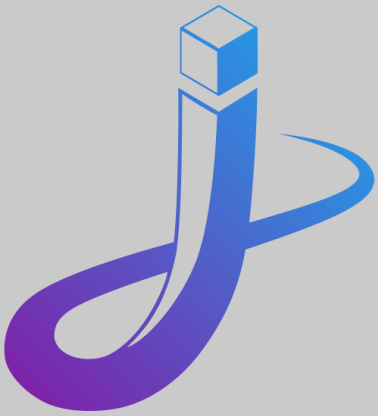


WHITEPAPER

INFINIVERSE | The World's Digital Layer

Abstract

Infiniverse is a decentralized augmented reality (AR) platform and metaverse on top of the real world, powered by the Solana[1] blockchain and Arweave[2]. Users can bring digital content into the real world, allowing it to be seen and interacted with by any other nearby users. The platform also allows users to place persistent content in the world, which remains in the same physical location even after the user has left the area or quit the application. However, due to the scarcity of real world space, users must purchase or rent land NFTs, which represent the digital layer of real world locations, in order to place persistent content.

Infiniverse has its own economy and marketplace which gives users the opportunity to earn cryptocurrency. The marketplace allows users to sell their creations, trade unique items, and buy and rent land NFTs, without a middleman taking a large cut. The blockchain gives users full control and security over their virtual currency, land ownership and assets, while content is duplicated and distributed across the Arweave network.

Initially, the platform runs on iOS and Android devices that support AR frameworks with positional tracking, such as ARKit[3] and ARCore.[4] In the future, support will be extended to smart glasses when these devices are more mature and widespread, appropriate for outdoor use, and include GNSS chips for geographic location tracking.

The goal is to create a rich parallel universe that users can seamlessly switch into, allowing them to experience diverse AR content and applications, all co-existing and interacting, and a thriving virtual economy that allows content creators to create real economic value, while keeping the proceeds.

1. https://solana.com/
2. https://www.arweave.org/
3. https://developer.apple.com/arkit/
4. https://developers.google.com/ar/discover/

Contents

Introduction

Infiniverse is an augmented reality land registry, content distribution platform and marketplace. It allows us to combine the entire world's digital space into a single, persistent, interactive, metaverse. Unlike in metaverses based on virtual reality (VR), digital content is overlaid on top of the real world in AR, using a smartphone or smart glasses. This allows users to remain connected to the real world and other people around them, while simultaneously experiencing virtual content.

Motivation

At Infiniverse, we believe that augmented reality represents a fundamental paradigm shift, and in particular, that AR smart glasses will be the next major form factor in computing, which will be as significant as the smartphone. These thoughts are echoed by industry leaders, including Apple CEO, Tim Cook[5]. Market research company Digi-Capital predicts that AR will reach a market revenue of over $90 billion by 2022[6], with exponential growth. While VR has recently been more in focus due to the popularity of metaverse, we believe that AR, not VR, will be the heart of the metaverse[7]. Back in 2017, AR technology became widely available, with the release of Apple's ARKit, compatible with all iPhones since 6S, and Google's ARCore. As a result, almost a billion smart phones were already compatible with AR technology by the end of 2018[6].

These frameworks allow a smartphone to use its cameras to scan and recognize features in the user's environment, in order to track the position and orientation of the smartphone, and find surfaces within the environment. As a result, virtual objects can be placed in fixed positions in the environment, rather than moving with the phone. This allows us to create applications with a new dimension of interaction—interaction with the physical environment.

However, while the technology and hardware to build AR applications is now available, accessible and high-quality content is needed to drive user adoption. We recognize a number of problems for users seeking AR content.

While some undoubtedly great AR apps have been released, as shown by their popularity, why should we be limited by a single theme when the app spans the entire world? But how can we experience multiple AR

5. https://www.independent.co.uk/life-style/gadgets-and-tech/features/apple-tim-cook-boss-brexit-uk-theresa-may-number-10-interview-ustwo-a7574086.html
6. https://www.digi-capital.com/news/2018/01/ubiquitous-90-billion-ar-to-dominate-focused-15-billion-vr-by-2022/
7. https://venturebeat.com/2021/12/28/future-augmented-reality-will-inherit-the-earth/

apps simultaneously, without it becoming a mess of overlapping virtual content? AR content will be all around us—but how do users know which content they wish to view? Without any system, popular locations will become overrun. We need to assign rights to users and app creators to place digital content in real world locations in a secure and provable way that we can all agree on. In addition, once we have diverse AR apps and content co-existing all over the world, how do we give them the ability to interact with each other, instead of each application being completely sandboxed?

