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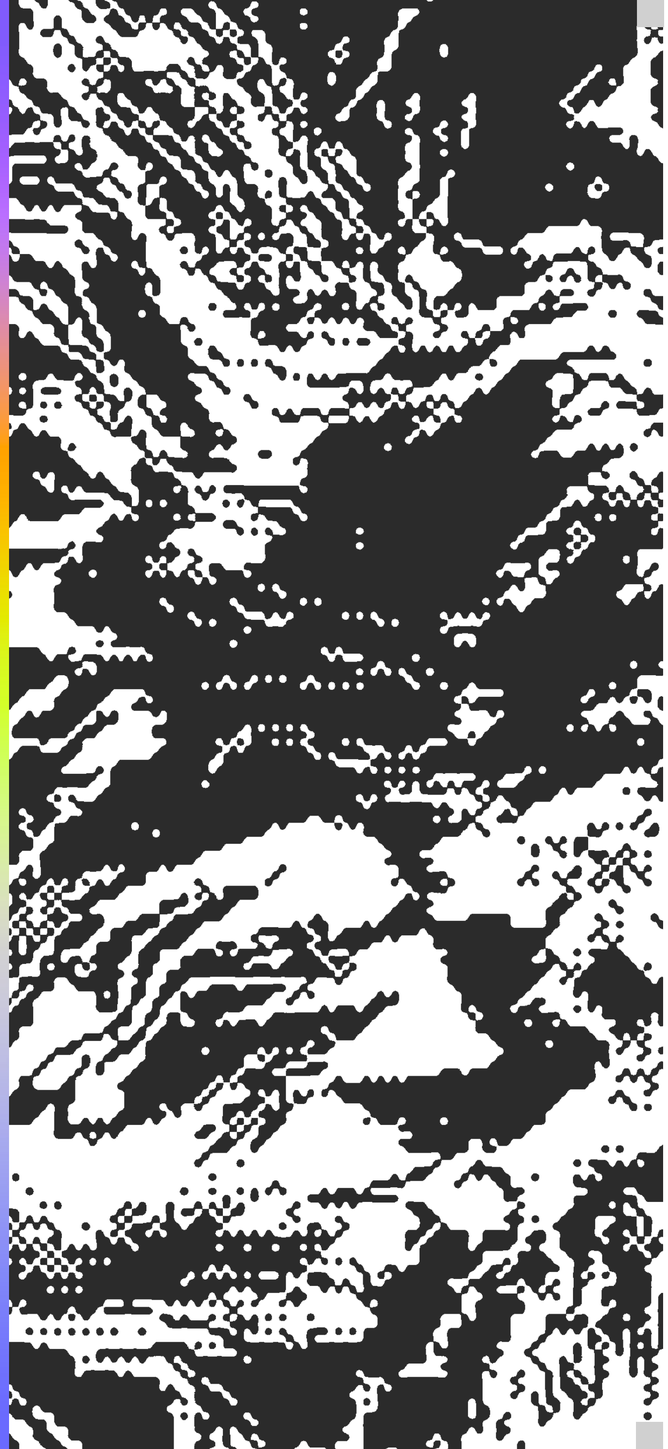

The Road to Interoperability

An Open Metaverse State of the Union By the People Building It

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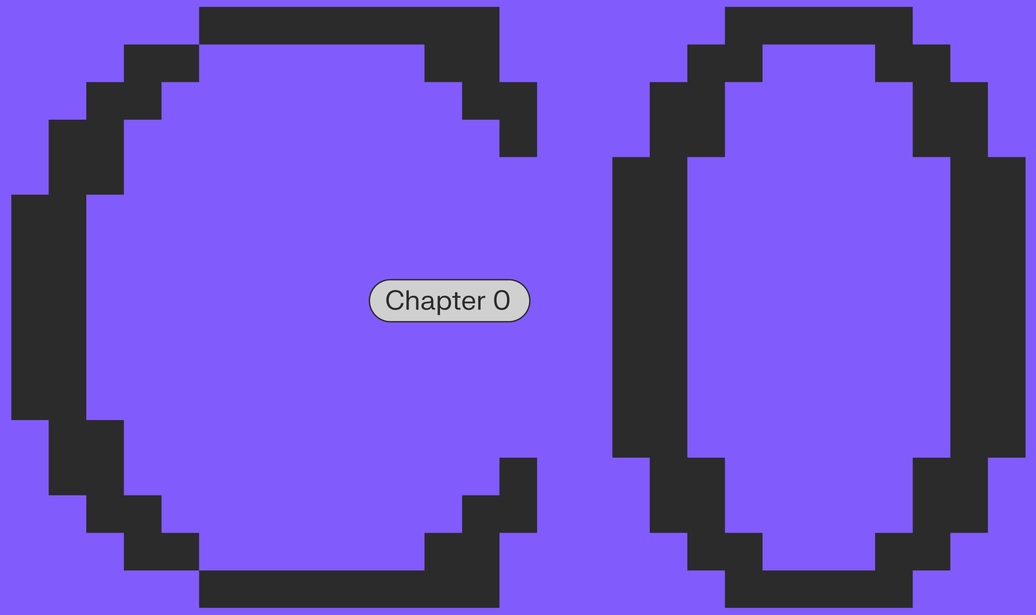

Chapter 0

Introduction

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Jonathan Brun

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Jonathan Brun is the CEO of Lighthouse. Prior to founding Lighthouse, Jonathan worked in venture capital, an industry where he invested in both the blockchain and traditional software spaces. He started his career in investment banking at a global bank, where he focused on M&A and capital markets transactions. An entrepreneur, dad, and avid martial arts practitioner, Jonathan has competed on the international scene in both judo and Brazilian jiu-jitsu.

Justine Massicotte

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Justine Massicotte is co-founder and CTO of Lighthouse. Prior, Justine worked as an AI scientist in charge of query suggestions for a world-leading search provider. Before going into tech, Justine was a philosophy researcher focusing on the role of spatiality and embodiment in consciousness. She is an avid learner who went as far as learning to read ancient Greek just because she found Plato funny.

INTRODUCTION

Founders' Letter

Gm friend, and welcome!

Since you're here, you've likely heard about the odd term, "metaverse," and have maybe wondered about its even more curious cousin, "open metaverse." What do they mean? Where do we stand? Why does it matter?

You might have read one of the many metaverse reports authored by major consultancies and financial institutions but felt they lacked connection to what's really happening in the trenches. You are looking for more technical depth, data-driven insights, and first-hand accounts from the leading builders and creators of the spatial web.

This report calls on the open metaverse community to answer those questions by surfacing rigorous, boots-on-the-ground perspectives from our smartest co-conspirators.

So let's begin with the most obvious (and most extraordinary) insight: you exist.

While we know governments don't always agree on who can enter certain places, what information we must share while doing so, and the liberties to which we are entitled, no one can deny that you exist, that you are a person, and that you are alive in the physical realm.

Today, a growing technological pervasiveness challenges this conventional reality. Since ancient times, humans have modified the physical plane to create boundaries, communities, and infrastructures that identify and unite us. In the last few decades, we have extended this instinct to modify our surroundings into the digital plane, creating a hybridized virtual and physical reality whose definition expands beyond geographical limitations.

Enter the age of the metaverse.

Unlike the physical world, where strict immutable laws like matter, gravity, motion, and mass delimit our experience of reality, the metaverse is our blank canvas. But that doesn't mean our digital reality can (or even should) exist without laws, limits, and boundaries. It's just that we get to design these constructs and conditions in ways that best suit prosocial human ends.

So how do we move around and exist in the digital realm? On what terms? According to whose rules?

PHOTO BY MIGUEL RAZA

Every single one of us at Lighthouse shares the same conviction: that users should be atomic unit of the metaverse, not platforms. Digital spaces must facilitate the free movement of individuals and their data, assets, and social connections from place to place, built upon technologies that allow exchange between ecosystems. This is far from being the case in our internet filled with walled gardens, but it still can be in the open metaverse. And that open metaverse cannot exist without extensive interoperability.

Every single one of us at Lighthouse shares the same conviction: that digital spaces must not resemble the walled gardens of the current internet era, built and circumscribed by Big Tech platforms that prevent the free movement of individuals and their data, assets, and social connections. The promise of an immersive, real-time virtual world can only be built upon technology that allows data exchange between segregated ecosystems. Therefore, the metaverse cannot exist without interoperability.

In fact, we think that the term "open metaverse" is redundant, unnecessarily repeating the same two interdependent ideas, as if the metaverse could be anything but open.

So why is the expression "open metaverse" gaining momentum despite its odd framing? Why is it in the title of this report and even in our company mission?

Why are organizations, thought leaders, and respected builders debating an idea that should be anything but controversial?

We believe that this tension is the result of an unspoken battle: established Big Tech players fear losing billions of dollars of equity value as the internet transitions towards a more open, interoperable, and user-centric architecture. Meanwhile, newcomers see a generational opportunity to build things from the ground up, create significant value in the process, and improve upon paradigms of the past.

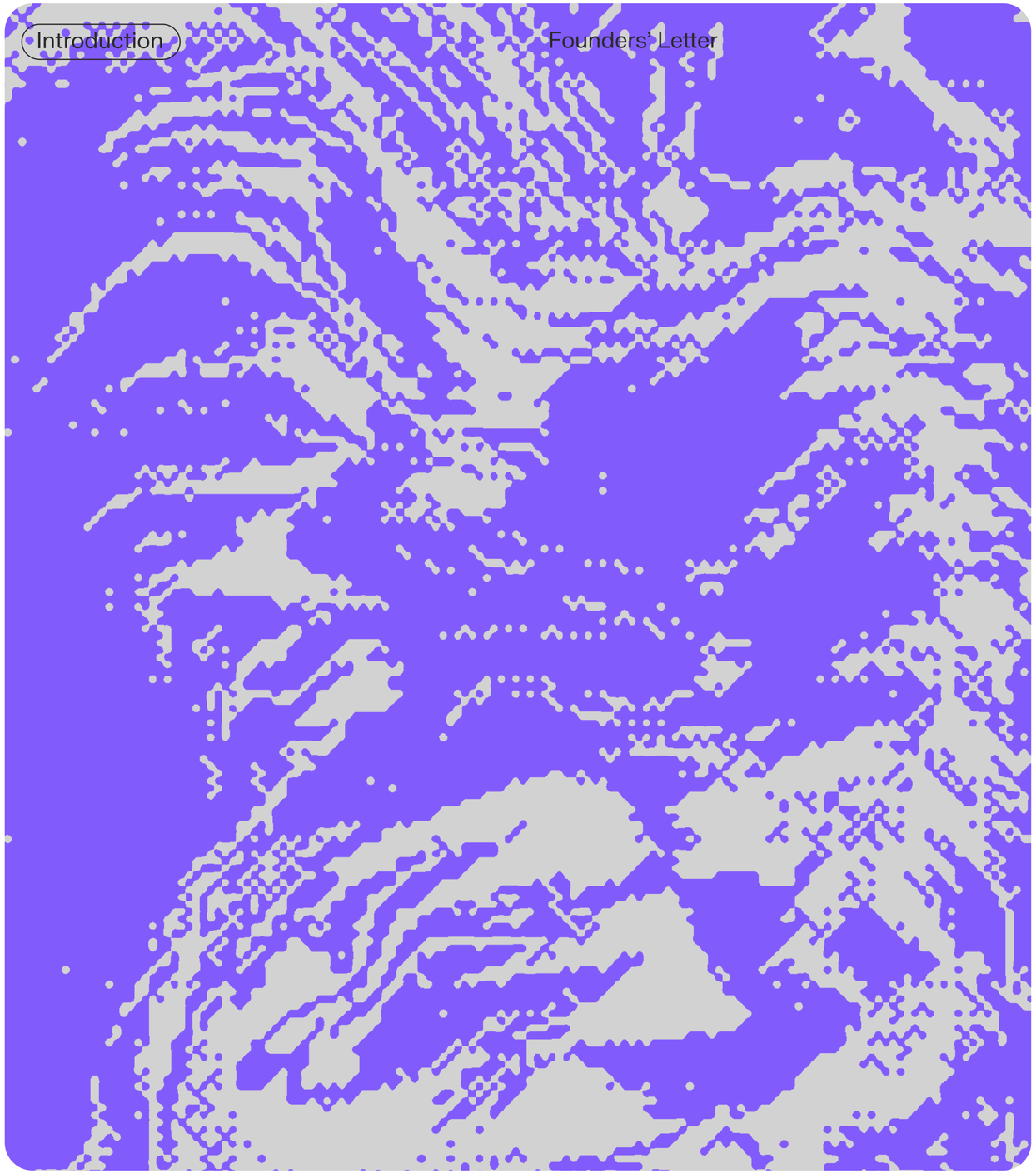
In reaction to this battle of ideologies, a group of emerging leaders — Lighthouse included — have rallied behind the odd pleonasm that is the open metaverse. We do this not to contrast an open metaverse with the paradoxical idea of a closed one, but rather to emphasize the part of the definition that should never be forgotten or diluted: the metaverse is by definition open, or it is no metaverse at all.

To better understand and capture the essence of the open metaverse movement, we decided to go directly to the source and speak to the people and companies building it. The result is this wide-ranging report on the state of openness in the metaverse as viewed by industry builders themselves. And since an open digital environment cannot exist without the unimpeded exchange of assets, value, and experiences across worlds, interoperability is the key feature we examine in this report.

In the course of research and speaking with our peers in the industry, some defining features of an open, interoperable metaverse became obvious:

Ten Building Blocks of the Open Metaverse

[1] Open-source software that frees developers to build without limitations	[6] Frameworks for composable intellectual property that transition internet users from tenants to owners of their digital experience
[2] Open standards that encourage composability	[7] Contextual privacy settings that preserve policy transparency, boundary integrity, and granular consent across all environments
[3] Minimally-extractive business models that align compensation with value creation	[8] User-centric identity management that moves the locus of control over personal data away from platforms and into users' hands
[4] Web-based accessibility free from third-party intermediaries and distribution chokeholds	[9] Neutral payment rails that facilitate digitally native forms of peer-to-peer value flows
[5] Decentralized storage independent of private, company-controlled servers	[10] Community governance that invites and rewards user ownership, sovereignty, and participation



Our belief in these guiding principles is why we started Lighthouse in the first place. Justine explored deeply the notion of identity that is so core to the metaverse when she was a University of Montreal philosophy researcher focusing on spatiality and embodiment in consciousness. She then expanded on identity in the context of technology, artificial intelligence, and privacy as she led the machine learning search and recommendations' development team at Coveo, a publicly-traded search company. These ideas also matter deeply to Jonathan as the crypto-pilled father of three young kids who will inherit this emerging and immersive digital future.

Lighthouse's mission is to support the adoption of the open metaverse by simplifying access to and discovery of the experiences it powers. We want creators to build great things, users to have fun, and virtual worlds to thrive — all with the ethos of openness and interoperability that birthed the internet. We are doing this through an intuitive navigation engine, aggregating the wonders of the spatial web, and collaborating with virtual worlds to ensure that creators are the ultimate winners of this digital rebirth.

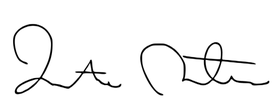
If we succeed, great content will help unlock visibility for worlds and creators. Discovery will be at every newcomer's fingertips, and creators will be able to build direct relationships with their fans, free from platform intermediation and financial extraction.

We have a long way to go. To be perfectly transparent, we are just getting started. But we believe a thriving metaverse is an ideal worth reaching for — and this vision drives us every day.

With all that said, thank you to our amazing contributors, to our killer team, and especially to you, reader, for caring about a topic whose importance cannot be overstated.

Have fun as you explore these pages!

Ju and Jo



Contributor Biographies

Evin Mcmullen
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Evin is the co-founder and CEO of Disco, your identity for the metaverse. Disco enables your personal data backpack, making data and reputation portable across web2 apps and web3 blockchain ecosystems. She is also co-founder of DAO Jones and inkDAO and an advisor to Web3 projects including Boys Club, Engage Raise, and NFT3. She is a graduate of Yale University.

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Fatemeh is the co-founder and Chief Metaverse Architect at Spaces DAO, a collective of architects and designers dedicated to building the future in the metaverse. As an architect interested in the intersection of technology, art, and design, she immediately found her passion within the metaverse and its NFT realms. She believes that architects and designers have a duty to get involved and help shape the future of the internet.

Fvckrender
Artist

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Fvckrender has already made his mark on the digital land, and it is a massive mark at that, bringing not just art, but community, utility, and ultimately entirely new worlds to the metaverse. A self-taught and native digital artist, has been innovating in the cyber world since long before it was his full time job. Originally from Montreal, he developed his artistic prowess from his own laptop, prioritizing his work every chance he could while working to support himself. Utilizing breaks and stolen moments before shifts, he taught himself to use the 3D art software that has since defined his career. Developing incredible dedication along with his skills, he began creating one piece of work every day — a tradition which continued for the next five years.

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Jamie is the founder and CEO of Outlier Ventures, a top web3 investor globally and top accelerator by volume. An early investor in cryptocurrencies, Jamie founded Outlier Ventures in 2014 with the belief that decentralized technologies would introduce new paradigms for the web and create a more equitable and open economic system. Today, Jamie is at the forefront of an investment landscape that spans various web3 technologies as they converge with media, commerce, and culture to lay the foundation for the metaverse.

Jin
Hacker Artist

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Jin is a founding member of m3org, Webaverse, Metafactory, and Neon Buidl, as well as author of the renowned open metaverse blog, Xrdevlog. A recognized thought leader in the space, Jin's writings and technical contributions to the open metaverse have played a key role in influencing an entire generation of builders in the space. Jin helps push for the open metaverse by educating users on the tools available to them to make it happen.

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@JonnyHowle

Jonny is the co-founder and Chief of Strategy at Disco. A product designer by trade, Jonny has been working at the intersection of design, ethics, privacy, identity and Web3 for the past 7 years. You can find Jonny in Breckenridge, Colorado skiing and producing hiphop and R&B music.

Justin Melillo
Mona

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Justin is the co-founder and CEO of Mona, the premier 3D world-building platform and web3 social network for the metaverse. A visionary 3D artist and AR/VR designer, Justin founded Mona with the mission of empowering people around the world to create, collect, and share high-quality, immersive experiences on the blockchain. Justin believes the metaverse should be creator-driven, decentralized, and accessible for all, which is why Mona strives to be the medium of the metaverse.

Luis Fernandez
Creator

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Luis is a metaverse architect and a hybrid creative to the core, always seeking meaningful experiences enriched through design and strategic thinking. A veteran design and retail industry executive with a forward-thinking vision and focus on innovation, Luis is also a member of the Council of Fashion Designers of America.

Robby Yung
Aminoca Brands

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@viewfromhk

Robby is the CEO of Animoca Brands, a leader in digital entertainment, blockchain, and gamification fields. Robby has successfully started several businesses in China and Hong Kong in telecoms and software applications, cable television, internet services, outdoor advertising, and publishing. He has raised multiple rounds of private and institutional venture capital and has been through four IPOs, several trade sales, follow-on financings, and multipe mergers and acquisitions.

Ryan Gill
Crucible

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Ryan is a pioneer of the open metaverse movement. He is the founder and CEO of the Crucible Network, an enterprise offering easy on-ramps for developers to leverage web3 technologies, as well as a founding member of the Open Meta DAO, an organization supporting the delivery of products, experiences, services, best practices, and tools underpinning the emergence of an open metaverse. Ryan stands out as a visionary leader and entrepreneur and has been among the first industry figures to promote the term "open metaverse."

Sébastien Borget
The Sandbox

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Sébastien is the co-founder and COO of The Sandbox decentralized metaverse, a virtual world where players can create, play, own, govern, and monetize their experiences using NFTs & SAND, the main utility token of the platform. Sébastien also became the President of the Blockchain Game Alliance in 2020, a non-profit organization of 400 key members of the industry. He was recently named #4 in *CoinTelegraph*'s Top 100 most influential people in crypto in 2022, and The Sandbox has been featured in *Time*'s Top 100 most influential companies of 2022.

Timmu Tõke
Ready Player Me

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@timmutoke

Timmu is the co-founder and CEO of Ready Player Me, a cross-game avatar platform used by more than 4,000 companies that has raised $72 million from a16z and others. Timmu has been building avatar technologies for nine years, from hardware 3D scanners to custom-built avatars for top gaming companies. He now focuses on simplifying the integration and ease of expression for users joining the open metaverse.

INTRODUCTION

Methodology

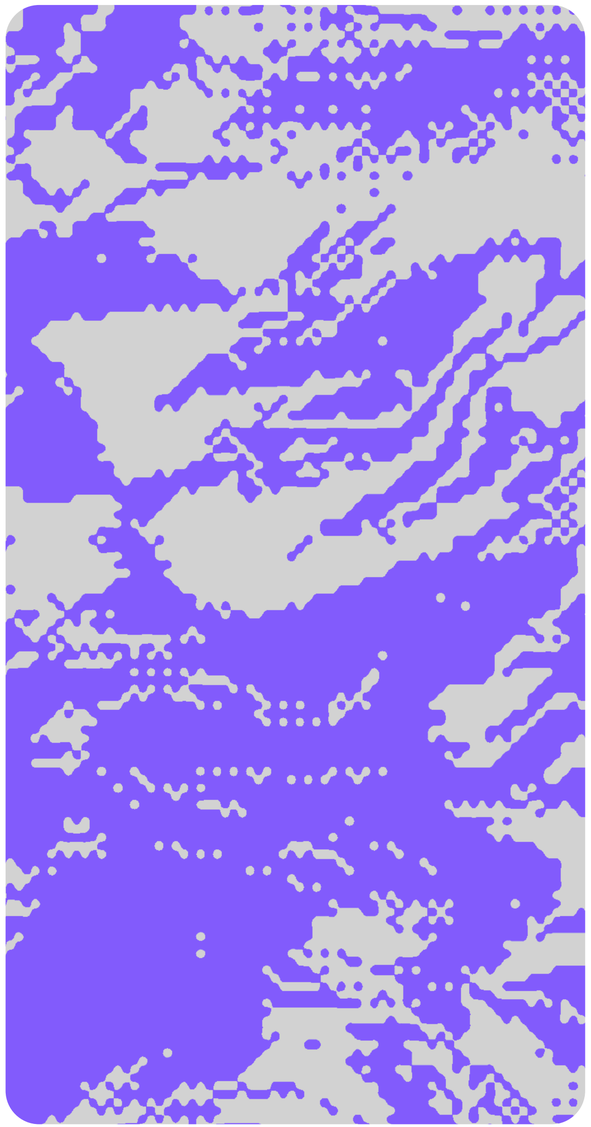
Throughout this report, we include excerpts from interviews with more than a dozen creators, founders, and builders across the open metaverse. These excerpts have been lightly edited for clarity but without changing their meaning.

When deciding which projects to include in this report, we made sure to invite influential stakeholders and thought leaders. Our contributors are the founders, developers, artists, and CEOs building today's open metaverse ecosystem. Our goal is to report on the industry-wide sentiment regarding interoperability, tapping into a relevant sampling of many key players setting the pace for the rest of the space.

While we asked each contributor for a customized list of questions, the invitation underpinning every interview was simple: Are you ready to build this thing? (This thing, of course, being the open metaverse.)

Thankfully, we found that most of our contributors and interviewees are just as enthusiastic about creating a truly interoperable metaverse as we are. These interviews offered important nuance and unique viewpoints, and we include synopses of our conversations throughout the report for richer context.

With that, let's begin.



INTRODUCTION

Disclaimer

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Fvckrender

[TWITTER]
@fvckrender

Fvckrender has already made his mark on the digital land, and it is a massive mark at that, bringing not just art, but community, utility, and ultimately entirely new worlds to the metaverse. A self-taught and native digital artist, has been innovating in the cyber world since long before it was his full-time job. Originally from Montreal, he developed his artistic prowess from his own laptop, prioritizing his work every chance he could while working to support himself. Utilizing breaks and stolen moments before shifts, he taught himself to use the 3D art software that has since defined his career. Developing incredible dedication along with his skills, he began creating one piece of work every day — a tradition which continued for the next five years.

His unique and futuristic style is both mechanical and eerily human, filled with raw emotion not often seen within machinery and tech. Currently based in Vancouver, BC, he continues to bolster his already impressive body of work, using the process of creating as a form of self-therapy. Using his art to illuminate and thereby overcome past traumas, he infuses it with striking vulnerability, balancing it with a necessary element of fun. His work has been featured in esteemed auction houses such as Christie's and Sotheby's. The recent success of his FVCK_CRYSTAL project has generated over $36 million in total revenue. Some notable clients include Ledger, Supreme, Hypebeast, The Hundreds, Swarovski, Dior, Avant Arte, Spotify, TIME, and many more.

[DIGITAL ARTIST]

[1] ## NFTs can help artists become less reliant on studio work.

Before NFTs, FVCKRENDER made his living, like most artists, through commercial work.

“I worked for people and worked for studios,” he told us. “And even back then, I always considered myself an artist, not a worker. I hated working in studios. I think it's people just abusing other people.”

When NFTs hit the scene, artists gained new freedoms, FVCKRENDER explained. “The NFT space gives artists the chance to truly discover themselves and create what they want to create. My approach to art really changed because I was able to be defined as a true artist instead of just, like, someone that works in a studio. This shifted my brain. I felt more connected to *why* I was making things.”

[2] ## Yet, artists shouldn’t underestimate the amount of work and dedication required to be successful in the metaverse and web3.

Through his NFT success and eventual founding of LVCIDIA, a space-themed virtual experience and NFT artist hub, FVCKRENDER has learned that an NFT art career is not just about striving for fast wins.

“You're putting your life into this,” he said, adding that LVCIDIA has a team of 40 people constantly working on the project.

Every idea requires fundraising, project management, creative design, and technical development. FVCKRENDER therefore appreciates how big of a challenge interoperability is from both an artistic and technical point of view. He cautions NFT buyers and collectors from getting too swept up in a new project’s roadmap without understanding the commitment needed to actualize the founders’ vision. When NFT projects promise utility, such as a PFP that can turn into a metaverse avatar one day, buyers should recognize that such ideas are still experimental.

Likewise, creators should also have patience with themselves: “When I see these NFT projects being like, ‘Oh, we're going to be a new Fortnite,’ I think, ‘you're never going to be Fortnite,’” FVCKRENDER said. “That doesn't mean you can’t do amazing and innovative stuff. But don't try to be something that you cannot be right now. It's going to take a decade to be Fortnite — not six months.”

[3] ## The digital artist’s tech stack can be simple.

“I'm only using Cinema 4D and OctaneRender,” FVCKRENDER told us. “I've been using them for almost a decade now. So that's pretty much it.”

Cinema 4D is a 3D computer animation, modeling, simulation, and rendering software, whereas OctaneRender is a GPU render engine. The LVCIDIA team uses Cinema 4D to create scenes and models that they import inside the Unreal Engine game engine.

Chapter 1

01

In the Rearview Mirror

A Brief History of the Metaverse [11]

From Text-Based Games to Immersive Worlds [13]

More Than Just Gaming [15]

How Interoperability Benefits Creators: [16]
In Conversation with Fatemeh Monfared and Luis Fernandez

Jonathan Brun
Co-founder &
CEO, Lighthouse

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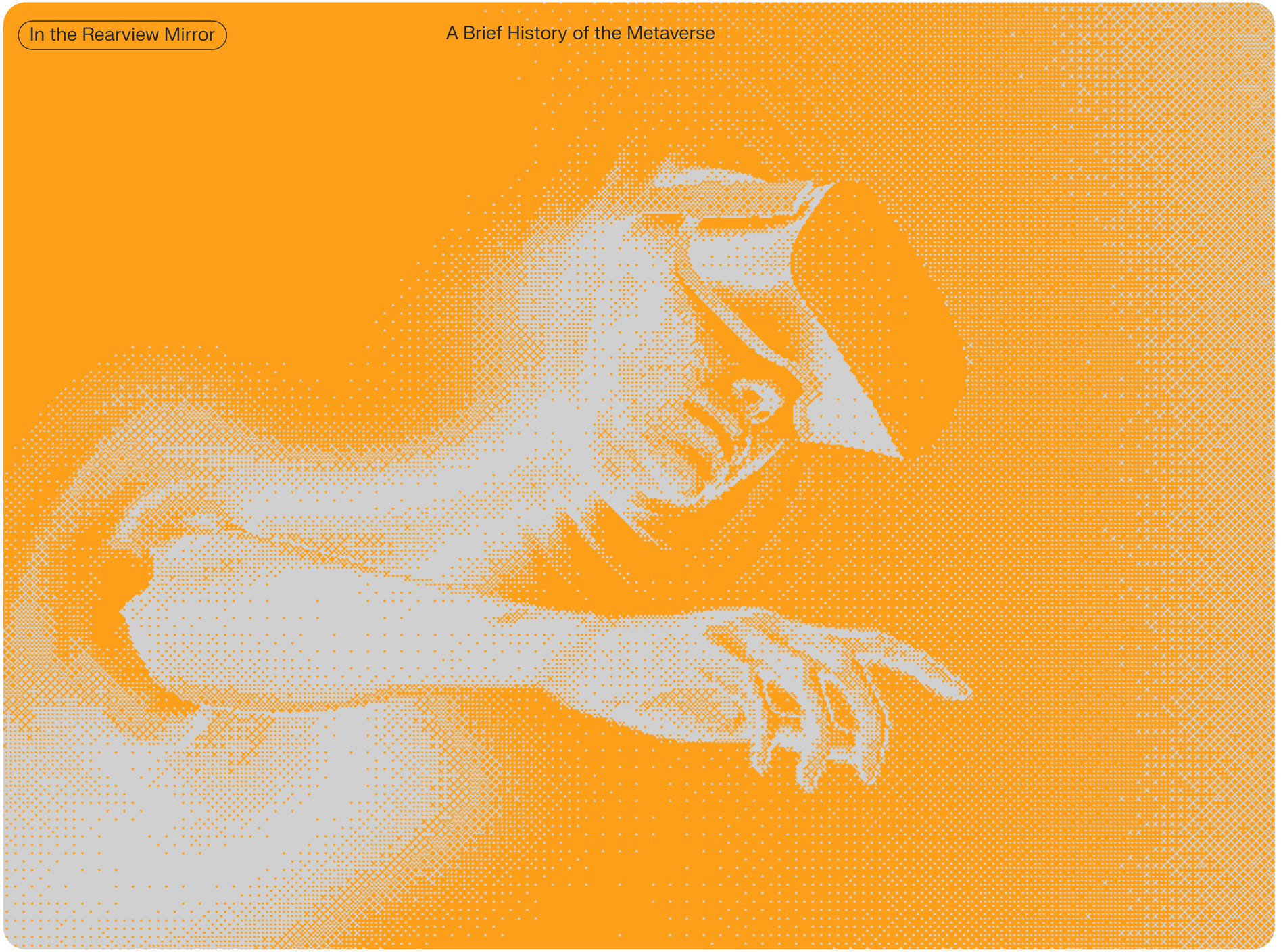
“At Lighthouse, we believe that the metaverse will completely change our way of interacting with the web.

It will empower users to step into the frame and live experiences instead of just seeing them from the outside. It will turn browsing from a solo experience to a multiplayer one, where surfing the web will be inherently social. We define this new 3D era of the internet as the spatial web.”



The term “metaverse” was coined by science fiction author Neal Stephenson in the 1992 novel, *Snow Crash*[1] and rose to near-ubiquity in 2021 thanks to Facebook’s high-profile rebrand[2] to Meta in a bid to capture the tailwind of an emergent phenomenon.

Generally speaking, the term “metaverse” refers to a parallel virtual plane where human interaction and activity take place, including leisure, recreation, socialization, work, and commerce.

But the concept existed well before 2021, and even before 1992. Writers have been describing the metaverse since at least the early 20th century. In 1935, about sixty years after the first moving picture[3] was published, American science fiction writer Stanley G. Weinbaum described what might be the earliest description of immersive virtual reality in his short story, “Pygmalion’s Spectacles.”[4]

Today, novelists and screenwriters continue to imagine the metaverse, inspiring countless engineers and technologists with the ideas they dream up.[5] But the metaverse is more than just a recreational fantasy. According to thought leader Matthew Ball, the innovation required for the metaverse and augmented reality (AR) in general will require sizable overhauls to many of the tools we currently use as well as those we will need in the future, such as new hardware and devices with better computing power.

Therefore, most of our contributors — as well as members of the industry at large — believe the metaverse will one day become the successor to the mobile internet. At the very least, the metaverse presents an opportunity for a global technology upgrade. And this, argues Ball, might “alter the balance of power between technology giants, independent developers, and end users” for decades to come.[6]

IN THE REARVIEW MIRROR

From Text-Based Games to Immersive Worlds

The origins of virtual computing worlds reach back to 1975, when programmer and caving enthusiast Will Crowther developed the first interactive fiction computer game, Colossal Cave Adventure.[7]

The pioneering, text-based adventure game inspired a young University of Essex student, Roy Trubshaw, to expand on Crowther's work by adding multiplayer functionality. The result was MUD (Multi-User Dungeon), the first multi-user adventure game — and arguably the first metaverse world.

Then came the aughts, an era in which many of us remember Second Life and Eve Online launching in 2003 as the first user-generated content (UGC) game platforms. These two worlds attracted millions of users and created complex game economies. Second Life hosted over one million regular users in its first year alone. For-profit companies such as Adidas, BBC, and Wells Fargo, along with nonprofits like the American Cancer Society, used Second Life to conduct some of the interpersonal aspects of their business operations.

By 2005, Second Life's GDP exceeded $30 million, and it grew to $500 million by 2009. In 2007, Second Life launched a stock exchange program to allow companies within the virtual world to raise capital using Second Life developer Linden Lab's proprietary currency, Linden Dollars — perhaps an early signal of the cryptocurrency-based economies we see in blockchain worlds today.

However, Linden Dollars weren't blockchain-based cryptocurrencies. The currency was proprietary, closed-source, and only valuable within the siloed parameters of Second Life itself. Though we now understand these limitations as perhaps the most obvious value propositions for blockchain technology, Linden Lab is still seen as an industry first mover that helped today's metaverse builders learn important lessons.

History of Virtual Worlds

SOURCE: LIGHTHOUSE

[1] YEAR	[2] NAME
1985	Mauad
1995	Active Worlds, Worlds Chat
2000	Animal Crossing
2003	Second Life, Eve Online
2004	World Of Warcraft
2005	Club Penguin
2006	Roblox
2009	Minecraft
2012	The Sandbox
2016	Rec Room
2018	Axie Infinity
2021	Horizon Worlds, Microsoft Mesh

Exploding Pace of Development Across Web3 Virtual Worlds

SOURCE: LIGHTHOUSE

[1] YEAR	[2] NAME	[3] AMOUNT
2018	Axie Infinity, Voxels	<5
2019	Alien Worlds	<10
2020	Decentraland, Somnium Space, Blankos Block-Party, Active Replica, The Nemesis	<15
2021	Mona, The Sandbox, Portals, Spatial, Oncyber, RareRooms	<30
2022	pax.world, Ethereum Towers, Shibaverse, Stage11, Treeverse, Alpha Verse, A0K1VERSE, SportsIcon, Bullieverse, Webaverse, The Brook, Illuvium, Nifty Island, Everdome, Genesis Worlds, Otherside, Star Atlas, Reach, Upland, Blocktopia, Xone	150+

IN THE REARVIEW MIRROR

Two Perspectives on Land Scarcity

“Metaverse platforms have been capitalizing on this notion of artificial scarcity and this idea of selling land in virtual worlds. The metaverse is the next evolution of the internet, and like the internet today, there is an unlimited amount of virtual land. As a creator-focused platform, selling limited plots of land wasn't the business model that we wanted to go after. This type of scarcity creates a huge barrier to entry for creators where they have to spend money just to get access to a plot of land in one of these worlds to start building. Even once they gain access, they then have a very limited set of tools to build with.

If we want the metaverse to be a vibrant and super high-quality place, we need to remove these limitations for creators. Until now, the conversation has been more about speculating on land sales and less about the actual artists. Our aim is to help elevate creators, and to cater to the brilliant 3D artists, architects, and game designers who want to realize their full creative vision in the metaverse. As we spend more and more time inside virtual worlds built by these creators, I believe the most value is going to accrue to spaces based on their artistic quality and creative merit, not based on their plot on a map. For us, it's really, really important that the metaverse be open and accessible, which is why it's free for any creator to build and mint their own metaverse world in Mona.

They really don't have any limits. They're not limited to one specific area or one plot of land. Anyone can actually build a world as large as they'd like, that can even take 30 to 40 minutes to run from one end to the other. The needs of creators and world builders drive everything we do.”

Justin Melillo, Co-founder & CEO, Mona

IN THE REARVIEW MIRROR

Two Perspectives on Land Scarcity

“I believe that if you want to design an open world built and owned by the community, every asset should be owned by the users. This includes not just the 3D characters, or the avatars, and not just the experience itself. That’s just the content that populates the experience. But even the land that hosts the experience is digital space that makes it accessible to everyone.

I believe that there are different models. Some could have infinite land, meaning an infinite number of experiences that are accessible. And some will have a finite number of lands. That is a design decision at the beginning. We thought that the value of experiences will add to the value of browsing a world that is finished in size, and this is more important and could work better than having an infinite number of lands. Because there are no limits to the number of worlds, the quality of the experiences that are maintained is lower.

It's like in the real world. You have cities like Manhattan or Paris or Tokyo. Usually because there is this lack of real estate, there is a growing population who demand to have access to great neighborhood restaurants, schools, or work. But when some areas get abandoned, people buy them back, redevelop the property, and make them attractive again. And so we will see that all the time. We see New York and Brooklyn. We see areas in Paris, and so on. So the idea here was for us to drive a design where there would never be abandoned property. There's an economic incentive to develop and always make the space valuable — even if it's not been maintained by the original creator.”

Sébastien Borget, Co-founder & COO, The Sandbox

"Being able to wear this pair of glasses and see visual effects and 3D assets seamlessly integrated with my environment around me — I always saw that as the clear future for extended reality (XR) and the future of digital asset ownership. And now, being able to marry to those two concepts, track unique digital assets on a public ledger, and merge them seamlessly with the real world to interact with them through interactive experiences across desktop web browser, mobile, VR, and AR — I see that as the future of the metaverse: one that is focused on creators and developers."

Justin Melillo
Co-founder & CEO, Mona

A BRIEF HISTORY OF THE METAVERSE

More Than Just Gaming

When people think of the metaverse presently, they are most likely talking about video games, which draw the largest portion of users[8] and deliver the best immersive experiences available today. With more than three billion gamers globally — close to half of the planet's population — the gaming industry has literally subsidized the development of real-time 3D rendering technologies for all of humanity for nearly 30 years.

Like the web today, the fully actualized metaverse will be everywhere, blended seamlessly through all facets of life. In retail stores, when grocery shopping, while socializing or during work functions, the metaverse will encompass a convergence of virtual experiences, platforms, and technologies far beyond its genesis in games.

Entering the metaverse will feel spatial and immersive, departing from the familiar scrolling of two-dimensional, text-based web pages or jumping between disjointed mobile applications. We predict that soon, people will interact in the metaverse similarly to how global business teams convene remotely on Zoom or Microsoft Teams. In fact, with Meta's new Quest Pro, people will take those business calls in the company's closed hemisphere of the metaverse via Meta's Zoom and Teams integrations — or through Meta's own Horizon Workrooms VR meeting software.[9]

How we collaborate to build the metaverse will impact nearly every arena of our lives — just like the internet did. Therefore, the importance of getting the metaverse "right" cannot be overstated. Because, as we have seen in everything from election tampering [10] to losing the cybersecurity race[11] to inciting real-world violence[12], getting digital technology "wrong" has far-reaching downstream effects on everything from social and political cohesion to flourishing commerce and trade.

Although the metaverse will be consequential for society, it's important to align on one fact: there is only one metaverse — just as there is only one internet. The metaverse is composed of many interconnected digital worldspaces, similar to how the internet consists of an infinity of web pages connected through the Internet Protocol Suite (IPS). And just as the open internet sparked debates around property rights management and permissionless distribution, the open metaverse brings with it a new set of challenges related to interoperability and governance. In trying to replicate and expand physical experiences into virtual realms, we must renegotiate and reexamine the social contracts, norms, and legal agreements governing everything from property rights and commerce to privacy, safety, and ethics.

"The metaverse is real-time 3D social media where people can create and engage in shared experiences as equal participants in an economy with societal impact."

Tim Sweeney
Co-Founder & CEO, Epic Games

HOW INTEROPERABILITY AFFECTS CREATORS

In Conversation with Fatemeh Monfared and Luis Fernandez

Conversations with prominent creators like Luis Fernandez and Fatemeh Monfared offer a "rubber-meets-the-road" perspective on interoperability — a technical and somewhat theoretical concept that can be hard to pin down in practical terms.

Fernandez is an architect, but considers himself at core a futurist and "hybrid creator." His breaktaking NFT Villa, which dropped on MetaMundo[14] on August 8, 2022, demonstrates how digital artists and designers can combine forward-thinking design with traditional aesthetics.

Meanwhile, Monfared is co-founder and chief metaverse architect at Spaces DAO,[15] a collective of metaverse designers. Her work has always existed at the intersection of technology, art, and design, and has now expanded to NFTs and the metaverse.

Ahead, we asked Monfared and Fernandez about how interoperability affects their creative work. Here were their takeaways.

Expect increasing complexity as more metaverse worlds are built.

Initially, said Monfared, building in the metaverse was somewhat easy. But now, more worlds have begun to crop up and designers have to consider interoperability with more intention than in previous years.

"We work on so many different platforms," she said. "Each of them have their own ways of uploading your files, and bringing your designs onto their platform."

Navigating these considerations takes time, she said — something all creators should build into their schedule as they forge ahead onto the spatial web.

Building in any metaverse world requires a growth mindset.

According to Monfared, designing in most web3 worlds is not yet a seamless experience. For example, The Sandbox platform, which is now in its Alpha Season 3, includes a free-to-download 3D asset creation tool that assists users in producing voxel-based NFTs that can be used inside the game. It also includes an NFT marketplace in which users can buy and sell such creations, along with a $2 million game-maker's fund for those who want to build, share, and monetize games in The Sandbox.[16]

"[The experience] is improving day by day," said Monfared. "The team is very close to the creators and updates us on everything that they're doing — so that's amazing." However, she notes that on most other metaverse platforms, builders simply need a universal GLB file to upload digital assets, while creators in The Sandbox must use its VoxEdit tool-building software suite.

Virtual worlds all have varying format and capacity constraints.

Artists like Fernandez who aspire to be "platform-agnostic" may feel the squeeze of interoperability's constraints. Particularly when designing rich 3D graphics, the limits and conventions of each world constrain the creative aspirations of cross-world builders.

"When I mentioned that I was designing a house in the metaverse," said Fernandez, "most people would ask me what platform I was building it in."

It was a challenge to answer that question. "I would always say not on any platform — that [the house] was metaverse-agnostic. Saying that was not common."

But how would he figure out how to build the house and then deploy it into many different existing virtual worlds? Could he remain platform-agnostic as he hoped?

"MetaMundo definitely made my life a lot easier," said Fernandez. "The villa was a huge, huge file because it included the virtual property's landscapes, the nearby ocean, the cliffs, and the house."

Files of that size can't be rendered in every existing metaverse environment, but Fernandez still desired to be as platform-neutral as possible. "We had to work to create files for each of the different platforms and then also rethink some of the design elements," he said.

For example, Fernandez compared Decentraland with Spatial: "Decentraland plots on streets with sidewalks. In that environment, the asset would have to have a border and an edge. But on Spatial, it's endless."

The process of customizing the design and catering to distinct environments was what Fernandez described, euphemistically and somewhat tongue-in-cheek, as "interesting."

Note

[Tue, 9/6/22 12:00PM EST]

The transcript is a partial excerpt from Lighthouse's first Meet the Metaverse Twitter space on September 6, 2022.[13] It was moderated by Anastasia Uglova and Jonathan Brun and has been edited for brevity and clarity.

Jamie Burke

[TWITTER]
@jamie247

U.K.-based Outlier Ventures is a leading global web3 accelerator and founder community with a renowned reputation as the go-to authority for web3 founders, investors, and enterprises.

An early investor in cryptocurrencies, Jamie founded Outlier Ventures in 2014 with the belief that decentralized technologies would create a more equitable and open economic system, thereby introducing an entirely new paradigm for internet use today.

Outlier Ventures is one of the most active investors globally within the web3 ecosystem, having grown its portfolio to 150 startups from every region of the world, helping raise $350 million in seed funding across its various accelerator programs. Since launching its award-winning accelerator program, Base Camp, in 2019 to help empower innovators in web3, Outlier Ventures has partnered with global industry leaders including Filecoin / IPFS, Polygon, Polkadot, and online luxury fashion retail platform FARFETCH, to host dedicated accelerator programs for these web3 ecosystems. Outlier Ventures also runs Ascent, a unique, fully-tailored token launch advisory program specifically created to work with teams to help maximize the success of a token launch.

Burke spoke to editor Megan DeMatteo in September 2022 about the economics of interoperability and why openness is more financially advantageous to metaverse companies.

[FOUNDER & CEO]
Outlier Ventures

[1] Today's mass market model devalues digital assets and the intellectual property creators behind them.

Though the open metaverse is still nascent, its promise of widespread interoperability is something of a blue ocean for today's tech startups. But success models of old will not necessarily work in web3, argued Burke.

Today, the success of an internet company is very much predicated on a mass market, he explained. "Streaming is a really great example of this principle, whether it's Netflix or whether it's a music streaming platform. The economics just don't work unless there's hundreds of millions of people using that platform."

This winner-take-all paradigm in which a startup or creator must monopolize a particular vertical to be profitable has resulted in a devaluation of digital assets.

"Digital assets are actually very distressed assets in an economic sense," Burke explained. "People don't want to pay for them — or at least they don't want to pay a lot for them. They're highly commoditized. And because of that, our current economic model fundamentally does not value the experience, the asset, or everything else. It has to do it *en masse*, just to make a reasonable return."

Consider Netflix: For the monthly price of about one fancy coffee in the U.S., consumers can watch an endless repertoire of intellectual property ranging from T.V. episodes to movies, standup comedy, reality shows, and more.

"People don't want to pay for digital assets — or at least they don't want to pay a lot for them. They're highly commoditized. And because of that, our current economic model fundamentally does not value the experience, the asset, or everything else. It has to do it *en masse*, just to make a reasonable return."

Jamie Burke
Founder & CEO, Outlier Ventures

“VCs are basically subsidizing the cost of acquiring market share for it to get to the point where there might be a break-even.”

Jamie Burke
Founder & CEO, Outlier Ventures

[2] The current paradigm doesn’t actually work — even for the victors.

Given the above factors, “it's a bit of a fallacy to assume that the current paradigm works for anybody,” Burke argued.

If startups operate in a winner-take-all economy, most will fail. Success becomes less about innovation, connection, and community, and more about the cost of capital.

“This is what Bezos did really well,” Burke said. “He was a Wall Street guy. He understood that Amazon would succeed by reducing the cost of capital. It’s cheaper for Bezos to borrow money than it is for anybody else in the market. And he can afford to lose money for perpetuity, while most startups can't afford to just lose money every year.”

This Silicon Valley-style approach to capital incentivizes the idea of wasting billions trying to compete for market share, as we’ve seen play out with Amazon, ride-sharing apps, and the like, said Burke.

“VCs are basically subsidizing the cost of acquiring market share for it to get to the point where there might be a break-even.”

[3] A long tail approach is more sustainable and beneficial for all.

The concept of shifting from loss-leading, mass market, mainstream business models to a long tail approach is predicated upon the idea that an artist, creator, or company just needs to find their 1,000 true fans to make an equivalent — if not superior — profit.

“Now, obviously that doesn't mean that there won't be platforms that emerge and dominate a particular vertical or moment in time,” said Burke, citing the NFT marketplace OpenSea as an outlier in this regard. But it’s actually more about the relationship between the platform, the consumer, the user of the platform, and any kind of third parties that are creating and exchanging,” he said.

Adding interoperability to this type of relationship only compounds the long-term financial potential, he added. “The powerful thing of course, is that if you utilize this 1,000 true fans concept, where effectively the creator is in control of their audience, they can realize that relationship in a monetary sense in different ways across different platforms to eventually migrate them. The value of this manifests into something that can be moved off platform. A digital asset could be resold in another environment, or it can be borrowed and lent against [as an NFT].” The economic unit of value only *grows* with more interoperability and demand.

So why are 1,000 fans in the open metaverse arguably more valuable, than, say, three million fans on Instagram? “The method of exchange for digital consumables is, in and of itself, a digital asset.”

Chapter 2

Economic Opportunity Along the Open Road

Unlocking Abundance in Creator-Driven Commerce [20]

Making Room for a Middle Class [22]

A Look at the Numbers [23]

Market Snapshot: A Partner Report by Nansen [25]

Unlocking Abundance in Creator-Driven Commerce

Anastasia Uglova
Head of Communications, Lighthouse

[Twitter]
@AnastasiaU

“In an era when most consumers have become digital creators, web3 is offering a way for them to get paid for what they're already doing – and will soon *demand* compensation for.”

