Application of Blockchain technology in power material performance and settlement

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Abstract. The current management mode and technical means of electric power materials can not meet the increasing business volume of electric power materials. In order to solve the problem that the existing management mode can not meet the demand due to the growth of power material business volume and the improvement of power service level, this application is carried out. Through the application of blockchain, artificial intelligence, mobile Internet and other technologies, the online flow of electronic documents in power material business, the blocking points of settlement business and the 7*24 all-weather settlement business are realized. Finally, it shortens the order execution cycle, reduces the cost of manual window, improves the business efficiency, and saves expenses for power grid enterprises and suppliers, and improves the quality and efficiency of supply chain operation.

1. Introduction
At present, the world is accelerating the development of blockchain technology, and the application of blockchain technology has been extended to many fields such as digital finance[1], Internet of Things, intelligent manufacturing, supply chain management, and digital asset trading. General Secretary Xi Jinping emphasized during the 18th collective study session of the Political Bureau of the Central Committee that "the deep integration of blockchain and the real economy must be promoted." In order to implement the central government's major decision and deployment on accelerating the construction of new infrastructure, conform to the development trend of digital economy and industrial transformation, give full play to the positive role of blockchain technology in the development of modern industry, and further explore the comprehensive service capabilities of blockchain[2]. Value creation ability, promote the implementation of new infrastructure construction and promote industrial transformation and upgrading[3].

In the report of the 19th National Congress of the Communist Party of China, General Secretary Xi Jinping put forward the new development concept of building a “modern supply chain”, and the State Council also clarified the work requirements for building a smart supply chain system. This demonstrates the important position of the supply chain system. At the same time, the wise decision of the party and the central government is to carry out a comprehensive, full-chain quality and efficiency...
transformation and improvement of traditional material management, taking innovation as the first driving force, and realizing the transformation of the material field into a smart supply chain. Fully transformed[4]. Through new infrastructure methods, the introduction of blockchain technology for central enterprises or regional advantageous industrial clusters such as energy, smart cities, and smart manufacturing can make material inventory and in-transit information available in real time, and suppliers can adjust production scheduling according to inventory to ensure supply. The demand side can make a reasonable construction plan based on the production scheduling and inventory information. Through the transparency of information, the organization and coordination capabilities between industrial enterprises can be improved, which is conducive to the construction of an emergency response system for materials in advantageous industries. Combining and using technologies such as the Internet of Things and big data can promote the balance of production, supply, and use of regional advantageous industries and related materials, realize efficient operation of materials, promote effective connection between upstream and downstream of the industrial chain, and promote coordinated industrial integration.

At the same time, the existing management models and technical means can no longer meet the increasing business volume of electric power materials. There are still poor inter-professional data interoperability, numerous business links, and some businesses still need to be handled offline in the power material contract fulfilment and settlement links. In order to solve the management bottleneck caused by the increase in the business volume of power materials and the increase in power service requirements, this paper proposes an application of power materials contract fulfilment and settlement based on blockchain technology. Relying on blockchain technology to realize the online circulation of electronic documents, clearing settlement business jams, and 7*24 all-weather settlement business processing and other scenarios. The order execution cycle is shortened, the labour window cost is reduced, the processing efficiency is improved, and the cost is saved for the supplier and the management quality and efficiency are improved.

2. Blockchain technology and development trend

2.1. The origin of blockchain technology
Blockchain technology originated from the foundational paper “Bitcoin: A Peer-to-Peer Electronic Cash System” published in 2008 by a scholar named “Satoshi Nakamoto”. In a narrow sense, a blockchain is a chained data structure that combines data blocks in sequence in chronological order, and is a distributed ledger that cannot be tampered with and is guaranteed by cryptography. Broadly speaking, blockchain technology uses block-chain data structures to verify and store data, uses distributed node consensus algorithms to generate and update data, uses cryptography to ensure the security of data transmission and access, and uses automated scripts. A new distributed infrastructure and computing paradigm in which smart contracts composed of codes are used to program and manipulate data[5].

