Khronos Fast Forward

Neil Trevett
Khronos President and VP Developer Ecosystems at NVIDIA

Khronos Connects Software to Silicon

Founded in 2000
**~ 200 Members |~ 40% US, 30% Europe, 30% Asia**

Open, royalty-free interoperability standards to harness the power of GPU, XR and multiprocessor hardware

3D graphics, augmented and virtual reality, parallel programming, inferencing and vision acceleration

Non-profit, member-driven standards organization, open to any company

Proven multi-company governance and Intellectual Property Framework

Khronos Standards for Spatial Computing
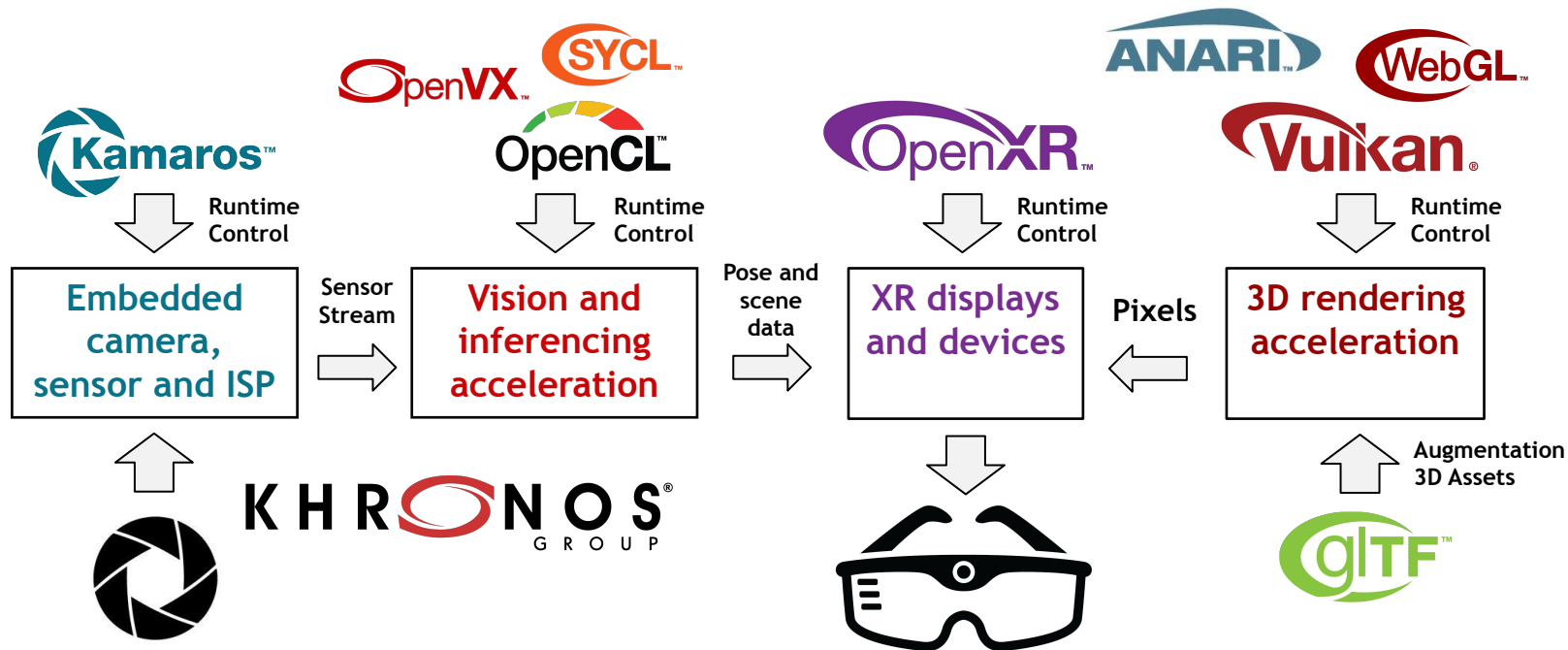
Khronos Active Standards

Khronos standards most relevant at SIGGRAPH

3D Graphics
Desktop, Mobile, Web

WebGL™ ANARI™

OpenGL|ES™ OpenGL™

Vulkan®

3D Asset
Authoring/Delivery

glTF™

COLLADA™

KTX™

Portable XR
Augmented and Virtual Reality

OpenXR™

Parallel Computation
Vision, Camera, Inferencing, Machine Learning

OpenCL™ Kamaros™

OpenVX™ NNEF™

SYCL™ SPIR™

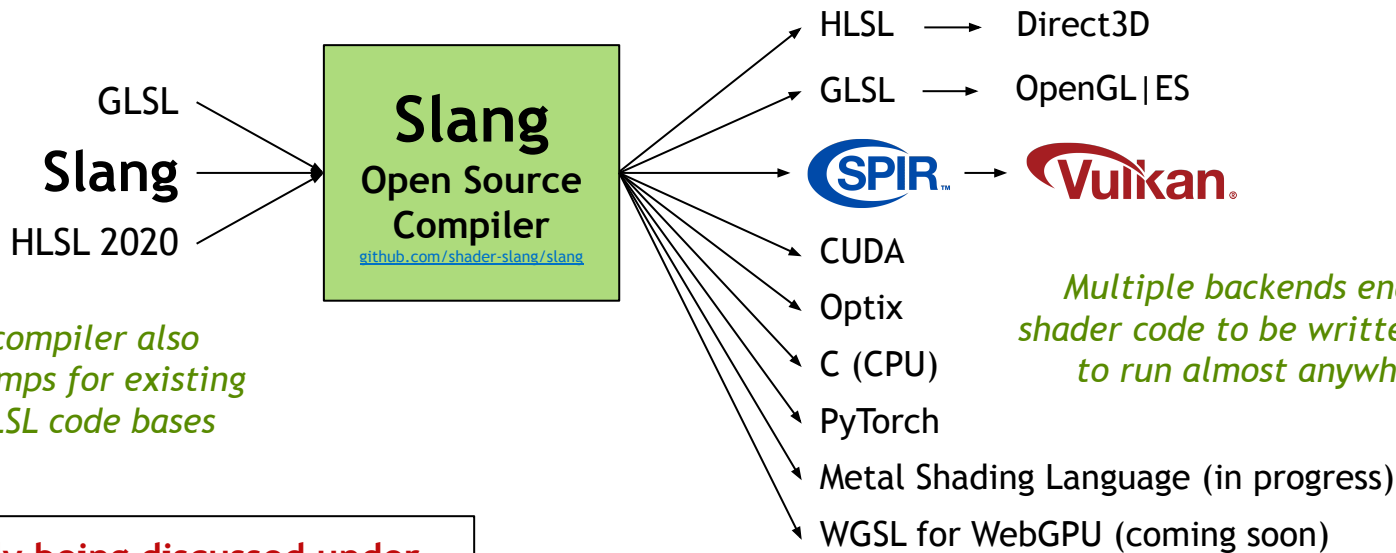Vulkan® SC™ OpenGL SC™ SYCL SC™ **Safety Critical APIs**

NEW! New Initiative under discussion – Slang Shading language

NVIDIA has proposed to bring Slang to Khronos

Slang is a fast-moving language designed specifically to meet the evolving needs of real-time rendering applications - including neural shaders

'Slang in Vulkan' presentation at the Vulkan BOF - 3PM Wednesday

GLSL

Slang

HLSL 2020

→

Slang
Open Source Compiler
github.com/shader-slang/slang

→ HLSL → Direct3D

→ GLSL → OpenGL|ES

→ SPIR → Vulkan

→ CUDA

→ Optix

→ C (CPU)

→ PyTorch

→ Metal Shading Language (in progress)

→ WGSL for WebGPU (coming soon)