We aim to solve these problems with the distribution of AR content. However, Infiniverse is greater than the sum of its parts. It is more than just a platform for AR content distribution and monetization: it is a persistent metaverse that extends the real world.

Benefits of Decentralization

Using decentralized technologies such as the Solana blockchain and Arweave has several significant benefits. With the blockchain, users have full control, ownership and security over their assets. A server crash, or a rogue employee, cannot erase your cryptocurrency, or your in-world asset and land NFTs. Indeed, even if the company shut down, another group could fork the project and the world would live on, with the same users, ownership records and content.

In addition, using a cryptocurrency for the in-world payments allows trade to take place immediately between users around the world, who may use different local currencies. Users do not need to rely on an intermediary to hold their currency for them; they always maintain control.

Using decentralized content distribution such as Arweave also provides a number of benefits. Most importantly, there is no central point of failure, as content is duplicated and made available around the world, forever. In addition, it results in potentially quicker speeds for users in remote locations, far away from any central servers.

Thanks to decentralization, Infiniverse cannot be destroyed and does not depend on any single person or organization. Unlike several online games and virtual worlds that have shut down in the past, despite still having a significant userbase[8], Infiniverse will live on for as long as its users want it to exist. This gives them a sense of security that all the time and effort they invest into the world will not be in vain.

8. https://www.gamesradar.com/7-games-shut-down-while-people-were-still-playing/

Use Cases

We next present some use cases that we believe will be particularly compelling. However, please bear in mind that Infiniverse is not limited to any specific themes and intends to give content creators as much freedom as possible to follow their imaginations.

Games & Entertainment

Pokemon Go[9] showed the potential of AR gaming in the real world, and continues to have 8 million daily active users[10]. However, unlike most games, Infiniverse is a sandbox. Users have the freedom to create many different kinds of games, with completely different themes, all co-existing, and even interacting with each other.

Digital Collectibles

A popular use case of many virtual worlds and massively multiplayer online games is digital collectibles. In Infiniverse, users have the freedom to create and trade any type of digital item that they can imagine. However, unlike collectibles in other virtual worlds, users are able to bring their items into the real world wherever they go, making these items feel much more compelling and potentially valuable.

Advertising

As the platform gains popularity, advertising will become a more and more effective use case. In particular, virtual ads displayed in real world locations with high foot traffic, such as Times Square, can potentially reach wide audiences more cost effectively than real ads.

