



Metaverse Standards Forum

NFT Wearables Metadata for the Metaverse

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Reviewer	Due Date	Status	Contact
Digital Asset Management Working Group	November 20, 2024	Complete	digital_asset_management@lists.metaverse-standards.org
MSF Domains (Peer Review)	December 17, 2024	Complete	oversight@lists.metaverse-standards.org
Use Case Taskforce	October 28, 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 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 Wearables Metadata for the Metaverse
Use Case Identifier
MSF2024-NFTMW-001 • Version 1.0 • Year of Release: 2025
Summary of Use Case
Description: This use case outlines the standardization of metadata for NFT wearables to ensure their interoperability across metaverse platforms. It focuses on the processes for creating, importing, equipping, and exporting these wearables. The goal is to allow users to move their digital assets between different environments while maintaining consistent appearance and functionality. Benefits: • Enhances interoperability between metaverse platforms. • Facilitates user ownership and control over digital assets. • Simplifies cross-platform wearable development for creators. • Increases user engagement and personalization opportunities in the metaverse. • Enables traceability, provenance, and authenticity of wearables.
Contributors and Supporters



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

Keywords

NFT Wearables, Metadata Standardization, Metaverse Interoperability, Metaverse Platforms, Cross-Platform Wearables, Digital Assets, Blockchain, User Ownership, Avatar Compatibility

Actors/Entities

- **NFT:** A digital asset with its metadata, such as properties and provenance, securely recorded on a blockchain.
- **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 and expect consistent functionality, ownership verification, and easy access to their assets in metaverse environments.
- **Blockchain infrastructure:** Entities responsible for maintaining the blockchain network where NFT metadata and ownership records are stored, ensuring data security and verifiability.
- **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 digital tool for storing, managing, and interacting with NFTs, enabling seamless access, transactions, and interoperability across platforms.
- **Digital Rights Management Entities:** Organizations that oversee the intellectual property aspects of creation and usage. They ensure the protection of the rights of designers, developers, and users.
- **Avatar:** The digital representation of a user within metaverse platforms. Avatars are customizable characters or entities that embody users in virtual environments, enabling interaction, expression, and participation in activities across different platforms.
- **Avatar Designers and Developers:** Professionals or companies specializing in the creation and development of virtual avatars. Their role involves designing and rigging avatars.
- **Avatar Creation Platforms:** (e.g., VR Studio, Character Creator, Metahuman, Ready Player Me) Online or offline tools and software suites where users can design and



customize their own avatars, often offering a range of features for personalization and animation.

Detailed Description of Use Case/Scenario

Preconditions:

- **Standardized Metadata Adoption:** Metaverse platforms must adopt and support the standardized metadata.
- **Metadata Structure Adherence:** Wearables must be minted using the agreed-upon metadata structure.

Main Flow:

1. **Create Wearables:** NFT creators design wearable assets (e.g., clothing, accessories) and define their properties (e.g., texture, color, 3D model). Metadata standards ensure that this data is stored in a consistent format, including compatibility requirements (such as file formats, animation properties, and platform support).
2. **Mint Wearables:** The wearable is minted on a blockchain with this standardized metadata, including creator information, asset details, usage rights, and a unique identifier.
3. **Import Wearables and Verify Ownership:** Users who own NFT wearables can import them into different metaverse platforms. The platforms read the standardized metadata, ensuring the wearable is rendered correctly, regardless of platform-specific graphics engines or avatar systems. This step also involves verifying ownership via blockchain.
4. **Equip Wearables:** Once imported, users can equip wearables on their avatars. The metadata dictates how the wearable should fit on different avatar types or sizes, ensuring visual consistency across platforms. Platforms apply the wearables in real-time, following the standardized rules for positioning, scaling, and animations.
5. **Export Wearables:** Users can export wearables from one metaverse platform to another. This involves extracting the NFT metadata and transferring it seamlessly between platforms, ensuring no loss of visual or functional fidelity. Ownership and provenance remain verifiable through the blockchain.
6. **Cross-Platform Wearable Usage:** Once equipped, wearables function as intended (e.g., clothing may animate, accessories may have physics-based movement). The standardized metadata ensures that functionality like collision detection, shaders, and interactions behave as designed, regardless of platform.

