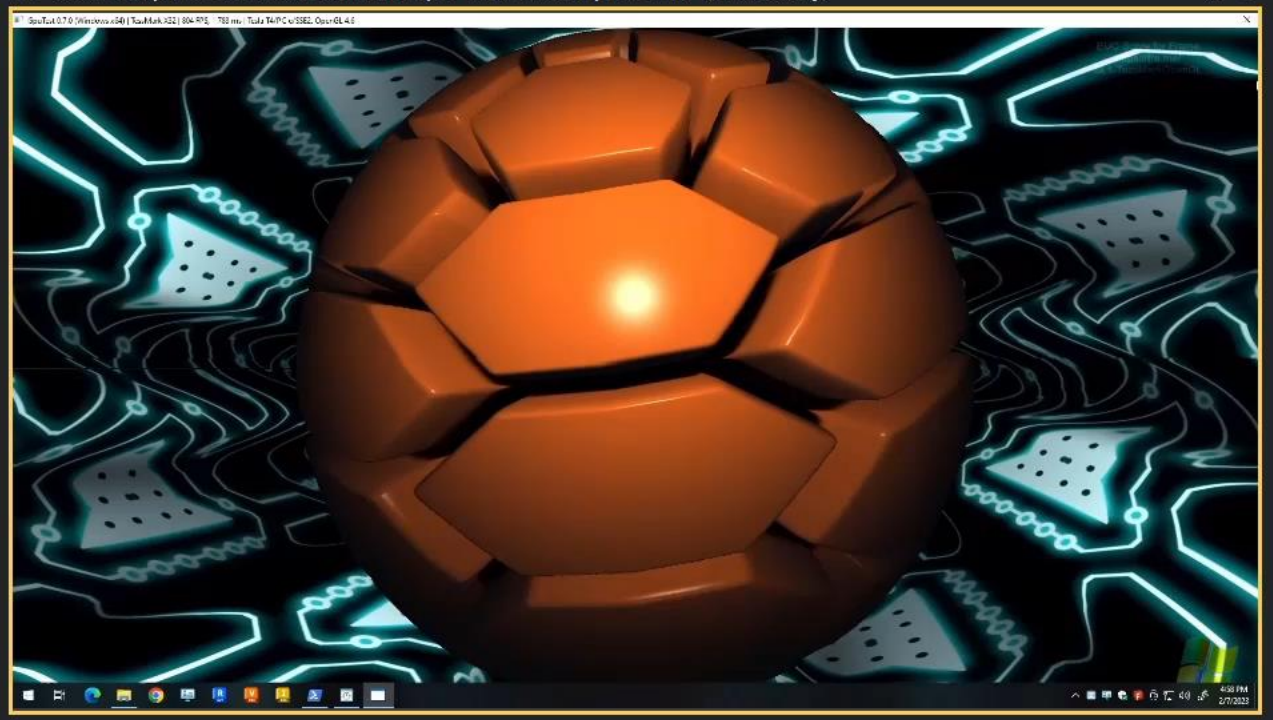
Ethernet
S: 16.0 Kbps R: 16.0 Kbps

Fewer details | Open Resource

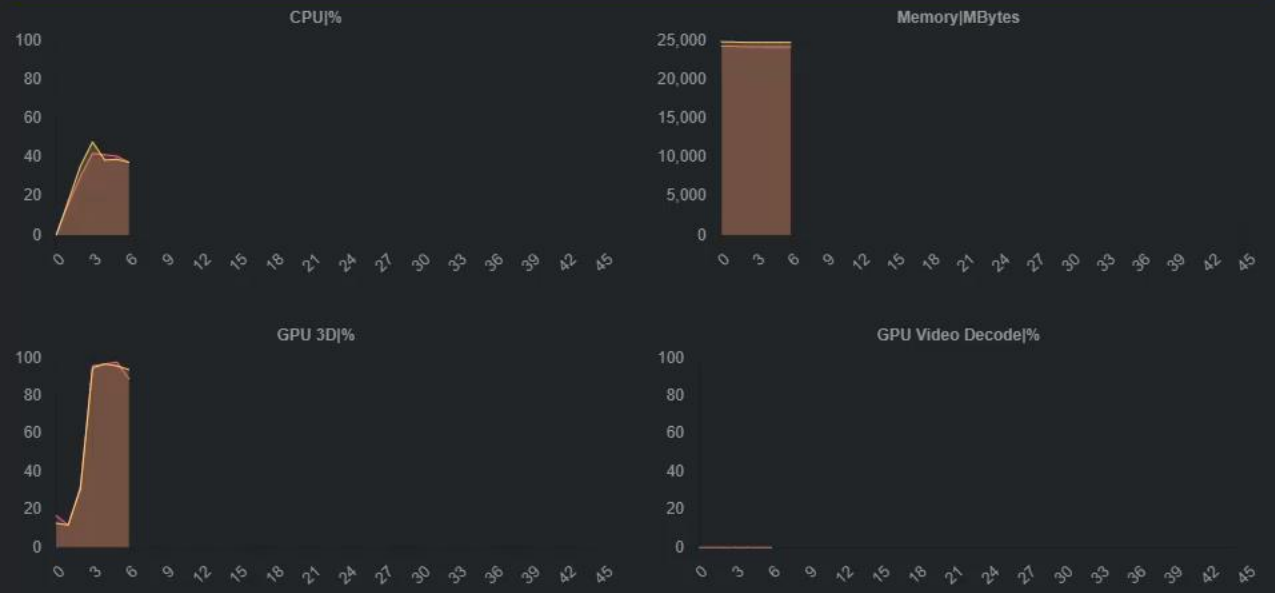
WebGL Water - Pro... Task Manager Resource Monitor

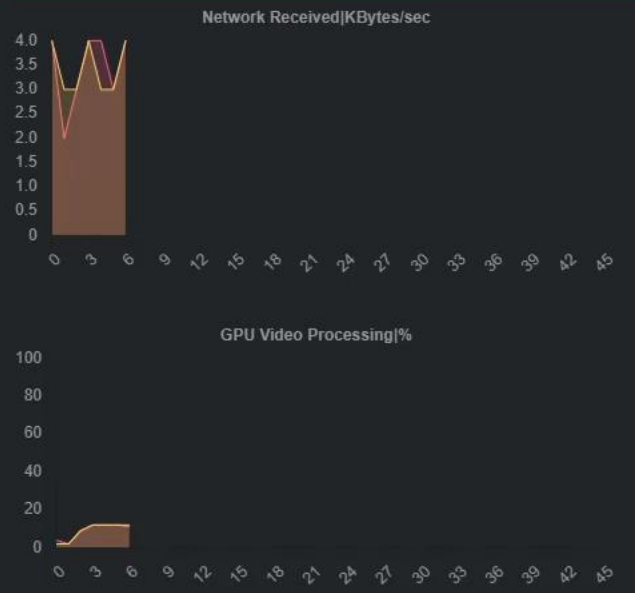
ENG DE 5:37 PM 1/6/2021

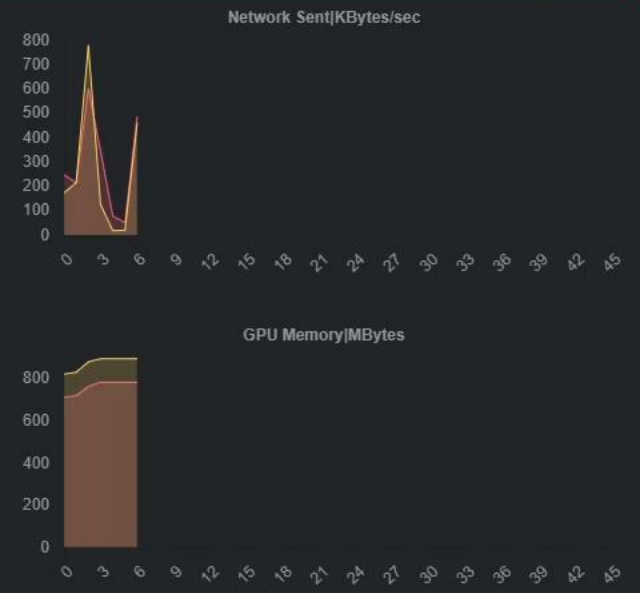
SL1-TessMarkOpenGL on Azure NC4asT4 v3 | HP t640 w/ GPU | FRP8 UDP (7ms latency)



