WorldCloud

WHITEPAPER

A distributed data infrastructure for Augmented Reality

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1. WorldCloud Project Overview

1.1 Project Introduction

WorldCloud is the decentralized infrastructure for the AR industry. Its aim is to use the power of crowdsourcing to collect data for a worldwide AR Cloud, and to comprehensively construct the ecosystem of the global AR industry.

1.2 The AR Market

In 2018, there will be 1.83 billion AR-enabled smartphone devices worldwide [(1)]. Apple's AR headset will also be available in 2020 [(2)]. Market research institutions predict that the global AR market will reach US $133.78 billion in 2021 and grow at an annual rate of 85.2% [(3)]. We can see that people are very optimistic about AR's potential, with some experts even believing that AR will replace smartphones and become the next universal computing platform.[(4)]

We expect that the number of users in the AR industry will exceed that of smartphones, and that the frequency of AR data invocation will exceed the frequency of web searches.

1.3 The Necessity of WorldCloud

With the official launch of ARKit and ARCore at the end of 2017 and early 2018, the media and global consumers are quite excited, but users have discovered that these technologies can do little more than local-area device localization and render virtual objects in the nearby environment. Even with the newest ARKit 2 or ARCore 1.2, AR apps are limited to a handful of toy-like experiences, such as simple tabletop games, using facial expressions to control cartoon characters, or placing virtual furniture in a room to preview a purchase. However, these are far from making AR the next universal computing platform.

One of the issues that must be addressed is allowing virtual objects in AR to be permanently stored in a fixed location in the real world across space, time, and devices, while allowing real-time interaction between users. This can't be done without WorldCloud.

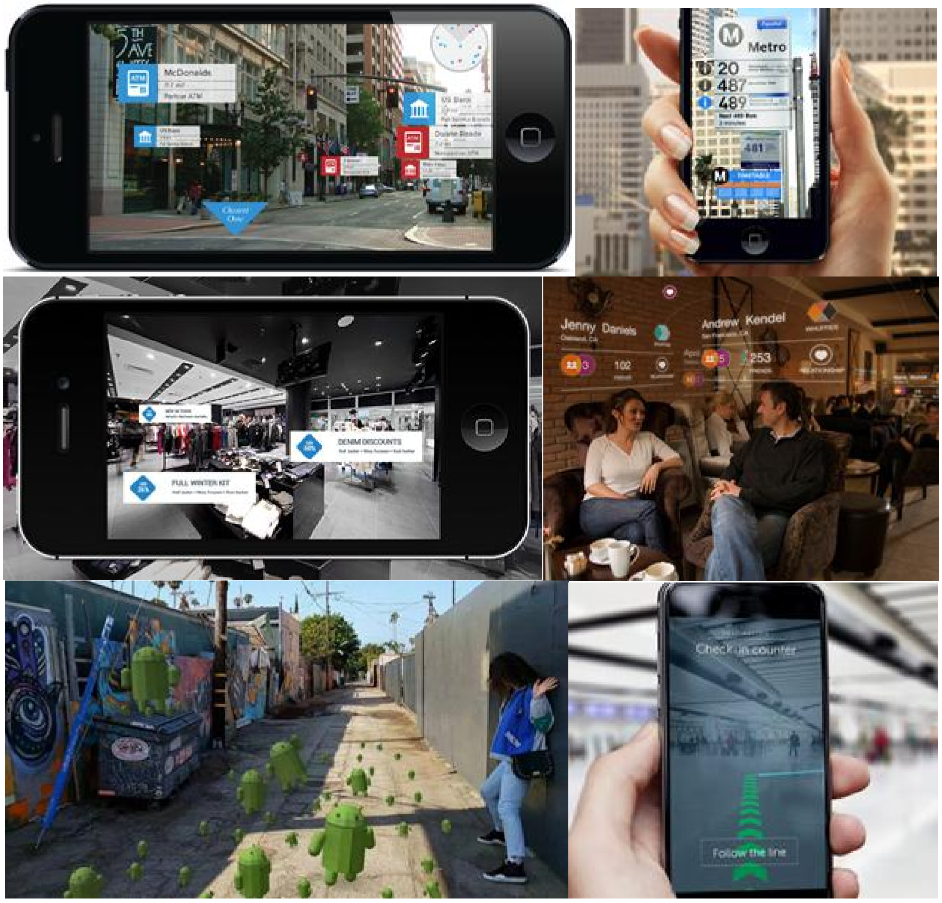
Google is a database that allows people to retrieve information about anything on the Internet, whereas WorldCloud is a database of the real world that allows people to retrieve data about any physical object.

We can think of WorldCloud as a digital copy of the real world, having the same size, shape and structure of the entire world. With WorldCloud, the true potential of AR can be realized: storing all human knowledge, where retrieval from this store requires no more than a glance.

Without a global AR cloud such as WorldCloud, AR has no future. WorldCloud is a hard requirement for the development of the global AR industry.

