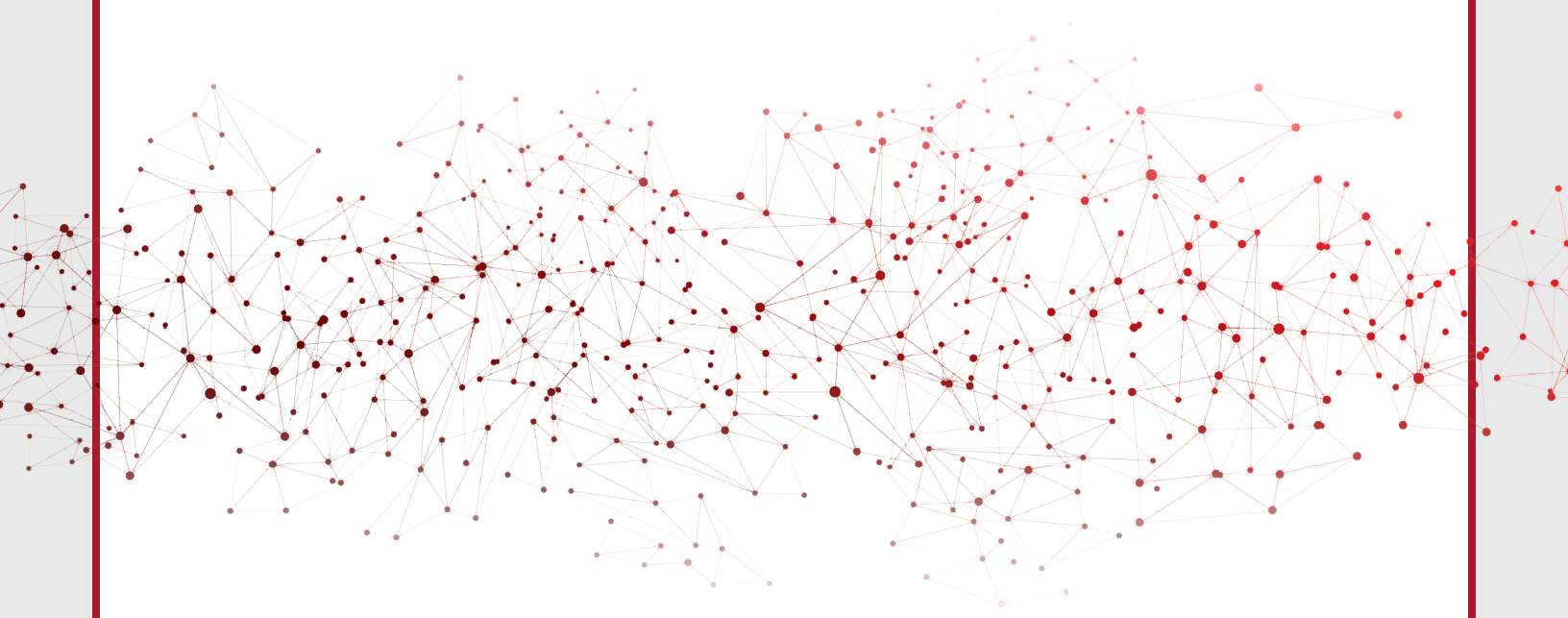
TECHNOLOGY PRIMERS FOR POLICYMAKERS

Augmented and Virtual Reality for the Metaverse



HARVARD Kennedy School
BELFER CENTER
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Harvard John A. Paulson
School of Engineering
and Applied Sciences

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AUTHORS

Jacob Boyd (Harvard Kennedy School / Northwestern Kellogg)

Sandra Lam (MIT Sloan)

Stephan Florian Rihs, PhD (Harvard Kennedy School / UPenn Wharton)

Li Sun (MIT Sloan)

Ariel Higuchi, *Tech Primers Project Lead* (Harvard Kennedy School)

Amritha Jayanti (Harvard Kennedy School)

REVIEWERS

Micaela Mantegna (Berkman Klein Center, Harvard)

Tibor Merey (Boston Consulting Group)

Greg Pryor (Reed Smith)

John Yang (United Talent Agency, former Magic Leap)

FACULTY LEADS

Ash Carter, Faculty Director, Technology and Public Purpose Project, *in memoriam*

Francis J. Doyle III, Dean, Harvard John A. Paulson School of Engineering and Applied Sciences

The Technology Primer Series was designed to provide a brief overview of each technology and related policy considerations. These papers are not meant to be exhaustive.

Technology and Public Purpose Project
Belfer Center for Science and International Affairs
Harvard Kennedy School
79 John F. Kennedy Street, Cambridge, MA 02138

www.belfercenter.org/TAPP

Harvard John A. Paulson School of Engineering and Applied Sciences
29 Oxford Street, Cambridge, MA 02138

www.seas.harvard.edu

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Executive Summary

Augmented Reality (AR) and Virtual Reality (VR) refer to computer-generated content that integrates into the real world (in the case of AR) or is entirely self-contained (in the case of VR). These technologies, typically accessed through smartphones and headset devices, allow users to access a shared virtual environment, often referred to as a metaverse.

It has been three decades since the term "metaverse" was coined, but a convergence of market factors and a level of sophistication of AR and VR technologies have created a new emphasis on the metaverse. In 2021, Facebook invested $10 billion in its Reality Labs division and renamed itself Meta Platforms, Inc.[1] Microsoft made a $70 billion dollar bet in 2022 on the metaverse in its acquisition of gaming studio Activision Blizzard.[2] Advancements in AR and VR have been made across several industries with notable use cases in gaming and entertainment, education and training, and virtual work.

While investments such as these have created enormous hype, significant technical limitations exist such as computing power, user discomfort, and interoperability challenges. Non technical barriers, including high hardware costs and supply shortages, have also created problems. Further, most of these platforms are being developed in isolation. To achieve the metaverse that many evangelists for this technology envision, significant coordination would need to occur between firms.

Governments have acknowledged the important role AR and VR will have in society, but regulation and governance structures are still underdeveloped. Many public purpose concerns related to current internet issues such as user privacy, intellectual property protection, and market power apply to AR/VR platforms and the metaverse. However, virtual experiences also pose new regulatory conundrums that will need to be addressed. While the European Union and China have taken some steps toward creating a regulatory framework for metaverse-related internet policy issues, the United States will need to make significant progress toward the many open legal questions that exist.

1 Naomi Nix et al., "Facebook Changes Name to Meta in Embrace of Virtual Reality," *Bloomberg News*, October 28, 2021, https://www.bloomberg.com/news/articles/2021-10-28/facebook-changes-name-to-meta-in-embrace-of-virtual-reality#xj4y7vzkg.

2 Karen Weise et al., "Microsoft will buy Activision Blizzard, betting $70 billion on the future of games.," *The New York Times*, January 18, 2022, https://www.nytimes.com/2022/01/18/business/microsoft-activision-blizzard.html.

PART 1: The Technology

What Is the Metaverse?

For the purposes of this primer, a **metaverse** can be defined as a simulated digital environment or virtual world that, in many instances, leverages augmented reality ("AR") and virtual reality ("VR") to create spaces for richer user experience and interaction. The definition of metaverse could overlap with that of "virtual world" and "virtual space," terms which are used to describe computer-simulated environments in which multiple users interact and communicate with each other.[3]

The goal of a metaverse is to create a substantially more immersive, engaging, and closer-to-life virtual experience than was possible with previous technologies. Enthusiasts see the metaverse as the next generation of the internet: a digital, interconnected reality seamlessly woven into our physical world. However, AR and VR are not necessary to access a metaverse. Today most users access metaverses using 2-D screens on personal computers and mobile phones. As AR and VR mature, the share of 3-D metaverse experiences is expected to increase.

Contrary to what one might expect, given the recent hype around this technology and potential future applications, metaverse-related applications have been around since the 1980s and 1990s (e.g., VR arcade video games)[4] and 2000s (e.g., virtual worlds such as Second Life).[5]

It is important to note that the metaverse is a concept. The metaverse is "created/enabled" through a combination of various technologies, as shown in figure 1.With that in mind, various competing visions and interpretations of the term metaverse do exist. The number of experiences and applications that can be labeled as the metaverse is almost endless. It is also important to note that the current landscape of virtual worlds is highly fragmented. No clear frontrunner has emerged yet, and their interoperability has not been established. Therefore, it seems more accurate to speak of metaverses or competing visions and definitions of new types of virtual experiences, rather than to speak of the metaverse as a unitary concept or definition. The term metaverse is also evolving based on emerging applications and technologies.

