OBSERVER TECHNICAL NOTE

GLOCAL WEATHER DATA TRADING PLATFORM

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English

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1. ABSTRACT

Weather observations are made in real time every day through a variety of methods including satellites, weather radars and ground-based observatories. Data obtained from these observations are used either as initial conditions for weather forecasts or as real-time weather monitoring. Since weather observations require costly equipment and trained personnel, they are generally performed in the public sector. However, unlike the developed countries where observation networks are built and operated, some underdeveloped countries do not provide such services. Even in countries where public observation networks are well established, their networks have often significant limitations in providing high-resolution weather information especially for megacities.

The OBSERVER intends to collect and distribute real-time weather data for regions where public observation networks are not well established. To realize this goal, the OBSERVER provides a platform that encourages observations by individuals and businesses, verifies the quality of the data and facilitates transparent data transactions. At OBSERVER, anyone can share real-time weather data that they collect using their smartphones, automobiles, mini weather stations, vessels or aircraft. The collected data is managed through big data technology and the observation history is recorded on a blockchain for legitimate compensation. This platform allows anyone in the world to provide weather data and purchase them on a real-time basis. This will be an alternative to the current limitations of the public observation networks and the inefficient data exchanges between countries.

2. BACKGROUND

According to a survey, U.S. residents use weather forecasts about 3.8 times a day (Lazo et al. 2009). Considering the population of the U.S., people in the U.S. alone use weather forecasts over 300 billion a year. Most weather information is used as a small piece of daily information, but in certain industries such as logistics, leisure, energy, agriculture and fisheries, it is used as high value-added information. The Swiss Federal Office of Climatology and Meteorology estimated the value of the free-of-charge climate information provided to the public at up to $360 million annually (Frei, 2010). In the U.S., the value of weather information was estimated to be approximately $31.5 billion per year (Lazo et al. 2009). Now, its value is on the rise due to rapid climate change and frequent extreme weather events.

The most important pieces of weather information are weather forecasts. Weather forecasts are the integrated outcome of numerical weather prediction model run on supercomputer. The numerical weather prediction model requires various input data such as air temperature, pressure, humidity and wind. These data should cover the globe without being limited by national borders (Fig. 1).

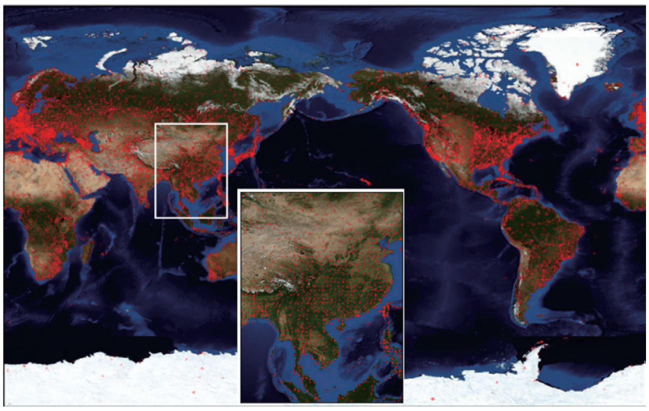
Weather observations are made in various ways. These include surface weather stations, balloon-borne radiosondes and remote sensing that utilizes radar and satellites. Ground-based weather stations generally observe air temperature, pressure, wind speed, wind direction and precipitation. Among these variables, air pressure serves as a basis for weather forecasts. This is because mid-latitude weather forecasts start by locating low- and high-pressure systems in a daily weather map. While ground-based observations may seem easy, installation and operation of the stations are not straightforward. For instance, regular weather stations are not randomly placed. They can be installed only in the regions that meet certain conditions (e.g., a site that keeps a certain distance from the road). The equipment is costly and the data is subject to quality control by meteorological experts.

Even if regular observation network is in operation, weather stations are often not evenly distributed. For instance, the Chinese Meteorological Administration operates about 700 weather stations, but the number of stations is significantly small in Tibet and North China (Fig. 1, Box).

