



From sci-fi concept to cutting-edge technology: KPMG's "Exploring the metaverse"

Synopsis



Introduction

2021 has been called the first year of the metaverse era. The metaverse concept came to prominence after sandbox gaming platform Roblox included it in its March 2021 prospectus, causing the company to become known as the "first metaverse concept stock." This was followed by Facebook officially changing its name to Meta in October 2021. Since then, widespread discussions have been taking place in capital markets and industries around the world, helping to transform the metaverse concept into a global phenomenon.

The metaverse is still a hot topic as we move into 2022. At the end of 2021, Shanghai officially incorporated the concept into its 'Five-Year Plan' for the development of its electronic information industry, while the term was also frequently heard in the Two Sessions held by local governments at the start of the new year. The metaverse has gained widespread attention thanks to the emergence of various consumer-oriented products that have been made possible by the continuous development of the different core technologies and hardware that underpin the concept. At the same time, the COVID-19 pandemic has changed the way people live and work and accelerated the digital transformation of enterprises, providing a unique opportunity for the metaverse concept to thrive.

As an emerging concept, the metaverse is full of unknowns. What is the metaverse? What elements will shape its technological ecosystem? What will work and life be like in the metaverse in the future? What changes will it bring to different industries? What are the challenges in terms of turning the concept into reality? The Exploring the metaverse report released by KPMG China covers all of these questions and more. By taking a panoramic view of the metaverse ecosystem, we performed an analysis based on four dimensions: the definition and specific characteristics of the metaverse, its basic hardware and core technologies, its prospects in 10 major scenarios, and the opportunities and challenges that lie ahead.



One concept with many interpretations: What is the metaverse?

People's understanding of what the metaverse is varies and there is no universally accepted definition. Discussions in the industry suggest that the metaverse represents a real-time online network empowered by the integration of different technologies, including blockchain, artificial intelligence (AI) and interactive sensing technologies. The metaverse is an ecosystem created through interaction between the digital and physical worlds and is expected to have a profound impact on people's livelihoods and work, business operations and the economic environment in general. In the future, we think that a mature, sophisticated metaverse will have the following six characteristics:



Digital immersive experience: Participative immersion is currently one of the most prominent features of the metaverse and a major breakthrough in the recent development of the concept. XR (extended reality) technology, which incorporates AR (augmented reality), VR (virtual reality) and MR (mixed reality), is being steadily developed to allow for total immersion in the metaverse. Based on this group of technologies, the metaverse can be extended from activities such as online gaming and social networking to online-offline integration of various real-life scenarios in order to provide the ultimate entertainment experience and enhance efficiency in daily life.

Openness: To accommodate a significant number of users and content, the systems that form the metaverse must open their technical interfaces to third parties, allowing for the diversification of the technological ecosystem. In addition, in order to keep a massive number of online users connected in real time and cultivate a strong social network, metaverse devices should have a low threshold to usage and be highly compatible with the rest of the ecosystem.

Virtual identity: Real-world users can interact in the metaverse through one or more identities. Users may be identified by their virtual names at the frontend and their real names at the backend, or may choose to remain anonymous, depending on the supervisory model. These virtual identities might be used to consume in the future metaverse.