The metaverse inherits a legacy of gaming economics: privately-owned developer studios operating for-profit business models that silo and lock in users to maximize in-game value. This legacy creates obstacles to interoperability. While existing models have successfully birthed dozens of unicorns, the current paradigm of enclosed game economies misses out on the massive value-creation opportunity of an open metaverse. That's because businesses optimize for in-game revenue, not metaverse GDP.

Imagine if our physical world were designed by developers. Social guardrails, customs laws, and diplomatic norms wouldn't be the only mandates of its design. Developers would also have to consider physical properties and encode programmatic rules governing oxygen, gravity, and other constraints. Unless the laws of physics in one reality comport with those of other places we might travel, tangible items from one environment would disintegrate inside another — just as an iPhone's emojis and videos appear distorted and grainy on a receiving Android device.[17] Clothing wouldn't transfer freely across spaces unless they were designed to be compatible with each other, nor would our hair and eye color render coherently and consistently wherever we go.

This thought experiment from our physical experience helps us envision the need for compatibility across digital experiences. A case in point:

A Fortnite user cannot use an avatar, weapon, or wearable from the Epic Games-owned world inside a different world, such as Activision-owned Call of Duty. Similarly, a user can't transfer rewards or earnings from one game to redeem them in another, nor does a person's identity (and gaming track record) follow them from one gaming ecosystem to the next.

We argue this status quo violates internet users' status as sovereign citizens: instead of enjoying ownership, we become mere metaverse tenants — with borrowed assets, borrowed friends, and borrowed identities.

> "A new generation of developers who appreciate interoperability and prefer an interoperable avatar system is emerging. The philosophy of developers has changed."
>
> **Timmu Tõke**
> Co-Founder & CEO, Ready Player Me

Creators likewise face a stark reality operating within the walled-garden ecosystems of legacy platform businesses. Most private game studios own the rights to all the intellectual property (IP) generated by developers and digital artists. Here as well, developers and designers are tenants, offering their creative capital in exchange for a paycheck and "a place to stay" with their art. Meanwhile, gaming studios negotiate closed-door mergers and acquisitions without consulting the people who built the world to begin with. This model stifles economic exchange and disincentivizes broader participation in the creator economy by funneling profits away from those who produce the most value in it.

> "Having a creator economy doesn't mean that there won't be platforms (OpenSea, for example) that emerge and dominate a particular vertical or moment in time. But it's actually more about the relationship between the platform, the consumer, the user of the platform, and any kind of third parties that are creating and exchanging.
>
> The powerful thing of course, is that if you utilize this 1,000 true fans concept, where effectively the creator is in control of their audience, they can realize that relationship in a monetary sense in different ways across different platforms to eventually migrate them. The value of this manifests into something that can be moved off platform. A digital asset could be resold in another environment, or it can be borrowed and lent against (as an NFT). The economic unit of value only grows with more interoperability and demand. The method of exchange for digital consumables is, in and of itself, a digital asset."
>
> **Jamie Burke**
> Founder & CEO, Outlier Ventures

ECONOMIC OPPORTUNITY ALONG THE OPEN ROAD

Making Room for a Middle Class

In 2004, *Wired* magazine editor Chris Anderson published an article[18] describing the "Long Tail" effect that's since transformed the creator economy in now-familiar ways.

Anderson's prediction hypothesized an overall niche-down effect in supply and demand, driven by the rise of e-commerce sites (in particular, Amazon) and the internet's power to generate online sales anywhere in the world. Anderson argued that prior to e-commerce, the tyranny of physical space created a precarious situation for authors, filmmakers, musicians, and content creators. Without a proven ability to sell out physical stadiums, make albums that fly off Best Buy shelves, or fill the seats of nationally franchised movie theaters, an artist could all-too-easily get elbowed out of the market by mainstream mega-hit generators.

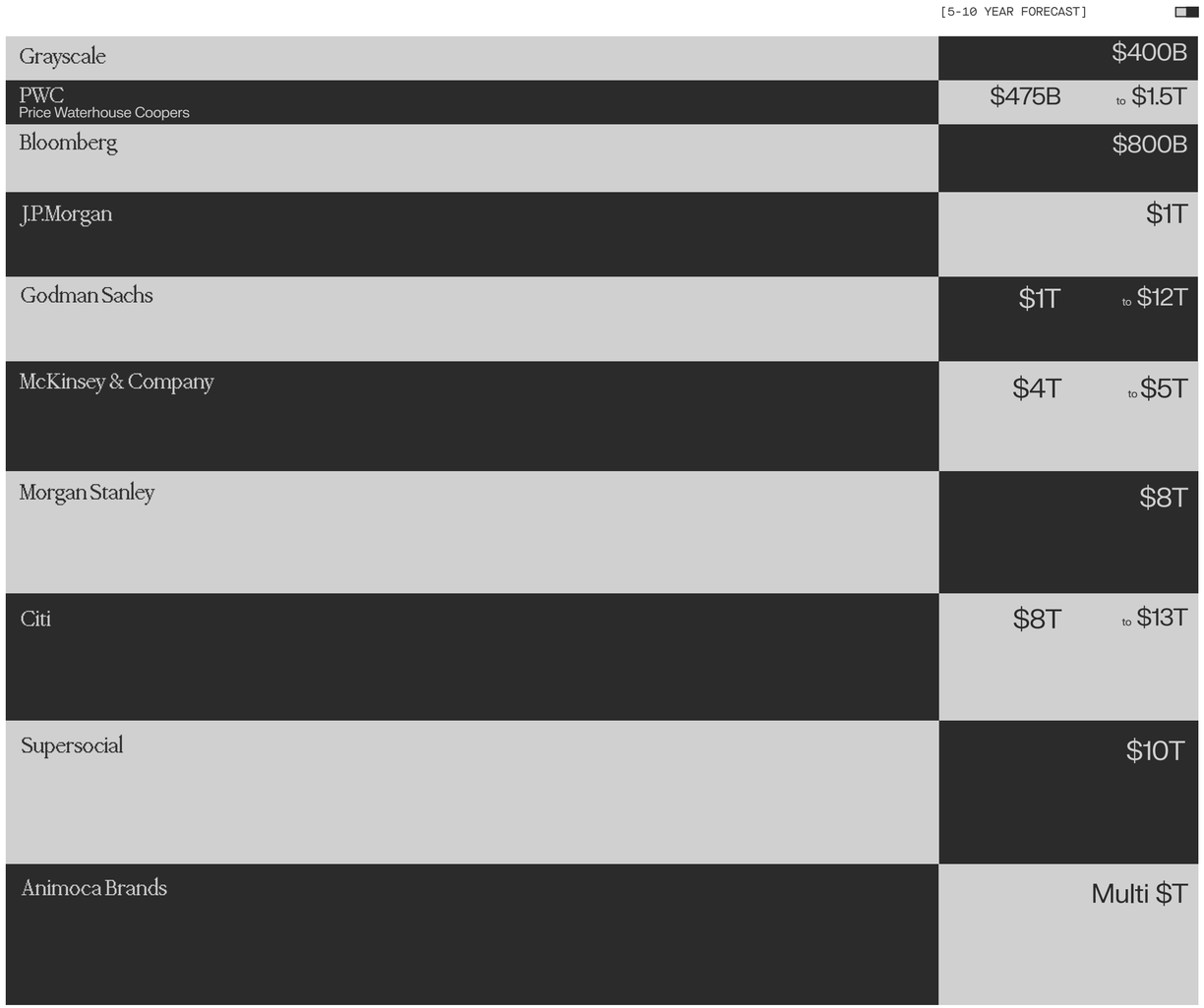
And so came the rise of e-commerce — an early signal of what we now refer to as the "web2" era of internet history. In theory, e-commerce would weaken the incumbents' market dominance secured through scale and physical distribution. Online shopping opened society up to borderless digital channels optimized through sophisticated recommendation algorithms and helped creators sell with fewer intermediaries to their "1,000 true fans," an idea popularized in 2008 by *Wired* co-founder Kevin Kelly. [19]

Despite the general accuracy of Anderson's prediction, centralized creator platforms such as TikTok, Instagram, Roblox, and Spotify still perpetuate many of the same visibility and success gaps as antiquated physical distribution methods: concentration of profits to incumbents, advertising-centric revenue models, and the ability of highly-funded projects to buy their way to attention. Platforms charge creators egregious fees (up to 75% in Roblox's case[20] and 100% for Meta and Twitter, who provide no kickback to creators), even though UGC and user data are the profit engine for nearly every centralized social media corporation. Investor Li Jin points out in her 2020 article, "The Creator Economy Needs a Middle Class," that only 2% of Patreon creators made the U.S. federal monthly minimum wage of $1,160 in 2017.[21] To achieve comparable annual earnings to that of a full-time U.S. minimum-wage worker, Spotify artists need at least 3.5 million streams per year.

In the context of the metaverse, our ability to grasp and apply the lessons of the past will make the difference between a future owned by its builders and users, and one in which they end up once again becoming the platforms' "product". [22]

Estimated Market Size of the Metaverse

SOURCE: NUMBERS SOURCED DIRECTLY FROM THE NAMED ORGANIZATIONS' METAVERSE REPORTS.



ECONOMIC OPPORTUNITY ALONG THE OPEN ROAD

A Look at the Numbers

The World Bank estimates that the digital economy is growing roughly 2.5 times faster than that of the physical world.[23] Even in its early stages, the metaverse has seen more than $120 billion worth of investments in 2022 versus $57 billion the year prior — though it is worth noting that "metaverse" definitions vary and elude objective precision.[24]

For example, it is nearly impossible to agree on the precise level of investment that has gone into macro categories such as "technology" or "the internet" over the years. The exact market scope of the metaverse at this early stage is likewise hard to estimate and depends on analysts' diverging assumptions around which market subsegments to include. Forecasts should be seen as directional at best, with readers placing more importance on relative year-over-year growth figures than absolute numbers.

In addition, metaverse users generate billions of dollars in transactions every year in the form of gaming rewards, tokens, cryptocurrencies, non-fungible tokens (NFTs), and fiat currencies (USD, EUR, GBP, CNY). Online transactions, virtual land ownership, and digital assets represent a growing share of the global gross domestic product (GDP). Global consulting firm McKinsey & Company predicts the metaverse's market value could swell to $5 trillion by 2030.[25]

According to J.P. Morgan's 2022 *Opportunities in the Metaverse* report, metaverse users spent $54 billion on virtual goods, skins, and lives in 2021 — about $12 billion more than movie-goers spent at the box office. Additionally, collectors, investors, and gamers together spent $44.2 billion on NFTs in 2021, according to blockchain data firm Chainalysis. [26] Meanwhile, Business Research estimates that in the gaming industry alone, microtransactions — i.e. digital in-game purchases that unlock new features, levels, and game-changing enhancements — amounted to $67.6 billion in 2022, with the potential to swell to $106 billion in 2026.[27]

And then there's the hardware: GSMA, a global organization unifying the mobile ecosystem, projects that gadgets and wearables could be worth $100 billion by 2030 and grow another fivefold by 2040.[28]

Here, we must pause to remind you that despite these impressive metrics, the full potential of the metaverse remains utterly unrealized. We are still in what metaverse land investment organization PangeaDAO describes as an initial "proto-metaverse" composed primarily of siloed digital worlds that don't yet interact.[29]

This indicates that the open metaverse has a long way to go to live up to its potential — as well as the expectations placed on it by investors, builders, and hardware manufacturers. For all that wealth to compound and circulate, open digital worlds must draw in far more users with experiences that create joy and connection, accessible onramps (regardless of the device price point or a person's ability to pay), as well as legal and economic frameworks that encourage trade and digital asset ownership among creators and consumers.

"The NFT space gives artists the chance to truly discover themselves and create what they want to create. My approach to art really changed because I was able to be defined as a true artist instead of just, like, someone that works in a studio. This shifted my brain. I felt more connected to *why* I was making things."

Fvckrender
Freelancer Digital Artist

We foresee the metaverse developing in a bottom-up, organic, and user-generated fashion, built by participants from all over the world — including individual builders, corporations, startups, studios, hackers, and Decentralized Autonomous Organizations (DAOs) — according to a set of emerging common standards that make distinct worlds, assets, and experiences mutually intelligible and compatible. More importantly, new options for buying and selling digital assets will invite broader participation in the creator economy by challenging the status quo of web2's extractive take rates — as high as 30% on Apple and Alphabet's mobile app stores[30] — and aligning compensation with value creation.

"I foresee that within three years, we will have at least one metaverse builder with a social media following of more than 100 million people and that five years from now, being a game designer or metaverse builder will become the #1 profession that kids aged 8 to 15 will aspire to when they're asked what they want to be when they grow up.

The creator economy is just getting started. And in the future, kids won't merely want to start businesses or YouTube channels — they'll want to build their own worlds and universes."

Jonathan Brun
Co-founder & CEO, Lighthouse

ECONOMIC OPPORTUNITY ALONG THE OPEN ROAD

Market Snapshot
A Partner Report by Nansen

About Nansen

Nansen is a blockchain analytics platform that analyzes 100M+ labeled cryptocurrency wallets and their activity to provide trading firms, hedge funds, and VCs with insights into the crypto and NFT markets. Nansen is funded by a16z, Coinbase Ventures, and Accel, among others.

Market analysis is particularly tricky in the metaverse industry. Analysts have to rely on on-chain data, which is incomplete because a lot of metaverse activity is stored off-chain. They therefore have to make nuanced inferences that go beyond looking at on-chain prices and trading volumes to track user sentiment and projects' health.

Metaverse projects that use blockchains as the infrastructure for their economic activities benefit from being able to transparently monitor how their users and investors interact with project assets. This is because on-chain activity is public by default — and therefore easy to access and analyze.

But on-chain transparency does come with significant drawbacks: it raises major privacy concerns that put users at risk and strains project budgets due to the high costs of on-chain storage.

To mitigate both, projects often elect to host some of their gaming and metaverse experience on closed servers. This means that, without access to in-depth analytics of off-chain activity, analysts can only paint an incomplete picture from on-chain data about meaningful metaverse adoption.

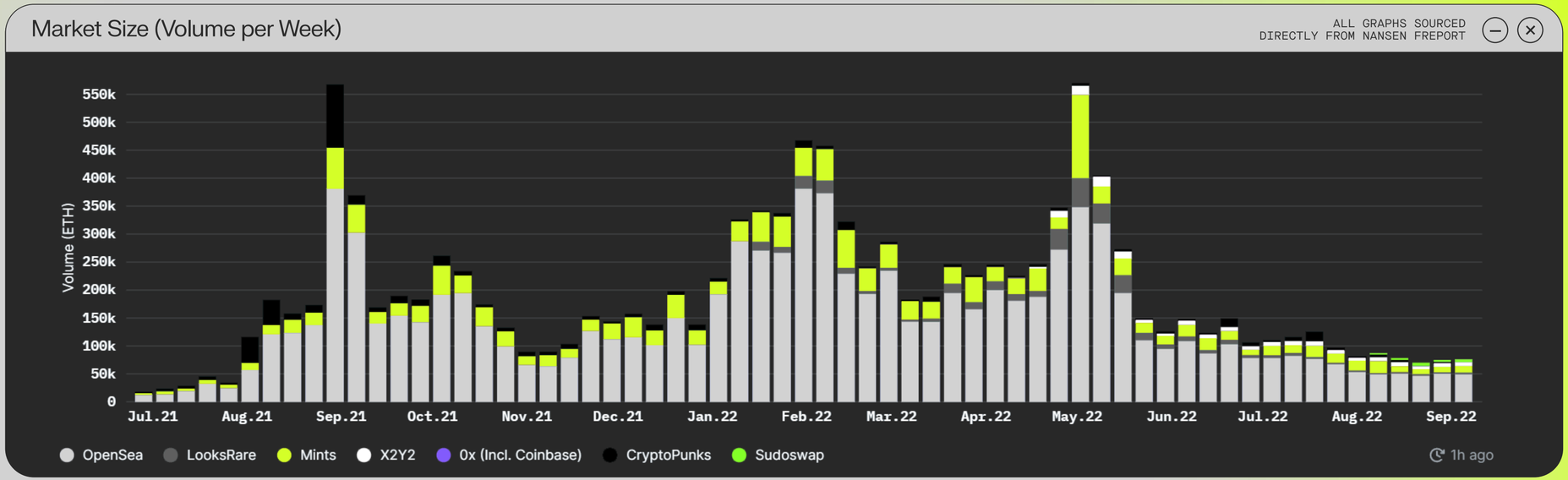
Despite these nuances, we can still observe patterns, interpret trends, and form general conclusions about how users and virtual land owners engage in the metaverse. Ahead, let's explore a few key indicators.

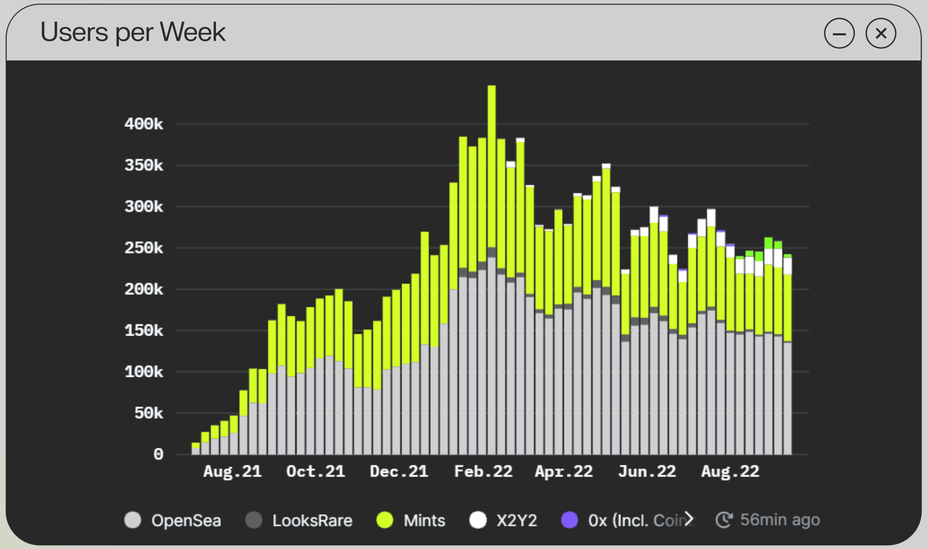
Peeking Behind the Hype Curtain

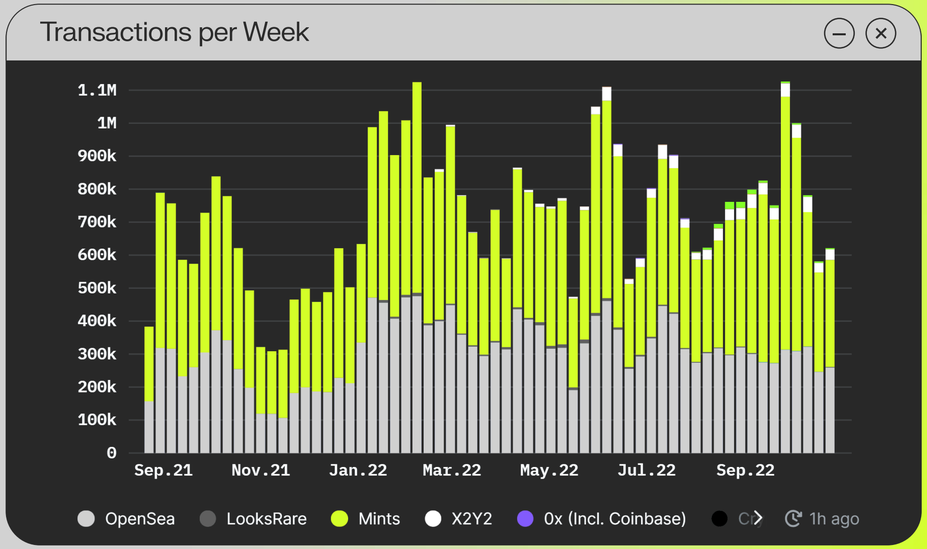
The year 2021 was indisputably the year of NFTs. According to research[31] led by Josh Stark from the Ethereum Foundation, creators on Ethereum earned approximately $3.5 billion in 2021. Adding in assets such as virtual lands and gaming NFTs, the total earned is even higher — closer to $3.9 billion[32] as projected by a16z.

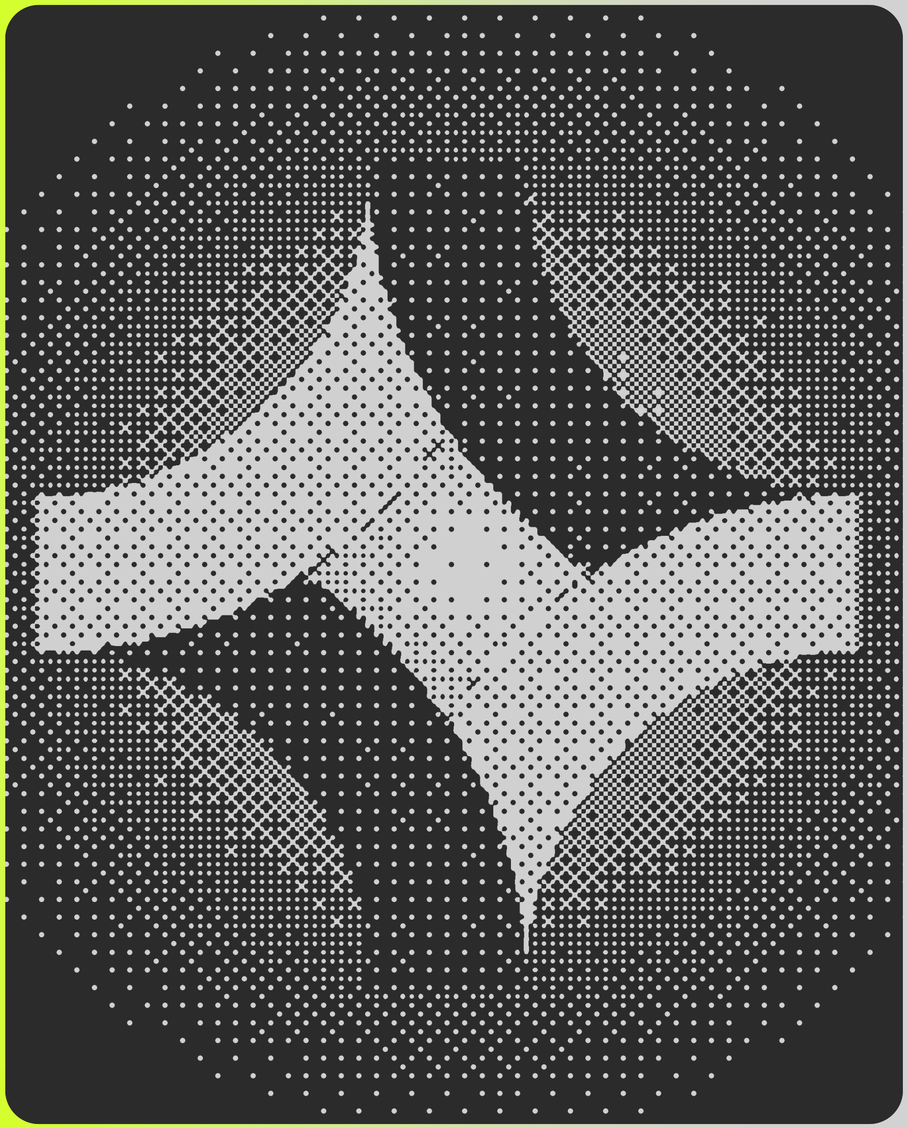
The market downtrend didn't have a direct negative effect on NFTs in the first months of 2022. While the price of Ethereum went down in January, volume in Ethereum-centric NFT marketplaces actually increased by 106% month over month. But with continued contraction in crypto markets and the price of Ethereum ranging close to the previous cycle peak, investor interest in NFTs started to dwindle, showing a steady decline in market volume beginning in May 2022.

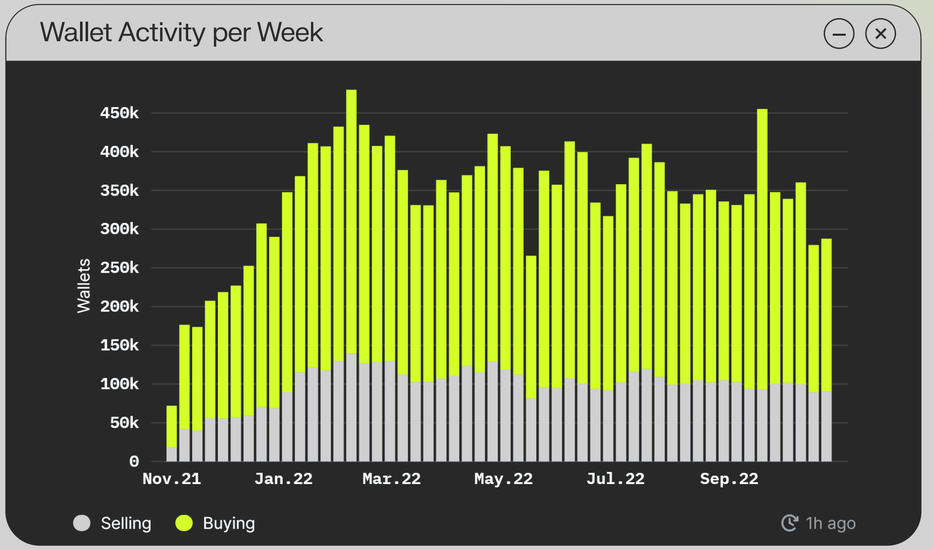
Surprisingly, market participation did not churn significantly despite negative market conditions. Total transactions have weathered the drop mostly unscathed, not diverging meaningfully from their 2021 average levels, and user numbers have remained relatively stable. Transaction traffic responded to the trend toward free minting and low-price initial sales by shifting away from buying and selling and towards minting.

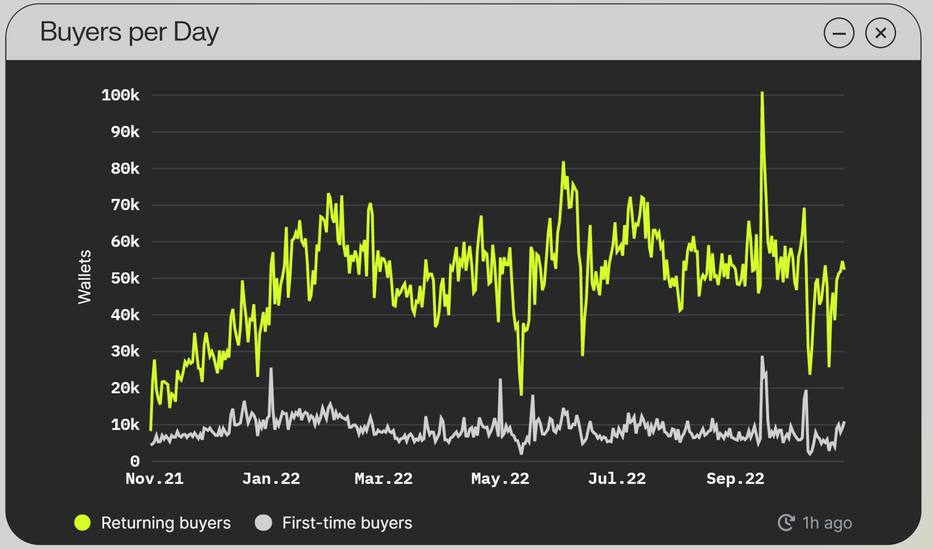












Longitudinally, transaction volumes remained the same on a three, four and six-month rolling average, suggesting that wallet activity will sustain as well. The number of daily buyers remained close to 2021 highs as a constant flow of new buyers replaced participant churn. The health of this traffic despite the fall in total financial value transacted foreshadows continued adoption of NFTs.

What It Means for the Metaverse

The NFT boom of 2021 was followed by corresponding expansions in metaverse and virtual lands markets. The number of projects vying for a slice of the crypto pie increased rapidly as OpenSea's monthly volume grew from $8 million in January 2021 to nearly $5 billion in January 2022. Meanwhile, prominent projects such as The Sandbox and Decentraland were initially met with consumer interest in their land assets.

Trading Volumes

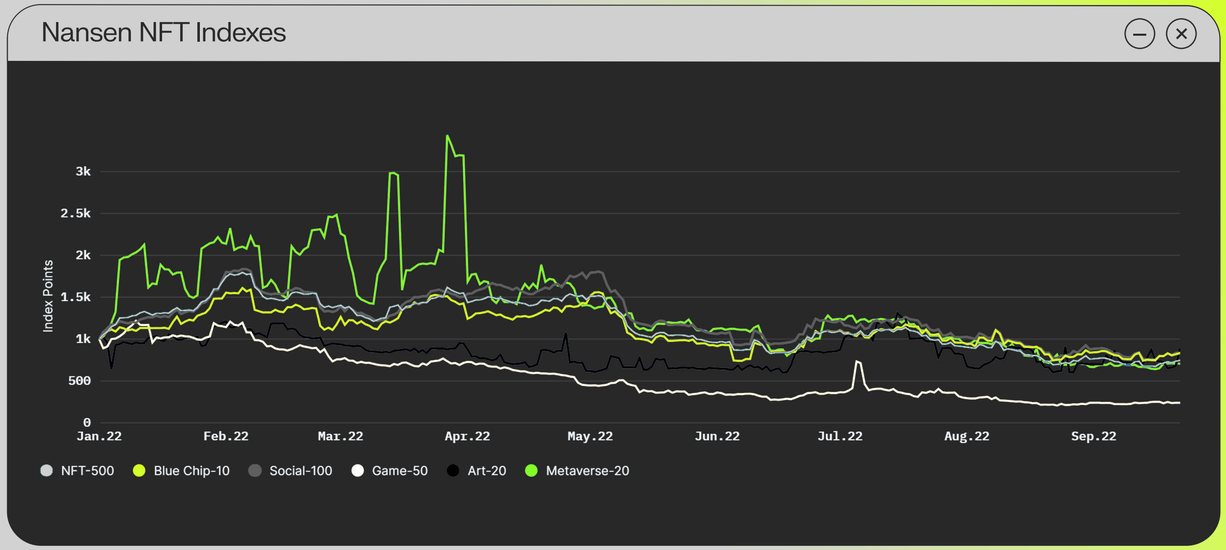
Except for volume spikes in certain collections, overall transactional traffic for metaverse projects has been in decline. This is partly due to the state of the market and partly because most of these projects either failed to show viable adoption or are still in developmental stages and cannot offer proper utility to compensate for diminishing hype.

While analysts can look to trading volumes in fungible tokens and profile picture (PFP) collections as reliable indicators of project adoption, metaverse asset volumes tell a more ambiguous story. That is because asset investors — as well as the target audience for the game — are quite different in virtual land markets. They're generally more interested in the future utility provided by a piece of land, rather than the fully materialized artistic value of a PFP project.

On the other hand, metaverse asset trading volume does serve as a good approximation of project resources, because a percentage of secondary sales accrues to the project's treasury. A project with a plentiful treasury can weather unfavorable market conditions better than one with fewer treasury funds — and is therefore more likely to sustain long-term growth.

For instance, in the 90-day period leading to October 2022, the volume for The Sandbox LANDs was 4,944 ETH on Ethereum (or $7.4 million at an ETH/USD ratio of $1,500), resulting in 247.2 ETH in project treasury revenues (or $370,000). This indicates that The Sandbox can rely on a healthy treasury to sustain operations during a market downturn. Meanwhile, Webaverse managed to earn more than 300 ETH in royalties (or $450,000) with approximately 4,000 ETH volume on OpenSea (or $6 million).

While this high trading volume is linked to minting and not a sustainable phenomenon that indicates adoption, it does show that Webaverse was able to expand its treasury during its mint, which positions it to better survive market uncertainties. Royalties earned through secondary sales represent revenues for NFT projects which can then be used to fund core operations and strategic development initiatives.



Better Indicators of Vitality

Where can analysts look for signs of a healthy virtual land market? They can look at *distribution,* which refers to the number of single holders in an NFT collection. When the average wallet holds a low number of project NFTs relative to the total distributed supply, analysts can infer a healthy distribution among regular users — that is to say, the project isn't dominated by wealthy "whales"[33] and institutional investors.

Likewise, when the percentage of the total project NFTs held by its top ten holders is not significantly greater than the rest of the project's holders, this shows less concentration of assets among fast profit-seeking traders, and more participation from everyday buyers. Rather than looking only at trading volume and asset prices to determine health and viability, projects seeking to empower individuals and improve access to metaverse experience creators should adopt these dual indicators — number of NFTs held by wallets on average and percentage of total supply held by its top ten wallets — as their desired targets.

Another illuminating indicator is how many "diamond hands" continue to hold a particular asset despite it losing value in an almost down-only bear market. This shows investor conviction in the project's team, technology, roadmap, or some other attribute — irrespective of external market conditions. Let's take the Ethereum-based role-playing game Worldwide Webb for example: WebbLand shows both a healthy distribution (a very high 47% wallet holder-to-total supply ratio) as well as holder conviction, with 57% of wallets holding without selling any assets.

"Diamond hands" is crypto slang for people who choose to hold onto an investment despite volatility and risks. Rather than selling when the asset — or the overall market — takes a beating or appears poised to take serious damage, diamond hands double down and maintain course, profiting as pressure turns coal into diamonds. This is contrasted with the slang term "paper hands," used to describe someone who sells an investment too early, turning it into worthless paper money.

Another interesting behavior we observe is how many investors bet on multiple worlds to position for capturing the eventual upswing of the broader metaverse narrative. The two most popular projects with the highest market cap show the highest mutuality: 22% of wallets holding Decentraland LAND are also holding The Sandbox LAND. These mutual holders amount to only 6.2% of all The Sandbox LAND owners, but possess 17% of the The Sandbox LAND supply and 12% of the Decentraland LAND supply.

The mutual bet on prominent projects is also apparent in fungible token holdings: 17% of The Sandbox's SAND holders have a positive Decentraland MANA balance, and 11% of MANA holders also own SAND. Clearly, a significant portion of investors foresee a bright future for both projects.

Virtual Worlds Cross-Ownership Table

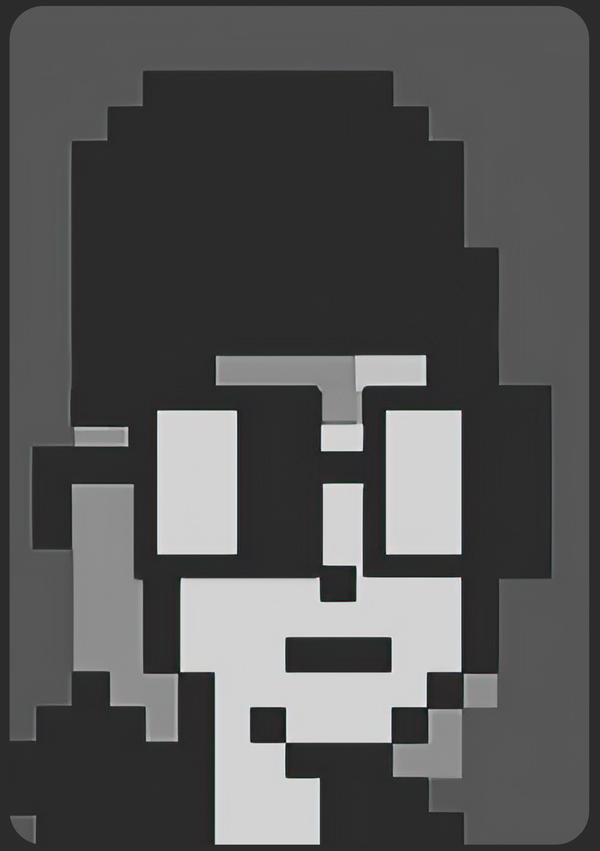
Number of Overlapping Wallets | % Mutual Wallets Concentration	Sandbox LAND			Decentraland: LAND			Othrdeed for Otherside			World Wide Webb: WebbLand			Farm Land by Pixels			NFT Worlds			CryptoVoxels Parcel			Somnium Space Land			Webaverse Genesis Pass			Treeverse Plots			Metroverse Genesis			FLUF World Burrows		
Sandbox LAND	**19130**	**100.0%**	**100.0%**	1192	6.2%	12.0%	1593	8.9%	5.8%	375	2.0%	9.8%	68	0.4%	5.1%	121	0.6%	1.7%	429	2.2%	29.1%	247	1.3%	16.9%	115	0.6%	2.0%	270	1.4%	6.1%	119	0.6%	7.9%	123	0.6%	3.8%
Decentraland: LAND	1192	22.3%	17.0%	**5335**	**100.0%**	**100.0%**	405	7.6%	1.7%	97	1.8%	1.8%	11	0.2%	0.3%	43	0.8%	0.6%	228	4.3%	13.9%	167	3.2%	14.1%	50	0.9%	1.7%	90	1.7%	1.9%	27	0.5%	1.2%	34	0.6%	0.7%
Othrdeed for Otherside	1593	4.7%	14.0%	405	1.2%	4.1%	**34178**	**100.0%**	**100.0%**	690	2.0%	18.5%	176	0.5%	9.8%	193	0.6%	2.8%	221	0.7%	8.0%	102	0.3%	5.8%	427	1.3%	7.0%	524	1.5%	13.0%	206	0.6%	12.0%	365	1.1%	15.0%
World Wide Webb: WebbLand	375	8.4%	4.3%	97	2.2%	1.1%	691	16.0%	3.0%	**4459**	**100.0%**	**100.0%**	153	3.4%	1.4%	70	1.6%	1.2%	115	2.6%	6.7%	44	0.0%	0.0%	155	3.5%	3.4%	260	5.8%	10.3%	86	1.9%	3.6%	69	1.5%	1.9%
Farm Land by Pixels	68	3.5%	0.9%	11	0.6%	0.1%	174	9.1%	0.5%	153	8.0%	6.1%	**1927**	**100.0%**	**100.0%**	22	1.1%	0.3%	6	0.3%	0.5%	1	0.1%	0.1%	27	1.4%	0.3%	40	2.1%	1.0%	46	2.4%	2.3%	24	1.2%	0.6%
NFT Worlds	121	11.8%	1.0%	43	4.2%	0.5%	192	18.8%	0.8%	70	6.8%	1.7%	22	2.2%	1.2%	**866**	**100.0%**	**100.0%**	27	2.6%	0.6%	20	2.0%	1.0%	18	1.8%	0.7%	39	3.8%	1.1%	17	1.7%	2.8%	15	1.5%	0.6%
CryptoVoxels Parcel	429	17.7%	8.8%	228	9.4%	8.3%	219	9.0%	1.0%	115	4.8%	5.5%	6	0.3%	2.2%	27	1.1%	0.4%	**2407**	**100.0%**	**100.0%**	171	7.1%	64.1%	126	5.2%	4.4%	95	3.9%	3.2%	15	0.6%	4.0%	29	1.2%	1.4%
Somnium Space Land	247	28.2%	6.4%	167	19.1%	7.5%	93	10.6%	0.6%	44	5.0%	1.5%	1	0.1%	0.6%	20	2.3%	0.4%	171	19.5%	13.7%	**875**	**100.0%**	**100.0%**	47	5.4%	1.7%	62	1.8%	3.2%	9	1.0%	0.4%	25	2.9%	1.4%
Webaverse Genesis Pass	115	3.0%	1.6%	50	1.4%	0.7%	427	12.0%	1.7%	155	4.3%	3.6%	27	0.8%	1.0%	18	0.5%	0.3%	126	3.5%	10.0%	47	1.3%	3.0%	**3561**	**100.0%**	**100.0%**	171	4.8%	4.8%	25	0.7%	1.1%	68	2.2%	1.2%
Treeverse Plots	270	7.7%	2.7%	90	2.6%	1.1%	528	15.1%	2.4%	260	7.4%	10.8%	40	1.1%	4.6%	39	1.1%	0.5%	95	2.7%	4.6%	62	7.1%	3.0%	171	4.9%	3.2%	**3509**	**100.0%**	**100.0%**	18	0.5%	1.0%	87	2.5%	3.7%
Metroverse Genesis	119	4.9%	1.2%	27	1.1%	0.3%	213	8.8%	0.5%	86	3.6%	4.0%	46	1.9%	4.4%	17	0.7%	0.3%	15	0.6%	0.7%	9	0.4%	0.2%	26	1.1%	0.3%	18	0.7%	0.5%	**2415**	**100.0%**	**100.0%**	22	0.9%	0.8%
FLUF World Burrows	123	3.5%	1.2%	34	1.0%	0.5%	365	11.0%	1.8%	69	2.0%	1.9%	24	0.7%	1.2%	15	0.4%	0.3%	29	0.8%	1.7%	25	0.7%	2.0%	68	1.9%	2.3%	87	2.5%	1.9%	22	0.6%	1.1%	**3499**	**100.0%**	**100.0%**

The Sandbox x DCL Ownership Overlap

Token A	Total Holders	Token B
SAND	408k	Decentraland MANA
Holders Token A	**Token Holder Overlap**	**Holders Token B**
174k	29.9k	264k
Percentage Token A	**Percentage Total Holders**	**Percentage Token B**
17%	7.33%	11%

Jin

[TWITTER]
@dankvr



[HACKER ARTIST] [VR DEVELOPER]

Jin is a well-known metaverse “OG” (i.e. “original gangster”) whose art and contributions to VR have earned him admiration and respect among the gaming and developer community. He has been involved with the development of metaverse-related technologies like VR, AR, cryptography, hacker art, and video game modeling for years. He is also a steward and organizer at Metaverse Makers (M3), an organization for metaverse builders and developers. (The organization reportedly liked the name “MMM,” or“M3” for short, because it represented an upside down “WWW,” or the world wide web. They couldn’t decide what the last “M” might stand for, so they decided to keep it open-ended and silent to signify multiple things — though a Google deep dive reveals the final “M” may sometimes refer to “Mastermind.”[126])

Below, we share some of the discussions between Jin and Lighthouse founder, Jonathan, over Discord or in the Mozilla Hubs Desert.

[1] You wrote one of the best threads I’ve read on Twitter about the rise of the Internet Cinematic Universe. Do you mind elaborating for our readers on the core ideas behind it?

Storytelling has been evolving from fictional worlds into transmedia universes. The most famous example is the Marvel Cinematic Universe (MCU). These universes are now expanding into gaming, the fastest growing and "always on" medium. Now imagine the Internet as a game we're all playing. The big difference between this and other cinematic universes is that we all have presence or digital real estate here. It is our shared universe we live, work, and play in. We're now immortalizing our art and memes onto an immutable public ledger via NFTs. In the next few years, these ingredients will shape together in other forms like film and games while sharing a common history.

I think we are getting to the point now where we have enough interesting ingredients we can weave together into a cinematic universe that we all have shared ownership of. But remember, it's not a shared universe if the characters in one story can't travel to the next.

[2] Openness, like decentralization, is a spectrum. You can use open-source tools, use decentralized storage, have rich public APIs, and proactively support external avatars and assets in your ecosystem. In a resource-constrained world, and looking at the current state of the metaverse, where do you think existing virtual worlds should focus first to become more open?

For a metaverse to be open, I consider several things:

[1]	Freedom of expression: custom avatars / worlds
[2]	Freedom to transact: neutral infrastructure for payments
[3]	Interoperable open standards and / or open-source
[4]	Right of exit: low switching costs to migrate content to third-party clients
[5]	Strong guarantees of privacy: ability to self-host a client / presence server and inspect what’s happening under the hood (e.g. Linux vs. Windows)

Someday, interoperability will be synonymous with digital ownership, bringing your avatar across different programs with ease via just a file, not a permissioned SDK. It will almost seem obvious in retrospect. We need to raise the bar of an open metaverse to mean more than just owning NFTs and a virtual world, which is too easy for Big Tech to co-opt and control in other ways.

“Webaverse builds on years of projects and experiments, bringing virtual worlds together with composable standards and optimizing for user freedom and interoperability by relying on popular open file formats and components like Three.js, WebGL, and WebXR.”

Jin
Hacker Artist & VR Developer

[3] How much do you think the lack of interoperability is a result of resource constraints versus a form of prisoner's dilemma where no one wants to invest resources towards open infrastructure without the guarantee that their competitors will?

One of the frustrating aspects of the metaverse trend for me has been all the talk of interoperability by the big companies, and yet the web is hardly ever mentioned by those same companies.

At the moment, we have all the technology we need to build the metaverse. Thus, it has become more of a coordination problem between the different projects. We got the internet by computers working together. I see the 3D open protocols as the stock that cooks everything together for virtual worlds. From experience, the hard part will be to align developers to build the connective tissue. Most are heads-down working in their own silos and many interop devs are volunteers.

My strategy with M3 is focused on content, documentation, and avatar interoperability.

[4] Can you share a little bit about the history of Webaverse? How did it come together? How did you approach building it and to what extent do you believe other open metaverse builders should be inspired by the way you built things?

In 2019, many from the Webaverse team participated in the first Metaverse Makers Meetup (M3) in Mozilla Hubs. M3 brought creators from every discipline worldwide to share their creations and find how the projects can interoperate. M3 is public, transparent, and open-sources its past event VODs and notes. Our shared interest in building the open metaverse is a belief that we're creating something greater than the sum of our parts.

Webaverse builds on years of projects and experiments, bringing virtual worlds together with composable standards. It optimizes for user freedom and interoperability by relying on popular open file formats and components like Three.js, WebGL, and WebXR. Over the years, other projects (like Emuki: a WebXR immersive console emulator, Exokit Web: a JavaScript library for composing multiple WebXR sites, Exokit Browser: a WebXR meta-browser used to load and blend virtual worlds, Exokit Avatars: complete web-based inverse kinematics avatar system, and XRPackage: package 3d web apps into a single file) have built the infrastructure necessary to create Webaverse. Prior to Webaverse, Avaer (@webmixedreality) was himself building engines and browsers that could run XR apps together, permissionlessly thanks to open standards. Avaer then built an open-source browser called MetaChromium that runs WebXR content anywhere alongside SteamVR.

Webaverse is an open-source and browser-based web3 metaverse engine, where anyone can build and host virtual worlds and gaming experiences on top of it. Ninety-nine percent of social VR is closed source — even most of the crypto-based VR. Webaverse is an outlier that took the high and difficult road to build a truly open stack from the ground up beginning years before any of the metaverse hype. For the first time, users will be able to create, experience, and monetize operable objects built on standard file formats through a familiar game interface: avatars, inventory, load-outs, and multiplayer parties. This strong foundation unlocks value by connecting communities in gaming, content creation, and blockchain technology. Uniquely, all users' content is created as operable tokens on the Ethereum blockchain. Creators can drag-and-drop assets (images, 3D models, avatars, scripts) into the game in real-time to showcase and monetize their creations. Users can buy parcels of land on which to persist content. The parcels are embedded in an expanding overworld hub curated by the Webaverse team. Webaverse's first game, Upstreet, has an evolutive storyline like Fortnite. It will be accessible across a range of devices including VR headsets because the system is powered in users' browsers.

[5] For those who don't know, you also have one of the richest metaverse-focused blogs, called Xrdevblog. Some of those pieces date back to early 2018. What got you interested in the space in the first place? Was it clear to you back then how big of a movement NFTs and the metaverse would become?

To me, the Internet has always been a place of freedom where you could do anything, be anybody, and be unrestricted from any of the cards you were dealt. You can truly carve your own destiny. I just loved and looked up to the Maker and Hacker culture. Then, right around when Palmer Lucky (the original inventor of the Oculus) had his Kickstarter in 2012-13, I was also binge-reading cyberpunk and sci-fi novelists like Neal Stephenson and William Gibson. As soon as I got my Dev Kit 1, I knew that VR was going to be the next big thing and that it needed to be in the hands of the people. I knew I could have an impact. As I see the metaverse as the next internet, I don't want to live, work, and socialize in a virtual world where a corporation owns everything.

It's fair to say that I've been interested in building in the open-source VR scene since the very beginning. I've documented a lot of stuff as I experimented with these technologies on xrdevlog. I published all my research online for others to see. While I'm experimenting with all of those projects, I always look for ways that they could become interoperable — and interconnected with one another.

As for crypto, I heard about it while living on the internet. Satoshi's mysteriousness was a really interesting story and I started mining Bitcoin and Litecoin on my computer to get some and play with it myself in 2010-11 while Bitcoin was less than $10. I knew it was the future when people started buying drugs with it, because if people could trust this technology enough to do that, it could also be safe enough to be used by the general public. I think of the blockchain as a shared data layer, and the underlying technology for the next wave of computing. One of the connections I saw with NFTs is that it could close the value for people to create open-source VR experiences.

[6] Do you believe that users will end up spending most of their time in the big four to five leading worlds as they do on social media platforms today? Or, on the contrary, do you think that a wide universe of very different places will coexist in a fragmented ecosystem?

Social is the killer use case for the metaverse and VR, but thinking in zero-sum games is a web2 concept. Instead of seeing other metaverse projects as competition, I'd rather find ways to complement or extend those systems. How to give users more freedom? How to give users more ways to connect, explore, and have fun?

I think virtual worlds are going to become networks and eventually economies. They will integrate with this larger ecosystem — this shared universe. Right now, most platforms are building in silos but also adopting open-source formats to optimize for preservation and interoperability. Each platform is trying to stabilize its own ecosystem but will aim for more interconnectedness soon thereafter. Most worlds already have web clients, so trespassing is a thing. In terms of wearables and avatars, it's totally possible for these things to be cross-platform.

"I think virtual worlds are going to become networks and eventually economies."

Jin
Hacker Artist & VR Developer

[7] What are some of the coolest things you've seen being built in the space around the notion of interoperability?

