

## Research on the Application and Countermeasures of Blockchain Technology in Telecom Industry

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### Abstract

**As one of the most revolutionary emerging technologies in this year, blockchain has created a new computational paradigm for low-cost trust building. This paper first introduces the relevant policies, core technologies of blockchain and the exploration of blockchain technology by domestic and foreign operators, and then describes the eight applications of blockchain in the telecommunications industry, and provides countermeasures and suggestions for accelerating the application of blockchain in the telecommunications industry.**

### Keywords

**Blockchain; Telecom Operators; Applications.**

### 1. Introduction

At present, a new round of technological revolution and industrial change sweeping the world, big data, cloud computing, the Internet of Things, artificial intelligence, blockchain and other new technologies are emerging, the digital economy is profoundly changing the way of human production and life. As a disruptive technology, blockchain is leading a new round of global technological and industrial changes, and promoting the transformation of information Internet to value Internet. Blockchain applications can reduce costs and improve efficiency for the real economy, boost high-quality development of traditional industries and accelerate industrial transformation and upgrading. At the same time, blockchain applications are being derived into new formats and become a new driving force for economic development.

With the development of blockchain technology, Chinese central government attaches great importance to blockchain and issued a series of documents to support it. The “Notice on the issuance of the 13th Five-Year National Informatization Plan” released by the State Council in December 2016 clearly stated the need to strengthen the innovation, test and application of new technologies such as blockchain, and for the first time put blockchain into the planning as a strategic frontier technology. Ministry of Commerce, Ministry of Industry and Information Technology and other national ministries issued policies to support the development of blockchain and other technologies in 2017 and 2018 ; In October 2019, in the 18th collective learning of the Central Political Bureau, General Secretary Xi Jinping stressed that the integrated use of blockchain technology plays an important role in new technological transformation and industrial innovation. We should take blockchain as an important breakthrough in independent innovation of core technologies, clarify the main direction of attack, increase investment, and strive to overcome a number of key core technologies to accelerate the development of blockchain technology and industrial innovation. In April 2020, the National Development and Reform Commission clarified the scope of new infrastructure. Blockchain, artificial intelligence and cloud computing are jointly used as new information technology infrastructure. In May 2020, there are 53 blockchain-related proposals in the NPC and CPPCC, which have increased compared with 2019, mainly focusing on government affairs, certificate traceability, tamper prevention and other fields.

Blockchain is both a challenge and an opportunity for telecom operators. The new business model based on blockchain may change the existing telecom value chain, but its creation of new business model may innovate the existing business model, improve efficiency, reduce costs and bring new

income. The encryption algorithm, point-to-point transmission, account and storage model provided by blockchain can help telecom operators to build information security infrastructure, realize cost reduction and efficiency of telecom business processes such as billing and settlement, supply chain management, roaming, and realize credible, safe and transparent information interaction.

## **2. Core technology of blockchain**

The concept of blockchain originates from the paper “Bitcoin : A Point-to-Point Electronic Cash System” published by China Bencong in 2008. This paper describes an encrypted digital currency (bitcoin) that can support the direct payment of both parties in untrusted transactions without a third-party trusted institution. Bitcoin avoids high dependence on central authority, high trust cost, poor reliability and security in traditional centralized system.

With the introduction of intelligent contracts, blockchain is endowed with programmable characteristics, which expands from proprietary technologies in the field of encryption digital currency to key technologies for building trust relationships in manufacturing, finance, education, medical and other vertical fields. Blockchain integrates core technologies such as peer-to-peer network, cryptography, consensus mechanism and intelligent contract.

### **2.1 Peer networks**

Peer-to-peer network is a distributed application architecture that allocates tasks and workloads among peer nodes, and is a networking technology or network communication form formed by peer computing model. There is no central authority node in the network. All nodes have the same status and need not pass through the central node when interacting. They are responsible for new node discovery, network routing, data validation, and can join or exit the network at any time. Using the above characteristics of peer-to-peer network, blockchain can organize each node to complete data generation, dissemination, verification and storage.

### **2.2 Cryptography**

Blockchain uses a variety of cryptography technologies such as hash function and asymmetric encryption technology to ensure the integrity, non-tamperability and verifiability of blockchain. Hash function is a kind of mathematical function which maps any length of data input into a fixed length output. It generally has the characteristics of unidirectionality, non-correlation and anti-collision. These features make it particularly suitable for fast computation, comparison and validation of data and are therefore widely used in blockchain. Due to the open and complex environment of blockchain network, transaction and block data dissemination need to rely on asymmetric encryption technologies such as information encryption and digital signature to ensure reliable communication between nodes.

