Launching the Metaverse Standards Forum
A Case Study

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Topics

What is the metaverse?
How will the metaverse likely be created?
Why the metaverse strongly depends on interoperability
Background to Khronos and its interest in the metaverse
Genesis, purpose and structure of the Metaverse Standards Forum
Progress so far and lessons learned!
The Metaverse Brings Together Diverse Technologies

The Metaverse combines the connectivity of the Web with the immersiveness of Spatial Computing
Combining multiple disruptive technologies

- Advances in GPU-driven real-time photorealistic graphics and simulation
  Scenes, avatars and objects
- Decentralized Trust and Storage
  ID and Reputation
  Economic transactions
  Persistence
- XR – Virtual Reality (VR) and Augmented Reality (AR)
  VR for generated environments
  AR to overlay the real world
- Artificial Intelligence (AI) a.k.a. Machine Learning
  Natural user interfaces
  Scene semantic understanding
  User generated 3D content

Epic MetaHumans
Roblox
Meta Quest Pro
NVIDIA Omniverse
Proto-Metaverse Consumer Use Cases

Enhanced student learning and engagement by transforming how educational content is delivered

Virtual spaces where gamers create their own content

Realistic environments where users can import their own authored assets

Augmenting Reality with persistent geo-locking, linking, occlusion and realistic scene illumination

Microsoft Flight Simulator

Roblox, Minecraft, Manticore

Fortnight, PUBG, Valheim

Realtime, multi-user gaming and socialization

Forbes, iLRN, Virbela

Open AR Cloud, Niantic

Microsoft Flight Simulator
Enterprise Proto-Metaverse Use Cases

Augmented Reality used in guided tasks and remote assistance are proven to boost productivity

Digital twins - virtual representation of a product, process, or place that measures mirrors and its physical counterpart - for monitoring, optimizing and prediction

Spatially indexing and streaming the digitized world for planning, visualization and simulation

Virtual Sports Leagues and immersive viewing of sports events

Immersive Training significantly increases understanding and retention

3D application interoperability for real-time immersive collaborative simulation and design
# Metaverse Reality vs. Hype

<table>
<thead>
<tr>
<th>The Hype</th>
<th>The Reality</th>
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</thead>
<tbody>
<tr>
<td>We will live our lives in the metaverse!</td>
<td>We will choose to use the metaverse when and if it is engaging, insightful and educational – and perhaps more productively than the average of 3 hours a day we on average spend watching TV today</td>
</tr>
<tr>
<td>You will need to plug into a VR headset to access the metaverse</td>
<td>Although VR will deliver some of the most immersive and AR could eventually replace mobile phones, there will be many ways to use Metaverse applications - including phones, tablets and PCs</td>
</tr>
<tr>
<td>The Metaverse will be a wild west of crypto currencies and NFTs</td>
<td>Web3 is a young area of innovation – and is still evolving how to enable systems of decentralized trust for ID, reputation and economic transactions that will be essential to the metaverse</td>
</tr>
<tr>
<td>The Metaverse market will be worth Trillions of dollars $ in the next few years</td>
<td>As with many transformative technologies, its evolution will take longer than we think, but its impact will likely be larger than we first imagined</td>
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How Will the Metaverse Evolve?

The World Wide Web changed the world
But in ways that were hard to predict when it was first invented

*The development of the metaverse will be equally hard to forecast*

Diverse emerging technologies are being brought together in novel ways

- Synthesized visual reality
- Universally portable 3D assets
- Practical XR optics
- Real-time environment scanning and semantics
- End-user 3D content creation tooling
- Accurate physical simulations
- Realistic avatars
- Online personas and social connections
- Machine learning for semantic understanding and assisted content creation
- User identity, security and privacy
- Effective remote social interactions
- Streaming of vast geospatial data sets
- Real-world geo-anchoring with persistence
- IOT sensor networks
- Universal digital twins
- Servers scaling to millions of simultaneous users
- Interoperable run-times
- Online economies and currencies
- Pervasive low-latency wireless connectivity and much more …

Technologies working together at pervasive scale need interoperability standards!

