Bringing Fire to the Volcano

AKA: Rendering Galaxy on Fire 3: Manticore with Vulkan on Mobile Devices

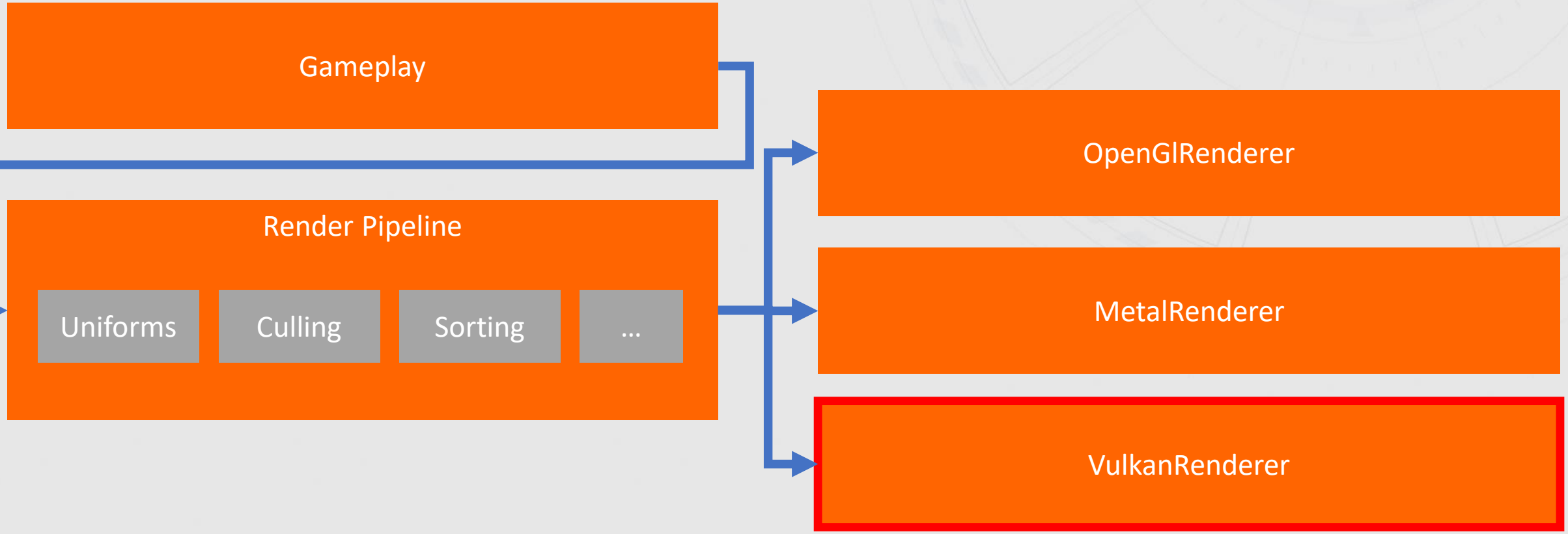
2017-05-25 / Vulkanised! / Deep Silver FISHLABS / Johannes Kuhlmann

Why are you here?

