# ITU Focus Group Technical Report

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## ITU Focus Group on metaverse (FG-MV)

## FGMV-16

# Accessibility in a sustainable metaverse

*Working Group 8: Sustainability, Accessibility & Inclusion*

# Technical Report ITU FGMV-16

## Accessibility in a sustainable metaverse

**Summary**

This Technical Report promotes and instructs on the adaptation of an integrated approach to accessibility and sustainability in the metaverse. It explores the integration of accessibility products and services in the metaverse and their associated social benefit and environmental impact. Emphasising the need for the early integration of accessibility and sustainability, this document presents information and guidance on how to incorporate sustainable accessibility products and services in the metaverse from the outset. Questions related to sustainability and accessibility in the metaverse need to consider the following:

- Social benefit of sustainable accessibility products and services in the metaverse.
- Challenges and opportunities of an accessible and sustainable metaverse.

**Keywords**

metaverse, accessibility, sustainability, inclusive design.

**Note**

This Technical Report 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 Report on "*Accessibility in a sustainable metaverse*" 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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## 1       Scope

This Technical Report presents ways in which to integrate accessibility products and services in a sustainable and energy efficient metaverse for people with diverse access needs. It covers a range of guidance for making the metaverse sustainable and accessible.

Note: Specific guidance on the system design and user requirement for accessible products and services in the metaverse are provided under "Technical Specification ITU FGMV- 04 - Requirements of accessible products and services in the metaverse: Part I – System design perspective" and "Technical Specification ITU FGMV- 05 - Requirements of accessible products and services in the metaverse: Part II – User perspective.

## 2       References

The following ITU-T Recommendations and other references contains provisions which, through reference in this text, constitute provisions of this Technical Report. At the time of publication, the editions indicated were valid. All Recommendations and other references are subject to revisions; users of this Technical Report 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 Report does not give it, as a stand-alone document, the status of a Recommendation.

None.

## 3       Terms and definitions

## 3.1       Terms defined elsewhere

This Technical Report uses the following 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 Artificial intelligence** [b-ISO/IEC 2382]: An interdisciplinary field, usually regarded as a branch of computer science, dealing with models and systems for the performance of functions generally associated with human intelligence, such as reasoning and learning.

**3.1.3 Augmented reality** [b-ITU-T J.301]: A type of mixed reality where graphical elements are integrated into the real world in order to enhance user experience and enrich information.

**3.1.4 Virtual reality** [b-ITU-T P.1320]: An environment that is fully generated by digital means. To qualify as virtual reality, the virtual environment should differ from the local environment.

**3.1.5 Diverse users** [b-ISO/IEC 71]: Individuals with differing abilities and characteristics or accessibility needs.

**3.1.6 Easy-to-understand language** [b-ISO/IEC 23859]: Any language variety which enhances comprehensibility. Note 1 to entry: Easy-to-understand language includes plain language, easy language and any intermediate variety. These varieties share many recommendations, but the extent of comprehensibility is different as they address different user needs.

**3.1.7 Product** [b-ISO/IEC 9241-11]: Item that is made or created by a person or machine.

**3.1.8 Service** [b-ISO/IEC 9241-11]: Means of delivering value for the customer by facilitating results the customer wants to achieve.

### 3.2 Terms defined here

This Technical Report defines the following terms:

None.

## 4 Abbreviations

| | |
|---|---|
| AD | Audio Description |
| AI | Artificial Intelligence |
| JPEG | Joint Photographic Experts Group |
| MT | Machine Translation |
| NMT | Neural Machine Translation |
| PNG | Portable Network Graphics |
| PoS | Proof of Stake |
| PoW | Proof of Work |
| PWD | Person With Disabilities |
| SVG | Scalable Vector Graphics |
| SRT | SubRip |
| UNCRPD | United Nations Convention on the Rights of Persons with Disabilities |
| VR | Virtual Reality |
| VTT | WebVTT |

## 5 Conventions

None.

