Beyond Performance: Introducing NVIDIA's New Graphics Debugger

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- Overview
- Demo
- Key Takeaways
- Q&A

Overview

The Story So Far...

- Nsight: Visual Studio Edition
 - Fully integrated into IDE
 - Graphics
 - Compute (CUDA)
 - 9+ years of learnings
- Ideal workflow for developers, but...
 - Reliant on VS ecosystem
 - Dependencies on compute for release

How can we improve?







Debugging

C++ Serialized Captures Event Timeline (Scrubber) Shader Editing Pixel History Resources Viewer Geometry Viewer API Inspection



Profiling

Range Profiler HW Perf Counters Shader Stats Event Timings Counter Selector API Stats GPU Trace



Ray Tracing (RTX)

DXR Capture/Replay DXR Frame Debugger Shader Bind Table View



	Debugging			Profiling				Ray Tracing (RTX)			
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Developer Choice

Nsight: VSE

+ Visual Studio integration+ Compute tools+ Tracing tools

Nsight Graphics

+ More frequent releases

- + Activities system
- + Advanced profiling

Demo

- 1. Nsight Graphics Tour
- 2. DXR Debugging
- 3. Optimizing Async Compute

Demo 1 - Nsight Graphics Tour



New, stand alone shell!

Nsight Graphics Tour



| 2

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	& Generate C++ Capture	editing.	ting resources. Other debugging teatures include pixel his	fory and live shader	
	@ GPU Trace	Supported APIs: D3D11, D3D12	?, OpenGL, Vulkan		Launch!
		 Additional Options 			
GDC	Cancel			Launch	
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Real time performance metrics

Scrub through the scene, better understand GPU rendering Live capture: return to your application at will



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Scrubber: break down frame co

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Event List: API event trace	veviceContext3::PSSetShaderResources(UNT StarStot = 0x00000	<0.01 - 8104 <0.01 - 8104 <0.01 - 8104 0.00 - 8104 0.00 - 8104 0.00 - 8104 0.00 - 8104	Format Offset Size Usage Bind CPU Format Offset Size Usage Bind CPU DXGL_FORMAT_R16_UINT 0 18 D3D11_USAGE_DEFAULT D3D11_BIND_INDEX_BUFFER 0x0000000	Misc 04 04000000000000000000000000000000000
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Events View: filter to find problematic API usage

Nsight Graphics Tour

Frequent shader changes can impact performance

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Hyper-linked UI for easy navigation

Pipeline Navigator: state categorized by GPU location

State laid out for easy inspection

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Inspect all resource types, views, etc.

Scrub through buffer revisions

	Resources View	×	
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DXR Debugging





DXR Debugging

Inspect bound Ray/Miss/Hit Shaders

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Visualize Root Parameters/Arguments

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Demo 3 - Profiling

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"The Peak-Performance Analysis Method for Optimizing Any GPU Workload"

Louis Bavoil https://devblogs.nvidia.com/

GPU Trace: How filled are my SMs?



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GPU Trace: How filled are my SMs?



Solution? Use a Compute Queue



Construct Compute Queue

```
#include < d3d12.h>
11
// Example of creating a compute command queue, needed to get any async compute
11
D3D12 COMMAND QUEUE DESC computeQueueDesc =
 D3D12 COMMAND LIST TYPE COMPUTE, // Type
 0, // Priority
 D3D12 COMMAND QUEUE FLAG NONE, // Flags
 0x0 // NodeMask
};
// Create a compute command queue
hResult = pD3DDevice->CreateCommandQueue(&computeQueueDesc, uuidof(ID3D12CommandQueue), (void**)&pD3DComputeCommandQueue);
// Create a compute command allocator
hResult = pD3DDevice>CreateCommandAllocator(D3D12 COMMAND LIST TYPE COMPUTE, uuidof(ID3D12CommandAllocator),
(void**) &pComputeCommandAllocator);
// Create a compute command list
hResult = pD3DDevice>CreateCommandList(0x1, D3D12 COMMAND LIST TYPE COMPUTE, pComputeCommandAllocator, NULL,
uuidof(ID3D12GraphicsCommandList), (void**)&pComputeCommandList);
```





