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| Template Version: January 2017 (Do not modify) |

**oneM2M Notice**

The document to which this cover statement is attached is submitted to oneM2M. Participation in, or attendance at, any activity of oneM2M, constitutes acceptance of and agreement to be bound by terms of the Working Procedures and the Partnership Agreement, including the Intellectual Property Rights (IPR) Principles Governing oneM2M Work found in Annex 1 of the Partnership Agreement.

#  Introduction

This contribution introduces gap analysis of existing metaverse related standards.

-----------------------Start of change 1-------------------------------------------

# Scope

The document is describing what services and platforms discovery scenarios are considered beneficial from a oneM2M standpoint and how these can be supported by oneM2M system. Based on the result of the technical report, it will identify possible advanced features and enhancements which the next oneM2M release(s) could support.

# References

The following text block applies.

References are either specific (identified by date of publication and/or edition number or version number) or non- specific. For specific references, only the cited version applies. For non-specific references, the latest version of the referenced document (including any amendments) applies.

## Normative references

Normative references are not applicable in the present document.

## Informative references

Clause 2.2 shall only contain informative references which are cited in the document itself.

The following referenced documents are not necessary for the application of the present document but they assist the user with regard to a particular subject area.

[i.1] oneM2M Drafting Rules.

NOTE: Available at <http://www.onem2m.org/images/files/oneM2M-Drafting-Rules.pdf>.

[i.2] ISO/IEC 14772-2:2004

NOTE: Available at <https://www.iso.org/standard/30893.html>

[i.3] ISO/IEC 19775-1:2013

NOTE: Available at <https://www.iso.org/standard/60760.html>

[i.4] ISO/IEC 18023-1:2006

NOTE: Available at <https://www.iso.org/standard/38442.html>

[i.5] 3GPP TR 22.856 v19.1.0

NOTE: Available at <https://www.3gpp.org/ftp/Specs/archive/22_series/22.856/22856-j10.zip>

[i.6] 3GPP TS 22.156 v1.0.0

NOTE: Available at <https://ftp.3gpp.org//Specs/archive/22_series/22.156/22156-100.zip>

# Definitions, symbols and abbreviations

Delete from the above heading the word(s) which is/are not applicable.

## Definitions

Clause numbering depends on applicability.

* **A definition shall not take the form of, or contain, a requirement.**
* **The form of a definition shall be such that it can replace the term in context. Additional information shall be given only in the form of examples or notes (see below).**
* **The terms and definitions shall be presented in alphabetical order.**

For the purposes of the present document, the [following] terms and definitions [given in ... and the following] apply:

Definition format

**<defined term>:** <definition>

If a definition is taken from an external source, use the format below where [N] identifies the external document which must be listed in Section 2 References.

**<defined term>**[N]: <definition>

**example 1:** text used to clarify abstract rules by applying them literally

NOTE: This may contain additional information.

## Symbols

Clause numbering depends on applicability.

For the purposes of the present document, the [following] symbols [given in ... and the following] apply:

Symbol format

<symbol> <Explanation>

<2nd symbol> <2nd Explanation>

<3rd symbol> <3rd Explanation>

## Abbreviations

For the purposes of the present document, the [following] abbreviations [given in ... and the following] apply:

Abbreviation format

<ABREVIATION1> <Explanation>

<ABREVIATION2> <Explanation>

<ABREVIATION3> <Explanation>

VR Virtual Reality

AR Augmented Reality

MR Mixed Reality

3GPP 3rd Generation Partnership Project

# Conventions

The key words "Shall", "Shall not", "May", "Need not", "Should", "Should not" in the present document are to be interpreted as described in the oneM2M Drafting Rules [i.1].

# Introduction

*Editor’s Note: This section provides the introduction of this technical report.*

# Background and Gap Analysis

*Editor’s Note: The section summarizes defines a concept of Metaverse from IoT perspective. This section also provides background and motivation of this technical report. State of the art for existing Metaverse related standards and gap analysis will be investigated.*

* 1. Background

The metaverse, while still in its nascent stages, signifies an expansive virtual space with the potential to become an integral part of human life, much like the internet has revolutionized communication and interaction. Just as the internet became a dominant means of communication, the metaverse could evolve into a primary medium for human interaction. For instance, advancements in metaverse technology could lead to a future where employees work in virtual spaces rather than physical offices. The metaverse is not a single technology but is built upon the development of various technologies, with key aspects and technologies including:

* **Internet of Things (IoT)**: In the metaverse services and spaces, IoT is expected to play a crucial role as an infrastructure technology that bridges virtual and physical spaces. While current metaverse services offer interaction through avatars in a virtual environment, the next phase will model and integrate actual spaces and IoT devices into the virtual realm, offering control and utility. IoT technology will extract digital information from real-world spaces and objects, linking them to the metaverse space.
* **Artificial Intelligence (AI)**: The plethora of data generated and collected in the metaverse can be leveraged for learning and enhancing intelligent metaverse services. Virtual avatars operating in the metaverse could be managed through AI chatbot technology.
* **Extended and Augmented Reality**: Technologies like Augmented Reality (AR), Virtual Reality (VR), and Mixed Reality (MR) have the potential to elevate metaverse services from two-dimensional to three-dimensional visualization and interaction. As AR devices become mainstream, computer vision technology could provide relevant information to users, and holographic images and videos could make surroundings and conversational partners feel lifelike.
* **5G/6G**: For the success of metaverse services, technology capable of fast, uninterrupted, and high-capacity traffic transmission is essential. Particularly, since the flagship services of the metaverse rely on video rather than text-based content, and predominantly on high-volume data transmissions such as holographic and immersive videos, mobile telecommunications technologies like 5G and 6G are crucial.
* **3D Modeling**: 3D modeling technology can realistically replicate the appearance and form of objects, using associated data to make the metaverse feel more authentic.
* **Edge Computing**: For a compelling metaverse experience, communication speed is crucial. Edge computing processes data and services at nodes closer to the user's device rather than at a central cloud server, enhancing response times to user actions.
* **Blockchain**: This technology could be used to securely protect and manage digital content and data. Blockchain can decentralize the metaverse to prevent slowdowns in usage speed and avoid data ownership and use by specific entities.

	1. Gap Analysis of Existing Metaverse related Standards

### ISO/IEC JTC 1

### Introduction

The International Organization for Standardization (ISO) and International Electrotechnical Commission (IEC) collaborate through Joint Technical Committee 1 (JTC1) to develop international standards for information technology. JTC1 SC 24 (or Subcommittee 24) is currently working on standardizing technologies related to the metaverse. The standardization efforts for the metaverse encompass various fields including Virtual Reality (VR), Augmented Reality (AR), the Internet, digital assets, data management, and user interaction. The scope of standardization relating to:

* Computer Graphics
* Image Processing
* VR, AR, and Mixed Reality (MR)
* Environmental Data Representation
* Visualization of, and Interaction with, Information
* (excluded: efficient coding of multimedia)

SC 24’s standards are crucial in enhancing compatibility, accessibility, and the quality of user experience in the implementation and expansion of the metaverse. SC 24 continually updates its graphics and image processing standards in response to technological advancements, adapting to the evolving needs of new technologies like the metaverse. As VR, AR, and metaverse technologies advance, the standards of SC 24 are also expected to evolve to reflect the requirements of these fields.

### JTC 1/SC 24 Working Groups

As shown as bellow, there are several working groups for the metaverse in JTC 1/SC 25:

* WG 6: Computer Graphics and Virtual Reality
* WG 7: Image Processing and Interchange
* WG 8: Environmental Representation
* WG 9: Mixed and Augmented Reality Continuum Concepts and Reference Model
* WG 10: Representation and Visualization of Information for Systems Integration
* WG 11: Health, Safety, Security and Usability of Augmented and Virtual Reality
* JWG 12: VR/AR/MR based ICT Integration Systems (with ISO/IEC JTC 1/SC 36)
* ISO TC 184/SC 4/JWG 16 (with JTC 1/SC 24)

The WG 6 works detail for virtual worlds and avatars information processing, WG 7 works on real world information and simulation processing, and WG 10 works on smart city integration, visualization and information processing in virtual worlds. The standards have been published that can be used for creating and simulating virtual worlds such as ISO/IEC 14772 Virtual Reality Modelling Language [i.2], ISO/IEC 19775 Extensible 3D [i.3], and ISO/IEC 18023 Synthetic Environment Data Representation and Interchange Specification [i.4].

Since the metaverse platform will be used everywhere such as business, education, and social purposes, standards for cybersecurity, identity, and permissions for virtual worlds must be provided. So that the WG 10 works on safe and secure UI/UX information processing for AR and VR. Also the ICT integration will be necessary for the business in various area, JTC 1/SC 24 and SC 36 established JWG 12 for ICT integration with VR/AR/MR in many industry sectors within metaverse application services.

### 6.2.2 Metaverse standards work in 3GPP

### 6.2.2.1 Introduction

The 3rd Generation Partnership Project (3GPP) is a global collaboration project that develops technical specifications for mobile communication systems, focusing on standardizing mobile networks. With the rise of interest in the metaverse and the evolution of 5G networks, 3GPP is also increasingly focusing on developing technical standards related to the metaverse. The technical report that focuses on identifying and analyzing the requirements and use cases specific to the metaverse or related technologies in the context of 5G networks in TR 22.856 [i.5]. Also the technical specification that addressing the stage 1 requirements for mobile metaverse services in TR 22.156 [i.6]. The creation of new specifications, particularly a Technical Specification (TS) numbered 22.XYZ titled "Mobile Metaverse Services" is expected. The TS is expected to be presented for information in September 2023 and for approval in December 2023. A wide range of companies supported this initiative, including Samsung, Orange, Telefonica, China Mobile, China Telecom, Nokia, Deutsche Telekom, Nokia, etc.

