EU Blockchain
Observatory and Forum

Metaverse

A Thematic Report Prepared By
The European Union Blockchain Observatory & Forum

An initiative of the European Commission

Contents

About this report

This is the ninth of a series of reports that will be published addressing selected topics in accordance with the European Commission priorities. The aim of this report is to explain what is the metaverse and why it has generated so much debate lately. It also explains the technological drivers that have made it possible and its potential use cases, before providing a vision for a future characterized by open, user-owned, and interoperable virtual worlds, also known as the Open Metaverse.

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Special thanks to Scope for the editorial review and language proofing.

Note

While we have done our best to incorporate the comments and suggestions of our contributors where appropriate and feasible, all mistakes and omissions are the sole responsibility of the authors of this report.

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Chapter 1: An introduction to the metaverse

1.1 METAVERSE DEFINED

The term 'metaverse' has recently concentrated the interest of businesspeople and regulators with its reputed transformative potential. As we will demonstrate, defining the metaverse is challenging – many have attempted to describe it, with varying degrees of success. Above all, the metaverse is currently an aspiration shaped by subjective experiences and desires. However, this does not mean that tangible characteristics cannot be attributed to it, nor that it lacks a substantial impact. The purpose of this report is to provide a grounded understanding of the metaverse and its potential. At the same time, given that the metaverse is still evolving, we hope to point in the direction providing the most societal benefits and warn of potential roadblocks.

'It is a gaming platform, a virtual retail destination, a training tool, an advertising channel, a digital classroom, a new gateway to digital experiences. The metaverse seems to be whatever people's imaginations dream it to be.'
McKinsey declares, in a report focusing on value creation in the metaverse.

'It's partly a dream for the future of the internet.'
Reports *The Verge*, in a widely circulated article.

'An embodied internet where you're in the experience.'
States Meta, in a Founder's letter.

'A seamless convergence of our physical and digital lives, creating a unified, virtual community where we can work, play, relax, transact and socialize.'
Notes JP Morgan's Onyx, in a report exploring opportunities in the metaverse.

Many similar definitions exist that view the metaverse as a fundamental shift in our world, due to technology becoming more advanced and ubiquitous. The key component is that the shift is powered by technology and is significant and universal, having a strong influence across disciplines, cultures or other barriers. The notion of a 'critical mass' of technologies 'coming together' to form the metaverse is also common. However, as with other technological breakthroughs of the past, we have every reason to believe that the metaverse will instead be a gradual and iterative process, and its impact, however significant, will also be studied and well understood.

The definitions above, albeit generic, point to **what** we should expect. Tech founders and tech companies have tried to address **how to get there**.

'Persistent, shared, 3D virtual spaces in a virtual universe.'
'Realtime 3D social medium where people can create and engage in shared experiences as equal participants in an economy with societal impact.'
Claim Roblox and Tim Sweeney, CEO of Epic Games, respectively.

Strategist Matthew Ball defines the metaverse:
'A massively scaled and interoperable network of real-time rendered 3D virtual worlds which can be experienced synchronously and persistently by an effectively unlimited number of users with an individual sense of presence, and with continuity of data, such as identity, history, entitlements, objects, communications, and payments'.

However, persistence, while critical to the metaverse, can extend beyond 3D rendered environments.
For instance, entrepreneur Jon Radoff claims:

'But the metaverse is not 3D or 2D, or even necessarily graphical; it is about the inexorable dematerialization of physical space, distance, and objects.'

Investor Shaan Puri takes this notion a step further:
'The metaverse is the moment in time where our digital life is worth more to us than our physical life.'

The above definitions indicate that the metaverse is a technology-driven shift leading to generalised and significant changes and new opportunities globally, across norms, disciplines, cultures or other barriers. Also central to the metaverse is the notion of persistent, cohesive, shared experiences, giving this transition a sense of establishing a new world. These experiences can be (but are not necessarily) immersive and interactive.

The main points of all above definitions are as follows.

(1) The generalised and significant shift across norms, disciplines, cultures or other barriers creates new opportunities.
(2) Persistent, cohesive, shared experiences give the sense of a new 'world'.
(3) Can be immersive and interactive, but users also can interact with it in a limited capacity. In other words, the metaverse is flexibly immersive.

Using the above definition as a springboard, we can examine some proto-metaverses to set a basepoint of what would qualify as a metaverse. We will use the term proto-metaverse to refer to any application that satisfies at least two of the three conditions listed above.

We will also use *Pokémon Go* and Facebook as examples, as they are positioned by their founders as gateways to the metaverse. *Pokémon Go* is a mobile game whose main goal is to collect (catch) creatures called Pokémon which are overlayed on a real-world map. *Pokémon Go* provides a cohesive and shared experience for its players, evoking the sense of a new world. At the same time, it is adaptable, interactive and immersive. Players can utilise its augmented reality (AR) features to overlay Pokémon and other game elements with real-world surroundings, but at the same time can stay up to date with what is happening in-game through notifications, or interact with it in a limited capacity through other devices like smartwatches. This means that *Pokémon Go* is also persistent, thus satisfying points 2 and 3 of our framework. However, while it did have a significant impact on the mobile gaming space, even the most loyal fans will concede that it did not have a generalised impact across norms, disciplines and cultures, and thus *Pokémon Go* cannot currently be considered a metaverse. For this to occur, Poké-coins, the game's native currency, would need to have a strong influence on the real economy, and the game should evolve to accommodate social interactions such as work or education, at the very least.

On the other hand, one need look no further than the impact Facebook (predominantly) had on our economies and societies to agree that this general-purpose shift across barriers created new norms and opportunities. Even countries that banned Facebook have introduced domestic clones. Facebook has thus also facilitated shared persistent experiences, through technologies such as push notifications, widgets and even home appliances. Facebook is not, however, currently adaptable and immersive.

We can condense the three-step framework above into its fundamental components, for a final definition of the metaverse: *"The metaverse is the product of a technology-driven shift with generalized impact through persistent and adaptable digital experiences."*

Table 1 Pokemon Go and Facebook – Metaverse characteristics

	Generalised impact	Persistence	Adaptability
Pokémon Go	✗	✓	✓
Facebook	✓	✓	✗

Even after defining the metaverse, several important questions remain. Indicatively, exploring virtual past worlds and their public perception can provide valuable insight for a more generalised, more impactful metaverse. At the same time, by looking at the technological, social and business drivers behind it, we can pinpoint areas of special regulatory and business interest.

Finally, perhaps the most important aspect of the metaverse relates to the competing visions that surround it, specifically that of a closed versus an open metaverse. For established players, especially in the technology and finance space, the metaverse is an opportunity for establishing total dominance. After all, our definition of a generalised, impactful, persistent and adaptable system touching upon all aspects of life would be the very meaning of success for some of today's more impactful entities. This is the definition of a closed metaverse, one that benefits a collection of large entities or a single large entity, at the expense of societal good. While an outright techno-feudal closed metaverse is unlikely as long as established institutions and regulations continue to exist, proponents of an open metaverse argue that by utilising open standards, an interoperable and accessible metaverse can benefit everyone. Central to enabling such an open metaverse are technologies such as blockchain, as well as the concept of Web 3.0, or an evolution of the internet where information and benefits are more decentralised.

1.2 DRIVERS OF THE METAVERSE

The reasons behind how and why we are moving from more primitive and siloed virtual worlds to the more holistic and impactful metaverse can be attributed to technological, social and business factors.

Technological factors driving the metaverse

The technological drivers of the metaverse are best understood by grouping them according to the following taxonomy of advances, meaning both an increase in power and capability, and a price decrease. The main technology factors are as follows.

- **Hardware.** This includes networking, processing speed both on servers and on edge devices, volatile (random access memory (RAM)) and non-volatile (solid state drive (SSD)) memory capacity and speed, specialised processing devices (in particular graphics processing unit (GPUs)), visualisation devices (screens, AR and virtual reality (VR) headsets, combo solutions), and location devices (Global Positioning System (GPS), accelerometers).