### **2.3 Consensus mechanisms**

It is a consensus issue in blockchain that how to make nodes with weak trust reach consensus on block effectiveness and save consistent data copies. In the early research in the field of distributed computing, a consensus mechanism was proposed to solve the problem of consistency, that is, how to ensure that the data of all nodes in the distributed cluster are exactly the same and can agree on a proposal. By drawing on the consensus research in the field of distributed computing, blockchain adopts the consensus mechanism to maintain a consistent blockchain view of nodes, so as to achieve stable and reliable operation of the system.

### **2.4 Intelligent contract**

Intelligent contract was first proposed and defined by cryptologist Nick Szabo as a set of commitments defined in digital form, including the agreement that contract participants can execute these commitments above. However, due to the lack of a safe and credible execution environment, it is difficult for smart contracts to ensure the correct implementation of contract terms without a trusted third party, so it has not been applied in practice for a long time. The emergence of blockchain promotes the rapid development of intelligent contracts. Its characteristics of de-trust and

untamperability provide a good execution environment for intelligent contracts. At the same time, intelligent contracts also give the underlying data of blockchain programmable and expand the application scope of blockchain. Intelligent contract in blockchain has the following characteristics: (1) Open and transparent: Intelligent contract inherits the open and transparent characteristics of blockchain, and any node can view the contract code; (2) Unchangeable : Blockchain guarantees the untamperability of stored data, so smart contracts cannot be changed once deployed to the blockchain; (3) Can be automatically executed: after an external event triggers the default condition, the smart contract performs the corresponding operation according to the prepackaged response rule.

### **3. Development status of blockchain technology in domestic and foreign telecommunications industry**

There are many natural junctions between blockchain technology and telecommunications industry. The decentralization, tamper proof and multi-party consensus mechanism of blockchain determine the important value of blockchain in solving the problem of multi-party common decision-making and establishing mutual trust in the cooperation of telecommunications industry, optimizing the cooperation and collaboration between operators and upstream and downstream industrial chains. At present, domestic and foreign operators have made strong efforts in the field of blockchain to promote basic platform research and development, key application pilot and ecological construction.

In foreign countries, AT & T in the United States first began to explore the application of blockchain in the telecommunications industry, and its patent on the use of blockchain technology to create family user servers was the first application exploration of the telecommunications industry in the field of blockchain. Orange of France Telecom chose to try blockchain in the field of financial services to improve the degree of automation and settlement efficiency, so as to reduce the cost of clearing institutions to a certain extent. The U.S. telecom operator Sprint, the U.S. blockchain company TBCASoft, the Japanese SoftBank Group, and Taiwan Telecom have established the CBSCG operator blockchain alliance to jointly build a global blockchain platform and ecology across operators, and provide various services across operators for telecom members and their customers. Telefonica, a Spanish telecom giant, cooperates with Rivetz, a security technology start-up, to develop smartphone solutions based on blockchain transactions and instant messaging. Swisscom, a large state-owned telecom supplier in Switzerland, established Swisscom Blockchain AG company, focusing on a series of services around blockchain technology, including enterprise-oriented solutions.

In China, China Telecom has built a trusted basic traceability platform for blockchain mirror chain, developed an IOT platform based on blockchain decentralization, and led the establishment of the first international standard project for distributed books in ITU-T SG16. Based on security standards, China Mobile actively promotes ITU-T to establish a blockchain (distributed book technology) security team; China Unicom has established the world's first international standard project on the Internet of Things blockchain in ITU-T SG20 with ZTE, CITIC and China Mobile; China Unicom, China Telecom and China Mobile jointly launched “NGNe blockchain scenarios and capabilities requirements” in ITU-T SG13 to study the application of blockchain in telecommunications networks.

### **4. Application of blockchain technology in the telecommunications industry**

#### **4.1 Telecommunication equipment**

There are a large number of hardware devices in the network of telecom operators, which are widely distributed in the core network, transmission network, data network, access network and other fields. Currently facing the following problems : the number of equipment, variety, manufacturers, batches, it is difficult to form top-down transparent penetrating management ; The whole process technologies of automatic collection, trusted storage, record traceability and intelligent analysis of inspection data are still incomplete, and data analysis is difficult. The underlying data storage based on blockchain, combined with IoT, AI and other technologies, can provide equipment inspection and equipment life cycle management services for operators to improve the quality and efficiency of inspection. From the level of provincial companies and groups, provincial companies inspect the equipment as required

and record it on the block chain ; The group obtains the trusted data on the chain and checks the implementation of equipment inspection in real time ; From the perspective of operators and equipment vendors, the equipment management platform interacts with the business system of operators through interfaces, synchronizes equipment fault information and equipment risk information in real time, predicts faults in advance and processes them in time.