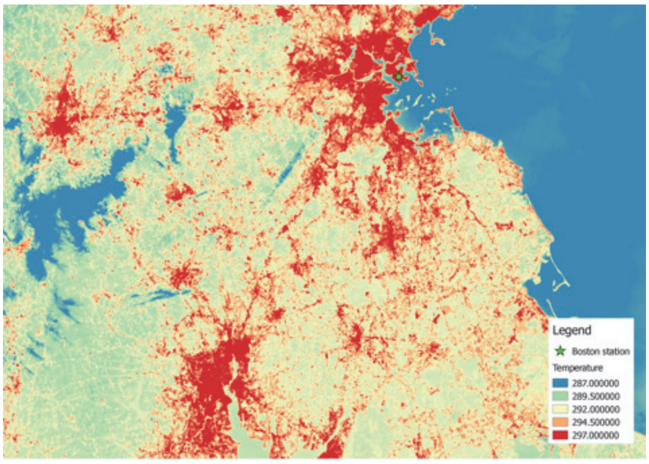
The regular observations performed by the public sector are usually optimized for weather forecasts, ranging from hundreds to thousands of kilometers. They are made only at a designated time and place. On the other hand, operational institutions around the world (e.g., European Centre for Medium-Range Weather Forecasts) are improving the spatial resolution of their numerical weather prediction models to 10 kilometers or even higher. Such high-resolution forecasts require high-resolution observations as well as regular ones.

In cities, high-resolution observations are crucial not only for weather forecasts but also for fine dust monitoring. In the current urban environment where various types of structures are built, two very different meteorological phenomena can occur at locations just a few kilometers away from each other. For instance, the distribution of urban heat islands is greatly affected by the arrangement of buildings (Fig. 2). Air pollutants also show complex distribution patterns depending on the flow of air within the city. Given rapid urbanization across the world, the need for detailed city-scale meteorological information is increasing. Some cities have already responded to such needs and have been carrying out high-resolution observations, but in reality, these cases are confined to only highly populated megacities in developed countries due to the sheer cost of operation.

The OBSERVER intends to establish a platform where meteorological data is secured through the efforts of individuals and private firms. Anyone can share weather data that are collected by smartphones, mini weather stations, automobiles, vessels or aircraft. The collected data are verified and managed through big data technology. They are also sold on a real-time basis to a variety of businesses as well as public sectors. The blockchain technology helps ensure transparent data transactions.



Distribution of regular weather stations in the world and those in China and Southeast Asia (boxed).



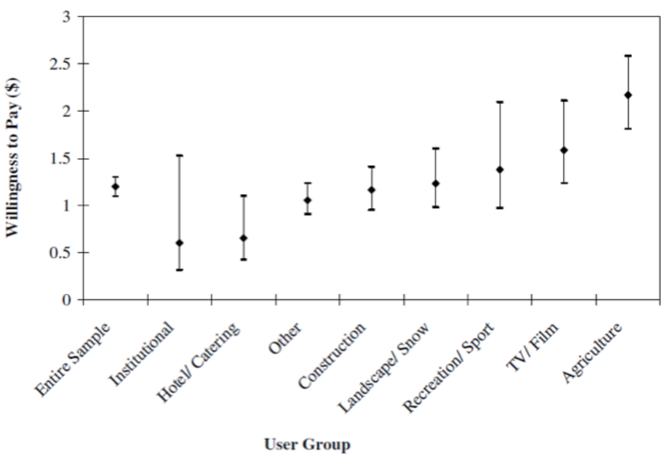
Urban heat islands in Boston, U.S.
[Taken from Climate Central 2014 report]

Where private weather observations are needed

- Observations in remote regions beyond regular weather networks
- High-resolution observations for short-term weather forecasts
- City-scale weather and fine dust monitoring

