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Supply chain financial service management system based on block chain IoT data sharing and edge computing

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Abstract The implementation of the "Internet +" policy advocated by the state has also led to rapid development of Internet finance. In order to promote changes in business development models, as a pioneering work for banks serving the real economy, supply chains are being developed to address small and medium-sized enterprises. The financing of enterprises, the transformation and development needs of banks themselves, and the promotion of logistics technology. Edge computing refers to an open platform that integrates network, data processing, storage and application core functions, and can provide the closest end-of-page service near the object data source to meet real-time, application intelligence, security and privacy Sexual needs. The core of supply chain financing is to establish an optimized plan that can effectively control supply chain financing. By integrating the financing literature of the supply chain, the settlement cost in the supply chain can be solved. Based on theoretical research, this article analyzes supply chain financing and block chain technology. Combined with the current specific situation of block chain in supply chain financing, the management system, cash flow of the supply chain, and risk control system are analyzed. All parties to the supply chain financing optimize the supply chain financing risk control system while reducing business costs and improving corporate efficiency, which greatly reduces the risks of all parties in the supply chain financing. The block chain Iota environment based on shared data and advanced data processing has very powerful theoretical and practical significance for promoting the development of commercial banks and enterprises.

1. Introduction

The implementation of the "Internet +" policy advocated by the state has also resulted in rapid development of Internet finance. This modern financial development method poses important challenges to the operation and development of tra-

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ditional commercial banks. Commercial banks compete with customers. The capabilities of the company are being rebuilt, the customer's development methods and methods must be rebuilt, and the profit model must be continuously improved. The development of the financial industry must be fundamentally changed. The new form of private financing, the cross-border competition between industrial capital and Internet financing has led to more and more financial themes, and the richness of financial activities and rapid changes in financial products have gradually created a broad The financial market spans multiple levels and fields. At this time, the rapid development of big data and cloud computer technology has created new financing models that are different from traditional financing. These have promoted changes in business development models. As a pioneering work for banks that serve the real economy, they are developing supply chains. Solve the financing problems of SMEs, the transformation and development needs of banks themselves, and promote the development of logistics technology. So far, the supply chain has become a powerful strategic controller, but the current supply chain is mainly reflected in several original fields, and the business varieties in these fields are relatively short.

Edge computing refers to an open platform that integrates network, data processing, storage and application core functions, and can provide the closest end-of-page service near the object data source to meet real-time, application intelligence, security and privacy Sexual needs. The Internet is an important driving force for the development of advanced data processing, and it is also the fundamental technology that supports the realization of the Internet of Things. Its technicians need computers. For the Internet of Things, the breakthrough of advanced technology means that many control technologies will be carried out in the local device instead of the cloud, and the process will be carried out in the local angle computer system. Because it is closer to users, it can also provide users with quick services and solve individualized needs.

During the "Internet development" period, the integration of all industries and fields with the Internet has become an inevitable trend of social development. More companies have begun to develop in the direction of networked liquidation and other independent business services, and actively use new Internet technologies. Integrate common business services such as payment, transfer, cash management, transaction financing and asset management, so as to realize the upgrade from the launch of a single financing service to professional financial management and measurement funds. From the perspective of company cooperation, we can assist the company in reducing production and operating costs, provide the company with complete financial services, and realize the company's rapid development. It is more convenient for commercial banks to implement their own strategic transformation, obtain customer satisfaction, and builds Unique advantages and competitiveness, create a well-known brand and company image, realize the retention of existing customers and the development of new customers to achieve sustainable profitability.

