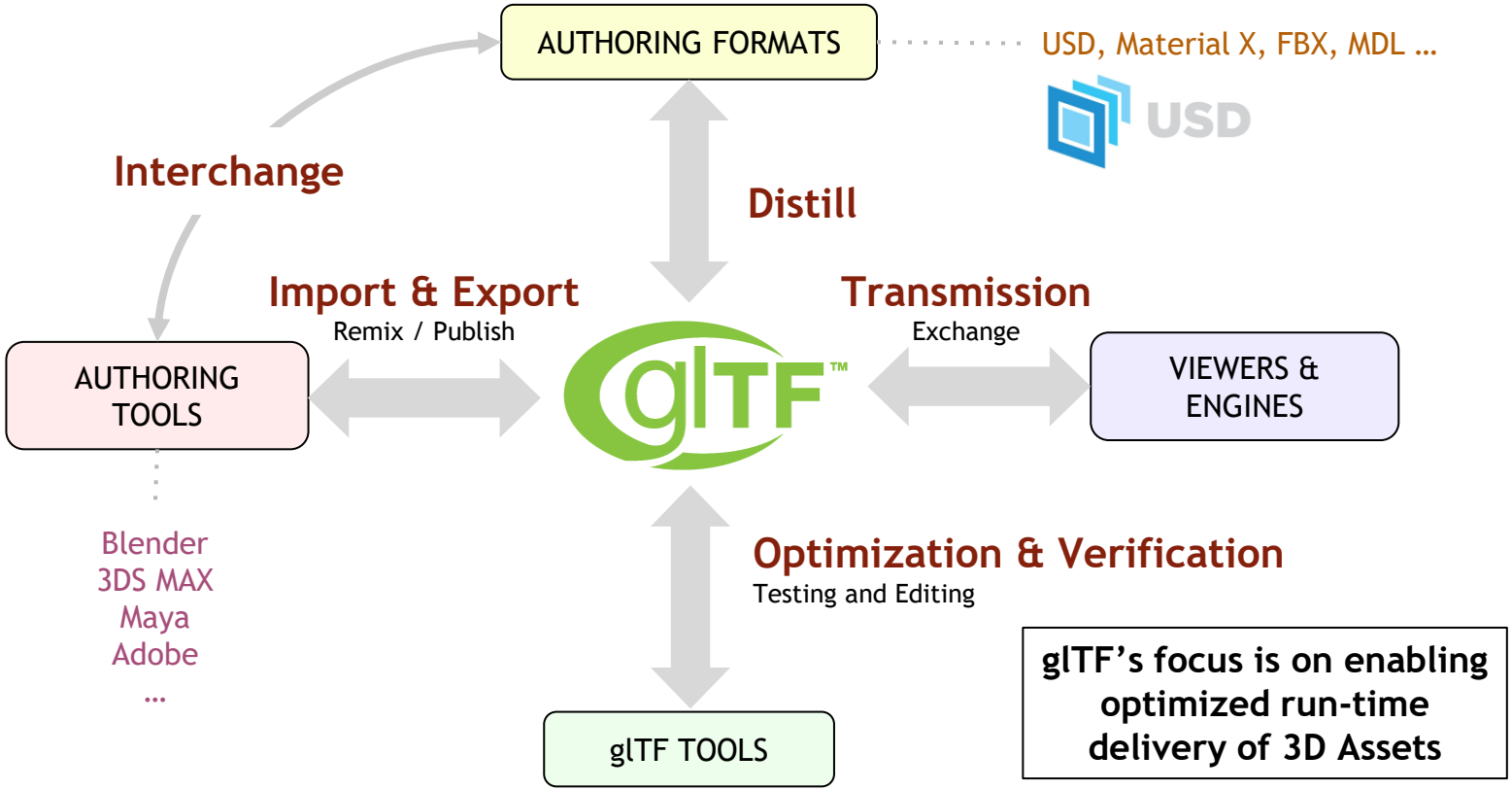
glTF: Transforming 3D Content Delivery for Real-Time Graphics