3 Richard A. Bartle, *Designing Virtual Worlds* (Indianapolis, IN: New Riders, 2003).

4 Benj Edwards, "The Wacky World of VR in the 80s and 90s," *PC Magazine*, April 17, 2018, https://www.pcmag.com/news/the-wacky-world-of-vr-in-the-80s-and-90s.

5 "Linden Lab announces name of new online world 'Second LifeTM' and availability of beta program," Linden Lab, October 30, 2002, https://www.lindenlab.com/releases/linden-lab-announces-name-of-new-online-world-39-second-life-39-and-availability-of-beta-program.

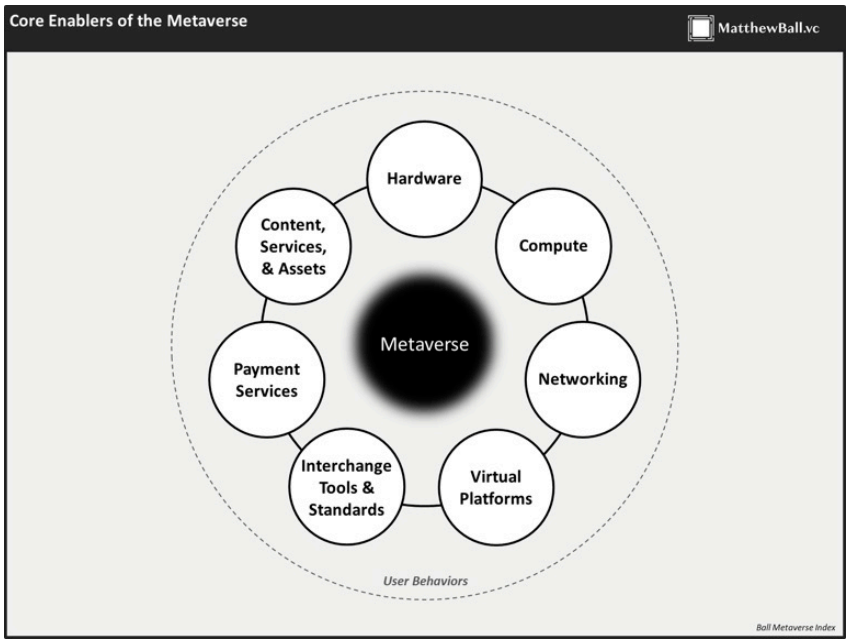

Figure 1. Reprinted from Matthew Ball, "Framework for the Metaverse," MatthewBall.Vc, June 29, 2021, https://www.matthewball.vc/all/forwardtothemetaverseprimer

What Isn't the Metaverse?

It is also important to clarify some common misconceptions about the metaverse:[6]

1. **Metaverse is not synonymous with VR:** Some have described the metaverse as the equivalent of VR, but while VR is indeed a way to experience the metaverse, many people participate without VR devices. VR devices are not the metaverse, just like smartphones are not the mobile internet.

2. **A metaverse is not just for gaming:** There are video games that exist in the metaverse, but that is not the metaverse itself. The metaverse experience has expanded beyond video games to daily interactions such as learning, working, and more.

3. **The metaverse is not a technology itself:** While the metaverse is an environment enabled by technology, it is not a technology itself. It is also not a single platform or a privately-owned entity. There are multiple metaverses operated by several companies, each with its own vision of what the metaverse could be.[7]

6 Ward de Kruiff, "What is the Metaverse & What is it Not?," epam, June 13, 2022, https://www.epam.com/insights/blogs/what-is-the-metaverse-and-what-is-it-not.

7 Stephen Shankland, "The Metaverse Will Be a Multi-Platform Mess," CNET, March 26, 2022, https://www.cnet.com/tech/computing/features/here-comes-the-multi-metaverse-mess/.

What Is AR and VR?

AR and VR are important technology enablers of the metaverse and are the core focus of this technology primer. The advancement of AR and VR technologies has led to the increasing popularity of the metaverse. Sometimes, the definitions of AR and VR can vary depending on the use case.

Augmented reality (AR) uses software and hardware technologies to enhance real-world experiences by overlaying digital elements (e.g., visual, sound, or other sensory features) onto real-world objects. Users perceive a virtual layer of data while simultaneously perceiving the real physical environment.

Virtual reality (VR) is a computer-generated simulation that alters users' perception of reality and allows them to interact with a three-dimensional environment. VR fully immerses a user in an imagined or replicated world (like video games, movies, or a flight simulation) or simulates presence in the real world (like watching a sporting event live).

How Are AR and VR Different?

The key difference between AR and VR is that AR incorporates your real surroundings, whereas VR is made up entirely of virtual information. VR creates a more immersive experience than AR in which the user is separated from the baseline sensual and perceptual experience of physical reality. Instead, it exposes users to an entirely simulated environment and stimuli (e.g., visual, sound, tactile inputs, and feedback).The use cases and required technology of AR and VR are also different. Table 1 contains simple use cases to illustrate the differences between AR and VR.

Table 1. AR and VR Use Cases

Use Case	AR	VR
User interacts with a ball as a digital element.	User opens an AR mobile application on the smartphone. The application augments reality by adding the presence of the ball in the real surroundings. The user can place the ball augmented in different locations by moving the smartphone camera as it interacts with real objects. **Figure 2.**[8] 	User puts on a headset and sees an entirely virtual environment where the ball is presented as an object. The user might use their motion, detected by sensors, to move, throw, kick, and resize the ball within the virtual environment. **Figure 3.**[9] 

8 Adapted from Milan Virijevic, Getty Images Signature, Canva.com.

9 Adapted from Janet Smith, "VR Headsets Give Viewers a Salmon's Underwater Eye View as UNINTERRUPTED Moves to Lonsdale Quay, July 14 to 24," *Stir*, July 11, 2021, https://www.createastir.ca/articles/uniinterrupted-lonsdale.

How Might AR and VR Be Integrated or Coexist?

Mixed reality (MR), or hybrid reality, is a term sometimes used to refer to immersive AR in which real and virtual worlds merge to produce new environments and visualizations where physical and digital objects coexist and interact in real time. Whereas AR often layers computer-generated images over the user's view of the physical world and VR provides total immersion into a virtual world, MR combines both worlds—virtual and physical objects coexist equally. One example is Microsoft HoloLens, a pair of MR smart glasses developed and manufactured by Microsoft that allows users to experience 3D holographic images that are designed to blend with the environment.

Extended reality (XR) is an umbrella term that covers all technologies, including AR, VR, and MR. Some do not accept the distinction between AR and VR anymore, and many believe that three to five years from now these categories will become blurry and converge, where these distinctions will no longer apply.[10] Figure 4 below represents how AR, MR, and VR overlap under the XR umbrella term.

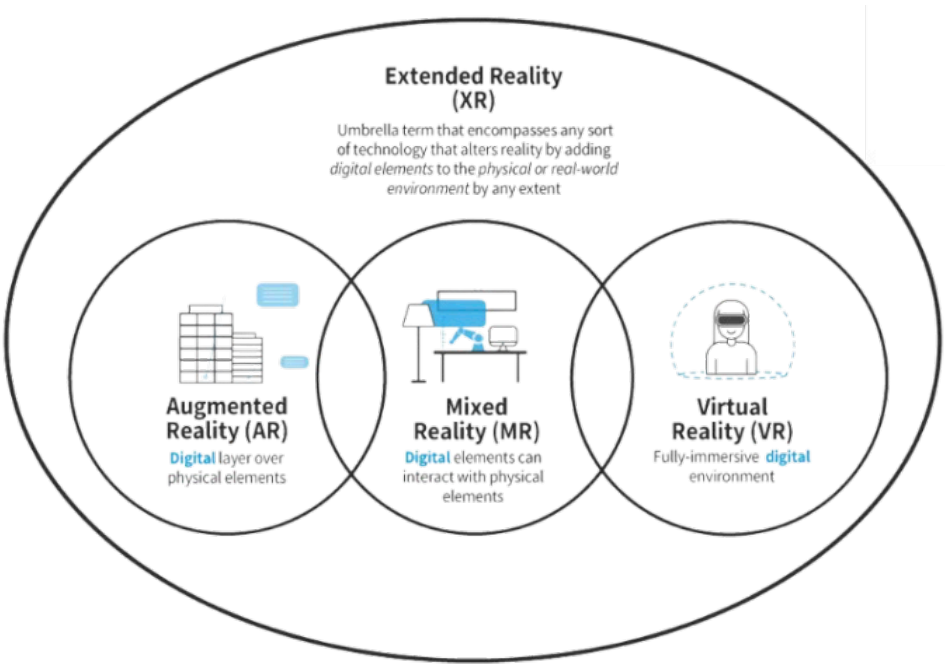

Figure 4. Reprinted from Laila Tremosa, *Beyond AR vs. VR: What is the Difference between AR vs. MR vs. VR vs. XR?*, Interaction Design Foundation, January 26, 2022, https://www.interaction-design.org/literature/article/beyond-ar-vs-vr-what-is-the-difference-between-ar-vs-mr-vs-vr-vs-xr.

