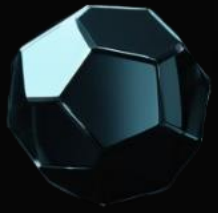


## Introducing: A New Open Source Profiler and Debugger for Android + Vulkan

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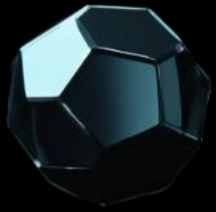
Chris Steinberg  
Samsung Austin Research Center &  
Advanced Computing Lab (SARC/ACL)





# Introducing:

A New Open Source Profiler/Debugger  
For **Android + Vulkan**



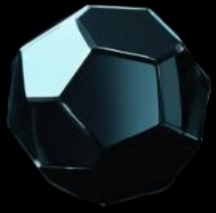
# Android + Vulkan Tooling – Why?

Vulkan (Android) tooling problem:

- Fragmented
- Lacks consistency among IHV's

Solution:

- A HW Agnostic tool for all hosts and targets
  - \* especially Android.



# Android + Vulkan Tooling – How?



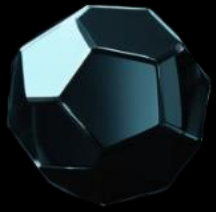
# Perfetto

+



**GFXReconstruct**  
**API Capture and Replay**

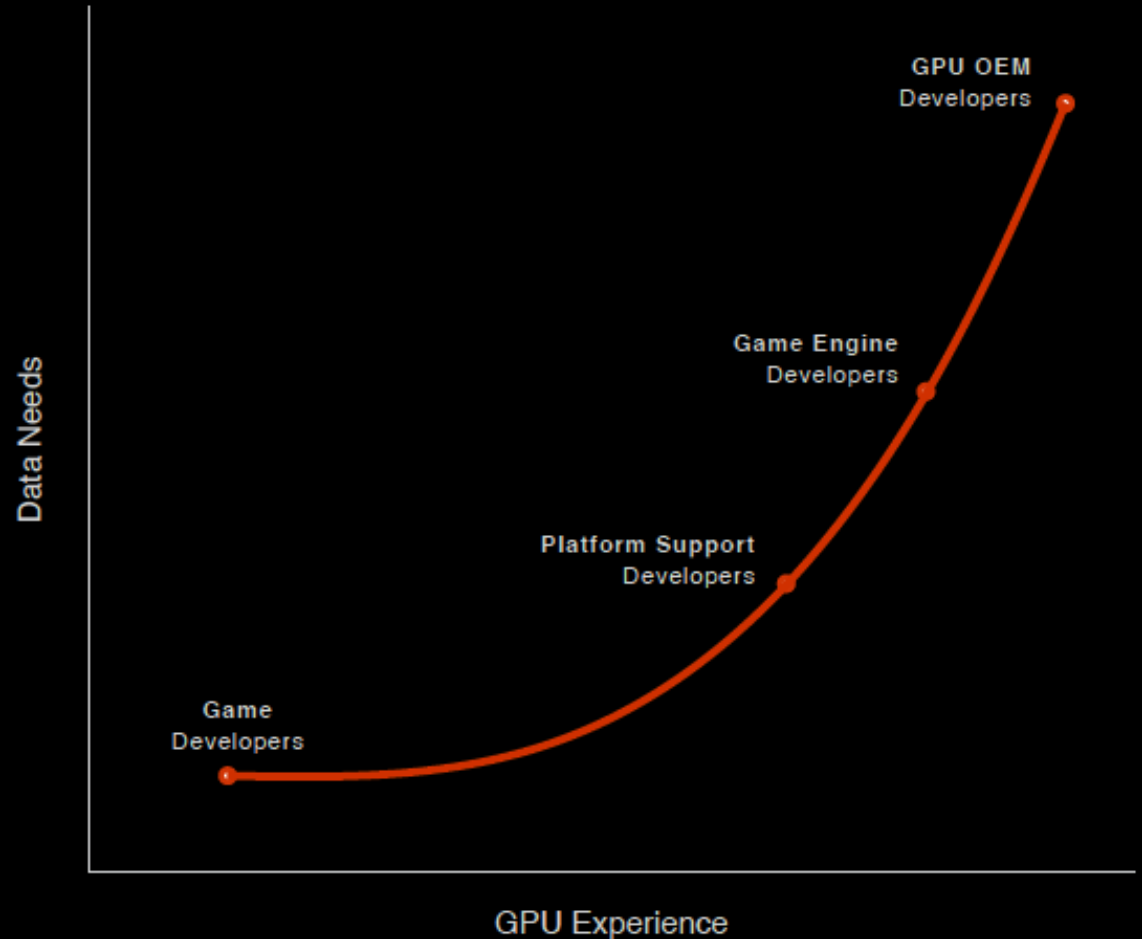
Open Sourced!