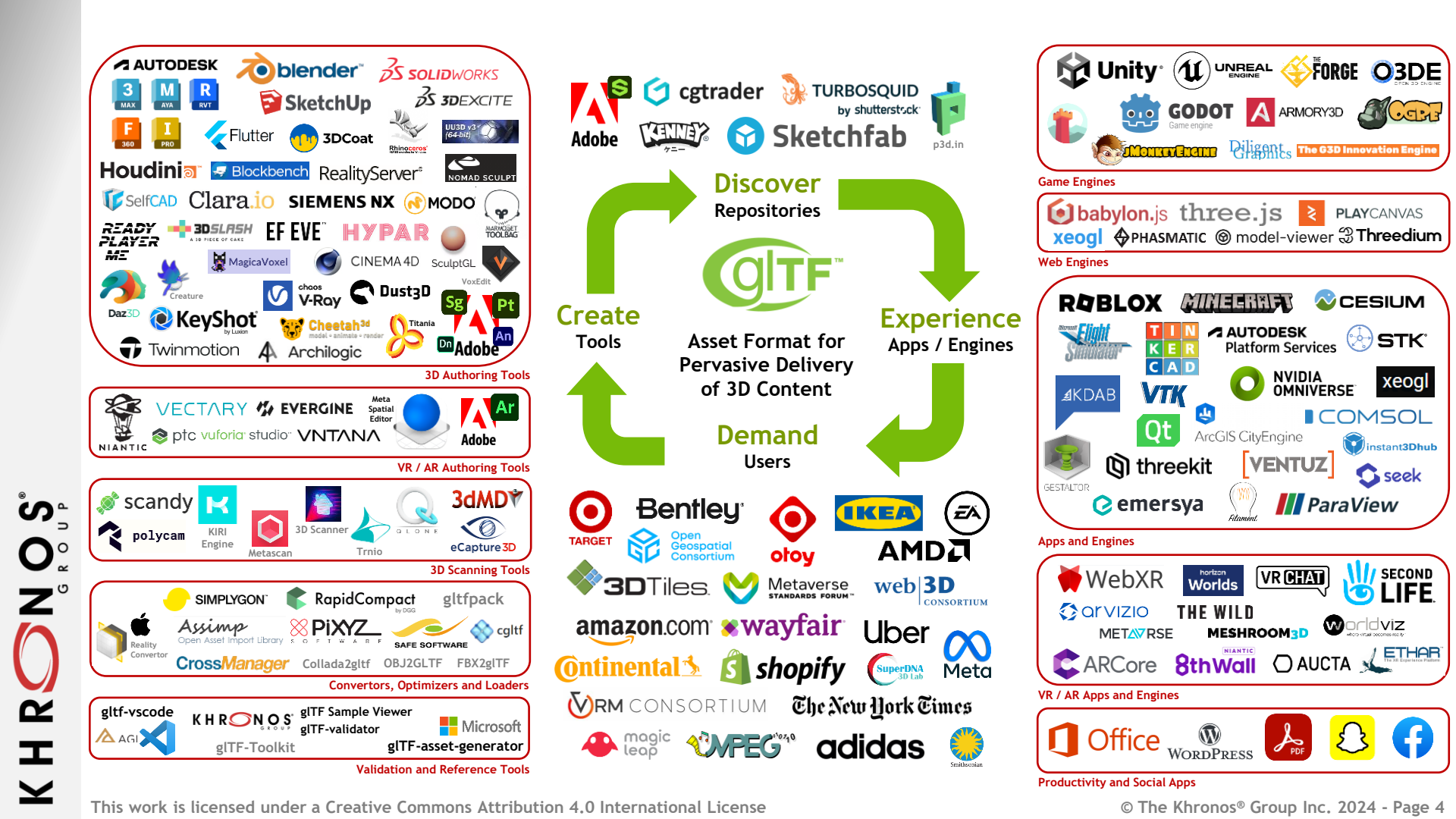
Khronos, VRM Consortium, Huawei

Speakers

Session Title	Speaker	Length
Khronos glTF and 3D Commerce Updates Metaverse Standards Forum	Neil Trevett, Khronos	20 minutes
The VRM Interoperable Avatar Standard	Hideaki Eguchi, VRM	15 minutes
glTF for Asset Sharing	Dr. Cai KangYing, Huawei	15 minutes
Audience Q&A	All	10 minutes

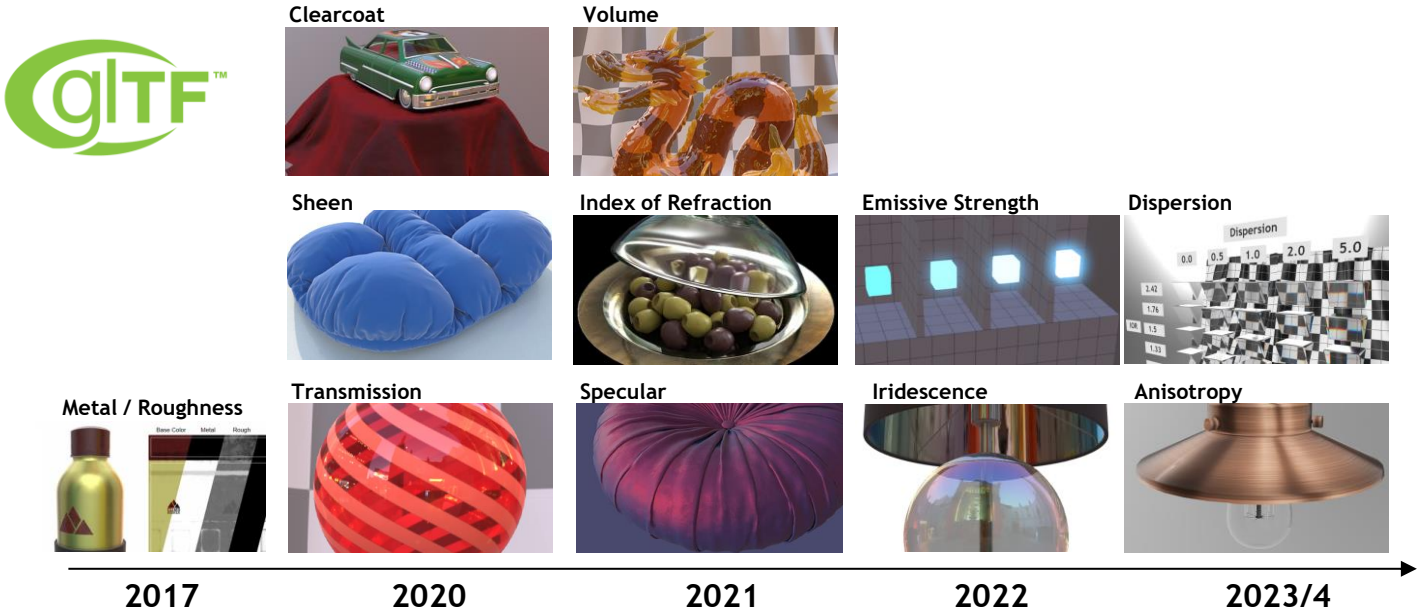
glTF - 3D Asset Transmission Format





glTF PBR Materials Roadmap

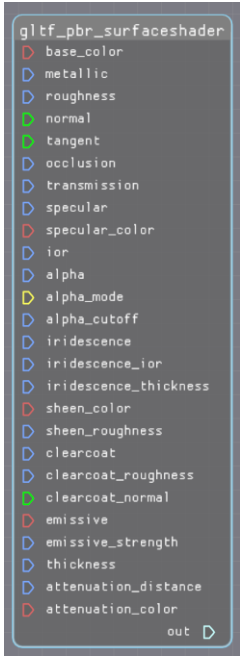
Incremental consolidation and meticulous specification of proven and accepted industry practice *as it becomes pervasively deployable*



Subsurface
In development

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

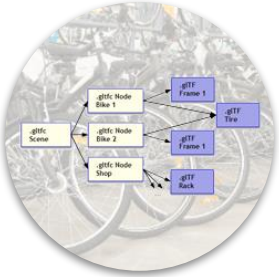


glTF Spatial Computing Roadmap

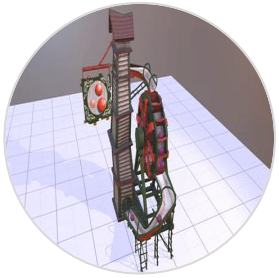
Interactivity

Node-based graph handling of user actions or events

Compose complex scenes from referenced glTF assets
Efficiency and flexibility in transmission/delivery use cases



Complex Scenes



Physics

Describes physical properties of assets

Triggered and controlled from interactivity node graph
3D spatialized audio with 6DoF source/listener capabilities,
Play, stop, pause, loop, and speed controls
Splitting, merging, up/down-mixing, reverb, filtering

