



Metaverse Standards Forum

NFT Metadata for the Metaverse (Avatar)

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Reviewer	Due Date	Status	Contact
Digital Asset Management Working Group	September 24, 2025	Complete	digital_asset_management@lists.metaverse-standards.org
MSF Domains (Peer Review)	October 30, 2025	Complete	oversight@lists.metaverse-standards.org
Use Case Taskforce	October 31, 2025	Complete	use_case_task_force@lists.metaverse-standards.org

The purpose of this template is to provide a structured framework for collecting and documenting use cases within the Metaverse Standards Forum (MSF). Use cases are essential for understanding real-world scenarios where metaverse technologies are applied and where interoperability challenges may arise. This template guides MSF members in providing a concise yet comprehensive description of a use case, including its title, identifier, and summary. It also encourages contributors to list the benefits of the use case, identify actors or entities involved, and describe the use case scenario in detail, emphasizing interactions, challenges, and requirements. Additionally, it prompts the inclusion of relevant technical information, such as implementations, success metrics, and challenges faced. This template aims to facilitate the gathering of valuable use-case data to inform standards development and foster collaboration within the MSF community.

MSF members and MSF Domain Groups are invited to submit use cases.

NOTE: Organizations such as SDOs who want to submit and add a use case would need a sponsor that is an MSF member. This process is established in order to have a contact person in MSF that can handle discussions and resolve open issues within regular meetings.

Eligible submitters:

- MSF Domain Groups
- MSF Members (Principal and Participant)
- External Organizations with Liaison Agreements (with the support of a MSF member that acts as sponsor)
- Standard Development Organizations (with the support of a MSF member that acts as sponsor)

Minimum Requirements for MSF Member Submissions not part of a Domain Group:

- Minimum required number of proposers: 3
- Minimum required number of supporters: 5

NOTE: Use cases submitted by SDOs and Liaison Organizations would also need to fulfill the same requirements (and would need a sponsor) unless they are submitted by a Domain Group.

MSF: Metaverse Standards Forum

POG: Pre-qualified Organizations and Groups

SPP: Standards Related Publications and Projects

DWG: Domain Working Groups

WG: Working Group

SDO: Standards Development Organization

Use Case Title
NFT Metadata for the Metaverse (Avatar)
Use Case Identifier
MSF2025-NFTA-001 • Version 1.0 • Year of Release: 2025
Summary of Use Case
Description: This use case focuses on standardizing metadata for NFT-based avatars within metaverse platforms. It aims to enable the creation, customization, ownership, and interoperability of avatars across various virtual environments. By establishing a consistent metadata framework, users can transport their avatars with maintained appearance, functionality, and identity, ensuring a seamless experience when moving between different metaverse platforms. Benefits: • Ensures consistent cross-platform functionality and visual fidelity of NFT assets. • Improves discoverability and categorization of assets through standardized metadata tagging. • Supports asset ownership and provenance tracking, enhancing security and user trust. • Facilitates compliance with industry standards, benefiting creators, users, and Platform providers. • Reduces user friction by enabling cross Platform portability of avatars.



- Supports ecosystem growth for creators and Marketplaces through consistent metadata and discoverability.

Contributors and Supporters

- Digital Asset Management Working Group
- MSF Domains (Peer Review)
- Use Case Taskforce

Keywords

3D Character Modeling, Asset, Audience Interaction, Avatar, Avatar Customization, Avatar Interoperability, Avatar Translation Framework, Biometric Avatars, Character, Cross-Platform, Decentralized Identity (DID), Digital Performance Art, Digital Identity, Digital Storytelling, Digital Theater, Digital Twin, E-commerce, Gaming, Games, Immersive Experience, Interactive Entertainment, Interactivity, Interoperability, Metadata, Metaverse, Metaverse Standards, Multi-platform Distribution, NFT, Provenance, Simulated Environments, Virtual Event Production, Virtual Goods, Virtual Presence, Virtual Production Software, Virtual Reality (VR), Virtual Set Design, Virtual Stage Production