Multiple backends enable shader code to be written once to run almost anywhere

The Slang compiler also provides onramps for existing HLSL and GLSL code bases

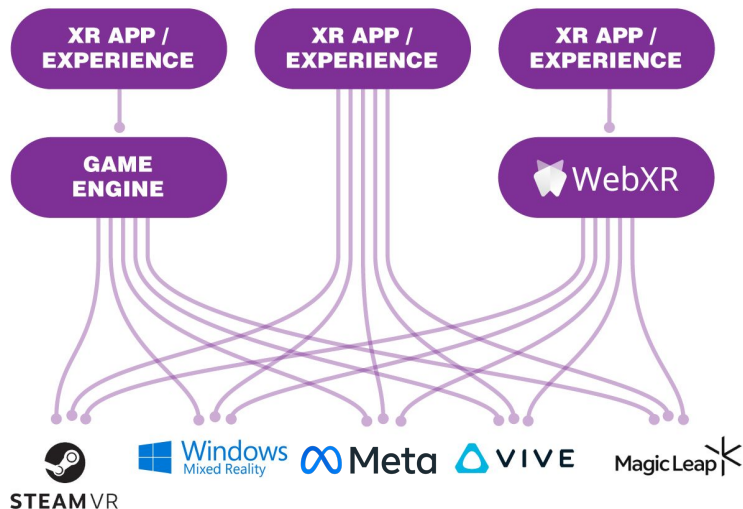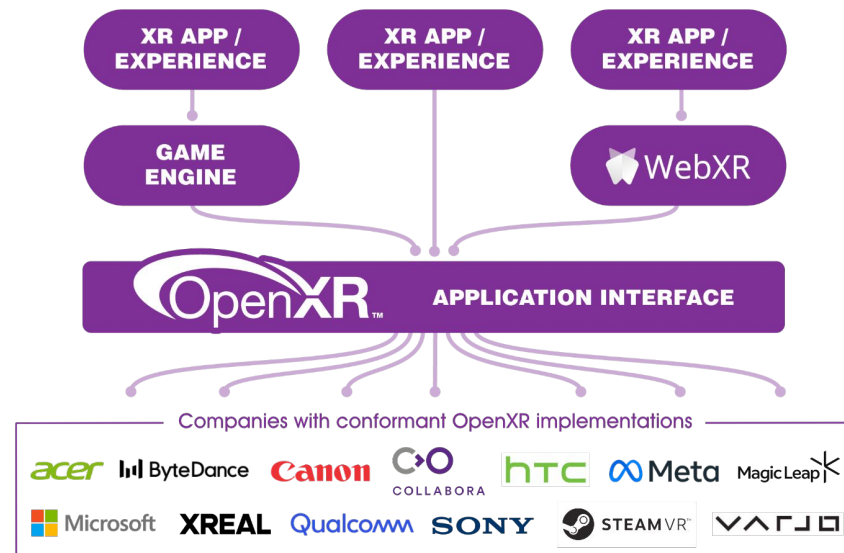**Currently being discussed under Khronos' New Initiative Process**

OpenXR

Empowering Cross-Platform Immersive Experiences

Neil Trevett
NVIDIA

OpenXR Cross-Platform Portability

Before OpenXR: Applications and engines needed separate proprietary code for each device on the market.

Companies with conformant OpenXR implementations

OpenXR provides a single cross-platform, high-performance API between applications and all conformant devices.

Applications and engines can portably access any OpenXR-conformant hardware

Conformant OpenXR Devices

Microsoft	Meta	htc
HoloLens and Mixed Reality Headsets. Hand and eye tracking extensions	**Rift S, Quest 3, Quest 2 and Quest Pro Meta Deprecated own API for OpenXR**	**Vive Focus 3, Vive Cosmos, Vive XR Elite, Vive Wave Runtime**
VALVE	VARJO	Canon
Valve Index Valve Deprecated OpenVR APIs for OpenXR	**All Varjo Headsets are fully compliant XR-3, XR-4**	**MREAL X1**
Magic Leap	XREAL	Snapdragon spaces
Magic Leap 2	**XREAL Air 2, Air 2 Pro, Air 2 Ultra**	**Qualcomm Snapdragon Spaces XR Development Platform**
acer	PICO ByteDance	SONY
Spatial Labs Display Series	**Neo 3 and Pico 4**	**Spatial Reality Displays**

The OpenXR Story So Far...

Empowering Cross-platform Immersive Experiences

OpenXR 1.1
Consolidates multiple extensions to streamline application development and reduce fragmentation
Adds new functionality with spec improvements

Increased focus on regular core spec updates
Balancing the need to ship new functionality *AND* consolidate widely proven technology

OpenXR achieves wide industry adoption

Leverage OpenXR's flexible design to explore new use cases
e.g., body tracking and advanced spatial computing

Establishing baseline XR functionality
Though industry consensus and contributed designs

OpenXR is foundation for experimentation
New functionality introduced through extensions

OpenXR 1.0 specification drafted

Vendor Proprietary API fragmentation
Clear industry demand need for a cross-platform XR open standard

OpenXR Working Group Formed

OpenXR 1.0 Released

New!

OpenXR 1.1 Released

2017   2019   April 2024

OpenXR 1.1 Key Extensions Promoted to Core

- **Local Floor Reference Space**
  - Gravity-aligned world-locked origin for standing-scale content
  - Estimated floor height built in
  - Recenter to current user position at the press of a button without a calibration procedure

- **Grip Surface**
  - Anchors visual content relative to the user's physical hand
  - Can be tracked directly or inferred from a physical controller's position and orientation

- **Stereo with Foveated Rendering for XR headsets**
  - Runtimes MAY optionally expose eye-tracked or fixed foveated rendering
  - Portable across multiple graphics rendering APIs

- **Additional enhancements**
  - Interaction Profile improvements
  - Spec language cleanup and clarifications

Engines, Browsers, and Libraries with OpenXR

UNREAL ENGINE	Unity	GODOT Game engine
Unreal has been providing support since 4.24. UE 5.0 supports OpenXR	Unity's OpenXR plugin available since 2020 LTS	Godot provides OpenXR support since March 2023 (Core 4.0 Alpha 4)
AUTODESK VRED Library	NVIDIA OMNIVERSE / NVIDIA CLOUDXR	
OpenXR supported since VRED 2023.4	NVIDIA Omniverse and CloudXR Platforms	WebXR in Chrome, Edge, and Firefox uses OpenXR as the default backend
COLLABORA / MONADO	Meta	stereokit
Open-source OpenXR Implementation	A lightweight XR Meta XR Simulator to Speed Unity OpenXR Development	Open-source mixed reality library for building HoloLens and VR applications

Khronos and W3C: Bringing XR to the Web

XR Applications and Engines
use an API from both the 3D and XR Stacks

three.js   babylon.JS   unity   UNREAL ENGINE   GODOT   **Engines**

WebGL   WebGPU   WebXR   W3C

OpenGL ES   Vulkan   OpenXR   KHRONOS GROUP

3D Stack
Driving GPUs to render scenes and augmentations

XR Stack
Handling XR Devices for creating UI

Coming Soon…

- **Extending hand tracking**
  - To include full body tracking

- **Enhanced handling of spatial entities**
  - Standardized methods to interact with the user's environment
  - Support for advanced spatial computing applications

- **Expanded haptics support**
  - Support immersive experiences through PCM, vibrotractiles, and transients

- **Controller render models (glTF)**
  - Showing and animating a model of the user's actual controller

OpenXR Specification

OpenXR SDK GitHub

Vulkan: Forging Ahead!
(fast forward version)

Tom Olson (Arm), Vulkan Working Group chair

Ten years ago, in a city far, far away...

