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ION Chain

IONCHAIN

A revolutionary IoT infrastructure based on blockchain and edge computing technology

Content

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

1.1 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.

1.2 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 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.

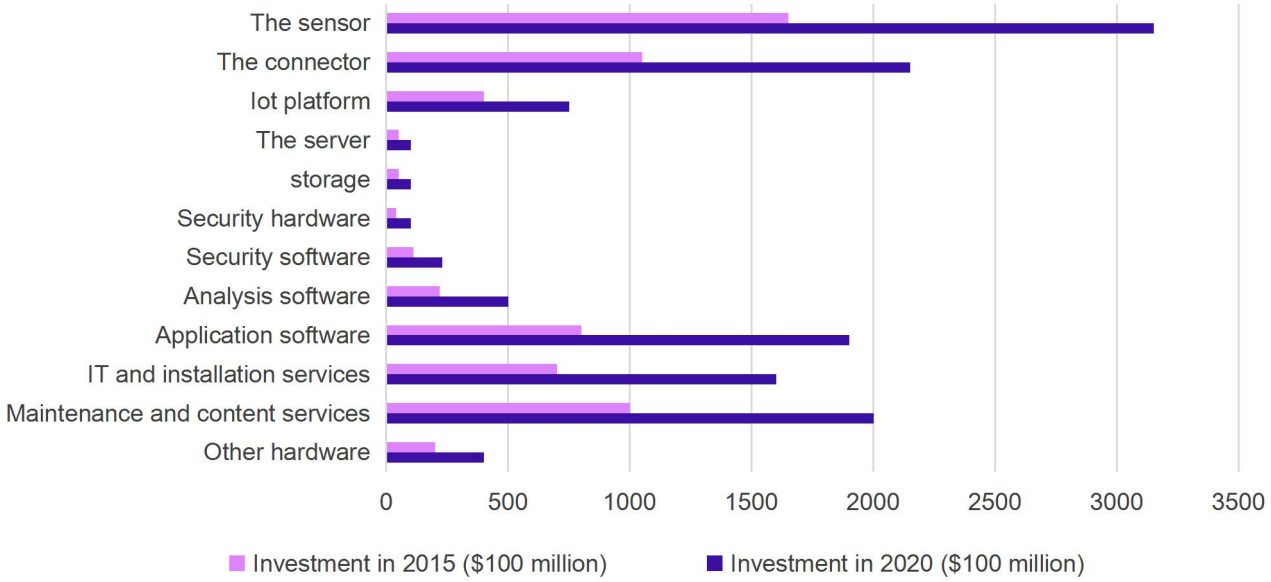


Figure 1.1 IoT industry development trend in next five years

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 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 dont 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 interactive real-time, such as VR, industrial IoT and autonomous driving, IoT networks built with cloud tend to be too slow. The delay of several hundred milliseconds from perception to execution makes it impossible to match the response/request from the control end.

1.3 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 application 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 or at the top of physical entities. 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.