GPU Trace: How filled are my SMs? File Connection Tools Window Help ◆ Connect ② Disconnect × Term vbook BadAsync.wvz 🗙 View: Async Group 🔻 Color By: Stages 🔹 🗷 Export... [] Zoom to fit 8000.00 µs Summary Capture Information Annotation 2000.00 µs 3000.00 µs 5000.00 µs 6000.00 µs 7000.00 µs Range: All Visible Num Warps: 215512 8540. 16 µs Num GPCxTPC: 7 Duration: Start: Num SM: . 8540.16 µs Compute Queue End: Queues are serialized...fences! visualizes from the top Warp Active Time 8540 1 0.00% 0.00us 1052.51µs 12.32% 1760367 222.17µs 2.60% 205570 ASync 377.38µs 4.42% 143239 occupied 6855.33us 80.27% SM Active Time Percent 4471.89µs 52.36% 2880 5500 33 73% 589 69 m 6 90% 1001.65us 11.73% GPCxTPC0 4068.27us 47.64% h-1. GPCxTPC2 1-41 Calls Command Lists Dispatche Queues are Duration DrawCall Count Dispatch Count 126.88 µs 114 serialized...fences! 38.85 µs 0

No (Real) Async: Debug with Nsight Graphics



GPU Trace: Much Better!

Graphics & Compute now overlap...better shader unit utilization!

33 🥺 NVIDIA



6000.00 µs

Frame time now just over 6ms...~2ms saved!

GDC

But wait...why is compute not full?



GPU Not Full: Debug with Nsight Graphics...



35 💿 nvidia,

GPU Not Full: Debug with Nsight Graphics...



Impact of Varying Register Count Per Thread



GPU Throughput: SOL

SOL = Speed of Light





<~10%, unit just not

taxed...

GPU Throughput: SOL

SOL = Speed of Light



unit more efficient, or could try and reduce work



GPU Throughput: SOL

SOL = Speed of Light



max throughput, will likely need to shift work to other units improve performance



Range Profiler



GDC

40 📀 NVIDIA

Range Profiler

Overall frame is mainly texture limited, but better to dig into ranges that have similar workloads

TEX: 26.9% | SM: 18.2% | L2: 12.6% | DRAM: 8.6% | CROP: 7.4%

Top SOLs	TEX:26.9% SM:18.2% L2:12.6% DRAM:8.6% CROP:7.4%		
GPU Idle	17.7%	Wait For Idle Count	207
TSL2 Stall Cycles	0.0%	Pixel Shader Barrier Count	0
SM Active	61.7%	SM Active Threads Per Instruction Executed	87.3%
SM Active Min/Max Delta	8.9%	SM Warp Stall Long Scoreboard	41.8%
SM Issue Utilization Per Active Cycle	27.1%	SM Warp Stall Barrier	1.8%
SM Occupancy (Active Warps Per Active Cyde)	29.1	SM Warp Stall Drain	0.9%

Range Profiler



Select largest/most expensive marker range in scene...

This range is mainly texture and shader unit limited...but dig a little deeper...

TEX: 45.2% | SM: 29.5% | L2: 23.1% | DRAM: 8.4% | CROP: 6.0%

Top SOLs	TEX:45.2% SM:29.5% L2:23.1% DRAM:8.4% CROP:6.0%		
GPU Idle	11.7%	Wait For Idle Count	9
TSL2 Stall Cycles	0.0%	Pixel Shader Barrier Count	0
SM Active	74.9%	SM Active Threads Per Instruction Executed	89.4%
SM Active Min/Max Delta	11.8%	SM Warp Stall Long Scoreboard	33.4%
SM Issue Utilization Per Active Cycle	33.4%	SM Warp Stall Barrier	0.0%
SM Occupancy (Active Warps Per Active Cycle)	25.4	SM Warp Stall Drain	0.0%