I believe avatars and identity are core to an open metaverse and that we need to own the tools that make them more accessible. So M3 and Webaverse have been teaming up to build open-source avatar builders with VRM export. We always look at things with the optics of more freedom and less friction.

VRM files are an extension of the widely supported glTF2.0 standard and can work between Blender, Unity, VRChat, NeosVR, Craftopia, and many other games. It's a standard for 3D avatars and is maintained by the VRM Consortium, which originated out of the VTuber world in Japan and was built on glTF. It is supported by hundreds of apps today, establishing itself as the number one avatar file format for the open metaverse. Practically any humanoid character model can be made a VRM avatar.

Justin Melillo

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While popular land-based metaverse platforms like Decentraland and Voxels capitalize on the notion of virtual land scarcity, Mona took a decidedly unique approach to value creation with its free-to-mint world-building platform in which artists may design high-quality metaverse environments as NFTs.

Launched in October 2021, Mona currently hosts more than 4,000 creators building out virtual worlds. The company doesn't sell virtual land or charge creators for anything upfront, but rather provides tools, systems, and protocols to enable anyone to build in the open metaverse.

"I saw a gap in the market," Melillo told us. "Digital artists, 3D creators, architects, and game designers were really underserved. Up until now, the conversation has been about land scarcity and who's buying or selling land. But for us, it's really important that the metaverse be open, accessible, and free to build for anyone."

In Mona, any creator can build and mint their own metaverse worlds and then host experiences within those worlds without limits. "You're not limited to one specific area or plot of land — you can actually build a world as large as you'd like, even one that could take 30 to 40 minutes to run from one end to the other," Melillo said.

Ahead, let's take a look at Melillo's takeaways from Mona's early success and explore how creators make monetizable experiences on the platform.

[CO-FOUNDER & CEO]
Mona

[1] Investing in the metaverse requires a long-term mindset.

"We really believe in the metaverse long-term," said Melillo. "Over the next decade, as we spend more and more time in virtual spaces, we really do believe that the value of online worlds is going to be derived from the actual creative and artistic merit of them."

Compared to the physical world, where land scarcity and location drive a property's long-term value, virtual worlds will be most valuable when they offer a unique, high-quality experience. After all, navigating from world to world is as swift as clicking "enter" on the keyboard, and coding allows developers to create an infinite amount of virtual geography.

The biggest value-add is therefore derived from a person's creative vision: "We believe in investing in creators and developers, which is why we wanted to approach Mona from a different perspective," said Melillo.

[2] Mona is a member of the Metaverse Standards Forum and utilizes decentralized peer-to-peer file storage systems.

"The discussion on interoperability is super, super important," said Melillo. "Especially when we're talking about building the concept of the open metaverse, which is one that isn't owned by one centralized entity."

Mona is therefore a member of the Metaverse Standards Forum. "It comes down to working together with others to make sure that everyone is using a common set of standards," Melillo explained. "In Mona, all the 3D assets that artists create are actually decentralized and stored on IPFS. Creators and collectors have true ownership of their digital assets minted on Mona."

The InterPlanetary File System (IPFS) is a peer-to-peer file sharing and storage protocol that utilizes a distributed file system. Mona also partnered with Filecoin, an open-source and blockchain-based cooperative storage and data retrieval network.

"As the metaverse evolves over the next centuries, we want to make sure that today's high-value 3D assets and works of art are preserved in decentralized storage and here to stay," Melillo said.

As in comparison, assets within a privately-owned metaverse world like Roblox or Meta's Horizon Worlds would disappear if the platform ever shut down. Storing assets on a decentralized network creates a universally-accessible backup system, and a paradigm for true ownership of digital assets.

[3] ## Mona focuses on interoperable avatar systems.

Beyond using decentralized storage, Mona is integrating other fun and exciting applications of interoperable assets.

For instance, VRM is the interoperable file format used for 3D avatar modeling, and Mona creators can now import VRM avatars into their worlds. The company also announced a partnership with Ready Player Me and has its avatar creator tool directly integrated into the Mona interface, meaning that users can customize their full-body avatars directly within the experience without leaving to an external website or app.

“Ready Player Me has an excellent interoperable avatar system,” Melillo explained. “We love their team and everything that they're building. We also see a huge community forming around custom avatars.”

The VRM format was popularized by the avatar chat application, VRChat, and is fully interoperable in nearly all types of interactive game experiences.

“Supporting file standards like that and giving creators and users the ability to purchase assets, then take their assets into Mona and other worlds, is really the key to unlocking the open metaverse,” Melillo said.

He added: “It's just really important that we have a lot of participation and collaboration amongst all the players in the space to ensure the creator, developer, and end user are at the forefront.”

"As we spend more and more time inside of virtual worlds, these experiences need to be super high quality. The most value is going to accrue to worlds based on their artistic quality and creative merit.
We aim to help elevate creators and cater to the brilliant 3D artists, architects, and game designers who want to realize their full creative vision in the Metaverse."

Justin Melillo
Co-founder & CEO, Mona

Chapter 3

3

Milestones Toward a Thriving Open Metaverse

Crafting the Conditions for Interoperability [36]

Ten Building Blocks of Open Worlds [38]

Reflecting Ourselves in the Metaverse: [57]
In Conversation with Disco's Evin McMullen and Jonny Howle

Crafting the Conditions for Interoperability

Robby Yung
CEO, Animoca Brands

[Twitter]
@viewfromhk

"In the physical world, we still have countries like China or North Korea that choose not to participate in the internet in the same way as other countries. I think we will see technology companies make those same decisions.

As a result, there will be impacts because consumers will choose systems they like to work within. I think what will happen is that where consumers get less benefit and less choice, they will maybe vote with their feet and go elsewhere."

We are arguably not ready for the metaverse — even though, to some extent, we are already living in it. Engineering teams and industry startups are still working on designing the necessary infrastructure, tools, and standards required to build a virtual reality in which real-time, synchronous events may occur and exchange data on a massive scale.

We recognize that total interoperability is impossible. It should be seen as a spectrum rather than an end-state.

Building towards an interoperable future is the path forward, but it also implies concrete bandwidth challenges for builders. Companies are all focused on shipping and executing their vision to their early users, which requires immediate focus and short iterative cycles.

The tradeoffs are stark, especially for young enterprises with limited resources. They have to be intentionally experimental and pivot quickly, taking focus away from long-term planning. In the startup environment, longer-term considerations regarding things like common data rails, surveillance-resistant privacy policies, decentralized data storage, user-centric identity management and login, sensible asset ontologies, rich APIs, and mutually-readable file formats often take a backseat to serving users in the here and now. Plus, the high-risk nature of venture capital often incentivizes unfortunate tradeoffs that favor user growth often at the expense of generating prosocial value[34] and protecting public goods such as cognitive autonomy,[35] user safety, data privacy, and asset and identity ownership. These goods are harder to price into a business model but they are central to the promise of an open, dignified, and humane metaverse.

Unless companies commit both individually and collectively to the long-term vision of an open metaverse, we will all lose out by building a fragmented experience that fails to deliver on the promise of true digital sovereignty.

Ahead, we outline ten key building blocks we see as fundamental to creating a thriving open metaverse. It's imperative that creators, studios, users, and developers alike internalize these principles and create in accordance with them.

Unless companies commit both individually and collectively to the long-term vision of an open metaverse, we will all lose out by building a fragmented experience that fails to deliver on the promise of true digital sovereignty.

"For us to have a chance at a more open and connected metaverse that consists of thousands and millions of worlds, there needs to be an easy way to navigate between them. What the big platforms are trying to do is like, 'This is my metaverse, and I'm gonna build walls around it.' It's so hard to come in and navigate between that and the rest of the digital world. And then there's charges and various ways to lock you in. So for us to have a chance for an open, connected metaverse, there need to be avatars to travel across worlds easily, money that travels across worlds and assets, and a lot else — and that's how we can potentially have a future that is different from the current power dynamics of the internet."

Timmu Tõke
Co-founder & CEO, Ready Player Me

MILESTONES TOWARD A THRIVING OPEN METAVERSE

Ten Building Blocks of Open Worlds

1. Open-Source Software

…THAT FREES DEVELOPERS TO BUILD WITHOUT LIMITATIONS AND ALLEGIANCES

The original internet, now popularly referred to as "web1," was built on open-source software. The term "open-source" refers to code that was created (often by multiple contributors) to be freely available, with licenses that allow for anyone to modify and / or redistribute it for all purposes, with proper attribution.

Open-source software gave birth to the application era of "web2," which leveraged open protocols and open standards to create the web we use today. Without open-source software, behemoths such as Google, Apple, and even Microsoft — which famously admitted to being on the "wrong side of history"[36] on the open-source debate — might not be a tenth of the businesses they are today. However, with the walled-garden business models of web2, companies also locked users and their data into the proprietary platforms built on top of those open infrastructures. [37]

Apple, for example, wrote its software using open-source code like the KHTML rendering engine for Safari and XNU for iOS, but still created a walled garden within its app store by keeping the application layer proprietary.[38] Through proprietary code and hardware-software integrations specific to Apple products, the company locked out competitors and enforced device exclusivity to successfully defend its market position — most notably for its iPhone. iTunes, iCloud, the App Store, Apple TV, and many other components are likewise carefully designed and integrated to ensure that users stay within the Apple ecosystem, and face considerable friction interacting with competitive products. In fact, Apple co-founder Steve Jobs once remarked that "phone differentiation used to be about radios and antennas," but predicted that the phone of the future will be differentiated by software. He forecasted that the App Store may one day be a billion-dollar marketplace.[39] Ten years later, the App Store exceeded $100 billion[40] in revenue for developers and arguably drove even more in iPhone sales, convincing users of its unique value proposition.

"Phone differentiation used to be about radios and antennas and things like that. We think, going forward, the phone of the future will be differentiated by software."

Steve Jobs, August 2008

Tech has a long history of using proprietary technology as an anti-competitive strategy. Perhaps the most notorious example is Microsoft's "embrace, extend, extinguish" approach, described in *United States v. Microsoft Corp*[41]:

- build something broadly compatible or establish a new standard
- incorporate features as part of that new standard that competitors do not support and cannot interoperate with
- marginalize competitors by becoming the new *de facto* standard through market dominance

Microsoft took this tack to defend against a number of competitive products, including Netscape Navigator, Java, and word processors, and spreadsheets vying for market share against its own Office applications. Then-co-founder and CEO Bill Gates said in 1998 of the decision: "One thing we have got to change in our strategy — allowing Office documents to be rendered very well by other people's browsers is one of the most destructive things we could do to the company. We have to stop putting any effort into this and make sure that Office documents very well depends on PROPRIETARY IE capabilities. Anything else is suicide for our platform".[42]

Lock-in directly affects developers as well as consumers. Apple, for example, offers many closed-source application programming interfaces (APIs) and often extends open standards to ecosystem-optimized file formats (such as the USDZ for augmented reality on its iOS platforms) to encourage developers to specialize and focus on the Apple ecosystem.

Hardware manufacturers are just as likely to push closed-source code under the disguise of better hardware performance, posing a significant challenge for the metaverse space. With entry points spanning across consoles (Sony's PlayStation, Microsoft's Xbox, Nintendo's Switch), AR/VR devices (Meta's Oculus, Microsoft's Hololens), and mobile (Apple's iPhone and Alphabet's Android), hardware heterogeneity creates incompatibilities between operating systems. Crucially, these incompatibilities are often a matter of choice, as many are driven more by strategic considerations than technology limitations.

Open-source software has remained a popular paradigm over the past 20 years, but in gaming, it still has a long way to go to becoming an engineering norm. Closed code will remain a key challenge for the metaverse because the companies investing the most in its development are also the ones who frequently make headlines with their legal battles over their anti-competitive practices. Projects like Webaverse and Mozilla Hubs, both indexed on the Lighthouse portal, are great examples of how open source software could and should be used in the context of the metaverse.

2. Open Standards

…THAT ENCOURAGE COMPOSABILITY AND COMPATIBILITY

Key to developing open-source software are open standards. These are standardized file types (like PDF and JPG) and coding languages (such as HTML) that are freely available for adoption across products, businesses, and projects. Industry-wide consensus on a set of standards and frameworks enables consistent implementations regardless of platform. Open standards allow projects to reach diverse users, fuel a multitude of use cases, and streamline costs, spurring healthy competition and broadening access.[43]

"At the moment, we have all the technology we need to build the metaverse. Thus, it has become more of a coordination problem between the different projects. We got the internet by computers working together. I see 3D open protocols as the stock that cooks everything together for virtual worlds. From experience, the hard part will be to align developers to build the connective tissue. Most are heads-down working in their own silos and many interop devs are volunteers."

Jin
Hacker artist & VR developer

Standards Are Required for the Web to Truly Evolve Once Again

SOURCE: LIGHTHOUSE

	Web 1	Web 2	Web 3
[1] TIME PERIOD	1996 → 2004	2004 → 2016	2016 →
[2] CONTENT	Existing info gathered into a single database	Info created in a local database	Info stored into a decentralized database
[3] INFORMATION	Read only	Read + write	Read + write + own
[4] INTERACTION	Web forms	Apps	dApps
[5] TECHNOLOGIES	HTML, FTP	Flash, Java, XML	RDF, RDFS, OWL

But reaching consensus is always easier said than done. Open, broadly adopted standards require coordination, knowledge sharing, flexibility, and awareness of tradeoffs. The modern web is marked by a long history of failed attempts to agree on universal standards, even though in principle most everyone understands the benefits. Just last year, for example, Alphabet, Apple, and Mozilla objected to W3C DID, a standard for self-sovereign identity, because, as some alleged, the new spec threatened their dominant positions.[44]

As hard as it is to build consensus among an industry of tech incumbents, it's even harder to accomplish in web3, where the ethos is to build at the edges — or the long tail — rather than driving toward the center to win mainstream dominance. People drawn to building decentralized, self-sovereign, and autonomous technologies are powerfully motivated by their resistance to centrally-imposed order, even when these digital freedoms come with a higher degree of complexity and organizational chaos. To normalize developing on common standards, web3 companies and developers first and foremost have to share a desire to interoperate and compose — and then commit to doing so from a strategic and architectural standpoint, even when that presents business complexity and *especially* when building to standards runs into tension with building to innovate. This means that standardization is as much a question of political will and business strategy as it is a technological challenge.

Below, we share an overview of the heterogeneous standards landscape across multiple verticals, including media types and file formats, interfaces, game engines and interchange tools, and device hardware.

SOURCE: TWITTER [45]

[OPEN STANDARDS]

Open 3D Object Media

There are currently several well-established standards around 3D file formats. This includes Pixar's USD and Industrial Light & Magic's Material X for the transmission of interchangeable 3D data, Nvidia's MDL for materials and lights sharing between applications, and Khronos's glTF for 3D delivery.

Indeed, more than 30 file formats exist for 3D object media. This presents a technical challenge to interoperability as well as an aesthetic one: platforms only support the visual interpretation that aligns with their graphical storyline. For example, voxel-based worlds like The Sandbox and Voxels have different styles from photorealistic projects such as Illuvium and Otherside, which naturally impacts how objects are presented.

To interoperate, developers and creators must reach agreement on standards and use tools that parse data from sources adhering to those standards. This level of shared ontology will enable more consistent data interpretation between platforms, allowing assets, avatars, and experiences to interoperate instead of staying locked into a given world, thereby limiting their aggregate value.

[OPEN STANDARDS]

File Formats

3D models and geometry

OpenCTM, SMD, wing, prt, usd, glb, 3d, usdz, vrml, glb, obj, fbx, gltf, dff, abc, skp, mesh, ply, b3d, egg, m2d, prc, nif, SLDASM, 3dmf, x3d, bm3d, dae, core3d, amf, lxf, u3d

Textures and materials

iob, usd, usdz, glb, gltf, mtl, dae, bfres

Scene file

aoi, OpenCTM, z3D, usd, c4d, mb, usdz, md3, vwx, blend, max, glb, usda, gltf, lwo, abc, lwf, pov, 3dm

Rigging and animation

OpenCTM, z3d,usd, usdz, cal3d, an8, bfres

[OPEN STANDARDS]

Application Programming Interfaces

APIs are essential to rendering 2D and 3D vector graphics in an interoperable metaverse. OpenGL and WebGL are two well-known rendering APIs, but unfortunately, most hardware manufacturers don't support them and advance their own proprietary libraries.

Standards used by today's popular gaming consoles

[1] OPERATOR	[2] INTERFACE
Microsoft	DirectX
Sony	GNMX
Apple	Metal
Nintendo	NVM (Nvidia)

Mobile devices typically support multiple standards, but they often restrict access to drivers. PC and Mac are more open than mobile, but optimized for their own operating systems. To seamlessly traverse an immersive metaverse, all user end-points will need to implement common cross–platform rendering standards like WebGL and OpenGL.

[OPEN STANDARDS]

Game Engines and Interchange Tools

Of the $188 billion generated in the gaming industry this year,[46] a significant portion has been directly powered by game engines such as Epic's Unreal Engine 5, Unity, and CRYENGINE. Game engines provide software environments crucial to the game experience, including sound, scripting, animation, memory management, 2D and 3D graphic rendering, and more.

Yet, while game engines and interchange tools have arguably done more to scale the metaverse than probably any other technological innovation up to this point, they still remain broadly incompatible with one another.

For instance, Unreal uses left-handed Z-up while Unity uses left-handed Y-up when controlling an avatar. Moreover, Unity uses C# while Unreal uses C++. Even though both languages are well regarded for game development, creators usually choose C++ for projects that require optimal resource utilization and performance since it allows for more control over the application resource management and the engine's source code. In contrast, C# is more suitable for independent web-based and desktop projects, as it is cheaper to develop, has a more readable syntax, and allows for a wider margin of error (for example, its built-in automatic garbage collection helps to avoid memory leakage). Even though learning a new language syntax isn't insurmountably difficult, going from C++ to C# and vice versa implies switching the entire ecosystem, a major hurdle for interoperability between projects. Although still early, we are seeing increased willingness from key market participants to better integrate their technologies to maximize user value as illustrated by the Autodesk - Unreal partnership announced in September 2022.

> "We know our customers are looking for more visualization and collaboration experiences through extended reality. Together with Epic Games, we will expand on what's possible. In immersive environments, designers can communicate to their project teams and clients with unparalleled realism how projects will look and feel upon completion for better decision-making and outcomes."[47]
>
> **Amy Bunszel**
> Executive Vice President
> of AEC Design, Autodesk

> "The metaverse cannot be limited to one device only. It's not VR only. It's not mobile or web, desktop, PC, or Mac, AR or VR. Rather, the metaverse is a myriad virtual worlds — across all digital devices — where users can access diverse experiences through a 3D avatar. It's more about social and creative experiences. Not just games, but also virtual concerts, virtual shows, art galleries, museums, and so on."
>
> **Sébastien Borget**
> Co-Founder & COO, The Sandbox

[OPEN STANDARDS]

Hardware

Hardware interfaces are the portals and gatekeepers to enter digital worlds. To see widespread adoption, this hardware has to be widely accessible. This means that metaverse experiences must be device agnostic — working sufficiently well regardless of the devices and price points users select. Consistent experience quality requires greater integration across devices, which in turn requires work done on standards and software to increase interoperability.

While computers and mobile will likely remain the most dominant gateways, VR headsets and AR glasses will continue to grow in availability and popularity. Although these wearable devices are expected to be the fastest-growing metaverse end-point segment in the immediate future,[48] we believe that mobile devices are likely to contribute the most to metaverse adoption — both because of the popularity of mobile games and the widespread availability and affordability of mobile devices relative to wearables.

3. Minimally-Extractive Business Models

…THAT ALIGN COMPENSATION WITH VALUE CREATION

App stores are not the sole barriers to entry by which companies monetize (and, ironically, suffocate) the creator economy. Platforms like Spotify, Alphabet's YouTube, Meta's Facebook and Instagram, as well as Twitter and Roblox impose even higher take rates against UGC than they do against games and worlds built by developers and sold in app stores — in most instances, providing no financial kickback at all to creators for their contributions.

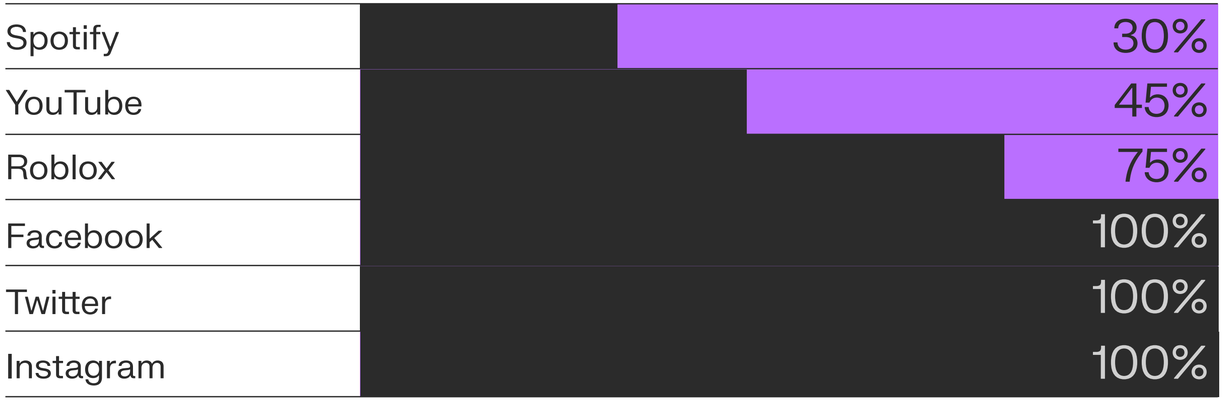
UGC is the crucial profit engine that drives platform businesses, which often monetize user contributions through advertising.

As demonstrated by massively scaled virtual worlds like Minecraft, Roblox, and Fortnite, UGC will power the metaverse just as it does legacy social media. The open metaverse ecosystem likewise depends on prolific contributions from creators who add to and compose upon the infrastructure built by companies and protocols. It simply makes good business sense to provide abundant financial incentives to creators to continue adding value to the ecosystem.

> "You know something is profoundly wrong with our economy when Big Tech has a higher take rate than the mafia."
>
> **Ritchie Torres** (D-NY)
> Member of the U.S. House of Representatives[49]

UGC Platform Take Rates

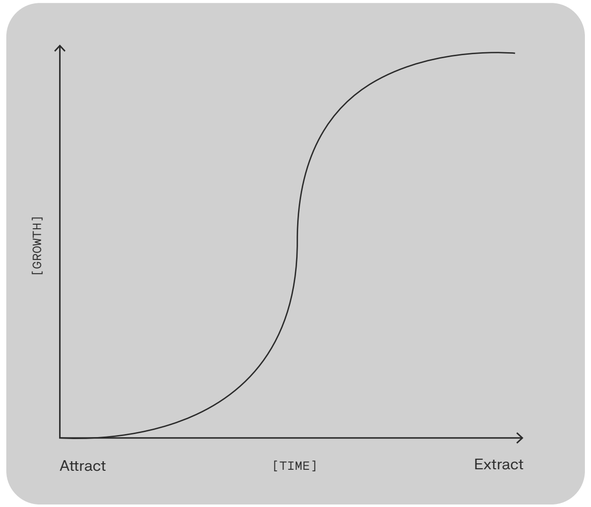
SOURCE: LIGHTHOUSE



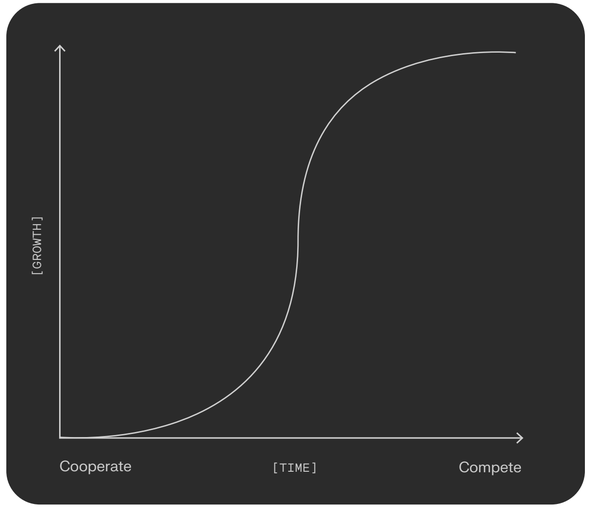
So why have high take rates become the norm across tech? Companies trend toward financial extraction over time because of what a16z's general partner Chris Dixon refers to as the S-curve in his article, "Why Web3 Matters." As companies gain market dominance, copycat innovations crop up. Consumers begin to care less about obtaining the newest gadgets and more about price and optionality. To expand and defend their market positions after the initial technological novelty wears off and satisfactory substitutes emerge, dominant centralized platforms follow a predictable life cycle of ecosystem enclosure to protect their moats:

"At first, they do everything they can to recruit users and third-party complements like creators, developers, and businesses. They do this to strengthen their network effect. As platforms move up the adoption S-curve, their power over users and third parties steadily grows. When they hit the top of the S-curve, their relationships with network participants change from positive-sum to zero-sum. To continue growing requires extracting data from users and competing with (former) partners."[50]

Platforms' Relationships to Users



Platforms' Relationships to Complements (Creators, Developers, Businesses)



SOURCE: FUTURE BY A16Z [51]

Builders and architects must remain careful of repeating the same S-curve pattern across the landscape of decentralized protocols, games, and worlds. Adequately incentivizing creators by compensating them fairly for their contributions will require ecosystem-wide commitment to minimally-extractive business models and take rates.

But how will web3 companies pay their bills if they also have to pay their creators? We believe that increased volume, usage, and economic value creation will play a key role here.

The ultimate network effect for the open metaverse will be emerging game designers and digital artists seeing their friends making a decent living from building in the spatial web. First, freemium models onboarded millions of users to gaming. Then, OpenSea's 2.5% fee attracted thousands of creators to the NFT space. Next, minimally-extractive fee structures will unlock metaverse adoption — and multiply its economic halo effects across every layer of the stack.

What emboldens today's dominant tech platforms to impose extractive fees instead of opting for the minimum necessary take rates while remaining profitable? Web2's defensive business strategy of data lock-in makes it difficult and inconvenient for users and developers to take their data and move it elsewhere if they don't agree with a platform's terms without losing access to their valuable code, social graphs, and reputation. There are effectively no alternatives, so users and developers face a binary choice: put up with monopolistic extraction and tolerate subpar treatment, or shut up and opt out of the dominant economic paradigm at their own financial peril.

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In contrast, two central tenets of web3, *data portability* and *data sovereignty*, together tip the scales to benefit creators. Data portability means that users and developers can leave any ecosystem that doesn't share their values. Crucially, they can opt out and still take their data with them because this data belongs to the sovereign owner of the on-chain record, and not to the platform whose end-user license agreements or service terms legally separate users and developers from sovereignty over their data.

Due to this dynamic, web3 companies are forced to compete on favorable take rates for UGC: OpenSea, as previously mentioned, charges just 2.5%[52] and still faces significant competition from players like LooksRare and sudoswap. If web3 companies don't offer minimally-extractive business terms, users and creators can and will simply move away to someplace better, presenting a powerful disincentive against extraction. This forcing function produces exciting business model innovations that fairly compensate creators of UGC while continuing to drive company revenues and growth.

Once creators experience sub-3% take rates, building in web3 will attract far more creator-driven UGC than already powers the dominant web2 paradigm.

The Internet and Web Applications Evolved in Cycles

Generally, mainstream adoption follows better UX. To scale, the open metaverse needs intuitive and secure payment rails (for both fiat and crypto), sophisticated search and discovery solutions, advanced identity and data management tools, and efficient networking, computing, modeling, and storage technologies.

Infrastructure and applications have always evolved iteratively. Developers tend to build the first apps on sub-optimal infrastructure. Then a wildly successful app leads to further investments in the underlying technologies, which subsequently drives more development efforts into apps with a better user experience.

SOURCE: METAVERSE AND MONEY: DECRYPTING THE FUTURE REPORT BY CITI [53]

CYCLE ↓

Apps	[1970] Messaging [1972] Email	[1]
Infra	[1973] Ethernet [1974] TCP/IP [1983] Send Email	[2]
Apps	[1970] Prodigy [1972] AOL	[3]
Infra	[1993] Mosaic [1994] InfoSeek [1998] Google Search	[4]
Apps	[1993] IMDB [1994] Amazon [1995] eBay	[5]
Infra	[1995] MySQL [1995] Java [1997] GoDaddy	[6]
Apps	[1999] Napster [2004] Facebook [2005] YouTube	[7]
Infra	[2001] Mailchimp [2006] AWS [2006] Shopify	[8]
Apps	[2009] Uber [2010] Instagram [2011] WeChat	[9]
Infra	[2009] MongoDB [2010] Stripe [2013] Docker	[10]
Apps	[2014] Amazon Echo [2015] Airtable [2016] Pokémon Go	[11]

4. Web-Based Accessibility

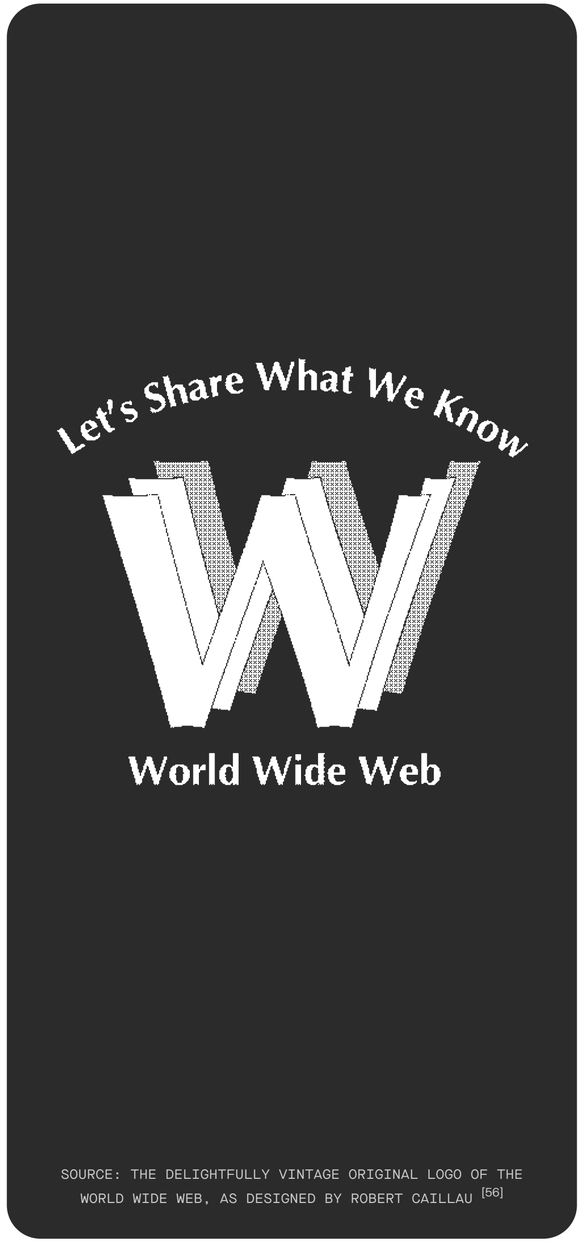
…FREE FROM THIRD-PARTY INTERMEDIARIES AND DISTRIBUTION CHOKEHOLDS

The metaverse will be shaped by the technologies used to access it. Web browsers serve as the internet's main portals, a role that increasingly extends into the metaverse as a larger portion of experiences becomes accessible through browsers.

Browser access is easy today thanks to a long history of intentional open-source design and mutual agreement among companies to render markup language in a consistent manner, regardless of the browser used to access a website. The World Wide Web — or "the web" for short — is the information system which sits atop the infrastructure known as the Internet Protocol Suite (IPS) and enables access to websites, documents, files, and resources online. Originally built for national defense purposes in the late 1960s with funding from the Advanced Research Projects Agency (ARPA),[54] the IPS remains commercially independent and open.

As browser companies began building their own portals to the web, standards diverged and websites were not always rendered consistently from one browser to the next. To corral this fragmentation back into alignment, the World Wide Web Consortium, known as the W3C, began work in 2008 to define technical specifications, guidelines, and standards designed to maximize consensus among developers, enabling them to "build rich interactive experiences, powered by vast data stores, that are available on any device."[55] Thanks to these efforts, web browsers today are built largely to agreed-upon standards. Users can elect to access the web through whatever browser company suits their needs and preferences, and enjoy a reliably consistent experience that renders code with fidelity to the developers' intent.

> "We really believe in the metaverse long-term as the next evolution of the internet. As we spend more and more time in virtual spaces for the next decades to come, we really believe that the value of virtual worlds is going to be derived from their creative and artistic merit."
>
> **Justin Melillo**
> Co-founder & CEO, Mona



SOURCE: THE DELIGHTFULLY VINTAGE ORIGINAL LOGO OF THE WORLD WIDE WEB, AS DESIGNED BY ROBERT CAILLAU [56]

After the rise of mobile, users acquired a new portal to digital applications: the app store and its native apps, which in 2020 represented 90% of daily mobile activity in the United States (compared to only 10% for websites accessed via mobile browsers).[57] In contrast, most desktop activity still happens inside browsers instead of desktop apps.

This discrepancy between desktop-based web activity and native mobile app usage is normal, yet worrisome when examined in the context of the metaverse. Mobile is an important access point to digital worlds — and likely to rise relative to desktop usage: take, for example, Roblox, which reports that 72% of all sessions take place on mobile, with only 25% on desktop and 3% via gaming consoles.[58]

While metaverse access via browsers remains free, mobile app stores, which are positioned to become the most important gateways to the metaverse, take a hefty cut of the traffic. Consider Apple and Google: Both companies force mobile application creators to pay a 30% fee on every sale, enabling them to run their app stores with a gross margin of 70-80%. Steam, Playstation, Xbox, and Nintendo also take a 30% cut on sales, while Epic shines comparatively by taking a more reasonable 12% fee.[59]

If the metaverse is truly the next iteration of the internet, it follows that access to it should be as open and unfettered as browsing the web today. But exorbitant app store take rates present significant barriers to adoption of this next iteration of the internet, as creators and developers will have to share their revenues with companies that enclose this access.

This economic model runs counter to the promise of a creator economy that benefits users and builders at least as much as the companies that gate access to it. Imagine Brave imposing a fee every time a user accesses a web site, or web developers paying Brave for users to browse their sites. While that feels instinctively wrong, it is the precise reality for most of today's mobile traffic.

And mobile is not the only frontier of economic openness: VR and AR glasses, as well as future generations of hardware yet to be invented, will all have their own app stores and related fee structures. A paywalled gateway to digital worlds, regardless of device, is a direct barrier to creation in an open metaverse that should be accessible to anyone anywhere.

Tim Sweeney
@TimSweeneyEpic

Apple has outlawed the Metaverse.

The principle they state, taken literally, would rule-out all cross platform ecosystems and games with user created mods: not just XCloud, Stadia, GeForce NOW, but also Fornite, Minecraft and Roblox.

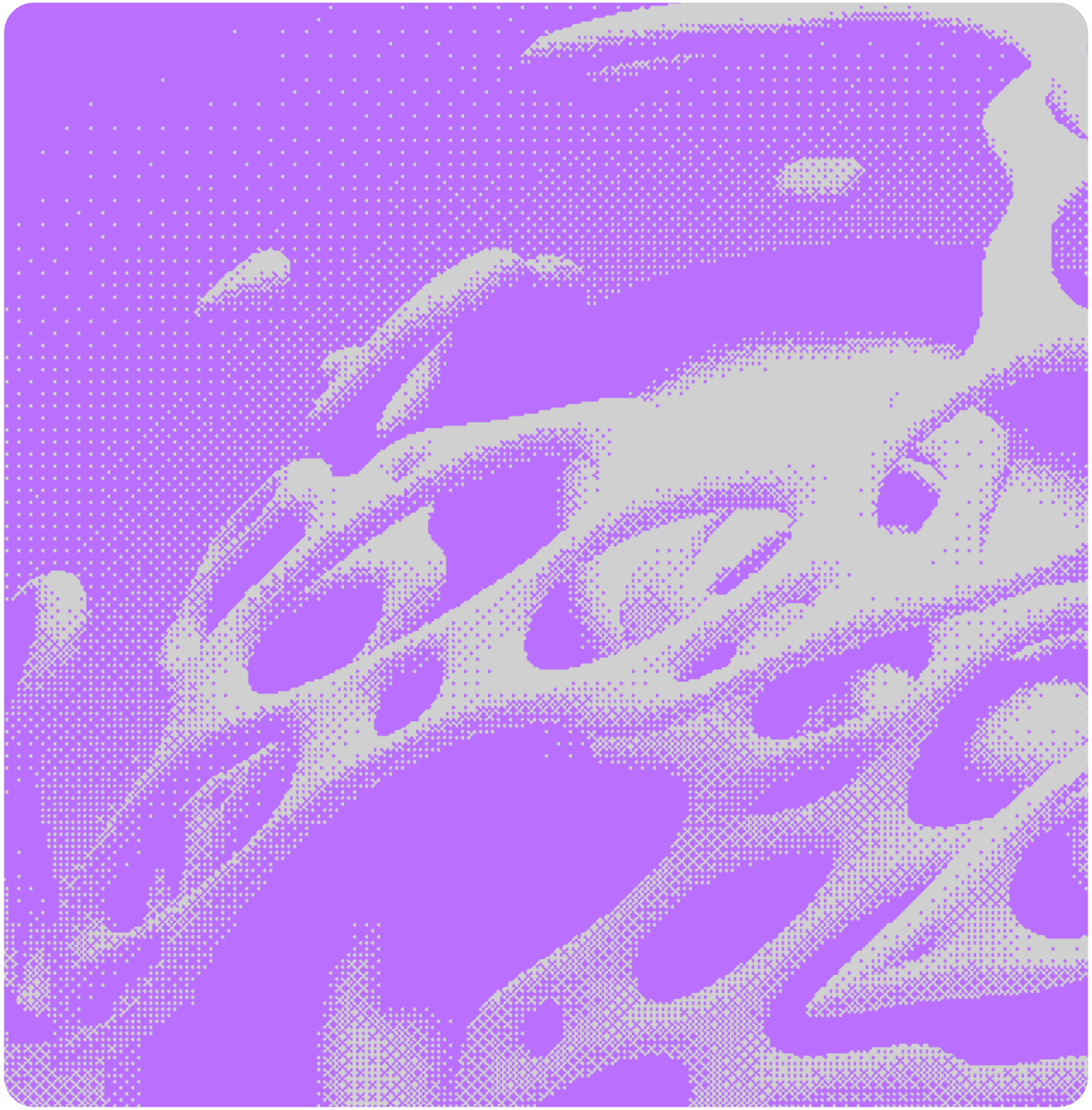
> The Verge @verge - AUG 6, 2020
>
> Apple confirms cloud gaming services like xCloud and Stadia violate App Store guidelines.
> theverge.com/2020/8/6/21357...

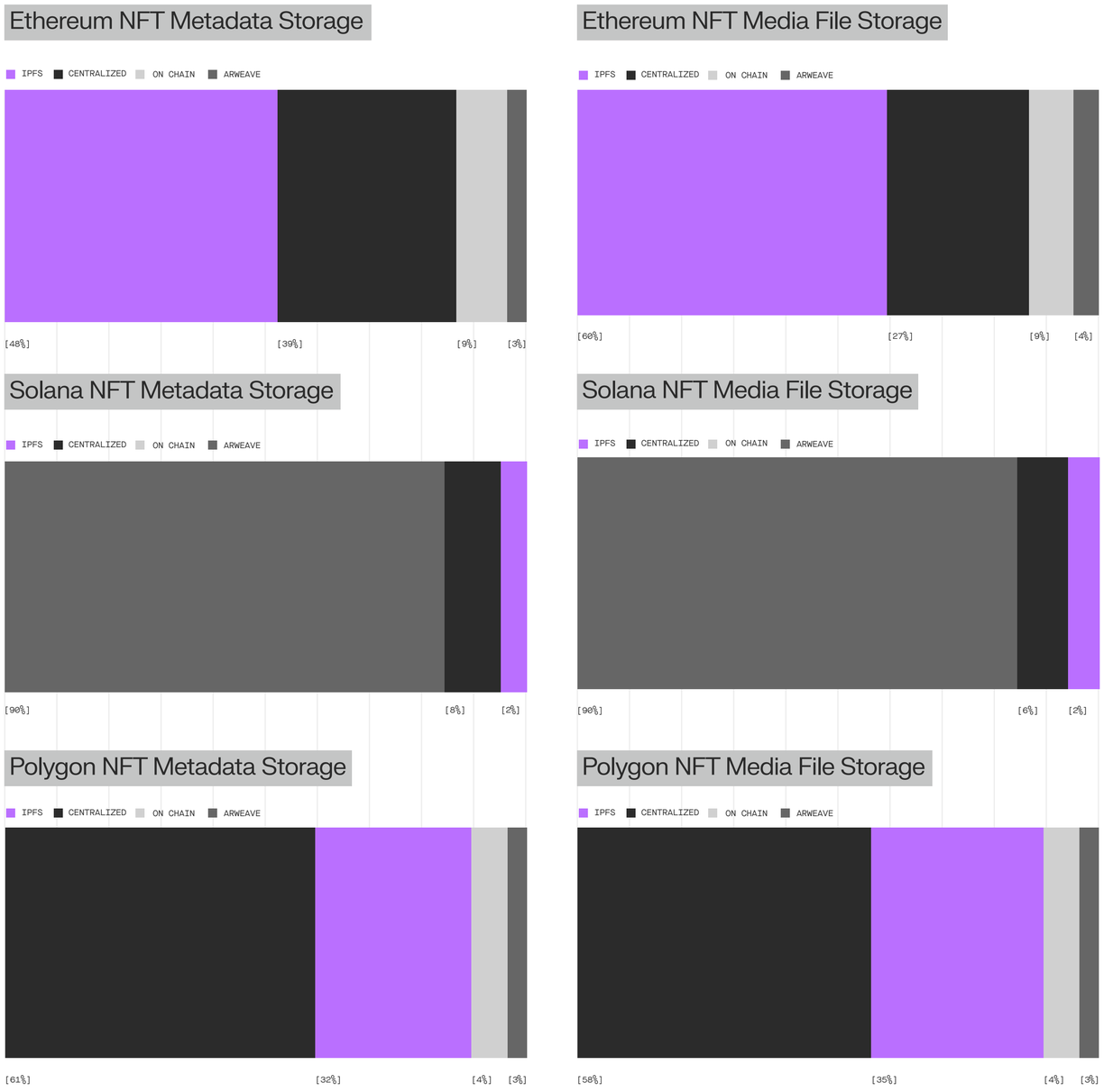
6;59 PM - AUG 6, 2020 - TWITTER FOR IPHONE

592 Retweets 93 Quote Tweet 2,865 Likes

Tweet your reply Reply

SOURCE: TWITTER [60]





SOURCE: THE CONTROL: THE STATE OF NFT DATA STORAGE [64]

5. Decentralized Storage

…INDEPENDENT OF PRIVATE, COMPANY-CONTROLLED SERVERS

Because NFT smart contracts are the system of record for web3 metaverse land and asset ownership, it is paramount to understand where the metadata — the images, video files, and audio files associated with those owned assets — actually lives.

There is a common misconception among crypto enthusiasts that NFTs are a wholly decentralized, sovereign, and censorship-resistant means of recording digital ownership. They may think, for instance, that owning a digital wearable NFT immutably links the wearable's image to its on-chain ownership record. But when it comes to metadata and file storage, not all NFTs are created equal — and where these files are stored matters greatly.

The first option is to store NFT data directly on the blockchain. While *on-chain storage* provides the strongest guarantees of persistence (since the entire blockchain would have to go offline for information to disappear), costs are high. On-chain storage requires sophisticated compression and therefore provides limited scalability for image, video, and 3D-intensive metaverse assets.

As a result, most NFT projects opt to store metadata elsewhere, preserving only the pointers to that storage within the on-chain smart contract. For off-chain storage, builders have two options: centralized and decentralized alternatives.

The traditional approach, *centralized storage*, is also the most fragile. There are a number of risks associated with storage on centralized servers, including censorship, data loss from user error and malicious attacks, and breaches that result in information theft. These risks account for billions of dollars in annual losses to businesses and consumers.[61]

Crucially, centralized storage turns server companies into single points of failure. Maintenance interruptions, servers going offline, or, worse, decisions by companies to restrict access or stop hosting certain information, can mean that creators and users lose their NFT data. This renders the asset unusable, even though the now-empty on-chain record persists.

"Whoever controls the server can also change the description and the content of the NFT at any point without the owner's permission," writes crypto researcher and data analyst Kofi Kufuor.[62] "This completely defeats the purpose of NFTs. If your assets can be seized, altered, or censored, then you don't have true ownership."

Decentralized storage alternatives, such as the InterPlanetary File System (IPFS), Arweave, and STORJ, represent the bulk of NFT metadata storage on Ethereum, Polygon, and Solana — and are used by most NFT marketplaces, such as the Mona Marketplace, Foundation, Coinbase, and OpenSea.[63] At a high level, these solutions' approach involves sharding bits of NFT files by breaking data into smaller chunks and distributing them to different nodes on a network. This eliminates the single points of failure associated with centralized servers and ensures that data remains intact and available even if a few nodes go offline. Users pay node operators in tokens to maintain data availability, and since no single node maintains all of the sharded data, users enjoy stronger guarantees of privacy and censorship resistance.

Because of their peer-to-peer nature, decentralized storage systems are also much harder for malicious actors to attack than servers — and impossible for centralized entities and companies to take down. To successfully carry out an attack, a hacker would have to penetrate every node running the protocol, making the exploit so expensive as to be basically infeasible.

Finally, decentralized methods are better at preserving data integrity and persistence because they identify data by its content, not by its server location. If a hash on a smart contract or webpage points to data whose location has moved, that link is dead. Content-specific hashes, however, are unique to the content they describe, pulling from a network instead of a server location and ensuring that fake files cannot be passed off as genuine.

Decentralized storage offers a more robust and censorship- and tamper-resistant method for protecting digital ownership. Increasingly, developers have been embracing decentralized solutions by building native support for platforms like IPFS and Arweave into their tools. Additionally, most recent marketplace platforms (such as LooksRare and sudoswap) have taken the time to decouple their frontend and backend systems. This approach exposes the platform's underlying functionality so that others can utilize it for their own needs. Improvements in this area will increase confidence in metaverse investment because brands and creators will limit their investments in metaverse experiences until they have strong and provable guarantees that their assets are safe from breach, interruption, and censorship.

6. Frameworks for Composable Intellectual Property

…THAT TRANSITION INTERNET USERS FROM TENANTS TO OWNERS OF THEIR DIGITAL EXPERIENCE

Open standards may provide the technical underpinnings connecting the open metaverse, but intellectual property (IP) laws ultimately govern how digital assets can move between parties and ecosystems. To support the unique use cases associated with digital property, society's IP frameworks must evolve beyond the increasingly inapplicable laws that exist today.

Throughout history, technological advancement have preceded shifts in how the public thinks about IP. The first commercial song, the first commercial book, the first open source line of code, the first webpage, and of course, the first NFT all share two common traits:

- they incrementally transformed the management of patents, copyrights, and trademarks, and
- they sparked vigorous debate within their respective communities about who can own what, and under which conditions those assets can be altered, copied, and commercialized.

Today, the Creative Commons nonprofit provides the most widely-used global public license, the CC0, allowing anyone from individual creatives to sizable institutions to grant the public permission to use their work freely.

There are six different Creative Commons (CC) license types, with CC0 being the most permissive. CC0 is similar to a public domain classification, which usually defines a work's copyright classification once the original copyright expires or an artist's estate decides to let the public use the work freely (as is common with classic art, literature, and musical works). CC0 licenses offer a standardized way to communicate and grant rights not expressly reserved. A creator can provide the public access to use CC0 content in its entirety for any and all purposes, whether commercial or private. This includes the right to display, perform, reproduce, publish, and modify the work.[65]

NFT creators and buyers alike appreciate CC0 licenses because free, public use of an NFT collection's artwork can potentially increase its popularity and recognizability — and therefore its upside value. But there's also something deeper at play. Artists debating the merits of CC0 in public forums like Twitter Spaces recognize that offering one's work to the public domain may grant a satisfaction that goes beyond monetization, since the artwork can live forever and evolve to take on any form. This allows for new art to emerge as its community of artists and owners builds lore around its origin and meaning — a key feature of how web3 communities cohere.

Some suggest this type of immortality is the ultimate wish of an artist or creator. Of course, web3 lawyers have noted that free use risks opening artwork up to derivative interpretations that may be undesirable: for example, being co-opted by extremist groups or used as symbols of violence, hate, or sexual exploitation. To address this concern, the venture capital firm a16z in 2022 released a set of free, public licenses known as "Can't Be Evil" Licenses, or CBE. Designed specifically for NFTs and inspired by the work of Creative Commons, the licenses are meant to serve three emerging goals of web3 creators, according to a16z:[66]

[1] To help NFT creators protect (or release) their intellectual property (IP) rights;

[2] To grant NFT holders a baseline of rights that are irrevocable, enforceable, and easy to understand; and

[3] To help creators, holders, and their communities unleash the creative and economic potential of their projects with a clear understanding of the IP framework in which they can work.