OpenGL / OpenGL ES BOF, SIGGRAPH 2014

Vulkan BOF Presentations

Vulkan: Looking back, and looking forward
- Tom Olson (Vulkan Working Group Chair / Arm)

Vulkan SDK: Where we started, and where we are going
- Karen Ghavam (LunarG)

Vulkan: Crash Diagnostic Layer
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Slang in Vulkan
- Hai Nguyen (NVIDIA)

EVOLVE – Next Generation Benchmarking
- Jasper Bekkers and Darius Bouma (Traverse Research)

Adding Vulkan to Pixar's Hydra Storm Renderer
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Vulkan Roadmap 2024 Profile

phoronix

ARTICLES & REVIEWS   NEWS ARCHIVE   FORUMS   PREMIUM   CONTACT   ⊘ CATEGORIES

Vulkan Roadmap 2024 Brings Shader Quad Control, Shader Maximal Reconvergence & More

Written by Michael Larabel in Vulkan on 25 January 2024 at 09:0

The Khronos Group today announced their Vul
specification for their latest API features and me
processors and other hardware. Vulkan Roadma
Vulkan Roadmap 2022 specifications to deliver

Khronos Drives Industry Support for Expanded 3D Features with Vulkan Roadmap 2024

Latest Vulkan Roadmap milestone defines the set of important shader and rasterization features that game and applications developers can rely on to be widely supported on mid-to-high-end GPUs starting this year.

Represents the second milestone on the Vulkan Roadmap
- Captures expected feature set for "immersive graphics" 2024-2026+

Vulkan Roadmap 2026 Milestone
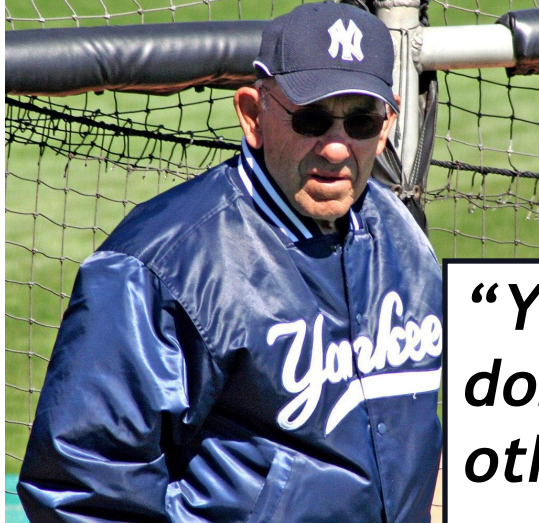
"You've got to be very careful if you don't know where you're going, otherwise you might not get there"

\- Yogi Berra

Our plans for the third milestone on the Vulkan Roadmap

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Shading Languages: it's complicated...

Vulkan is defined to accept shaders in the SPIR-V IR

- In theory, how you generate it is up to you
- But, the ecosystem needs standards and stability

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Some developers will always prefer HLSL
- Microsoft has been very welcoming and accommodating – thanks!
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Slang is an option
- NVIDIA has offered to place it under community governance
- Khronos is one possible hosting consortium – under discussion

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Vulkan Video is a Thing!

- **Vulkan Video expands Vulkan capabilities**
  - Accelerated processing of streamed media into the Vulkan pipeline

**Vulkan Video is increasingly providing
cross-platform media framework acceleration**

Status tracked at
https://blogs.igalia.com/vjaquez/vulkan-video-status/

Ray tracing in Mobile is a Thing too!

arm

Qualcomm
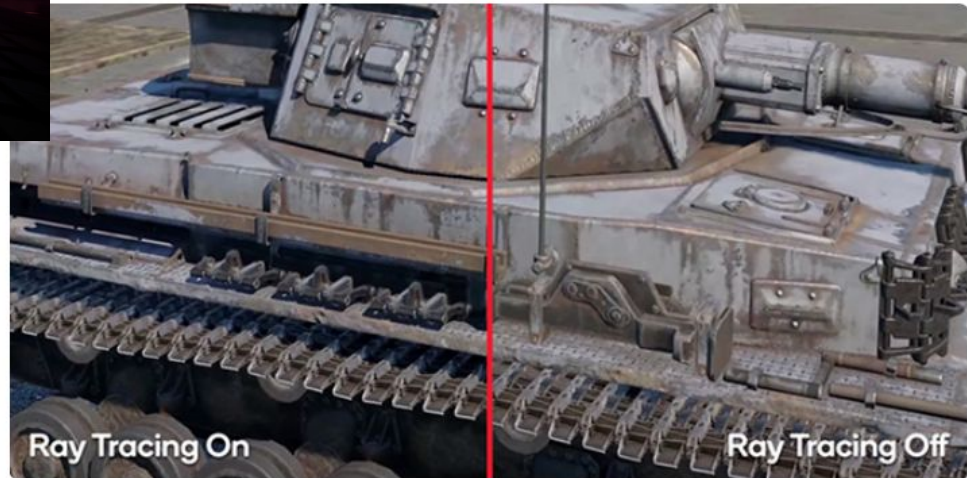
Ray Tracing On   Ray Tracing Off

https://www.qualcomm.com/news/onq/2023/05/hardware-accelerated-ray-tracing-improves-lighting-effects-in-mobile-gaming

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Professional Rendering

Artwork by Emily Bisset, courtesy of Adobe

Substance 3D Stager

**Vulkan Ray Tracing in Aurora:
An Open Source Real-Time Path Tracer**

https://github.com/Autodesk/Aurora

AUTODESK Flame
Vulkan

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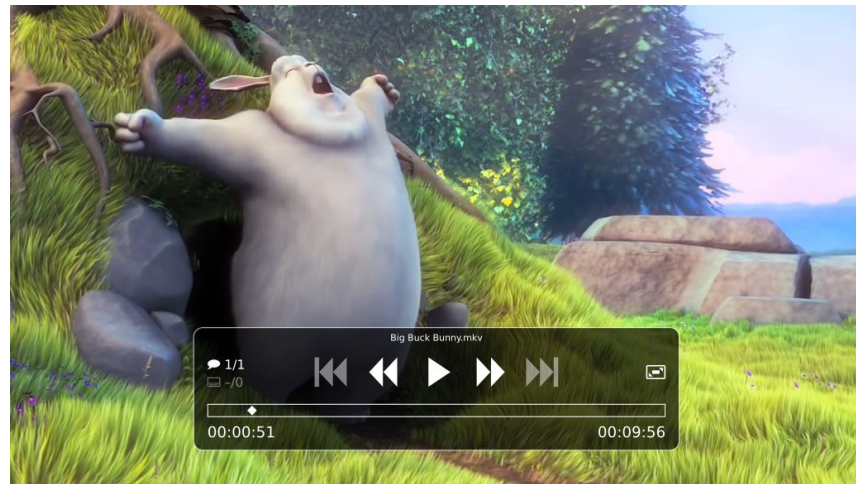**Adding Vulkan to Pixar's Hydra Storm Renderer**
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What's New:

Documentation and Developer Support

Vulkan Documentation Project

Bring Vulkan documentation together in one place

- Specification, Vulkan Guide, Proposal documents, Samples…

- Easy navigation and cross-linking

- https://docs.vulkan.org

- Please report issues at https://github.com/KhronosGroup/Vulkan-Site

Vulkan Samples Repository

A home for Vulkan sample code
- Intended to help you learn to use Vulkan effectively
- GPU, OS, and platform neutral, well tested
- On github in open source (Apache 2.0)
- Access via docs.Vulkan.org or at github/KhronosGroup/Vulkan-Samples