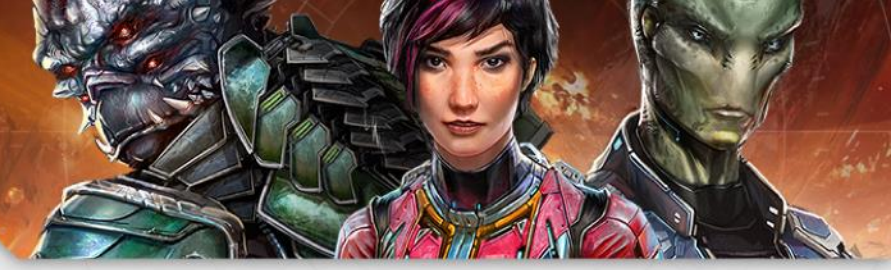

ACTUAL
INGAME
FOOTAGE


Road to Vulkan

Starting Point



DescriptorSet Bindings



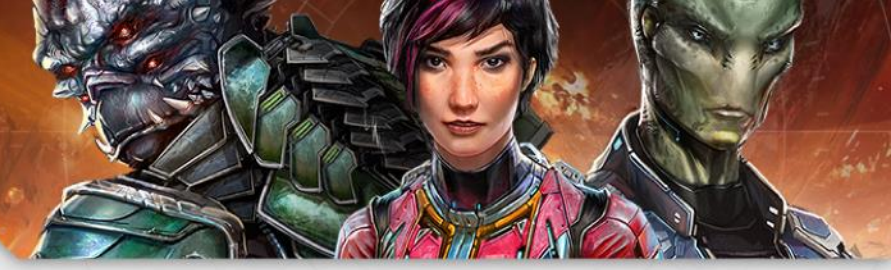
Uniforms

- 1 DescriptorSet per shader
- use `VK_DESCRIPTOR_TYPE_UNIFORM_BUFFER_DYNAMIC`
- 1 big buffer
  - for all objects
  - for all in-flight frames

Textures

- our API accepts arbitrary shaders/textures combination
- tried updating DescriptorSets
  - too slow
- so... cache‘em
  - {Shader, Textures}->DescriptorSet

Pipeline State Management



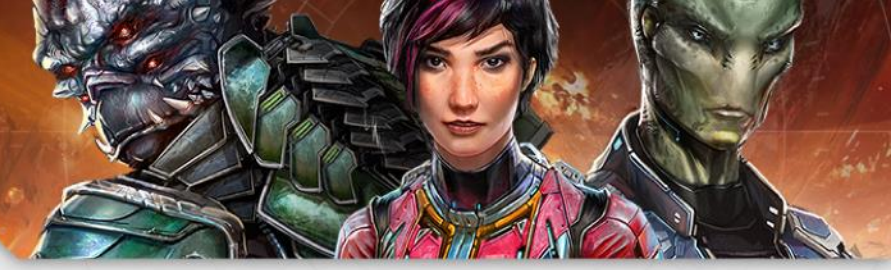
Pipeline State

- combines
  - vertex layout
  - shader
  - render target
  - raster/blend state
- have to be managed somehow
- take long to be compiled

Solution

- cache‘em
  - hash all inputs
  - if not compiled yet, compile async
- on load, pre-warm cache

Don‘t forget the Asset Pipeline



Precompile Shaders

- we use
  - Google‘s shaderc
  - GLSL -> SPIR-V
- can share GLSL code that way

Shader Reflection

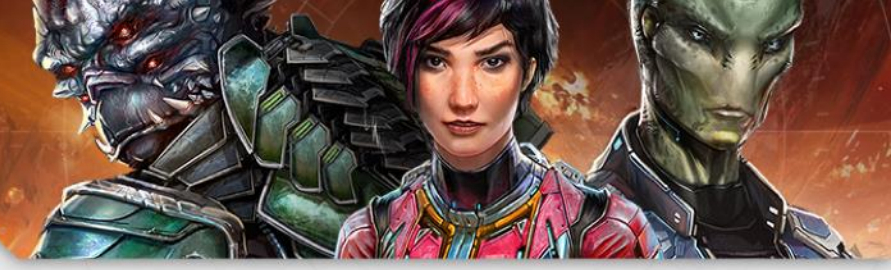
- bring your own
- SPIRV-Cross
- just assume?

What did we learn on the road?

