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There's more than one metaverse

Abstract: Will there only be one Metaverse in the future? Since October 2021, many virtual worlds suddenly called themselves "Metaverse", but is that justified? What is the meaning behind the pervasive term Metaverse? How can it be approached from a pragmatic and research-oriented point of view, and maybe separated a bit from pure marketing? This paper tries to contextualise the term and thereby offer an orientation for readers from different industries. Based on a review of past and present activities, we will propose our own definition of the term Metaverse. This is applied to analyse different application scenarios before the paper continues with a general discussion. In a direct comparison, we will tabulate some worlds that already call themselves a Metaverse and check them against criteria from our own definition. In conclusion, we present relevant focal points for a potential future Metaverse resulting from this comparison.

Keywords: Blockchain; extended reality; metaverse; mixed reality.

1 Introduction

The Metaverse-topic has received a lot of attention since October 2021, when Mark Zuckerberg announced – amidst Facebook's historic crisis [1] – that he would rebrand his social media company Facebook Inc. into Meta Platforms, Inc (short: Meta), as this brand would better reflect what the company was doing today.

Moreover, he announced to invest billions of dollars over the next years to make the Metaverse a reality. But is there only one Metaverse? Microsoft also already invested into the space for years with HoloLens and now combines its collaboration-software Teams with the real environment via Windows Mixed Reality and Mesh for Teams. NVIDIA pushes Omniverse as a collaboration platform for virtual worlds and concentrates on connecting leading 3D-tools to facilitate the work for 3D-designers. It also announced to work on "Earth-2", a digital simulation of our planet that would employ AI-technologies to better predict our climate and come up with better countermeasures to tackle climate change. So, the marketing of tech companies and analysts is bristling with superlatives, again, as well as borrowing from science fiction literature. But what is behind the pervasive term "Metaverse" and how can it be approached from a pragmatic and research-oriented point of view, and maybe separated a bit from pure marketing?

2 A brief history lesson

The term "Metaverse" was coined in science-fiction literature and therefore does not have a universally accepted and scientifically grounded definition. But it was obviously inspired by technological development up to its inception in the early 1990s. In a breadth-first approach, we will therefore first present different views about features, characteristics, and definitions of the Metaverse. For this, we preferably cite researchers and practitioners who have been concerned with related work for decades. But we also cover its original author as well as one new author and experienced venture capitalist who is currently popular, not least with Facebook-founder Mark Zuckerberg. We then derive our own definition and use it to assess and discuss typical scenarios the Metaverse is frequently associated with.

The promise of the Metaverse is not entirely new. Virtual and Augmented Reality, which collectively form a big part of the technological basis of the vision "Metaverse", have been envisioned, researched and (partially) applied since at least 1968 [38]. William Gibson's ground-breaking cyberpunk-novel "Neuromancer" came out in 1984 and provided the original definition of the related word cyberspace. At the heights of the first Virtual Reality wave of the 1980s and 1990s, author Howard Rheingold published his travel-report-styled "Virtual Reality" book, aptly subtitled "The Revolutionary Technology of Computer-Generated Artificial Worlds – and How It Promises and Threatens to Transform Business and Society" in 1991 [3].

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Figure 1: Example of retail advertisement in Roblox (Walmart – Universe of Play).

Figure 2: Example of a colloborative VR-meeting with a HMD and controllers (Meta horizon workroom).

That's a year before Stephenson's novel. Stephenson himself reported on the laying of the longest communication wire on Earth in 1996 [4]. Likewise, in 2018, Charlie Fink published his Metaverse-book [5] which also resembled a travel-report through technology-land by a writer. One of his recurring themes was: "the killer-app is other people" (which resembled Nokia's "Connecting People" slogan). Since October 2021, statements [6], pre-prints (some with 700 references, which must be some kind of record) [7], guides [8], white-papers from industry representatives [9], and papers from marketing professionals started to appear [10].