A community effort
- Khronos member ISVs, IHVs, contractors
- Interested community members
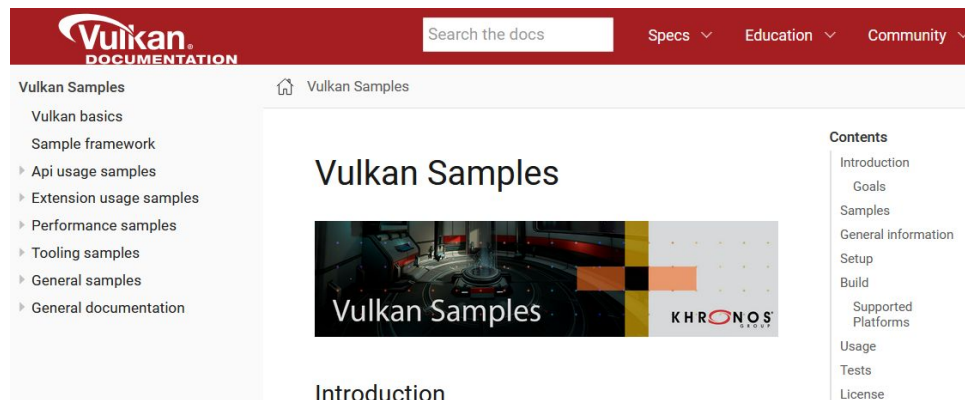
Some recently added samples

Sparse Image / virtual texture (Mobica)

OIT using per-pixel linked lists (community)

Mobile NeRF (Qualcomm)

https://developer.qualcomm.com/blog/generating-3d-scenes-2d-images
-more-efficiently-mobile-nerf-rendering-using-vulkan-adreno-gpu

Vulkanised!

First full-scale Vulkanised was held in February 2023

- Hosted by Google in Munich, Germany
- Three days of talks, panels, demos, and a Vulkan course
  - All on line at https://vulkan.org/learn#videos

Second in February 2024

- Hosted by Google in Sunnyvale, California

Vulkanised 2025
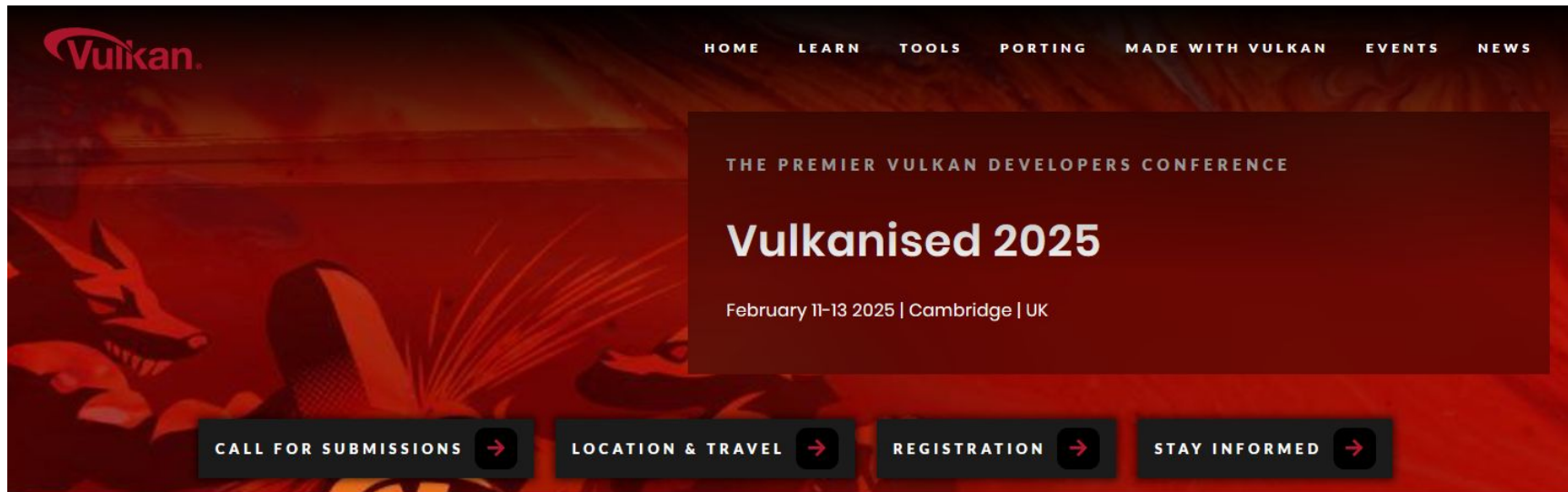
Vulkanised 2025

The 7th Vulkan Conference | Cambridge, UK | Feb 11-13, 2025

The Premier Vulkan Developer Conference

To be hosted by Arm in Cambridge, UK – submissions due Oct. 11

Thanks!

ANARI

Jeff Amstutz
NVIDIA

API Design: Balancing Opposing Forces

API Uniformity

Handle-based Objects

Generic Parameters + Arrays

Object/Array Updates

Scene Hierarchy

Concurrency + Parallelism

API Synchronization Semantics

Graphics/Compute API Interop

…

?

Feature Differentiation

Supported API Extensions

Performance (Frame/Update Latencies)

Supported Hardware Features

Image Quality

Scene Size (Memory overhead, LoD, Out-of-core, Distributed, etc…)
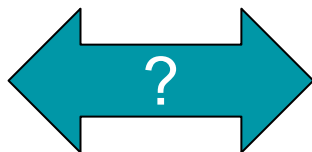
…

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…

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Extensions

...rame/Update
...ies)

...vare Features

...uality

...che Size (Memory overhead,
LoD, Out-of-core, Distributed,
etc…)

…

only *"what"* and *"when"*

not *"how"*

ANARI Development Stack
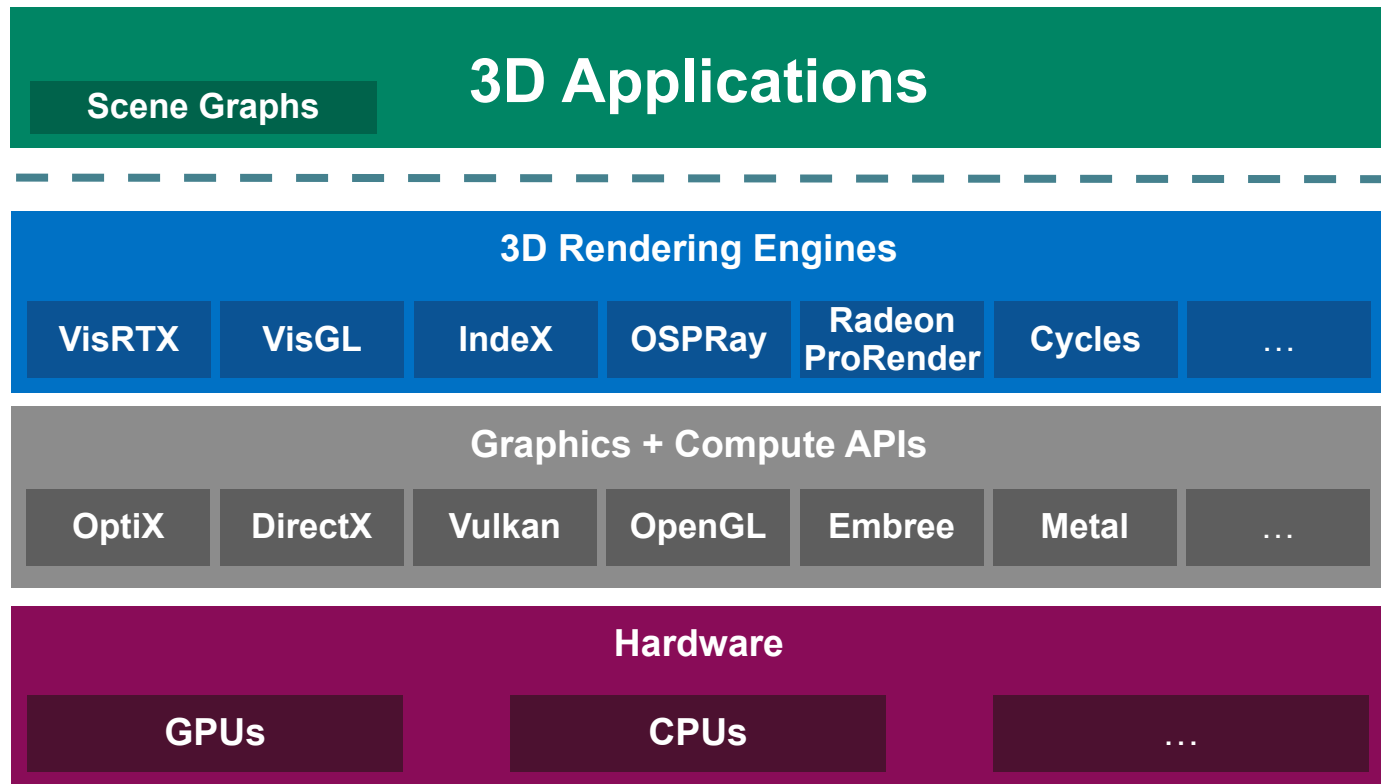
Open-source SDK includes Conformance Test code

```
Working Group Launched March 2020
    │
    ├──→ SDK v0.1.0 March 2022 ──→ SDK v0.2.0 July 2022 ──→ SDK v0.3.0 Feb 2023 ──→ SDK v0.7.0 August 2023 ┈┈→ SDK v0.10.0
    │
    ├────────────────────────────────────────────────────────────────────────→ Adopters Program v1.0
    │
    └──→ V1.0 Provisional Specification November 2021 ──→ Industry Input and Feedback ──→ V1.0 Final Specification August 2023
```