You have to pay respect

- Maximum allocation count
- Texture compression formats
- Memory alignment requirements
- Framebuffer formats
- API version
- Composite alpha flags

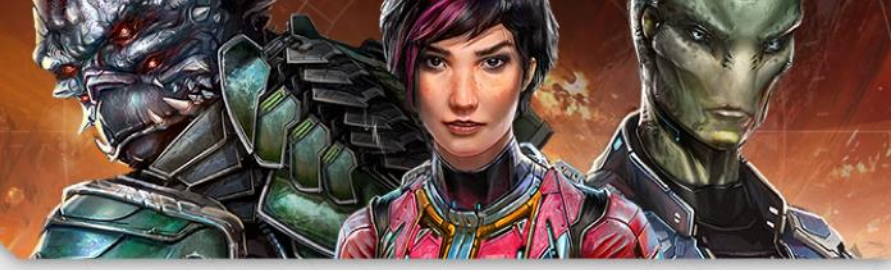
Validity doesn‘t imply correctness



- Super useful, use them!
- Device specific
- Load validation layers in order
- May go missing due to Play Libs
- Validation layers WIP

SAMSUNG
82

It‘s easy to lose your device



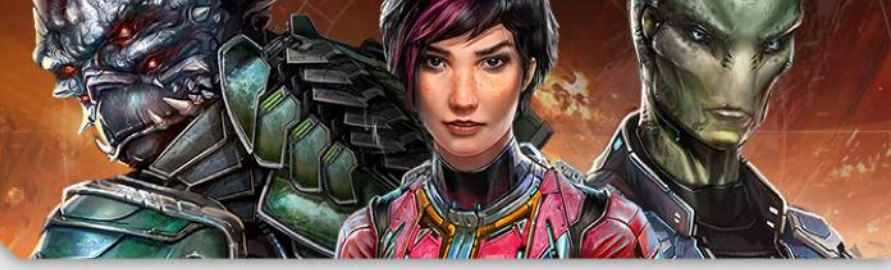
`VK_ERROR_DEVICE_LOST`

Super difficult to debug

Causes include, but not limited to

- garbage uniforms
- unbound textures
- synchronization issues

Drivers have issues, too



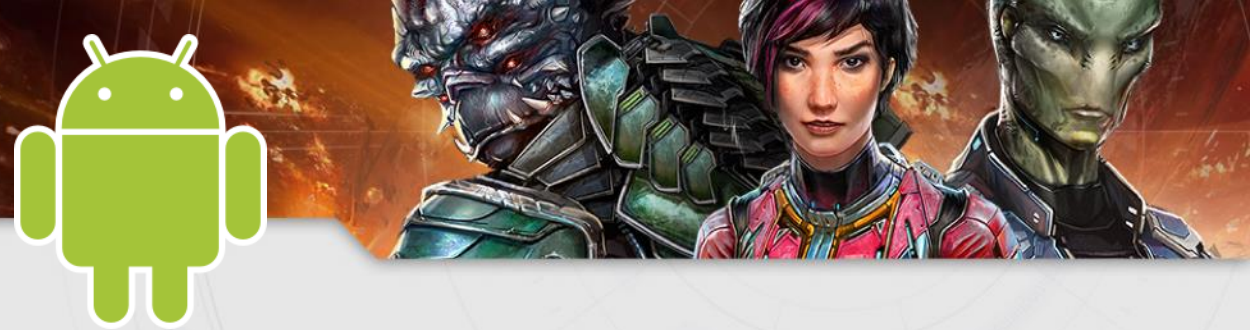
E.g. Adreno

- DescriptorSet binding order
- dynamic pipeline state

Devices behave differently

- can/cannot map buffer twice
- render sub pass dependencies
- texture depth == 0

