



# SwiftShader

Conformant CPU-based Vulkan 1.1 Implementation



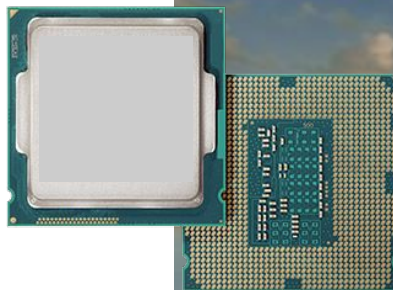
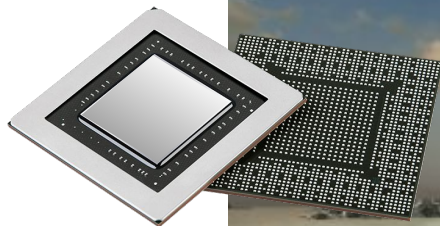
Nicolas Capens / X.Org Developer Conference - Montreal / October 2019

# Introduction

- Graphics driver for the GPU
- Accelerated by
  - Multi-core
  - SIMD vectors
  - Specialized instructions
- APIs
  - DirectX 8 & 9\*
  - OpenGL ES 2 & 3\*
  - Vulkan

**Vulkan**®

\* no official conformance claimed



# Google all-in on Vulkan

- Low overhead is key
- Vulkan mandatory for Android Q/10 except in extreme low-end
- Chrome has Vulkan support
  - WebGPU has Vulkan backend
    - 3x framerate, 2% CPU vs. WebGL
  - Skia has Vulkan backend
- Stadia = Vulkan on Linux
- Fuchsia Vulkan-only



# Project Pastel

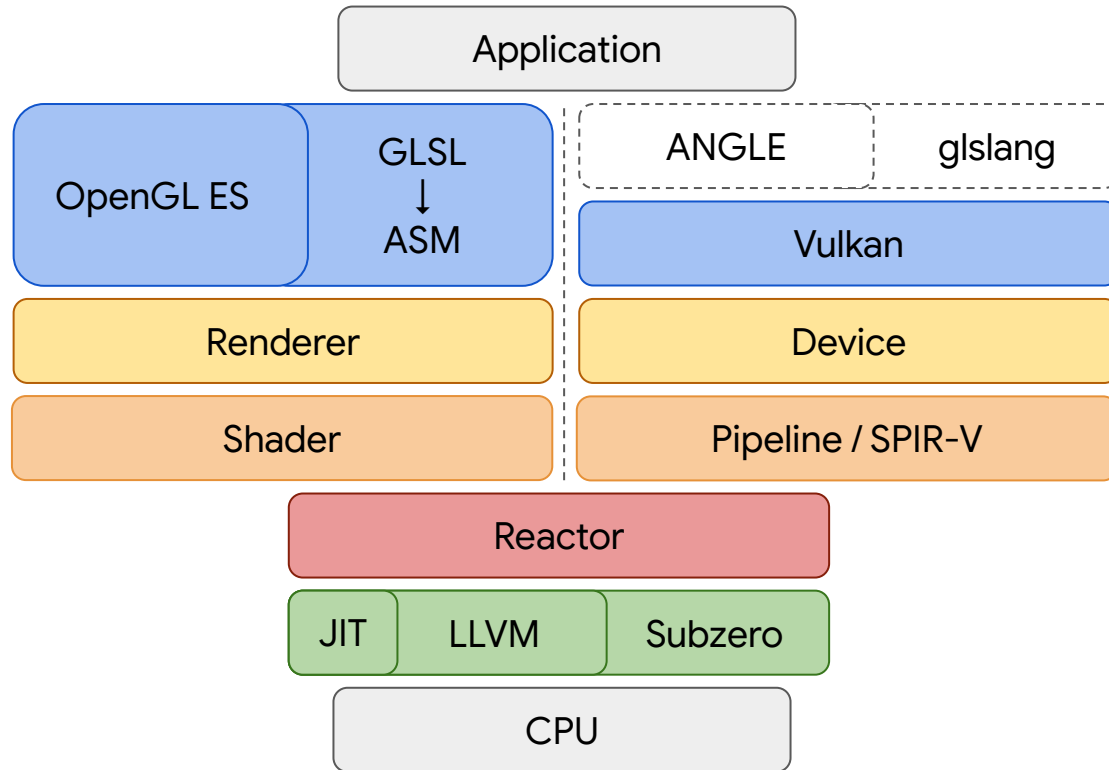
Android 10 Reference Rasterizer

Min-spec CPU-based Vulkan 1.1

Foundational for what's next



# SwiftShader's Transition to Vulkan-only



QUAKE

“ The fastest instruction is the one that is never executed. ”

