



IONChain

A revolutionary IoT infrastructure based on blockchain
and edge computing technology



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Abstract

Along with the emergence of cryptocurrencies, the blockchain technology has developed rapidly in recent years. In the 13th Five-year National Informatization Plan issued by the State Council of China, blockchain technology was mooted as one of the frontier technologies within the National Strategic Layout. Blockchain technology is going to provide the fundamental infrastructure for the next generation of Internet – the Internet of Value, and is now collaborating with emerging technologies in different fields to progressively expand the application range. As we know, IoT network is seen as an extension of the Internet, so it is inevitable that IoT will eventually be merged with blockchain. Especially considering the security issues involved with massive amounts of data potentially being collected by IoT devices in the future.

IONChain aims to solve a wide range of the current problems of IoT networks in terms of data security, data circulation, data sharing and data transactions, thus enhancing the efficiency of the whole IoT ecosystem. IONChain introduces the concept of “One Device, One Coin, One Code” which facilitates the integration of IoT devices with the IONChain blockchain network. With the use of Edge Computing technology, it enables every device on the IoT network to be utilized as a mining machine, making every IoT device that uses IONChain subject to mining rewards. Owing to the use of blockchain technology, the data source will always be reliable and verifiable on the IONChain network. Furthermore, the value of the data is quantified and data transfers are fast and secured. This makes it easier for IoT standards to emerge, unlocks a plethora of new IoT application scenarios and boosts the whole industry to enter the next level of development.

Key words: *IONChain, Blockchain Technology, IoT Technology, Edge Computing Technology*

1. Introduction

1. Origin of IONChain

In 1887, the famous Swedish physicist, Arrhenius, proposed his theory of ionization, which posits that similar to molecules and atoms, ions are also a fundamental particle in the formation of substances. IONChain is so named because the IONChain will act as the underlying link between all the IoT devices to support the decentralized P2P communications among all the devices, much like the ion is an integral element of the atom, and without it the atom would not be what it is. Making IoT devices able to exchange value between each other automatically with the use of smart contracts is going to create innumerable application scenarios for the whole industry, pushing it into a new era.

2. The development and weak points of the Internet of Things

IoT network is the key component of a new generation of Information Technology and it is also the indispensable stage of development in the Information Era. IoT stands for Internet of Things, and it means that when we reach this stage of Internet development, smart devices we use will be connected with each other. IoT network is applied widely in the integration of network through IntelliSense, Identification technology, Pervasive computing and other perceptive telecommunication technologies. Therefore, IoT is also named as the 3rd wave of global information technology after computers and Internet. IoT is vastly expanding the range of possible Internet applications. Therefore, we can say that application innovation is the core, and user experience is the soul of IoT development.

According to the statistics of IDC, and international data company based in USA, in 2015 the overall investment in global IoT market was 736.9 Billion dollars and it is predicted that this number will increase up to 1289.9 Billion dollars by 2020. This means that the average annual growth rate of the industry is 15.02%. The number of IoT devices carrying IoT software and transmitting data have reached 14.866 billion in 2015, and it is predicted to grow up to 30 billion by 2020.

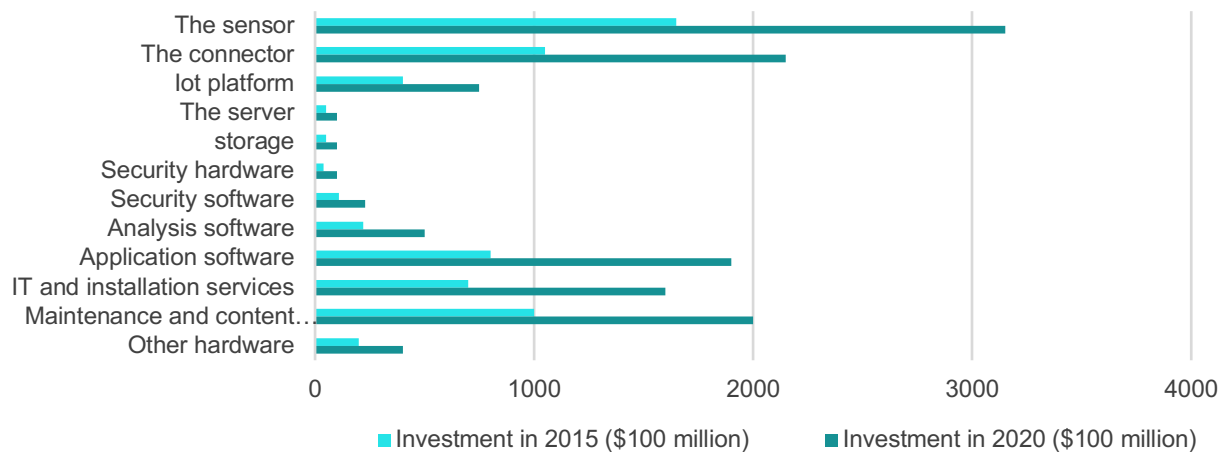


Figure 1.1 IoT industry development trend in next five years

The IoT market in China is projected to grow from 930 billion RMB in 2016 to 1830 billion RMB in 2020, which means doubling in size by 2020(Data source: China Industrial Information Network).

It has been 20 years already since the concept of IoT was first proposed. Since then, the technology has evolved and developed, making a big progress. However, at the stage we are today, there are still some serious unresolved issues:

1) Business model for the IoT industry still not established

In every information industry revolution, a well established business model is inevitably emerging. However, in case of IoT we don't have any such model clarified yet. RFID is up to now the only example of a large-scale IoT deployment. The main economic benefits of IoT introduction are mostly derived from the enhanced performance of various electronic components while huge data resources generated by IoT have not been applied in any large scale business scenario yet.

2) Lack of data security and privacy protection

Data security and privacy protection have always been one of the most serious threats brought by the emerging Internet technology. IoT devices are gathering data of both businesses and individuals. It is possible to use this data to trace the activity of businesses and individuals which raises concern among many people, especially that the majority of IoT data is stored in the hands of only a handful of companies from the top of the ecosystem.

A single user is not able to control the private data he/she provides to the system. He/she doesn't know where does it go or how is it used. In recent years there have been cases of successful hacker attacks on those huge centralized storage servers where major companies store data.

3) Lack of interoperability between platforms

The centralization of IoT data creates barriers for data sharing and circulation. Leading companies in nearly every industry are rushing to stake their claims on the new market frontier of IoT Big Data, hoping to take the lead in this new chapter of Information Age. However, it is often the case that many other companies that could potentially utilize this data are competitors with those big industry leaders. This creates a situation where real data sharing is just an empty talk - without it being traded and circulated it becomes very difficult to extract the real value of it and realize its potential.

4) The shackles of cloud computing architecture

In recent years the network bandwidth increase has been increasing exponentially. Cloud computing is now mainstream in IoT industry. However, for application scenarios that require real-time interactions, such as VR, industrial IoT and autonomous driving, IoT networks built on cloud tend to see delay of up to several hundred milliseconds from perception to execution, which is too slow a response to the control end.

3. Disruption of the traditional IoT industry with the use of edge computing

Edge computing technology is an open platform that integrates network, computation, storage and applications at the edge of the network, near the source of the data. It can be a solution to IoT sector problems in terms of fast connection, real-time operation, application intelligence, data optimization, security&privacy protection and so on. Edge computing is a bridge between the physical entities and industrial connections. Cloud computing layer is still able to access the historical data of the Edge layer.

The emergence of edge computing technology comes along with the development of intelligent terminals, which has gradually attracted attention of the practitioners from numerous industries. Many people are presenting edge computing as opposed to cloud computing. However it is better to

see them as complementary. Under the right conditions, the Edge can become a crucial optimization layer of the Cloud.

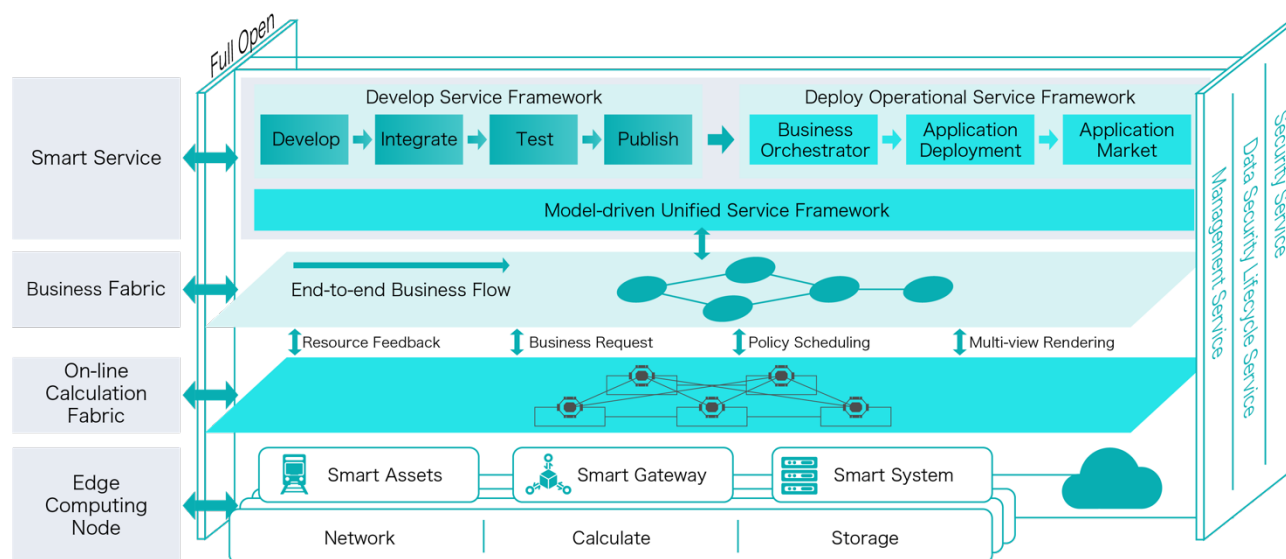


Figure 1.2 Reference architecture 2.0 of edge computing

It's been proven at this point that traditional cloud computing architecture cannot provide the real-time response requested in many application scenarios. Using edge computing in Industrial Internet of Things, Smart Home technologies, Internet of Vehicles, and other IoT areas is going to decrease the network feedback latency, improving the user experience and significantly expanding the amount of use case scenarios.

Edge computing technology solves the long-standing IoT industry problems of adequate privacy protection and data security. Despite the promises made by top cloud services providers, data breaches are still occurring fairly often and concern for privacy is ubiquitous. By utilizing the edge computing technology we are going to empower the users, letting them take control of their data and set up the limits of who can access it. At the same time, edge computing can still seamlessly integrate with the cloud computing platform which allows for a flexible design of a system.

Processors based on ARM architecture are in all kinds of nodes within the IoT network, from mobile phone to router and from UAV to industrial terminal. Devices' chip performance still follows the Moore's Law, the nodes of IoT networks are being programmed to perform more and more complicated data processing, moving on to contain storage or even AI solutions. At this point in the development of IoT technology, we already have large enough number of smart devices to be able to generate enough data required for many complex application scenarios. Reconstructing the

traditional IoT network infrastructure and integrating it with edge computing architecture will be one of the main tendencies in IoT for the next few years.

