

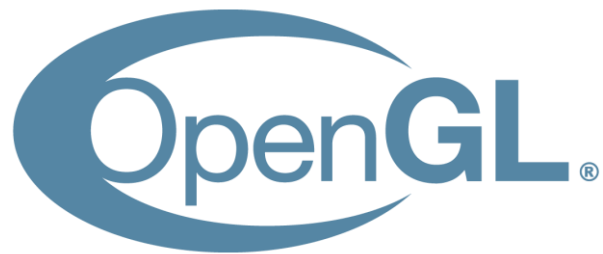


3D Graphics with Vulkan and OpenGL

The Khronos Group
August 15, 2018

Schedule

| | |
|------|---|
| 2:00 | Vulkan and OpenGL Updates <ul style="list-style-type: none">• Tom Olson (Arm), Neil Trevett and Piers Daniell (NVIDIA) |
| 2:40 | Vulkan Shader Compiler Updates <ul style="list-style-type: none">• Lei Zhang and Ehsan Nasiri (Google) |
| 3:10 | Running OpenCL C Kernels on Vulkan for Fun and Profit <ul style="list-style-type: none">• Eric Berdahl (Adobe) |
| 3:40 | Vulkan: Mark My DWORDS <ul style="list-style-type: none">• Hai Nguyen (Google) |
| 4:10 | State of the Art Engines in Vulkan <ul style="list-style-type: none">• Dan Baker (Oxide Games) |
| 4:45 | Porting Unity to Vulkan <ul style="list-style-type: none">• Mikko Strandborg (Unity) |
| 5:30 | Khronos Networking Reception |



Vulkan and OpenGL Updates

The Khronos Group
August 15, 2018

Vulkan and OpenGL ES Updates

Vulkan Today and Tomorrow

- Tom Olson (Arm), Vulkan WG chair

Vulkan Portability Initiative

- Neil Trevett (NVIDIA) Khronos President and VPI TSG chair

OpenGL and OpenGL ES Update

- Piers Daniell (NVIDIA), OpenGL / OpenGL ES WG chair



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Vulkan Today

**Tom Olson, Arm
Vulkan WG Chair
August 15, 2018**

Vulkan Today: Availability

Support from the major GPU vendors
Now standard in desktop driver drops

Hardware and Drivers

AMD  arm ANV

 BROADCOM®

 Imagination

 intel

 NVIDIA®

 QUALCOMM®

RADV

 VeriSilicon

Platforms



Supported on the major open OSes
Hundreds of millions of Android devices



Game Engines

Vulkan rendering paths in most of the leading engines



CRYENGINE



Croteam
Serious Engine



Content is shipping on desktop



Vulkan-only AAA
Titles on PC



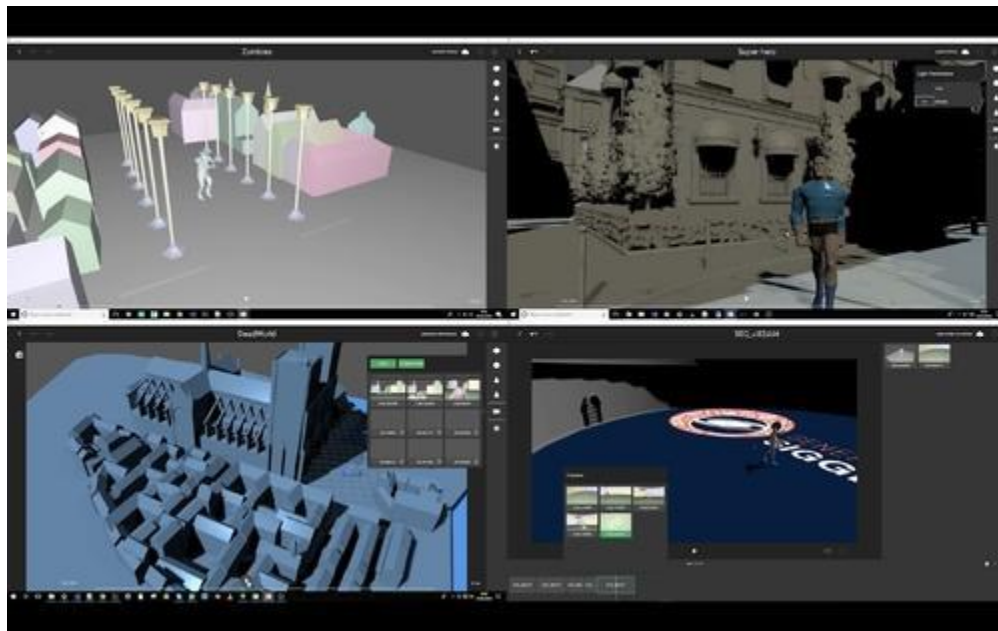
Dota 2 on PC
and macOS



AAA titles on Linux



It's not just about games...



“PocketStudio is designed to allow filmmakers to easily create, play, and stream 3D animation sequences in real time using real-time collaborative editing, a unified workflow, and other real-time technologies, such as augmented reality”

<https://s2018.siggraph.org/conference/conference-overview/real-time-live/>

**PocketStudio with Vulkan support
Featured at Realtime Live! - SIGGRAPH 2018**

Content is shipping on Mobile too!



Plus....
Lineage 2 Revolution
Heroes of Incredible Tales
Dream League Soccer...