10 KPMG, "The Future of the Metaverse and Extended Reality," April 2022, https://kpmg.com/xx/en/home/insights/2022/04/the-future-of-the-metaverse.html; Emory Craig, "XR Glasses Coming in Five Years According to Qualcomm," Digital Bodies, June 3, 2020, https://www.digitalbodies.net/xr-glasses-coming-in-five-years-according-to-qualcomm/.

Components of AR/VR for the Metaverse

One helpful approach to a taxonomy of AR/VR in the metaverse is thinking about the infrastructure required for access to these experiences.

Hardware: AR/VR can be accessed via traditional mainstream devices, such as smartphones, laptop computers, tablets, or gaming consoles. More sophisticated applications require the user to obtain an AR/VR set that typically consists of glasses or a headset, handheld controllers, or other sensors and input mechanisms that can enable a more immersive experience. These consumer hardware devices rely on strong computational central processing (CPU) and graphics processing units (GPU) and sensors.

As the number of AR and VR users climbs, mobile AR, which leverages smartphone cameras and processing power to superimpose information on what the phone is seeing, helps bridge the transition. More than half of the six billion smartphones in use today are sufficiently powerful to enable mobile AR.[11]

Example of an AR headset

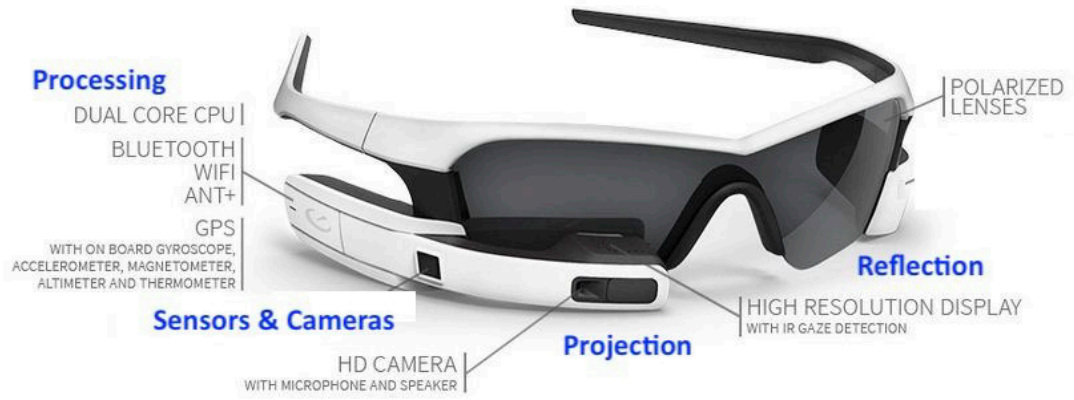

Figure 5. Reprinted from Sanket Prabhu, "What Is Augmented Reality and How Does It Work?," ARreverie Technology (blog), December 18, 2017, http://www.arreverie.com/blogs/how-ar-work/.

Software: AR/VR experiences in the metaverse require programs and code to run on physical hardware. Much like in the console or mobile space, device manufacturers will likely provide a general framework for applications or games and third-party developers will need to use the programming language and tools provided by the manufacturer. In terms of programming language and complexity, there is no significant deviation from traditional programming (similar languages and graphics engines).

11 Jean-François Bobier et al., *The Corporate Hitchhiker's guide to the Metaverse* (Boston: Boston Consulting Group, 2022).

PART 2: Applications and Market Overview

As of today, neither consumers nor businesses have widely adopted metaverse applications. While there are more use cases being discussed, a report by Wunderman Thompson showed that only 38 percent of global consumers have heard of the term metaverse.[12] The average consumer does not own a sophisticated AR/VR device (only 17.7 percent of the U.S. population is estimated to own a VR headset)[13] and does not frequent a virtual world to work, socialize or play on a daily or even weekly basis. Most experts and observers agree that the vision of a fully-fledged and seamless virtual experience is still years, perhaps even decades away.

While several new devices expected to launch may accelerate technical advancement, many experts expect that the actual shift toward a broader adoption of AR/VR technology will realistically take another five to ten years.[14] Therefore, a lot of the current debate and hype about the metaverse should be met with a healthy dose of skepticism and scrutiny.

Although some major corporations have invested heavily into AR/VR, most companies are still in the experimentation/pilot phase of exploring AR/VR technology. Applications for AR/VR technology have developed across several sectors; table 2 below highlights some of the most significant current use cases and recent examples.

12 Wunderman Thompson, "Wunderman Thompson Launches 'Into the Metaverse' - a Metaverse Road Map for Brands," *CISION PR Newswire*, September 16, 2021, https://www.prnewswire.com/news-releases/wunderman-thompson-launches-into-the-metaverse---a-metaverse-road-map-for-brands-301377977.html.

13 Andrew Kirkcaldy, "How Many People Own VR", *PC Guide*, August 19, 2022, https://www.pcguide.com/vr/faq/how-many-people-own-vr/.

14 See Mark Zuckerberg's comments in Meta Inc.'s Q1 2022 earnings call: "(I)t's not going to be until those products [Meta's AR/VR/metaverse efforts] really hit the market and scale in a meaningful way and this market [the metaverse] ends up being big that this will be a big revenue or profit contributor to the business. . . . Maybe primarily, this is laying the groundwork for what I expect to be a very exciting 2030s when this [AR/VR/metaverse] is . . .sort of more established as the primary computing platform at that point." "Meta Earning Call," Q1 2022 Results Conference Call, Meta, Inc., April 27, 2022, https://s21.q4cdn.com/399680738/files/doc_financials/2022/q1/Meta-Q1-2022-Earnings-Call-Transcript.pdf.

Applications & Use Cases

Table 2. AR/VR Current Applications and Use Cases

Industry	Overview	Examples
Military	Simulate battlefield training	Microsoft HoloLens
Gaming	Allow for 3D in-game experience	Oculus Quest (Meta); HTC VIVE
Entertainment	Sporting events and concerts	VR concert by Imagine Dragons; National Basketball Association courtside in Oculus
Education	Classroom learning	Froggipedia
Virtual work/collaboration	Virtual meetings	Horizon Workrooms (Meta)
Immersive e-commerce	VR shopping	Audi and Sephora
Healthcare	Surgery and psychotherapy	Stanford Medicine Neurosurgical Simulation and Virtual Reality Center by Surgical Theater

Each use case described in Table 2 is outlined in more detail below

Military: The U.S. military is piloting the use of AR/VR technology to train soldiers by simulating battlefield scenarios and to better equip soldiers with more advanced awareness tools. **Example:** In March 2021, Microsoft secured a deal to produce a customized HoloLens headset for the U.S. Army. The headset is meant to provide enhanced situational awareness that will enable soldiers to fight, rehearse, and train using a single platform.[15] The device uses an Integrated Visual Augmentation System to allow soldiers to see through smoke and dark environments, use holographic imagery for training, and 3D terrain maps projected onto their field of vision.[16]

Gaming: Video games are the most prominent VR use case for consumers, allowing them to experience video games in 3D, which enhances the in-game user experience. **Examples:** Many manufacturers of VR headsets have developed their own games, which are bundled with the purchase of their hardware. The major players are Oculus (acquired by Meta), Google, HTC VIVE, Microsoft, and Samsung.[17] Independent game developers like Unity are also developing 3D games compatible with the VR consoles.

