SwiftShader
Conformant CPU-based Vulkan 1.1 Implementation

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

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

* 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
"The fastest instruction is the one that is never executed." —Michael Abrash
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++;
            case '<': p--;
            case '+': (*p)++;
            case '-': (*p)--;
            case '[': loops.emplace_back(); loops.back().test(*p != 0);
            case ']': loops.pop_back();
        }
    }
}

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

Android

Web

WebGL

OpenGL ES

ANGLE

Vulkan

SwiftShader

WebGPU

Dawn

WebGL

Metal

DX12

Vendor Driver
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.googlesource.com