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A16z “Can't Be Evil” Licenses

SOURCE: A16Z CRYPTO [67]

LICENSE	Exclusive Commercial Rights	Non-Exclusive Commercial Rights	Non-Exclusive Commercial Rights (Creator can terminate license for hate speech)	Personnal Use License	Personnal Use License (Creator can terminate license for hate speech)	Public Domain
ABBREVIATION	CBE-Exclusive	CBE-Commercial	CBE-Commercial-No-Hate	CBE-Personnal	CBE-Personnal-No-Hate	CBE-Public
COPY, DISPLAY & DISTRIBUTE	■	■	■	■	■	■
SUBLICENSE	■	■	■	■	■	
COMMERCIAL USE	■	■	■			■
MODIFY & ADAPT	■	■	■			■
ALL SPEECH PERMITTED	■	■		■		■
CREATOR RETAINS NO RIGHTS	■					

When making the case for NFT licenses intended to govern digital property rights, a16z explained that “many people buy NFTs to own an avatar, an artwork, or any number of other creative outputs — but the reality is they usually can’t be sure of what they’re getting.”[68] That is because an NFT purchase is usually just a tokenID with metadata that points to content that lives on either a server location or decentralized storage network — and this underlying content can and often does change as artists and owners alter or “compose” their NFT assets. While composability and the idea of “remixing” art and culture are core to the web3 ethos, the resultant ambiguity creates confusion for NFT buyers and creators as to their precise rights. CBE licenses are already open and accessible for anyone to use.[69]

It is important to caveat that there are inherent limitations to standardized licenses. For example, CBE licenses currently only cover copyright and exclude trademark considerations. The CBE license system is also “exclusively aligned to U.S. law – which could prove limiting given the geographically limitless nature of the market for NFTs,” according to the law firm Schoenherr.[70]

As we shift more of our lives — including our art and our belongings — online, clarity around rights owners’ legal standing will unlock the commercial potential of digital assets. Legal adoption of new-generation IP frameworks like Can’t Be Evil provides essential economic guarantees, without which neither brands nor creators — or their customers — would feel secure in their investments.

7. Contextual Privacy Settings

...THAT PRESERVE POLICY TRANSPARENCY, BOUNDARY INTEGRITY, AND GRANULAR CONSENT ACROSS ALL ENVIRONMENTS

Privacy’s role in public life has historically been hard to pin down — even before the advent of technologies such as analog, CCTV and satellite cameras, device fingerprinting, and biometric analysis challenged our notions of personal space. Its uncertain legal standing and philosophical roots have befuddled jurists, legislators, and entrepreneurs for centuries. Indeed U.S. privacy law hasn’t evolved much since legal scholar William Prosser defined the four privacy torts in his landmark 1960 *California Law Review* article, “Privacy.”[71]

But unlike in the physical world, where our daily interactions are not subject to granular capture and analysis, online, you are your data. **And if you don’t know what’s happening to your data, then you don’t know what’s happening to your digital body.** Put thus, having no control over what happens to our bodies challenges conventional notions of consent — and feels, justifiably, violating.

If we already don’t know what’s being done to our digital bodies on the internet we have today, how will we know what’s happening to us across the full spectrum of the open metaverse? The surface area for consent infringement multiplies exponentially with each additional virtual world we travel through. Does each offer its own approach to privacy policy and protection — and a distinct End-User License Agreement (EULA) governing how it proposes to treat your digital body? Must we become familiar with the details of how one Terms of Service (TOS) agreement differs from the next, that we might empower ourselves to fully comprehend our options? These pressing questions require answers if users hope to exercise informed and enthusiastic consent in the metaverse.

Once the open metaverse we envision gives rise to hundreds, thousands, and even millions of exciting worlds to explore, it’s plain to see how a digital future without broadly accepted and interoperable notions of consent quickly becomes unworkable for even the most technically adept and legally knowledgeable among us. But there’s no need to telescope out to the immersive future to appreciate the enormity of the challenge. People are often surprised to learn that the Cambridge Analytica scandal that rocked Meta (then Facebook) in 2016 involved no data breach or information security failure.

The 87 million harvested social media datasets used to microtarget voters and sway elections were freely available because the platform's inadequate privacy protections allowed these manipulations to occur — no 3D immersion in VR required.[72] In fact, Michael Kosinski, then a doctoral student at Cambridge University, proved in 2008 that:

> "On the basis of an average of 68 Facebook 'likes' by a user, it was possible to predict their skin color (with 95 percent accuracy), their sexual orientation (88 percent accuracy), and their affiliation to the Democratic or Republican party (85 percent). But it didn't stop there. Intelligence, religious affiliation, as well as alcohol, cigarette and drug use, could all be determined. From the data it was even possible to deduce whether someone's parents were divorced.
>
> The strength of [this] modeling was illustrated by how well it could predict a subject's answers. Kosinski continued to work on the models incessantly: before long, he was able to evaluate a person better than the average work colleague, merely on the basis of ten Facebook 'likes.' Seventy 'likes' were enough to outdo what a person's friends knew, 150 what their parents knew, and 300 'likes' what their partner knew. More 'likes' could even surpass what a person thought they knew about themselves." [73]

If all that predictive precision is possible without any immersion in three-dimensional VR, then what can metaverse analytics accomplish? David Nuti, a Vice President at Nord Security, writes:

> "In an augmented reality environment, a company may want to serve me an advertisement for a couch because they can see in my augmented environment that my couch is kind of ratty in the background. Through artificial intelligence, they'll serve me up a color of a new couch that matches the paint on the wall of my house. If I serve up an advertisement, it's no longer knowing that I'm serving up the advertiser to the person, but how long my eyeballs are focused on that content." [74]

Advertisers — as well as scammers, social engineers, foreign adversaries, and other unsavory actors — go to great lengths to capture this **data exhaust: the trail of personal telemetry users leave behind as they navigate the internet.** Data exhaust is valuable to advertisers and other interested parties because it powers prediction models that enable them to exert *concealed influence* on the data subject.[75] Data exhaust capture is most often used to sell targeted ads, but lawmakers, policy experts, and technologists increasingly agree that the use of digital telemetry to manipulate behavior is correlated and even causally linked to political polarization, online toxicity, depression, social isolation, and distrust in democratic institutions.[76]

And even if it is merely to serve ads, users have the right to know when their digital bodies and cognition are targeted in order to make informed decisions about whether to accept or ignore this influence. Digital advertising practices intentionally obfuscate the context necessary for informed decision-making. In her book, *Privacy in Context*, philosopher Helen Nissenbaum, an information sciences professor at Cornell University, points to a fine line, "however fuzzy, between entrepreneurial salesmanship and unethical manipulation" that is determined by whether information is assembled to overtly obtain consent — or to conceal the targeted influence altogether.

When ads are stripped of context, users can't make agentic decisions. For example, signs in a mall are visible to everyone who passes by and surrounded by context clues — i.e. *this is a mall, here is a shop, that is an ad*. While these clues are largely the same in physical spaces for everyone (although artificial intelligence innovations using mobile phones are rapidly merging e-commerce analytics with physical and point-of-sale notifications), digital environments often intentionally strip contextual information — i.e. *this is an ad, I am being served this ad because my data exhaust indicates I would be interested, I'm shown this ad at this specific hour because I am bored, tired, or most susceptible to influence right now* — making informed consent impossible to obtain.

Defending against intrusive advertising and undue manipulation are not the only reasons for improving digital privacy. We also need it for free society to function. Privacy from unwarranted influence and intrusion promotes free thought and expression, the development of moral autonomy and self-determination, and the pursuit of self-actualization within a social contract — while its absence produces a distorted view of conventional wisdom, values, and opinions, creating societal fault lines that lead to polarization and instability. For example, people fearing cancellation, job loss, reputational harm, retribution, or peer disapproval may self-censor, falsify their preferences, [77] and communicate ideas that conceal their true perspectives. The public mistakes these falsified preferences for widely-held and accurate opinions, thereby quieting or dissuading dissent. Over time, this produces a *chilling effect*, in which people inhibit the legitimate exercise of their rights simply out of fear that there *might* be repercussions, even when those fears are unfounded and have no basis in law.[78] Privacy, in other words, is inseparable from human dignity.

SOURCE: TWITTER [79]

Surveilled spaces invite confirmation bias and groupthink because they place our survival needs for social approbation above our developmental needs for autonomy and choice. Privacy takes on new urgency given the default-public nature of the blockchain, a key metaverse building block for which we admittedly advocate

in this report. Viewed through that lens, consider the richness of data that web3 makes available for surveillance: not just biometrically-inferred data, but also detailed financial transactions, governance votes, and wallet holdings.

Blockchains are certainly no panacea, despite the popular narrative that *data sovereignty* is crypto's answer to the platform panopticon. Blockchains free user-generated data from platform capture and lock-in, allowing users and developers to export their social graphs and take their data where they want. But the only real change is where that consensually agreed-upon user telemetry is stored: in the cloud or on the public ledger. Meta and Alphabet are no longer the sole owners of users' digital history; instead, anyone with access to the internet and a block explorer can do with it as they wish. And, since even blockchain-enabled metaverse worlds still capture a sea of off-chain data to maintain efficiency and scalability, the same basic challenges around privacy remain and require a thoughtful and coordinated strategy — crypto or not.

> A 2020 Decrypt study of 133,000 Ethereum names and balances "found it possible to work out where people would be in the future, see insights into business deals and know just how much money people really have — all by observing public blockchain data."[80]

There's a psychological reason that large-scale data models like the above study (and the machine learning models that Cambridge Analytica used to target Facebook users in 2016) can make such astonishingly precise predictions. That is because, while we filter how we present ourselves in social settings, we do not filter "private" digital activity that we erroneously believe takes place in our personal space — without capture, analysis, or prediction from observers of whom we are blissfully unaware.

The behavioral surplus that emerges from our digital histories, our biometrically-enhanced metaverse interactions, and our wallet details will produce surveillance capitalism in blockchain-enabled environments just as it does today, because surveillance capitalism is not a byproduct of a particular business model (centralized versus decentralized), but of ineffective and outdated frameworks for managing private identity and interaction data.

It comes down to one important distinction: what is popularly considered *data sovereignty* in crypto is actually *data transparency* and *data availability*. For data to be sovereign, users must be able to exercise granular control over who sees their private information, when, under what conditions, and in which contexts. But unfortunately, without undergoing a significant upgrade, blockchains are even less equipped than web2 platforms to manage users' variable privacy boundaries in the rapidly shifting contexts of immersive, biometrically-informed virtual worlds.

Finally, privacy is highly context-dependent. People have different privacy expectations across different contexts: for example, what you choose to confide to a psychiatrist or spouse will be different from what you tell your parents and what you share on social media. Metaverse rules governing access to and availability of that data to various parties will need to expand or contract accordingly.

This is precisely why prevailing privacy frameworks such as the Generally Accepted Privacy Principles (GAPP), the General Data Protection Regulation (GDPR), and the California Consumer Privacy Act (CCPA) are maladapted to managing privacy boundaries in context: it's impossible to predict and govern all possible data-transfer scenarios. That would be like trying to predict the future — devising governance for all data types and transmission principles for all users of all digital technologies everywhere.

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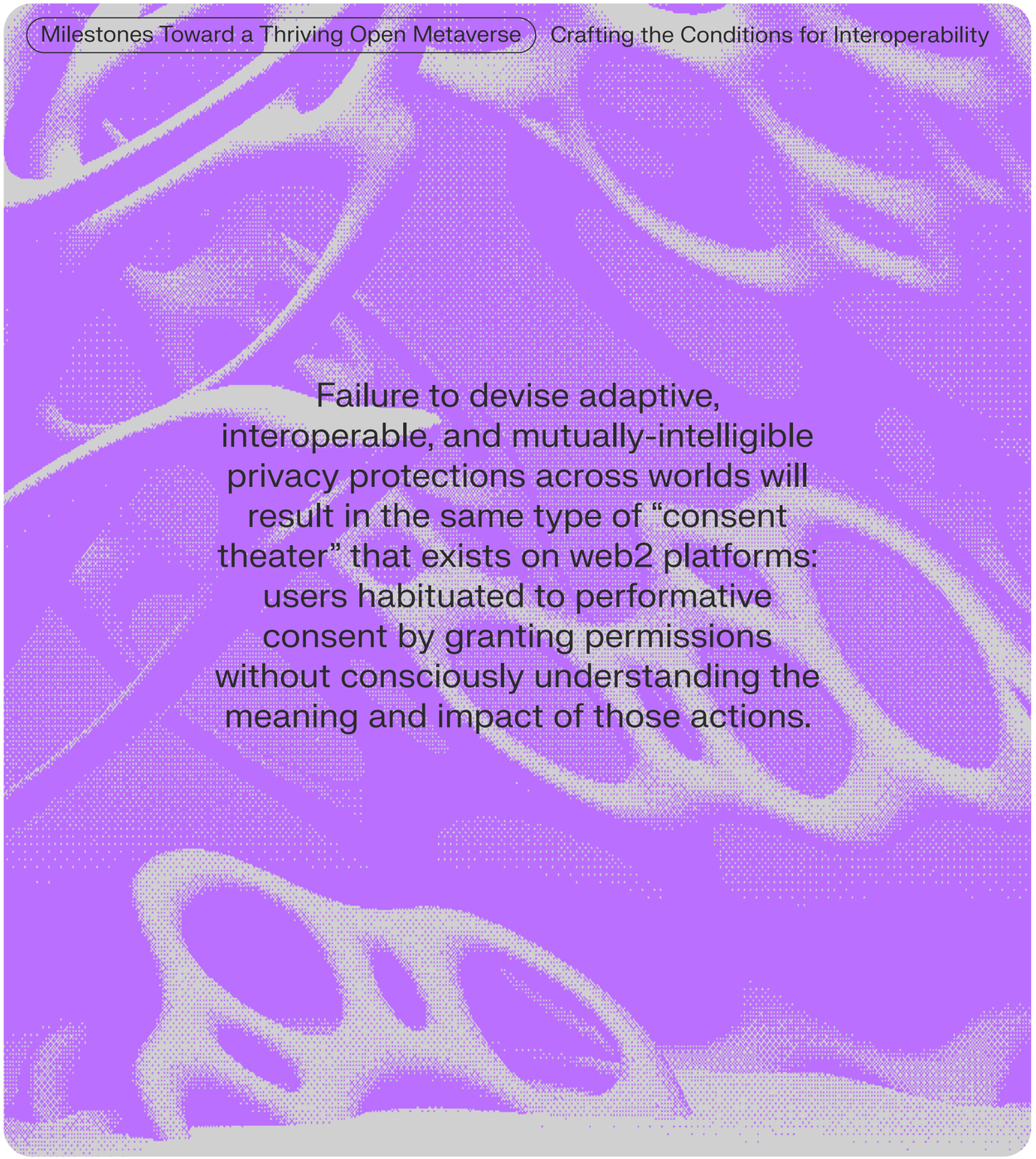


Instead, privacy frameworks will have to be more responsive and adaptive in real-time compared to today’s practice of writing lengthy and highly technical policies and overly prescriptive regulatory frameworks that produce friction for users and design contradictions for developers — without a proportionate increase in contextual privacy defense.

Since it’s impossible to write a privacy scheme for every context, companies settled on a workaround: they notify users at sign-on or log in to obtain broadly global consent from users to relinquish data and decision rights in exchange for service. This way, they stay compliant while passing responsibility off to users.

Importantly, there’s no expectation that users will actually read these policies in order to grant informed and enthusiastic consent: a 2008 study determined that, to make a rational and conscious choice about whether a given platform’s service terms are compatible with their preferences, users would have to study and compare the policies of every website visited, which would take six full workweeks or 244 hours in a year.[81] This is wholly impracticable purely from a productivity standpoint, even given the comparatively simple landscape of the web in 2008. These numbers balloon when adjusted for the present — and for new digital environments.

It’s the same in crypto as it is with web2’s overlong policies and GDPR-enforced cookie popups: few have the willpower or expertise to pore over financial data or understand the code written in smart contracts to determine the privacy impact of the data exhaust that signatures leave behind. The metaverse needs something substantially better, not only because the privacy impact of myriad worlds cannot and should not be left to users to manage, but because failure to devise adaptive, interoperable, and mutually-intelligible privacy protections across worlds will result in the same type of “consent theater” that exists on web2 platforms: users habituated to performative consent by granting permissions without consciously understanding the meaning and impact of those actions.

Digital worlds that purport to care about user agency cannot offer their own divergent and incompatible privacy protection schemes distinct from other worlds. The need for cooperation in this regard is both obvious and existentially important to safeguard human dignity in immersive environments that are capable of reality capture.

This calls for frameworks that are broadly applicable, adaptive to context, and centered on users — not platforms, companies, or products — because users have the most relevant and actionable contextual information upon which to formulate a defensive response. Unfortunately, privacy policies tend to separate users from control over their data and preferences because these policies are written to protect data custodians (the platform, company, or product) and not the data subject (the user). This stems from identity management architectures in which companies provision identities to users (and are therefore responsible for the data and rights ascribed to those accounts) instead of users provisioning and self-custodying their own.

Focusing on privacy policies and regulations is in a way a red herring, and because it’s been the wrong answer all along, the problem has persisted. **For privacy to work better in the metaverse, the first step is actually to shift the power over identity away from data custodians and into the hands of data subjects.** This requires broad metaverse adoption of decentralized, self-sovereign, and user-centric identity management.

"The future is an open-framework approach where everybody has ownership in a shared collective future. As I honed in on that, identity became the key point of all of it. Everybody gets really caught up in [metaverse] environments and worlds, the economy, and the objects.

But really, at the core, identity — and who you are, how you portray yourself, how you represent yourself, and how you secure that — became really important."

Ryan Gill
Founding member, Open Meta DAO;
Founder & CEO, Crucible;
Venture Partner, Outlier Ventures

8. User-Centric Identity Management

…THAT MOVES THE LOCUS OF CONTROL OVER PERSONAL DATA AWAY FROM PLATFORMS AND INTO USERS' HANDS

In the metaverse, people will no longer merely surf or use the internet — and will increasingly enter it. They will gather and interact online in ways that social media has, up to this point, only hinted at being possible. They will enter these spaces using constructed identities that will take the form of avatars, and that represent the aspects of themselves that they wish to project in a given context. To take a business meeting, that avatar — and its reputation history — might be more professional. A game of virtual paintball might be enjoyed in camouflage skins while projecting player stats, and an outing to an NFT gallery might call for a more polished avatar and its social score.

Around 70% of consumers in the U.S. say that their digital identity is as important as their real-life identity.[82] The industry seems to agree: leading avatar creator platform Ready Player Me, a contributor to this report, announced this summer a $56 million Series B funding round led by a16z[83] and launched an API for avatar interoperability just months later.[84] For the open metaverse, digital identity is not only a market opportunity but a core component of consent.

Identity is formed by how we imagine who we are to the external world, and how that external feedback shapes the parts of ourselves that we share in different settings. It makes sense, then, that users should be the ones in control of their digital identities. They are the ones, after all, who know the most about their immediate context as well as their own needs and desires in order to respond accordingly.

"People will create avatars for a use case. If you're visiting a lot of different galleries or social virtual worlds, that's a similar use case and you'll have one avatar for that. If you use VR for a meeting with the team or customers, you will have a more professional avatar.

In general, how we think about people creating avatars is similar to creating your social media profile. If it's your Instagram, show your cool self, but if it's your LinkedIn, it's your professional self. So you have an identity for different use cases. But then inside the use cases, people are pretty consistent with their avatars."

Timmu Tõke
Co-founder & CEO, Ready Player Me

Unfortunately, the opposite is true online today: digital identities have historically been provisioned to users by companies in the form of accounts — a social login, an email address, even a phone number. Instead of users provisioning themselves with full custody and ownership over who they are in digital lands, a power dynamic is established the moment they access the free and open web. They build up "rented" identities that can be taken away at any time and agree to confusing service terms furnished by social media companies and email providers that users do not, and are not expected to, read.

How did we end up centering companies, not users, in the management of identity data? This stems from what is sometimes referred to as the internet's original sin: a failure to build the internet with a persistent, portable, and composable identity layer that allows users to self-custody their privacy decisions and self-govern how they connect, to what services, and under what terms. In fact, underlying the issue of privacy management is a deeper question about identity, which originates from the same problem: the absence of self-owned, user-centric identity and access controls.

We can trace this absence to the internet's evolution from the read-only web1 era to the interactive web2 world. Companies had to issue identifiers of some kind so that users could log in with usernames (or email addresses) and passwords. While it solved one problem (accessing their accounts), it created *identity data silos* across every website where users created accounts. This led many frustrated users to duplicate their one or two most memorable passwords across all internet sites — often with the infamous "password123" combination that is irresistible to hackers.

The problems mounted: millions of insecure, easy-to-guess passwords replicated across thousands of sites, creating expensive and embarrassing breach liabilities for companies. The main purpose of a company website, after all, has been to grant users access to interact with the brand, not to manage their digital accounts and personally identifiable information (PII). It makes sense that companies wanted to get out of this risky business of storing sensitive data and managing expensive cybersecurity schemes to fend off hackers. When platforms with more ambitious plans for PII came along offering to "log in with Google," "log in with Facebook," and "log in with Amazon," websites were very relieved to outsource that headache to bigger players.

This gave rise to *federated identity*. When two websites (or domains) are in a federation, users can log in (or authenticate) to one site and then access other sites without going through a separate login process. Online, this is what happens when users sign in with their Google accounts at sites not managed by Alphabet or use Amazon to pay for purchases with other vendors. At work, a more limited version of this is Single Sign-On (SSO), where workers log in once to gain access to all of the company's websites and resources.

For users, federated identity meant streamlining their fragmented identities across disparate websites into one convenient login experience. For federated identity providers like Meta, Alphabet, and Amazon, this gave access to vast stores of user telemetry to mine for insights and predictive data modeling — the "digital oil" of the advertiser-driven attention economy.[85] Crucially, this centralization of identity data into federations abstracted interaction and identity decisions away from users and their context.

Federated identity also shifted the responsibility for information security from individual websites to collective federations with much better resources to defend against data breaches by offering benefits such as multi-factor authentication and account recovery. In taking responsibility for data security assurance, federations also had to protect themselves. So they wrote rather awkward, technical, and overly prescriptive policies. These policies deal with data breaches and improvements in information security, a discipline that focuses on the management and protection of sensitive PII. But they have predictably failed to maintain the contextual integrity of their users' privacy boundaries. That is because *privacy security* is distinct and separate from *information security*.

"Since this model of identity management separated users from custody over their data, privacy governance has focused on how companies should handle their users' data, and not what users should be able to do with their own data. But privacy is a continuum of people's ever-shifting boundaries and preferences that ebb and flow according to situation, environment, time, and mood. These characteristics defy the prescriptive, uniform definitions promulgated by centrally-defined regulatory frameworks and legal remedies. Contexts shift while governance remains static and codified, leaving user privacy boundaries vulnerable to exploitation."

Anastasia Uglova
Head of Communications & Ecosystem Development, Lighthouse

Privacy security concerns itself more with consent for boundary management and the metadata contained in our data exhaust, a data type that falls outside the scope of information security management.

Importantly, the consolidation and convenience provided by federated identity did not offer users a proportionate increase in control or consent. To use the internet, people largely have to agree to companies' terms, which is quite counterintuitive. Since companies want *you* (to play their game, use their service, create UGC, and populate their world), shouldn't they be expected to agree to *your* terms, and not the other way around? So what might metaverse privacy management that puts users in control of their own consent preferences look like?

As Lighthouse Head of Communications Anastasia Uglova (and one of the authors of this report) writes in her Master of Science thesis, *Averting Cambridge Analytica in the Metaverse*, user-centric identity management requires that we contemplate "the full expression and management of a comprehensive range of available choices across all systems, while providing users with a granular understanding of their options and how they interact with other systems."[86] This sounds overwhelming, she writes, only if we limit ourselves to thinking of identity management in the ways we are accustomed to today: as a centralized process where governance takes place exogenously, beyond the user, through universal practices and compliance requirements imposed from outside.

Metaverse users need to be able to modulate the amount and type of data exhaust they emit — and they should be able to do this at their own discretion, as they see fit. Since people all want different things, any exogenous identity solution that centers anyone other than the user will invariably fall far short of contextual integrity. Unless privacy policies and identity frameworks propose to predict the future, they cannot possibly give people exactly what they want, everywhere, when they want it.

This gets even less workable when those contexts are in constant transition across multiplicative digital environments.

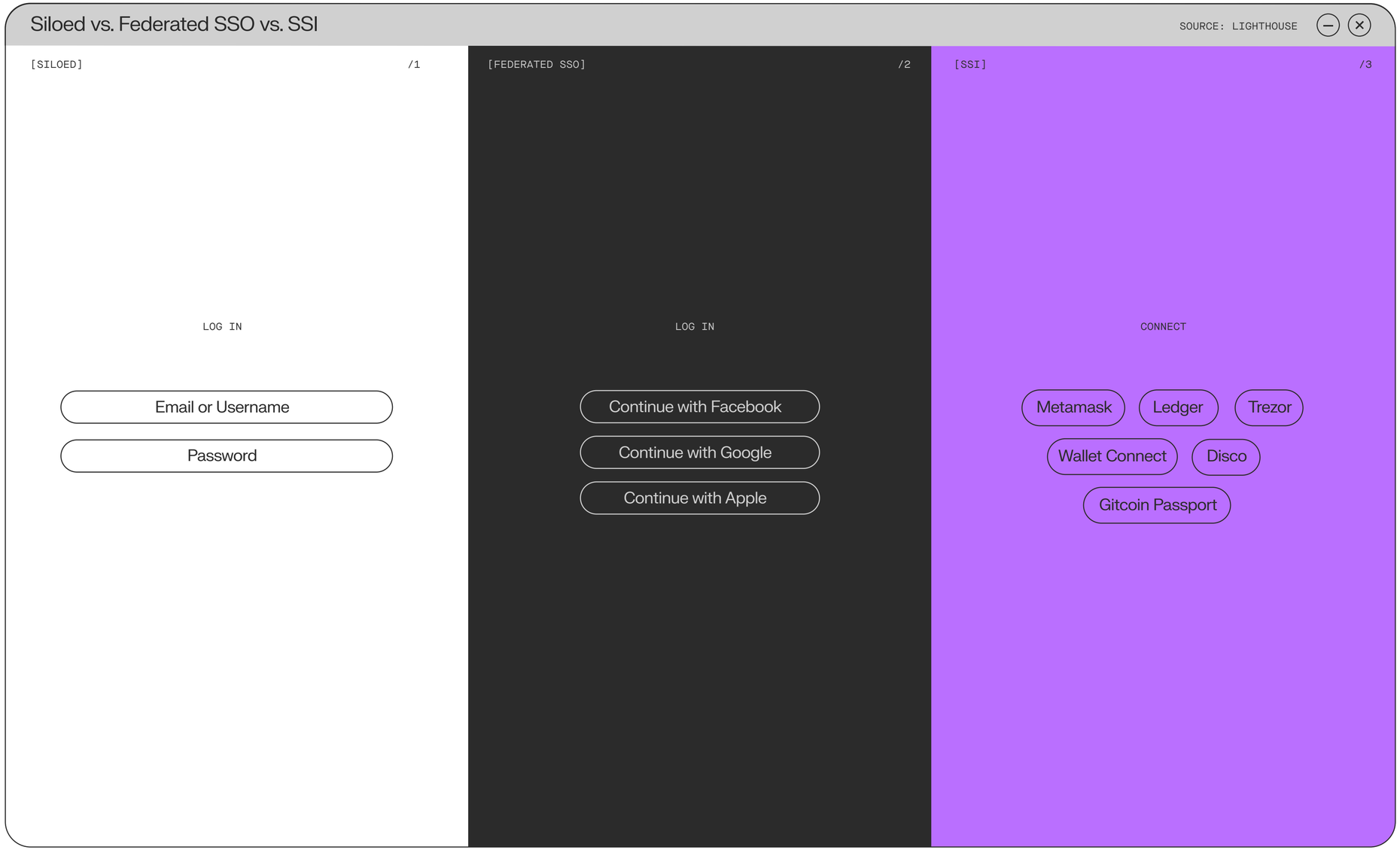
So should metaverse users forgo expecting consent for their digital bodies in virtual lands? Not exactly. If we are to shift away from centralized, platform-driven management towards more flexible approaches, who better to show the requisite discretion than the user herself?

Self-sovereign identity (SSI) is a crucial building block toward architecting identity controls governed at the most local level: by the user for whom the immediate context is most apparent. By assigning all identity data directly to a user — whether through a wallet address or a decentralized identifier — SSI eliminates identity custodians and limits overexposure of PII to federations. Encrypted attributes append directly to a self-provisioned user identity, and only designated parties with the right keys for the designated period can access these attributes. Because the flow of information between parties happens only with the cryptographic consent of the identity owner whose verifiable credentials are requested, SSI forms an essential primitive for coherent management of privacy and identity needs across varying contexts, environments, and worlds.

SSI is distinct from solutions offered by wallets such as MetaMask, Phantom, and Rainbow. Full SSI manages credentials in addition to the financial assets and token holdings that wallets do, forming a more complete picture of user identity attributes than merely how much crypto they hold.

Several examples of SSI solutions exist today, with many, such as Spruce[87] and Trinsic[88], attracting significant investment to prove their viability across both web2 and web3. This report also recognizes a spectrum of options and in-between solutions until SSI can be fully built out, tested, and adopted throughout the digital ecosystem. Ready Player Me, for example, offers an important component of off-chain interoperability by allowing anyone to use their API to create consistent avatar identities across metaverse games. Users can keep their avatars to move between metaverse worlds, although the history and reputation are not portable. However, the consistency across worlds allows users greater control over their self-presentation than having to create custom avatars from scratch for each environment.

Clearly, the market for decentralized identity solutions that put users in control is uncharted territory that is still ripe for innovation and experimentation. Ahead, we speak with Disco, a company that is advancing both thought and product leadership in SSI, about their vision for consent and identity in the metaverse.



REFLECTING OURSELVES IN THE METAVERSE

In Conversation with Disco's Evin McMullen and Jonny Howle

Disco, a startup that has captured enormous mindshare among the decentralized identity community, has likewise been preaching the gospel of privacy and consent to crypto audiences more broadly. Disco describes itself as a purveyor of “fine data backpacks” — self-sovereign identity wallets where users can privately and interoperably store their verifiable credentials, claims, memberships, NFTs, and other identity data. Users can take all this self-sovereign data with them anywhere they go in the metaverse — whether that’s in crypto, in real life, in web2, or anywhere in–between.

Ahead, we speak to co-founders Evin McMullen and Jonny Howle about the evolution of digital identity from federated models — where companies like Alphabet and Meta manage their users’ identity data — to self-sovereign data fully owned and controlled by users.

[1] ANASTASIA UGLOVA

How does identity in the metaverse differ from identity on the familiar two-dimensional internet? And do we need to upgrade our thinking at all?

[1] EVIN MCMULLEN

At Disco, we like to think of the metaverse as your ability to show up in any digital or physical environment and receive a personalized experience as a result of the parts of yourself that you choose to share. We do not think of the metaverse as hanging out inside of someone else's website with an iPad strapped to your face. What this means is that we need to consider the persistence of your identity and all of the wonderful data that describes you across platforms, across chains, across web2 and web3, into physical space, and back. You are the same person who shows up, regardless of how you choose to present yourself in those various different environments.

[1] JONNY HOWLE

I'd also say that having a private key is a step change in the way we interact online. There's a big trade-off that as you move from web2 — where we have email and password recovery — into web3, there's a jarring change in how you interact with identity. It's not “log-in” anymore. It's: “connect your digital wallet.”

[2] ANASTASIA UGLOVA

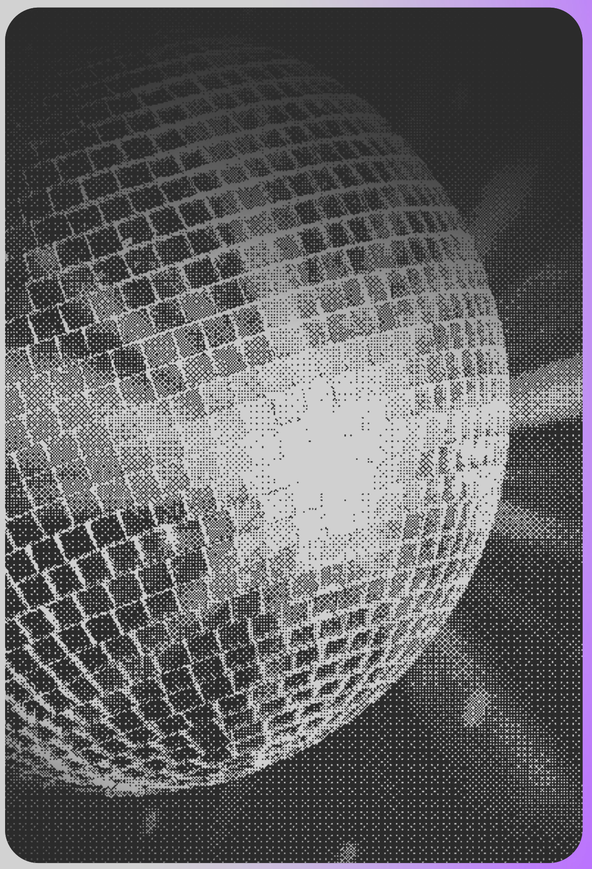
The past 15 years of online life have been defined by an intentional shift away from self-custody over data and privacy preferences in favor of convenience offered by large platforms and federated identity management.

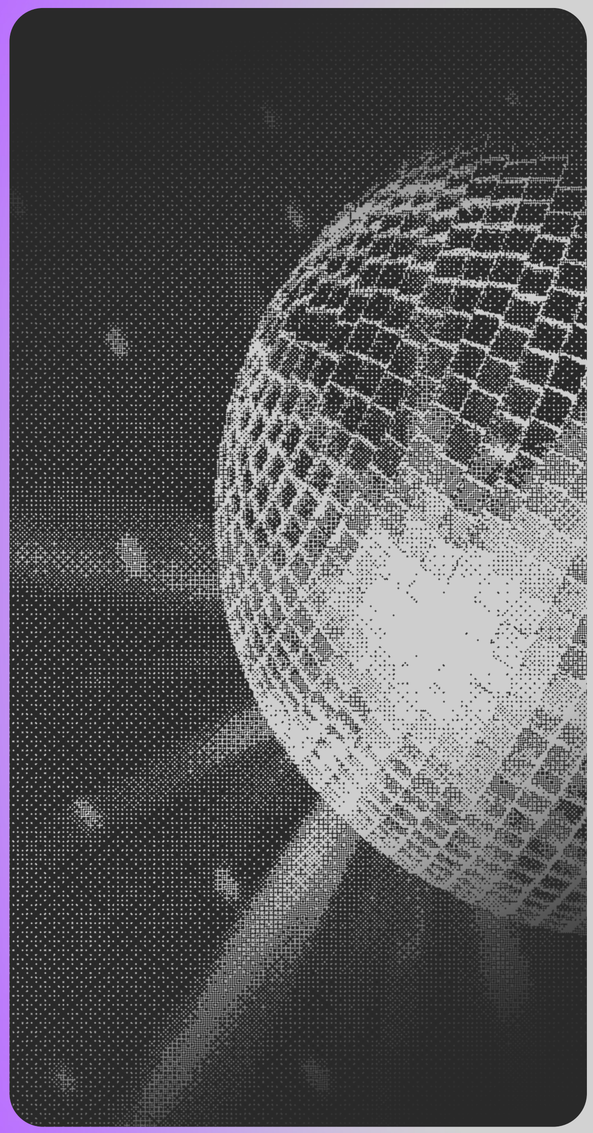
Do people want self-custody? Is that realistic to expect from users? And how can technologies help train the right habits to empower self-custody, despite 15 years of user experience design training the exact opposite behavior in users?

[2] EVIN MCMULLEN

So people don't wake up in the morning with dreams of logging in. And I don't think anybody considers the most exciting part of their digitally-enabled experiences to be password management. Rather, I think what people want is a broad variety of personalized experiences well suited to removing friction from their lives and adding delight and value. To that end, to the extent that self-custody further enables better personalization, more delight, and less friction, I think that it will become a desirable state of being.

Now, in terms of the logistics of what self-custody actually entails, I think that's a whole separate subject unto itself. But human beings want what they have always wanted. Since the dawn of time, people have just been trying to vibe with their friends and enjoy the types of experiences and opportunities that bring them delight.





[3] ANASTASIA UGLOVA

You've made the “data backpack” into a kind of shorthand for consensual data sharing. How do you envision the data backpack works in the metaverse?

Walk us through the experience from a user’s point of view.

[3] EVIN MCMULLEN

At Disco, we think of your data backpack as your ability to own and control and exercise selective disclosure about the data that describes you — such that it can be aggregated from a plurality of providers and presented to any environment, application, counterparty, and physical space. As we think about persistent digital environments — whether they are centralized or decentralized — we think that it is really exciting that you would be able to bring all this metadata that describes you, or some subset of it, to any one of those environments.

From a technical perspective, this is as simple as connecting your wallet or other identifier to one of these platforms, then calling Disco API in for the subset of data that you give permission to be decrypted to define the known universe about you that is presented to that application or to that environment. And then this data can be used to deliver personalized experiences to you.

[4] ANASTASIA UGLOVA

What technologies do users need to have to use the data backpack?

[4] EVIN MCMULLEN

Starting out, we are excited to empower Ethereum key holders to bring their own keys — regardless of the wallet used — to the Disco web app. And then those cryptographic keys are what are used to manage issue requests, disclose, and selectively revoke verifiable credentials written about them or that they write about others.

We're really excited that the verifiable credential spec[89] has quite a flexible signature scheme and, as such, you can use keys from many different identifiers. Moving forward, Disco will be enabling keys from other base chains as well as other web2 identifiers to interact in a similar manner.

[5] ANASTASIA UGLOVA

What's the market size and demand for this already?

What needs to be true to see mass adoption and widespread literacy or mastery over these concepts?

[5] EVIN MCMULLEN

In the grand Ethereum ecosystem, there are about 500,000 active wallets per day. Depending on the day it can be up to a million or so.

And so that's the first quarter of the ecosystem in which we are providing these capabilities. Obviously, the crypto market as a whole is larger than that. And so we see the opportunity to kind of snowball first from the ecosystem of folks who already have private keys in their hands and are already engaged in the act of self-custody. But then generally, the horizon line is pretty broad.

Every single person on the planet has an identity and has had one since the day that they were born! To the extent that we are able to empower larger and larger swaths of these individuals through semi-custody and custodial solutions in the future, we're really excited about that.

McMullen and Howle named the company “Disco” because, as they like to say, individuals are the “multifaceted center of the party.”

“You should be able to reflect your data and your identity to the world however you choose,” McMullen said — much like a disco ball reflects its light outwardly in all directions.

“People are the same way when we show up with our Ethereum addresses, email addresses, and private keys, even though we may only be reflecting one of those facets forward at a time — depending on the environment we’re in.”

"This might change, but with the technology at our disposal today, I don't think you can have a metaverse without blockchain. I'm not one of those people who subscribe to the Ready Player One school of VR immersive metaverse. I think that's just a particular high-end experience within the metaverse.

I think you have to have web3 underlying metaverse experiences to provide the digital rights management, the copyright protection for people's IP, in order to have interoperability. Otherwise you have a walled garden.

Everything's not an island anymore. You can take your stuff and bring it from place to place. This interoperability, in my opinion, makes the metaverse."

Robby Yung
CEO, Animoca Brands

9. Neutral Payment Rails

…THAT FACILITATE DIGITALLY NATIVE FORMS OF PEER-TO-PEER VALUE FLOWS

While AR and VR immersion is core to what's invoked within the mainstream imagination regarding the spatial web, the metaverse is actually more about digital ownership than hardware entry points. The difference between what the industry is starting to call "the metaverse" and today's world of siloed video games, social media, and various applications is just the fact that, in the metaverse, these experiences will interconnect and transfer both value and items intelligibly across worlds.

This, of course, will require payment rails and a money transfer network that allows users to realize aggregate value wherever they go. **Neutral payment rails empower users to accrue, interconnect, and transfer currencies and assets across virtual worlds in a frictionless manner.** An open economic layer is a defining characteristic of the metaverse, which makes neutral payment rails and services a key piece of the interoperability puzzle.

Whereas digital payment methods like ACH and wire transfers provide the illusion of instant peer-to-peer money transfer, the reality is that custodial financial solutions simply replicate the legacy models of centralized banking. High platform fees, unpredictable waiting periods, and third-party intermediaries cut into the money transfer process, siphoning their cuts from the top — and away from creators.

At Lighthouse, we believe that creators need a financial system that is custom-built for the needs of the digital world. So let's explore. What might that look like?

Crypto proponents argue it makes more sense to utilize blockchain-based digital assets inside the metaverse rather than adapt centralized digital payments for today's emerging needs. We understand why: blockchains offer a digitally-native global infrastructure for direct asset transfers without intermediaries and high fees. But blockchains are not a catch-all solution — nor do they resolve the data privacy problems of the web2 era.

1/2

"There's an astounding amount of industry-wide confusion about the metaverse, driven mainly by the fact that so many walled-garden platforms claim to be metaverses without qualifying what their definitions mean exactly. Roblox claims to be a metaverse. Fortnite claims to be a metaverse. People even think of Meta as a metaverse.

But in reality, they are not metaverses, just impressive platforms with considerable user-generated content. You can explore that user-generated content with an avatar, but you do not own any of the digital assets that you create, earn, or buy on those platforms. You cannot take any of that content from one of those platforms to another.

Sébastien Borget
Co-Founder & COO, The Sandbox

2/2

"The developers of the platform do not allow you to take an asset like an avatar and put it on sale on the marketplace outside of that platform. They do not allow you to take your virtual currency, exchange it for fiat, and cash it out or use it to buy something in another place.

If we were to hold most metaverses up to these standards, only blockchain-based metaverse worlds woudl satisfy these conditions."

Sébastien Borget
Co-Founder & COO, The Sandbox

Blockchain technologies do, however, offer the open metaverse several concrete benefits:

[1] Provable Persistence

Because they are decentralized, blockchain-based virtual worlds provide a sense of provable persistence. If one of the leading UGC web2 worlds were forced to close or went bankrupt, all the capital, time, and efforts invested from creators in their ecosystems would go to waste. In contrast, it would be nearly impossible to totally shut down the Bitcoin or Ethereum networks, even if one wanted to. Blockchains offer a persistence guarantee that significantly derisks investment of both capital and time spent building and creating assets and environments.

[2] Credible Neutrality

Because governance is likewise decentralized — often within DAOs — blockchain-based networks are credibly neutral in that no centralized authority can exercise arbitrary censorship, change access rules overnight (see Twitter, Facebook, etc.), and are permissionless. Well-designed DAOs aim to align user and owner incentives and approach governance like democratic nation-states, prioritizing GDP for the whole over profits for some. There are obvious improvements that still need to be made around DAO governance, but inviting all stakeholders to participate in an ecosystem-wide decision-making process already represents a major leap forward from the status quo.

[3] Composability and Interoperability

Because they are inherently composable and increasingly interoperable, blockchain-based worlds enable (i) faster and cheaper content bootstrapping through NFTs, (ii) less user and developer lock-in because they can easily port their work and assets elsewhere, (iii) lower fees stemming from both user-owner governance alignment and the absence of system rigidity, (iv) larger Total Addressable Market (TAM) due to the less fragmented nature of an interoperable market, (v) faster and cheaper settlement, and (vi) easily upgradable tech stack enabled by the modular nature of web3 software.

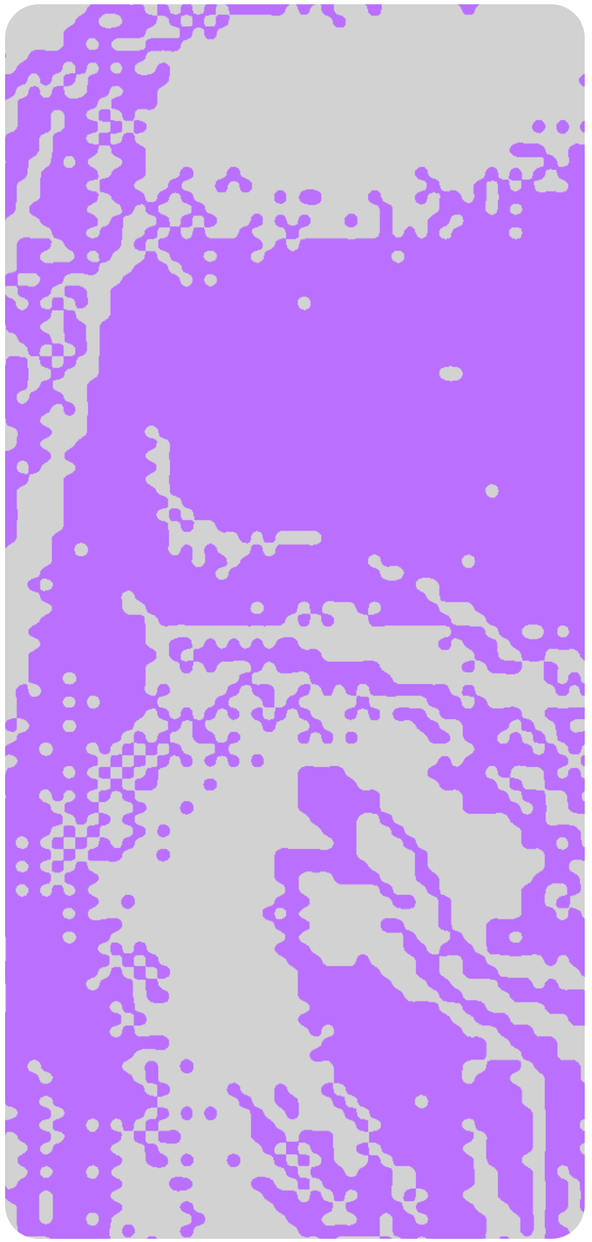
[4] Digital Ownership

By enabling ownership of digital assets without a centralized authority, NFTs operate as more than art, becoming the backbone of the digital economy. From a monetization perspective, they are a liberating force for creators — with the potential to redistribute value to the edges. Notably, NFTs do not singlehandedly solve ownership interoperability. They play a key role in unlocking digital ownership and facilitating asset trades. But without agreements on interoperable data standards, they provide no guarantee that the data they contain can be properly read, interpreted, and rendered by all metaverse environments.

[5] Sovereignty

Blockchains enable new coordination mechanisms, surface shared values, and empower networks to form and evolve without the need for a centralized authority. In that regard, blockchains can serve as a substrate for individual sovereignty over their finances and identities, and, in the context of the metaverse, their digital lives.

Despite their benefits, blockchains still have a long way to go. There are obvious distribution limitations for blockchain-based worlds — especially given that they are not yet accessible via traditional mobile app marketplaces. An even trickier obstacle for mainstream commercial adoption is the legal uncertainty surrounding the status of NFTs as investments — a confusion that's further complicated by vague regulatory sentiment from governments regarding the legal status of cryptocurrencies. User experience, scalability, security, price volatility, scams, unclear regulations, and transaction costs likewise pose significant barriers to widespread usage. Proponents are optimistic because of blockchains' unrealized potential — and because the space feels like a return to the web's founding principles of openness and freedom — recognizing that in practical terms, much remains to be done.



10. Community Governance

…THAT INVITES AND REWARDS USER OWNERSHIP, ENGAGEMENT, AND PARTICIPATION

Engagement has earned a bad rap in the attention economy, but in web3, it's a key feature of successful communities that participate in self-determination, collective mythmaking, and governance.

Virtual worlds are composed of real people, creating real businesses, and forming real relationships. Although companies may provide the initial build, they are brought to life by their contributors and would not exist without their participation, no matter how elaborately architected and exquisitely designed. Empty worlds devoid of UGC would provide little value to anyone without their users — and yet, when it comes to setting rules, product direction, and key governance decisions, platforms tend to keep all the control.

One critical open metaverse promise is that it will be a neutral space for all to build upon — and to have a say in how it plays out. Credible neutrality — or, more precisely, the provable guarantee that no single entity will unilaterally steer the destiny of an ecosystem in a given direction — is a prerequisite for a metaverse that is not merely open but materially and fundamentally different from the corporate-controlled reality we live today.

Today, crucial decisions about our digitally intermediated lives and how we interface with technology are made behind closed doors or by black box algorithms that evade public scrutiny under the guise of intellectual property protection. Not only do the users who create most of the value in social media have zero say in its governance, but government policy likewise lags in providing meaningful protection, breathlessly catching up to impose post-scandal punity instead of forward-thinking guardrails.

So what does viable community governance look like? In its crudest form, every stakeholder in a given project has a voice — and binding input — in determining the direction that the project takes. This means that users do not merely hold financial tokens but also voting rights. Crucially, these voting rights should have little correlation with financial token holdings to avoid wealthy investors and speculators buying up all the governance power in a project and leaving users with no more say in their digital lives than they currently enjoy today.

Even more importantly, the open metaverse depends on interoperability in governance exactly as much as it does in other domains. Governance is a reputation game that rewards participants for their involvement in a given ecosystem. Here, a portable, mutually-intelligible reputation is crucial — that is, unless the intent is to lock the most engaged community members into a single ecosystem to the exclusion of other digital realms, as has been the case with user lock-in across web2.