Audio

glTF Interactivity

- **Portable description of how content should respond to user actions or events**
  - Defined by a Node-based graph – sweet spot between flexibility and security
- **Distillation of engine accepted practice**
  - Unity (Visual Scripting), Unreal (Blueprints), Nvidia Omniverse (Action Graph)
- **Node graph provides flexible scene updates**
  - Any scene state can be used in the calculation/animation of any other scene state
- **Enables simple interactive applications**
  - Games, Education, Design Review, e-commerce

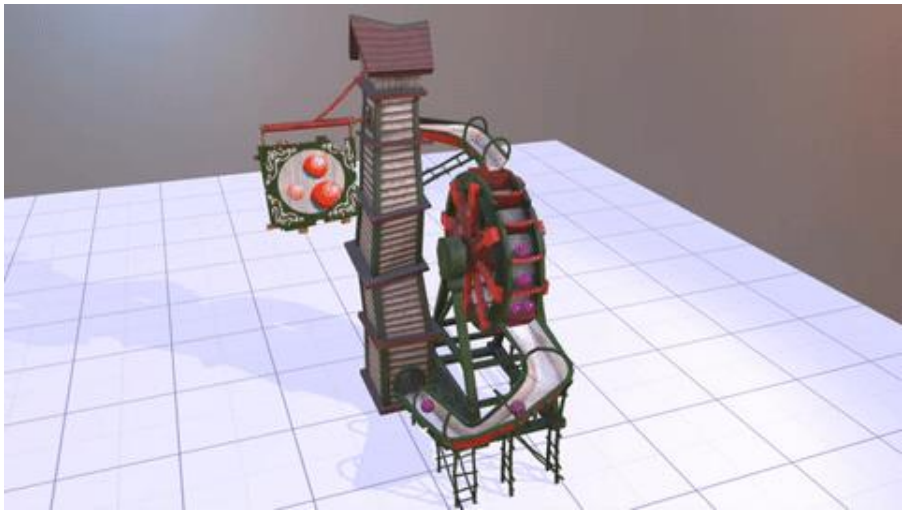
glTF 2.0

Interactive glTF

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

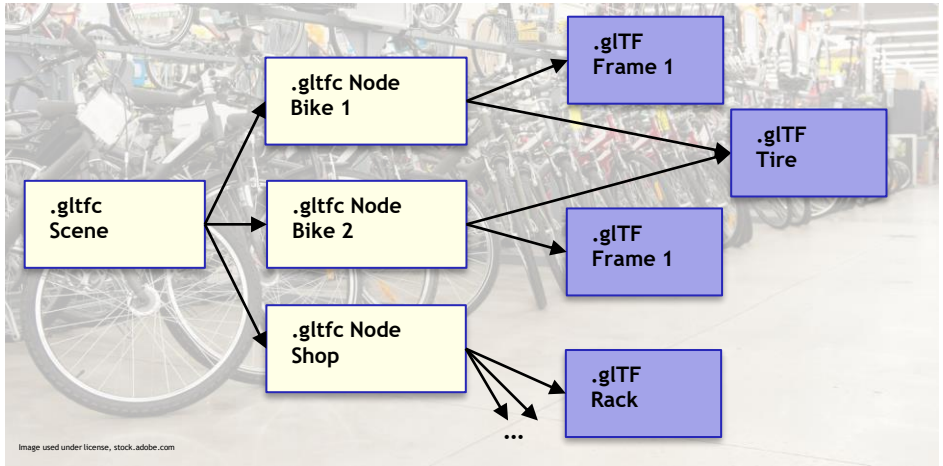
Distillation of widely adopted physics engines practices



glTF External References

- **Compose scenes from multiple glTF assets**
  - External glTF files references
- **Designed for efficiency in transmission/delivery use cases**
  - Placement, Configuration, Cache Reuse, Personalization, Deferred Loading, LODs, Mesh Variants

Join in the ongoing discussions at
https://github.com/KhronosGroup/glTF-External-Reference/tree/main/explainers



glTF Roadmap Overview

	Baseline Today	Short Term **Roadmap (23-24)**	Roadmap **Discussions**
Geometry	Draco Mesh Compression meshopt Compression		Quads, SubDiv Vector Displacement Implicit spheres and strands? Nerfs, Gaussian Splats
External References		Placement, Configuration, Cache Reuse, Personalization, Deferred Loading, LODs, Mesh Variants	
Textures and Materials	KTX 2.0 textures w Basis Universal Material Variants PBR Core + PBR Extension Wave 1-4	PBR Wave 5: Subsurface Scattering MaterialX Node graph update HDR Universal Textures Video Textures, Procedural Textures	PBR: Diffuse Transmission, Material X Procedural Textures
Animations	Keyframe/Skinned	Blender-compatible animation	Multi-track animation/blending Skeletons, Rigs and Anchors Animation Compression
Lights	Punctual Point, spot, and directional		IES, Rectangular Area Dome/Image
Interactivity		Node-based Behavior Graph	
Physics		Collisions, Rigid Bodies, Joints	Deformable Bodies
Audio		Playback (e.g., play, stop, loop), Spatial audio, Signal processing (gain, delay, pitch, reverb, filtering), multiple channels with splitting, merging Animation control and dynamic update of node properties	

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, Cloth Simulation, Virtual Try-On, Stitching / detailing