CODEMASTERS®



netmarble
Games



Breaking News: Fortnite on Vulkan on Android

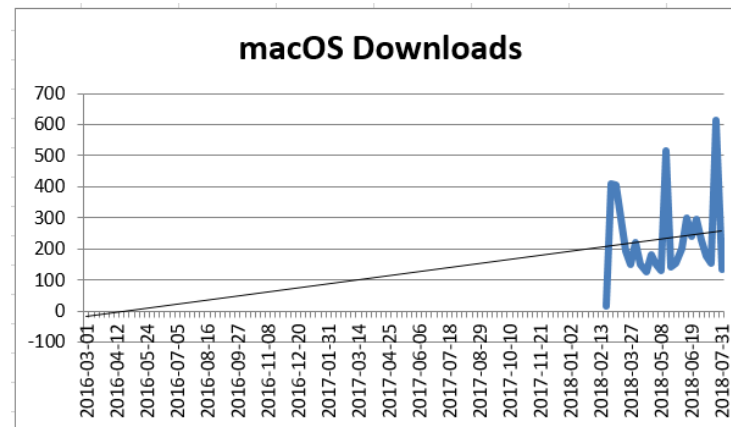
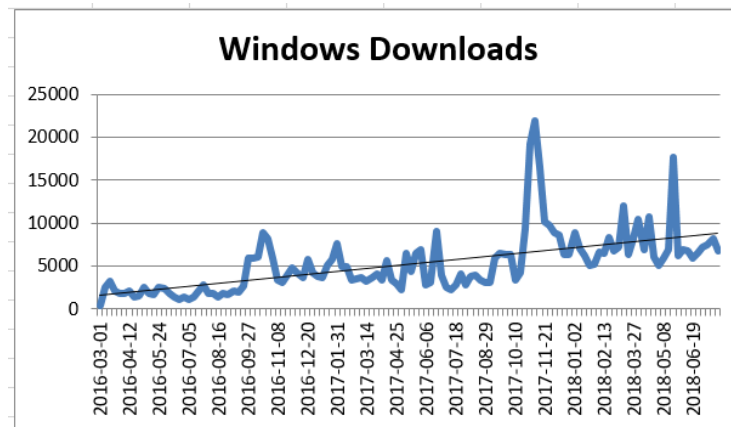
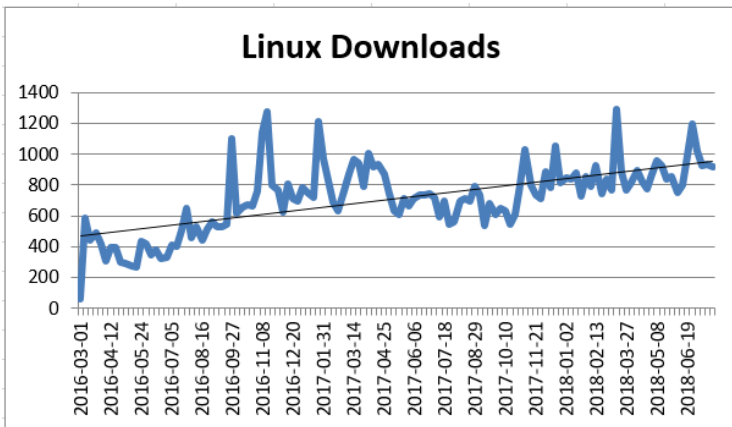


FORTNITE

Vulkan[®]

Fortnite on Android uses Vulkan on select phones for optimal performance, including the best-performing Samsung - the Galaxy Note9

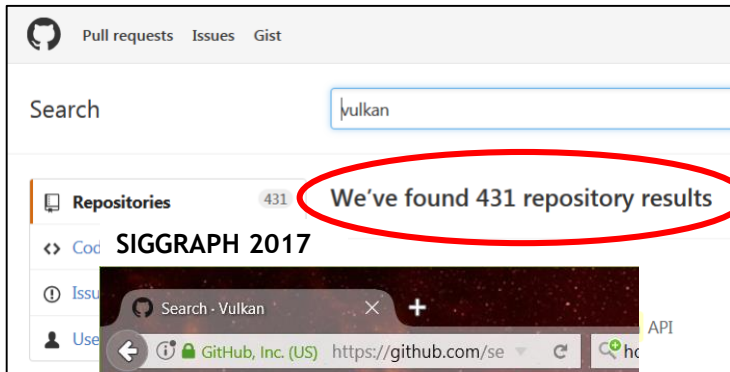
Developer Activity - SDK



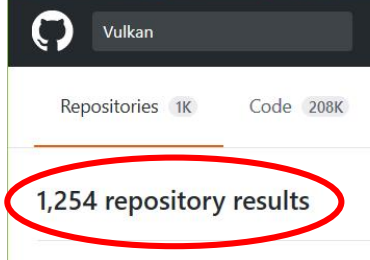
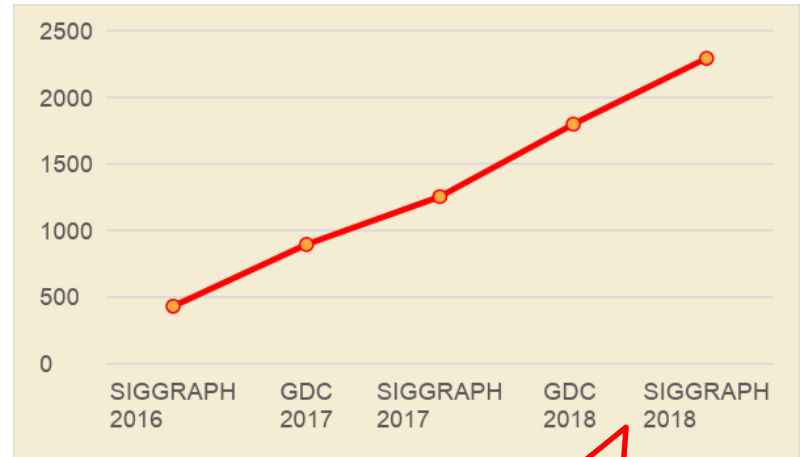
LunarG Vulkan SDK
Download rate increases every year since launch
<http://vulkan.lunarg.com>

Developer Activity - GitHub Projects

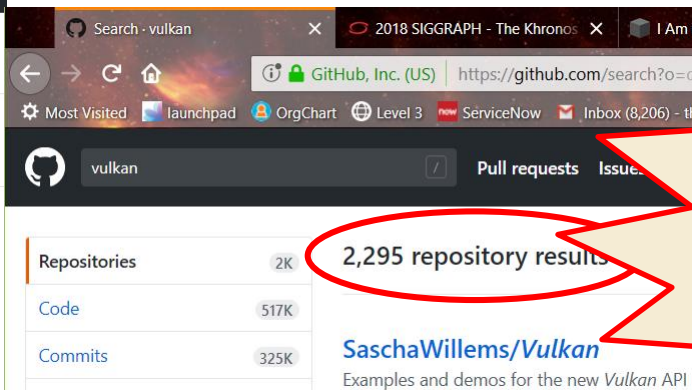
SIGGRAPH 2016



Trend over time



SIGGRAPH 2018



GitHub adds 2.5 Vulkan-related projects per day!