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

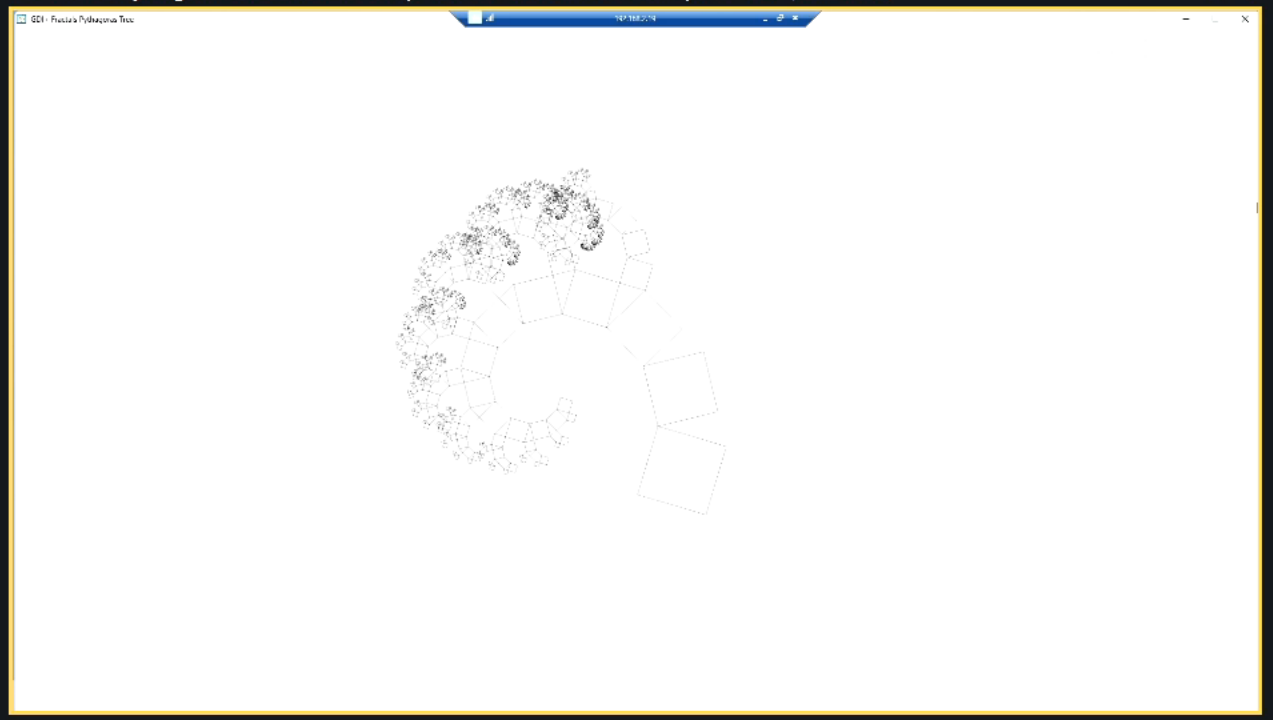




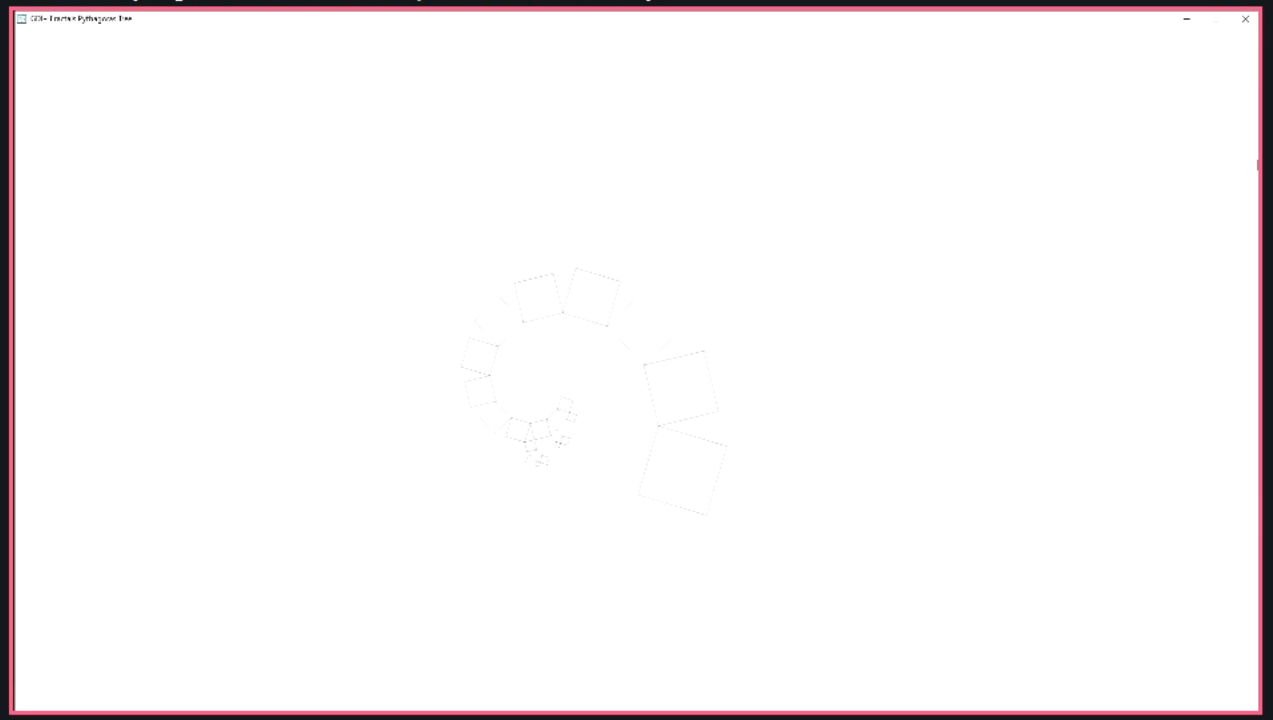


00:00:07 00:00:45 Help Report

SL3-FractalsPythagoras on Remote Desktop Lancelot w/ NVIDIA M5000 | RDP UDP (20ms RTT)



SL3-FractalsPythagoras on Azure NV4as v4 | FRP8 UDP (15ms latency)



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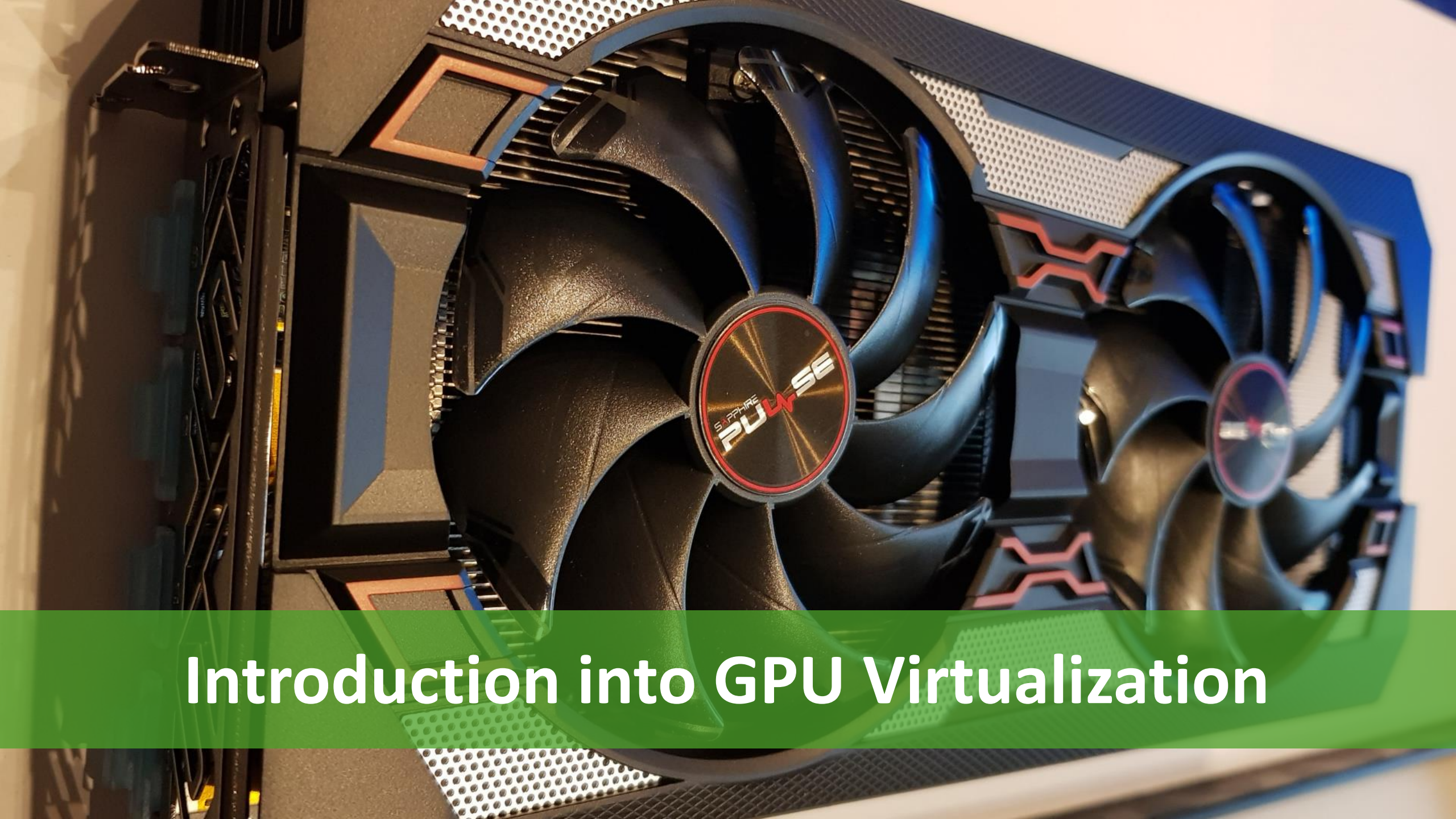
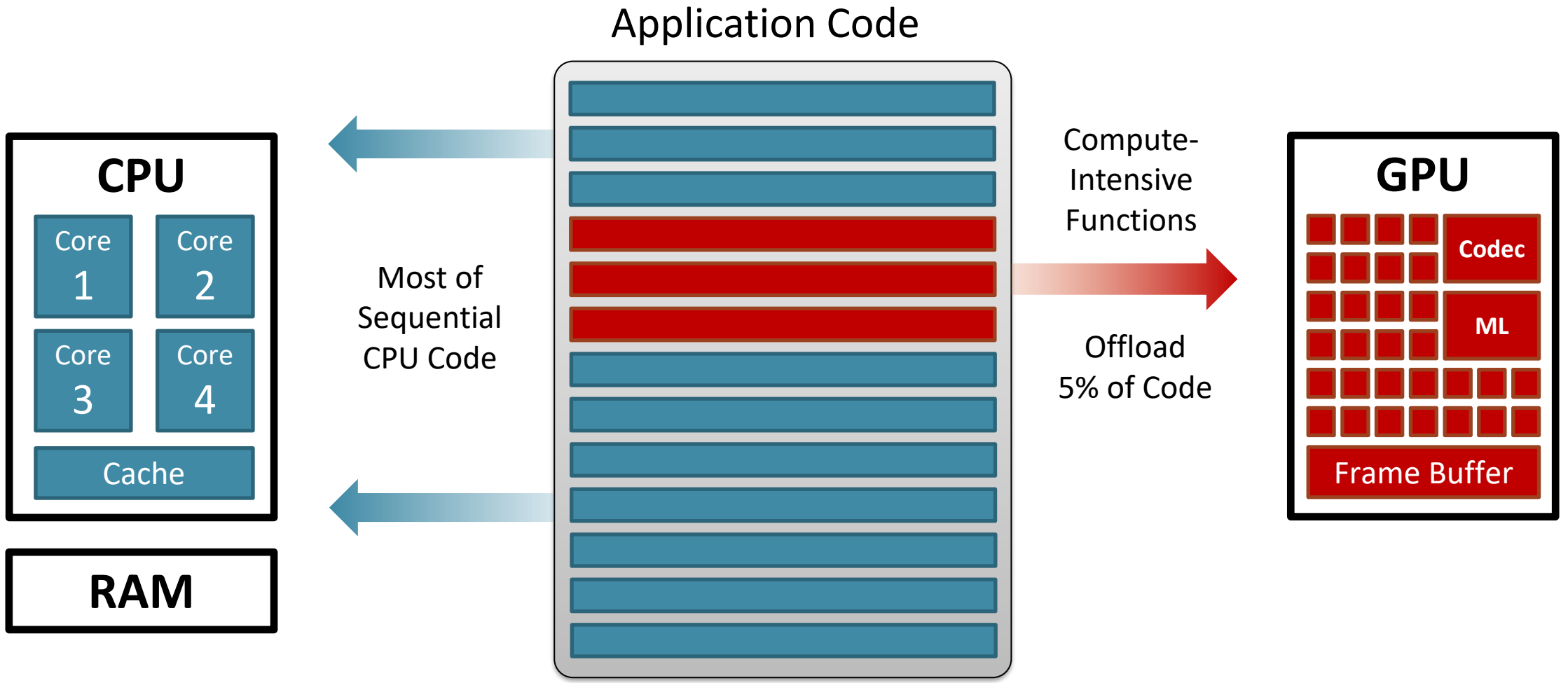


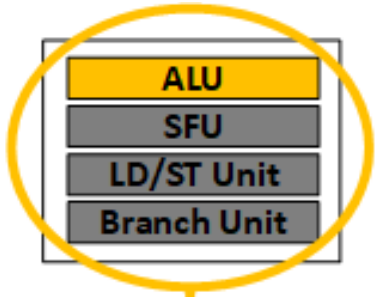
Introduction into GPU Virtualization

The Benefit of GPUs



GPU Architecture

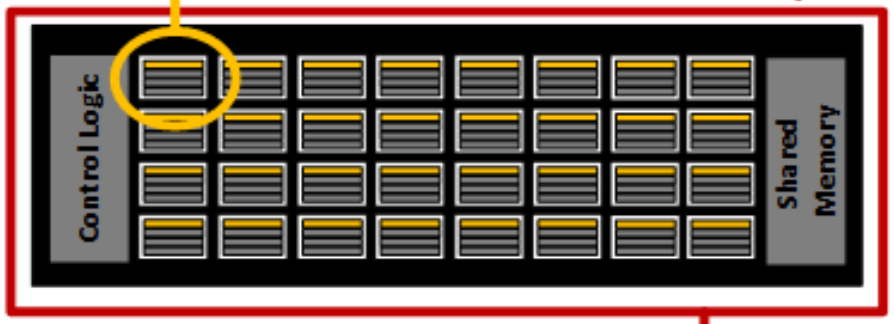
Execution Unit (EU),
CUDA Core (NVIDIA speak)
Shader Processor (SP) (AMD speak)



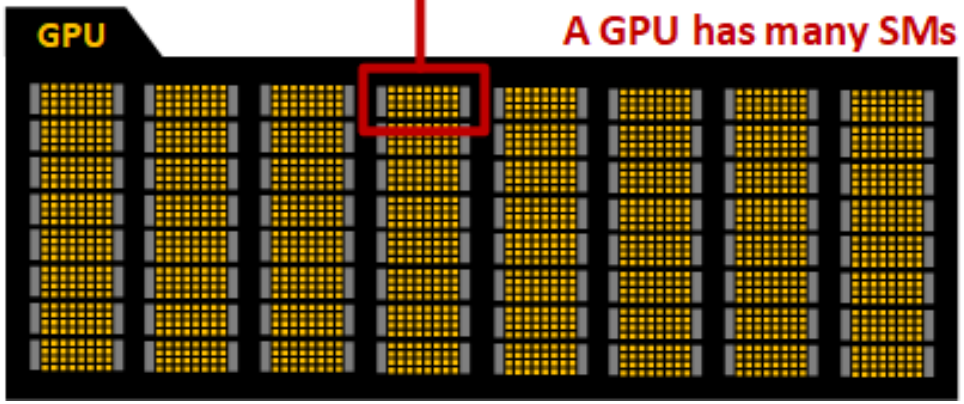
"Shader"