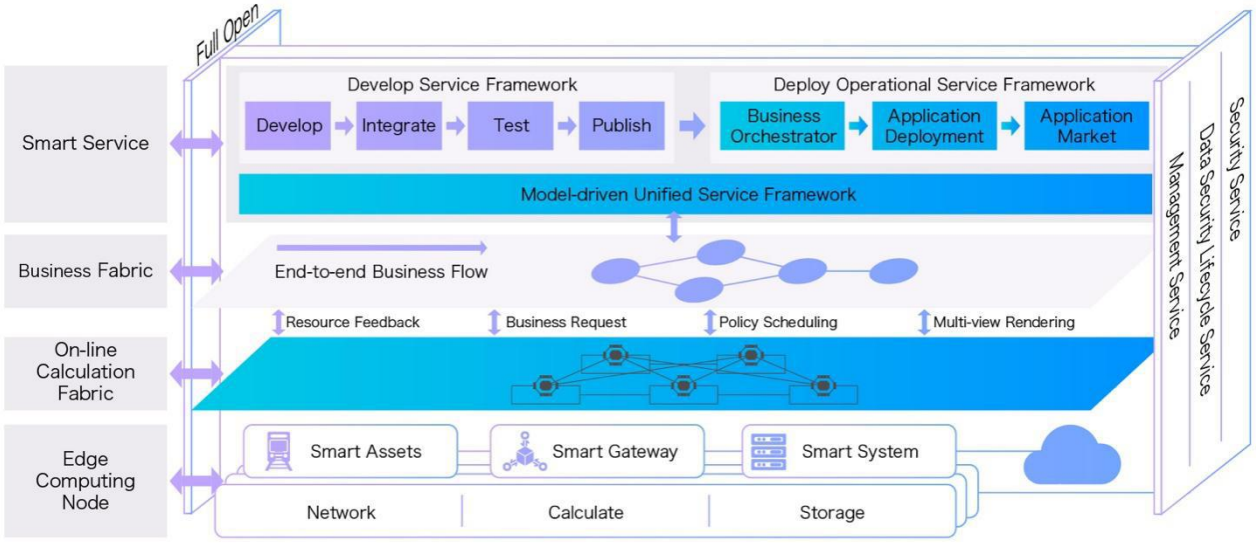


Figure 1.2 Reference architecture 2.0 of edge computing

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 technology, 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 buy top cloud services providers, data breaches are still occuring 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. As the 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.

1.4 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 algorithim” . 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. ION 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 ION 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). The IPFS is going to enable the 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 allows not only mobile phone mining but also 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 is designed to be able to handle massive amounts of IoT data in the future. At the same time, storage and transaction processing separation creates another layer of protection for the data.

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.

