CERTAIN ASPECTS OF THE CONVERGENCE OF ARTIFICIAL INTELLIGENCE AND METAVERSE: NORMATIVE SECURITY

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Humanity's desire to build a truly inclusive and sustainable digital future requires foresight in decision-making, understanding, and implementation of business practices, where digital technologies can realize their full potential and contribute to the improvement of human life. Digital transformation and innovation reflect trends aimed at using the latest technologies for positive and sustainable economic and societal changes. In the conditions of war, given the damage caused to the Ukrainian economy and infrastructure as a result of Russian aggression, Ukraine needs institutional capacity for rapid recovery, reconstruction, and modernization of the country. One of the reconstruction tools, according to the EU Regulation on the creation of a mechanism (instrument) in Ukraine [1], the possibility of accelerating the sustainable green and digital transition is considered. The tools of such a transition are: digital transformation and protection of the integrity of digital infrastructure, communication and information systems, and the corresponding supply chains [2].

In this context, scholars in various fields of economics are increasingly paying attention to the metauniverse (Metaverse) as an object and a new space for conducting research from economic, ecological, social, and cultural points of view. According to the definition proposed by the International Telecommunication Union ITU-T FGMV-20 focus group, the metauniverse is "an integrative ecosystem of virtual worlds that offers immersive experiences that change existing and create new values" [3]. So, for example, three-dimensional (3D) virtual agents of artificial intelligence (AI) in virtual reality (VR) or holograms in augmented reality (AR) can form new possible forms of interaction in the metaverse, in which traditional channels give way to interactive ones. Everyone can create their own avatar in the metaverse and freely explore the simulated environment. Similarly, remote or hard-to-reach places, processes, etc. can be simulated in the metauniverse. The increase in the level of interaction and immersion offered by the metaverse opens up

unprecedented opportunities and challenges for scientific research aimed at the rapid recovery, reconstruction, and modernization of the country during wartime and in the post-war period. In this regard, a deeper understanding of how to address the challenges and seize the opportunities presented by the metaverse is required, along with identifying the directions for further research into potentially new forms of interaction.

At the international level, G7 and G20 countries, along with international standardization organizations, aim to equip competent authorities and market operators across various jurisdictions with tools to enhance the resilience of digital systems and mitigate risks. This effort is particularly relevant in the context of the highly interconnected metaverse system and requires further harmonization of key requirements and the establishment of a sequence of relevant best practices. To highlight the current trends of the metaverse and the convergence of innovative digital technologies, in particular artificial intelligence (AI) and machine-to-machine interaction, this article outlines the possibility of the emergence of new frontiers of the metaverse based on the formation of normative approaches for research applications.

Metaverse, as a part of web 3.0 of the new generation of the Internet, is considered a new way of interacting with real, AR, VR, or mixed reality. Users access the meta-universe through 3D viewers that are connected to realistic avatars, other users, objects, events, virtual journeys, and more. In ensuring a scalable, sustainable architecture of the metauniverse, a key role is played by the infrastructure of information and communication technologies (ICT), and network infrastructure, in which storage infrastructure and computing power infrastructure are the fundamental elements of this system.

Technologies such as VR, AR, digital doppelgangers, blockchain, media encoding and AI contribute to the formation and development of the metauniverse, which provide immersive experiences, real-time synchronization, security, and enhanced interaction. In particular, VR and AR technologies improve interaction, inclusive accessibility, optimized productivity, and safety. Digital twin technologies, which unite the physical and virtual worlds, play a key role in simulating and synchronizing the metaverse in real-time. The diverse and dynamic nature of the metauniverse is matched by decentralized and tamper-proof blockchain technology, which lays the foundation for a shared virtual environment and secure, verifiable transactions of digital assets. In the context of the metaverse, where there are immersive and dynamic multimedia experiences, media encoding is the basis for the seamless distribution and consumption of content across different metaverse platforms. AI technology itself in the metaverse represents a new dimension of intelligent and adaptive interaction with the user that optimizes performance in this dynamic digital space. The inclusion of large language models enhances AI's ability to create a single metauniverse that transcends individual platforms and boundaries and promotes interoperability in the digital space. Compatibility is a key factor in the interrelated process in the metauniverse. A lack of interoperability between metauniverse platforms can lead to a fragmented user experience and inconvenience, as users will not be able to interact or share their experiences across metauniverses of the metaverse will be