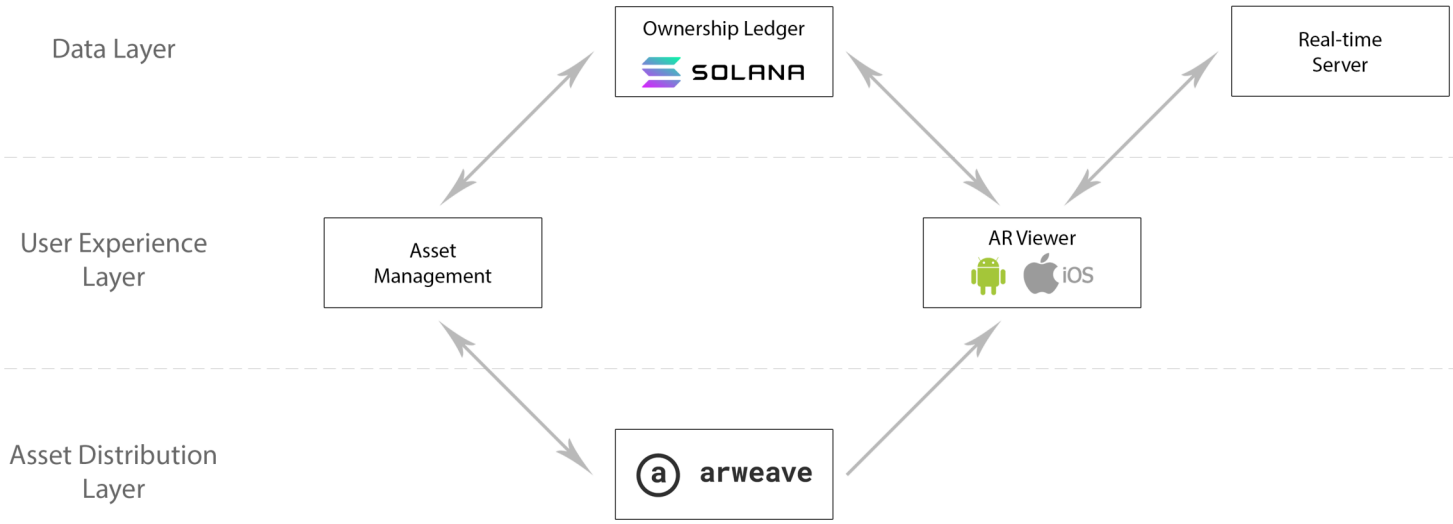
Education

Combining the real world with digital content is an effective way to create immersive educational experiences. Some of these educational experiences could be particularly relevant to specific real world locations, such as historical education. Virtual museums could transform the tourism industry. For example, they could show virtual gladiators fighting in the Colosseum or ancient Egyptians building the pyramids.

9. https://www.pokemongo.com/
10. https://activeplayer.io/pokemon-go/

Technological Architecture

The Infiniverse technology stack is made up of several components in three main layers: Data, User Experience and Asset Distribution.



Ownership Ledger

The ownership ledger is made up of smart contracts running on the Solana blockchain. It keeps track of ownership of NFTs, namely, land and assets.

Land represents the digital space of a real world location, with ownership giving a user the right to place persistent content in that location, as well as to vote on decisions affecting the local virtual community. Land assets are rectangular in shape, with each piece of land having the same orientation: its sides face north, east, south and west. This ensures that we are not left with irregular shapes between two plots, utilizing space as efficiently as possible, and allows us to store land positions more efficiently.

In order to simplify things further, users cannot arbitrarily pick any land size and position. Instead, the world is split into pre-defined plots, where each land is one second of latitude and one second of longitude, and the corners are placed at whole seconds of latitude and longitude. This gives each land a latitude length of 30.72m throughout the world, while a land's longitude length is 30.92m at the equator, reducing in length as it gets closer to the poles. This seems to be a reasonable size which gives a user plenty of space to place content on their land. Therefore, with predefined plots of one second in latitude and longitude, each land is simply defined by the degrees, minutes and seconds of the latitude and longitude of just one of its corners.

When a user purchases a piece of land, another user may not place digital content in that location. However, users are free to trade their land with other users, or alternatively, rent out their land for a fixed duration. Users that own really popular spots, could potentially split up their plot into smaller pieces, and rent each piece separately. Land may be purchased by going to its real-world location with the AR viewer, or with the land registration tool in the asset management interface.

The blockchain also keeps track of asset ownership. The asset creator can mark them as unique or non-unique. Unique assets can only have one owner, and can be traded between users. Non-unique assets can have several owners, but only one intellectual property owner, allowing only that owner to create new copies to distribute to other users. Assets can also be marked as non-tradeable. For example, some kind of achievement badges could be created that can only be collected at certain real world locations, as proof that the user visited that location. Such assets are a good candidate for being non-tradeable.

AR Viewer

The AR viewer consists of smartphone (and in the future, smart glasses) apps which allow the user to enter and view the virtual layer on top of the real world. Using their smart devices, users walk around the real world, buy land, bring their content into the world, and experience and interact with the metaverse.

Virtual content is divided into two categories:

- Attached content
- Persistent content

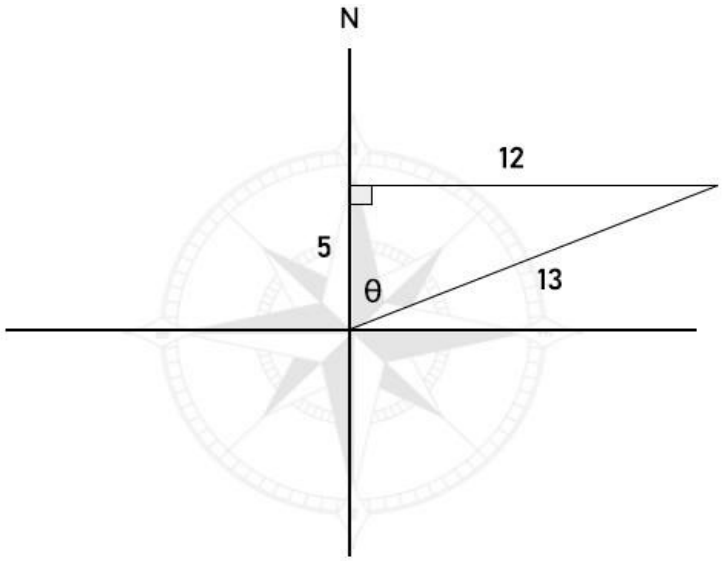
Attached content is any content that a user carries around with them in the world. A simple example is a virtual pet. For as long as the user is in Infiniverse, their attached content exists in the world and follows them around. Any other users that come to the same geographic location will also be able to see and interact with that attached content, unless it is set to private. However, as soon as a user quits the application, all of their attached content leaves the world along with them. Users entering an area with many other users and a large volume of attached content may need to pay a small fee to bring their attached content into that area, or alternatively, temporarily scale down the size of their attached content. This ensures that popular locations do not turn into a big mess of overlapping virtual content.

