

# A Comprehensive Overview of the Fundamental and Applications of Metaverse

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**Abstract:** Nowadays, Metaverse is very popular around the world. People read a lot of news reports about the metaverse every day. In many people's minds, the metaverse may be the future of humanity. Most investors prefer to invest companies which have some relationship with Metaverse products. However, how metaverse would fully integrate into our lives is still unclear, and there are numerous proposed solutions in the market. In order to evaluate the feasibility of metaverse applications, we will focus on what Metaverse is, the existing Semi-Metaverse attempt, the existing Metaverse application and the Metaverse university that the CUHKSZ's students made in this paper. Besides, we will also talk about the potential risks that the Metaverse may bring. At the end, we illustrate what Metaverse need to prepare and improve in the future. If Metaverse can be realized in the future, it will bring infinite convenience to human life. However, it is still very difficult to fully realize Metaverse depending on today's science and technology.

## 1. Introduction

Metaverse was first mentioned in a scientific fiction novel, *Snow Crash* [1], Written by Neal Stephenson. Metaverse is a combination of “meta” and “verse” (universe). It tends to explain as a 3D world, a new kind of world that combines the physical world with the Internet. People can do whatever they want in this new world and have unlimited creativity. In this imaginary world, there is a common law, a common currency, and perfect technology to keep everyone safe. Facebook became the first tech giant to fully onboard Metaverse and promoted it heavily [2]. In order to implement Metaverse, Facebook spent a lot of money on this project every year. But even Facebook can't guarantee that this world will be fully realized. To realize this fantasy, technology needs to get better, and creativity needs to be enhanced. All the companies involved in the Metaverse should contribute as much as possible to this project. Meanwhile, concerns such as privacy, security, and money issues are uncertain whether people are in Metaverse or in the real world. People are not secure enough for everything.

## 2. Fundamental Components of Metaverse

### 2.1. Technological Integration

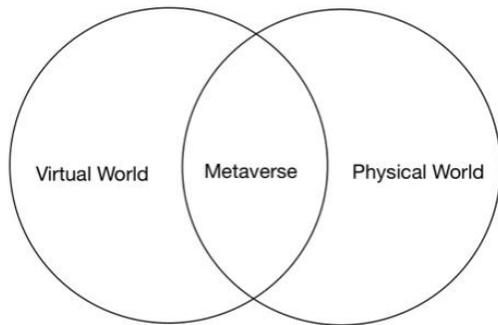
Metaverse describes a world that combine today's online social world with the physical world. It means the blending of digital and physical in a virtual environment (Figure 1). Metaverse converges internet and extended reality (XR) to achieve the goal. XR covers virtual reality (VR),

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augmented reality (AR) and mixed reality (MR) [3]. In the metaverse, it uses XR to make individual users to do everything they want in their physical world and also something that they cannot do in their real life. Meanwhile, blockchain is another trending technology that has the potential to be implemented in metaverse to serve as the currency. Metaverse is similar to real-world society which includes regulations, cash, products and so on. Users can not only accept every set but also create and contribute in this world, for example, they can create their own products or games.

### 2.2. Ecosystem

In a safe ecosystem, the identity information and property of all users need to be protected, currency circulation and perfect legal management should be realized here. In the current era of rapid development of science and technology, the emergence of 5G, artificial intelligence, XR to a certain extent to lay the foundation for the metaverse. However, it must still have a huge gap between the latest technology and the technology that the metaverse needs. In order to the achieve metaverse, people need to invest how to create this ecosystem based on existing technology.



**Figure 1** The Relationship between Virtual World, Physical World and Metaverse

### 3. Existing Semi-Metaverse Attempts

In this section, we will review existing semi-metaverse applications in different sectors of the market.

#### 3.1. Gaming

Minecraft is a game that comes closest to the idea of the Metaverse in the current world. This is a game that the user can play on multiple platforms, including PC, smartphone, console, etc. and other devices such as VR headset is not required. Players can create any architectures by their own efforts from the first point of view in any scenes of this game. However, this game has no relationship with our real world, and players cannot really do any deals that involves goods that have impact in real-life with other people. Therefore, this is only the Semi-Metaverse game. In Minecraft, player can experience the creativity that the Metaverse wants to give but it's still just a game, and people can't spend all their time creating their own world in this game world. If the Metaverse wants people to actually live and create in this ecosystem, it's a very difficult thing to do. People in real world need to work, to meet their friends and to accompany their family, and not all of them have the energy to create another world in the Metaverse.