Vulkan can run on Android 6



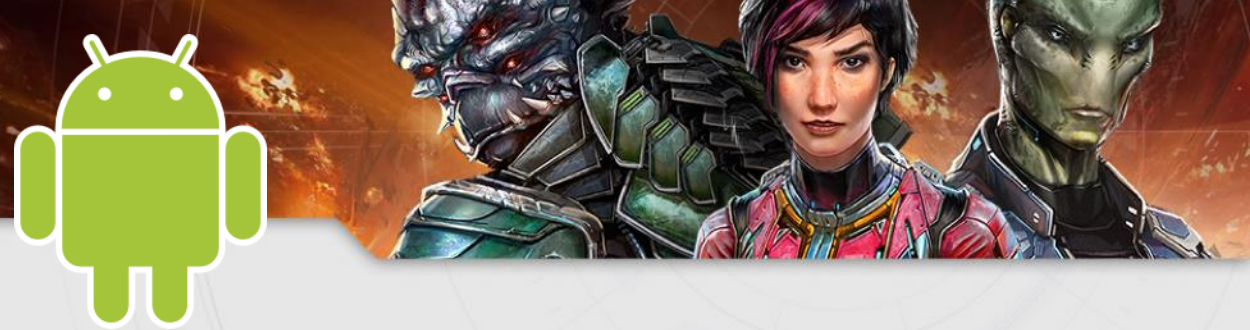
Cannot depend on libvulkan.so

- load dynamically
- may use Vulkan wrapper

But 6 != 6

- API version can be 0.0.1
- can get `VK_ERROR_INCOMPATIBLE_DRIVER`

Life Cycles



You have to handle it (duh)