Postconditions

- **Consistent Experience:** Wearables are fully functional and visually consistent across all supporting metaverse platforms.

Implementations and Demonstrations or Technical Feasibility



Implementations and Demonstrations

- [Decentraland](#) and [The Sandbox](#): Both platforms support NFT wearables and allow users to import and use NFTs, though interoperability between these platforms is limited without standardized metadata.
- [OpenVoxels](#): Users can create and wear NFT-based clothing and accessories within its platform.
- [OpenSea](#): A marketplace that facilitates the creation, buying, and selling of NFT wearables. While it supports the trade of wearables, there is currently no standardized metadata format that guarantees cross-platform functionality.
- [Spatial](#): Spatial is a user-generated content (UGC) gaming platform that enables developers to create, publish, and monetize multiplayer games across web, mobile, and virtual reality (VR) platforms. Utilizing the Unity game engine and the C# programming language, the platform supports the integration of NFT wearables, allowing users to personalize their avatars with unique digital assets. However, similar to other platforms, interoperability of these wearables across different virtual environments is limited due to the absence of standardized metadata formats. ([Polygon](#), [Solana](#))

Technical Feasibility:

- Metadata standardization is technically feasible using existing blockchain technologies; file formats such as **glTF** (for 3D models) and **SVG** (for 2D graphics); and NFT standards including [EIP-721](#) and [EIP-1155](#).

Challenges:

- **Interoperability and Attachment Standards:** Different Avatar Standards and platforms pose a challenge for defining Universal Attachment Points for Wearables. To foster creativity, Wearables should maintain a high degree of Flexibility, ensuring that Creators Are Not Limited by rigid, pre-defined spatial coordinates for their digital assets
- **Defining Wearable Scope:** Establishing a clear and consistent definition for what constitutes a Digital Wearable Asset and its functional and aesthetic inclusions is critical. Ambiguity in Scope Definition can lead to inconsistencies in Cross-Platform Recognition and Marketplace Categorization, causing confusion for users and developers.
- **Content Sensitivity and Regulation:** The global nature of the metaverse complicates the management of Content Sensitivity, which is subject to diverse Cultural Norms and Governmental Regulations. The vast array of individual Ideological and Social Concerns makes it exceedingly difficult for platforms to unilaterally control all potential issues associated with user-created Digital Content.
- **Physiological and Dimensional Constraints:** Managing the Physical Limitations of a Wearable asset within an Avatar System requires standardized scaling and physics rules. Decisions must be made on whether a Wearable should Automatically Scale if its dimensions are inappropriate and if digital assets should be assigned Simulated Properties such as Weight, Mass, or Volume to maintain realism and system integrity.
- **Interactivity and Physics Engine:** The seamless interaction of a Wearable with the Platform's Scene and its underlying Physics Engine is essential for user experience. Failures in Interactivity Management or improper application of Simulated Physics can

lead to visual glitches, clipping issues, and a fundamental breakdown in the Platform's Scene or World, disrupting Immersion and Credibility aspects.

- **Security of Metadata Integrity:** Ensuring the Immutability and Security of the Wearable NFT Metadata itself is paramount. A single Breach or Manipulation of the metadata (which can contain the Asset Reference URI, traits, and functional parameters) can lead to the Permanent Loss of Utility or fraudulent alteration of the underlying Digital Wearable. This requires robust decentralized storage solutions to prevent Single Points of Failure or unauthorized Metadata Overrides.
- **Regulatory Compliance of Metadata Content:** The Metadata of NFT Wearables must comply with various cross-jurisdictional regulations, particularly concerning Intellectual Property (IP) and Data Privacy. Non-compliance arises if the metadata includes unverified IP (trademarked logos, etc.) or if the Attachment Data contains sensitive user biometric/identity data, requiring explicit adherence to regulations such as GDPR or similar Data Protection Laws.
- **Lack of a Unified Metadata Schema for 3D Assets:** While core NFT standards (e.g., ERC-721/1155) successfully manage ownership, they lack a mandatory, unified JSON schema for complex 3D or functional properties. This absence of standardized fields for critical wearable data—such as Render Properties, Rigging Points, or Collision Meshes—forces each platform to create its own custom schema, resulting in functional inconsistencies and inhibiting seamless cross-platform interoperability.
- **Scalability of Metadata Retrieval & Indexing:** The massive and increasing volume of unique Wearable NFTs requires a highly Scalable Infrastructure capable of rapidly indexing and retrieving complex Metadata across different blockchains and marketplaces. An inability to Efficiently Process these large data streams can lead to Latency and Performance Degradation in marketplaces and virtual worlds, severely impacting the user experience during asset loading and transaction verification.