Author Neal Stephenson coined the term "Metaverse" in his 1992 cyberpunk-novel "Snow Crash" [11]. He described a dystopian society with a western cultural imprint, in which the state largely withdrew and handed his functions over to big corporations. Its inhabitants have lowly jobs, such as his protagonist "Hiro Protagonist" being a 10-min pizza deliverer, and otherwise spend their time in a parallel virtual world, the Metaverse, represented through their avatars. A mysterious virus, mixed with drugs and religion, transmits from the digital, virtual world into reality and onto people. Protagonist fights as a freedom-hacker (much like the 1970s explorers whose culture once ignited the tech-boom in Silicon Valley [12]) against the menace to society looming in the Metaverse. Chronologically, Tim Berners-Lee had previously just presented the World Wide Web to newsgroup "alt.hypertext" on 06.08.1991. Stephenson's book was originally planned as a comic, which failed for unknown reasons, and did not receive much attention in Germany until the author wrote a more successful book and the Dotcom-Bubble burst in the early 2000s. It is noteworthy in the context of this paper that Stephenson is an advocate of free software, as can be taken from his 1999 essay "In the Beginning . . . was the Command Line" [13].

The substantial 2007 "Metaverse Roadmap" featured, amongst other things, the then prominent Second Life. It contained several definitions [14] and presented the following as a point of departure: *"The convergence of (1) virtually enhanced physical reality and (2) physically persistent virtual space. It is a fusion of both, while allowing users to experience it as either"* [15, p. 4]. The first part can be understood as Augmented Reality (AR), which in recent years was increasingly used synonymously with Mixed Reality (MR). The second part can also be understood as a

Figure 3: Example of Academic Conference Poster-Sessions in Gather (GI VR/AR 2021), Mozilla Hubs (PZAI PhD-Meeting), Virbela (ISMAR 2020, IEEE VR 2022) in the domain of VR/AR.
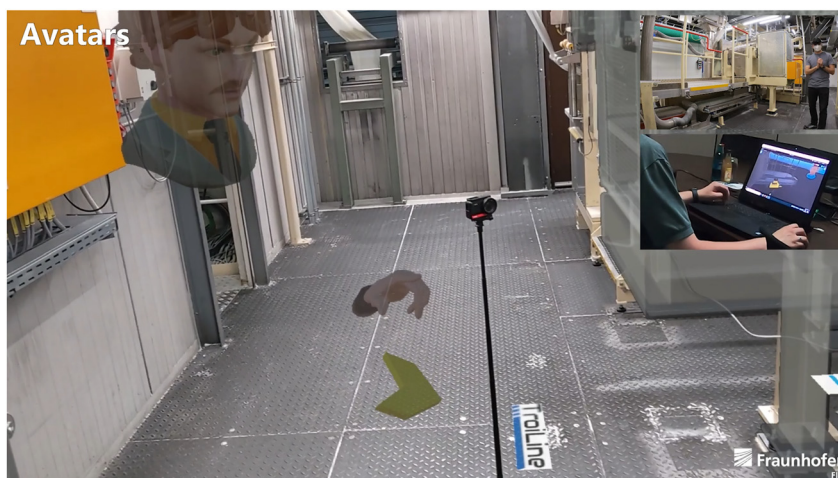

Figure 4: Example of an Industrial Metaverse application featuring Avatars and digital twins with HMD and Handtracking and AR/VR roles (5GTroisdorf IndustrieStadtpark).

virtual world, or even Virtual Reality (VR). For definitions of both, we recommend dedicated literature [16, 17]. The amount of blurring the analogue and the digital bits was once academically conceived as MR, but this meaning is now less clear, not least due to large corporate marketing budgets being poured down that alley [5, p. 25]. Further terms like Mediated Reality, eXtended Reality and cross-/x-reality (XR) might add to the confusion [18]. For the purpose of this paper it is sufficient to acknowledge that the lines between VR and AR are blurry, but that they are not the same the, and that XR can act as a placeholder for these different things [19].

