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A Typology of Metaverses

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Diverse types of metaverses exist. We present a typology of metaverses to elaborate how different features and technologies are being incorporated in metaverse solutions that are targeted at different groups of users and the benefits they are looking for.

The global bank, Citi, estimated that by 2030, there will be up to 5 billion metaverse users and the metaverse economy will reach between US$8 trillion to US$13 trillion.[1] Yet the term *metaverse* lacks a clear definition[2] and whether a true metaverse currently exists is debatable.[3] A simple way to look at the metaverse is that it is the current Internet's "enhanced and upgraded" version.[4] Different technology companies, media commentators, journalists, and technology writers have different "ideas" regarding the way the Internet should improve. They thus have their own ways of defining, classifying, and characterizing the metaverse and expressing what is significant about this innovation.

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Among defining features of the metaverse that have been proposed are 1) 3D virtual reality (VR) and augmented reality (AR) applications that can create an immersive and illusionary environment and simulate the real world,[5] 2) a decentralized functioning economy based on blockchain and cryptocurrencies,[6] 3) interoperability to allow users to navigate across platforms and take digital identity and assets with them,[7] 4) digital avatars representing users,[8] and 5) real-time synchronous communication.[4]

Often, many of these features are irrelevant and redundant for tasks and purposes for which the metaverse is used. Moreover, technical and practical challenges currently prevent the incorporation of some features in metaverse solutions. For instance, technologies haven't yet sufficiently developed to address the problem of cross-platform interoperability in various metaverses. Thus, diverse types of metaverses exist to serve different user groups and needs. This article develops a typology of metaverses. The typology elaborates how different features and technologies are being incorporated in metaverse solutions depending on the purpose for which

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they are designed and the benefits that users expect.

TYPOLOGY OF METAVERSES

Among the approaches and proposed features of the metaverse discussed previously, the first two involve the incorporation of so-called the *fourth revolution technologies*[9]: AR/VR and blockchain. The typology presented in this article is based on whether or not a metaverse incorporates these technologies. Regarding VR and AR, one view is that 3D-based immersions that utilize these technologies are an essential feature of the metaverse.[5] Contrary to this view, others argue that a tendency to emphasize on VR and AR as a precondition has clouded the metaverse's development.[10]

Another source of disagreement lies in the roles of blockchain and associated innovations, such as crypto-assets and Web3. Some analysts have asserted that a true metaverse needs to be decentralized utilizing blockchain and cryptocurrencies.[8] For instance, due primarily to the lack of a clear description of how ownership of identities and assets function, some argued that the metaverse that Meta is creating is fake.[11] Others have, however, argued that while blockchain, crypto-assets, and Web3 play a key role in realizing the metaverse's potential, they just provide principles and technologies to support the development of this innovation. Many metaverse companies reportedly have no plan to implement blockchain and crypto-assets in their solutions.[12] We summarize the aforementioned discussion in Table 1, which presents a classification and examples of some major metaverses.

Degree of decentralization (the horizontal axis)

Web2 and Web3 advocates are debating regarding the metaverse's centralization and decentralization.[14] A key consideration here is how much users can control the contents and the environment. While some metaverses are centrally controlled by the platforms, others are user controlled.

Those who play down the role of decentralization argue that 3D avatars can be created without blockchain, and games can be played in closed platforms.[15] In centralized metaverses, such as Fortnite, Roblox, and Horizon Worlds, which offer 3D VR experiences, users are limited within the parameters set by these entities. The virtual community lives within the confines of a centrally controlled environment. While a user can interact with others and share experiences, they cannot control or own pieces of the environment.[16]

On the other hand, user ownership of digital assets is a key aspect of decentralized metaverses. Advocates of user-controlled metaverses have envisioned that decentralized technologies based on blockchain will be the key building blocks of the metaverse economy. For instance, nonfungible tokens (NFTs) represent ownership of virtual in-game items, avatars, real estate properties, and other assets. NFTs also enable the authentication of these assets and identities. In decentralized metaverses, cryptocurrencies play the same role that money does in the modern economy. For instance, cryptocurrencies are needed to buy NFTs, such as real estate, and clothes and shoes for the avatar. Metaverse platforms, such as The Sandbox and Decentraland have their own cryptocurrencies.