4. IONChain network built for computing at the edge (IONChain Fog Computing)

At the early stage of IONChain project development, the focus is put on ensuring data security and help facilitate data circulation, trading and sharing. The intention is to break the regular platform barriers and establish the connection with IOT network nodes of any type or scale through decentralized blockchain technology. Each of the IoT device manufacturers, IoT constructors, data owners and requestors can take what he or she needs within the IONChain network to form a completed closed loop of IoT business.

IONChain meets the architecture requirements of the Edge computing technology perfectly and can make full use of the computing power of the network nodes themselves. These nodes will meet the nearby connecting requirements for computation and storage of IoT devices. This will lead to increases in the time efficiency of the IoT perception-computing-response process. There are a large number of application scenarios which require low feedback latency within the IoT network. The edge computing solution could be the creative platform for these scenarios. These fields will have a negligible effect on cloud computing.

Dependent on the features of edge computing, IONChain introduces the concept that “every device is a mining machine”, which means that each of the IoT devices connected to IONChain will be able to mine and receive remuneration through the „Ionization algorithm“. The system will accurately calculate the precise rewards from the functions, data volume, time (e.g.: time length of terminal controlled, time length of data collection, etc.) 、 space (areas covered by terminal or terminal cluster) and many other dimensions. IONC will incentivize self interested small or medium enterprises or even individuals to join IoT projects and push forward the development of IoT facilities. Thereafter it will enter the new dimension of public participation in the IoT systems construction and trading.

After a thorough research on existing IoT networks, the IONChain team has come up with an innovative concept that we called “One Device, One Coin, One Code”. Our system was developed with the premise of integrating the current IoT hardware and infrastructure. “Device” part in our concept stands for IoT devices, “Coin” stands for IONC and “Code” is the unique identification code

for the IoT devices inside the IONChain network. The identification code can be embedded in the hardware of IoT devices in order to “stamp” the data with it from the very beginning. This feature combined with the immutability of records on the IONChain distributed ledger makes all the data unique, reliable and therefore effectively traceable. At the same time, IONChain is going to provide software-level data conversion, data processing, data packaging tools and nodes for the already established Internet of Things system. With complete data security we can achieve the forward compatibility of our design. This is particularly important considering the current fragmentation of the IoT devices software market. We hope that this will also help to speed up the formation of industry standards.

In order to solve the contradiction between data block volume and transaction speed, IONChain introduces IPFS (Inter Planetary File System) to allow distributed, encrypted storage of IoT data. Access to the relevant data will be restricted only to the users in possession of the relevant private key. Stealing or tampering with the data is extremely difficult as security of IONChain is ensured by the combined computing power of all the mining devices in the system. It is important to note that one of the unique features of IONChain is that it provides infrastructure to utilize a myriad of IoT devices to participate in the mining process. Thanks to the separation of storage and transaction processing which solves the data block size/transaction speed contradiction, the system will be able to handle massive volume of IoT data in the future, which is in nature an additional layer of protection for the data security.

With the use of smart contracts technology, users can design their own digital agreements, automating the settlements of data trading. Data trading will evolve from human-to-machine to machine-to-machine. This in turn will result in the emergence of a multitude of innovative business models.

2. Application scenarios of IONChain

IONChain can adapt to whatever field an IoT network can cover and IONChain will be an indispensable cog within the IoT ecosystem in the future.

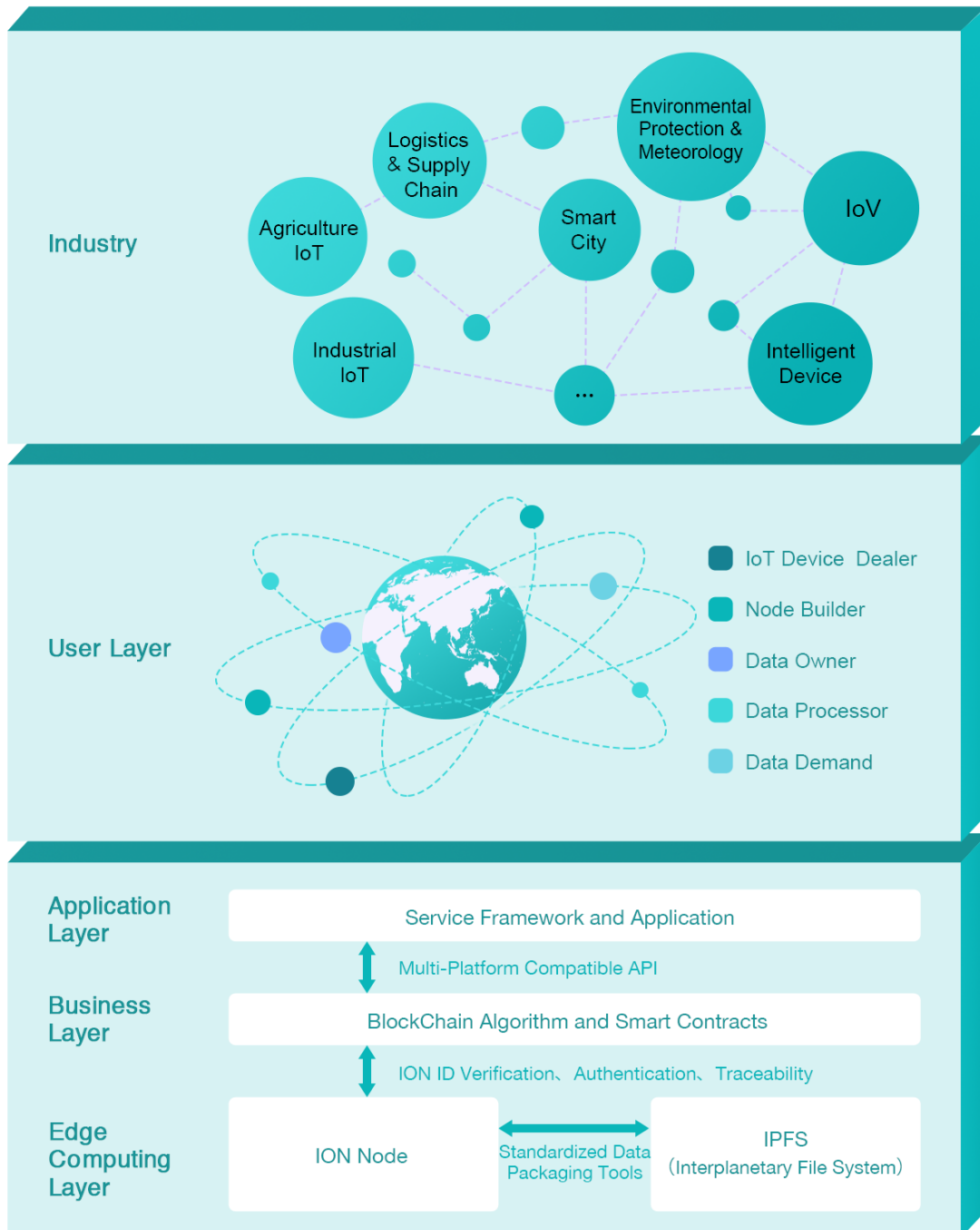


Figure 2.1 Relationship between IONChain and IoT

2.1. Data security and privacy protection

IONChain applies decentralized storage methods and heralds radical changes to IoT security and privacy. It has some unique advantages over traditional centralized networks in terms of defending from external attacks and surviving catastrophes.

Case 1: In recent years, there has been widespread concern and condemnation about smart devices violating the privacy of the individual, on smart phones or other smart devices. User's regular activities and behaviors are uploaded privately in the background, and this data forms clear user portraits for big data analysis companies to commercialize and exploit. These resources will be utilized towards targeted advertising, or copied, sold by batch, and even stolen by criminals. Thus, those who control the authorization of centralized nodes have a lot of power. IONChain will disrupt this situation, making IoT data flexible to store in local or distributed nodes with encryption to ensure the security so that users have absolute control on the data. This private data can be used either by yourself only or you have the option to exchange your data with other nodes who value it. Even if a certain node is under attack or encounters some disaster, no data will ever be lost.

2.2. Exchange and circulation of IoT data

In a traditional IoT network, the data processing and usage of the Internet owner is mainly limited to improving its own value. Meanwhile, the data relevant analysis is only determined within a certain scope of the IoT network. IONChain will break the island dilemma of IoT data and monetizing the process, which will enable the speeding up of data circulation and exchange.

1) B2B data exchange

In IONChain ecosystem, traditional production enterprises can be the data providers. Suppose the enterprise is a part of the existing IoT network. On top of the basic layer of the current IoT network a data trading node is added. The node provides standardized peripheral data interfaces. Terminal devices will then use those interfaces to upload various IoT data, packaged in an unified format(compatible with the IPFS) to the IONChain ledger. The data transactions will be automated using smart contracts. The private keys for downloading the purchased data packages will be automatically released after the funds transfer has been recorded on the ledger.

Case 2: Company A has built a production line, but is dissatisfied with the production efficiency after running it for some time. The production needs to be optimized. Via IONChain data trading platform, company A finds out that company B in Asia has released sensor data and production line video of a similar assembly line. Company A obtains sensor data and operation videos from Company B via IONChain and greatly improves its productivity. IONChain helps solve a cross-regional problem and removes technical barriers on a much lower cost.

2) C2B data exchange

Data providers can be IoT network participants with single or multiple IoT data sources. Data buyers can then publish data inquiries through IONChain network. Individuals can use IONChain to upload data which will be monetized later in the system. On the other side, companies can obtain this data which is normally scattered and hard to get and then integrate it to create value using big data.

Case 3: An Internet start-up company A wants to acquire personal information and the daily routines of car users to analyse data and develop a relevant business. This kind of data was previously monopolized by the mapping and navigation software giants. Up to now, it has been impossible for small companies to gather this data themselves using traditional methods. The process of attracting traffic and then acquiring user habits would take too long and so the company couldn't exist in the meantime as it wouldn't be profitable. However thanks to IONChain incentive model some of the car users will perhaps be willing to exchange their personal data for a compensation, automatically transferred to them with the use of smart contracts. Another company B can then publish a data request for the same kind of data that the company A have already gathered and analysed. In this case, company A can decide to sell or share the data and/or any relevant materials to the company B using the IONChain data exchange system.

2.3 Smart contract facilitates sharing economy

IONChain supports not only data exchange but also the transaction of operation authority. Smart contracts can be customized to pertain to certain scenarios, allowing device-human, and device-device interactions, and transferring value through the decentralized network.