2. Related work

In recent years, the rapid development of new block chain technology has attracted close attention from experts and scholars and the industry. Literature [1] believes that block chain is a distributed accounting technology, and its main characteristics are decentralization and anonymity. Difficult to manipulate and difficult to operate and controllable. It can use technologies such as timestamp, encrypted hash, digital signature, etc., to realize transmission between unknown nodes in an environment of incomplete trust. Document [2] records that the use of block chain technology can provide security for an insecure environment and privacy protection. Document [3] records that block chain technology has completed the unreliable exchange of medical data between cloud service providers. The document [4] records data protection based on block chain to improve data protection and accessibility in the cloud environment. Literature [5] uses block chain technology to provide security guarantees for cloud-based applications. Literature [6] completed a block chain-based auditable IoT data sharing plan. Literature [7] pointed out that the data management of security and privacy protection based on the alliance chain is used for data exchange. In short, the application of block chain technology in data sharing in the cloud environment already has a theoretical foundation and practical development projects. Now, the connection between block chain and the Internet of Things has been studied by some experts and scholars. The document [8] records that a method is based on the network architecture defined by the block chain, which completes a stable peer-to-peer distributed network. Every individual in the Internet of Things system can also work without a trusted third party. Can be interactive. Literature [9] can use block chain to control and help large-scale Internet. Internet of Things registration, broadcasting and TV services, and withdrawal of access permissions through smart contracts; the Internet of devices enjoys the right to manage resources, rather than being monitored by a central agency. The document [10] records pointed out a distributed control access system based on block chain, which establishes a smart contract to access certain transactions. Edge computing is an opposite concept cloud computing. Literature [11] suggests moving cloud services closer to the end users. The document [12] records that its central idea is to transfer data processing and communication resources from the cloud to the network nodes so that they can serve the computer faster, which is the edge hub of the mobile network. Respond to advanced users and reduce some communication delays and network congestion.

Supply chain financing is the focus of block chain application research. As far as the concept of supply chain is concerned, literature [13] refers to the core of supply chain financing is to establish an optimized plan that can effectively control supply chain financing. By integrating the financing literature of the supply chain, the settlement cost in the supply chain can be solved. Literature [14] pointed out that the supply efficiency in capital flow is low. Only when there is a liquidity problem, people will realize the flow of capital, which leads to the emergence of supply chain financing. Its main research areas have also expanded from initial financing functions to capital circulation and financing optimization. Literature [15] defines supply chain financing as a comprehensive method that can improve the visibility of the supply chain and control all connections with capital. Literature [16] believes that the Internet of supply chain financing can reduce the financing costs and loan qualifications of small, medium and micro enterprises. Literature [17] believes that science, technology and financial tools used to manage the liquidity of supply chains can benefit many aspects. From the perspective of information asymmetry, literature [18] believes that the Internet, big data and other technologies can reduce costs, obtain customer information at low frequencies, and ensure the authenticity of data. Credibility is a technical guarantee to promote the development of supply chain financing. Based on the viewpoint of Internet financing, literature [19] pointed out the Internet "e-commerce supply chain model" and the supply chain innovation method under "P2P". With the two financial models of "supply chain financing" and "online supply chain refinancing", the risks of supply chain financing are also very complicated. Literature [20] divides the risks of supply chain financing into two categories: systemic risks and non-systematic risks. Systemic risks include macro risks, industry risks, and supply chain systemic risks, while non-systematic risks mainly include credit risk, inventory risk and operational risk. Literature [21] takes the logistics financial system information system as the research object and draws conclusions. Reducing costs and improving efficiency are the most useful tools to improve corporate governance, based on the block chain supply chain financing theory. Literature [22] proposed the use of block chain technology to implement the application of block chain technology in the supply chain. The literature [23] pointed out that chain integration refers to block chain technology that can benefit all links of the supply chain and improve the overall capability and level of the supply chain. The new way to integrate the data system of block chain technology with the supply chain is that information can be shared, and different companies between the financial department and the company can be quickly processed.

3. IoT data management model based on block chain and edge computing

3.1. Overall structure of data management

Fig. 1 shows the IoT data management structure of block chain and edge computing. The data management structure includes the consumer layer, which is composed of IoT devices and advanced computer networks. It is a distributed storage layer and a block chain layer interface server managed by the following personnel.

