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The Metaverse and its Potential for the United States

Final Report

May 2023

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Table of Contents

Executive Summary

The metaverse is envisioned to be the next significant iteration of the internet. While still in its nascent stage, early metaverse experiences around 2D augmented reality ("AR"), artificial intelligence ("AI"), and immersive 3D virtual reality ("VR") technologies are emerging through current connectivity infrastructure and user devices (e.g., smartphones, computers, headsets).

Over time, as technologies and applications continue to evolve and connect, they have the potential to transform the way in which societies and economies interact, bringing together physical and virtual worlds through seamless and immersive experiences. Emerging use cases illustrate how metaverse technologies may affect the ways in which business-to-business (B2B) and business-to-consumer (B2C) markets interact, and how virtual worlds can simulate and optimize real-world activities.

... benefits to the US through stronger economic growth and an increase in exports.

The US is investing heavily in the metaverse and is leading its development globally. In time, this should bring benefits to the US through economic growth and an increase in exports. Large US technology firms, including Meta, Microsoft, and NVIDIA, are working to build the metaverse by producing devices, platforms, and technologies to power new immersive experiences. Smaller US firms, such as VictoryXR, Double A Labs, and Spot, are also investing in metaverse technologies.

... the metaverse could contribute between US$402bn and US$760bn to US annual GDP by 2035.

The nascent nature of the technology makes the size and timing of the metaverse's economic impact uncertain. This is reflected in the literature, with a wide range of estimates published, using a variety of different methodologies. However, based on the level of investment that is currently predicted, we estimate that the metaverse could contribute between US$402bn and US$760bn to US annual GDP by 2035.

There are several potential business drivers of economic opportunity.

— First, **x-reality experiences** may transform B2C and B2B experiences by integrating metaverse technologies such as VR, AR, and AI. For example, companies such as Nike are already using VR technologies to sell virtual goods and generate new revenue streams; and some entertainment companies are also experimenting with metaverse applications, such as the GRAMMY Week on Roblox, to offer virtual experiences to fans.

— Second, **enterprise simulations** may lead to efficiency improvements, as firms discover ways to use the metaverse to optimize physical processes. For example, NVIDIA is developing metaverse technologies that aim to reduce the time and costs to train self-driving cars. Ericsson, the Swedish telecoms company, is working with NVIDIA to optimize the layout of 5G radio networks. Amazon and PepsiCo are already using similar technologies to optimize the design of their distribution centers using 'digital twins' to simulate alternative layouts. Metaverse technologies are also allowing increased efficiency in contexts other than businesses. For example, cities have begun using it to help plan and visualize new developments.

— Finally, **augmented workforce experiences** can be used to train workers, and to enhance remote working and learning. For example, surgeons can simulate surgical procedures in 3D and receive feedback in real time on their actions. The metaverse could improve remote working by making communication more life-like, and it could improve the quality of remote education by making learning more immersive and interactive.

Collaboration between government, businesses and civil society will be needed to raise digital skills and to increase digital connectivity.

While the US is in a prime position to lead and benefit from the development of the metaverse, its potential benefits may not be widely felt. Evidence suggests that there continues to be significant digital divides across the US population in terms of connectivity (e.g., affordability, rural coverage), as well as in digital skills, that impact how widely accessible even current internet enabled experiences are. Digital divides disproportionately affect older citizens, rural inhabitants, lower income households, and minority groups (see for example Hecker, I. & Briggs, A. 2021). Cooperation across the private and public sectors will be needed in these key areas to facilitate the equitable distribution of value creation, particularly among historically disadvantaged groups for both existing and future technologies.

Further collaboration will also be needed to build trust and social acceptance in emerging technologies. This could be assisted by increasing transparency about how hardware and software have been designed for end users, how they handle and process data, as well as communicating the economic and social benefits of the technologies.

The coming years will be decisive for the widespread development and adoption of metaverse. Businesses, governments, and community organizations will all have a role to play in fostering a sustainable and inclusive metaverse ecosystem. In doing so, the US will have the opportunity to remain a global technology leader, and realize the significant opportunities that the metaverse might bring.

1. What is the metaverse?

Transforming commerce and communication

"The metaverse is 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."

– Ball, M., (2021) "Framework for the Metaverse. The Metaverse Primer"

The internet in its current form (Web 2.0) has had a far-reaching impact on economies and societies around the world. It has shaped the ways that people, businesses, and governments interact with each other in everyday life, and has had significant economic and social impacts.[1] The metaverse is envisioned to be the next significant iteration of the internet. While still in its nascent stage, early metaverse experiences around 2D augmented reality ("AR"), artificial intelligence ("AI"), and immersive 3D virtual reality ("VR") technologies are emerging through current connectivity infrastructure and user devices (e.g., smartphones, computers, headsets). These are already offering users a more interactive means of communication. As technologies and applications continue to evolve and integrate, the metaverse is expected to support even more immersive and interactive experiences in virtual worlds. Early applications suggest that this technological revolution could further transform commerce, communication, and public services.[2]

Businesses are driving the change. In this technological transformation of the internet, where virtual worlds and AI simulate and augment the physical world around us, there are three primary ways that will be valuable to businesses in the near term:[3]

— **X-reality experiences: bringing into the metaverse events or experiences that until now have only been possible in the physical world.** This means offering hybrid, virtual and physical experiences that bring persistent worlds, transient experiences, and connected commerce to both industrial and consumer audiences. XR experiences can therefore enable users to bridge physical distances even more effectively than the internet. Some examples include a virtual car showroom offering test drives, and sporting events creating virtual ringside experiences.

— **Enterprise simulation: combining physical and virtual 3D objects in the metaverse to create physics-realistic virtual versions of real-world environments to simulate scenarios and optimize operations.** Organizations are leveraging virtual worlds to redesign production facilities and optimize manufacturing operations, among other applications.

— **Augmented workforce experience: offering immersive learning, training, onboarding experiences and augmented worker processes to improve efficiency and reduce errors through AR, VR, and AI/machine learning (ML).** This is already happening, for example, with virtual onboarding and immersive training of employees in the US defense forces.

Over time, these innovations have the potential to foster new economic opportunities, create new business models, and open new avenues for simulation, entertainment, engagement, collaboration, research, and business operations. To achieve this, progress will be needed in building an ecosystem of public and private sector players, and in establishing the standards, platforms and protocols that govern it (see Box 1).

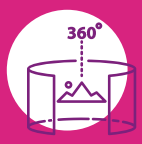
Organizations are leveraging virtual worlds to redesign production facilities and optimize manufacturing operations, among other applications.

US technology firms such as Meta, NVIDIA and Roblox are investing heavily in metaverse technologies.[4] After its acquisition in 2014 of Oculus, the VR headset developer, Meta established Reality Labs, an operation dedicated to building metaverse technologies and experiences.[5, 6] Meta is also developing a supercomputer to power metaverse-related workloads.[7, 8] NVIDIA is investing in a version of the metaverse to enable businesses to collaborate, and build "digital twins" of factories, warehouses and telecoms networks.[9] Roblox has a mission to build a human co-experience platform which allows developers to build virtual worlds and players to create digital avatars that they can take with them across different metaverse applications. As of 2022, Roblox had 52 million daily users.[10]

The opportunity of the metaverse will be driven by collaboration between diverse ecosystem players. Its development is leading to the creation of both domestic and international partnerships, spreading innovation and know-how in the process. For example, Meta recently established a partnership with Qualcomm to develop specialized chipsets for VR devices.[11] In another recent development,[12] Kura Technologies, an AR headset developer, partnered with Taiwanese chip manufacturer (TSMC) to build Kura's new high-performance chipset.[13] Deloitte's Unlimited Reality offering extends an alliance with NVIDIA to develop the enterprise metaverse, using AI Computing and NVIDIA's Omniverse Enterprise platform to collaborate on 3D design and physical world simulation.[14]

The **momentum being built by US business can help the US to be the lead** in the evolution of the internet, generating domestic and global benefits. This has the potential to increase US economic growth and exports as the country develops metaverse software and hardware that can be used around the world.

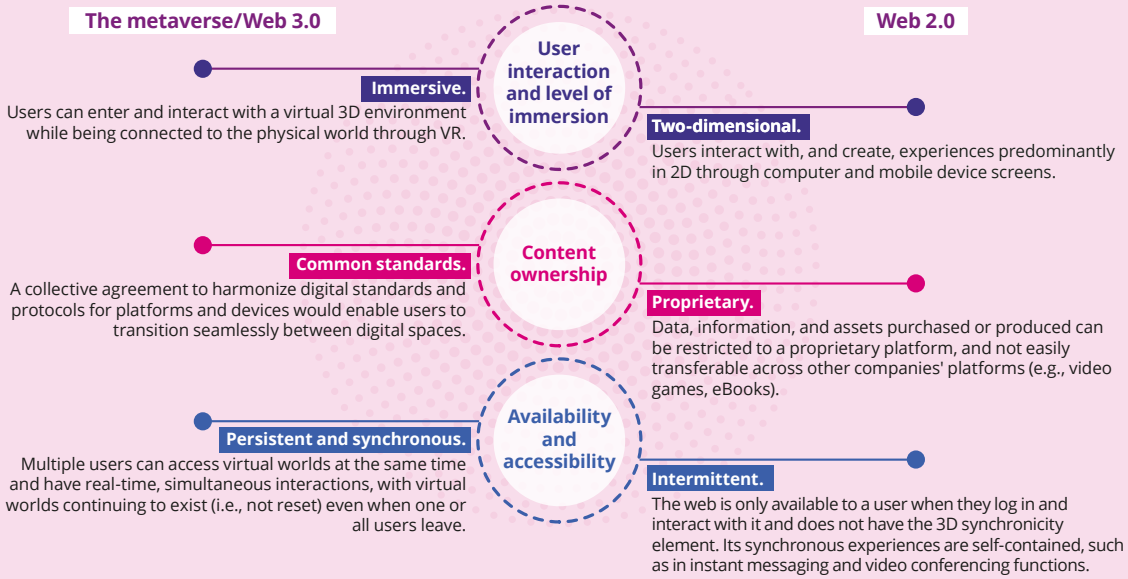
Box 1. Common principles of the metaverse, compared to the previous generation of the internet



BUILDING A METAVERSE ON COMMON PRINCIPLES

While there is no single all-encompassing definition of the metaverse, there are common principles that will likely characterize it. These principles are set out in Figure 1, along with a comparison to the previous generation of the internet, Web 2.0.