Case 4: Take for example a residential district close to the CBD area, where there is often a huge demand for car parking. Some of the households are willing to rent out their empty parking lots

if they are not making use of them. By installing smart locks, the households and those seeking parking can automatically control who uses the parking space via smart contract and complete the transaction without any human intervention. Simultaneously property management staff can connect with IONChain as another node. After the transaction has been completed the profits will be calculated and distributed accordingly. Transaction settlements within the system will be dependent solely on IONC. There is no need to involve any bank or other third party institutions. No transaction fee will be required.

2.4 Edge computing optimizing IoT user experience

Some of the IoT applications could not materialize as they required very fast response time which could not be achieved with the cloud server latency. Thanks to the edge computing technology used by the IONChain, efficiency of the whole systems improves significantly and as a result new business ideas can flourish.

Case 5: A large-scale warehousing enterprise is using RFID devices and managing data using private cloud as data storage center. However, as their business expands and the number of warehouses keeps growing, it is becoming harder and harder to centrally manage such big amounts of data. This problem becomes most apparent at the end of the month when some data intensive operations such as inventory check up or incoming and outgoing stock settlements need to be performed. Issues of response timeout can occur frequently, adversely affecting the efficiency. IONChain nodes deployed in different warehouses will perform data intensive operations on the Edge which will greatly reduce data request and feedback time. At the same time data will be automatically synchronized in a distributed, more efficient way using the IONChain blockchain.

3. Overall technical architecture

As the next generation IoT network technical architecture based on Internet of Value, IONChain applies a unique IONIZATION algorithm to meet the requirements of the blossoming IoT industry. The inspiration for the IONIZATION algorithm comes from the formation of ions. Ionization is the process by which an atom or a molecule acquires a negative or positive charge by gaining or losing electrons to form ions, often in conjunction with other chemical changes. Similarly, the IONIZATION algorithm separates two core functions of the blockchain - value creation and value transfer. New business models will occur after combining through and separating the value creation layer and value transfer layer. Under the current blockchain technical architecture, value creation and value transfer are combined, which has great practical value in certain instances. The success of Bitcoin and Ethereum is based on this kind of algorithm. However, these algorithms are not suitable for the future requirements of the growing IoT industry. IONChain algorithms are designed to make it possible for every IoT device to become a mining machine allowing them to constantly create value. However as the IoT devices come in all types and forms, the value created is varied depending on the device type and function.

The requirements of IONChain future ecosystem cannot be met if we continue to follow the existing protocol which is a combination between value creation and value transfer. Hence the IONIZATION algorithm was developed for IONChain, and the *raison d'être* for this algorithm is to separate value creation and value transfer.

After the separation has been made, the value creation layer is responsible solely for creating the value. Each type of IoT device will have a specifically tailored algorithm designed. Just like the ions after ionization, the value created by different IoT devices in the IONChain network can be combined into new types of consensus algorithms that will 'translate' the value generated in different scenarios into the unified standard expressed in IONC coins.

Following on from this, the value transfer layer allows for transferring value within the IONChain system. All participants of the IONChain ecosystem can exchange their value freely through the value transfer layer.

3.1. IONChain Value Generation Process

The value generation process of IONChain can be divided into four layers of system architecture. These are value creation, value verification, value evaluation and value confirmation.

3.1.1. Value generation

Value generation encompasses IoT devices and Edge Computing Centers near the device, in which the IoT device means all kinds of devices connected to IONChain. All of them have default on the IONChain consensus protocol and have the IONChain identification code, in which the device manufacturer information, device identification, and other related information are included. All the information is stored in the device encrypted with zero knowledge proof algorithm. Each of the IoT devices can be used as a mining machine, and the information from it can produce IONC coins after certain algorithm verification. All the IoT devices embedded in IONChain communicate via customized IMQTT protocol by IONChain.

The MQTT protocol was initially developed by IBM for communication between IoT devices. However, it does not include the value transfer layer. IONChain adds the function of value transfer on top of MQTT protocol, creating IMQTT protocol. With the use of IMQTT protocol, IoT devices can not only exchange data, but also realize value transfer.

In order to support the currently still relatively weak computing capabilities of IoT devices, IONChain will help to set up the Edge Computing Centers. These will be the intermediary computing devices set up close to the IoT devices. Connected to the network, they would provide much higher computing power than the IoT devices alone. Using this intermediary computing layer makes it more reliable for IoT devices to join the network and transfer their data and value.

Value generation layer is therefore a combination of IoT devices and Edge Computing Centers. Due to the limited computing capabilities of IoT devices, it is hard to accurately calculate the value created by IoT devices. Thus, IoT devices upload relevant information to the mining machines, and the mining machines calculate accordingly using the Data Quality Proof and Time Lapse Proof algorithms. Upon completion of the value generation calculation, it is be passed to the next layer for verification.

3.1.2. Value verification

The value verification is similar to the consensus algorithm in other blockchains. The relevant parties interested in the data provided by an IoT device are required to cooperatively complete the

value verification. Upon completion, the value will be transferred to the next layer for evaluation. If the verification fails, the created value is returned as invalid.

3.1.3. Value evaluation

The value evaluation layer is the second tier of value verification. In this step, the verification of the authenticity of the value is completed. This process is jointly completed by the relevant parties. This layer of protection was set up in order to make sure that the IONChain system is able to counter malicious attacks such as double spending.

3.1.4. Value confirmation

The value confirmation function is to package the verified value, and then pass on the packaged information to the value transfer part, so that the value created by the IoT device is officially present in the IONChain ecosystem in the form of a digital currency.

3.2. Value transfer in IONChain

The value transfer part of the IONChain is divided into six layers in the system architecture. These are the application layer, Service Layer, IONChain Protocol Layer, Smart Contract Layer, Blockchain Layer and Data Storage Layer.

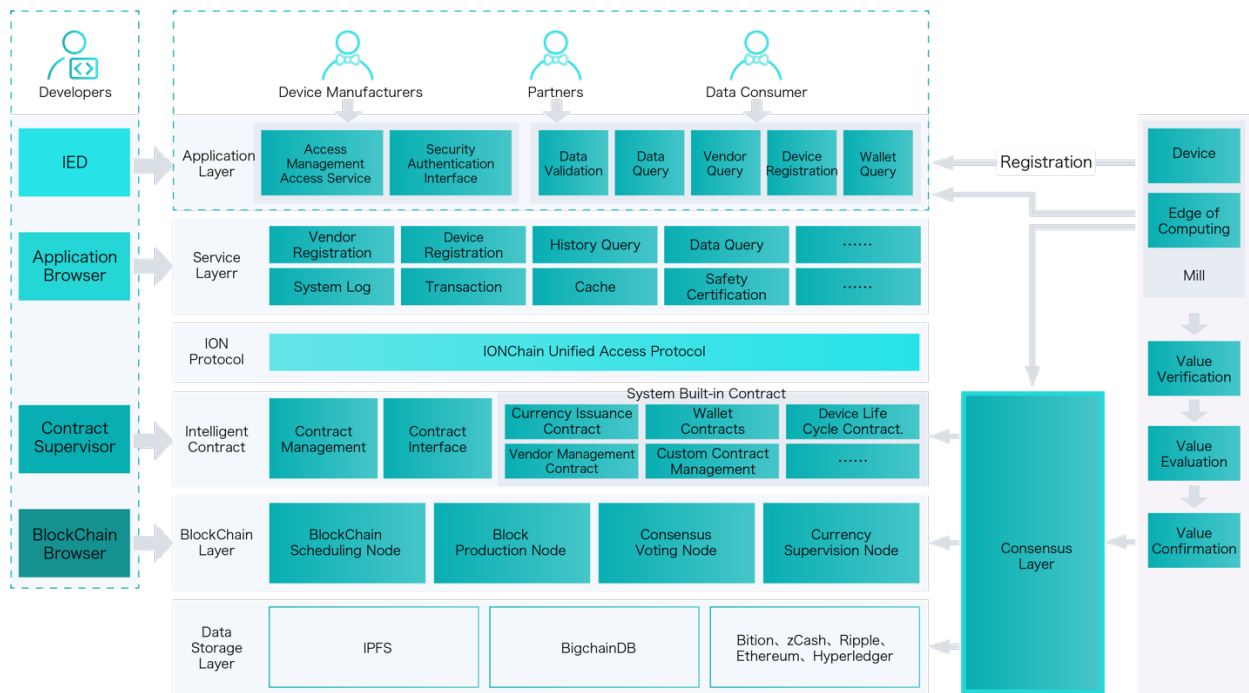


Figure 3.1 IONChain system architecture

3.2.1. Application layer

Application layer is the user interface layer of the IONChain. It provides REST API interfaces based on the HTTP protocol. The devices can request access to IONChain through this layer. IONChain interface provides anti-counterfeit verification function of both the IoT devices and the vendors. The application layer of the IONChain adopts the plug-in function to make it more convenient to connect new businesses. At the initial stage of the system development, the system will include the following built-in services: Data validation, Data Query, Vendor Query, Device Registration, Wallet Query.

3.2.2. Service layer

Service layer is an abstraction of the internal modules inside IONChain. The IONChain contains many components, all of which provide external interfaces through the server. The interface used by the service layer is generally a program rather than the end user. Therefore, the service layer interface adopts the binary-based GPRC protocol. The service layer is currently available only for the internal components. In the future, we will consider to make the service layer available also for the core nodes.

3.2.3. Protocol layer

IONChain provides a unified access protocol at the protocol layer, including consensus protocol, network protocol, currency swap protocol, and so on. IONChain provides external services through a unified protocol. In the future development of the IONChain platform, the IONChain protocol will be a common protocol for all third-party applications.

3.2.4. Smart contract layer

Smart contracts are an important part of the IONChain. They are the bridges connecting blockchain layer with the applications. At the same time, smart contracts also play an 'adhesive' role, allowing to bind user requirements and blockchain consensus algorithms together. They make sure that users can legally and safely use the data stored on the blockchain in order to create added value. The smart contract layer consists of two parts: contract management and contract interface. Contract management is responsible for the deployment, installation, debugging, running and other operations of a smart contract. Smart contract interface is provided for external systems. The IONChain provides a set of system contracts for system-related operations. Those include:

1) Currency issuance contract

The currency issuance contract is used for currency issuance, re-issuance, lock and other functions. It is maintained together with relevant nodes and only valid after it is multi-signed. The currency issuance contract is the core of IONChain and it is maintained with the IPOS consensus algorithm.

2) Wallet contract

Wallet contract is used to manage user's wallet. Both IoT devices and participants have their own wallet accounts. The wallet contract is for wallet creation, maintenance, freeze and so on.

3) IoT device life cycle contract

The device contract is specifically set up to manage the maintenance of a device life cycle. It includes uploading device information onto the chain, information circulation, activation, deletion and other related actions..

4) **Manufacturer management contract**

This contract is used to maintain equipment manufacturer information, which includes uploading manufacturer information onto the chain, information circulation, freeze, release and so on.

5) **Custom Contracts Manager tool**

The Custom Contract Manager tool allows users to develop and manage their own contracts. It can be used by all the users, but the user-defined contracts can only be seen by the accounts authorized by the contract creators. Custom Contract Manager provides users with custom contract lifecycle management capabilities.

