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Accessibility requirements for metaverse services supporting IoT

Working Group 8: Sustainability, Accessibility & Inclusion

Technical Specification ITU FGMV-15

Accessibility requirements for metaverse services supporting IoT

Summary

The virtual world based on real-world data collected through IoT technology and using XR technology as UX is collectively referred to as a metaverse supporting IoT. The ideally constructed metaverse interface should prevent persons with disabilities and those with specific needs who have difficulty using certain senses in the real world from feeling this difficulty in the metaverse. This Technical Specification defines the accessibility requirements that metaverse services supporting IoT should have.

Keywords

accessibility, digital twin, metaverse, Internet of Things (IoT)

Note

This Technical Specification is an informative ITU-T publication. Mandatory provisions such as those found in ITU-T Recommendations are outside the scope of this publication. This publication should only be referenced bibliographically in ITU-T Recommendations.

Change Log

This document contains Version 1.0 of the ITU Technical Specification on "*Accessibility requirements for metaverse services supporting IoT*" approved at the 4th meeting of the ITU Focus Group on metaverse (FG-MV), held on 4-7 December 2023 in Geneva, Switzerland.

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Additional information and materials relating to this Technical Specification can be found at: https://www.itu.int/go/fgmv. If you would like to provide any additional information, please contact Cristina Bueti at tsbfgmv@itu.int.

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1 Scope

This Technical Specification provides accessibility requirements for the metaverse services supporting IoT. The scope of this Technical Specification concerns accessibility requirements for the metaverse services supporting IoT.

2 References

The following ITU-T Recommendations and other references contain provisions which, through reference in this text, constitute provisions of these Technical Specification. At the time of publication, the editions indicated were valid. All Recommendations and other references are subject to revision; users of this Technical Specification are therefore encouraged to investigate the possibility of applying the most recent edition of the Recommendations and other references listed below. A list of the currently valid ITU-T Recommendations is regularly published. The reference to a document within this Technical Specification does not give it, as a stand-alone document, the status of a Recommendation.

[ITU-T Y.4000] Recommendation ITU-T Y.4000/Y.2060 (2012), *Overview of the Internet of things.*

[ITU-T Y.4204] Recommendation ITU-T Y.4204 (2019), *Accessibility Requirements for Internet of Things Applications and Services.*

3 Definitions

3.1 Terms defined elsewhere

3.1.1 accessibility [b-ITU-T F.791]: The degree to which a product, device, service, or environment (virtual or real) is available to as many people as possible.

3.1.2 accessibility features [b-ITU-T F.791]: An additional content component that is intended to assist people hindered in their ability to perceive an aspect of the main content.

3.1.3 assistive technology [b-ITU-T F.791]: Piece of equipment, product system, hardware, software or service that is used to enable, maintain or improve functional capabilities of individuals with disabilities.

3.1.4 person with age related disabilities [b-ITU-T F.791]: A person with cognitive or physical disabilities caused by the aging process. Examples are impaired eyesight, deafness in varying degrees, reduced mobility or cognitive abilities.

3.1.5 person with specific needs [b-ITU-T F.791]: Includes persons with disabilities (PWD), persons who are not literate, those with learning disabilities, children, indigenous people, older persons with age related disabilities, and anyone who has a temporary disability.

3.1.6 specific needs [b-ITU-T F.791]: This replaces the use of the term ‘special needs’. This term refers to a wide range of categories including women, children, youth, indigenous people, older persons with age related disabilities, persons with illiteracy, as well as persons with disabilities (PWD), see [b-ITU PP Res.175], [b-WTDC Res.58], and [b-WTDC AP]. See also clause 6.39 of [b-ITU-T F.791].

3.1.7 universal design [b-UNCRPD]: The design of products, environments, programmers and services to be usable by all people, to the greatest extent possible, without the need for adaptation or

specialized design. "Universal design" shall not exclude assistive devices for particular groups of persons with disabilities where this is needed.