- Standards accelerate market opportunities and drive increased volume
- Reduce consumer confusion
- Increase product capabilities and usability
- Enable focus on differentiated innovation
- Reduce costs and speed time to market

Recent metaverse visibility has significantly heightened industry interest in open standards - some of which have been in development for years

Darwinian Evolution

Elevates technologies and services that gain market success

Creating a wavefront of commercial opportunities as the metaverse emerges incrementally
The Promise of Metaverse Interoperability

Interoperability is the key to the metaverse scaling beyond a series of disconnected silos

Decentralized trust and storage
Enable any service to access and confirm ID, reputation, payments, and ownership with a persistent history

Interoperable 3D objects and avatars
Take your personal avatar and objects you have earned, built or purchased seamlessly across multiple services

Travel between different spaces
With minimal friction and consistent user interface but with agreed ‘border customs’ to respect IP ownership, business models, age appropriateness, gameplay, rendering style etc.

and much more.....

If achieved, this level of interoperability would escalate the economy and utility of the metaverse beyond any single space or service
Ubiquitous Standards for the Metaverse

Industry Standards
Standards are the basis for ubiquitous infrastructure

Multiple Standards
Widely adopted platforms require many hardware and software standards

Constellation of Standards
An open and inclusive metaverse at pervasive scale will need the right standards at the right time – from MANY standards organizations!

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
Khronos “Connects Software to Silicon”

Standards Organization founded in 2000
~200 Members ~ 40% US, 30% Europe, 30% Asia

Non-profit, member-driven, open to any company
Well-defined multi-company governance and IP Framework

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

Khronos APIs used for XR (augmented or virtual reality)
The opportunity of the metaverse arises from combining multiple disruptive technologies

Making technologies work together requires interoperability

Pervasive interoperability to drive the full potential of the metaverse requires widely available open standards

Creating the constellation of open standards necessary for the metaverse will involve diverse standards organizations

Effective cooperation and communication between standards organizations and with the wider industry will foster the standards we need sooner

A venue for cooperation between standards organizations and the wider industry to foster the development of interoperability standards for an open and inclusive metaverse

Khronos sees industry metaverse activity creating unprecedented interest in its standards

Khronos initiates and funds the formation of a non-incorporated (for a fast organizational bootstrap) cooperative forum to gauge industry interest
Better Metaverse Standards – Sooner!

- Coordination and cooperation between Standards Developing Organizations (SDOs) and wider industry
- NOT another SDO! All standardization ‘heavy-lifting’ continues at existing SDOs
- Open to all, no participation fee, no NDA, no patent licensing
- The Forum exists to accelerate the mission of its members – including SDOs and advocacy organizations
Forum Launch FAQ

- Is the Forum going to try to ‘define and solve the metaverse’?
  - No! The focus will be on practical, actionable interoperability projects that can ‘move the needle’ on aspects of the metaverse that are needed today by broad consensus. We are ‘baking the open standard bricks’ for the metaverse, not trying to ‘build the whole cathedral’

- Is the Forum a new standards organization?
  - No, the Forum is a unique venue to coordinate requirements and support for existing SDOs developing standards relevant to the metaverse

- Is the Forum competing with other metaverse-related organizations?
  - No! We welcome other organizations to join the Forum, and we hope that the opportunity for wider visibility and cooperation can help them further their mission

- Why is Khronos acting as host?
  - Promoting industry cooperation is part of Khronos’ mission, our membership requested we help bootstrap the Forum as an open, neutral forum for the benefit of all. Khronos is a non-profit and is funding initial Forum operations. Khronos receives no special membership rights, and is willing to help the Forum evolve to meet industry needs
Today - Over 2300 Members and Counting

Wide diversity of organizations, including...

**SDOs**
Khronos, W3C, Open Geospatial Consortium, IEEE, OMG, ASWF, Spatial Web Foundation, VRM Consortium, XRSI, OMG, Open AR Cloud, OMA3 ...