3.2.5. **Blockchain layer**

The blockchain layer is the core of IONChain, and consensus algorithm is the most important part of the blockchain layer. In order to better match the features of IoT network IONChain applies some changes to the classic POS algorithm. Upon adding our modifications, we have called this new algorithm IPOS.

IONChain revises the algorithm to match IoT requirements better, creating the IPOS algorithm. IPOS algorithm is the upgrade of POW and POS, and it is divided into two parts: electing a group of block producers and scheduling production. The election process makes sure that stakeholders are ultimately in control because stakeholders lose the most when the network does not operate smoothly. How people are elected has little impact on how consensus is achieved on a minute to minute basis. Therefore, this document will focus on how consensus is reached after the block producers have been chosen.

To help explain this algorithm I want to assume there are 3 block producers: IoT device supplier (A), IoT data consumer (B), and IoT authority (C). Because consensus requires $2/3 + 1$ to resolve all cases, this simplified model will assume that IoT device supplier (A) is deemed the tie breaker. In the real world there would be 21 or more block producers. Like in Proof of Work, the general rule is that longest chain wins. Any time an honest peer sees a valid strictly longer chain it will switch from its current fork to the longer one. I will show by example how IPOS operates under some conceivable network conditions. These examples should help you understand why IPOS is robust and hard to break.

1) **Normal Operation**

Under normal operation block producers take turns producing a block every 3 seconds. Assuming no one misses their turn then this will produce the longest possible chain. It is invalid for a block producer to produce a block at any other time slot than the one they are scheduled for.

2) Minority Fork

Up to $\frac{1}{3}$ of the nodes can be malicious or malfunction and create a minority fork. In this case the minority fork will only produce one block every 9 seconds while the majority fork will produce 2 blocks every 9 seconds. Once again, the honest $\frac{2}{3}$ majority will always be longer than the minority.

3) Multiple Production by Disconnected Minority

The minority can attempt to produce an unlimited number of forks, but all of their forks will be shorter than the majority chain because the minority is unable to grow the chain faster than the majority.

4) Network Fragmentation

It is possible for the network to fragment so that no fork has a majority of the block producers. In this case the longest chain will fall to the largest minority. When network connectivity is restored the smaller minorities will naturally switch to the longest chain and unambiguous consensus will be restored.

It is also possible to have 3 forks where the two longest forks are the same length. In this case the producers on the 3rd (smaller fork) will break the tie when they rejoin the network. There is an odd number of producers so it is impossible to maintain a tie for long. Later we will cover producer shuffling which will randomize order of production to ensure that even if two forks have the same number of producers, the forks will grow in different length bursts causing one fork to take over the other, which helps to avoid double spending.

5) Multiple Production by Connected Minority

In this scenario minority IoT consumer (B) produces two or more alternative blocks on their time slot. The next scheduled producer IoT authority (C), may choose to build off of any one of the alternatives produced by IoT consumer (B). When this happens, it will become the longest chain and all nodes that selected IoT consumer (B1) will switch forks. It does not matter how many alternatives

blocks a minority of bad producers attempts to propagate, they will never be part of the longest chain for more than a round.

6) Last Irreversible Block

In the event of network fragmentation, it is possible for multiple forks to continue to grow for a prolonged period of time. In the long-run, the longest chain will win, but observers require a means to know with certainty when a block is absolutely part of the fastest growing chain. This can be determined by checking the confirmation by $2/3+1$ of the block producers. Note that this “rule” is similar to the 6-block confirmation “rule” for Bitcoin. Some smart individuals can contrive a sequence of events where two nodes could end up on different last irreversible blocks. This edge case requires an attacker to have total control of communication delay and to utilize that control not once, but twice, minutes apart. If this were to happen, then the long-term rule of the longest chain still applies. We estimate the odds of such an attack to be close to 0 and the economic consequences to be so insignificant that it is not worth worrying about.

7) Lack of Producers Quorum

In the unlikely event where there is no clear quorum of producers, it is possible for the minority to continue producing blocks. In these blocks stakeholders can include transactions that change their votes. These votes can then select a new set of producers and restore block production participation to 100%. Once this happens the minority chain will eventually overtake all other chains operating with less than 100% participation. During this process all observers will have the knowledge that the network state is in flux until a chain emerges with 67% participation. Those who choose to transact under these conditions take risks similar to those who choose to accept less than 6 confirmations. They do so with the knowledge that there is some small probability that consensus may ultimately settle on a different fork. In practice this situation is far safer than accepting blocks with less than 3 Bitcoin confirmations.

8) Corruption of Majority of Producers

If the majority of producers become corrupt then they can produce an unlimited number of forks, each of which will appear to be advancing with $2/3$ majority confirmation. In this case the last irreversible block algorithm reverts to longest chain algorithm. The longest chain will be the one approved by the largest-majority which will be decided by the minority of remaining honest nodes.

This kind of behavior would not last long because the stakeholders would eventually vote to replace these producers.

9) Transactions as Proof of Stake (TaPoS)

When users sign a transaction, they do so under a certain assumption about the state of the blockchain. This assumption is based upon their perception of recent blocks. If the consensus on the longest chain changes then it could potentially invalidate the assumptions the signer had when they consented to the transaction. With TaPoS all transactions include a hash of a recent block and are considered invalid if that block does not exist in the chain history. Anyone who signs a transaction while on an orphaned fork will find the transaction invalid and unable to migrate to the main fork. A side effect of this process is security against long-range attacks that attempt to generate alternative chains. Individual stakeholders directly confirm the blockchain every time they transact. Over time all blocks are confirmed by all stakeholders and this is something that cannot be replicated in a forged chain.

10) Deterministic Producer Shuffling

In all the examples we showed a round-robin scheduling of block producers. In reality, a set of block producers is shuffled every N blocks where N is the number of producers. This randomization ensures that block producer B does not always ignore block producer A and that anytime there are multiple forks of identical producer counts that ties are eventually broken.

11) Conclusion

IPOS is robust under every conceivable natural network disruption and even secure in the face of corruption of a large minority of producers. Unlike some competing algorithms, IPOS can continue to function when a majority of producers fail. During this process the community can vote to replace the failed producers until it can resume 100% participation. There is no other consensus algorithm that is robust under such high and varied failure conditions.

Ultimately IPOS gains significant security from the algorithms chosen to select the block producers and verify that the nodes are of high quality and unique individuals. Using the process of approval voting ensures that even someone with 50% of the active voting power is unable to select even a single producer on their own. IPOS is designed to optimize performance of the nominal condition of 100% participation of honest nodes with robust network connections. This gives IPOS

the power to confirm transactions with 99.9% certainty in an average of just 1.5 seconds while decreasing in a graceful, detectable manner that is simple to recover from.

3.2.6. Data storage layer

IONChain provides two ways to store data on the blockchain, which are based on IPFS and BigChainDB.

IPFS is an emerging standard for storing content addressable files. Content-addressable storage is a mechanism for storing information that can be retrieved based on its content rather than its location. Stated another way, all files stored using IPFS are given names derived from the hash of their content.

What this means is that the same file will have the same name on every computer, and the contents of that file can never change without also changing the name of the file. It also means that when you download a file from a server you can verify that it is the exact file you requested by recalculating the name based on the content provided by the server.

IPFS also provides a peer to peer (P2P) network layer that allows computers to discover and share files based on their deterministic names. However, this P2P network layer does not provide or guarantee storage, hosting, or bandwidth. As it is currently structured, the IPFS network expects users to provide their own servers and related infrastructure.

The final version of IONChain is to provide all IoT devices with legal identifications, and because of the strict requirement for data storage capacity, IONChain chose the IPFS system.

IPFS system can store smart contract data, transaction records, and other core data. However, IONChain is designed for future IoT networks, which need to store also the business data. Therefore, IONChain introduces BigChainDB as business data storage engine to meet data research requirements. BigChainDB has some advantages of blockchain, like decentralization, immutability and asset registration & transfer. Decentralization is realized through the consortium which consists of nodes with voting rights. The consortium is a P2P network composed of super nodes. (Light takes 70 microseconds to run half circle of the earth, and some of the financial application need latency from 30 to 100 microseconds. Because of the network bandwidth limit, these nodes should be set up close to each other . Voting is on top of the uniform function layer in the database. The immutability function is realized through several schemes: fragmentation replication, not allowing for updates or revisions, regular database backup, all signature encryption, block and vote. Every vote

on each block must include the hash of the previous block. Every entity which has the right to create asset is able to establish their own asset; the new asset can only be accepted by the new owner only if it meets the encryption requirements. This means hackers or hacked administrators have no access to modify any data, and there is no risk of single point of failure. Scalability of the system allows legal contracts and certificates to be stored directly in the blockchain database.

IONChain provides intelligent contract engine with highly customized abilities, and all kinds of operations can be completed via smart contracts. The contract management depends on IPOS consensus algorithm, and the system is governed by machines other than man. There is a built-in system contract based on IPOS algorithm, and it has higher authority than normal user contract. The system contract needs multi-authorization before it is done.

4. Economic model

4.1. Commercial value of IONC token

IONC is the official token of IONChain. It can be utilized by different participants in IONChain ecosystem. The maximum supply of IONC is 800 million. It is going to be released gradually for 20 years. After 20 years, the administrative committee elected by IONChain users using the consensus mechanism will decide whether to re-issue IONC tokens based on the amount of on-chain devices, amount of data being processed and the overall level of IONC abundance in the ecosystem.

IoT devices and data access constitute the core parts of IONChain ecosystem, therefore IONC token is going to be used to reward devices and data providers. The yearly supply of IONC tokens increases along with the demand for data access. However, the upper limit is pre-set.

IONC token is an indispensable part of the IONChain system as it is a single most crucial part of its economic model.

From the perspective of the ecosystem:

IONC token is the only authorized cryptocurrency, which binds together all the participants of the IONChain ecosystem allowing them to take part in the value creation process within the system. The overall value of IONChain is going to increase as more and more transactions and purchases are going to happen within the network. The IONChain mining rewards mechanism is aimed at increasing the participation rate of all IONChain users, incentivizing many smaller IoT devices to participate in the mining process thus effectively decentralizing it.

From the perspective of an individual:

To build up a complete ecosystem, IONChain is going to distribute rewards to the users in exchange for the access to their IoT devices and for the generated data. IONChain data and user privacy protection is based on encryption algorithms and anonymity. Uploading data is rewarded with IONC tokens. Users can also spend the tokens to purchase various value-added services within the ecosystem.

From the perspective of business entities:

With more and more IoT data gradually uploaded to IONChain, the value of the whole ecosystem for big data analysis and AI related use cases will keep increasing. Business entities will be willing to purchase IONC tokens in order to be able to use them paying for on-chain data analysis services. Those services can help enterprises improve their business. They can also provide a basis for completely new types of business models.