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Vulkan
Tomorrow

Vulkan Roadmap Philosophy

What do Vulkan developers need to be successful?

It's not just about the specification...

- API and shading language functionality
- Ease of use, tools, support
- Implementation quality / reliability
- Availability on target hardware and platforms
- ...

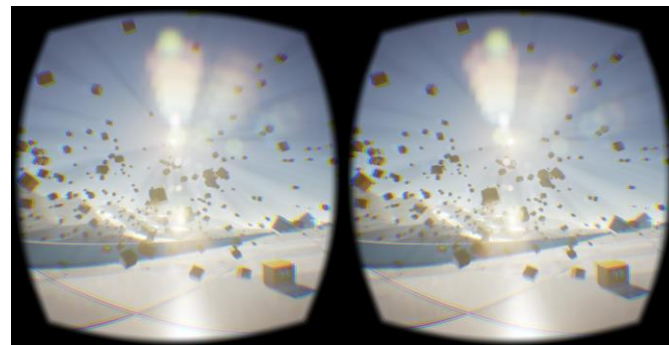
Everything we do is driven by developer and ecosystem priorities

Challenge: Functionality

Vulkan 1.1 is here!

Multiview (KHR_Multiview)

- Render to multiple image views simultaneously



Multi-GPU support (KHR_device_group*)

- Transparent access to homogeneous multi-gpu systems

Advanced Compute Functionality (KHR_16bit_storage, KHR_variable_pointers, ...)

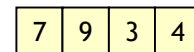
- Read and write 16-bit quantities stored in GPU memory; restricted pointers
- Subgroup operations

Better HLSL support (KHR_relaxed_block_layout)

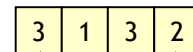
- Match HLSL memory data layout constraints

Cross-process/API sharing (KHR_external_*)

- Share memory & sync primitives across API / process boundaries



Shuffle



Add

Functionality: New KHR extensions

KHR_draw_indirect_count

- Source draw count parameter from a buffer in GPU-writable memory
- Greater flexibility for GPU-generated work

KHR_8bit_storage

- Allow 8-bit types in uniform and storage buffers
- Improved compute support (clspv etc)

EXT_descriptor_indexing

- Dynamically non-uniform (aka bindless) resource access
- KHR version in progress

Under Discussion

Reduced precision arithmetic types

Detailed driver property queries

Variable-resolution rendering

Device-independent performance counter queries

Memory residency management

Depth / Stencil resolve

New synchronization primitives

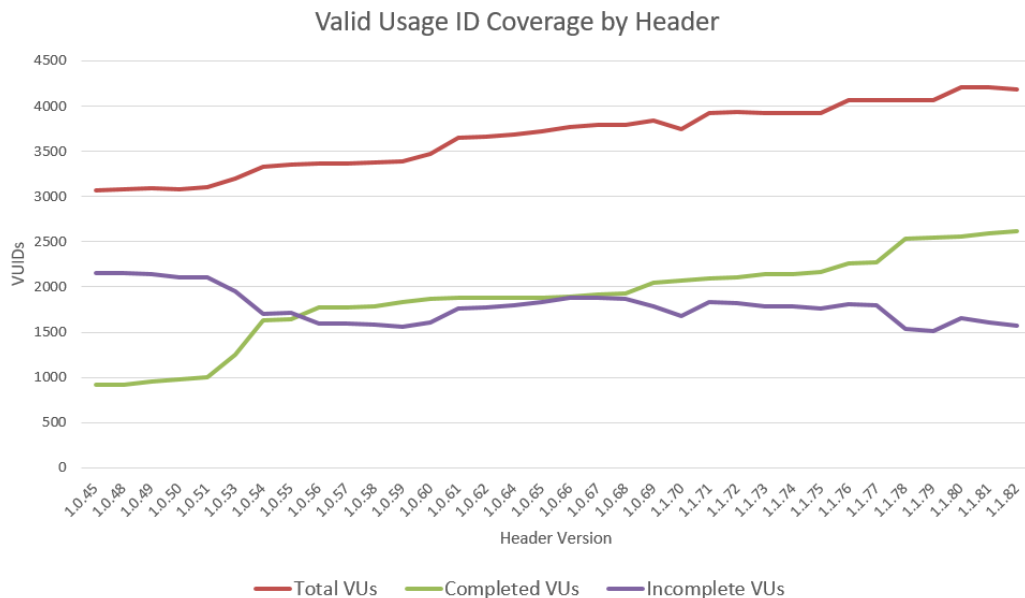
Ray tracing

Video

... the list goes on

Everything we do is driven by developer and ecosystem priorities

Challenge: Tools - Validation



Changes in our validation workflow

- Working Group has begun handling basic validation for new KHR extensions
- Frees up LunarG to tackle more challenging validation cases

Validation: Coming Soon

GPU Assisted Validation

- Runtime resource access checking
 - EXT_descriptor_indexing (bindless) resource references
 - Array index and buffer offset validation