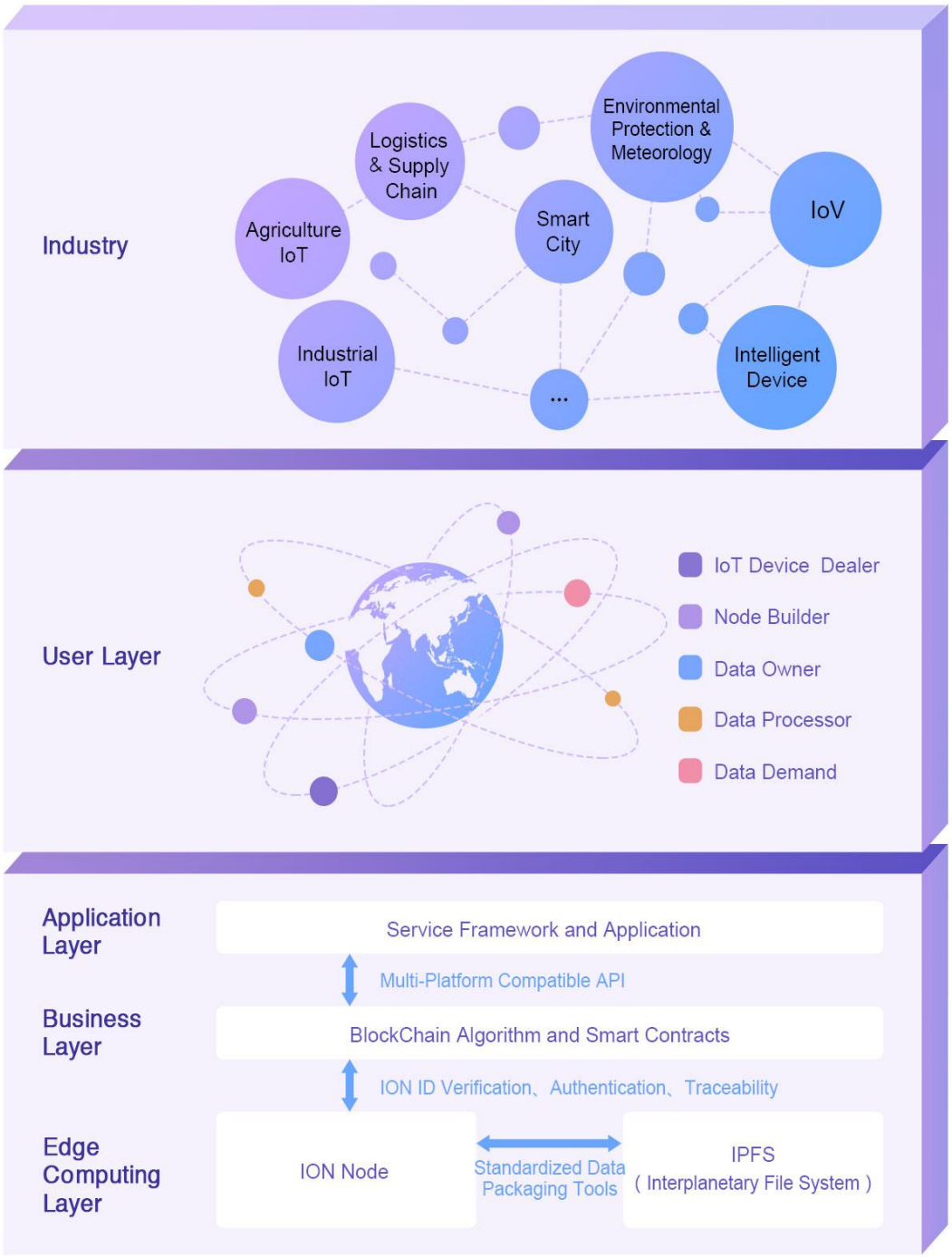


Figure 2.1 Relationship between IONChain and IoT

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 have built a production line, but is dissatisfied with the production efficiency after running it for some time. The production needs to be optimized. Using the

IONChain data trading platform, company A finds out that the Asian company B has released sensor data and production line video of the same type of assembly line. Through the purchase of data, the production line is optimized and the operation video is learned, so that the production efficiency is greatly improved, and at the same time cross-regional, breaking through the technical barriers. The cost has also been greatly reduced. What's more, the technology is across regions, which reduces the cost to break through technical barriers.

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 goliaths. 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 across many variables and can complete free interactions between device to devices and devices to humans, and the decentralized network can accommodate transfers of value within the system.

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 intelligent locks (should I explain intelligent 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 ION. 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. In inorganic chemistry, when salt is ionized, it produces anions and cations, which can be combined again to produce new substances. Similarly, the IONIZATION algorithm separates two core functions of value creation and value transfer on the blockchain. New business models will occur after combing through and separating the value creation layer, value transfer layer and other IoT relevant features.

Under the current blockchain technical architecture, value creation and transfer are combined, which has great practical value in certain instances and this value will increase in time. The success of Bitcoin and Ethereum is the best evidence for this kind of algorithm. However, these algorithms are no longer suitable for the future requirements in the IoT industry. At IONChain, we think of every device as if it were a mining machine. Every IoT device in IONChain will play the role of a mining machine, and they will constantly create value. However all of the features of devices and values created are varied according to device and function.

The requirements of IONChain cannot be secured if we continue to follow the existing protocol which is a combination between value creation and value transfer in the blockchain. 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 facet of value creation is responsible solely for creating the value. With regards to differing devices, those corresponding algorithm will be tailored so that they can meet the diverse requirements demanded by IoT devices. IoT device to become a new consensus algorithm and create uniform value according to the IONChain standard, supported by a uniform consensus algorithm layer.

Following on from this, the value transfer layer can focus on transferring value in the IONChain system. All components of IONChain can exchange their value freely through the value transfer layer.

3.1 Value creation of IONChain

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

Value creation encompasses IoT devices and edge computing centers near the device, in which the IoT device means all kinds of devices embedded in IONChain. All of them have default on the IONChain consensus protocol and got the identification code of IONChain, in which the device manufacturer information, device identification, some special notes, and other related information are included. And all the information is stored in the chip after encrypted with zero knowledge proof algorithm. Each of the IoT devices can be taken as one mining machine, and the information from it can produce ION 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. In order for IONChain to realize the idea of utilizing every device on the IoT network as a mining machine and make all the data tradable, we designed ION mining to be possible on every device. 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.