In terms of implementation, first assume that there is a distributed data recording ledger. This ledger is only allowed to be added but not allowed to be deleted. The basic structure of the bottom layer of the ledger is a linear linked list, which is also the source of its name “blockchain”. The linked list consists of a series of “blocks”, and subsequent blocks record the hash value of the leading block. To add new data, it must be placed in a new block. And whether this block (and the transaction in the block) is legal can be quickly verified by calculating the hash value. Any maintenance node can propose a new legal block, but must go through a certain consensus mechanism to reach an agreement on the final selected block[6].
2.2. Technical characteristics of blockchain

2.2.1. Classification of blockchain
According to the different participants, it can be divided into public chain, consortium chain and private chain.

Public chain, as the name suggests, anyone can participate in the use and maintenance, such as the Bitcoin blockchain, the information is completely open;

The private chain is managed and restricted by centralized managers, and only a few internal people can use it, and the information is not disclosed;

The alliance chain is somewhere in between. Several organizations work together to maintain a blockchain. The use of the blockchain must be restricted access with permissions, and relevant information will be protected, such as supply chain institutions or bank alliances.

At present, the public chain is easier to attract the attention of the market and the media, but more commercial value will land on the alliance chain and the private chain. According to different usage purposes and scenarios, it can be divided into currency chains for the purpose of digital currency, property rights chains for the purpose of recording property rights, crowdfunding chains for the purpose of crowdfunding, etc. There are also general chains that are not limited to specific application scenarios. Most of the existing blockchain implementations include at least the network layer, consensus layer, smart contract, and application layer. The implementation of the alliance chain often introduces a certain authority management mechanism.

2.2.2. Blockchain technology stack
1) Blockchain ledger
Blockchain ledger is a unique data recording format. Blockchain is “block + chain”. The so-called block refers to the meaning of data blocks. Each data block is connected by a certain mark to form a chain, which is connected block by block. There are many similar recording methods in life, such as the accounting books of enterprises. Every month, the accountant summarizes the accounting vouchers into account books and closes them monthly. In this way, after a period of time, a continuous account book is formed on a monthly basis, with data for each month. It is equivalent to a block, and the block and the block are connected in series through the year and month. In Bitcoin, a block is generated approximately every 10 minutes, and the block mainly contains transaction data and summary information of the block.

2) Blockchain consensus mechanism
In the blockchain system, what each node must do is to keep its own ledger consistent with the ledger of other nodes. The consensus algorithm is actually a rule, and each node confirms its own data according to this rule. In the blockchain system, there are many such algorithm schemes, such as PoW, PoS, DPoS, PBFT, etc. The blockchain system uses this screening algorithm or consensus algorithm to reach agreement on the ledger data of each node in the network.

3) Blockchain encryption algorithm
Blockchain ledgers are connected blocks. The connections between blocks are often not related by data addresses, but by a kind of data called hash value, which is through a password. Calculated by the hash algorithm in the algorithm. If someone tampered with the data of a certain block in the middle, then the following blocks will have to be modified. At this time, it is not simply a matter of modifying

Figure1. Chain structure of blockchain
the address of the following block to end, because the following block is passed through the zone. The block hash points to it. As long as the previous block changes, the block hash is invalid and the correct block cannot be pointed to.

Another application of cryptographic algorithms is the Merkle tree structure. In fact, in addition to calculating the hash value of the entire block, each transaction data contained in the block will also be calculated a hash value, which is called "transaction hash". Every transaction hash can be calculated. Uniquely represents a transaction. After hashing all the transactions in a block, a set of transaction hashes can be obtained, and then by processing these transaction hashes, the data structure of a hash tree is finally obtained. The top of the hash tree is the root, called “Merkel Root”. Through this Merkel root, the transactions in the entire block can be constrained. As long as there is any change in the transaction in the block, the Merkel root will change. By using this, the integrity of the block data can be ensured. Of course, the application of cryptographic algorithms in the blockchain system is far more than that. For example, the use of cryptographic algorithms to create account addresses and sign transaction transactions requires the application of cryptographic algorithms.

