Vulkan 101

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What is Vulkan?

- **A 3D graphics API for the next 20 years**
  - Logical successor to OpenGL / OpenGL ES
  - Modern, efficient design
  - An open, industry-controlled standard

- **Here, now**
  - Released in February 2016
  - Available today for Windows / Linux
  - Shipping in Samsung Galaxy S7
  - Support announced in Android ‘N’

- **Different!**
  - Fundamental change in philosophy
  - Requires corresponding changes in applications

Why did we do this?

- Traditional APIs had issues…
- Developers weren't happy

http://www.joshbarczak.com/blog/?p=154

http://richg42.blogspot.com/2014/05/things-that-drive-me-nuts-about-opengl.html

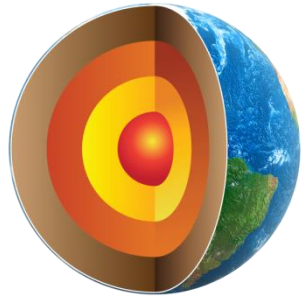
Problems with OpenGL / OpenGL ES

- **Programming model doesn't match GPU HW**
  - Especially in mobile
  - Driver magic hides the mismatch
- **CPU intensive**
  - Lots of state validation, dependency tracking
- **Complex, buggy, unpredictable drivers**
  - Different bugs and fast-paths on every GPU
- **Fundamentally single-threaded**
  - Can't use multi-core CPUs effectively
- **…not to mention twenty years of legacy cruft**

Enter Vulkan…

- **Design discussions start in October 2012**

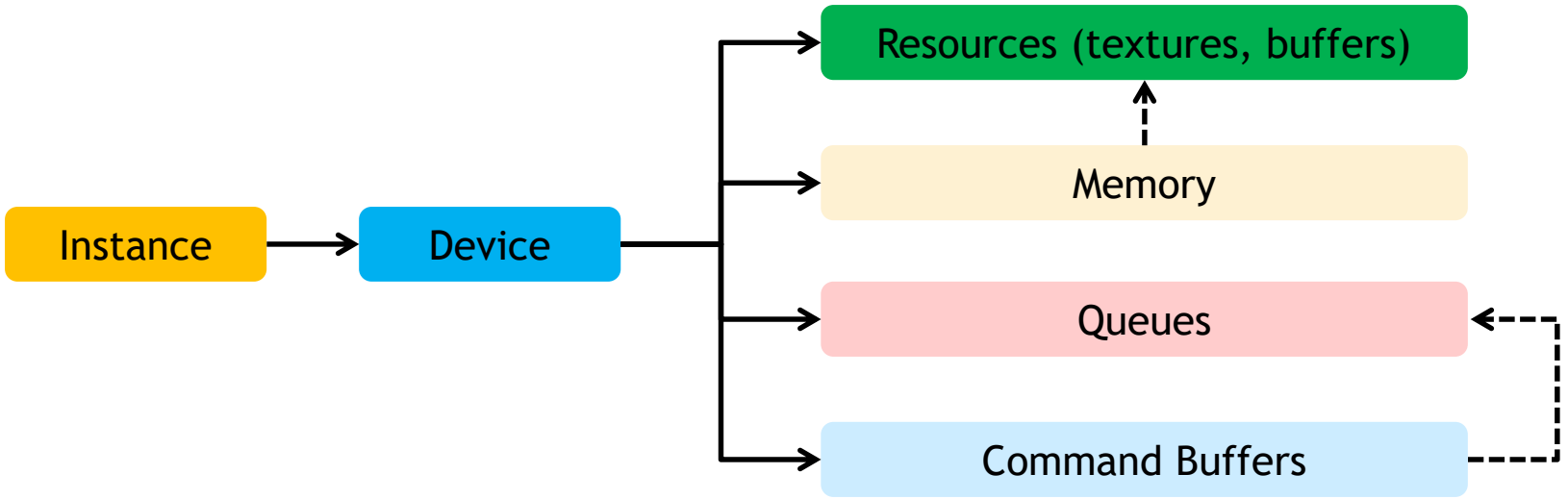
- **Moves into high gear in July/August 2014**
  - Commitment from key ISVs
  - AMD donation of Mantle



