Topics

1. Paths to interoperability: open standards and open source
2. Principles behind making successful open standards
3. Open standards lifecycle
4. Building industry cooperation around open standards
Khronos Connects Software to Silicon

Open, royalty-free interoperability standards to harness the power of GPUs, multiprocessors and XR hardware

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

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

Well-defined multi-company governance and IP Framework

Founded in 2000

>180 Members ~ 40% US, 30% Europe, 30% Asia
Standards Make Technology Pervasive

Standards are the basis for ubiquitous infrastructure

IEC 60038 Standard voltages
IEC 60228 Conductors of insulated cables
IEC 60269 Low-voltage power fuses
IEC 60320 C13 Connectors and C14 Inlets
IEC 60884 Household Plugs And Socket-Outlets
IEC 61970 APIs for energy management systems

Widely adopted platforms require multiple standards

Making a vision such as the pervasive metaverse will involve a constellation of standards!
Open Standards and Open Source

Open Standard = Shared Specification

Best When ...
- Competitive advantage in implementation innovation
- Industry needs multiple implementations
- Need a stable design target
  But..
- Can take time to generate consensus on a new version
  Conformance testing is vital

Open Source = Shared Implementation

Best When ...
- No competitive advantage in implementation
- Industry consensus to share implementation resourcing
  Need rapid updates
  But..
- Can fork and fragment
  Need governance model clarity
Open Standards and Proprietary Technology

- Technology becomes Proven
  Business interests are better served by cooperation than competition
  Areas of Emerging Consensus
  Beachhead standardization opportunities

- Proprietary Products and Technologies
  Rapid Innovation
  Darwinian testing ground
  Smart Innovators can retain long-term advantage

- Complex and Interdependent Relationship

- Multi-company Governance
  Open Standards
  Do not R&D!!
  Satisfy wider need for technologies
  Thread of continuity for industry forward progress

- Standards Move the Industry Forward
  Frees competitive energy to find new ways to innovate value

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Basic Principles for Successful Open Standards

‘Open’ means...
- Open to all who wish to participate in their creation
- Created under transparent, well-defined multi-company governance
- No company has superior voting or ownership rights
- Designs based on technical merit
- No restrictions on who can implement and adopt

‘Free’ means...
- No charge for access to specification documents
- No charge to users of specifications
- Royalty-free patent license to implementors from all involved in creating the specification
- More Member Patents == More Protection

Industry adoption is the measure of a standard’s success
- Voluntarily, market-driven usage throughout the industry
- Adoption needs an ecosystem to enable effective usage of the standard
How Are Open Standards Made

Enabling applications and engines to portably leverage hardware acceleration

Run-time Optimized 3D Assets
For pervasive deployment and interoperability

3D Graphics
GPU graphics and compute acceleration for native and web platforms

Portable XR
AR and VR runtimes, HMDs and UI

Sensor Processing
Vision and sensor processing, inferencing acceleration

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Khronos Cooperative Framework

Khronos Board
Strategy, budget
and oversight

$\$ 
One vote per
industry member

API Working Groups
(Industry, Academic and
Associate members)

Advisory Panels
Individual industry experts
by invitation, no fee.
Provide requirements and
draft spec feedback

Adopters
Programs

Conformance
Tests
Royalty-Free
Specifications
Implementations, Tools
Documentation, Samples
Educator Guidelines
Courseware Materials

Educators / Certifiers
Create Courses
Training and Certification

Developers
Develop applications
freely using APIs

Adopters
Build conformant
implementation and products

Industry and
Community
Feedback and
contributions on
released materials

Open and
royalty-free. Often open sourced

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Open Standard Lifecycle

- **New Initiatives**
  How does the industry decide to start new standardization initiatives?

- **Cooperative Framework**
  What are the organizational principles that enable effective consensus?

- **IP Framework**
  The legal framework to enable pervasive implementation and adoption

- **Conformance and Adoption**
  Widespread deployment of consistent and protected implementations

- **Building Ecosystems**
  Investing in documentation, tools, education and outreach activities
Khronos New Initiative Process

1. Discussion and consensus on three critical questions before investing time and resources:
   1. Is a standard needed?
   2. Is the right time to create the standard?
   3. Is Khronos the right organization to create it?

If so, capture the use cases and requirements in a Scope of Work Document to enable a Working Group to start design.