4）Network routing mechanism

The blockchain system is a distributed network, and the nodes in these networks mainly rely on the network routing function to connect and communicate with each other. In a distributed network structure, there is no designated server, and everyone cannot directly exchange each other's identity information through a server, and can only rely on contacting each other and disseminating information. In the blockchain system, this function is generally defined as a protocol called “node discovery protocol”. In addition to discovering nodes, a more important function is to synchronize data. If a node wants to keep its own ledger data up to date, it must update its own data from time to time. Where to update? Since there is no server to download, it is through neighboring nodes. By sending data requests to neighboring nodes to obtain the latest data, each node acts as a server and a server. In this way, each node in the network will reach a data agreement at a certain moment.

2.3. The development of blockchain

So far, blockchain technology has roughly gone through 3 stages of development:

Figure 2. The development stage of the blockchain

1）Blockchain 1.0

The typical features of Blockchain 1.0 mainly include: a chain-like data block structure in units of blocks, a shared account book across the entire network, asymmetric encryption, and open source code.

2）Blockchain 2.0

Blockchain 2.0 attempts to create a shared technology platform and provide BaaS services to developers, greatly improving transaction speed, greatly reducing resource consumption, and
supporting multiple consensus algorithms such as PoW, PoS, and DPoS, making DAPP development easier. Typical features include: smart contracts, DAPP, virtualization, etc.

3. Blockchain 3.0
The blockchain 3.0 stage is to build a completely decentralized social network, which means that a social trust relationship can be formed at a very low cost, which greatly reduces the operating cost of the entire society. Under Blockchain 3.0, applications such as automated procurement, intelligent Internet of Things applications, virtual asset exchange and transfer, information storage, etc. can be realized, which can be used in various industries such as art, law, development, real estate, hospitals, human resources, etc.

3. Construction of Smart Supply Chain for Grid Enterprises
The connotation of the smart supply chain is to transform from the demand-driven of the traditional supply chain to the supply-driven, and promote the development of the supply chain by improving the quality and efficiency of the supply side. The innovation of the modern (smart) supply chain has adapted to the power grid company’s growth from speed to high quality. The transformation of growth. The modern (smart) supply chain achieves goals that are further extended on the basis of the traditional supply chain. The goal of the traditional supply chain is to reduce costs and increase efficiency for existing stocks, thereby improving the quality of economic operation. In addition to accomplishing the traditional goals of the modern (smart) supply chain, it is more important to transform the supply system to create new value, new wealth, and new kinetic energy through the innovation and development of the supply chain.

3.1. Characteristics of smart supply chain
1) In-depth integration of the whole process of digitization
   Its core is to promote the digitization of the entire supply chain process through the in-depth integration of information technology with all links of the supply chain, eliminate information blind spots, achieve data integration, and improve data quality.
2) Comprehensive networked collaboration
   Its core is to promote the networking of the supply chain ecosystem, enhance business interoperability, data availability and resource sharing, and comprehensively promote the efficient operation and continuous innovation of the supply chain ecosystem under the support of a networked platform.
3) Intelligent support from multi-dimensional perspectives
   Its core is to rely on blockchain, big data and artificial intelligence to promote the intelligent of supply chain operations and decision-making, and to realize supply chain business automation execution, predictive decision-making, and heuristic changes.

3.2. Main construction content
1) Smart purchase
   Relying on technical means such as blockchain, big data, artificial intelligence, mobile applications, Internet of Things, etc., in terms of procurement plan and bidding document review, expert database resource allocation, extraction plan verification, and bid evaluation site management and intelligent applications, Realize the intelligent of procurement review, intelligent of bid evaluation, compliance of the procurement process, and coordination of expert resource allocation, and finally realize “intelligent review, sunny procurement”. Through structured procurement standards, promote the automatic comparison of key parameters for bid evaluation, and at the same time strengthen the application of comprehensive evaluation of suppliers in the bid evaluation process, realize the optimization of suppliers, and ensure the quality of purchased products and services. Eventually realize “intelligent selection of high-quality products, strong network quality”.
2) Digital logistics
Taking the whole process of material supply as the main line, integrating warehousing, distribution, emergency, waste, contract, supply, settlement and other businesses, focusing on the application of Internet of Things, mobile Internet and other technologies, intelligently carrying out accurate matching of supply and demand, rolling planning, and full visibility of logistics. Business innovations such as dynamic optimization of standards and global deployment of resources have achieved more complete visualization, accuracy, and agility of material supply, and achieved the goals of “intelligent gathering of resources, visual deployment”, “intelligent connection of supply and demand, and convenient fulfilment of contracts”.