- **Software.** This includes computer vision in its various guises (analysis of the non-animated and human interaction context), language recognition (speech and written), language composition, as well as several other applications of artificial intelligence (AI) and machine learning. It also includes general advances in the realistic rendering of 3D objects and various blockchain-related patterns, in particular public key infrastructure.

- **Data.** This often-underestimated part of the technical infrastructure relates to data from the real world, in particular maps and other location data.

- **Integration.** This includes combinations of the above, e.g. using advances in hardware and software to understand the context of an image captured and being able to augment it, both in real time; new and standardised ways to interact with metaverse objects using technology primitives from the blockchain space, in particular, their PKI-driven application programming interface (API) structures.

We will demonstrate how these hardware factors combine to create a metaverse experience not previously possible, using an example rather than developing a fully-fledged framework, and starting with the familiar example of *Pokémon Go*. As established, *Pokémon Go* is an AR game about capturing creatures called Pokémon in the wild; it was particularly popular after its initial launch in 2016.

What was necessary for it to work? To play it in AR mode, one needed a smartphone with a good camera, decent processing power and good spatial awareness via accelerometers – with all three, Pokémon could be observed and caught in the wild, i.e. one would see them overlaid over the video stream captured live from the camera. Moreover, a phone with good location services was needed, as the Pokémon would appear in actual physical locations – everyone around this location at that time would see the same creature appearing. To set this up, one also needed a good database of real-world locations, which the producer had from an earlier game. Finally, one needed a phone with decent battery life, relying on improved battery technology as well as the availability of external batteries, which became more extensively widespread during that time.

Pokémon Go would not have been possible much before 2016, because most of these factors were not in play – either they did not exist at all, or not in sufficient numbers, or not at an acceptable price point. This technology is necessary for achieving adaptable digital experiences ranging from minimally to maximally interactive and immersive. In other words, *Pokémon Go* can be a notification on a smartwatch, animation on a home screen, overlayed on the real world and fully interactive, and possibly even a fully immersive VR experience.

The second example is *Second Life*, which was initially released in 2003. This was another proto-metaverse experience based on the non-mobile internet. The enabling factor here was Internet Explorer 6, as well as the emergence of broadband internet connection, which allowed a rudimentary depiction of a virtual landscape holding everyone's avatars. *Second Life* and related spaces have been around, and improved, ever since. We are now seeing a Cambrian explosion of similar virtual worlds that make use of the latest in VR technology. While we did not yet have *Pokémon Go* (arguably, VR headsets were still not sufficiently comfortable for the mass market), people were increasingly spending more time in VR – which leads us to our third example.

One of the important developments of the last year was the rise of non-fungible tokens (NFTs), which are essentially representations of 'ownable' assets (often works of art) whose ownership is determined using public key infrastructure and that are registered on a blockchain. The development of public key infrastructure and focus on blockchain user experience played an important role here.

Sociological factors driving the metaverse

However, simply because something can be done, it won't necessarily be popular without the right social demand and dynamics in place. The sociological factors go hand in hand with the technological factors identified above – technological progress led to sociological changes when those new technologies were used. One key sociological change is the emergence of social media that increasingly enrich, or even substitute, people's social and professional lives. Another key sociological change is the COVID-triggered emergence of a working-from-home social environment, especially amongst the middle classes.

In a way, digitally enabled social networks or working-from-home environments are a VR of their own: one can follow what people do in their private lives on Facebook and Instagram and can look at how they present themselves to the world on TikTok. On LinkedIn, one can see their professional lives, and on Twitter, one can have real-time conversations with people from all over the world, as well as epic flame wars. And of course, these interactions can be augmented using voice messages, voice calls and even video calls.

All of this means that people today are used to carrying out their social interactions independently of their physical location – in a sense, this is already a 'social metaverse'. The technological advances noted earlier

fit in here very neatly: they serve to keep improving that environment to make it closer and closer to the real world – or even to surpass it in some ways, because the virtual world does not suffer from the limitations of the physical world. In that sense, a computer screen is a 'bug' that inhibits more meaningful interaction, not a 'feature'.

We close this section with a brief discussion of the NFTs referred to earlier and described as being more of a social phenomenon. We need some technology to represent NFTs, but arguably this technology has existed, if not for decades (allowing for a somewhat wider definition), at least for several years (the Ethereum Blockchain and the NFT token standard were around for years before becoming popular). There are multiple possible explanations for this, but in our view, one key factor was simply the social coordination around NFTs that pushed them into a virtuous cycle of increased attention and progress.

Business factors driving the metaverse

There is a cynical view that the metaverse is the next big thing that tech companies need for the next turn of the hype cycle. Whilst we do not believe that this is the fundamental dynamic in the metaverse space, it is certainly a dynamic that should not be underestimated. The normative power of the large tech companies with their nearly unlimited resources, however, faces competition from community-driven initiatives such as the Open Metaverse Initiative of the University of Nicosia (UNIC).

There is no doubt that the metaverse will bring extraordinary business opportunities for those who get it right, not only in the hardware sector (which may not be that profitable if today's tech giants use it as a loss leader to attract people to their metaverse real estate) but also, for example, in the events space where people can meet, show off their virtual property, listen to music, watch videos and maybe even dance and play together. These opportunities are explored in greater depth in the next section.

Finally, the metaverse in the workplace could help solve the working-from-home conundrum, where even when geographically separated, well-established teams often find it easy to work together, but may have trouble integrating new members into the team. Whilst our tools of cross-location interaction are truly impressive, they still fall short – quantitatively and qualitatively – compared to office life with shared lunches and water cooler chat. Maybe the metaverse, or a specific business version of it, will be able to fix that.

The COVID-19 pandemic and accompanying social shifts influenced the rise of the metaverse in many different ways:

- staying at home necessitated the use of digital tools to keep in touch with job colleagues, family, friends, etc.;
- mobility restrictions accelerated the demand for virtual spaces for people to maintain social interactions (either for professional or entertainment purposes);
- in academic settings, virtual online learning platforms proved to be a key tool for continuing education;
- virtual conferencing as well as virtual tutoring accelerated the adoption of the virtual world concept;
- branding and marketing techniques also had to evolve and adapt.

The impact of each factor is not yet fully understood and is beyond the scope of the present paper.

1.3 FROM VIRTUAL WORLDS TO THE METAVERSE

On the importance of studying the history of virtual worlds

We have already provided an umbrella definition for the metaverse and explained why it has recently re-emerged. Before discussing the economic potential of the metaverse, we must first outline the areas that it will influence the most. We have already hinted that the metaverse's influence is generalised. However, after studying the evolution of virtual worlds and proto-metaverses, we feel strongly that two clusters will serve as vehicles for the metaverse to become more generalised.

These clusters are recreation, education and industry. The term recreation refers to activities practised by individuals for enjoyment rather than work. This is a broad category that encompasses first and foremost gaming, but increasingly, other social media experiences. With the term education and industry, we refer to digital experiences designed with work and learning in mind. This concept is recent, partially fuelled by the rise of social media and alternative work arrangements.

Naturally, the two categories are rather porous. A gold farmer (player trading game assets for real-world money) in a massive online multiplayer game blurs the line between recreation and work, as do employees using a company's VR chatroom to throw a digital work party. Increasingly, we expect this line between recreation and work or education to blur even further, with individuals in the metaverse able to seamlessly transition from one mode to the other, much as in real life.

However, until this vision comes to fruition, studying the evolution of virtual worlds yields valuable information in several different areas. Among other things, it provides us with a roadmap of how today's business environment will evolve to address consumer needs, and an idea of the size of this transition and the areas likely to be influenced by the metaverse first.

As noted earlier, before the 'metaverse' was known as such, it was common to refer to proto-metaverses and similar concepts as 'virtual worlds'. This meant an environment generated through technological means that allowed different individuals to interact with it and between each other, using digital representations of themselves varying in complexity depending on the technological resources available.