Figure 1. Overview of common principles of the metaverse and comparison to the previous generation of the internet



Sources: Nick Clegg (2022); Nath (2022); The University of British Columbia.

— Firstly, the **immersive** principle of the metaverse will allow users to combine real and virtual worlds using different extended reality (XR) technologies such as AR, VR, and mixed reality (MR), together with advances in AI and haptic feedback (i.e., simulating the feeling of touch) to provide tactile engagement.

— Secondly, **common standards** will allow users to experience multiple worlds whilst seamlessly transferring their presence and assets (e.g., non-fungible tokens or NFTs) between different virtual worlds. This will likely require an agreement on common protocols and standards to be used across different platforms.

— Finally, **persistence and synchronicity** refer to the existence of digital worlds that do not reset when users leave them but evolve continually over time as users interact with it and with each other akin to the real world.

The user experience of the metaverse is built on several layers of technology and services

A range of devices can be used to access metaverse applications, but the levels of immersion they provide, their cost and dependence on technology enablers vary. The metaverse is often associated with immersive 3D VR experiences through headsets, but smartphones can also be used to access metaverse experiences in 2D via apps, internet browsers and inbuilt cameras. In the US, 85% of adults owned a smartphone in 2021,[15] suggesting that in the near term, smartphones will be the most likely point of entry for some key emerging use cases. At the same time, innovation has the potential to produce new and more affordable ways of engaging with the metaverse with more immersive VR and XR experiences becoming a larger part of the ecosystem in the future.

The metaverse is often associated with immersive 3D VR experiences through headsets, but smartphones can also be used to access metaverse experiences in 2D via apps, internet browsers and inbuilt cameras.

To build the metaverse, four key inter-connected areas will be important (see Figure 2):

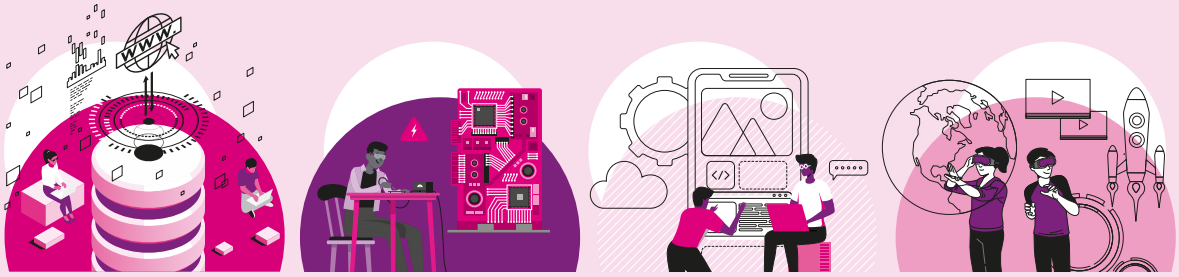
01. Continued **digital infrastructure** improvements over time to ensure existing and emerging technologies are supported with high-quality processing, low cost of data transmission and efficiency.
02. **Hardware, protocols and standards** to improve accessibility and interaction.
03. **Enhanced content and experiences**, to differentiate the metaverse for the end-user.
04. **Platforms** to house and develop content and 'worlds'.

These four components are interconnected and work together to create a foundation for metaverse innovation to develop, for demand for its offerings to grow, and for economic benefits to spread across the US.

Regulation will also be crucial so that businesses have the confidence to invest in metaverse technologies and consumers can feel safe using it. Public policy, regulation, and governance frameworks will be needed to facilitate the development of metaverse technologies and provide an enabling ecosystem for the metaverse to develop as a safe, secure and inclusive environment for consumers and enterprises to use and invest in.

Collaboration between the private sector, academia and the public sector will be another critical requirement. However, progress in these areas does not guarantee that all parts of society will benefit. The extent to which the benefits are enjoyed will depend on access to the internet along with digital skills and social acceptance. There is a risk of the continuation of an existing 'digital divide' between people, who are lacking means of access to the internet, and the rest of society. This concern, together with the fundamentals and enablers of the metaverse, is explored in Section 3.

Figure 2. The four key components crucial to the emergence and adoption of the metaverse



Digital Infrastructure	Hardware, Protocols and Standards	Content and Experiences	Platforms
More innovative and immersive content will require continuing to maintain dependable and secure digital infrastructure to process and transmit increasing volumes of data. This could include: • Cloud, data centers and edge computing • Computing power • Blockchain technology • Connectivity infrastructure	Higher levels of immersion will require device sophistication (e.g., AR/VR headsets) at affordable prices. This includes: • Smartphones and other user devices • Device manufacturers • Operating systems • Sensors • Common technical standards	For the metaverse to commercially succeed, there also needs to be access to, and demand for innovative content and experiences. This includes: • Users (consumers and businesses) • Content creators • Product developers • App developers	More sophisticated and affordable devices will increase the demand for supporting technology, such as fit-for-purpose platforms and system integration. This will involve: • AR/VR platform builders and creators • Software and IP development • Technology firms • Software engineers • AI/ML

Public Policy and governance frameworks

Public policy and regulation will also be crucial in fostering trust in metaverse applications for both consumers and businesses. This could include digital and innovation policy, data protection, online safety, competition, taxation, and cybersecurity.

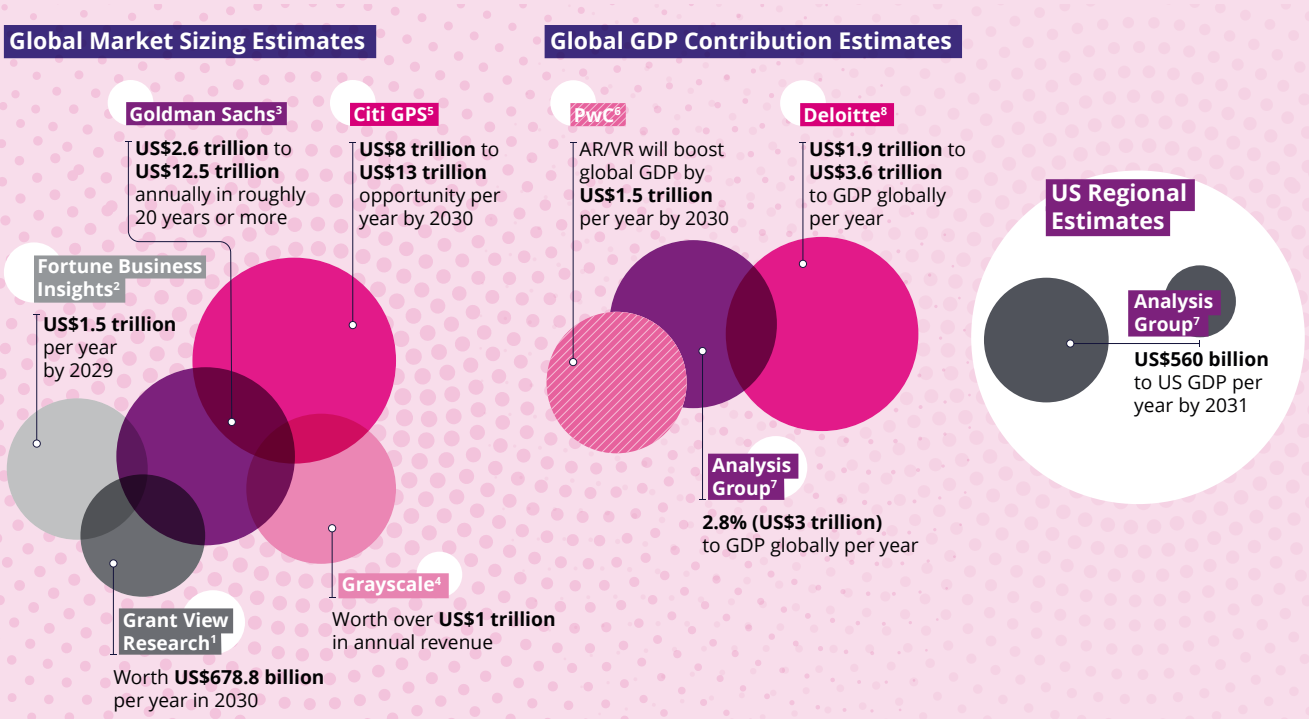
Source: Deloitte analysis

2. The opportunity for the American economy

The metaverse has the potential to make a significant contribution to the American economy

By transforming commerce and communications, the metaverse has the potential to be a significant economic opportunity for the US. However, it encompasses nascent technologies, and the size and value of this opportunity is difficult to estimate with precision. This is reflected in the wide range of estimates that have been produced for the potential market size (i.e., additional revenue) and potential economic contribution (i.e., addition to GDP). In spite of the differences, all the estimates that have been made suggest that the global economic potential of the metaverse is significant (see Figure 3).