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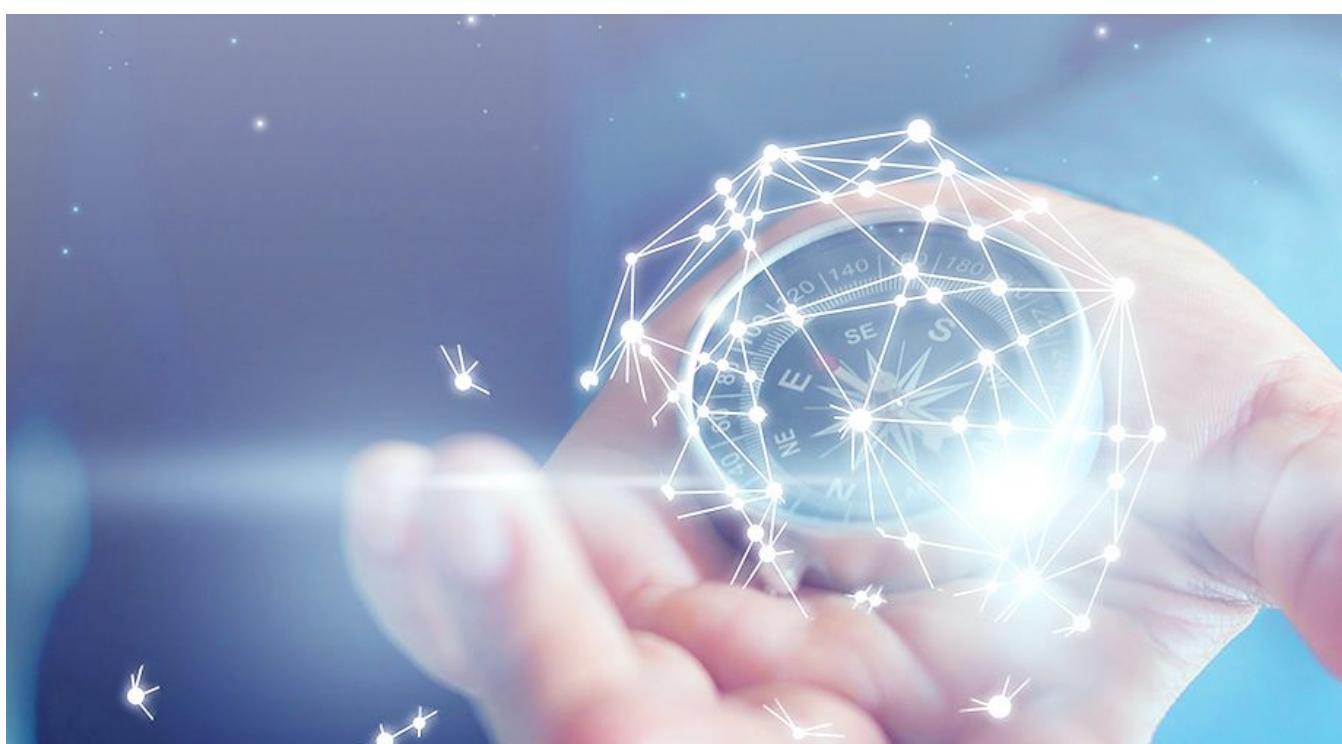
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Ongoing evolution: The metaverse is constantly evolving. That means regardless of whether participants are online or offline, the metaverse is always up and running, and impacting users' virtual identities.

Virtual-real interaction: By simulating and replicating the physical world, digital twins and other technologies extend the boundaries of the digital world and react to the physical world. In the metaverse, the digital and physical worlds will gradually merge, interact and influence each other.

New authentication methods: Using NFTs (non-fungible tokens) and other blockchain technology, every file and digital item in the metaverse era can be assigned a unique label and a special purpose, making each one a unique and verifiable product. In the future, prices in the metaverse may be determined by various factors, such as market consensus or the scarcity and liquidity of these products.