Adopters Program v1.0
Adopters Agreement
Testing Process
Conformance Tests
1Q24

Industry Input and Feedback

glTF-compatible Physically-based materials
Improved object interface and error handling
Directly mapped array parameters
Revamped runtime feature queries
Improved volume shading

V1.0 Final Specification August 2023 ┈┈→ V1.1 Spec WIP

ANARI 1.0 Launch

All specification, SDK and Conformance Test development work done publicly on GitHub

Data Parallel Rendering

Updates Since SIGGRAPH 2023

- **New Adopters Program**
  - Help secure future ANARI SDK development through official conformance!
  - Improved Conformance Test Suite (with more on the way!)

- **Many SDK Improvements + Additions:**
  - Initial version of an OpenUSD Hydra plugin 'hdAnari' now available
  - New Blender add-on - contributions welcome!
  - Application debug layer can be enabled without code changes
  - Helium now provides a generic host-side array implementation

- **New Implementations and Integrations coming online**
  - New applications: OVITO, Ascent | Improved integrations: VTK, VTK-m, ParaView, VisIt
  - New devices: Visionaray (CPU/CUDA), Barney (OptiX + MPI parallel), Cycles (prototype),...

Lots more detail at the 'Exploring ANARI' BOF 10AM Wednesday

ANARI™

glTF & 3D Commerce

Alexey Medvedev
Meta

glTF – 3D Asset Transmission Format

AUTHORING FORMATS

USD, Material X, FBX, MDL …

USD

Interchange

Distill

Import & Export
Remix / Publish

Transmission
Exchange

AUTHORING TOOLS

VIEWERS & ENGINES

Blender
3DS MAX
Maya
Adobe
…

Optimization & Verification
Testing and Editing

glTF TOOLS

glTF's focus is on enabling optimized run-time delivery of 3D Assets
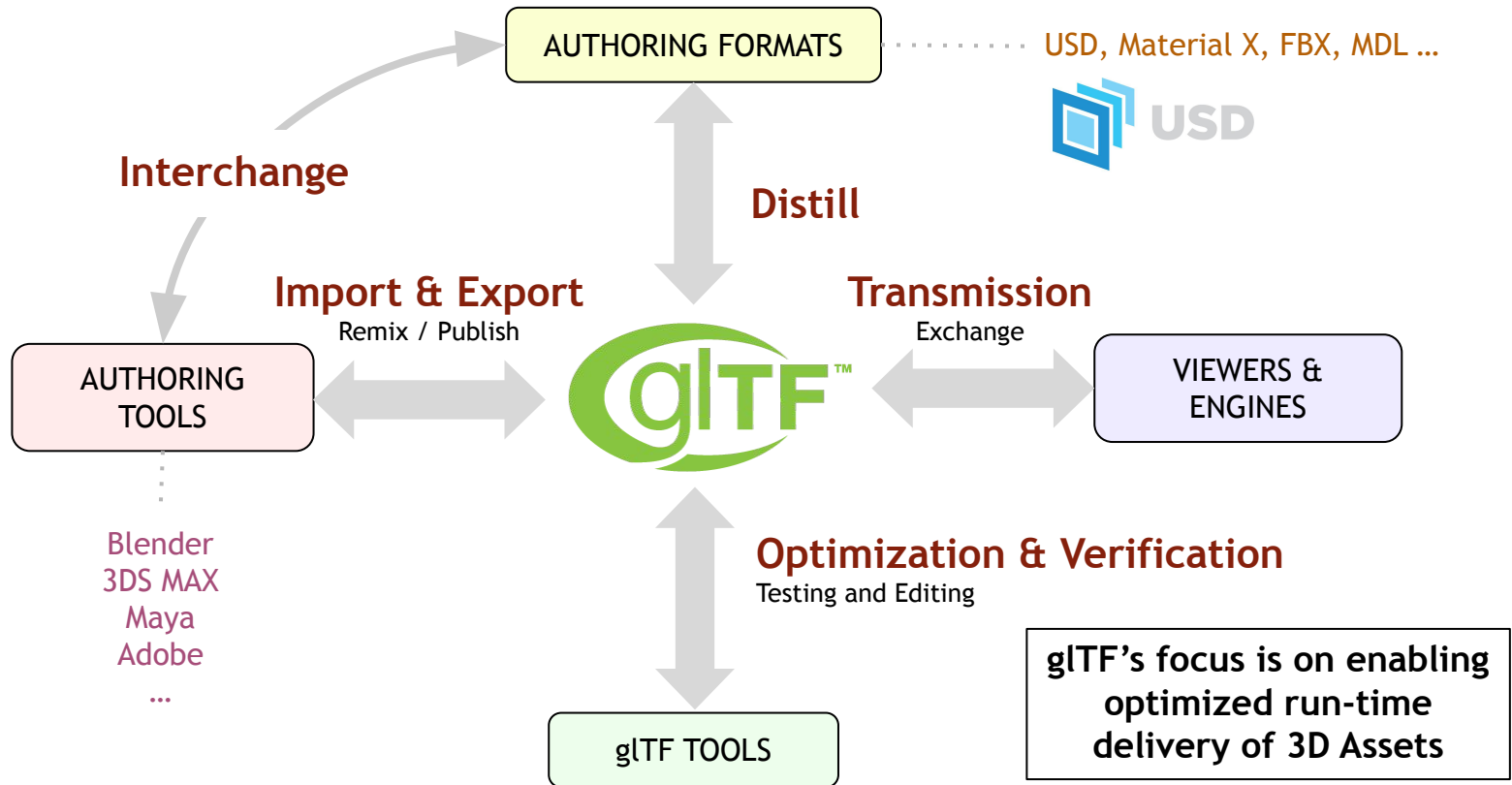
Increasingly Foundational for Other Standards

VRM CONSORTIUM

Customized interactive 3D avatar
format based on glTF + extensions
(.vrm extension)

3DTiles — Open Geospatial Consortium

Streamlined streaming and rendering
large-scale 3D geospatial datasets
uses glTF + extensions
(.b3dm and .i3dm extensions)

ISO/IEC 12113:2022
ICS > 35 > 35.040 > 35.040.30
**Information technology — Runtime 3D asset
delivery format — Khronos glTF™ 2.0**
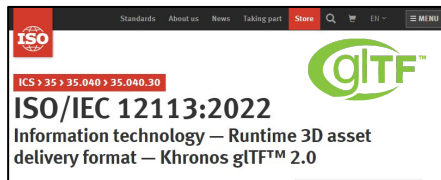
glTF as an ISO standard
solidifies global recognition and
adoption as a 3D asset format