Synchronization Validation

- Validate synchronization valid usages as defined by specification

Challenge: Implementation Quality

Vulkan CTS investments

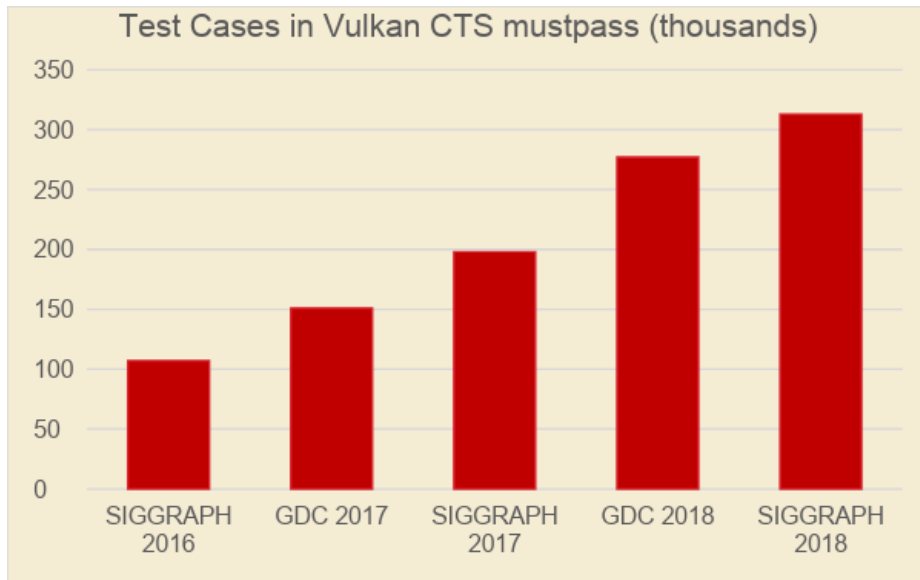
- Khronos's largest engineering project
- Adding 100K test cases / year

Raising the bar

- Old tests are now withdrawn on a rolling basis

You can help!

- Raise issues and PRs at <https://github.com/KhronosGroup/VK-GL-CTS>



Challenge: Availability on closed platforms

- Vulkan Portability Initiative
 - Enable running a subset of Vulkan over another API via shim library
- MoltenVK shim available for macOS / iOS
 - Open source library: <https://github.com/KhronosGroup/MoltenVK>
- gfx-rs shim in development for multiple backends: inc. Metal and DX12
 - <https://github.com/gfx-rs/portability>
- macOS SDK
 - <https://vulkan.lunarg.com/>
- Give us feedback
 - <https://khr.io/vulkanpifeedback>
- Caveat Coder - WIP
 - Conformance test program in development



Challenge: Issues we don't know about

This is where you come in...

- What (if anything) makes it hard for you to use Vulkan successfully?
- What are the most important problems for us to focus on?

We'll take feedback anywhere, any time

- General issues: <https://github.com/KhronosGroup/Vulkan-Ecosystem>
- Spec issues: <https://github.com/KhronosGroup/Vulkan-Docs>
- SDK issues: LunarXchange (<http://vulkan.lunarg.com>)
- Here, on the street, slack, reddit, in the hotel bar, ...

We look forward to hearing from you!



K H R O N O S[™]
G R O U P

Vulkan Portability Initiative

SIGGRAPH, August 2018

Neil Trevett | Khronos President
NVIDIA | VP Developer Ecosystem

ntrevett@nvidia.com | [@neilt3d](https://twitter.com/neilt3d)