Content Developers test and validate assets

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

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

Sample Viewer
Asset Display Exemplar

Validator
Asset Correctness

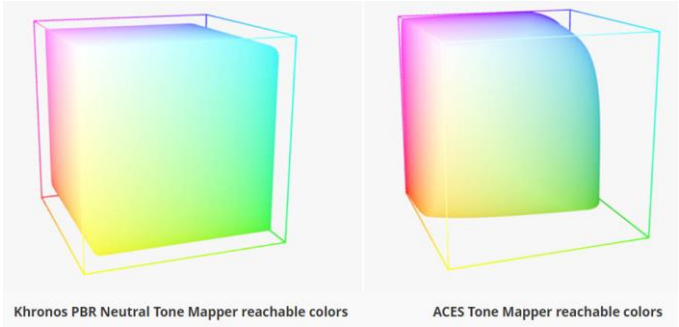
Asset Library
Showcase & Test Assets

Asset Generator
Generate unit tests

Render Showcase
Web-based display comparisons

Khronos PBR Neutral Tone Mapper

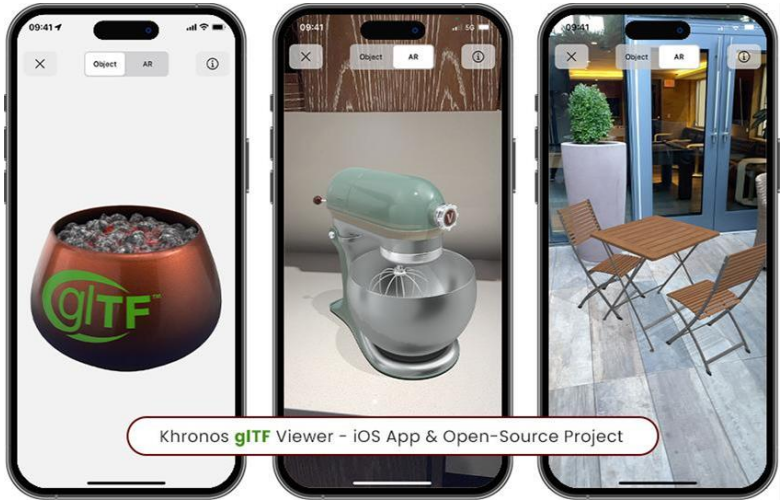
- **True-to-Life Color Rendering of 3D Products**
  - Released in May 2024
  - Specification and sample implementation
- **1:1 match for colors up to a certain maximum value**
  - The remainder of color space used as headroom for compressed highlights
- **Wide adoption and support by 3D tools and engines**
  - <model-viewer>, Autodesk, Babylon.js, Blender, Dassault, Filament
  - London Dynamics, Phasmatic, Three.js, and ThreeKit



glTF Viewer for iOS

OPEN-SOURCE

- **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



Metaverse Standards Forum

***Assist* standards organizations in their mission to create interoperability in 3D, AI, XR etc.**

Gather broad input to inform standards development and drive visibility, adoption, testing and usage

Enable standards organizations to leverage each other's work and minimize overlaps/fragmentation

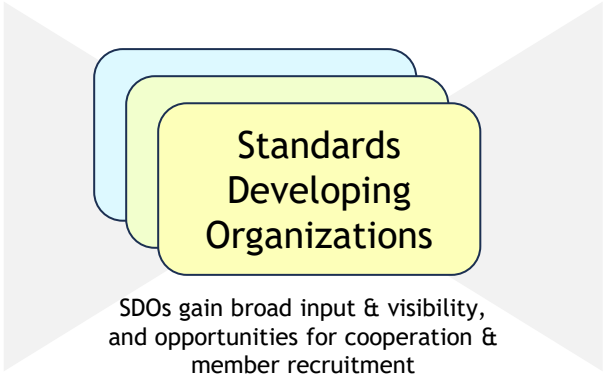
Pre-standardization

Identification of standardization gaps

Discovery of opportunities for standards organizations to leverage or align each others work

Create broad consensus on use cases and requirements

Generating reviews and feedback for draft specifications



SDOs gain broad input & visibility, and opportunities for cooperation & member recruitment

Post-standardization

Interoperability testing and testbeds

Development of conversion and layering tools

Publication of educational materials, reports, best practices & guidelines etc.

Bottom-up, pre- and post-standardization activities help address urgent 'pain points' creating a wavefront of short-term business opportunities on the road to an open, standards-based metaverse

USD and glTF Interoperability Working Group

The Forum's glTF/USD 3D Asset Interoperability Working Group is enabling communication and cooperation between the glTF and USD communities

550 Members in the Forum working group includes many participants from both SDOs AND broader industry

Wide cooperation complements 1-1 liaisons between SDOs

glTF™

KHRONOS GROUP

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

Metaverse STANDARDS FORUM™

Cooperation between glTF and USD ecosystems is a significant industry benefit

Alignment over requirements and roadmaps

Pragmatic projects to address immediate, real-world interoperability pain points

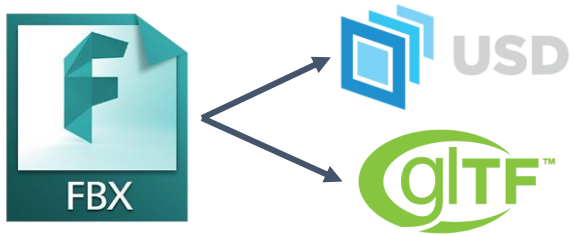
OpenUSD

AOUSD Alliance for OpenUSD

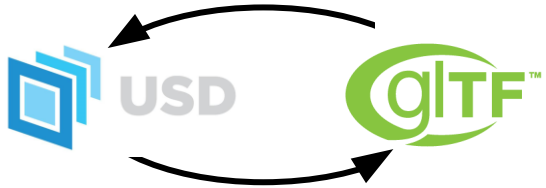
Extensible framework and ecosystem for describing, composing, simulating, and collaboratively navigating and constructing 3D scenes

USD and glTF Interoperability Working Group Projects

- **Initiate pragmatic projects to address immediate, real-world interoperability pain points**
  - Discovery and exploration of interoperability issues
  - Testbeds to exercise existing or prototype interoperability solutions
  - Development of guidelines, documentation, or open source tooling to address and expand interoperability
  - Create USD/glTF specification recommendations to AOUSD/Khronos standardization bodies
  - All results to be publicly distributed
- **Two initial projects being initiated**
  - Any organization is encouraged to join the Forum to participate



FBX Migration Project



glTF ⇄ USD Interoperability Project

glTF as Foundational Standard

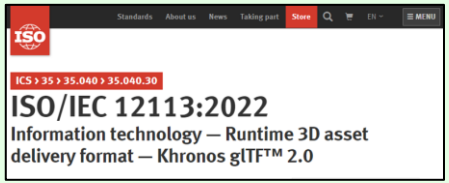
Khronos welcomes working collaboratively to leverage glTF extensibility

Market-specific extensions and use of glTF defined by partner standards organization
Accelerates development of market segment functionality
Avoid needless duplication and fragmentation