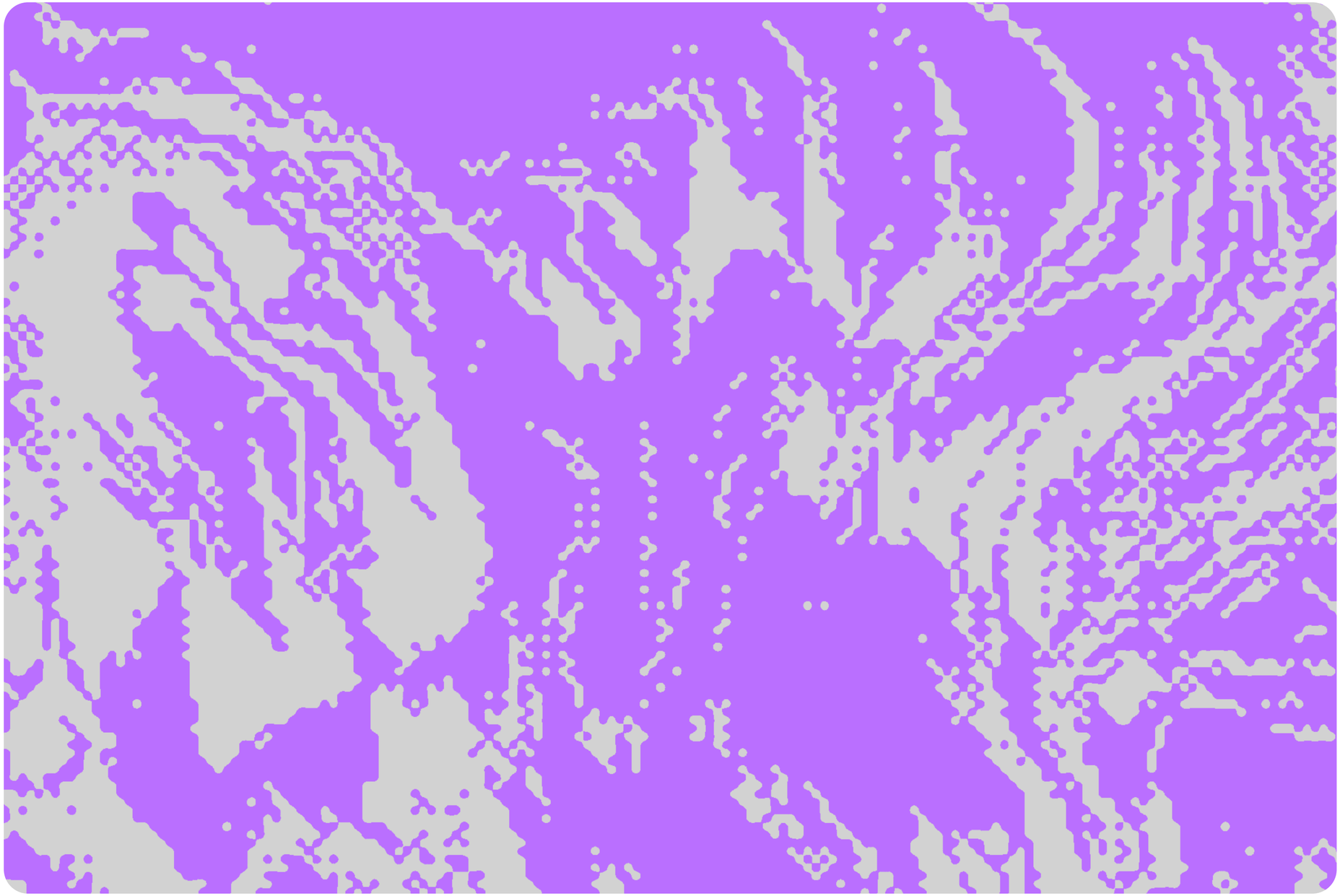
Community governance across the open and interoperable metaverse requires protocols that empower delegates and voters to accumulate reputation in one ecosystem and take it with them to the next — without having to build up reputation from scratch to have a say in their experience. Reputation that sits locked away in a silo creates an obvious deterrent to free and unfettered navigation across the open metaverse because it incentivizes communities to remain in ecosystems where they have a say instead of exchanging value, assets, and experiences across digital borders.This imposes unnecessary upper limits on the growth, adoption, and viability of the open metaverse economy. Reputation protocols such as Orange Protocol, Metopia, TrustGraph, Sismo, rep3, Govrn, and Disco are ecosystem-agnostic identity primitives that provide the essential substrate for interoperable, and, eventually, cross-chain community governance.

"Community should be your guiding star metric. Our belief is that if you have community, then you have everything else. You will have retention, you will have users, you will have revenues — everything follows from building and fostering community.

One of the early mistakes I saw a lot of people who came from traditional game development backgrounds make was this: they would think about making a marketplace so people can sell their NFTs, and they would get to the end of their pitch and fail to consider what they would do for NFT holders outside of their ecosystem. I'd ask, 'What if I have a Bored Ape — what can you do for me?' And they wouldn't have an answer because they hadn't thought about that yet.

But it's really important. Think about what you are going to do for the rest of the [web3] community, and the community will reward you if you provide utility. It's about being part of the broader metaverse network of interoperability. Plan that from day one."

Robby Yung
CEO, Animoca Brands



Without community governance, the metaverse is unlikely to see brands significantly increase their investments. Creators will not feel it worth the effort to ply their trade providing user-generated content they have few rights over. And users will not expend their valuable time and emotional energy on worlds that find their input irrelevant. The internet could not have birthed the powerful commercial force of e-commerce if the internet had an “owner” who could de-platform any business built on top of it.

One version of the future offers a 3D construct that differs from today’s social media landscape only in degree of immersion: the economy is financed by and dependent upon advertising rather than creator-driven value. The open version — where user feedback drives governance and worlds can’t unilaterally cut someone out — demands community governance to shift value generation and exchange from advertisers to creators and users.

We feel there is room for optimism on this front. Several open metaverse worlds are already incorporating community governance in their business models. Otherside, for example, is a metaverse world built by Yuga Labs that expressly states in their litepaper[90] that they are “committed to creating governance systems that are built from the bottom-up and truly representative of the evolving community needs.” Decentraland has set up a DAO for users to vote on governance proposals[91] that are “created by the community and work as the consensus mechanism used to outline policies and changes to the Decentraland ecosystem.” Other examples of metaverse worlds that place a premium on community governance are The Sandbox[92] and Aavegotchi.[93] As the open metaverse economy continues to grow and generate value for creators and users, worlds that ignore community governance will face financial pressure to either fall in line, shift revenues to advertising-generated business models, or fold.

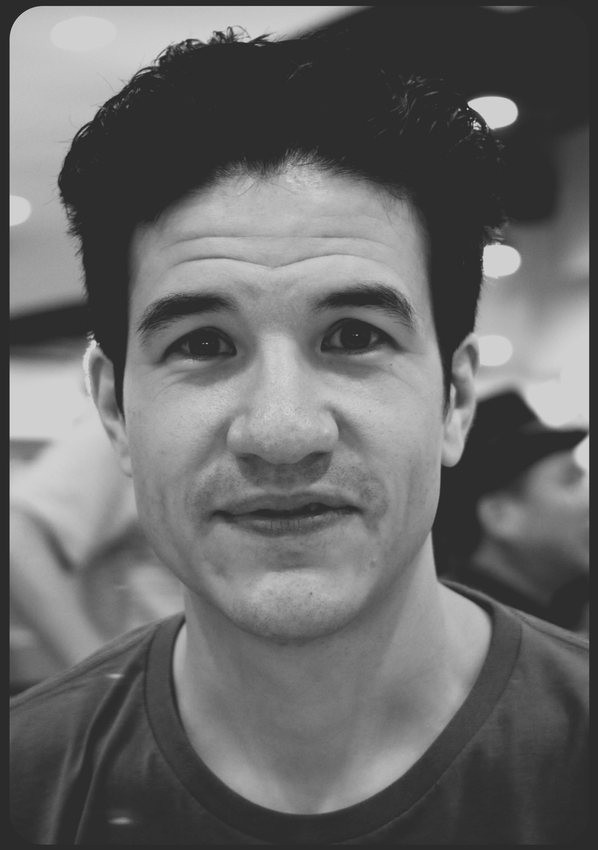
Robby Yung

[TWITTER]
@viewfromhk

Founded in January 2014 by Yat Siu and David Kim, Animoca Brands is a leader in gaming and blockchain technology. The company is known for its impressive investment portfolio split across more than 340 properties that include crypto wallets, e-sports games, guild games, blockchain-based games, web3 infrastructure, DeFi protocols, digital art, and metaverse experiences.

While many corporations are now embracing NFTs, Animoca Brands bet successfully on blockchain's disruptive potential comparatively early. In 2018, Animoca Brands became the exclusive mobile distributor of the Ethereum-based game CryptoKitties in Greater China, in addition to investing in blockchain software company Dapper Labs' $15 million series A funding round the same year.

Ahead, we speak to CEO Robby Yung about NFTs, interoperability, and his advices for new founders.



[CEO]
Animoca Brands

[1] ## Blockchain and NFT adoption can start small — from a place that feels familiar.

Back in 2018, the Animoca Brands team had an opportunity to meet the folks from Axiom Zen, which later spun off into Dapper Labs. "We worked with them on CryptoKitties before they launched it," Yung told us.

While blockchain was a new and noteworthy technology at the time, Yung attributes the success of their partnership to its sheer practicality: "We felt it was just quite simple. We looked at games and thought 'Okay, so people buy virtual currencies in games and then spend the virtual currency to buy virtual stuff. And this is how most game companies in the world make their living. What if we just tokenized it?'"

The simple answer, explained Yung, was that people wouldn't have to change their behavior drastically. And this, so far, has been the secret to Animoca Brands' successful blockchain adoption across its portfolio.

"Consumers just get to do what they're already doing," Yung said. "You don't have to teach anybody how to do anything. We basically just made the games we already make in a way that people can own the stuff instead of just in essence 'renting' it."

Given the choice between rental and ownership, Yung thinks people will always choose ownership. Keeping this simplicity in mind helps Animoca choose strategic blockchain projects that don't add unnecessary layers of complexity onto the user journey. The philosophy is simple: Let people play the way they always have, but give them NFTs with real provenance and digital ownership.

"Of course, making a blockchain game is harder than we thought," Yung added. "That part ended up taking a couple of years." But once Animoca Brands cracked the code, the customer experience, in theory, could be fairly identical to what it always has been.

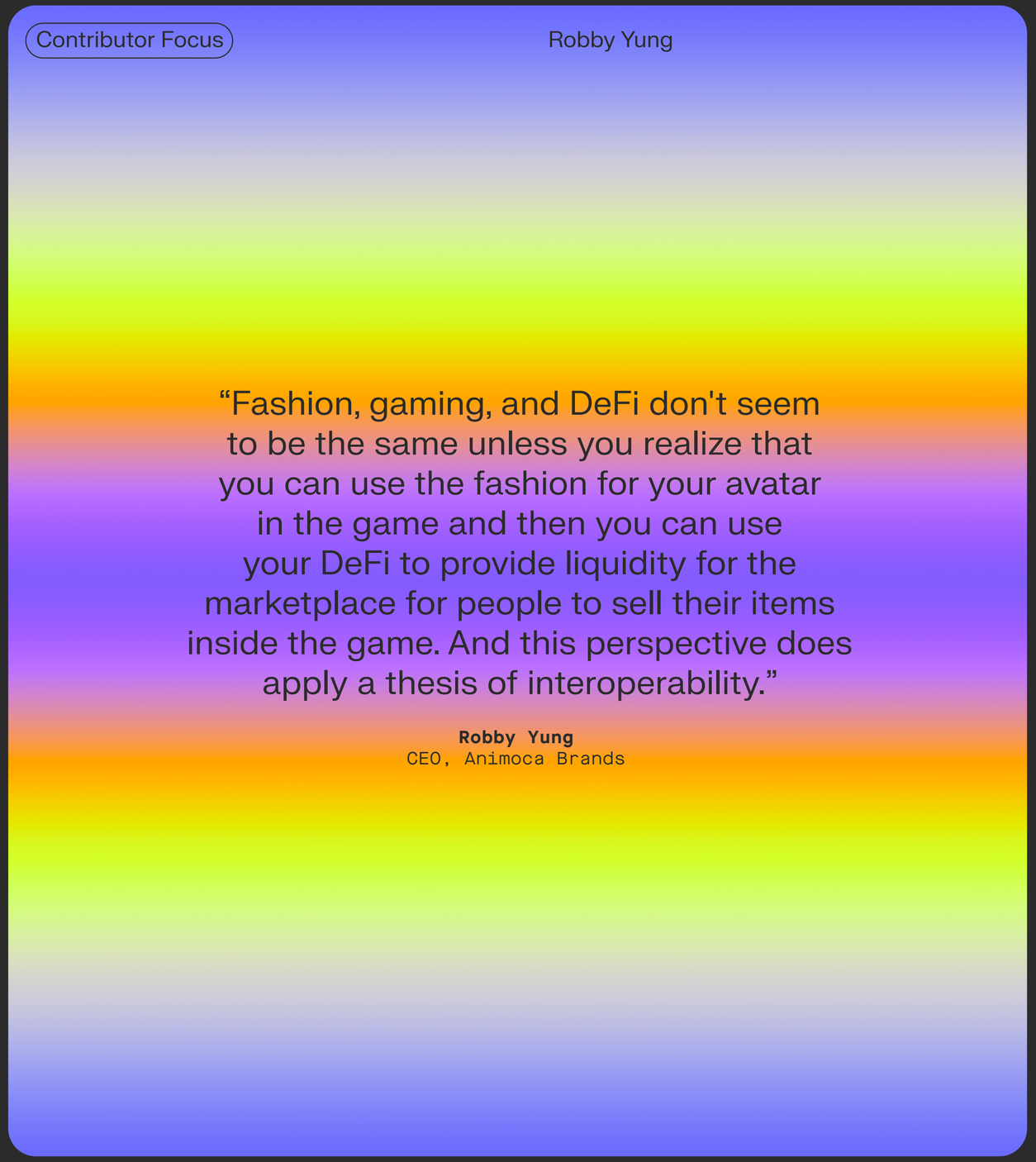
In other words: Keep it consumer-friendly and don't try to teach your customers brand new behavior all at once. NBA Top Shot was a great example project, Yung pointed out, because its creators gave users a simplified custodial wallet, unlike other blockchain projects that are more crypto-native by design — and therefore more complex to navigate.

[2] ## The open metaverse depends on blockchain.

"I don't think you can have a metaverse without blockchain," Yung explained. "I'm not one of those people who subscribe to the Ready Player One school of VR immersive metaverse. I think that's just a particular high-end experience within the metaverse."

While high-quality graphic rendering and VR immersion is core to what's invoked within the mainstream imagination regarding the spatial web, the metaverse is actually more about seamless digital asset ownership. The difference between what the industry is starting to call "the metaverse" and today's world of siloed video games, social media, and various applications is just the fact that, in the metaverse, these experiences will interconnect.

"Everything's not an island anymore," Yung said. "You can take your stuff and bring it from place to place. This interoperability, in my opinion, makes the metaverse."



Blockchain is what makes such ownership possible, he explained: “I think you have to have web3 underlying metaverse experiences to provide the digital rights management, the copyright protection for people's IP, in order to have interoperability — otherwise you have a walled garden.”

[3] ## Animoca Brands’ investment philosophy is focused on web3 culture.

“When it comes to investments, we like to focus on what we call the general area of web3 culture,” Yung told us. “Games are the biggest piece of content that we invest in, but we also invest in art, music, fashion, and DeFi because DeFi is part of web3 culture.”

All of these categories, when viewed through the lens of web3, have the potential to interoperate with each other.

“Fashion, gaming, and DeFi don't seem to be the same unless you realize that you can use the fashion for your avatar in the game and then you can use your DeFi to provide liquidity for the marketplace for people to sell their items inside the game,” Yung said. “And this perspective does apply a thesis of interoperability.”

Finally, Animoca Brands also invests in web3 infrastructure, including wallets, lending protocols, Layer 1 blockchains, and Layer 2 scaling solutions.

[4] ## Interoperability is a user acquisition strategy — and more.

For a metaverse world to be successful, founders must build for interoperability from day one, advised Yung — especially when facing the task of designing a token economy.

“Community should be your guiding star metric. Our belief is that if you have community, then you have everything else. You will have retention, you will have users, you will have revenues — everything follows from building and fostering community.”

And that’s where interoperability comes in, Yung explained: “One of the early mistakes I saw a lot of people who came from traditional game development backgrounds make was this: They would think about making a marketplace so people can sell their NFTs, and they would get to the end of their pitch and fail to consider what they would do for NFT holders outside of their ecosystem. I’d ask, ‘What if I have a Bored Ape — what can you do for me?’ And they wouldn't have an answer because they hadn't thought about that yet.”

But it's really important, argued Yung. “Think about what you are going to do for the rest of the [web3] community, and the community will reward you if you provide utility. It's about being part of the broader metaverse network of interoperability. Plan that from day one.”

Chapter 4

Compass for the Spatial Web

A Look at the Future of Spatial Navigation [66]

Mental Models for Metaverse Search [67]

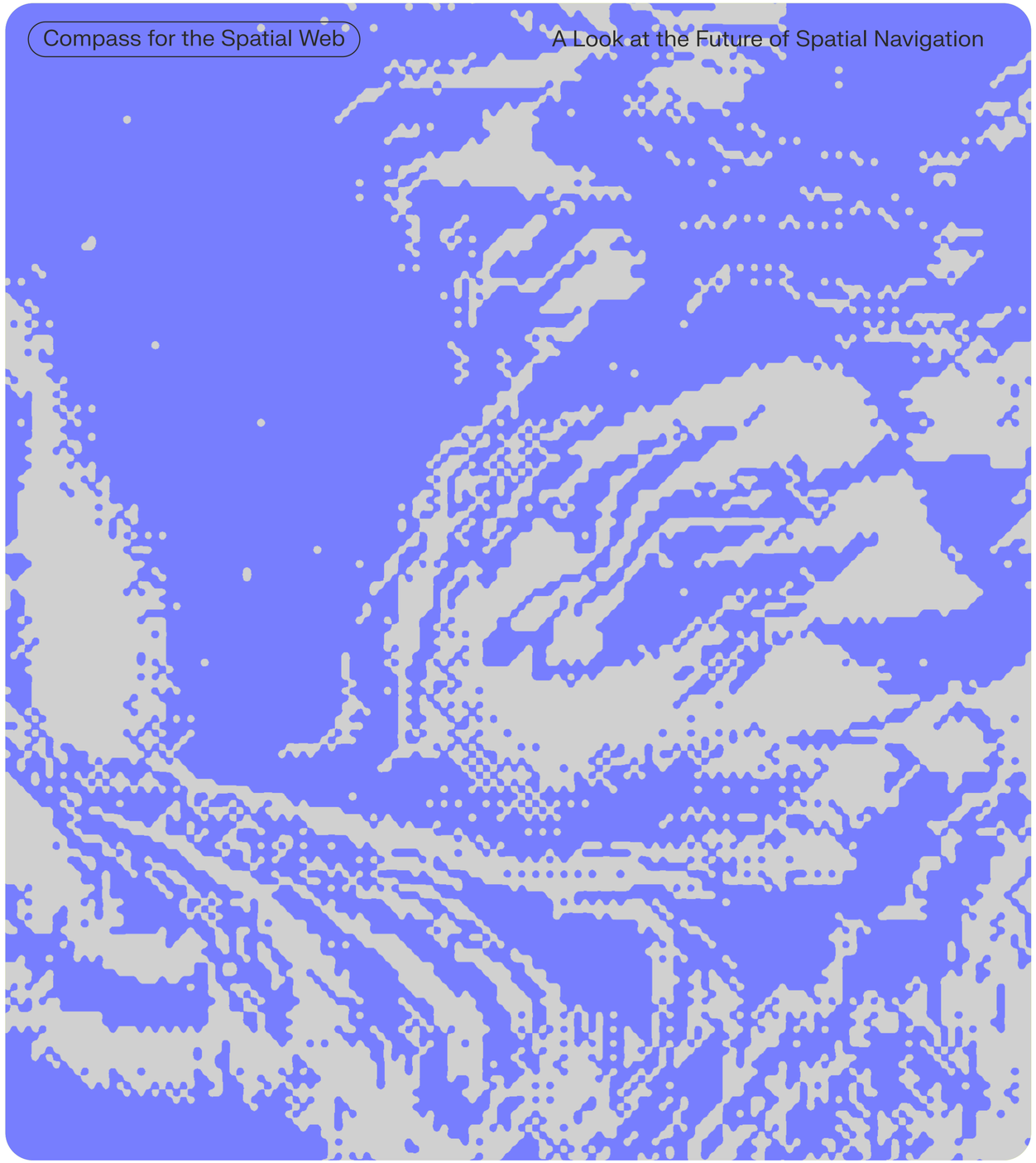
Mapping the Future: A Partner Report by SGDL-LLG [72]

A Look at the Future of Spatial Navigation

Ryan Gill
Founder & CEO,
Crucible

[Twitter]
@ryancrucible

“Most people stand where they are and look forward. But flexing the muscle of innovation is actually doing the opposite, where you look 20 years in the future and work backwards to the point that you're standing in.”



COMPASS FOR THE SPATIAL WEB

Mental Models for Metaverse Search

What are the coolest places to explore across the metaverse? Which world should you jump into next? Are any of your friends currently logged in? Where can you find a Hogwarts-inspired universe, a holodeck to wield your bat'leth, or an immersive Dungeons & Dragons campaign in full costume? Is the meta-rap party of the century happening without you being aware of it? How do you join an in-person book club from miles away, visit your favorite yoga studio while on vacation, or take part in the music festival while at home recovering from a cold?

Those are all questions that users ask themselves when embarking on their metaverse journey. Unfortunately, with the applications at our disposal today, getting a clear answer is nearly impossible. Unlike internet search, where everything is accessible from a single entry point, exploring different metaverse worlds currently requires users to jump across siloed platforms, hoping to stumble on something relevant and resonant.

Spatial search is a topic that we've thought deeply about at Lighthouse. Simplifying discovery across the open metaverse is our *raison d'être*. While we don't claim to have all the answers, when it comes to helping users navigate the metaverse's content cornucopia, we've definitely learned a few things along the way. Let's dive into some of them.

If you found your way to this report, there's a good chance that you've already mastered the art of searching for things online. Many years of school, work, and online stalking most likely taught you to use the right keywords, follow hyperlink trails, and leverage relational applications to find what you need.

Although you might be an internet search black belt, you'll soon realize that metaverse search differs in several fundamental ways.

Data availability: not all servers are created equal

Browsers are our #1 tool when it comes to surfacing information on the World Wide Web. But how do they work?

Browsers enable access to and representation of data that sits on different web servers. This is where the first major difference between metaverse search and internet search comes in: While data is open and readily available to be found and fetched from web servers on the internet, metaverse worlds usually have their data sitting in closed, game-optimized servers, making traditional retrieval techniques unsuitable for metaverse search.

Simply put, there is no unified, holistic, and publicly-accessible base of standardized data for metaverse-native browsers like Lighthouse to tap into. This creates a troublesome challenge for searching and surfacing data, to which the key alternatives are:

[1] Bots / Crawlers

Far from being a mature technology, one option to index the metaverse involves writing AI-powered software applications called crawlers. These crawlers, which are proficient on the traditional web of text, images, and video, nonetheless face fundamental limitations when it comes to metaverse search. Recognizing, contextualizing, and indexing 3D interactive media is a significant challenge that remains partially unsolved to this day. For more on this, see "Mapping the Future," a section by our friends at SGDL-LLG, at the end of this chapter.

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[2] Data Sharing

Another alternative involves world makers sharing their data in a standardized way, either through APIs or directly on-chain. In the case of data sharing, the Open Banking initiative provides an interesting case study of a sector that transitioned from siloed and opaque data management practices to a relatively open data sharing framework. Although Open Banking positively impacted the financial sector in many countries across the globe, it was for the most part imposed by regulators.[94] Many metaverse observers are hopeful that virtual worlds will voluntarily move toward greater transparency and interoperability for the benefit of users. To some extent, the optimism shown by business leaders in this report is an early sign of the sector's intrinsic motivations toward openness.

Data taxonomy: interpreting 3D interactive media

Now that we've covered the first fundamental difference between internet and metaverse search — *data availability* — let's explore a second important point: *data taxonomy*.

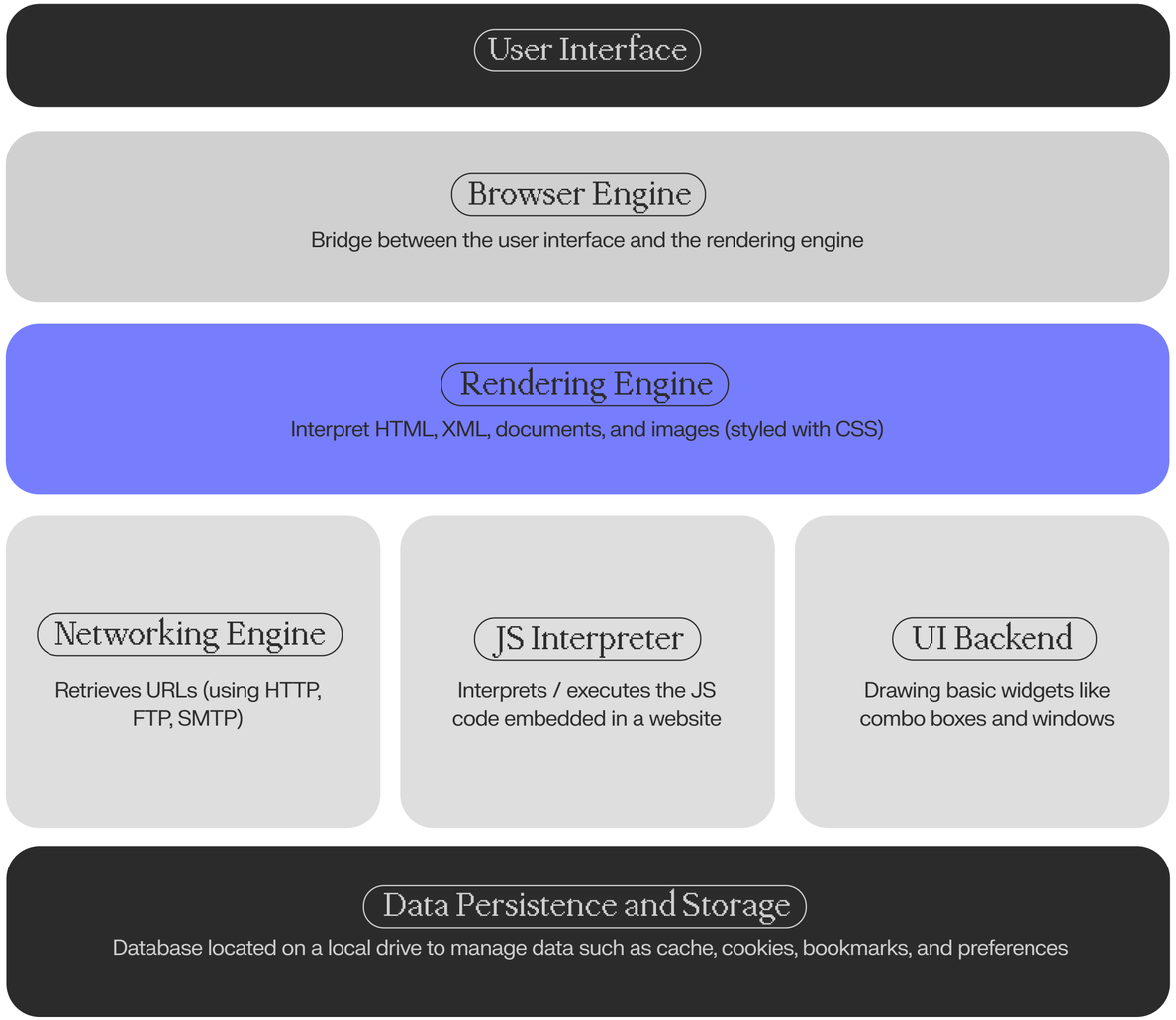
The information-centric semantic web that we all know and use is mostly text-based and two-dimensional. Users search for and through keywords to get where they want to go. In contrast, the experience-centric metaverse is mostly based on interactive media and is three-dimensional. This changes things quite a bit.

The text-based taxonomy of the web we know and use every day is quite simple: letters turn into words, which then turn into phrases and paragraphs. Letters are the atomic unit of a query and are by their very nature sufficiently descriptive.

3D interactive media are more complex and abstract. Assets are composed of thousands and often millions of voxels or polygons that, when bundled together, form scenes and entire universes. The subject of a query can be bundled in a theoretically infinite grouping of polygons the further out we zoom our perspective on a given scene. More often than not, there is not a clear line in the sand on where the scope of a search starts and ends.

An Overview Of How the Key Components of Browsers Tie Together

SOURCE: LIGHTHOUSE



Furthermore, while search is mostly descriptive on the traditional web, metaverse search tends to be contextual. This implies that tagging an element with descriptors is not sufficient to respond to users' needs. Discovery solutions need to not only find an asset based on its attributes, but to also have a broader understanding of the context in which it exists at any point in time.

From a discovery perspective, the level of granularity offered and supported for executing a search requires judgment, especially if data is to be shared from worlds via APIs. The question of data taxonomy therefore becomes a pragmatic one. If we agree that data must be shared, what exactly should we share to maximize user utility while making information sharing a technically manageable process for all parties involved?

Before real-time AI crawling becomes more efficient in a 3D context, and before past metaverse search behaviors reach a scale where they prejudice powerful recommendations, making judgment calls on what types of data must be made searchable is the logical first step towards building search capabilities with realistic, practical usability in mind.

Data dynamism: worlds in constant mutation

Beyond data availability and data taxonomy, an important distinction between metaverse and internet search can be framed as *data dynamism*. 3D interactive media are, well, interactive. They change a lot, and in the metaverse, they're often created by the users themselves.

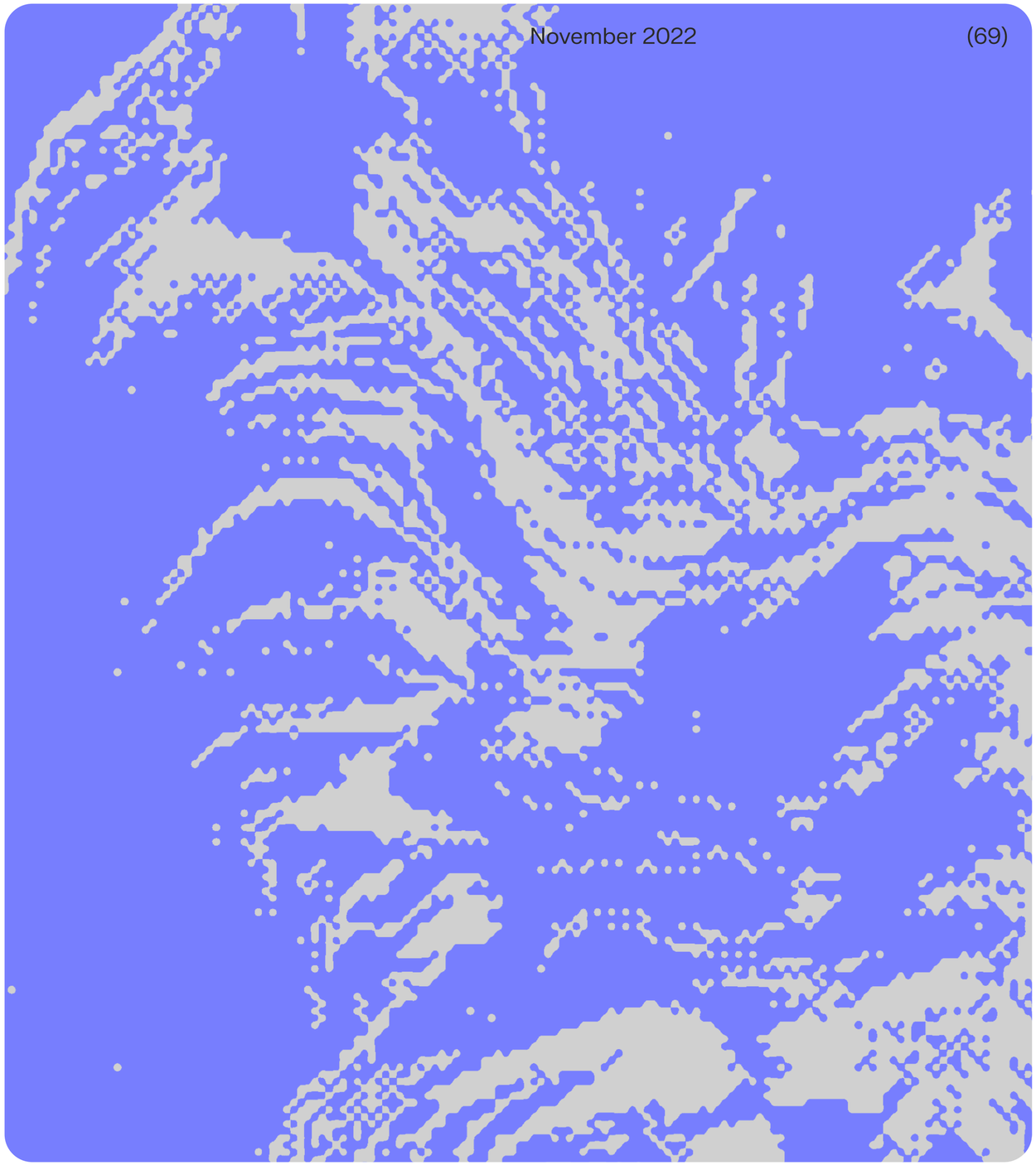
From a search perspective, this means that the shelf life of a descriptive tag is much shorter in the metaverse. What used to be a castle two seconds ago is now a pile of dust. The preponderance of user-generated content also implies that the creators themselves are usually the best placed to define what a specific experience is and does.

Data dynamism creates challenges in the context of indexation, but also impacts recommendation quality. How can a new, high-quality experience attract more eyeballs versus an already established one with broader visibility? Quickly separating signal from noise in a world where new content is constantly created and remixed is a challenge that even the largest companies struggle with today.

Data discovery: passive versus active

Finally, how will users actually search for things? Will they type queries to find what they're seeking (mainly prevalent in the desktop and keyboard-enabled world) or scroll through a constant AI-powered stream of things to do (the bulk of mobile internet discovery)? Obviously, it will be a mix of both — but if one behavior is much more prevalent than the other, discovery solutions will need to adapt their approach for relevance.

An argument could be made that passive discovery (recommendation-based) will capture a leading role in the metaverse. Rapid improvements in AI and the rise of the mobile internet have already made passive discovery society's primary way of discovering information online. After all, mobile applications are built for swiping, not typing. Looking at the evolution



of search functionality of proto-metaverse virtual worlds like Roblox also reinforces the thesis that discovery will indeed be driven more by contextual recommendations than text-based search.

Finally, taking a historical perspective on the early nature of the metaverse provides an interesting data point. In the early days of the web, before users actually knew what existed on the internet, portals such as AOL and Prodigy found product-market fit much sooner than search engines. Many users even thought that portals *were* the internet! When it comes to metaverse search, a portal-like user interface approach focused on recommendations might indeed be the logical stepping stone to simplify discovery and user onboarding while the technology around 3D data portability, taxonomy, and dynamism matures and new design patterns emerge.

From Theory to Product

Our primary goal at Lighthouse is to build a product that people love and use. Developing powerful metaverse search capabilities is of utmost priority, but translating them into an intuitive and fun interface that serves users is what really counts.

Informed by these insights, our approach is four-pronged:

[1] ### Data availability

Our headquarters in Montreal, Quebec is also a global hub for both gaming and AI. While we continuously track academic research on crawler-driven indexation, the bulk of our efforts prioritizes direct data integration with worlds. We believe in mutually-beneficial relationships and predict a future where most cross-world discovery in the open metaverse is driven by an ecosystem that puts users and creators at the "center of the party," as our friends at Disco would say.

[2] ### Data taxonomy

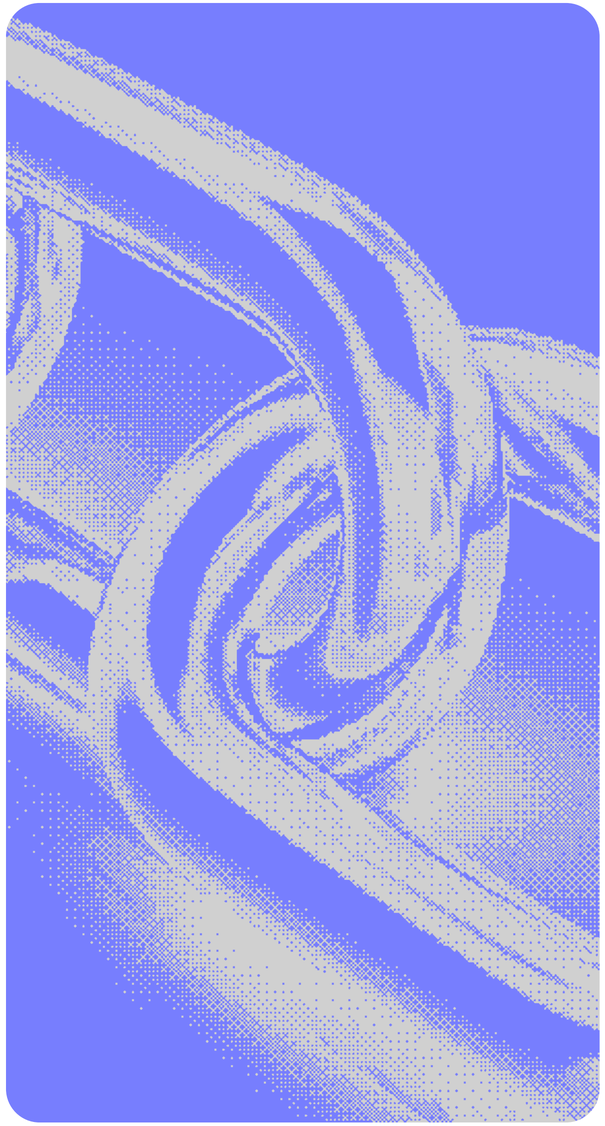
We always start with the user journey in mind. For now, we believe that explorers and creators alike mostly care about finding worlds, experiences, parcels, events, and their friends — and that informs how we categorize and tag information.

[3] ### Data dynamism

To track the diversity of experiences being built, we enable experience creators to use a Lighthouse feature that we call *Gates* to list their creations. From their Gates (think, "gateways to the metaverse"), creators and users alike can add defining tags and descriptors natively on Lighthouse. And, in line with our commitment to openness and portability, these are always exportable to other applications. The process is similar to how discovery platforms such as YouTube work. We see this organic, bottom-up, creator-driven indexation of experiences as the most scalable way to bootstrap user-generated content discovery.

[4] ### Experience discovery

Finally, we believe that merely slapping a search bar on a metaverse content and experience discovery application won't cut it. The metaverse is the digital frontier, and users should be accompanied and guided on their journeys. We maintain focus on passive discovery and recommendations to bring the best of the metaverse directly to users.



LIGHTHOUSE

The Open Metaverse Navigation Engine

Discover places, friends, experiences, and events across the spatial web

About Lighthouse

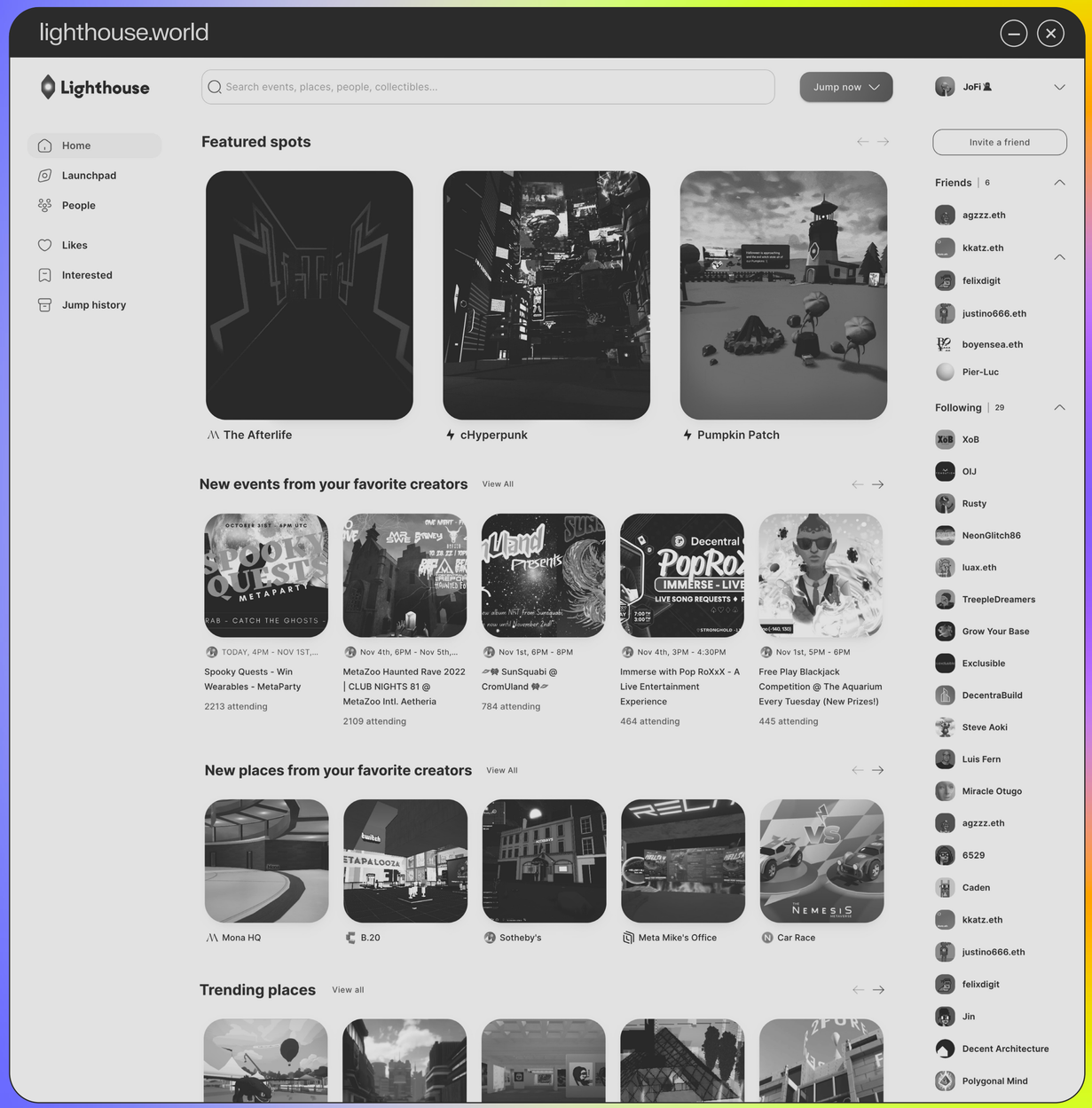
Lighthouse is building the open metaverse navigation engine, a unified interface empowering users to search for places, events, friends, creators, assets, and experiences across and within virtual worlds. The Lighthouse portal currently indexes experiences from more than 20 leading virtual worlds, including ecosystems such as Hyperfy, Mona, Oncyber, Portals, Spatial, The Sandbox, and many others.

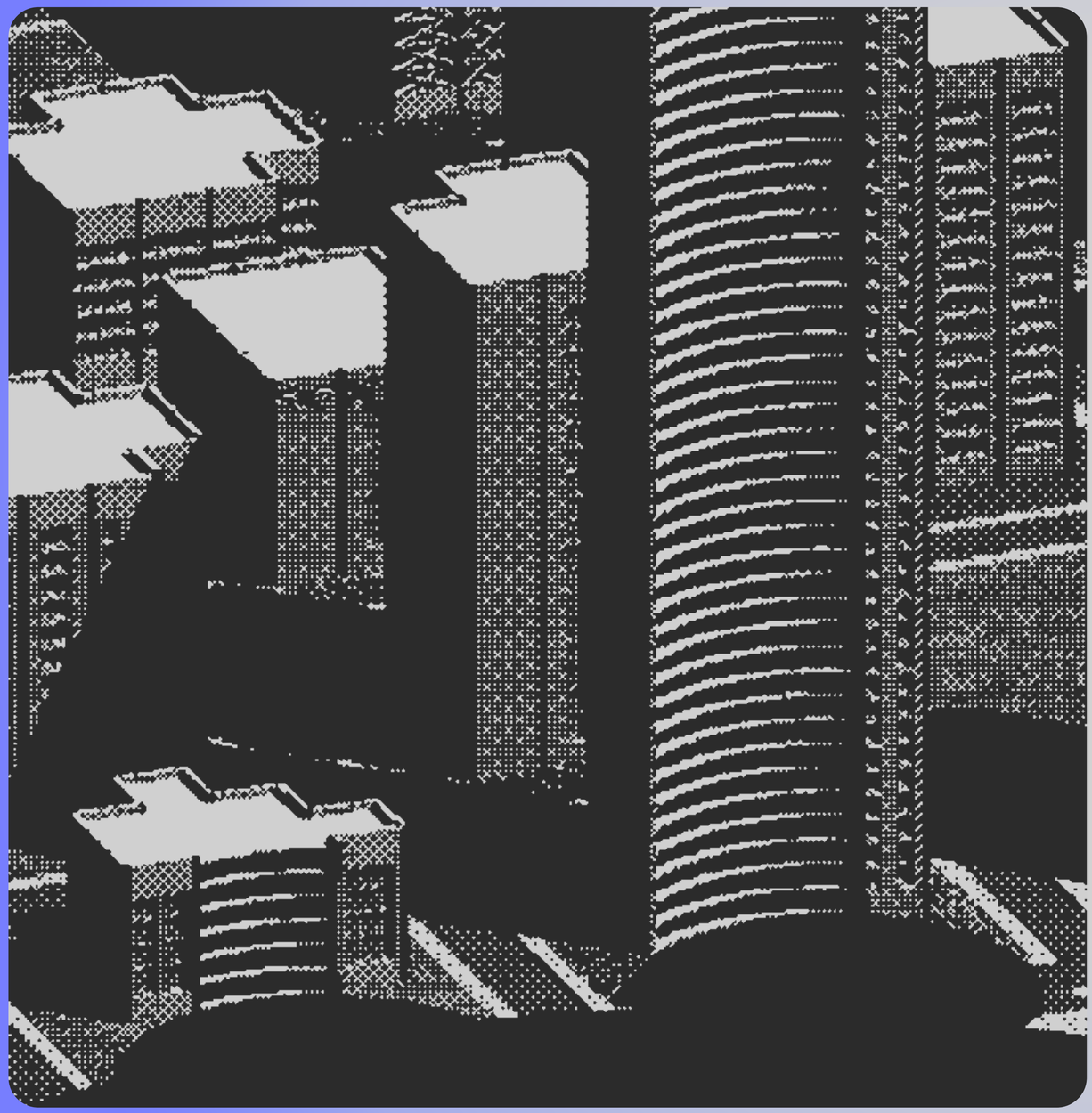
Our Browser Extension

The Lighthouse browser extension sits at the center of cross-world discovery.
Download it now to empower your friends to find you across the open metaverse.

→ Download Lighthouse

LEARN MORE AT LIGHTHOUSE.WORLD OR ON TWITTER AT LIGHTHOUSE_WRLD





COMPASS FOR THE SPATIAL WEB

Mapping The Future: A Partner Report by SGDL-LLG

About SGDL-LLG

SGDL Innovation - LLG is a Swiss-Canadian company specialized in data modeling, visualization, indexing, and encryption for high-dimensional data structures. Its IP-intensive innovation leverages more than 20 years of applied research in mathematics, spatial information, and parallel computing.

The company is renowned for its core expertise and innovative edge in the development of a universal digital protocol to optimize, communicate, and secure all geometric and graphic information. Its Research & Innovation (R&I) Partnerships team is currently focused on building and exploiting the first portfolio of patents dedicated to the processing of N-dimensional data and their overall security.

Much has been written about the relationships between smart cities, digital twins, and the metaverse. Unfortunately, thoughtful literature reflecting on the future state of automation and interoperability of spatio-temporal relationships, two foundational building blocks of the metaverse, is still lacking. Here, we explore these elements by presenting what we see as the ten key challenges standing in the way of a broader interoperability across the metaverse. We also consider some pragmatic avenues for business operators to solve these challenges and bring the metaverse from where it is, to where it could be.

The Duality of Temporal and Spatial Cities

The metaverse is essentially a real-time data and query system for spatial information acquired through 3D modeling or real-time sensors, and supplemented with temporal information.

The two concepts of spatiality and temporality together form the spatio-temporal metaverse. To differentiate between these two elements, this piece will refer to temporal cities as the function of describing and managing events and their chronology and spatial cities as the function of organizing multidimensional spaces and their interactions with various static or mobile avatars and objects.

To illustrate the challenging requirements of a broader interoperability across the metaverse, we will use the example of two worlds: one physical and one virtual. Both exchange information and influence one another in real-time.

