Khronos Fast Forward

Neil Trevett, VP Developer Ecosystems, NVIDIA
Khronos President
Welcome to Khronos Fast Forward!
Highlights of the latest in Khronos APIs plus where to go for more details

https://www.khronos.org/events/2023-siggraph
Khronos Connects Software to Silicon

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

Founded in 2000
~ 200 Members | ~ 40% US, 30% Europe, 30% Asia
Khronos Active Standards

3D Graphics
Desktop, Mobile and Web

3D Assets
Authoring and Delivery

Portable XR
Augmented and Virtual Reality

Parallel Computation
Vision, Camera, Inferencing, Machine Learning

Safety Critical APIs
Khronos Standards for Spatial Computing

- **Embedded camera, sensor and ISP**
  - Vision and inferencing acceleration
  - Sensor Stream
  - Runtime Control

- **OpenVX**
  - Runtime Control

- **OpenCL**
  - Runtime Control

- **OpenXR**
  - XR displays and devices
  - Pose and scene data

- **Vulkan**
  - Runtime Control

- **ANARI**
  - Pixels

- **WebGL**
  - 3D rendering acceleration

- **Kamaros**
  - Augmentation 3D Assets

- **K H R O N O S**
  - 3D Assets

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Khronos and W3C: Bringing XR to the Web

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

3D Stack
Driving GPUs to render scenes and augmentations

XR Stack
Handling XR Devices for creating UI

Engines
three.js, babylon.js, unity, UNREAL ENGINE, GODOT

3D Stack
WebGPU

XR Stack
WebXR
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 will evolve the WebGL specification and support multiple implementations
    - ANGLE's Metal backend supports WebGL 2.0 in Safari on macOS/iOS
    - Coming soon to Chromium on macOS
    - display-p3 support is in progress in Firefox

![WebGL 2.0 is available on 95% of browsers](image)
New WebGL Extensions

- **Pixel Local Storage** Extension
  - Developed by Chris Dalton from Rive
  - Programmable blending and other use cases
  - In Draft in Chrome Canary
    - Enable WebGL draft extensions in about:flags
  - [Live demo](#) implements blend_equation_advanced
    - [source code](#)

- **Multiple useful extensions** are being ported from OpenGL ES
  - EXT_blend_func_extended
  - 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_clip_cull_distance
  - WEBGL_polygon_mode
  - WEBGL_render_shared_exponent
  - WEBGL_stencil_texturing
Visualization, Rendering and ANARI

Many new 3D rendering technologies are available to scientific visualization applications. Techniques such as path tracing provide significant visualization enhancements.

- Ray casting of surface color
- Directional lighting and shadows
- Ambient occlusion lighting
- Directional lighting with ambient occlusion
- Directional lighting with path traced indirect lighting
- Directional lighting with ambient occlusion and path traced indirect lighting

BUT can be complex and time-consuming for domain experts to use low-level rendering APIs. Rendering engines can hide that complexity - and a rich diversity of vendor and open-source rendering engines are now available - BUT every rendering engine uses a different API.

Cross-Platform 3D Rendering Engine API
Simplified application development
Application portability to any engine supporting ANARI
ANARI 1.0 Launched Last Week!

Simplified Application Development
High-level API to describe WHAT is to be rendered not HOW

Application Portability
Common API for ANY rendering-engine independent of vendor, platform or ecosystem

Cross-Platform 3D Rendering Engine API

ANARI 1.0 Finalized
Multiple implementations shipping and open-source SDK available

Scientific Visualization Beachhead
Many types of application will benefit from ANARI
Scientific Visualization Before and After ANARI

ANARI applications are portable to any engine supporting the ANARI API
Independently of vendor, platform or ecosystem
**ANARI Development Stack**

**Scene Graphs**
- Apps and Engines
  - ANARI API used to build in-memory scene representation
  - NO rendering details prescribed
  - C99 frontend API dispatch library with C++ type-safe wrappers
  - Extensible API design with installable development layers

**Acceleration APIs**
- Engines use in-memory scene representation to drive rendering operations
- Explicit control over hardware resources and operations
- Vulkan, OpenGL, DX12, Metal
- Embree, OptiX, Radeon Rays, CUDA, OpenCL, etc.