PDF

ISO/TS 32007 brings
glTF 2.0 as a supported
3D asset into PDF

MPEG

ISO/IEC 23090-14:2023
MPEG-I for immersive media experience
uses glTF + extensions as its scene graph
(.mp4 extension)

X3D

ISO/IEC IS 19775-1:2023 (X3D)
MPEG-I for immersive media experience
uses glTF + extensions as its scene graph
(.mp4 extension)

Cross Standards Cooperation

Cooperation between glTF and USD ecosystems is a significant industry benefit

Asset format to enable 3D content to be pervasively delivered and displayed on a wide diversity of native and web viewers, applications and engines

Multiple open-source projects including OpenPBR and MaterialX

Extensible framework and ecosystem for describing, composing, simulating, and collaboratively navigating and constructing 3D scenes

Metaverse Standards BOF
Presentation by glTF/USD Interoperability Working Group
Tuesday 11:30AM Room 710

glTF PBR Materials Roadmap

Incremental consolidation and meticulous specification of *proven and accepted industry practice*

Clearcoat

Volume
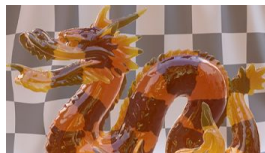
Sheen

Index of Refraction

Emissive Strength
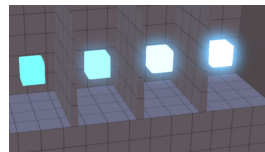
Dispersion
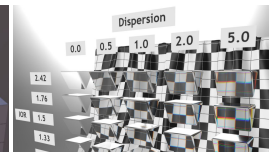
Metal / Roughness

Transmission
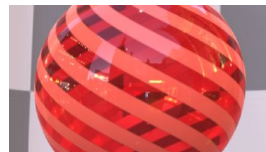
Specular

Iridescence
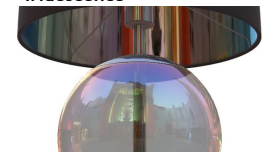
Anisotropy

Subsurface In development

2017   2020   2021   2022   2023/4

Khronos glTF PBR available in MaterialX

- **glTF's PBR material is available as a node graph in MaterialX since 2022**
  - Being updated for 2024

- **Next step: feed MaterialX as a set of procedural texture inputs into glTF PBR**
  - Enable much higher detail in smaller assets
  - Remain compatible with existing PBR shaders
  - Optional texture atlas fallbacks for compatibility
  - Extension in development


```
gltf_pbr_surfaceshader
  base_color
  metallic
  roughness
  normal
  tangent
  occlusion
  transmission
  specular
  specular_color
  ior
  alpha
  alpha_mode
  alpha_cutoff
  iridescence
  iridescence_ior
  iridescence_thickness
  sheen_color
  sheen_roughness
  clearcoat
  clearcoat_roughness
  clearcoat_normal
  emissive
  emissive_strength
  thickness
  attenuation_distance
  attenuation_color
                    out
```
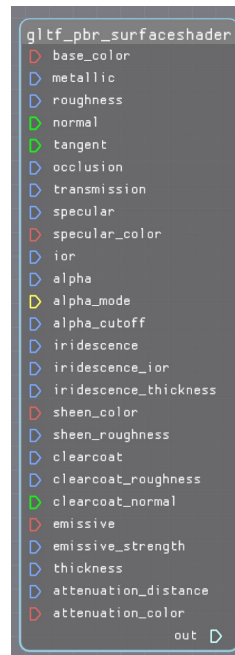
Khronos PBR Neutral Tone Mapper

- **True-to-Life Color Rendering of 3D Products**
  - Released in May 2024
  - Specification and sample implementation

- **1:1 match for colors up to a certain maximum value**
  - The remainder of color space used as headroom for compressed highlights

- **Wide adoption and support by 3D tools and engines**
  - <model-viewer>, Autodesk, Babylon.js, Blender, Dassault, Filament
  - London Dynamics, Phasmatic, Three.js, and ThreeKit

Linear   ACES   PBR Neutral

Khronos PBR Neutral Tone Mapper reachable colors   **ACES Tone Mapper reachable colors**
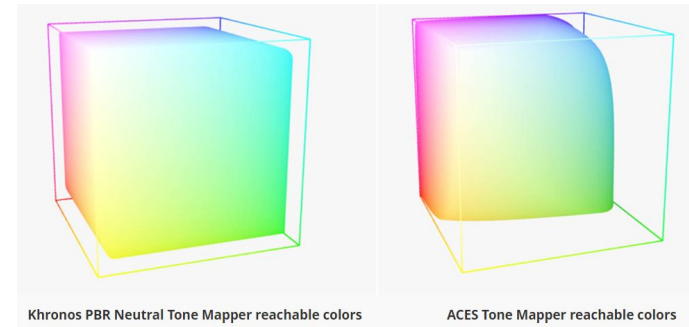
glTF Viewer for iOS

- **Khronos Releases Open-Source iOS App for Viewing glTF Files**
  - Available on the Apple App Store and supports AR mode
  - Source code available on GitHub under the Apache 2.0 license

Khronos **glTF** Viewer – iOS App & Open-Source Project
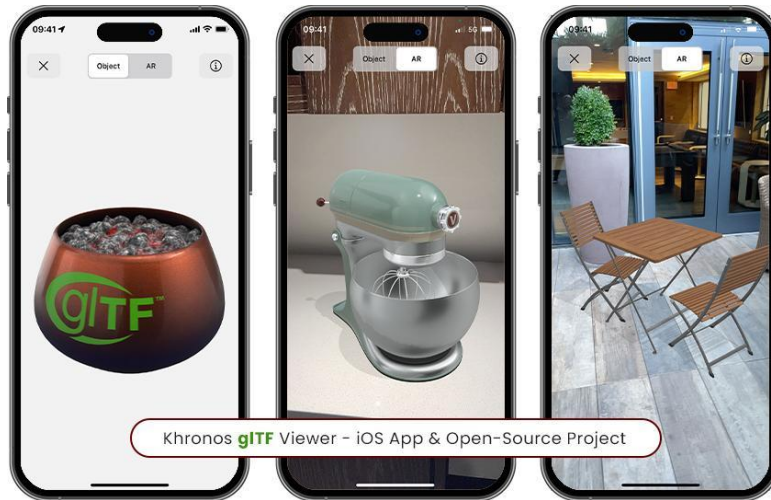
glTF Spatial Computing Roadmap

Interactivity

Physics
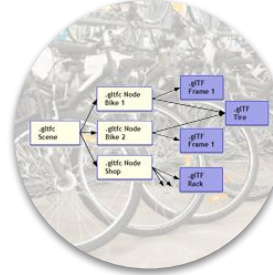
Complex Scenes

Audio

glTF Interactivity Extension

- **Uses behavior graphs to add logic and behaviors to glTF assets**
  - Interactive assets portable across eCommerce sites, applications, XR experiences etc.
  - Focus on safety, portability and ease of implementation
- **Distillation of engine accepted practice**
  - Unity (Visual Scripting), Unreal (Blueprints), Nvidia Omniverse (Action Graph)
- **Invitation for Public Comments issued!**
  - Draft Specification on GitHub | Khronos webinar on interactivity
  - Feedback on GitHub pull request | glTF Interactivity Graph Authoring Tool (WIP DCC React App)
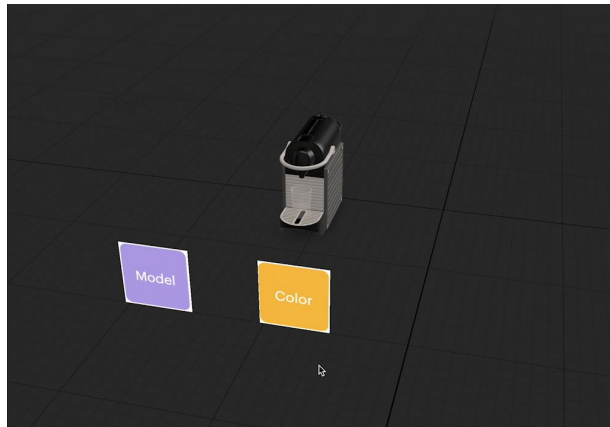
glTF 2.0
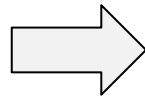
glTF 2.0 with KHR_interactivity

glTF Physics

- **Express the physics properties of assets in a platform independent way**
  - Provides procedural animation
  - Makes scenes more interesting, believable, and dynamic
- **Enables scene understanding**
  - Possible with render geometry, but much more efficient with physics
- **Rigid Bodies**
  - Collision geometry | Rigid bodies
  - Motions | Materials
  - Joints | Filters