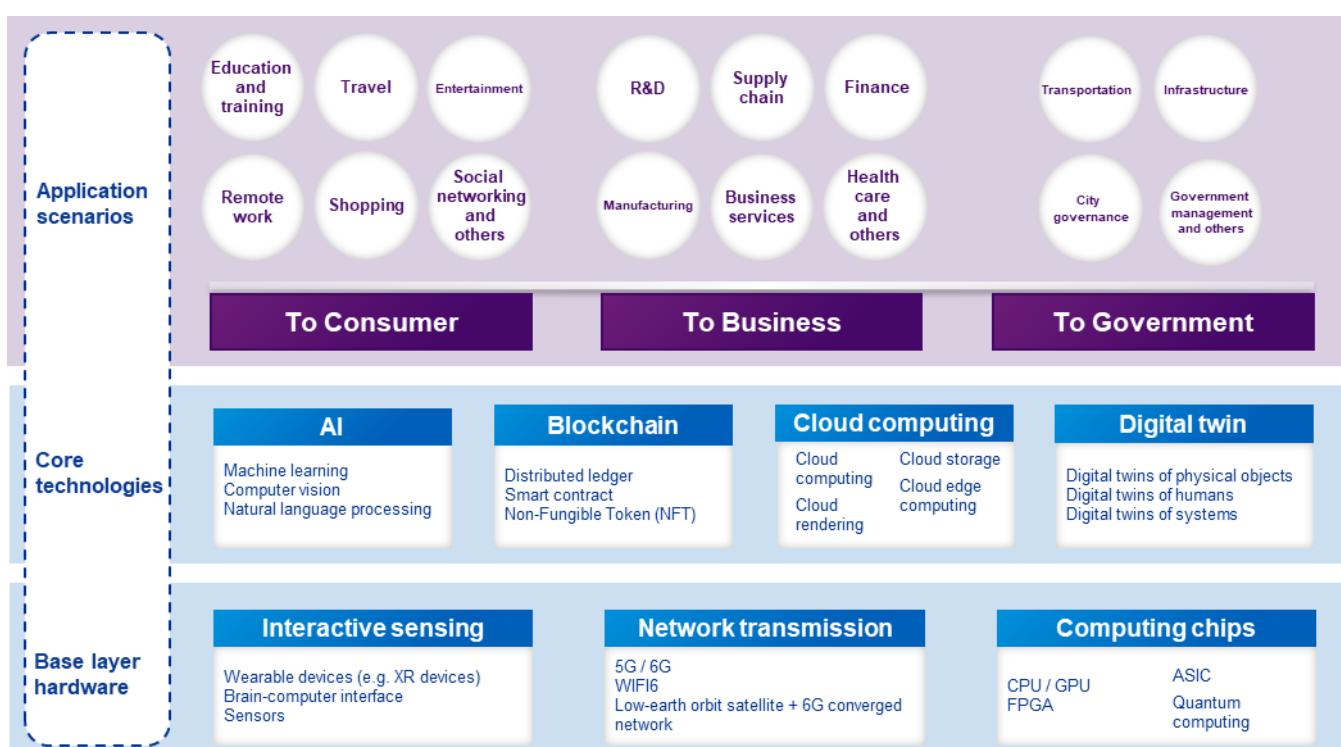




The metaverse ecosystem: technology empowers invention

The metaverse ecosystem is made up of several major components, including base-layer hardware components, core technologies and application scenarios (see Figure 1). The base layer consists of basic hardware, such as interactive sensing devices, network transmission devices and computing chips. On this basis, AI, blockchain, cloud services, digital twins and other core technologies can be combined to build a rich digital world. The metaverse can be widely applied on the consumer side, the enterprise side and the government side. Overall, it will have a profound impact on areas such as entertainment, shopping, remote work, finance, manufacturing, city governance and R&D. It will bring about changes to economies and business models that may lead to the emergence of new ways of doing business.

