Using Render Doc

UE and Oculus Quest 2

Rob Segal Get Set Games

Who am I?

- I'm Rob!
- Co-Founder/Technical Director at Get Set Games
- Using Unreal for about 8 years
- Currently doing some exploration work in VR on Quest 2
- I write occasionally at **sarcasticcoder.com**

What are we talking about?

- RenderDoc. What is it?
- Non documented cases in setup and usage
- Example usage scenarios
 - Auto instancing
 - Distance Culling

Not covering...

- Unreal/RenderDoc integration
- General usage of RenderDoc
- CPU or GPU bound

Development Setup

- UE 4.27.2
 - Github Oculus Fork
- Quest/Quest 2
- Render Doc
 - Meta Fork v44.1 (forked from v1.22)

Development Setup

- Build engine from source
 - Distribute through UGS (Unreal Game Sync)
- Using Vulkan but equally applicable to OpenGL projects
- Development, Test and Shipping configuration built nightly

What is RenderDoc?

A graphics debugger that allows quick and easy single-frame capture and detailed introspection of any application

RenderDoc

Latest Release: v1.25 - 1 Feb, 2023

Download (Win x64) -

RenderDoc is a free MIT licensed stand-alone graphics debugger that allows quick and easy single-frame capture and detailed introspection of any application using Vulkan, D3D11, OpenGL & OpenGL ES or D3D12 across Windows, Linux, Android, or Nintendo

should

Open Development

I work on RenderDoc myself and you can always contact me with any problems or comments. I'll respond to you directly and personally, and I'm used to helping people with private or NDA'd projects.

Platform Support

RenderDoe supports Windows, , and Android for capture and replay out of the box. Nintendo Switch[™] support is distributed separately for authorized developers as part of the NintendoSDK. Captures are portable between different platforms and hardware.

Screenshots

Open Source

Customisable

access to frame captures.

RenderDoc is 100% open source sability matters. Tools and development all happens have a low barrier to entry and github. Check out the source and easy to use and understand. see how any feature RenderDoc makes the process of is implemented, port a bug you've getting started as smooth as found, or request a new feature or possible, and simplifies common workflows. ovement.

Widely Used

On top of being able to modify the RenderDoc is the debugger of source to change or customise choice for many people within the game industry, academia, and behaviour, RenderDoc embeds the hobbyists. Engine-level python runtime for progammatic integration ships in Unity, and in Unreal.

Usability Focus

RenderDoc has been one of the most dependable PC graphical debugging tools for us over the years. Best thing, it's open source, you can roll-out your wn features and contribute fixes.

Tiago Rodrigues (Ubisoft Montreal) RenderDoc is our primary tool for frame analysis & debugging on PC. It is extremely robust and supports a wide range of workflows and functionality We've been excited to contribute features and small fixes, and look forward to doing so in the future.

- Michael Vance (Activision)

RenderDoc has been an instrumental tool in getting a quick overview of a frame and understanding what is going on.

- Matthäus G. Chaidas (AMD)

Render Doc... but not the one you want



Render Doc - Meta Fork!

Why or when would I use it?

- GPU bound
- Determining draw call count
- Review contents of render buffers (stencil, depth, etc.)
- Interested/curious about what the GPU is doing

What can it do?

- Review frame draw call count
- Review buffer usage (stencil, depth, etc.)
- Shader debugging/analysis
- Verify GPU instancing of shared meshes
- Texture format and resolution verification

RenderDoc for Oculus v30.8 (forked from v1.16)			- 🗆 ×
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Launching a VR Application

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Launching a VR Application

VR Profiling Interpretations and Considerations

Things to keep in mind when interpreting the data from profiling tools.

Advanced

While profiling tools can provide data about how your project is performing in VR, there are some points to consider when interpreting those values.

Delays can appear in odd places in the GPU and CPU profilers, most often as occlusion or scene graph traversal time. If those numbers are abnormally high, it's possible that it's a false positive.

TIP

Often when profiling, you'll notice that you pop between 90 Hz and 45 Hz. The difference is accounted for because the Compositor acts much like a vsync. If you miss framerate, it delays you until the next frame entirely. So, you tend to go down in brackets of 90 / n, where n is a whole number. Because the fps reporting is an average, it won't always report as a whole number, unless the drop is sustained. If you're bouncing back and forth between making framerate and not, you may see some fraction of a jump.