15 Mary Jo Foley, "US Army Postpones Its $22 Billion Microsoft Augmented-reality Headset Deliverables to Late 2022," ZDNet, October 14, 2021, https://www.zdnet.com/article/us-army-postpones-to-2022-its-22-billion-microsoft-augmented-reality-headset-contract.

16 Deborah. Bach, "US Army to Use HoloLens Technology in High-tech Headsets for Soldiers," Microsoft Transform, June 8, 2021, https://news.microsoft.com/transform/u-s-army-to-use-hololens-technology-in-high-tech-headsets-for-soldier/.

17 Bryan Wirtz, "The World's Largest Virtual Reality Companies: Meet the Studios Dominating the Industry," Game Designing, August 25, 2022, https://www.gamedesigning.org/gaming/virtual-reality-companies/.

Entertainment: VR allows fans to experience entertainment events without the constraint of physically being there. VR events are becoming more prominent in the entertainment space as the technology is applied to all forms of entertainment. **Examples:** The National Basketball Association (NBA) offers virtual courtside seats on Meta's Oculus device. The Oculus headset simulates a courtside experience by allowing NBA fans to experience live in-game immersive views and feel close to the action. Major League Baseball is also utilizing VR technology to give their fans a 360-degree in-game experience at home. The National Football League and NASCAR have also been experimenting with VR to provide in-game/in-race experiences for their fans.

Education: During the COVID-19 pandemic, both schools and employers increasingly turned to online learning to educate students and the workforce in a virtual environment. AR and VR technology can be used to enhance the virtual learning experience. **Examples:** Froggipedia is an AR mobile device app that teaches students about the anatomical details of a frog. Instead of dissecting a frog in-person, students can dissect the frog virtually. Another example is the VR Microsoft HoloLens' HoloTours, which allows students to virtually explore a new city rather than viewing photos in a textbook. While the Froggipedia app is a few dollars, the Microsoft HoloLens headset is several thousands of dollars, making it largely unaffordable for most classrooms.

Figure 6. Reprinted from Elliot Hu-Au, "Microsoft HoloLens' Holotours: Making History Come Alive," Virtual Reality for Education, October 22, 2016, http://virtualrealityforeducation.com/microsoft-hololens-holotours-making-history-come-alive/.

Virtual work and collaboration: Participating in virtual meetings using applications such as Zoom or Microsoft Teams is now commonplace full use of AR/VR technology to engage in is still nascent.[18] Much of the value of the metaverse may ultimately lie in business applications, such as virtual meetings and training sessions. **Example:** Meta created an internal VR meeting room called Horizon Workrooms, allowing work colleagues to collaborate and conduct meetings using avatars.

18 Mark Purdy, "How the Metaverse Could Change Work," *Harvard Business Review*, April 05, 2022, https://hbr.org/2022/04/how-the-metaverse-could-change-work.

Figure 7. Reprinted from "7 Tips for Powering Up Your Sales Enablement Using a Virtual Reality Platform," MeetinVR (blog), March 15, 2021, https://www.meetinvr.com/2021/03/15/sales-enablement/.

Immersive e-commerce experience: Using VR headsets shoppers can browse through virtual showrooms and virtually meet with friends to go shopping as if they were inside a physical store.
Example: VR and AR allow users to virtually "try on" products without the presence of the actual product. For example, Sephora teamed up with AR company ModiFace to release an app called Sephora Virtual Artist. After scanning the user's face, the app applies algorithms based on the user's facial features to recommend products accordingly. The app also comes with tutorials and recommendations, where the user can learn and experiment with different products on their virtual face.

Healthcare applications: In 2021, the global healthcare VR market was valued at $459 million.[19] Two prominent VR use cases include applications to enhance surgery and psychotherapy.
Example 1 - surgery: In 2022, VR helped surgeons simulate the complex operation of separating congenital twins by allowing surgeons to visualize different scenarios in an operation and collaborate in real time with surgeons in different countries.[20] In 2017, Stanford Medicine announced that it began using a "new software system that combines imaging from MRI's, CT scans and angiograms to create a three-dimensional model that physicians and patients can see and manipulate—just like in a VR game." The VR system, created by Surgical Theater, helps train medical residents, assist surgeons in operations, and educate patients.[21]
Example 2 - psychotherapy: VR psychotherapy has been successfully used to treat people with post-traumatic stress disorder, anxiety, phobias, depression, etc. The advantage is that the VR

19 "Virtual Reality (VR) in Healthcare Market Size," Fortune Business Insight, May 2022, https://www.fortunebusinessinsights.com/industry-reports/virtual-reality-vr-in-healthcare-market-101679.

20 Shiona McCallum, "Conjoined Twins Separated with the Help of Virtual Reality," *BBC News,* August 1, 2022, https://www.bbc.com/news/technology-62378452.

21 Mandy Erickson, "Virtual Reality System Helps Surgeons, Reassures Patients," Stanford Medicine, July 11, 2017, https://med.stanford.edu/news/all-news/2017/07/virtual-reality-system-helps-surgeons-reassures-patients.html.

environment can be personalized to the patients' needs.[22] For example, in VR exposure therapy, patients are exposed to safe and controlled virtual environments designed to recreate personalized experiences. By mimicking the personalized trauma, therapists can gradually treat patients' symptoms through the exposures in VR.

Barriers and Limitations

There are several technical and nontechnical limitations in the development of AR, VR, and the metaverse.

Technical limitations:

- **Optical correction/adjustment:** AR/VR headset lenses need active optics that rapidly adjust focus. This causes significant visual fatigue on the user. Researchers are working to improve the field of view and resolution in near-eye displays to address visual fatigue.

- **Computing power:** Although gradually improving, AR and VR still require powerful computing capabilities to render the technology. The high computing power must be processed in a relatively small device, which comes with some challenges:

    - Reaching wide-spread adoption of the metaverse will require massive networking power, both from fixed (fiber) networks as well as mobile networks.

    - To continue to increase the performance of headsets, while at the same time driving down their size and weight, computing and storage needs to be moved off the headset and be computed and stored elsewhere (e.g., on another device nearby, on an edge server, or in the cloud).

    - Given the immersiveness of the experience, the connection between the headset and the remote server (latency) tends to be very slow.

- **User comfort:** Some users experience motion sickness and discomfort with the headsets (e.g., some headsets can weigh three pounds).

22 Jeremy Sutton, "What is Virtual Reality Therapy? The Future of Psychology," Positive Psychology, November 4, 2020, https://positivepsychology.com/virtual-reality-therapy/.

- **Interoperability:** Currently users lack the ability to transfer digital goods and information across different metaverses.[23] There are "many different file formats used to structure and store data in different metaverses."[24]

- **Immersiveness:** Even the most cutting-edge products, both in the current and upcoming generation, do not yet provide anywhere near the seamlessness and immersiveness of people engaging with each other in person.

Nontechnical limitations:

- **High cost of hardware:** High-end systems are very expensive although the cost of customer-facing products has decreased significantly.

- **Market fragmentation:** Multiple competing metaverses with different interfaces, rules, and virtual environments can create confusing user experiences.

- **Supply shortages:** The manufacturing shortage of electronic parts, particularly chips, could severely constrain hardware production.

- **High barrier to entry:** The limited number of devices currently on the market could reduce innovation speed.

- **Accessibility:** Large swaths of the population are likely not to engage with the metaverse due to accessibility and cultural constraints. They might not be able to purchase the hardware and navigate the technology, or they may prefer not to engage with the metaverse due to a strong preference for in-person experiences and a strong aversion to some of the visions currently promoted by metaverse enthusiasts.

23 The lack of interoperability is not only a technical limitation. In Part 4: Public Purpose Considerations, the authors provide a brief description of interoperability concerns pertaining to user mobility and the portability and digital assets.