#### 3.2. Social Network

There are several applications that can make people meet, communicate or have fun in the virtual world by using VR equipment. People can find their own community in order to chat with each other, and also, they can travel to any places that they want. Besides, people can create their own avatars for this virtual world. For example, VR chat is a game that people use Quest to play and chat with their friends in the virtual world [4]. They can use their own avatars to live in this world. Although Quest can make people more immersive, people still cannot really meet with their friends and feel their friends' real emotion. Maybe, VR chat can shorten the distance between people but it can not replace in-person interaction completely. People's social network needs are not only talking to each other but also face to face contact.

#### 3.3. Healthcare

At present, the application of AR technology in medical area is more and more accepted, especially in surgery. By wearing AR equipment, doctors can understand various indicators of the human body during surgery and view 2D or 3D perspective images based on image technology, thus improving the accuracy [5]. The superposition of the real world and the generated virtual images and data further enables doctors to better judge the effectiveness and safety of surgical plans. However, wearing AR devices for a long period of time does not provide a good enough experience for the doctor, especially in voice commands and gestures. In the future, the technology still needs continuous development in order to give surgeons a better experience in the operations.

#### 3.4. Real Estate

In the real estate field, XR is particularly prominent and can give people a good enough sense of experience. In Matterport, when people look at a building or house through a phone or computer, they can completely immerse themselves in the space of the building or house and reach any place they want to go in this building through technology [6]. In addition, the technology allows people to view a stereoscopic image of the house to get a fuller picture. This technology is now widely used in the real world. When people want to buy a house or rent a house, they can use this technology on the housing website instead of just looking at a few photos.

#### 3.5. Education

Nowadays, virtual technology also has certain development in education. The technology allows students to take a virtual tour of the school. Students only need to click the icon to visit and understand the campus and can walk to any classroom in the campus through the virtual tour to check the teaching equipment and use. Besides, this technology can also help students to better understand cultural heritage buildings by explaining details [7]. Also, because any icon can be clicked on the pictures of these historic buildings, students can learn these background stories.

### 4. Roblox – A Deep-dive into a Popular Metaverse Application

Roblox (Figure 2) is an exiting Metaverse application. Players can interact with their friends, create their societies and economical transactions.

#### 4.1. Business Model

In Roblox, it has a mature economy system built on a currency called Robux [8]. Users can use fiat money such as U.S. Dollar to purchase Robux through the Roblox Client and Roblox website. They can spend Robux to buy decorations for their characters in the game. At the same

time, developers, creators, and other users can earn Robux from the application by creating engaging experiences and compelling items that users prefer to buy. Apparently, creators can only make enough money if they create environments and Settings that appeal to players. When there is a certain amount of Robux in the account, either the developer or the creator can convert the Robux into real-world currency according to the official conversion standard. Thus, both players, developers and creators are in this cycle. Creators and developers create scenes and items for players to spend Robux on, and the Roblox platform gives Robux to creators and developers in order for them to make money and continue to develop better products. During this process, the platform will cut a portion of the proceeds, which is essentially the same as charging tax in real life.

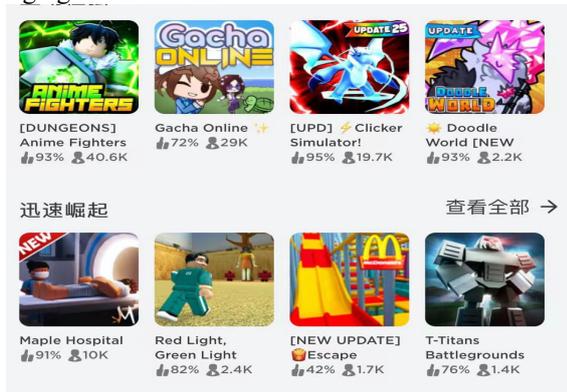


Figure 2 Roblox Homepage

#### 4.2. User demographics and trends

As of December 31, 2021, Roblox had 45.5 million daily active users worldwide. Through the statistics, about 67% of Roblox users are under 16 and 32% of users in the United States and Canada. Roblox’s number of daily active users is growing rapidly and stabilizing. In Figure 3, number from 19.1 million at the end of 2019 to 45.5 million at the end of 2021. In particular, the number of daily active users increased by almost 10 million in Q2 2020 compared to Q1 2020 [9]. These users created over 1 million hours of engagement in over 1,900 experiences in Roblox in 2021. Each daily active users spent an average of 2.5 hours each day [8].