Actors/Entities

- **NFT:** Represents the digital asset with its metadata securely recorded on a blockchain, containing essential information about the asset's properties, provenance, and compatibility.
- **NFT Creators:** Individuals or organizations responsible for designing and minting NFTs with standardized metadata to ensure cross-platform compatibility.
- **NFT Minting Tool:** Software used to mint NFTs, facilitating metadata creation, schema adherence, and export in a standard format for interoperability.
- **Metaverse Platforms:** Virtual environments that enable users to access, use, and transfer NFT assets. These platforms rely on standardized metadata to ensure consistent rendering and functionality.
- **Users/players:** End-users who own, equip, or interact with NFTs across platforms. Users expect consistent functionality, ownership verification, and easy access to their NFTs across metaverse environments.
- **Chain:** A blockchain network that maintains immutable NFT ownership records and a pointer (URI) to the asset's metadata, while ensuring the underlying data security and verifiability of all maintained records
- **Marketplace Providers:** Platforms that facilitate the discovery, sale, and/or exchange of NFTs, relying on standardized metadata to enhance asset discoverability and classification.
- **Wallet:** A secure user-controlled digital tool for storing, managing, and interacting with NFTs, enabling seamless access, transactions, and interoperability across platforms.



- **Avatar:** The digital representation of a user within metaverse platforms, serving as customizable characters that embody users in virtual environments and enable interaction across different platforms.

Detailed Description of Use Case/Scenario

Preconditions:

- **Metadata Adoption:** Metaverse platforms adopt and support the standardized avatar metadata.
- **Minting Compliance:** Avatars are minted (created) using the agreed-upon metadata structure.

Main Flow:

1. **Customize Avatars:** Creators develop avatars and define essential metadata properties (e.g., file format, resolution, usage terms) using the governing metadata model.
2. **Mint Avatar:** The minter mints the avatar along with metadata sufficient for cross-platform interpretation, enabling recognition and appropriate rendering by participating platforms. This metadata includes the creator's digital identity, asset details, usage rights, and a unique identifier (e.g., contract address, token ID).
3. **Interact with Environments:** Avatars interact with virtual environments and other users as intended. Standardized metadata ensures behaviors like movements, expressions, and interactions are preserved across platforms.
4. **Use Avatars Across Platforms:** Avatars serve as a persistent digital identity, enhancing user recognition and reputation. Standardized metadata allows avatars to participate in platform-specific activities (e.g., games, social events) seamlessly.
5. **Initiate Translation:** User attempts to bring avatar from Platform A to Platform B. Platform B identifies the source format and rigging system.
6. **Execute Translation:** Translation capabilities convert the avatar's 3D model, rigging, and animations to Platform B's requirements. Avatar appearance and functionality are preserved through the translation while adapting to platform-specific constraints.

Postconditions

- **Consistent Identity:** Avatars maintain persistent functionality, appearance, and user recognition across all supporting metaverse platforms.
- **Seamless Functionality:** Avatars function correctly and appear consistently across all supporting metaverse platforms.
- **Verifiable Ownership & Standards Compliance:** Ownership and provenance remain verifiable via blockchain, while assets adhere to discoverability and categorization standards, ensuring seamless integration and compliance across platforms.

Implementations and Demonstrations or Technical Feasibility



Implementations and Demonstrations

AI-Generated Avatar Systems

- [**Avaturn \(in3D\)**](#): Generates full-body, rigged avatars from selfies with blendshape support; exports for engines/workflows. Supports .fbx, .glb formats.
- [**Didimo**](#): Cloud-based photo-to-avatar pipeline for high-fidelity, rigged digital humans (head+body) integrated into apps. Supports .fbx, .gltf/.glb formats.
- [**Inworld**](#): AI-driven character brains and dialog systems for Unity/Unreal avatars, adding personalities and real-time behaviors. Integrates via SDK with existing rigs (no new formats).
- [**Meshy**](#): Text/image-to-3D character generation with auto-rigging and animation presets; exports engine-ready. Supports .fbx, .obj, .glb, .usdz formats.

Blockchain-Native Avatar Platforms

- [**CryptoAvatars**](#): NFT-native platform for 1/1 avatars with VRM-first portability across compatible apps. Supports .vrn format.
- [**Decentraland**](#): Web3 metaverse where avatars are composed from NFT wearables; uses glTF/GLB for interoperability and open tooling. Supports .glb, .gltf (wearables).
- [**The Sandbox**](#): Blockchain metaverse with voxel-based avatars created in VoxEdit; on-chain assets for cross-experience use. Supports .glb, .gltf, and voxel pipeline.