VRM	3D Tiles	MPEG	X3D	PDF	Additional Market Segments
Avatar Format *.vrm extension*	*.b3dm and .i3dm extensions*	ISO 23090-14:2023 MPEG-I *.mp4, miv, ivr*	ISO 19775-1:2023 X3D4 *.x3d extension*	ISO/TS 32007 glTF in PDF *.PDF extension*	

glTF™

Foundation of
Core specification and
glTF working group extensions

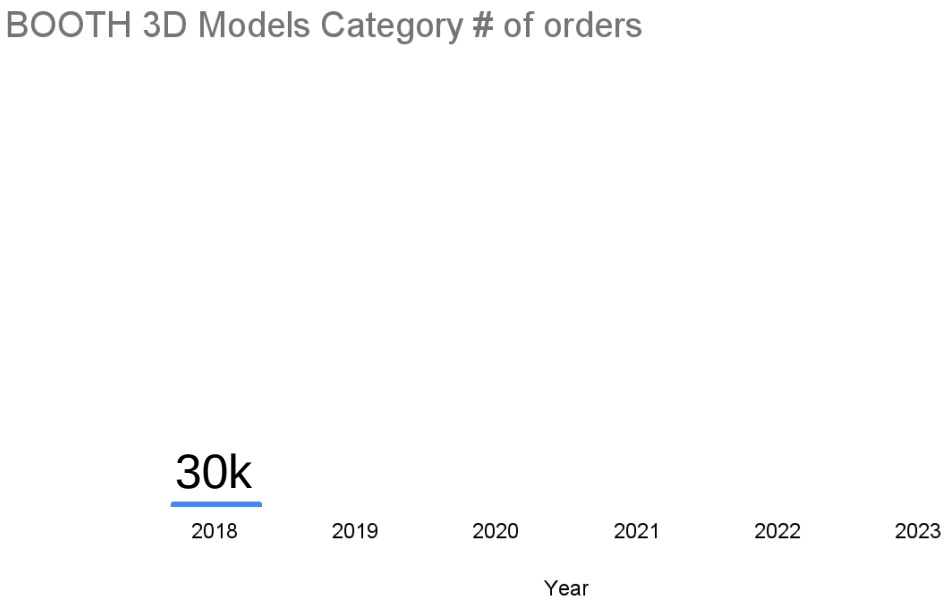


VRM Interoperable Avatar Standard

Hideaki Eguchi, VRM Consortium

The Avatar Market is Growing Steadily

According to BOOTH, the number of orders placed for the 3D models category has seen steady growth since 2018.



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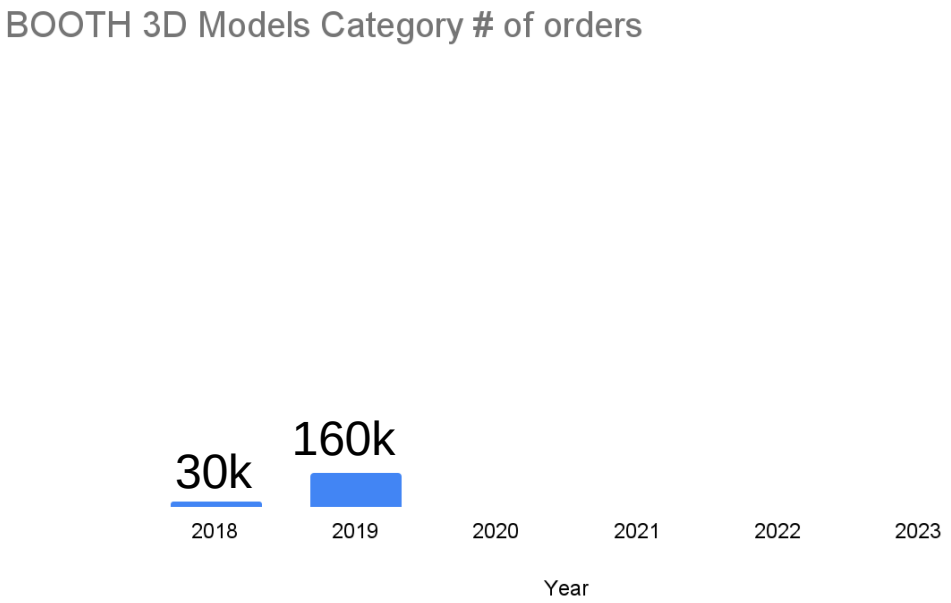

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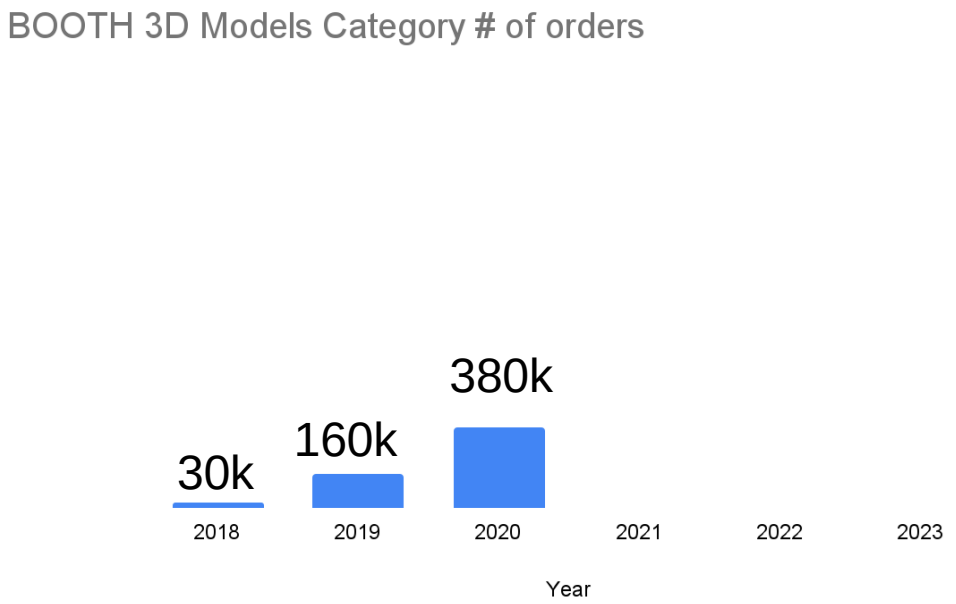