www.khronos.org

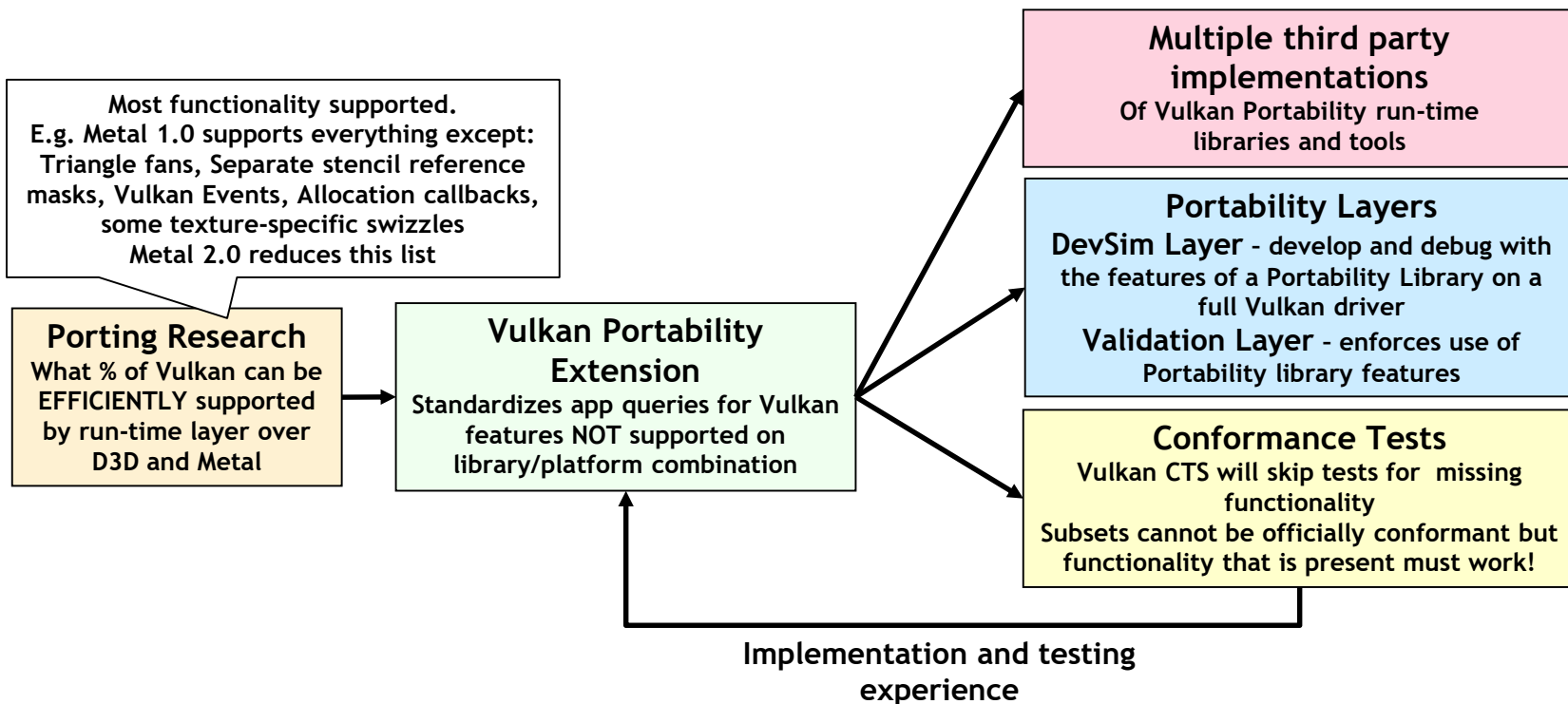
Vulkan Platform Availability



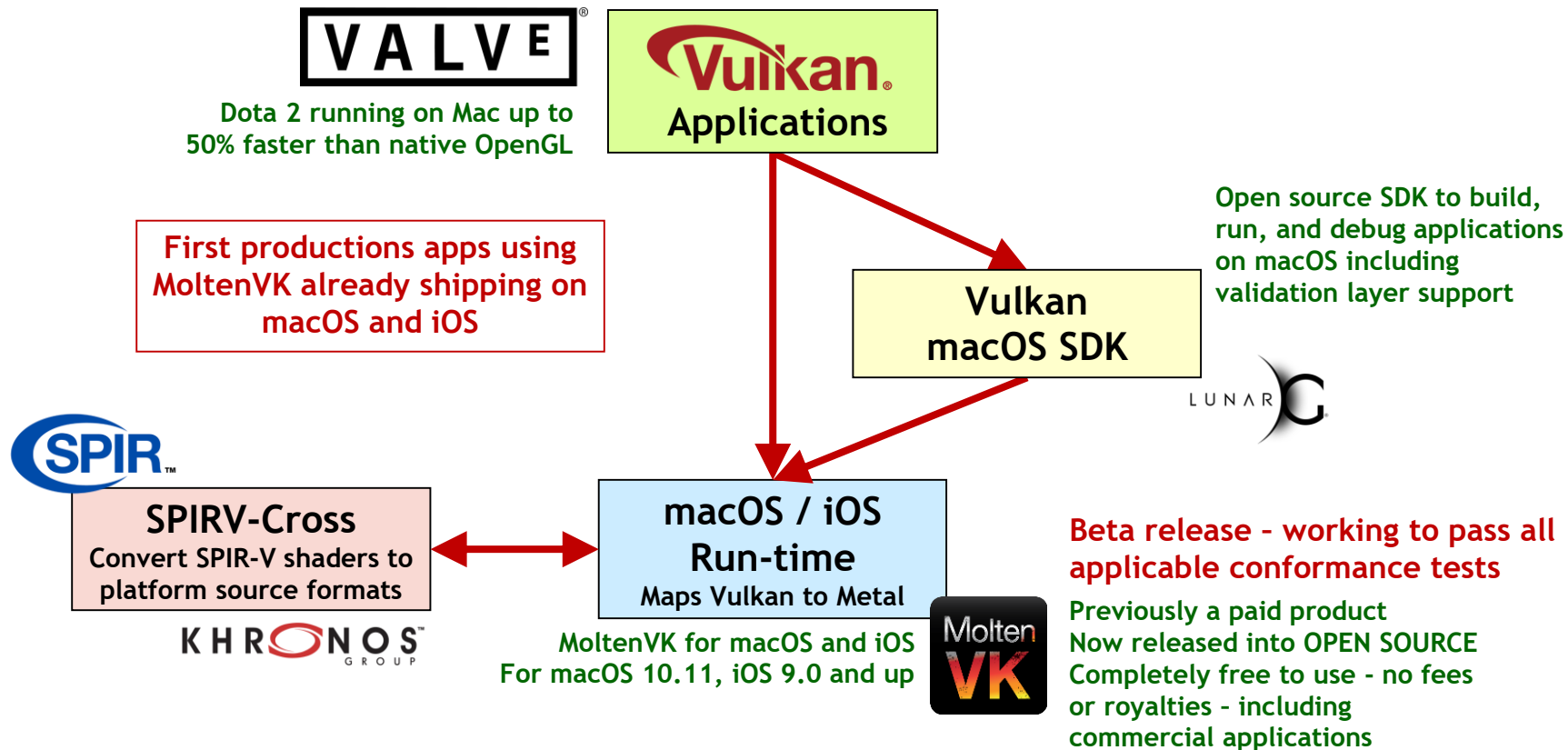
Vulkan is available on Android 7.0+

Vulkan Portability Initiative