Persistent content must be placed on land owned or rented by the user. It stays in the same location, no matter where the owner is, or whether they are currently running the application. Persistent content may

be free for other users to interact with, or it may be premium content which needs to be unlocked with a micropayment.

When the user first starts the application, they can see only their attached content. They need to wait for their sensors to initialize and get a lock of their real world position and orientation before they can see persistent content or other users' attached content. Their geographic location is found using the GNSS sensor on the device, which uses GPS and other satellite systems.

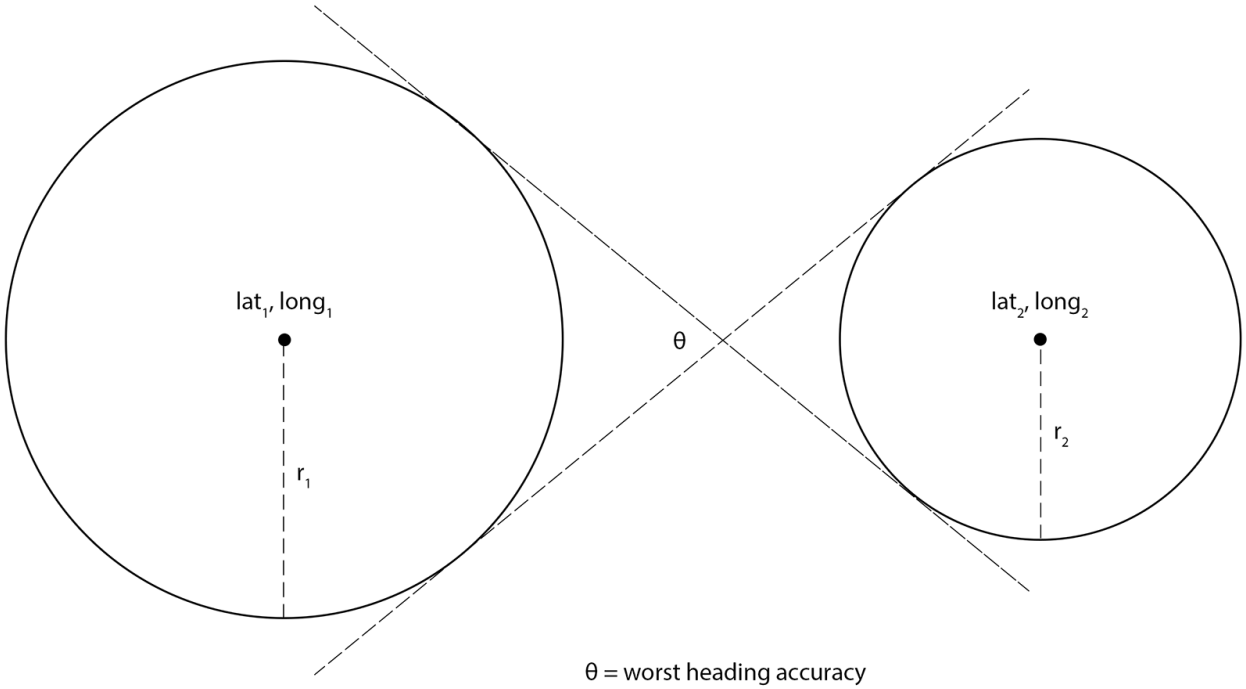
However, finding their orientation relative to north, or heading, is more challenging. The magnetometer sensor on smartphones is often very inaccurate, and needs to be calibrated frequently. Instead, we can find the user's heading by having them start walking in one direction after their position is found. By comparing successive GNSS readings, the user's heading can be calculated, with accuracy depending on the accuracy of the GNSS data. For example, if the user walks for 13 meters in a straight line, and the GNSS data shows that they have moved 5 meters north and 12 meters east, using trigonometry we can calculate the user's current course as 67 degrees from North. With the positional tracking, we also know where the user is facing—hence their heading.