Apart from that, IONC token can also be used in the following situations:

- a) Rewards for the IoT devices used as miners;
- b) The longer you hold the tokens, the bigger your chance to be elected as the IONChain council member, subject to the Constitution and requirements therein;
- c) Compensation for the cost of running data search, statistics and smart contract analysis. Nodes running smart contracts will get awards accordingly;
- d) As the fuel for running DAPP on the ion chain, the node running the API called by DAPP will receive the reward corresponding to the running consumption of API;
- e) As a transaction fee for transferring the IONC currency between accounts, the billing node award is paid accordingly;
- f) Each IONC coin can track its origins, and can save and trace part of the data through the IONC currency;
- g) nodes responsible for the communication between IONs (access to IoT devices) on IONChain, and accounting will get corresponding awards;
- h) R&D expense for the developers is a compensation paid by IONC users.

4.2. IONC token distribution

The IONChain platform issues its own system token: IONC, total supply is 800 million.

- Circulation: 25%
- Mining rewards: 25%
- Community construction & incentives: 20%
- R&D Team: 20%
- Node incentives: 10%

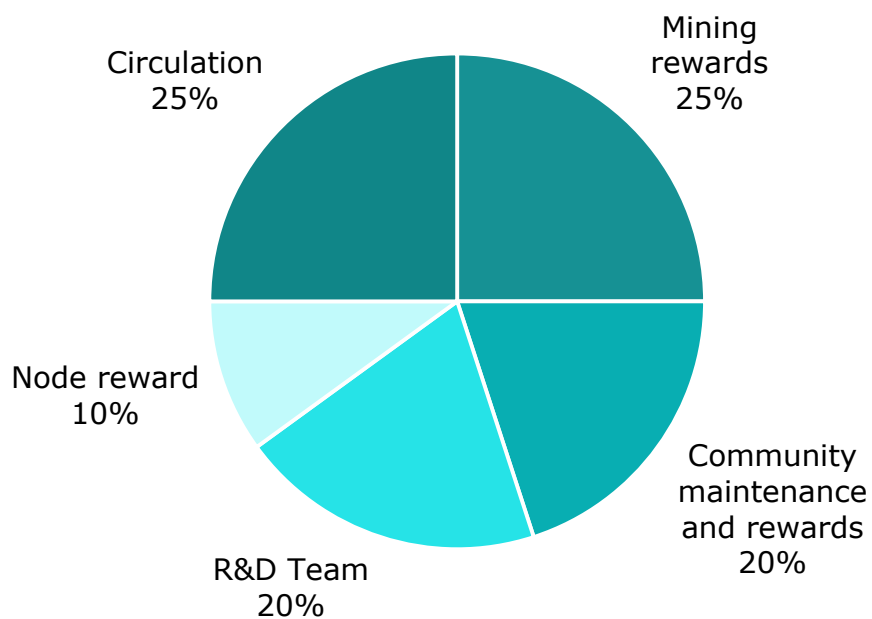


Figure 4.1 IONChain economic model

4.3. IONC token distribution explanation

1) Circulation

IONChain platform will give away IONC tokens for community promotion, up to 25% of the total amount of tokens to be issued.

2) Community construction & incentive

Of the digital currency issued by the IONChain platform, 20% of the will be used to support and incubate various IONChain-based DAPPs. We are also relying on the power of our community to keep the IONChain moving forward. Of course, after the IONChain R&D team completes the architecture, it will also work on the R&D of DAPP commercial applications. Also, IONChain is going to provide community applications with both fund and technical support, which is an important economic strategy to facilitate the improvement of IONChain.

3) Mining Reward

On the IONChain, each device is a mining machine. All IoT devices connected with IONChain will work as mining machines to provide computing power and participate in the consensus mechanism. IONChain platform will incentivize IoT manufacturers to join in with 25% of the total supply tokens, which includes device authorization, connection,, access, data provision, transactions, forwarding, traffic, etc. (Any DAPP based on IONC protocol produces positive interaction on the data asset provided by IoT terminal).

4) Node incentive

For any blockchain project, it is required to build up consensus scheme to make sure the global state of all the nodes is the same. IONChain will use 10% of the total token supply to incentivize the nodes to provide computing power and storage guarantee.

5) R&D Team

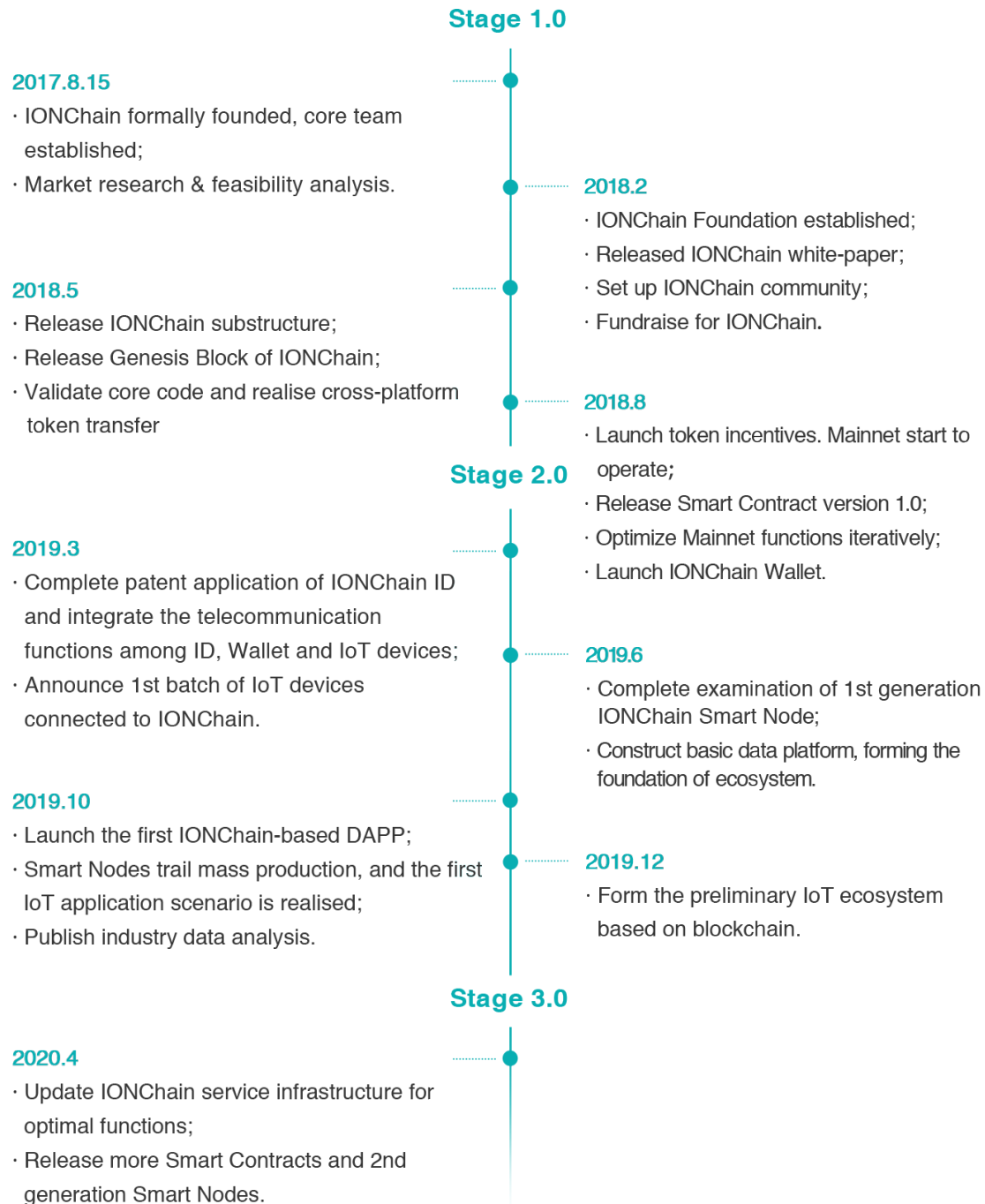
IONChain will take out 20% of total tokens to incentivize the founding team because they have provided resources and technical support for early development of IONChain. However, to ensure smooth development of IONChain project, token reward for team members will be locked for 36 months.

33% of the reward tokens will be released 12 months after the initial IONC token sale, and it takes up 6.6% of the total supply; 24 months later, 33% of the reward tokens will be unlocked, which is 6.7% of the total supply; in the 36th month, we will unlock the rest of the 34% reward tokens, which will account for 6.7% of the total supply.

The whole process above will be completed in the 36th month.

5. Road map

The IONChain is committed to building new technical standards and redefining the value of the Internet of Things. Therefore, the challenges faced by IONChain are unprecedented. The expected roadmap for development is described below:



6. Core team members and consultants

6.1. Core team members



Terry Liu
CEO & Founder

- 16-year experience of consulting and system architecture.
- Technology team management experience with over 300 employees.
- Former CTO of Onechain Fintech, Founder of Vonechain Blockchain and IoT systems.
- Former senior director of Accenture.
- Integrated Technology expert, designed integration solutions for Huawei, China Mobile, SAIC and so on.
- Senior blockchain lecturer for MA courses at Fudan University.
- MBA of East China Normal University.



Robert Feng
Technical Director

- 15 years experience of programming and systems architecture
- Founder of technical blockchain community BlockchainBrother .
- Core developer of Hyperledger project in China.
- Participated in the development of Hyperledger Fabric Explorer open source project .
- First author of 《Practical application of blockchain》 published by China Machine Press.



Danny Yü
Product Director

- More than 10 years experience on IoT device design.
- Industries including agriculture, medical, intelligent scenic spot and intelligent gateway.
- complete top-level design of IoT systems and application scenarios.