24 A Matthew Ball, "The Metaverse: And How It Will Revolutionize Everything" (New York: Liveright, 2022).

Market Development

The AR and VR market size was valued at $14.84 billion in 2020 and is projected to reach $454.73 billion by 2030, representing a compound annual growth rate (CAGR) of 40.7 percent[25] (for comparison, the Internet of Things market has a CAGR of 26.4 percent).[26] Growth of the mobile gaming industry and increase in internet connectivity act as key drivers of the global AR and VR market. In addition, an increase in the use of consumer electronic devices is expected to fuel the global augmented and VR market growth.[27]

North America dominates the AR and VR market given the growing demand from gaming, entertainment and media, aerospace and defense, retail, and manufacturing industries. North America is also the home of major technology players with advanced research capabilities.

By application, the AR and VR market share was dominated by the consumer segment in 2020, which is expected to remain the dominant segment in upcoming years.[28] However, beyond consumer use cases (e.g., video games), the adoption of AR and VR technology has also been heading toward enterprises. Innovative companies are experimenting with a wave of new applications for AR and VR, driving the growth of the overall market.

In a recent study that polled information technology and business leaders 7 percent reported that they are making significant investments in VR, 15 percent plan to invest in the next three years, 10 percent reported that they are making considerable investments in AR, and 24 percent are planning to invest in the next three years.

25 Vikas Gaikwad, "Augmented and Virtual Reality Market," Allied Market Research, October 2021, https://www.alliedmarketresearch.com/augmented-and-virtual-reality-market.

26 Fortune Business Insights, "With 26.4% CAGR, Internet of Things (IOT) Market worth USD 2465.26 Billion by 2029," Global Newswire, August 3, 2022, https://www.globenewswire.com/news-release/2022/08/03/2491076/0/en/With-26-4-CAGR-Internet-of-Things-IoT-Market-Worth-USD-2465-26-Billion-by-2029.html.

27 Gaikwad, "Augmented and Virtual Reality Market."

28 Ibid.

PART 3: Current Governance and Regulation

While iterations of AR/VR technologies have existed for many years, regulatory and governance frameworks have struggled to keep pace. As of today, no laws exist that are specific to the metaverse, although regulation is being designed to control different components of this digital space. However, some of the existing laws governing the web and technology industry in general are applicable. Several traditional regulatory concerns around privacy, security, intellectual property, and the market power of big tech corporations carry over to a metaverse context.

Metaverse governance is a multifaceted challenge with tradeoffs between interoperability, privacy, safety, and security that will be hard to neatly manage. Existing models may not work in the metaverse, and new models will have to go through stress testing before they can be enacted at scale.

Currently, few major international organizations or bodies have attempted to tackle the issue of metaverse regulation. A recent proposal at the 2022 World Economic Forum is one of the major nonprofit initiatives dedicated to providing frameworks for potential future governance and regulation.

It is likely that any regulatory attempts will take place on a national level (with the exception of the European Union), across the domains of telecommunications and internet regulation, as well as competition (antitrust) regulation and enforcement. Both legislative and executive branch actions may be considered.

Navigating Law in a Virtual World

AR and VR for the metaverse present legal questions for courts, companies, and users. Some are new takes on classic legal questions that will not require a fundamental rethinking of legal doctrine. However, AR and VR may raise more fundamental questions about whether these simulated realities are not "real" in the way we normally use the term. Regulators will need to adapt current frameworks to new augmented, mixed, or entirely new virtual realities.

As with the internet, metaverse platforms operate across country borders and generally national laws apply to prosecute offenses. Metaverse platforms also have their own policies and procedures to regulate from inappropriate speech to how data can be accessed, which will be influenced by domestic laws. Governments in several countries are in the process of implementing laws that will better protect children in the metaverse.

Laws in the metaverse will initially draw upon the laws of the countries in which the relevant platforms operate, in a similar way that social media platforms or search engines do so today. However, the mainstream internet platforms of today are much more limited in scope than metaverse platforms. In fully immersive digital worlds, it is conceivable that metaverse platforms will self-regulate, that is, implement internal compliance policies and procedures (i.e., private laws.) Virtual world laws may interact and overlap with national and international laws in a much broader array of areas than internet platforms have, creating discrepancies and novel legal questions.

If a global audience gravitates toward one, or even just a few metaverse platforms, a single platform and its privacy laws may have more influence than even large nation-state governments. For example, Facebook had approximately 2.91 billion monthly active users in the fourth quarter of 2021, dwarfing the population of any nation-state. If a metaverse platform reaches a similar user base, its role in lawmaking and standard setting could be profound.

While current laws may be able to resolve some legal issues arising from augmented or virtual technologies, many questions remain unanswered. For example, how might the law treat "street crimes"—behavior such as disturbing the peace, indecent exposure, or deliberately harmful visuals—in VR and AR? Open questions remain in several areas of the law including tort, intellectual property, contract, defamation and free speech, and tax law.

U.S. Regulation and Governance

While no U.S. laws currently exist that are specific to the metaverse, several laws pertaining to speech, privacy, antitrust, and protection of minors are relevant. For a more detailed explanation of many of these laws please see the "Technology Primer: Social Media Recommendation Algorithms" for policymakers.[29]

Section 230 of the Communications Decency Act of 1996 (CDA, Section 230). Enforced by the Federal Communications Commission, CDA's Section 230 provides protection to "interactive computer service providers," from liability related to: (1) hosting information provided by another information content provider, and (2) voluntarily acting "in good faith" to restrict access to objectionable material. Given much of the content created on the metaverse would be generated by third parties, platforms would likely meet the necessary elements of a Section 230 defense and thus enjoy broad immunity.

29 Constanza M. Vidal et al Technology *Primer: Social Media Recommendation Algorithms* (Cambridge: Belfer Center for Science and International Affairs, 2022), https://www.belfercenter.org/publication/technology-primer-social-media-recommendation-algorithms.

First Amendment: The creation and curation of content is considered speech by the Supreme Court, which means that AR/VR content can be constitutionally protected as lawful speech under the First Amendment.

Children's Online Privacy Protection Act of 1998 (COPPA): Implemented by the Federal Trade Commission, COPPA provides data protection requirements for children's information collected by online operators.[30] Specifically, COPPA prohibits collecting personal data from children under the age of thirteen without obtaining parental consent prior to data collection.

State-level privacy laws: The states of California, New York, Texas, Colorado, among others, have passed or attempted to pass new legislation to protect citizens' privacy rights. This is an important step because AR/VR devices also collect private and confidential information that can be accessed and disseminated on the internet without the user's consent. As AR/VR devices are able to collect biometric and behavioral information about users—information that can be sold or compromised— it is critical that there be transparency, practical options, and security for the interested parties.

California Consumer Privacy Act (CPPA) is a particularly strong state data law that gives consumers more control over the personal information that businesses collect about them.[31] This new law provides new privacy rights for California consumers, including:

- The right to know about the personal information a business collects about them and how it is used and shared;
- The right to delete personal information collected from them (with some exceptions);
- The right to opt-out of the sale of their personal information; and
- The right to nondiscrimination for exercising their CCPA right.

Proposed Federal and State Legislation

CDA's Section 230 reform: Several bills in both the U.S. Senate and the House have been introduced to address concerns around Big Tech and content moderation.

Federal data privacy laws are also being considered such as the American Data Privacy and Protection Act.

30 Stephen P. Mulligan and Chris D. Linebaugh, "Data Protection Law: An Overview," Congressional Research Service, March 25, 2019, https://crsreports.congress.gov/product/pdf/R/R45631.

31 "California Consumer Privacy Act (CCPA)," State of California, Department of Justice, Office of the Attorney General, March 28, 2022, https://oag.ca.gov/privacy/ccpa.

California Age-Appropriate Design Code Act (A.B. 2273):[32] Aims to improve the privacy protection of minors online by compelling platforms to assess the privacy and protection of children in the design of any digital product or service they offer.

As U.S. federal and state laws are underdeveloped in this area, we have provided some examples below on law in other countries leading digital regulations.

International Regulation and Governance

Europe

General Data Protection Regulation (GDPR): This comprehensive framework for the protection of user data and privacy includes consumer access and information rights, restrictions on data storage processing, and other consumer protections.