The role of the edge computing center is to compensate for the weak computing capabilities of IoT devices. It is an intermediary computing device set up close to the IoT device. It is connected to the network and provides 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 creation 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 relevant value creation algorithm. Upon completion of the value creation calculation, it is be passed to the next layer for verification.

3.1.1 Value verification

The value verification is similar to the consensus algorithm in blockchain. 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.

3.1.2 Value evaluation

The value evaluation layer is mainly to further verify the verified value. 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.

3.1.3 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 ion chain in the form of a digital currency.

3.2 Value transfer in IONChain

The value transfer part of the ion chain is divided into six layers in the system architecture. The six layers are the application layer, service layer, protocol layer, smart contract layer, blockchain layer and data storage layer.

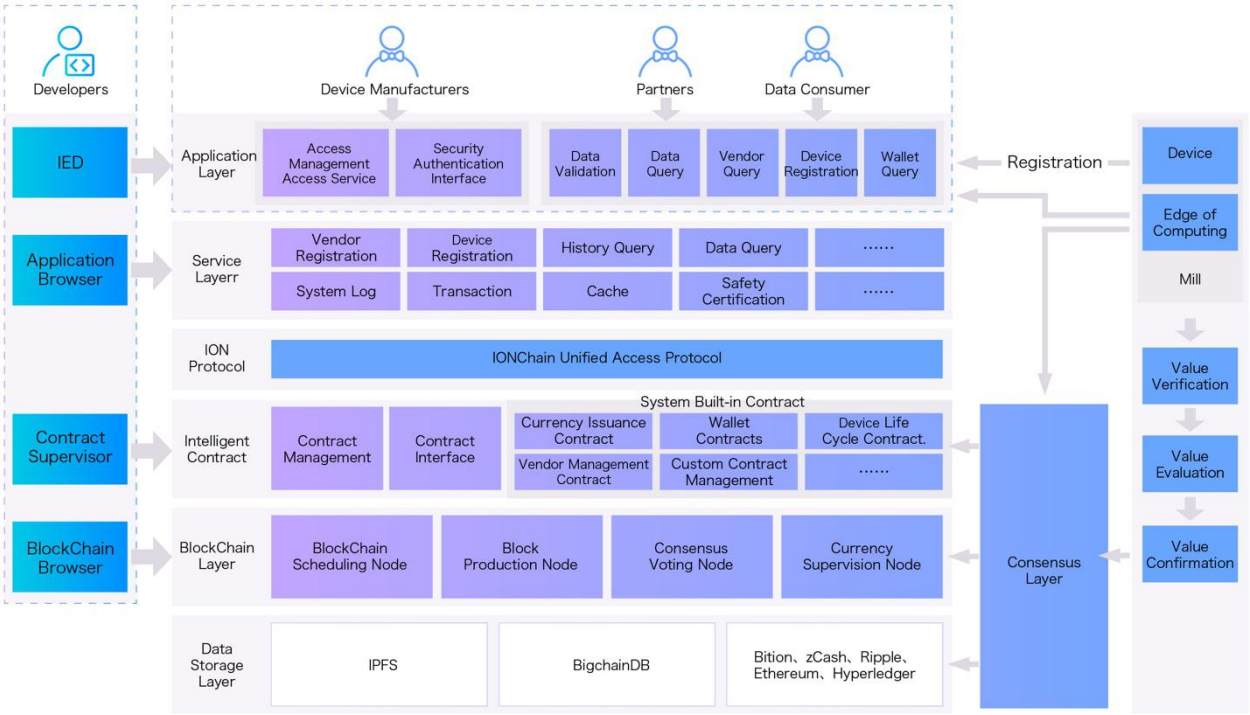


Figure 3.1 IONChain system architecture

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, vendor search, device registration, wallet and so on.

3.2.2 Service layer

IONChain extracts the service layer from the internal modules of the system. The IONChain contains many components, and all of them provide external interfaces through the server. The interface used by the service layer is generally a program other 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 the role of adhesives, 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 stuff.