$$\theta = arcsin(\frac{12}{13}) \approx 67°$$

However, GNSS samples come with an accuracy parameter, representing the radius in meters which makes a circle in which the user's actual position should be. Therefore, calculating the heading based on samples that are close together would be inaccurate, because if the two position circles of the samples overlap, the heading could be in the entire 360 degree range. Hence, we wait until we have two position circles that do not overlap before we are confident in our heading calculation. However, as errors in successive GNSS readings are usually correlated, a good heading estimate is often available before this model would suggest.

Henceforth we continue to update our heading calculation based on newer samples, as the greater the distance between two points through which the user has passed, the smaller the heading error. With a radius of 5m, which is typical for GPS, a user would need to walk an average of 10 meters in one direction before they have two GNSS readings without overlap in their position circles. While this is not ideal from a user experience perspective, in the future accurate position and orientation will be able to be calculated almost instantly in many locations, using technology such as Google's Visual Positioning System[11], which recognizes the user's position and heading by matching the smartphone's camera data with their extensive mapping database.



Once the user's real world position and orientation is calculated, we continue to track their movements using the positional tracking provided by ARKit and ARCore. We continuously adjust this position with new GNSS readings, to correct for any drift in the positional tracking, or inaccuracies in the original heading calculation (which would cause further movement to be in the wrong direction).

11. https://www.androidauthority.com/google-maps-visual-positioning-system-navigation-863139/

However, given the user's latitude and longitude, and the latitude and longitude of some content nearby, we need to calculate the distance between them in meters, in order to accurately place content in the world relative to the user. In addition, using the user's last known latitude and longitude, and the distance in meters they have moved since then, we need to calculate the user's current latitude and longitude, in order to continuously report the user's position to nearby users.

We can do this using a planar approximation. While this would be inaccurate over large distances, it is only being used for calculating the distance between a user and content in their vicinity, for which its accuracy is completely sufficient. Each degree of latitude is approximately 111 km apart, while each degree of longitude depends on the current latitude. It is calculated by multiplying the cosine of the latitude by the length of one degree of longitude at the equator, also approximately 111 km. Therefore, the length of one degree of longitude ranges from approximately 111 km at the equator, to 0 at the poles.

Given two sets of latitudes and longitudes, we use the following equations to calculate the north and east distances between them:

$$North\ Distance\ (Lat_1,\ Lat_2) \approx 111000 \times (Lat_2\ -\ Lat_1)\ meters$$
$$East\ Distance\ (Long_1,\ Long_2) \approx 111000 \times (Long_2\ -\ Long_1) \times cos(\frac{Lat_1+Lat_2}{2})\ meters$$

Conversely, given one set of latitude and longitude, and the north and east movements in meters from that point, we use the following equations to calculate the second set of latitude and longitude:

$$Lat_2 \approx \frac{North\ Distance\ (Lat_1, Lat_2)}{111000} + Lat_1\ °$$
$$Long_2 \approx \frac{East\ Distance\ (Long_1, Long_2)}{111000 \times cos(\frac{Lat_1+Lat_2}{2})} + Long_1\ °$$

However, this does not take into account the user's altitude, which is needed in order to vertically place content that is nearby, but not close enough for the user to have scanned the ground surface under the object. Ideally, we need a vertical accuracy of a few decimeters, otherwise these objects will appear to be floating in the air, or under the ground. Unfortunately, the altitude data calculated by GNSS sensors is very inaccurate. Other options for getting altitude include the barometric sensor, available on most modern smartphones and data from a digital elevation model (DEM). Top of the line barometric sensors claim an absolute accuracy of about four meters in altitude[12], while Digital Globe provides DEMs with satellite images taken every two meters[13]. However, making use of this data can be difficult with bridges and rooftops, or other situations in which a user may be standing higher than the terrain elevation.