Figure 3. Global estimates of the metaverse: market size and GDP contribution



Notes:

1. Value in 2021 US$. Grand View Research (2022) Market Analysis Report*;*
2. Value in 2021 US$. Fortune Business Insights (2022), Metaverse Market Size, Share & Covid-19 Impact Analysis*;*
3. Goldman Sachs (2021), Framing the Future of Web 3.0*;*
4. Grayscale (2021), The metaverse*;*
5. Citi GPS (2022), Metaverse and Money*;*
6. Value in US$ 2019. PwC (2019), Seeing is believing*;*
7. Value in US$ 2015. Analysis Group (2022), The Potential Global Economic Impact of the Metaverse*;*
8. Value in US$ 2021. Deloitte (2022), The Metaverse and its Potential for Türkiye

Analysis Group has estimated that the metaverse could contribute US$560 billion per year to US GDP by 2031,[16] which is approximately one-sixth of the estimated US$3 trillion impact on global GDP. Their work is based on an assumption that growth of the metaverse globally might follow a similar pattern to growth in mobile telecommunications technology, in the past.

In making our own estimate of the potential economic impact at global and country level, we have instead applied an established relationship between ICT capital investment[17] and economic growth. Our estimate also depends on several modeling assumptions, including forecasts of global GDP and different ICT investment scenarios. (See Box 2 for an overview of the methodology.)

Based on global metaverse investment scenarios set out in the literature, the potential economic contribution of the metaverse to US GDP could be between US$402 billion and US$760 billion annually by 2035 (equivalent to between 1.3% and 2.4%). This suggests that the metaverse may lead to a significant increase in the value of goods and services being produced in the US. Given the emerging state of the technology, the timing and size of the economic benefits are dependent on an enabling environment for its growth and adoption. This issue is explored further in Section 3.

The metaverse may lead to a significant increase in the value of goods and services being produced in the US.

Box 2. Overview of the methodology to estimate the economic impact of the metaverse[18]

METHODOLOGY OVERVIEW

To estimate the impact of the metaverse in the US, the methodology estimates the potential global economic impact of the metaverse, based on global metaverse investment scenarios. It then apportions this global total to obtain country level estimates. For the analysis, two scenarios for global investment in the metaverse, based on the literature, are considered:

— **Baseline scenario** where global metaverse investment is US$140bn per year from 2022 to 2029;

— **Upside scenario** where global metaverse investment is US$270bn per year over the same time period.

Using estimates from the economic literature on the relationship between investment in ICT capital and economic growth, the analysis suggests that metaverse investments could add **US$1.9-US$3.6 trillion** to global annual GDP by the end of 2035 (in 2021 US dollars); this would be approximately **1.3% – 2.4%** of global GDP in 2035. To apportion this global total, a proportion is attributed to the US based on its forecast contribution to global GDP. Following this, the two scenarios for metaverse investment are estimated to generate an economic contribution for the US of between US$402-US$760 billion per year by 2035. For a detailed description of the methodology, please see Deloitte's report 'The Metaverse and its Potential for Türkiye'. Please note that following the release of the Türkiye report, the IMF subsequently (in April 2023) published updated GDP forecasts, which have been used in this paper.

These impact estimates are dependent on several assumptions and external forecasts, including:

— Country level and global real GDP forecasts from the IMF for 2022-2028, and a CAGR for 2029-2035 based on World Bank figures for GDP over the period 2009-2019.

— The investment scenarios considered look at spending that is likely to arise from large technology firms in the development of metaverse platforms and technologies. Therefore, they do not necessarily consider wider, longer term, investment that may take place across a number of wider domains such as in communications, connectivity and underlying infrastructure.

— Global ICT investments in the metaverse being incremental to other ICT investments, rather than substitutes for ICT investments that will no longer take place.

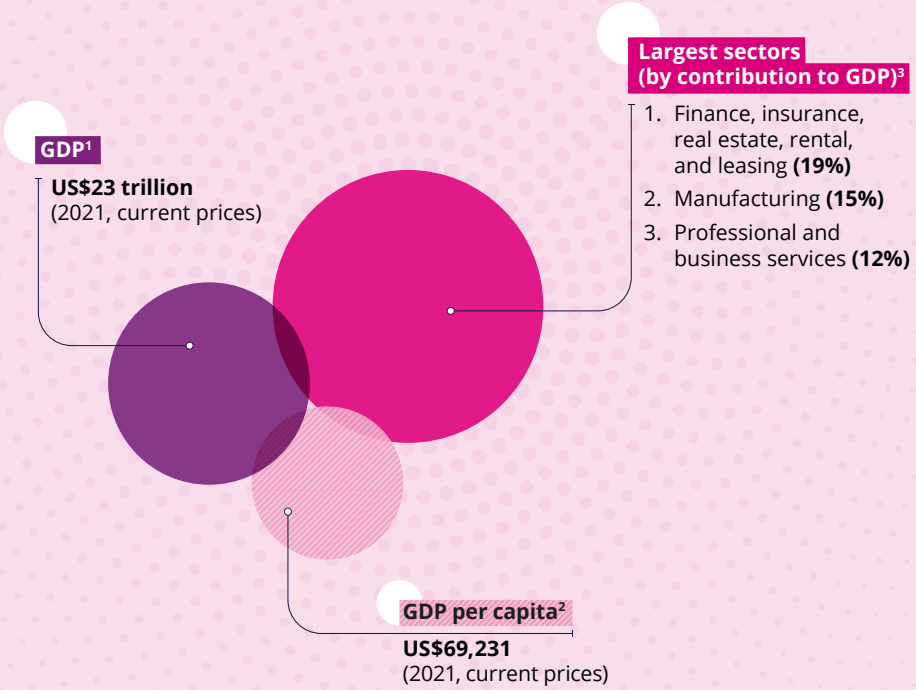
— The development of an enabling environment to support adoption of the metaverse, e.g., sustaining current rates of investment into network infrastructure.

— Exclusion of metaverse-related investments by firms outside the ICT sector or by public authorities, which may indicate that the estimates are conservative.

Therefore, caution should be maintained over the exactness of the estimates as a result of assumptions and forecasts differing over time. Consequently, the impact of the metaverse both globally and in the US may be larger or smaller.

The US is a large, socially and economically diverse country

Figure 4. Key US economic statistics



Notes:

1. Bureau of Economic Analysis via Statista (2022);
2. IMF via Statista (2022);
3. Bureau of Economic Analysis (2022), Gross Output by Industry.

The US is the largest economy and second largest exporter in the world, with a GDP of US$23 trillion and exports of goods and services worth US$3.5 trillion in 2020.[19] US companies are able to supply a large domestic market of consumers and businesses. The US is also an affluent country, with a high GDP per capita, suggesting there is a large pool of potential consumers and businesses able to afford technological innovations.[20]

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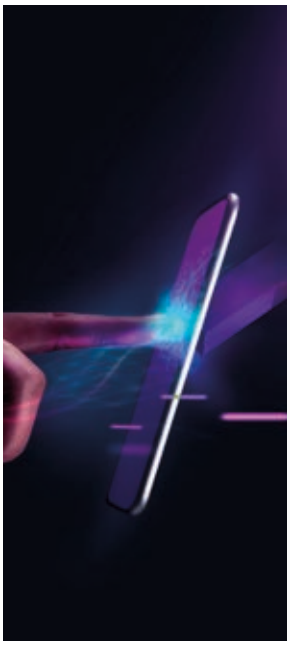


Callout 1. A focus on the Digital Divide

A 'digital divide' exists between urban and rural areas and between Americans of different ethnicities. While data suggests that, overall, the US has good internet coverage provided by 4G, 5G and fixed broadband, rural areas are often less well served. Smartphone ownership is also lower in rural areas.

Black and Hispanic Americans are less likely than White Americans to have fixed broadband at home and are also less likely to have sufficient digital skills.

Source: Pew Research Center *(2021)*

However, these headline figures mask substantial variations both within and between states. Some indicators of income and wealth inequality put the US behind some developed economies such as the United Kingdom, Canada and Germany.[21] In part, this reflects the socioeconomic and sectoral differences across states. For example, while the headline rate of unemployment in the US was 3.5% as of December 2022,[22] there were big variations between states. Nevada had the highest rate of unemployment at 5.2% and Utah the lowest at 2.2%.[23] The **State New Economy** Index, which measures the economic structures of states to assess whether they match the 'ideal' structure for an innovation-driven economy, suggests that while Massachusetts is judged to have an economic structure ready to harness the innovation-driven economy, Mississippi does not.[24] Its report suggested that this difference results from Massachusetts being home to more technology and professional service firms and a high-skilled labor market, whereas Mississippi has more traditional industries and conditions that are not so well-suited to embracing an innovation-driven economy. Data also shows that there are big differences across the country in median incomes between ethnic groups and between urban and rural communities.[25, 26]

So, while the US as a whole is better positioned to afford the immersive hardware and software for experiencing the early and forthcoming metaverse applications, significant segments of the population may not be ready to benefit fully. Further discussion on differences at state level are discussed in Section 3.

The following sections of this report discuss the potential opportunities that could arise from the metaverse in various fields. As shown in Figure 5, metaverse technologies are expected to generate new commercial opportunities as well as wider health, educational and environmental benefits.

There will be opportunities to create new markets and improve the efficiency of business operations.

Figure 5. The metaverse potential opportunities

New markets and operational opportunities

New revenue streams

- Some brands and retailers who have until now only sold physical clothes have begun selling virtual versions in the metaverse. Content creators and entertainment firms are also beginning to offer virtual experiences via the metaverse.
- **For example**: West Elm, the furniture retailer, is using the metaverse to allow customers to purchase furniture for their virtual homes.