Digital Markets Act (DMA)[33] **and Digital Services Act:** These new pieces of European Union regulation on digital markets and services contain new and far-reaching provisions related to leveling the playing field in the digital space. For example, platform providers will be required to enable access to third-party payment services as well as apps by third-party developers, and third-party app stores will have less freedom to rank their own products or services over those of other companies. Given the consolidation of metaverse platforms,[34] several potential enforcement actions may be brought against metaverse companies based on the DMA in the coming years.

Parental control law: Law no. 2022-300 enacted March 2022 in France[35] requires manufacturers of devices that allow access to sensitive content to build in a pre-installed parental control function that allows parents to restrict access.

32 "This bill . . . would require a business that provides an online service, product, or feature likely to be accessed by a child to comply with specified requirements, including configuring all default privacy settings offered by the online service, product, or feature to the settings that offer a high level of privacy protection offered by the business, and providing privacy information, terms of service, policies, and community standards concisely, prominently, and using clear language suited to the age of children likely to access that online service, product, or feature," as quoted in California AB2273, The California Age-Appropriate Design Code Act, TrackBill, https://trackbill.com/bill/california-assembly-bill-2273-the-california-age-appropriate-design-code-act/2228971/.

33 See "Questions and Answers: Digital Markets Act: Ensuring Fair and Open Digital Markets," European Commission, October 31, 2022, https://ec.europa.eu/commission/presscorner/detail/en/QANDA_20_2349.

34 Patrick McGee, "Meta Sparks Anger by Charging for VR Apps," *Financial Times*, June 29, 2022, https://www.ft.com/content/e8910bad-b873-407d-b1ca-46eb4ceb3db2.

35 Kristof Van Quathem, Alix Bertrand, and Nicholas Shepherd, "France Enacts New Law on Parental Controls," Lexology, March 10, 2022, https://www.lexology.com/library/detail.aspx?g=7644ba21-cc7f-41b8-b3c4-16f99defb0a3.

China

The Personal Information Protection Law[36] lays out for the first time in China a comprehensive set of rules around data collection, processing, and protection, that were previously governed by piecemeal legislation. This legislation is similar to the European GDPR and addresses concerns over the amount of data that companies, especially internet sector companies, collect from users.

Content censorship: Around the world, regulators are concerned about the social impact of video games, especially among children. Chinese regulators—who oversee the world's biggest gaming market—froze the approval of new domestic online game licenses in late March 2018. Subsequently, in 2019, China imposed a ban on games that feature blood or corpses. Game developers will need to reintroduce censored versions of the titles to avoid legal risks. However, China's desire to dominate the global VR market leads us to believe that regulators will not attempt to stifle the industry with heavy-handed regulation.

Protection for minors: China recently passed a series of anti-digital addiction laws. Most recently in 2021, China restricted online gaming time for children under 18 to three hours weekly.[37] Additionally, China imposed age restrictions on live streaming. Age restrictions are likely to emerge in the coming years, which will prevent children from accessing violent games.

Ban on cryptocurrency: A key factor for shaping the kind of metaverse that emerges in China is the country's blanket ban on cryptocurrencies. However, the government encourages the development of blockchain technologies and is not critical of non-fungible tokens (NFTs), which are known in China as digital collectibles.

Self-Regulation and Governance

Self-regulation efforts so far have mostly centered around topics of interoperability and the development of common standards across the industry. While many major (and smaller) industry players have signed on and joined these initiatives, critics argue that it is not in their best interest to comply and that progress for these efforts will be limited at best. In recent years, social platforms have become more inclined to protect user privacy and safety due to the negative public relations consequences of failing to do so. Almost certainly, metaverse platforms and environments will be inclined to follow suit.

36 Miranda Katz, "The Personal Information Protection Law: China's Version of the GDPR?," Columbia Journal of Transnational Law, February 15, 2022, https://www.jtl.columbia.edu/bulletin-blog/the-personal-information-protection-law-chinas-version-of-the-gdpr.

37 See the Reuters coverage at "Why and How China is Drastically Limiting Online Gaming for Under 18s," Reuters, August 21, 2021.

Several examples of self-regulation and self-governance have emerged in the last several years:

Innovation guidelines: Firms have identified guiding principles for product development, such as privacy, inclusiveness, and interoperability, that are broadly considered in product design. One example is Meta's Responsible Innovation Principles.[38]

Oversight boards: Firms such as Meta have developed oversight boards that include independent journalists, politicians, and other experts to provide final judgment on content issues including those related to VR.

However, these efforts have been met with significant criticism. Meta established its global oversight board in 2020, a first-of-its-kind internet governance body. The firm received criticism that the board was a way to abrogate the responsibility of moderating Facebook to another body. While all of the board's decisions are binding, its policy recommendations are not, and the company is sometimes unwilling to heed recommendations.[39] The board itself has faced questions over its political balance, with Republicans arguing it is ideologically skewed toward left-wing academics.[40]

Interoperability groups for the metaverse: Organizations, such as the nonprofit Open Metaverse Interoperability Group, serve as an open-source community of industry professionals and enthusiasts advocating for a more open internet.[41]

Industry standards: The Metaverse Standards Forum is an industry group that brings together standards organizations and companies for industry-wide cooperation on interoperability standards. The group includes over 500 firms and the major metaverse companies. The Metaverse Standards Forum provides a venue for cooperation between standards organizations and companies to foster the development of an open and inclusive metaverse and interoperability standards by funding projects. Standards generated by the forum are driven by industry and are nonbinding. Standards development organizations include the Khronos Group, the World Wide Web Consortium, the Open Geospatial Consortium, the Open AR Cloud, and the Spatial Web Foundation, and others.

38 "Responsible Innovation: Meta," Meta, accessed September 7, 2022, https://about.facebook.com/metaverse/responsible-innovation/.

39 Sara Fischer, "Meta Provides Another $150 Million in Funding for Its Oversight Board," *Axios*, July 22, 2022, https://www.axios.com/2022/07/22/meta-facebook-oversight-board-funding.

40 Matthew Field, "Facebook's 'Supreme Court' Spends $25M in Its First Year," *Telegraph*, July 17, 2022, https://www.telegraph.co.uk/business/2022/07/17/facebooks-supreme-court-spends-25m-first-year/.

41 "Open Metaverse Interoperability Group," omigroup, February 17, 2022, https://omigroup.org/.

Private metaverse governance: Corporate/centralized iterations of virtual worlds are likely to follow traditional rules of corporate governance. For example, the metaverse created by Meta is likely to be a virtual environment fully owned and run by the firm, which determines access rules and controls the marketplace. Consequently, overall legal responsibility resides with Meta and its board of directors, who would be the addressees of any regulatory or enforcement action.

Decentralized metaverse governance: Decentralized metaverse applications or virtual worlds are likely to follow a different model of corporate governance. Advocates argue that one day decentralized autonomous organizations (DAOs) could provide a governance structure for the metaverse. A DAO is a method of organizing a company or entity that provides all decision power to its members. All of the DAO's actions and funding can be seen and analyzed by anyone because every transaction is recorded on the blockchain. This transparency reduces the risk of corruption, illicit activity, or fraud by preventing important information from being censored.

However, decentralized metaverse governance may also reduce accountability and responsiveness to regulatory and legislative pressure. If a decentralized platform does not have a designated geographical seat, headquarter, or board of directors, it may be more difficult to enforce regulation on the decentralized platform.

Part 4: Public Purpose Considerations

The scope and nature of public purpose considerations pertaining to AR/VR in the metaverse will depend both on the specific application at hand, and the future direction of the metaverse industry. If ultimately most metaverse applications will be dominated by centralized, corporate platforms (such as Meta, Apple, etc.), many existing concerns around the power of large gatekeeper companies on the internet will most likely carry over to the metaverse.[42] At the same time, regulation and enforcement would, in theory, be relatively straightforward. If, however, the competing vision of a more decentralized, user-run and user-owned metaverse is realized, the new more fragmented governance might pose distinct challenges for both regulations and their enforcement.[43]

Generally, we believe that many long-term public purpose considerations and debates from related fields in the past few decades—gaming and protection of minors online, big tech regulation, antitrust law, online intellectual property protection, security, identity, inclusivity—will come to bear in a metaverse context. Consequently, from today's perspective, the metaverse may not pose many fundamentally new public purpose conundrums. However, existing public purpose concerns may be exacerbated by emerging AR/VR and metaverse applications.[44]

Public purpose issues related to AR/VR for the metaverse[45] include several considerations.