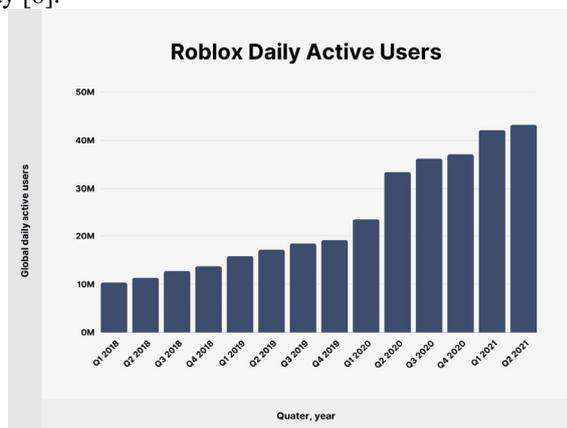


Figure 3 Roblox’s Number of Daily Active Users

#### 4.3. Profitability

Roblox’s revenue grew from \$508.4 million in 2019 to \$1919.2 million in 2021. Free cash flow also increased from \$14.5 million to \$558 million [8]. However, if the growth in daily active users is not enough to cover Roblox’s operating costs, there will be a crisis in profitability. As creators and developers create more compelling experiences for players, players will spend more Robux supporting on the platform and attract more new users to Roblox. That’s how Roblox continues to make money to keep the platform going and develop more.

#### 4.4. Risk Factors

There are also many risk factors associated with Roblox. Roblox relies on the constant innovation of creators and developers to attract users. If creators and developers continue to churn out, that could be detrimental to Roblox. Moreover, the platform and hardware on which Roblox is run are out of control, and problems in these areas can affect Roblox usage and user comfort. Roblox’s main users are teenagers and children, so if Roblox cannot protect their private information and provide a healthy and safe online gaming environment, it may bring dangerous to children which can also cause dramatic loss to Roblox. In the current environment, there are many uncertain factors. Roblox needs to take a lot more effort to address these risk factors.

### 5. Case Study - A University Campus Prototype

Students at the Chinese University of Hong Kong Shenzhen have created a virtual university-themed Metaverse in Unity which shown in Figure 4. In this CUHKSZ Metaverse, students have unified tokens that can be traded in official stores or with other players [10]. In the same way, students have plenty of room to create whatever they want in this CUHKSZ Metaverse. The GPS location of electronic devices in the physical world can be synchronized to the CUHKSZ Metaverse in real time so that students can find someone who are similar to them in real life and make more friends. By connecting the virtual world to the physical world, students can accomplish goals more quickly and efficiently and create more objects, but the CUHKSZ Metaverse still needs to be improved. There is no guarantee that people will want to use all of the functions in the virtual world that are synchronized with the real world. In addition, a better CUHKSZ Metaverse needs to be built on a platform comparable to the real world, and the current technology does not fully realize the ideal CUHKSZ Metaverse.

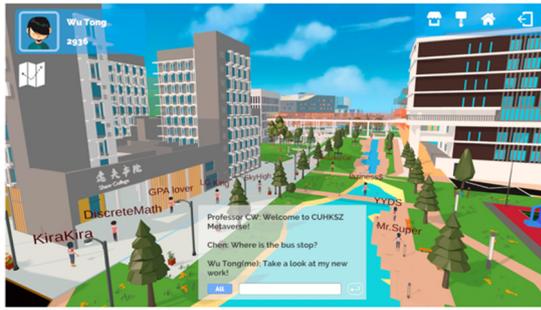


Figure 4 CUHKSZ Metaverse developed in Unity

## 6. Potential Concern

Even though most people are optimistic about the Metaverse and many companies spend a lot of money building it every year, there are still many potential problems.

### 6.1. Privacy

The idea behind the Metaverse is that people can make friends in this virtual world and connect with the real world. People can set up their avatars but the personal information each user provides in the Metaverse needs to be authentic if it is connected to the real world. The limits of personal information disclosure are very difficult to grasp. In front of strangers, people are reluctant to disclose most of their personal privacy, and people show different states and want to tell different information in front of different people. For example, the current WeChat moments can set up friend groups. People will post different updates in moments to inform different groups. People tend to be more reserved and private with colleagues and friends they don't know well than with close friends and family. In Metaverse, it's hard to define all of this because everyone's acceptance is equally different.