Complementing existing revenue streams

- Other companies are using the metaverse to market their physical products, or even allow consumers to try before they buy with virtual overlays.
- **For example**: Wendy's opened a virtual restaurant in the metaverse that visitors can explore, earning discounts on food in Wendy's (physical) restaurants.

Health impacts

- The metaverse provides an opportunity to widen access to healthcare by allowing those living in remote areas to virtually access doctors.
- **For example**: Proximie, a technology firm, is using AI, AR and machine learning technology to allow doctors to remotely 'scrub in' to operating rooms anywhere in the world.

Education impacts

- The immersive nature of the metaverse may help improve the quality of remote education through better collaboration and communication. It may also increase access to education through allowing students to access a wider number of colleges.
- **For example**: Firms such as VictoryXR – an Iowa-based SMB – creating immersive classrooms.

More efficient business operations

Optimizing physical processes

- Firms are using the metaverse to build 'digital twins' – virtual replicas of physical processes – for things such as self-driving cars, factories or telecom networks.
- **For example**: Ericsson is using a digital twin of its network equipment to understand how 5G radio antennas can be best placed within a city to optimize network performance.

Enhance employee training

- Large companies across the US including in the retail, aviation and financial services sectors have started using the metaverse to train employees with immersive VR training.
- **For example**: Large companies across the US, such as Walmart, SAP and Delta, are using emerging metaverse experiences to train employees in VR.

Improving remote working

- It could make communication and interaction with colleagues more life-like, aiding collaboration.
- **For example**: Several companies have already begun using metaverse experiences for online meetings, with Meta using its Horizon Workrooms software and Microsoft through its Mesh platform.

Environmental impacts

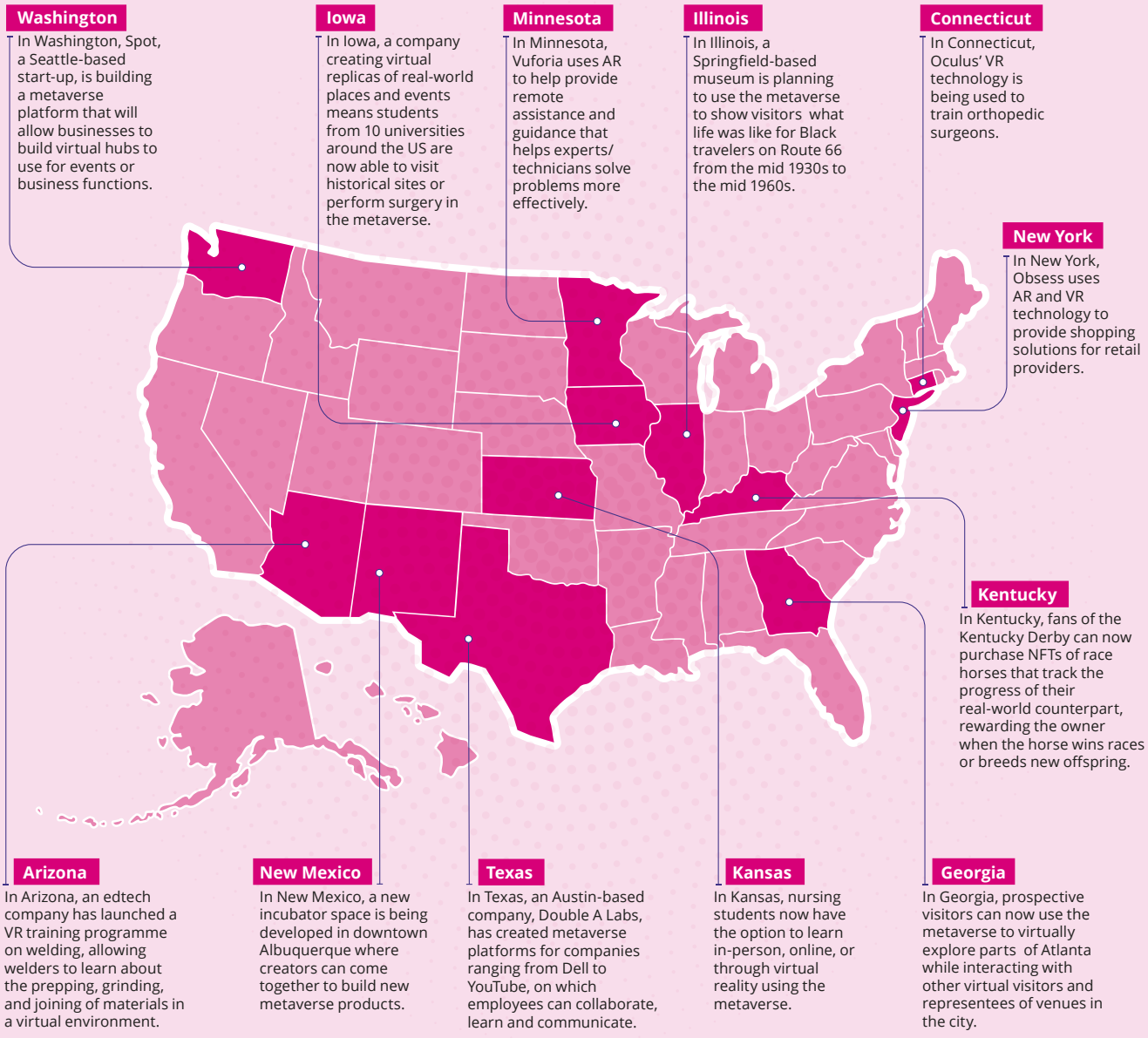
- The metaverse may help reduce individuals' carbon emissions through reduced need to travel as a result of remote working, and virtual socializing. The Metaverse could also enable businesses and manufacturers to streamline operations and reduce waste.
- **For example**: Firms involved in developing the metaverse have released statements on their commitments to environmental mitigation, including for example, the likes of Microsoft, Meta and Amazon.

Sources: Business Wire (2022). West Elm, *Kelly, C. (2022).* Wendy's opens metaverse restaurant in Horizon Worlds, *Proximie (2022).* About Us, *VictoryXR (2021).* About Us, *NVIDIA (2021),* Ericsson Builds Digital Twins for 5G Networks in NVIDIA Omniverse, *Anderson, J. & Rainie, L. (2022).* The Metaverse in 2040, *PwC (2022).* What does virtual reality and the metaverse mean for training?, *BusinessGreen (2022).* Amazon, Microsoft, and Meta join drive to slash CO2 from phones, laptops, and speakers, *BusinessGreen (2022).* 2021 Sustainability Report – Meta Sustainability (fb.com), *Forbes (2022).* How Microsoft Is Leading The Response To The Climate Crisis.

Potential new market and operational improvement opportunities for businesses

The contribution of the metaverse to US economic growth is expected to be driven by businesses harnessing new revenue streams, augmenting existing business models, as well as bringing operational efficiencies. There are already examples of companies, across the US, that have started to use metaverse technologies in these ways (See Figure 6).

Figure 6. Examples of the metaverse being used across the US



Source: Iowa Capital Dispatch; The State Journal Register; CNBC; Public Gaming; Discover Atlanta; PR Newswire; Yahoo; ARVR Magazine; WIBW; GeekWire; eacpds; Obsess – Virtual Store Platform.

New revenue streams

Already businesses across the US have used metaverse technologies to create substantial new revenue streams. For example, some brands and retailers that in the past have sold only physical items of clothing are now also selling virtual versions in the metaverse. Nike began selling digital sneakers in 2021, after acquiring RTFKT, a retailer of virtual shoes and clothing.[27, 28, 29] And West Elm, the furniture retailer, has created an early metaverse experience allowing customers to buy furniture for their virtual homes on Roblox.[30]

Digital assets such as non-fungible tokens (NFTs) could play an important role in the future of commerce online. NFTs – digital assets with unique identifiers to prove ownership – could enable businesses to sell a wide variety of assets in the metaverse, from digital works of art to land.[31]

Businesses across the US have used metaverse technologies to create substantial new revenue streams.

Some content creators and entertainment firms are starting to offer virtual experiences via metaverse technologies. With a richer set of media to work with, creators are developing huge multiplayer games, interactive art exhibitions and fashion shows, as well as immersive on-line concerts and sporting events.[32] For example, Megan Thee Stallion organizes virtual concerts, and the Recording Academy presented the 64th Grammy Awards in the metaverse.[33] The Universal Hip Hop Museum – due to open in New York City by 2024 – will open in the metaverse before it opens in the physical world.[34] Fans of the **Tonight Show** are now able to make virtual visits to the studio where the program is filmed.[35] Events, staged in the metaverse, may enable firms to reach bigger audiences, as well as people who are unable to attend physically because of distance, cost or other accessibility issues.

Metaverse technologies are also being used to generate new B2B revenue streams. For example, Microsoft has begun packaging its AI and AR offerings for commercial users – such as Kawasaki, a manufacturer of motorcycles, engines, and heavy equipment, which is using Microsoft's AR headset to help its factory workers build robots, manage supply chains, and make repairs.[36]

Complementing existing revenue streams

Companies are also using metaverse technologies to market their physical products. The restaurant chain Wendy's has opened a virtual restaurant for visitors to explore and earn discounts on food in Wendy's physical restaurants.[37] Similarly, at Chipotle's metaverse restaurant, visitors may win real-life burritos by trying to roll them in a virtual environment.[38]

Callout 2. The benefits of the metaverse for SMBs

The metaverse may also benefit small and medium-sized businesses (SMBs) in the same way that the internet did in the past. The (Web 2.0) internet enabled SMBs to expand their reach to new markets, both domestically and overseas, by reducing fixed costs of entry and through cost-effective targeted advertising. It also meant that consumers could find them more easily and purchase from them online.