# Android + Vulkan Tooling – Who?

## Target Customers

- Game Engine Developers
- Game Studio Developers
- OEM GPU Developers & Platform Engineers





# Demo Time

⏏ + -

No profiles available

+

Welcome x

Start

- New Profile...
- Open Profile...

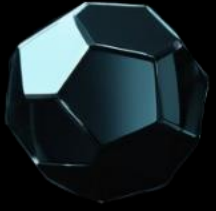
Recent

No recent profiles

PROPERTIES

No selection

Show welcome page on startup



# Android + Vulkan Tooling

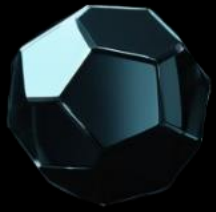
## Future Opportunities:

- Improve work flows for performance analysis
- Make GPU Tooling approachable with use-case documentation
- Provide sandbox for generating new plugins (E.g., Raytracing, Machine Learning)



Signup to provide feedback

[g.co/userresearch/vulkanised](https://g.co/userresearch/vulkanised)



# Future Opportunities:

## Collaborate with US!

Samsung (SARC) & Google  
collaborating together

- Opportunities
- Standardize & enrich data through IHV collaboration
- Early Access Program
- Open Sourced



Signup to provide feedback

[g.co/userresearch/vulkanised](https://g.co/userresearch/vulkanised)



Questions?

# BACKUP

## Screenshots

No profiles available

Start

### New Profile

#### Quick Configuration

#### Configurations

No data available

#### PROPERTIES

No selection

#### Quick Configuration

Common Peretto GFXR

Name

Notes

Device Full Android on S5E9945 ERD (00000bb50e9f6153)

Mode  Launch  Attach

#### Application

Package com.khronos.vulkan\_samples (debuggable)

Activity Default

Optional Arguments --es sample subpasses

#### Capture Triggers

Start Frame (inclusive)

Frame 50

Stop Frame (inclusive)

Frame 100

#### Output

Directory /home/c.steinberg/sokatoa/profiles

Restore Defaults

Save as new configuration

Capture Close

Show welcome page on startup

Welcome x

No profiles available

Start

### New Profile

Quick Configuration

Configurations

No data available

Quick Configuration

Common Perfetto GFXR

- Enabled
  - CPU
    - Frequency and Idle States
    - Scheduling Chains / Latency
    - Thread Slices
  - GPU
    - GPU Activity
    - Counters
    - Selected Counters [Select Counters...](#)
    - Poll Rate ( $\mu$ s) 1000
    - GPU Memory
  - Memory
    - Poll Rate (ms) 1000
  - Battery
    - Poll Rate (ms) 1000
    - Collect Power Rails
    - Collect Energy Breakdown
  - SurfaceFlinger Events
  - Use Advanced
    - Advanced Properties [Edit...](#)

[Save as new configuration](#)

[Restore Defaults](#) [Capture](#) [Close](#)

Show welcome page on startup

No profiles available

Start

**New Profile**

Quick Configuration

Configurations

No data available

Common Perfetto GFR

Enabled

Compression Type LZ4 ZLIB None

Memory Tracking Mode Page Guard

- Copy on Map
- Separate Read
- Persistent Memory
- Align Buffer Sizes
- Unblock SIGSEGV
- Signal Handle Watcher