Eric Fang
BD and Ecological
Construction

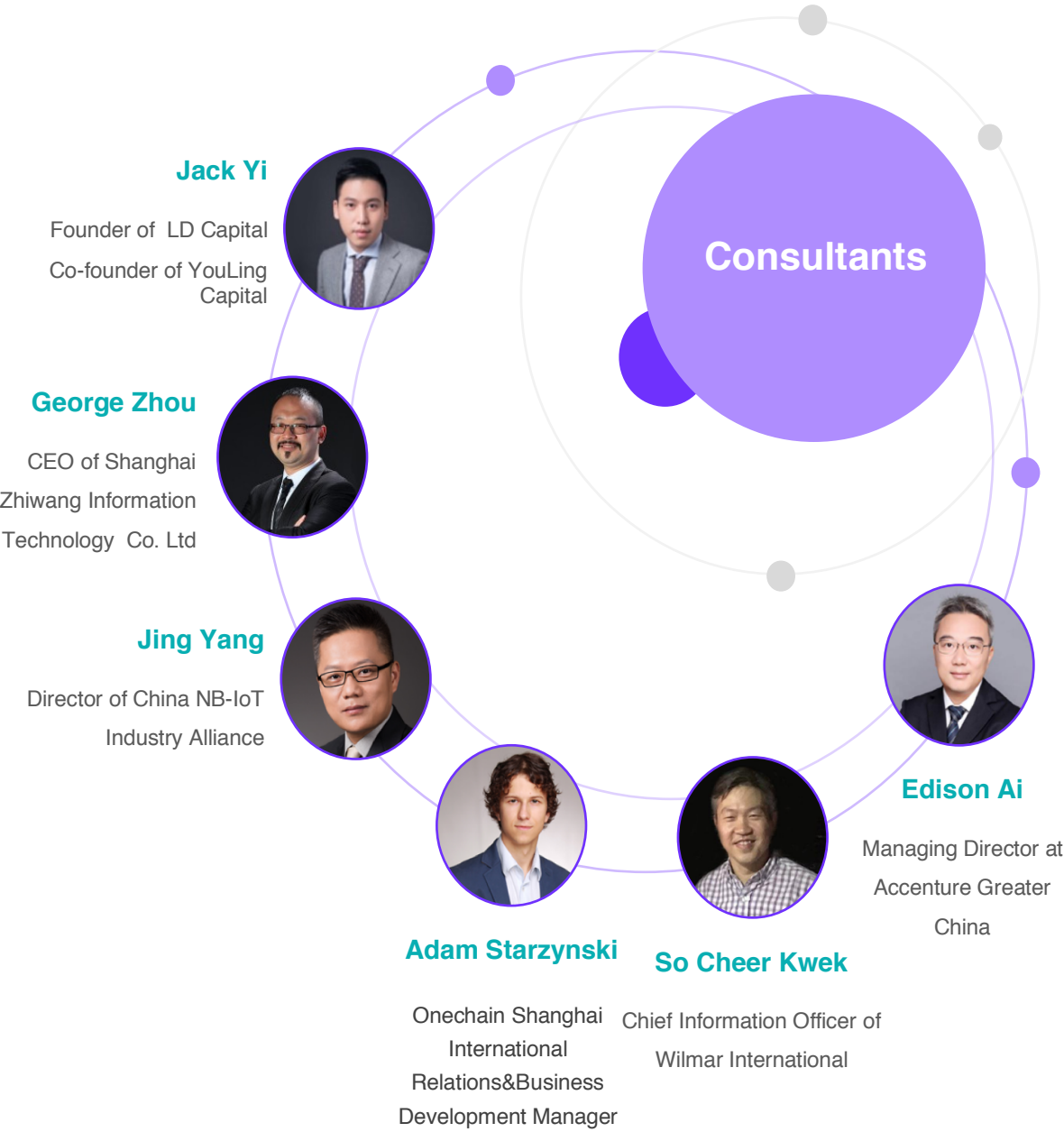
- Co-founder of Shidian Capital.
- Over 10-years experience on marketing development and business management in telecommunication industry, worked for Huawei US, HTC China and China Unicom (Shanghai), etc. Practical experience on managing enterprises with various attributes and intercultural teams.
- More than 5-years experience in ecosystem build-up for startup companies. In 2011, started the first entrepreneurship NGO in Shanghai and is now a Deputy Chairman of Shanghai Entrepreneurial Alliance.
- 2-year experience on cryptocurrency investment and blockchain projects management. Invested in more than a dozen different projects. Master of Information Technology from University of Birmingham, National Senior Entrepreneurship Consultant, travelled over six continents, enjoys long-distance running, exercises and reading.



Daniel Wu
Chief Architect

- Blockchain Technology & Security Encryption Expert
- Hyperledger China core developer, participated in Hyperledger Fabric Explorer project development
- In blockchain programming since 2014

6.2. Consultants



7. Disclaimers

This document is for information purposes only and the content is for reference only. It is not an invitation or an offer to invest in IONChain or any related company stakes or securities. . The above information or analysis does not constitute any specific investment recommendation or advice.

None of the content in this documentation shall be construed expressly or otherwise as an invitation or offer for investment. The contents of this document shall not be construed as an invitation to participate in fundraising of any form. Nothing in this White Paper whether expressly stated or otherwise shall be treated as encouraging participation in any fundraising activity. The request for a copy of this White Paper or sharing this White Paper with others shall not amount to any representation on your part or on the part of IONChain nor shall it be construed as an offer on your part or on the part of IONChain.

All participants have to meet the required age in their countries to have full capacity and shall be solely responsible to comply with the laws of the country that he/she is residing in. All participants represent that he/she has acted voluntarily and have a clear understanding of the IONChain platform, and the contents of this White Paper.

IONChain will ensure that all the information in the White Paper is up to date and accurate. In case of any misunderstanding caused by an inaccurate translation in this White Paper or in any other situation where there is discrepancy between the original version and this White Paper, the participants acknowledge that the original version of this White Paper is in the Chinese language.

During the development process, our platform design might be subject to modifications and updates, including but not limited to platform scheme, token system, token distribution and so on. Should the contents of this White Paper change at the later stages of the project development, our team will publish announcements and updated versions of the White Paper to keep all parties informed and up to date with the project.

IONChain shall not be responsible for any loss, damage however caused whether directly or indirectly to any party arising out of or in connection with any contents of this White Paper or any reliance on this White Paper:

IONC is the official token of the IONChain platform, which is a vital tool for the efficiency of the platform. It is not an investment product. Owning IONC tokens does not entitle the owner to the ownership, control or decision-making authority of IONChain platform. IONC is the encrypted token of the IONChain platform. It does not fall into any of the categories listed below:

a) *Any kind of currency;*

- b) Securities;*
- c) Stakes of legal entities;*
- d) Shares, bonds, bills, authenticated stakes, certificates or any other documents having legal consequences;*
- e) Debenture; and*
- f) A unit in collective investment scheme.*

Whether the IONC value will increase is dependant on the market discipline and market demand for the use of IONChain platform. In the worst case scenario it may even not have any value at all. IONChain and IONChain Foundation do not make any promise or representation on the increase or decrease in the value of IONC tokens and shall not be liable for any loss or damage howsoever caused in the event of the increase or decrease of IONC tokens.

To the maximum extent permitted by applicable law, the team is not responsible for the damage and risks arising from the participation in the issuance of IONC tokens including, but not limited to, direct or indirect personal damage, loss of commercial profits, loss of business information or any other economic loss.

IONChain platform will comply with any regulations and industry self-regulations that are beneficial to the healthy development of the industry. All the IONC token holders are required to accept and follow the relevant regulations and/or inspections required by the authorities. At the same time, they need to disclose all the information required to complete such inspections. All this information should be complete and accurate.

The IONChain platform clearly presents the possible risks to the participants. By deciding to participate in the issuance of IONC tokens , participants confirm their understanding of the terms and conditions detailed in the original Chinese version of the White Paper and translated to English for reference only.

Participants accept the potential risks of their participation and decide to take responsibility for all the possible risks, loss, damage and consequences.

ANNEX 1 – LEGALESE AND RISK FACTORS

1. RISK FACTORS

The token sale, the business and operations IONChain Foundation (including but not limited to the issue and distribution of IONC) (collectively, the “**Project**”) are subject to numerous risks, many of which are beyond the control of IONChain Foundation. Outlined below are certain development risks associated with the Project, and does not cover all risks associated with the Project.

Each participant should complete independent due diligence into the Project, peruse, comprehend and consider carefully the risks described in this White Paper before deciding to support the Token sale. Supporting the Token sale shall be an action based upon prudent decision and will be deemed as the relevant Participant having been fully aware of and agreed to take all the risks described in the White Paper.

1.1 TECHNOLOGY

(i) **Development.** Without completing the development of the IONChain, it will be impossible to fully anticipate the challenges associated with ensuring the IONChain is able to incorporate the components. Depending on the implementation challenges, there may be changes to the design, implementation plans and execution of the IONChain. While the IONChain Foundation team will use its reasonable efforts to develop and implement the IONChain, there is no assurance that a completed version of the IONChain will be released and there may not be an operational IONChain.

(ii) **Key man risk.** The development team currently consists of less than 40 developers. Expansion of the team will be a priority for IONChain Foundation following the token sale.

(iii) **Reliance on internet infrastructure.** The IONChain relies on the performance and reliability of the internet infrastructure of the markets in which it operates. There may not be alternative networks or data servers in the event of failures or interruptions with the internet infrastructure. Any unscheduled service interruption or failure could result in unavailability or limited performance of the IONChain.

(iv) **Errors in source code.** Despite security audits and peer review, nobody can guarantee that the code used by both IONChain Foundation is error free and IONChain does not represent the same. It may contain certain flaws, errors, defects and bugs, which may disable IONChain in its operations. Such flaws, if any, would compromise the usability, stability, and/or security of both the IONC and the IONChain, and consequently bring adverse impact on IONC and the IONChain. By disclosing this, IONChain has expressly set out the limitations to the source code and shall in no way be liable for any loss or damage suffered arising out of or in connection with such errors.

1.2 TOKEN

(i) **Loss of private key.** Private keys are necessary for accessing blockchain assets. Should a private key be lost or destroyed, access will be permanently unrecoverable. The loss of a private key either by IONChain Foundation or a participant could result in the loss of IONC.

(ii) **Compromised conversion process.** Once main chain of IONChain has completed, IONC will

be transferred from ERC20 to the main chain of IONChain. Should the main chain of IONChain or ERC20 become compromised by a hack or other mechanism, there is no certainty that IONChain Foundation will be able to issue to holders of the IONC the accurate number of IONC at all.

(iii) **Volatile nature of cryptocurrency.** Since IONChain Foundation will need to use funds in the fiat currency of each market the company operates in, a drop in the value of the funds will result in reduced resources for IONChain Foundation to operate.

(iv) **Liquidity of IONC.** Trading of the IONC is not a responsibility or objective of IONChain Foundation. Secondary trading of the IONC will be conducted between voluntary market participants. There may be a possibility that the IONC is not attributed any value or offered for trading by exchanges or marketplaces, which would incur difficulty for the token holder to divest their tokens. Due to different regulatory regimes in different jurisdictions and the obstacles of citizens of certain countries to open accounts at cryptocurrency exchanges, the liquidity of IONC may be materially different in different countries thus resulting in substantial price discrepancies.

1.3 COMPETITION

(i) **Perceived or exposed flaws.** It is possible that a comparable product could become popular due to a perceived or exposed flaw of the IONChain that is not addressed by IONChain Foundation effectively and expediently. There may also be a perceived advantage of a comparable product that includes features not incorporated in the IONChain. If this product achieves a significant market share, the financial condition of IONChain Foundation will be adversely affected and there may be a negative impact on the demand for, and price of, the IONC.

1.4 SECURITY

(i) **Privacy of IONChain Foundation Private Net.** IONChain Foundation has access to a large amount of information through the IONChain, and the improper use or disclosure of such information could harm our reputation. IONChain Foundation may be subject to security breaches and attacks, which may compromise the security of the information store in the private net IONChain Foundation maintains. IONChain Foundation may not have the resources or technical sophistication to anticipate or prevent rapidly evolving types of cyber-attacks. Failure to do so would result in a loss in confidence of the IONChain Foundation's business.