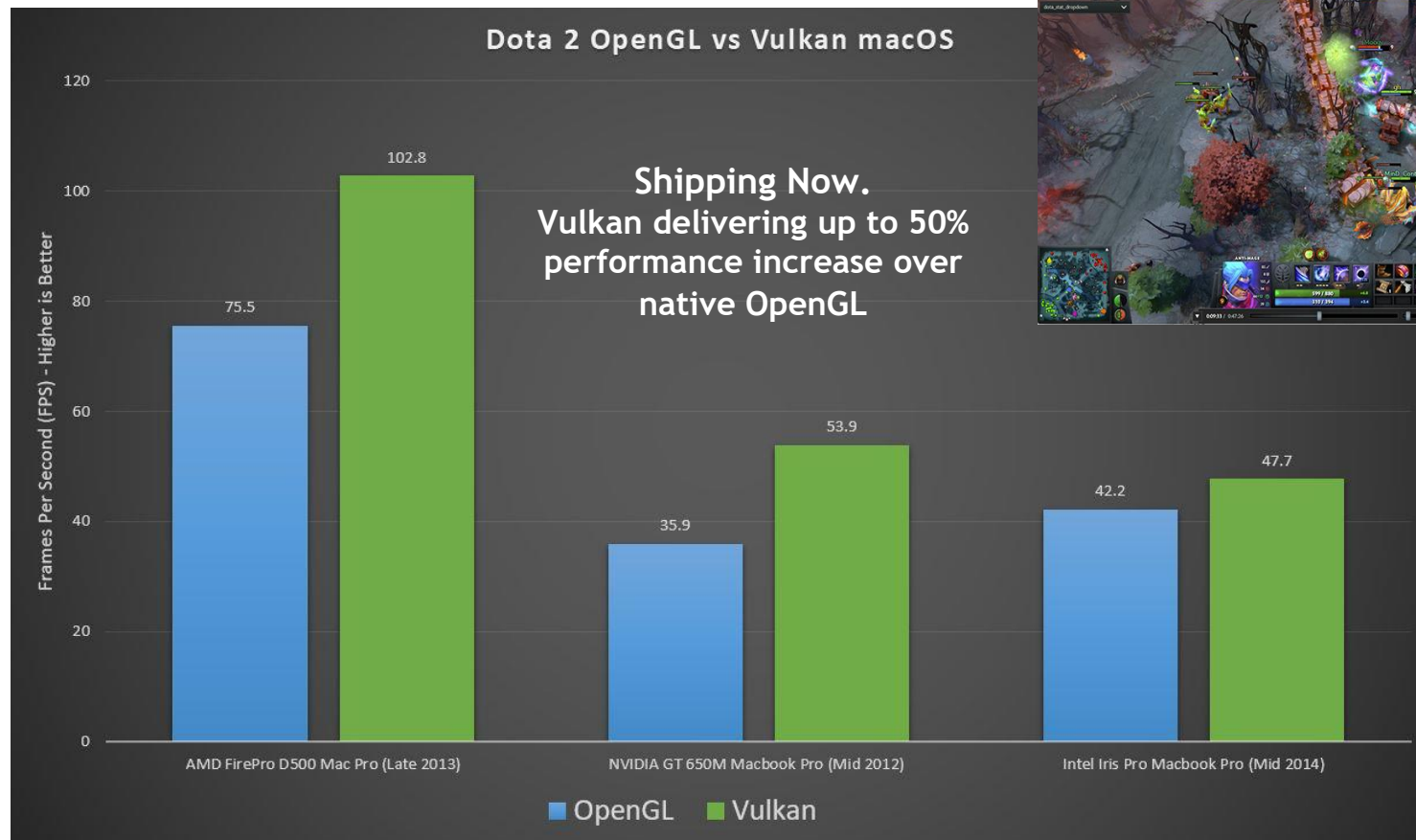
Enabling and accelerating the creation of tools and run-time libraries for Vulkan applications to run on platforms supporting only Metal or Direct3D