1.4 WorldCloud Applications

- A search engine of the real world. Look at any building, landmark, lake, mountain range, shop, item, etc., and instantly get information about this object.
- Ubiquitous smart shopping, where you can instantly get detailed information about what you see, such as product descriptions, prices, user reviews, etc.
- The most complete three-dimensional map, much more useful and accurate than two-dimensional maps provided by Google and other providers. It will allow for accurate navigation to any physical location, including indoor locations; this is a necessary prerequisite for perfected self-driving vehicles, letting vehicles understand the shape of the world, and will also allow automated drone navigation to become a reality.
- Massively-multi-user real-time AR social networking. When you see a person, you can instantly get public information that he/she willingly shares, such as their socialization preferences and contact information.
- Multi-user AR games that understand the real world; for example, virtual personalities who can understand the structure of any physical location and can properly sit on furniture or interact with physical objects.
- . . . And many, many uses that we haven't thought of yet.



1.5 The purpose of this white paper

This white paper introduces a brand new Decentralized AR Data Network (DARDN) and WorldCloud, a blockchain-based ecosystem using WRLD tokens for value circulation, which serves as the basis for the operation of the DARDN.

The purpose of WRLD tokens is to provide incentives for global users to collect AR data for WorldCloud. At the same time, WRLD tokens also motivate users to share their unused storage, computation and bandwidth resources as buffer nodes to provide real-time data and device localization computation for nearby AR users. This will provide an immediate and reliable supply of AR data, and enable great user experience in AR applications.

Furthermore, WRLD tokens are used as a store of value and driver of the global AR ecosystem, and can be used to purchase ad space, in-app purchases, physical goods and many other items in AR-enabled applications (soon to be all applications) that ecosystem participants desire.

2 Current Roadblocks in the AR Industry

Though the future of the AR industry is bright, there is a major challenge that must be overcome: collecting the vast amount of data based on the real world to construct a global AR cloud.

2.1 Immensity of the Real World

Collecting all the data needed for good AR user experience takes an incredible amount of work. There is a vast amount of physical objects of interest in the world, ranging from a mountain range to a tiny wall socket. We can roughly estimate the amount of data that the WorldCloud needs to store: there are 800,000 buildings in New York City alone [5], and each building contains multiple valuable data points (such as shops, shelves, bathrooms, entrances, power sockets, etc). Examples of useful AR data include descriptions and ratings of retails stores, categories of products sold on store shelves, and markers for objects of interest such as toilets, power sockets and vending machines.

It would be impossible to build a complete database containing all the AR data in the world in one fell swoop; instead, this must be done one step at a time, beginning with generalized data (such as buildings) and moving towards more specific data (such as power sockets). It would be best to begin with the most valuable data and gradually move to cover all the more detailed data that people are likely to be interested in.

We estimate that when there needs to be 100,000 data points per square kilometer (one data point per 10 square metres) at the very minimum in any urban setting for visual search, one of the most important AR applications, to be actually useful. Short of this, data will be too sparse to sustain an acceptable user experience and desired information will be insufficient in general.

For example, New York City has an area of 784 square kilometres which means that there needs to be at least 78.4 million data points in NYC alone. Because of the complexity of modern cities, and since Artificial Intelligence technology cannot understand what the objects it sees actually are, this work can only be done manually. Although AI technology has come a long way in the past decade, and specifically machine learning can be applied to carry out the work of automatically creating data points, machine learning requires the availability of vast amounts of data for training, which can only be obtained through manual labeling, which brings us back to manual data collection.

Were a company to build a team to collect this data, assuming that each person, working quickly, can collect 240 data points per day (resulting in 62,880 data points per year), collecting the minimum amount of data for New York City alone would take 1,247 people an entire year to complete. The cost of collecting data on a global scale is unaffordable for any company, regardless of its size or financial prowess.

2.2 The Power of Crowdsourced Data Collection

Google's Local Guides Program claims that 50 million people have provided crowdsourced data for Google Maps (primarily the names of brick and mortar stores, reviews, photos, etc). However, due to the lack of economic incentive, only 700,000 new data points are added globally each month through the Local Guides program [(6)]. At this rate, even if all of the newly generated data points are in New York City, it would take Google close to 10 years to collect enough data in the city to make WorldCloud useful.

Yelp users provide data for the platform at a much faster rate, but since user generated content on the platform are mostly reviews for businesses, and writing reviews is a creative and enjoyable process for many people, it is very different from the process of collecting AR data, which can be repetitive and monotonous.

We believe that harnessing the power of people worldwide is the right way to solve the problem of collecting data for WorldCloud, but traditional crowdsourcing based on sense of achievement alone, with no economic reward, is not feasible. We believe that an incentive system enabled by blockchain technology is the best solution for building WorldCloud.

Blockchain technology solves this problem perfectly and encourages society to contribute its immeasurable power. By utilizing the prospect of economic income as a motivator (similar to Bitcoin mining), people are incentivized to do something that on the surface seems to have little real value to themselves.

We expect WorldCloud to deliver very significant economic benefits to data collectors worldwide. The monetary incentive will be the driving force in getting the world's users fully involved in the development of the WorldCloud, allowing the WorldCloud ecosystem to grow quickly and become an irreplaceable cornerstone of the global AR industry.