Figure 1 *The metaverse ecosystem*

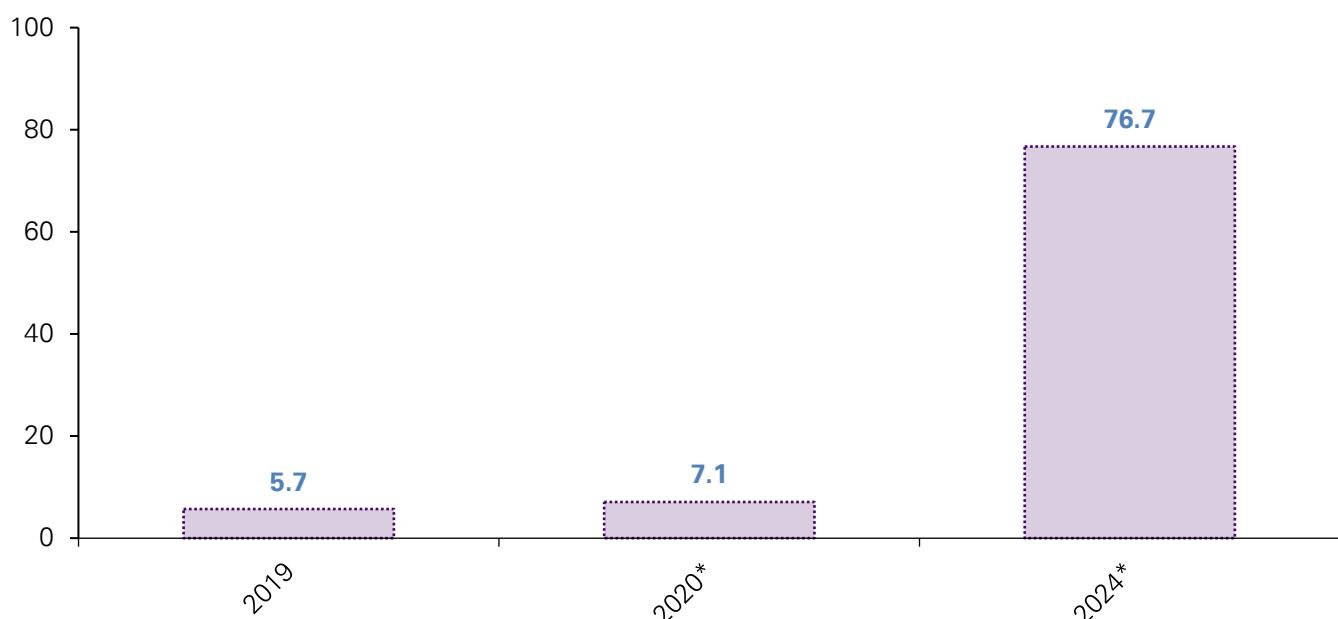


Source: KPMG China



- **Interactive sensing** devices: At present, there are two ways to interact in the metaverse. The first is to outfit users with wearable devices such as XR helmets, smart bracelets and electronic skins to pick up their movements, with images delivered to the user through a head-mounted *display (HMD)* to complete the interaction. The second is to directly collect brainwaves or electronic signals through implanted or detachable brain-computer interfaces and then perform steps including calculation and compilation to enable human-computer interaction. The brain-computer interface concept is still in the experimental stage and has not yet been successfully applied in a business scenario. Therefore, from the perspective of technical feasibility, XR devices represent the most promising path toward meeting the current interactive and development needs of the metaverse, and they will be the focus of metaverse infrastructure in the future. At present, the “Inside-out+6DoF” spatial *positioning* and motion capture solution is one of the more mature technologies in this industry. Market research firm IDC expects as many as 76.7 million VR HMDs to be shipped worldwide in 2024, more than 10 times the number shipped in 2020 (see Figure 2).

Figure 2 | *Shipments of AR/VR HMDs worldwide (in million units)*



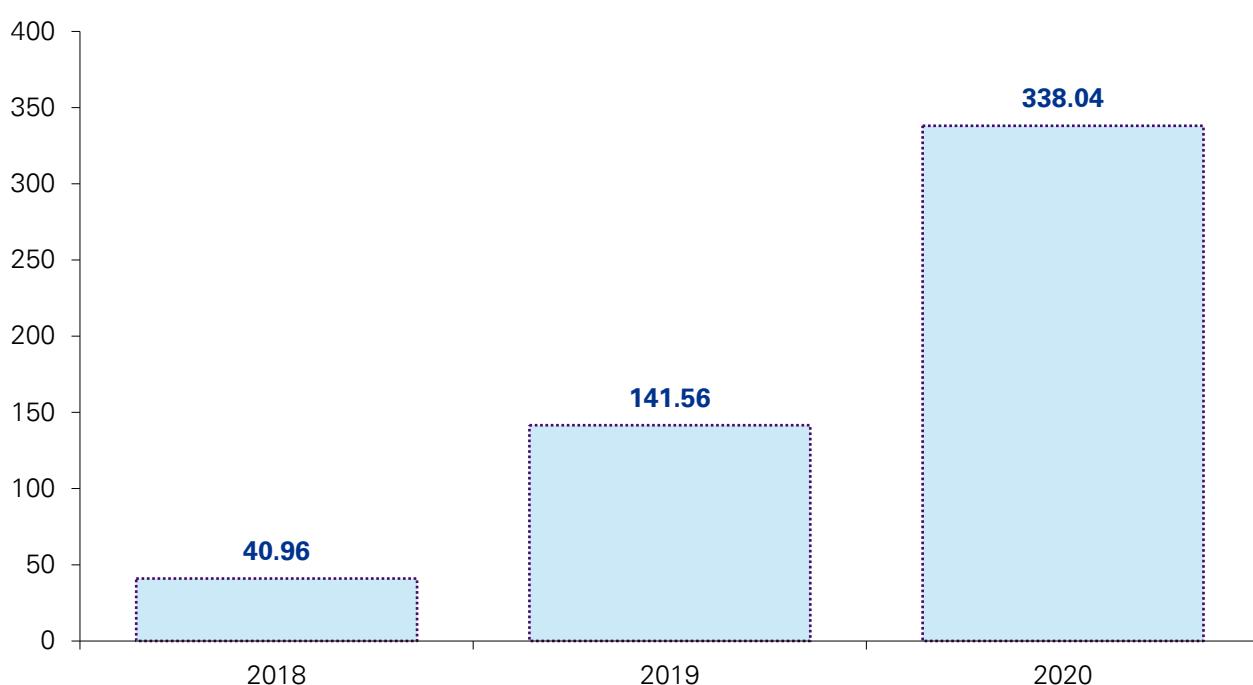
Source: IDC, Statista, KPMG analysis

* represents forecasts.

- **Network transmission:** An immersive experience is the most prominent feature of the metaverse; and the transmission of high-resolution, low-latency images is indispensable to delivering such an experience. In this context, the wide adoption of 5G networks, and 5G terminals in particular, as well as the coverage of base stations play a decisive role in making wireless lightweight XR devices possible at the current stage. The metaverse should be accessible ‘anytime anywhere’, which requires high network connectivity. In order to address this requirement, many countries are proactively implementing the model of ‘coverage by base stations + signal reception by terminals’, while also exploring the ‘low-earth orbit satellite + 5G/6G’ converged communication network model.
- **Computing chips:** In the future, more professional and efficient AI chips will be needed to meet the metaverse’s huge computing power demands. For this reason, we expect to see the rapid development of ASIC chips for specific applications, customized FPGA chips, and GPU chips with higher performance and rendering capabilities.
- **Blockchain and NFT technology:** Blockchain is the fundamental technology for the pricing and trading systems of the metaverse, and non-fungible tokens (NFTs) represent an important type of blockchain technology. NFTs are digitalized ledger on blockchain that carries transactional information. Any changes to the NFTs are broadcasted across the entire chain through the blockchain’s consensus mechanism to ensure data is immutable and updated in real time. Each NFT is indivisible, irreplicable and unique, and therefore they have great potential in the area of digital asset authentication. The size of the NFT market hit USD 338 million in 2020, representing a year-on-year increase of 139 percent (see Figure 3).