### 6.2.2.2 Mobile Metaverse Services

3GPP defines the Mobile Metaverse Services that encompass a wider meaning related to VR and AR with the 5G system.

### Requirements for Mobile Metaverse Service in 3GPP. The 5G networks are essential for the development of the metaverse. The high speed, low latency, and high reliability of 5G enable real-time interactions in the metaverse, high-quality 3D graphics streaming, and participation of a large number of users. To support the metaverse, 3GPP must address technical challenges in various aspects, including network performance, security, data management, and interfaces. As 3GPP is working on standardizing network functionalities and services optimized for the metaverse, there are requirements for mobile metaverse services, focusing on enhancing XR-based services via 5G systems. The requirements about functional service and performance, security, authorization and privacy, and charging aspects:

* Localized mobile metaverse service: emphasizes immersive services integrated with a user’s real-world experiences and considers AR/MR media and spatial localization for enhanced experiences.
* Avatar-based real-time communication: supports conversational XR communication among multiple users and involves capturing user gestures and expressions for avatar-based interactions.
* Digital asset management: addresses the management of digital assets associated with a user and includes personal data management and compliance with regulations.
* Performance: defines performance metrics for various mobile metaverse services, such as traffic flow simulation, collaborative engineering, and tele-operated driving. The performance parameters include latency, service bit rate, reliability, and area traffic capacity.
* Security, authorization, and privacy: specifies requirements for security and privacy, focusing on authorization policies and data confidentiality.
* Charging aspects: details charging information for actions related to spatial anchors, digital asset management, and avatar-based communication.

### 6.2.2.3 Metaverse Use Cases in 3GPP

3GPP is developing 5G technical specifications suitable for use cases like VR, AR, and the metaverse. Also, they defines “mobile metaverse” as user experiences facilitated by 5G systems, encompassing interactive and immersive XR media, including haptic media. It envisions diverse service providers catering to different customer segments, including consumers, enterprises, and industries.

The consumer mobile metaverse services are discussed initial developments in commercial consumer-oriented services like metaverse gaming and VR social media. It covers use cases like attending VR events, virtual shopping or visits, AR content interaction, situational awareness, and immersive communications as follows:

* Attending VR events such as sports, gaming, concerts
* Virtual shopping or visit experiences like tourism, real estate
* Presentation of AR content on a virtual screen (e.g., movies)
* Interaction with AR content in a location-aware manner (e.g., in museums, shopping malls)
* Situational awareness about the user’s surroundings while walking or driving
* Immersive communication with other entities – digital representations of users or application-generated content
* Mobile metaverse live concerts

The enterprise mobile metaverse services are driven by remote working, these services will integrate core business applications using XR and VR technologies. It envisages an interconnected world of enterprise and industrial mobile metaverse services, blending IT and operational technology systems as follows:

* XR-enabled collaborative and concurrent engineering
* Virtual showrooms, products, or stores
* Interaction with AR content in a location-aware manner, including the creation and discovery of spatial anchors
* Virtual meeting rooms in financial services

The industrial mobile metaverse services are expected to bring cost, productivity, safety, and flexibility improvements. It focuses on XR media for operation monitoring, analysis, and control, including digital orchestration of robot fleets and remote operations as follows:

* Remote critical healthcare services, including surgery and treatment
* AR/VR-based tele-operation of remote devices or vehicles
* Immersive tele-operation driving in hazardous environments
* Virtual emergency drills using 5G metaverse technologies

In addition to common aspects, it identifies common enablers across all mobile metaverse services, such as localized services, enhanced real-time communications with avatars, XR media delivery, and digital asset management. One of example, the use case on synchronized predictive avatars focuses on the implementation and application of predictive avatars in the metaverse. This use case centers on the concept of virtual humans in the metaverse. It likely involves the development and utilization of avatars that can predict and simulate user behaviours or intentions in various scenarios within the metaverse environment. The use case would specify the initial conditions required for the implementation and operation of predictive avatars, such as technological capabilities, network requirements, and user interaction parameters with pre-conditions. The service flows detail the processes and interactions involved in the functioning of predictive avatars, from the creation to their real-time operation in the metaverse that shown in the figure 5.1.2.2.2-1. After describes the expected outcomes or changes following the implementation of the predictive avatars, it would outline how current technological features and standards either partially or fully support the functionalities required or highlights any new technological standardization requirements for standardization for this use case.

### 6.2.3 Gap Analysis

The standardization from ISO focus on reference architecture and model based on use cases such as mixed and augmented reality, extensible 3D, and humanoid animation.

The standardization from 3GPP focus on performance and functional service requirements depending on use cases such as influence quantity or characteristic parameter. For example, the 5G-enabled traffic flow simulation and situational awareness use case has requirements of transfer interval time (20~100ms), max allowed end-to-end latency (5~20ms), and etc.