If you'd like to remove this for testing, sometimes it's useful to run the game emulating stereo rendering, instead of running in the device itself. To do so:

- Launch the game with -game -emulatestereo -res=2160x1200 on the commandline
- Ensure vsync is off with r.vsync 0 in the console
- Update the screen percentage to emulate the oversampling we have to do for VR with r.screenpercentage 137 in the console

This will emulate the GPU and CPU performance characteristics without the annoyances of the variable framerate.

It's worth explicitly noting that if you're hitting 90 frames a second most of the time, and then make a change and notice a drastic drop, you're probably falling prey to the Compositor "vsync" issue noted above. As soon as you tip over the cliff, you'll see drastic changes in numbers.

Launching a VR Application - PC



Render Doc service running on device



Remote server not running or failed to start

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Attach to running instance

Starting the Render Doc service

Launching via Android Debug Bridge (ADB) shell...

adb '-s 1XXXXXXXX shell am start -n com.oculus.renderdoccmd.arm64/.Loader -e renderdoccmd remoteserver'



Render Doc capture on headset

Profiling mode



There is alot of noise....

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Much better...

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43-78	✓ Slate3D	40.57291568
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Use Development builds for captures

Less good...

Filter using keyword "draw"

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Highlight draw call



Highlight draw call - auto-instancing



Highlight draw call - nothing!

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1425-2987	✓ MobileBasePass	0.00
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Time duration

Distance Culling



Do we really need to draw this?

Designing Visuals, Rendering, and Graphics > Visibility and Occlusion Culling > Cull Distance Volume

Cull Distance Volume

An overview of how to use the Cull Distance Volume to cull Actors in your Levels as specified distances based on their size.

Cull Distance Volumes are a useful optimization tool that defines what distance to draw (or make visible) any Actor within the volume. These volumes store any number of size and distance combinations called Cull Distance Pairs. The Actor (along its longest dimension) and then assigned to that Actor instance in the level. Cull Distance Volumes are most useful for optimizing large outdoor levels that have detailed interiors. The interiors can be culled when they are sn unimportant.

Setup and Usage

Cull Distance Volumes can be added to your level through the Place Actors panel in the Editor, and you can scale it to fit the level.



Cull distance volume

Draw distance

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Auto-Instancing

Auto-Instancing is a feature that automatically combines multiple draw calls into one instanced draw call.

Mesh Auto-Instancing on Mobile

Mesh Auto-Instancing on Mobile

How to enable mesh auto-instancing on mobile.

Intermediate

	ON THIS PAG
	Steps
The UE4 Mesh Drawing Pipeline implements a mesh auto-instancing feature that merges draw calls, which can greatly	
improve graphics performance. This functionality is now available for mobile devices with some additional settings	Result
configuration.	
\triangleright	Limitations
Steps	
	SEE ALSO
1. Locate the Config folder for your project and open DefaultEngine.ini.	Mesh Drawin
2. Add the following lines:	Performance
r.Mobile.SupportGPUScene=1	
r.MoDile.UseGPUScenelexture=1	

Save your changes and close the file.

NOTE

Enabling this feature will cause shaders to be rebuilt for mobile platforms. If you have Unreal Editor set to Android Preview mode, the editor will recompile shaders accordingly. Large projects may have a long iteration time.

Result

By enabling the above settings for your project, auto-instancing will be enabled for all devices. r.Mobile.SupportGPUScene enables auto-instancing on mobile devices. However, they will use the same buffer as a desktop build. Mali devices only support buffers of up to 64 kb and are unable to support this feature normally. r.Mobile.UseGPUSceneTexture will make the auto-instancing process use a texture instead of a buffer to store the required information, enabling Mali devices to use

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Instanced draw calls

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2547-2551	> MME_Prop_Standard SM_Torch_Holder_02	
2553-2557	MME_Prop_Standard SM_Torch_Holder_02	
2550-2563	MME Prop. Standard SM. Tran. Blades, 01	

SM_Torch_Holder_02 - Same mesh but multiple draw calls?

Statistics - Pre Changes

Stats for com.getsetgames.MyGame1_2023.03.01_23.40_frame549.rdc. File size: 270.18MB (435.17MB uncompressed, compression ratio 1.61:1) Persistent Data (approx): 77.76MB, Frame-initial data (approx): 353.51MB

*** Summary *** Draw calls: **464** Dispatch calls: 6 API calls: 1878 API:Draw/Dispatch call ratio: 3.99574

320 Textures - 179.90 MB (179.77 MB over 32x32), 11 RTs - 167.72 MB. Avg. tex dimension: 581.068x577.149 (594.763x593.927 over 32x32) 66 Buffers - 76.00 MB total 25.00 MB IBs 46.00 MB VBs. 423.62 MB - Grand total GPU buffer + texture load.