Figure 3

*Global market value of NFT-related transactions from 2018 to 2020
(in million USD)*



Source: Statista, KPMG analysis



- **AI:** AI can provide technical support for many applications in the metaverse, including intelligent speech, NLP (natural language processing), machine learning and computer vision. These capabilities will empower and form an application framework for communication and exchanges between users, between users and systems, and between different systems in the metaverse. At the same time, AIGC (AI-generated content) is gradually becoming an important and productive source of content in the metaverse.
- **Cloud technology:** At the current stage, cloud technology has been applied in various ways — from cloud storage and cloud computing to cloud applications. The technology has also evolved based on actual needs to include cloud computing, fog computing, edge computing and terminal computing, which are deployed based on the location of the cloud servers. With respect to the metaverse, the development of cloud technology currently focuses on computing power, storage and rendering.
- **Digital twin technology:** As a cutting-edge technology in the field of emulation and simulation, digital twin technology is well suited to serve the metaverse's aim of expanding and extending the real world. It has become fundamental for building a digital replica of the real world in the virtual world. It will make the process of constructing the metaverse more efficient, while also giving users a more genuine sensory experience.





The roadmap to a thriving metaverse: prospects in 10 major application scenarios

In the 18th century, Jules Verne, one of the pioneers of science fiction, was well-known for the fanciful machines he depicted in his writing, such as submarines and rockets. At the time, they were considered make-believe, but of course now they are a reality. As the metaverse gradually takes shape, we may have a front-row seat in watching a new sci-fi fantasy turn into a reality. Although the technologies underpinning it are still in their early stages, we expect the metaverse to impact a range of industries once it moves into full swing, especially in the following 10 areas: entertainment, social networking, retail, manufacturing, finance, health care, remote work, training and education, research and development, and city governance.