3. WEATHER MARKET

Do weather observations (or weather information in general) have commercial value? In fact, high-resolution observations and forecasts are already being commercially used in a broad spectrum of sectors including agriculture, food, medicine, travel, leisure, health, beauty, insurance, retail, automobile, energy, military, science, disaster prevention and public services. According to IBM, the total damages from the five most destructive weather events of 2014 amount to $17.4 billion worldwide with insured losses of $11.8 billion. In the case of Switzerland, the Federal Office of Meteorology and Climatology reported that the estimated benefits of extrapolating weather and climate information in the agriculture sector are valued at $42 million, adding that the sector could cut 100 million Swiss Francs in costs by using weather and climate data to accurately estimate the energy demand (Frei, 2010). Weather information is important for other sectors as well: it greatly affects travel- and leisure-related products, health and beauty supplies and retail companies. It is also an integral component of vehicle development (e.g., self-driving car technology), urban planning and development (e.g., smart city) and disaster prevention.



Willingness-to-pay by commercial sectors
(Rollins and Shaykewich, 2013)

Rollins and Shaykewich (2013) conducted a study on Canadians' willingness-to-pay for weather forecasts. The figure varied from $0.6 to $2.17, with a mean of $1.2 (Fig. 3). The numbers may seem small, but the combined benefits are estimated to exceed $16 million per year as there are potential buyers of real-time weather information.

Weather information is now widely available online in a broad range of prices from virtually free to thousands of US dollars. While public weather forecasts are mostly provided for free or at a low cost, the costs go up with high-resolution forecasts and customized data. Long-term observations are also sold at a high price.

As big data technology continues to mature, the use of weather information is trending upwards at a significant pace. Companies are incorporating weather information to earn greater profits; in fact, a growing number of multinational companies are buying small weather companies. Monsanto, a leading provider of agricultural products, announced the acquisition of The Climate Corporation in 2013. The deal was reportedly valued at approximately one billion US dollars, which came as a surprise to many, although the relationship between agriculture and weather is evident. Monsanto later acquired an agtech software company HydroBio and launched the Climate FieldView platform, designed to help farmers access customized weather data to better manage their crops and optimize yields. Farmers need to pay an annual subscription rate of approximately $1,000 to use the Climate FieldView platform. In 2015, IBM bought The Weather Company at approximately two billion US dollars. It is now combining big data and artificial intelligence (AI) technologies for global weather forecasts.

4. OBSERVER

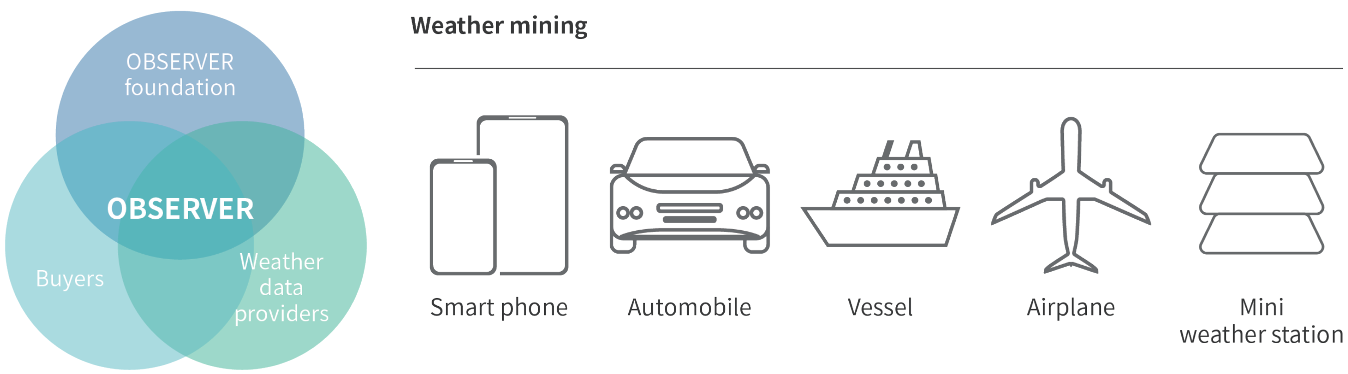
The OBSERVER is founded on the vision that "anyone can produce weather data and purchase it at a reasonable price." At OBSERVER, weather observations are made worldwide on a real-time basis, with data being made available to the public without government interference. Big data technology allows for systematic data management, while blockchain technology enables transparent data trading. To this end, the OBSERVER intends to collect data, conduct quality control and provide standards for data transactions.