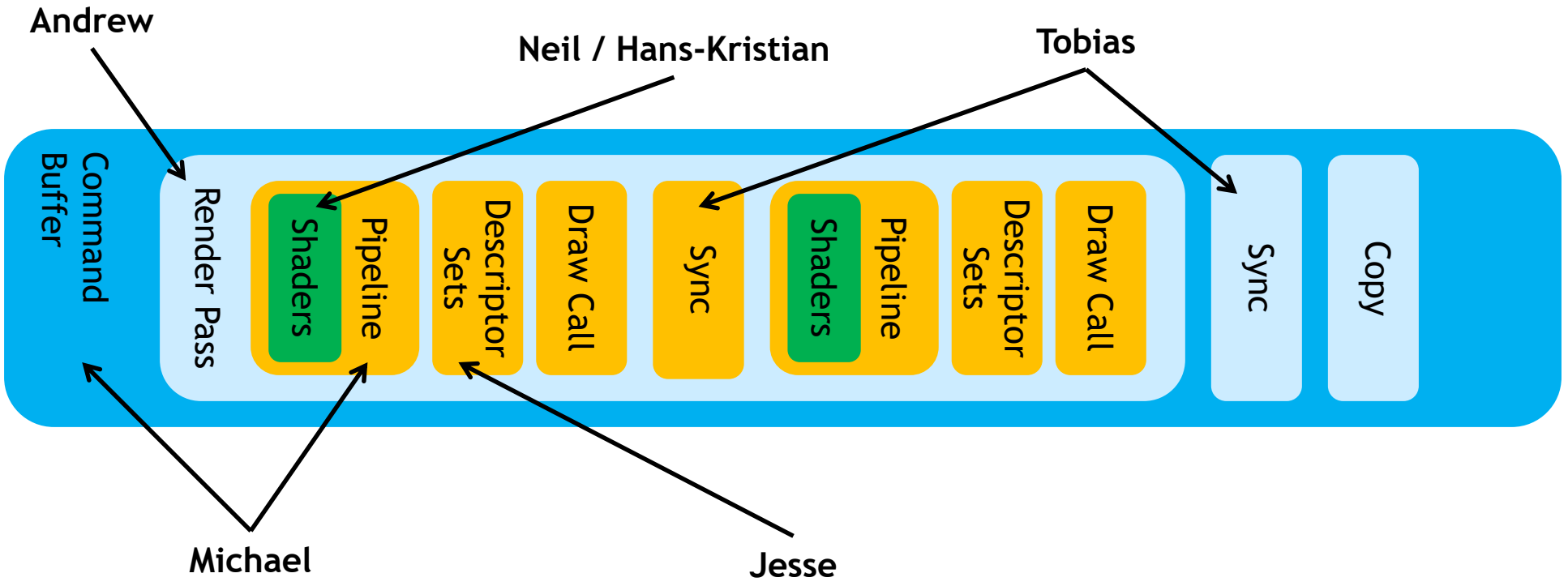
- **A lot of very hard work follows…**

- **Release to public in February 2016**
  - Conformant drivers from four IHVs
  - GLSL to SPIR-V compiler
  - Debug and validation tools

Vulkan in one slide



Vulkan in ~~one slide~~ two slides



The principle of *Explicit Control*

- **You promise to tell the driver**
  - *What* you are going to do
  - *In sufficient detail* that it doesn't have to guess
  - *When* the driver needs to know it

OpenGL lets you specify important information very late, and change it at any time. It's convenient, but has huge performance costs.

- **In return, driver promises to do**
  - *What* you asked for
  - *When* you asked for it
  - *Very quickly*

OpenGL drivers often defer work until later, move it to another thread, or even ignore your commands, based on guesses about your intent. Vulkan drivers won't.