(1) The block chain includes IoT data identifiers and user license content. The block chain manages all systems for user access and data analysis. All users can access the data in the Internet of Things only through the control access system of the block chain.
(2) The storage layer includes an edge server surrounded by IoT devices. After the data of the IoT device is generated, the data is encrypted and signed and stored in the interface server. The attached file is operated by the data manager to receive subsequent data requests and search for related information.
(3) The consumer layer is composed of devices that want to access IoT data. Users only need to interact with the nearest user server to obtain the data they need, without having to think about the specific details of the data structure, let alone talking about joining the block chain.

3.2. Distributed storage based on edge computing

3.2.1. Server operating mechanism

The storage architecture of distributed edge computing is shown in Fig. 2. Each server has 170 layers of K-bucket mechanism stack. For k-bucket I, the server storage distance is $[2^{i-1},2^{i})$.

3.2.2. Block propagation delay

Through the computing and storage capabilities of IoT nodes, the extended delay of block chain is studied, and the computing and storage capabilities of IoT devices are introduced. The survival function of the computer function of the Internet of Things device is X:

$$\bar{F}_c(x) = Pr(X > x) = \left[\frac{x}{\sigma_c}\right]^{-\zeta}, x \geq \sigma_c > \zeta \tag{1}$$

The probability density function of the computer power X of the IoT device is as follows:

$$f_X(x) = \begin{cases} \frac{\zeta\sigma_c^{\zeta}}{x^{\zeta+1}}, x \geq \sigma_c \\ 0, x < \sigma_c \end{cases} \tag{2}$$

The survival function of the storage capacity y of IoT devices is as follows:

$$\bar{F}_s(y) = Pr(Y > y) = \left[\frac{y}{\sigma_s}\right]^{-\zeta}, y \geq \sigma_s > \zeta \tag{3}$$

Assume that the threshold of the computing node of the computing node is XC, and the threshold of the storage capacity of the consensus node is YC. Then the consensus probability of IoT nodes is:

$$F_{con} = \bar{F}_c(X_c)\bar{F}_s(Y_c) = \left[\frac{X_c}{\sigma_c}\right]^{-\zeta}\left[\frac{Y_c}{\sigma_s}\right]^{-\zeta} \tag{4}$$

The number of consensus nodes is as follows:

$$N_c = NF_{con} \tag{5}$$

The expectations of computing consensus nodes are as follows:

$$\mathrm{E}(X)_{con} = \int_{X_c}^{+\infty} \frac{\zeta X_c^{\zeta}}{x^{\zeta}} dx \tag{6}$$

If the IoT node can be used as a verification node, the possibilities of using the IoT node as a verification node are as follows:

$$\begin{aligned} F_{ver} &= Pr(X_v < X < X_c)Pr(Y_v < Y < Y_c) \\ &= [Pr(X > X_v) - Pr(X > X_c)] \\ &\quad \cdot [Pr(Y > Y_v) - Pr(Y > Y_c)] \\ &= \left[\left[\frac{X_v}{\sigma_c}\right]^{-\zeta} - \left[\frac{X_c}{\sigma_c}\right]^{-\zeta}\right]\left[\left[\frac{Y_v}{\sigma_s}\right]^{-\zeta} - \left[\frac{Y_c}{\sigma_s}\right]^{-\zeta}\right] \end{aligned} \tag{7}$$

Expect to check the computing power of the node as follows:

$$\mathrm{E}(X)_{ver} = \int_{X_v}^{X_c} \frac{\zeta X_v^{\zeta}}{x^{\zeta}} dx \tag{8}$$

The number of verification nodes is:

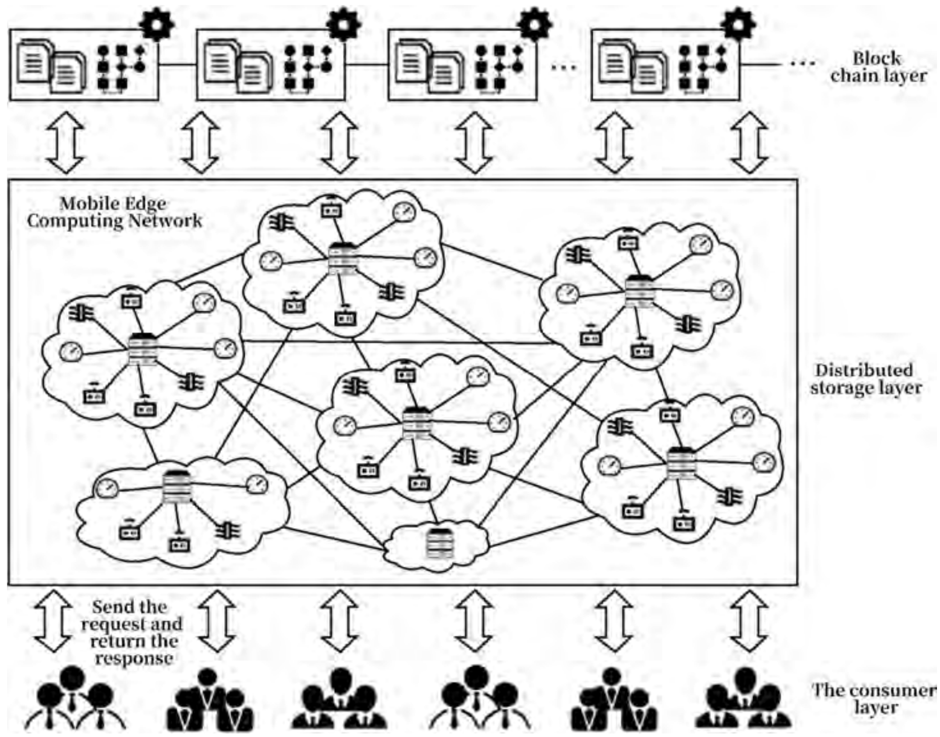

Fig. 1 IoT data management system architecture based on block chain and edge computing.

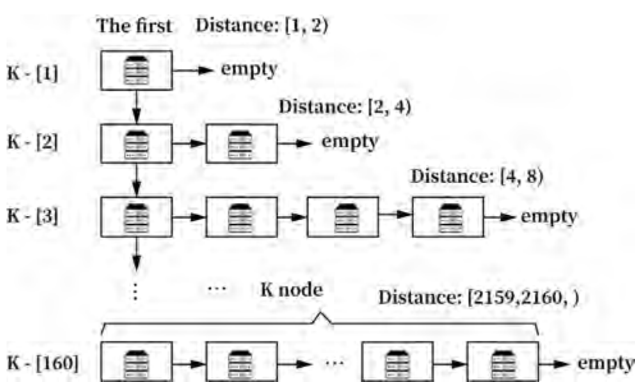

Fig. 2 Distributed storage structure based on edge computing.

$$N_v = NF_{ver} \quad (9)$$

When the block is s, the formula for the block transfer delay is:

$$\tau_{p,b} = \frac{s}{c} log(N) \quad (10)$$

In the formula, C is the average channel capacity of each link. For blocks, the verification delay for a single node is:

$$\tau_{1,v,b} = \frac{sU}{f_m} \quad (11)$$

Here u is the cycle number information of each CPU, then the total verification delay of block transfer in the entire network is:

$$\begin{aligned}\tau_{v,b} &= \alpha N_v \frac{sN}{f_{m,c}} + (N_c - 1)\frac{sU}{f_{m,v}} \\ &= \alpha N_v \frac{\beta_1 sU}{E(X)_{ver}} + (N_c - 1)\frac{\beta_1 sU}{E(X)_{con}}\end{aligned} \quad (12)$$

So, the average expansion of the block is:

$$\begin{aligned}\tau &= \tau_{p,b} + \tau_{v,b} + 2(N_c + \alpha N_v - 1)\tau_{RTT} \\ &= \frac{s}{c}[log(N_c + \alpha N_v - 1)] + \alpha N_v \frac{\beta_1 sU}{E(X)_{ver}} \\ &\quad + (N_c - 1)\frac{\beta_1 sU}{E(X)_{con}} + 2(N_c + \alpha N_v - 1)\tau_{RTT}\end{aligned} \quad (13)$$