Weather observations have been largely considered as a public service. Indeed, weather observation networks are typically maintained by tax revenue and data exchanges are conducted through the inter-governmental organization (World Meteorological Organization). This makes it hard for individuals or private companies to access location-specific weather data on a real-time basis.

Unlike public weather services that require large initial investments in sophisticated instruments, individuals and private firms can make their own observations at any place and time. Personal observation is already an indispensable part of our daily lives. For instance, a person can measure air temperature or pressure using his/her smartphone and share the data online. In other words, without any expensive instrument or expertise, individuals can measure meteorological conditions and send out their data via worldwide cable and wireless networks. This may help overcome the limitations of existing public observation systems and inefficient data exchange platform.

The three main components of the OBSERVER are weather data providers, buyer and the OBSERVER foundation (Fig. 4). Weather data providers send real-time observations to the OBSERVER foundation where observations are quality-controlled and processed into the database. Data providers receive payment once they send out the data and every time their data is sold. All transactions take place on a blockchain platform in a secure and transparent manner.

Since the OBSERVER collects data in various forms, quality control is critical. The OBSERVER does not rely on data providers or buyers to check data quality. Instead, data quality is controlled by the OBSERVER foundation, which is also in charge of data management and transactions. Although this is different from the decentralized blockchain platform, it is a necessary move to ensure data quality which cannot be done without meteorological expertise.

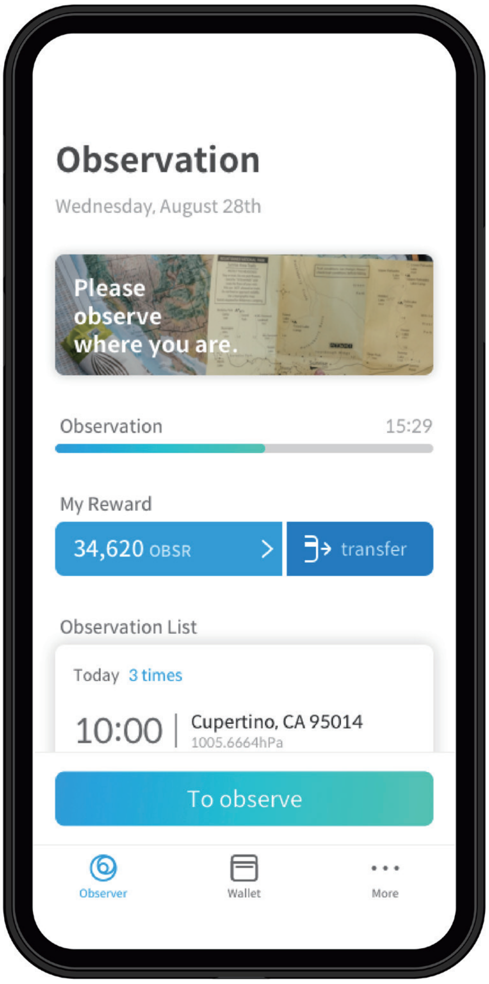


OBSERVER ecosystem and examples of weather mining methods.

5. WEATHER OBSERVATION

The OBSERVER aims to promote weather observations conducted by individuals and private companies. Individual observers are not required to use certain types of instruments nor to guarantee data quality. This fundamentally sets private observations in the OBSERVER apart from public observations that are conducted with standard meteorological instruments to measure basic weather variables (e.g., air temperature, pressure, humidity, precipitation, wind, solar radiation, etc.) with a certain level of quality. In OBSERVER, individuals can measure meteorological variables from various tools such as smartphones, automobiles or mini weather stations. For instance, observer A can measure air pressure by using his/her smartphone while observer B can measure humidity with his/her mini weather station. Their data are sent to the OBSERVER foundation and are quality-controlled by meteorological experts.