Researcher Steve Benford of the Mixed Reality Lab at the University of Nottingham previously worked on the foundations of spatial interaction in large virtual environments [20] and was responsible for the concepts of early collaborative virtual worlds [21, 22]. In late 2021, he associated the term "Metaverse" with the following five properties (shortened, for full details c.f. [23]):

- **A virtual world:** *this is, in my opinion, the most important characteristic of a metaverse. You could explore it using a computer, gaming console, mobile, wearable technology or other device, experiencing 3D graphics and sound along the way. The idea is that this makes you feel more present* [24] *in the metaverse, and presumably less present in the everyday world (where your body stubbornly remains).*
- **Virtual reality**. *You need a virtual reality headset for this. [..]*
- **Other people**. *The metaverse is social. There are lots of other people there, represented as avatars. [..]*
- **Persistence**. *This means the virtual world is available whenever you want to visit it. [..]*
- **Connection to the real world**. *In some visions of the metaverse, the virtual stuff in the virtual world actually represents real stuff in the real world. For example, you might fly a virtual drone in the metaverse to steer an actual drone in the real world. People talk about the real and virtual as being „digital twins".*

In her 2021 ISMAR-Keynote (Int. Symposium on Mixed and Augmented Reality) "Metaverse from Fiction to Reality and the Research Behind it", researcher Mar Gonzales-Franco of Microsoft Research (now Google) presented the importance of **interoperability** as the most important requirement and biggest hurdle. Moreover, she highlighted **ecosystems** and **operating systems,** as well as the importance of **applied research** and presented an avatar-library [25].

Researcher Mark Billinghurst [17] from the Empathic Computing Lab at University of South Australia and the University of Auckland is one of the most influential and most cited authors in the area of Mixed and Augmented Reality. He also highlights the importance of **interoperability** and an **open platform:** *„The Metaverse will have arrived when a avatar created on an Adobe platform will be able to walk from a Facebook/Meta social space into a SteamVR game, and be viewed in AR/VR headsets from Apple, Microsoft, Vive and others. It will be a completely open platform"* [26].

Developer, author and investor Tony Parisi is co-author of the original definition of VRML, the Virtual Reality Markup Language [27], and has been deeply involved with technical requirements for 3D-graphics on the web [28]. In 2021, Parisi presented his seven rules of the Metaverse [29] and postulated that a Metaverse that deviated from his rules would not be the Metaverse, but something else. Parisi's rules are: (1) There is only one Metaverse, (2) The Metaverse is for everyone, (3) Nobody controls the Metaverse, (4) The Metaverse is open, (5) The Metaverse is hardware-independent, (6) The Metaverse is a Network, (7) The Metaverse is the Internet.

In his essays on the topic, investor and author Matthew Ball describes eight categories that can also be understood as a layer-model: hardware; network; compute; virtual platforms; interchange tools and standards; payments; Metaverse content, services, and assets; user behaviours [30]. Crypto- and blockchain-technologies are attached to different layers. Ball defined the Metaverse as follows: "The Metaverse is a **massively scaled** and **interoperable network of real-time rendered 3D virtual worlds** which can be **experienced synchronously** and **persistently** by an **effectively unlimited number of users** with an *individual sense of presence,* and with *continuity of data,* such as identity, history, entitlements, objects, communications, and payments." He also recently wrote a book on the subject [31] and is known to have an influence on Facebook/Meta-Founder Mark Zuckerberg [32].

2.1 Our definition of the term Metaverse

The notable definitions identified in the previous section span 30 years. While we cannot subscribe to everything that was mentioned in them, we see them as our foundation to propose the following definition of the term "Metaverse", which is mainly based on the considerations of Benford, Billinghurst, and the Metaverse Roadmap:

1. A Metaverse is a combination of virtual worlds and augmented real worlds. They are not closed systems but linked with each other and with reality.
2. A Metaverse is a social medium in which people can interact, communicate, collaborate, but also trade and own property.
3. A Metaverse is persistent and long-lasting but can also include temporally limited sessions.
4. A Metaverse is an integrated system that entails and utilizes XR- and other technologies. This requires utilized components to be as open and interoperable as possible, ideally using open standards.
5. In addition to getting immersed in virtual worlds (VR) and augmented real worlds (AR/MR), capturing the

state of the user and the real environment are key actions for Metaverse applications.