Max Restores 1

- Omit Null Hardware Buffers
- Force FIFO Present Mode
- Optimize After Capture

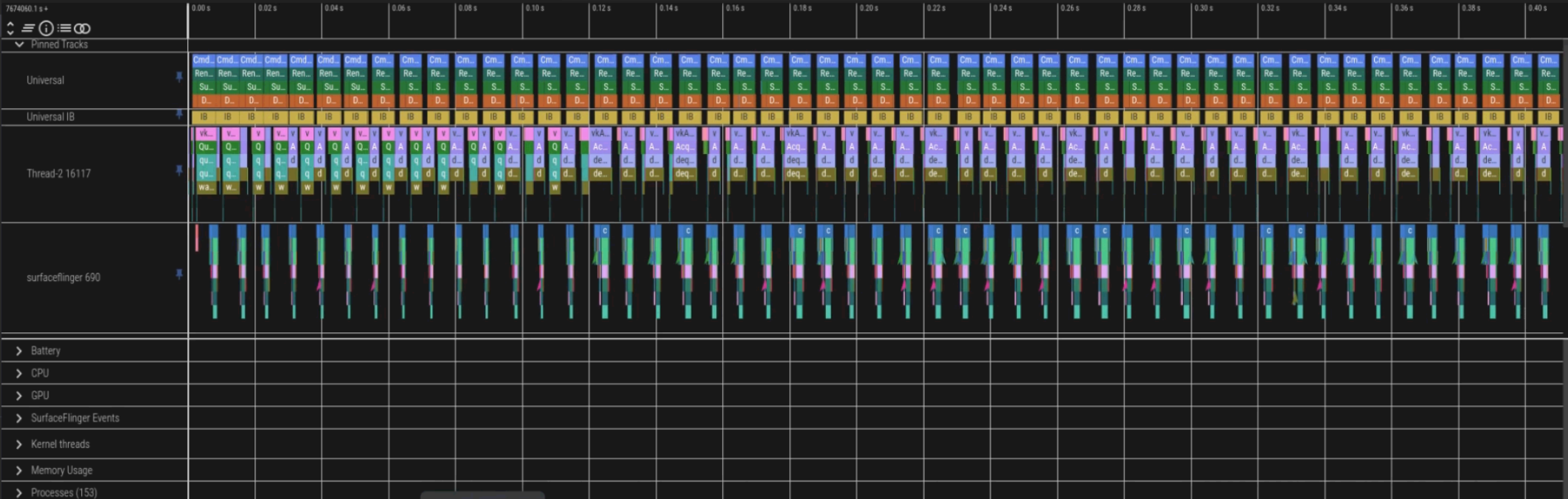
Restore Defaults

Save as new configuration

Capture Close

Show welcome page on startup

Search

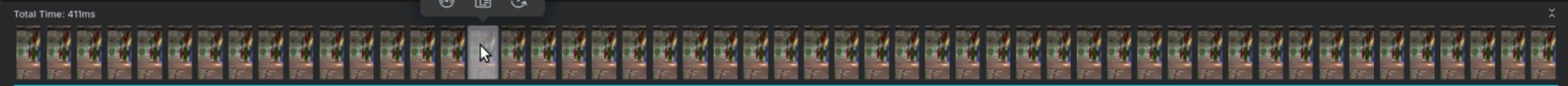


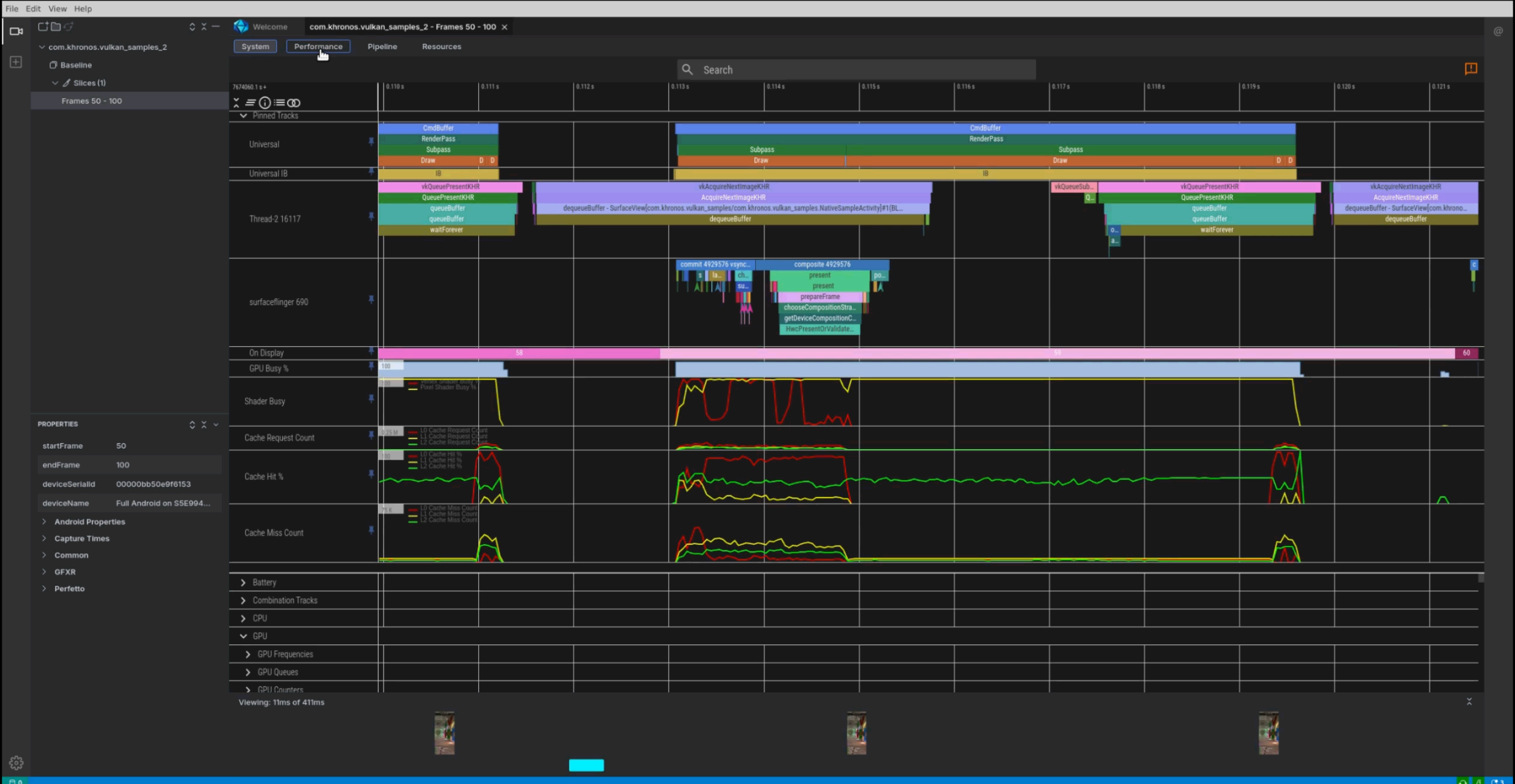
- > Battery
- > CPU
- > GPU
- > SurfaceFlinger Events
- > Kernel threads
- > Memory Usage
- > Processes (153)

PROPERTIES

- startFrame 50
- endFrame 100
- deviceSerialId 00000bb50e9f6153
- deviceName Full Android on SSE994...
- > Android Properties
- > Capture Times
- > Common
- > GFXR
- > Perfetto

This block shows a detailed view of a single frame capture. It features a small 3D scene rendering of a hallway with a red and green character. Below the scene, technical data is displayed: 'Frame 65' and '8ms'. There are also icons for refresh, list, and zoom.





com.khronos.vulkan\_samples\_2

Baseline

Slices (1)

Frames 50 - 100

System Performance Pipeline Resources

Command Performance Showing 14 of 216