An SM has many EUs

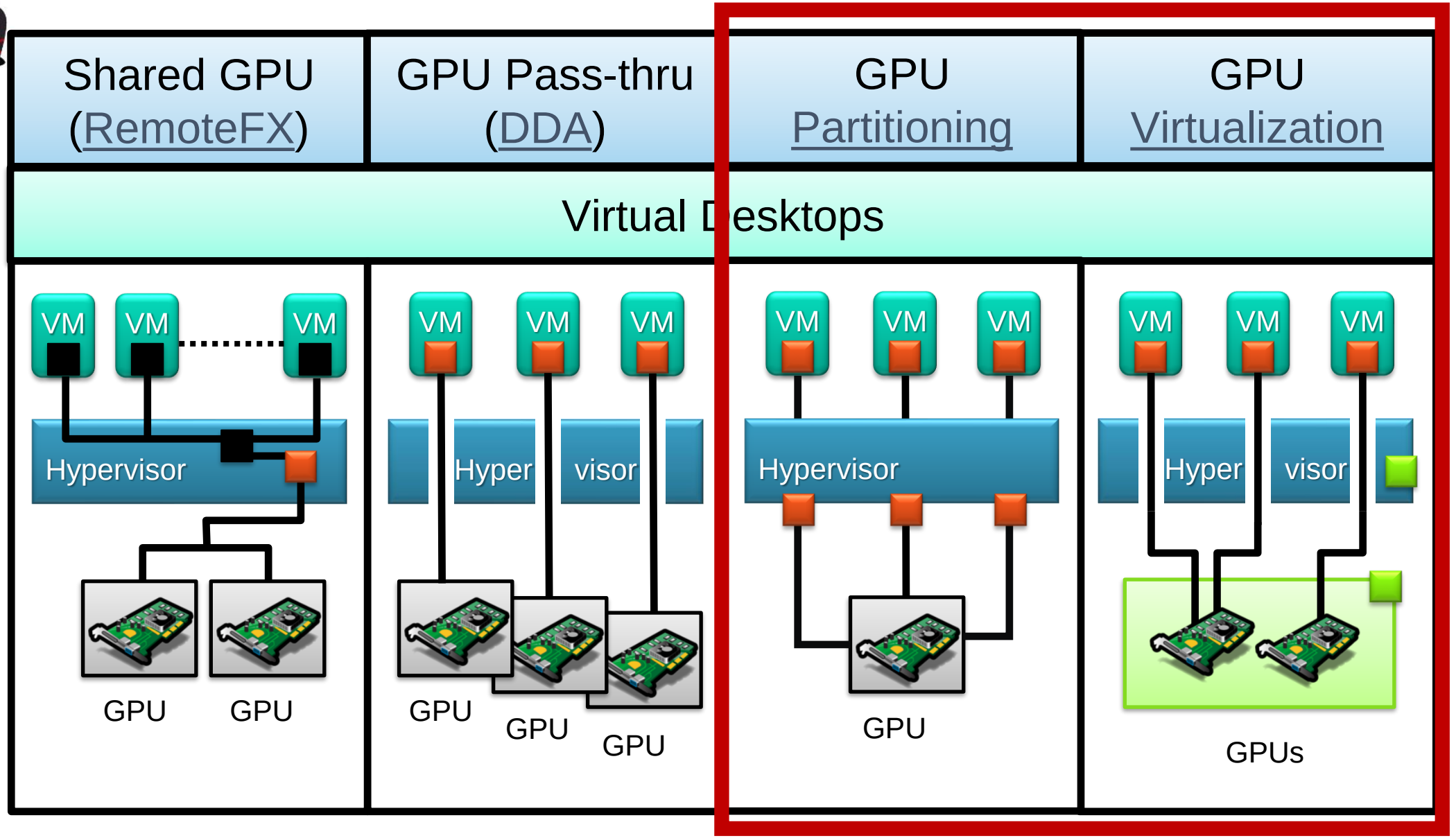
Streaming Multiprocessor (SM)
or Computer Unit (CU)



A GPU has many SMs

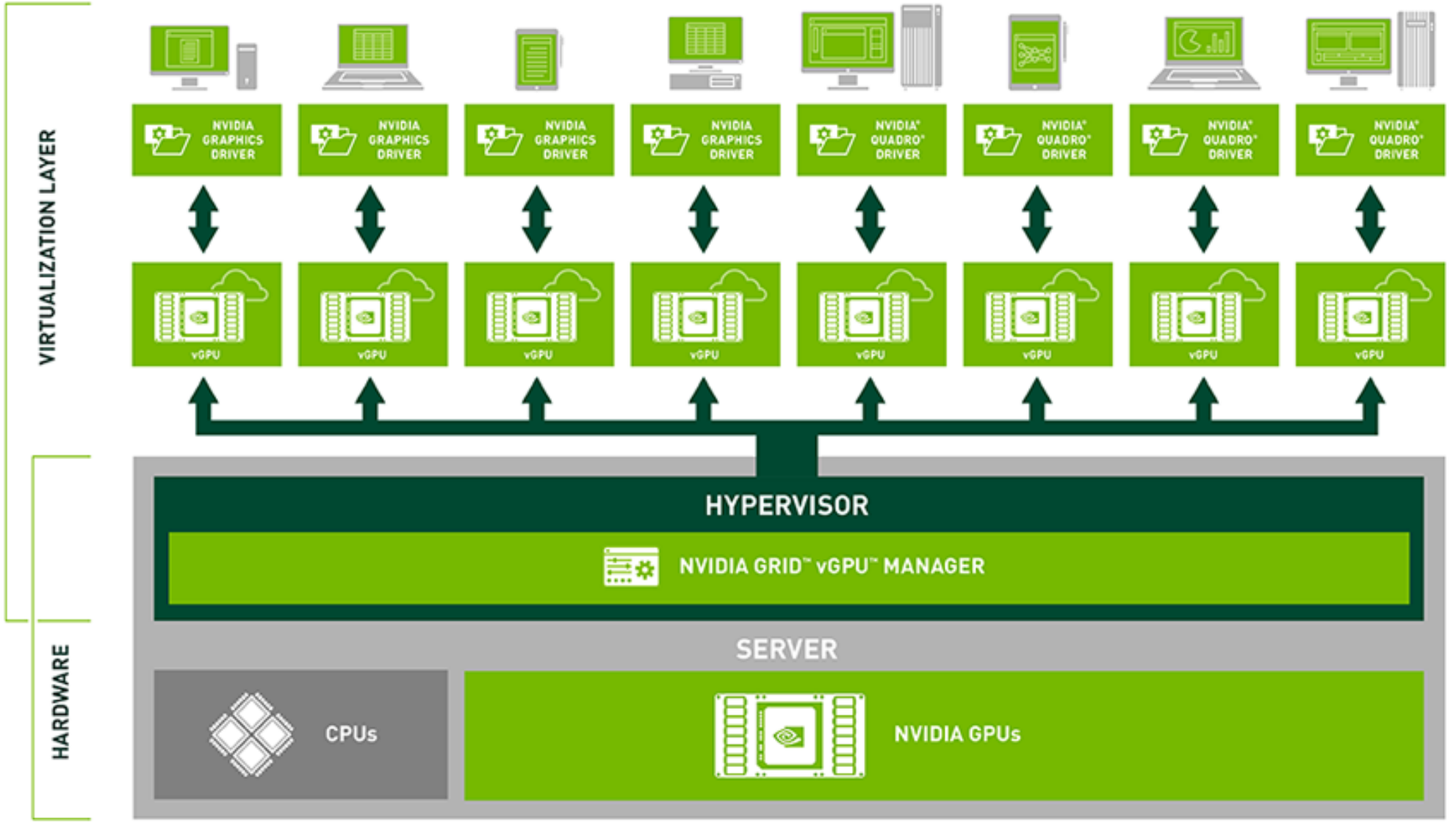


GPU Virtualization



NVIDIA

NVIDIA GPU Virtualization



NVIDIA Hardware Encoders

GPU	H.264 (AVCHD) YUV 4:2:0		H.264 (AVCHD) YUV 4:4:4		H.264 (AVCHD) LOSSLESS		H.265 (HEVC) YUV 4:2:0		H.265 (HEVC) YUV 4:4:4		H.265 (HEVC) LOSSLESS	
	MAX Color	MAX Res.	MAX Color	MAX Res.	MAX Color	MAX Res.	MAX Color	MAX Res.	MAX Color	MAX Res.	MAX Color	MAX Res.
Kepler	8-bit	4096 x 4096	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Maxwell (1st Gen)*	8-bit	4096 x 4096	8-bit	4096 x 4096	8-bit	4096 x 4096	N/A	N/A	N/A	N/A	N/A	N/A
Maxwell (2nd Gen)	8-bit	4096 x 4096	8-bit	4096 x 4096	8-bit	4096 x 4096	8-bit	4096 x 4096	N/A	N/A	N/A	N/A
Maxwell (GM206)	8-bit	4096 x 4096	8-bit	4096 x 4096	8-bit	4096 x 4096	8-bit	4096 x 4096	8-bit	4096 x 4096	8-bit	4096 x 4096
Pascal	8-bit	4096 x 4096	8-bit	4096 x 4096	8-bit	4096 x 4096	10-bit	8192 x 8192**	10-bit	8192 x 8192**	10-bit	8192 x 8192**
Volta	8-bit	4096 x 4096	8-bit	4096 x 4096	8-bit	4096 x 4096	10-bit	8192 x 8192	10-bit	8192 x 8192	10-bit	8192 x 8192
Turing	8-bit	4096 x 4096	8-bit	4096 x 4096	8-bit	4096 x 4096	10-bit	8192 x 8192	10-bit	8192 x 8192	10-bit	8192 x 8192

AMD

SR-IOV: “PCIe SCSI Chain”