OBSERVER's most common ways of observation are by using smartphones and mini weather stations. However, it also considers other individual and corporate options such as automobiles, vessels and aircrafts.



Observer App

Smartphones : Air pressure, Cloud, etc.

Most of smartphones have built-in pressure sensors. Any smartphone owners can share pressure data based on their GPS with Observer and become part of a Observer member. First Observer will compensate with OBSR coins for exchanging the data to Observer wallet smartphone application. Then users can transfer OBSR coins to any other wallets that accepts OBSR coins.

A smartphone is also useful for taking pictures of clouds. An observer can simply take low-resolution pictures of the sky and send them to the OBSERVER foundation through the smartphone App. The photographs can be used to estimate cloud cover and to visually monitor real-time weather conditions.

Mini Weather Stations:
Air pressure, Temperature, Humidity, Particulate Matter, Raining or not Ultraviolet (UV), etc.

Mini weather stations can also share their observations with the OBSERVER. Many equipments are already available in both online and offline stores. The small observational device, which is connected to a local wireless network, can measure outdoor air temperature and humidity, pressure and transmit the data to the OBSERVER foundation in real time.

Automobiles:
Air pressure, Temperature, etc.

Automobiles manufactured in recent decades are topped with sensors that measure air temperature and pressure. Automobile owners therefore can be a part of the OBSERVER by extracting weather information from the automobile with the OBD (On-Board Diagnostics) scanner and syncing it with their smartphones. All they need to do is to install the OBD scanner on their automobiles (only once) and open the OBSERVER App. Other instruments, which are designed for automobile observations, could be also utilized.

Vessels:
Air pressure, Temperature, Humidity, Precipitation, Wind, etc.

Equipped with a range of meteorological instruments, large vessels are also capable of generating weather data. Marine weather observations hold significant economic values as they are often difficult to conduct. They are particularly valuable for navigation routes services and weather prediction businesses. Such high value-added information can be sent in real time via the communication networks of shipping companies to the OBSERVER foundation and verified for its quality. This can be done through a strategic partnership with shipping companies.

Observer MWS V.1 and Installation examples

Aircrafts:
Air pressure, Temperature, Humidity, Wind, etc.

All aircrafts are mounted with weather observation equipments. The upper-air observations they produce are of great value. In particular, the aviation observations during the take-off and landing, when most airplane accidents occur, are enormous sources of added values. If the meteorological data from individual aircrafts and major airlines are communicated to the OBSERVER foundation through the airport communications network, it could create a new market.

Others:
VOCs, NOx, SO_4, O_3, radiation, etc.

Individuals and companies can participate on observing air quality (O_3, NOx, SO_4) or radiation.Observer expect to build a permanent network of atmospheric conditions with help of the private sector.Similarly, radiation map can be constructed as long as the accuracy of personal radiometers is ensured.

6. ECOSYSTEM OF OBSERVER

The OBSERVER is composed of three main components as shown below: weather data providers, buyers and the OBSERVER foundation.