The metaverse has the potential to have similar benefits for SMBs – particularly those providing services and entertainment via metaverse technologies. In the same way that the internet has enabled SMBs to sell goods to customers abroad, the metaverse will enable small and novel service providers to reach distant customers across the globe.

For instance, zSpace provides AR and VR hardware and software and educational content to enable students to learn in a superimposed and virtual environment. Learning becomes more motivating and engaging, and in addition users develop digital skills that help to prepare them for the future ways of working.

Sources: IT Business Edge *(2022)*, zSpace webpage

The metaverse could also complement existing retail businesses. For example, consumers visiting a virtual store could try on clothes before ordering the real items. This could increase sales, and also reduce the number of e-commerce returns, a significant cost to retailers and the environment.[39] Snap and True Fit (headquartered in California and Massachusetts respectively), have developed apps that utilize ML and AI technology to allow shoppers to try on virtual clothes before buying.[40, 41] Wanna Fashion, another Californian firm, has developed similar technology for trying on shoes.[42]

The creation of virtual worlds could improve the efficiency of business operations

Metaverse technologies are expected to improve the efficiency and productivity of businesses, by optimizing their physical processes, and improving the effectiveness of both employee training and remote working.

Optimizing physical processes

Firms are using the metaverse to build 'digital twins' – virtual replicas of physical processes and environments for things such as self-driving cars, factories, telecom networks and even cities. Digital twins allow users to optimize the design of objects or buildings before their manufacturing or construction. This has the potential to save time and money for businesses. These virtual replicas can also be used for studying performance, running simulations, and making predictions. For example, in order to keep San Francisco Airport running smoothly, the airport's managers rely on the airport's digital twin, which uses the performance data of the physical asset it mirrors.[43]

Ericsson, the Swedish telecoms company, is using NVIDIA's Omniverse platform to create a city-scale digital twin to help optimize the location of 5G radio antennas to maximize performance and coverage. Ericsson can therefore optimize its network infrastructure virtually before building them physically. The digital twin is so accurate that it can measure the knock-on impact on wireless signals even from moving a virtual tree.[44, 45]

NVIDIA's version of the metaverse, the **Omniverse**, is being used to design and 'train' self-driving cars. Training self-driving cars in the real world would require millions of miles of testing in different traffic conditions. This would make the process time-consuming and hugely expensive. Using metaverse technologies to augment real-world data with synthetic data can speed up the process. Metaverse technologies can also be used to generate scenarios that are too dangerous to test in real life, such as when another vehicle is not correctly centered in its lane, so that self-driving vehicles can 'learn' to respond to these situations.[46]

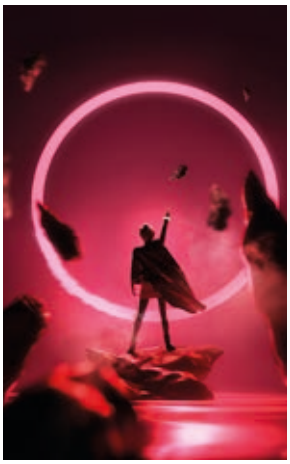
Using metaverse technologies to augment real-world data with synthetic data can speed up the process.

General Electric (GE) uses digital twins to improve the maintenance of jet engines; and Amazon and PepsiCo have both built digital twins of their distribution centers to optimize their design and layout before making physical changes.[47, 48, 49]

The metaverse may also help improve worker productivity. Lowe's, the hardware store, is using metaverse technologies to restock shelves by helping shop assistants to see what needs to go where.[50] Mercedes Benz USA (MBUSA) uses a virtual remote support service which enables technicians at its 383 authorized dealerships to collaborate with Mercedes Benz specialists anywhere in the world to more promptly resolve complex maintenance issues.[51]

Enhancing skills training for employees

The metaverse may also be used to improve the effectiveness of training and enhance employee skills. Large companies across the US, such as Walmart, SAP and Delta, are already using immersive VR training technologies. It has been found that their employees learn up to four times more quickly than with traditional classroom-based learning.[52, 53]



Callout 3. Employee training in the metaverse

Double A Labs, headquartered in Austin, creates online collaboration spaces and offers team training and engagement services. The immersive work environments allow employees to utilize centralized resources, clickables, and real-time collaboration tools to maximize the effectiveness of training.

Source: Double A Labs.

Training that uses VR has the potential to encourage people to be more empathetic and appears to be more effective in changing behavior than in conventional forms of training. DICE (Dangerous, Impossible, Counterproductive, or Expensive and rare), the acronym coined by Jeremy Bailenson is applied in one of his books as a guide on when to use VR.[54]

In industries where employees handle equipment or tools, metaverse technologies can provide a safe and always-available environment in which to learn and improve skills. For example, surgeons could practice procedures in a virtual environment before using them in a real-life operation, or revisit operations that may occur less frequently. Pfizer is already using metaverse technologies to train its employees in producing sterile injectables.[55]

Metaverse use cases may also be used to improve the soft skills of employees in consumer-facing roles.[56] Employees can role play by interacting with avatar clients or consumers and learn how to deal with difficult situations.

Metaverse technologies can also be used to familiarize new recruits with the culture of the organization they are joining. Microsoft has recently launched **Mesh for Teams**, which creates a virtual environment with personalized avatars, where new employees can interact with new colleagues around the world.[57]

Overall, the application of the technology for employee training suggests that using metaverse technologies could help boost productivity, increase employee satisfaction, and improve business outcomes.

Metaverse technologies can also be used to familiarize new recruits with the culture of the organization they are joining.

Improving remote working

In the US, 27% of all work is now being done remotely.[58] The metaverse could enhance the quality of remote working by making communication and interaction with colleagues more life-like, and by improving collaboration. Some companies have already begun using AR/VR technologies for online meetings and collaboration: Meta, for example, uses its Horizon Workrooms software and Microsoft its Microsoft Mesh platform.

Callout 4. Virtual hubs for businesses

Spot, a Seattle-based startup, allows users to build virtual hubs for hosting events and business functions. Using its technology could boost productivity, increase employee satisfaction and improve overall business outcomes.

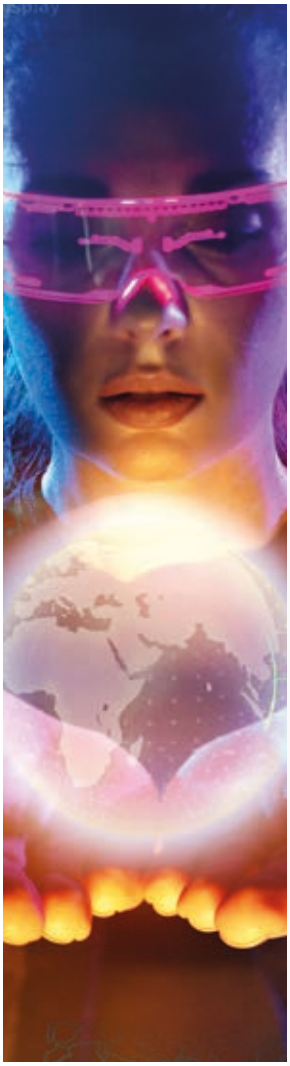
Source: Spot.

Some of the largest multinational companies are based in the US, with headquarters in major cities, and hubs in other states and countries. In 2019, US multinational corporations employed 44 million workers around the world, including 29 million in the US.[59] For these companies, the benefits from more effective remote working and international collaboration could be transformative.

The metaverse may bring benefits to healthcare, education, and the environment

Healthcare impacts

Metaverse technologies also provide an opportunity to widen access to healthcare by enabling virtual access to doctors and medical staff for people living in remote areas.[60] There are examples of 'connected health' solutions and digital transformation to improve access to healthcare emerging from across the world.[61] In the US, technology firm Proximie is using AI, AR and ML technology to allow doctors to 'scrub in' remotely to operating rooms anywhere in the world. Specialist clinicians can therefore use their medical knowledge to advise surgeons in real time while they carry out procedures.[62]



Callout 5. The metaverse and city planning

Metaverse technologies have the potential to enhance urban planning applications. By creating digital twins of physical cities, urban planners can conduct more immersive experiments and run data-rich simulations to better organize cities by seeing impacts on traffic, pollution, and other factors.

US cities are beginning to adopt the metaverse to aid city planning. New Rochelle, New York, for example, has developed a VR platform where citizens can preview proposed developments before they are built. The platform was used to preview the city's plans to transform a highway into a 'linear park' in a manner similar to New York City's High Line.

Adam Salgado, the commissioner of the new development in New Rochelle, was positive about the contribution the metaverse had made to the development process. He said using the metaverse had opened up the process to a wider circle of residents, with younger people more likely to comment than they normally would.