This type of digital environment has been around for more than half a decade, and dates back to the 1970s. The origin of virtual worlds is usually associated with video games and the gaming industry, a subset of recreation. The realms of fantasy and science fiction were, and still are, a very fertile ground for the development of these virtual worlds. They allow players/users to embed themselves in worlds that are otherwise physically impossible to engage with. Often these virtual worlds follow pop culture trends for this very reason: for example, the *Lord of the Rings* films in the early 2000s matched the rise and consolidation of *World of Warcraft*, just as the 'revival' of the zombie genre has coincided with online worlds such as DayZ. However, not all virtual worlds deal with recreational 'impossible worlds': 'real' virtual worlds also exist with purposes other than 'gaming', as the prime example of *Second Life* shows. Consequently, it is possible to make a first distinction for the evolution of virtual worlds, between what we will call gaming-recreational and non-gaming-recreational. We will also refer to the former as 'gaming virtual worlds' and the latter as simply 'virtual worlds'.

Recreational virtual worlds: Gaming

Both gaming and non-gaming recreational virtual worlds share certain elements: putting together different users in the same shared space at the same time; the existence of a graphical interface; interactions occur in real-time; the space is interactive (i.e. it reacts to the user's actions); and they are persistent.

Each of these elements has been improved or upgraded as technological capabilities have become better, cheaper and more accessible. In this sense, technological developments can be tracked using four main factors: (1) realism, (2) ubiquity, (3) interoperability, and (4) scalability. As mentioned above, gaming virtual worlds have long dominated the arena of virtual worlds, and continue to do so. It is possible to trace the origins back to text-based virtual worlds in the late 1970s. While these first virtual worlds could host just a couple of players, today player numbers are in the millions. In terms of gaming virtual worlds, one may distinguish between massive multi-user online role-playing games (MMORPGs), multi-user dungeons (MUDs), tinyMUDs and MUDs object oriented (MOOs).

The key element that defines this chronological evolution is the development of better graphics to represent the virtual world. In this sense, the very first gaming virtual worlds – MUDs – were text-based. In this category, we can pinpoint examples like *MUD1*. These first examples were much closer to physical games like the classic *Dungeons and Dragons*. As such, users relied on their imagination to picture these virtual worlds. Interactions between the users and the virtual world rely on text-based commands. Just as in fantasy-based roleplaying

and tabletop games, players could also draw up physical representations of that imaginary world to guide themselves through the game.

After MUDs, tinyMUDs emerged, which allowed for more interaction from the players themselves, beyond the game-like objectives, such as fighting an enemy or performing a quest. In this sense, some social elements were introduced as part of the virtual world, like creating virtual objects and showing them to other players. However, the technical components didn't allow for the development of a proto-economy. This was later addressed by MOOs, where given greater technological development, it was possible for users to further interact with each other.

All these improvements, and more importantly, the experience gained from experimentation, gave rise to the latest and current stage of gaming virtual worlds that is dominated by MMORPGs. It is within these worlds that all the characteristics previously mentioned have come to the fore and are in full display. Prime examples are *Ultima Online*, *EverQuest* and *World of Warcraft*. Many of these have been up and running for more than a decade, with an active and healthy user base alongside a vibrant community and economy. The conflation of real life and virtual life started to emerge as many players began relationships as digital avatars but later met in person, even getting married and forming families.

Recreational virtual worlds: Social worlds

The consolidation of MMORPGs and, more importantly, the fact that they were technically feasible and provided an attractive environment, sparked an interest in them for purposes beyond 'mere gaming'. During the early 2000s, it is possible to appreciate the emergence of proper social virtual worlds such as *Second Life* or *Habbo Hotel* because of how the latter demonstrated the possibility of having a strong social online system, supported by outside resources. The clear difference is that the gaming aspect is lacking in the social virtual worlds, or at least is not the main objective.

While the future of social virtual worlds is still uncertain, certain trends can be identified, given their history. In this sense, each iteration builds upon the previous: at first, these virtual worlds merely offered the possibility of reading and writing in them, but later it was possible to personalise them and even create content, which helped to build communities: currently, we are approaching a dual experience between the virtual world and the real one.

However, virtual worlds, as populated by humans, albeit under their avatars, have raised some concerns over their lifetime. Some researchers have grouped their concerns around certain issues: (i) privacy, (ii) user diversity, (iii) fairness, (iv) user addiction, and (v) cyberbullying.

Not only is it possible to highlight these general concerns, but in fact virtual worlds have proved to be an experimental arena for many similar real-life situations. For example, the Corrupted Blood incident in *World of Warcraft* has been studied by scientists who analysed how to react to a quickly spreading epidemic in a manner that would be impossible in real life. Since virtual worlds are populated by humans, they provide direct and novel insight into how we, as a community, operate in these extreme circumstances.

Education and industry virtual worlds

Social virtual worlds gradually started expanding to other aspects of real life, including education and work. *Second Life's* website still lists several universities that maintained social spaces or campuses in the metaverse. In a 2007 interview, Rebecca Nesson (currently dean for academic programmes at Harvard) discussed the benefits of delivering the course 'CyberOne: Law in the Court of Public Opinion' in *Second Life* from the perspective of the lecturer, which is still important in today's educational environment. Among other arguments, Nesson claimed:

'Some people don't have the confidence to interact in a classroom, especially with one of the world's greatest law professors, but can do so in *Second Life*. … In *Second Life*, that problem of students not participating in class discussions just totally disappeared.'

Some of the above issues remain true even today. The proliferation of universities and other educational or cultural communities was not unique to *Second Life*. In fact, 'museum districts' and similar social-cultural spaces seem to emerge as the first use-cases of proto-metaverses.

At the same time, proto-metaverses with virtual economies gave birth to virtual-only as well as virtual-physical industries. On their wiki page, *Second Life* broadly categorises jobs as 'unskilled' and 'skilled'. Unskilled jobs are those that don't require real-life skills, and this is entirely confined within the boundaries of *Second Life*. Two indicative examples are models and shopkeepers, both serving the digital-equivalent role of a real-life model or shopkeeper. The second kind of job, 'skilled jobs', bring real-life skills to the virtual world. This includes artists, fashion designers or architects responsible for virtual clothes and textures, or freelancers and entrepreneurs monetising other aspects of the virtual world. This categorisation is in no way unique to *Second Life*. Concepts such as educational institutions in virtual worlds, or real-life embassies and other businesses can also blur the line between the two. Finally, as virtual worlds become more generalised and persistent, we expect digital-native jobs to play a bigger role.

Final categorisation of virtual worlds

The evolution of the virtual worlds can also be analysed from different planes where application innovation can be perceived:

1. based on their purpose,
2. based on the constraints and hurdles faced,
3. based on the stakeholders involved.

Based on their purpose

(a) In the beginning, the tool served community-based communication purposes (chat rooms, MUDs, etc.).
(b) Then videogaming gained traction (*Maze War*).
(c) Eventually, they evolved to respond to needs for social interactions (*Second Life*).
(d) There, education and industry applications emerged.
(e) The metaverse pertains to an expansion of this, to more generalised, persistent and adaptable experiences.

Based on the constraints and hurdles faced

(a) First versions were severely constrained by technology limitations (graphics, processors, connectivity, etc.).
(b) Privacy issues arose (users start to realise there were concerns over personal data shared across systems).
(c) Nowadays, legislation hurdles for the candidate building blocks (cryptos, implications in the real world, etc.) are stepping into their runway (e.g. blockchain tokens to pay for real estate applications). Technical challenges also remain unresolved.

Based on the stakeholders involved (interested)

(a) First, they were mostly represented by peer-to-peer or community users (tech community, users interested in gadgets, etc.): in summary, simple users with internet access.
(b) Larger teams comprising groups of users more aligned with different topics of interest with the support of internet companies only.
(c) Today, physical-world corporations are economically motivated to take part in the metaverse market. They also provide inputs (services) for metaverse definition.