3 AR technical details

3.1 Functions Required by the AR Cloud

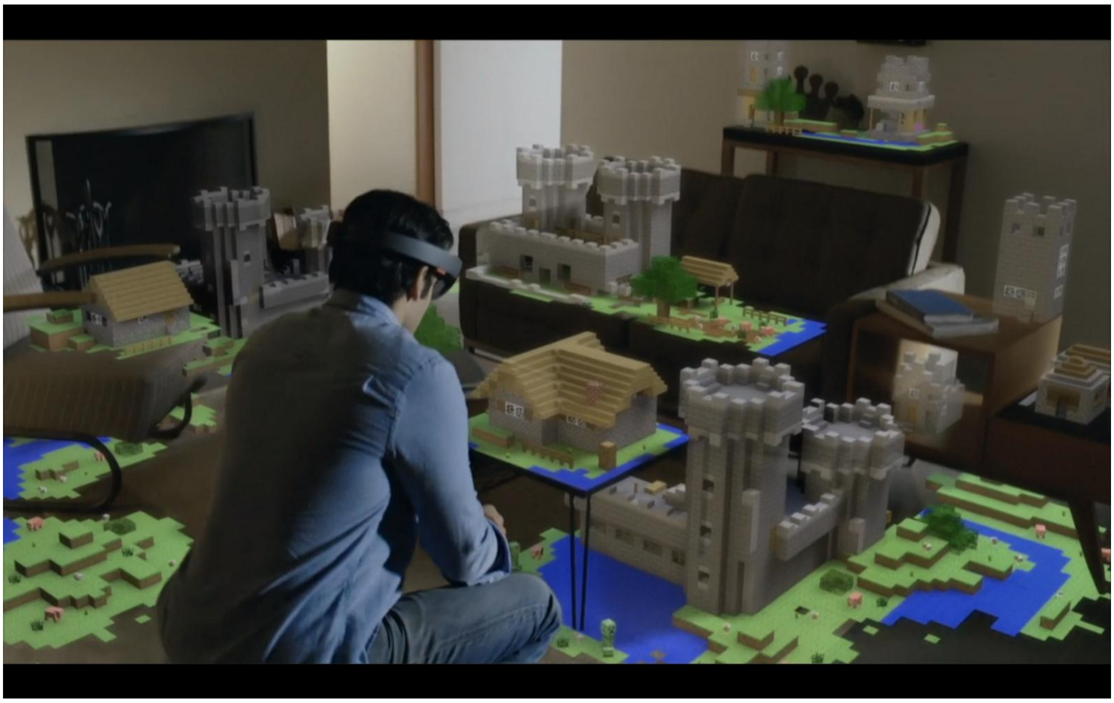
A commercial AR cloud needs to be able to do two things:

1) Create a permanently, updateable point cloud that represents the 3D shape of the real world - a digital recreation of reality.

Point clouds are data points within a set of three-dimensional spaces (based on x, y, z coordinates) and are widely used in multiple industries. Collecting point cloud data based on the real world is a solved problem. There are a variety of hardware and software solutions that enable the collection of point clouds, and this technology will soon become widely available (The next generation iPhone may have a built-in lidar; Qualcomm's newest Snapdragon 845 processor will have a powerful point cloud processing chip in preparation for the availability of on-device lidar).

A point cloud is a set of data points within a three-dimensional space (based on x, y, z coordinates) that are frequently used in multiple industries. Collecting point cloud data based on the real world is a problem that has been solved, with a variety of hardware and software technologies that can be used to collect point clouds. This technology will soon become a commonplace (e.g. the next generation of iPhones may have lidars, and Qualcomm's next generation Snapdragon 845 processor will have powerful point cloud processing capabilities).

Using the point cloud data of the environment, an AR application can understand the shape and structure of the environment and thus interact with those elements properly.



The virtual objects in the game can be placed correctly on the furniture in the room, because Hololens scanned the room's point cloud data in advance.

WorldCloud has special requirements for its point clouds, where they can be neither too dense nor too sparse. If the point cloud density is too high, processing will be too slow to satisfy the user experience necessary for real-time use, and too much storage space will be required. If the point cloud is too sparse or incomplete, device localization accuracy cannot be achieved, resulting in the virtual content not being displayed properly. In other words, the AR cloud is a special kind of point cloud with its own format and parameters.

The most important issue that WorldCloud must solve is device localization.

2) Perfect device localization

Device localization refers to a user's device (such as a smartphone, AR headset, etc.) being able to identify its exact position and orientation (its rotation) in the real world. With this, virtual objects can be accurately displayed and superimposed in the correct positions in the real world.

Current sensors in smart phones can achieve very rough device localization, but because of poor accuracy (a GPS has a +-5 meter error; compasses have a +-90 degree error; and gyroscopes will drift slowly), the actual display position of virtual objects may often end up far from where they ought to appear. ARKit relies on the detection of large planes (such as floors and walls) to achieve device localization within a local area so that virtual items can be placed on the floor and walls, but the localization is limited to a local area, and the device still doesn’t know its position and orientation in the real world. This prevents virtual items from being placed at fixed real-world locations, such as on the top of the Eiffel Tower.

With the global AR cloud, it is possible to perfectly achieve the localization of devices everywhere, allowing virtual objects to be displayed at physical locations. This solution uses feature points (such as the edges and vertices of buildings and furniture) to compare the local point cloud captured by the user's device in real time with the global point cloud within WorldCloud to find the specific position and orientation of the device. The premise is to have pre-collected global point cloud data.

3.2 AR data required by WorldCloud

There exists a wide variety of AR hardware devices from smartphones, to head-mounted displays. Because the sensors and camera components used in the hardware differ, WorldCloud needs to be flexible enough to support all current and future AR hardware and devices.