3.2 Terms defined in these Technical Specification

These Technical Specification define the following terms:

None

4 Abbreviations and acronyms

These Technical Specification use the following abbreviations and acronyms:

AAC	Augmentative and Alternative Communication
AR	Augmented Reality
IoT	Internet of Things
MR	Mixed Reality
UX	User eXperiences
VR	Virtual Reality
XR	eXtended Reality

5 Conventions

The following conventions are used in this Technical Specification:

– The keywords "is required to" indicate a requirement that must be strictly followed and from which no deviation is permitted if conformance to this Technical Specification is to be claimed.

– The keywords "is recommended" indicate a requirement that is recommended but which is not absolutely required. Thus, this requirement need not be present to claim conformance.

– The keywords "can optionally" indicate an optional requirement that is permissible, without implying any sense of being recommended. This term is not intended to imply that the vendor's implementation must provide the option and that the feature can be optionally enabled by the network operator/service provider. Rather, it means the vendor may optionally provide the feature and still claim conformance with the specification.

6 Overview of accessibility user problems in the metaverse supporting IoT

Digital twin technology, implemented through data accumulated through the Internet of Things (IoT) based technology, builds an identical virtual world to the real world. The digital twin can be used to digitally implement the geographical and temporal environment of the real world to monitor various information, conduct complex experiments or predict future events. Immersive extended reality (XR) technologies, such as augmented reality (AR), virtual reality (VR), and mixed reality (MR), can be used as a user experience (UX) in this virtual world. The virtual world based on real-world data collected through IoT technology and using XR technology as UX is collectively referred to as a metaverse supporting IoT. The metaverse supporting IoT can provide services in various fields, such as remote medical services, smart factories, smart agriculture, and simulation education.

Metaverse is a virtual space where people can interact with other people or some objects, which can be any “Thing” on the Internet of Things (IoT). Also, it is a means of communication. Metaverse has a spatial concept that participants can recognise it. In addition, through the metaverse, users interact and communicate within this virtual space. For one person to participate in the metaverse, one must first be able to recognise this virtual space and any objects in it (whether human or virtual) and interact in various ways. Persons with disabilities who have difficulty using certain senses may also have

difficulty recognising this space sensibly or spatially and communicating with the existence of this space.

The ideally constructed metaverse interface should prevent persons with disabilities who have difficulty using certain senses in the real world from feeling this difficulty in the metaverse. Depending on the user's choice, persons with visual disabilities in reality, may be able to experience the sense of being seen in the metaverse, or they may be able to use the metaverse by utilising the feeling of an invisible reality.

However, persons with disabilities who cannot fully use sensory channels (e.g., visual, auditory, tactile, etc.) connected to XR's immersive environment may not be stimulated enough to feel the presence of the metaverse. As a result, persons with disabilities may not experience sufficient immersion in the environment, and users may have difficulty immersing in the environment.

In order to ensure accessibility in the metaverse, barriers must be removed, sometimes this can be done by using appropriate assistive technology, to satisfy user's specific needs. In this case, users with disabilities can be trusted as if they exist in the real world with a sense of immersion, including assistive technologies.

Since the metaverse services based on the IoT platform are composed of a virtual world based on various information collected from the real world, the metaverse should be configured to accurately reflect the core elements of reality needed by persons with disabilities.

To maximise the expected benefits of services when persons with disabilities use XR devices in metaverse supporting IoT, accessibility should be increased by reflecting the sensual, spatial, and communication methods of persons with disabilities in the real world as appropriately as possible.

Figure 1 summarises the areas of accessibility user problems in the metaverse supporting IoT.