Cross-Platform Avatar Services

- [**Ready Player Me**](#): Avatar-as-a-service with SDKs for Unity/Unreal/Web; enables one avatar across apps via standardized exports. Supports .glb (via SDK).
- [**VRoid Studio & VRoid Hub \(Pixiv\)**](#): UGC avatar creation and hosting centered on VRM standard; supports multi-engine exports/imports. Supports .vrn format.

Social VR Platforms

- [**Meta Avatars \(Horizon/Quest\)**](#): Scalable avatar system for Horizon apps and integrations, focusing on identity and expression in Meta's ecosystem. SDK-driven (no general mesh import/export).
- [**Spatial \(powered by Unity\)**](#): Cross-device social/UGC platform supporting Ready Player Me and direct GLB imports for consistent identity. Supports .glb (assets); Ready Player Me pipeline.
- [**VRChat**](#): UGC social VR with Unity SDK (Avatars 3.0) for custom rigged avatars and creator ecosystems. Supports .fbx (Unity pipeline); .vrn (via UniVRM).

Gaming Ecosystems

- [**Fortnite \(UEFN/Creative\)**](#): Massive ecosystem for avatar customization and creator pipelines within Fortnite runtime. Uses platform-specific and UEFN asset pipelines.
- [**Roblox**](#): Ecosystem with persistent avatar identity across experiences; supports robust creator pipelines and FBX imports. Supports .fbx (creator pipeline), proprietary runtime formats.
- [**ZEPETO**](#): Mobile-first avatar network for fashion/UGC; enables FBX uploads for cross-world use. Supports .fbx (creator pipeline).



Enterprise Solutions

- [MetaHuman \(Epic Games\)](#): High-fidelity digital human tooling for Unreal/DCC pipelines in enterprise/film/games. Integrates via Unreal Engine (Quixel Bridge) and DCC workflows.
- [Microsoft Mesh \(Avatars for Teams\)](#): Enterprise avatars tied to Microsoft 365 identity for immersive Teams experiences. SDK-driven (no general mesh import).
- [NVIDIA Omniverse \(incl. ACE\)](#): OpenUSD-based pipelines with avatar microservices (speech, facial animation) for DCC-to-engine asset movement. Supports .usd (native), .fbx/.gltf/.glb imports.

NFT Metadata for Avatars on GitHub

- [Awesome 3D Avatar Collections](#): Curated repository of NFT avatar projects, standards, and tools for blockchain-integrated 3D assets.

Technical Feasibility:

- **Metadata Standards**: Using existing NFT standards like [ERC-721](#) and [ERC-1155](#) for metadata, embedding ownership and provenance details, and combined with 3D formats like glTF and FBX for model interoperability, ensures avatars can be consistently rendered and verified across platforms.
- **Blockchain Verification**: Leveraging blockchain for ownership and provenance ensures secure, immutable records of avatar data, including customizations and usage rights, facilitating trust in cross-platform transfers.
- **API and Metadata Schemas**: APIs supporting standardized schemas (e.g., aligned with Schema.org) enable seamless import, rendering, and application of avatar NFTs without reconfiguration, enhancing discoverability in marketplaces and metaverses.

Challenges:

- **Interoperability Across Platforms**: Avatar systems across platforms rely on diverse techniques, such as skeletal rigging, blend shapes, morph targets, and procedural generation. The challenge is ensuring appearance and animations translate accurately across incompatible rendering pipelines while preserving character identity and visual fidelity.
- **Customization Scope and Persistence**: Users apply platform-specific tools for avatar customizations that lack equivalents elsewhere. The challenge involves delineating base NFT customizations from overlays and guaranteeing persistence of modifications during cross-environment transfers.
- **Avatar-Specific Content Sensitivity**: As direct user representations, avatars encounter moderation issues tied to identity expression, cultural representation, and age-appropriateness. The challenge lies in balancing self-expression with diverse platform policies and global cultural sensitivities.
- **Avatar Identity and Privacy**: Avatars act as enduring digital identities that accrue reputation, relationships, and behavioral data. The challenge is safeguarding privacy amid identity continuity, averting impersonation, and controlling disclosure of linked personal data.