—Michael Abrash



# Reactor

```
const char insts[] = ">>[-]<<[->>+<<";

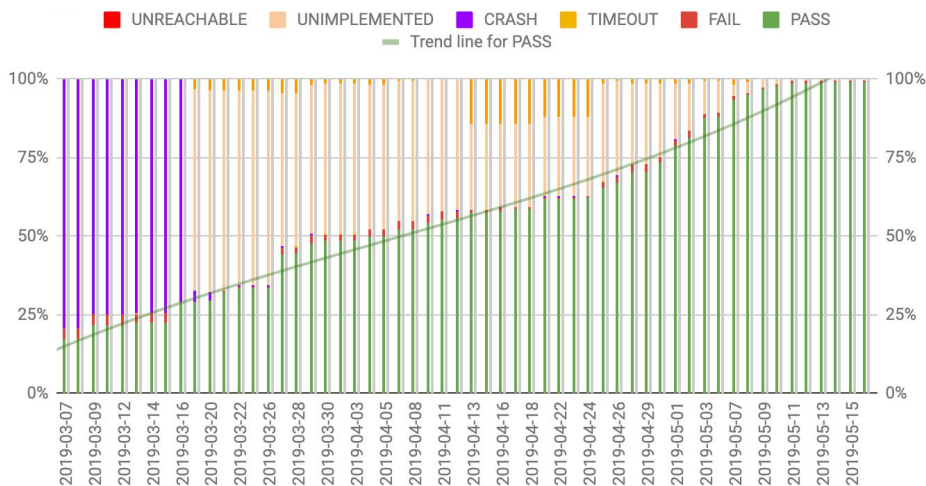
Function<Void(Pointer<Byte>)> brainfuck;
{
    Pointer<Byte> p = function.Arg<0>();
    std::vector<Loop> loops;

    for(char op : insts)
    {
        switch(op)
        {
            case '>': p++; break;
            case '<': p--; break;
            case '+': (*p)++; break;
            case '-': (*p)--; break;
            case '[': loops.emplace_back(); loops.back().test(*p != 0); break;
            case ']': loops.pop_back(); break;
        }
    }
}

char data[] = {1, 2, 3};
brainfuck(data);
```