Find	Cc	W	*	x	⌕	Duration (ns)	GPU Busy %	GPU Busy Cycles	Scalar ALU Busy %	Vector ALU Busy %	L0 Cache Hit %	L0 Cache Request Count	L0 Cache Miss Count	Complex Vector ALU B...	
>						Frame 64	6527110	100	5210271	8.15	58.84	25.75	2919419	893298	68.53
▼						Frame 65	6511250	100	5177502	8.18	59.02	25.46	2915594	893177	68.75
▼						Queue Submit 0 (queue: 3) (thread: 2)	6511250	100	5177502	8.18	59.02	25.46	2915594	893177	68.75
▼						Command Buffer 0 (Instance: 21)	6511250	100	5177502	8.18	59.02	25.46	2915594	893177	68.75
						vkCmdPipelineBarrier 0									
						vkCmdPipelineBarrier 1									
						vkCmdPipelineBarrier 2									
						vkCmdPipelineBarrier 3									
▼						Render Pass 0	6488281	100	5144733	8.2	59.21	25.44	2912653	891170	68.97
>						Subpass 0	1754570	100	1376298	3.96	10.79	81.45	2160698	437621	3.65
>						Subpass 1	4725039	100	3768435	9.8	77.35	4.68	751955	453549	93.42
						vkCmdPipelineBarrier 4									
						Queue Present (queue: 3) (thread: 2)									
>						Frame 66	6508672	100	5177502	8.17	59.01	25.37	2909105	892311	68.76

## PROPERTIES

startFrame 50  
 endFrame 100  
 deviceSerialId 00000bb50e9f6153  
 deviceName Full Android on S5E994...