experienced very soon. A retrospective review of the development of the metaverse with the help of big data in the framework of the initiative known as "Adding a New Dimension to the Past", already makes it possible to model hypothetical spatio-temporal 4D reconstructions of the past with modern digital technologies and infrastructure and to create a collective digital information system of the future that will reflect the economic evolution in different sectors of the economy using the AR/VR program at different times. Such computational models are seen as key resources for the development of new critical reflections on the future in the metaverse, which will make it possible to make informed decisions.

Establishing a standardized framework and jointly agreed terminology for the implementation of semantic interoperability of the metauniverse requires the development of a common concept and scenarios based on standardized protocols and interfaces for different technologies and platforms. Data exchange for consistent user interfaces between the various metauniverse platforms is a major element of this interoperability. The increased level of interaction and immersion that the metaverse offers presents unprecedented opportunities and challenges for research. Some organizations and brands seeking to better position their products and services have already taken the first steps to harness the potential of the metaverse in their research. Among the well-known companies developing practical versions of the metaverse today are: Apple, NVIDIA, Decentraland, Roblox Corporation, Unity Software, Amazon, Epic Games, and others. The motivation for the development of the metauniverse in leading companies is due to the improvement of production efficiency, the promotion of innovations and the synergistic interaction of virtual and physical environments. In particular, as highlighted in a recent review of research on the metaverse in various areas of the economy and aimed at increasing productivity, solving global problems and promoting sustainable development, include such as: medicine, manufacturing, agriculture, banking, energy, retail and fashion, education. city management, transport, urban construction, and environmental protection [4].

Given that the metaverse is currently a new field, and its concepts and application scenarios are extremely diverse and multifaceted, the issues of immersive technologies are currently being investigated by various working groups related to the metaverse. To support countries, cities and industries to stimulate innovation and implement innovative digital technologies on the eve of the opening of the World Telecommunication Standardization Assembly 2024 (WTSA -24) in October 2024 in New Delhi (India) held the fifth symposium of global standards (GSS -24) "Formation of a new momentum of digital development: new technologies, innovations and international standards" [5], which discussed the role of international standards in the formation of the metauniverse and ensuring its significant impact on the field of telecommunications. Experts predict that the metauniverse will be based on seven main technologies: 5G technology, augmented reality, brain-computer interfaces, cloud computing, blockchain, digital twins and AI. As noted, of these technologies, AI is the most important part of the metaverse due to its potential to scale it.

In the development of the metaverse, AI is a necessary technology not only in the fields of computer vision and natural language processing but also in VR and augmented reality (AR). For example, in AR technology, AI is used for immersive rendering, detection of virtual and real objects, and 3D reconstruction of objects, helping to ensure the diversity and usability of AR applications. Eventually, most of the 3D imagery, animation, and language in the metaverse will likely be generated by AI. Machine learning models can also be used to automate smart contracts, and distributed ledgers, and support other blockchain technologies for virtual transactions. AI technology is also expected to help expand the metaverse by supporting object detection, improving visualization, and providing control under Bucharest Resolution 214 "Artificial Intelligence and Telecommunications/ICT Technologies" [7]. However, despite its promise and potential, the metaverse still has many challenges to overcome. However, AI is likely to be among the technological tools that can help overcome these challenges.