**Rendering Engines**
- Intel OSPRay, Radeon ProRender, NVIDIA VisRTX etc.

**Hardware**
- CPUs, GPUs etc.

**VMD Rendering using ANARI**
- Minimal Cell, 87M Beads
- Martini v3 force field, U. Illinois

Processing to construct a scene description with application-specific structures, traversals, and metadata
ANARI - Try It Today!

- Open-source ANARI SDK
  - Loadable debug and trace layers
  - Example applications demonstrating ANARI concepts
- Implementations shipping now on rendering engines from AMD, Intel and NVIDIA
  - AMD Radeon ProRender
  - Intel OSPRay
  - NVIDIA VisRTX + VisGL
- ANARI beyond Scientific Visualization
  - Blender and Omniverse

Proof-of-concept Blender Add-On
Amazon Lumberyard Bistro
NVIDIA Open Research Content Archive (ORCA) 2017

ANARI-USD Brings ANARI applications to USD/Omniverse
NVIDIA OmniGraph geometry processing

Give us your feedback and requirements on ANARI GitHub
What rendering features important to your application domain?
For what new application domains and use cases would you use ANARI?
https://www.khronos.org/anari
https://github.com/KhronosGroup/ANARI-Docs
https://github.com/KhronosGroup/ANARI-SDK

ANARI BOF
Khronos BOF DAY, Wednesday 10AM
JW Marriott Platinum Salon D
Vulkan Development on Apple

Vulkan SDK, Layers and Tools on Mac
Streamlines application development for Apple devices

Vulkan SDK
Running on macOS

SPIRV-Cross
Open-source disassembler
Converts SPIR-V shaders to Metal Shading Language

macOS / iOS / tvOS
Vulkan to Metal API Mapping Layer

Hardware Capability Viewer
for macOS and iOS on app store

Profile JSON Config Files

gpuinfo.org
Public Database

Database Export

Database Upload

Vulkan Development in Apple Environments BOF
Wed Aug 9, LACC RM 518, 09:00

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Vulkan Update

Tom Olson, Arm
Vulkan Working Group Chair
Vulkan

A modern API for graphics and compute on GPUs
  • Descended from OpenGL / OpenGL ES
  • Radically cross-platform
  • One API across desktop and mobile

No-compromise focus on performance
  • Driving use case is AAA games

Developer has control / responsibility for
  • Memory and object management
  • Scheduling and synchronization
  • Multithreading
  • Error checking
Vulkan Adoption

Engines
- CIDER
- GODOT
- unity
- source
- Unreal Engine
- Cineview Serious Engine
- NetEase Games
- UX3D
- CINDER
- XENKO
- CRYENGINE

Platforms
- Windows and Linux
- Desktops and Cloud
- Mobile
- Game Streaming Platforms
- Gaming Platforms
- Apple Platforms (via translation layer)

Desktop and Mobile GPUs and SOCs
- AMD
- BROADCOM
- ARM
- Google
- HUAWEI
- IMAGINATION
- NVIDIA
- MEDiatek
- QUALCOMM
- Intel
- Samsung
- VeriSilicon

Note: The version of Vulkan available will depend on platform and vendor

http://vulkan.gpuinfo.org/
Vulkan Adoption: Games

Desktop Games

Mobile Games
Vulkan Adoption: Non-Games

Artwork by Emily Bisset, courtesy of Adobe
Vulkan Adoption: Non-Games

Autodesk Fusion 360 uses Vulkan for cross-platform post-processing and display of simulation results.