> Android Properties  
 > Capture Times  
 > Common  
 > GFXR  
 > Perfetto

Viewing: 11ms of 411ms



com.khronos.vulkan\_samples\_2

- Baselene
- Slices (1)
- Frames 50 - 100

System Performance Pipeline Resources

Find

Commands Showing 33 of 306

- Frame 64
- Frame 65
  - Queue Submit 0 (queue: 3) (thread: 2)
    - Command Buffer 0 (Instance: 21)
      - vkCmdPipelineBarrier 0
      - vkCmdPipelineBarrier 1
      - vkCmdPipelineBarrier 2
      - vkCmdPipelineBarrier 3
      - Render Pass 0
        - Subpass 0
          - RP subpass #0
            - Opaque objects
              - 'flagpole' mesh, primitive #0
                - vkCmdDrawIndexed 0
              - 'Material\_\_25' mesh, primitive #0
                - vkCmdDrawIndexed 0
              - 'Material\_\_298' mesh, primitive #0
                - vkCmdDrawIndexed 0
              - 'leaf' mesh, primitive #0
                - vkCmdDrawIndexed 0
              - 'Material\_\_57' mesh, primitive #0
                - vkCmdDrawIndexed 0
              - 'bricks' mesh, primitive #0
                - vkCmdDrawIndexed 0
              - 'ceiling' mesh, primitive #0
                - vkCmdDrawIndexed 0
              - 'column\_a' mesh, primitive #0
                - vkCmdDrawIndexed 0
              - 'arch' mesh, primitive #0
                - vkCmdDrawIndexed 0
              - 'column\_c' mesh, primitive #0
                - vkCmdDrawIndexed 0

... > Opaque objects > 'Material\_\_25' mesh, primitive #0 > vkCmdDrawIndexed 0

START VS FS END

Pipeline Start State < > Global > Graphics Pipelines > 6 > Vertex Input State > Attribute Descriptions

Find...

Command

- Command Info
- Command Arguments

Pipeline

- Graphics Pipeline Info
- Dynamic States
- Input Assembly
- Rasterization
- Color Blend

Global

- Instances
- Physical Devices
- Queues
- Devices
- Surfaces
- Swapchains
- Graphics Pipelines
- Pipeline Layouts
- Pipeline Caches
- Command Pools
- Command Buffers
- Command Buffer Insta...
- Render Passes
- Descriptor Pools
- Descriptor Sets
- Descriptor Set Layouts
- Framebuffers
- Samplers
- Images
- Image Views
- Buffers
- Semaphores
- Fences
- Debug Names

Location	Binding	Format	Offset
2	2	R32G32B32 SFLOAT	0
1	1	R32G32 SFLOAT	0
0	0	R32G32B32 SFLOAT	0

Viewing: 11ms of 411ms





File Edit View Help

Welcome com.khronos.vulkan\_samples\_2 - Frames 50 - 100 com.khronos.vulkan\_samples\_2 - frag Shader 454 x

com.khronos.vulkan\_samples\_2

- Baseline
- Slices (1)
- Frames 50 - 100

PROPERTIES

startFrame 50

endFrame 100

deviceSerialId 00000bb50e9f6153

deviceName Full Android on SSE994...