Safety: Protection of Minors, Risk of Identity Theft, and Fraud

- **Protection of minors:** With minors potentially spending more time socializing, gaming, and consuming entertainment in more immersive virtual environments, dangers to their mental health and the potential for disruption of their social and general development will increase. For instance, they may be exposed to inappropriate/explicit content or bullying and harassment by other users.[46]

42 See the Federal Trade Commission's recent enforcement actions. Mark McCarthy, "FTC's Case Against Meta's Acquisition of Within Seeks to Shape the Emerging VR Market," Brookings, August 4, 2022).

43 See Tambiama Madiega, Polona Car, Maria Niestadt, and Louise Van de Pol, "Metaverse: Opportunities, Risks, and Policy Implications," briefing, European Parliamentary Research Service, June 2022, 7: "Experts warn that intellectual property (IP) enforcement is a challenge in the metaverse environment. This is because it is more difficult to identify the provider that can take down infringing content, since metaverse content is distributed and replicated across decentralized networks running on Web 3.0 and blockchain-based platforms."

44 See the assessment by Tom Wheeler, "The Metachallenges of the Metaverse," Brookings, September 30, 2021.

45 Compare, for instance, the enumeration in the European Parliament Research Service Briefing, that lists competition, data protection, liabilities, financial transactions, cybersecurity, health, and accessibility and inclusiveness. Madiega et al., "Metaverse."

46 See the example of a BBC reporter who entered a virtual world posing as a 13-year-old. Andy Phippen, "Protecting Children in the Metaverse: It's Easy to Blame Big Tech, But We All Have a Role to Play, " *Conversation*, February 28 2022.

- **Regulatory gap 1 - consumer protection and safeguards:** As in traditional gaming, consumer protection and safeguards for minors are lacking, and children may easily spend hundreds of dollars on virtual goods or other items. While the economic liberty and self-expression of the consumer should be respected, certain guardrails should be put in place to ensure that minors are not taken advantage of. For example, consider the case of "loot boxes," which are virtual items that users can purchase. The loot box, similar in concept to gambling, is a game of chance. The user does not know what is in the box; there is a low probability that the item in the box is of high value and a high probability that the item is of low value. Without guardrails in place, minors may be taken advantage of when targeted by advertisements and cannot evaluate the benefit and costs of a loot box or similar purchases.

- **Regulatory gap 2 - speech/content moderation:** While protections around hate speech, harassment, and protection of minors exist in many jurisdictions, and most likely apply to companies offering virtual world services, it may be worthwhile considering more concrete legal requirements around content moderation and user protection in these new virtual spaces.[47] Misconduct and harassment by an avatar (e.g., sexual harassment) may not be covered sufficiently at this point.[48]

- **Identity theft and identity management and solutions:** While virtual worlds and blockchain-based applications can incorporate robust identity management solutions, identity theft in the metaverse is currently much easier than in the physical world.[49] Identity thieves may easily use a user's real name and likeness, and pose as them, often without easy recourse for the authentic user to claim fraud and retrieve their identity. Effective alerts and actions against identity fraud are also limited in the current technological environment. Through the introduction of (mandated or self-regulated) digital identity management solutions, this danger could be mitigated in the future.[50]

  - **Regulatory gap 1 - rights of digital persons:** Clarification may be needed on personality rights in the metaverse, as pertaining to the rights of one's digital twin identity and personhood (avatar).[51]

47 It is also important to note that the moderation of AR/VR content and voice in real time is markedly distinct from the simple task of moderating text, such as social media postings and might need to be regulated and implemented differently. See Ryan Hsu, "Meet the New 'Verse, Same as the Old 'Verse: Moderating the Metaverse,'" *Georgetown Law Technology Review*, May 2022.

48 See Tanya Basu, "The Metaverse Has a Groping Problem Already," *MIT Technology Review*, December 16, 2021.

49 See Louis Rosenberg, "How the Metaverse Will Create New Forms of Fraud and Deception," bigthink.com, April 25, 2022. Another version of this is the so-called evil twin, where hackers use personal data about an individual to create a digital twin of that person (based on their traits and likeness), to control and use for fraudulent purposes.

50 For potential solutions, see the Identity section in the following Frank Badalamenti, Roberto Hernandez, Vikram Panjwani, and Emmanuelle Rivet, "Trust and Risk Considerations for the Metaverse," *pwc*, April 5, 2022.

51 See Madiega et al., "Metaverse," 7.

- **Regulatory gap 2 - identity management and authentication:** Used to reduce the likelihood of identity theft, fraud, harassment, and counterparty risk more broadly. In the absence of industry consensus on shared verification standards and a more stringent management of digital identities, regulation may be required to provide a framework on these topics.[52]

- **Fraud:** A number of features of cryptocurrencies and metaverse applications, such as the anonymity of users and user wallets (accounts), and the absence of stringent securities and transactions regulation and enforcement, can lead to an increased risk of fraud.[53] In contrast to fraud in the physical world, where the counterparty is known and can be held liable through the traditional legal system, prosecution and enforcement of claims in the virtual world is highly challenging.

  - **Regulatory gap 1 - digital offerings and transactions:** More stringent regulation of digital offerings and transactions, comparable to existing securities or banking regulation, may be needed to discourage fraudulent behavior.

  - **Regulatory gap 2 - digital property rights:** Regulatory clarification may be needed for the definition, transfer, and enforcement of digital property rights, such as when dealing with NFTs.[54]

Privacy: Collection of More, and More Sensitive Data

- Concerns around privacy and data protection apply to metaverse applications as much as they apply to traditional internet/web services. However, the concerns are potentially heightened by the fact that troves of new sensible data can be collected, such as biometric data (response time, brain waves, etc.). Also, providers offering both traditional internet and metaverse infrastructure (Apple, Meta, Microsoft, and the like) might connect and monetize these comprehensive data sets in potentially concerning ways.[55]

  - **Regulatory gap - health data:** It is important to note that AR/VR headsets and devices will potentially allow companies to collect ever more kinetic, health, and physiological data on users, similar to health data collection through smart wearables. The data feed of a user's emotional state, stress level, heartbeat, reaction time, and the like may, combined with other data sources, provide corporations with an even more complete understanding of the user. More specific regulation for the processing, usage, and sale of these types of data may be considered in certain jurisdictions.

52 See, for instance, Paul Sawers, "Identity and Authentication in the Metaverse," VentureBeat, January 26, 2022; and Shade Oladetimi, "Protecting Your Digital Identity in the Metaverse," *JD Supra*, June 14, 2022.

53 Some sources view transactional risks as the main metaverse concern. Martin Boyd, "Regulating the Metaverse: Can We Govern the Ungovernable?," *Forbes*, March 31, 2022.

54 For some of the potential legal issues pertaining to NFTs, and how existing internet protocol might still be sufficient to navigate them, see Sophie Goossens and Nick Breen, "NFTs: Ownership in the Metaverse—the Birth of a New Concept," *ReedSmith*, August 1, 2022.

55 See Tatum Hunter, "Surveillance Will Follow Us into 'the Metaverse', and Our Bodies Could Be Its New Data Source," *Washington Post*, January 13, 2022.

Security: Infrastructure, Cybersecurity, and Governance Risks

- Centralized metaverses (Meta Horizon Worlds, Roblox) run by large corporations on its cloud servers presumably constitute a similar security environment to traditional corporate internet players (Meta, Google, Amazon, etc.). Other decentralized metaverse applications may rely on a more decentralized infrastructure, user input, or computing capacity, that is, they are run on a large number of user devices randomly distributed across its network or may be run through a DAO. These decentralized metaverse applications are subject to other additional security and governance risks.[56] For instance, a bad actor may acquire most of the computing capacity or voting rights and then take the entire project/application offline (in the context of bitcoin, this is known as the "51 percent problem"). On the flip side, these decentralized networks are potentially less vulnerable to central server attacks or security exploits.

- On the cybersecurity side, AR/VR devices—and the fact that most services will run on cloud infrastructure—will provide additional entry points for malicious attackers, therefore, maintaining device security and integrity will be key.[57] This will, in part, also depend on the users and the amount of care they invest to prevent those attacks.