The interoperability challenge for a virtual world connected to the physical one goes beyond 3D visual correspondence. To accurately translate the duality of temporality and spatiality into a realistic virtual experience that extends beyond gaming into broader use cases across industry, medicine, and art, metaverse architects must map geometric, physical, and graphical attributes across both temporal and spatial cities. Reliable interoperability between these three attributes — and the ability to perform real-time spatio-temporal queries — requires elaboration and adoption of technological compromises around a central database organization capable of sustaining a complete behavioral and dynamic connection between spatiality and temporality. The result would be a kind of synchronized virtual-to-physical-world pipeline enabling communication between people and objects connected to the physical world with their avatars in the virtual world.

Interestingly, this pipeline works both ways: Metaverse architects can use geometric and physical spatio-temporality to inform virtual *immersion*, but they can also rely on graphics, volumetric display, and spaxel technologies (pixels that are not fixed to a two-dimensional display matrix) to inform *emersion* from the virtual world to the physical one.

Before diving into the ten key challenges holding back broader metaverse interoperability, let's establish context on where we stand today.

The Coexistence of Three Spatial Cities

The three major groupings of spatial cities representation are geometric, physical, and graphic. The search for interoperability between these three groupings requires the permanent elaboration and adoption of technological compromises around how to structure and organize data.

The ultimate objective is to allow real-time spatio-temporal queries, as well as additions or modifications among these spatial families.

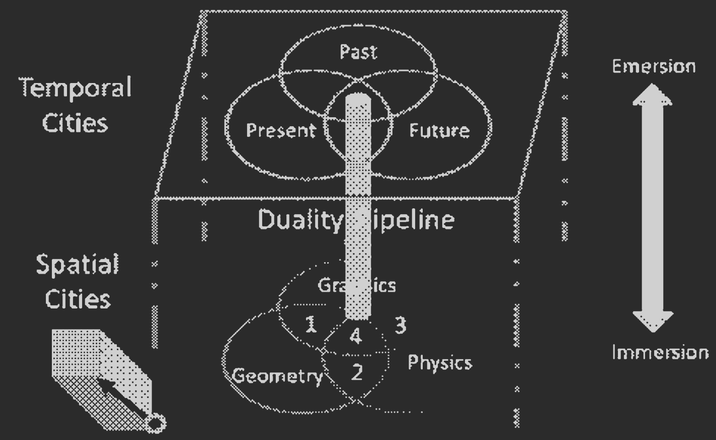
The Multirepresentation and Multiscaling Paradigms

The metaverse must manage multiple geometric data at totally variable resolutions and precision. The multi-resolution geometric paradigm raises real theoretical and practical challenges in order to efficiently manage and synchronize data. To solve this problem, complex mathematical representations are coupled with 3D representations (BIM, CAD, WebGL, game engine) that operate as the system conductor, making classic 3D geometric and graphical mock-ups (represented as triangles) interactively subservient to equation systems.

Another great challenge of the metaverse is the multiscale representation of geometric models. The scale spectrum of cities ranges from the macro- to the microscopic (from buildings to land, for example), and is often measured by advanced technical equipment. The 3D modeling strategies adopted ultimately guide our ability to describe multiscale geometric or physical models. These are conveniently characterized by the level of detail (LOD) of the spatial information provided. In general, the more LOD that is required, the more mathematical representations must be developed.

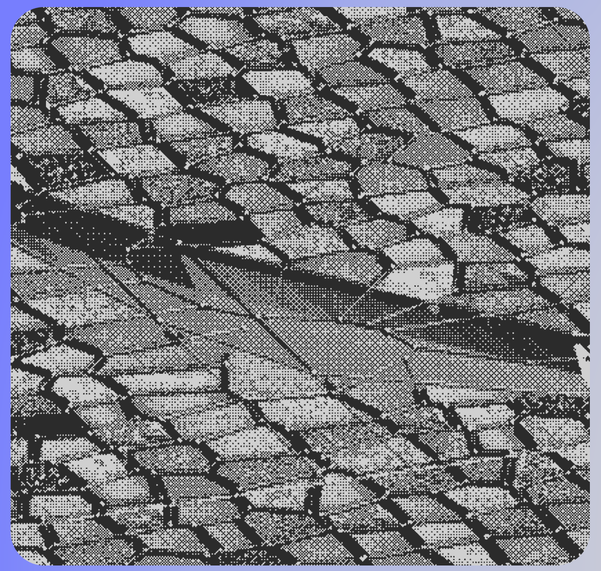
In terms of graphical or visual mockups, the ability to represent multi-scale environments depends on the rendering system and is influenced by the constant conflict between the production velocity of realistic and real-time images and the prohibitive memory size of some graphical databases based on textures and triangles.

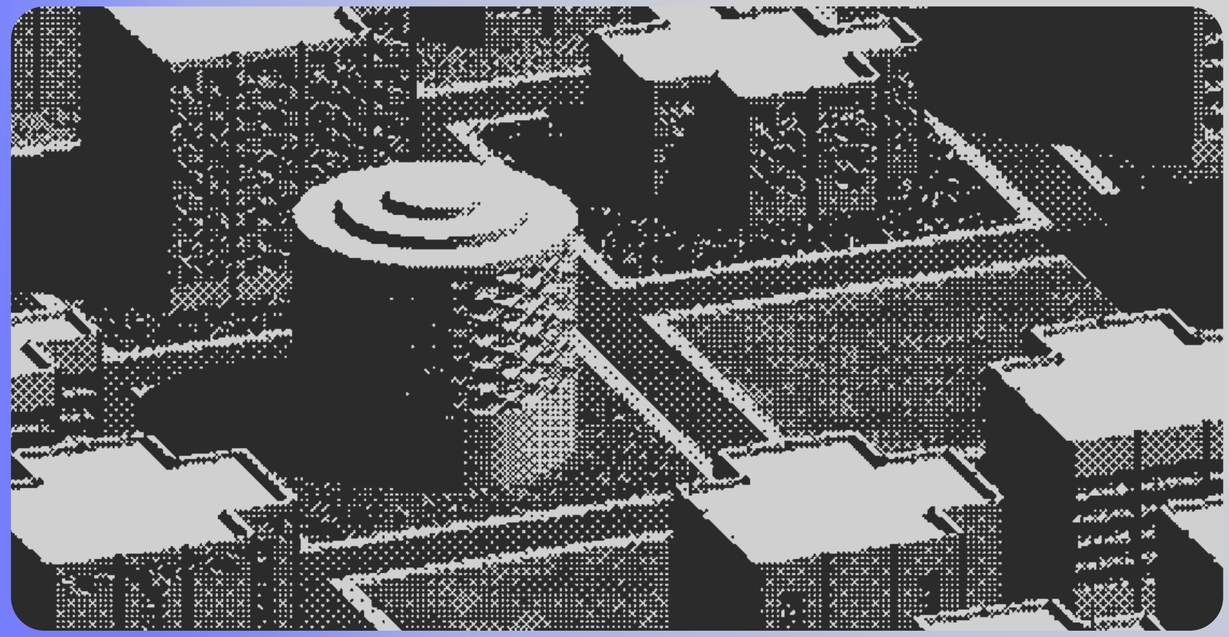
The Duality Pipeline



Spatial Representation Families

[1] Geometry	3D Modeling	Topological Relationships	Scene Graph	Geographical Relationships
[2] Physics	Structural Relationships	Material	Environement Data	Telecom
[3] Graphics	Rendering Approach	Hardware Acceleration	Clustering Optimization	[I][E]mmersive Devices





Beyond The Polygonal Metaverse

The interoperability of classic GIS, CAD, and BIM software, as well as the integration of these data with inputs from lidar or photogrammetric acquisition campaigns, is mainly carried out today using the triangle as a geometric and graphical unit. Triangles are commonly obtained from lidar point clouds or by discretizing synthetic geometry models. This approach is clearly one of the Achilles' heels of the metaverse because of the intrinsic theoretical limitations of polygonal modeling.

Below we present three approaches to modeling the metaverse, moving from the concrete representation of real cities in the metaverse to the now widely popular topic of generative AI.

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[1] Real Cities Representation in the Metaverse

There are currently several key problems in how we represent real cities in the metaverse. In the first place, geometric data acquired through lidar or photogrammetry is both *heavy* and *sparse*: It is *heavy* because this geometric "big data," consisting of large sets of 3D points, must be integrated into sufficiently intelligent cartographic data mapping software. And it is *sparse* because the absence of semantics on this data — such as initial knowledge about how points of reference in urban or architectural components like roofs, walls, and roads interrelate — leaves a significant gap in the constitution of spatial information for the metaverse. Furthermore, the spatio-temporal system must somehow allow visual and robotic controls of virtual urban spaces to pass through surface solutions without topological references.

This requires converting point clouds into clusters or "soups" of triangles without physical notions of emptiness and fullness, all without relations to the physics of materials and building structures. As such, today our attempts to properly represent real cities in the metaverse have been incomplete at best.

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[2] Pseudo-Random Cities

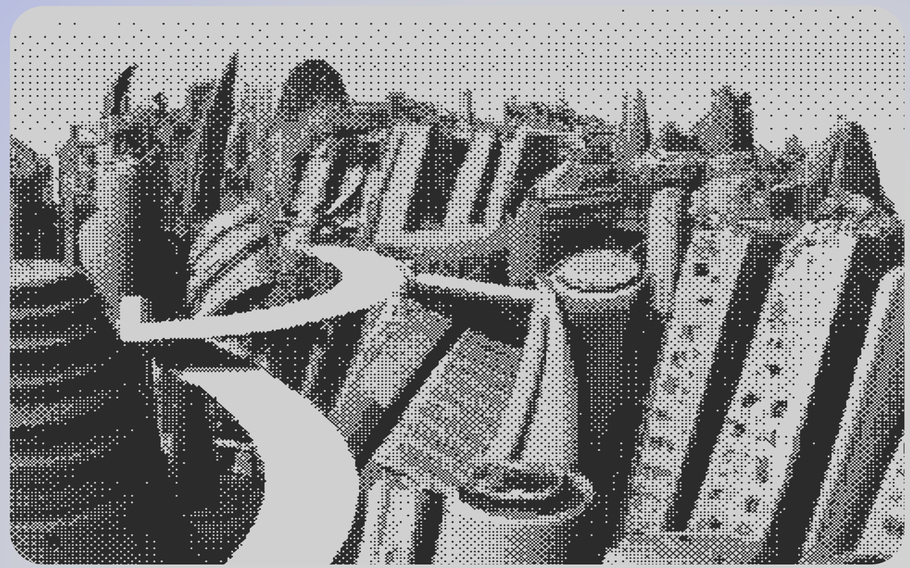
The figures to the left illustrate the pseudo-random growth of a city in the metaverse. This approach allows architects to create spatio-temporal models that respect the laws of physics and is ideal for using the metaverse as an urban simulation laboratory. Pseudo-random modeling is at the extreme end of spatial modeling complexity, requiring significant computing power for visual representation and, in general, immersive robotics processing.

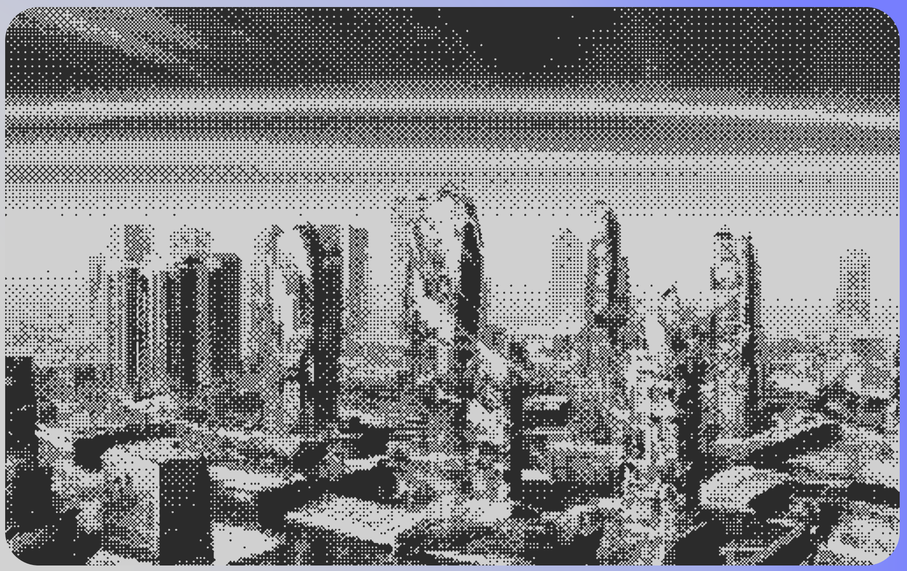
[BEYOND THE POLYGONAL METAVERSE]

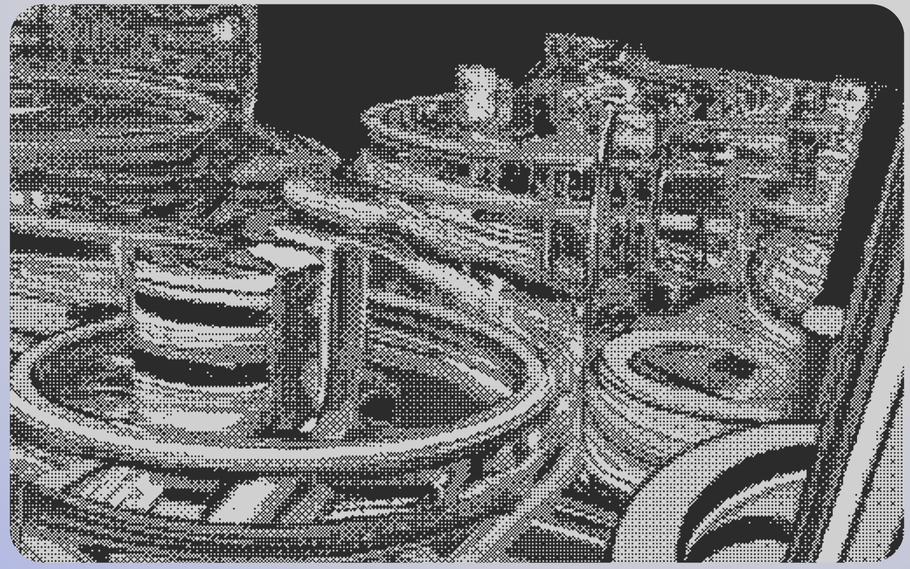
[3] Utopian Cities

Another technique is structurally incoherent utopian modeling of the type possible using artificial intelligence software such as DALL-E. The figures on the right show a series of four images of utopian cities generated from the query: *a futuristic city made with space filling curves*. These images can be transformed into lidar images of cities in 3D through Monocular Depth Estimation techniques, which provide depth to the pixels. This approach can quickly fill and furnish the metaverse of mainly graphic cityscapes, creating worlds disconnected from the physical world, and closer to imaginative environments and dreams.

Finally, hybrid procedural techniques allow for direct generation of futuristic 3D cities with or without artificial intelligence. These are highly experimental and create topological inconsistencies in the geometric or graphic models they generate; however, they may be appropriate for some spatio-temporal mapping needs.







The Ten Challenges

[1] Spatial Data Representation and Geometric Exchange Formats

The geometric data used to model objects in 3D is extremely heterogeneous, forcing metaverse architects to triangulate often incompatible geometric formats with varying levels of spatial intelligence and requiring special graphics rendering pipelines. This heterogeneity can be broadly grouped into three families of 3D model geometric representation: point, surface, and solid. The gaming world favors surface representations by triangles or volumetric point representations by voxels, design favors parametric surface representations, and industry favors solid representations. Data conversions and exchanges between previous formats form what we call the *geometric ring*. These can be extremely delicate, with some mathematical problems having no known solutions today.

The persistence of the metaverse over time also requires accurate representation of spatial data obsolescence, a phenomenon particularly common to geographic information systems and gaming environments that are in constant transition. Obsolescence results from either changes or destruction of spatial data or from the evolution of geometric precision — for example, the resolution in the number of points (pixels or voxels) or polygons of an object. Files generated from triangles or lidar data have a limited lifespan that depends directly on compromises between precision and memory capacity of 3D display graphics cards or real-time processing units.

To protect against this obsolescence of data, one favorable solution is to select 3D models with geometry described by equations in absolute precision, independent of the context of geometric, physical, or graphical processing. Otherwise, updates to obsolete files must follow procedures similar to automatic maintenance of spatial images covering the earth at increasingly shorter time intervals.

[2] Spatial Data Rendering

Graphic models contain all the information necessary for interactive visual immersion in the metaverse. The gaming world relies on hardware to display realistic scenes in near real-time. In this sense, the historical development of specialized game hardware has *de facto* imposed the triangle as the main rendering unit. As a result, some metaverse architects conceive of the spatio-temporal metaverse as a massively multiplayer game universe.

Visualization is an essential component of 3D navigation and simulation in complex urban and territorial scenes — and, by extension, in the spatiality of the metaverse. Because data associated with the creation of a 3D volumetric map becomes heavier as the number of objects increases and / or gets more detailed, the interactive visualization of this data becomes increasingly problematic.

In addition, the constant multiplication of new VR devices opens the door to more intuitive and performant visualization and robotic control systems. The metaverse must therefore deal with different — and sometimes incompatible — graphic rendering technologies. These include point, triangle, parametric surface, volumic, and voxel rendering, as well as volumetric display and spaxel technologies dedicated to immersive techniques.

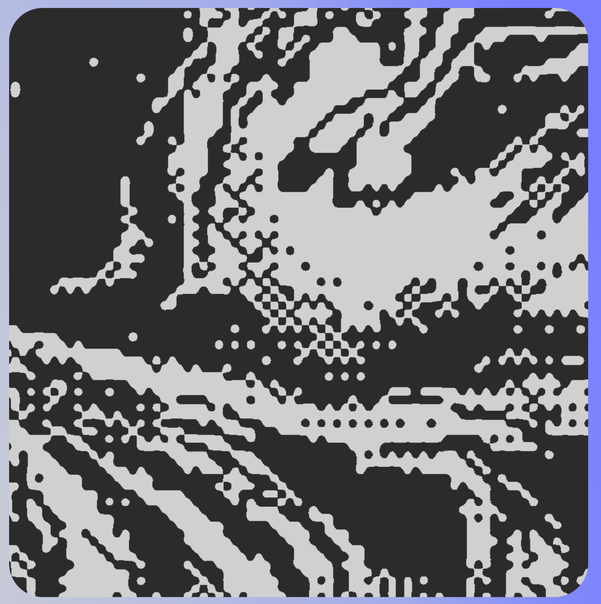
The multitude of pipelines and graphic rendering systems of the metaverse is a critical factor in the evolution towards an interoperable and unified metaverse.

A versatile metaverse that is not exclusively focused on gaming — one that integrates physical phenomena — should offer volumetric immersion. The volumetric nature of data allows real-time scanning of buildings, their structural components, and their underground infrastructure. Classic virtual reality features are therefore enriched with tomography possible through voxel representation (medical MRIs) or in native equation mode (algebraic ray tracing).

[3] Geometric Rendering

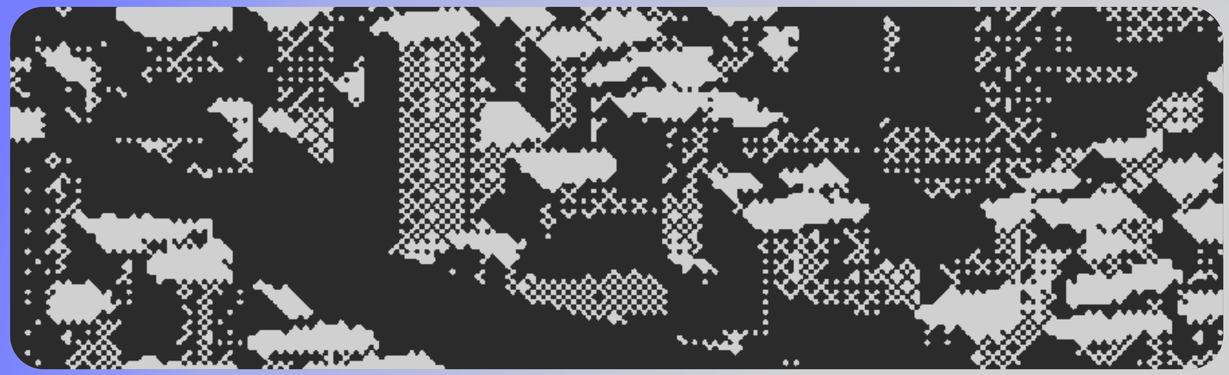
The human race will generate about 33 zettabytes of data by 2025, or 3.3 followed by 22 zeros. It is likely that the metaverse will require storing similar amounts of digital information primarily of a space-time order in the short term. The memory demands of storing geometric and graphic models and archiving obsolete models limit scalability, especially because these demands are steadily increasing. For example, some museum images of paintings have very high-resolution sizes exceeding five terabytes. In 3D, the size of lidar files and triangulated models tends to explode. Standard options for sharding memory or compressing data are necessary for memory management in the metaverse, but they are unfortunately not enough.

Emerging storage techniques leveraging synthetic DNA allow compression of the 33 zettabytes generated by the human race in a small vial. Although these techniques are already functional for storage and could be candidates for metaverse archiving,



they remain unrealistic for reading real-time data. Current costs of generating synthetic DNA are also dissuasive. There are some promising alternatives to synthetic DNA that may become viable in the longer term, all with a view towards escaping the heavy magnetic storage demands of non-perennial information.

[THE TEN CHALLENGES]



[4] Robotics and Spatial Mapping

To locate oneself in the metaverse, mapping it in 3D is essential — first in the virtual space based on the geometric model and then, if applicable, to synchronize with physical space. With the advent of drones and flying vehicles in physical and virtual urban spaces, managing mobile avatars means that mapping the virtual world should ideally be spatio-temporal.

The first step is drawing a topological adjacency graph linking empty spaces to full spaces and then establishing building plans with 3D metrics. This formalized mapping via graphs can be done manually by designers of 3D virtual world infrastructure or automatically by robot avatars.

Synthetic lidars are especially interesting for simultaneous localization and mapping because they allow spatial-temporal synchronization between virtual and physical sensor sets to compare virtual and physical information. This allows systems to detect, anticipate, and control by differentiation any potential intrusions and collisions of obstacles — or to facilitate the geometric recognition of environments.

[5] Spatio-Temporal Indexing

Key to real-time queries on the data and metadata of the metaverse is spatio-temporal indexing. Three major multidimensional indexing strategies emerge as candidates. The first two, *database* and *voxel indexing*, are well suited to decentralized metaverses with their own resources for hardware acceleration in edge computing configurations. The third, *space-filling curves*, offers a hyperspatial indexing system based on simple encoding and decoding functions that calculate real-time indices without needing to store metadata in memory tables.

[5.1] Data Indexing

Data indexing links metadata fields together in the most efficient and fast way currently possible. Column-oriented architectures are often in competition with older row-oriented architectures. For a centralized metaverse, the main problem is the increased complexity of updating these databases. Queries and permanent changes are particularly time-consuming.

[5.2] Voxel Indexing

Voxel indexing is well suited because it allows a hybrid visual representation containing spatio-temporal information. In terms of memory, these technologies are halfway between volumetric visualization and information representation. Current applications of voxel indexing are most prevalent in GIS and gaming.

[5.3] Space-Filling Curves Indexing

Space-filling curves (SFC) are based on mathematical models of curves used universally today to index, encrypt, and compress textual or visual information and multidimensional datasets. These curves form the basis for a large number of real-time mobile geolocation indexing systems. A spatial indexing system based on a multidimensional SFC approach makes it possible to manage, identify, geolocate, and coordinate different mobile actors circulating in the mathematical city: human beings, autonomous ground robots, drones, mobile 3D printers, and, in general, connected objects. Such a system can easily be interconnected with the classical space-filling curve systems used by industrial or open-source spatial databases.

[6] Spatial Access Method

The different methods of accessing spatio-temporal data determine the performance of queries and interactive database modifications in an indexed metaverse. Whether the data is static or dynamic determines the method used.

In a graph-based scene representation, trees of nominal identifiers provide references for 3D objects, allowing access to information based on its hierarchical rather than metric or topological organization. This type of representation is essentially manual, with techniques for intelligent recognition of features and their hierarchical organization entirely too complex to conceive and deploy.

Spatio-temporal clustering of data can help eliminate unnecessary access to databases. Here, the algorithmic strategy is based on prior exclusion of data to be processed, allowing systems to bypass non-visible graphic data and, in robotics, to avoid processing collisions between objects too far away from each other to be relevant. Families of arborescent clustering, such as R-tree and other variants, are well adapted to static geometric environments without frequent changes. As for dynamic avatars, mobile bounding boxes with simplified geometries that quickly exclude avatars contained in these boxes are ideal. Finally, where the data is localized and accessible in distributed architectures such as separate servers or clouds, physical clustering can lead to appreciable gains in the exclusion of data to be processed.

[THE TEN CHALLENGES]

[7] Geolocation

[7.1] Geocoding

The metaverse should be equipped with effective spatial indexing systems that can be linked to geocoding systems such as geohash in the physical world. For this, the metaverse needs geolocated addresses that allow it to operate in volumetric worlds and address the positions of points in space or in matter, such as in walls. The inverse volumetric geocoding in physical space thus aims to determine the physical address corresponding to the 3D data acquired by the various sensors — in particular, GPS. The physical address can also be obtained from the spatio-temporal coordinates of a point in the 4D digital model, empowering search for all associated metadata across various linked databases.

[7.2] Big Data Frameworks and Infrastructures

Metaverse architecture should make use of the best big data frameworks on the market to allow real-time spatio-temporal database indexing and ensure the security, confidentiality, and traceability of user data. The use of open-source platforms such as Elasticsearch, Splunk, and Apache Spark seems to favor open architectures.

However, such interoperability of solutions adopted at the software level is more difficult to conceive through hardware. In the latter case, metaverse architecture must make high-performance computing resources available to users, either through specialized machines with edge computing access, or else with direct centralized access to cloud computing. In either case or in a hybrid form, this architecture should allow connected, light, and mobile applications to access mapping, visual, and physical simulation functions — all of which are very demanding and require heavy computation.

[8] Spatial-Temporal Communications

Metaverse communication, both real-time and deferred, must synchronize information exchange between spatial and temporal models. To do this, the metaverse must be equipped with communication models and protocols that can handle millions of simultaneous messages. Here, advancements in connected object communication protocols such MQTT, a standard messaging protocol for the Internet of Things (IoT), provide an advantage.

In addition to communication protocols, the metaverse must be equipped with the communication model itself. The theoretical computer model of actors derived from real-time 3D animation techniques is a good candidate. This mathematical model considers actors as the only primitive functions necessary for concurrent programming. Actors communicate by exchanging messages. In response to a message, an actor can perform local processing, create other actors, or send other messages. This approach endows the metaverse not only with a communication model but also with self-programming.

[9] Cybersecurity

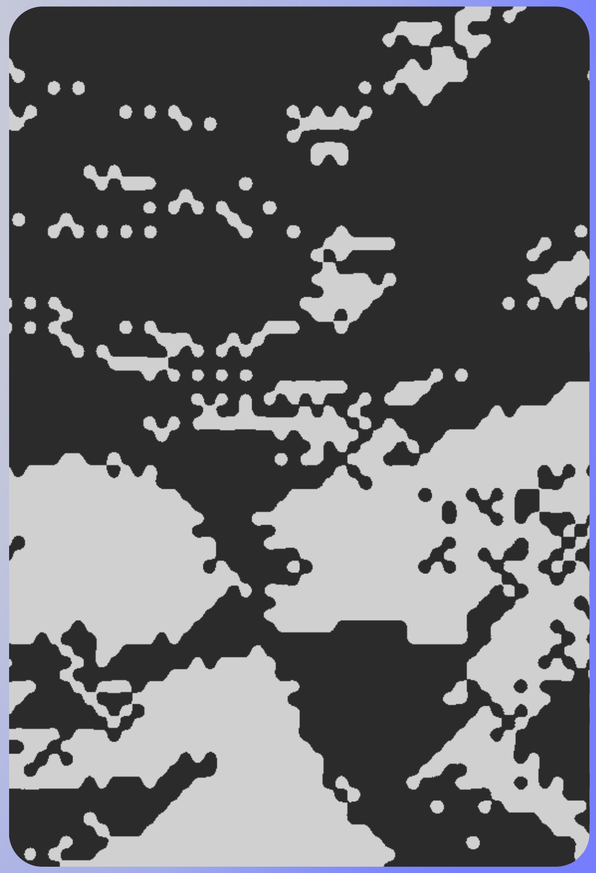
In the metaverse, cybersecurity is often perceived through the generalized concept of blockchains, but other avenues, such as traditional digital signature systems, remain fully relevant and can be adapted or extended to the metaverse. While blockchains offer several advantages on the security front, they also present a number of limitations and problems (energy consumption, for example) that complicate their generalization into the metaverse.

[9.1] Blockchain and NFT

Current technological approaches do not fully encompass the concept of duality between physical and virtual worlds. In most cases, the metaverse is more subordinate to the physical world and not fully autonomous. This characteristic is easily understood through the analogy of NFTs developed to manage property rights across the metaverse. While NFTs are used to represent things in the metaverse, their capacity to exchange hands and transfer between worlds fully depends on physical world activity and is limited by the graphical representation format of each ecosystem. From this angle, the metaverse is controlled from the physical world and is completely subject to it.

[9.2] Proof of Location

To free the metaverse from third-party trust mechanisms controlled externally from the physical world, users will need to be able to prove the location of avatars in a given time. Proof of location is a method developed through the blockchain to certify positions of objects connected to specific moments in the physical world — drone deliveries, for example. This spatio-temporal certification can be accompanied by encrypted data that also allows for indexing space by certifying avatar positions at specific moments. The problem therefore lies in the adoption of a general blockchain principle to manage the temporal city and its relations with the spatial city and in the negative hypothesis of the adoption of a system based on digital signatures and their peer-to-peer verification.

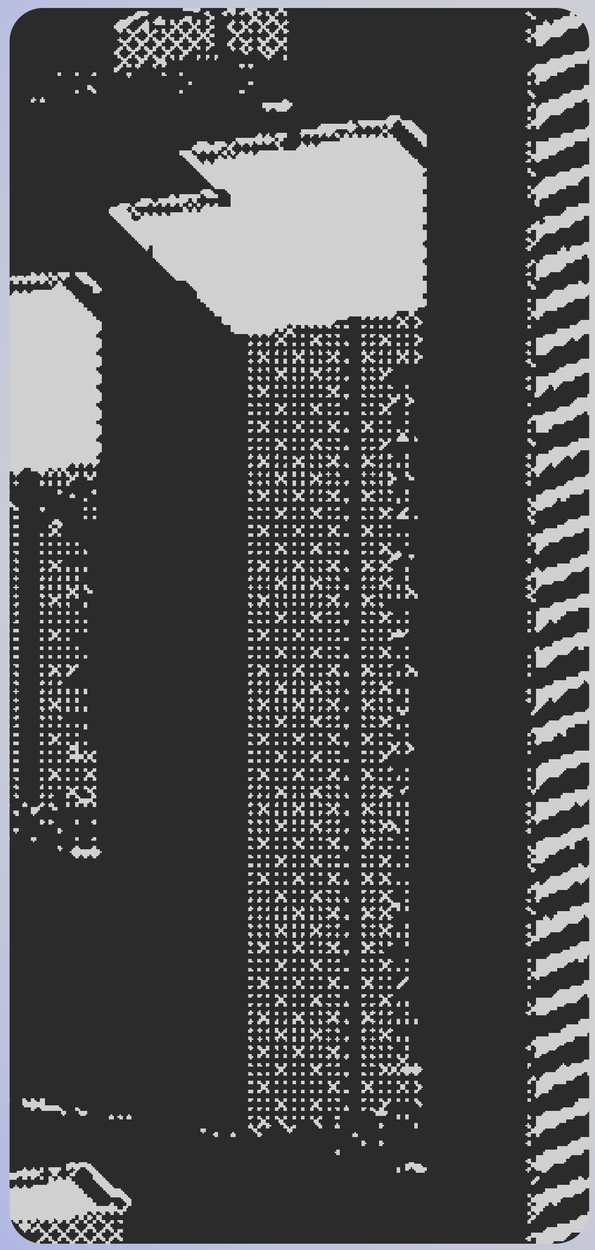


[THE TEN CHALLENGES]

[10] Centralized or Concurrent Virtual Cities

Controlling massive data and metadata characterizing the different 3D digital models and their associated spatial databases requires specific organization of information to allow instant queries and processing for purely 3D operations. These include visual identification of architectural components, collision detection, and spatio-temporal synchronization between models or for multidimensional operations such as management of metadata or spatio-temporal data.

For true interoperability between geometric, physical, and graphical mockups, metaverse architecture requires a central spatio-temporal database to orchestrate all complex algorithmic processing through a unified spatio-temporal index. A local or distributed satellite database can then be subordinated to the central database. The latter can act as a true hub for processing heterogeneous spatial data previously unified and coupled with a protocol for communicating geometric information that allows the entire system to operate partially in master-slave mode and partially in concurrent mode.



Metaverse and The City: Trends and Opportunities

From GIS to the Metaverse

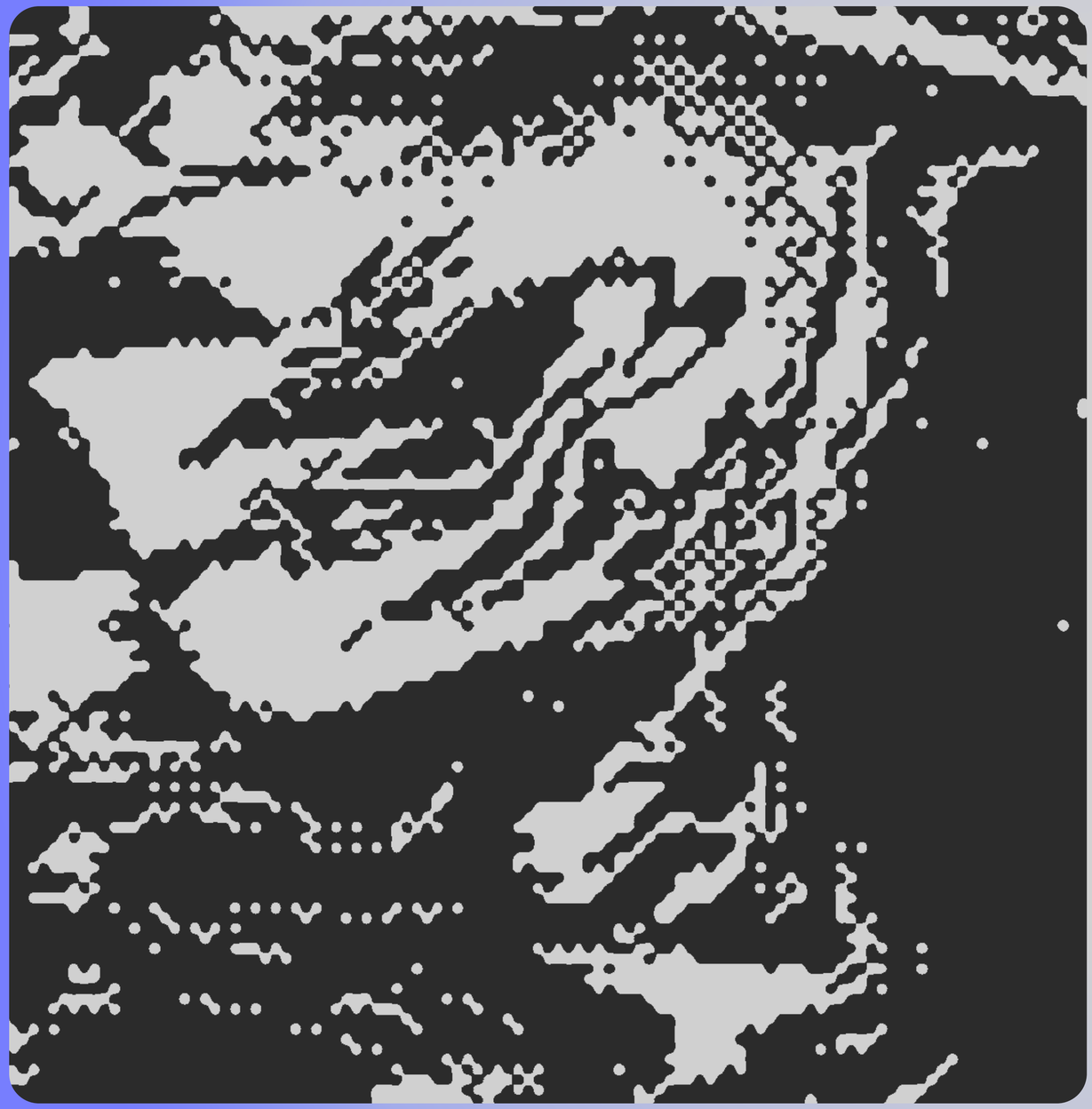
From the beginnings of GIS over 50 years ago to the digital models that cover most large cities and metropolises, geospatial technologies have progressed impressively in service quality and precision. Fueled by these advances, decision-makers and politicians show growing interest in implementing city information models or digital twins on their territory. As smart city implementations become more common, we expect city participation in the metaverse to represent the next major phase of adoption. Indeed, GIS experts are already thinking about the “geoverse.”

The reality is obviously more complex. Cities typically lack mathematical and algorithmic modeling resources. At present — and with the exception of transportation and energy fields — most urban governance lacks interoperability between business knowledge databases and does not embed industrial simulation models. Attention remains focused on photorealistic representation and neglects simulation extrapolation and virtual-to-physical interaction capacity, despite being already available through IoT. This obviously applies to visible (above ground) information, but even more so to the city's underground. Although knowledge about outcrops, topography, and surface modeling is becoming more precise, there are still many unknowns about the composition and occupation of this hidden face of the universe. This lack of information is crucial, impacts many activities, and poses enormous security problems. The energy transition accentuates this pressure, because renewable energies, in whatever form, are no less land-intensive than fossil carbon energies.

For digital twins and the metaverse, the stakes are enormous, adding data acquisition to the already long list of challenges this section covers. Although ground penetrating radar and electromagnetic or acoustic detection have improved tracking, these technologies continue to face difficulties, including the limits of the material (parasitic frequencies, depth of networks) and external disturbing elements (traffic, parking, pedestrians). These factors as well as the nature of the ground greatly influence information accuracy and require a lot of visual analysis and post-processing. These issues are now well known, and several countries have launched vast programs and databases to consolidate and exploit existing data, including NUAR in the United Kingdom and BRO in the Netherlands.

Harmonizing Business Models for Urban Data Interoperability

An urban metaverse implies multi-dimensional and multi-sector activities between different design, management, and maintenance systems, all of which share common, but most often derived or partial, representations of the same physical reference. Engineering has largely adopted BIM for both buildings and infrastructure, but management and control applications require a systematic filtering of this information. This is necessary to allow their projection in a specific work context, which is generally less demanding in geometry but requires the creation of relationships that are not always explicit in the design phase. This is especially true for connections to networks, site insertions, and topography, as well as the definition of rules of use and access to spaces and equipment. The work of the Open Geospatial Consortium and Building Smart International has unlocked sharing of geometric data and their semantics, but the translation of business constraints still needs to be standardized.



Applications are still intended for professional users who have the skills to download, process, and analyze data. But this legacy of siloed organizations is not sustainable — nor can it allow the professional network to grow. To work in the metaverse, these data must be made comprehensible, integrable, and exploitable by machines, geoanalytical tools, and AI. This is one of the tasks that the Metaverse Standards Forum will have to confront in order to create the conditions necessary to achieve complete interoperability in the metaverse's value chain.

First Implementations and Limitations

Unlike other sectors such as gaming, an urban metaverse cannot be created from scratch. It must be associated with physical assets, objects, and processes that must be reflected in real-time. The idea of making these objects accessible through VR and immersive technologies is not new. But in order to achieve this, the lack of interoperability has only been partially solved by extraction, transformation, loading (ETL) operations that distort and desynchronize universes. A new generation of standards, such as GeoAPI, for example, associated with alliances between complementary and sometimes rival industries makes it possible to overcome these limits and repair these discontinuities. This is already visible in implementations that combine CAD and BIM information with connected geospatial platforms and game engines.

Finally, while digital twins can be used on a simple tablet or smartphone, the metaverse will require users to immerse themselves by entering a virtual space. This means that there is a certain level of accessibility but also acceptability that still separates the two. But once professional circles adopt these technologies, much of this resistance will abate. Like other now-classic devices such as the smartphone, their uses will become apparent and available to the general public.

The technical challenges to metaverse interoperability are numerous, but so are the intellectual breakthroughs at our disposal to solve them. The example of physical-to-virtual world interactions to illustrate the interoperability challenges of spatio-temporal cities provides a viable framework to anticipate both the human and technical roadblocks of the future. Addressing them will be a multidisciplinary effort that puts human actualization at the center of our collective pursuit of an open metaverse.

Ryan Gill

[TWITTER]
@ryancrycible

Perhaps one of the earliest open metaverse promoters, Ryan Gill launched Open Meta DAO in April 2021 to provide a community-run forum for developer education and open standards discussion.

Open Meta DAO has an inaugural membership of 88 contributors and currently invites anyone across the spectrum — from the metaverse-curious to experienced developers — to join. Core to its mission is a beta protocol entitled *Emergence*, that outlines innovative web3-native tools that help game developers better contribute to an interoperable future. Emergence emphasizes the interface between crypto wallets and game engines, thereby focusing on such aspects as Ethereum Virtual Machine (EVM) compatibility and digital asset inventory management.

Here, we ask Gill for his thoughts on open standards in the metaverse.

[FOUNDER] Open Meta DAO

[FOUNDER & CEO] Crucible

[VENTURE PARTNER] Outlier Ventures

[1] ## Big tech's business model isn't going to fly in the metaverse.

Big tech has taken over in a lot of ways, said Gill. But when we immerse ourselves into this technology, practices once known as "normal" business or data models are going to become obsolete.

"I think the incumbents are loosening their grip on that," Gill said.

The open metaverse is the antithesis to surveillance capitalism, argued Gill. "It's much more of a movement of people. It acknowledges more people and gives them an opportunity to build and contribute. You don't hear that kind of rhetoric from Big Tech."

[2] ## Crypto will be mandatory — but not the way you think.

We asked Gill, "Do you think crypto and web3 are mandatory for the open metaverse?"

His answer: Yes, but more in the sense of cryptography, or the study of secure communication and data authentication.

"I don't think crypto in the sense of speculative cryptocurrencies is necessary," said Gill. "I define the metaverse much more as an open framework for ownership."

The significance of web3 and cryptography is therefore most important as an advanced math-based technology allowing for digital payment rails, asset ownership, and exchange — but not necessarily to make sure your Bitcoin or Bored Ape moons.

[3] ## Decentralization requires one central identity that only the individual user owns.

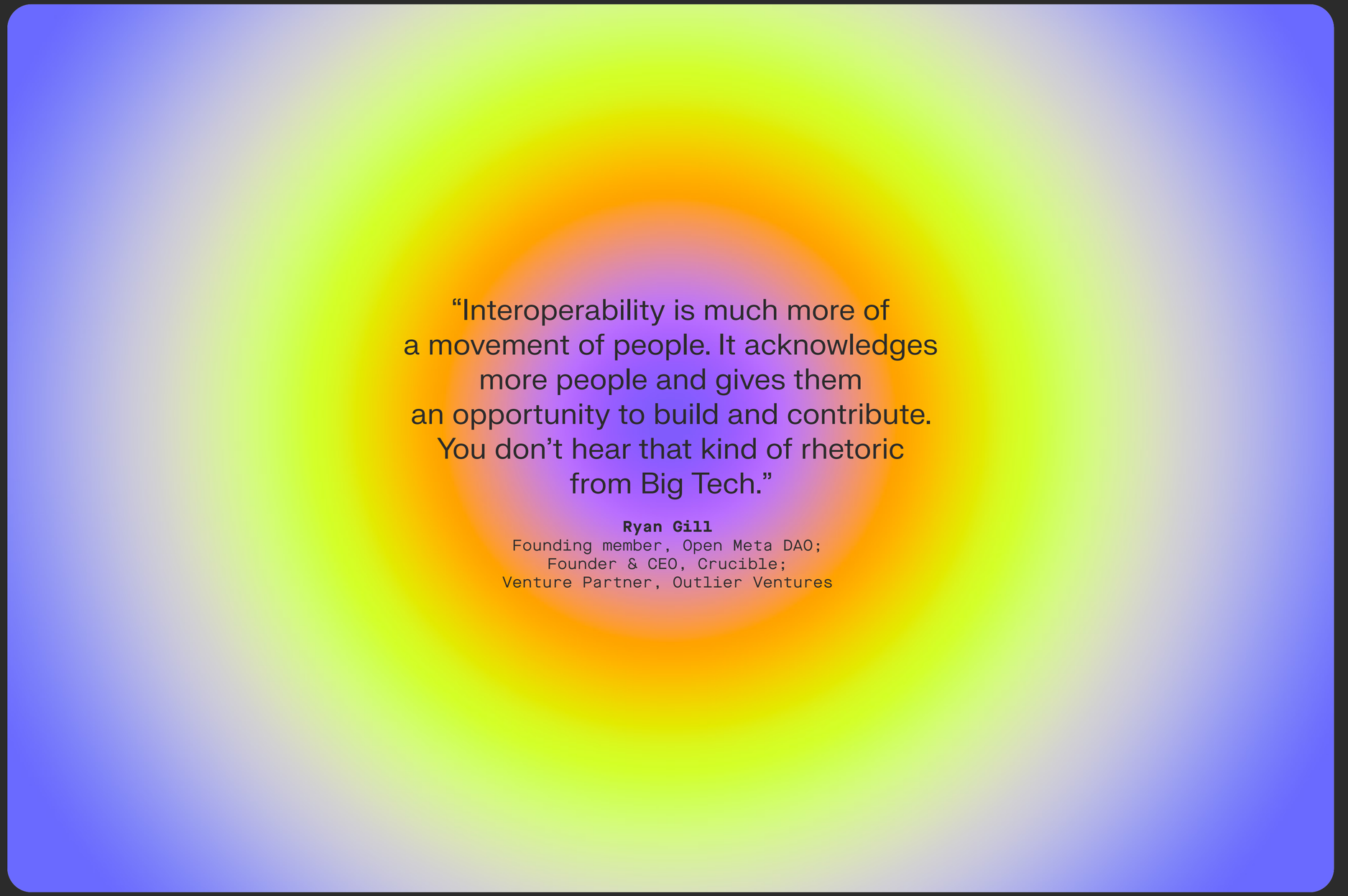
In 2017, Gill realized that blockchain technology would be the economic underpinning for any metaverse economy.

"About that time, I had been working on a couple of projects here and there. I was living in Tokyo, and I was working pretty closely with [the entrepreneur] Peter Diamandis. I was immersed in a lifestyle that allowed me to recognize that the future is scattered all over the world — it's just not equally distributed."

After getting used to that kind of thinking, Gill explained, it became evident that the metaverse is inevitable.

And while this ah-ha moment might have incited a Black Mirror-esque panic in someone else, Gill began to see that the antidote to a surveillance capitalism-governed future is an open-framework approach where everybody has ownership in a shared collective future.

"As I honed in on that, identity became the key point of all of it," said Gill. "Everybody gets really caught up in [metaverse] environments and worlds, the economy, and the objects. But really, at the core, identity — and who you are, how you portray yourself, how you represent yourself, and how you secure that — became really important."



[4] Emergence SDK’s role in the open metaverse.

As both the founder of Open Meta DAO and Crucible, Ryan is behind a highly anticipated innovation in the metaverse space: the Emergence SDK.

Emergence is a protocol for game developers that integrates with game engines such as Unreal Engine and Unity through a web3-based SDK. It empowers game developers with wallet authentication, smart contracts, avatar systems, and NFT inventory services. The protocol is designed to be an easy onramp for the open metaverse, made available in games, virtual worlds, virtual reality, and more.

When asked about his upcoming plans for the SDK, Ryan commented:

“We have a lot of great announcements coming up over the next few months. Our beta is currently live and we are very close to announcing the next phase of the protocol’s public release.”

The Emergence protocol provides the necessary tools for creators to start building interoperable worlds where users can create their on-chain personas and load their avatars, inventory, and data into the metaverse worlds of their choosing.

Sébastien Borget

[TWITTER]
@borgetsebastien

The Sandbox is one of the most popular blockchain-based virtual worlds where players can build, own, and monetize their gaming experiences on the Ethereum blockchain. According to Borget, NFTs were a natural fit for The Sandbox ecosystem, which first came on the scene in 2011 as a comprehensive UGC game on iOS and Android. The Sandbox's publisher, Pixowl, migrated the platform over to blockchain in 2018 in order to give users the added benefit of securing IP ownership over their creations through smart contracts.

Ahead, we speak to Borget about The Sandbox's migration to blockchain and his thoughts on interoperability.

[CO-FOUNDER & COO]
The Sandbox

[1] NFTs will attract top creators to gaming platforms.

NFTs are important for keeping UGC games competitive and attractive among top creators, Borget explained. The Sandbox team has observed the benefits of this approach firsthand. "We've been working in mobile gaming for over 11 years," he said. Originally, the concept of UGC sandbox games empowered players to become creators "just by the touch of their finger using the screen," a revolutionary new interaction for gaming. "That's basically what the new innovation for iOS and Android smartphones was in 2011," said Borget. "When we launched, we saw huge success rapidly — like more than 40 million downloads over time."