Chapter 2: Metaverse typology & applications

2.1 METAVERSE USE CASES

Having explored how virtual worlds evolved from purely recreational, gaming and social roots to industry and education, we can now provide an overview of metaverse use cases, using the above framework as a basis. In our analysis we present the metaverse as a platform innovation, meaning an innovation upon which other innovations can be developed.

Recreation – Gaming and socialisation

Some claim that video games will be the 'killer application' of the metaverse. We do not entirely agree with this evaluation. As we have shown, gaming-focused proto-metaverses evolve to encompass other social interactions, beyond simply gaming. However, it is not hard to see why many point to the importance of gaming. The biggest VR and AR market today (two core technologies for the metaverse) is gaming. *Fortnite*, a popular multiplayer shooter game that is free to play while offering in-game microtransactions, generated revenues of USD 5.1 billion in 2020. Epic Games, the studio that produces *Fortnite*, was valued at USD 31.5 billion in April 2022, after securing USD 2 billion in funding from Sony. Video game makers are already pursuing more advanced proto-metaverses. The gaming market has developed a burgeoning industry of hardware, composed of devices specifically produced to enhance the gaming experience. Of course, we do not refer to computers that may serve different purposes, but to the more specific hardware for eXtended reality (XR) including VR, AR and mixed reality, such as smart glasses, as well as associated software. This relation between virtual experiences and physical hardware is best explained with Meta's VR Oculus Quest 2 headsets, which sold 10 million units during their first year in the market, according to Qualcomm, producer of the Snapdragon chipset that powers the device.

Again, the familiar pattern of gaming evolving to more generalised interactions emerges. Since Ariana Grande staged a concert in the video game *Fortnite* last August, many other artists have performed live in other proto-metaverses. It is not hard to see how these could become a space for other digital and digital-physical experiences such as sporting events.

Industry and education

Below, we provide several metaverse use cases related to industry and education.

Virtual work and collaboration

Virtual work and collaboration became increasingly popular during the pandemic. New tools are promising more efficient collaboration in the metaverse. Hundo, for example, is a learn-2-earn platform for Gen Z, where you can earn as you learn. It has a new take on CVs and resumes with an on-chain record of achievements, all in the blockchain/metaverse. This way, a new generation of young people is empowered to learn, earn and work around the world. Related innovative technologies include Meta's Horizon Workrooms and Mesh from Microsoft.

Virtual learning, virtual education, virtual universities

We are moving towards a world where the hybrid reality of the physical and the digital coalesce to provide an immersive experience of learning. NASA uses AR and VR aboard the space station for remote control of robots or to complete maintenance tasks with AR remote assistance. Other opportunities include training new employees in the metaverse, much like Hyundai Mobis. They have designed the metaverse Experience and Untact Online Trip programme for this purpose, facilitating bonding between remote employees more easily.

Virtual markets

There is a great deal of speculation about what virtual markets should look like in the metaverse. The fundamental difference is that in the metaverse, everything is expected to be tokenised with fungible, non-fungible, hybrid or composable-NFT tokens. The metaverse is expected to build up a fundamentally new economy focusing more strongly on NFT markets and creator economies. On top, tokenised assets are expected to form services that might serve as basic building blocks of other services in the form of 'money Lego' somehow similar to the decentralised finance (DeFi) space. Certainly, it remains an open question whether decentralised services will be used in the metaverse, instead of more traditional and more centralised tokenisation likely to heavily exploit classic fiat payments or central bank digital currencies.

Advertising, marketing, and sales

Virtual fashion is a trending topic and will be helpful for environmental sustainability as well. The design part of this is where most of the money (for the creators) is made. Creators can continue to earn money from their designs and buyers can still show off their new fashion articles, while at the same time minimising the externalities of the manufacturing process.

Smart industry, smart manufacturing

Industry and smart manufacturing will certainly benefit from virtual, augmented or mixed reality. Examples include allowing new house owners to design the exterior or interior of a home and allowing architects to design or construct better houses. A similar idea is to provide a VR for aeroplane designers or maintainers to improve operational or maintenance speed and quality.

What remains, however, is the question of how synergies between metaverse and smart industry or manufacturing can be established, beyond a pure VR experience. Such applications are rather like private VR worlds for a certain company and are not necessarily meant to be integrated by other public domains. Other disruptive innovations like tokenisation or NFT might also not be best suited to such private corporate domains.

Extended social media

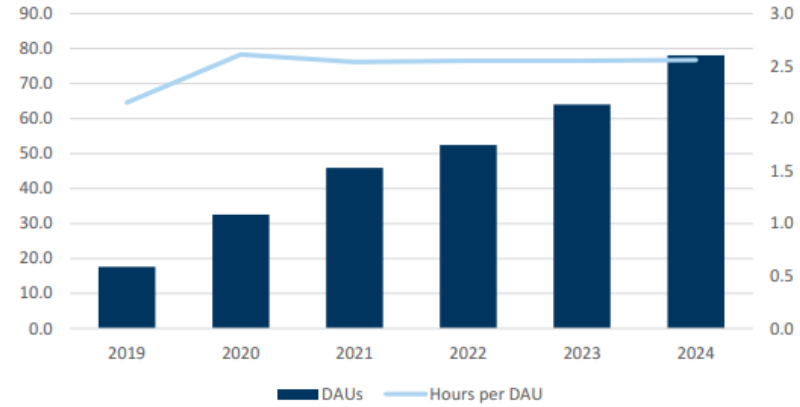
As discussed earlier, sooner or later the virtual worlds expand to encompass more social interactions. With its rebranding as Meta, Facebook aims to lead the way in this transition and to expand to fulfil all three characteristics discussed in Chapter 1. Other social networks will follow suit. As mentioned, Twitter and Instagram are implementing NFTs, which many consider the digital artefacts of the metaverse, in what could be the first step in this transition.

2.2 METAVERSE SIZE AND MARKET

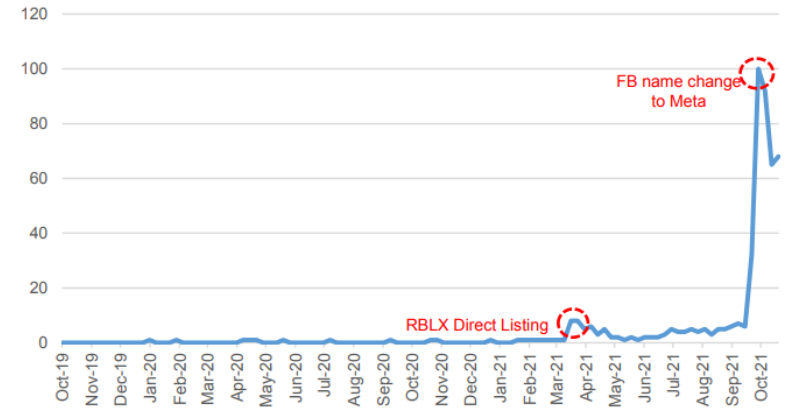
Estimates about the economic value of the metaverse are as diverse as the definitions for it. Indicatively, among several existing studies, surprisingly high figures exist, such as '10x the total value of the entire current global economy'. More modest estimates also exist, however: Bloomberg Intelligence calculates that metaverse revenues 'could approach USD 800 billion in 2024'.

This ambiguity is reflected in the industry reports. On the one hand, in a 177-page report from March 2022, Citibank predicts an USD 8 trillion metaverse by 2030, representing 10 % of today's world economy. A similar report by JP Morgan's Onyx brings this estimate down to USD 1 trillion.

As an indicative measure of the rising interest around metaverse, Google searches of the term skyrocketed by 7.200 % in 2021, especially after Facebook changed its company name to Meta. Roblox in particular reached over 55 million daily active users in February 2022.