Torch holder instance #1

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132	115	30.01544189	4.16204548	22.99676895	7	1	1	1510.
133	117	31.32950783	-2.17240739	23.76891327	7	2	2	1509.
134	116	24.56603622	-2.63229036	19.01213646	7	3	3	1517.
135	118	30.01544189	4.16204548	22.99676895	7	4	4	1509.
136	119	24.56603622	-2.63229036	19.01213646	7	5	5	1510.
137	120	24.13248444	1.00358641	24.09916306	7	6	6	1524.
138	119	24.56603622	-2.63229036	19.01213646	7	7	7	1517.
139	118	30.01544189	4.16204548	22.99676895	7	8	8	1516.
140	121	25.10790634	2.53201842	19.46219254	7	9	9	1529.
141	122	16.33172798	1.33652377	-16.68109322	7	10	10	1540.
142	123	21.19865417	-2.89211297	-13.91786671	7	11	11	1539.
143	124	15.48695469	-0.31549916	-13.12418079	7	12	12	1529.
144	123	21.19865417	-2.89211297	-13.91786671	7	13	13	1526
145	122	16.33172798	1.33652377	-16.68109322	7	14	14	1529.
146	125	15.48695469	-0.31549916	-13.12418079	7	15	15	1529
147	126	16.33172798	1.33652377	-16.68109322	7	16	16	1530
148	127	15.48695469	-0.31549916	13.12418079	7	17	17	1526.
149	128	22.36273003	-0.84406126	-17.64671898	7	18	18	1522.
150	127	15.48695469	-0.31549916	-13.12418079	7	19	19	1524.
151	129	23.14271927	1.56428099	-12.78127861	7	20	20	1528
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209		2.87495995	-16.6240139	48	7	7	457 35
20042	19.4482708	4.90468216	-15.18131828	48		0	467.00
210	17.22141457	1.85056078	-15.986619	48	0	0	400.00
211	22.04066849	0.44421247	-16.77472687	48	10	10	450.75
208	22.15910912	2.87495995	-16.6240139	48	11	11	459.00
210	17.22141457	1.85056078	-15.986619	48		11	460.33
212	15.25339508	-0.0009861	-16,08424377	48	12	12	454.00
213	17 19935608	-2 42900324	-16.60957527	48	13	13	461.12
210	17 22141457	1.85056078	-15 996619	48	14	14	452.53
212	17 10035600	-2 42900324	-16 60957527	40	15	15	454.51
213	22.15010012	2.92500324	16.60337327	40	16	16	454.25
214	22.15910912	-2.87690165	-16.6240139	40	17	17	455.01
211	22.04066849	0.44421247	-16.77472687	48	18	18	462.16
214	22.15910912	-2.87690163	-16.6240139	48	19	19	460.02
213	17.19935608	-2.42900324	-16.60957527	48	20	20	459.39
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130	115	30.01344103	4.10204340	22.99070090		0	0	1516.92
131	116	24.56603622	-2.63229036	19.01213646	/	1	1	1510.55
132	115	30.01544189	4.16204548	22.99676895	/	2	2	1509.30
133	11/	31.32950783	-2.1/240/39	23./689132/	/	3	3	1517.09
134	110	24.56603622	-2.63229036	19.01213646	/	4	4	1509.3
135	118	30.01544189	4.16204548	22.99676895	7	5	5	1510.5
136	119	24.56603622	-2.63229036	19.01213646	7	6	6	1524.6
137	120	24.13248444	1.00358641	24.09916306	7	7	7	1517.0
138	119	24.56603622	-2.63229036	19.01213646	7	8	8	1516 9
139	118	30.01544189	4.16204548	22.99676895	7	6	0	1520.0
140	121	25.10790634	2.53201842	19.46219254	7	10	10	1540 1
.41	122	16.33172798	1.33652377	-16.68109322	7	11	10	1540.1
142	123	21.19865417	-2.89211297	-13.91786671	7	11	10	1559.9
143	124	15.48695469	-0.31549916	-13.12418079	7	12	12	1529.2
44	123	21.19865417	-2.89211297	-13.91786671	7	13	13	1526.6
45	122	16.33172798	1.33652377	-16.68109322	7	14	14	1529.4
46	125	15.48695469	-0.31549916	-13.12418079	7	15	15	1529.2
47	126	16.33172798	1.33652377	-16.68109322	7	16	16	1530.0
48	127	15.48695469	-0.31549916	13.12418079	7	17	17	1526.6
49	128	22.36273003	-0.84406126	-17.64671898	7	18	18	1522.4
150	127	15.48695469	-0.31549916	-13.12418079	7	19	19	1524.7
151	129	23.14271927	1.56428099	-12.78127861	7	20	20	1528.2
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What's the difference?