3) Panorama quality control
The panoramic quality control business chain relies on the application of the whole process of physical ID material supply, and uses the new technologies of big, cloud, material, mobile, smart, and chain as the link to create a smart innovation model for quality supervision and management and supplier management. Through intelligent or mobile collection of quality supervision information such as remote manufacturing supervision information, manufacturing, test and inspection information, supplier credit information collection, multi-dimensional analysis of quality control information, optimized configuration of inspection resources, and differentiated control strategies for manufacturing supervision and random inspection Optimization, supplier verification strategy optimization, to achieve intelligent identification, dynamic assessment and control of product quality, production schedule, supplier credit risk, intelligent aggregation of quality control information throughout the life cycle of materials, accurate traceability of supplier quality issues, and achieve “intelligent quality status”, “Precise monitoring”, “intelligent gathering of information, full traceability” design goals.

4) Intelligent decision
The smart decision center builds a new supply chain smart operation model. On the one hand, it smartly improves material standards, and realizes multi-dimensional analysis, business forecasting, and risk management from the three aspects of procurement, supply and quality control. It monitors and quickly responds to business changes in real-time and improves material intelligence business. Chain operation quality and efficiency.

4. Actual application

4.1. Business application scenarios
1) “Online circulation” of electronic documents
Based on the management concept of “people-oriented, service-oriented”, we strive to provide all relevant units with comprehensive, humanized and convenient all-round services, as well as convenient, efficient and humanized work experience, thereby improving work efficiency and improving service levels. Taking the electronic service as the starting point, the management of the material supply chain has been fully transferred online to realize the electronic transfer of documents. The project realizes the mobile terminal circulation of five types of documents (cargo delivery order, arrival inspection order, storage order, delivery order, and warranty order), reducing delivery time and improving settlement efficiency. At present, all parties to the project have completed the on-site handover, acceptance and warehousing operations. The documents involved can be directly processed in the palm-based Yidian APP. There is no need to transfer paper documents. It truly realizes that “more data runs, fewer personnel Run errands”. Become an important means to build a smart supply chain system.

2) Unblock settlement business “blocking points”
In the past, the settlement business processing model was that the supplier brought all kinds of documents and invoices to the supplier service hall, and completed document scanning, invoice pasting, and front desk submission in the supplier service hall, which was inefficient and often caused
“congestion”. condition. The online operation of the system moves the “blocking point” of the process forward. The supplier has already processed the electronic documents, and there is no need to form various documents into paper materials, just click on the data to upload in the APP. At the same time, you can take pictures and upload the pictures of the invoices. After printing the paste sheets, you can paste the bills at home, saving work time in the supplier service hall. After making an appointment through the mobile app, you can quickly complete the document settlement business by mail, scan code at the front desk, and self-service terminals, which greatly improves the efficiency of business processing.

3) “7*24” all-weather processing

Combined with the supplier’s self-service terminal equipment, it can realize 24-hour business uninterrupted processing, and is not restricted by holidays. Suppliers can use the APP remote appointment function at any time and place. There is no need to go to the supplier service center window to wait in line. One-stop invoice processing can be completed through self-service terminal equipment, thus forming a new scenario application.

4.2. Technical route and implementation method

1) Information technology and material core business docking

Through the application of cutting-edge information technology, we can realize the comprehensive perception of data in the material supply link, promote the integration of different professional data, and discover, analyze and solve material supply chain problems through information interaction, and improve the quality and efficiency of business processing in the material fulfillment and settlement links. The platform layer relies on the material allocation platform, full-service data center, ERP system material module, and financial control system material and payment business data, and forms a comprehensive data service platform through big data analysis, artificial intelligence, blockchain and other technologies to provide data for applications support.
The project application layer selects integrated coordination of material settlement, automated settlement and payment application, and electronic processing of settlement documents as scenario applications. At the same time, the smart supply chain application scenarios are enriched and expanded through self-service terminals. The network layer of the project is accessed through the company’s backbone network, and secure technical means are used to achieve strong isolation of internal and external data and restricted access. At the same time, it supports 5G equipment in terms of mobile terminal access to ensure a better application and service experience. The terminal layer uses APP and supplier self-service terminals as core business access points to realize real-time perception of the status of all project participants such as suppliers, project units, construction units, supervision units, and material units, for business flow, process optimization, and provide basis for service improvement. Effectively tap the potential value of material data, quickly respond to changes in demand, and ensure the scalability and practicability of the system.