Requirements:

Technical and Functional Requirements

- **Avatar Compatibility:** The NFT metadata must contain essential attributes that define the asset's structural and dimensional properties to ensure correct fitting and rendering across diverse virtual platforms. This includes defining the target skeletal standard, the precise attachment point, and the necessary transform data (position, rotation, and scale) required for programmatic, platform-agnostic avatar integration.
- **Standardized Metadata Schema:** The system must adopt a standardized metadata schema (e.g., aligned with ERC-721 and ERC-1155), as this is essential for all NFT Wearables Metadata to facilitate seamless cross-platform usage and enhance asset discoverability.
- **Ownership and Provenance Verification:** The system must support verification of NFT Wearables ownership and provenance tracking through blockchain-based mechanisms to establish trust and authenticity while preventing fraudulent ownership claims.
- **License Management Systems:** The system must track license types, usage permissions, temporal constraints, and enforcement mechanisms relevant to NFT



Wearables. The associated metadata must express these license terms to ensure proper rights management and usage compliance.

- **Digital Asset Rarity System:** The system must utilize systems for describing editions, total supply, and trait combinations within NFT Wearables Metadata that remain aligned when assets transfer between Platforms, preserving scarcity metrics and asset value integrity.
- **Access Control and Permissions:** NFT Wearables Metadata must include permissions specifying who can view, equip, or transfer the NFT, as well as any token-gated access requirements, to secure asset usage and protect intellectual property.
- **Audio Asset Standardization:** The system must define audio metadata specifications relevant to NFT Wearables (e.g., sound effects, looping audio), including format requirements, quality metrics, synchronization data, and integration with visual elements, to ensure consistent audio asset behavior and accessibility.
- **Notifications:** The system must deploy real-time alert mechanisms to notify users of critical metadata changes (e.g., changes to the asset's attributes, permissions, or core URI). This ensures transparency and prevents loss of trust due to unexpected changes to the asset's utility or appearance.
- **Regulatory Compliance Frameworks:** The system must ensure that the use, storage, and sharing of NFT Wearables Metadata complies with all relevant Legal and Regulatory Requirements, including data protection, intellectual property, and privacy laws, preventing legal issues and enhancing user trust.
- **Scalability Solutions:** The system must develop scalable solutions that handle large volumes of real-time requests for NFT Wearables Metadata without leading to Performance Degradation, ensuring reliable and efficient asset 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 Wearables Metadata prior to rendering or transaction finalization. This explicitly protects against fraudulent data injection and asset misrepresentation.
- **User-Friendly Interfaces:** The NFT Wearables Metadata Standard must be designed to facilitate the creation of Intuitive and User-Friendly Interfaces for viewing and managing the asset's attributes. This directly improves User Satisfaction and encourages broad platform adoption.
- **Audit and Reporting Tools:** The system must implement tools for Auditing and Reporting on all critical changes to the NFT Wearables Metadata (e.g., updates to rendering hints, material specs, or usage permissions). This provides transparency and accountability, helping verify asset integrity and usage compliance.

Interoperability Requirements:

- **Standardized Protocols:** The system must establish common protocols for rendering, physics, and interactions to align the functional behavior of NFT Wearables across Platforms, preventing functional discrepancies.
- **Cross-Platform Compatibility:** The system must provide validation that NFT Wearables Metadata is correctly interpreted and consumed to achieve accurate asset import and rendering across diverse device classes (VR headsets, mobile, desktop) and engine

stacks, ensuring true portability and functional consistency across heterogeneous runtimes.

