The status of metaverse and digital twin technology development*

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Abstract

Metaverse refers to a world that transcends reality. Metaverse is a compound word of meta (transcendence) and universe (universe). The impact of the corona pandemic has provided an opportunity to rapidly grow the metaverse based on realistic content along with online and non-face-to-face environments. Various content and service platforms reflecting the concepts of metaverse and digital twin are rapidly spreading around the world in line with the pandemic situation. As their needs accelerate in response to the COVID-19 situation, the technology of metaverse and digital twin is attracting attention again as an indispensable condition for business, culture and art, national industry, and public services. In particular, the metaverse requires the balanced development of ecosystem components based on various advanced convergence technologies. In this paper, the concept of metaverse and digital twin, types of platforms, and development status are examined, and trends of key element technologies are investigated and analyzed. As these key element technologies, XR sensory technology, avatar technology, and other XR devices and parts were examined. Through this, we want to clearly pinpoint the direction in which the metaverse will develop through future technologies, services, and follow-up research.

Keywords : Metaverse, Digital Twin, Contents, Emerging Markets, Metaverse Platform, Metaverse Devices, Core Technologies

Major Classification Code : Artificial Intelligence, Analysis of   Metaverse Market, WelfareEconomics

1. Introduction

Metaverse was first introduced by Neil Stevenson (Stevenson, 1992). Here, the metaverse is the world where the avatar communicates and experiences with other avatars, and is a space made of electronic information in which the avatar moves. Here, a conceptual system called mixed reality that integrates the concepts of real reality, virtual reality, and augmented reality has been proposed (Fast-Berglund et al., 2018; Milgram, & Kishino, 1994). Here, the real space and the information space are not separate things, but are connected to each other, and it has been developed from the perspective that it can be understood in the form of a "Reality-Virtuality Continuum" spectrum depending on which value is emphasized more. The concept started in this way continues with the emergence of technologies and

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concepts such as cybernetics, machine hand, HMD (Sutherland, 1968), telepresence, artificial reality, media room, cyberspace, data glove, virtual reality, augmented reality, metaverse, and avatar. Developed core concept that encompasses this metaverse as a whole is that human beings can experience "another body (avatar)" through sensory feedback, and through this, "experience" another world (remote field, virtual world).

In the mid-to-late 2010s, virtual reality and augmented reality began to be understood more rapidly by the public. In the 2020's, it was talked about again as if it was a new concept all over the world. In a space where virtual and reality converge and the boundary disappears, that is, people and things interact in a space where the boundaries of virtual reality have disappeared. It is a world (platform) that creates the production and consumption of new values (Lee et al., 2011; George et al., 2021) through social and cultural activities (see Figure 1).

These concepts basically presuppose 3D spatial/form information of the real world (Kim, 2020). As a yardstick for judging the advent of the metaverse, it is possible to suggest the level and extent of the reproduction of 3D form information. Also, it can be said that this is the point of contact with the basic concept of the digital twin.
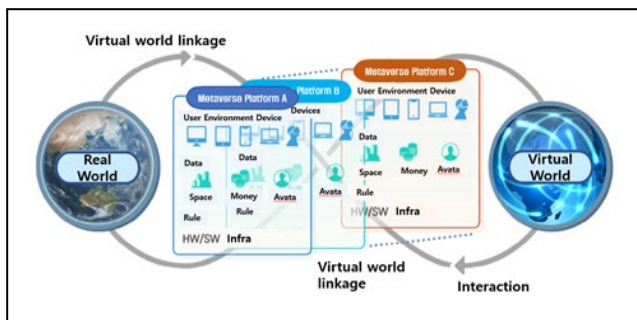
Source: Korea Distribution White Paper (2022)

Figure 1: Metaverse Conceptual Diagram

The concept of digital twin was first introduced around 2003 by Professor Michael Grieves of Michigan University (Greaves, 2014). It was a declarative concept that digital information and physical goods should achieve equivalence from the perspective of manufacturing and, more broadly, Product Lifecycle Management (PLM) (Marcos de Oliveira & Andreatta, 2021). Basically, from the time of product design to the level of form equivalence in which individual parts are directly connected to manufacturing, information on the assembling process is also digitized, and information about the operating process and state when the finished product is used is converted back to digital information.

It should be able to be returned. It was expected that through this, it would be possible to monitor the entire product lifecycle and to efficiently and effectively manage

(distributed) manufacturing plants and processes to optimize product manufacturing and service costs. Then, as the concepts of virtual reality and metaverse were talked about again from the mid-2010s, the necessary computer hardware and software technology developed. started Here, as the concept of digital twin is extended to the actual operating system and further to the service that requires real-time interaction in the metaverse, the reproduction and simulation of the operation process and state has become more important. This is because, in many cases, it is still the most difficult to obtain a shape-based numerical analysis model and simulation technology.