12. https://www.bosch-sensortec.com/bst/products/all_products/bmp380
13. https://www.digitalglobe.com/products/advanced-elevation-series

While the AR viewer is mostly an outdoor experience, there are also ways to locate a user in indoor locations. Google's Visual Positioning System is mapping certain indoor locations, for example shopping malls, and providing the technology for applications to locate themselves within those locations[14], by comparing the camera data against Google's visual maps. In addition, persistent AR anchors would allow a user to leave virtual objects in certain locations in their homes. Furthermore, a user is always able to interact with their attached content, regardless of whether their geographic position is locatable.

Real-time Server

The real-time server is required by the AR viewer in order keep track of the positions of all users in real-time. This allows users to know the location of all nearby users and hence display their attached content accurately. As real-time user positions are not persistent, they do not need to be stored on the blockchain and are more efficiently managed with a real-time server. In addition, this server is used to send real-time events, such as when land is purchased nearby or land content is updated, lowering latency and reducing bandwidth requirements of the smart contracts.

Asset Management

The asset management interface can be accessed both via the mobile app as well as on the web. It allows users to import content into the world, buy land NFTs, manage their land, and buy and sell assets on the marketplace. When a user creates some content, or sources it somewhere outside Infiniverse, they must first import it into the world. After importing, they can ensure that the content looks as they expect, set its default size and orientation, and do one or more of the following:

- Attach the content to follow them around the world in the AR viewer.
- Persistently place the content on land they own or rent
- List it on the Infiniverse marketplace

However, if they mark an object as unique and sell it on the marketplace, it is removed from their assets and they are no longer able to place it on their land or attach it to themselves. Listing assets on the marketplace may require a small fee, in order to reduce spam.

14. https://techcrunch.com/2017/05/17/google-has-an-indoor-positioning-tech-in-the-works-called-vps/

Purchased land NFTs can be traded or leased between users in the asset management interface. Here, users can also place and rearrange content on their land. They can also create premium content, by setting a fee to unlock the content on their land. Owning or leasing land also gives users voting rights. Users can make suggestions about the laws of their local community, and vote on these suggestions in a referendum. For example, virtual residents in Amsterdam may vote on whether adult content should be restricted to the areas of the real world Amsterdam red light district.

Furthermore, tools will be provided to allow the user to easily create content within Infiniverse, instead of having to import it from an external application. For example, integrating with existing free model libraries, or creating a mechanism to virtually paint or combine 3D blocks. In addition, an SDK will be released, initially supporting Unity[15], to allow developers to create more interactive experiences.

Asset Distribution

The asset distribution layer consists of an Arweave network that hosts all of the content in Infiniverse. Using a decentralized storage network improves availability and bandwidth and removes a central point of failure. The asset distribution layer is also able to host different versions of the same content, for example for different platforms or high/low quality versions. The AR Viewer chooses the appropriate content to download for the specific user.

Arweave even goes a step further than most decentralized storage networks: it stores content forever. For anything that is uploaded to Arweave, the cost covers storing the data in perpetuity, making this technology a perfect partner to blockchain. Therefore, users have no worry that their asset content will be lost: once it's uploaded, it's online for good.

Furthermore, full decentralization requires a consensus mechanism to allow for the removal of illegal content. Users are able to report illegal content, which must be confirmed and removed by moderators. Users can elect moderators, who make the final call on which content is illegal. Moderators that make bad decisions can be removed by the community adjusting their voting preferences.

15. https://unity3d.com/

Why Solana?

There are several blockchain platforms for creating general-purpose smart contracts and tokens, including Ethereum[16], the first major player in the space and still the most widely used. However, Ethereum suffers from a number of problems common to Proof of Work (PoW) blockchains: slow transaction times and large fees during periods of high load. Indeed, Ethereum's limit is currently approximately 15 transactions per second[17]. During periods of average use, transactions take a few minutes to be confirmed. During high load, such as upon the release of a highly popular Ethereum application, the network slows to a crawl[18], with transactions taking several hours to complete and fees skyrocketing.

For Infiniverse to be successful, transactions must be both cheap and instant. Imagine a user stumbling upon some interesting content in a particular location that they need to purchase to unlock. They would need to wait a few minutes in the best case, or even hours in the worst case. In addition, many of these purchases would be microtransactions, in which the fee would likely be higher than the actual price. This would be very inefficient and highly discouraging to potential users.

The Solana mainnet launched in February 2020. It uses a Proof of Stake (PoS) consensus algorithm, instead of PoW, along with several other innovations unique to Solana, such as Proof of History[19]. Solana's consensus technology is significantly more efficient than Ethereum's PoW, with Solana capable of processing more than 50,000 transactions per second[20].