As mentioned above, WorldCloud needs to provide a reasonably dense global point cloud. This point cloud needs to have the following properties:

- The density and format must allow the hardware and equipment provided by the user to calculate, in real-time, the feature points required for device localization, and the amount of data must account for bandwidth limitations;
- The point cloud data collected by different devices must be able to be spliced together so that a large number of users can build a global point cloud together
- The cost of collecting point cloud data must be relatively low, and can ideally be completed with ordinary mobile phones

Future AR devices will be able to support WorldCloud regardless of the imaging technology used as long as they can scan the surrounding environment to generate a local point cloud, as future smartphones and AR headsets are sure to have the relevant components.

3.3 WorldCloud's data format

WorldCloud's point cloud data uses a modified PCD file format:
The entire WorldCloud point cloud consists of a collection of cubic units measuring 1 meter x 1 meter x 1 meter (so that each unit's volume is 1 cubic meter).
The header data for each cubic unit is:
LONG LAT RESOLUTION
LONG: longitude
LAT: latitude
RESOLUTION: Number of points per 1-meter dimension

The data in each cubic unit consists of multiple points that contain normal data:
x y z normal_x normal_y normal_z
x y z indicates the position of a point in three-dimensional space
Normal_x Normal_y Normal_z expresses the normal direction of the surface at this point
Each data type is float, stored in binary format to reduce storage space and optimize computation speed.

This point cloud is a regular point cloud, which means that data consists of rows and columns, similar to pixels in a bitmap. The advantage of regular point clouds is that because the relationship between adjacent points is known, the computation speed of nearest neighbor (NN) algorithms, which are used in point cloud feature matching, is greatly improved.

4 WorldCloud's Design and Solutions

4.1 WorldCloud's design

The WorldCloud uses blockchain technology and a data verification council for providing incentives for data collection, while using a location-based distributed storage network (DARDN) for data invocation, storage and device localization computation.

Smart contracts based on the ERC20 token standard will be deployed on the Ethereum network. There are several reasons for this. First, Ethereum provides the best support for smart contracts at the moment. Second, WorldCloud will use a DAICO as its fundraising mechanism.

4.1.1 A Decentralized Storage Network

After researching previous distributed storage systems, such as Git, BitTorrent, IPFS, etc., we designed a distributed AR cloud storage system specifically optimized for location and point cloud data. The main differences between WorldCloud and previous distributed storage systems are:

(1) each node stores only the data of the nearby area
(2) fast retrieval of data near the user's location from the closest nodes
(3) in addition to data storage, nearby nodes also help carry out localization computation to offset the work that needs to be performed on the user's (often low-performance) device
(4) newly collected data can be automatically compared with stored data to ensure the new data's authenticity
(5) redundant storage of data ensures the reliability of data storage

Based on the characteristics of AR data, and in the interest of efficiency and good user experience, WorldCloud places an emphasis on the geolocation information in data. When placing data into distributed storage, it will preferentially search for nearby nodes according to location information and store the data in the nearest nodes. When a user's device invokes data, it will also make calls to nodes that are closest in distance.

The user's device is often a low-performance mobile phone or AR headset, which might not be able to run the device localization computation in real-time, or consume too much battery power doing so. With the DARDN, the local point cloud data captured by the user's device is sent to the nearest node to carry out localization calculation, and the user's device position and orientation data is continuously sent back to the device from the node, making high quality real-time device localization available on all user devices.

WorldCloud's DARDN is based on a permanent, decentralized, and commercially sustainable architect of storing and sharing data. It is a distributed protocol that utilizes location-based retrieval, versioning, and point-to-point hypermedia:

Location-based retrieval: the data is identified by the actual physical location of the overlaid data, rather than by file hash value or file save location;
Versioning: traceable data revision history;

Point-to-Point Hypermedia: In addition to point cloud data, the network can also store various types of associated data, such as text, pictures, videos, hyperlinks, etc. to describe a building, for example.

The DARDN can store global AR cloud data and provide convenient, instant, secure calls and device localization service for users who need this data.

4.1.2 Incentives for collecting data based on geographic locations

We've designed a new, incentive system for real-world data collection based on geographic location. The incentive system uses smart contracts to provide an appropriate motivational structure for building WorldCloud with the goal of accelerating the development of the AR industry.

We divide the real world into blocks according to longitude and latitude, and determine whether or not there is land (or islands) present in a particular block. These will be called valid blocks, of which there are 1000 in total.

A total of 500 million WRLD tokens will be equally distributed among the valid blocks, each block having 500,000 WRLD tokens.

Every time a new piece of data is created and written to a particular block, there is a reward of one millionth of the WRLD tokens remaining in this block.

Of this reward, the data collector receives 50%, and the data collection tool provider and Verification Council participants each receive 25%.

The advantage of this incentivized approach is that for locations with large amounts of data, such as Hong Kong, Tokyo, New York, Paris, and London, there will be large numbers of data collectors, but the number of WRLD tokens available is determined by the number of valid blocks, which is a fixed number. To be able to attain more WRLD tokens, the data in these areas will be collected quickly.

For places with smaller amounts of data, such as the Gobi Desert or Siberia, the smaller number of people means that the cost of data collection is higher. But collecting a piece of data in these areas rewards a larger amount of WRLD tokens, motivating the data collection effort in these remote areas.

Regarding issues of different data having different values: the more important the data, the easier it is for this data to pass council verification, meaning that it will be collected earlier.