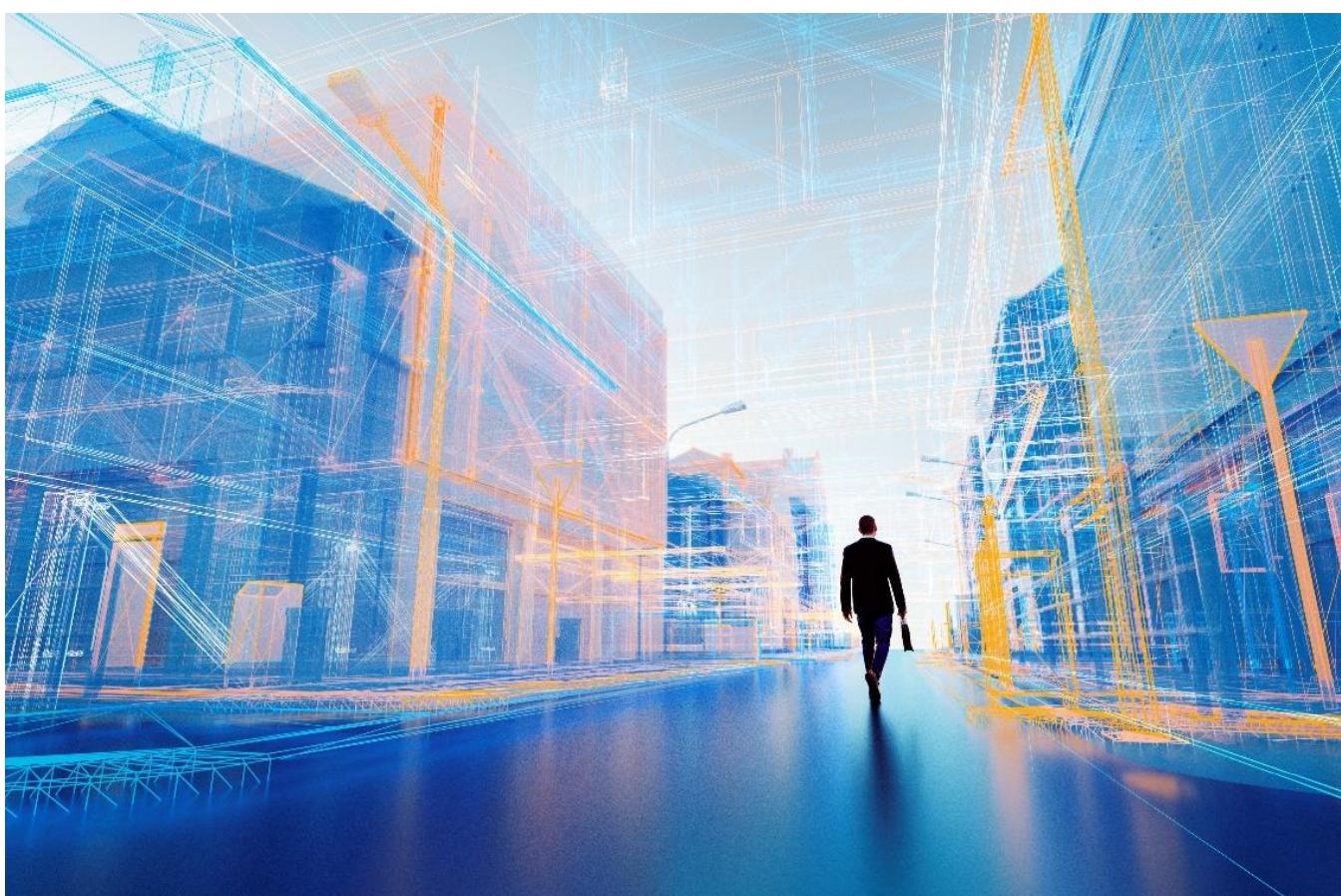


Source: KPMG China

- **Entertainment:** Entertainment may be one of the first industries to embrace the metaverse, as technological upgrades promise to deliver a more immersive experience to users. For example, online games are being developed to create virtual worlds that simulate and extend beyond the real world, pushing the boundaries of people's imaginations. As the base-layer hardware and technology continues to advance, games will become an open world where a massive number of online players can interact in real time. The metaverse has also started to be applied in movies and television programs, as well as in various other performances and activities, demonstrating its promising future in the entertainment sector.



- **Social networking:** In the metaverse, a virtual reality platform will be built leveraging holographic virtual imaging technology to extend interactions from simple voice, text, picture and video sharing to virtual real-life activities such as hanging out with friends, shopping, watching concerts and playing games, anytime anywhere. The depth of this immersive experience will significantly raise user satisfaction and loyalty. Compared with traditional internet-based social networks, the metaverse will blur more lines between online and offline activities.
- **Retail:** People, goods and shopping scenarios are core elements of retailing, and the metaverse will reshape retail in these three aspects. In the metaverse, people refer to not only common digital doubles but also virtual idols. In the future, consumers will be able to buy and mix-match different outfits, make-ups, travel kit sets and even residences for their digital doubles, which will meld the virtual world with the real one and create new growth opportunities. Against this backdrop, many brands have begun to work with metaverse platforms to create their own virtual spaces and provide consumers with a new shopping experience.
- **Manufacturing:** The metaverse can play a role in driving the intelligent transformation and upgrading of the manufacturing industry. By building a digital twin of the manufacturing industry that is proportionate to the one in the real world, we can collect and analyse data on product R&D, manufacturing and sales, and then feed the results back to the production activities in the real world. This will help to improve planning and design, efficiency and quality, as enterprises shift toward intelligent manufacturing.





- **Finance:** In the metaverse, banks can provide immersive services that are fully omnipresent. Customers can access their bank's service center with their virtual avatars and enjoy services provided by virtual AI staff through one click. They can also "summon the bank" at any time and provide specific instructions for financial services. In addition, with the help of blockchain encryption technology, customers can more conveniently access imperceptible financial services through seamless identity authentication. We should also note that as the core component of the economy, the financial sector has certain special stringent requirements regarding risk and compliance management. Therefore, when applying the metaverse in the financial sector, we should pay careful attention to the new risks it may bring.
- **Healthcare:** The metaverse can play a role in areas such as pathological research, medical diagnosis, telemedicine, patient care and health monitoring. With advancements in technology, virtual medical diagnosis and treatment will also transition from 2D to 3D, which will hopefully lead to significant medical breakthroughs. Currently, VR, AI and other technologies are being applied in many scenarios at the forefront of the medical industry.
- **Remote work:** The COVID-19 pandemic has made remote work and online communication more popular. When it comes to online meetings, 'holographic virtual conferencing' in the metaverse can create a sense of physical participation, immersion and even solemnity that cannot be delivered in traditional remote conferencing. Wearing special glasses, you will see holographically-projected conference rooms, product models and screens. 3D images of your companions will also appear next to you.
- **Education and training:** In the traditional education and training sector, many students face difficulties in understanding abstract concepts and practicing what they have learned; meanwhile, teachers sometimes have no choice but to adopt a one-size-fits-all approach that may make their lessons less interesting for some students. The emergence of the metaverse has provided a new opportunity for the reform and innovation of educational methods as it allows for the creation of a visual teaching environment based on virtual reality technology. By putting on wearable devices such as HMDs, students will be able to freely interact with and explore the teaching environment, turning a passive learning process into a more active, experiential one.
- **R&D:** In the field of scientific research, the metaverse and digital twin concepts are not only helpful in simulating a real-world environment. By applying machine learning to massive data sets and harnessing AI's continuous iteration capabilities, the metaverse can more accurately draw conclusions and calculate probabilities, helping researchers reduce the costs associated with simulations and experiments. These advantages will make the metaverse an indispensable driver of intelligent scientific research in the future.
- **Municipal governance:** Through simulation, metaverse can serve as a valuable experimental environment and provide a useful reference for the construction of smart cities.