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. According to the features of IoT network, IONChain applies fundamental components of graphene technology and makes depth optimization.

Based on DPoS algorithm, the graphene technology provides serials of general blockchain

components, including network, block, link, wallet, and of course DPoS algorithm. However, IONChain revises the graphene algorithm to match IoT requirements better, which is called 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 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 most conceivable network conditions. These examples should help you understand why IPOS is robust and hard to break.

I will show by example how IPOS operates under most 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 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 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 ofcorruption 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 IPFS system.

IPFS system can store smart contract data, transaction records, and other core data. However, IONChain is designed for future IoT networks, which needs to store all 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 ION token

ION is the official token of IONChain. It can be utilized by different participants in IONChain ecosystem. The maximum supply of ION 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 ION tokens based on the amount of on-chain devices, amount of data being processed and the overall level of ION abundance in the ecosystem.

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

ION 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:

ION 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 small 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 ION 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 ION 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, ION 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;

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 ION currency between accounts, the billing node award is paid accordingly;

f) Each ION coin can track its origins, and can save and trace part of the data through the ION 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 ION users.

4.2 ION token distribution

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

- Circulation：25%
- Mining rewards: 25%
- Community construction & incentives: 20%

- R&D Team: 20%
- Node incentives: 10%

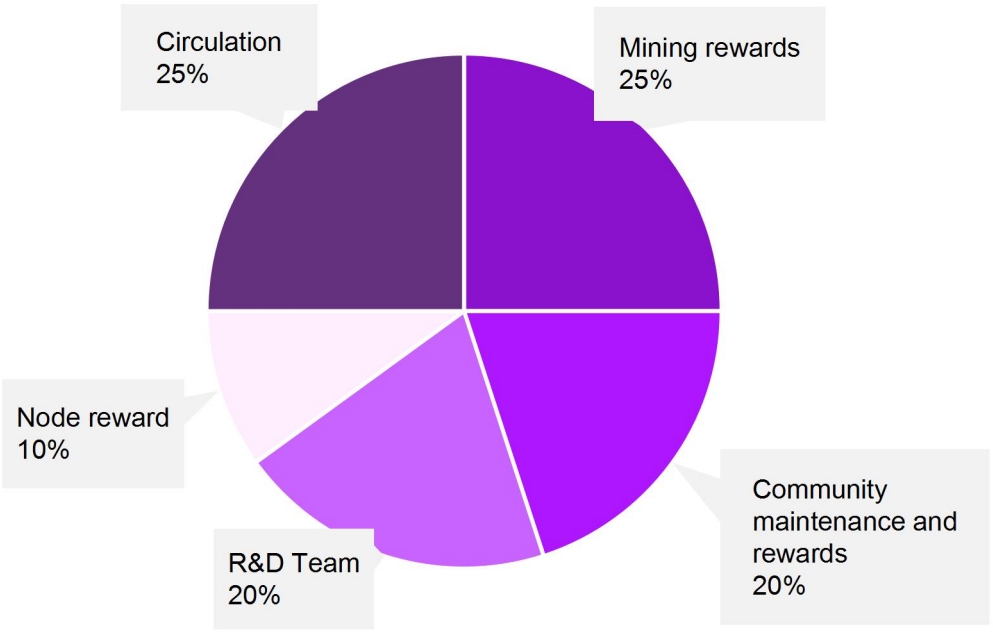


Figure 4.1 IONChain economic model

4.3 ION token distribution explanation

1) circulation

IONChain platform will give away ION tokens for community promotion, altogether 25% of the total amount

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 ION 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