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1

VIRTUAL WORKSTATION

RADEON PRO GRAPHICS DRIVER

2

VIRTUAL WORKSTATION

RADEON PRO GRAPHICS DRIVER

UP TO **32 USERS** PER CARD

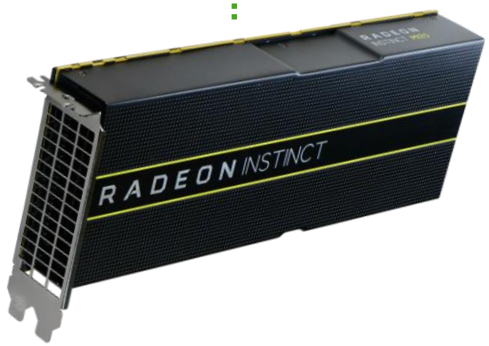
n

VIRTUAL WORKSTATION

RADEON PRO GRAPHICS DRIVER

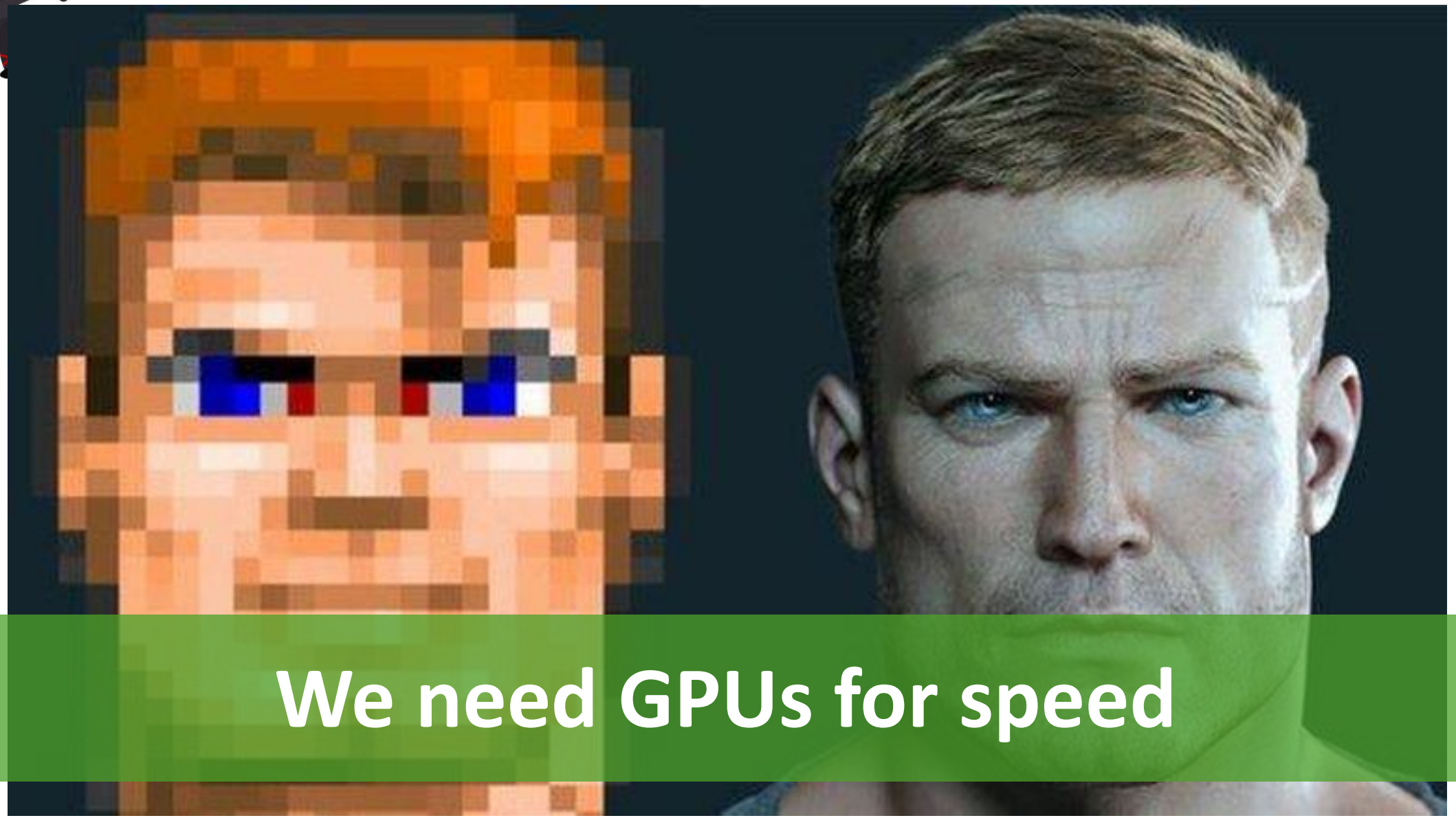
Each Virtual Function is given a dedicated & isolated slice of the GPU and memory. Memory can be fractions of a GigaByte.

The Physical Function is the controller for access to the registers assigned to a Virtual Function.



The guest OS recognizes the GPU as a pass-through device

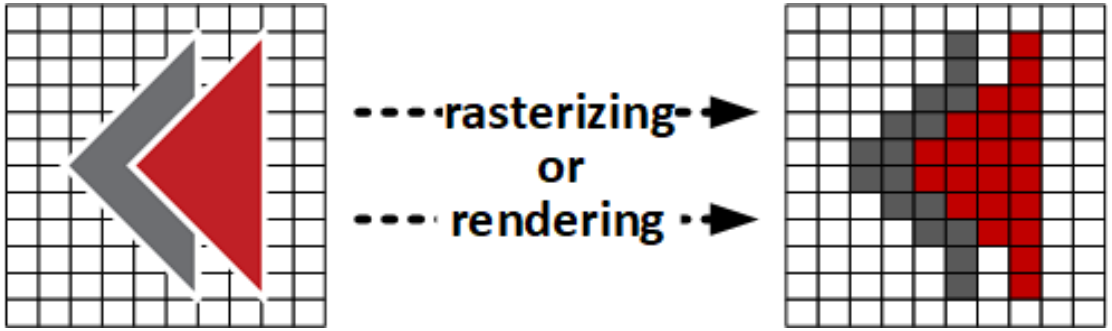
Memory is wiped between context switches.



We need GPUs for speed

GPU Benefits to Remoting

- Hardware-accelerated video encode and decode (codec) – H.264/H.265 aka MPEG-4 AVC (Advanced Video Coding)
- Hardware-accelerated encoding of the remoting protocol data stream
- Rendering graphical objects created by Windows Desktop Manager and applications into the frame buffer – GDI, GDI+, DirectX, OpenGL



GPU-Accelerated VM Types for AVD

- **NV-series** (retired) and **NVv3-series** VMs with virtualized NVIDIA M60 GPUs (1 GPU with 8GB VRAM = one-half M60 card, GRID vGPU) - Aug 2016
- **NVv4-series VMs** with partitioned AMD MI25 GPUs (1/8, 1/4, 1/2, or 1 GPU with 2 to 16 GB VRAM) - Jun 2017
- **NCasT4_v3-series VMs** with AMD EPYC2 Rome CPU and NVIDIA T4 GPU (1 or 4 full GPUs with 16GB or 64GB VRAM) - Sep 2018
- **NVadsA10 v5-series VMs** with AMD EPYC Milan CPUs and partitioned NVIDIA A10 GPU (1/6, 1/3, 1/2, 1 or 2 GPUs with 4 to 48GB VRAM) - Apr 2021
- **[Preview] NGads-series VMs** with AMD V620 GPUs (1/4, 1/2 or 1 GPU with 8 to 32GB VRAM)
- **On my personal wish list**: VMs with NVIDIA L4 GPUs

Azure VM Types under Test with GPU

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Instance	CPU	CPU Base Clock Speed	Max CPU Speed	vCPUs	RAM	Storage Type	Storage Size	GPU	GPU VRAM	Display	OS	GPU Release Year
Microsoft Azure												
Azure NV6	Intel Xeon E5-2690v3	2.6 GHz	3.5 GHz	6	56 GB	Standard SSD	256GB	NVIDIA M60	8 GB	FHD	Win10 22H2	Aug 2015
Azure NV4as_v4	AMD EPYC 7V12 - Rome	2.45 GHz	3.3 GHz	4	14 GB	Premium SSD	256GB	AMD MI25	2 GB	FHD	Win10 22H2	Jun 2017
Azure NV8as_v4	AMD EPYC 7V12 - Rome	2.45 GHz	3.3 GHz	8	28 GB	Premium SSD	256GB	AMD MI25	4 GB	FHD	Win10 22H2	Jun 2017
Azure NV16as_v4	AMD EPYC 7V12 - Rome	2.45 GHz	3.3 GHz	16	56 GB	Premium SSD	256GB	AMD MI25	8 GB	FHD	Win10 22H2	Jun 2017
Azure NV32as_v4	AMD EPYC 7V12 - Rome	2.45 GHz	3.3 GHz	32	112 GB	Premium SSD	256GB	AMD MI25	16 GB	FHD	Win10 22H2	Jun 2017
Azure NC4asT4_v3	AMD EPYC 7V12 - Rome	2.45 GHz	3.3 GHz	4	28 GB	Premium SSD	256GB	NVIDIA T4	16 GB	FHD	Win10 22H2	Sep 2018
Azure NC8asT4_v3	AMD EPYC 7V12 - Rome	2.45 GHz	3.3 GHz	8	56 GB	Premium SSD	256GB	NVIDIA T4	16 GB	FHD	Win11 22H2	Sep 2018
Azure NC16asT4_v3	AMD EPYC 7V12 - Rome	2.45 GHz	3.3 GHz	16	110 GB	Premium SSD	256GB	NVIDIA T4	16 GB	FHD	Win10 22H2	Sep 2018
Azure NV6adsA10_v5	AMD EPYC 74F3 - Milan	3.2 GHz	4.0 GHz	6	55 GB	Premium SSD	256GB	NVIDIA A10 4Q	4 GB	FHD	Win11 22H2	Apr 2021
Azure NV12adsA10_v5	AMD EPYC 74F3 - Milan	3.2 GHz	4.0 GHz	12	110 GB	Premium SSD	256GB	NVIDIA A10 8Q	8 GB	FHD	Win10 22H2	Apr 2021
Azure NV36adsA10_v5	AMD EPYC 74F3 - Milan	3.2 GHz	4.0 GHz	36	440 GB	Premium SSD	256GB	NVIDIA A10 24Q	24 GB	FHD	Win10 22H2	Apr 2021

NCas_T4_v3 and NV6ads_A10_v5

Size	vCPU	Memory: GiB	Temp storage (SSD) GiB	GPU	GPU memory: GiB	Max data disks	Max NICs / Expected network bandwidth (Mbps)
Standard_NC4as_T4_v3	4	28	180	1	16	8	2 / 8000
Standard_NC8as_T4_v3	8	56	360	1	16	16	4 / 8000
Standard_NC16as_T4_v3	16	110	360	1	16	32	8 / 8000
Standard_NC64as_T4_v3	64	440	2880	4	64	32	8 / 32000

Size	vCPU	Memory: GiB	Temp storage (SSD) GiB	GPU partition	GPU memory: GiB	Max data disks	Max uncached disk throughput: IOPS/MBps	Max NICs / Expected network bandwidth (Mbps)
Standard_NV6ads_A10_v5	6	55	180	1/6	4	4	6400 / 100	2 / 5000
Standard_NV12ads_A10_v5	12	110	360	1/3	8	4	12800 / 200	2 / 10000
Standard_NV18ads_A10_v5	18	220	720	1/2	12	8	25600 / 384	4 / 20000
Standard_NV36ads_A10_v5	36	440	1440	1	24	16	51200 / 768	4 / 40000
Standard_NV36adms_A10_v5	36	880	2880	1	24	32	51200 / 768	8 / 80000
Standard_NV72ads_A10_v5	72	880	2880	2	48	32	80000 / 1200	8 / 80000

Installing GPU Drivers

NVIDIA GRID Drivers

- The NVIDIA GPU Driver Extension installs appropriate NVIDIA CUDA or GRID drivers
- Alternatively, you may install NVIDIA GPU drivers manually
- NVIDIA GRID driver installers for NV,NVv3 and NVads A10 v5-series VMs used as virtual workstations
- The GRID drivers redistributed by Azure don't work on non-NV series VMs, the one exception is the NCas_T4_V3 VM series

AMD GPU Drivers

- The AMD GPU Driver Extension installs AMD GPU drivers on a NVv4-series VM (MI25 MxGPU)
- The NGads V620 Series VMs support the AMD Cloud Software driver (preview)
- You can use Azure Resource Manager templates to deploy Azure VM extensions

Configure GPUs in AVD VMs

Activate GPU and H.264 / AVC444 usage by Group Policy

GPEdit.msc: Local Computer Policy\Computer Configuration\Administrative Templates\Windows Components\Remote Desktop Services\Remote Desktop Session Host\Remote Session Environment

- Enable “Use the hardware graphics adapters for all Remote Desktop Services sessions”
- Enable "Prioritize H.264/AVC 444 Graphics mode for Remote Desktop Connections“
- Enable "Configure H.264/AVC hardware encoding for Remote Desktop Connections"

Configure GPUs in AVD VMs

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Local Group Policy Editor

File Action View Help

- OOBE
- Portable Operating System
- Presentation Settings
- Push To Install
- Remote Desktop Services
  - RD Licensing
  - Remote Desktop Connection Client
  - Remote Desktop Session Host
    - Connections
    - Device and Resource Redirection
    - Licensing
    - Printer Redirection
    - Profiles
    - RD Connection Broker
    - Remote Session Environment
    - Security
    - Session Time Limits
    - Temporary folders
- RSS Feeds
- Search
- Security Center
- Shutdown Options
- Smart Card

Remote Session Environment

Use hardware graphics adapters for all Remote Desktop Services sessions

Edit policy setting

Requirements:
At least Windows Server 2012, Windows 8 or Windows RT

Description:
This policy setting enables system administrators to change the graphics rendering for all Remote Desktop Services sessions.