6. Metaverse-participation is multi-modal and can be accomplished with varying intensities and representations, such as embodiment through avatars. Participants can seamlessly change the form and intensity of their participation.

7. A Metaverse is tightly coupled with reality. Information, actions, and interactions can be exchanged between both worlds, real and digital, and can influence each other. Using digital twins allows for cooperative interactions with things in the real and virtual world.

3 Analysis of typical application scenarios

Using our definition as a lens, this main section will present various typical application scenarios that can be observed when people and corporations speak about the Metaverse.

3.1 Marketing goes metaverse(s)

For companies, the connection to a Metaverse is appealing in many regards. There are a variety of use cases in recruiting, onboarding, meetings, marketing, as well as in research and development and production. The area that has already been most engaged with XR is the marketing department. Volvo invented its own "Volvoverse" especially for the launch of the new XC40 Recharge in India and claimed to reduce CO2 consumption for such an event to negligible levels [33]. Companies are also trying to set up shops in Roblox – a gaming platform that has been very popular since 2006 as a free-to-play model, especially amongst children and young people, and has also been usable in VR since 2016 – selling digital products as well as promoting real products in their stores. Walmart opened "Walmart Land" in September 2022, a Roblox environment that is mainly used for concerts and other events, and "Universe of Play", an environment that distributes digital toys to users as rewards for tasks [34] (Figure 1). The fact that this approach by Walmart probably still misses the target group at Roblox is shown by the below-average ratings on the platform of around 50% [35].

For many companies, virtual reality seems to offer a further platform for advertising and, at the same time, to sell digital twins of real products or even entirely digitally "limited" products in a cost-saving way. Gucci, for example, offers the "Gucci Virtual 25" shoes for under €20; these can be worn in the Gucci app as a filter over one's own feet or as a digital object in Roblox (in their own world, Gucci-Town) or VRChat [36]. This makes these shoes one of the first products that can be used in both VR and AR, and across platforms at that, an example of a product of a future Metaverse.

Outside of the marketing industry, larger companies have found profitable opportunities in the use of HMDs [37, 38] and virtual worlds, particularly in the areas of recruiting and onboarding. For example, due to effects of the COVID-19 pandemic, Accenture focused on recreating digital twins of their office complexes in partnership with Microsoft and their VR platform AltspaceVR [39]. This environment, called "The Nth Floor," allows employees to virtually experience meetings, as well as normal workday activities in their digital counterparts of their offices, with a focus on social interaction between employees for the company [40]. For instance, Accenture's Christmas parties were also implemented in VR at the end of 2020. To facilitate access to the virtual world, approximately 60,000 Oculus Quest 2s were distributed to the company's employees in 2021, including new hires [41]. The approach seems to be paying off; Accenture was highly praised by employees for their inclusive approach in the age of the home office. AltspaceVR as a platform can be customized by the user as desired – own worlds can even be created via the Unity development platform – but seems to play a rather subordinate role for the future at Microsoft. Microsoft is currently focusing on "Microsoft Mesh", a cross-technology variant that also includes Teams for the desktop PC and Hololens. AltspaceVR is only mentioned under "Featured Applications" [42].

3.2 The metaverse of meta

Meta also already offers its own applications for companies for its Metaverse idea. With Horizon Workrooms [43], there is a first approach of a VR meeting room which was specifically thought up for virtual reality, in contrast to other VR meetings, in which participants usually simply stand or sit with an avatar in front of a presentation screen. In Workrooms, there are options to draw on a wall with the controller or even to use the real table at which one is sitting as a digital drawing surface (Figure 2). Direct integration of the PC and its monitors is also possible. However, this also shows what a world developed by the Big Tech looks like. There is much less customizability here, compared to programs like VRChat [44] or Neos VR [45], where worlds can be created entirely with Unity or even within the world itself and avatars are compatible with numerous character creators like ReadyPlayerMe [46] or Tafi [47].