While Ethereum has its own plans for scaling in the future, at this point they've been talking about it for years, with little to show thus far. There are also other alternative blockchains, which also offer more efficient transactions and significantly lower fees than Ethereum. However, we find the Solana roadmap, scalability, fees and user-friendly focus more promising. Indeed, Bank of America predicts that Solana could even become the Visa of the digital asset world[21].

Nonetheless, Infiniverse is not necessarily tied to a specific blockchain: should a superior blockchain be released in the future, we can always switch platforms without major issues, or even implement multi-chain solutions and token bridges such as Wormhole[22], if such a solution makes sense for Infiniverse.

16. https://www.ethereum.org/
17. https://bravenewcoin.com/news/vitalik-ethereum-en-route-to-a-million-transactions-per-second/
18. https://www.bbc.com/news/technology-42237162
19. https://www.gemini.com/cryptopedia/solana-blockchain
20. https://break.solana.com/
21. https://www.coindesk.com/business/2022/01/12/solana-could-become-the-visa-of-digital-asset-world-bank-of-america/
22. https://wormholebridge.com/

Economy

With the advances in decentralized finance (DeFi), users will be able to purchase land NFTs and trade on the marketplace using Solana or any token on Solana. The goal is to allow users to create real economic value in the metaverse, and move that value between Infiniverse and the real world, as they please.

Sources of Income

There are a number of avenues users can take to start a business and earn crypto:

- Selling content on the marketplace
- Renting and selling land
- Placing premium content on land
- Doing jobs for other users

Marketplace Sales

Artists, developers and other content creators can sell their creations on the Infiniverse marketplace, in exchange for crypto, with low commissions. Assets sold on the marketplace can also be marked as unique, allowing users to trade digital collectibles.

Renting and Selling Land

Early adopters have the opportunity to buy land throughout the world before other users. As the Infiniverse user base grows, newer users may demand land in high-traffic areas, such as central locations in big cities, in order to increase exposure to their content. Users that purchase these land plots will be able to earn crypto by selling or renting out their land.

Premium Content

While persistent content found on land can and often will be free to see and experience, users also have the ability to place premium content—that is, content that must be unlocked with a microtransaction.

Doing Jobs

Users can post jobs on a board, for other users to complete in the world, in exchange for payment. For example, users could be paid to attach ads to themselves and walk around in high-traffic areas, as an alternative to placing persistent ads on land.

Challenges

While we believe that we are building something truly groundbreaking, we recognize that there are a number of challenges that must be overcome in order for Infiniverse to reach mass adoption. The following presents some of the most significant issues.

GNSS Inaccuracy

One of the main challenges in creating a great user experience is GNSS inaccuracy. Mobile GNSS receivers provide data accurate to within approximately five meters. As a result, a user may see persistent content drift between sessions, or two users may not see some content in the same location. Furthermore, as the GNSS data is also used to calculate the user's heading from north, a user's view of content in their vicinity may be somewhat rotated. This further amplifies the distance some content may be from its correct location, making it more difficult for multiple users to have a compelling experience together.

However, GNSS systems are becoming more accurate. In particular, the Galileo satellite navigation system, as well as the newer GPS satellites, use dual frequency signals for highly accurate positioning. Broadcom released the first dual frequency mobile receiver, which will be used by smartphones from 2018, and makes GNSS data accurate up to 30cm[23], when enough of the newer satellites are visible. With decimeter accuracy, Infiniverse will become a significantly better experience for its users. Furthermore, in the future we may be able to get accurate positioning without GNSS, instead using mapping technology such as Google's Visual Positioning System.

Battery Life

While augmented reality and GNSS both use significant battery life on smartphones by themselves, combining the two can cause the battery to drain and the device to get quite hot. However, battery technology is constantly improving, and smartphone components are getting more efficient. Indeed, the new Broadcom chip uses half the power of its predecessor, despite the improved accuracy[23]. In addition, in the future we may not need to rely on GNSS as much, when we can get accurate positioning using mapping data such as Google's Visual Positioning System.

23. https://www.broadcom.com/blog/word-on-the-street-media-roundup-for-broadcoms-bcm47755-dual-frequency-gnss-receiver

Limited Mobile Bandwidths

Walking around the world and experiencing beautifully detailed content can be a very immersive experience, however downloading all of the 3D content can use up a large amount of bandwidth. While this is not a problem for most home internet connections, mobile connections are often limited to a few gigabytes per month, with the user being throttled, or paying extra usage charges when they go over the limit.