#### **4.2 Dynamic spectrum management and sharing**

Wireless spectrum resource is an essential cornerstone to support wireless communication data transmission, which belongs to the important strategic resources of the country. With the exponential explosion of communication data, the shortage of wireless spectrum resources and low spectrum utilization have emerged. Therefore, since 2005, China has conducted extensive and in-depth research on spectrum resource sharing wireless communication system and cognitive radio network. However, there are still problems such as the lack of unified record of user frequency information, the leakage of node privacy, and the lack of sufficient trust mechanism for the sharing transaction of spectrum resources.

The dynamic spectrum sharing based on blockchain can make use of the distributed book structure provided by blockchain to make the circulation records of spectrum trading transparent, untampered and traceable. All participants in the blockchain can supervise the information and establish the trust relationship between the chains of spectrum trading. Based on the consensus mechanism of block chain, the authentication information and spectrum resources are effectively bound and registered before the spectrum transaction, so that the whole network node can verify the validity of the authentication information at the same time, and thus identify the owner of the spectrum assets. By establishing a new and reliable spectrum resource rights system, it provides a strong guarantee for maintaining spectrum sovereignty. The rules are established in the spectrum transaction, and the intelligent contract code representation is used instead of the contract to realize the chain payment and improve the automation level of the transaction.

#### **4.3 Digital authentication**

Equipment identity management is a typical application of blockchain penetrating into the Internet of Things. Blockchain can provide each Internet of Things equipment with a unique digital identity ID, register the ID onto the chain, and record all information of the digital identity through the jointly maintained accounts, so as to realize the identity authentication, access control, anti-counterfeiting and traceability of the equipment. By constructing the equipment identity management system based on blockchain as the background accounting system, the equipment identity can be obtained and verified by the implementation of the blockchain intelligent contract consensus, and the mapping relationship between the identity of individual entities and the identity of the equipment at the end of the ownership can be established, so that the equipment end can also verify whether the identity of the requester has access rights in the authorization mode, and realize the bidirectional credible and safe traceability verification between the equipment end and the user.

#### **4.4 International roaming settlement**

International roaming service is one of the many services that telecom industry mobile Internet service providers or operators can provide. From the perspective of international roaming settlement mechanism, the generation process of international roaming charges is more complex, involving domestic operators and roaming operators. At present, there are more than 700 operators in the world. The opening process of roaming business between operators is complicated and there are many risk points. If the roaming business is opened, it is necessary to establish mutual roaming relationship, negotiation of roaming protocol and roaming settlement. Blockchain technology can meet the challenges of safety and efficiency of operators of international roaming settlement business. Since 2020, China Telecom blockchain team has begun exploring the use of blockchain technology to address some of the pain points in the current international roaming business. Using the characteristics of blockchain technology in trusted value exchange and tamper proof, a trusted and mutual authentication roaming protocol file and financial settlement file system can be shared between

operators and their roaming partners. At the same time, call list verification and bill reconciliation settlement are made. All roaming public reference records are chained to realize traceability, safety and transparency, improve settlement efficiency, and reduce the complex dispute settlement and arbitration mechanism caused by inconsistency.

#### **4.5 Data circulation and sharing**

With the wide popularization and application of big data, the value of data resources is gradually valued and recognized, and the demand for data circulation and sharing is also increasing. Driven by the active promotion of national policies and the drive of local governments and industry, telecommunication operators have actively arranged and practiced the circulation and sharing of telecommunication data, but there are still the following problems: lack of standardization and completeness in data transactions, and the core issues such as data confirmation and data pricing have not been fully solved; Data security and privacy protection requirements are increasingly prominent, lack of technical means; The existing centralized way of data circulation lacks credibility in the telecommunications industry. Building a decentralized data circulation and system based on blockchain technology, sharing metadata, sample data, data acquisition requirements, data transactions and ownership transfer information; Before the generation or circulation of data resources, the confirmation information and data resources are effectively bound and registered to provide technical support for the maintenance of data sovereignty ; The intelligent contract rule code is used to replace the contract, realize the automatic acquisition of online payment and data access rights, and improve the level of transaction automation.