See [https://www.khronos.org/blog/vulkan-for-cloud-based-transient-compute](https://www.khronos.org/blog/vulkan-for-cloud-based-transient-compute)
Vulkan: Forging Ahead

Vulkan Update - Tom Olson, Arm / Vulkan WG chair

**Vulkanised 2023**

- Full-scale Vulkan conference in February 2023
  - Hosted by Google in Munich, Germany
  - Three days of talks, panels, demos, and a Vulkan course
  - All online at https://vulkan.org/learn/videos
  - Hoping to repeat in 2024 in US or Asia

**API Evolution**

<table>
<thead>
<tr>
<th>Version</th>
<th>Year</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.0</td>
<td>2016</td>
</tr>
<tr>
<td>1.1</td>
<td>2018</td>
</tr>
<tr>
<td>1.2</td>
<td>2020</td>
</tr>
<tr>
<td>1.3</td>
<td>2022</td>
</tr>
</tbody>
</table>
Vulkan: Forging Ahead

Vulkan SDK Progress - Karen Ghavam, LunarG CEO / Engineering Mgr
Vulkan: Forging Ahead

Teaching Vulkan - Lukas Lipp (TU Wien), Bernhard Kerbl (INRIA)
Vulkan: Forging Ahead

Vulkan at Autodesk - Henrik Edström, Mauricio Vives, Vipul Kapoor, Jasmin Roy

- Vulkan and Open Source Graphics at Autodesk
- Vulkan Ray Tracing in Aurora: An Open-Source Real-Time Path Tracer
- Vulkan for Cross-Platform Viewing of Large AEC Models
- Porting Autodesk Flame from OpenGL to Vulkan

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

https://github.com/Autodesk/Aurora
Vulkan: Forging Ahead

Debugging Vulkan Ray Tracing - Hai Nguyen, independent
Vulkan: Forging Ahead

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(break)

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Thank You!
OpenXR Update

Cristina Scheibler, Dimenco
OpenXR Cross-Platform Portability

Applications and engines can portably access any OpenXR-conformant hardware

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

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

<table>
<thead>
<tr>
<th>Adopted by</th>
<th>Features</th>
</tr>
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<tbody>
<tr>
<td><strong>Microsoft</strong></td>
<td>HoloLens and Mixed Reality Headsets. Hand and eye tracking extensions</td>
</tr>
<tr>
<td><strong>Meta</strong></td>
<td>Rift S, Quest, Quest 2 and Quest Pro. Meta Deprecated own API for OpenXR</td>
</tr>
<tr>
<td><strong>HTC</strong></td>
<td>Vive Focus 3, Vive Cosmos, Vive XR Elite, Vive Wave Runtime</td>
</tr>
<tr>
<td><strong>STEAMVR</strong></td>
<td>Valve Deprecated OpenVR APIs in favor of OpenXR</td>
</tr>
<tr>
<td><strong>VALVE</strong></td>
<td>All Varjo Headsets are fully compliant (VR-1, XR-1, XR-3, VR-3)</td>
</tr>
<tr>
<td><strong>Collabora’s Monado</strong></td>
<td>Collabora’s Monado open-source OpenXR Implementation</td>
</tr>
<tr>
<td><strong>Magic Leap</strong></td>
<td>Magic Leap 2</td>
</tr>
<tr>
<td><strong>XREAL</strong></td>
<td>XREAL Light and XREAL X</td>
</tr>
<tr>
<td><strong>Snapdragon</strong></td>
<td>Qualcomm Snapdragon Spaces XR Development Platform</td>
</tr>
<tr>
<td><strong>Spatial Labs Display Series</strong></td>
<td>Neo 3 and Pico 4</td>
</tr>
<tr>
<td><strong>Spatial Reality Display</strong></td>
<td>(Conformance expected summer 2023)</td>
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# Engines and Browsers with OpenXR Support