- **Economic Barriers Disincentivizing Adoption:** Platforms profit from native avatars, accessories, and customizations, creating silos. The challenge is surmounting resistance to external NFT avatars that erode sales while clarifying funding for shared infrastructure.
- **Rigging and Animation System Incompatibility:** Platforms employ mismatched skeleton structures, bone hierarchies, inverse kinematics solutions, and controllers unresolvable by metadata alone. The challenge is standardizing rigging without full rebuilds per platform's animation system.
- **Avatar Performance and Scalability:** High-end gaming supports detailed polygons, shaders, simulations, and high frame rates (e.g., 60 fps), whereas mobile, VR, and web platforms face tighter limits (e.g., 30–90 fps). NFT avatar metadata standards must enable dynamic adaptation of polygon counts, resolutions, and asset complexity to meet platform constraints without degrading visual identity or causing drops, stutters, or load failures at scale. Leveraging AI, machine learning, and augmented reality (AR) can further optimize real-time performance, automate avatar generation and behavior adjustments, and enable seamless interaction across digital and physical environments.
- **Avatar Context Appropriateness:** Context-specific designs imply behaviors and styles unfit for other settings. The challenge is assessing suitability (e.g., gaming avatars in professional spaces) and enabling auto-adaptation or restrictions by context.
- **Avatar Physics and Simulation:** Varied physics engines handle cloth, hair, soft-body, and collisions differently. The challenge is uniform behavior standardization for avatar elements across disparate implementations.
- **Semantic and Contextual Incompatibility:** Platform-earned attributes and achievements lack parallels elsewhere (e.g., warrior scars in corporate settings). The challenge is semantic translation of indicators and roles, safeguarding user investment in avatar history.
- **Avatar Translation Framework Requirements:** Incompatible 3D formats, rigging, shaders, and controllers demand translation over direct import. The challenge is crafting capabilities that retain identity and functionality, adapting to technical needs without visual or animation loss.
- **Avatar Behavioral Pattern Persistence:** Avatars evolve traits, behaviors, and patterns via interactions and AI. The challenge is transferring these developments between platforms to avoid restarting and eroding character identity.
- **Common Accessibility Standards:** Users with disabilities require modifications such as high-contrast modes, simplified geometry, alternative control schemes, and assistive technology compatibility. The challenge is transferable adaptations across platforms, preventing reconfiguration and exclusion from mismatched features.

Requirements:

Technical and Functional Requirements

- **Standardized Metadata Schema:** Adoption of a standardized metadata schema (e.g., aligned with ERC-721 and ERC-1155 for NFTs) is essential. Common metadata fields may include: file format (USD, MOV, JPG, GLB), asset category (environment, avatar, accessory, prop), material specifications, creator attribution, rights holder, usage permissions, rendering hints, and level-of-detail references. Metadata may be organized



into profiles such as Basic (core properties), Attachable/Wearable (equipment systems), Scene (environments), Interactable (object behaviors), Vehicle (movement), Royalty (revenue/rights), and Identity (authentication), as demonstrated by integration frameworks like MVMD.org. This facilitates seamless cross-platform usage and enhances avatar discoverability by providing a consistent format for all metadata.