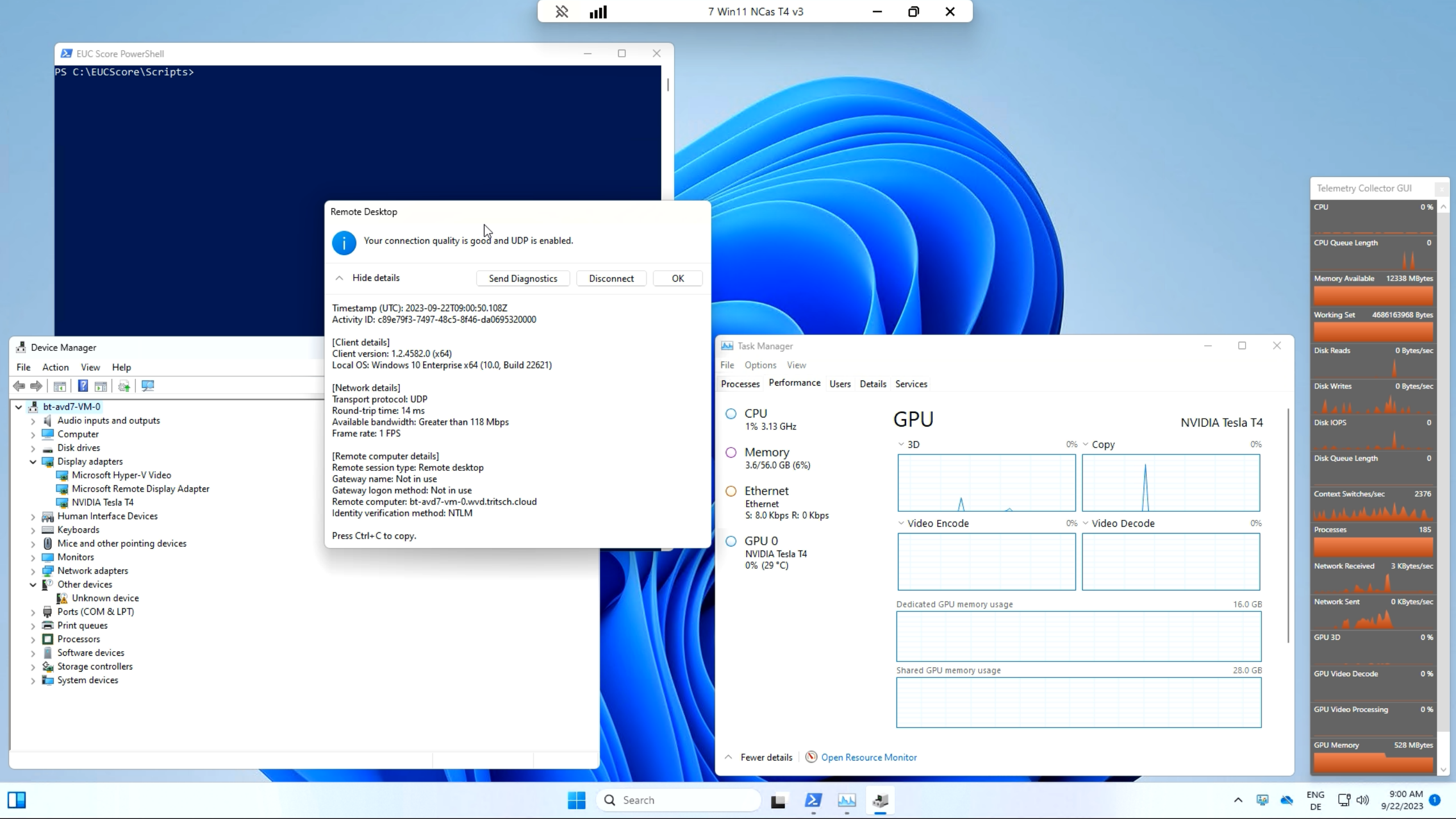
If you enable this policy setting, all Remote Desktop Services sessions use the hardware graphics renderer instead of the Microsoft Basic Render Driver as the default adapter.

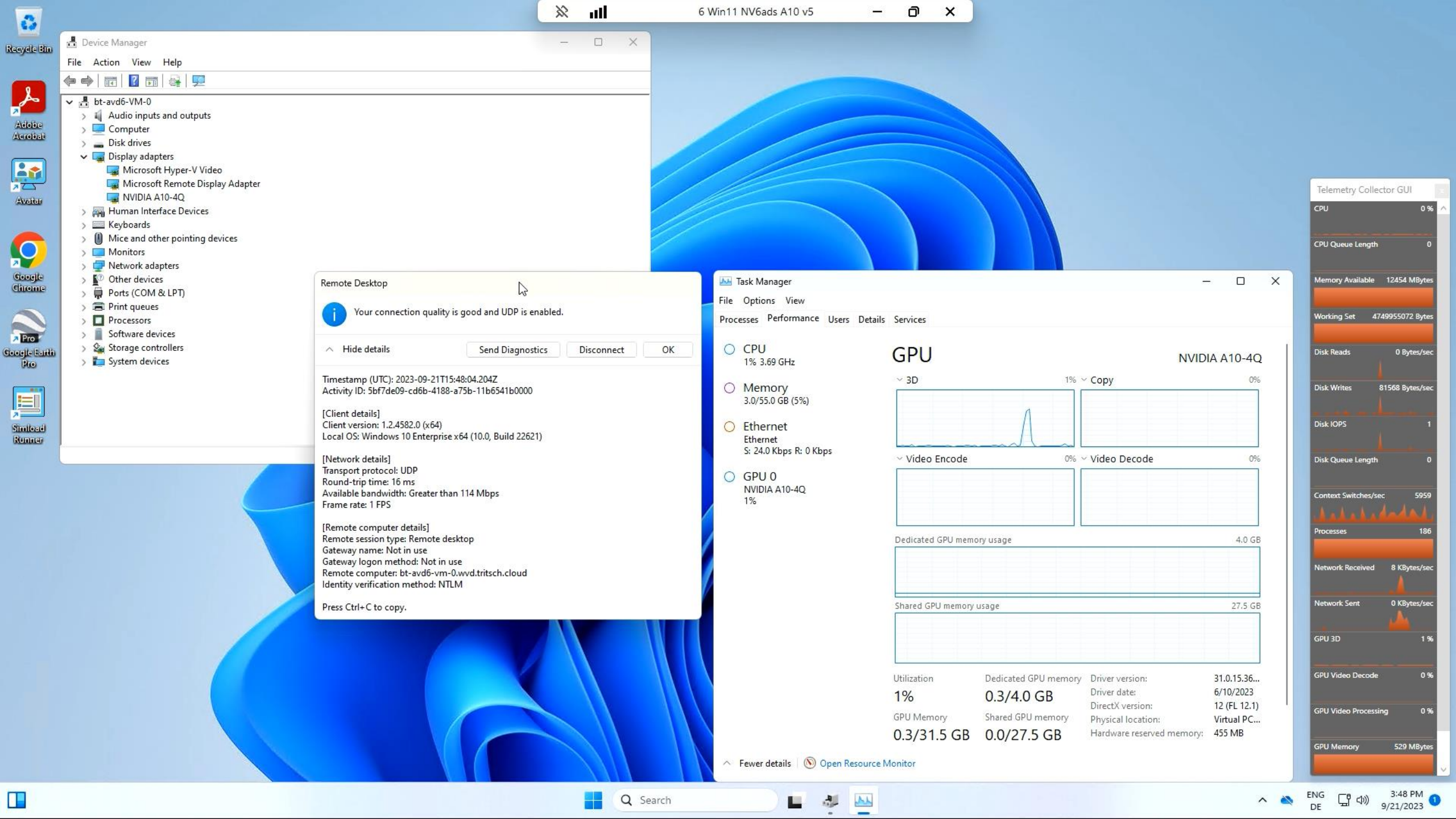
If you disable this policy setting, all Remote Desktop Services

Setting	State
RemoteFX for Windows Server 2008 R2	
Limit maximum color depth	Not configured
Enforce Removal of Remote Desktop Wallpaper	Not configured
Use hardware graphics adapters for all Remote Desktop Serv...	Enabled
Limit maximum display resolution	Not configured
Limit number of monitors	Not configured
Remove "Disconnect" option from Shut Down dialog	Not configured
Remove Windows Security item from Start menu	Not configured
Use advanced RemoteFX graphics for RemoteApp	Not configured
Prioritize H.264/AVC 444 graphics mode for Remote Desktop...	Enabled
Configure H.264/AVC hardware encoding for Remote Deskt...	Enabled
Configure compression for RemoteFX data	Not configured
Configure image quality for RemoteFX Adaptive Graphics	Not configured
Enable RemoteFX encoding for RemoteFX clients designed f...	Not configured
Configure RemoteFX Adaptive Graphics	Not configured
Use WDDM graphics display driver for Remote Desktop Con...	Not configured
Start a program on connection	Not configured
Always show desktop on connection	Not configured

Extended Standard

17 setting(s)


7 Win11 NCas T4 v3
EUC Score PowerShell
PS C:\EUCScore\Scripts>
Remote Desktop
Your connection quality is good and UDP is enabled.
Hide details
Send Diagnostics
Disconnect
OK
Timestamp (UTC): 2023-09-22T09:00:50.108Z
Activity ID: c89e79f3-7497-48c5-8f46-da0695320000
[Client details]
Client version: 1.2.4582.0 (x64)
Local OS: Windows 10 Enterprise x64 (10.0, Build 22621)
[Network details]
Transport protocol: UDP
Round-trip time: 14 ms
Available bandwidth: Greater than 118 Mbps
Frame rate: 1 FPS
[Remote computer details]
Remote session type: Remote desktop
Gateway name: Not in use
Gateway logon method: Not in use
Remote computer: bt-avd7-vm-0.wvd.tritsch.cloud
Identity verification method: NTLM
Press Ctrl+C to copy.
Device Manager
File Action View Help
bt-avd7-VM-0
Audio inputs and outputs
Computer
Disk drives
Display adapters
Microsoft Hyper-V Video
Microsoft Remote Display Adapter
NVIDIA Tesla T4
Human Interface Devices
Keyboards
Mice and other pointing devices
Monitors
Network adapters
Other devices
Unknown device
Ports (COM & LPT)
Print queues
Processors
Software devices
Storage controllers
System devices
Task Manager
File Options View
Processes Performance Users Details Services
CPU
1% 3.13 GHz
Memory
3.6/56.0 GB (6%)
Ethernet
Ethernet
S: 8.0 Kbps R: 0 Kbps
GPU 0
NVIDIA Tesla T4
0% (29 °C)
GPU
NVIDIA Tesla T4
3D 0%
Copy 0%
Video Encode 0%
Video Decode 0%
Dedicated GPU memory usage 16.0 GB
Shared GPU memory usage 28.0 GB
Fewer details
Open Resource Monitor
Telemetry Collector GUI
CPU 0 %
CPU Queue Length 0
Memory Available 12338 MBytes
Working Set 4686163968 Bytes
Disk Reads 0 Bytes/sec
Disk Writes 0 Bytes/sec
Disk IOPS 0
Disk Queue Length 0
Context Switches/sec 2376
Processes 185
Network Received 3 KBytes/sec
Network Sent 0 KBytes/sec
GPU 3D 0 %
GPU Video Decode 0 %
GPU Video Processing 0 %
GPU Memory 528 MBytes
Search
ENG
DE
9:00 AM
9/22/2023