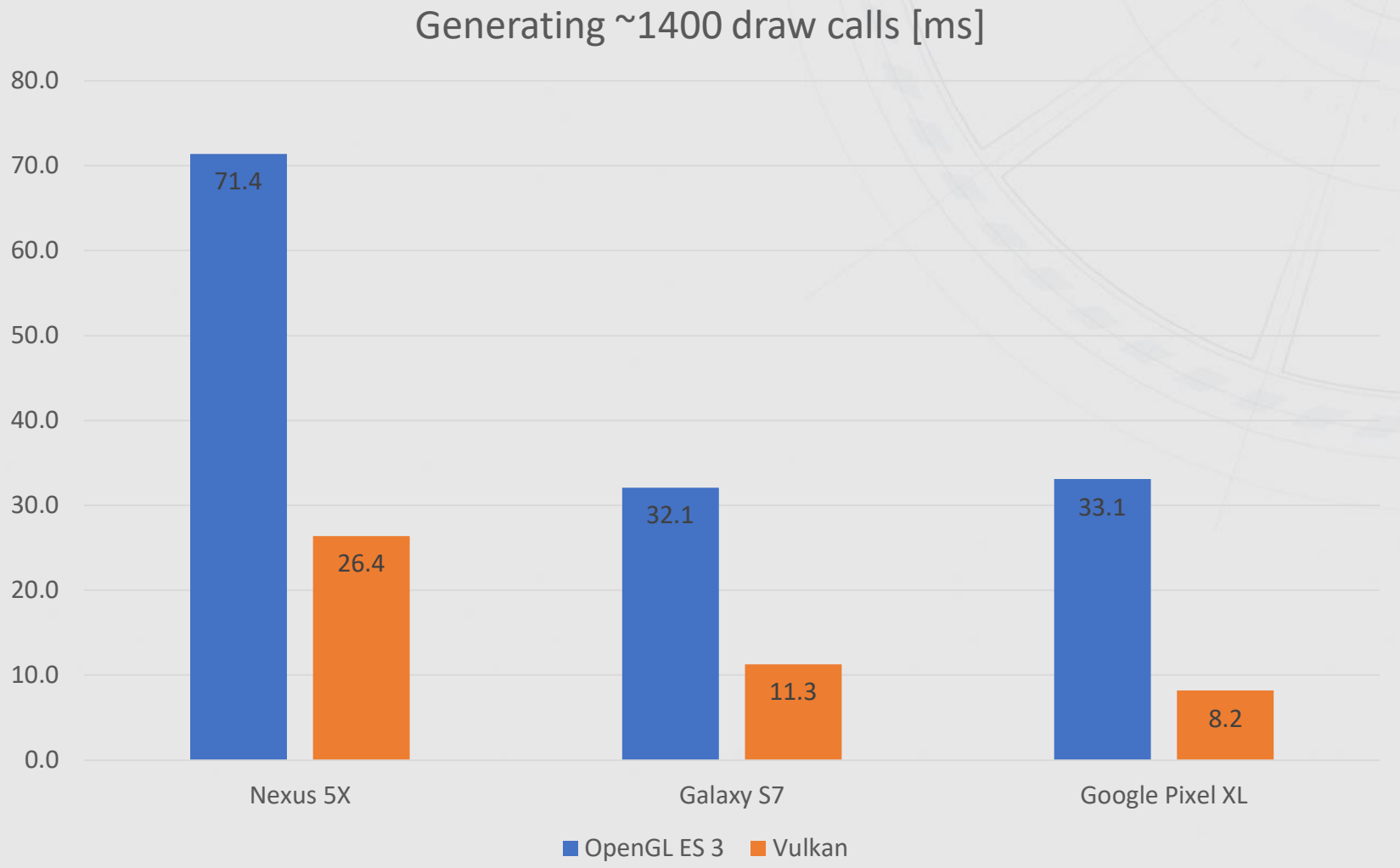
Surface is destroyed and re-created

Must re-create swapchain and its framebuffers

Some Numbers

Lines of Code

Timing Drawcalls



Summary

If slow, cache it!

Vulkan does indeed improve performance

Expect work from fixing for different drivers/devices

Thank you!

Questions?