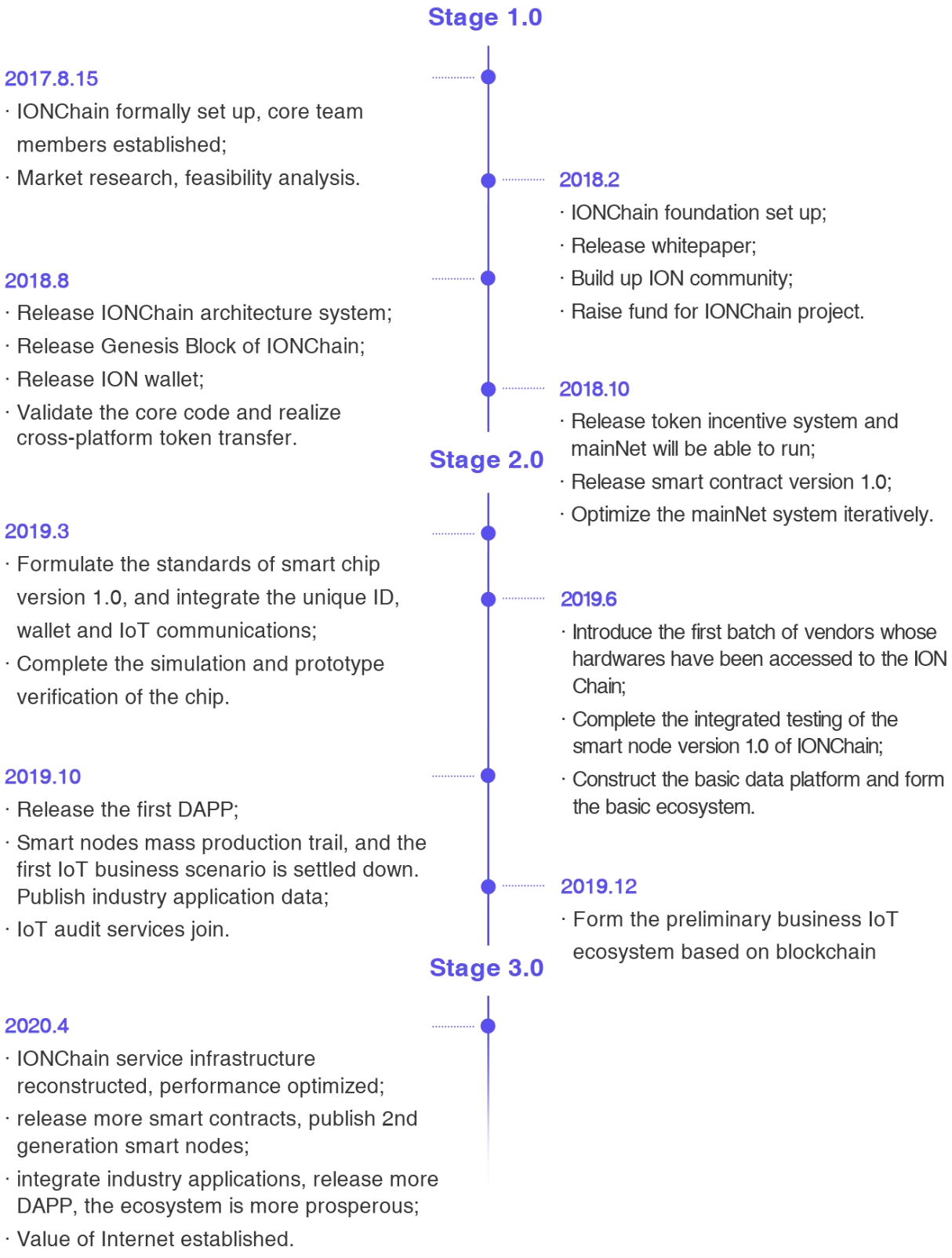
IONChain will take out 20% of total tokens to incentivize the founding team because they provide resources and technical support for early development of IONChain. However, to ensure smooth development of IONChain project, token reward for team members will be locked for 36 months.

33% of the reward tokens will be released 12 months after the initial ION 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 34% reward tokens, and it accounts for 6.7% of the total supply.