In recent years, digital twin-type systems have lowered the requirements for shape equivalence and are focusing a little more on real-time condition monitoring and operation reproduction and simulation. It is being developed in a form that exists (Wortley, 2022).

2. Metaverse Platform Types and Development Status

Metaverse can be broadly classified into 1) social relationship formation type, 2) digital asset transaction (Market) type, and 3) remote collaboration support type (Assistant) depending on the purpose of use (Korea Distribution White Pater, 2022). Each of these types is expected to develop independently in the beginning, and then develop into a form with integrated functions as several types of merges with each other. Also, in October 2021, Meta (formerly Facebook) announced the expansion of platform functions by releasing Horizon Home (personal space), Horizon World (social space), and Horizon Workroom (collaboration space) (Kim, 2021).

Metaverse has emerged as a platform that will bring a new paradigm shift just as the ICT ecosystem (Lee et al. 2021) in the past has shifted from PCs to smartphones. It is also attracting attention as the next-generation internet of decentralization. (see Figure 2).
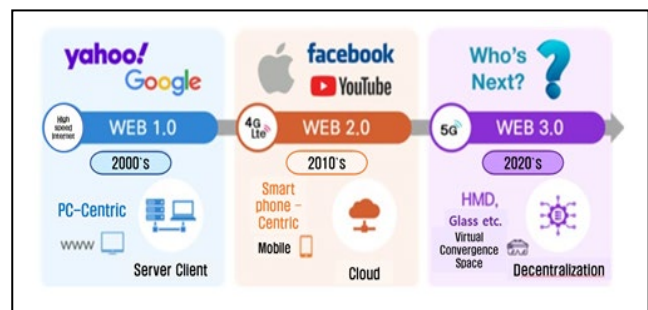
Source: Korea Distribution White Paper (2022).

Figure 2: ICT paradigm change by era

2.1. Social Relationship Formation type

It is a platform that has the functions of group play, cultural activity and social relationship formation through SNS, play, and games, and Roblox and ZEPETO are representative examples. Roblox (Kharif, 2021), a service launched in 2006, allows players that look like Lego to be decorated with various items. Unlike Minecraft, where blocks were released earlier, blocks are not limited to cuboids, but exist in various forms, and use Roblox Studio to create a virtual world. Roblox has a UI like that of a game creation tool, and various rules and effects can be created using Roblox scripts based on Lua, a programming language. On the other hand, ZEPETO is a service launched in 2018 by SNOW Co., Ltd., and you can customize the character's gender, appearance, and clothes according to your taste. Recently, it has received a lot of attention by wearing virtual costumes through partnerships with famous overseas brands and holding fan meetings with popular celebrities. ZEPETO also provides tools called ZEPETO STUDIO and BUILDIT, which you can use to create and wear clothes and other items.

Table 1: Type 1 of Metaverse Platform And Examples

Type	Company	Property
Social relationship formation Type ("Group play and cultural activities on SNS and games")	○ ROBLOX **ROBLOX**	○ Metaverse's pronoun, recognizing games as a **'society'** - Roblox Studio (production tool) users **create content and generate revenue**
	○ ZEPETO **ZEPETO**	○ Formation of **social relationships** centered on avatars and play - Decorate one's avatar and participate in **social activities** such as **playing with other users in a virtual space**

2.2. Digital Asset Transaction Type

Decantraland and Earth2 are representative platforms for digital asset trading types. Decantraland is a platform for realizing virtual land and building construction and transaction services based on the Ethereum blockchain.

Users can create, experience and monetize content and applications on the Decentraland platform, where Earth2 feature land is a non-fungible, transferable and finite digital asset stored in an Ethereum smart contract. Contents can be implemented in a variety of ways, from static 3D scenes to interactive systems such as games.

Earth 2 is a game that creates a virtual world that maps a virtual earth 1:1, and is a platform for virtual real estate transactions in a digital twin earth. Investment activities that reflect the desire to create economic value are possible by reproducing the real world including major attractions. At first, there were many game developers and users who wanted a special experience such as immersive augmented reality (AR).