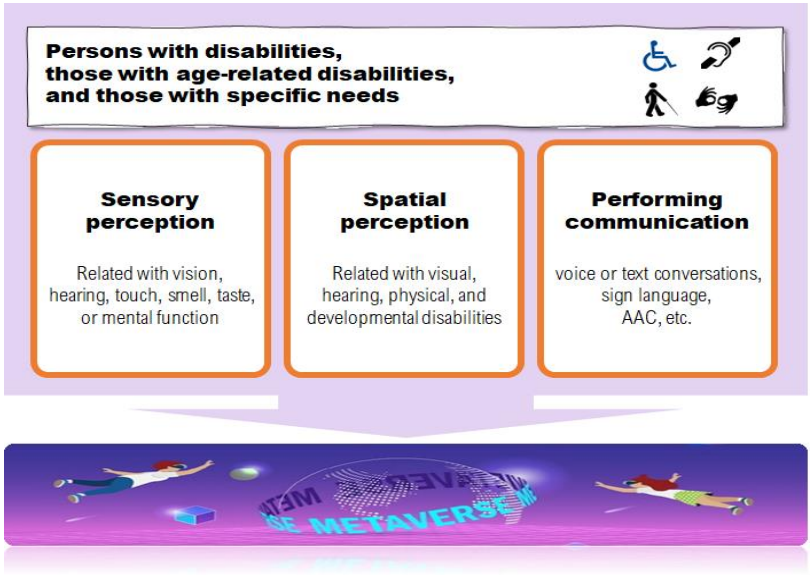

Figure 1 - Three areas of accessibility user problems in the metaverse supporting IoT

The user problems of the persons with disabilities, those with age-related disabilities and those with specific needs in each area are as follows.

- **Sensory perception:** Sensory perceptions can vary in scope depending on the type of user experience (UX) the metaverse service provides. A metaverse service based on XR may utilise one or many senses, such as vision, hearing, touch, smell, taste, or mental function. Specific users who have difficulty with these senses can be less immersed. When presenting alternative technologies to users, persons with disabilities may want to project real-world difficulties into the metaverse for a "perfect sense of reality" or, if there is a way, may not want to feel real-world difficulties as much as in the metaverse. For example, some persons with hearing

disabilities who have cochlear implants can actually hear to some extent. Still, some prefer to turn off the transmitter when not in use in favour of an inaudible environment. They would prefer an alternative representation of sound rather than hearing it even in the metaverse.

- **Spatial perception:** Metaverse is based on virtual space, which projects the real world. In reality, persons with disabilities perceive space differently for each type of disability. The practice of recognizing space may or may not be the same as those without disabilities. The method of recognising and using space varies for each type of disability, such as visual, hearing, physical, and developmental disabilities. This area also concerns the accessibility of navigation through the virtual world. For example, persons with visual disabilities who do not recognize space by sight utilise different senses and memories. Use tools such as a cane to identify the area and recombine it in their head to identify space.
- **Performing communication/action**: In reality, people communicate in various ways. In addition to the means of communication for persons without disabilities, such as voice or text conversations, additional methods, such as sign language and Augmentative and Alternative Communication (AAC), may also be considered for the means of communication for those with disabilities. As in the case of sensory perception, people with disabilities may want to bring real communication methods to the metaverse as they are, or they may wish to use methods that were not possible in real life in the metaverse. This area also concerns manipulating virtual objects and controlling the virtual environment, including powering on/off, volume control and settings. For example, a person with hearing disabilities who uses sign language as their primary communication medium may want to use it in the metaverse even if the metaverse service supports voice communication capabilities to users with hearing disabilities.

7 Accessibility requirements for metaverse services supporting IoT

Digital twin technology is to make real-world objects into “twin” virtual objects in the virtual world and to virtualize and simulate the real world in the virtual world.

Although it is called a digital twin, it is unnecessary to reflect the real world 100% in the virtual world. Substituting all real information into the virtual world does not meet the purpose of virtualizing or simulating digital twins. The purpose of the digital twin is to test and verify what real information becomes a parameter and how a change in some parameters results in a specific outcome through virtualization or simulation of the real world.

Accessibility problems in the real world can be overcome through digital twins using the metaverse. However, this can lead to distorted information in virtualizing and simulating the real world through digital twins to observe specific results. Providing accessibility through digital twins and metaverse requires proper control and notification of these distortions.