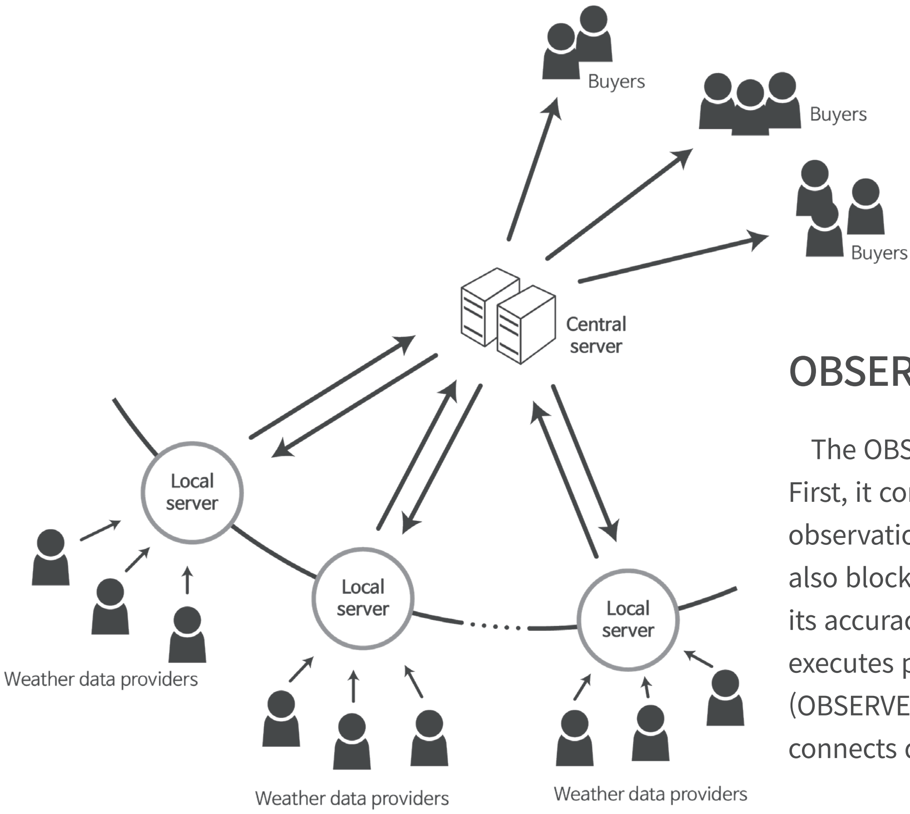
Weather Data Providers

Individuals and private companies can measure weather conditions from a variety of sources (e.g., smartphones, automobiles, mini weather stations, vessels, aircraft, etc.) and share them on a real-time basis. These observations can be done consciously or subconsciously. For instance, an automobile connected to the OBD scanner can automatically measure air pressure every 30 minutes as soon as the engine starts and deliver the data to the OBSERVER foundation via smartphone. Individuals can take a picture of the sky and send it to the OBSERVER foundation. Aircrafts and vessels, which are mostly operated by corporations, already have communication networks in place. Just by adding the OBSERVER to their networks, high value-added weather information can be sent to the OBSERVER foundation.

Buyers

Buyers of historical and real-time weather data could be individuals, companies or government. Customers, like weather service providers, can process OBSERVER's data to offer real-time information on urban weather. Weather information obtained from automobiles can be directly applied to automobile navigation systems. By combining OBSERVER's data with AI technology (e.g., IBM's Watson and Google's deep learning algorithm), weather service providers can make hyper-local short-range weather forecasts. Daily observations can be also purchased by government agencies in agriculture, energy, disaster prevention and public services. Among others, the data archived in the OBSERVER can be useful for local governments looking to develop smart cities.

Airlines and ship routing companies can take great advantages of OBSERVER's real-time weather data as well. Airlines can use OBSERVER's data to check airport weather and monitor clear air turbulence. As for ship routing companies, they can monitor real-time weather and marine conditions with OBSERVER's data.



OBSERVER Foundation

The OBSERVER foundation performs multiple roles. First, it controls the quality of real-time weather observations and archives them into the database. It also blockchains the weather information based on its accuracy. In addition, the OBSERVER foundation executes payment of routine compensation (OBSERVER coin) for successful observations and connects data providers and buyers.