Table 2: Type 2 of Metaverse Platform And Examples

Type	Company	Property
Digital asset transaction Type ("Direct transactionin virtual space, virtual building, virtual prodeuc,etc.")	○ Decentraland **Decentraland**	○ Blockchain-based virtual land and building construction and transaction - Space experience through avatar, advertisement through virtual billboard, shopping in virtual shopping mall, community creation
	○ EARTH2 **E∧RTH2**	○ Virtual real estate transaction in the digital twin district - Investment activities reflecting the desire to create economic value by reproducing the real world including major attractions

2.3. Remote Collaboration Support (Assistant) Types

Microsoft mesh and NVIDIA Omnibus are representative platforms of the remote collaboration support type that have remote communication and business support functions by virtualizing reality. MS Mesh is a technology that utilizes the AR device HoloLens 2, and it is a platform where you can meet other people in virtual reality, talk face-to-face, and share various tasks.

It is a platform that actively utilizes mixed reality (MR) technology to create new information such as sight and hearing by fusing virtual reality and the real world. Using HoloLens 2, it provides a collaborative space in mixed reality and supports 3D content visualization and interaction.

On the other hand, NVIDIA Omnibus is an easily extensible platform for 3D design collaboration and scalable multi-GPU, photorealistic real-time simulations, enabling real-time remote collaboration and simulation support in

industrial applications, multi-user design collaboration and physically accurate real-time simulations. and industrial digital twin construction support.

Table 3: Type 3 of Metaverse Platform And Examples

Type	Company	Property
Remote collaboration support (Assistant) Type ("Remote communicationand multi-collaboration support")	○ Messi Microsoft	○ Support for remote collaboration in a mixed reality environment - Using HoloLens 2 to provide a collaborative space in mixed reality and support for 3D content visualization, interaction, etc.
	○ Omnibus NVIDIA.	○ Real-time remote collaboration and simulation support in the industrial field - Supports multi-user design collaboration, physically accurate real-time simulations, and building industrial digital twins

3. Metaverse and Digital Twin Core Technology Development

3.1. XR Immersive Technology

There are various sensory technologies classified by keywords such as AR, VR, MR (Mixed Reality), and XR. In the early days, metaverse developed in the direction of developing services centered on daily life and social activities such as games, play, and communication based on PCs and smartphones, and was used first by specializing in specialized areas such as XR-based manufacturing training that maximized immersion, the service is expected to gradually spread to daily life and work areas.

Although the spread of XR devices is still in its infancy, the emergence of innovative XR devices and next-generation form factors is expected as the XR market grows significantly in the future. As chronic problems such as the weight, image quality, and dizziness of XR devices are improved, the spread of metaverse services that provide a high level of immersion is expected. Google Glass was released to the general public in 2012, but it was engulfed in

controversy over its high price, limited features, and invasion of privacy. Microsoft HoloLens (Boyle, 2016) has established itself as the most successful and commercialized AR glasses.

In the case of HoloLens 2, it is priced at several million won, but 200,000 units have been sold and are being used in certain industries (Hanna et al., 2018). Apple, which led a new industry with the iPhone, is also planning to release AR glasses, and the related HMD (Head Mounted Display) market is expected to grow more than 10 times by 2025.

As the metaverse service usage method is expected to change centering on devices, domestically finished products are scarce and dependence on foreign products is deepening. Samsung, LG, etc. released VR devices in 2015 and 2018, and small and medium-sized enterprises (SMEs) are also developing related technologies and devices, but no great results have been achieved. In the case of XR immersive technology, among domestic companies, Giant Staff implemented non-face-to-face XR live performances such as girl group ESPA showcase, and WYSIWYG Studio built XR Stage, a metaverse production platform. In addition, CJ E&M is building a large virtual production studio while starting the virtual production business.

3.2. Avatar Technology: Production Tools (Engine, SW)

Sophisticated avatars that imitate human expressions and actions enable delicate communication and interaction based on emotional connections even in the virtual world. Avatar is developing in the direction of spreading sympathy with humans by increasing digital human activities that incorporate AI technology in various fields such as entertainment, education, distribution and broadcasting. As development tools that can quickly create digital humans were released from Epic Games and NVIDIA, non-professional companies were able to easily incorporate digital humans through the services of these companies.

As the lifestyle of having multiple jobs spreads in various metaverses, and a new job group that produces economic value in the virtual world appears, it is bringing about a big change in society as a whole. With the proliferation of low-code and no-code development tools, anyone can easily develop and create activities on the metaverse.

Game engines such as Unreal and Unity have been expanded and used to produce metaverse content, and major ICT companies are also providing AR application development tools such as Apple ARKit, Google ARCore, and Amazon Sumerian. In Korea, companies such as HelloApps, Utplus Interactive, Sears Lab, and Maxt are providing metaverse development tools for beginners. In addition, although domestic game companies have their own high-spec game engines, they have not yet expanded into the

metaverse field.