3D and 2D interfaces (the vertical axis)

One view is that the metaverse is a shared, 3D VR immersive environment.[6] However, some companies have developed 2D metaverses to mimic social interactions. The current Internet works well if static files, such as an e-mail and a spreadsheet need to be sent from one device to another. They are reviewed or modify in an independent and asynchronous manner. It wasn't built for live and interactive experiences, especially when a large number of participants are involved.[12] Likewise, virtual spaces, such as Zoom, mostly allow a single conversation. In physical worlds, participants move fluidly from one conversation to another. A simple 2D metaverse can improve this aspect by allowing people to interact more naturally.

TABLE 1. Diverse metaverses: A typology and examples.

Decentralized economy based on cryptocurrencies ➡ 3D VR/AR content ⬇	No	Yes
No	[1] › 2D virtual meeting spaces (for example, Gather Town)	[2] › 2D Web3 games (for example, Reality Chain, Crypto Quest, Osiris[13])
Yes	[3] › 3D metaverses in which users are within confines of a centrally controlled environment (for example, Fortnite, Roblox, and Horizon Worlds)	[4] › 3D metaverses based on decentralized blockchains (for example, Decentraland and The Sandbox)

The four cells in Table 1

Cell [1]. Some organizations utilize 2D metaverses to overcome the limitations of current video meetings and bridge the gap between real-life and virtual interactions.[17] The goal is to facilitate social interactions rather than economic transactions. Blockchains are thus irrelevant. One example is gamified interactive virtual meeting space Gather Town.

Gather's 2D virtual meeting space can mimic many of the features of real-life interactions. The Gather meeting space allows users to create their own avatar and navigate a virtual map. Due to the proximity chat feature, users feel that they are running into coworkers in the hall. When the user is close to someone, they can see and hear their audio and video feed. When the user moves away, sound drops and mutes and the video disappears. Unlike on a Zoom call, users are not forced to be in a single conversation. The app allows users to move fluidly between conversations as speakers or listeners.[17]

Gather had 4 million users in 2021 May,[18] which according to the company's website, exceeded 10 million in September 2022. Organizations have been using it to enhance collaboration among workers. The University of Chicago, University of Pennsylvania, and other higher education institutions have created virtual campuses on Gather. Individuals are also hosting games nights and throwing parties on the platform.[18]

University of Chicago has used Gather to recreate their school (https://app.gather.town/app/ZMF4gi9L05UhV4Ud/UChicago) so that students, faculty and staff could study together, meet up around campus, or engage in activities, such as playing poker.[19] Gather simulates the real UChicago campus with features, such as the main quad, classrooms, dorms, dining halls, group study rooms, theaters, and a special grad student lounge.[20]

Cell [2]. Examples of metaverses in this category are decentralized, 2D multiplayer blockchain-based games. To take an example, Osiris (https://osirismetaverse.com/) is a 2D metaverse that provides dynamic virtual world with games. It also has currency, and assets that are owned by players. The avatars of Osiris are referred to as Cosmic Kids which are Ethereum-based ERC-721 utility tokens.[13] Cosmic Kids provide access to the Osiris community and game client. Another example is the 2D metaverse game Crypto Quest. The game is based on Solana blockchain and is inspired by a Japanese role-playing game.[21] A third example is Reality Chain, launched on Octopus Network. Reality Chain describes itself as a social gaming metaverse (https://www.realitychain.io/). It offers nonimmersive, multiplayer 2D (and 3D) games.[22] Octopus is a cryptonetwork, which is used for launching and running Web3-based application specific blockchains (appchains). Note that an appchain is used for a specific set of custom-designed applications.[23]

In the education sector, for instance, 3D metaverses can support learning and facilitate interaction between teachers and students.

Cell [3]. Centralized 3D metaverses are realizing the value creating potential in diverse activities. In the education sector, for instance, 3D metaverses can support learning and facilitate interaction between teachers and students. 3D metaverses also make possible to conduct experiments with or feel phenomena that are impossible or difficult to create in the real world.