4.2 Data Collection

4.2.1 Reasons for Using Manual Collection

AR app development and data invocation demand a high standard for AR data, and as a result the collection of AR data is quite different from that for other types of data. At present, many location-based data collection methods are semi-automatic, like Google's Street View cars, which collect map and geographic data based on the real world through AI-assisted image capture.

Unfortunately, in using artificial intelligence-based robots to collect data automatically, the following problems are encountered:

- AI cannot judge what data is valuable and worth collecting;
- Neither cars, drones nor mobile robots can move freely in the real world;
- Even if the 3D modeling of an object can be done automatically, today's AI technology cannot collect the object's associated information, such as determining whether a building is a restaurant, which shelves are filled with beverages, and so on;

This is why Google's Street View cars are limited to capturing data along streets and the environment surrounding them, taking only simple panoramic photographs, and are not yet capable of identifying and labelling objects along these streets.

4.2.2 The WorldCloud Data Collection Solution

Different types of data have different input methods and different values. The WorldCloud provides data standards for different AR data, and provides the API interface for community-developed data collection tools.

There are two data collection schemes for the WorldCloud.

4.2.2.1 3D Mesh Drawing

The first is a 3D mesh authoring tool as a mobile app. The advantage of such a data collection scheme is that it can complete data collection quickly, there is essentially no learning curve, and the results can be viewed immediately following authoring, allowing the mesh to be tweaked to increase accuracy. In the early days of WorldCloud's construction, because global point cloud data is incomplete, data collectors cannot carry out data collection with the aid of device localization (which requires the global point cloud).

Although while collecting data for WorldCloud, device localization can be carried out simultaneously (using SLAM), it is not possible to automatically determine the location of new data within the global point cloud, so it is best to use this extremely simple method to complete large chunks of data first. The 3D mesh created with this method can then be used for reference and is very helpful for collecting accurate point cloud data later.

The process for 3D mesh data entry involves touching a smartphone screen with your finger to draw a 3D model to as closely resemble the shape of a real-world object as possible (easily achievable with simple geometric shapes, like rectangular cuboids, etc). Many aids exist to facilitate this process, including topographic and building foundation position and shape data provided by map data service providers, which greatly simplifies the mesh drawing process.

For example, let's assume that map data has provided the location and shape of the foundations of a large commercial building. To enter data from a coffee shop on the ground floor of the building, the data collector simply drags out a rectangular shape similar to the coffee shop, using the shape of the building's foundation as an aid.

After inputting the data of the 3D model, the data collector also needs to enter associated information about this data point according to the WorldCloud data standard. Continuing with the example above, the data collector can enter information such as the name of the cafe, its website, and public reviews (e.g. its Yelp links).

4.2.2.2 Point Cloud Scanning

The second data acquisition scheme is using equipment that will automatically generate point clouds.

Devices that would be suitable for this role include the Asus ZenFone AR smartphone, depth cameras such as the Intel RealSense, Microsoft Kinect and Occipital Structure Sensor, or handheld lidar devices such as the Paracosm PX-80. In the next 1 to 2 years, most smartphones on the market will also have the ability to capture point cloud data. The advantage of this method is that it can collect accurate 3D data and also has a low learning curve.

Early on when the global point cloud is still incomplete, after collecting new point cloud data, the collector needs to put the newly captured point cloud in the correct position using the reference data created using the first data collection scheme.

As WorldCloud become more complete, this approach should become the main method for collecting AR data, and encourage the development of relevant data collection tools by community participants worldwide.

4.2.3 WorldCloud Data Standards

Data Collection Method	Equipment	Data Format
3D mesh authoring tool using mobile phone app	Any smartphone	Scene graph
Automatic point cloud generation using 3D scanning equipment	Depth-enabled smartphone, depth cameras, lidars, 3D scanners, etc.	Point cloud

Data Quality Verification Criteria:
The accuracy of physical position and shape of point cloud data corresponding to the objects in the real world;
Point cloud density, noise, accuracy, and how well it fits with real world objects;
The accuracy of detailed descriptions of data points;
The accuracy of information associated with data points;
Completeness of information associated with data points;
Whether data points refer to third-party sources (Yelp, public comments, Wikipedia, etc);
Maintaining freedom from bias in the writing of related information

The data requirements for the WorldCloud are very large, but because it stores point cloud data, there is ample opportunity for compression to reduce storage requirements. Unlike the point cloud requirements in other industries, implementing an AR cloud requires only the point cloud to accurately localize a user’s device. For a space of 10 by 10 by 10 meters with high structural density, the WorldCloud point cloud occupies only about 5MB of storage space.

4.2.4 Data Ownership for Collectors

Due to the particularity of AR data, in order to avoid the situation where there are large chunks of missing data during data invocation, data collectors do not own the rights to the collected data, but instead have the rights of use and income.

4.3 The Data Verification Council

Not all data can be written to the WorldCloud; the AR industry requires high data standards, and different third parties have different requirements for data in order to provide users with a great AR experience.

A Verification Council is set up to determine whether or not the data can be written to the WorldCloud.

Members of the Verification Council must hold WRLD tokens to be responsible for the data being written, and will participate in data verification in a process predetermined by smart contract code.

4.3.1 The First Council Members

Members of the Verification Council have the right to decide whether or not to include data in the WorldCloud, just as they are responsible for the availability, precision and reliability of the data being written.

The first Members of the Verification Council will consist of enterprise users who provide third-party data collection tools or who are members of well-known development groups in the AR industry. The reasons are as follows:

First, AR application developers who provide third-party data collection tools have a clear understanding of the requirements of AR data and the data types that meet the requirements of development and usage.