    - **Regulatory gap - security:** The establishment of a minimum threshold of (cyber)security and governance standards, by means of self-regulation or actual regulation, may help mitigate these concerns.

Environment: Energy Consumption as a Key Concern

- **Energy usage:** Similar to other blockchain-based services and applications, AR/VR metaverse applications will consume significant amounts of energy, for the servers, the underlying blockchain (currency) infrastructure, and hardware devices. While energy efficiency is expected to increase gradually, this still poses an environmental concern.

    - **Regulatory gap - energy consumption:** Policymakers may want to provide incentives or even legal requirements for service providers to reduce the energy consumption of their devices and services, or they may want to limit certain types of applications with an outsized ecological footprint.

56 "Many projects in web3 include a governance aspect, in which token-holders can put forward and vote on proposals to alter the network. While this presents an opportunity for continual evolution and improvement, it also opens a backdoor to introduce malicious proposals that may damage the network if enacted. Attackers have devised new methods to circumvent controls, commandeer leadership, and loot treasuries. Once a theoretical concern, governance attacks have now been demonstrated in the wild. Attackers can take out massive 'flash loans' to swing votes,..." as quoted in Riyaz Faizullabhoy and Matt Gleason, "Web 3 Security: Attack Types and Lessons Learned," Andreessen Horowitz, April 23, 2022.

57 See Rick Bye, "Technological Challenges to the Security of the Metaverse," *Technology Magazine*, August 29, 2022.

Accessibility Limitations

- If the metaverse one day becomes a ubiquitous platform for social gatherings, people with disabilities such as visual impairment or sensory process disorders[58] may have difficulties accessing activities in a metaverse if the platforms are not designed with accessibility in mind.[59] Comfort with the use of digital equipment and technology is also required to access and navigate metaverse applications.

    - **Regulatory gap - accessibility:** Concrete statutory requirements may be needed to ensure that AR/VR devices and metaverse applications are built to accommodate accessibility needs.

Market Concentration/Antitrust Concerns: -Open Innovation or Oligopoly?

- Like e-commerce or social media, metaverses will enjoy a certain degree of network effects: users are more likely to join a platform their contacts are using. These network advantages could lead to a limited number of companies and platforms as frontrunners. With outsized market power, these firms could manage access to their ecosystem in restrictive ways, putting up entrance barriers for potential newcomers. There are strong economic incentives to engage in anti-competitive practices, in the absence of effective regulation banning such behavior.

- Additionally, it seems that many of the leading players in today's consumer internet (e.g., Meta, Apple, Microsoft), through existing infrastructure and substantial funding and investments, are well-positioned to be leading players in the metaverse space. Their potential market dominance across both traditional consumer internet and future metaverse applications might exacerbate antitrust concerns. Given that the metaverse market is still in its infancy, it seems all the more important that a large number of actors beyond traditional major technology companies are able to operate and innovate in that space, to encourage competition and user value creation.[60]

    - **Regulatory gap 1 - interoperability and portability:** The interoperability of virtual worlds, and portability of assets (such as avatars, or avatar accessories such as clothing in the form of NFTs) would give users greater control over the digital content they create by allowing users the flexibility to move their content across different platforms.[61] However, it is doubtful that industry self-regulation alone will lead to interoperability and portability of assets, given that there is a strong incentive for the leading players to maintain their advantage and build a walled garden infrastructure around their respective digital worlds.

58 Gus Alexiou, "Is the Metaverse Likely to Be Accessible and Inclusive of People with Disabilities?," *Forbes*, March 31, 2022, https://www.forbes.com/sites/gusalexiou/2022/03/31/is-the-metaverse-likely-to-be-accessible-and-inclusive-of-people-with-disabilities/?sh=62da20334d20.

59 See Mayank Sharma, "How the Metaverse Could Worsen the Digital Divide," *Lifewire*, January, 12, 2022.

60 See Alison McCauley, "The Battle for Control of The Metaverse: Can Open Innovation Outrun Corporate Domination?," *Forbes*, March 22, 2022.

61 See, among others, Rolf Illenberger, "The Metaverse Paradox: Why the Industry Needs Standardization," World Economic Forum, July 11, 2022.

- **Regulatory gap 2 - market dominance and antitrust concerns:** Much like effective gatekeeper/platform regulation is lacking in most jurisdictions when it comes to the traditional web and online services, many jurisdictions currently do not have comprehensive antitrust frameworks that would prevent individual players gain an overwhelming advantage in the metaverse marketplace, or to leverage their market power to exclude other actors from entering that space.[62] To foster true and sustainable innovation and prevent monopolization, more stringent antitrust regulation—or more extensive application of existing regulation—might be required.[63]

Taxation

- Taxation of digital transactions and goods has proven challenging and will remain so. Given that many virtual worlds are running on their own virtual economies, equivalents of sales tax and value-added tax of goods and services should be considered.[64] This would most likely require companies to adopt fiat money instead of existing cryptocurrencies. Similarly, traditionally highly taxed and tightly regulated activities, such as gambling, are currently being carried out in the metaverse[65] in circumvention of existing tax and regulatory regimes. Regulators will need to fill those loopholes.[66] Federal and state budgets, and with them, the broader public, might benefit.

    - **Regulatory gap - clarity and enforcement:** Lack of clear guidelines and enforcement mechanisms for existing taxation to certain virtual spaces and applications.

62 For an overview and potential segways for antitrust action given existing regulatory regimes, see Wilson Sonsini, "Antitrust: Into the Metaverse," Wilson Sonini, March 18, 2022.

63 In the United States, recent antitrust enforcement actions by the Federal Trade Commission taken in the metaverse context rest on a somewhat shaky legal foundation. See Cecilia Kang, "F.T.C. Chair Upends Antitrust Standards with Meta Lawsuit," *New York Times*, July 28, 2022.

64 Some states in the United States are moving in that direction, see the example of Washington. Caile Gole, "How Should States Tax NFT Sales?," CPA Practice Advisor, July 31, 2022.

65 See, for instance, the Decentraland casino and related offerings. Eli Tan, "Who's Using the Metaverse? Poker Players in Decentraland," Coindesk, February 3, 2022.

66 See Tom Ara, Mark Radcliffe, Michael Fluhr, and Katherine Imp, "Exploring the Metaverse: What Laws Will Apply?," DLA Piper, June 22, 2022.

Selected Readings and Additional Resources

The list below highlights some of the citations in this document or comprehensive documents on specific topics and is not meant to be exhaustive.

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- Bellini, Heather, et al. Virtual & Augmented Reality. Understanding the Race for the Next Computing Platform. Profiles in Innovation Series. (New York: Goldman Sachs, January 2016).

- Shamash, David, and Robin Andre Nordnes. State of The Open Metaverse 2021/22. (London: Outlier Ventures, 2021).

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- Lemley, Mark A., and Eugene Volokh. "Law, Virtual Reality, and Augmented Reality." University of Pennsylvania Law Review 166, no. 1051 (April 2017). https://doi.org/10.2139/ssrn.2933867.

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About the Technology and Public Purpose (TAPP) Project

The arc of innovative progress has reached an inflection point. It is our responsibility to ensure it bends toward public good.

Technological change has brought immeasurable benefits to billions through improved health, productivity, and convenience. Yet as recent events have shown, unless we actively manage their risks to society, new technologies may also bring unforeseen destructive consequences.

Making technological change positive for all is the critical challenge of our time. We ourselves - not only the logic of discovery and market forces - must manage it. To create a future where technology serves humanity as a whole and where public purpose drives innovation, we need a new approach.

Founded by former U.S. Secretary of Defense Ash Carter, the TAPP Project works to ensure that emerging technologies are developed and managed in ways that serve the overall public good.

TAPP Project Principles:

1. Technology's advance is inevitable, and it often brings with it much progress for some. Yet, progress for all is not guaranteed. We have an obligation to foresee the dilemmas presented by emerging technology and to generate solutions to them.

2. There is no silver bullet; effective solutions to technology-induced public dilemmas require a mix of government regulation and tech-sector self-governance. The right mix can only result from strong and trusted linkages between the tech sector and government.

3. Ensuring a future where public purpose drives innovation requires the next generation of tech leaders to act; we must train and inspire them to implement sustainable solutions and carry the torch.

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