Bringing Vulkan Apps to Apple Platforms Today

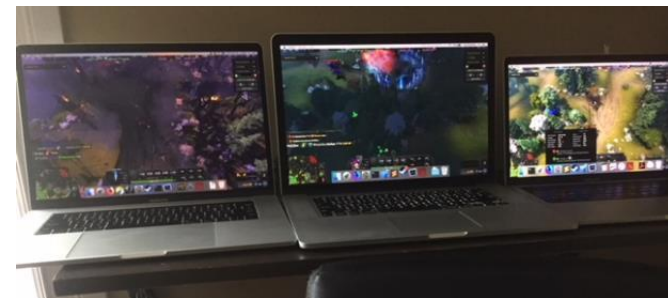


Valve - Vulkan Dota 2 on macOS



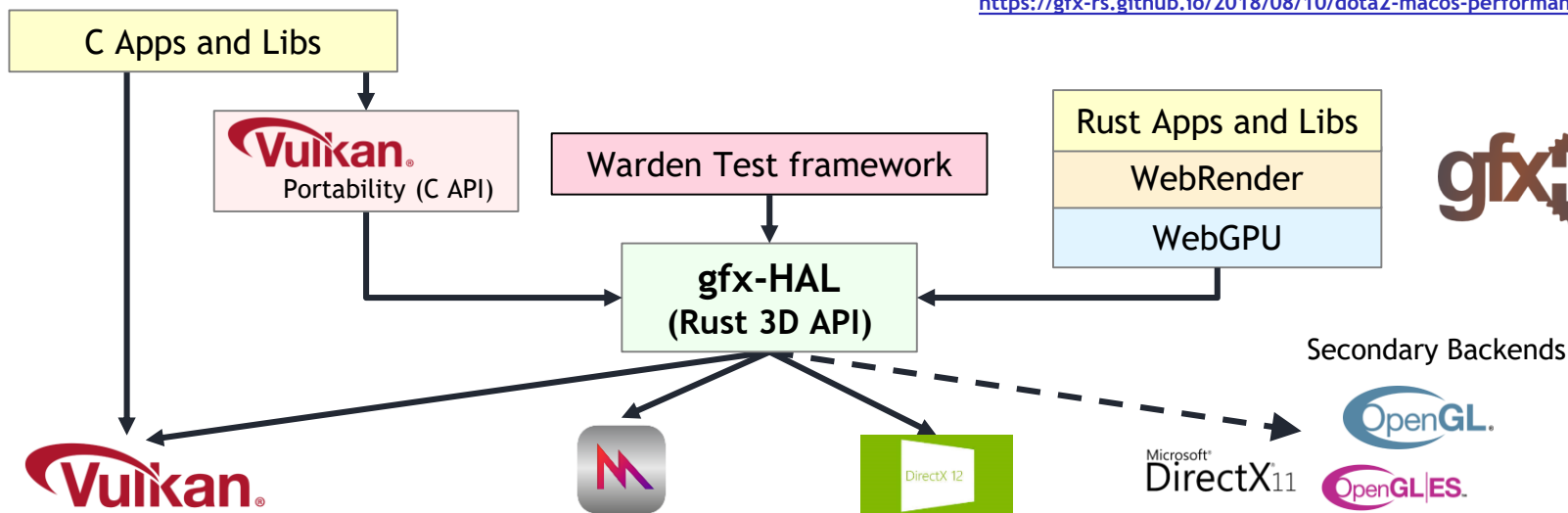
gfx-rs

- Vulkan Portability over D3D, Metal, and OpenGL
 - D3D layer useful for Vulkan on UWP platforms such as Windows 10 S, Polaris, Xbox One
 - <https://github.com/gfx-rs/gfx>
 - <https://github.com/gfx-rs/portability>

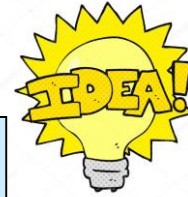


Efficiently running Dota 2 on Mac - working to increase conformance coverage

<https://gfx-rs.github.io/2018/08/10/dota2-macos-performance.html>



Khronos Education Forum



Support educators to teach
Khronos technologies!



Educators can connect
to share and discuss
course materials

Khronos Education Forum

Online Hub for collaboration

<https://www.khronos.org/education>

Shared course materials under permissive license

Open to all - no fees or membership required

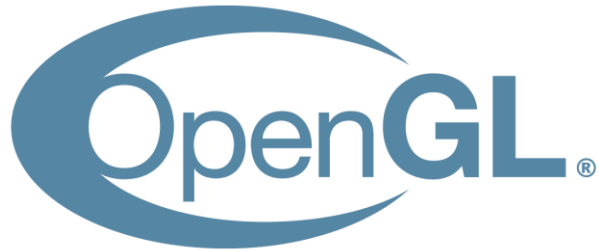
Just send an email to education@khronos.org



Direct contact with
Khronos working
groups and industry
for review and
feedback



Oregon State University Graphics Class with Vulkan Ref Cards



OpenGL/ES Update

Piers Daniell

OpenGL and OpenGL ES WG Chair

August 15, 2018

OpenGL/ES Collaboration



OpenGL and OpenGL ES meetings merged

- Same chairperson for both groups
 - Piers Daniell (NVIDIA)
- OpenGL and OpenGL ES remain separate working groups
 - Market focus of each group remains the same
- Improved efficiency
 - Member overlap leveraged

OpenGL/ES Spec updates

OpenGL and OpenGL ES spec fixes

- Our primary activity over the last year
- OpenGL 4.6 and OpenGL ES 3.2 updated in June, 2018
- Extensive use of GitHub for easier collaboration with the community

GLSL and ESSL spec source merged

- Converted to asciidoc
- Improves maintainability and reduces divergence
- Newly generated specs released June, 2018



Happy Birthday OpenGL ES!

OpenGL ES celebrates 15 years

- OpenGL ES 1.0 shipped June 2003
- The most prolific 3D API ever and still growing!
- Ships on billions of devices

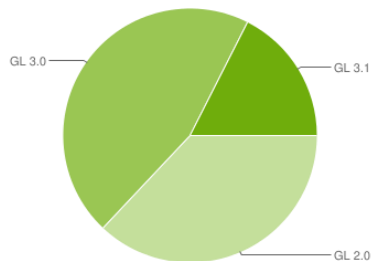


OpenGL ES 3.2 Adoption

OpenGL ES 3.2.5 Conformance Test Suite released

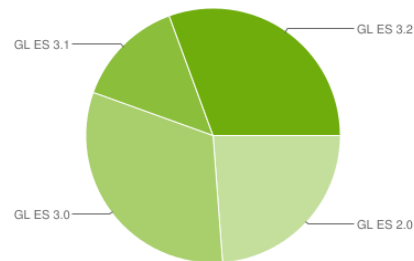
- Encapsulates multi-year Khronos investment
- Removes legacy testing code and is now 100% open source

OpenGL ES 3.2 adoption still growing



| OpenGL ES Version | Distribution |
|-------------------|--------------|
| 2.0 | 37.0% |
| 3.0 | 45.5% |
| 3.1 | 17.5% |

Data collected during a 7-day period ending on November 9, 2017



| OpenGL ES version | Distribution |
|-------------------|--------------|
| 2.0 | 23.8% |
| 3.0 | 31.7% |
| 3.1 | 13.9% |
| 3.2 | 30.6% |

Data collected during a 7-day period ending on July 23, 2018.

OpenGL ES Ecosystem

New vendor extensions registered

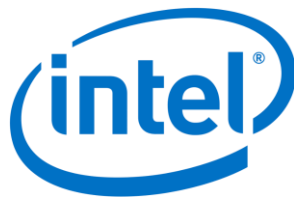
- `GL_EXT_clip_control`
- `GL_EXT_texture_mirror_clamp_to_edge`
- `GL_MESA_tile_raster_order`
- `GL_QCOM_texture_foveated`
- `GL_MESA_program_binary_formats`
- `GL_NV_clip_space_w_scaling`
- `GL_NV_stereo_view_rendering`
- `GL_NV_conservative_raster_pre_snap`
- `GL_EXT_EGL_image_external_wrap_modes`
- `GL_EXT_texture_format_sRGB_override`
- `GL_INTEL_blackhole_render`
- `GL_EXT_EGL_image_storage`
- `GL_MESA_framebuffer_flip_y`
- `GL_AMD_framebuffer_multisample_advanced`