Khronos members or non-members

Idea for a new Khronos Initiative

No IP Commitments
High-level requirements and use case discussions only

Khronos organizes a discussion forum
Open to all

Initiative Proposal

Khronos establishes an Exploratory Group to CREATE a Statement of Work
Open to all
Under NDA

Scope of Work

Detailed Cooperative Designs
Work and participants protected by Khronos IP Framework

Khronos Working Group

Khronos Members
Khronos Cooperative Framework

A Safe Place To Cooperate

Membership and Adopters Fees
Non-profit organization
Cooperative investment to build standards
AND their ecosystems

Transparent Processes to Build Consensus
All members have full access to materials and activities
One member One Vote

Membership NDA
Encourages more open dialog between members

Agreed Definition of Conformance
Conformance tests ensure consistent implementations from multiple vendors

IP Framework
Members won’t assert their patents against officially conformant implementations

Any entity, commercial or academic, is welcome to join

Royalty-free Specifications
Conformance Tests and Adopters Programs
Documentation and examples
Open-source SDKs and tools
‘Traditional’ IP Frameworks

SDO Members

Explicit identification of patent licenses needed by specification implementers

Limits on scope of grant to protect Members’ IP portfolios

Open Specification

Implementers

Need clarity on patent license terms from the specification creators to decide whether to adopt

Fewer fees and restrictions encourages wider adoption

Typical Traditional IP Frameworks

SDO Members are asked to list essential patents they are aware of (with license terms for their own)
Some SDOs allow terms with royalties - but typically must at least be reasonable and non-discriminatory (RAND)
Implementers negotiate licenses with SDO Members individually or through a ‘patent pool’
‘Modern’ IP Framework

Khronos Members
Agree to a ROYALTY-FREE reciprocal license to any essential patents they own for any CONFORMANT implementation of a ratified specification (fail-safe and no patents need be disclosed)

License covers only the explicit contents of the specification - not other possible implementation technologies (key to protecting member IP portfolios)

Implementers
Any entity can use a Khronos specification with no trademark or patent licenses at any time

Formal Adopters are enabled to submit Conformance Test Results for trademark license and (optional) reciprocal patent licenses (no negotiation with Khronos or Khronos Members is needed)

Explicit reciprocal patent license in Membership and Adopter Agreements
Enhances mutual protection and clarity
Builds network of licensing protection for the standard from Members and Adopters
Implementation, Conformance and Adoption

Every open standard needs Conformance Tests and an associated Adopters Programs for defining conformance and ensuring cross-vendor portability.

OpenXR
Open source
Conformance Tests

Test Results Review

OpenXR
Adopters Website

Contribute test fixes and enhancements
Submit Test Results

Prototype
OpenXR Implementation

OpenXR Implementer

Use tests to aid development with no charge

Production
OpenXR Implementation

Execute Adopters Agreement. Adopters Fee per specification version. Trademark license and access to Adopters Website to make submit test results

OpenXR
Adopter

Test Results Approved. Khronos grants Trademark and Patent License

Conformant OpenXR can use OpenXR logo and has patent protection under the Khronos IP Framework

OpenXR Working Group

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Open Standards and Open-Source Synergy

Open source is a vital tool at every stage of creating an open standard and its ecosystem.

Specification Source
(CC-BY 4.0)

Definitive Specification
(PDF and HTML under Khronos Copyright)

Conformance Test Source
(Apache 2.0)

Adopter Portal
(for submission and review of test results)

Implementations, SDKs and Tools
(Apache 2.0)

Remixes and Suggested Corrections

Developers
No fees for specification access

Implementers
Free access to conformance tests and specification but no trademark license or IP license for implementation

Adopters
Conformant Implementations gain Trademark license from Khronos and Reciprocal IP license from Khronos Members and other Adopters. Adopter fees waived for bona-fide open-source projects

Open-Source Resources
Made available on GitHub for community use and contributions

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Many standards organizations seek liaison opportunities to leverage or influence each other's work, and avoid duplication of effort, while respecting each other's expertise, processes and IP frameworks.

For example, Khronos's Liaison Agreements are constantly expanding and reflect the diverse ways that industry consortia can productively cooperate.
Liaision Example: 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

XR Stack
Handling XR Devices for creating UI

Engines

three.js
babylon.js
unity
UNREAL ENGINE

WebGL
GPU
WebXR
W3C

OpenGL ES
Vulkan
OpenXR
International Standards

- Most standards are created by Standard Developing Organizations (SDOs)
  - Fast moving industry consortia

- International Standards (IS) are created by multiple national standardization bodies
  - Often constitute the regulatory basis for public procurement of IT goods and services
  - Significantly widens the market recognition of a specification

- ISO/IEC JTC 1 PAS (Publicly Available Specification) Submission Process
  - Enables the transposition of a widely adopted industry standard into an IS
  - The SDO can remain in control of the PAS and IS to prevent fragmentation

- Khronos is the most recent SDO to be approved as a JTC 1 PAS Submitter
  - One of fourteen SDOs globally
  - glTF 2.0 will be Khronos’ first PAS Submission

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<tr>
<th>glTF’s journey to become an International Standard</th>
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<td>May 2021</td>
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<td>Khronos accepted as JTC 1 PAS Submitter</td>
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Closing Thoughts

No standard ever built itself
Participation is the life blood to creating open standards

Creating Standards takes passion and patience
Of those that see the benefits to the industry and society

Please consider getting involved
You will be made very welcome!