Nashville, Tennessee-based Fisk University has been using VR in research labs since 2021. In chemistry classes, VR allows students to visualize the way atoms are arranged in a protein, which is helpful in pharmaceutical drug research.[24] The university is also enhancing its premed program with VR cadavers. In the VR lab, a human heart can be pulled out from the chest cavity of a cadaver. Students can feel the weight of the heart in their hands and examine it. Student can enlarge the organ. The class can see and touch the ventricle walls. They can compare different hearts to understand the results of health decisions humans make when they are alive. They engage in a class discussion and collectively agree on the correct diagnosis.[25]

The University has not purchased cadavers due to high costs and maintenance challenges. A virtual cadaver lab makes scientific learning affordable. Virtual cadavers do not degrade and are easy to maintain. It is possible to add features and specialties over time, such as surgical procedures, and comparative learning between human and animal. Likewise, students can learn microbiology at the cellular level.[26]

Cell [4]. This cell consists of decentralized 3D virtual worlds and games. For instance, Decentraland and The Sandbox are both Ethereum-based metaverses, which allow players to own, buy, and sell NFTs. For instance, in The Sandbox, users can own a land plot in the form of an NFT. They can use their land parcels to develop custom games and locations and monetize them.[27] Likewise, Decentraland, which is arguably the first metaverse to be built on the blockchain,[28] is owned by its users and is governed through a decentralized autonomous organization (DAO). Users can play games, explore, and interact with games and activities. They can purchase parcels of land, which can be used to build marketplaces and applications.[29] Decentraland has three native tokens. LAND representing parcels of digital land and Estate representing merged parcels are ERC-721 tokens. MANA is an ERC-20 token serving as its currency.[29]

IMPLICATIONS FOR USERS AND DEVELOPERS

A typology has significant implications for consumers and businesses in making decisions regarding the types of metaverse to be developed and used. Currently centralized Web2 metaverses, such as Roblox, Fortnite, and Minecraft are dominating the metaverse economy. While these platforms are benefitting from huge userbases, users themselves have not been able to make the most of the opportunities offered by the metaverse due to their centralized nature.[14] Especially, users have not been able to realize Web3's benefits, such as more control over the environment and web communities they are parts of.[30]

Many current centralized 3D metaverse solutions (Table 1, cell [III]) are not able to ensure strong safety, privacy, and security. Child safety is viewed as among the biggest concerns in metaverse-based virtual learning. Metaverses, such as Roblox and Fortnite are reported to have features that are unfriendly to child safety.[31] In Roblox, for instance, ill-intentioned adults can contact children.[32] Privacy, security, and safety can be enhanced by moving from Cell III to Cell IV. Platforms, such as Decentraland, which allow only those with verified school board accounts to access its virtual school grounds can be a better choice.[31]

Different metaverses differ in infrastructural needs. Ultrawide bandwidth technologies, such as 5G cellular networks are important to access many 3D-virtual worlds (Table 1, Cells III and IV).[33] For instance, some games require access to advanced technological resources. In June 2022, Web3 entertainment company Gala Games announced that its blockchain linked game titles would be distributed through the Epic Games Store.[34] Epic Games, which has arguably grown from game to metaverse,[35] however, has no server in Africa, which puts African gamers at a disadvantage. Since the servers are in other continents, African gamers' reachability, also known as *ping*, is adversely affected, which compromises the quality of their game. African gamers playing on European servers experience 160–200-ms ping, compared to European players' less than 20 ms. A European player can see the African player first and can fight more quickly.[36]

Many colleges and universities that are implementing the metaverse and are becoming metaversities, are also using bandwidth-intensive VR applications.[37] For instance, Fisk University's VR cadaver lab runs on 5G network, which provides a low latency, high capacity, and high speed. 5G offers higher definition graphical detail, which makes it possible to recognize veins and arteries. Thanks to the low latency of 5G, all participants can have a concurrent experience, which ensures that the whole class stays in synch.[26]

That is not to say that high bandwidth is not needed in 2D metaverses. Despite being a 2D video experience, Gather Town requires advanced network and computing infrastructure. For instance, the video chat is an essential component to the experience, which requires very low latency as users move around or connect to people.[17]

It is fair to say that the current Internet can be upgraded and enhanced in various ways by adding a number of features and functionalities. Thus, there are many different varieties of metaverses.

The typology of the metaverse discussed previously can help us understand how different metaverses create value for users in many different ways in relation to the importance given to different metaverse features. For some metaverse applications, added benefits can be achieved by incorporating new technologies and including additional features. For instance, many current 3D metaverses offer experiences such as immersive games and immersive learning but perform poorly in privacy, security, and online safety. By incorporating Web3 features in these metaverses, users' privacy, security and safety can be enhanced.

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