## 6 Context

The metaverse holds the potential to revolutionize social interaction by providing new opportunities to communicate, learn, work, and interact online [b-Vladutescu]. However, as with any new technology, the metaverse presents various ethical, societal, and environmental questions that demand our attention. For example, how can we build a metaverse that is both sustainable and accessible to a diverse range of users and what form will it take? Questions concerning the future design and functionality of the metaverse have largely dealt with these two topics separately. This is despite the fact that both accessibility and sustainability are interlinked concepts that feature in the United Nations' Sustainable Development Goals [b-UN SDG]. More, specifically, Goal 10 (Reduced Inequality) recognises the importance of ensuring the transition to carbon zero is inclusive to everyone, irrespective of age, sex, disability, ethnicity, religion, economic or social status. More broadly, the SDGs recognise the importance of developing sustainable solutions that safeguard against inequality and exclusion. Consequently, factoring in accessibility and sustainability in the metaverse requires a two-prong approach that considers the social benefit of accessibility services in the metaverse and their associated environmental cost.

### 6.1 Social benefit of accessibility products and services in a sustainable metaverse

In the age of accelerated climate change, ensuring that the metaverse is sustainable and easy to use for people of all capabilities is of pressing concern. Embedding accessibility into all sustainable

initiatives in the metaverse safeguards against exclusion and improves its overall usability for a diverse range of users. For example, a less energy intensive metaverse can allow access for users with slower internet connections or older devices. This in turn not only broadens the usage of the metaverse but also reduces the need for users to acquire new devices, thus curbing electronic waste. By addressing both environmental and accessibility concerns together, we can foster a more inclusive and sustainable metaverse that accommodates the needs and preferences of a broader spectrum of users.

## 6.2 Challenges and opportunities of an accessible and sustainable metaverse

As demand for energy increases, technological advancements such as the metaverse not only place an additional strain on our efforts to decarbonise our energy production in line with targets set out in the Paris Climate Agreement [b-UN Paris], but also present new and complex challenges in achieving these environmental objectives.

Accessibility services, such as interlingual subtitles and intralingual audio captions, are now an essential prerequisite to ensure that all users, including persons with disabilities, can exercise their human rights to equitable access to digital technology and content [b-UN CRPD]. Artificial intelligence (AI) can improve the accessibility of products and services by using underlying technologies such as speech recognition, text-to-speech, and language translation. When combined with blockchain, these services can be securely deployed and shared, making content and resources more accessible to users with disabilities and those who speak different languages [b-Oncins a]. AI technology such as Machine Translation (MT) has come to play an increasingly pivotal role in supporting the delivery of such accessibility services, specifically access to information in different languages (b-Greenwood). However, the computational power needed to train state-of-the art neural language processing models comes at a significant environmental cost [b-Strubell]; [b-Shterionov]. According to one case study, the carbon emissions associated with training the BERT language model was equivalent to a trans-America flight [b-Strubell]. The high energy demands of MT engines can be attributed to recent developments in hardware and training methods in the neural networks. While these recent advancements have improved accuracy, this has come at a considerable environmental cost [b-Strubell]; [b-Shterionov]. Tied to these environmental issues are ethical concerns related the use of translator's data to train Neural Machine Translation (NMT) engines [b-Moorkens] as well as data issues related to privacy, algorithmic bias, assessment, accountability, data ownership and security, and accessibility and inclusion. Despite the increasing computational power required to develop these NMT engines, such an increase yields only marginal gains in accuracy, especially for low resourced languages, i.e., languages that have limited availability of parallel text data, linguistic resources, and tools for training translation models for example, regional and minority languages like Catalan and Urdu [b-Shterionov]; [b-Goyle]. Against the backdrop of growing environmental concerns, redirecting our attention away from an exclusive emphasis on accuracy towards the development of energy efficient NMT engines can provide a path to simultaneously achieve environmental and accessibility objectives for the metaverse.

When considering the sustainability and accessibility of the metaverse, it is important to take into consideration the devices users will use to access it. To access the metaverse, users normally use a Virtual Reality (VR) headset, which poses several accessibility issues for users with additional access needs. For example, users with limited mobility might have difficulty performing the hand gestures required for metaverse navigation, such as swiping or pinching [b-Haynes]. Additionally, the weight, size and multimodal nature of the VR headset may pose problems for some users if worn over extended periods of time [b-Haynes]. Moreover, operating these devices may present difficulties for users who lack digital literacy skills, potentially exacerbating the digital divide.