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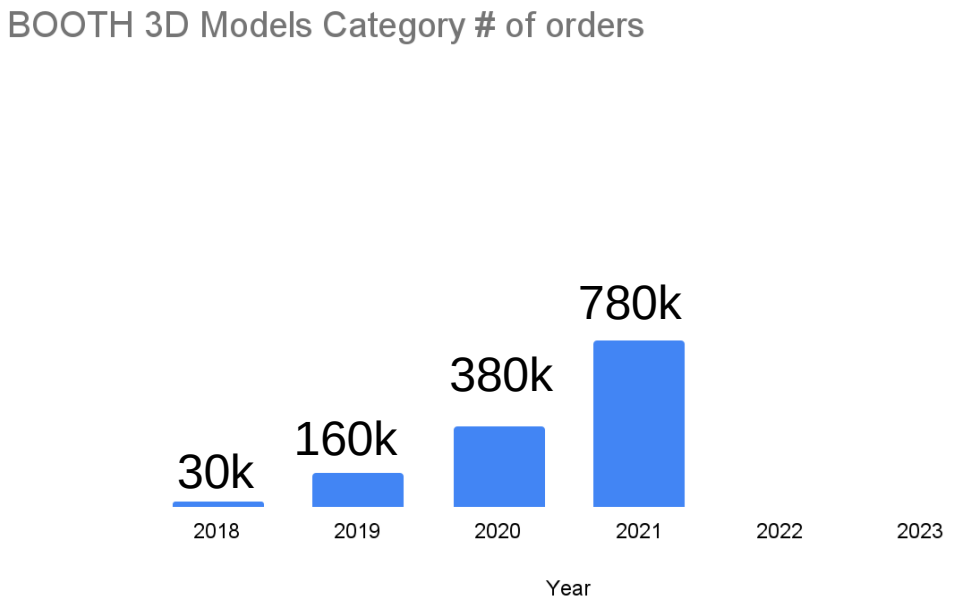

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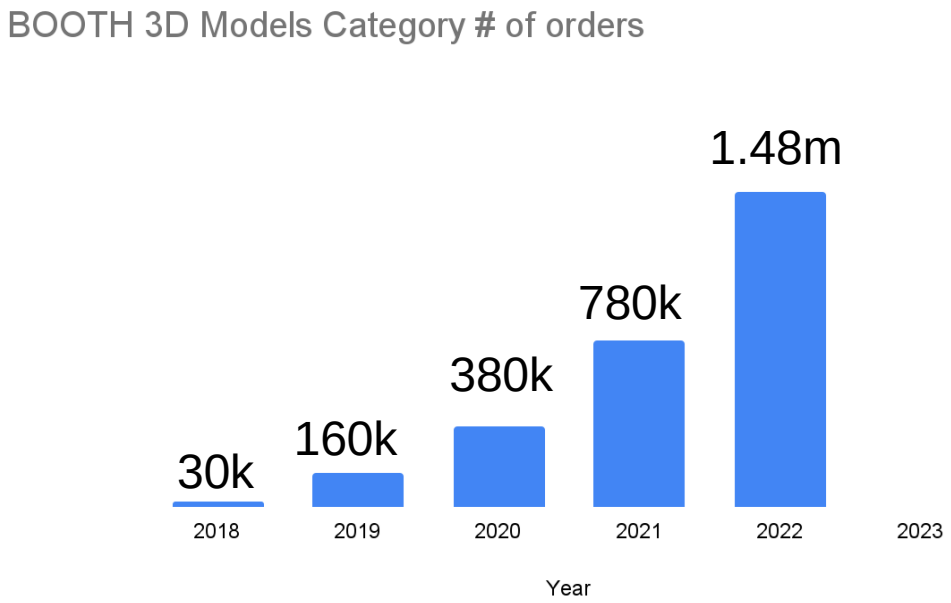

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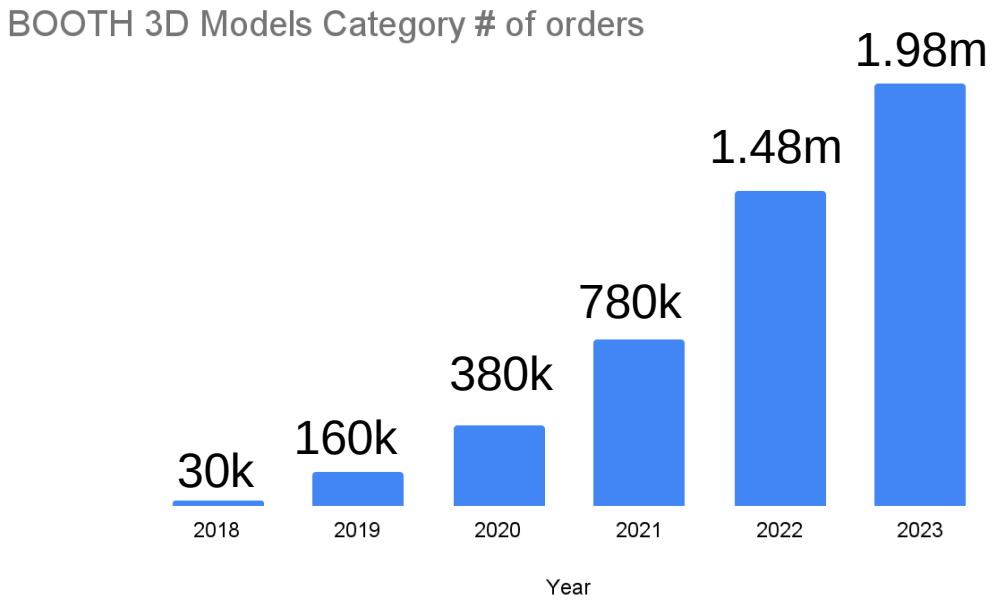

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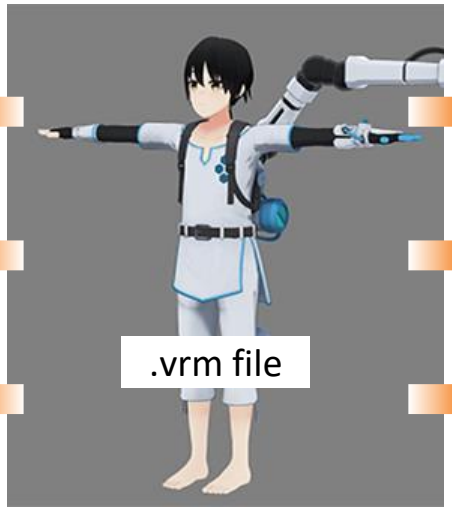
VRM: The Interoperable Avatar Format