Sources: CNBC *(2022),* Bloomberg Cities Network *(2022).*

Metaverse technologies are already helping to train surgeons and are aiding doctors while they conduct surgery. For example, VR headsets are being used to train orthopedic surgeons at the University of Connecticut's medical center. Surgeons use the headset to practice surgical procedures in 3D, such as pinning a broken bone, and they receive feedback after each attempt.[63]

In the future, the metaverse may also enable surgeons to conduct surgery remotely (i.e., without the physical presence of a doctor with the patient). However, this technology is still at a very early stage of development.[64]

Metaverse technologies may also be used to help patients recover from surgery more quickly. A recent study found that patients who were given a VR headset to view a range of relaxing immersive programs during surgery required fewer sedatives and had a shorter recovery time than patients who were not given a headset.[65]

The technologies are also being used in real-life surgical operations. Projections of a patient's internal anatomy can be overlaid by AR on to a surgeon's field of vision, to provide guidance through an operation. Neurosurgeons at John Hopkins University have been using this solution. Using headsets from the medical technology firm Augmedics, the internal anatomy of patients, taken from a CT scan, is projected onto the surgeons' field of vision, while they perform spinal fusion operations.[66]

Metaverse technologies are also helping treat trauma patients. A psychologist at the University of Southern California has developed 'VR exposure therapy'. Patients suffering from post-traumatic stress (PTS) wear a VR headset to confront their trauma using simulations. For example, in treating veterans of the wars in Afghanistan and Iraq, rather than recalling the situation causing the trauma, simulations of Middle Eastern themed cities and deserts may be used to help process PTS in a safe and controlled way.[67]

Use of metaverse technologies in medical settings is growing. A recent estimate by Market Research Future is that s the 'healthcare metaverse market' could be worth US$5.37 billion by 2030 (representing a compound annual growth rate of 48.3%).[68]

Metaverse technologies also provide an opportunity to widen access to healthcare by enabling virtual access to doctors and medical staff for people living in remote areas.

Educational impacts

Many students in the US already learn remotely. In 2020, 75% of all undergraduate students in the US were enrolled in at least one online learning course, and 44% were taking online courses exclusively.[69] The numbers were no doubt elevated because of COVID-19, but there is evidence that the new habits have stuck, and students are still taking more online courses than in the past.[70, 71]

Callout 6. Universities in the metaverse

In spring 2021, Morehouse College in Atlanta (Georgia) became the first 'metaversity' (i.e., a university in the metaverse), thanks to a partnership between the alma mater, VictoryXR and Qualcomm Technologies.

VR technology is used to create a digital twin campus, replicating the physical Morehouse College as a virtual 3D copy and in real time. The digital twin can be explored and inhabited in the same way as physical spaces in real life, and classes follow their regular dynamics, but in a virtual context.

Since 2021, VictoryXR has continued to grow its network of collaborating universities. Today there are ten metaversities across the US, among them the University of Maryland Global Campus, the Southwestern Oregon Community College and the South Dakota State University.

Sources: Morehouse College *(2021),* VictoryXR *(2021),* The Elective – College Board *(2022)*

The immersive nature of the metaverse may help improve the quality of remote education. Firms such as VictoryXR, an Iowa-based SMB, have created virtual 3D classrooms for immersive remote learning.[72] Compared to current 2D technology, this should improve collaboration and communication between students and teachers, given that students could be able to move around in the metaverse and teachers could be able to demonstrate their teaching more clearly.

Metaverse technologies may also be used to improve access to education. Allowing remote attendance by students may mean that they can choose from a wider range of colleges without having to leave home, at the same time reducing their costs. Currently, most students, enrolled in four-year public college courses, are at a college close to their home.[73] If the metaverse enables students to attend colleges or universities further from home, this could help increase opportunities, particularly for individuals who live in places where the choice of colleges is limited.[74] In addition, VR has the opportunity to enhance learning opportunities for students on the autism spectrum through being able to tailor a sensory-friendly environment and can provide repeated practice for social scenarios.[75]

However, to realize all the potential educational benefits, the quality and availability of education in the metaverse will need to match in-person learning and be offered at a competitive and affordable price.

Environmental impacts

The US is committed to reaching net zero greenhouse gas emissions by 2050,[76, 77] but analysis from climate groups suggest that more action is needed to hit this target.[78]

Based on the latest available figures, transportation is the largest source of greenhouse gas emissions in the US.[79] The metaverse may indirectly reduce transport carbon emissions by reducing individuals' needs to travel, as a result of improved remote working and virtual socializing. Analysis by the International Energy Agency suggests that when a commute is by car and over four miles, working from home is more environmentally friendly. (For shorter journeys or using public transport, working from home results in more carbon emissions than commuting, due to higher residential energy usage).[80] According to the latest available data, 88% of workers in the US commute by car, and the average commute is 12 miles.[81]

However, the full environmental impact of the transition from current technologies to metaverse technologies is unclear. There are two main reasons for this. First, a widespread adoption of the metaverse will likely require the production of enormous quantities of new devices such as headsets. Manufacturing these devices will consume raw materials and energy. Commitments to integrating low-carbon production solutions will be vital to reduce their environmental impact. Businesses involved in developing the metaverse such as Microsoft, Meta and Amazon have published statements on their environmental policy commitments, including plans to become carbon negative and tackling the climate impact of internet-connected devices.[82, 83, 84]

Second, the metaverse is expected to contribute to the continued growth in wider data traffic volumes which has been a general trend in internet usage observed over time.[85] This could mean that some local data centers will move into the cloud. Although the cloud is 22% – 93% more energy efficient than local data centers,[86] the large volumes of data could require increased computing power, which would have a negative environmental impact, due to increased emissions.[87] Embedding circularity principles into the design, build and operation of data centers will help elevate resource efficiency to reduce water use and waste.

The metaverse may indirectly reduce transport carbon emissions by reducing individuals' needs to travel, as a result of improved remote working and virtual socializing.

The positive and negative factors outlined in this section are not an exhaustive list and serve as examples only. Although the metaverse may bring some positive environmental benefits through reductions in travel, it is also expected to have negative consequences, and it is still too early to evaluate what the overall net impact will be.

3. Building the metaverse in the US

An enabling environment is needed to realize the potential benefits of the metaverse

The metaverse is expected to evolve gradually to more interconnected and immersive experiences. However, as this technology develops, several economic, social, and technological factors will need to be in place to achieve widespread adoption of the metaverse and promote innovation. These factors are further examined in this section. They can be grouped into two broad metaverse enablers (see Figure 7):

01. **Technology fundamentals**: Prerequisites for the metaverse to exist and operate in a country (e.g., connectivity, device capability)

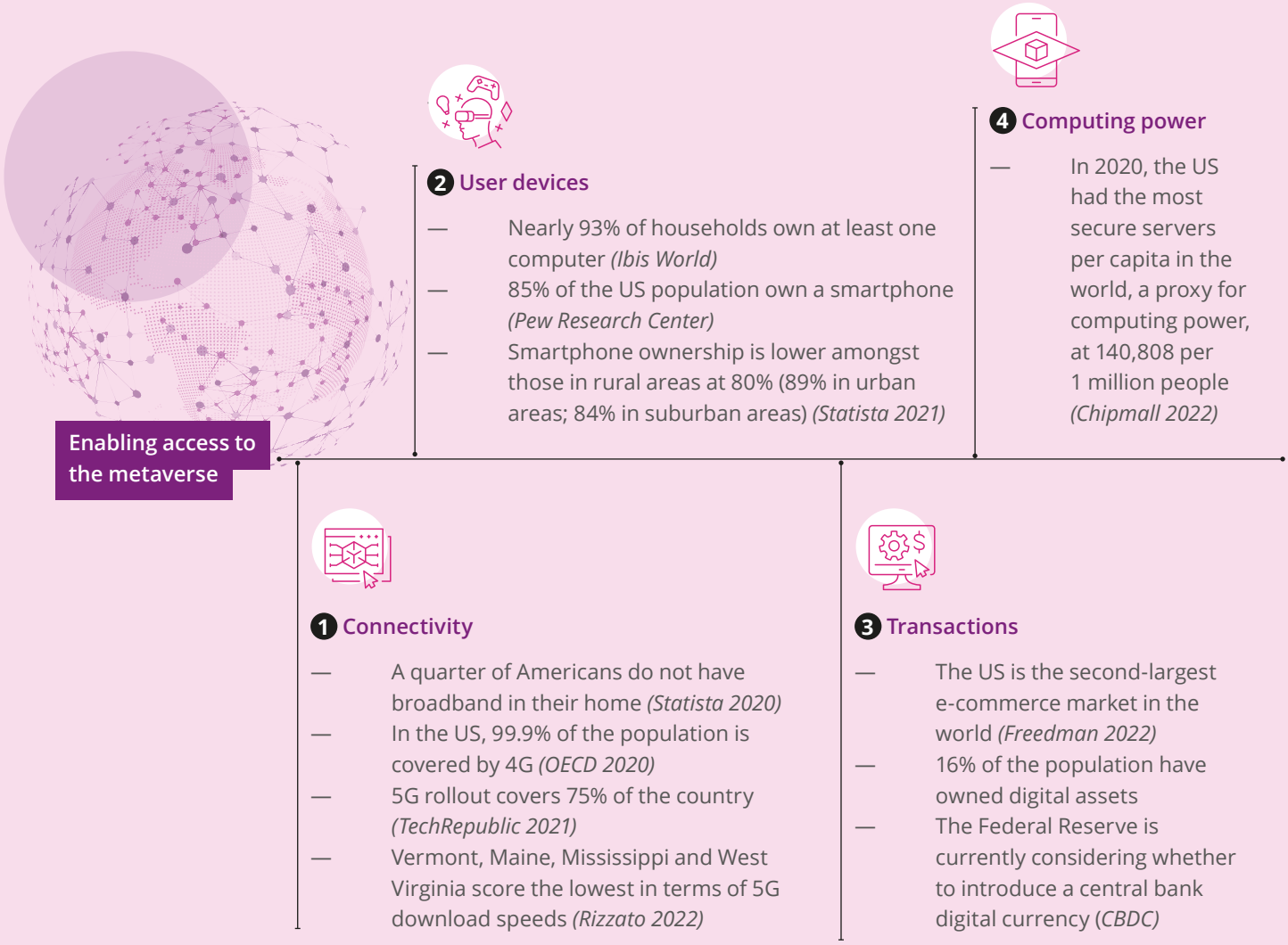
02. **Ecosystem enablers**: Factors that may determine the adoption and wider success of the metaverse (e.g., social acceptance, digital skills for users and professionals)

These two pillars provide a framework that can be updated over time as the direction of innovation and requirements of the technologies become clearer, and more appropriate metrics to measure progress become available.