From the perspective of sustainability, Information and Communication Technology (ICT) devices like smartphones, laptops, tablets, and VR headsets all generate waste throughout their lifespan. Up until recently, the pollution generated by ICT devices has been largely overlooked. One possible reason for this oversight is the fact that the manufacturing, production, and eventual disposal of the

ICT devices including those that facilitate accessibility take place elsewhere, usually in developing countries where environmental legislation and labour laws are less stringent [b-Williams]. For example, most of the materials that go into ICT devices like smartphones and laptops—such as cobalt, copper, silver, gold, tin, tungsten, lithium, and tantalum—are extracted directly from mines in the developing world. This extraction comes at a significant cost to local communities and the surrounding natural environment. There is also the issue of the short lifespan of ICT devices, which poses a significant challenge to our efforts to reduce our e-waste. Currently, the disposal of digital devices is outsourced to developing countries where a "backyard" industry has developed [b-Williams]. A more energy efficient metaverse that can accommodate users with older devices, eliminates the need for users to upgrade or replace their devices. This not only lessens the economic burden on users but also contributes to the reduction of e-waste.

It is not enough to simply measure the environmental impact of the manufacturing and disposal of the ICT devices needed to support users in the metaverse, it is also crucial to take account of the operation of these devices. ICT tools and the digital infrastructure that supports them require energy. This energy normally takes the form of electricity. The source of this electricity varies from country to country. For example, the electricity used to power a device from a country that predominantly produces renewable energy like Norway emits less carbon into the atmosphere than a country like the United States, which derives most of its electricity from the burning of fossil fuels [b- Ritchie]. This energy is commonly referred to as "digital carbon footprint", denoting the subsequent unit of carbon emitted into the atmosphere as a result of digital devices and the networks that support them. This includes the production and operation of ICT devices and the systems that support them– from the cooling of the servers that store our data to the electricity we use to power our mobile devices. The complex supply chain and operation of ICT pose significant environmental risks that jeopardise our efforts to prevent lasting environmental damage.

If accessibility in the metaverse is to be sustainable, more attention to the environmental cost of the tools and networks we use needs to be at the heart of all discussions about a metaverse for a diverse group of people. By embracing sustainability and accessibility as key cornerstones of a healthy society, we can build a metaverse that is truly sustainable and beneficial to diverse users.

# 7 General considerations

To fulfil the full potential of a metaverse, it needs to be built to be sustainable, accessible, inclusive, and equitable across the spectrum of ability. In line with the United Nations' SDGs, questions related to the sustainability and accessibility of the metaverse require an integrated approach that considers the social benefit and associated environmental cost of the necessary infrastructure to meet accessibility requirements. Designed well, the metaverse can lead to new opportunities for a wide variety of people to live, work and interact online by breaking down everyday physical barriers, such as geographical distance and limited transport networks. However, if accessibility is not factored in from the development stage, the metaverse risks replicating wider societal inequity. Therefore it is important to be aware of the impact of the choices that are made when a sustainable metaverse is designed so that it is open to a diverse range of users. This includes the adoption of accessibility and usability principles in all metaverse content.

# 8 Guidance on accessibility products and services in a sustainable metaverse

The following sections provide guidance and questions to consider when designing a sustainable and accessible metaverse.

## 8.1 Ensure usability and accessibility by default

By adopting usability and accessibility conventions and best practice at the design stage [b-W3C], we can ensure that users with diverse access needs are met so that they can access, understand, navigate, and interact with multimedia content in the metaverse. This includes the integration of audio

description, interlingual subtitles and intralingual audio captions, to help users access, understand, navigate, and interact with multimedia content in the metaverse environment.

## 8.2    Avoid duplication of content

The duplication of content in the metaverse can lead to higher energy consumption. By leveraging AI to generate content and accelerate the creation process, and utilizing blockchain to search for, identify, and detect existing content, we can reduce the redundancy of duplicated data. This not only streamlines the creation and verification of content but also minimizes the amount of data needed to power the metaverse. However, it is important to weigh this against the substantial energy consumption associated with the use of some blockchain technology [b-Schinckus]. One strategy for addressing this concern is by prioritising the use of different blockchain consensus mechanisms, such as opting for Proof-of-Stake (PoS) over Proof-of-Work (PoW). In a PoS blockchain, the energy usage is considerably lower compared to PoW, as it doesn't rely on resource-intensive mining to authenticate a transaction. Instead, PoS designates validators to create blocks based on their ownership or "stake" in the blockchain network [b-Fernando]. With regards to accessibility, upcycling, or repurposing accessibility services such as audio description and subtitles minimises the duplication of content by identifying existing audio description and subtitling scripts that can be reused across different platforms or translated into different languages [b-Oncins b]; [b-Jankowska]; [b-Orero].