Meta has its own avatar creator, which does try to be very inclusive (there are no gender defaults, and everything can be mixed), but avatars from other programs are not compatible, nor are accessories. When it comes to the design of the meeting room, only the variants provided by Meta are possible, and only since an update has there been the option to add images – such as your own company logo – to the walls. The freedoms of customizability that many have come to appreciate in VRChat, and other social VR apps are drastically reduced here to a few options, with no connection to open standards. A skeptic would suspect that further customizability will eventually disappear behind paywalls. The integration of classic desktop PCs in Workrooms is already very well advanced, but the PC-user likely will see himself as a spectator in VR meetings rather than a real participant in the discussion. The Horizon Worlds app [48] on the other hand, which is only available in a few countries outside of the U.S., offers more customization options and even the option to create your own 3D models within the world, but the platform is still so unpolished that even Meta employees must be forced to use it [49]. This raises the general question of the major benefit of VR-meetings versus a traditional 2D world. Most VR-presentations only include presentation slides, and the 3D space is not used for this purpose. In the last two years, several online conferences relied on VR instead of classic 2D worlds. In most cases, the added value was not apparent. For example, the Gather platform [50] may be appealing more to older users with its pixel graphics and old-school 2D-RPG design, but it is much more flexible with its effective spatial audio and the ability to quickly create and design your own rooms (Figure 3). The optional video chat can be set at will, from bilateral conversations to large meetings. So, if the graphics and physics in 3D virtual worlds aren't yet at a level that meeting or conferencing participants can really take advantage of, why would a company invest in this expensive but currently inferior technology?

3.3 Industrial metaverses

So perhaps it should be the other options that virtual worlds offer for a company's personal intranet. After all, digital twins are not only useful for pitching goods in the Metaverse, but they can also be used practically. In this regard, NVIDIA's "Omniverse" focuses on the development and use of digital twins in production and architecture [51]. By combining digital development tools and structured pipelines, the development process of the Metaverse should be significantly improved. Visualization in VR and AR is also implemented in the process. These digital twins of machines, buildings or vehicles can then be used in production as well as for maintenance and further development. In the current 5G project "5GTroisdorf IndustrieStadtpark", we at Fraunhofer FIT have already developed the possibility to collaboratively use a digital twin simultaneously in VR and AR, including Avatars for the users in both worlds, with the help of a HoloLens 2 [52] (Figure 4). A server renders the AR version of the twin remotely, which enables a higher resolution, and the twin is then projected on top of the real machine. Both users can move around the digital twin and interact with it, and can see each other, including a separate video stream. This can help perform remote maintenance that is guided from the VR side. The merging of both worlds, the virtual world and the real one, has been missing in many approaches to the Metaverse, although in 2000 with TOWER [53] a first system was presented already that mapped real and online activities into virtual world to support the awareness in a collaborative environment [54]. It is already technically possible today in the construction sector to place digital 3D models directly on the construction site using AR technologies and to match them with reality. In this context, the entire construction process could even be recorded persistently.

3.4 Metaverses in education

Another scenario where we can see what the future of the Metaverse has to offer are the approaches to use virtual worlds in education to impart knowledge. Time travel, like that of Timeride [55], allows VR to be used to experience everyday life in other centuries, for example Cologne in 1926. Furthermore, companies like ClassVR [56], NearpodVR [57] or MergeEdu [58] have already developed hundreds of individual learning scenarios for any school subject. Both ClassVr and MergeEdu also offer AR cubes that can be used to project augmented mini worlds onto a cube via a tablet or VR glasses with an integrated camera [59]. With platforms such as AvantisWorld [60], ClassVR enables its own form of Metaverse, in which topics and learning content are divided into zones and individual learning scenes. The students can experience the learning content together; in the background, it is possible for the teacher to track the learning process of the students. The possibility of a school Metaverse is thus within reach, but the companies themselves are limited by the fact that they sell their own hardware in addition to the software. Although it is possible to better adapt the software to the hardware – Apple has been doing this for years – schools are therefore tied to a specific company by the high acquisition costs. However, it would make more

sense for education to rely on open standards and create the possibility of being able to use popular mainstream VR glasses in schools as well. Should we see a similar boom in VR as in the smartphone sector in the next few years, the bring-your-own-device approach would be quite appropriate as well. By using the same device, both at school and at home, the possibility of a linked Metaverse would become more realistic.