Distillation of widely adopted physics engines practices
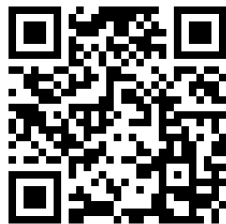
[Specification](#)
feedback welcome!
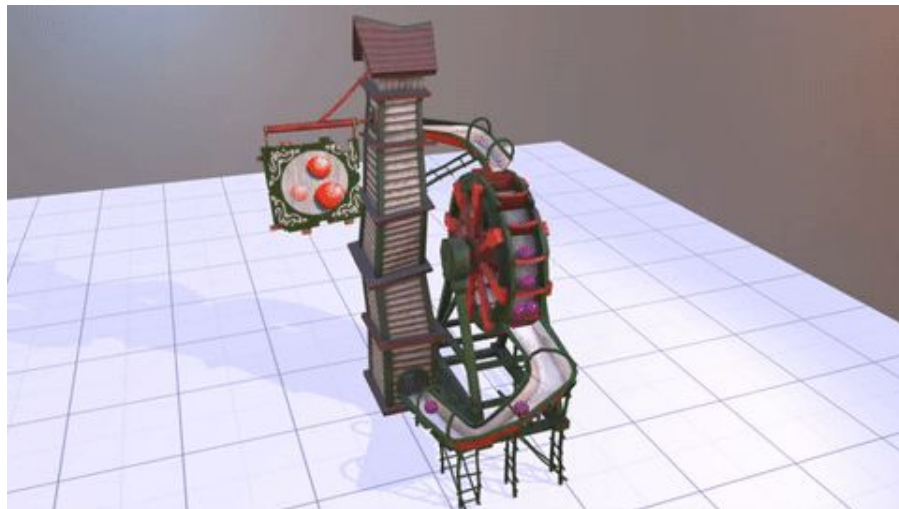
glTFX : glTF eXternal References

- **Meet user requirement to reference multiple glTF assets**
  - Complex scenes, Level-of-Detail, streaming, smart loading, scene change...
- **Adds a new glTF file type (glTFX)**
  - Contains eXternal reference to glTF files
  - New file does not specify any meshes, animations, materials, etc. directly
- **Draft spec:** [khr.io/127](khr.io/127)

Image used under license, stock.adobe.com

Scene → Node Bike 1, Node Bike 2, Node Shop
.glTF Frame 1, .glTF Tire, .glTF Frame 2, .glTF Rack
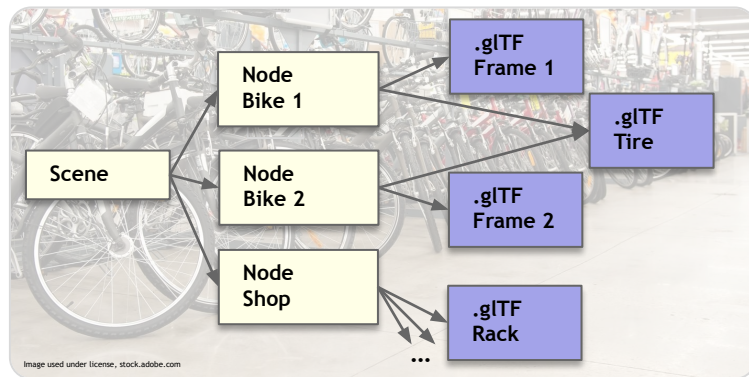
Webinar
Watch the Recording
[khr.io/122](khr.io/122)

Khronos 3D Commerce

Making 3D Pervasive – in the Real World

Build Once, Use Everywhere
Developing tools and techniques for 3D assets to be reliably and consistently used and displayed across diverse platforms and engines

Multiple Projects Underway
Render Showcase - evolve and expand Render Fidelity Site
Tone Mapping (PBR Neutral), exposure and lighting
Apparel: Skeletal & Facial Anchoring, Virtual Try-On, Stitching / detailing, Simulation

Content Developers
test and validate assets

The equivalent of an API
Conformance Test Suite
(Vulkan has >3M tests)

Public comparoson of multiple engines
1) Early warning of inconsistencies
2) Incentive to implement functionality

Sample Viewer
Asset Display Exemplar

Asset Library
Showcase & Test Assets

Render Showcase
Web-based display comparisons

Validator
Asset Correctness

Asset Generator
Generate unite tests

Two glTF BOFs to Come and Learn More!

Innovations in 3D Content Delivery and Use
Tuesday, July 30: 8:30 am - 11:30 AM
Room 710

Start	Session	Presenter
8:30	glTF Intro and Roadmap	Alexey Medvedev, Meta
8:45	Interactivity	Peter Martin , Adobe
9:00	Physics	Eoin Mcloughlin, Microsoft
9:10	Audio	Chintan Shah, Meta
9:20	Complex Scenes	Leonard Daly, Daly Realism
9:30	AEC & Geospatial	Sean Lilly and Adam Morris, Cesium
9:45	Q&A	*All*
10:05	Image Compression	Stephanie Hurlburt & Rich Geldrich, Binomial
10:20	PBR Materials	Alexey Medvedev, Meta
10:30	Tone Mapping	Emmett Lalish, Google
10:40	Content Creation	Eric Chadwick, DGG

Slightly more in Depth

Innovations in 3D Content Delivery and Use
Wednesday, July 31: 8:30 am - 11:30 AM
Hyatt Regency Denver Capitol Ballroom 1-3

Start	Title	Presenter
1:00	glTF Intro and Roadmap	Alexey Medvedev, Meta
1:05	Interactivity	Peter Martin , Adobe
1:20	Physics	Eoin Mcloughlin, Microsoft
1:30	Audio	Chintan Shah, Meta
1:40	Complex Scenes	Leonard Daly, Daly Realism
1:50	AEC & Geospatial	Sean Lilly and Adam Morris, Cesium
2:05	Q&A	*All*
2:25	Image Compression	Stephanie Hurlburt & Rich Geldrich, Binomial
2:40	PBR Materials	Alexey Medvedev, Meta
2:50	Tone Mapping	Emmett Lalish, Google
3:00	Content Creation	Eric Chadwick, DGG
3:25	Q&A	*All*