6 Win11 NV6ads A10 v5
Recycle Bin
Adobe Acrobat
Avatar
Google Chrome
Google Earth Pro
Simload Runner
Device Manager
File Action View Help
bt-avd6-VM-0
Audio inputs and outputs
Computer
Disk drives
Display adapters
Microsoft Hyper-V Video
Microsoft Remote Display Adapter
NVIDIA A10-4Q
Human Interface Devices
Keyboards
Mice and other pointing devices
Monitors
Network adapters
Other devices
Ports (COM & LPT)
Print queues
Processors
Software devices
Storage controllers
System devices
Remote Desktop
Your connection quality is good and UDP is enabled.
Hide details
Send Diagnostics
Disconnect
OK
Timestamp (UTC): 2023-09-21T15:48:04.204Z
Activity ID: 5bf7de09-cd6b-4188-a75b-11b6541b0000
[Client details]
Client version: 1.2.4582.0 (x64)
Local OS: Windows 10 Enterprise x64 (10.0, Build 22621)
[Network details]
Transport protocol: UDP
Round-trip time: 16 ms
Available bandwidth: Greater than 114 Mbps
Frame rate: 1 FPS
[Remote computer details]
Remote session type: Remote desktop
Gateway name: Not in use
Gateway logon method: Not in use
Remote computer: bt-avd6-vm-0.wvd.tritsch.cloud
Identity verification method: NTLM
Press Ctrl+C to copy.
Task Manager
File Options View
Processes Performance Users Details Services
CPU
1% 3.69 GHz
Memory
3.0/55.0 GB (5%)
Ethernet
Ethernet
S: 24.0 Kbps R: 0 Kbps
GPU 0
NVIDIA A10-4Q
1%
GPU
NVIDIA A10-4Q
3D 1%
Copy 0%
Video Encode 0%
Video Decode 0%
Dedicated GPU memory usage 4.0 GB
Shared GPU memory usage 27.5 GB
Utilization
1%
Dedicated GPU memory
0.3/4.0 GB
GPU Memory
0.3/31.5 GB
Shared GPU memory
0.0/27.5 GB
Driver version: 31.0.15.36...
Driver date: 6/10/2023
DirectX version: 12 (FL 12.1)
Physical location: Virtual PC...
Hardware reserved memory: 455 MB
Fewer details
Open Resource Monitor
Telemetry Collector GUI
CPU 0 %
CPU Queue Length 0
Memory Available 12454 MBytes
Working Set 4749955072 Bytes
Disk Reads 0 Bytes/sec
Disk Writes 81568 Bytes/sec
Disk IOPS 1
Disk Queue Length 0
Context Switches/sec 5959
Processes 186
Network Received 8 KBytes/sec
Network Sent 0 KBytes/sec
GPU 3D 1 %
GPU Video Decode 0 %
GPU Video Processing 0 %
GPU Memory 529 MBytes
Search
ENG DE
3:48 PM 9/21/2023

EUC Score Single-Session Benchmarking

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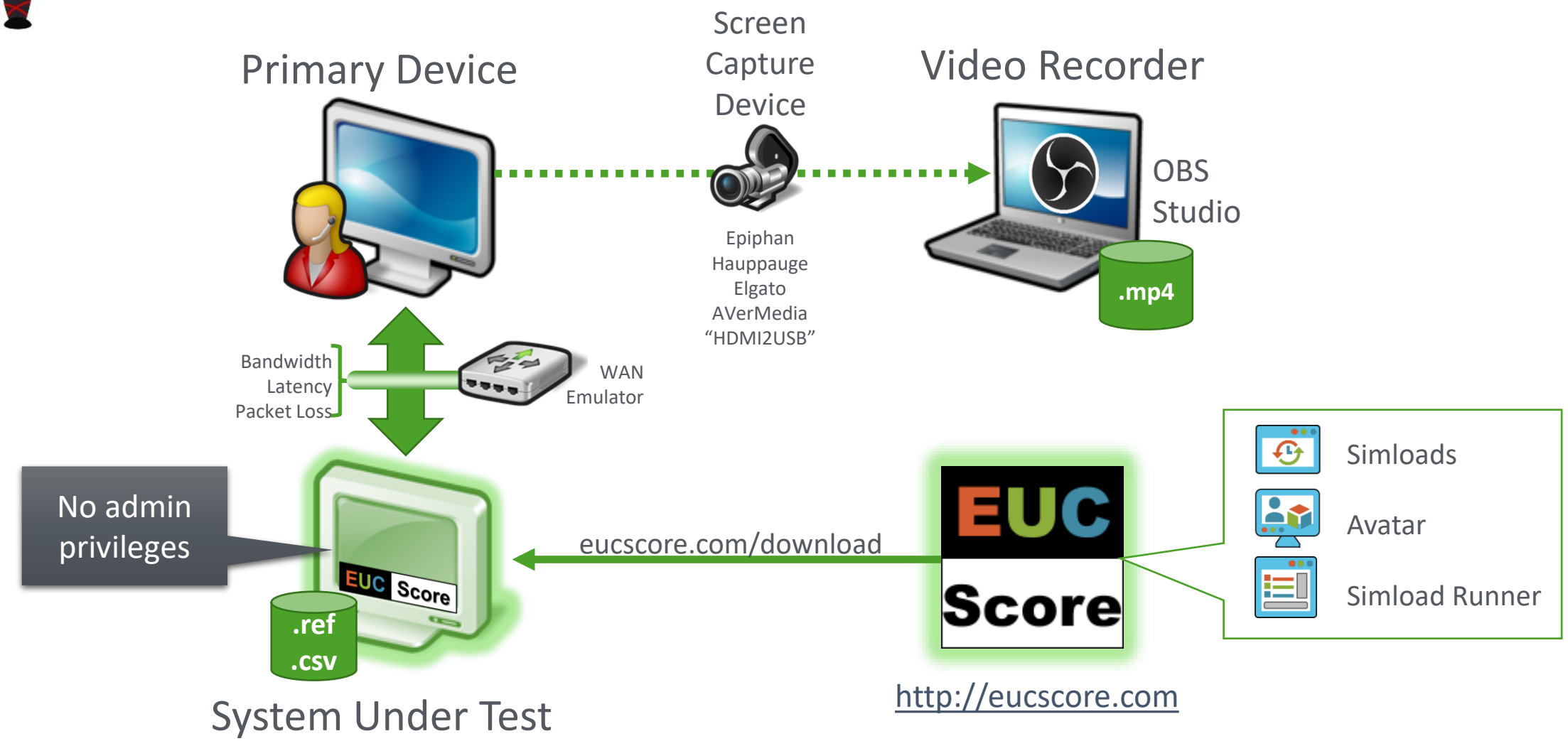

Sync Player – Visual Data Analytics

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Primary User Endpoint

User Experience

Remoting Protocol

Telemetry Data
User Activities

System Under Test

Title

Specs Button

Maximize Button

Screen Video

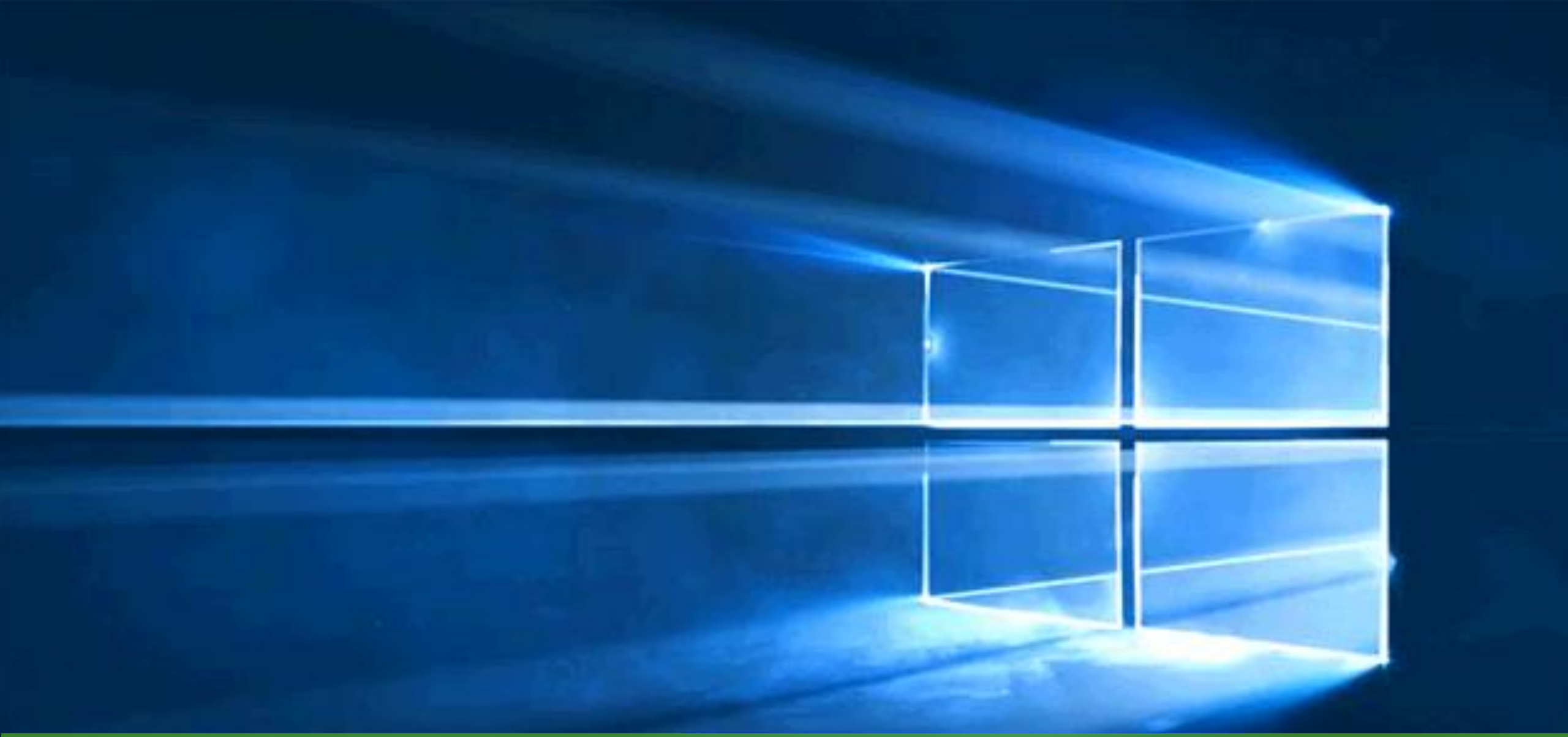
Activities

Telemetry Charts

Timeline and Video Controls

Report Button

EUC Score



Sync Player Showtime

More Test Apps

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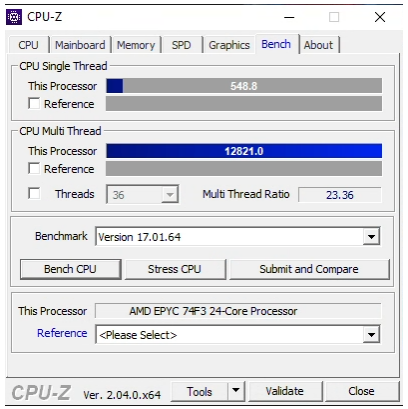
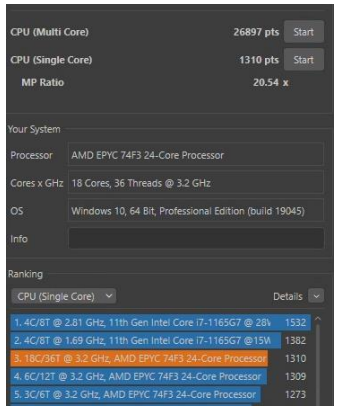
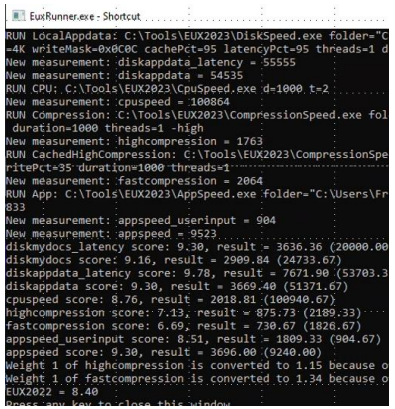