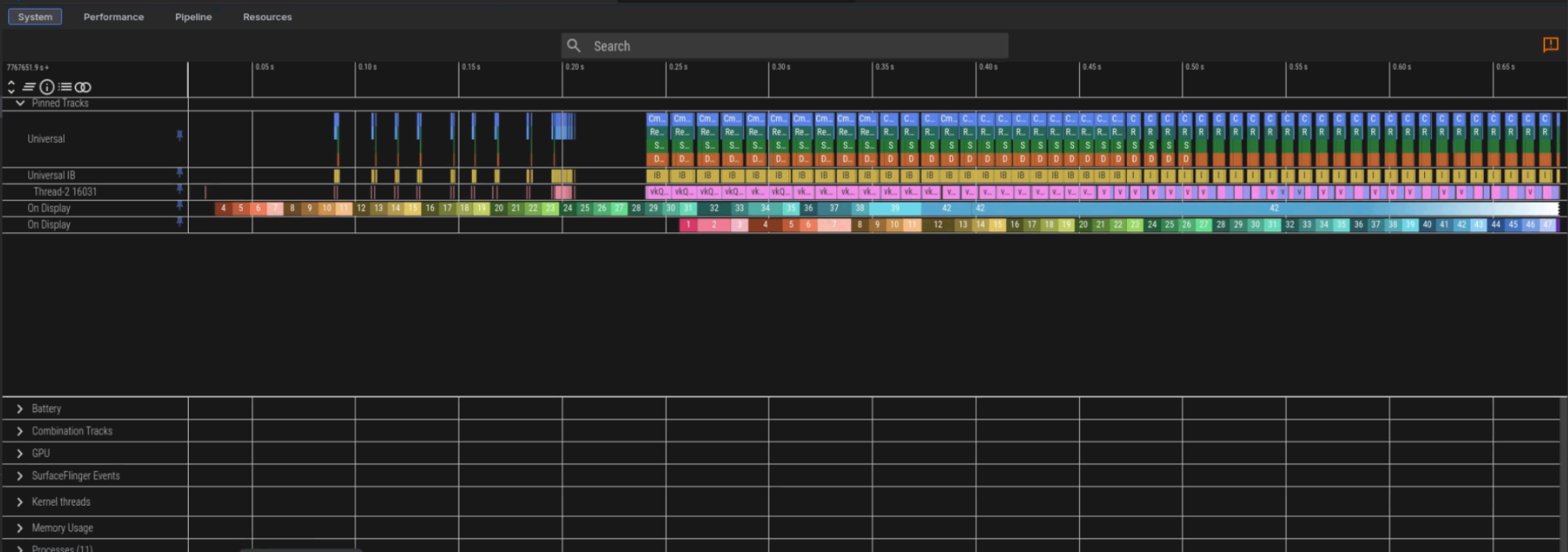
- Android Properties
- Capture Times
- Common
- GFXR
- Perfetto

Code - frag Baseline (GLSL) Version 1 x

```
1 // This file was generated from Sokatoo with the following command:
2 // spirv-cross '/home/c.steinberg/sokatoo/profiles/com.khronos.vulkan_samples_2/raw_shaders/sh454' --output '/home/c.steinberg/sokatoo/profiles/com.kh
3 //
4 // This is for debugging purposes only. It is not intended for reverse engineering or production use.
5
6 #version 460
7
8 layout(set = 0, binding = 0) uniform mediump sampler2D base_color_texture;
9
10 layout(location = 2) in vec3 in_normal;
11 layout(location = 1) out vec4 o_normal;
12 layout(location = 1) in vec2 in_uv;
13 layout(location = 0) out vec4 o_albedo;
14
15 void main()
16 {
17     vec3 normal = normalize(in_normal);
18     o_normal = vec4((normal * 0.5) + vec3(0.5), 1.0);
19     vec4 base_color = vec4(1.0, 0.0, 0.0, 1.0);
20     base_color = texture(base_color_texture, in_uv);
21     o_albedo = vec4(normal, 1.0);
22 }
23
24
```

com.khronos.vulkan\_samples\_2

- Baseline
- Slices (1)
  - Frames 50 - 100
  - Replay Slice - Frames 50 - 100



PROPERTIES

startFrame 50

endFrame 100

deviceSerialId 00000bb50e9f6153

deviceName Full Android on SSE994...