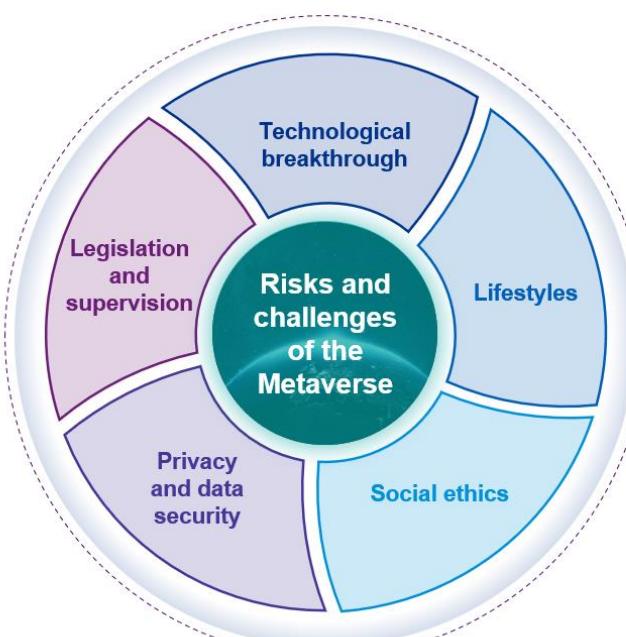


Navigating the metaverse: the opportunities and challenges ahead

When an engineer at Motorola invented the first handheld cell phone in 1973, it was hard to imagine that it would evolve into the smartphone of today and influence our work and life in every single way. Technology is turning science-fictional ideas into reality. In view of the rapid advances in technology, we expect to see faster development of the metaverse, which should bring a new wave of technological empowerment and opportunity to different industries.

While there is vast room for the metaverse to develop, we should bear in mind that it is a massive systematic project that is still in the very early stages of development. There is still a long way to go before it can be widely adopted, and we should be careful not to hype up the concept just yet. On 18 February 2022, the China Banking and Insurance Regulatory Commission ("CBIRC") issued the *Warning on Risk of Illegal Fund Raising in the Name of the "metaverse"* to alert the public about illegal activities such as fake metaverse investment projects, fraud in the name of metaverse blockchain games, malicious speculation on metaverse real estate, and illegal profit-making schemes involving fake metaverse virtual currency.^[1] At present, there are many important issues affecting the future development of the metaverse, particularly in the following five areas: technological breakthroughs, lifestyles, social ethics, privacy and data security, and legislation and supervision (see Figure 4).