**Platforms**
Meta, Microsoft, Sony, Google, Baidu, Huawei, General Motors, RedHat, Siemens, Tencent, Mozilla, Paramount ...

**Tools and Engines**
Epic, Unity, Adobe, Autodesk, Ottoy, Maxon, Cesium, ESRI, Blackshark.ai, Croquet, Lamina1, Niantic, Ready Player Me, DGG, Manticore ...

**XR**
HTC, Magic Leap, Nreal, Panasonic, Tobii, 2Space ...

**Hardware**
NVIDIA, Intel, AMD, HP, Acer, Dell, Qualcomm, Samsung, Sony, MediaTek, Oppo, Lenovo, ZTE, LG ...

**Wireless and Networking**
China Telecom, Deutsche Telekom, T-Mobile, Verizon, NTT, AT&T, Telefonica, Juniper, Comcast ...

**3D Commerce**
Alibaba, Alvanon, Avataar, CLO, Browzwear, IKEA, VNTANA, Metaverse Fashion Council, Target, Wayfair ...

**Universities and Institutes**
Stanford, John Hopkins, Yale (XRP), Queens University Belfast, University Salford, New York Institute Technology, APMG ...

**Advocacy**
XRSI, AREA, XR Association, VRAR Association, XR Guild, Web3 Marketing Association, International Virtual Reality Healthcare, Swiss Institute for Disruptive Innovation, IOT Consortium, Metaverse Japan, RIAA ...
Organizing for Effective Forum Action

1. Gather interoperability Topics from all members
Online input from all members on actionable topics that need improvement today!

Over 200 topics suggested and counting, for example:
- Database of metaverse standards
- Taking 3D assets between worlds
- Asset LODs
- glTF / USD interoperability
- Avatar customization / animation
- 3D Apparel and Fashion
- Cloth Simulation
- Metaverse traversal
- Geospatial ontologies
- Geospatial streaming
- Decentralized User ID
- Ethical framework
- User privacy
- Child safety
- Payment frameworks
- Etc. etc..

2. Organize Topics into Domains
Consensus on member interest AND where the Forum can add industry value

<table>
<thead>
<tr>
<th>Topics naturally falling into Domains</th>
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<tbody>
<tr>
<td>Privacy, Safety, Security, Inclusion</td>
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<tr>
<td>Interoperable 3D Assets</td>
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<tr>
<td>Real/Virtual World Integration</td>
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<tr>
<td>Identity (was User Identity)</td>
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<tr>
<td>Avatars and Apparel</td>
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<tr>
<td>Teaching, Education, Certification</td>
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<tr>
<td>Metaverse Standards Register</td>
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<tr>
<td>XR and UI</td>
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<tr>
<td>Metaverse Definition</td>
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<tr>
<td>Networking</td>
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<tr>
<td>Geospatial</td>
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<td>Payments and Economy</td>
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<td>Runtimes and Object Model</td>
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<td>Governance and Advocacy</td>
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<tr>
<td>Video Broadcasting and Meetings</td>
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<td>Forum Outreach</td>
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<tr>
<td>Tooling and Creators</td>
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<tr>
<td>Gaming</td>
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<td>Health and Medical</td>
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<td>Performance and Scalability</td>
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<td>Business Analytics</td>
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3. Create Domain Working Groups
Make recommendations and work products publicly available

Any Forum member can propose and participate in any Domain Working Group

Forum Working Groups focus on effective, pragmatic projects to enhance short business opportunities:
- Generating requirements for standards development
- Interoperability testbeds and plugfests
- Open-source tooling
- Recommendations and guidelines
- Etc.
Forum Working Group Pipeline

**Metaverse Standards Register**
Publicly available database mapping the landscape of metaverse-relevant standardization activities

**Privacy, Cybersecurity & Identity**
Recommendations for responsible innovation that mitigates human and societal harm from privacy risks

**gltF/USD 3D Asset Interoperability (visuals, behaviors)**
USD and glTF cooperation to increase synergy and reduce duplication of effort, gaps, and fragmentation