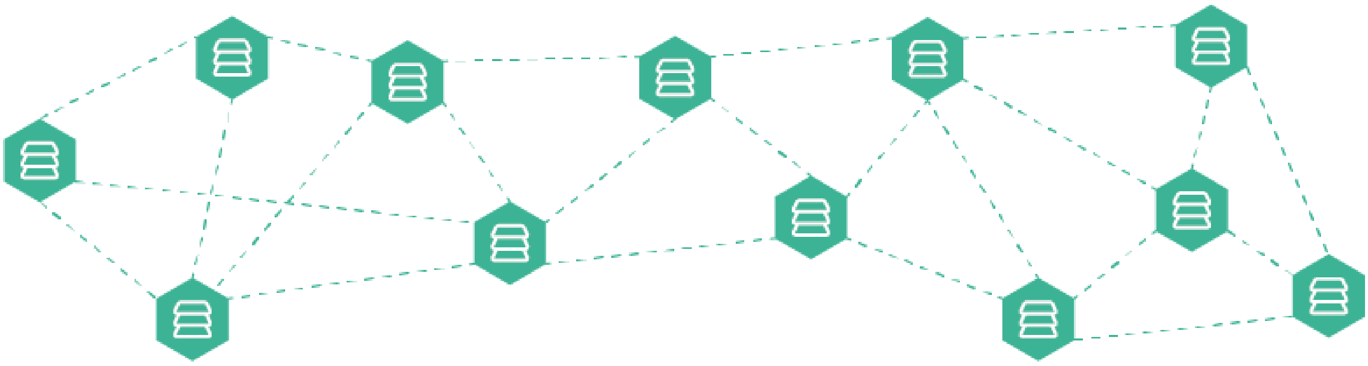
The OBSERVER foundation operates a local server and a central server. Once observations are collected, they are temporarily stored in the local server while the central server conducts quality checks. The role of the central server is to verify, manage and distribute the data.

The quality of individual observations is tested in the following three steps. The first step is to verify the collected data (except photographs) and compare it to local climatology. Then, the data is compared with other data produced at the same time from nearby locations. The final step involves a machine-learning algorithm, which is used to establish the reliability of the data. The machine-learning algorithm incorporates a numerical weather prediction model output as well as observational data. Once the data is verified, it is managed with big data analysis technology.

7. ECONOMIC MODEL OF OBSERVER

7-1 OBSERVER COINS

All payments and transactions in the OBSERVER are made in OBSR, a transaction coin.



OBSERVER COIN (OBSR): Coin for transactions

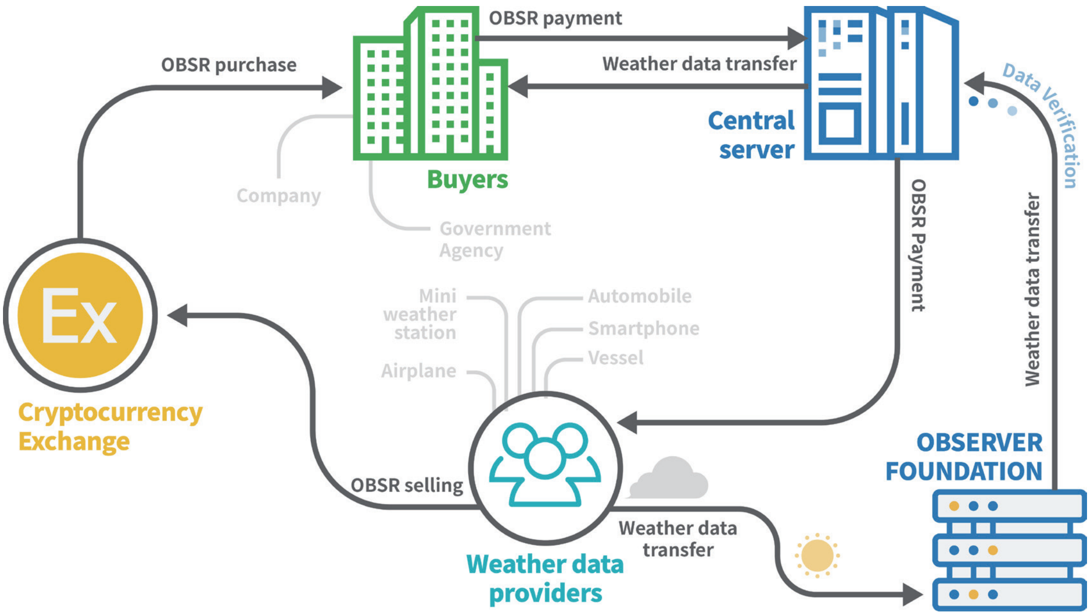
OBSR is a coin listed on the cryptocurrency exchanges and used in transactions of the data. The data providers receive OBSR on two separate occasions: the first is when their data is quality-checked and the latter is each time the data is sold. In order to access weather data, buyers need to purchase OBSR from the cryptocurrency exchanges and pay in the OBSERVER foundation. The value of OBSR will increase with a greater public interest in the OBSERVER project and higher demand for its data. This, in turn, will result in better compensation for the data providers.