j.kuhlmann@dsfishlabs.com / @j66k

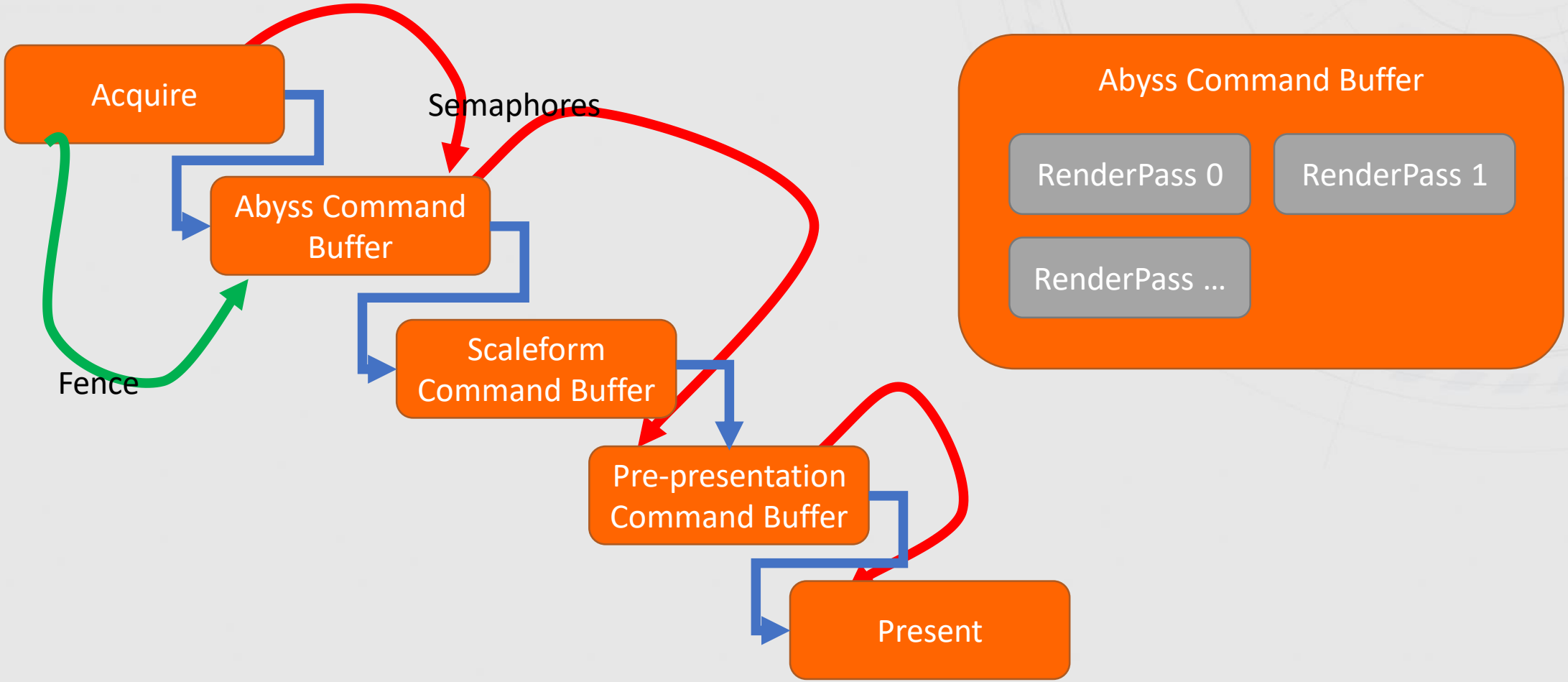
Laundry List

Bonus

```
class Renderer { public:
// -- Lifecycle handling --
    virtual void initialize() = 0;
    virtual void createContext(RenderContextState&, RenderTargetDescriptor const&, bool debug) = 0;
    virtual void destroyContext() = 0;

// -- Per-frame rendering --
    virtual ParameterBuffer* getParameterBuffer() = 0;
    virtual void execute(const RenderQueue&) = 0;

// -- Render pipeline states --
    virtual HardwareResourceHandle getPipeline(Mesh const&, RenderState const&, Shader const&, RenderTarget
const*, bool sync);
    virtual std::size_t removeUnusedPipelines(std::size_t minUnusedFrames);

// -- Resources --
    virtual Texture* newTexture(const TextureDescriptor&, task::Task* parentTask = 0) = 0;
    virtual void destroyTexture(Texture*) = 0;
    virtual Mesh* newMesh(const MeshDescriptor&, task::Task* parentTask = 0) = 0;
    virtual void destroyMesh(Mesh* mesh) = 0;
    virtual Shader* newShader(const ShaderDescriptor&, task::Task* parentTask = 0) = 0;
    virtual void destroyShader(Shader*) = 0;
    virtual RenderState* newRenderState(const RenderStateDescriptor&) = 0;
    virtual void destroyRenderState(RenderState*) = 0;

// -- Dynamic meshes --
    virtual MappedBufferHandle* mapDynamicMeshIndexBuffer(Mesh&, RenderBuffer& frameContext) = 0;
    virtual void unmapDynamicMeshIndexBuffer(MappedBufferHandle*, std::size_t indexCount) = 0;
    virtual MappedBufferHandle* mapDynamicMeshVertexBuffer(Mesh&, std::size_t vertexBufferIndex, RenderBuffer&
frameContext) = 0;
    virtual void unmapDynamicMeshVertexBuffer(MappedBufferHandle*, std::size_t vertexCount, Aabb const&) = 0;

// -- Render targets --
    virtual void createRenderTarget(RenderTarget*) = 0;
    virtual void destroyRenderTarget(RenderTarget*) = 0;
    virtual void resizeRenderTarget(RenderTarget*) = 0;
    virtual void copyRenderTargetToMemory(RenderTarget*) = 0;
};
```

Synchronization

Bonus



Implementation: Dynamic Meshes

- Buffer size *= maxInFlightFrames
- Cycle through ranges of buffer per frame
- “stream” mode, must write every frame
- Note: cannot map buffer twice; so write indices/vertices after each other

Debugging Tips

- Of course, validation layers
- Tools: Renderdoc
- vkDeviceWaitIdle()
- Check result after each function, print error