Source: Company data, Goldman Sachs Global Investment Research



Google Trends (https://www.google.com/trends)

Source: Google Trends, Data compiled by Goldman Sachs Global Investment Research

Figure 1 – Roblox - Daily active users and hours per daily active users

As of the first half of 2022, more than USD 120 billion has been invested in the metaverse space, which is more than double the amount of money invested in 2021. Venture capital (VC) and private equity (PE) alone have dedicated USD 13 billion to metaverse funding. More and more established technology companies, like Meta, Microsoft, Nvidia, Apple and Alphabet are investing to capitalise on this opportunity. The common belief driving all these investments is that technology, as we know it, is about to undergo a major regeneration.

Indicatively, Meta has dedicated more than USD 10 billion to its Reality Labs division, which produces metaverse-related hardware such as VR goggles, while Microsoft has planned a USD-69-billion acquisition of gaming company Activision Blizzard. Nvidia released the Omniverse platform; Sony is planning on releasing a PlayStation VR2 headset late this year and Apple is examining the possibility of entering the AR space in 2023. Andreessen Horowitz recently released USD 600 to invest in game studios, metaverse infrastructure and games by launching Games Fund One. Improbable, a metaverse technology company, raised USD 150 million from this funding. Moreover, brands and corporations outside the tech spectrum are also

entering the metaverse race. Disney was assigned a senior executive to supervise the company's metaverse strategy and LEGO invested in Epic Games, the company that created *Fortnite*. Accordingly, Epic Games collaborated with Balenciaga, a luxury brand to showcase its latest collection in a virtual space.

Nonetheless, the crypto space and the NFT space are two significant factors that have encouraged the growth of the metaverse and accompanying investment. More than USD 30 billion was invested in cryptocurrencies in 2021, while the NFT marketplace OpenSea raised USD 300 million at a USD 13.3 billion valuation in a Series-C funding round led by Paradigm and Coatue. Furthermore, Adidas' NFT collaboration with the famous Bored Ape Yacht Club NFT collection sold more than USD 100 million.

To date, technology companies are the biggest investors in the metaverse space, with a total metaverse investment even higher than when AI was at a similar stage in its evolution, which was USD 39 billion in 2016. However, VC and PE investments in AI seem to be somewhat comparable to investments in the metaverse, with AI investments ranging from USD 6 million to USD 8 billion in 2016 and metaverse investments ranging from USD 6 million to USD 9 billion, so far.

It is also worth noting that an increasing number of tech companies and non-tech companies are very keen on joining the metaverse space in various enterprise use cases. More than half of the metaverse-aware companies state that they are metaverse adopters. Marketing campaigns are running in the metaverse, e.g. the launch of the recent Balenciaga collection; Meta, among other companies, is holding corporate meetings in the metaverse; healthcare events and conferences are taking place in the metaverse; and BMW is looking to build a digital factory twin on the Nvidia Omniverse.

Several sectors are leading the way for a broad metaverse adoption and intend to dedicate a significant amount of capital to metaverse investments. The most prominent sector to invest in the metaverse is energy and resources (18 %), with high tech (17.5 %) and automotive, machinery & assembly sectors (17 %) competing for second place. Both the tourism and the media & entertainment sectors take the third place, at 15 %. Insurance and healthcare are also to dedicate a notable amount of money to the metaverse, while construction is the sector with the smallest investment so far.

Figure 2 below present the percentage (%) of firms within industry **that are metaverse adopters (currently a small fracture of the total companies in the sector)** — and have already launched metaverse initiatives, as well as their plan for **future metaverse investment** (i.e. the prospective share of their digital budget in 3-5 years).

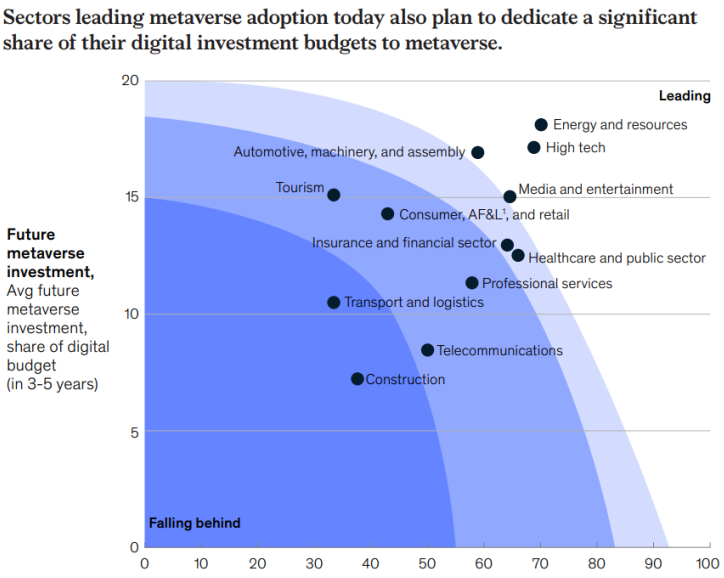


Figure 2 Sectors Leading Metaverse Adoption (Source: McKinsey report, Value creation in the Metaverse, June 2022)

From a social point of view, almost 60 % of consumers asked are eager to join in the transition of everyday activities to the metaverse; better connectivity with people is the highest incentive (44 %). Exploration of digital worlds (26 %) and meeting & collaborating remotely with colleagues (10 %) are the second and third highest incentives, respectively.

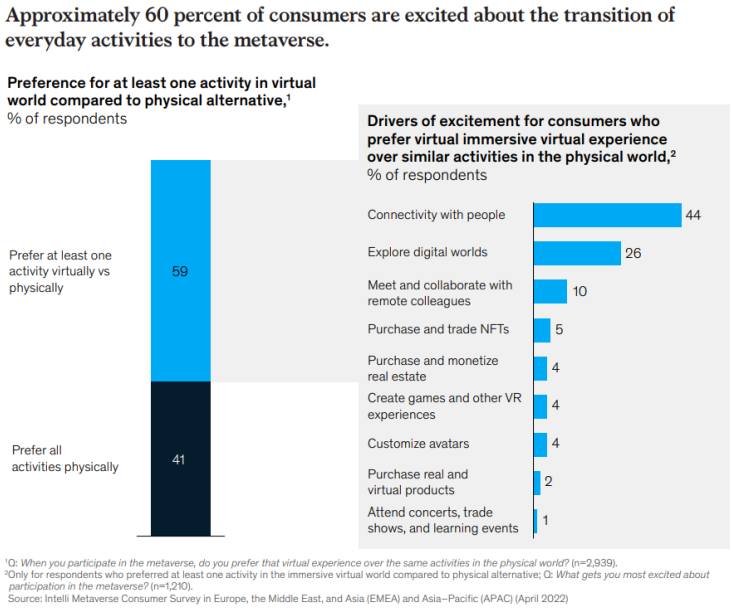


Figure 3 Consumer activity preference Metaverse vs Real World (Source: McKinsey report, Value creation in the Metaverse, June 2022)

It is unquestionable that the metaverse spectrum is still shifting and that its economic potential varies and may even fluctuate. However, according to a McKinsey report, the metaverse space is expected to have a

USD 5 trillion impact by 2030, currently equivalent to the world's third-largest economy, Japan. Although each industry has a different potential in the metaverse space, there are inevitably implications for all, regardless. Indicatively, there is an estimated market impact of between USD 2 trillion and USD 2.6 trillion on e-commerce by 2030, while the advertising market is expected to have an impact of USD 144 billion to USD 206 billion.

Chapter 3: Competing visions of the metaverse

3.1 THE EVOLUTION OF THE WEB

In Chapter 1, we provided the following definition for the metaverse.

'The metaverse is the product of a technology-driven shift with generalised impact through persistent and adaptable digital experiences.'

Having explored the potential size and impact of the metaverse, we can now examine how exactly this shift will come about, as well as its wider implications. As discussed in the introduction, there are two broad competing visions, that of a closed metaverse, and that of an open metaverse.

A closed metaverse is less generalised, persistent and adaptable, with a continuation of existing business models than an open metaverse. Similarly to how today's digital world is mediated by a handful of tech firms, a metaverse evolving from this trajectory would be owned and operated by a handful of powerful firms. Advocates of this closed metaverse point to the experience, networks and resources of tech giants, claiming that they are uniquely positioned to facilitate this transition. These advocates do not use the term 'closed metaverse', but despite promises of interoperability of all forms, the core elements of a closed metaverse will remain siloed behind walled gardens.