OBSERVER and Blockchain technology

The OBSERVER uses blockchain technology to enable transparent data management, effortless data trade and efficient compensation.

A buyer can immediately purchase the weather data by paying with OBSR anywhere in the world. The use of OBSR eliminates the issues that arise from conventional purchasing methods, such as unstable foreign exchange rates and disturbances in wiring and mailing remittances. The details of transactions are recorded in the blockchain and are managed transparently.

7-2 ECONOMIC MODEL



Economic model of OBSERVER

Individuals and private firms can carry out both simple observations (e.g., monitoring a single variable such as air pressure) and comprehensive observations (e.g., multiple variables including air temperature, pressure, humidity and precipitation) using mobile and stationary devices. The data provided by private observers goes through a verification process and is then given an Impact Factor (IF) depending on the location, the type of data and the quality.

OBSR payment for real-time observations

Observation platform records the values of each observation (IFs) and operates as the basis of OBSR payment for successful observations. There is a limit on the total daily assignment of IFs. The total amount could differ depending on the region and the type of variables. For instance, while the maximum IF assignment for air pressure in an urban area would be 100, that in an island area would be only 50. Even for the same region, precipitation data may get 10 times more than other variables. This means that the amount of IF assigned to weather data providers may vary depending on the time and location of observations.

Let us assume that five data providers observed air pressure in a region where total daily IF assignment is 50 (Table 1). Observer A performed observations for 24 hours using a mini weather station and received a Quality Factor (QF) of 1.0 after data quality checks. On the other hand, observers B, C and D received QF of 0.5 for 12-hour observations using a smartphone, while observer E sent the data to the OBSERVER foundation but was given a QF of 0.0 due to equipment malfunction. In this case, IF may be distributed as shown in Table 1.

If 50 OBSRs are provided as compensation for the above observations, 40% (20 OBSRs) is paid to observer A. It is important to note that the smaller the number of local observers and the higher the quality of the data, the larger the rewards will be.

Weather Data Providers	Quality Factor (QF)	Total IF / Total QF	IF distribution
A	1.0	50/(1.0+0.5+0.5+0.5+0.0) = 20	20 × 1.0 = 20
B	0.5		20 × 0.5 = 10
C	0.5		20 × 0.5 = 10
D	0.5		20 × 0.5 = 10
E	0.0		20 × 0.0 = 0

Table 1. Example of IF distribution

OBSR distribution for data sales

Customers may purchase OBSR from an external cryptocurrency exchange and use it in the OBSERVER foundation. Once the transaction is complete, the data is transmitted to the customer. The OBSR that customers pay is used for the data provider royalties and for the OBSERVER foundation management costs. It is also directed to future compensations. This creates a win-win structure for weather data providers, buyers and the OBSERVER foundation.

OBSR MIning control

The OBSERVER foundation allocates 65% of the total supply of OBSR to the weather observarion compensation(see business note).

8. OTHER CONSIDERATIONS

This technical note is intended to present the OBSERVER's vision and to explain how the OBSERVER works, but not to encourage investment from public or professional investors. Thus, the OBSERVER shall not be held liable for any financial losses caused by this technical note. The content in this technical note is based on the time of its creation and is subject to modification. Therefore, the final business content of the OBSERVER may differ from what is described in this note. The descriptions in this note are filed for domestic and international patents with the Korean Intellectual Property Office and are legally protected.

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