But even though early UGC developments helped the company earn considerable revenue and rise to popularity, content creators eventually grew frustrated with the limitations of UGC's futility to enhance their financial bottom line, Borget added.

"People couldn't really monetize the content they created, and we were losing our top creators." The limitations of the Apple Store and the Google Play Stores didn't allow profit sharing between developer studios and individual creators, Borget explained. "We had no way to share a portion of the revenue from the value that the users were contributing by putting more content and attracting more players to the ecosystem."

Thanks to NFTs, The Sandbox has effectively discovered a new way to compensate creators for designing and selling digital assets. Players can buy NFTs on a secondary marketplace like OpenSea from anyone directly themselves, and creators can code lifetime royalties into smart contracts so they are compensated each time their creations change hands.

"That was really a major revolution in gaming," Borget said. "That's basically what we've been working on since 2017. We built a new version of The Sandbox. We incorporated NFTs from the beginning — that was important. We felt like if we were just to add on top of the existing mobile game, which already had a virtual currency and free-to-play economy, that would be more of a struggle, and it wouldn't really encompass the full possibility of what this technology could allow."

> "You can explore that user-generated content with an avatar, but you do not own any of the digital assets that you create, earn, or buy on those platforms."
>
> **Sébastien Borget**
> Co-founder & COO, The Sandbox

[2] True interoperability means multiple devices.

The metaverse cannot be limited to one device only, Borget said. “It’s not VR only. It’s not mobile or web, desktop PC or Mac, or AR or VR.”

Rather, the metaverse is a myriad virtual worlds — across all digital devices — where users can access diverse experiences through a 3D avatar (or avatars). “It’s more about social and creative experiences,” Borget said. “Not just games, but also virtual concerts, virtual shows, art galleries, museums, and so on.”

[3] There’s no metaverse without digital ownership.

There’s an astounding amount of industry-wide confusion about the metaverse, said Borget, driven mainly by the fact that so many walled-garden platforms claim to be metaverses without qualifying what their definitions mean exactly. “Roblox claims to be a metaverse,” Borget said. “Fortnite claims to be a metaverse. People even think of Meta as a metaverse.”

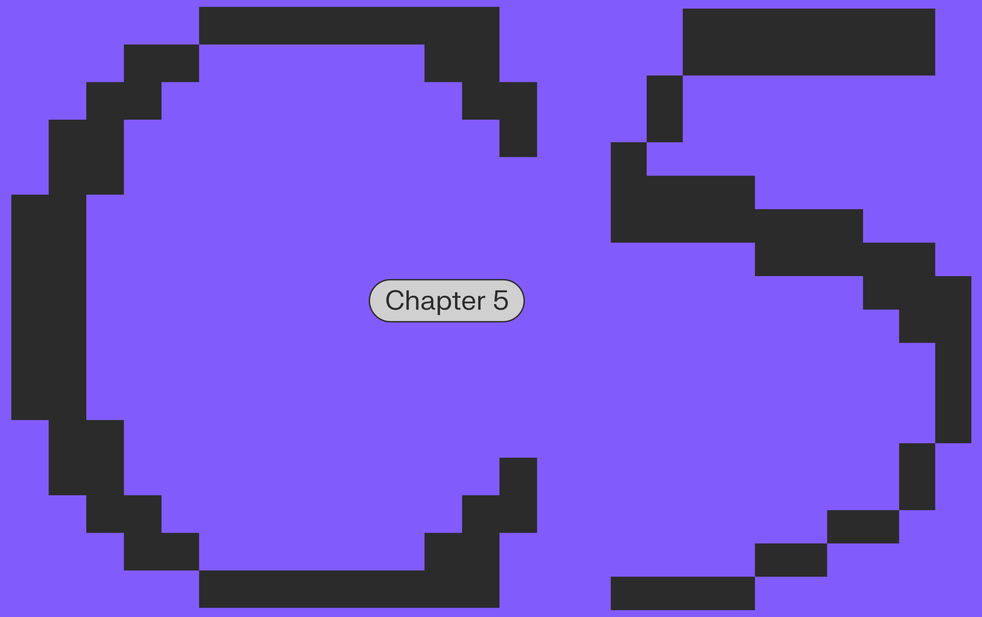
But in reality, they are not metaverses, argued Borget — just impressive platforms with considerable user-generated content. “You can explore that user-generated content with an avatar, but you do not own any of the digital assets that you create, earn, or buy on those platforms,” he said. “You cannot take any of that content from one of those platforms to another. The developers of the platform do not allow you to take an asset like an avatar and put it on sale on the marketplace outside of that platform.

They do not allow you to take your virtual currency, exchange it for fiat, and cash it out or use it to buy something in another place.”

If we were to hold most metaverses up to these standards, Borget argued that only blockchain-based metaverse worlds satisfy these conditions.

“The limitations of the Apple Store and the Google Play Store didn’t allow profit sharing between developer studios and individual creators. People couldn't really monetize the content they created, and we were losing our top creators. We had no way to share a portion of the revenue from the value that the users were contributing by putting more content and attracting more players to the ecosystem. ”

Sébastien Borget
Co-founder & COO, The Sandbox



Chapter 5

Where We're Going, We Need...

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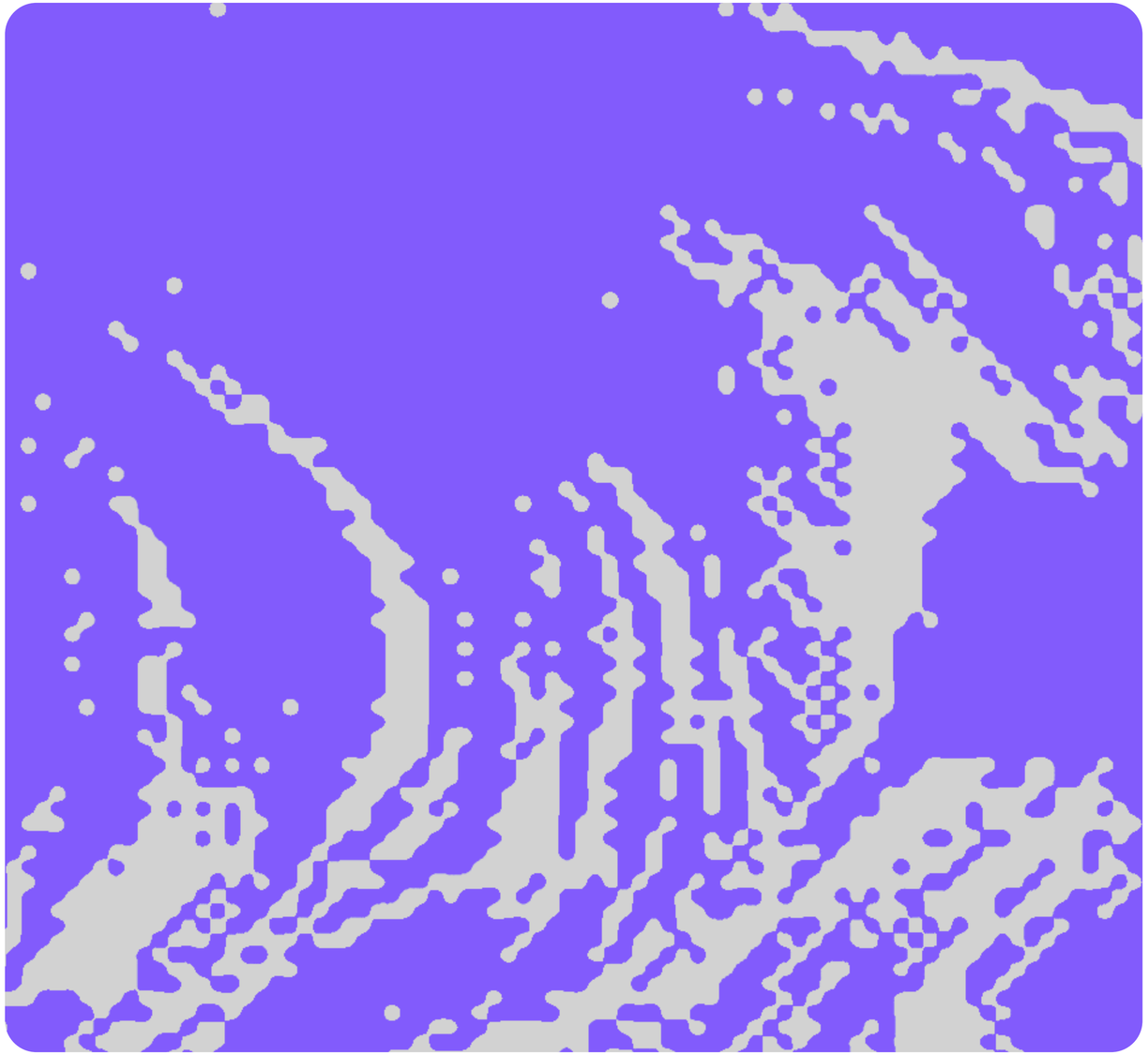
Funding the Metaverse: A Partner Report by White Star Capital [97]

Robby Yung
CEO, Animoca Brands

[Twitter]
@viewfromhk

"If Facebook, Fortnite, and Minecraft all decided to open themselves up and be interoperable today, I would call that the metaverse.

I don't see any reason why what we have today is not already the metaverse, except it lacks the interoperability and the ability to take your stuff from place to place. If we were able to have that interoperability, then we've largely got the metaverse already. Interoperability may not be a sexy vision, but I think it's a more fair and inclusive one."



We have defined the metaverse, identified its various benefits, problems, and financial incentives, and explored the necessary building blocks for openness. But how does the ideal of interoperability contrast with industry norms?

Jon Radoff, CEO of Beamable, a technology company providing services to game developers, outlines three challenges developers and founders face when designing for interoperability:[95]

[1] Technology

The systems for enabling systems to interoperate; these are *engineering* problems.

---

[2] Economic Alignment

The economic incentives that motivate groups and creators who participate in an interoperable ecosystem; this is a *social* and *business* problem.

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[3] Making it Fun

Keeping things fun ensures that consumers will keep wanting to engage in your game or metaverse world; this is a *design* problem.

Within these categories, the open metaverse landscape currently poses several key challenges to achieving the future outlined in this report:

Engineering problems include upper limits to immersive multiplayer processing and computation as well as standardization efforts around software, hardware, and file formats. Standardization is of course as much a question of economic alignment around business strategy and political will as it is about technology.

Development and adoption of crypto-native payment methods and blockchain-powered worlds will require both economic and technological alignment among interoperating players, as well as intuitive design to bring blockchain experiences into the mainstream.

Finally, making the metaverse a fun (and, we would add, *humane*) place to visit rests on making ethical design choices and policies that invent and enable new user habits and interaction patterns, innovate use cases, and protect users' privacy, biometric and identity data, consent, and safety.

Truly, all of these are engineering problems at their core, but overcoming them will require the full interdisciplinary weight of economic incentive, political will, sound policy and governance, and ethical, groundbreaking design. Let's briefly survey current challenges within each of these in detail.

WHERE WE'RE GOING, WE NEED...

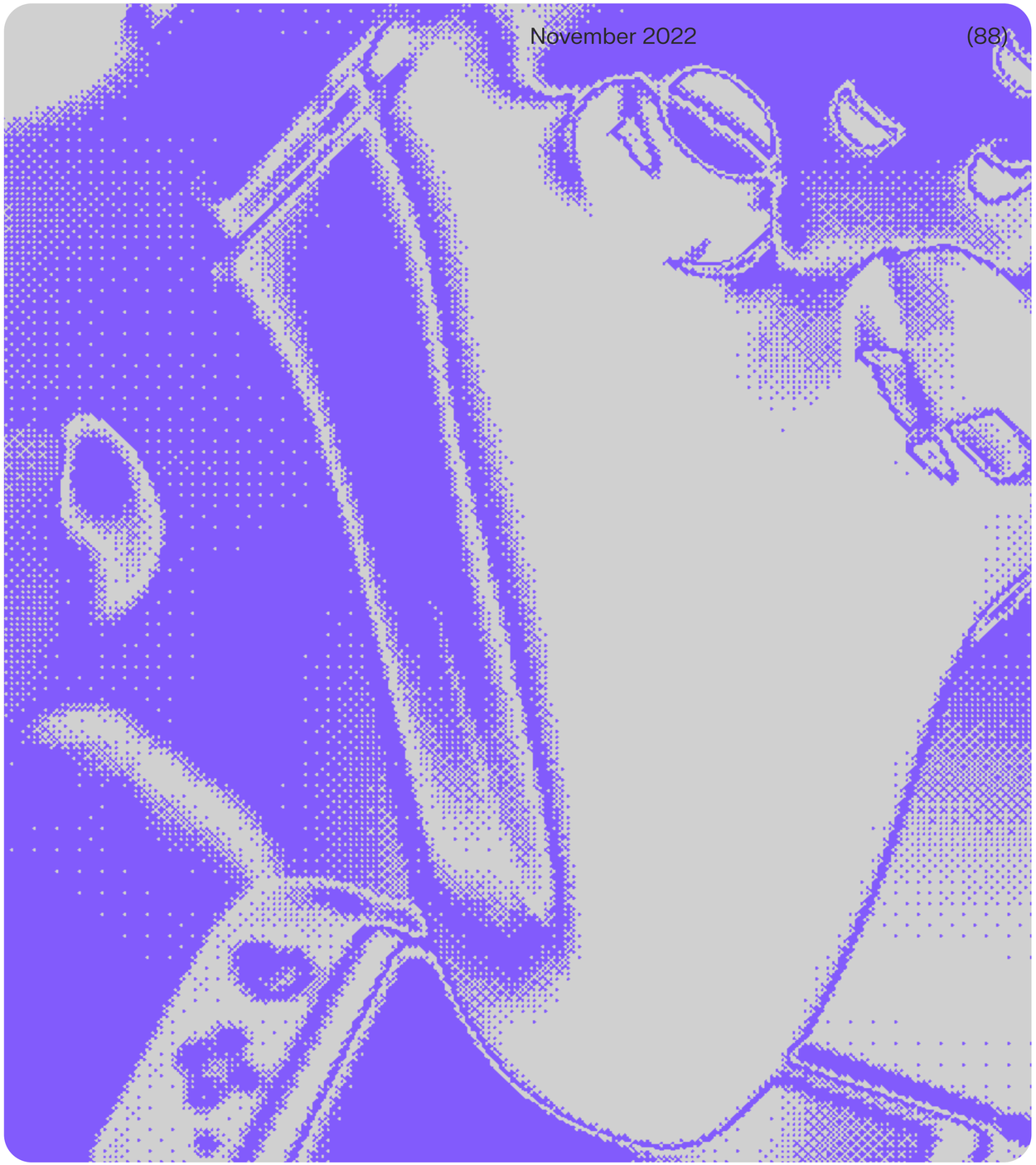
Optimizing for Multiplayer

Real-time, immersive multiplayer experiences support a large number of concurrent users. Massively multiplayer online games (MMOs) frequently host hundreds or thousands of users on the same server. They are capable of doing so without crashing, but their requirements for immersion are a fraction of what the metaverse requires. Metaverse performances by the likes of Lil Nas X, who drew in 33 million views with his 2020 Roblox concert,[96] underscore the increased pressures on computational efficiency.

This presents a major technical challenge — a dilemma known as the *n-squared problem*. Much like physical rooms, digital environments have space constraints, too — and digital constraints are surprisingly limiting! When a particular metaverse world or experience inside that world reaches its upper limits for hosting concurrent users with high-enough quality UX to meet users' expectations for *synchronicity* (the feeling of realistic presence with others sharing the same experience), the environment can crash or glitch in annoying ways that destroy the experience. This is because maintaining shared server state becomes exponentially harder with each additional user.[97] This challenge is especially daunting for smaller worlds that lack the resources and computing power of market leaders like Roblox or Fortnite.

And it is not just emerging virtual worlds that face this upper-limits problem. Even metaverse giant Meta struggles to sustain concurrent usage at scale. Each of the 10,000 worlds that comprise its metaverse environment, Horizon, can only accommodate a few dozen people at any given time because projecting a virtual shared space across multiple headsets requires more computation capacity than is available today. Meta compensates by duplicating worlds that exceed capacity, creating an overflow environment.[98] Naturally, mitigation strategies by smaller up-and-comers in the open metaverse space may not be quite as comfortable or adequate as Meta's.

The most sophisticated solution to this problem to date, Improbable's Morpheus technology, can reportedly support over 10,000 concurrent users in a high-fidelity and lag-free experience.[99] Hadean, another metaverse infrastructure company, recently raised $20 million in a Series A from Epic Games to solve the computation problem.[100] Ideally, of course, the metaverse would not only meet but exceed the limits of physical space, hosting however many users wish to delight in its environments whenever they see fit.



"We expect the metaverse to be different from traditional social media platforms and naturally grow in fragmentation over time. We see a future where persistent 3D digital spaces become as ubiquitous as web pages today, blossoming in a bottom-up fashion and being created by large enterprises, individuals, and everything in between."

Jonathan Brun
Co-founder & CEO, Lighthouse

WHERE WE'RE GOING, WE NEED...

Interoperable Fragmentation or Convenient Consolidation?

The key premise of an open metaverse is that users will be able to move unrestricted across disparate ecosystems to meet their needs and aspirations. Interoperability simply makes good business sense — and for developers, it is a better and more pragmatic way to build without borders and market limitations. But interoperability comes with increased complexity and the potential for fragmented, high-friction user experiences that slow adoption.

On the other hand, if coordination among a handful of the most powerful tech companies provided a unifying substrate for metaverse worlds, then users could expect smooth, coherent, and compatible metaverse experiences. After all, if we really had mutually-intelligible file formats, data rails, and governance frameworks that serve their business goals and attract users, there wouldn't be any need to wrangle a motley collection of decentralized idealists to grudgingly agree to interoperate.

But would that collaboration among coordinating incumbents leave enough room for builders of open and decentralized worlds to also contribute to the spatial web? Or, would new entrants be forced to play by the incumbents' terms — including accepting their fees, preferential standards, and enclosed data structures at the risk of being left out of the interoperable inner circle?

Even more worrisome, society has already paid dearly for the status quo constructed by web2: platform-style compatibility and convenience come at the expense of the prosocial values we've outlined above, such as data sovereignty, economic openness, community governance, and user consent and agency. Replaying these same old patterns in the metaverse — a digital failure mode that externalizes far too many harms to make up for its innovations — negates the purpose of laying new internet pipes that all but reinvent digital communication and compute.

We have an opportunity now to consciously construct a better web. So what will this new web look like?

How the Web Consolidated

To orient along the spectrum between fragmentation and consolidation — and understand the resultant tension between interoperability and convenience — we can look to history for clues. Traditional social media was fragmented in the early days, but social media platforms went through a phase of hyper-consolidation over the last decade. Today, incumbents like Meta (Facebook, WhatsApp, Messenger, Instagram), Alphabet (Google, YouTube), and Bytedance (TikTok, Douyin) all share similar business goals and user acquisition strategies to protect their positions. Propelled by network effects and protected by sophisticated user and developer lock-in tactics, these platforms excel at attracting and retaining users, and make it nearly impossible for new entrants to compete for market share.

Will the metaverse face a similar shift toward consolidation? Web3's current fragmentation annoys and scares off users. How can web3 shore up its independence and stem the tide toward convenient consolidation driven by outcry from frustrated users? Will open metaverse builders prioritize coordination to increase interoperable compatibility? Can they innovate new interaction patterns that delight and retain users -- rather than pushing them away towards incumbent platforms?

Several trends leave observers optimistic that not only is an interoperable future possible (and even probable), but that fragmentation may not be as bad as it sounds.

SOURCE: TWITTER [101]

> "Social is the killer use case for the metaverse and VR, but thinking in zero-sum games is a web2 concept. Instead of seeing other metaverse projects as competition, I'd rather find ways to complement or extend those systems. How to give users more freedom? How to give users more ways to connect, explore, and have fun?"
>
> **Jin**
> Hacker Artist & VR Developer

Positive Indicators of Interoperable Openness

Perhaps the most promising sign of open collaboration we've seen to date is the formation of self-governed online working groups. Metaverse Makers (M3), has been operating a metaverse interoperability community since 2019, with open-sourced notes available on GitHub,[102] a code database where at least 83 million developers contribute, share, and review software code freely. Similarly, the Open Metaverse Interoperability Group (OMI) was formed in April 2021 to explore the necessary conditions for interoperable development. The organization's mission is to bridge virtual worlds by aligning on standards for identity, social graphs, and inventory.

In June 2022, over 35 founding member brands and organizations — including Meta, Microsoft, Epic Games, and NVIDIA — formed the Metaverse Standards Forum (MSF), of which Lighthouse is also now a member. MSF is open to any organization at no cost and focuses on the development of interoperable 3D assets, real and virtual world integration (also known as "phygital" experiences or assets), and ethical issues like privacy, accessibility, and safety.

In July 2022, two more collectives formed to push for the open metaverse: Open Metaverse Alliance for Web3 (OMA3) and NEON_BUIDL. The first, OMA3, is a group of web3 metaverse platforms, and the latter, NEON_BUIDL, is primarily coders and architects building digital assets within worlds. OMA3 develops standards specifically on the basis of consensus. The original founding members include representatives from UGC-style metaverse worlds such as The Sandbox, Decentraland, and Somnium Space, as well as developers from games like Splinterlands, Alien Worlds, and Axie Infinity.

Finally, the World Economic Forum recently launched an initiative that brings together key stakeholders to build an economically viable, interoperable, safe, and inclusive metaverse.[103] They intend to focus on two areas: governance of the metaverse (how the technologies and environments are developed) and value creation (designing incentives and identifying risks to be mitigated). Partners include Animoca Brands, Sony, Microsoft, Meta, Walmart, and many more.

The formation of industry consortiums to coordinate requirements and resources to spur the creation and evolution of open standards signals a major milestone for metaverse development. It means that brands and entities are committed to influencing the direction of the metaverse towards a vision of openness, inclusion, and interoperability.

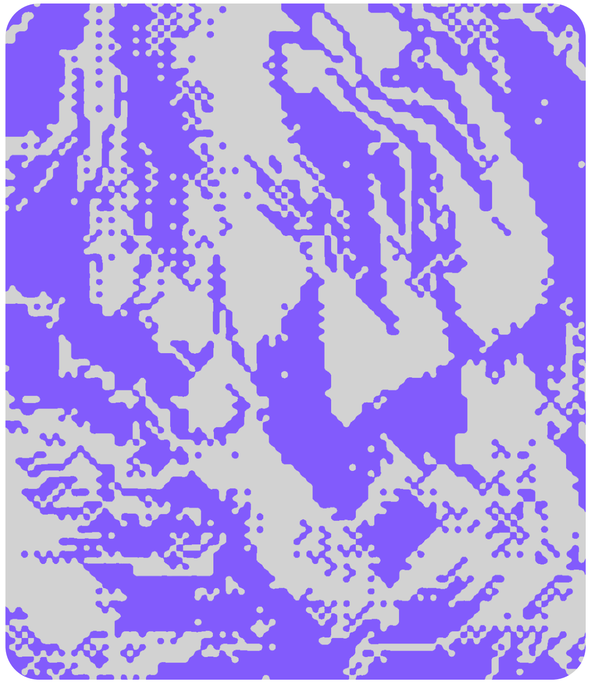
"OMA3 was formed literally by friends contacting each other and saying, 'Hey, we should really do this because the industry needs this — would you guys be in?'" explained Animoca Brands CEO, Robby Yung. "The idea for it from the beginning was always that it would be an inclusive group. The goal is not to have specific leadership, but for this to be the industry agreeing on what the industry wants."

"We made the announcement a couple months ago, and opened it up for applications. Literally hundreds of companies have applied," Yung told Lighthouse during his interview, showing desire among metaverse builders to preserve interoperable openness.

Interestingly, noted Yung, one participant in OMA3's first meeting complained that in the tech industry, standards often result from a particular company or brand gaining dominant market share through a combination of technical innovation and better marketing — and then "ramming their standard down everybody else's throat" through ecosystem enclosure. In so doing, the dominant player often imposes restrictions and barriers to entry that keep new and smaller players out.

The historical tension between innovation and standardization will always remain a balancing act between pushing the boundaries of what's possible (think electric cars breaking into the dominant gasoline-powered automotive industry) and serving users better (for example, Uber breaking into and transforming the established taxi industry), versus making cynical business decisions to defend their moats against competition, even when that may not be in the best interests of consumers (recall Alphabet, Apple, and Mozilla objecting to the W3C DID specification and Microsoft's legendary anti-competitive battles with Netscape and Java).

"That's how it often works in technology," Yung said. "And we said, 'Well, that's exactly what we don't want. That's what we're trying to avoid.'"



Nine Trends Foreshadowing Fragmentation

At Lighthouse, we observe nine distinct trends that point toward optimism in the metaverse naturally growing more fragmented. In fact, not only is appetite for interoperability among web3 builders high enough to stave off consolidation, but fragmentation is not necessarily undesirable or to be avoided.

As long as the open metaverse maintains mutually-intelligible data formats, privacy settings, and ownership and IP frameworks among ecosystems, fragmentation actually produces plurality: of opinion, of vision, of governance, and of experience. These byproducts benefit society.

Fragmentation, in fact, is how we get a world where many worlds fit.

Devices

Metaverse entry points will span across desktop, mobile, console, VR, and AR devices. While we expect most virtual worlds to support cross-platform gameplay, some worlds will choose to specialize for specific device types, creating natural fragmentation.

Blockchains

Depending on their focus, virtual worlds comprising the metaverse will make different trade-offs regarding the ecosystems they choose to build upon. Ethereum, L2s, Flow, Solana, and other L1s appeal to different audiences, builders, and use cases, again creating natural fragmentation.

New Tools

UGC will be core to the rise of the metaverse. With the democratization of tools such as AI, no-code software, and game engines, barriers to entry for building 3D experiences will continue decreasing, empowering anyone to create a piece of the metaverse.

Economics [CAPITAL] Funding

Tokens provide strong economic incentives to early adopters, which bootstrap network usage. Users become owners and, ultimately, evangelists. Given the clear incentives to create or join ecosystems early on in their lifecycle, we expect a constant and consistent flow of new web3 projects emerging across the metaverse.

As metaverse adoption grows, its upside potential will become clearer, reducing the risk profile perceived by capital providers to invest in the space. Clearer paths to exit and usage will support a vibrant funding environment.

Design [EXPERIENCE] Use Cases

While webpages are similar from a design standpoint, virtual worlds' graphics and gameplay vary greatly. Pixel, vector, cutout, and photorealism, as well as open worlds, sandbox, and RPG games, demonstrate how different designs influence the metaverse experience. No single world will satisfy all design preferences at once.

3D, persistent, and real-time digital spaces can serve many use cases for gaming, social, work, health, education, and commerce. The breadth of use cases enabled by the metaverse is likely to morph into a wide array of specialized ecosystems.

Composability [PORTABILITY] Sovereignty

Through standardization and permissive intellectual property frameworks, each new unit of content created can help accelerate the growth of another ecosystem. Wider adoption of composable IP can drastically reduce the barriers to content creation.

The last and perhaps most powerful reason for a fragmented metaverse is that we expect a constant reduction of user lock-in imposed by platforms. As switching costs approach zero due to open standards, multi-ecosystem interactions will hopefully become the norm.

SOURCE: LIGHTHOUSE

WHERE WE'RE GOING, WE NEED...

Blockchain Adoption

Decentralized finance and blockchain gaming have attracted approximately three million and six million users, respectively. There are fewer than half a million users actively participating in NFT platforms and only a few thousand in web3 virtual worlds.[104] These are not particularly impressive figures.

Many consumer brands, fashion companies, and financial institutions have begun exploring the space, but a large part of their motivation comes from a fear of missing out (FOMO) on the next cultural and marketing trend. To date, few NFT projects made by brands have leveraged the real utility potential of NFTs, such as identity, loyalty programs, and commerce. NFT markets are also highly concentrated to the most engaged or wealthiest early adopters, and only 20% of user addresses on OpenSea accounted for 80% of secondary NFT sales in 2021.[105]

In short, a blockchain-enabled open metaverse has a long way to go to prove itself worthy of the mainstream. There are several factors contributing to lackluster adoption: user safety, poor user experience, widespread speculation, high transaction costs, and early nature of the space.

Overall, blockchains offer a much better digital payment alternative to the current payment methods used in popular "closed" virtual worlds such as Minecoin, V-bucks, and Robux, which are proprietary to their unique ecosystems, non-refundable, and charge expensive platform fees. Most importantly, blockchains serve as a verification layer and proof of provenance, which can help turn the status quo of walled-gardens controlled entirely by companies into an open and borderless metaverse governed by users.

An important caveat here is that blockchains remain more of a potential than a proven solution. The ongoing bear market has slowed opportunities for companies to test and iterate on product-market fit. User habits are still embryonic and user experience research on web3 front-ends is a very young discipline. Meanwhile, regulations to limit toxic behavior and privacy abuse are basically nonexistent. In the NFT space, scams and wash trades are still slowing adoption, with some $2.8 billion in crypto assets stolen in 2021.[106] The metaverse in particular needs to distance itself from being considered a financial gold mine by its earliest, wealthiest, and most prolific adopters. Mainstream purchases in the metaverse will be small in value, so it is important to ensure low transaction costs and accessible asset prices to reduce speculation.

At the same time, the current lull in market hype affords builders and developers the opportunity to imagine and design technological, economic, discovery, and content infrastructure from first principles rather than falling back on entrenched and unsatisfactory payment paradigms of the web2 era.

[1] Technology

is the underlying infrastructure powering the metaverse, including storage, compute, hardware, and bandwidth.

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[2] Payment Rails

provide the economic infrastructure supporting the metaverse economy. This layer includes traditional payment tools, crypto exchanges, wallets, marketplaces, and DeFi services.

[3] Virtualization and Discovery

platforms and technologies facilitate the distribution and discovery of content and enable creation and management of 3D assets, digital identity, social graphs, and content moderation. This category includes game engines, asset creation tools, commerce enablers, and discovery solutions like Lighthouse.

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[4] Content and Experiences

draw users into virtual spaces that can be accessed via the internet. These are digital environments where large user groups can gather, interact, create content, and conduct activities such as commerce, education, socializing, and work.

WHERE WE'RE GOING, WE NEED...

Design Choices for Tomorrow

As the internet matured, dominant content formats consistently shifted to richer and more immersive expressions, first from text to images, and then to video. The evolution toward 3D interactive media is another step in that direction, enabling richer, more interactive and immersive content experiences.

Blogging, research, and citizen journalism emerged out of the text-based web where AOL reigned supreme. E-commerce and social media took off once images became more prevalent — and Facebook, Amazon, and Instagram crept into AOL's market dominance. The transition to video gave rise to the influencer and streaming economies, bringing stardom to creators on TikTok, Twitch, and Netflix.

These changes, propelled by technological improvements that bring previously niche and often cumbersome tools to the mainstream, are typically first embraced by younger demographics. More than half of GenZ gamers report feeling more like themselves online than in the physical world[107] and are increasingly turning to gaming as the center of their social sphere. Such insights give us clues as to what emergent tools may come next.

New Interfaces for Emergent Use Cases

Just like social media turned internet users into content publishers, we expect that accessible and intuitive game creation tools will democratize digital artistry and 3D game design, making video game-like experiences just as ubiquitous.

> "Being able to wear this pair of glasses and see visual effects and 3D assets seamlessly integrated with my environment around me — I always saw that as the clear future for extended reality (XR) and digital asset ownership."
>
> **Justin Melillo**
> Co-founder & CEO, Mona

The metaverse is increasingly popping up in some unexpected places — the runway, in corporate settings, in theme parks. High-end fashion brand Carolina Herrera sold a digital gown in Roblox for $5,000.[108] Disney recently patented 3D metaverse technology to provide AR experiences to park guests.[109] And by October 2022, Thumbay Group, a healthcare company based in the United Arab Emirates, plans to open a hospital in the metaverse. [110] We predict experiments for nearly every conceivable use case of AR, VR, and XR in years to come.

Like all social media, the open metaverse depends on network incentives: more people using products and services in the open metaverse leads to more value accruing to creators, developers, users, and fans, growing the overall network pie.

To get more people exploring metaverse use cases, we need user-friendly experiences and interfaces that feel welcoming and that represent heterogeneous perspectives, backgrounds, and needs. User experience will be a critical component of the open metaverse's success (or, more bleakly, its capitulation to corporate

> "The bear market has not affected sentiment about the metaverse at all. I get the same amount of messages from students who are trying to get into the metaverse.
>
> They're fascinated by it. They want to know what can be done within it. They see the potential of it. There's a lot of new talent excited to come in and explore."
>
> **Fatemeh Monfared**
> Co-founder & Chief Metaverse Architect, Spaces DAO

centralization) because consumers care more about having a delightful, intuitive, and seamless experience than they do about overcoming a stiff technological learning curve or making a principled stand against incumbent tech.

The crucial thing to understand is that consumers just want to go on about their lives. **It's not their job to ensure that technology is safe, ethical, and pro-social — but it *is* the open metaverse's job to ensure that what we build meets all three criteria in addition to being fun and easy to use.** If early metaverse and web3 adopters don't prioritize ethical, intuitive, human-centered design, incumbent tech with more manpower and resources may capitalize on open metaverse inefficiencies by gating, mediating, and further centralizing metaverse experiences in the name of pain-free convenience.

Threat Modeling for Informed Consent

With respect to interfaces, the area of threat modeling to obtain unambiguous and enthusiastic consent from users is unfortunately both underdeveloped and underrepresented in information security design.

The identity community is hopeful that self-sovereign wallets will grow to replace custodial email logins.[111] But to realize this vision while keeping their data and finances secure across an internet without middlemen, users will have to rapidly develop new habits for self-custody — a challenge, given that most data sovereignty practices have been expressly abstracted away in web2 in favor of frictionless UX. History has proven that web users value seamless convenience, often even prioritizing it above safety. This means that web3 wallets must be designed for clarity, comprehension, and ease-of-use — so that they don't sacrifice sovereignty, safety, and security for pain-free convenience.

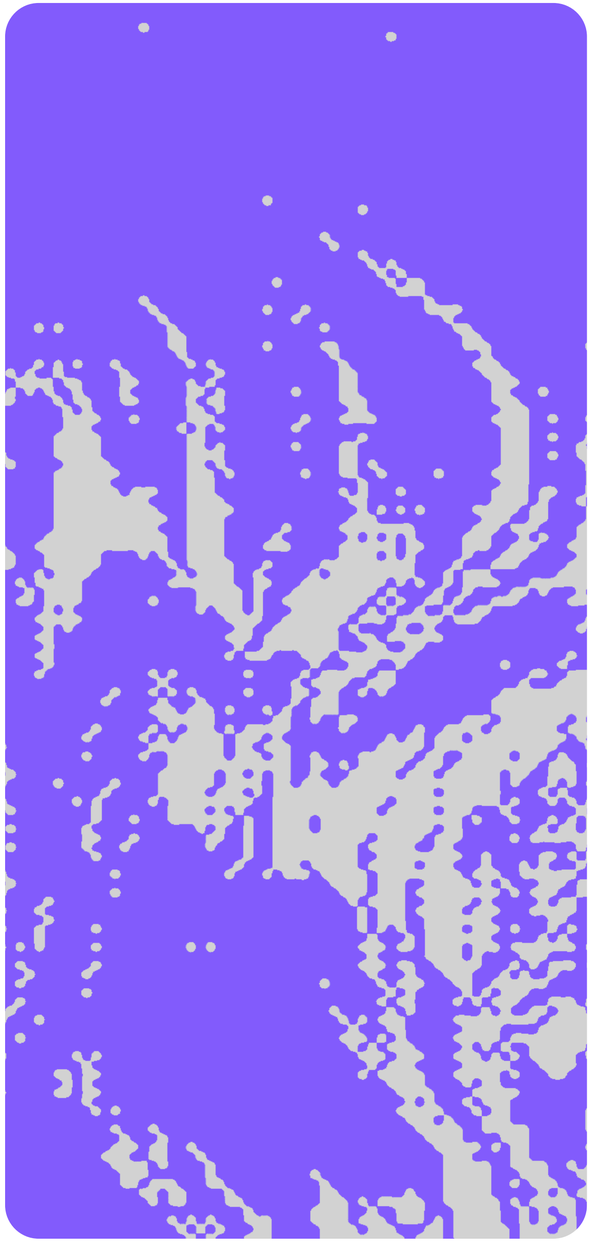
There are two other design patterns that complicate matters for users and that web3 must avoid inheriting. The first is the practice of obtaining *performative* instead of *informed and enthusiastic* consent by presenting long TOS and EULAs riddled with technical terms and legalese that users are not expected to read or comprehend. The second is ubiquitous cookie pop-ups designed purely to meet GDPR compliance — and that frustrate rather than inform users.

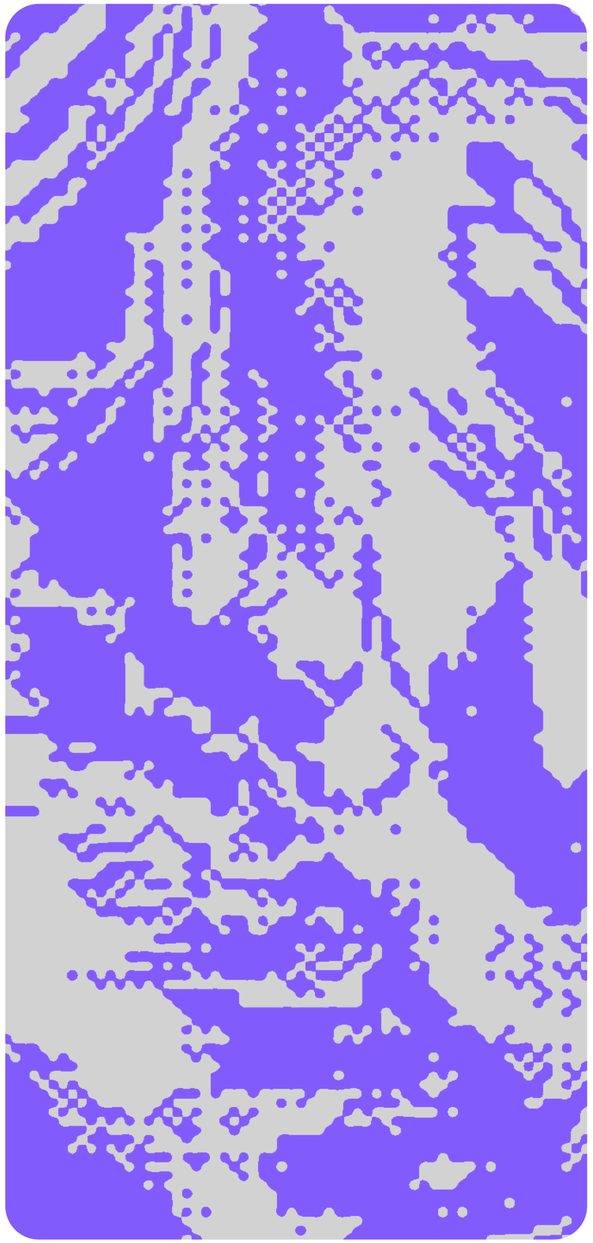
As we've already covered, such performative practices trained deleterious habits into users, who quickly hit "accept" or click away the pop-ups because doing so is easier amid the demands of their busy lives.

> "I imagine that some people are questioning why we are talking about consent in a usable security talk. And, friends: because there are no secure systems without consent."
>
> **Antonela Debiasi**
> Product Design Lead, Metamask[112]

The same sort of consent theater has likewise been harmful for product designers and developers, whose trained motivation is to design interfaces to satisfy compliance requirements instead of obtaining informed consent with due rigor. As unfortunate as this trend has been in web2, it becomes existential in web3 because there is no "way back" for users who consent to signing smart contracts that forever live on the blockchain, or who send away their funds without an intermediary to assist with fraud or user error. As these decisions affect people's everyday lives, web3 adoption requires developers to accept a new responsibility to truly inform users about their permissions. Despite initially lagging interest, usable security is finally gaining attention among wallet and protocol designers. At the October 2022 Devcon conference in Bogotà, Metamask's product design lead, Antonela Debiasi, presented a talk on usable security in web3 that addresses designing for consent in her words:

> "When we talk about consensual technology, we talk about having control over our digital bodies — which of course include our data and for sure, our money.
> As wallet developers, we have the responsibility to think critically about how to expose the user to a decision that directly affects their digital body."[113]





Adaptive Frameworks for Protecting Privacy in Context

Another related area that calls for attention is designing for privacy. People's privacy preferences are highly dependent on context: there is no such thing as all privacy in all settings, all of the time.

Design for privacy must be inherently adaptive and responsive. Instead of focusing on policies, agreements, and regulations, we should define what privacy-preserving conditions designers should achieve, not how to get there. In other words, tell them what their goal is, not how to do their jobs.

Unfortunately, even forward-looking privacy frameworks such as the X Reality Safety Initiative (XRSI) fall short of delivering the flexibility and nuance necessary to protect contextual integrity. The XRSI seeks to proactively anticipate the privacy impacts of emergent technologies by recommending ways to "satisfy CCPA and GDPR requirements" and "provide just-in-time disclosures to individuals and obtain their affirmatively expressed consent."[114] Such attempts to "future-proof" technology by enumerating all possible contexts and interactions of some hypothetical future extend the same awkward and disruptive consent notification requirements of web2 into immersive environments whose precise properties haven't even been invented yet.

In her graduate research on digital privacy, Uglova draws on inspiration from battle-tested information security practices to offer an adaptive framework for privacy management.[115] Information security professionals adhere to the *Confidentiality, Integrity, and Availability triad* (often reffered to as CIA) to make defensive decisions about private data:

[1] Confidentiality
requires that private data be encrypted or otherwise protected from unauthorized access.

[2] Integrity
means that data must remain accurate and free from unauthorized tampering or alteration.

[3] Availability
assures reliable access from authorized parties to private data upon request.

This framework defines the minimum outcomes for data security that practitioners must meet in performing their duties. However, since best practices are constantly improving in response to an ever-evolving threat landscape, it does not prescribe any specific methods for how to meet those outcomes. Rather, it entrusts response and adaptation to on-the-ground professionals with the richest context to do their jobs.

But information security only pertains to data objects, while privacy governs a more amorphous and liminal space — not just of data, but of the expectations people attach to that data as well as its purposes and uses. So to chart a similarly flexible approach for a more subjective set of concepts, Uglova recommends that practitioners consider an alternate triad: *Confidentiality, Interoperability, and Agency*:

[1] Confidentiality
Confidentiality remains unaltered, as privacy can be assured only by restricting access to authorized parties under authorized conditions.

[2] Interoperability
The framework recommends interoperability as a core practice in privacy management, because keeping up with ever-shifting privacy boundaries while navigating an expanding metaverse becomes unworkable if each world maintains a distinct policy.

[3] Agency
Finally, the agree-or-opt-out paradigm that users face today is not only coercive, but far too limiting to tend to the increased contextual complexity of immersive spaces. Users will face greater impact to their consent boundaries — particularly because in many cases, their biometric data will be involved. Instead of merely clicking "accept" — or else closing the window and missing out on an essential avenue of modern life — users must have agency to exercise meaningful and pluralistic choice about actions that affect their digital bodies and cognition.

This framework is currently in effect at KERNEL, a cohort-based learning program for rising and current crypto professionals. The privacy policy, adopted in November 2022, further commits to preserving practices that "serve the continued creation of safe and intimate spaces for critical thought and honest, nuanced dialogue, free of surveillance or self-censorship."[116]

The Convergence of VR and AI

The attentive reader might be wondering: with all that context-dependent agency and pluralistic choice about our data, how are we ever going to get anywhere in the metaverse without getting inundated with thousands of consent notifications? Isn't this just another version of the consent spam and cookie popups that exhaust and irritate users today — and a key reason we have performative acceptance instead of informed, enthusiastic consent in the first place? This type of friction, even when well intentioned, overwhelms users rather than welcoming and onboarding them into new experiences. Here, again, intentional design — assisted by AI — is key.

Billionaire entrepreneur and PayPal co-founder Peter Thiel famously stated, "Crypto is libertarian, AI is communist,"[117] underscoring the perceived divergence of operating values and political philosophies motivating the work within each discipline. But the future for both is more interdependent than Thiel suggests.

The explosion of AI technologies like GPT-3 and stable diffusion into the mainstream has propelled a frenzy of investor interest in the sector.[118] Increased capital flows into applied AI research will impact all sectors of consumer technology, including the metaverse. Here, we see an opportunity to improve consent management through AI-assisted permissioning.

For example, a user may define a set of default permissions, which, if the privacy-preserving CIA triad sees adoption, will be mutually-readable and interoperably-accepted by a plurality of digital worlds. But, faced with a consent moment that falls outside the range of options covered by the user's preset defaults, an AI-enabled "consent bot" may be able to extrapolate, with some reasonable degree of confidence based upon the user's prior preferences or those of similar users, what the user would decide. The user may of course roll back these AI-inferred responses and declare new preferences, but the automated, reasonably-intelligent assistance — that learns and improves from users' prior history — can help avert consent spam while aggregating a wealth of practical information about how users actually think about and exercise their freedoms.

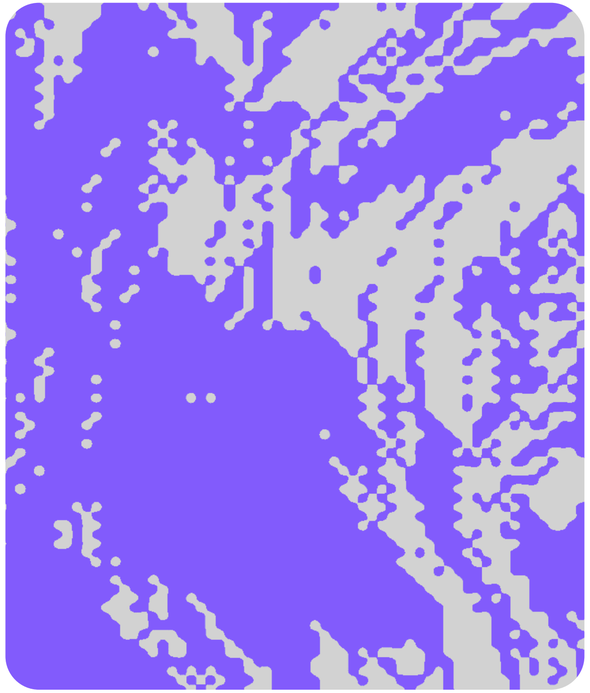
Finally, in the metaverse, users do not merely read content but immerse in it, interacting with diverse people who hold highly divergent viewpoints in a shared space. Content moderation at scale is already a sizable challenge on social media. The potential for harmful effects from abusive behavior is amplified in UGC-first VR environments, as documented in *a Georgetown Law Technology Review* article on moderating the metaverse: [119]

1/2

"Users can physiologically and psychologically react to VR experiences as if it were happening to them in real-life. Meta's Chief Technical Officer, Andrew Bosworth, has stated that toxic environments, particularly for women and minorities, could be an 'existential threat' to any metaverse plans, while at the same time acknowledging that creating safe VR worlds may be 'practically impossible' at scale. However, heavily moderating the metaverse also will not work, especially as a practical matter."

2/2

"While Meta might like to rely on AI to filter VR/AR interactions, doing so would require every second of every interaction to be monitored and analyzed. Putting aside the unsettling privacy concerns inherent in such monitoring, it would require untold amounts of computing power, making it practically impossible."



These dynamics can already be seen today. *The New York Times* published an exposé late last year on abuse in VRChat,[120] a game available on Oculus (among other headsets), a device that Meta has rated safe for teenagers but that has already seen rampant assault, bullying, misinformation, and hate speech — with few available mechanisms to report misbehavior. Over a single 11-hour period, Callum Hood, the head of research at the Center for Countering Digital Hate, "recorded more than 100 problematic incidents on VRChat, some involving users who said they were under the age of 13. In several cases, users' avatars made sexual and violent threats against minors, he said. In another case, someone tried showing sexually explicit content to a minor."[121]

Here, industry faces important trade-offs between AI innovation and overexposure of user data to ongoing monitoring. As with all digital technology, the delicate balancing act between usability and security — or between convenience and consent — is never over.

WHERE WE'RE GOING, WE NEED...

Funding the Metaverse: A Partner Report by White Star Capital

About WSC

White Star Capital is a global multi-stage technology investment firm that invests in exceptional entrepreneurs building ambitious, international businesses. Active in North America, Europe, and Asia, our presence, perspective, and people enable us to partner closely with founders to help them scale internationally from early stage onwards.

While $88 billion in venture capital (VC) was invested into crypto companies from 2013 to 2022,[A] metaverse investments totaled just $11 billion. As the youngest category within a group that includes SaaS, fintech, e-commerce, and digital health — each of which outnumbers total crypto funding — it makes sense that the metaverse is the smallest VC category. It stands out, however, as the only industry with meaningful invested capital growth in 2022. Whereas VCs on average put 44% less capital to work this year across other parts of tech, they more than doubled their investments into metaverse companies compared to last year.

Is the metaverse becoming more "real" than it was a year ago? Where can we see signs of tangible progress?

We examine these questions by placing the metaverse within the broader context of technology.