Figure 7. Overview of technology fundamentals and ecosystem enablers overview

Metaverse technology fundamentals

Figure 8. Enabling access to the metaverse



Source: Relevant citations are provided in the endnotes.

1 Connectivity

For the foreseeable future, immersive metaverse adoption will continue to be driven predominantly through VR. Almost all VR content is currently consumed over fixed networks through Wi-Fi. With respect to AR, existing services today are largely 2D and already supported by today's networks. As a result, existing fixed network capacity and mobile coverage, in combination with future network investments for 5G, particularly fixed wireless access, fiber-optic cables, along with continued development of edge computing, is likely sufficient to support the ongoing use of the Internet and foreseeable metaverse use cases. Further use cases are expected to develop gradually over the coming years.

The US has almost complete 4G coverage,[88] and 5G rollout is progressing but there is still a connectivity divide, particularly in terms of high-speed broadband coverage.[89] A Pew Research Center survey found that the most common reason for not having home broadband connection is cost: 50% of respondents without a home broadband connection gave unaffordability as the reason.[90] After cost, lack of coverage was the next most common reason for not having home broadband (cited by nearly a quarter of respondents).

There are also differences in fixed broadband coverage across the US. Connecticut has almost universal fixed 25/3 Mbps broadband internet coverage,[91] with 99% of the population covered. On the other hand, rural states Mississippi, Arkansas and West Virginia have lower fixed 25/3 Mbps broadband internet coverage, with between 80% and 82% of households covered in each state.[92] Closing these connectivity divides will support wider access to existing technologies as well as future metaverse experiences.

2 User devices

Devices such as AR and VR headsets, computers and smartphones are needed to access short-term metaverse applications. Overall, the US has a very high ownership of computers and smartphones, which can provide an early entry into the metaverse experiences. However, there is some variation in smartphone ownership across states. For example, 85% of adults in Idaho own a smartphone compared to 70% in Nevada.[93] Cost appears to be the most common reason for not owning a smartphone.[94]

Over the past decade, AR and VR headsets have become more affordable, and Americans are increasingly willing to spend money on them.[95] Sales in 2021 over the Thanksgiving through to Christmas holiday period more than doubled compared to the same period in 2020.[96] However, the high prices of more sophisticated devices will be prohibitive for some people, restricting the opportunity for widespread adoption of some metaverse applications.

3 Transactions

Digital payment processes, platforms and systems must be available to support transactions in the metaverse. The US is well positioned: it has an efficient payment system and there is widespread use of digital payment methods and e-commerce.[97]

Still, many in the US remain excluded from the banking system, and this limits their ability to make digital payments to providers who require customers to have a linked bank account. According to the FDIC, in 2021 Mississippi had the highest proportion of 'unbanked' households (11%), i.e., households in which no one has a checking or savings account at a bank or credit union. The lowest proportion of 'unbanked' households (1.2%) was in Utah.[98] However, the FDIC did not establish what proportion of 'unbanked' households were using other means to conduct digital payments (such as money transfer services). Expanded adoption of digital identification has the potential to improve access to digital payments and support inclusive economic opportunity in the metaverse.[99]

4 Computing power

The computing requirements of the metaverse in the future are not yet clear.[100] However, substantial computing power will be needed to provide immersive experiences to many people at the same time. The US ranks number one in the world for having the most secure servers per person, a proxy measure for computing power. In 2020, it had 140,808 secure servers per million people.[101] This gives the US a significant advantage when it comes to achieving the envisaged principles (e.g., synchronicity and immersion) of the metaverse on a large scale.

Metaverse ecosystem enablers in the US need to focus on inclusivity ...

Figure 9. Ecosystem Enablers

Digital Skills

- 35% of Americans in employment are proficient in digital skills and 33% have advanced skills
- However 13% have no digital skills and another 18% have at best only limited digital skills *(ITIF)*

Social Acceptance, Security, and Privacy

- The US have a Cybersecurity Index of 100, making it best in the world *(ITU)*
- The US have the best score for privacy regulation *(Inclusive Internet Index)*
- However, only 58% of Americans have trust in online privacy *(Inclusive Internet Index)*

Technological Readiness of Businesses

- The US ranks 1st in the G7 for digital readiness *(EIU)*
- The US ranks 2nd in the world in the Global Innovation Index *(Global Innovation Index)*

Competition and Interoperability

- The US ranks 1st among 100 countries as the best country for start-ups *(StartupBlink)*
- The US ranks 10th in the world in the terms of competitiveness *(IMD)*

Digital skills

A digitally-skilled population is needed for widespread take-up of the metaverse. The US has a large world-leading technology sector, and its advanced programmers, engineers and innovators will play a key role building the metaverse.

Despite this, parts of the population have limited digital skills. This divide is often more pronounced with age, socioeconomic status and those living in rural communities.[102] A 2018 OECD skills survey found that 19% of American adults had 'low' ICT skills, meaning that they were unable to use email, search the internet or perform other basic digital tasks.[103] Without the requisite skills, people may be unable to operate the devices and use the software for accessing the metaverse.

Evidence suggests that the lack of digital skills impacts minority communities disproportionately. It has been reported that 48% of Black people and 31% of Hispanic people, aged 16 to 24, have at best limited digital skills, compared to only 16% of White people of the same age.[104]

Using educational attainment as a proxy measure, there is also evidence to suggest that digital skills vary across states. For example, 94.5% of over 24-year-olds living in Maine and Vermont graduated from high school or a higher institution (the highest across the US) compared to just 84.4% in California (the lowest).[105] This suggests that more support might be required to enable the wider adult population to have the required skills to benefit from metaverse technologies.

Social acceptance, security and privacy

In response to the COVID-19 pandemic, consumers' lives have moved more online. In 2020, over 90% of the US population were using the internet and more than one-third of the population were online "almost constantly".[106], [107] There also appears to be a growing awareness of the metaverse. A recent survey found that 59% of Americans are familiar with the concept of the metaverse, and a significant minority (42%) also said that they were positive about the idea of engaging with the metaverse in their daily lives.[108]

However, a recent survey by Ipsos found that 84% of Americans are at least 'somewhat' concerned about the safety and privacy of the personal data they provide on the internet.[109] As metaverse technologies and applications are developed, new specific protections will be needed, governed, and augmented as use cases emerge. This is already evident for business applications such as digital twins and in healthcare provision, which will generate increasing volumes of sensitive data. This will require transparency in the use of data, to build trust amongst users, both consumers and businesses, so that people understand the trade-offs between the potential benefits of the metaverse and providing the data that is required to enable it. More widely, consideration will also need to be given to ensuring people feel protected against manifestations of online harm in virtual worlds, such as harassment, and fraud and deceptive practices in virtual worlds.[110]

Technological readiness of businesses

The take-up of new metaverse technologies will ultimately be determined by businesses capabilities and culture. US businesses are well placed to adopt new technologies, and a significant proportion of them are already developing capabilities to harness the metaverse. A PwC survey found that 51% of companies already have roles that focus on "metaverse activities", a further 31% plan to create such roles, and 41% are investing in the necessary technology.[111]

Businesses that do not possess the required skills are at risk of being left behind and unable to benefit from the opportunities the metaverse may bring. The OECD has found that a digital skills gap is one of the biggest barriers to digital adoption by SMBs, suggesting that these businesses will need support around access to finance, motivation to undertake training, awareness and time constraints is required to increase digital adoption amongst SMBs.[112] The OECD has pointed to the role that Higher Education institutions can play in identifying the digital course best suited to the needs of particular students and entrepreneurs. This would increase awareness of the training available, and so reduce the time necessary to identify and select the best courses, therefore incentivizing spending more time in undertaking and completing the training.

Competition and interoperability

The development of the metaverse will be driven by many individuals, businesses and governments from across the world whose objectives may not necessarily be in alignment. There is a risk that multiple versions of metaverse may emerge. The creation of multiple incompatible versions would likely harm both the consumer experience and competition, and users would struggle to move freely between virtual worlds.

Competition in the digital space is on the agenda of Congress and a number of proposals have been discussed and implemented (e.g., the Digital Platform Commission Act).[113] Engagement and collaboration between businesses, users, and Congress will be critical for encouraging an approach which achieves a balance between competition and common standards, without harming investment incentives.

There are moves to create common standards across the metaverse as a way of achieving seamless transition across digital platforms and between digital worlds. The Metaverse Standards Forum is one of several places where standards organizations and firms building the metaverse can come together to coordinate their efforts and test common standards and protocols for different pieces of hardware and software.[114]

4. Next steps

As a large, advanced economy with world leading technology firms, the US is well positioned to harness the potential of the metaverse. The US is also well placed to lead its global development. This is expected to bring significant economic benefits, as US firms can use the metaverse to generate new revenue streams and to improve efficiency. The US is also likely to export metaverse technologies around the world. We estimate that the metaverse could contribute between US$402bn and US$760bn to the annual GDP of the US by 2035.

However, in order for the potential benefits of the metaverse to be felt more widely, progress will need to be made on closing the connectivity divide, increasing digital skills and addressing concerns about trust and safety in the metaverse. Firms, national and federal governments, and wider society will all have a role to play for this to succeed.

Addressing the connectivity divide

Continuing to expand connectivity for those who are unconnected or under-connected will benefit consumers, businesses, and the entire internet ecosystem, including enabling wider access to existing services as well as to future metaverse experiences. This will require consideration on what steps can be taken to support low-income households with the cost of internet access, as well as investment and innovation to connect rural areas where the economics of deployment are more challenging.