To assist users in keeping within their limits, content on Infiniverse will be available in a high and low quality version. Users will be able to set which level of detail they prefer, depending on their bandwidth. The application will also report how much data has been used in the current month, to allow users to carefully manage their usage. However, with mobile bandwidths constantly increasing worldwide, we foresee this issue becoming less relevant in the future. In particular, the upcoming 5G network may prove to be crucial for mass adoption of content-rich mobile AR applications[24].

GNSS Spoofing

The danger of relying on location data from smartphones is that it can easily be spoofed. Indeed, there are many applications available on the app stores that allow a user to do that. Pokemon Go is known to suspend users that are caught using one[25]. Using a spoofing application in Infiniverse would allow a user to place their attached content anywhere in the world, instead of where they actually are, potentially devaluing the value of land. In addition, it would allow them to collect digital assets that can only be acquired by going to a specific real-world location.

However, there are a number of strategies available to detect GNSS spoofing. iOS and Android provide libraries to get the user's approximate location based on their wifi and cellular data. This location can then be compared to the data reported from the GNSS to check if they match. While GNSS is easy to spoof, spoofing the wifi and cellular signals would require the user to know the expected values, which is very difficult unless they've already been to that location. Other strategies include looking at the pattern from successive GNSS readings, as it may be difficult for a spoof to follow the same pattern that a normal user would have, even if they are moving around in the same general area. It is also possible to detect the presence of many commonly used spoofing applications.

24. https://www.verizon.com/about/news/how-5g-will-improve-augmented-and-virtual-reality
25. https://support.pokemongo.nianticlabs.com/hc/en-us/articles/360001743487-Three-Strike-Discipline-Policy

Unfortunately, enforcing anti-spoofing would require restricting some of the smart contract to applications that have been digitally signed by us, thus impacting decentralization. However, there are a number of projects that are working on a decentralized proof of location, including FOAM[26] and XYO[27]. Therefore, in the future we may be able to prevent spoofing without sacrificing full decentralization.

Lack of Nearby Users

A major challenge of building a user generated virtual world on top of the real world is a lack of nearby users in the early stages. While most virtual worlds that can be accessed from a home computer would already have some people to interact with, once they reach over 1000 users, in Infiniverse the first 1000 users would likely be spread throughout different countries. Therefore, early users may find the experience less enticing, with a lack of other users to interact and share the experience with.

However, users will be able to use the application even without other users nearby. For example, they may have persistent content to explore in their area. In addition, they can trade digital collectibles on the marketplace, and place them around their home, as if they own them in real life. They will also have incentive to buy land in locations that may have significant users in the future. Despite this, we recognize that user activity will be concentrated around specific hubs, mostly in metropolitan areas. On the other hand, concentration of activity in large cities may lead to meetup groups forming, allowing enthusiasts to easily meet other players.

Furthermore, in the future we plan to allow real world locations plus their digital content to be visited remotely in VR. For example, Google Earth VR[28] already allows you to fly around the real world in VR, using a mixture of their data gathered from satellites, street view, and imagery from airplanes. All it would take is Google, or a similar service provider, opening up their service to developers via an API, which allow us to embed their VR world view, and augment it with digital objects. As a result, Infinverse could become a mixed AR/VR experience, with AR users being able to see the VR avatars of users visiting real world locations remotely. However, a remote mode would need some restrictions on attached content, to avoid devaluing land, and the problems described under GNSS spoofing above.

26. https://foam.space/
27. https://xyo.network/
28. https://arvr.google.com/earth/

Conclusion

In this paper, we presented Infiniverse, a decentralized, persistent metaverse that augments the real world. The platform allows users to experience, interact with and trade user-generated AR content. Users earn cryptocurrencies, by selling assets on the marketplace, renting and selling land NFTs, placing premium content on their land and doing jobs for other users. Content creators keep the majority of the economic proceeds of their creations, with low commissions on the marketplace. Asset ownership is secured using the blockchain, and the virtual world cannot be destroyed as it has no central point of failure. In the future, when AR smart glasses are widespread, Infiniverse will feel like a parallel universe that users can seamlessly switch into, while remaining connected to the real world. We cannot wait to see what kind of world our users will create.