- ***No driver magic!***

Loader, layers, and extensions

- **Vulkan has no dependencies on external APIs**
  - ICD loader is built-in
  - Window system binding is (semi) built-in

- **A side benefit: Layers**
  - Loader can install intercept libraries (“layers”)
  - E.g. trace, debug

- **Extensions**
  - Must be enabled at initialization time

Multithreading

- **All objects visible / accessible to all threads**

- **Most operations are *externally synchronized***
  - Application must prevent unsafe concurrent access
    - E.g., recording to the same command buffer
    - E.g., submitting to the same queue
  - Application must manage object lifetimes
  - Note, many objects are immutable
  - Concurrent read access is OK

- **Allocation / creation *are* internally synchronized and may block**
  - Per-thread pool allocators keep this reasonably cheap

Error handling

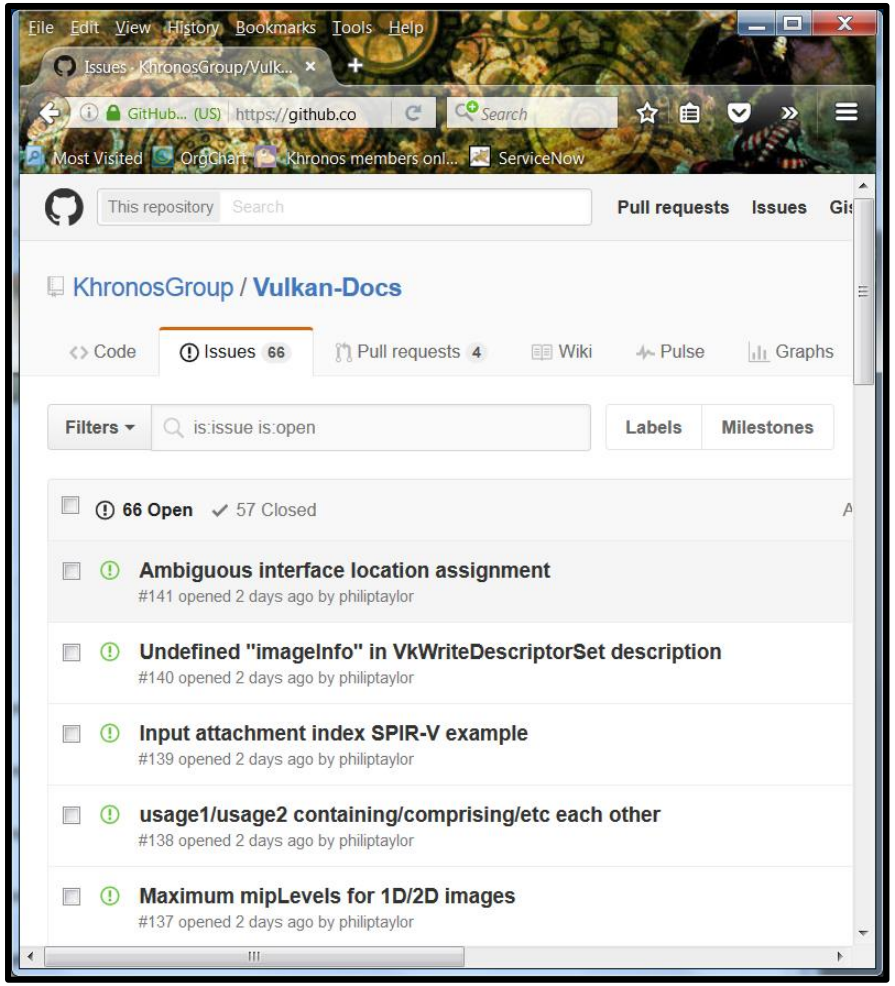
- **Vulkan is optimized for correct applications**
  - Does not (generally) check for invalid usage
  - Does not track dependencies
  - Does not (generally) provide thread safety
  - Breaking the rules results in undefined behavior

- **Vulkan *does* check for errors you can't predict**
  - Out of memory
  - Device lost
  - Other system errors…

- **Layers to the rescue!**
  - Can enable *validation layers* during development

Community

- **A new attitude**
  - ISV member input drove key decisions
  - Consulted with hundreds of developers
- **Strong commitment to open source**
  - Loader
  - Validation and other layers
  - SPIR-V tools: compiler, validator, …
  - Conformance tests
  - Specification
- **All at https://github.com/KhronosGroup**



Should you be using Vulkan?

- **Challenges**
  - Verbose and complex
  - Lots of exposed sharp edges
  - Lots to learn

- **Opportunities**
  - Much lower driver overhead
  - …which you can spread across multiple threads
  - More predictable performance
  - Mobile friendly

- **Realities**
  - Ecosystem is still immature
  - Will need to ship GL/DX versions for years to come

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