Generate VRM file using a 3D avatar creation tool



Metaverses

Avatar streaming tools

VR space meeting services

VR space communication

VR game (Let's play)

Live show

Cross-platform VR world connection and collaboration

VRM: glTF extensions

VRM is a collection of extensions for glTF

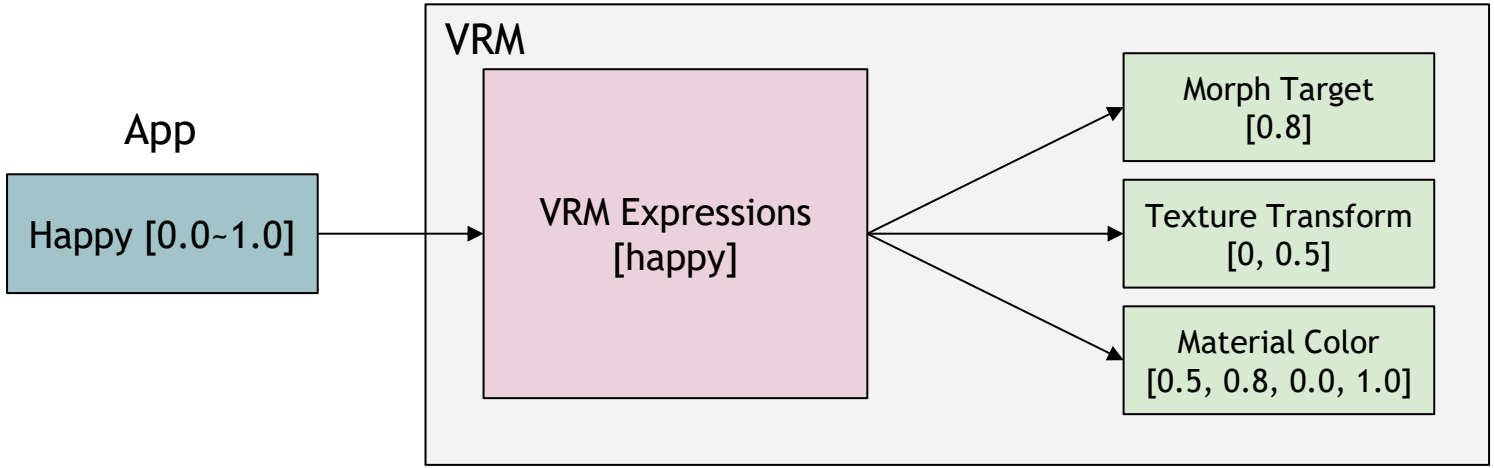
- VRMC_vrm
  - humanoid: bone structure
  - meta: author, license, etc.
  - firstPerson: FPV camera, meshes to hide for FPV
  - expressions: eye movement, lipsync, facial expression
  - lookAt: eye rotation range
- VRMC_materials_mtoon
  - Toon shading spec
- VRMC_springBone
  - Spring-like procedural animation (hair)
- VRMC_node_constraint
  - Roll constraint, aim constraint, rotation constraint

```
{
  "extensionsUsed": [
    "VRMC_vrm"
  ],
  "extensions": {
    "VRMC_vrm": {
      // VRM extension
      "specVersion": "1.0",
      "humanoid": {},
      "meta": {},
      "firstPerson": {},
      "expressions": {},
      "lookAt": {},
    },
    "VRMC_springBone": {},
    "VRMC_node_constraint": {}
  },
  // glTF-2.0
  "materials": [
    "extensions": {
      "VMRC_materials_mtoon": {}
    }
  ],
}
```

https://github.com/vrm-c/vrm-specification/tree/master/specification

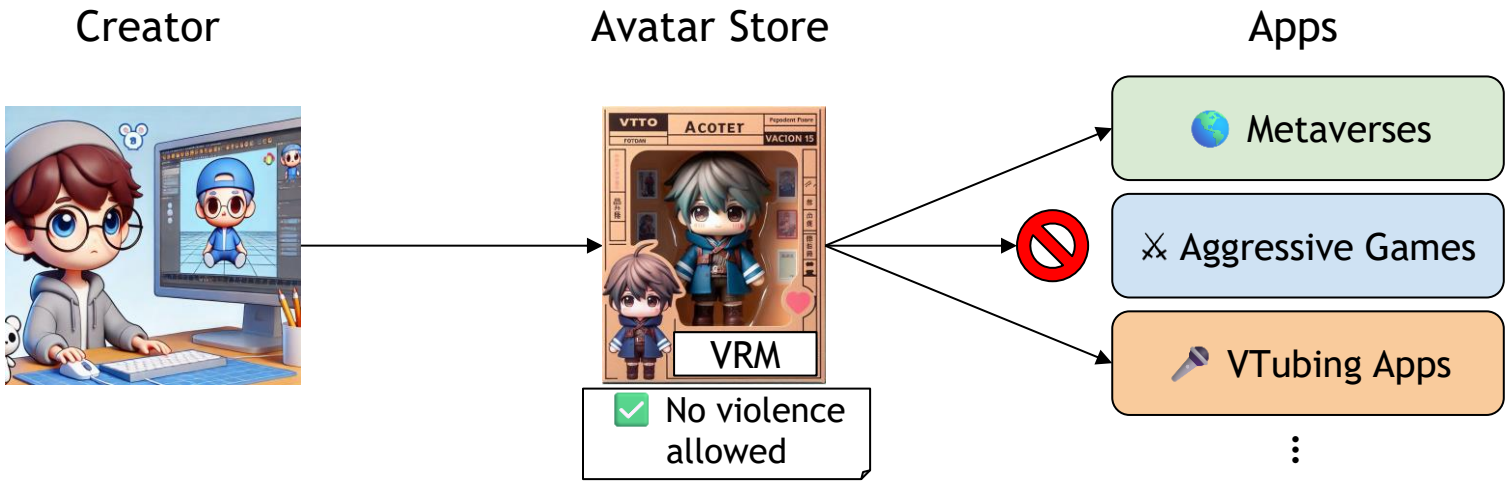
VRM for App Developers

- VRM provides a unified set of APIs for controlling any avatar.
- Officially maintained importer library for Unity
- The community-maintained library for Three.js, Godot, Unreal, Blender and more
- Over 2 million avatars are already in existence, waiting to be imported into your app.**(VRoid Hub)**