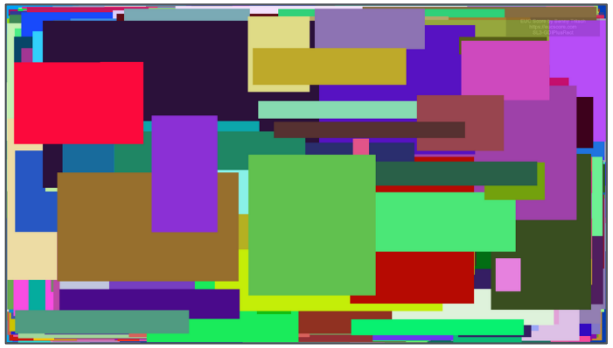
GPU-Z



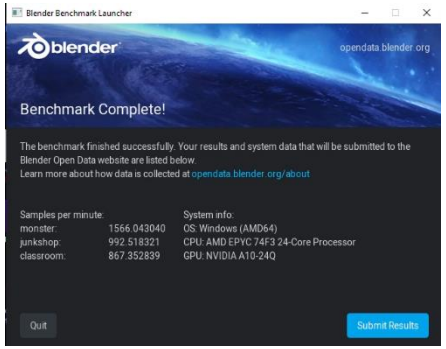
CineBench



Login Enterprise EUX Score



EUC Score – Sore Simloads



Blender

SPECviewperf

GPU Instances – Performance & Costs

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Instance	CPUZ - ST	CPUZ - MT	CBR23 - MC	CBR23 - SC	EUX 2023	EUC Score App Dialog	EUC Score App Start	EUC Score GDI+ Fractals Dragon	EUC Score GDI+ Fractals Pythagoras	EUC Score GDI+ Rectangles	EUC Score IOPS		Price		EUC Score GDI+ /Price	EUX Score /Price
	better▶	better▶	better▶	better▶	better▶	◀better	◀better	◀better	◀better	◀better	◀better					
Microsoft Azure																
Azure NV6	256	1789	3843	671	7.37	0.28	0.62	8.71	15.31	1.55	5.57		1.33		6.41	5.54
Azure NV4as_v4	348	997	2304	893	7.95	0.29	0.68	106.89	194.31	1.3	14.08		0.47		214.54	16.91
Azure NV8as_v4	375	2107	4673	937	8.25	0.29	0.65	26.52	49.36	1.05	6.34		0.94		27.29	8.78
Azure NV16as_v4	395.7	4246	9445	945	8.03	0.29	0.66	10.36	20.83	1.3	3.98		1.88		5.76	4.27
Azure NV32as_v4	395.4	8414	17896	959	8.37	0.29	0.65	4.3	8.96	1.18	2.88		3.76		1.28	2.23
Azure NC4asT4_v3	365.8	1490	2988	909	8.22	0.28	0.61	4.21	8.58	1.08	11.3		0.81		5.68	10.11
Azure NC8asT4_v3	376.7	3059	7029	942	8.3	0.28	0.61	4.14	8.21	1.12	3.92		1.24		3.62	6.69
Azure NC16asT4_v3	395.9	6020	13959	956	8.28	0.28	0.61	4.52	8.87	1.16	3.67		2.14		2.27	3.87
Azure NV6adsA10_v5	494.4	2105.2	4895	1273	8.41	0.28	0.57	36.32	78.85	0.73	5.26		0.82		47.29	10.29
Azure NV12adsA10_v5	511.7	4016	9818	1309	8.36	0.28	0.57	19.12	36.42	0.82	2.68		1.63		11.50	5.12
Azure NV36adsA10_v5	548.8	12821	26897	1310	8.4	0.28	0.56	3.8	7.91	0.82	1.9		5.47		0.76	1.54

Price in US$/hour (global average)

Quantitative results, no exact science

GPU Instances – Performance & Costs

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Instance	Blender CPU Monster	Blender CPU Junkshop	Blender CPU Class	Blender GPU Monster	Blender GPU Junkshop	Blender GPU Class	SPEC 2020 3dsmax	SPEC 2020 catia	SPEC 2020 creo	SPEC 2020 energy	SPEC 2020 maya	SPEC 2020 medical	SPEC 2020 smx	SPEC 2020 solidw		Price		SPEC Perf /Price	GPU Perf /Price
	better▶	better▶	better▶	better▶	better▶	better▶	better▶	better▶	better▶	better▶	better▶	better▶	better▶	better▶					
Microsoft Azure																			
Azure NV6	26.73	16.21	14.2	157	97	79	44.67	43.35	67.31	23.05	151.39	24.73	194	96		1.33		60.6	83.41
Azure NV4as_v4	15.63	9.09	7.8	FAIL	FAIL	FAIL	4.09	4.10	4.22	1.42	12.72	2.22	28	11		0.47		18.1	FAIL
Azure NV8as_v4	33.4	19.53	16.55	78	16	30	9.99	11.95	19.70	25.87	35.47	7.05	59	27		0.94		26.0	43.68
Azure NV16as_v4	66.53	40.07	32.68	162	56	79	23.53	23.64	37.92	37.22	86.62	14.41	120	56		1.88		26.5	52.68
Azure NV32as_v4	134.32	80.9	67.02	358	148	197	69.54	48.36	54.79	49.64	202.09	31.84	277	128		3.76		28.6	62.29
Azure NC4asT4_v3	21.24	12.38	11.04	725	485	465	83.68	64.26	102.26	38.48	241.46	46.62	293	155		0.81		157.5	686.44
Azure NC8asT4_v3	45.94	27.18	23.12	725	485	463	83.64	62.40	92.56	38.55	246.50	46.88	292	155		1.24		102.6	449.59
Azure NC16asT4_v3	90.92	55.74	47.12	709	471	466	84.00	59.04	80.78	39.10	248.49	47.17	295	158		2.14		59.1	256.39
Azure NV6adsA10_v5	32.72	19.74	16.09	FAIL	FAIL	FAIL	14.40	18.09	24.58	11.30	51.07	10.73	51	31		0.82		32.5	FAIL
Azure NV12adsA10_v5	67.11	41.5	33.44	371	216	196	42.69	41.44	51.57	32.51	125.94	21.93	109	67		1.63		37.6	159.75
Azure NV36adsA10_v5	199.24	125.35	97.6	1566	992	867	144.37	97.79	108.25	86.31	419.07	74.63	451	260		5.47		37.5	208.74

Price in US$/hour (global average)

Quantitative results, no exact science

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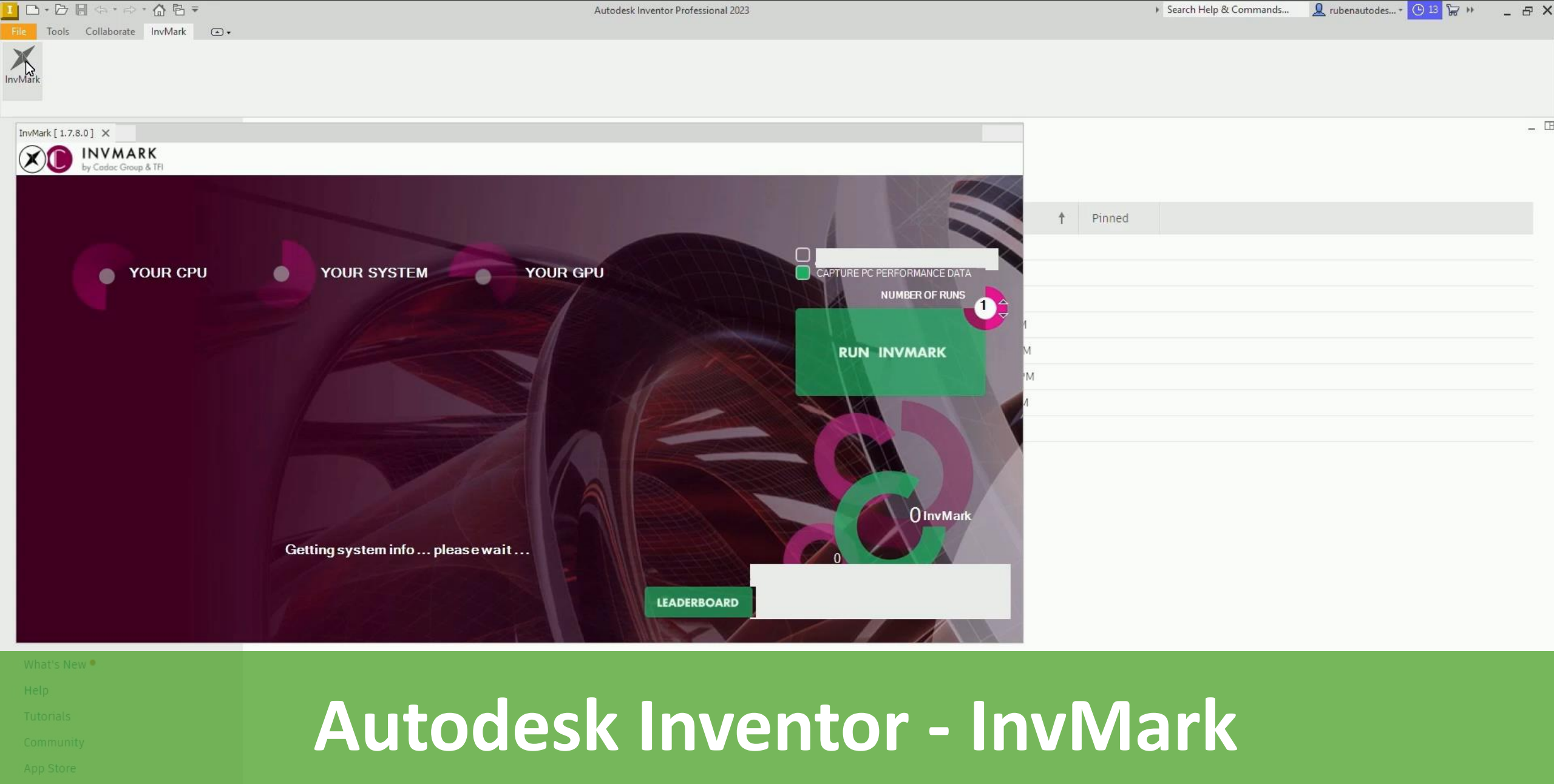
CAD – BIM – Visualization