Other Key Considerations:

- **Privacy:** NFT Wearables Metadata systems must be designed to explicitly avoid storing sensitive user data (e.g., in shared public metadata fields) when shared across Platforms, ensuring compliance with privacy regulations and protecting user privacy.
- **Cybersecurity:** Robust cybersecurity measures, securing access to user data, NFT Wearables, and their metadata, must be implemented to mitigate risks of unauthorized access and data breaches, explicitly preventing the unauthorized duplication or integrity loss of the asset's attributes.
- **Identity Verification:** The system must integrate identity verification with blockchain-based ownership verification to authenticate user interactions, particularly when equipping or modifying NFT Wearables, preventing identity fraud and ensuring secure proof of asset ownership.
- **Networking and Latency:** The system must be designed for efficient data retrieval and transfer of NFT Wearables Metadata without latency issues, ensuring that the asset's attributes (e.g., visual fidelity, permissions, state) are accessible and rendered in real-time across all integrated metaverse platforms.
- **Ownership:** The system must provide granular user controls that allow owners to limit the disclosure of optional, platform-specific NFT Wearables Metadata across Platforms and contexts, supporting compliance and user expectations for data sovereignty.
- **Digital Ethics:** The system must address ethical considerations by establishing clear guidelines and mechanisms (such as affiliating with an Ethics Board or utilizing transparent data governance) for the proper, unbiased, and ethical use of NFT Wearables Metadata and any derived user interaction data.
- **Provenance:** The system must maintain accurate and immutable tracking of data sources, creation history, and every critical change to the NFT Wearables Metadata (e.g., version control, attribute modifications) to uphold the integrity and trustworthiness of the digital asset over its entire lifecycle.
- **Accessibility:** The system must ensure the NFT Wearables Metadata and its associated management controls are accessible to all Owners, regardless of their technical expertise, and must adhere to recognized accessibility standards (e.g., WCAG) to maximize inclusivity and participation.

Relevant Domain Working Group (WGs):

- MSF WGs:
 - Digital Fashion Wearables for Avatars
 - Interoperable Characters/Avatars
 - Privacy, Cybersecurity and Identity
 - Volumetric Media Interoperability
- OMA3 NFT Standards WG
- Khronos Group WGs:
 - 3D Commerce



- WebGL
- OpenXR

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 Wearables, particularly through standards like glTF and WebGL for 3D graphics.
- **Ethereum Foundation:** As a major blockchain platform for NFTs, the Ethereum Foundation's involvement ensures that wearable metadata aligns with blockchain standards such as EIP-721, and EIP-1155, and ERC-6551.
- **Metaverse Standards Forum (MSF):** The overarching body that drives interoperability and standards across metaverse platforms, facilitating collaboration between stakeholders like OMA3 and SDOs.
- **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.
- **Schema.org:** Provides a shared vocabulary for describing internet-based resources, allowing search engines and platforms to parse metadata efficiently.
- **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.
- **Khronos Group:** An open consortium that creates royalty-free interoperability standards for 3D graphics and Extended Reality (XR). This is enabled by the contributions of its various WGs, which include 3D Commerce (standardizing digital wearable models), WebGL (enabling browser-based 3D rendering), and OpenXR (defining a unified API for cross-device VR/AR application deployment).

Relevant Specifications, Publications and Projects (SPPs):

- **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.
- **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/gITF 3D asset format**, rules for **avatar fitting** (hides/replaces), and **Linked Wearables** technology for cross-platform NFT representation.

- **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 (gITF):** An open-standard, highly optimized 3D file format developed for the efficient transmission and fast, real-time rendering of models and scenes. It is the widely accepted **delivery format** for wearables and other assets in most metaverse platforms due to its performance characteristics.
- **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 gITF for metaverse deployment.

Related Use Cases

- NFT Metadata for the Metaverse – General Use Case (MSF2025-NFTG-001)
- NFT Metadata for Avatars in the Metaverse (MSF2025-NFTA-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 Wearables Metadata for the Metaverse, and or based on feedback received from MSF stakeholders that warrants an update in the future.