- **API Integration for Metadata Management:** Development of APIs that allow Platforms to read, validate, and implement NFT metadata dynamically is crucial for real-time updates and interoperability. This enhances user experience by allowing real-time modifications (e.g., dynamic textures or animations on avatars) and ensures avatars remain synchronized across Platforms.
- **Ownership and Provenance Verification:** Systems need to support verification of avatar ownership and provenance tracking through blockchain-based mechanisms, distinguishing base NFT properties from user customizations via separate storage for modifications. This establishes trust and authenticity while preventing fraudulent ownership claims and enabling transparent transaction histories for personalized avatars.
- **Discoverability and Tagging System:** Standardized tags and categories must be used within metadata to improve avatar searchability within Platforms and across Marketplaces. This enhances user experience by enabling accurate, intuitive search and filtering functions for avatar traits and customizations.
- **License Management Systems:** The system must track license types, usage permissions, temporal constraints, and enforcement mechanisms. Metadata needs to express license terms including permissions for viewing, using, or sublicensing avatars, with optional support for token-gated access. This ensures proper rights management, usage compliance, and intellectual property protection while facilitating seamless license verification across Platforms.
- **Digital Asset Rarity System:** The system must include mechanisms for describing editions, total supply, and trait combinations that remain aligned when avatars transfer between Platforms. Cross-platform rarity descriptors ensure edition numbers and trait uniqueness maintain consistency. This enables accurate valuation and authenticity verification while preserving scarcity metrics and avatar value integrity across different ecosystems.
- **Environmental Impact Tracking:** Optional environmental impact descriptors and sustainability disclosures should be included in standardized formats compatible with blockchain-verifiable initiatives. This provides transparency regarding environmental costs, enables cross-platform sustainability tracking, and supports sustainable practices in avatar creation and trading.
- **Access Control and Permissions:** Metadata must include permissions specifying who can view, edit, or transfer an NFT avatar, as well as any token-gated access requirements and context-based flags (e.g., for gaming, professional, or educational suitability). This ensures that only authorized users interact with avatars, securing usage and protecting intellectual property while enabling platforms to automatically filter or adapt based on environment requirements.
- **Audio Asset Standardization:** Audio metadata specifications must include format requirements, quality metrics, accessibility features, collaborative credits, synchronization data, and integration with visual elements. This ensures consistent audio asset behavior



and accessibility across Platforms while maintaining proper attribution for avatar-related sounds (e.g., voice lines or effects).

- **Notifications:** The system must deploy real-time alert mechanisms to notify users of critical metadata changes (e.g., changes to an avatar's attributes, permissions, or core URI). This ensures transparency and prevents loss of trust due to unexpected changes to the avatar's utility or appearance.
- **Regulatory Compliance Frameworks:** The system must ensure that the use, storage, and sharing of NFT Metadata complies with all relevant Legal and Regulatory Requirements, including data protection, intellectual property, and privacy laws, preventing legal issues and enhancing user trust for avatar ownership.
- **Scalability Solutions:** The system must develop scalable solutions that handle large volumes of real-time requests for NFT Metadata without leading to Performance Degradation, ensuring reliable and efficient avatar loading and rendering across all platforms.
- **Verification Services:** The system must utilize robust, decentralized methods to continuously validate the integrity and authenticity of the NFT Metadata prior to rendering or transaction finalization. This explicitly protects against fraudulent data injection and avatar misrepresentation.
- **User-Friendly Interfaces:** The NFT Metadata Standard must enable the development of intuitive and user-friendly interfaces for viewing and managing avatar attributes. Platforms supporting NFT avatars should prioritize simplicity and ease of use for both technical and non-technical users, incorporating clear navigation and customizable visual features to enhance user satisfaction and drive broad platform adoption.
- **Audit and Reporting Tools:** The system must implement tools for Auditing and Reporting on all critical changes to the NFT Metadata (e.g., updates to rendering hints, material specs, or usage permissions), including avatar progression, achievements, and earned modifications. This provides transparency and accountability, helping verify avatar integrity and usage compliance.
- **Translation Framework:** Adopt a common translation framework for avatar creation, customization, and interaction to ensure seamless representation, customization, and interactions across realms (for e.g. [MSF's Avatar and Character Translation Framework](#)). This framework establishes a common baseline using Khronos's glTF 2.0 standard, along with guidelines for importing/exporting meshes, materials, skeletons, animations, physics, and metadata, enhancing cross-platform interoperability.

Interoperability Requirements

- **Standardized Protocols:** The system must establish common protocols for rendering, physics, and interactions to align the functional behavior of NFT avatars across Platforms. This prevents functional discrepancies between Platforms, allowing users to experience avatars as designed across environments.
- **Cross-Platform Compatibility:** Participating Platforms commonly support open 3D avatar formats (for example glTF and FBX) and consume the metadata they intend to render across environments, including bridging between Web2 and Web3 ecosystems. This ensures the avatar's rendered geometry and material properties maintain visual and functional consistency, regardless of the Platform's rendering engine or avatar system.