The whole process 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 the 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 of over 300 members.
- Former CTO of Zhiwang Fintech, Founder of Zhiwang blockchain and IoT system.
- Former senior director of Accenture.
- Integrated technology expert, and design integration solutions for Huawei, China Mobile, SAIC and so on.
- Senior blockchain lecturer for master courses in Fudan university.
- MBA of East China Normal University.

Robert Feng
Technical Director

- 15 years experience of developing and architect.
- Founder of technical blockchain community BlockChainBrother .
- Core developer of Hyperledger project .
- Sponsor of Hyperledger 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.
- Industry includes agriculture, medical, intelligent community, intelligent scenic spot and intelligent gateway.
- Host and complete top-level design projects for IoT system and application scenario landing.

Chun Chieh Li
Marketing Director

- 20 years experience of television media & PR; achieve both provincial and national awards.
- Former COO & Chief Editor of ChainB （the leading blockchain media of China）.
- Co-founder & Former VP of Marketing and Content Production in Uni-Live.
- Graduated from Fudan University.

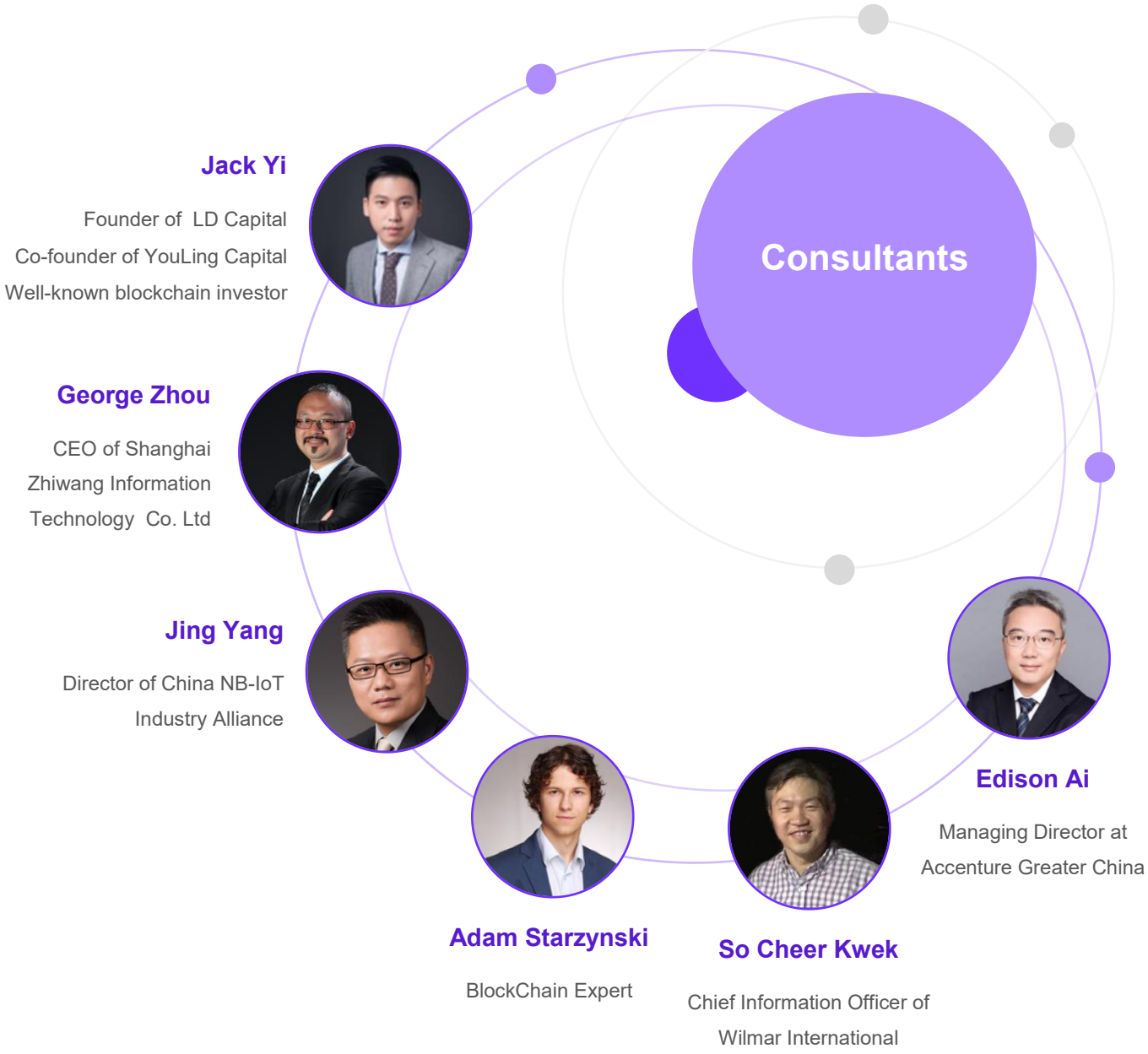
Eric Fang
BD and Ecological Construction