However, at this stage, the emergence of the metauniverse does not yet have a clear idea of the direction and stages of technical development. A brief road map of metauniverse standardization is now presented through the lens of research by international standardization bodies. In the standardization system, the Standardization Subcommittee of the Joint Technical Committee for Standardization ISO / IEC deals with issues of developing standards for AI concepts, frameworks, systems, and guarantees for ensuring reliability, security, and AI technologies. JTC 1/ SC 42 "Artificial Intelligence" [6]. In addition, in the Joint Technical Committee (JTC) of the International Standardization Organizations (ISO) and International Electrotechnical Commission (IEC) development, maintenance, and promotion of standards in the field ICT is taken care of by ISO / IEC JTC 1 "Information technologies". ISO / IEC JTC 1 is responsible for such critical IT standards as "Software and Systems Engineering" (ISO/IEC JTC1/SC 7), "Computer Graphics, Image Processing, and Environmental Data" (ISO/IEC JTC1/SC 24), "Information security, cyber security and privacy protection" (ISO/IEC JTC1/SC 27), "Methods of automatic identification and data collection" (ISO/IEC JTC1/SC 31), User Interfaces (ISO/IEC JTC1/SC 35), Cloud Computing and Distributed Platforms (ISO/IEC JTC1/SC 38), Internet of Things and the Digital Twin (ISO /IEC JTC1/SC 41), etc.

To promote the formation of a common vision of the future, in addition to the above-mentioned standardization bodies, such organizations as the ITU, ISO/IEC, the immersion group of the Web community [8], and others are investigating the issue of the metauniverse. In particular, the International Telecommunication Union (ITU) Research Group ITU-T SG3 is investigating the economic and policy implications, including regulatory frameworks, taxation, and economic models, that are associated with virtual platform economies in the metaverse [9]. General functional requirements for metauniverse networks , optical transport networks and access network infrastructures are being worked on by research groups ITU 13 "Networks of the Future" [10] with an emphasis on IMT -2020, cloud computing and trusted network infrastructures, as well as ITU-T SG15 [11] regarding the integration of VR and AR technologies into optical transport networks and access network

infrastructures to support requirements in the metaverse . Research on multimedia coding, systems and programs, taking into account virtual worlds, platforms for social interaction (ITU-T SG16) [12], security (ITU-T SG17) [13] and infrastructure of a smart city in the metaverse , which ensures improvement of the general functionality and intelligence of connected communities within the metaverse (ITU-T SG20) [14].

Global standards, especially in networking and communications, create opportunities for interoperability, security and deliver key benefits for both users and network operators. At the same time, the future of emerging technologies is inextricably linked to open source, the driving force behind innovation. Open source has become a "de facto standard" by providing developers need such reference devices and bases for applying standards in practice. Open source projects implemented in Ukraine with the support of the Swiss-Ukrainian EGAP Program, implemented by the Eastern Europe Fund and financed by Switzerland, contribute to the achievement of the synergy of software and hardware, integration of fragmented markets, and the creation of new technologies and new models [15].

The convergence of AI and the metaverse could revolutionize critical industries such as public services, disaster risk reduction, urban planning, and smart manufacturing, and drive innovative solutions for the sustainability of the digital future [16]. Recently, metaverse has become one of the breakthrough areas of innovation with great potential for economic development [17].

Given the need to create standards for AI applications in various fields (medicine, industry, agriculture, energy, banking, etc.) that are aimed at increasing productivity, solving problems, and promoting economic sustainability, it is advisable to create task forces to encourage interdisciplinary cooperation in the standardization sector in the metaverse, which would contribute to the development of AI requirements to meet the needs of specific industries.

An urgent topic that currently requires research and implementation in the domestic context is the formation of a platform for the participation of interested organizations in a unique dialogue on the creation of innovative ecosystems and the development of the potential of innovative digital technologies, including artificial intelligence (AI) and the metauniverse. It is also important to create a technical standardization committee in Ukraine regarding future networks and the adaptation of new network technologies that will be able to meet the changing needs of public digital infrastructure and contribute to the further development and harmonization of international standards related to risk management and management systems.

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