In developed economies, technology is ubiquitous in professional and personal life. Using smartphones and computers, users constantly slip in and out of the perpetual and persistent internet via popular software applications. The internet is crucial to people's contemporary understanding of technology — and in turn, of the physical world around us — because both notions are so deeply embedded into the fabric of modern life.

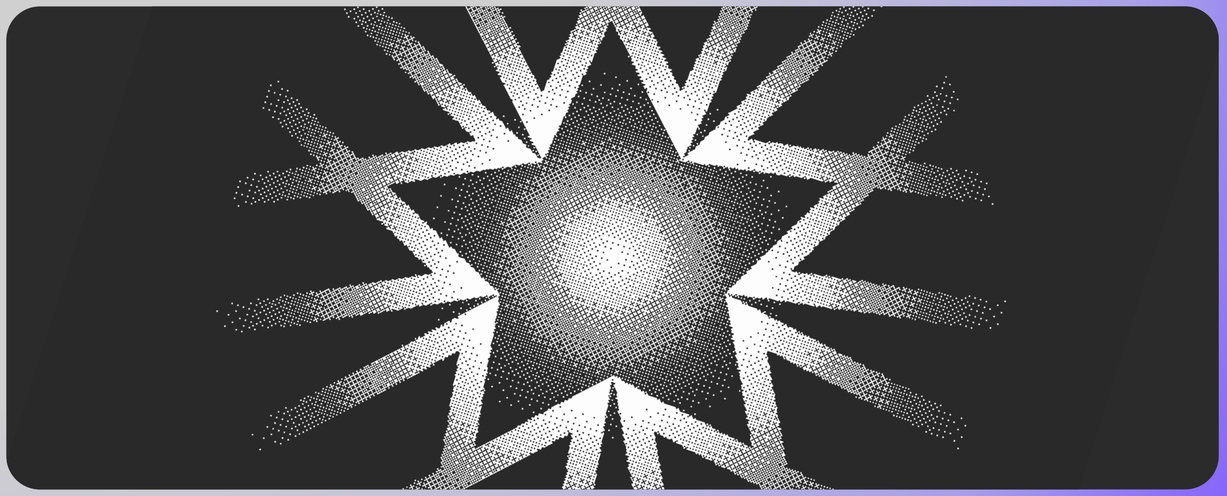
But just over twenty years ago, nothing about the internet was obvious. Even today, the internet is not as ubiquitous as it may feel to those of us who live digitally-mediated lives — nor is it synonymous with technology as a whole.

More than a third of the global population has yet to access the internet.[B] Nearly 75% of market capitalization in the S&P 500 represents companies outside the technology sector.[C] Even though the top five largest companies in the S&P 500 are all technology companies, only two of them are internet-native: Amazon and Alphabet. Apple, Microsoft, and Tesla are the other three technology leaders whose core businesses operate as much outside of the internet as they do within it.

Total VC Investments, 2021-2022

SOURCE: PITCHBOOK, WHITE STAR CAPITAL ANALYSIS

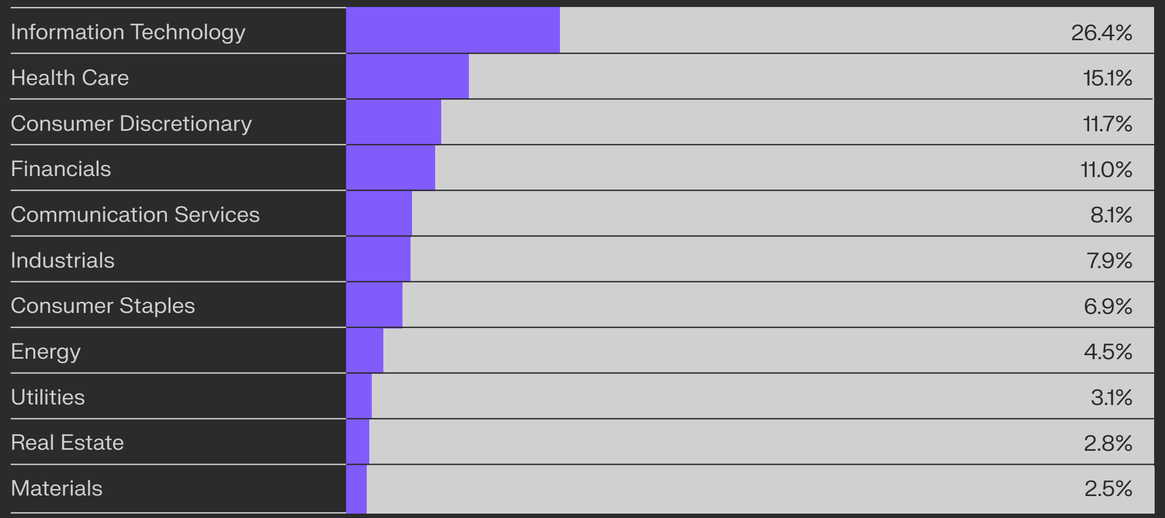
	[2021]	[2022 YTD]	[2022 Est]	[YoY % vs. YTD]	[YoY % vs. Est]
Metaverse	$1.9bn	$4.4bn	$5.3bn	133%	179%
Crypto	$30.4bn	$28.1bn	$33.7bn	-8%	11%
Fintech	$122.1bn	$73.3bn	$87.9bn	-40%	-28%
SaaS	$168.0bn	$99.8bn	$119.8bn	-41%	-29%
Digital Health	$23.7bn	$10.4bn	$12.5bn	-56%	-47%
E-commerce	$41.3bn	$13.7bn	$16.5bn	-67%	-60%
Weighted Avg				-41%	-29%
Weighted Avg (Excl. Metaverse and Crypto)				-44%	-33%
Weighted Avg (Metaverse and Crypto only)				1%	21%



[A] According to data from investment news and analysis firm, PitchBook
[B] Roser, M. (2015, July 14). Internet. Our World in Data. https://ourworldindata.org/internet
[C] S&P 500® | S&P Dow Jones Indices. (n.d.). https://www.spglobal.com/spdji/en/indices/equity/sp-500/

Sector Breakdown

SOURCE: S&P 500, 2022



Constituents: Top 10 by Index Weight

SOURCE: S&P 500, 2022

[1] CONSTITUENT	[2] SYMBOL	[3] SECTOR
Apple Inc.	AAPL	Information Technology
Microsoft Corp	MSFT	Information Technology
Amazon.com Inc	AMZN	Consumer, Discretionary
Tesla, Inc	TSLA	Consumer, Discretionary
Alphabet Inc A	GOOGL	Communication, Services
Alphabet Inc C	GOOG	Communication, Services
Berkshire Hathaway B	BRK.B	Financials
Unitedhealth Group Inc	UNH	Health Care
Johnson & Johnson	JNJ	Health Care
Exxon Mobil Corp	XOM	Energy

A phenomenon in constant evolution, the future of the internet is no easier to forecast today than it was twenty years ago. But increasingly, the term "metaverse" is being used to describe one way that the internet's polymorphous future will unfold.

This report emphasizes that the metaverse is not a single company, or a place, or a new noun to replace gaming or VR. At White Star Capital, we believe that the metaverse instead describes a future state of the internet in which new internet-native companies generate the remaining 75% of the economic value across the S&P 500.

To create multiple trillions of dollars of new economic value through an internet-led total transformation in industries such as healthcare, financial services, and global consumer brands, the metaverse will need to advance beyond the hallmark features of today's internet. So what can the metaverse deliver beyond the already superior customer experience, unprecedented economies of scale, and self-propelling network effects that we enjoy on the internet today?

Programmable economic incentives, user ownership, and immersion are emerging as significant vectors of progress. Today's internet innovations are driven equally by blockchain-based systems as by 3D virtual worlds. While the ultimate experiential form factor and visual style of the metaverse remain unclear, it is certain that creativity and experimentation will drive this progress just as they did in the previous two decades.

To this end, we view interoperability — unbound by the constructs of the current internet protocol suite — as the single most important enabler of the metaverse.

For progress to compound productively, builders must index for architecture and design choices that prioritize interoperability and maximize software composability beyond what is possible today.

Taking inspiration from leading metaverse companies, we highlight six that are finding new ways to scale UGC, building infrastructure tools for the entire ecosystem, and empowering virtual creators, communities, and identities.

Some of them are contributors to this report while others are close friends to both White Star Capital and Lighthouse. In their own ways, they all contribute to bringing the metaverse to life.

[1] Tech Infrastructure
Improbable

[2] Economic Infrastructure
Zora

[3] Virtualization and Discovery
Ready Player Me

[4] Content and Experiences
Yugalabs
Spatial
Roblox

WHITE STAR CAPITAL

Roblox

About the Firm

Operator of an online video game platform that lets young gamers create, develop, and monetize games for other players. The firm offers a hybrid of a game engine, publishing platform, online hosting and services, marketplace with payment processing, and social network. The platform is a closed garden that Roblox controls, earning revenue in multiple places while benefiting from outsourced game development.

[YEAR FOUNDED]	[HEADQUARTES]	[TOTAL RAISED]	[SECTOR FOCUS]
2004	San Mateo, USA	$14.7bn	Game Publishing

Select Investors

Altimeter Capital · Altos Ventures · Andreessen Horowitz · Dragoneer · Greylock Partners · Index Ventures · First Round Capital · Temasek · Tiger Global

WHITE STAR CAPITAL

Improbable

About the Firm

Developer of a metaverse platform designed to offer virtual gaming experiences. The company offers a computation platform that helps to create simulations of the real world, as well as helps to experience immersive and persistent virtual worlds for gaming, enabling users to play games related to defense, energy, city efficiency, health, and finance sectors.

[YEAR FOUNDED]	[HEADQUARTES]	[TOTAL RAISED]	[SECTOR FOCUS]
2012	London, UK	$867M	Virtual Reality Software

Select Investors

Andreessen Horowitz · CMT Digital · Digital Currency Group · Ethereal Ventures · SoftBank · Temasek

WHITE STAR CAPITAL

Yuga Labs

About the Firm

Developer and owner of NFTs and digital collectibles, most known for the creation of the Bored Ape Yacht Club and its acquisitions of CryptoPunks and Meebits. The company also created a metaverse gaming platform called Otherside.

[YEAR FOUNDED]	[HEADQUARTES]	[TOTAL RAISED]	[SECTOR FOCUS]
2021	Miami, USA	$450M	NFTs and Web 3 Gaming

Select Investors

Andreessen Horowitz · Aminoca Brands · Coinbase · Lightspeed Venture Partners · The Sandbox · Thrive Capital · Tiger Global

WHITE STAR CAPITAL

Ready Player Me

About the Firm

Developer of a cross-game avatar platform for the metaverse. The company's platform offers 3D printing and scanning of human sculptures intended for use in virtual reality and games, thus enabling developers to integrate 3D models into existing games, game engines, or virtual reality applications.

[YEAR FOUNDED]	[HEADQUARTES]	[TOTAL RAISED]	[SECTOR FOCUS]
2014	Tallinn, Estonia	$77M	Virtual Avatars

Select Investors

Andreessen Horowitz · Collab + Currency · Endeavor · Konvoy Ventures · Plural · Samsung Next

WHITE STAR CAPITAL

Zora

About the Firm

Operator of a cryptocurrency-driven marketplace intended to buy, sell, and trade in limited-edition non-fungible tokens (NFTs). The company's platform utilizes blockchain technology to offer secondary market value to digital files including photos, videos, audio, and music, and includes features such as drop alerts and notifications, providing artists and businesses with accessible tools to create NFT collections and sell them without hassle.

[YEAR FOUNDED]	[HEADQUARTES]	[TOTAL RAISED]	[SECTOR FOCUS]
2020	San Fransisco, USA	$69M	NFTs and Marketplaces

Select Investors

Coinbase
Green Base Ventures
Haun Ventures
Kindred Ventures
Paradigm
Variant

WHITE STAR CAPITAL

Spatial

About the Firm

The company's platform helps creators design and host virtual spaces that can be accessed from any device, enabling users to discover, collaborate, search, brainstorm, and share content in the most immersive way possible.

[YEAR FOUNDED]	[HEADQUARTES]	[TOTAL RAISED]	[SECTOR FOCUS]
2016	New York, USA	$47M	Virtual Space

Selected Investors

White Star Capital
Pine Ventures Partners
Korea Investment Partners
Maven Growth Partners
Inovia Capital

Timmu Tõke

[TWITTER]
@timmutoke

Timmu Tõke and co-founders Rainer Selvet, Kaspar Tiri, and Haver Järveoja launched a 3D scanning technology in 2014, then spent four years collecting facial scans in public places like airports, concert halls, and museums.

The team has since used its database of over 20,000 high-quality facial scans to develop a selfie-to-avatar solution before launching Ready Player Me in 2020 with the goal of becoming the go-to metaverse avatar technology provider.

We speak with Tõke about the technical challenges that come with making avatars compatible across as many metaverse ecosystems as possible.

[CEO & CO-FOUNDER]
Ready Player Me

[1] ## Interoperability is evolving from a hopeful ideal into a norm.

Ready Player Me is quickly becoming the most well-known avatar system of the metaverse. Tõke attributes this to both his company's developer-friendly tools and the growing awareness of interoperability.

"A new generation of developers who appreciate interoperability and prefer an interoperable avatar system is emerging," said Toke. "The philosophy of developers has changed."

Meanwhile, Ready Player Me users themselves also take their avatars across multiple games and experiences, without any prompting from the company, says Toke. "It hasn't been a focus for us to push them to do that," he said. Rather, the company focuses entirely on building the best tools for developers, which naturally results in the creation of high-quality avatars that users desire to take with them across worlds.

[2] ## People will want different avatars to express facets of their identities in different contexts.

"People will create avatars for a use case," said Toke. "For example, if you're visiting a lot of different galleries or social virtual worlds, you'll have a social avatar for that."

But then you'll likely want an avatar for your professional identity: "If you have a VR meeting with coworkers or customers, you will need a more professional avatar," Tõke says.

Creating avatars is generally similar to creating your social media profile, argues Toke. For instance, your Instagram may show off a person's artistic side, whereas LinkedIn is most often used to showcase someone's professional accomplishments.

[3] ## Consistency presents a significant technical challenge.

Creating a consistent avatar UX across countless metaverse worlds has always been — and continues to be — one of the biggest technical challenges of the metaverse. Avatar types all operate at different speeds and according to unique Laws of Demeter (LoD), a software design principle that impacts how much information must be shared between digital objects. Additionally, avatars in distinct worlds may require different file formats, making it hard to predict what technical specs might be necessary for travel between worlds.

"It's definitely a lot of experimentation," said Tõke. "Now we're starting to have a scalable content system so anyone can create avatar fashion assets and skins that work on an unlimited number of body types and styles."

Finally, while consistency presents numerous technical problems to be solved, the quality and design aesthetic of the artwork itself may also vary between artists and developers of varying skill and experience levels.

Parting Words

[104]

A Letter from the Editors [105]

A Letter from the Designers [106]

Footnotes [107]

JONATHAN BRUN

Parting Words

The first takeaway that we hope readers will retain from this report is that the metaverse presents a unique opportunity to integrate the learnings of our last thirty years of digital living into what we believe will become the new dominant paradigm of the web. There is no debating it: the web, or, more precisely, our way of interacting with it, needs to change in order to become less intrusive for users, less extractive for creators, and more inclusive for all. If done right, the metaverse invites us to build things anew in a way that respects our individual dignity and autonomy and preserves our essential freedoms and our sense of play — unencumbered by manipulation, concealed influence, and information extraction.

The second takeaway is that the next generation of metaverse leaders already understands this opportunity and is here expressly to build a better future informed by their experience of where web2 fell short of what people deserve. Whether driven by moral imperatives or capitalistic aspirations, pushing for more openness and interoperability is on everyone's agenda. The future will not look like the past. In the economy of tomorrow, players that refuse to build with an open development mindset, or who keep reverting to the old platform-centric paradigm, will be left behind.

Finally, the last takeaway of this report is that regardless of how ambitious our metaverse aspirations may seem, we will still miss the mark by a wide margin — and we're glad for that! In 2014, renowned financier Aswath Damodaran published an article in *FiveThirtyEight* arguing that Uber could not be worthy of its $17 billion valuation at that time.[122] His premise was that the taxi market was simply not large enough — regardless of how much we stretched it — to support such an exorbitant valuation. Today, Uber's market capitalization stands at $56 billion, with a peak valuation breaking $100 billion in the first half of 2021. Aswath completely missed the mark on that one, not because he is bad at what he does (he is actually amazing), but because he failed to account for how expansively an improved user experience can expand the total addressable market of a product or service — even opening up peripheral opportunities such as Uber Eats. Humans are generally bad at thinking exponentially. We try to project the future linearly in a nonlinear world. In the context of the metaverse, chances are that even the most ambitious among us will find ourselves on the conservative side of history.

To wrap up, I'd like to finish with a prediction on the future that matters a lot to me as a father and metaverse tinkerer.

In 2019, Lego released a study that shocked the world. The group surveyed 3,000 children aged 8-12 and over 320 parents with children aged 5-12 to figure out what kids wanted to become when they grew up.[123]

About a third of the kids claimed that they wanted to become YouTubers, while only 11% said that they wanted to become astronauts — my personal childhood dream! This survey is not alone. Another one driven by First Choice in the United Kingdom surveyed 1,000 children aged 6-17. More than 50% of the kids wanted to become YouTubers.[124]

Both surveys caused a media frenzy and boomers went bananas, but that's beside the point. What matters is that democratizing a new medium for digital expression and empowering culture to emerge organically completely shifted humanity's professional aspirations — and, by extension, changed our collective future.

I believe that the democratization of game design tools, AI, and the complementary unlocking of digital artists' capacity to make a living off their craft through new technologies such as NFTs, will make metaverse creators the YouTubers of the future.

The next generation of YouTube-born cultural figures like Justin Bieber, Shawn Mendes, and Dua Lipa will not be singing songs on YouTube. They will build worlds in Mona, The Sandbox, Webaverse, Hyperfy, Oncyber, and thousands of other environments that millions of people will experience. Most likely, Bieber, Mendes, and Lipa will actually perform *in* them!

I foresee that within three years, we will have at least one metaverse builder with a social media following of more than 100 million people and that five years from now, being a game designer or metaverse builder will become the #1 profession that kids aged 8-15 will aspire to when they're asked what they want to be when they grow up. In fact, I plan to eventually introduce my two sons and daughter to computers by showing them how to build metaverse experiences.

They're all still too young for that now. Until then, I'll wrap up this, *my tenth review of the report*, to go get a good jiu-jitsu roll with them — one of the many things that will always be better in the physical world than the digital one!

See you in the metaverse,
Jonathan

A Letter From The Editors

Dear friends,

Despite its rhetoric of trustlessness, building in web3 and the open metaverse is an intentional practice of trust among collaborators. This report has been an exercise of that principle in practice, as both of us, Anastasia and Megan, experienced while co-creating together.

Prior to joining forces for this report, each of us traveled distinct pathways to the metaverse: Anastasia is a digital privacy researcher who wrote her graduate thesis on averting the types of privacy and identity harms that could lead to another version of Cambridge Analytica in the spatial web. [125] Megan is a personal finance journalist turned web3 nerd who can't "un-see" the observations she's made about digital ownership and consumer sovereignty while reporting on crypto since right before the 2021 bull market. While buzzy headlines drive the news cycle, this longform endeavor offered Megan the chance to learn about the people dedicating years to building our digital future — and to translate their vision to those of us wondering how that future looks.

The gravity of this moment is palpable for both of us: internet users are fed up with the exploitative practices of the platform-driven and ad-supported attention economy — and they demand better. And, while crypto seems poised to reactively reconstruct the web anew, it is also on a path to entrench some of the most worrying features of our digital present: rampant monitoring and surveillance of user data on public ledgers, design choices that prioritize growth and profit over user safety, and tactics that enclose economies rather than setting them free. But therein, of course, lies the opportunity: with the benefit of hindsight, we don't merely have to demand better while repeating the past. We can actually *do* better, and writing this report together was our contribution to charting that path forward.

We are both motivated by what's at stake in the next iteration of the internet if we don't pause to learn from web2's failures while iterating on its successes. We also ascribe to web3's ethos of composable contributions and collaborative narrative, which helped us embrace and conquer the colossal task of researching, compiling, writing, and editing over 100 pages of insights and interviews about the edges of the spatial web. Like open-source code, we didn't always know where we would end up, but we were tightly enough coupled by our shared ideas about interoperability to surrender to the process and trust what emerged.

On that note, we'd like to express gratitude to the contributors who shared their time and trusted us to accurately represent their insights. This report was, in a way, a form of performance art. If we wrote this report by ourselves, our artifact would represent an enclosure of perspective, siloed away from the community it describes. We wanted instead to practice the principles we were writing about by composing multiple points of view into something representative and whole. We sought perspectives rather than pushing only our own, solicited external contributions from the wider community, and gave credit where it's due: to the creators.

Writing this report was transformative — as any provocative discussion should be. We hope this offering sparks many delightful conversations to come.

To inspiration and transformation through collaboration,

Anastasia and Megan

Anastasia Uglova

[Twitter]
@AnastasiaU

Anastasia Uglova is Head of Communications and Ecosystem Development at Lighthouse. A writer and public educator, Anastasia's research focuses on privacy, consent, and agency in digital spaces. She is a KERNEL and 2012 Global Health Corps fellow and has held communications roles at Notion, NPR, NBC, the U.S. Senate, and Cato Institute. Prior to completing her M.S. in privacy and information security at UT Austin, Anastasia spent six years in East Africa working in global health, women's education, and workforce development. She spends her free time traveling, skydiving, and practicing acro yoga, and holds a B.A. in government and international relations from Cornell University.

Megan DeMatteo

[Twitter]
@megdematteo

Megan DeMatteo is a journalist, editor, and Push-cart-nominated poet currently based in New York City. She has written hundreds of articles for leading money and personal finance sites like CoinDesk, TIME's NextAdvisor, CNBC, and more. In 2021, Elizabeth Warren cited Megan's CNBC article in her letter to Secretary of Education Miguel Cardona. Megan holds a bachelor's degree in Spanish, an M.A. in creative writing, and certificates in the healing modalities of hatha yoga and narrative medicine. She loves singing and spending leisurely time outside.

Alycia Rainaud - Maalavidaa

Creative Director

Graphic Designer | Digital Artist

Mental Health Advocate

Maalavidaa is Alycia Rainaud, a French-Canadian Graphic Designer and Digital Artist based in Montreal. Her highly saturated abstract aesthetic finds its inspiration in Jungian therapy, color therapy, and meditation. Alycia's work aims to explore the complexity of emotions through creative introspection as a path to increase emotional intelligence and mental health sensitivity. With this aim as a work thread, she founded Heal The Deal, the metaverse's first emotional support club, a safe space driven by a creativity and empathy, as well as a gateway to a new path in Alycia's journey.

[Instagram]
@maalavidaa

[Founder]
Heal The Deal, Metaverse's emotional support club

Chloé Grienenberger

Creative Director

Graphic Designer | CGI Artist

Chloé Grienenberger is a French multidisciplinary designer based in Paris. She shifts between non-directive artistic projects and more conventional corporate projects (from visual identity and logotype to 3D images — stills or moving). She's always looking for new challenges and truly believes that nowadays, design has to be seen through a holistic perspective. This ideology has brought her to push her limits and learn new skills to bridge various mediums into her daily routine. She tends to develop an approach that is both artistic and narrative while expanding her interest in the borders that separate reality from the virtual world.

[Instagram]
chloe.grieneneberger

A Letter From The Designers

Dear readers,

If you've come this far, then that means our job is finally done, and that eventually, we did it well. For our mission as designers and creatives is to always tell intricate stories in the most immersive and sensible way.

From the get go, we understood the challenges that the whole team has faced with making this a complete and clear experience for you. And so, naturally, our primary goal was not only to do their tireless efforts justice, but also reflect their undying passion for everything metaverse in these pages.

It goes without saying that as multidisciplinary individuals ourselves, we have become acquainted with all web3 intricacies for a couple of years now, and haven't looked back ever since. These hyperlinks between our creative realms taught us the immense value and utter importance of constantly seeking new ways to bring colors to meanings. And without exception, this report showed us that, no matter how complex a topic can be, it's the visual story that makes it welcoming. Basically, nothing's impossible with a good gradient.

With this sense of familiarity, we hope that we made this a pleasant experience for you, and perhaps one that you'll be inclined to revisit again.

Whether because our colors stayed with you afterwards or because one of Alycia's original textures got stuck in your mind. At the end of the day, our brightest pride is to imagine how you'll internally visualize this report when you're thinking back at it.

We would love to extend our gratitudes to all the amazing people involved in this adventure and for the creative freedom that we've been granted. Being able to sleep at night without fearing tomorrow's feedback on a visual is a gift that few designers get to enjoy (wish this was a joke). A priceless gift from the team who stuck with us when we added more pixels, more colors, more textures and details, with the aim of redefining the visual feel and potential of what the metaverse experience could be. Because after all, that's what web3 is about: granting freedom.

If this marks the end of this report, we are sure that this is certainly not the end of the journey. Until then, we'll still be here dreaming in neons and imagining worlds if you're looking for us.

Best,
Alycia and Chloé

01

[1] Tan, E. (2022, June 8). Neal Stephenson Coined 'Metaverse' in 1992. Now He's Building One. *CoinDesk*. https://www.coindesk.com/business/2022/06/08/neal-stephenson-coined-metaverse-in-1992-now-hes-building-one

[2] Paul, K. (2021, October 29). Facebook announces name change to Meta in rebranding effort. *The Guardian*. https://www.theguardian.com/technology/2021/oct/28/facebook-name-change-rebrand-meta

[3] American Experience. (2017, December 29). The Early History of Motion Pictures. *American Experience | PBS*. https://www.pbs.org/wgbh/americanexperience/features/pickford-early-history-motion-pictures

[4] Weinbaum, S. G. (2016, April 21, 2016). *Pygmalion's Spectacles*. Simon & Schuster. https://www.simonandschuster.com/books/Pygmalions-Spectacles/Stanley-G-Weinbaum/9781682999219

[5] Chow, A. R. (2022, March 31). How Top Fiction Writers Are Thinking About the Metaverse. *Time*. https://time.com/6163109/metaverse-fiction-scifi

[6] Ball, M. (2022). *The Metaverse: And How It Will Revolutionize Everything*. Liveright.

[7] Microsoft. (n.d.). Get Colossal Cave Adventure. *Microsoft Store*. Retrieved October 28, 2022, from https://www.microsoft.com/en-us/p/colossal-cave-adventure/9wzdncrdlv4h

[8] *Exploring the metaverse and the digital future*. (2022, February 26). GSMA Asia Pacific. https://www.gsma.com/asia-pacific/resources/metaverse-report

[9] Bell, K. (2022, October 11). Meta will integrate Zoom and Microsoft Teams into its VR workspaces. *Engadget*. https://news.yahoo.com/meta-will-integrate-zoom-and-microsoft-teams-into-horizon-workrooms-174012859.html

[10] Cadwalladr, C. and Graham-Harrison, E. (2018, March 17). Revealed: *50 million Facebook profiles harvested for Cambridge Analytica in major data breach*. Retrieved October 27, 2022, from https://www.theguardian.com/news/2018/mar/17/cambridge-analytica-facebook-influence-us-election

[11] McMaster, H. R. (n.d.). *Is World War III Already Here?* (A. Raskin & T. Harris, Interviewers). Center for Humane Technology. https://www.humanetech.com/podcast/45-is-world-war-iii-already-here

[12] Smith, A. (2021, October 25). Facebook whistleblower says riots and genocides are the 'opening chapters' if action isn't taken. *The Independent*. https://www.independent.co.uk/tech/facebook-whistleblower-zuckerberg-frances-haugen-b1944865.html

[13] *Meet The Metaverse: What do we need for the metaverse to succeed?* (Lighthouse [@Lighthouse_wrld], Interviewer). (2022, September 6). https://twitter.com/i/spaces/1LyxBqMzkvzJN

[14] Fernandez, L. (n.d.). *metaEstates_VILLA*. MetaMundo. Retrieved October 28, 2022, from https://www.metamundo.co/luisfern5/metaEstates_VILLA

[15] SpacesDAO. (2022). Retrieved October 26, 2022 from https://spacesdao.xyz

[16] The Sandbox Game — *User-Generated Crypto & Blockchain Games*, 2022, https://www.sandbox.game/en

[17] Canales, K. (2022, September 8). Tim Cook says Apple doesn't get many requests to fix green bubble messages to Android users. *Business Insider*. https://www.businessinsider.com/tim-cook-buy-mom-iphone-apple-android-green-bubble-2022-9

[18] Anderson, C. (2004, October 1). The Long Tail. *WIRED*. https://www.wired.com/2004/10/tail

[19] Kelly, K. (2008, March 4). 1,000 True Fans. *The Technium*. https://kk.org/thetechnium/1000-true-fans

[20] Yang, P. (2022, January 5). Roblox: Gaming, the Creator Economy, and the Metaverse. *Medium*. https://medium.com/@peteryang/roblox-gaming-the-creator-economy-and-the-metaverse-7ed5a8957ff8

[21] Jin, L. (2021, August 31). The Creator Economy Needs a Middle Class. *Harvard Business Review*. https://hbr.org/2020/12/the-creator-economy-needs-a-middle-class

[22] Lu, D. (2021, January 19). The Social Dilemma review: How big tech companies use us for profit. *New Scientist*. https://www.newscientist.com/article/2255588-the-social-dilemma-review-how-big-tech-companies-use-us-for-profit

[23] *Digital Development Overview*. (n.d.). World Bank. Retrieved September 29, 2022, from https://www.worldbank.org/en/topic/digitaldevelopment/overview

[24] *Meet the metaverse: Creating real value in a virtual world*. (n.d.). McKinsey & Company. Retrieved September 29, 2022, from https://www.mckinsey.com/about-us/new-at-mckinsey-blog/meet-the-metaverse-creating-real-value-in-a-virtual-world

[25] *Value creation in the metaverse*. (n.d.). McKinsey & Company. Retrieved September 29, 2022, from https://www.mckinsey.com/capabilities/growth-marketing-and-sales/our-insights/value-creation-in-the-metaverse

[26] *The NFT market report*. (n.d.). Chainalysis. Retrieved September 29, 2022, from https://go.chainalysis.com/nft-market-report.html

[27] *Online microtransaction market size 2022 and growth analysis*. (n.d.). The Business Research Company. Retrieved September 29, 2022, from https://www.thebusinessresearchcompany.com/report/online-microtransaction-global-market-report

[28] *Exploring the metaverse and the digital future*. (2018, November 26). GSMA Asia Pacific. Retrieved September 29, 2022, from https://www.gsma.com/asia-pacific/resources/metaverse-report

[29] Metaverse Interoperability. (2022, July 26). *Pangea*. https://mirror.xyz/pangeadao.eth/zqJww07x6n5vN3a8oKi2SbRDKzWBgyo9APa8eWA4asY

[30] Nicas, J. (2020, August 14). How Apple's 30% App Store Cut Became a Boon and a Headache. *New York Times*. https://www.nytimes.com/2020/08/14/technology/apple-app-store-epic-games-fortnite.html

[31] Stark, J., & Van Ness, E. (2022, January 17). The Year in Ethereum 2021. *Josh Stark*. https://stark.mirror.xyz/q3OnsK7mvfGtTQ72nfoxLyEV5lfYOqUfJloKBx7BG1I

31

32

[32] Masuoka, D., Lazzarin, E., Dixon, C., & Hackett, R. (2022, May 17). Introducing the 2022 State of Crypto Report. *a16z crypto*. https://a16zcrypto.com/state-of-crypto-report-a16z-2022

[33] https://www.investopedia.com/terms/b/bitcoin-whale.asp

[34] Center for Humane Technology. (2022, July 21). We Need Zebras (Not Unicorns). *Center for Humane Technology*. https://www.humanetech.com/insights/we-need-zebras-not-unicorns

[35] Uglova, A. (2022, January 4). Cognitive Consent in Digital Privacy (Part 1 of 3). *Ana*. https://ana.mirror.xyz/XhSTOgQvG9gBMGsyPgnGnUqvCGysrQBf2pz-KGDev9U

[36] Hruska, J. (2020, May 18). Microsoft: We Were on "The Wrong Side of History" With Open Source. *ExtremeTech*. https://www.extremetech.com/computing/310688-microsoft-we-were-on-the-wrong-side-of-history-with-open-source

[37] Radoff, J. (2021, November 24). Web3, Interoperability and the Metaverse - Building the Metaverse. *Medium*. https://medium.com/building-the-metaverse/web3-interoperability-and-the-metaverse-5b252dc39da

[38] Nillabyte. (2009, September 5). *Apple's Steve Jobs Comments on Open Source 2003 01 07 Macworld SF* [Video]. YouTube. https://www.youtube.com/watch?v=cMPQuv34vxQ

[39] Miller, C. (2018, July 25). Even Steve Jobs didn't realize how big the App Store would be, newly unearthed interview shows. *9to5Mac*. https://9to5mac.com/2018/07/25/steve-jobs-10-year-app-store-interview

[40] Axon, S. (2022, April 28). Apple has made nearly $100 billion so far this year. *Ars Technica*. https://arstechnica.com/gadgets/2022/04/apple-has-made-nearly-100-billion-so-far-this-year

[41] *Microsoft Engaged In A Predatory Campaign To Crush The Browser Threat To Its Operating System Monopoly*. (n.d.). U.S. Department of Justice. https://www.justice.gov/sites/default/files/atr/legacy/2006/06/01/V-A.pdf

[42] Gates, B. (1998, December 5). *Plaintiff's Exhibit 2991 (Comes v. Microsoft)*. Slated Antitrust. http://antitrust.slated.org/www.iowaconsumercase.org/011607/2000/PX02991.pdf

[43] Metaverse Interoperability. (2022, July 26). *Pangea*. https://mirror.xyz/pangeadao.eth/zqJww07x6n5vN3a8oKi2SbRDKzWBgyo9APa8eWA4asY

[44] Claburn, T. (2022, July 1). *W3C overrules Google, Mozilla's objections to identifiers*. The Register® - Biting the hand that feeds IT. https://www.theregister.com/2022/07/01/w3c_overrules_objections

[45] Uglova, A. [@AnastasiaU]. (2022b, October 26). Twitter. https://twitter.com/AnastasiaU/status/1585286193654136832

[46] Browne, R. (2022, July 7). *Video game sales set to fall for first time in years as industry braces for recession*. CNBC. https://www.cnbc.com/2022/07/07/video-game-industry-not-recession-proof-sales-set-to-fall-in-2022.html

[47] Unreal Engine. (2022, October 5). Epic and Autodesk join forces to accelerate real-time experiences. *Unreal Engine*. https://www.unrealengine.com/en-US/blog/epic-and-autodesk-join-forces-to-accelerate-real-time-experiences

[48] Metaverse Market. (2022). In *Global Market Estimates*. Global Market Estimates. https://www.globalmarketestimates.com/market-report/metaverse-market-3698

[49] Torres, R. (2022, March 17). A liberal case for cryptocurrency. *New York Daily News*. https://www.nydailynews.com/opinion/ny-oped-a-liberal-case-for-cryptocurrency-20220317-n6iaevmh5jeszkpiaqwco-g742q-story.html

[50] Dixon, C. (2021, October 7). *Why Web3 Matters. Future*. https://future.com/why-web3-matters

[51] Ibid.

[52] *What are service and creator fees?* (n.d.). OpenSea. https://support.opensea.io/hc/en-us/articles/1500011590241-What-are-Service-and-Creator-fee

[53] Citi GPS. (2022). Metaverse and Money: Decrypting the Future. In *Citi GPS: Global Perspectives & Solutions*. Citi. https://icg.citi.com/icghome/what-we-think/citigps/insights/metaverse-and-money_20220330

[54] Featherly, K. (2022, September 14). ARPANET | *Definition, Map, Cold War, First Message, & History*. Encyclopedia Britannica. https://www.britannica.com/topic/ARPANET

[55] *Standards* - W3C. (n.d.). Retrieved October 28, 2022, from https://www.w3.org/standards

[56] World Wide Web. (n.d.). In *Wikipedia*. Retrieved October 28, 2022, from https://en.wikipedia.org/wiki/World_Wide_Web

[57] Wurmser, Y. (2020, July 9). The Majority of Americans' Mobile Time Spent Takes Place in Apps. *Insider Intelligence*. https://www.insiderintelligence.com/content/the-majority-of-americans-mobile-time-spent-takes-place-in-apps

[58] Wise, J. (2022, September 24). Roblox Statistics 2022: Revenue, Growth & Market Share. *EarthWeb*. https://earthweb.com/roblox-statistics

[59] Nicas, J. (2020, August 14). How Apple's 30% App Store Cut Became a Boon and a Headache. *New York Times*. https://www.nytimes.com/2020/08/14/technology/apple-app-store-epic-games-fortnite.html

[60] Sweeney, T. [@TimSweeneyEpic]. (2020, August 6). Twitter. https://twitter.com/timsweeneyepic/status/1291509151567425536

[61] 2022 Data Breach Investigations Report. (2022). In *Verizon*. Verizon. https://www.verizon.com/business/resources/reports/dbir

[62] Kufuor, K. (2022, April 21). The State of NFT Data Storage. *The Control*. https://thecontrol.co/the-state-of-nft-data-storage-c471c1af58d5

62

63

[63] Ibid.

[64] Ibid.

[65] DeMatteo, M. (2022, September 13). What Is CC0? The Copyright Designation Buzzing in the NFT Space. *CoinDesk*. https://www.coindesk.com/learn/what-is-cc0-the-copyright-designation-buzzing-in-the-nft-space

[66] Jennings, M., & Dixon, C. (2022, August 31). The Can't Be Evil NFT Licenses. *a16z crypto*. https://a16zcrypto.com/introducing-nft-licenses/

[67] Ibid.

[68] Ibid.

[69] *GitHub - a16z/a16z-contracts: a16z Contracts is a library for solidity contracts, including licenses*. (n.d.). GitHub. Retrieved October 28, 2022, from https://github.com/a16z/a16z-contracts

[70] Tipotsch, A. K. (2022, October 4). NFT Licenses That "Can't Be Evil," Are They Any Good? *The Fashion Law*. https://www.thefashionlaw.com/nft-licenses-that-cant-be-evil-are-they-any-good

[71] Prosser, W. L. (1960). Privacy. *California Law Review*, 48(3), 383. https://lawcat.berkeley.edu/record/1109651

[72] Uglova, A. (2020, May 9). A Letter to Americans Explaining the InfoSec & PsyOps Misinformation Problem on Social Media. *I'm Probably Wrong*. https://medium.com/im-probably-wrong/towards-a-baseline-infosec-psyops-understanding-of-the-misinformation-problem-on-social-media-895784564918

[73] Krogerus, M., & Grassegger, H. (2017, January 28). The Data That Turned the World Upside Down. *VICE*. https://www.vice.com/en/article/mg9vvn/how-our-likes-helped-trump-win

[74] Preimesberger, C. J. (2022, January 31). Metaverse vs. data privacy: A clash of the titans? *VentureBeat*. https://venturebeat.com/data-infrastructure/metaverse-vs-data-privacy-a-clash-of-the-titans/

[75] Uglova, A. (2022, January 4). Cognitive Consent in Digital Privacy (Part 1 of 3). *Anastasia*. https://ana.mirror.xyz/XhSTOgQvG9gBMGsyPgnGnUqvCGysrQBf2pz-KGDev9U

[76] Thompson, N. (2019, April 23). Tristan Harris: Tech Is 'Downgrading Humans.' It's Time to Fight Back. *WIRED*. https://www.wired.com/story/tristan-harris-tech-is-downgrading-humans-time-to-fight-back

[77] Kuran, T. (1997). *Private Truths, Public Lies: The Social Consequences of Preference Falsification* (Reprint). Harvard University Press

[78] The Establishment Clause and the Chilling Effect. (2020). *Harvard Law Review*, 133(4). https://harvardlawreview.org/2020/02/the-establishment-clause-and-the-chilling-effect

[79] Srinivasan, B. [@balajis]. (2022, October 8). Twitter. https://twitter.com/balajis/status/1578646497784389633

[80] Copeland, T. (2020, February 21). We tracked 133,000 Ethereum names and exposed their secrets. *Decrypt*. https://decrypt.co/19423/we-tracked-133000-ethereum-names-and-exposed-their-secrets

[81] Fraiman, J. et al. (2022). Serious Adverse Events of Special Interest Following mRNA Vaccination in Randomized Trials. *SSRN*. https://papers.ssrn.com/sol3/papers.cfm?abstract_id=4125239

[82] *Value creation in the metaverse*. (n.d.). McKinsey & Company. Retrieved September 29, 2022, from https://www.mckinsey.com/capabilities/growth-marketing-and-sales/our-insights/value-creation-in-the-metaverse

[83] Töke, T. (2022, August 23). Ready Player Me x Andreessen Horowitz: Announcing our $56M Series B. *Blog | Ready Player Me*. https://blog.readyplayer.me/series-b-announcement-a16z

[84] Takahashi, D. (2022, October 10). Ready Player Me launches API for avatar interoperability. *VentureBeat*. https://venturebeat.com/games/ready-player-me-launches-api-for-avatar-interoperability

[85] Toonders, J. Y. (2015, August 7). Data Is the New Oil of the Digital Economy. *WIRED*. https://www.wired.com/insights/2014/07/data-new-oil-digital-economy

[86] Uglova, A. (2022b, July 8). Averting Cambridge Analytica in the Metaverse. *Ana*. https://ana.mirror.xyz/wTaL2MDgRNaTSFcnJormfNFHI3aCXB400G748y0SaBI

[87] Spruce. (2021, November 10). Spruce Raises $7.5 million to Scale Decentralized Identity and Storage. *Spruce*. https://blog.spruceid.com/spruce-raises-7-5-million-to-speed-the-development-of-user-controlled-id-and-data

[88] Trinsic Raises $8.5M for Decentralized Identity Platform. (2022, June 29). *Business Wire*. https://www.businesswire.com/news/home/20220629005152/en/Trinsic-Raises-8.5M-for-Decentralized-Identity-Platform

[89] *Verifiable Credentials Data Model v1.1*. (2022, March 3). https://www.w3.org/TR/vc-data-model

[90] *Enter the Otherside*. (n.d.). Retrieved October 28, 2022, from https://otherside.xyz/litepaper

[91] *Decentraland DAO*. (n.d.). Retrieved October 28, 2022, from https://governance.decentraland.org

[92] *What Is The Sandbox (SAND)*. (n.d.). Messari. Retrieved October 28, 2022, from https://messari.io/asset/thesandbox/profile/governance

[93] *AavegotchiDAO* (n.d.). Retrieved October 28, 2022, from https://dao.aavegotchi.com

[94] Impact Report June 2022 – Key Insights On Adoption and Business Use. (2022, July 11). *Open Banking*. https://www.openbanking.org.uk/insights/open-banking-impact-report-may-2022-key-insights-on-adoption-and-business-use

[95] Radoff, J. (2022, January 4). Web3, Interoperability and the Metaverse - Building the Metaverse. *Medium*. https://medium.com/building-the-metaverse/web3-interoperability-and-the-metaverse-5b252dc39da

[96] Kastrenakes, J. (2020, November 16). Lil Nas X's Roblox concert was attended 33 million times. *The Verge*. https://www.theverge.com/2020/11/16/21570454/lil-nas-x-roblox-concert-33-million-views

96

97

[97] Neelakantam, S. (2021, March 18). Building a realtime multiplayer browser game in less than a day-part 2/4. *Medium*. https://medium.com/swlh/building-a-realtime-multiplayer-browser-game-in-less-than-a-day-part-2-4-f1f10976fcf3

[98] Hill, K. (2022, October 7). 24 Hours in the Metaverse Version of Facebook Was Surprisingly Fun. *The New York Times*. https://www-nytimes-com.cdn.ampproject.org/c/s/www.nytimes.com/2022/10/07/technology/metaverse-facebook-horizon-worlds.amp.html

[99] Bloomberg. (2022, April 7). Improbable raises US$150m to establish M² (msquared), a metaverse network and ecosystem powered by its morpheus technology. *Bloomberg*. https://www.bloomberg.com/press-releases/2022-04-07/improbable-raises-us-150m-to-establish-m-msquared-a-metaverse-network-and-ecosystem-powered-by-its-morpheus-technology

[100] UK Startup Hadean raises a $30M Series A to power the Metaverse - Hadean. (2022, October 21). *Hadean*. https://hadean.com/news/uk-startup-hadean-raises-a-30m-series-a-to-power-the-metaverse

[101] Lipton, J. [@JuliaLipton]. (2026, October 10). Twitter. https://twitter.com/JuliaLipton/status/1579558569770643456

[102] *M3*. (n.d.). GitHub. Retrieved November 2, 2022, from https://github.com/M3-org

[103] *New Initiative to Build An Equitable, Interoperable and Safe Metaverse*. (n.d.). World Economic Forum. Retrieved November 3, 2022, from https://www.weforum.org/press/2022/05/new-initiative-to-build-an-equitable-interoperable-and-safe-metaverse

[104] Finneseth, J. (2022, July 12). Blockchain-based games see an uptick in users despite bear market conditions. *Cointelegraph*. https://cointelegraph.com/news/blockchain-based-games-see-an-uptick-in-users-despite-bear-market-conditions

[105] *The NFT market report. Chainalysis*. (n.d.). Retrieved September 30, 2022, from https://go.chainalysis.com/nft-market-report.html

[106] Soni, Sandeep. "Over $7.7B Worth of Cryptos Stolen in 2021; $2.8B Lost in Rug Pulls: Study." *The Financial Express*, 22 Dec. 2021, https://www.financialexpress.com/market/over-7-7b-worth-of-cryptos-stolen-in-2021-2-8b-lost-in-rug-pulls-study/2386724

[107] The Metaverse: New Study Reveals Surprising Gen Z Insights. (2022, April 19). *Razorfish*. https://www.razorfish.com/articles/perspectives/razorfish-vmg-metaverse-research

[108] McDowell, M. (2022, September 20). A digital Carolina Herrera gown just sold for $5,000 on Roblox. *Vogue Business*. https://www.voguebusiness.com/technology/a-digital-carolina-herrera-gown-just-sold-for-dollar2000-on-roblox

[109] Disney patents metaverse technology for theme parks that would track visitors while projecting personalized 3D images for them. (2022, January 10). *Business Insider*. https://www.businessinsider.com/disney-patents-metaverse-technology-ar-virtual-world-projector-2022-1

[110] Hasan, S. (2022, July 13). UAE will let you check in at the hospital in the metaverse soon. *WIRED* Middle East. https://wired.me/technology/uae-hospital-metaverse

[111] Tobin, A., & Reed, D. (2016). The Inevitable Rise of Self-Sovereign Identity. *Sovrin*. https://sovrin.org/wp-content/uploads/2018/03/The-Inevitable-Rise-of-Self-Sovereign-Identity.pdf

[112] Debiasi, A. [Ethereum F. (2022, October 15). *Usable Security in Web3* [Video]. YouTube. https://www.youtube.com/watch?v=YzgpX-scQ5I

[113] Ibid.

[114] XR Safety Initiative. (2022, February 16). The XRSI Privacy and Safety Framework. XRSI – *XR Safety Initiative*. https://xrsi.org/publication/the-xrsi-privacy-framework

[115] Uglova, A. (2022b, July 8). Averting Cambridge Analytica in the Metaverse. *Ana*. https://ana.mirror.xyz/wTaL2MDgRNaTSFcnJormfNFHI3aCXB400G748y0SaBI

[116] *Privacy Policy*. (n.d.). Kernel. https://www.kernel.community/en/guiding/privacy

[117] Mann, S. (2018, February 1). Peter Thiel Says, "Crypto Is Libertarian, A.I. Is Communist." What the Heck Does That Mean? Inc. https://www.inc.com/sonya-mann/thiel-ai-cryptocurrency.html

[118] Asay, M. (2022, March 25). AI investments soared in 2021, but big problems remain. *TechRepublic*. https://www.techrepublic.com/article/ai-investments-soared-2021-big-problems-remain

[119] Asay, M. (2022, March 25). AI investments soared in 2021, but big problems remain. *TechRepublic*. https://www.techrepublic.com/article/ai-investments-soared-2021-big-problems-remain

[120] Frenkel, S., & Browning, K. (2021, December 30). The Metaverse's Dark Side: Here Come Harassment and Assaults. *New York Times*. https://www.nytimes.com/2021/12/30/technology/metaverse-harassment-assaults.html

[121] Ibid.

[122] Damodaran, A. (2014, June 19). Uber Isn't Worth $17 Billion. *FiveThirtyEight*. https://fivethirtyeight.com/features/uber-isnt-worth-17-billion

[123] Taylor, C. (2019, July 19). Kids now dream of being professional YouTubers rather than astronauts, study finds. *CNBC*. https://www.cnbc.com/2019/07/19/more-children-dream-of-being-youtubers-than-astronauts-lego-says.html

[124] Ibid.

[125] Uglova, A. (2022b, July 8). Averting Cambridge Analytica in the Metaverse. *Ana*. https://ana.mirror.xyz/wTaL2MDgRNaTSFcnJormfNFHI3aCXB400G748y0SaBI

[126] Jin. (2021, July 20). The Metaverse Makers. *Webaverse*. https://webaverse.ghost.io/the-metaverse-makers

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The Road To Interoperability

An Open Metaverse State of the Union By the People Building It

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