- Android Properties
- Capture Times
- Common
- GFXR
- Perfetto

Samsung GPU: Samsung Exynos 980

Frame 59 10ms

Frame 59 10ms

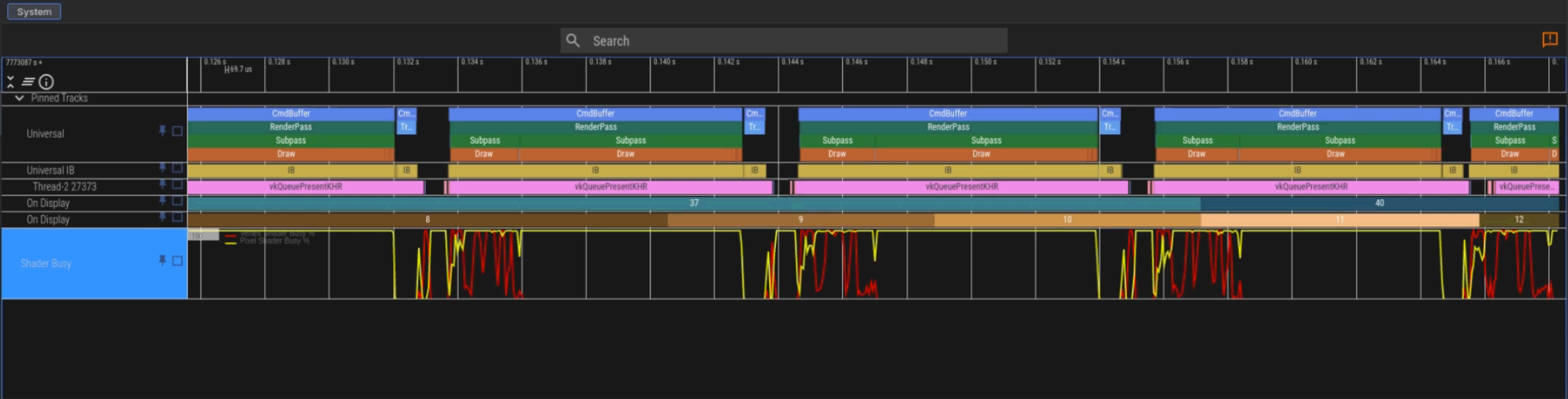




System

com.khronos.vulkan\_samples\_2

- Baseline
- Slices (1)
  - Frames 50 - 100
  - Replay Slice - Frames 50 - 100\_norms
  - Replay Slice - Frames 50 - 100\_diffuse

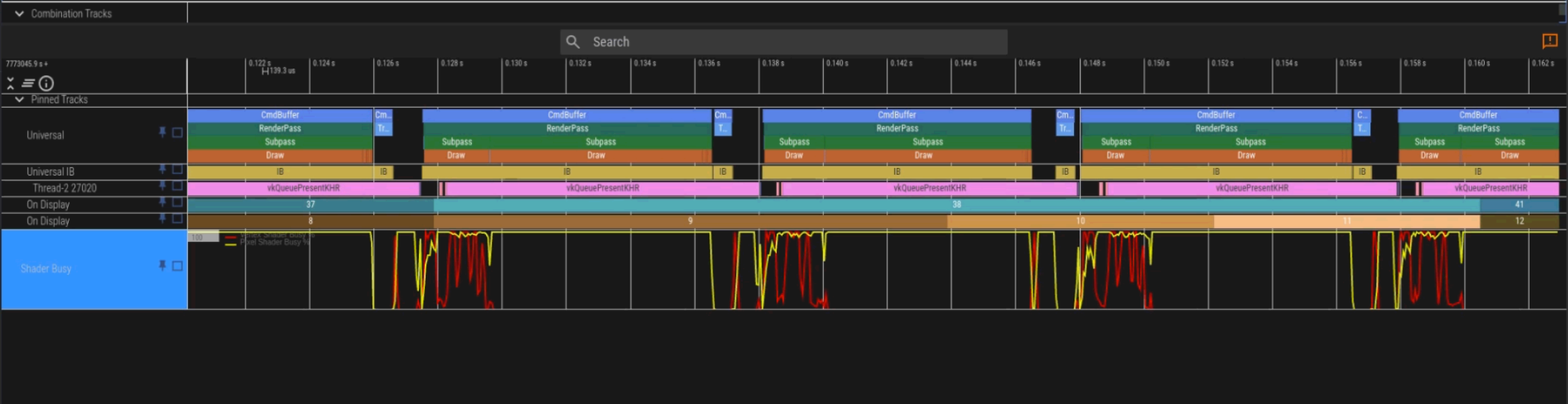


PROPERTIES

deviceSerialId 00000bb50e9f6153

deviceName Full Android on SSE994...

- Android Properties
- Capture Times
- Common
- Perfetto
- Replay



Combination Tracks

Viewing: 42ms of 552ms

Viewing: 42ms of 525ms



End of Slides