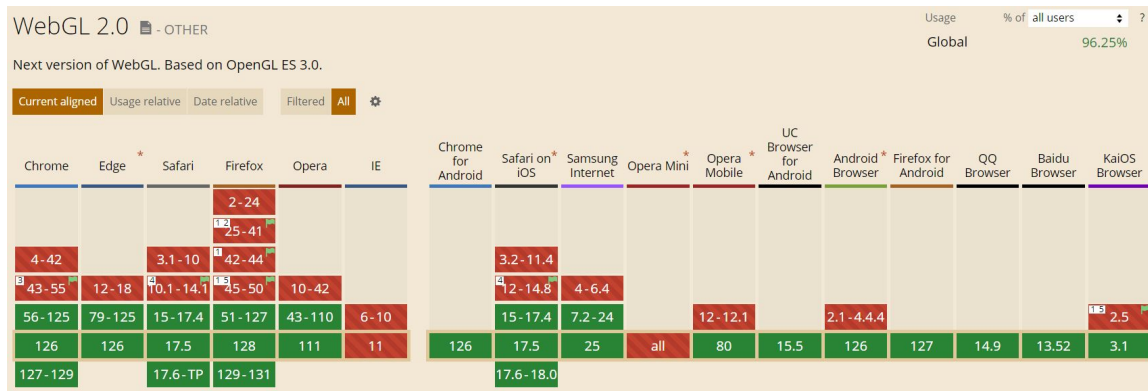**Part of the Khronos BOF Series**

WebGL + WebGPU

Ken Russell
Google

WebGL Update

- **Khronos is fully supporting development of WebGPU at W3C**
  - Working for a smooth transition for developers between WebGL and WebGPU
  - WebGPU brings GPU Compute to the Web using Vulkan/DX12/Metal backends

- **WebGL is pervasive and will be used by many applications for many years**
  - Khronos is evolving the WebGL specification and supporting multiple implementations
  - ANGLE's Metal backend supports WebGL 2.0 in Safari on macOS/iOS
    - Shipping in Chrome on Mac/ARM; coming to Mac/Intel
  - Firefox's WebGL implementation is similarly advancing

WebGL 2.0 is available on >96% of browsers

WebGL 2.0 📄 - OTHER

Next version of WebGL. Based on OpenGL ES 3.0.

Current aligned | Usage relative | Date relative | Filtered | All ⚙

Usage % of all users
Global 96.25%

	Chrome	Edge	Safari	Firefox	Opera	IE	Chrome for Android	Safari on iOS	Samsung Internet	Opera Mini	Opera Mobile	UC Browser for Android	Android Browser	Firefox for Android	QQ Browser	Baidu Browser	KaiOS Browser
				2 - 24													
				25 - 41													
	4 - 42		3.1 - 10	42 - 44				3.2 - 11.4									
	43 - 55	12 - 18	10.1 - 14.1	45 - 50	10 - 42			12 - 14.8	4 - 6.4								2.5
	56 - 125	79 - 125	15 - 17.4	51 - 127	43 - 110	6 - 10		15 - 17.4	7.2 - 24		12 - 12.1		2.1 - 4.4.4				
	126	126	17.5	128	111	11	126	17.5	25	all	80	15.5	126	127	14.9	13.52	3.1
	127 - 129		17.6 - TP	129 - 131				17.6 - 18.0									

Pixel Local Storage Extension

- **Programmable blending and other use cases**
  - Developed by Chris Dalton from Rive with significant contributions from Alexey Knyazev
- **Specification being finalized**
  - In Draft in Chrome Canary
  - Implementation in ANGLE is tracking the spec and can ship soon afterward
  - [Specification](#) | [Source Code](#) | [Live demo](#) implements blend_equation_advanced
  - Enable WebGL draft extensions in about:flags
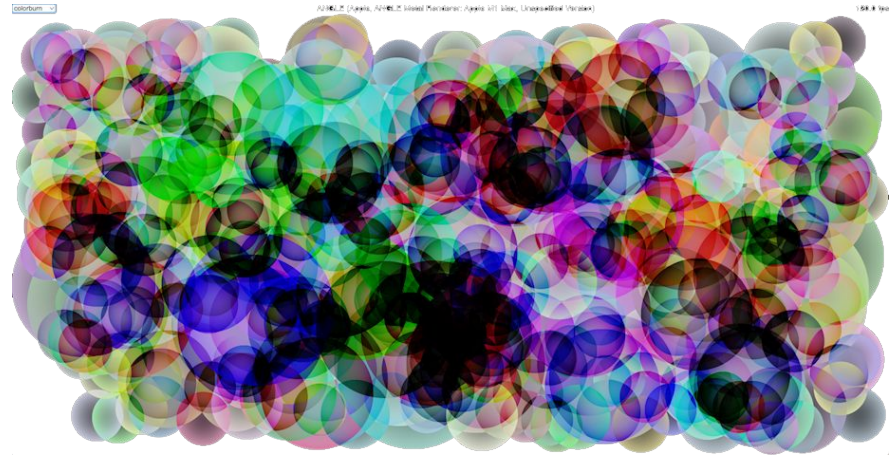
New WebGL Extensions

- **Multiple useful [extensions](#) have been added to WebGL**
  - Ported from OpenGL ES to WebGL
- **These are now shipping in browsers**
  - Enhance, speed up, and simplify applications
  - Always test for the presence of the extension and include fallback paths

[EXT_clip_control](#)

[EXT_conservative_depth](#)

[EXT_depth_clamp](#)

[EXT_polygon_offset_clamp](#)

[EXT_render_snorm](#)

[EXT_texture_mirror_clamp_to_edge](#)

[NV_shader_noperspective_interpolation](#)

[OES_sample_variables](#)

[OES_shader_multisample_interpolation](#)

[WEBGL_blend_func_extended](#)

[WEBGL_clip_cull_distance](#)

[WEBGL_polygon_mode](#)

[WEBGL_render_shared_exponent](#)

[WEBGL_stencil_texturing](#)

WebGPU Updates

- **The WebGPU ecosystem is solidifying!**
- **Firefox Nightly and Safari Technology Preview have WebGPU support today**
  - Try your content and ensure it works across browsers!
- **WebGPU specification is nearing Candidate Recommendation!**
  - Aim to transition to Living Standard afterward
- **Lots of ecosystem progress including [Three.js's WebGPU backend](#)**
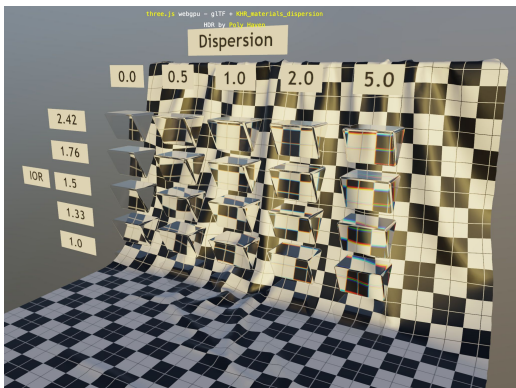
More exciting news in the Khronos WebGL + WebGPU BOF 9AM Wednesday morning!

Khronos Group Sessions at SIGGRAPH

Day	Time	Session Type / Title	Standards
Mon, Jul 29	3:30pm - 4:30pm	Khronos Fast Forward	3D Commerce, ANARI, glTF, OpenXR, Vulkan, WebGL
Tue, Jul 30	8:30am - 11:30pm	glTF: Innovations in 3D Content Delivery and Use	3D Commerce, glTF
Wed, Jul 31	9:00am - 9:30am	Advancements in WebGL and WebGPU ...	WebGL & WebGPU
Wed, Jul 31	10:00am - 11:00am	Exploring ANARI ...	ANARI
Wed, Jul 31	11:00am - 12:00pm	OpenXR: Transforming the Future of Cross-Platform XR	OpenXR
Wed, Jul 31	1:00pm - 3:00pm	glTF: Transforming 3D Asset Delivery for Real-Time Graphics	OpenXR
Wed, Jul 31	3:00pm - 6:00pm	Vulkan, Forging Ahead (including Slang talk)	Vulkan
Wed, Jul 31	6:00pm - 9:00pm	Social: Khronos Group Networking Reception	All
Thu, Aug 1	11:50pm - 12:15pm	Siggraph Talk: Neutral Tone Mapping for PBR Color Accuracy	glTF

Thank You! Have a Great Show!

More Information
www.khronos.org
memberservices@khronosgroup.org