2) Blockchain-based technical architecture

In order to ensure the authority of the circulation of online electronic documents, to ensure data security, and to ensure that the data cannot be tampered with. The system introduces blockchain technology in the research and development process to create a credible collaboration platform for real identity authentication. The application of blockchain technology can certify key nodes in the material supply link. Through the distributed storage of data, the "centralization" of data storage is realized, and a reliable and solid credit system is established for both ends of the supply chain.

![Blockchain application architecture](image)

The electronic signature based on blockchain technology solves the cumbersome operation of the traditional electronic key method. Both parties in the supply chain can conduct business through the mobile phone, which successfully solves the interoperability and service agreement due to the traditional electronic signature limited to the CA center certificate. , Resulting in poor applicability and high protection costs.

3) Application of terminal equipment to achieve manual business replacement

The supplier self-service terminal is equipped with facial recognition, RFID, OCR, automatic control and other technologies to realize supplier identification, invoice scanning and data reading, invoice and logistics credential association, logistics credential automatic archiving, etc., that is, the
real realization of the same equipment. The business replacement of window staff releases a large amount of human resources and effectively alleviates the reception pressure of the supplier service center.

4.3. Application hardware environment

According to application requirements, the required hardware servers mainly include database servers, file storage servers, blockchain node servers, data interface servers, application servers and reverse proxy servers, etc. The specific requirements are shown in the following table:

| Serial number | Equipment name       | Quantity | Use                                      | Configuration requirements                      |
|---------------|----------------------|----------|------------------------------------------|------------------------------------------------|
| 1             | database (host)      | 1        | Store structured core business data      | 16-core CPU, 250G local storage, 1T disk array (dual machine sharing), 32G memory |
| 2             | database (Prepare)   | 1        |                                          |                                                 |
| 3             | File storage server  | 2        | Store unstructured data, such as files, pictures, etc. | 8-core CPU, 500G local storage, 16G memory |
| 4             | Blockchain node server | 7    | Provide blockchain services such as consensus and sorting | 8-core CPU, 250G local storage, 16G memory |
| 5             | Data interface server | 2        | Docking with other system data interfaces to realize data interaction | 8-core CPU, 250G local storage, 16G memory |
| 6             | application server   | 2        | Deploy intranet/extra net applications    | 16-core CPU, 250G local storage, 32G memory    |
| 7             | Reverse proxy server | 2        | External network application load balancing and reverse proxy | 8-core CPU, 250G local storage, 16G memory |

4.4. Actual application effect

This application effectively responds to the problem of order granulation and fragmentation derived from the lean management of the distribution network project of the power grid company, and
effectively guide the surge in business volume, and solves the problem of actual pain points in the power material business. Taking the research of smart supply chain as the direction, promote the management of material supply chain to be fully online.

According to calculations, the material supply cycle has been shortened from an average of 45 days/order to 30 days/order. Project participants and suppliers can save more than 5 times the time invested in the material supply link, and work efficiency has increased by more than 3 times. Up to now, a total of 4.597 billion yuan has been processed for supplies, saving suppliers about 50 million yuan in travel costs. During the epidemic, suppliers have handled more than 60,000 business transactions involving 1.08 billion yuan. At the same time, it reduces a lot of manpower and labor costs, reduces the chance of manual errors, and reduces unnecessary other expenditures.

5. Conclusions
This application is based on solving the actual pain points in the construction of the smart supply chain system. Through the application of blockchain, artificial intelligence, mobile internet and other technologies, the research of the smart supply chain is the main direction to reduce human intervention and break the power materials. The management bottleneck between the two has realized the collaborative management of the power material business, effectively improved the quality and efficiency of supply chain management, promoted the deep integration of blockchain and the real economy, promoted the application of new enterprise infrastructure construction and promoted industrial transformation and upgrading.

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