Supporters of an open metaverse claim that the generalised, persistent and adaptable nature of the metaverse will only compound existing issues with big tech and the financial system. Instead, they argue for a reimagining of the web infrastructure underpinning the metaverse, a return to its interoperable and open roots, but with the flexibility of today's digital applications.

Each of these competing visions relies on different assumptions about the future of the web, and in particular on the debate of Web 2.0 vs Web 3.0. Compared to the first Web 1.0 in the 1990s, Web 2.0 and Web 3.0 are later incarnations of the web. Web 2.0 is the internet today and Web 3.0 is the internet that will exist in the future. In the transition from Web 2.0 to Web 3.0, blockchain and cryptocurrencies play a fundamental role. Before analysing the debate on an open vs a closed metaverse, we will consider the evolution of the web in greater detail.

Web 1.0: Read-only web

1. The web put businesses and people online for the first time.
2. Paper-based ledgers were replaced by database ledgers.
3. Business computers expanded, picking up operations management apps.
4. Web ads reached other businesses and customers, replacing the yellow pages.
5. Many consumers had computers connecting over the web.
6. The internet provided connectivity to most businesses and consumers.
7. Businesses used the internet to build brand images to earn consumer trust.
8. Security comprised a user id and password.

How was this phase born?
The goal of Web 1.0 was to create open, decentralised protocols that allowed information-sharing from anywhere. Its roots can be traced to Tim Berners-Lee's invention of a hypermedia solution architecture for

global information-sharing at the European Organization for Nuclear Research (CERN) in 1990. This became the foundation for the internet, evolving into uniform resource identifiers as network addresses, hypertext transfer protocol (HTTP) and hypertext markup language (HTML) as a way to display text and visual information on a computer screen. Other open protocols such as transmission control protocol/internet protocol (TCP/IP) and simple mail transfer protocol (SMTP) also prevailed.

Web 1.0 provided an easy way for many people to share read-only data quickly and cheaply in global communities, using tools like web content managers (MediaWiki, for instance) and blog applications. Therefore Web 1.0 is also commonly referred to as the 'read-only web'. Importantly, this version, Web 1.0, also known as the internet, prevailed over 'information superhighway', a similar iteration but based on closed standards.

Web 1.0 capabilities are still in heavy use. But with the arrival of Web 2.0, the ability to create interactive web applications that send and receive data between two computers became common. This was the technology that led to the explosion in the web (and later smartphone) application marketplace.

Web 2.0: Read-write web

1. Web 2.0 delivered online ordering and payment for businesses and consumers.
2. Business database ledgers now sent data to other businesses' ledgers.
3. Business computers expanded operations to improve online customers' experience.
4. APIs now provided improved data and services integration between businesses.
5. Most consumers had computers or mobile devices to connect over the web.
6. The internet connected most people and some devices.
7. Users generated content that was distributed through proprietary (non-interoperable) standards.
8. Independent rating services expanded to rate businesses, improving consumer trust.
9. Additional security features were central directory services and federated authority (e.g. Google, Facebook IDs).

The read-only Web 1.0 did not solve business integration problems nor provide end-user web applications other than simple information-sharing in web browsers. New standards evolved that allowed for a 'read-write' internet, also called Web 2.0. In Web 2.0, fully interactive applications allowed end-to-end integration flows for B2B solutions (both real-time and batch) and end-user real-time applications. Most of the online and digital world we access today on computers and mobile devices is built on this technology.

With the increased popularity of the internet, end-user-generated content became an integral part of the internet. By end-user-generated content, we mean both content created by users explicitly for the intention of being consumed by other users (blog posts, YouTube videos, Tweets, TikTok videos, etc.) and content available only to platform owners (users' activity, preferences, purchases, etc.). Increasingly, this user-generated content became the bedrock for most monetisation schemes, predominantly either by increasing user engagement in ad-supported platforms or by using their activity, behaviours, etc. to improve advertisement models and placement. Finally, user data can also be sold directly for profit. Naturally, platform owners reap the direct financial benefits of the above, whereas users benefit indirectly through entertainment, participation in online communities, knowledge found in blogs and search engines, communication and more. Even in activities where the end user earns money directly, such as ecommerce, platform owners take a share of their profits in various ways. One of the main factors in this (remedied by Web 3.0) is the lack of interoperable standards for user-generated content. While attempts such as RSS had a limited impact, social media and other platforms succeeded in getting their proprietary platforms accepted and widely used.

Web 3.0: Read-write-own web

1. Money as a native feature of the internet.
2. Decentralisation.
3. User control over identity and privacy.
4. Community governance and creator economy.

Web 3.0 makes use of technological tools nurtured in the decentralised blockchain space to give users the option of a feature-complete internet experience, without the need for platform owners or other intermediaries. We should note here that Web 3.0 does not necessarily mean that centralisation or intermediation will disappear entirely. Instead, when it makes sense, Web 3.0 will provide the tools for creating decentralised and community-governed systems that can be at least as feature-rich as those found in Web 2.0. Another way to view this is that Web 3.0 allows us to reclaim some decentralised aspects of the internet, without regressing to Web 1.0. Due to its use of Web 2.0 technologies, it can also be thought of as a superset of Web 2.0 and Web 1.0.

The term Web 3.0 was coined by Ethereum co-founder Gavin Wood. It is a succession of Web 2.0 that addresses some of its fundamental issues, especially those relating to the dominance and power of big tech. In Gavin's own words, 'The big problem with this (Web 2.0) is [that it is] sort of the same thing as placing all your eggs in one basket, if something goes wrong with one of these services, you know, the service is suddenly unavailable for an awful lot of people. […] Furthermore, the keyword here is trust. We're having to trust the people behind the services. We're having to trust the owners of the companies that run the service … And so yeah, we kind of managed to architect ourselves into this, somewhat like a dystopian version of what the world could be.'

Web 3.0 is a return to the fundamentals of a decentralised and open Web 1.0, but with all the modern capabilities of Web 2.0. Proponents argue that blockchains and smart contracts will serve as the fabric of Web 3.0, making big tech redundant. As an example, public addresses could replace proprietary accounts in the various social media, creating a decentralised social media identity and social graph of interactions between users. New social media could utilise this information in several ways, from creating better interfaces for existing social media, to embedding them in new experiences, only having to request permission from the end user. Naturally, centralised social media and other applications can (and will) be built atop decentralised systems, yet in this setting, users have agency over their data. At the same time, due to the decentralised infrastructure, they could opt to 'move' elsewhere without the switching costs imposed by existing walled gardens. Notably, this will result in two main dynamics: a) the main differentiating factor of products in Web 3.0 will be user experience and capabilities (since the user can choose to move their data freely); b) smaller players with legitimately innovative or desirable products will have a better opportunity to bootstrap their products and compete. Naturally, open blockchains, smart contracts, DeFi and NFTs are integral parts of this transition, as are bridges to the TradFi and real world that will facilitate user-choice in Web 3.0.

Ethereum Foundation's Josh Stark explains:

'Web 3.0 is about power. It's about who has control over the technologies and applications that we use every day. It's about breaking the dynamic that has shaped the last decade of the web: the trade-off between convenience and control. […] We can have the benefits of the internet without handing the majority of power to a minority of companies.'

Figure 4 below provides an overview of the differences between the iterations of the web.

	Web 1.0	Web 2.0	Web 3.0
Interact	Read	Read-Write	Read-Write-Own
Medium	Static Text	Interactive Content	Virtual Economies
Organization	Companies	Platforms	Networks
Infrastructure	Personal Computers	Cloud & Mobile	Blockchain Cloud
Control	Decentralized	Centralized	Decentralized

Figure 4 Web 1.0, 2.0, 3.0 comparison

Note: This comparison is not definitive.