4 Discussion

Will there be only one Metaverse in the future? The question is difficult to answer and rather depends on whether one would also define that there is only "one Internet". Because as well as the Internet is also divided into very many areas, forums and forms of interaction, with many servers and networks behind it, the Metaverse will also not always look the same with every world or follow the same rules or physical laws. So far, it is still unclear how the worlds will be connected and what role the user will play in it. The scenarios and their examples clearly show that there are many different paths to the Metaverse. Currently, very few virtual worlds are interconnected, e.g., through the exchange of the user's avatar or information, let alone built on a common standard. However, contrary to Parisi's opinion that "There is only one Metaverse", we believe that there will be different worlds with different set of rules that will be connected both digitally and through reality. It is unlikely that users will be in the same Metaverse privately, with the same avatar skin as the one they want to wear in their corporate Metaverse. Work-life balance will also be evident in future metaverses. Still, a fluid, transition-free, user-driven exchange of information is immensely important. Products acquired digitally on one platform must be able to be transferred to other platforms without difficulty.

Our comparison chart also shows that none of the self-proclaimed metaverses to date meet all our own criteria (Table 1). Companies cannot just build their own VR environment or rent from one of the popular providers and immediately call it a Metaverse with a few social interaction options for employees. In this chart we did not include Xi Rang, which is the Metaverse of Baidu, the Chinese equivalent to Alphabet. For Xi Rang, there is no data which can be verified outside of China, and you need a special invitation to join this Metaverse. We also did not include Microsoft Mesh, simply because it is still in development and most of the features aren't included in the preview version yet. On most platforms, social sharing and buying or viewing digital products are currently the only real interactions with the digital world. In most cases, the virtual worlds are almost completely isolated from the real world, and only individual objects can be exported or shown. Even the worlds that already enable a connection with AR to the real world limit this connection to pure visualization with minimal interaction in some cases.

The term Metaverse is sometimes used in conjunction with the term web3 as well as technologies such as blockchain or distributed ledger. Applying the metaverse definition introduced in this paper we can easily identify the role of the blockchain technology [61] for its realisation.

The Metaverse is considered as an open combined system that is linked with the reality. This requires digital identities for both, the objects in the reality as well as the Metaverse, as well as means for the transfer and exchange of assets between different metaverse worlds. The Self-sovereign identity concept as well as the tokenization services of a blockchain provide ideal services for this. The Metaverse as a social medium for trading and owning properties requires a notary and clearinghouse that can be easily realized by appropriate smart contract. The past interest in the NFT concept and its possible adoption by the Metaverse is an indication that both concepts could

Table 1: Table caption: status of the different metaverses (green: (partly) integrated, red: not integrated).

	Metaverse (Meta)	Omniverse (NVIDIA)	5GTroisdorf (Fraunhofer FIT)	VRChat / Neos VR	Decentraland	AltspaceVR (Microsoft)	Roblox
Linked Worlds	red	green	green	red	red	red	green
Social Medium	green	red	red	green	green	green	green
Persistent	green	red	red	green	green	green	green
Interoperable	red	green	green	green	red	green	green
State Analysis	green	red	red	red	red	red	red
Multi-modal	red	red	red	red	red	red	red
Exchange	red	red	red	red	red	red	red

benefit from each other in certain cases. The blockchain based NFT concepts provides services for the tokenization of assets and the Metaverse offers the visualization and illustration services to use the digital art associated with an NFT in an appropriate 3D environment. The capability of a blockchain to guarantee the immutability of transactions or assets supports the requirement that the Metaverse is long lasting and persistent. As such the blockchain can serve not only as a digital land registry, but also as a history keeper for the provenance of the assets in a Metaverse.