- **Device and Software Compatibility:** Validation of avatar import and rendering must occur across device classes (VR headsets, mobile, desktop) and engine stacks. This encourages portability across heterogeneous runtimes without requiring any specific platform.

Other Key Considerations:

- **Privacy:** NFT Metadata systems must avoid storing sensitive user data, especially when shared across Platforms, to comply with privacy regulations, with dedicated controls for behavioral data (e.g., avatar movement patterns, interaction preferences) separate from visual appearance. This protects user privacy and maintains Platform compliance with data protection laws.
- **Cybersecurity:** Robust cybersecurity measures, securing access to user data, NFT avatars, and metadata with appropriate protections, reducing risks of unauthorized access. This protects users' personal and avatar data, mitigating risks of data breaches and unauthorized duplication of avatars.
- **Identity Verification:** The system must integrate identity verification with blockchain-based ownership verification to authenticate user interactions with NFT avatars. This builds user trust by preventing identity fraud and ensuring that users can securely prove avatar ownership.
- **Networking and Latency:** Network and infrastructure optimization is required to reduce latency for loading avatars and enable real-time metadata updates. This ensures that NFT avatars load and respond quickly, preserving quality and performance for the user.
- **Ownership:** The system must provide granular user controls that allow owners to limit the disclosure of optional, platform-specific NFT Metadata across Platforms and contexts. This supports compliance and user expectations for data sovereignty without prescribing any mechanism.
- **Digital Ethics:** The system must uphold ethical standards by establishing clear governance mechanisms—such as affiliation with an Ethics Board and transparent data practices—to ensure the proper, unbiased, and responsible use of NFT metadata and user interaction data. As avatars increasingly represent real individuals, measures must prevent misuse such as identity theft or deepfakes.
- **Provenance:** The system must maintain accurate and immutable tracking of data sources, creation history, and every critical change to the NFT Metadata (e.g., version control, attribute modifications) to uphold the integrity and trustworthiness of the avatar over its entire lifecycle.
- **Accessibility:** The system must ensure that NFT metadata and its management controls are accessible to all owners, regardless of technical expertise, by adhering to recognized accessibility standards such as WCAG. Platforms supporting NFT avatars should prioritize inclusive design, ensuring usability for people with different abilities and providing customizable features—such as text-to-speech and visual customization options—to promote broad participation and equitable access.

Relevant Domain Working Group (WGs):

- MSF WGs:



- 3D Asset Interoperability using USD and glTF WG
- Interoperable Characters/Avatars
- Digital Fashion Wearables for Avatars
- Privacy, Cybersecurity and Identity
- 3D Web Interoperability
- Volumetric Media Interoperability
- Standards Register
- OMA3 NFT Standards WG
- Khronos Group WGs:
 - 3D Commerce
 - 3D Formats
 - Web GL
 - OpenXR
- W3C WGs:
 - Immersive Web
 - GPU for the Web

Relevant Pre-qualified Organizations and Groups (POGs):

- **W3C (World Wide Web Consortium):** Plays a key role in developing web standards that could support the metadata structure for NFT Avatars Metadata, particularly through standards like GLTF and WebGL for 3D graphics.
- **Khronos Group:** An open consortium creating royalty-free standards for 3D graphics and XR to enable seamless avatar rendering, customization, and interaction in metaverses. Key WGs include: 3D Commerce (refines 3D avatar model compatibility/streaming); WebGL (browser-based 3D rendering without plugins); WebGPU (high-performance web API for complex avatar graphics/computation); and OpenXR (unified VR/AR API for cross-device deployment)
- **Ethereum Foundation:** As the major blockchain platform for NFTs, the Ethereum Foundation's involvement ensures that NFT metadata aligns with core blockchain token standards, specifically **ERC-721**, **ERC-1155**, and [ERC-6551](#).
- **Schema.org:** Provides a shared vocabulary for describing internet-based resources, allowing search engines and platforms to parse metadata efficiently.
- **Alliance for OpenUSD (AOUSD):** An open, non-profit organization dedicated to the standardization, development, evolution, and growth of the OpenUSD (Universal Scene Description) technology.
- **Open Metaverse Alliance for Web3 (OMA3):** Directly involved in creating fundamental metaverse interoperability standards, including those driven by its NFT Standards WG for Metadata and Wearables, among its other working groups.
- **Virtual Reality Model (VRM) Consortium:** The VRM Consortium focuses on standardizing 3D humanoid avatar models for virtual and augmented reality applications, ensuring interoperability across various platforms.
- **Open Metaverse Interoperability (OMI) Group:** An open-source community dedicated to building interoperable technology for the metaverse, designing protocols for identity, social