(ii) **Theft of proceeds.** There may be attempts to steal the token sale proceeds received by IONChain Foundation (including the fiat currency amount converted therefrom). Such a theft or attempted theft may impact the ability of IONChain Foundation to support its expansion and development of the IONChain. While IONChain Foundation will adopt best practice technical solutions to keep the Token sale proceeds safe, certain cyber-thefts may not be preventable.

1.5 THIRD PARTY

(i) **Ceasing of collaboration with partners.** IONChain Foundation is in advanced discussions with multiple partners and has entered into agreements with certain partners on the development of IONChain. In the event any collaboration does not materialise or existing collaborations are

terminated, IONChain Foundation will be seeking alternative partners or develop the IONChain independently. In the event IONChain Foundation does not collaborate with a partner that is comparable to its existing partners, the IONChain may face difficulties in expansion and challenges in making the IONChain commercially feasible.

(ii) **Reliance on partners.** The IONChain primarily relies on IoT smart device manufacturers access their devices on the IONChain platform. We may not be able to establish or maintain mutually beneficial commercial relationships with such partners.

(iii) **Risk of mining attacks.** As with other cryptocurrencies, the blockchain used for the IONC is susceptible to mining attacks, including but not limited to double-spend attacks, majority mining power attacks, "selfish-mining" attacks, and race condition attacks. Any successful attacks present a risk to the IONC, expected proper execution and sequencing of IONC transactions, and expected proper execution and sequencing of contract computations.

(iv) **Other third party failures.** IONChain Foundation's business involves dependency on other service providers. For example, a temporary shutdown of IONChain Foundation's cloud web server could lead to the IONChain Foundation service being put on hold. As the business grows larger, IONChain Foundation will work to reduce the dependency on third party services.

1.6 MARKET RISK

(i) **Limited interest.** There may be limited interest in the community in the use of utility tokens. As the IONChain is a new product, there is no certainty that the IONChain will be adopted or used. The size and engagement level of IONChain's user base is critical to the success of IONChain Foundation. IONChain Foundation cannot assure that the user base and engagement levels of the IONChain will grow. Such a limited interest could adversely affect the development of the IONChain.

(ii) **No prior market.** Prior to the Token sale, there had been no public market for the IONC. There is no assurance that an active trading market for the IONC will develop, or if it develops, be sustained.

(iii) **Price Volatility.** The trading market price of the IONC may fluctuate significantly and rapidly as a result of, amongst others, perceived risk of IONC, negative publicity on IONChain Foundation, the IONChain or the operating performance of IONChain Foundation. IONChain Foundation bears no responsibility for such price volatility.

1.7 REGULATORY RISK

(i) **New token regulation introduced.** Regulatory authorities around the world may introduce new regulations to regulate the use of crypto-tokens. IONChain Foundation may receive queries, notices, warnings, requests or rulings from one or more regulatory authorities from time to time, or may even be ordered to suspend or discontinue any action in connection with the token sale. Regulatory authorities around the world may also deem IONC as virtual commodities, digital assets or even securities or currencies and therefore could be either prohibited from being traded or held, or be permitted to be traded or held, subject to the tax levied, in certain jurisdictions pursuant to local regulatory requirements.

1.8 OTHER

(i) **Conflict of Interest.** There may exist potential circumstances where the interests of IONChain

Foundation may diverge from those of IONC holders. IONChain Foundation is not obliged to refrain from such decisions in the interests of the company. By supporting the Token sale, each Participant will be deemed to have acknowledged these potential conflicts of interest and to have waived any claim with respect to any liability arising from the existence of any such conflicts of interest.

(ii) **Unidentified Risks.** IONChain Foundation recognizes that there are things that will be discovered in the development process which at this point cannot be predicted. In other words, despite best efforts, IONChain Foundation may not yet know all the risks that will be associated with the Project. Part of the rationale behind the fundraising is to ensure that IONChain Foundation has sufficient funds to be able to solve such issues as they arise and be able to continue to grow the business.

2. SUPPORTING THE TOKEN SALE

2.1 Supporting the token sale is voluntary. No person will be deemed as committed or obliged to support the token sale as a result of visiting www.ionchain.org, registering himself/herself with www.ionchain.org, requesting or reading any materials (including the White Paper) made available by IONChain Foundation or communicating with IONChain Foundation in any manner.

2.2 Each person shall only support the token sale (a “**Participant**”) through direct participation with IONChain Foundation, subject to such person’s satisfaction of IONChain Foundation’s “know-your-customer” and “anti-money-laundering” exercises.

2.3 Each Participant will, upon supporting the token sale, be deemed as having perused and comprehended the White Paper in full (among other things, the risk factors of the Project) and having voluntarily accepted all the terms and conditions including but not limited to the disclaimers made and the risks disclosed in the White Paper.

2.4 IONChain Foundation shall be entitled to take any action to identify any Participant at any time, even after the closing of the token sale. If IONChain Foundation conducts “know-your-customer” exercises or any other kind of customer due diligence to verify the identities of all or part of the Participants, the Participants concerned shall provide all such information on a timely basis and shall meet all such requests as may be sought or instructed by IONChain Foundation for that purpose. This shall equally apply to Participants who purchased IONC via the secondary markets, or other secondary purchase mechanisms, as well as primary sales during the token sale.

2.5 If IONChain Foundation discovers the purchase of IONC by any Participant violates any anti-money laundering, counter-terrorism financing or other regulatory requirements, such purchase shall be invalid with retroactive effect and IONChain Foundation shall be entitled to immediately deny the relevant person’s admissibility to the token sale, reject delivery of any IONC, irrespective of any payment that could have been made by that Participant.

3. NON-FINANCIAL NATURE OF IONC

3.1 An IONC is not, nor should be construed, understood, deemed or interpreted as:

(a) an equity interest, voting or non-voting security (or its like) in, or claims against, IONChain Foundation or any other entity in any jurisdiction;

- (b) equity or debt investment of any kind in any venture;
- (c) any securities having intrinsic value or market price;
- (d) any form of financial derivative;
- (e) any commercial paper or negotiable instrument;
- (f) any form of investment contract between the relevant holder and any other person;
- (g) any commodity or asset that any person is obliged to redeem or purchase;
- (h) any note, debenture, warrant or other certificates that entitles the holder to interest, dividend or any kind of return from any person;
- (i) any unit in collective investment scheme.

4. PARTICIPANTS' REPRESENTATIONS AND WARRANTIES

4.1 To support the token sale, each Participant shall represent and warrant to IONChain Foundation that:

- (i) all the information submitted by him/her to IONChain Foundation is true, complete, valid and non-misleading;
- (ii) the Participant is not a Restricted Participant;
- (iii) where the Participant is a natural person, he/she is of sufficient age to support the token sale and is a natural person with a full civil capacity of conduct under the laws of the jurisdiction where he/she is domiciled or maintains citizenship;
- (iv) where the Participant is a company or association or body of persons, corporate or unincorporated (i) it is duly incorporated and validly existing under the laws of its country of incorporation; (ii) it has the legal right and full power and authority to participate in the token sale and enter into agreements in connection with the token sale, which when executed will constitute valid and binding obligations on such Participant; and (iii) it is not prohibited by its constitution or any applicable laws from participating in the token sale;
- (v) the Participant understands blockchain, distributed ledger technology and crypto-tokens and is fully aware of the risks associated with the Project;
- (vi) the Participant's support of the token sale is voluntary and based on its own independent judgment without being coerced, solicited or misled by anyone else;
- (vii) the Participant is permitted by the laws of each jurisdiction to support the token sale and is legally permitted to acquire, receive and hold crypto-tokens;

(viii) no consent, approval, order or authorization of, or registration, qualification, designation, declaration or filing with, any federal, state or local governmental authority is required on his/her part in connection with the participation in the token sale;

(ix) the Participant only uses such crypto-tokens as lawfully acquired through mining and/or trading to make payment in the token sale and does not support the Token sale for any money-laundering, terrorism financing or other illicit purposes;

(x) the Participant understands and accepts that there is no warranty or assurance that the network of miners will allocate the IONC to the Participant as proposed by these terms;

(xi) the Participant will transfer IONChain Token from a wallet respectively within a wallet service provider that technically supports IONC. The Participant understands and accepts, that failure to ensure this may result in the Participant not gaining access to their IONC;

(xii) the Participant understands and accepts that if they exceed their individual limit, their participation exceeding the limit in the token sale will not be accepted by the Smart Contract System;

(xiii) the Participant will take sole responsibility for any restrictions and risks associated with the creation of IONC by the Smart Contract System as set forth below;

(xiv) the Participant waives the right to participate in a class action lawsuit and/or class wide arbitration against IONChain Foundation and/or any individuals involved in the creation of IONC;

(xv) the Participant understands the creation of any IONC does not involve the purchase of securities as defined by relevant and applicable legislation and law or any equivalent in any existing or future public or private company, corporation or other entity in any jurisdiction;

(xvi) the Participant understands that, the creation of IONC, and the development of IONChain Foundation's objectives carries significant financial, regulatory and reputational risks as further set forth in these terms;

(xvii) the Participant understands and expressly accepts that there is no warranty and/or representations whatsoever on IONC, the Smart Contract System and/or the success of Project, expressed or implied, to the extent permitted by law, and that the Smart Contract System is used and IONC are created and obtained at the sole risk of the Participant on an "as is" and "under development" basis and without, to the extent permitted by law, any warranties of any kind, including, but not limited to, warranties of title or implied warranties, merchantability or fitness for a particular purpose;

(xviii) the Participant understands and accepts that all token sale transactions are final and may not be reversed, except in cases where transactions have exceeded an individual cap or the total maximum cap or the total amount raised is less than the minimum cap required. By participating in the token sale, the Participant acknowledges that he has no right to request a refund for any reason, and that Participant will not receive money or other compensation for any IONC that is not used or remains unused by the Participant;

(xix) the Participant understands with regards to IONC, no market liquidity may be guaranteed and the value of IONC over time may experience extreme volatility or depreciate in full;

(xx) the Participant understands that the Participant bears the sole responsibility to determine if the Participant's participation in the token sale, the creation, ownership or use of IONC, the potential appreciation or depreciation over time (if any), the allocation of IONC and/or any other action or transaction related to IONChain Foundation have tax implications for him; by holding or using IONC, and to the extent permitted by law, the Participant agrees not to hold any third party (including developers, auditors, contractors and/or founders) liable for any tax liability associated with or arising from the creation, ownership or use of IONC and/or any other action or transaction related to IONChain Foundation;

(xxi) as part of the Token sale process the Participant will use their own account (address) with a private key associated to this address and password. The password is used to encrypt the Participant's private key. The Participant understands that the Participant must keep their password and private key safe and that the Participant may not share them with anybody. The Participant further understands that if their private key and/or password is lost or stolen, the Participant will not be able to generate a new password or recover their private key, and if the Participant also loses their private keys and password, the IONC associated with the Participant's account (address) will be unrecoverable and will be permanently lost. Furthermore, the Participant understands that there is no recovery mechanism for lost keys and passwords, so no one will be able to help the Participant retrieve or reconstruct a lost password and private keys and provide the Participant with access to any lost IONC;

(xxii) the Participant aims to acquire IONC primarily for its primary function as a cryptographic token (which are not redeemable, associated with financial return or backed by any underlying asset or repurchase commitment and do not necessarily have market value or transaction between peers) without expectation of any profit or financial yield and does not contemplate to use IONC for any financial, speculative, illegal or non-ethical purpose;

(xxiii) the Participant understands and accepts that the Participant may not have any expectation of influence over governance and/or management of the Project; and

(xxiv) (except having specifically communicated to and been permitted by IONChain Foundation in advance) the Participant is supporting the token sale for their own benefit and is not acting as a nominee or agent for or on behalf of any third party.