**Asset Management (web3, protection, digital rights)**
Digital rights, protection, portability, access, availability

**Interoperable Avatars**
Cross-platform avatars and characters for film, gaming, fashion and social platforms

**Digital Fashion/Wearables**
Clothing (including layering), shoes, hats, accessories

**3D Web Interoperability**
Enable the broadest possible interoperability of Metaverse Content using the Web

**Real/Virtual World Integration (Digital twins, IOT)**
Constructs to describe and integrate the physical world and created representations

**Network Requirements and Capabilities**
Constructs to describe and integrate the physical world and created representations

https://metaverse-standards.org/domain-groups/
Example Asset Interoperability Testbed Project

- **Goals**
  - Confirm asset behaviours and attributes satisfy use cases
  - Test publishing and transmission pipeline
  - Exercise interoperable behaviours in multiple runtimes
- All engine and platform vendors invited to participate
- Cooperative shared open-source and assets

**Tools create assets using open standards**

**Run time engines ingest and process assets**

**USD-based tools**
Author assets and publish into glTF

**Web-based Configurator**
Material variants

**Runtime Demos**
Open door, start engine
Drive course with physics simulation
A Unique Cooperative Opportunity

Broad global participation in the Forum enables a unique opportunity for metaverse standards cooperation, coordination and leadership for Forum members to accelerate their objectives.

Comprehensive, international gathering of industry requirements and expertise in Forum Working Groups.

Any Forum member can propose, lead, contribute to, participate in, or monitor Domain Working Groups.

Wide visibility and adoption of Forum initiatives.

The Forum receives regular requests for cooperation from organizations such as the World Economic Forum and the ITU.
Lessons and Next Steps

- Model of layered cooperation is proving to be productive and could apply to other domains
  - If there are multiple SDOs and companies in a domain that could benefit from closer cooperation

- Don’t stay unincorporated if there is strong industry participation
  - Corporation shields participants from lability and enables membership funding
  - The Forum just incorporated as a 501(c)(6) – and is adding a paid membership tier to fund ongoing activities

- Automate a streamlined online joining process if expecting significant participation
  - Gather member profiles on joining - size, location, domains of interest - to better understand your membership

- Coordinate outreach and response to media enquiries as well as standardization work
  - The Forum established a speaker bureau that has been effective in handling significant outreach opportunities

- Provide training and support to Working Group Chairs on logistics and organizational goals and norms
  - Turnover is typically more dynamic than organizations evolving multi-generational standards

- Challenges?
  - The general economy right now
  - The metaverse hype cycle – the downs AND ups

As always, multi-organization cooperation can provide the thread of continuity for industry forward progress as quarterly results and daily news cycles swirl and evolve
Get Involved!

A unique opportunity for metaverse standards cooperation, coordination and leadership in many domains
Often driving increased participation in existing standardization
The Forum needs experienced standards professionals to help create and promote effective cooperation in multiple metaverse-related activities
The Forum is open to any organization!

https://metaverse-standards.org/
Background
Open Standards Make Technology Pervasive

INTEROPERABILITY standards define precise COMMUNICATION
E.g., software to hardware, client to server, organization to organization

Open Standard = Shared Specification

Open Source = Shared Implementation

Open standards with rigorous conformance testing enable consistency across multiple implementations that can meet the needs of diverse markets, price points, and use cases.

Open standards often use open source to spread the implementation effort for sample implementations, tools, samples, conformance tests, validators etc...
Personal Journey

1992
3D Graphics on PCs

1994
Vice President

2000
3D Graphics Standards
President

2003
3D Graphics on Mobile Phones

2005
Vice President

2011
3D Graphics on the Web
Netscape Example
Need for Embedded API Standards

A truly OPEN standard
Is not controlled by a single company - but is under multi-company governance
Is freely available to use by any company without royalty payments

Bad Standards
- Overprescribes implementation details
- Forces everyone to implement a lowest common denominator
- Stifles innovation
  -> Commoditization