graphs, and inventory to enable seamless integration of digital assets across diverse virtual environments.

- **Web3D Consortium:** An independent, member-driven organization developing and promoting royalty-free open standards for 3D graphics and communication on the web (e.g., X3D and H-Anim for humanoid animation), enabling seamless integration of NFT avatars into diverse virtual environments.

Relevant Specifications, Publications and Projects (SPPs):

- **[MVMD Avatar Integration Profile](#):** A non-normative example from the Metaverse Metadata Directory demonstrating how existing standards (e.g., ERC-721, glTF) can be combined to create comprehensive NFT avatar metadata, covering rigging, animations, attachments, and traits—without mandating specific implementations for flexible adoption.
- **EIP-721, EIP-1155 and ERC-6551:** Ethereum token standards (Non-Fungible and Multi-Token, respectively) that establish the foundational on-chain ownership model for unique or limited-edition digital assets, providing the initial structure for NFT metadata.
- **ERC-6551:** This newer standard creates Token Bound Accounts (TBAs), allowing a base avatar or character NFT to have its own smart contract wallet. This enables the base NFT to directly own and equip other wearable NFTs, establishing a portable, on-chain inventory system essential for complex metaverses.
- **Graphics Language Transmission Format (glTF 2.0):** An open, royalty-free specification often called the "JPEG of 3D." It defines an efficient, compact file format for transmitting and loading 3D scenes and models. For NFT avatars, it supports linked 3D assets—both dynamic and static animation—enabling vendor-neutral, low-overhead experiences across browsers, metaverse platforms, and AR/VR devices.
- **FBX (Filmbox):** A proprietary file format created by Autodesk that is a standard for exchanging 3D data, including complex animation, rigging, and materials, between professional digital content creation (DCC) software. It is typically used as the authoring format in the production pipeline before being converted to glTF for metaverse deployment.
- **Decentraland's Wearable NFT Standards:** Decentraland has developed specific standards for the creation and use of NFT wearables on their platform, which could serve as a reference or starting point for broader interoperability: structured metadata (wearable.json), GLB/glTF 3D asset format, rules for avatar fitting (hides/replaces), and Linked Wearables technology for cross-platform NFT representation.
- **Web3D Consortium ISO-ratified X3D and H-Anim:** Web3D develops and promotes the ISO-ratified X3D open standard, which offers a robust scene graph architecture to describe, store, and communicate 3D content. This framework is vital because it includes the H-Anim (Humanoid Animation) standard, which provides the consistent, globally-standardized humanoid skeleton necessary to ensure NFT wearables have reliable metadata for attachment and positioning on any avatar in any virtual environment.
- **[VRM Specification](#):** An open, platform-independent 3D avatar format built on glTF 2.0, developed by VRM Consortium for use in VR, AR and metaverse environments. It extends glTF with humanoid rigging, blendshapes, animations, and a comprehensive meta field containing model details such as name, authors, licensing information (typically under

VRM Public License). For NFT avatars, VRM enables standardized metadata for traits and usage permissions, supporting cross-platform portability, consistent rendering, and integration with ownership-verification systems.

Related Use Cases

- NFT Metadata for the Metaverse (General, MSF2025-NFTG-001)
- NFT Wearables Metadata for the Metaverse (MSF2024-NFTMW-001)
- Avatar Components / Attachables Use Cases
- Interoperable Digital Assets Use Cases

Additional Comments

- This document is a living artifact and may be subject to revisions on a periodic basis to reflect the future state of NFT Metadata for the Metaverse (Avatar), and or based on feedback received from MSF stakeholders that warrants an update in the future.