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<thead>
<tr>
<th>Engine/Browser</th>
<th>OpenXR Support Details</th>
</tr>
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<tbody>
<tr>
<td>Unreal Engine</td>
<td>Unreal has been providing support since 4.24. UE 5.0 support OpenXR</td>
</tr>
<tr>
<td>Unity</td>
<td>Unity’s OpenXR plugin available since 2020 LTS</td>
</tr>
<tr>
<td>Godot</td>
<td>Godot provides OpenXR support since March 20233 (Core 4.0 Alpha 4)</td>
</tr>
<tr>
<td>stereokit</td>
<td>Open source mixed reality library for building HoloLens and VR applications</td>
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<tr>
<td>NVIDIA Omniverse</td>
<td>NVIDIA Omniverse and CloudXR Platforms</td>
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<tr>
<td>Chrome, Edge and Firefox</td>
<td>WebXR in Chrome, Edge and Firefox uses OpenXR as the default backend</td>
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## OpenXR Games and Applications

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<th>Blender uses OpenXR for native scene inspection in VR</th>
<th>Adobe Substance 3D Modeller uses OpenXR for VR support</th>
<th>Kitware’s Paraview uses OpenXR for VR support</th>
<th>Meta Horizon Workrooms</th>
<th>OpenBrush uses OpenXR for Desktop and Quest support</th>
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<td>War Thunder now uses OpenXR</td>
<td>Cubism uses OpenXR for VR support</td>
<td>Vermillion uses OpenXR for VR support</td>
<td>The Light Brigade uses OpenXR for VR support</td>
<td>XPlane12 uses OpenXR for VR support</td>
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<td>Minecraft uses OpenXR for desktop VR support</td>
<td>Microsoft Flight Simulator uses OpenXR for VR support</td>
<td>Supports over 27 devices thanks to OpenXR</td>
<td>Phasmophobia switched from OpenVR to OpenXR</td>
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OpenXR SDK 1.0.28 - July 2023

- Hand tracking and interaction improvements
- Improved support for Android-based devices
- Mac development support
- New Meta extensions: face tracking and virtual keyboard
OpenXR CTS 1.0.27 - May 2023

- Improvements for Android
- Tests for all supported rendering formats (Vulkan, D3D12, etc)
- Console Only Testing
Coming soon…

• Increased accessibility
• Expanded haptics support
• Controller render models (glTF)
• New extensions
• Tutorials
glTF Update

Alexey Medvedev, Meta
Chair, 3D Formats Working Group
glTF

- PBR
- Interactivity
- Composition Format
- Physics
- Geospatial
- Tooling
- Tutorials
- KTX/Texture Compression

Encouraging broad adoption, including for 3D functionality in PDF and MPEG
glTF

- JPEG of 3D
- glTF<->USD interop
The Evolution of PBR in glTF

Metal / Rough

2017

Clearcoat

2020

Sheen

Volume

Index of Refraction

Transmission

Specular

2021

Clearcoat

Sheen

Volume

Index of Refraction

Specular
The Evolution of PBR in glTF

- Emissive Strength
- Iridescence
- Anisotropy
Interactivity

• A Portable way of describing how the content should *respond to user actions or events*.

Node based graph
Bringing Interactivity to glTF

Interactivity = User input + dynamic changes of the scene state

This new glTF extension:
- Provides blueprint for implementation of Interactive Assets (static geometry + behaviors)
- Empowers development of simple interactive applications (Games, Education, Design Review, e-commerce...)

glTF 2.0 + KHR_interactivity = Interactive glTF
Composition

- Compose scenes and behaviors (in future) from multiple glTF assets
- Designed for efficiency in transmission/delivery use cases: Placement, Configuration, Cache Reuse, Personalization, Deferred Loading, LODs, Mesh Variants
- Composition is extensible, selected future glTF extensions may also be used directly by glTF Composition
- This is a final name for Complex Scenes
- New file extension: .gltfc
Physics

• Express the physics properties of assets in the platform independent way:
  - Collision geometry
  - Rigid bodies
  - Motions
  - Materials
  - Joints
  - Filters
Geospatial

Expand the capabilities of glTF and related technologies to better address the needs and requirements for transmission and display of 3D models, scenes, and interfaces for geospatial applications