(xxv) the Participant shall when requested upon by IONChain Foundation to provide documentary proof of source of funds, identity documents, residency status and all other such relevant information as may be required by IONChain Foundation to fulfil any obligations in law with respect to knowing your client ("KYC") obligations.

4.2 All the above representations and warranties made by a Participant shall be true, complete, accurate and non-misleading on and from the date of that Participant making a payment hereunder throughout the token sale and onwards. IONChain Foundation reserves the right to reject and invalidate the payment by, and withhold the relevant IONC from, any Participant who has made a false representation in the sole judgment of IONChain Foundation.

5. NO REPRESENTATION OR WARRANTY BY IONCHAIN FOUNDATION

5.1 IONChain Foundation does not make, and hereby disclaims, any representation or warranty with respect to IONChain Foundation and IONC (including their respective merchantability or fitness for particular purposes). Each Participant's decision to support the token sale and purchase any IONC shall be made based on his/her own knowledge of IONChain Foundation, IONC and IONChain and the information disclosed in the White Paper. Without prejudice to the generality of the foregoing, each Participant will accept the IONC on an "as is" basis, irrespective of the technical specifications, parameters, performance or function thereof.

5.2 No person is authorised to give any information in connection with IONChain Foundation, IONChain and IONC or the token sale that is not contained in this White Paper.

6. LIMITATION OF LIABILITY AND INDEMNIFICATION

6.1 IONChain Foundation hereby expressly disclaims its liability, and shall in no case be liable to any person, for:

- (i) any person's support of the Token sale in violation of any anti-money laundering, counter-terrorism financing or other regulatory requirements that are imposed in any jurisdiction;
- (ii) any person's support of the Token sale in violation of any representation, warranty, obligation, covenant or other provision under this White Paper, and the resulting failure or inability to retrieve his/her payment or to claim relevant purchased IONC;
- (iii) early termination of the token sale for any reason;
- (iv) failure to distribute, offer, utilise or deal with the Reserved IONC;
- (v) failure or abortion of IONChain Foundation development or expansion and resulting failure to develop the IONChain;
- (vi) delay or rescheduling of the IONChain development and resulting failure to meet any anticipated milestone;
- (vii) any error, bug, flaw, defect or otherwise of the source code of IONChain Foundation or the IONChain;
- (viii) failure of IONC to meet any specific purpose, or unfitness for any specific use;
- (ix) utilisation of the proceeds raised through the token sale;
- (x) failure to completely disclose any information relating to the development of IONChain Foundation or the IONChain on a timely basis;
- (xi) any Participant's divulgence, loss or destruction of the private key of his/her cryptocurrency or crypto-token wallet (inter alia, the wallet of IONC as downloaded and used by that Participant);
- (xii) any default, breach, infringement, breakdown, collapse, service suspension or interruption, fraud, mishandling, misconduct, malpractice, negligence, bankruptcy, insolvency, dissolution or winding-up of any third party used to buy IONC;

(xiii) any difference, conflict or contradiction between this White Paper and an agreement between any Participant and any third party;

(xiv) trading or speculation of IONC by any person;

(xv) listing or delisting of IONC on or from any cryptocurrency exchange;

(xvi) IONC being classified or treated by any government, quasi-government, authority or public body as a kind of currency, securities, commercial paper, negotiable instrument, investment or otherwise that may be banned, regulated or subject to certain legal restrictions;

(xvii) any risk factors disclosed in this White Paper and any damage, loss, claim, liability, punishment, cost or other adverse impacts that are caused by, associated with, in connection with, incidental to or consequential to that risk factor;

(xviii) any failure or delay in the delivery and receipt of IONC (when exchange for IONC) by the Participant; or

(xix) occurrences of natural disasters, acts of God or other events beyond the control of IONChain Foundation that affect the businesses and/or operations related to the Project.

6.2 To the maximum extent permitted by the applicable laws, regulations and rules, the Participant shall indemnify, defend, and hold IONChain Foundation harmless from and against any and all claims, damages, losses, suits, actions, demands, proceedings, expenses, and/or liabilities filed/incurred by any third party against IONChain Foundation arising out of a breach of any of these terms hereunder.

7. TERMINATION

7.1 IONChain Foundation may be entitled to terminate the token sale if any of the following occurs:

(i) IONChain Foundation decide to abort the sale by making an announcement on www.ionchain.org;

(ii) IONChain Foundation decides to terminate the token sale prior to the close of the token sale;

(iii) IONChain Foundation is required by applicable law to terminate for whatever reason;

(iv) the Token sale is held illegal or irregular under the applicable laws of any jurisdiction, is prohibited, banned or forced to cease by any government in any jurisdiction; and

(v) IONChain Foundation ceases to operate prior to the end of the Token sale, including as a result of any force majeure event and cannot resume.

7.2 IONChain Foundation shall have the full discretion to declare termination of the token sale upon the occurrence of any of the above events, while Participants shall not be entitled to object to or deny the decision made by IONChain Foundation.

7.3 Upon termination of the token sale, IONChain Foundation shall, within one (1) month, refund its

received token sale proceeds (net of costs incurred by IONChain Foundation to conduct the Token sale) to the respective Participants. Other than as set forth in this section, IONChain Foundation shall be under no obligation to any Participant for the termination of the Token sale.

7.4 Notwithstanding the termination of the Token sale:

(i) the representations and warranties made by each Participant shall remain true, accurate, complete and non-misleading; and

(ii) the challenges and risks set forth shall still apply.

7.5 Sections 3, 4, 5, 7, 8, 10, 13, 14, 15, 16 and 17 of Annex 1 shall survive the termination of the token sale and remain effective and binding.

8. TAX

Each Participant shall declare, bear and pay all such taxes, duties, imposts, levies, tariffs and surcharges that might be imposed by the laws and regulations of any jurisdiction as a result of or in connection with the receipt, holding, use, purchase, appreciation, trading or divestment of IONC (no matter whether purchased during the Token sale or otherwise acquired); and each Participant shall be solely liable for all such penalties, claims, fines, punishments, liabilities or otherwise arising from his/her non-payment, underpayment, undue payment or belated payment of any applicable tax. IONChain Foundation gives no advice and makes no representation as to the tax implications of any Participant's participation in the token sale and shall have no liability towards the Participant for the same.

9. NO WAIVER

The failure of IONChain Foundation to require or enforce strict compliance by the Participant with any provision herein or IONChain Foundation's failure to exercise any right herein shall not be construed as a waiver or relinquishment of IONChain Foundation's right to assert or rely upon any such provision or right in that or any other instance. The express waiver by IONChain Foundation of any provision, condition, or requirement of the White Paper shall not constitute a waiver of any future obligation to comply with such provision, condition or requirement.

10. SEVERABILITY

If any portion of this White Paper is held illegal or invalid, whether in whole or part, under the laws of any jurisdiction, such illegality or invalidity shall not affect the legality or validity of the rest of the White Paper in that jurisdiction nor the legality or validity of the White Paper in any other jurisdiction.

11. TITLE AND SUBTITLES

The titles and subtitles used in this White Paper are used for convenient reference only and are not to be considered in construing or interpreting this White Paper.

12. RIGHT TO AMEND

IONChain Foundation may revise the Token sale Terms from time to time in any circumstances, including but not limited to:

- (i) changes in the type of cryptocurrency used for the Token sale;
- (ii) changes in the value and features of IONC;
- (iii) changes in the Governing Law and Jurisdiction; and
- (iv) any other changes that may be required from time to time following changes to business practices and further or required developments to the Project.

13. THIRD PARTY WEBSITES OR PLATFORMS

IONChain Foundation may provide certain hyperlinks to third party websites, and the inclusion of any hyperlinks or any advertisement of any third party on www.ionchain.org or other platforms does not imply endorsement by IONChain Foundation of their websites, products or business practices. If the Participant accesses and uses any third party websites, products, services, platforms and/or business, the Participant does that solely at his/her own risk for which IONChain Foundation will bear no liability.

14. AUDIT OF THE SMART CONTRACT SYSTEM

14.1 Prior to the launch of the Smart Contract System it will have, on a reasonable effort basis, undergone security audits by technical experts. The audit aims to confirm that the Smart Contract System has, with regard to both accuracy and security, been programmed according to the current state of the art.

14.2 However, the Participant understands and accepts that smart contract technology is still in an early development stage and its application is of experimental nature which carries significant operational, technological, financial, regulatory and reputational risks. Accordingly, while the audit conducted raises the level of security and accuracy, the Participant understands and accepts that the audit does not amount to any form of warranty, including direct or indirect warranties that the Smart Contract System, the IONC is fit for a particular purpose and/or do not contain any weaknesses, vulnerabilities and/or bugs which could cause, inter alia, the complete loss of IONC.

15. INTELLECTUAL PROPERTY RIGHTS

The token sale terms shall not entitle you to any intellectual property rights, including the rights in relation to the use, for any purpose, of any information, image, user interface, logos, trademarks, trade names, Internet domain names or copyright in connection with [website address], the token sale and the IONC.

16. ENTIRE AGREEMENT

The token sale terms contain the entire agreement between IONCHAIN FOUNDATION and the Participant and supersede all prior agreements, understandings and/or arrangements in relation to the token sale terms. The Participant to this agreement shall not enforce the token sale terms.

19. GOVERNING LAW

The White Paper will be governed by and interpreted in accordance with the laws of the Republic of Singapore.

20. PERSONAL DATA PROTECTION

By interacting with, submitting information to IONChain Foundation, you agree and consent to IONChain Foundation collecting, using, disclosing and sharing your Personal Data, and disclosing such personal data to the IONChain Foundation's authorised service providers and relevant third parties in the manner set forth in the Data Protection Policy by IONChain Foundation.

rights in relation to the use, for sale.

17. TOKEN SALE JURISDICTION

The Token sale is initiated and takes place worldwide and is not linked to any specific jurisdiction. The Participants may be from any jurisdiction in the world, other than Restricted Participants.

18. THIRD PARTY RIGHTS

The Contracts (Rights of Third Parties) Act (Chapter 53B) of Republic of Singapore shall not under any circumstances apply to the token sale terms and any person who is not a party to this agreement shall not enforce the token sale terms.

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