PD:61.8% VPC:28.9% ZROP:14.5% L2:7.8% DRAM:6.1%		
10.6%	Wait For Idle Count	8
0.0%	Pixel Shader Barrier Count	0
69.0%	SM Active Threads Per Instruction Executed	87.4%
4.5%	SM Warp Stall Long Scoreboard	20.7%
6.4%	SM Warp Stall Barrier	0.0%
6.8	SM Warp Stall Drain	0.4%
	PD:61.8% VPC:28.9% ZROP: 14.5% L2:7.8% DRAM:6.1% 10.6% 0.0% 69.0% 4.5% 6.4% 6.8	PD:61.8% VPC:28.9% ZROP: 14.5% L2:7.8% DRAM:6.1% 10.6% Wait For Idle Count 0.0% Pixel Shader Barrier Count 69.0% SM Active Threads Per Instruction Executed 4.5% SM Warp Stall Long Scoreboard 6.4% SM Warp Stall Barrier 6.8 SM Warp Stall Drain



Key Takeaways

Summary

- Nsight Graphics is the next-gen graphics debugger
 - DXR Debugging
 - Range Profiler
 - GPU Trace

NVIDIA DevTools is committed to...
 increasing release frequency
 solving developer pain points
 improving developer productivity



- Close collaboration to help make the best tools for our developers
 - Work history buffer i.e. timing activity
 - HW Performance Counters
 - GPU Occupancy Viewer
 - Performance warnings
 - DXR visualization

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22	DrawInstanced(3,1,0,0)		sm_sol_min_pct
24	DrawInstanced(3,1,0,0)		× sm_sol_pct
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The Future of Nsight Graphics

- H1 '18
 - Vulkan 1.1 support
 - Linux Support
 - Improvements to Range Profiler
 - GPU Trace 1.0
 - DXR improvements
- H2 '18
 - GPU Trace for Vulkan
 - Pixel History (DX12 & Vulkan)
 - DXR Profiling

What's Next?

- Visit our Booth (#223) to check out Nsight Graphics, DXR Debugging and GPU Trace
- Check out Louis Bavoil's talk in 30 minutes to learn more about performance triaging with the Range Profiler
- Watch our Videos: <u>http://j.mp/nvidia-devtools-videos</u>

Join our Early Access Program and get Nsight Graphics here: <u>https://j.mp/ngfx</u>

(https://developer.nvidia.com/nsight-graphics)



We're Hiring!

http://www.nvidia.com/object/careers.html



Thank you! Questions?



Booth #223 - South Hall www.nvidia.com/GDC

Need to contact us? NsightGraphics@nvidia.com

Get Nsight Graphics here: https://j.mp/ngfx (https://developer.nvidia.com/nsight-graphics)

NVIDIA Sessions

Day	Time	Room	Speaker	Title
Thurs Mar 21	17:30-18:30	3022	Louis Bavoil Principal Engineer	Fixing the Hyperdrive - Maximizing Rendering Performance on NVIDIA GPUs
Fri Mar 23	10:00-11:00	3022	Nuno Subtil Senior Developer Technology Engineer	NVIDIA Vulkan Update
Fri Mar 23	11:30-12:00	3001, 3003	Alex Dunn Senior Developer Technology Engineer	Aftermath – Advances in GPU Crash Debugging
Fri Mar 23	12:15-13:15	3022	Bryan Dudash Senior Manager Developer Technology	Capture Amazing Content with NVIDIA Ansel Photo Mode and Highlights Video Capture Tool
Fri Mar 23	13:30-14:30	3022	Evan Hart, Principal Engineer	Advances in the HDR Eco-System
Fri Mar 23	15:00-16:00	3022	Cem Cebenoyan Director of Engineering	Accelerating your VR Games with VRWorks

Need to contact us? NsightGraphics@nvidia.com

Get Nsight Graphics here: https://j.mp/ngfx (https://developer.nvidia.com/nsight-graphics)