Obviously, several of these features may also be realized by other technologies such as Solid [62], but the blockchain technology appears to be very suitable to address several metaverse aspects. This explains why several metaverse systems apply the blockchain technology such as LAMINA1 [63]. In particular, the aspect that users in the Metaverse not only cooperate, but can also act and acquire ownership, as well as the fact that the Metaverse is persistent and durable, requires a technical basis that enables secure and traceable trading transactions and thus also the acquisition of ownership in the Metaverse moves the Distributed ledger technology as an important basic technology in the foreground [64].

A Metaverse of the future is in the hands of the user. They must be able to shape the world as they see it, including deciding what kind of virtual world they want to share and with whom. VR chatroom apps like VRChat or Neos VR are more successful than tech giants like Meta, despite their smaller development teams, because their users can truly participate in the building of these worlds and are not just seen as consumers. Decisions about the direction these platforms take depend heavily on the associated community. This is already evident on (non-)VR platforms like Roblox and Fortnite. Here, the people using the platforms decide which content they find interesting. Companies like Gucci or Walmart will therefore hardly be able to gain a foothold in such metaverses if their goal is merely to market their goods without considering what the target group actually holds on this platform. Ownership in a game or app has value only within a community if there are no connections to the other platforms. It is questionable how much digital products retain value if they can actually be copied at will, but companies artificially limit their number of units. The connection to the real world could create added value here. Platforms without an XR component will therefore never be able to evolve into a real Metaverse because they will always be limited to one terminal device. According to a study by McKinsey [65], although the most popular consumer interests for VR worlds are "People Connectivity (44%),"

"Exploring Worlds (26%)," and "Meet and Collaborate (10%)," these are also usually the only activities that VR platforms have to offer at all. To live out the own creative design is hardly possible, also due to the current hardware performance, or cannot be implemented without high basic knowledge in 3D design or programming. Many of the worlds are "explorable," but changes are often not saved for all users. The lack of persistence means that no further development is possible from the user's point of view. The example of the Ethereum-based virtual world Decentraland [66] shows how quickly a community collapses if it does not see a purpose for the platform. Currently, this world counts about 40–50 active users daily, with only people who buy something with MANA, the cryptocurrency in Decentraland, counted as users [67]. In comparison, VRChat has consistently had over 25,000 daily users for the past two years. This highlights one of the core problems for a future Metaverse: Without a community a platform dies and without a purpose for the users a community dies.

These community aspects also apply to industrial companies. Technologies are only accepted in the long term if they are seen by employees as making their work easier and not as an additional burden. In times of the pandemic, all collaboration tools that made it possible to interact socially with each other despite a home office went through the roof. The only thing here was that you always had to choose one of the providers. Why aren't there already open standards that allow you to have a meeting with participants from Zoom, Teams and Webex at the same time? This would also give local providers a better chance of establishing themselves in the market. The same is true here for future XR platforms: should open standards be used for both data exchange, data storage on any servers, security and ecosystem structure to ensure interoperability of the Metaverse in the future. At the developer level, approaches to this future already exist, such as OpenXR from Khronos [68], an open, royalty-free standard for AR and VR. This standard has already been publicly endorsed by over 30 of the major developer companies, including three of the Big Tech companies, Meta, Alphabet and Microsoft.

Our "5GTroisdorf" project has also shown that Europe and Germany cannot wait for the Metaverse to be handed to them ready-made at some point. In times when people want to prevent their own data from being stored all over the world, Germany itself must also try to participate in the development of the standards and structures of the Metaverse. In doing so, it is also completely legitimate that foreign technologies are used for this, but that the

platforms run on European servers. Only in this way can we escape the fact that we become only the consumer and not the contributor or, in the worst case, even the product in the Metaverse.

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