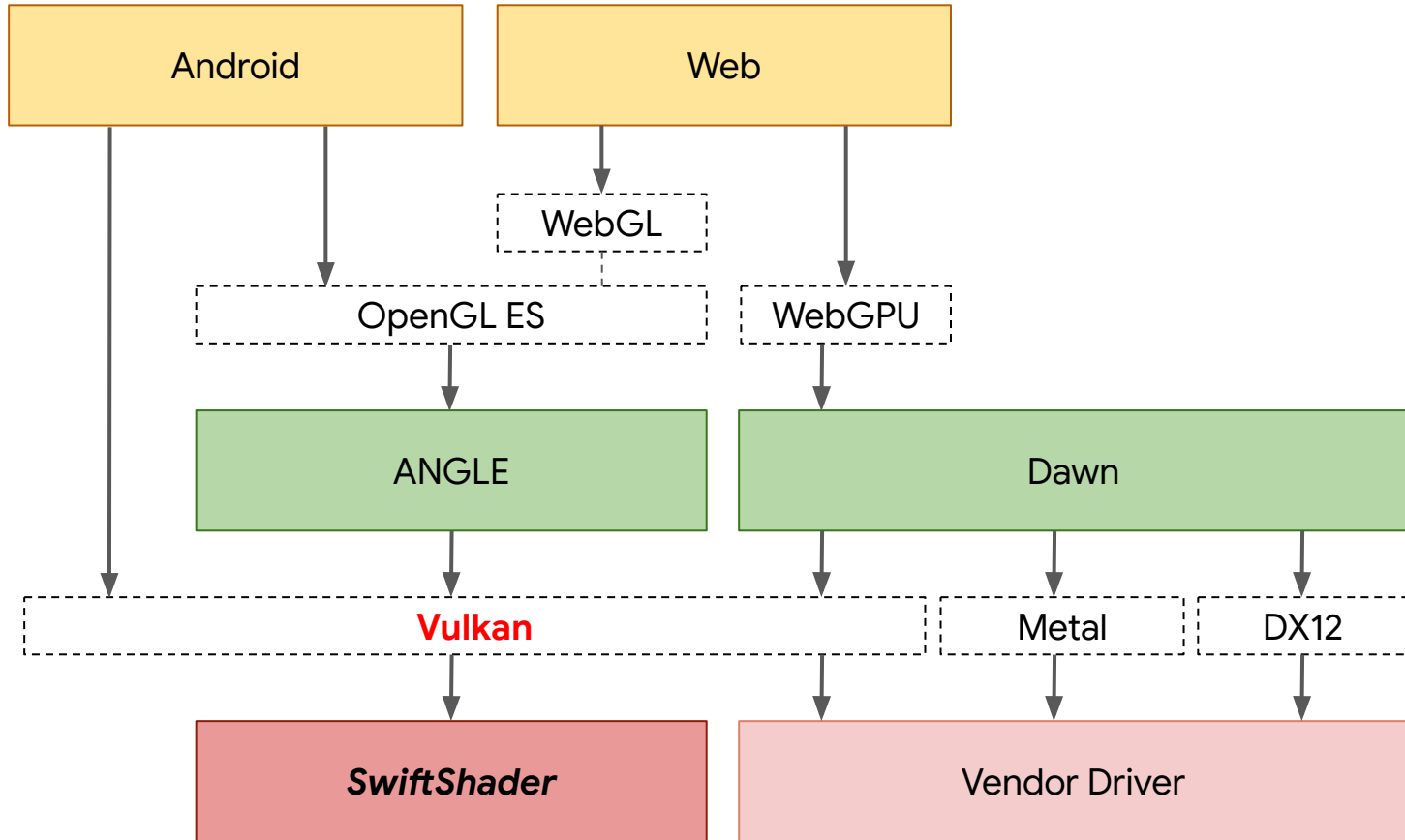
# SwiftShader Vulkan ICD

- Vulkan 1.1.3.3 conformant
- Android 10 CTS conformant  
VK\_\*\_android\_hardware\_buffer exception
- x86 and ARM, 32 bit and 64 bit
- WSI for desktop and mobile





# Making 3D Universally Accessible



# Testing at scale

dEQP test run in 15 minutes

Cloud ~1/10 cost without GPU

Cuttlefish: Cloud Android

LLVM bottleneck

Lightweight JIT → tiered JIT

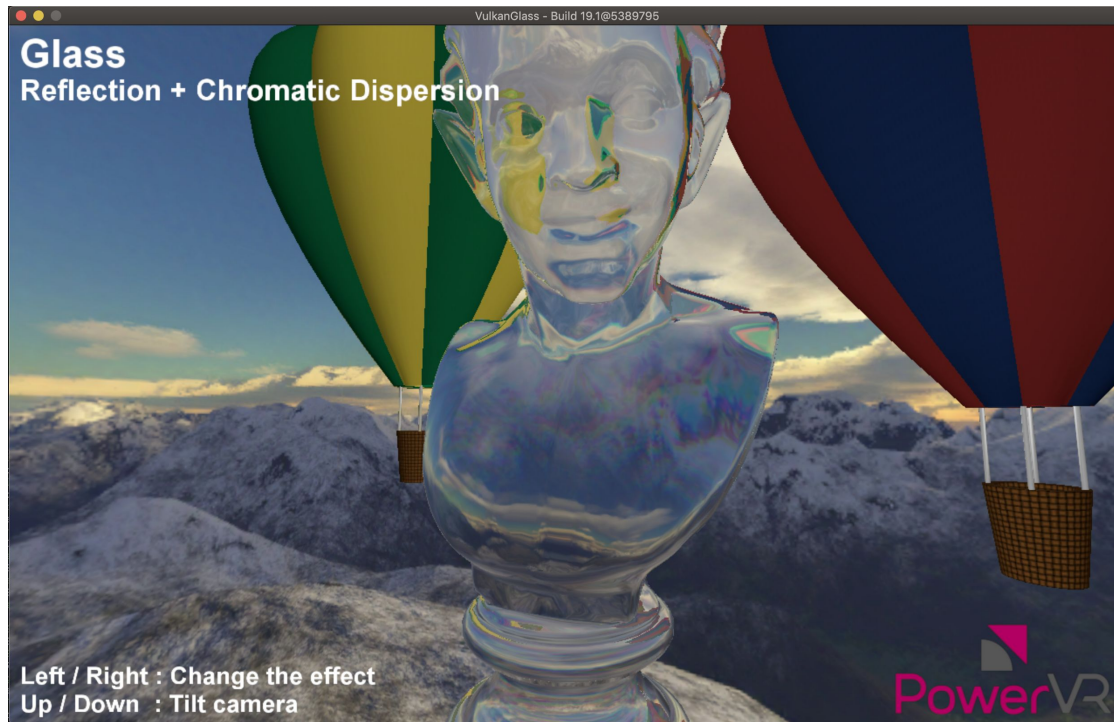


# Demo

PowerVR SDK 'Glass'

30+ FPS on Macbook

Despite no significant  
focus on performance yet!



# Conclusion

Conformant, consistent,  
Hardware-independent



Windows, Linux, macOS,  
Android, Fuchsia on x86,  
ARM, and more

[swiftshader.googleusercontent.com](https://swiftshader.googleusercontent.com)