3.2 OPEN VS CLOSED METAVERSE IMPLEMENTATION PATHS

Defining characteristics for the closed and open metaverse

As explained above, the defining attributes of a 'closed' metaverse are closed systems, platforms or services, also referred to as walled gardens, where access is controlled by the platform or service operator, either through hardware or software or both, controlled by the operator. It is typically subject to an end-user licence or service agreement with the operator, whereby users need an account with the operator to access the platform; where governance is centralised in the platform or service owner or operator; and where users licence, but do not 'own' their digital objects or assets, and cannot thus take or use them elsewhere or sell them for financial gain elsewhere.

Ball summarises: 'Each of these platforms works hard to lock developers and users to their platforms by forcibly bundling separate businesses, such as hardware, drivers/APIs access, software distribution, payment solutions, services, identities, and entitlements. […] To maintain control, each hardware platform gatekeepers or cripples potentially competitive Metaverse-related technologies.'

Critically, economic value accrues primarily to the system or platform operator rather than the users. A closed metaverse (and related applications or experiences) utilises Web 2.0 infrastructure, business models, governance models and revenue schemes. Although it may integrate elements of Web 3.0 technology, it does so in Web 2.0 fashion. As a result, Metaverse 2.0. inherits the benefits and drawbacks of Web 2.0 applications. A closed metaverse, as with closed markets, excludes or reduces competitiveness. As regards privacy and personal freedom, a closed metaverse, even if initially introduced by a private company, could readily be seized, powerfully directed or influenced by a number of actors with authority (public or private).

By contrast, the defining characteristics of an open metaverse are end-user choice and sovereignty over data and information, facilitated by Web 3.0. When utilising an open architecture, both open, trustless, permissionless systems as well as closed, permissioned, trusted systems can be built. The opposite does not hold, however; i.e. open systems cannot be built atop proprietary and closed infrastructures. By closed systems, we mean here applications prevalent in the Web 2.0 of today, including social media and content distribution platforms. By open systems we mean platforms where access is open, not determined or gated by a central operator, and where users own their digital objects, thus enabling an 'ownership society' and the development of global communities coordinated with economic incentives, where transferability of value can occur beyond a particular ecosystem. There are thus no significant technological, legal or financial barriers to the broad participation of market members.

In open systems, governance and economics tend to accrue to the users rather than a central operator. The technological model likewise tends toward a distributed or decentralised model, censorship resistant with no single counterparty and no single point of failure. Permissionless spaces (open metaverses) being under decentralised governance tend – by design – to protect privacy and personal freedom, securing them not by contracts and regulations but by designing the protocols of permissionless systems in a way which supports the use of privacy anonymity-enhanced tools.

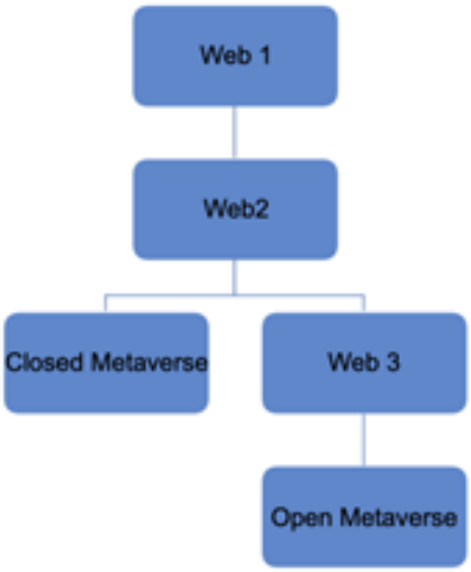


Figure 5 Relation between Web2, Web3 and Closed, Open Metavers

The problems generated by walled gardens are already addressed, to some extent, by the EU Digital Market Act (DMA) Regulation (provisional act).

Blockchain and the open metaverse

The role of blockchain and its various elements in the open metaverse

As indicated above, open, permissionless blockchains play an integral role in the open metaverse. At the very least, open and permissionless blockchains present the best solution currently available for deploying general-purpose systems to serve as the future of the internet. In the open metaverse, the essential decisions and processes needed for its functioning are decentralised. There may be self-governing cities or districts within a space that apply their policies, rules or access criteria.

The equally important role of a blockchain network is to secure the value and integrity of assets created on that infrastructure. Forms of value in the metaverse may include cryptocurrencies, i.e. fungible tokens, as well as NFTs, which can be understood fundamentally as subjects of property rights on the blockchain. Both fungible and non-fungible tokens can be used, deployed and transmitted within and across systems and platforms in an open metaverses (platforms) framework. The permissionless platforms communities tend to build the tools which enable and facilitate interoperability between different decentralised applications (dApps) and even between different networks. The common standards and wide interoperability resulted in the creation of the DeFi system and open economy. Common standards and open-source codes enable new service providers to freely enter the open metaverse, without the decision of platform central administrators (non-existent in the open metaverse).

Blockchains can also interconnect with existing applications (financial or otherwise) from Web 2.0 and can even allow for the deployment of centralised applications, or applications with centralised components (such as front ends). Ultimately, as has been stressed before, this will facilitate end-user choice.

NFTs as digital artefacts have already touched upon the importance of NFTs for an open metaverse. A distributed database, apart from being a base for issuance and clearing a cryptocurrency (native currency and fungible tokens), could also store NFTs. NFTs are unique crypto assets or representations of on-chain and off-chain goods or rights.

As pointed out in the Citi report, 'Blockchain primitives change the fundamentals of digital asset ownership by bringing in:

- Standardization (e.g., the ERC-721 standard, which defines how non-fungible tokens, or NFTs, are accessed/transferred)
- Interoperability (i.e., which can work with different wallets and exchanges as the token is recorded on the underlying blockchain)
- Tradability (i.e., which enables auctions on marketplaces enabling liquidity)
- Composability (i.e., which allows open-source apps to build on top of one another)
- Immutability (i.e., which allows for recording on the blockchain for posterity)'

In the context of payment rails, blockchain open standards and programmable payments effectively enhance the content creators' profits. The source of profits is directed payments (a fraction of the payments) made by users, received automatically by content creators when a user acquires or accesses some created content: art objects, games, experiences and unique goods.

Web 2.0 and permissioned blockchains can also accommodate NFTs, with Twitter and Instagram being the first examples. However, the difference with the open metaverse is that the NFTs based on permissioned blockchains or created inside the fully controlled dApp are (or may be) still fully controlled by centralised platforms' operators, who may change the smart contracts connected to the NFTs, or who may decide which type of smart contracts it may be technically possible to connect with NFTs created on the closed platforms.

This shows that the whole DeFi system and thriving economy may be (and is already partially) created based on the use of smart contracts at the higher levels of a decentralised network. The European Union Blockchain Observatory & Forum (EUBOF) *Decentralised Finance (DeFi)* report provides an in-depth explanation.

DeFi as a financial system and decentralised governance in the open metaverse

The cryptocurrency, smart contracts and NFTs may be used to build open as well as walled-garden platforms. Something that mostly differentiates closed from open metaverses is the type of governance. Centralised management of a closed metaverse is concentrated in one entity or a small group of closely cooperating entities, linked by contractual relationships. Centralised management is held by a board of directors, comprising easily identifiable persons; the financial assets of the platform's operator are stored in easily identifiable banks. This type of governance enables governments to impose obligations on centralised platform operators and to enforce these obligations effectively by threatening platform operators with huge fines and/or other sanctions. All mentioned entities/persons constitute 'access points' for law enforcement agencies; sanctions are relatively easily enforced against them. From a regulatory point of view, a centrally governed metaverse is far easier to control and steer, despite its enormous size.

On the other hand, the permissionless spaces under decentralised governance obviate the need for central management. Before the times of blockchain, the cooperation processes between a large, globally dispersed group of people needed to be coordinated by using legal links (contracts and other legal institutions to establish corporate structures).