#### **4.6 Internet of Things applications**

With the popularization and deepening of the Internet of Things technology in the industry, human society is entering a new era of “Internet of Things, ” but there are still many problems that restrict the Internet of Things to play its potential ability, including numerous access devices, and the security and credibility of the equipment itself and its collected data are difficult to guarantee. The ability to centralize data storage devices and users and control devices can easily cause privacy and security concerns; There is no effective cooperation mechanism between industry applications, and the value transfer of application data is still difficult. The combination of blockchain technology and Internet of Things technology can achieve the effect of dual-sword combination, including but not limited to expanding the opening capacity of IoT platform and establishing data stores based on blockchain technology, and promoting the high-speed flow of Internet of Things data. Blockchain IoT platform adopts a unified data model record to ensure consistent understanding of data between different applications ; Blockchain is used to record data fingerprints, encryption mechanism and privacy authorization mechanism to ensure user privacy and data asset security. It can also maximize the connotation of sharing economy in smart home Internet of Things, environmental protection Internet of Things, vehicle networking, computer room leasing and other scenarios.

#### **4.7 Cloud network integration**

User 3A (authentication / authentication / billing), interconnection and interoperability, and cost settlement are three major obstacles affecting the global cloud network integration of operators. Blockchain technology helps to achieve business collaboration between cloud and multi-network from authentication to charging. For cross-network connection, blockchain + AI identifies massive hardware and parameters, and analyzes the performance and fault of interconnection and interoperability in real time; For cross-cloud docking, blockchain + AI automatically records and analyzes the cloud data throughput and interface behavior, and provides a credible basis for cloud collaboration and settlement; For cloud network integration, cloud network business based on the alliance chain, the alliance enterprise “cloud + multi-network” sales authorization certification, accounting traceability.



#### **4.8 Multi-access edge calculation (MEC)**

In the MEC at the edge of the mobile network, due to the limitations of the computer room and environment, the hardware resources of MEC are often limited, and there are some devices around MEC that have strong processing capabilities, such as mobile phones / cameras / personal computers. These resources may be used to strengthen the ability of MEC. Local network servers connected by MEC, or some personal computers in the local network, have certain storage and computing resources. Using blockchain technology, the resource network of “infinite nodes” can be constructed by aggregating all kinds of idle resources, so as to aggregate into a powerful resource pool and optimize the real-time deployment and utilization of resources distributed in each node, which can effectively help MEC deployers to save costs and improve efficiency. The combination of MEC blockchain technology can provide rich computing resources for sharing, for video broadcast, local caching and other services, GPU resources can also be used for AI training. Operators of MEC can make returns by means of chain integration or chain payment. After the transaction, MEC can operate the corresponding resources on the access blockchain.

### **5. Countermeasures to promote the application of blockchain in telecom industry**

#### **5.1 Enhancing the strength of independent R&D and accelerating the breakthrough of blockchain core technology**

By gathering resources such as industry, university and research, supporting universities and research institutes to build blockchain innovation laboratories and research centers, closely tracking the development frontiers of international blockchain technology, building a basic blockchain technology research and development platform, accelerating the innovation and evolution of core technologies such as asymmetric cryptography, consensus algorithms, intelligent contracts, and reducing the difficulty of landing blockchain technology applications.

#### **5.2 Building and promoting national blockchain infrastructure BSN**

At present, the development of blockchain industry is seriously fragmented, and there is no industrialization-oriented blockchain standard system. In the new track of blockchain, operators' collaborative progress is the trend, and BSN provides a good opportunity for deep cooperation among the three. BSN is a platform for operators to cooperate closely with blockchain industry, which helps to jointly explore the application value of blockchain in digital assets, telecommunications assets, and new generation network construction. Through co-construction and promotion of BSN blockchain network deployment, the high cost problem of LAN architecture for alliance chain applications is changed. Relying on existing network resources and provincial and municipal data centers, urban public nodes throughout the country are established to form a blockchain service platform serving the whole country, so as to reduce the development, deployment, operation and maintenance, interoperability and supervision costs of blockchain applications.

#### **5.3 Actively developing pilot demonstration of blockchain technology**

Aiming at the application scenarios of telecom equipment management, dynamic spectrum management and sharing, digital identity authentication, international roaming settlement, data circulation and sharing, Internet of Things, cloud network integration, and multi-access edge computing, this paper organizes and implements representative blockchain technology application projects, establishes models, forms a replicable and easy-to-operate blockchain technology application demonstration platform, and promotes the integration and development of blockchain technology and telecom industry.

#### **5.4 Improve the training mechanism of blockchain talents and build blockchain talent team**

Focusing on the development and application needs of blockchain technology, a three-dimensional introduction network of deep-level and multi-channel blockchain talents is constructed. On the one hand, it supports colleges and vocational colleges to set up blockchain technology application-related

majors, and speed up the cultivation of blockchain technology application professionals relying on blockchain laboratories and talent training bases. On the other hand, we should pay attention to the cultivation of high-end technical talents, and jointly train blockchain masters and doctoral students with foreign famous universities, research institutions and well-known enterprises, so as to promote the training and introduction of Sino-foreign cooperative talents.

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