Good Standards
- Prescribes only interoperability
- Enables implementation diversity
- Encourages innovation
  -> Differentiation

Open Standard APIs in Embedded Markets

Enable cross-platform software reusability
Decouple software and hardware for easier development and integration of new components
Provide cross-generation reusability
Facilitate field upgradability
# Open Standards Why’s, When's and How’s

<table>
<thead>
<tr>
<th>WHY</th>
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<tbody>
<tr>
<td><strong>Grow Markets</strong></td>
<td>By reducing consumer confusion and increasing capabilities and usability</td>
</tr>
<tr>
<td><strong>Reduce Costs</strong></td>
<td>By sharing ecosystem development between many companies and driving volume</td>
</tr>
<tr>
<td><strong>Speed Time to Market</strong></td>
<td>With well-proven functionality, testing and interoperability</td>
</tr>
<tr>
<td><strong>Enable Innovation</strong></td>
<td>Free companies compete on value differentiators: quality, performance, power etc.</td>
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<table>
<thead>
<tr>
<th>WHEN</th>
<th></th>
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<tr>
<td><strong>Proven Technologies</strong></td>
<td>Don’t do R&amp;D by standards committee</td>
</tr>
<tr>
<td><strong>Consensus Need</strong></td>
<td>The downside of not having a standard is clear to all</td>
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<thead>
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<tr>
<td><strong>Multi-company governance</strong></td>
<td>Avoid single-company control or dependency</td>
</tr>
<tr>
<td><strong>Well-defined IPR Policy</strong></td>
<td>Royalty-free standards have clearer path to wide adoption</td>
</tr>
<tr>
<td><strong>With Extensibility</strong></td>
<td>Enable a responsive innovation pipeline to meet customer and market needs</td>
</tr>
<tr>
<td><strong>Thoughtful Abstraction</strong></td>
<td>Focus on interoperability and avoid over specifying implementation which stifles innovation</td>
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</table>
Standards Developing Organizations in the Forum so far

- ASWF (Academy Software Foundation)
- CALCONNECT
- CES (Consumer Technology Association)
- enosema
- EXPRESS Language Foundation
- IEEE (Advancing Technology for Humanity)
- KHRONOS Group
- OMG (Object Management Group)
- Open Geospatial Consortium
- Open AR Cloud
- OMI Group
- Spatial Web Foundation
- VFX and Animation
- Scheduling
- Consumer
- Concept Management
- Information Models
- XR and Networking
- Run time APIs and file formats
- Business
- Geospatial Standards
- Connecting physical and digital worlds
- Open Metaverse
- IOT and Digital Twins
- IEEE P2874
- Volumetric Format Association
- Avatars
- X3D
- VFX and Animation Concept
- Management
- Information Models
- XR and Networking
- Run time APIs and file formats
- Business
- Geospatial Standards
- Connecting physical and digital worlds
- Open Metaverse
- IOT and Digital Twins
- IEEE P2874
- Volumetric Format Association
- Avatars
- X3D
Forum Organization

Any entity interested to participate (not individuals)

Any member may choose to become a Principal at any time

**Principal Agreement**
- Designated as Principal in outreach materials

Yes

- Wish to commit effort to Forum oversight, and/or considering funding projects?

No

**Participant Agreement**
- Designated as Participant in outreach materials

**Principals**

- **Oversight Committee**
  - Refine Charter as needed
  - Approve Domain Working Groups
  - Project Funding
  - Logistics and scheduling

**Domain Working Group Meetings and Activities**
- Create Charter Documents
- Project Execution

**Plenary Meetings**
- Discussion and Discovery
- Priorities and Goals
- Domain Working Group Proposals

Forum initiated and hosted by Khronos for fast organizational bootstrap

- **Principal Good Standing**
  - Votes = 2 out of last 3 meetings
  - Active Principal = 1 out of last 4 meetings

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- Wish to commit effort to Forum oversight, and/or considering funding projects?

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- Create Charter Documents
- Project Execution