Today, without using any legal institutions, and based only on decentralised blockchain technology and smart contracts, it is possible to establish trustless basic foundations for decentralised cooperation between large groups of people. Centralised management is no longer needed to ensure the execution of the goals of large communities. The metaverse community and decentralised autonomous organisations (DAOs) typically may have no legally appointed representatives (e.g. board of directors) nor shareholders to serve as 'access points' to the community/DAO for law enforcement agencies. The management decisions are taken by using governance tokens and executed automatically by open-source code (according to the rules implemented in the code). Existing elements of off-chain governance can also be decentralised, not requiring the identification of DAO members: the crucial decisions regarding implementation of changes to the protocols are taken informally within the whole community. The decisions are discussed within the community until it is evident that some of the discussed changes are accepted by a sufficiently large majority of the community; the changes to the open-source codes are implemented by developers who may not be identifiable by the community and/or

by law enforcement agencies. However, today's legal frameworks have not been adjusted to account for many of the above innovations.

Open vs closed metaverse

Table 2 below highlights the differences between the models of an open and a closed metaverse:

Table 2 Open vs Closed Metaverse

	Closed metaverse	Open metaverse
Infrastructure	Platforms Serve as the basis for deploying applications and tools	Networks and platforms Serve as the basis for deploying applications and tools, as well as other platforms (platform for other platforms)
Governance	Centrally governed by identifiable entity or entities.	Provides the ability for decentralised community-based governance, as well as algorithmic governance.
Values	Decisions are based mainly on adding shareholder value.	Decisions are based mainly on adding stakeholder value.
Business models/revenues sources	Advertisements, subscriptions, digital items and services Business models must account for intermediation.	Advertisements, subscriptions, digital items and services Disintermediation will introduce new business models.
Privacy, data, ownership, identity	Stored in centralised databases and managed by authorised private and public providers. Limited user control over information enforceable by law. Digital content is managed and controlled by providers.	Stored in decentralised and centralised databases and managed by authorised private and public providers as well as smart contracts. User control over information ranges from limited to complete and is enforceable by law and/or algorithmically. Some digital content cannot be managed or controlled by providers.
Assets and financial services	Proprietary asset registries, financial interoperability necessitates intermediation and is subject to fees and inefficiencies.	Possibility for universally shared registries of digital and physical assets (NFTs or blockchain). Intermediated and efficient financial services which can interoperate with legacy finance.

Chapter 4: Conclusions

At the time of writing this report (late 2022), it is still too early to draw definitive conclusions on the **desirable**, let alone the **commercially successful** or the **socially optimal** characteristics of metaverses. Even the very definition of the term we have offered, as well as similar definitions found in the scientific or business literatures, cannot be considered definitive – the technology, its applications and its use cases are rudimentary and are still evolving. Attempting to draw final conclusions about the metaverse today is as risky as it would have been in the early 1990s to attempt to predict the future path of the internet: one might be able to successfully foresee certain use cases, like information search and media digitisation, but it would have been virtually impossible to anticipate the exact nature of digital social network applications, ride-hailing and private room-renting platforms, and the myriad of apps dominating our mobile phones today.

However, as in the case of the internet, we can investigate early, proto-metaverse implementations and draw some conclusions regarding the development of virtual worlds.

To start with, it is worth observing that **the metaverse is both already here and still far away**. Most of the people, at least in the developed world, already spend (perhaps too much) time interacting with other people over digital channels, so much so, that at times they may rightly feel that they live more in the digital than in the physical sphere. At the same time, though, the kind of immersive and persistent experiences implied in full-blown definitions of the metaverse (where users wear headsets or other devices to embed themselves in wholly virtual or AR worlds populated by other, similarly immersed, users) are quite a few years away – if they are ever realised at scale.

Defining a set of **characteristics** that a fully mature metaverse might possess will allow us to consider specific implementations, current or future.

Such characteristics include:

1. **Photorealism,** i.e. the degree to which the metaverse world resembles the physical world and is sufficiently indistinguishable from it, to the casual observer;
2. **Immersiveness,** i.e. the degree to which users can (or must) embed themselves inside the world to use it, for example by wearing a VR headset;
3. **Persistence**, i.e. the degree to which the interaction experience ‘follows’ users in their daily lives in an always-on fashion;
4. **Data ownership**, i.e. the degree to which users own the assets they possess in the virtual world (avatars, objects, land, etc.) and can take them off the metaverse to be used in other virtual worlds;
5. **Openness,** i.e. the degree to which the virtual world is open to developers to create new spaces, experiences, objects and applications;
6. **Censorship resistance**, i.e. the degree to which users can be prohibited from accessing the virtual world, restricted in their experiences or expelled from the metaverse, by a centralised authority who ‘owns’ and controls the world.

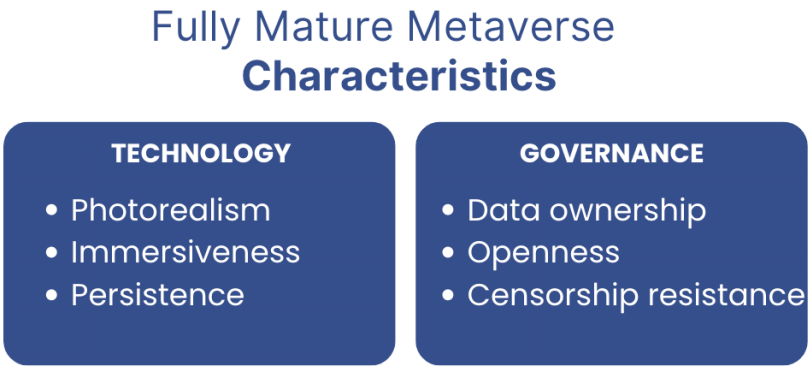


Figure 6 Characteristics of a mature metaverse

Of the above properties, the first three are **technology** focused, while the latter three are related to the **governance** (or business model) of the metaverse.

- Technology is always much easier to analyse. Arguably, it is progressing fast towards creating solutions that increase the photorealism, immersiveness and persistence of metaverses, and one can anticipate that all technical challenges will be ultimately solved.
- By contrast, it is by no means certain whether successful virtual worlds of the future (successful in the sense of attracting large numbers of users who consistently live, work and play on them) will be built and owned by centralised organisations (who exercise various degrees of authority in restricting open access to developers, users and competitors), or whether more decentralised designs will prevail, resulting in open, interoperable and censorship-resistant metaverses.

Much will depend on whether the future maturity phase of the metaverse will be characterised by a dominating single metaverse (the **mega-metaverse** scenario) or a multitude of vertically focused metaverses emerging to support specific use cases, needs and communities (the **niche metaverses** scenario).

- **Many niche metaverses**. It may be that different Web 3.0 environments will become popular for different applications, much as different platforms are used today in Web 2.0. In that scenario, it becomes important for users to be able to move seamlessly between such virtual worlds, taking with them whatever parts of their identity or assets they choose. This debate on the openness and interoperability of metaverses will dominate development in the sector and will determine whether Web 3.0 metaverses will indeed be different from today's walled-garden platforms that are monopolised by big technology firms.
- **One mega-metaverse**. Alternatively, it may be that a very successful single mega-metaverse will dominate, where different 'neighbourhoods' are devoted to specific uses. This scenario might take several different forms: for example, we might see a duopoly of large metaverses, perhaps even geographically focused, like the internet today, between China and the rest of the world; or one multi-purpose mega-world surrounded by application-specific satellites. Again though, the same governance questions emerge: under what conditions will the owner of this mega-metaverse (either an existing or a new big-tech firm) allow third-party developers to build spaces, experiences and applications in it? Will users truly own (and be able to monetise) their assets in this new world or will they be subject to a Web 2.0-like walled garden where they are effectively locked into a new monopoly that accrues all benefits of the platform?

Such governance questions are important and will determine the shape of the technology world we are now building. Europe, supporting freedom, justice, openness and fair competition, should lead the global debate by initiating policies that provide a fair foundation and equal opportunities for private companies and decentralised communities alike, to build the open metaverse(s) of tomorrow.