## 8.3    Create simpler and cleaner user interface

A simpler user interface can be beneficial for a diverse range of users. For example, when a user interface is simple and well-structured, it ensures that users who rely on screen readers can accurately interpret onscreen information. Moreover, for individuals with low levels of literacy, a simplified design with clear and easy-to-understand language can help them access, understand, navigate, and interact with metaverse content more effectively. It also lessens the cognitive load for some users, making it easier for them to focus on the task at hand. This is particularly important for ensuring equal access to information and opportunities.

## 8.4    Prioritise the use of icons for navigation

Prioritising the use of icons that are easy to read, in combination with alternative text, can enhance navigation within the metaverse. This, in turn, can lead to faster information retrieval and reduced search times within the metaverse, potentially contributing to energy savings for user devices. Furthermore, prioritising the use of icons and alternative text in the metaverse can provide valuable assistance to users with low levels of literacy and those who use screen readers.

## 8.5    Build a more energy efficient metaverse for people and the environment

Building a more energy efficient metaverse is beneficial for the environment but also easier for users who use older devices or have slow internet connections. Efficiency can be measured by factors such as data consumption, accessibility across various devices, energy consumption, and the overall user experience. By optimizing these factors, the metaverse can save users money on data and extend the battery life of their devices. A more energy efficient metaverse can also save users money on data and extend the battery life of their devices. It also lessens the financial burden on individuals with older devices by eliminating the need for them to purchase new devices.

## 8.6    Find alternative file and media formats

Providing alternatives file and media formats for informational and accessibility content can reduce the environmental impact of the metaverse and improve accessibility. Alternatives to video for informative content, such as SVGs animation and real text descriptions can be more accessible and energy efficient compared with traditional video formats [b-Greenwood]. Unlike JPEG and PNG, which are composed of a grid of pixels, SVGs uses mathematical formulas to define shapes, lines,

curves, and colours, which means that these images are scalable. Since the graphics are defined mathematically, they can be scaled up or down to fit different screen sizes and resolutions without pixelation or blurriness.

With regards to accessibility in the metaverse, the choice of file formats may vary depending on platform compatibility and specific requirements. For subtitles, the choice of a subtitle file format can also impact the overall file size. Larger file sizes require more energy to be handled, processed, and stored. The choice of subtitle format often relies on specific requirements of the platform, desired features (such as styling and positioning) and compatibility with the content being subtitled. Two commonly used subtitling formats are SRT (SubRip) and VTT (WebVTT). SRT files are generally smaller in size than VTT files, primarily due to their simpler format that includes basic text and timecodes for subtitles. VTT files, on the other hand, include additional features such as text styling and positioning, which can result in larger file sizes. However, the actual file size can vary depending on the content and the specific formatting used in the subtitle. Due to the immersive nature of the metaverse, information about the subtitle's placement will need to be incorporated into its design, which may result in larger file size. Therefore, for the sake of accessibility VTT files may be a more suitable choice compared to SRT, as they are better tailored to an immersive environment like the metaverse.

## 8.7     Use more energy efficient AI

Using more energy efficient AI can ensure a more sustainable and accessible metaverse by facilitating faster access to information. AI supports accessibility services like speech-to-text software and text-to-speech software as well as MT. Using a more energy efficient AI, also referred to as "Green AI" [b-Schwartz], can lead to better outcomes for users of the metaverse in terms of accessibility and energy efficiency.

## 8.8     Create intuitive design and provide easy-to-understand language alternatives

Employing easy-to-understand language and simple, intuitive design can make the metaverse more accessible, improving the user experience and reducing its overall digital carbon footprint. By adopting easy-to-understand principles in the design of the metaverse, we can make it easier to access, navigate, understand, and interact with a wide range of potential users.

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