- Liaison with Open Geospatial Consortium (OGC)
- Very large data sets
- Specialized data handling (Hierarchical Level of Detail - HLOD)
Tooling and Tutorials

Content Creation
- Tutorial Videos
- glTF-Compressor
- Asset Auditor
- Asset Repository
- glTF support in Blender

Pipeline & Distribution
- KTX Tooling
- glTF-Compressor
- glTF SampleViewer
- glTF on iOS
- Composite Scenes
- Asset Auditor
- Metadata
- Asset Repository
- Blender

Education
- Tutorial Videos
- glTF Sample Viewer
- Project Explorer
- glTF on iOS
- Composite Scenes
- Asset Repository
- Blender

Futures
- glTF SampleViewer
- glTF on iOS
- Composite Scenes
- Metadata
- Asset Repository
- Blender
KTX 2.0 Supports Basis Universal Compression

Compact, visually rich, assets that can be efficiently rendered on diverse platforms

Open-source Basis Universal encoder with supercompression produces compact textures for transmission

Open-source tools pack supercompressed textures into KTX 2.0 container and then pack KTX textures into glTF assets

Open-source C++ and WebAssembly transcoding to GPU compressed formats

Use GPU compressed textures native to platform
- Desktop: BC*
- Mobile: ETC1/2, PVRTC1, ASTC
Short Term glTF Roadmap

- **Behaviors** (inc. animation pointer)
- **Audio**
- **PBR Subsurface**
- **MaterialX Node**
- **Composition**
- **Physics**
- **Animation+ (Blender interface)**
- **Multi-track animation**

- **4Q23**
- **1Q24**
- **2Q24**
- **3Q24**

Finalized Specifications with Initial Implementations
Dan Frith, Avataar
Chair, 3D Commerce | Vice Chair, 3D Formats
Khronos Ecosystem Segmentation

Multiple Khronos standards are often relevant to developers with similar requirements. Khronos currently identifies six such market segments. Working Groups within a segment coordinate and cooperate to develop coherent solutions and outreach programs.
Khronos Ecosystem Segmentation

3D content is poised to become pervasive in retail. Virtual representations of products will be everywhere from ads, web on mobile & computer, Augmented Reality, Virtual Reality to Mixed Reality devices.
glTF Ecosystem
glTF Ecosystem & 3D Commerce

Discover Repositories

Create Tools

Experience Apps / Engines

Drive Demand

Users

3D Asset Format for Efficient Transmission and Processing

http://glTF-Meta.org/glTF-Project-Explorer

VR / AR Authoring Tools

3D Scanning Tools

Converters, Optimizers and Loaders

Validation and Reference Tools

Game Engines

Web Engines

Apps and Engines

VR / AR Apps and Engines

Productivity and Social Apps
Industry Support glTF & 3D Commerce
Importance of standardisation:
- Physical to Digital Consistency
  - Getting as close to the real thing as possible increases e-commerce conversion, online duration for consumers & reduces returns of physical products, increasing brand trust.
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  - Processing & bandwidth can be varied therefore the lower the loading time the better. glTF stores 3D model information in JSON format. The use of JSON minimizes both the size of 3D assets and the runtime processing needed to unpack and use those assets.
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- **Physics, Scene Composition & Interactivity**
  - When compared to traditional 2D methods, 3D converts consumers but adding in Physics, Interaction & Multi-Sku and Scene Composition, consumers can play with e-commerce.
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- **Metaverse & Wearable AR (New Customers)**
  - As new devices become more readily available and more affordable, so does the need to bring a consistent experience in other types of space and device. The demographic changes as does the requirement.
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- **NeRF (Neural Radiance Fields), Machine Learning & AI in 3D**
  - The use of generative AI in 3D Asset & scene creation whilst following standards
We Look Forward to Discussing More Details!

Come to the Khronos Networking Reception on Wednesday evening!
After the Khronos BOF Day in JW Marriott Platinum Salon C/D

https://www.khronos.org/events/2023-siggraph