OpenGL 4.6 Adoption

OpenGL 4.6 Conformance Test Suite released

- Initial release in January and updated in April
- Open-source available on GitHub
- Intel, NVIDIA and soon AMD are OpenGL 4.6 adopters

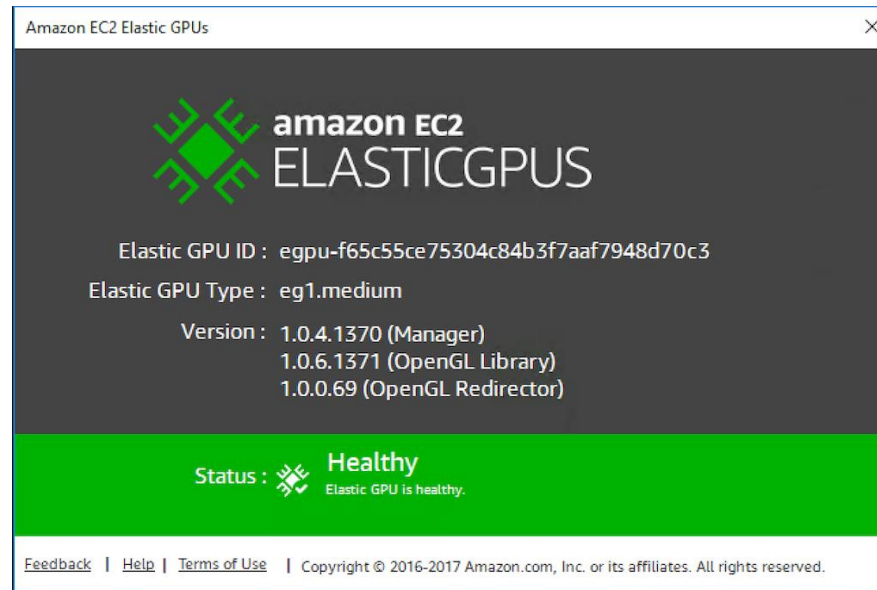


OpenGL Adoption

New OpenGL 4.3 Adopter



- Amazon Web Services, Inc. - Amazon EC2 Elastic GPUs





OpenGL Ecosystem

New vendor extensions registered

- GL_MESA_tile_raster_order
- GL_MESA_program_binary_formats
- GL_NV_conservative_raster_pre_snap
- GL_NV_conservative_raster_underestimation
- GL_AMD_gpu_shader_half_float_fetch
- GL_EXT_shader_framebuffer_fetch
- GL_EXT_shader_framebuffer_fetch_non_coherent
- GL_INTEL_blackhole_render
- GL_EXT_EGL_image_storage
- GL_AMD_framebuffer_multisample_advanced

NVIDIA OpenGL Update

New Turing Extensions coming soon

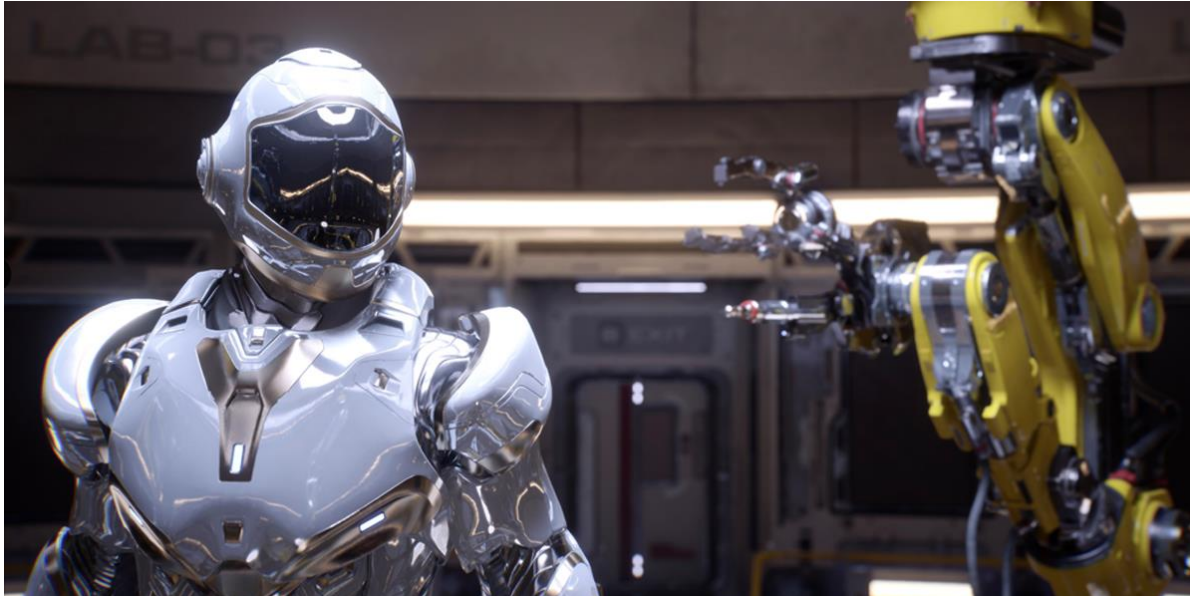
- Variable Rate Shading
- Texture Space Shading
- New Shader Extensions
- And more...

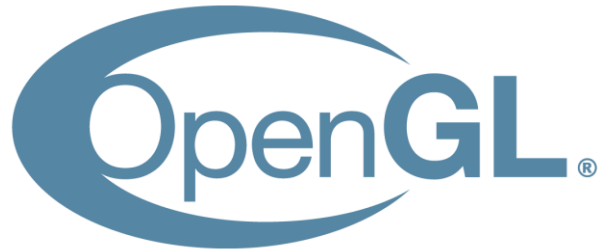


NVIDIA Demos

Khronos Networking Reception 5:30pm

- Vulkan Raytracing with Turing
- Nsight Graphics with Vulkan Raytracing support





Thanks!

Questions?