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302 215 21.19865417 -2.89211297 -13.91786671 48 21 21	462.1
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Automatic LOD Generation

real Engine 4.27 Documentation 🔻	> Working with Content > Content Asset Types > Static Meshes > Static Mesh How To > Setting Up Automatic LOD Generation	Sea
r pages		
eal Engine 4 Documentation	Setting Up Automatic LOD Generation	
What's New	How To use the Automatic LOD Generation system in UE4.	
+ Release Notes		
Beta Features	Intermediate	
Experimental Features		
Understanding the Basics		
Working with Content	▶ LOD0	
Artist Quick Start	▶ LOD1 Screen Size: 0.004	
 Content Asset Types 	▶ LOD2 Screen Size: 0.001	
+ Skeletal Meshes	D LOD3 Screen Size: 0	
— Static Meshes	The Automatic LOD generation system allows you to automatically reduce the polygon count of your Static Meshes to o	reate LODs with the
+ Static Mesh Editor UI	Unreal Engine 4 (UE4) Editor. Automatic LOD generation uses what is called quadratic mesh simplification to help gene Static Meshes. Quadratic mesh simplification works by calculating the amount of visual difference that collapsing an ec	rate the LODs for lge (by merging two
— Static Mesh How To	vertices) would generate. It then picks the edge with the least amount of visual impact and collapses it. When this happ	ens, the tool will pick
Setting Up Automati	collapse edges until it reaches the requested target number of triangles. In the following guide, we'll show you how-to : automatic LOD generation system in your UE4 projects.	setup and use the
Importing Static Me		
Set LOD Collision	Setup	
Creating and Using	In the following section, we will exact a new project that has Starter Content, and then ensure a Static Mach asset to	work with
Setting Up Collision	in the following section, we will create a new project that has starter content, and then open up a static mesh asset to	WORK WITH.
Setting Up Materials	N O T E For this part of the how-to guide, we will use the SM_Rock Static Mesh that comes with the Starter Content. How	ever, feel free to
Setting Up and Usin	use any static mesh of your choosing to follow along.	
Strip Unused LOD	1. If you have not done so already, open, or create a new UE4 project, making sure that the With Starter Content s	etting is enabled.
Working with UV Cha	Unreal Project Browser	×
Per-Platform LOD Sc	Project Settings	

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Statistics - Post Changes

Stats for com.getsetgames.mygame1_2023.02.15_10.58_frame765.rdc. File size: 258.49MB (522.77MB uncompressed, compression ratio 2.02:1) Persistent Data (approx): 66.96MB, Frame-initial data (approx): 452.58MB

*** Summary ***

Draw calls: 266

Dispatch calls: 30

API calls: 1225

API:Draw/Dispatch call ratio: 4.13851

217 Textures - 287.92 MB (287.79 MB over 32x32), 21 RTs - 174.00 MB.
Avg. tex dimension: 875.469x867.969 (902.053x899.354 over 32x32)
56 Buffers - 66.00 MB total 22.00 MB IBs 39.00 MB VBs.
527.93 MB - Grand total GPU buffer + texture load.

References

- <u>TechArtAid Rendering Passes</u>
- Tech Art Aid Dissecting a Frame with RenderDoc
- <u>RenderDoc for Oculus</u>
- How to Optimize your Oculus Quest App w/ RenderDoc: Getting Started + <u>Frame Capture</u>
- <u>Auto Instancing On Oculus</u>
- VR Profiling Interpretations and Considerations
- How to Optimize your Oculus Quest App w/ RenderDoc: Walkthroughs of Key
 Usage Scenarios and Optimization Tips Part 1
- How to Optimize your Oculus Quest App w/ RenderDoc: Walkthroughs of Key
 Usage Scenarios and Optimization Tips Part 2



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