### 6.2. Security Concern

As with privacy, security is important. As users' location, information and relationship are updated in real time in the Metaverse, their safety is also controlled by the provider of Metaverse. No company can guarantee that all users' information will not be stolen by hackers, so people need to worry about their safety when the vast amount of information reaches the Metaverse. In the physical world, everyone's information is managed by state departments, which is quite secure. However, the Metaverse was created out of a private enterprise. Once any important information about people is leaked out, this can lead to very serious consequences.

### 6.3. Fraud/Financial Crimes

In the current situation, it is very difficult to achieve a standard financial solution in the Metaverse. First of all, if the ultimate goal of Metaverse is to achieve an international community that connects people from different sovereign states, it is impossible to reach a

consensus of currencies from country to country. The only tokens that are likely to appear in the Metaverse might be cryptocurrencies. The topic of the Metaverse has reached the level of fervor it is currently being discussed, thanks in part to the advent of cryptocurrencies. Cryptocurrencies are circulating currencies under certain conditions and have a uniform conversion standard, but in many regions, they are still not legal tender. Cryptocurrencies are as unstable as a roller coaster in terms of conversion, which brings constant panic and more and more fraudulent tokens appearing to make more buyers' money fraudulent. Issuers continue to make money by overpricing tokens, but purchasers can't resell the cryptocurrency they bought.

## 7. Conclusion

With the existing technology, it is still a very difficult thing to fully integrate the virtual world with the physical world. What the Metaverse has to achieve is not just a complete combination but also the need for people to adapt to living in this virtual world, which is therefore even more difficult. Today's applications and inventions related to the concept of Metaverse bring more possibilities and creativity to a certain extent, but there are also many problems. The current meta-universe products do not yet provide a sufficient level of comfort and convenience. People have become accustomed to the current application of electronic devices and getting along in the physical world. Living in the Metaverse, a virtual world, still requires constant adaptation. In addition to that, the privacy, security, and property of users are also not guaranteed. The future of the Metaverse still requires a lot of human, financial and intellectual resources to develop and realize it.

## REFERENCES

1. Neal Stephenson. 2014. Snow crash. Bragelonne.
2. The Facebook Company is now Meta. (2021, November 23). Retrieved June 21, 2022, from <https://about.fb.com/news/2021/10/facebook-company-is-now-meta/>
3. Gerencer, T. (2021, April 20). *What is extended reality (XR) and how is it changing the future?: HP® Tech takes*. What Is Extended Reality (XR) and How Is it Changing the Future? | HP® Tech Takes. Retrieved June 21, 2022, from <https://www.hp.com/us-en/shop/tech-takes/what-is-xr-changing-world>
4. VRChat on Oculus quest. (n.d.). Retrieved June 22, 2022, from <https://www.oculus.com/experiences/quest/1856672347794301/>
5. Dennler, C., Bauer, D.E., Scheibler, AG. et al. Augmented reality in the operating room: a clinical feasibility study. *BMC Musculoskelet Disord* **22**, 451 (2021). <https://doi.org/10.1186/s12891-021-04339-w>
6. Why Matterport. Matterport. (n.d.). Retrieved June 22, 2022, from <https://matterport.com/why-matterport>
7. Thinglink. (n.d.). *Create unique experiences with interactive images, Videos & 360° media*. ThingLink.

- Retrieved June 21, 2022, from <https://www.thinglink.com/en-us/>
8. United States Securities and Exchange commission. 2021. Roblox Corporation Form 10-K, 6-68 pages.
  9. *Roblox User and growth stats 2022*. Backlinko. (2022, January 5). Retrieved June 21, 2022, from <https://backlinko.com/roblox-users#roblox-monthly-active-users>
  10. Haihan Duan, Jiaye Li, Sizheng Fan, Zhonghao Lin, Xiao Wu, and Wei Cai. 2021. *Metaverse for Social Good: A University Campus Prototype*. *Proceedings of the 29th ACM International Conference on Multimedia*. Association for Computing Machinery, New York, NY, USA, 153–161. <https://doi.org/10.1145/3474085.3479238>