VRM for Avatar Creators

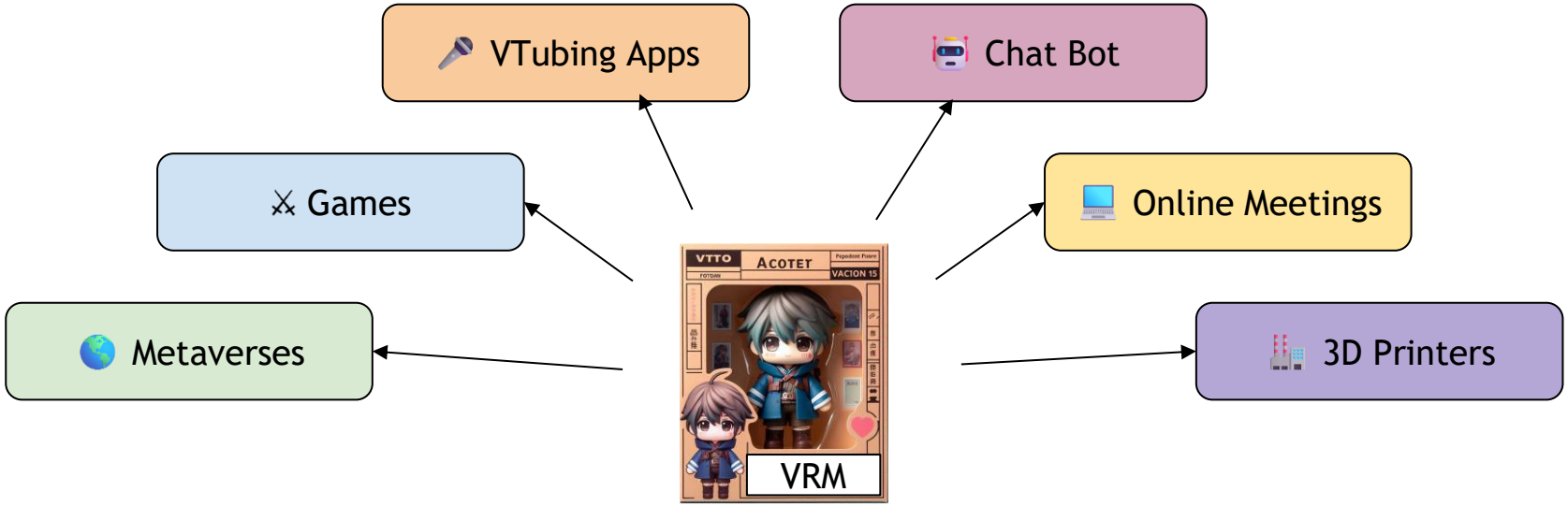
- Create an avatar conforming to a single standard, sellable to users of dozens of different applications
- Pre-defined avatar license which can be configured to meet basic avatar needs.
- Common avatar features: spring physics, toon shading, binary expression



Images generated with Copilot

VRM for Users

- Purchase one avatar which can be used in dozens of different apps
- Everything is in a single file: Easy handling, no conversions

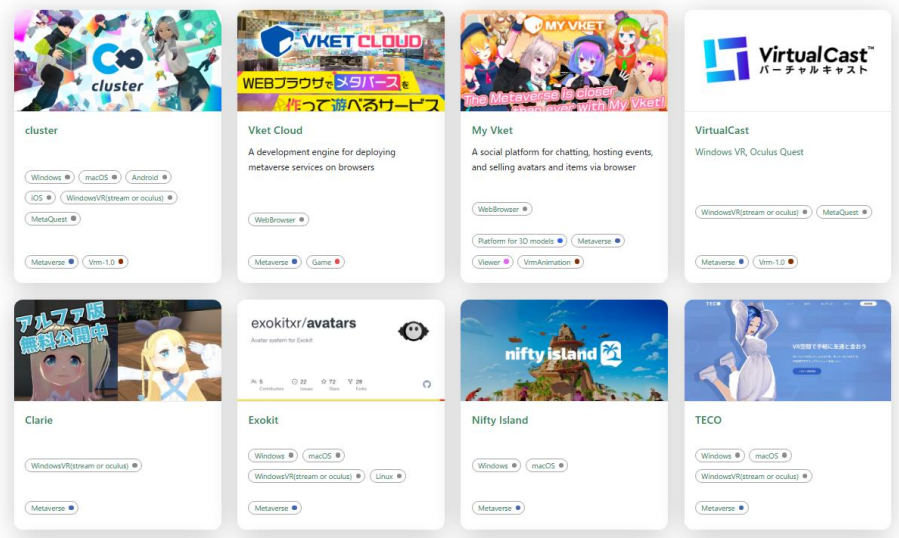


Images generated with Copilot

VRM: Success in Japan

VRM is widely accepted as a interoperable avatar format in Japanese dev communities

- In our showcase page, 176 apps and tools has been reported to support VRM format
- Over two million avatar is uploaded to VRoid Hub alone



VRM: To be International

We are already seeing growing enthusiastic support for VRM outside of Japan

With the collaboration between The Khronos Group and VRM Consortium, we will explore integrating VRM functionality into glTF, increasing the reach and presence to international communities

glTF: Transforming 3D Content Delivery for Real-Time Graphics

Dr. Cai KangYing
Sr. Technology Researcher, Graphics Standards

Khronos BOFs at SIGGRAPH Asia

Day	Time / Room	Session Title	Standards and Projects
Tuesday 3rd	1:00-2:00PM, G408	Khronos Fast Forward	Vulkan, OpenXR, Slang, ANARI, glTF
Wednesday 4th	1:00-2:00PM, G407	Slang Shading Language	Slang
Wednesday 4th	3:30-4:30PM, G407	Immersive Web with Khronos and W3C	WebGL, WebXR, WebGPU, three.js
Thursday 5th	2:15-3:15PM, G407	OpenXR Update and Roadmap	OpenXR
Thursday 5th	3:30-5:30PM, G407	Vulkan Update and Ecosystem	Vulkan, Vulkan SC, Slang
Friday 6th	1:00-2:00PM, G408	glTF 3D Transmission Format	glTF, VRM Avatar Format

All BOF slides and videos will be uploaded to the
Khronos SIGGRAPH event page

SIGGRAPH ASIA 東京 2024 TOKYO 3–6 DEC

Khronos BOFs

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