The Latest on Khronos Standards

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Khronos Standards for Spatial Computing

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

- **OpenVX**, **SYCL**
  - Runtime Control

- **OpenCL**
  - Runtime Control

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

- **Vulkan**
  - Runtime Control

- **ANARI**
  - Runtime Control

- **WebGL**
  - Runtime Control

- **GLTF**
  - Augmentation 3D Assets

- **KTX**
  - 3D rendering acceleration
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

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

WebGL
WebGPU
OpenGL ES
Vulkan

XR Stack
Handling XR Devices for creating UI

WebXR
OpenXR
NVIDIA Omniverse
GODOT
UNREAL ENGINE
stereokit

Engines
three.js
babylon.js
Chrome
Firefox
Unity
Google Chrome
Mozilla Firefox
Unity
Google Chrome
Mozilla Firefox
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 supports multiple implementations
    - ANGLE’s Metal backend supports WebGL 2.0 in Safari on macOS/iOS
    - Coming soon to Chromium on macOS
    - display-p3 wide-gamut color profile support is in progress in Firefox

WebGL 2.0 is available on 95% of global browsers
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
glTF Pervasive Adoption

3D Authoring Tools

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

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glTF and USD

glTF design goals are complementary to authoring formats such as USD

- Designed for compact, fast run-time delivery
- Aligning glTF and USD ecosystems is significant industry benefit
- Khronos working for glTF to be a seamless distillation target for USD with lossless roundtripping
- Designed for powerful authoring collaboration

Innovate on pervasive deployment of proven technology
Optimize for run-time use cases on cloud, desktop and mobile (native and web)
Precise specification and open-source tooling for multi-vendor consistency
Pure file format - no mandated run-time behavior
Be a cooperative distillation target for authoring formats
glTF - 3D Asset Transmission Format

glTF 2.0 is now an ISO/IEC International Standard

Encouraging broad adoption, including bringing 3D functionality to PDF and MPEG
glTF PBR Evolution

Incremental consolidation and meticulous specification of accepted industry practices

- **Clearcoat**
- **Volume**
- **Sheen**
- **Index of Refraction**
- **Transmission**
- **Specular**
- **Emissive Strength**
- **Metal / Roughness**
- **Iridescence**
- **Anisotropy**

Timeline:
- 2017
- 2020
- 2021
- 2022
- 2023
Short Term glTF Roadmap

- **Finalized Specifications with Initial Implementations**
  - PBR Subsurface
  - glTF PBR MaterialX Node
  - Audio
  - Composition
  - Interactivity
  - Physics
  - Multi-track animation
  - Animation+ (Blender interface)

Date Milestones:
- **4Q23**: glTF PBR MaterialX Node
- **2Q24**: glTF PBR MaterialX
- **3Q24**: Multi-track animation
- **2Q24**: Animation+ (Blender interface)
- **1Q24**: Audio
- **4Q23**: Interactivity
- **3Q24**: Physics
glTF Interactivity

- Portable description of how content should respond to user actions or events
  - Interactivity defined by a Node-based graph
- Distillation of engine accepted practice
  - Unity (Visual Scripting), Unreal (Blueprints), Nvidia Omniverse (Action Graph)
  - Similar design process to PBR extensions
- Enables simple interactive applications
  - Games, Education, Design Review, e-commerce
glTF Physics

• Express the physics properties of assets in a platform independent way
  - Enables 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
glTF Composition

- Compose scenes and behaviors 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 by glTF Composition
  - Including behaviors

Final naming of ‘composition’ and .gltfc file extension may change - seeking to avoid confusion with (much more complex) USD composition
KTX GPU Texture Container Format

KTX 2.0 enables universal distribution of supercompressed GPU Textures with on-the-fly decompression to native GPU formats for significant transmission AND memory savings!

Models downloadable here
Khronos and the Metaverse Standards Forum

- The metaverse is driving significantly increased interest in interoperability standards!
- Khronos recognized the need for broad standards cooperation to avoid duplication, eliminate gaps, and gather use cases and requirements
- Khronos bootstrapped the Forum in 2022 and successfully executed the Forum’s transition an independent consortium in April 2023

Khrongos launches the Forum in bootstrap mode to quickly start cooperative work while determining industry interest

37 Founding Companies including Meta, Microsoft, NVIDIA, Epic, Unity, Adobe, Autodesk

The Forum grows to over 2500 Member organizations

Multiple Domain Working Groups working to improve interoperability one project at a time

June 2022

End 2022

April 2023

The Forum incorporates with unanimous agreement from its membership

Independent, self-funded, non-profit industry consortium

The Forum’s mission is to create a wavefront of business opportunities through fostering interoperability ‘brick-by-brick’ on the road to the metaverse
Thank You! Have a Great Show!

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www.khronos.org

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