The federal government and some states are already taking steps to improve coverage and access. For example, the Rural Digital Opportunity Fund, a US$20 billion project, aims to financially enable internet service providers to extend broadband to underserved rural areas across 49 states over the next 10 years.[115] Furthermore, President Biden's Bipartisan Infrastructure Bill set aside US$65 billion to provide "affordable, dependable, high-speed internet" to all citizens of the United States through, among others, the establishment of a US$14 billion Affordable Connectivity Program and a US$3.2 billion Emergency Broadband Benefit Program by the Federal Communications Commission.[116,117]

Increasing digital skills

Digital skills of both users and developers will be needed to access and benefit from the opportunities the internet provides, including the metaverse and its applications.

Companies involved in building the metaverse are taking steps to improve digital skills among the population. Microsoft, for example, has provided funding to increase digitals skills amongst the Black and African-American communities.[118] Google has launched an initiative to increase digital skills amongst Black women.[119] Meta is partnering with Jobs for the Future, a nonprofit organization, to use metaverse technologies to support SMBs, particularly those which have been disadvantaged in the labor market.[120]

States also have initiatives aimed at improving digital skills. The California Emerging Technology Fund, for example, partners with community-based organizations to increase digital literacy amongst the population.[121] Closing these digital gaps will not happen overnight, and it will require collaboration between the private sector, the states, and federal bodies to finance and deliver initiatives that can improve the population's digital skills at all ages, in both schools and the workplace, and through lifelong learning schemes. Technology firms should also consider how hardware design can be made more user-friendly.

We estimate that the metaverse could contribute between US$402bn and US$760bn to the annual GDP of the US by 2035.

Ensuring trust and safety in the metaverse

It is not always possible to foresee how new technologies might impact our lives, or for how long such impacts might endure. Indeed, the concept of the metaverse is still at an early stage, and it is not yet certain what its full range of applications will be. However, as the number of immersive and interactive experiences grow, communication and commerce in virtual worlds will become more akin to physical interactions in the real world. In order for consumers and businesses adopt these technologies, they will need to feel safe using them.

This is not an issue for one party to face alone. To foster a basis from which metaverse technologies might succeed, collaboration will be needed between businesses, government, and civil society. This could be assisted by increasing transparency about how hardware and software have been designed for end users, how they handle and process data, as well as communicating the economic and social benefits of the technologies. Policy makers, in collaboration with businesses and community organizations, will need to support and foster innovation, while ensuring that society feels protected without stifling incentives for innovation.[122] Open discussions at an international level will also be needed to prevent the development of divergent and disconnected virtual worlds that hinders competition and choice.[123]

The coming years will be decisive for the widespread development of metaverse use cases and enabling factors in the US. Collaboration will be critical, not just within the US, but globally. Businesses, government, and community organizations will all have a role to play in fostering a sustainable and inclusive metaverse ecosystem. By doing so, the US will have the opportunity to take a leading role on the global stage to support and shape the metaverse.

Appendix A: Glossary of terms

Metaverse

Various organizations and researchers have produced definitions for the metaverse, but there is not yet a widely accepted definition.[124] In absence of a universally accepted definition, the metaverse is today best understood as **"a set of digital spaces that you can move seamlessly between (...) and that will help people in different locations connect and feel like they are together in person. (...) The metaverse will include 2D experiences, as well as ones projected into the physical world fully immersive 3D ones too."** [125] The various definitions of the metaverse all agree that it involves the convergence of separate technologies to create an immersive environment in which users interact with their surroundings as in the physical world.[126]

Metaverse technologies

The metaverse will eventually make use of a combination of different extended reality technologies such as AR, VR and MR to offer immersive interactions and experiences. Definitions of these technologies and explanations of the differences between them are given below.[127]

Augmented Reality (AR)

AR overlays digitally-created content onto the user's real-world environment, which remains at the center of the experience. AR does not create a whole new digital environment: it enhances the real world while ensuring that users are still aware of their surroundings and themselves. AR requires a screen that can be projected on the real world, such as transparent optics or a smartphone that captures the real world and then shows an augmented version of it.

Virtual Reality (VR)

VR is an immersive technology that creates a simulated digital environment, away from the user's real-world environment. This virtual world is accessible through devices and is not necessarily subject to the physical rules of the real world. VR experiences are usually accessed through a headset and input device (e.g., a controller) displaying this new virtual world and allowing users to navigate through it. Additional items of hardware can enhance the user's experience and allow full body motion tracking and feedback, such as haptic gloves, virtual rooms and treadmills.

Metaverse involves the convergence of separate technologies to create an immersive environment in which users interact with their surroundings as in the physical world.

Mixed Reality (MR)

MR seamlessly blends the real world and digitally-created environments, which coexist and interact with each other. Hence, MR combines elements of both AR and VR, putting interactive virtual objects into the real world. The real world remains central to the user experience, maintaining spatial awareness and gesture recognition as in AR, but virtual objects can coexist and interact with real objects. One of the key features of MR is that virtual and real-world content can interact in real time. [128]

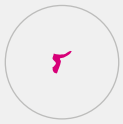
Common standards

One of the key principles of the metaverse is the need for common standards, a collective agreement to harmonize digital standards and protocols for platforms and devices would enable users to transition seamlessly between digital spaces. This means that user data/assets (e.g., avatars, cryptocurrencies, virtual goods) and virtual systems (e.g., movement, rules, consequences) should be consistent and unified across virtual worlds, enabling a seamless transition across multiple platforms. [129] For example, under the principle of common standards users who have obtained cryptocurrencies in one virtual world should be able to use them in a completely different virtual world.

Synchronicity

The ability to provide synchronous experiences, where users can see real-time updates from the virtual world itself and from interaction with millions of users at the same time. The principle of synchronicity means that the virtual world is constantly updated and does not reset when a user leaves it.[130]

Appendix B: Examples of the metaverse across the US

State	Industry	Company	Description
New York 	**Retail**	Obsess	Obsess uses AR and VR technology to provide shopping solutions for retail providers, the virtual store platform offers 3D 360 shopping experiences on the clients' websites, mobile apps, and social channels. The mission of the firm is to reinvent the e-commerce experience into a visual, interactive, social and highly engaging experience.
Kentucky 	**Sport/ leisure**	ZED Run	Fans of the Kentucky Derby can now purchase NFTs of racehorses that track the progress of their real-world counterpart, rewarding the owner when the horse wins races or breeds new offspring.
Georgia 	**Tourism/ leisure**	Atlanta Meta World	Prospective visitors can now use the metaverse to virtually explore parts of Atlanta while interacting with other virtual visitors and representees of venues in the city. Atlanta Meta world is a visually realistic virtual world with the starting point of the experience is the visitor information center in Centennial Olympic Park. Visitors can explore many areas of the park and in the near future, will be able to visit and explore attractions.
Texas 	**Technology**	Double A Labs	An Austin-based company, Double A Labs, has created metaverse platforms for companies ranging from Dell to YouTube, on which employees can collaborate, learn and communicate. Users can access their favorite content and collaboration tools from one easy-to-use web or mobile interface allowing companies to effectively support their internal teams and reach new audiences.
New Mexico 	**Technology**	Rainforest Innovations	New incubator space is being developed in downtown Albuquerque where creators can come together to build new metaverse products. Dubbed "the Jungle", the incubator space is expected to be a central gathering and collaboration space where people come together to create new, innovative products which they can test and showcase. The idea is that the incubator will help drive innovation in the creative industries that will contribute to the Metaverse.

State	Industry	Company	Description
Arizona 	**Education/ training**	OcuWeld	An edtech company has launched a VR training programme on welding, allowing welders to learn about the prepping, grinding, and joining of materials in a virtual environment. OcuWeld's virtual environment provides students the academic benefits of accessibility, autonomy, and amplification. Students can access the platform anytime and anywhere without WiFi.
Kansas 	**Healthcare**	KU medical center/ Victory XR	Nursing students now have the option to learn in-person, online, or through virtual reality using the metaverse. This will include the creation of a digital replica of KU campus and classrooms so students can use VR to transform their experience when they are remote learning.
Washington 	**Education/ training**	Spot	Spot, a Seattle-based startup, is building a metaverse platform that will allow businesses to build virtual hubs to use for events or business functions. Users can communicate with each other through chat or video conferencing functions.
Iowa 	**Education/ training**	Victory XR	A company creating virtual replicas of real-world places and events means students from 10 universities around the US are now able to visit historical sites or perform surgery in the metaverse. Students can wear virtual-reality headsets to access a 3D, computer-generated simulation of real-world places and events where participants can move through and interact with others.
Minnesota 	**Education/ training**	Vuforia	Vuforia uses AR to help provide remote assistance and guidance that helps experts/technicians solve problems more effectively. It is an easy to deploy, mobile-based guidance and collaboration AR tool, which enables pairs of mobile device users to collaborate around a shared view of objects and environments, with smart 3D annotation capabilities.
Illinois 	**Tourism/ leisure**	Springfield convention and visitors Bureau	A Springfield-based museum is planning to use the metaverse to show visitors what life was like for Black travelers on Route 66 from the mid-1930s to the mid-1960s. The immersive and interactive experience using AR & VR is being developed for Route history, which in part highlights stories around the Black experience on the historic route.

Source: Iowa Capital Dispatch; The State Journal Register; CNBC; Public Gaming; Discover Atlanta; PR Newswire; Yahoo; ARVR Magazine; WIBW; GeekWire; eacpds; Obsess – Virtual Store Platform

Endnotes

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