Figure 4 *Risks and challenges facing the development of the metaverse*

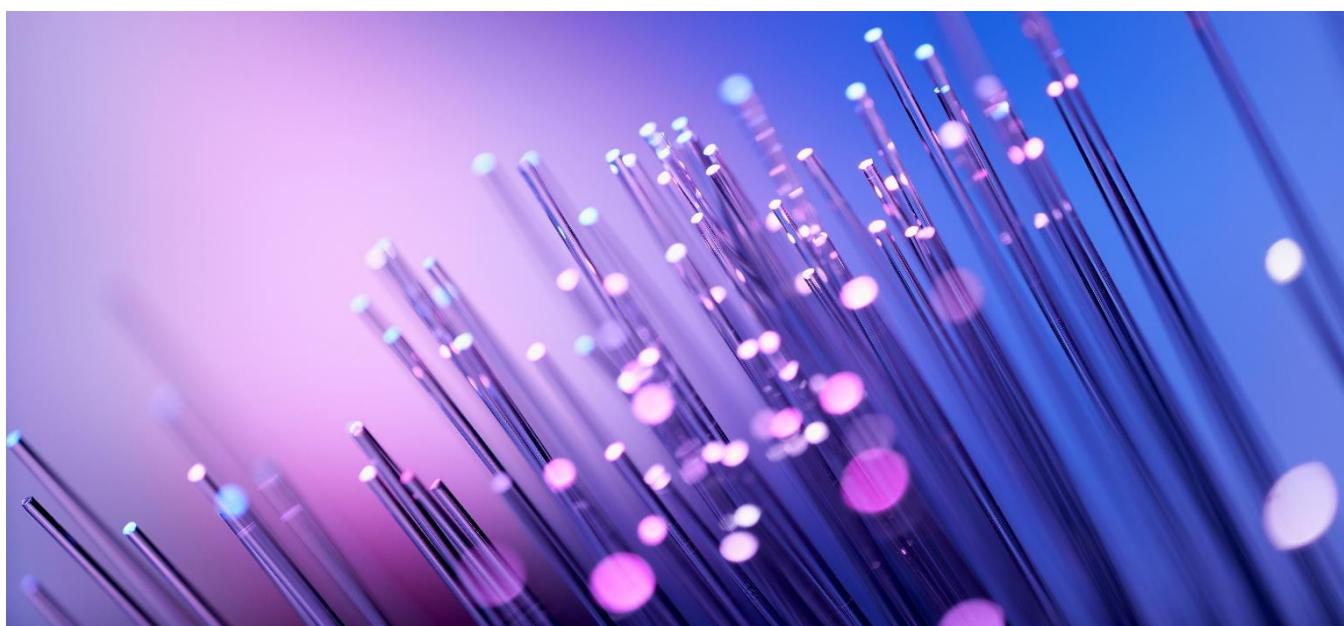


Source: KPMG analysis

[1] Reuters, China warns against using metaverse as tool for illegal fund-raising, February 2022: <https://www.reuters.com/world/china/china-warns-against-using-metaverse-tool-illegal-fund-raising-2022-02-18/>.



- **Technological breakthroughs:** As a systematic project, the metaverse involves many technological ideas that are still in a conceptual stage; and as the Cannikin Law suggests, "a chain is only as strong as its weakest link". In order to turn these ideas into reality, strides still need to be made in the development of many underlying technological capabilities, including the base layer hardware, fundamental applications and core algorithms.
- **Lifestyles:** Major technological advancements often significantly change people's way of life and even the social structure. All of these changes are not necessarily positive. While the metaverse quietly moves lifestyle changes forward, people should avoid becoming so addicted to the virtual world that they neglect daily interaction with other people and society in the real world.
- **Social ethics:** Different people may have different views and make different choices when it comes to the well-known 'trolley problem'. However, in the near future, instead of a human being, an AI system driving an autonomous vehicle may be the one responding to this problem. In September 2021, the National New Generation Artificial Intelligence Governance Professional Committee issued the *Ethical Norms for New Generation Artificial Intelligence*, which prioritises six areas—advancing human welfare, promoting fairness and justice, protecting privacy and security, assuring controllability and trustworthiness, strengthening accountability, and improving the cultivation of ethics—with the goal of embedding ethics throughout the entire lifecycle of the development and adoption of AI.^[2] The metaverse represents an open digital world with a high degree of freedom where different participants may have different values, religious beliefs and ethical constraints. For this reason, questions around how to strike a balance between different relationships and establish social norms to regulate individual relationships, resource allocation, power structures, and conflict resolution, among other matters, need to be reviewed and discussed in depth.



[2] Georgetown University Center for Security and Emerging Technology, Ethical Norms for New Generation Artificial Intelligence Released, October 2021: <https://cset.georgetown.edu/publication/ethical-norms-for-new-generation-artificial-intelligence-released/#:~:text=On%20September%202025%2C%20the%20National,to%20provide%20ethical%20guidance%20to>.



- Privacy and data security: Data will be one of the most important production resources in the economy of the future. The immersive nature of the metaverse means that it will generate and use massive amounts of data, far exceeding that required in the PC and Internet era. Compared with 2D data (such as text, pictures, and videos), the metaverse adopts 3D technologies and even involves senses like touch, taste and smell, which will inevitably lead to the exponential growth of data. This huge upswing in data use will also make personal privacy and data security issues, which are already under heightened public scrutiny, even more crucial in the metaverse.
- Legislation and supervision: As an extension of the real world, the metaverse will have a widespread impact on society and the economy. For this reason, relevant legal and supervisory systems need to be established to ensure that it operates in an orderly manner. Given that the metaverse is open, decentralised and virtual in nature, its supervision could be more complicated and should be developed over time.

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