This section lists accessibility requirements for the metaverse supporting IoT. Requirements are divided into three subsections: sensory perception, spatial perception, and requirements for performing communication.

7.1 Accessibility requirements on sensory perception

When implementing digital twins through the immersive environment of the metaverse, the following accessibility requirements on sensory perceptions should be considered.

1. When the information to be virtualized or simulated with a digital twin is visual information, a metaverse service is required to provide a function for the virtual object to be magnified, expressed in high contrast, or adjusted brightness according to the user's cognitive ability.

2. A metaverse service is required to provide an auditory or tactile alternative means to visual information.

3. When expanding or reducing virtual objects, a metaverse service is required to notify a user that a distorted perception of texture, volume, and depth may interfere with the user's information acquisition.

4. When a specific colour is changed and expressed for a colour-blind user, a metaverse service is required to notify that distorted perception of colour and texture may interfere with the user's information acquisition.

5. When a high contrast function is used to increase visibility, a metaverse service is required to notify that distorted perception of shape, colour, and texture may interfere with the user's information acquisition.

6. When contrast is adjusted, a metaverse service is required to notify that distorted perception of shape, colour, texture and depth may interfere with the user's information acquisition.

7. When audio content description is provided as an alternative to visual information, audio content description is required to explain the shape, colour, texture, volume, and depth of the virtual object so that information equivalent to that of the user who visually acquires information can be obtained.

8. When providing an alternative means of recognizing visual information by tactile information, a metaverse service is required to provide information on the shape, texture, volume, and depth of virtual objects through tactile information, and colour information is required to be provided through separate audio information.

9. When the information to be virtualized or simulated with a digital twin is auditory information, a metaverse service is required to provide a function that can change the loudness, pitch, and tone of the virtual object according to the user's cognitive ability upon the user's discretion.

10. When the loudness, pitch, or tone of the virtual object is changed at the user’s discretion, a metaverse service is required to notify that the distorted perception of the changed audio may interfere with the user's information acquisition.

11. For users who do not recognize the direction of audio, a metaverse service is required to provide a function that visually expresses the direction of audio.

12. When assistive technologies such as hearing aids and cochlear implants are used, a metaverse service is recommended to provide means to adjust the size, height, tone, and direction of the virtual object's audio so that they are not distorted. Also, a metaverse service is required to notify that the size, height, tone, and direction of the virtual object's audio may be distorted and may interfere with the user's information acquisition.

13. A metaverse service is required to provide a visual or tactile alternative means to audio information.

7.2 Accessibility requirements on spatial perception

When implementing digital twins through the immersive environment of the metaverse, the following accessibility requirements on spatial perceptions should be considered.

1. A metaverse service is recommended to provide appropriate visual and tactile information elements to assist spatial recognition of persons with visual disabilities.

2. When visual and tactile information elements for spatial recognition are provided, a metaverse service is required to clearly indicate whether they are information elements existing in reality or provided by the metaverse.

3. A metaverse service is recommended to be able to utilize auxiliary means such as the tactile paving and braille information panels that persons with disabilities use to recognize and move space in the real world.

4. A metaverse service is required to provide the function of moving to a specific location as a reference.

5. A metaverse service is required to provide information on the location and direction of the space of the persons with disabilities using appropriate information boards, audio guidance, AACs, etc.

7.3 Accessibility requirements for performing communication/action

When implementing digital twins through the immersive environment of the metaverse, the following accessibility requirements for performing communication or action should be considered.

1. A metaverse service is recommended to provide the direction of audio information to help persons with visual disabilities locate the other party.

2. The metaverse service is required to provide sign language interpretation and speech-to-text conversion functions for voice conversations.

3. A metaverse service is required to ensure compatibility with accessibility devices such as hearing aids and cochlear implants.

4. The metaverse service is recommended to provide a real-life mobility experience to users who use mobility aids such as white sticks, wheelchairs, and electric wheelchairs.

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