supported by Greg Corke

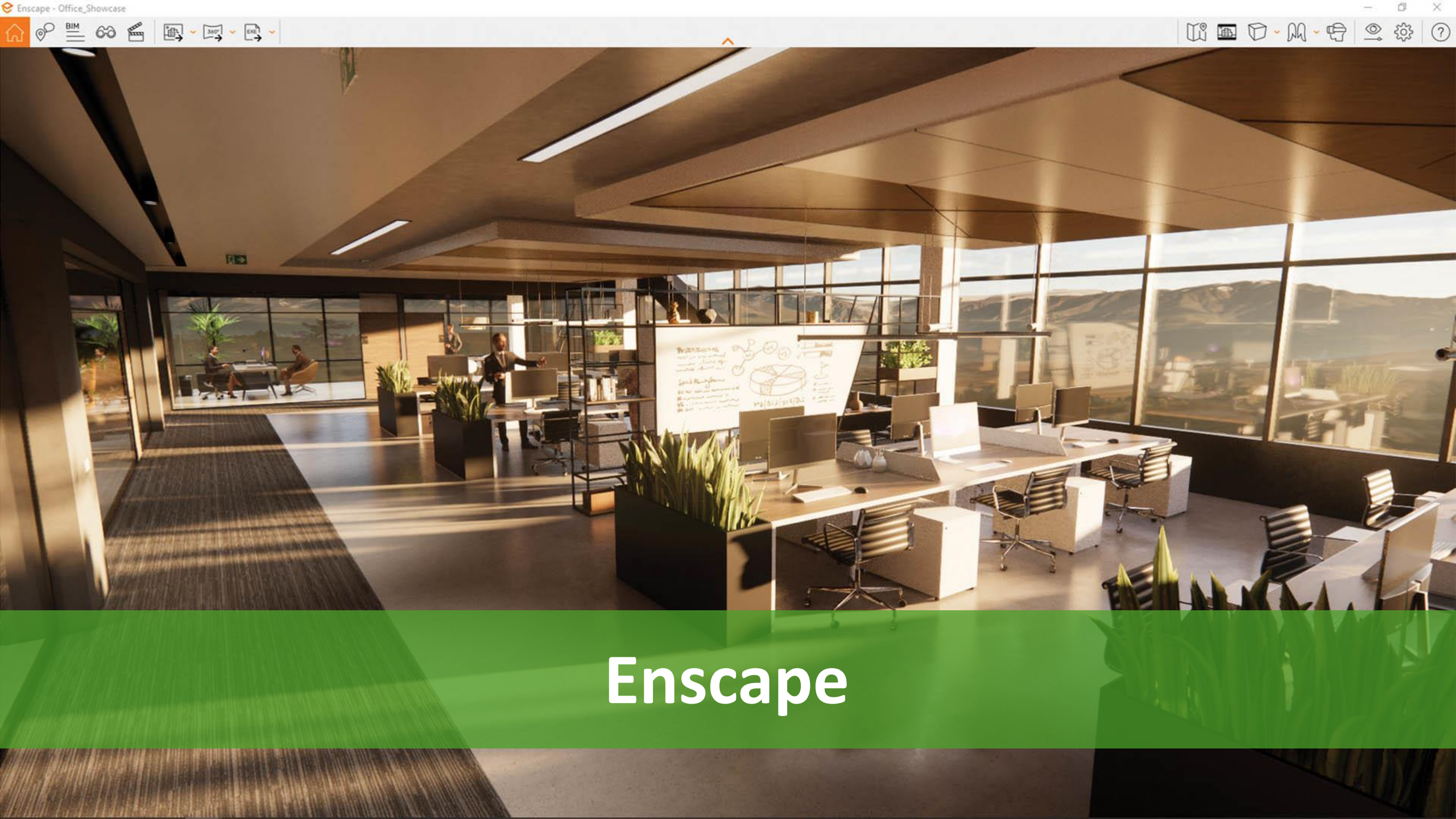
Unreal Engine



Autodesk Inventor - InvMark

Autodesk VRED

KeyShot


Enscape - Office_Showcase
BIM
Enscape

V-Ray

GPU Instances – Performance

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Instance	vRay 5 - CPU	vRay 5 - RTX GPU	Keyshot 11 - CPU	Keyshot 11 - GPU	Revit 2021 RFO - update (sec)	Revit 2021 RFO - create (sec)	Revit 2021 RFO - export (sec)	Revit 2021 RFO - Render (sec)	Revit 2021 RFO - Graphics (sec)	Revit 2021 RFO - Rotate (sec)	VRED 2023 - no AA	VRED 2023 - med AA	VRED 2023 - ultra high AA	Enscape 3.1 - sample	Unreal Engine 4.26 Audi - RT ON	Unreal Engine 4.26 Audi - RT OFF	Inventor 2023 - Modelling	Inventor 2023 - Drawing	Inventor 2023 - FEA	Inventor 2023 - SIM	Inventor 2023 - Graphics	Inventor 2023 - RT	Inventor 2023 - Data Translate	Inventor 2023 - Assy Pattern	Inventor 2023 - Assy Constraint	Inventor 2023 - ST	Inventor 2023 - MT
Microsoft Azure																											
Azure NV6_v3	2594	FAIL	0.49	4.6	16.5	187.8	546.9	143.7	48.6	4.15	34.0	19.6	9.2	41.0	FAIL	26.2	748	539	709	865	1714	512	557	626	824	7576	3397
Azure NV12_v3	3425	FAIL	0.66	4.6	14.4	178.9	521.0	104.9	46.1	3.96	34.0	19.6	9.2	42.5	FAIL	26.5	806	590	724	891	1736	765	580	676	831	7942	4088
Azure NV8as_v4	3275	FAIL	0.64	FAIL	12.7	160.4	488.2	115.6	56.5	5.63	10.1	4.8	2.8	15.4	FAIL	4.4	896	577	876	539	1318	689	616	558	572	7312	4012
Azure NV16as_v4	6288	FAIL	1.24	FAIL	12.8	149.4	455.1	61.6	44.5	3.69	17.4	9.4	4.9	27.1	FAIL	18.5	1136	693	879	774	1936	1382	654	697	783	8669	5407
Azure NC4asT4_v3	2301	589	0.44	23.5	12.7	147.3	490.9	150.1	41.2	3.84	65.8	37.7	18.2	74.6	25.1	41.1	770	581	869	1259	2251	469	620	981	1116	10164	3452
Azure NC8asT4_v3	4954	662	0.89	23.6	12.4	141.4	452.7	81.6	37.5	3.28	64.7	37.0	17.9	71.7	23.9	41.8	1000	755	907	1244	2345	954	670	988	1148	10473	5064
Azure NC16asT4_v3	9533	734	1.79	24.6	12.6	143.6	455.1	47.4	39.9	3.23	63.5	37.9	17.9	77.5	24.8	40.9	1321	857	881	1217	2523	1981	681	895	1162	10240	6379
Azure NV6adsA10_v5	3404	FAIL	0.67	6.6	9.2	115.0	351.2	112.6	37.1	2.78	19.5	12.6	7.5	2.1	FAIL	2.6	961	811	1095	1384	1988	715	865	1256	1387	12236	4953
Azure NV12adsA10_v5	7030	351	1.32	13.9	8.8	101.2	314.3	56.4	31.0	2.28	39.7	25.4	15.1	51.5	FAIL	27.6	1274	1027	1101	1525	2616	1411	933	1165	1450	12735	7068
Azure NV36adsA10_v5	20283	1544	3.99	52.4	9.2	98.5	316.4	27.3	25.9	2.09	138.3	78.1	41.1	134.2	47.1	88.9	1742	1194	1040	1480	2937	3928	929	1312	1470	12409	9280

Price in US$/hour (global average)

Quantitative results, no exact science

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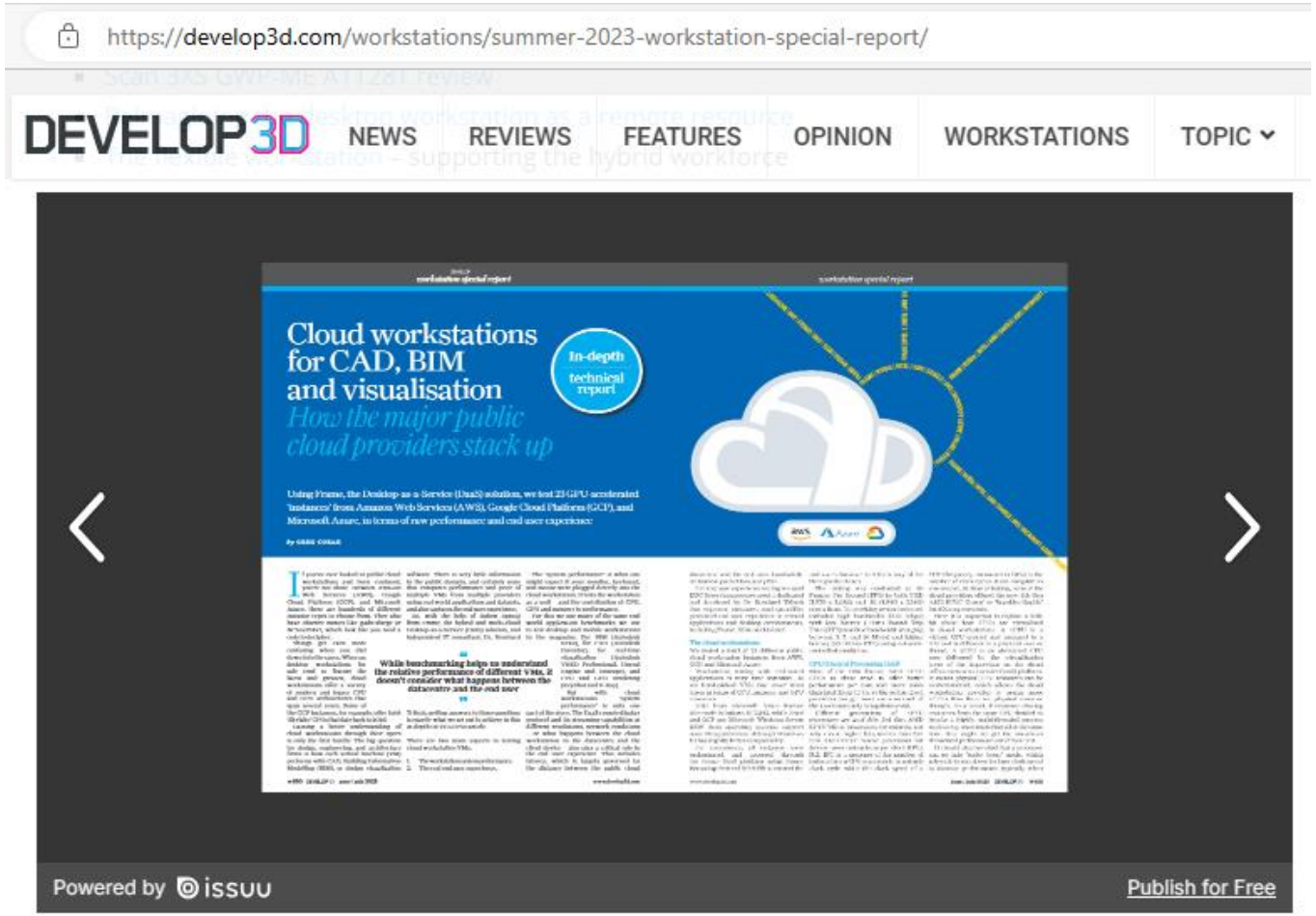
DEVELOP3D Article by Greg Corke



https://ux.fra.me/
https://aecmag.com/workstations/cloud-workstations-for-cad-bim-and-visualisation/
https://develop3d.com/workstations/summer-2023-workstation-special-report/

Observations

- Azure NVv4 VMs do not provide great performance, despite the AMD M25 GPU – low 3D performance, no video encoding / no hardware encoding exposed
- Azure NV4v4 is limited in fps (18 is max) and it may fall behind CPU-only VM types
- Azure NC8asT4 – if you don't need the vCPUs or RAM, then go for the NC4asT4 – same GPU; SPEC performance almost the same, but 30% cheaper
- Azure NV6adsA10 more CPU and RAM at the same price as the NC4asT4; But NC4asT4 provides much better GPU performance because of full GPU vs GPU partition
- If you really need GPU performance don't use Azure NVadsA10 with smaller GPU partitions, the NCasT4 with dedicated GPU provides better performance
- Azure NVadsA10 has high base clock speed – 3.2 GHz
- Winner on Azure: NC4/NC8asT4 – Great price/perf ratio – dedicated GPU!
- If you have still the NV6/NV12 running, then switch to NC4/NC8 – migrate away; check GPU availability
- CAUTION: NCasT4 VM types with missing certification for CAD applications may be a deal breaker

Final Remarks

- Cloud Workstations beat 2–4-year-old CAD/CAM workstations
- But a Cloud Workstation cannot beat a modern physical Workstation in performance, as the GPUs in the Cloud are years behind and CPUs have a lower clock speed
- Only very few people need an extreme high-end workstation (CAD/CAM and media designers – I'm not taking gamers into account)
- Performance is only one (key) topic in decision making
- GPU-accelerated VM types are approx. factor 1.5 to 2 more expensive than comparable CPU-only VM types, but in multi-session setups scalability may be better
- Availability of GPU-accelerated VM types is a massive challenge!!!

Next Step: Add Network Influence

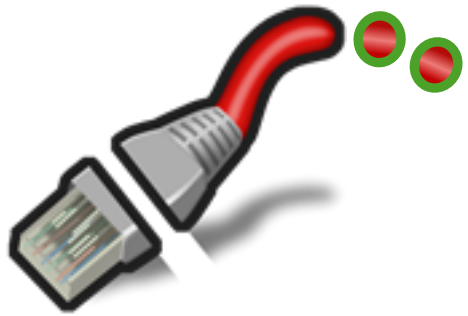
The richer the graphics, the more bandwidth it will take

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)

Call to Action

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

info@eucscore.com

EUC Score

https://eucscore.com

NOTE: The EUC Score toolset including the Simloads is free for community benchmarks…

We love Feedback

https://workplaceninjasummit2023.sched.com/

Workplace Ninja Summit 2023

Thank you