3.3. Other XR Device Core Technologies and Parts

In the metaverse, all components of the physical real world and the virtual world are connected, and for all users to control it through an avatar or actual physical action, an interface device that can interact anytime and anywhere is needed. On various platforms of metaverse, interaction was usually provided only with the keyboard and mouse. In addition, interaction through body movement was provided using a controller connected to a VR device or through a limited motion tracking device. Oculus Touch, announced in 2016, is a VR-only controller, and it is possible to secure stability through more natural hand gestures and a wrap-around appearance than conventional remote control or baton-type controllers (Orland, 2016). In addition, it was evaluated as a more intuitive controller because it resembles the action of a user holding an object in order to press the trigger-type detection button attached to the front of the controller. Since the Oculus Touch, most VR controllers have taken on a similar shape.

As core components for XR devices, it can be said that the image panel, that is, the micro display, optical lens module (optical system), ToF (Time of Flight) sensor, component board, camera, battery and operating system (OS) are important (Han et al., 2022). In addition, various components such as 3D scanners, motion capture sensors, eye tracking sensors, gyro sensors, and sound modules can be used to implement the metaverse. First of all, looking at the operating system among them, many XR devices released so far use Google's Android OS. It is judged that there is a high possibility that the experience will be maintained. Therefore, Meta (formerly Facebook) is developing Oculus' own OS to reduce dependence on Android. Graphics performance is important for metaverse's competitive pictorial, but major overseas manufacturers such as NVIDIA, AMD, Intel, Qualcomm, and ARM have high dominance in the GPU market, so there are not enough operators who can compete with them. NVIDIA Geforce, AMD Radeon, etc. are representative GPU brands, and Intel, Apple, Qualcomm, and ARM have their own built-in graphics and are equipped with them. In addition, Microsoft developed its own HPU (Holographic Processing Unit) and installed it on the HoloLens. In Korea, Samsung Electronics developed its own processor Exynos and installed it in its smartphone, but ARM's Mali-G78 is still used for the integrated graphics.

For the activation of the metaverse service, it is important that avatars and contents are safely used and traded on the metaverse. For this purpose, blockchain-based smart contracts and non-fungible token (NFT) technology are being used (Belk et al., 2022). In addition, user authentication in the metaverse service is very important, and blockchain-based decentralized identity authentication (Jeon et al., 2022; Kim, 2019) and bio-authentication technologies are being studied a lot. Representatively, companies such as Decentraland, The Sandbox overseas, Wemade Tree, Way2Bit, Division Network, and Coinplug in Korea are applying NFT technology to assets in Metaverse. In addition, it can be said that it is very important to secure the reliability and asset compatibility of the digital currency in the metaverse in order to expand the economic activities in the metaverse to the digital economy ecosystem. We are trying to use blockchain-based virtual cryptocurrency technology for metaverse. However, it is still difficult to expand the metaverse economy in Korea due to regulations such as prohibition of export of in-game profits.

In addition, as described above, various components such as microdisplay, optical system, ToF (Time of Flight) sensor, driving board, camera, 3D scanner, motion capture sensor, eye tracking sensor, gyro sensor, and sound module are used to implement the metaverse. In the case of microdisplay, development and investment are mainly focused on Micro LED and OLEDoS. Optical combiner technology, which is a key element of augmented reality implementation, includes a polarizing beam splitter, a free-form prism, and a waveguide method.

4. Conclusions

Metaverse and digital twin strategies are evolving into optimal technologies that can provide people with a bright future as a means of resolving the difficulties of the people who are in the blind spot of cultural services and public welfare policies. In the future, the metaverse is expected to come in an era of creating more immersive content using various authoring tools and augmented reality and virtual reality technologies. I guarantee that people will not gather because of the name of the metaverse, but only if there is a value that people can find in the metaverse.

Therefore, we avoid "Metaverse for Metaverse", apply virtual reality and augmented reality technology to services that can give people value, and provide an easy and convenient UI for users to create their own content, if we provide the ability to create a community using this, metaverse will be with us as the next-generation Internet (Lee, 2021). For this, the expansion of the metaverse ecosystem is more important than anything else, and it is essential that each component grows and cooperates and connects with each other. As major overseas ICT companies dominate various fields within the metaverse ecosystem, the competition to take the lead in the metaverse ecosystem is expected to intensify. Accordingly, it appears that domestic companies need to respond more quickly.

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