Second, AR application developers who provide third-party collection tools are both the first generation of data collectors in the AR industry and consumers of large amounts of AR data.

Taking into consideration that the number of business participants will be limited in the beginning, and the number of nodes limited, the first Verification Council will consist of about 10 enterprise nodes, which will have been recruited globally by the WorldCloud Foundation and voted for by the community. The number of nodes will increase subsequently.

4.3.2 Data Verification Policy

For data supplied by data collectors, members of the Verification Council will conduct verification to vote on whether the data will be written into WorldCloud.

Because AR data is a representation of the real world, the risk of data collection fraud must be taken extremely seriously. As enterprise users are strong in their ability to distinguish whether data is authentic, it is important to the accuracy and usability of collected AR data.

If voting results show that at least 75% of the Council members agree, then the data will be written into the WorldCloud and the credibility of the data collector and the members of the Verification Council who voted for it will be increased, while those who voted against it will have their credibility decreased.

If the voting results show less than 75%, the data is not written to the WorldCloud.

If less than 30% of the voters agree to have the data written, then not only will the data not be written to the WorldCloud, but the data collector and those who voted for it will also have their credibility reduced.

These basic data standards will be provided with the data collection tools; such a data verification system will discourage and punish malicious attempts at data acquisition while improving the overall quality and collection efficiency of WorldCloud's data.

Credibility ratings will be used to indicate how reliably a node can be depended on to verify data. The ratings will automatically change after data verification is complete, and cannot be modified by any single user.

4.3.3 Council membership updates

Members of the Verification Council of the WorldCloud are not static, but are selected from among those who provide accurate AR data, and from AR industry practitioners, developers and organizations. The members will hold their positions for each voting cycle (tentatively set at 7 days), and there can be up to 32 members in the Verification Council (tentative).

When the membership of the Verification Council is at its max capacity and the next time the number of Council members increases, the 20% of the Council members with the lowest credibility rating will be removed from their responsibilities.

Among them, 10% of the positions are appointed to the data collectors with the highest credibility. If the data collector in the first place declines, the data collector in the second place is given this opportunity, until the 10% of positions are filled.

The other 10% is selected by the WorldCloud Foundation among the enterprise organizations of the AR industry where final choices will be made via community voting.

The point of such elections is to ensure that when industry standards for AR data change, the WorldCloud verification process can be changed accordingly, avoiding situations where verified data is unusable because they no longer conform to industry standards.

Council member discipline policy

We will impose punitive measures of revoking the membership of those with declining credibility. The credibility threshold is 60% below the average credibility of the Council as a whole (tentative).

The vacancies in those positions will be filled during the next Council membership selection cycle.

Data collector discipline policy

We will impose punitive measures of revoking data collection rights for data collectors with declining credibility, after which point they will not be permitted to partake in data acquisition. The credibility threshold is 60% below the average reputation of collectors (tentative).

In addition, the same penalty will be applied to data collectors who upload several instances of invalid AR data in a short span of time, in order to prevent DDOS attacks.

4.3.4 The Backup Council

Because AR data is submitted at an uneven rate, the workload of the Verification Council may become enormous even when utilizing technology-assisted verification. Among the 32 nodes, there may be situations where verification cannot keep up with the data or respond in a timely manner. Therefore, a Backup Council system will be set up.

Members of the Backup Council will be granted verification powers in the event of repeated failures by members of the Verification Council to verify data.

Those whose credibility puts them in the top 20% of nodes are considered members of the Backup Council. After partaking in data verification, WRLD token rewards will be given to those who participated in the process.

4.4 Data Invocation

WorldCloud will provide a stable API interface for data invocation; anyone will be able to use the API to make WorldCloud data calls.

4.4.1 Tiered Data Invocation Costs

WorldCloud's normal data calls are extremely inexpensive, but this may lead to other issues such as malicious high-frequency calls. Taking this into consideration, WorldCloud will use a tiered usage fee design.

We define the average number of calls in the previous hour as N. The cost of calling a node X times in one hour is as follows:

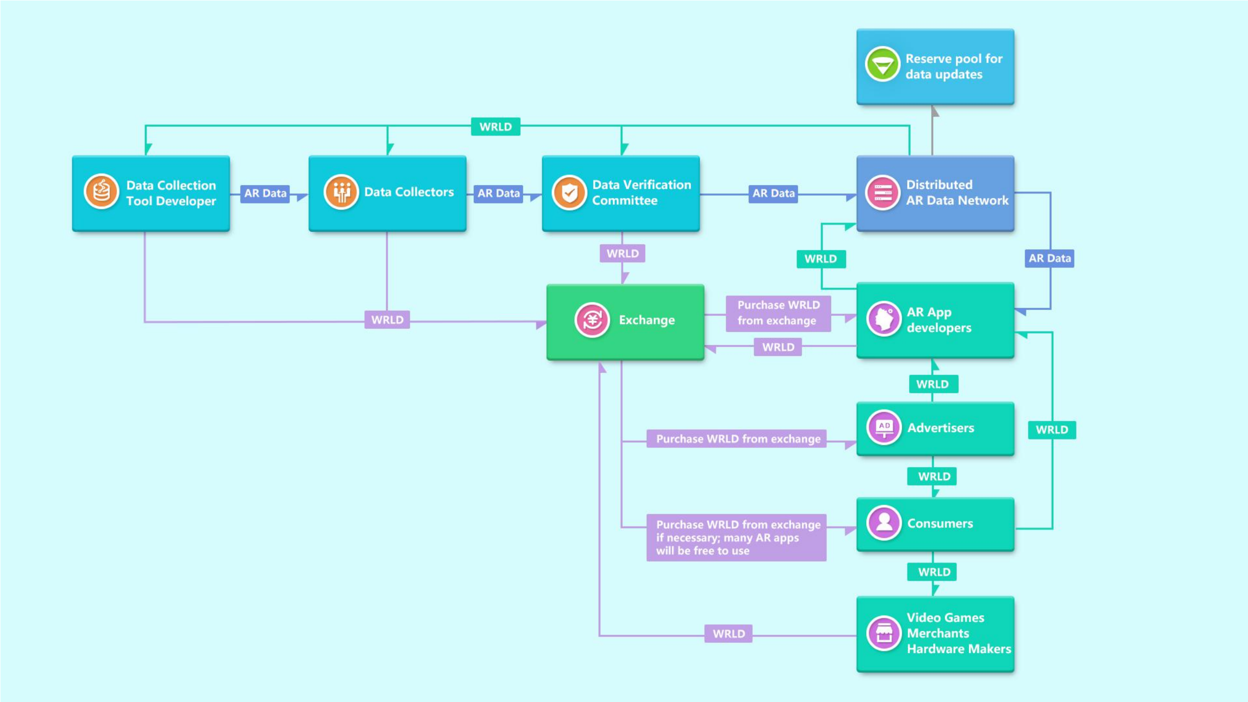
Number of Calls	Calling cost
$X \leq N * 120\%$	Standard

N * 120% < X ≤ N * 220%	1.5 times
X > N * 220%	5 times

The cost of the call will be divided into three payments: the first to the data collector at 80% of the fee, the second to the storage provider at 10% of the fee, and the third to be paid to the reserved token pool at 10% of the fee. The reserved token pool is used for rewarding data collectors when some of the same data is updated.

5 Applications of the WRLD token

5.1 Ecosystem Design



The WorldCloud Foundation is committed to creating a global AR infrastructure and value-based circulation ecosystem based on blockchain technology. Global AR industry veterans and users will work together to fully utilize the power of crowdsourcing to advance the development of AR smoothly and efficiently.

Because of the ecosystem design of the WorldCloud, the project will quickly reach the broadest levels of usage of blockchain technology and become a landmark for blockchain progress.

WRLD tokens are the native asset of WorldCloud. A WRLD token's value comes from its ability to easily characterize and measure digital economic activities in the WorldCloud ecosystem. The value of the WRLD token is based on three factors:

1. Calling data from the WorldCloud requires a certain amount of WRLD tokens;
2. WRLD tokens will be used to pay for services and commodities provided by ecosystem

businesses;
3. Holding WRLD tokens grants the opportunity to become a member of the Verification Council

WRLD tokens are created when data is submitted to the WorldCloud, and are distributed to the collection tool providers, data collectors, and Verification Council members according to the reward policy outlined in previous sections.

When data in the WorldCloud is called by a third party developer, WRLD tokens must be obtained from the three aforementioned parties to be paid to the data collector and the Reserve Token Pool. When any stored data is updated, rewards are provided from the Reserve Token Pool.

Third-party AR developers may allow advertisers or online merchants to pay for their expenses with WRLD tokens. They may also accept WRLD tokens as payment for virtual game items, merchandise, etc.

In the future, the WorldCloud will become the infrastructure of the global AR industry, and WRLD tokens will become the primary means of circulation of AR ecosystem assets, providing strong liquidity for the global AR ecosystem.

5.2 Incentives

All those who contribute during the data collection phase will be rewarded with WRLD tokens, which will serve as the primary source of WRLD token generation.

5.2.1 Incentives for data collection

The data collector acts as the data provider, and when data is written to the WorldCloud, WRLD tokens are awarded to him or her according to WorldCloud's incentive smart contract. Data collectors also have the right to use and distribute the AR data they contribute.

As data in the real world changes, AR data will also need to be updated frequently. Data collectors will have to pay a small processing fee to invoke their own contributions, with the payment going into the Reserve Token Pool, which will be used to reward future data updates.

At the same time, a small amount of WRLD tokens are awarded to the developer of the data collection tool used by the data collector.

5.2.2 Incentives for data verification

The data Verification Council’s contribution will also be rewarded with WRLD tokens during the data upload process.

5.2.3 Incentives for data storage and localization service

For AR data to be written, those responsible for the distributed storage will also be rewarded with WRLD tokens. This WRLD token reward will be paid to the storage party at the time of data invocation.

In addition to providing storage, the user might also require assistance with device localization computation when his/her AR device is not powerful enough to carry out this computation on its own. The storage nodes are also rewarded for providing this service.

5.3 Payment for data invocation

Calling AR data will be one of the WorldCloud's primary driver of WRLD token circulation. A large volume of data calls will provide a huge boost to the circulation of WRLD tokens. Data call payments for all nodes will be paid to data collectors and the Reserve Token Pool.

5.3.1 App Development data usage payment

If the amount of WRLD tokens obtained through the provision of data collection tools are insufficient for the payment required for app development, the developer will need to purchase WRLD tokens from other users.