- Co-founder of Shidian Capital.
- Over 10-year working experience on marketing development and business management in telecommunication industry, and worked for Huawei US, HTC China and China Unicom (shanghai), etc. Practical experience on managing enterprise with various attributes and intercultural teams.
- More than 5-year experience about ecosystem build-up for startup investment. In 2011, started the first entrepreneurship NGO in shanghai and it is now one of the deputy chairman entities of Shanghai Entrepreneurial Alliance. One municipal entrepreneurial incubator which takes up 2000 square meters is running by himself.
- 2-year experience on cryptocurrency investment, project management. Have invested more than a dozen different projects. Independent and profound research skills. Master of Information Technology from University of Birmingham, National Senior Entrepreneurship Consultant, travelled over six continents, enjoyed long-distance running, exercises and reading.

Daniel Wu
Chief Architect

- Blockchain and encryption expert.
- Core developer of Hyperledger.
- Start working in blockchain development from 2014.

6.2 Consultants



7 Disclaimers

This document is for information purposes only. the content is for reference only and it doesn't involve any suggestion to invest in IONChain or any related company stakes or securities. Any such decision must be taken in accordance with the applicable security laws and other relevant laws. The above information or analysis does not constitute any specific investment recommendation or advice.

None of the content in this documentation can be explained as forcing investment. The contents of this document cannot be seen as forcing participation in the fundraising. Nothing in or related to this White Paper should be treated as encouraging participating in the fundraising, including requesting a copy of this White Paper or sharing this White Paper with others.

Any participants taking part in the fundraising have to meet the required age in their countries and have full capacity for civil conduct. All the investors voluntarily participate in the fundraising and have to have clear understanding of the IONChain platform.

IONChain will keep making sure that all the information in the whitepaper is up to date, realistic and accurate. In case of any misunderstanding caused by an inaccurate translation in this paper or in any other situation where there is discrepancy between the original version and this paper, the investors acknowledge that the original version of this whitepaper is the Chinese language version. 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 whitepaper change at later stages of the project development, our team will publish announcements and updated versions of the whitepaper to keep all the interested parties well-informed and up to date with the project. All the investors should get the latest version of the whitepaper in time and adjust their investment strategies accordingly. IONChain platform would like to clarify that we don't take any responsibility if the investors loss being a result of:

a) *what is said in this documentation*
b) *inaccurate information in this whitepaper*
c) *any behavior caused by this whitepaper*

The IONChain team will try their best to realize all the targets mentioned in this whitepaper, but we cannot make definitive promises because of deterministic force.

ION 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 ION tokens does not entitle the owner to the

ownership, control or decision making authority of IONChain platform. ION 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*

Whether or not the ION 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. Our team does not make any promise for that and we do not take any responsibility for the consequences of the value increase or decrease.

To the maximum extent permitted by applicable law, the team is not responsible for the damage and risks arising from the participation in the fund raising 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 ION 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 fund-raising, they confirm their understanding of the terms and conditions detailed in the original Chinese version of the whitepaper and translated in good will in this English version of the whitepaper. They accept the potential risks of their investment and themselves decide to take responsibility for all the possible consequences. They cede the right to blame the IONChain team for any problem related to this investment.