According to WorldCloud’s design, the data invocation during app development is a one-time payment. Once the fee is paid, using data of a particular location is unrestricted during the entire app development process.

However, if the data at that location is updated, the developer will need to pay for that data again.

5.3.2 Production app data usage payment

During use, applications makes a small payment for calls to the WorldCloud, upon which it obtains a limited window of time to make calls. The payment amount is verified according to the frequency of calling the data and the calling time, which is in accordance with the data invocation policy. The developer has the ability to view what data was called by the user, which provides accurate usage metrics for future functions such as AR advertising campaigns.

5.4 AR ecosystem participants

AR ecosystem participants will come from every industry in the world, such as advertising, gaming and even luxury goods. The WorldCloud ecosystem will meet the needs of businesses across the globe for augmented reality and will need to display any appropriate information before AR users.

AR ecosystem participants will be the main force for the purchase of WRLD tokens. They will primarily be used to pay AR app developers for services provided (such as advertising space), as well as handle the spending and usage scenarios of WRLD token holders.

6 Allocation of WRLD tokens

The total amount of tokens will be 1 billion, never to be increased.

Token Distribution

50% Incentives for ecosystem participants, such as data collectors, node providers, data verifiers, and acquisition tool developers
20% Private equity and DAICO
15% Team
10% Community building and other collaborative efforts (support for third party development teams, etc.)
5% Marketing, consultants, exchanges

Use of Proceeds
42% Development of technology
18% Marketing
15% Business collaboration and third party developer support
12% Operations, infrastructure, exhibitions and general participation
3% Legal and financial services

6.1 Why DAICO?
The WorldCloud team is committed to building the cornerstone of the AR industry, subject to oversight by all investors. To increase trust among contributors, a DAICO will be used for fundraising.

6.2 What is DAICO?
Any ICO is exposed to the risk of team irresponsibility or that the project is merely a scam, and any voting system faces 51% attacks, vote-buying and other deficiencies. With DAICO, these risks are minimized.

The DAICO contract is issued by a development team that needs to raise funds. The DAICO contract begins with the "Contribution Mode", which specifies a mechanism by which each person can contribute ETH to the contract and receive the corresponding token. This can be any kind of mechanism with a capped sale, an uncapped sale, a Dutch auction, an interactive token issue, a KYC dynamic individual cap sale, or any mechanism chosen by the team. When the contribution phase is over, the ether can no longer be contributed, the initial token balance will be set, and then the token can be traded.

At the end of the contribution phase, the contract has one major state variable: tap (in units of wei/sec), with an initial value of zero. Tap determines the amount that the development team can withdraw from the contract every second. It is implemented as follows:
At the same time, there is a mechanism for the token holders to vote for a solution. There are two solutions:

- Increase tap value
- Permanently destroy the contract (or more accurately, put the contract into withdrawal mode, where the remaining ether can be withdrawn proportionally to the token holder)

Both options can be initiated by a majority vote through arbitration (i.e. yes – no – absent / 6 > 0). Note that the tap value cannot be lowered by voting. Owners can voluntarily lower the tap value, but they cannot unilaterally increase the tap value.

The purpose of this is that voters can give the development team a reasonable monthly budget that is not too high, and if the team continues to prove its capabilities, the budget can be raised by voting. If voters are not satisfied with the team's progress, they can shut down DAICO altogether and get their money back.

7 Team and Advisors

7.1 The WorldCloud Team

Freeman Fan - Serial Entrepreneur, Founder and CEO, Multiverse (premier provider of AR/VR technology solutions and games); Founder of Simple Thrill, built games with 30M+ players as an indie developer; M.S. Stanford University

Robert Liang - Expert blockchain architech; previously IBM Blockchain Foundation Developer, blockchain technology consultant; implemented multiple blockchain solutions for IBM's clients using Hyperledger and Ethereum technologies; Avanade principle solutions engineer; 15 years of experience in enterprise IoT, cloud computing and database development; MS in Computer Science from the Utah State University

Elie Ahad - Expert in computer vision and image processing; previously senior engineer of the Hololens project at Microsoft, responsible for core technologies including computer vision, rendering pipeline, real-time 3D visualization; previous experience include senior engineering positions at Microsoft Research (Surface project), OmniVision, Micron Technologies, Xerox and Disney; 25 years of experience in augmented reality technology, computer vision, image processing and human-computer interaction research and development

Yohan Duval - Computer Science Ph.D., INSA Toulouse; Expert in augmented reality, SLAM and localization technology; expert in training automation using AR and VR technology

Zekun Li - Computer Science M.S., USC; Software Engineer, Facebook; expert blockchain engineer; Creator of the blockchain game Decentraverse

Arnold Zhang - Blockchain technology fanatic; Creator of the blockchain game Decentraverse; full-stack web engineer; B.S. in Computer Science

Veronica Ge - Project Manager, China Merchants Group, M.S. in Management Science, Stanford University

Junior Ferreira - Global marketing manager; Founder of Knova eSports; Marketing manager at Nordstrom

+6 more (please see worldcloud.io)

7.2 Advisors

Mike Fischer - VP of Marketing, Microsoft; CEO, Square Enix Inc.

Zachary Fitzner - Expert blockchain architect and token economics consultant; Advised projects such as 4New, ResiBids, Project Districts, Vantage Token, Gizer, High Vibe Network, etc.

8 Citations

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