3.3. Simulation experiment design

3.3.1. Unstructured data storage

The structuring of data is structure first, followed by adding data, and first there is unstructured data, and then the structure is formed after adjustment. Some voices, images, videos, etc. are encoded according to a specific format. Unstructured data is too large to be converted into structured data, and is mainly stored in NoSQL databases. Four kinds of non-relational databases are analyzed to provide references to unstructured data sources, as shown in Table 1.

3.3.2. Data routing layer

Based on the data information of each large-scale data platform, this paper selects the conditions for restricting data sources, as shown in Table 2.

Table 1 Mainstream non-relational databases.

Classification	Mainstream database	Performance	Scalability	Complexity	Advantage	Disadvantage
Key-value database	Redis.Riake	Big	Big	Small	Fast retrieval	Data cannot support complex structures
Column database	HBase,Casandra	Big	Big	Small	Fast retrieval	Functionally restrictive
Document database	CouhDB 、MongoDB	Big	General	Small	Data structure is not strict	Slow retrieval
Graph database	Neo4J,OrietDB	General	General	Big	Real-time related algorithms	Low data scalability

Table 2 Constraints of data source description files.

Field	Owned storage location	Do you have to	Is it unique
Data source name	Connect up and down	have to	Only
Data collector	Connect up and down	Have to	Not unique
Data owner	Connect up and down	Have to	Not unique
Data reference format	Connect up and down	Have to	Only
Data summary	Connect up and down	Have to	Not unique
Detailed data description	Consecutive	Have to	Not unique
Data Format	Consecutive	Have to	Not unique
Types of data source management tools	Consecutive	Have to	Not unique
Data source access method	Consecutive	Have to	Only
Data access protocol	Consecutive	No need	Not unique

3.3.3. Blockchain layer

The blockchain platform uses the POW consensus algorithm. Although the security is strong, the consensus speed is slow and smart contracts are not supported, so it is difficult to meet the requirements of high-frequency interaction and logical extension under data sharing. The specific results are shown in Table 3:

3.3.4. Contract layer

The contract layer is the core of the logical business plan, which consists of various smart contracts. These contracts are digital. Through the block chain, it is possible to ensure the identity of all participants in transaction processing, code execution, state maintenance and resources. At present, the maturity of smart contracts in the block chain has changed greatly. As an important part of the programmability of the block chain, smart contracts can be related to the development time and security performance of the system. Table 4 shows the research status of smart contracts on different platforms.

3.3.5. Presentation layer

The presentation layer is at the top of the architecture, allowing users to visually exchange data from different terminals by calling the service layer interface. Table 5 shows the technologies used by different terminals and the corresponding specific applications

3.3.6. Custom core algorithm

Table 6 is the situation of related algorithms:

3.4. Experimental results and performance analysis

3.4.1. Degree of decentralization of block chain network

The main feature of block chain is decentralization. In an ideal situation, one or several entities have no right to control and destroy the entire block chain network. Current research points out that the cost factor is a value for detecting the

Table 3 Mainstream Blockchain 2.0.

Blockchain type	Leading agency	Consensus mechanism	Consensus speed	Theoretical fault tolerance	Incentives
Ethereum	Community	POW + POSe	16 s	48%	Currency
EOS	IBMe	DPOSe	4 s	About 49%	Currency
BCOS	Wanxiang Blockchain	PBFTe	Second level	About 34%	Scene
Neo	Neo Enterprise	PBFTe	Second level	About 34%	Currency
Fabric	Hyperledger community	RAFTe	Second level	1%	Scene

Table 4 Mainstream smart contracts.

Blockchain type	Programming language	Development tool maturity	Development difficulty
Ethereum	Solidty,Srpent, LLL	Mature	Medium difficulty
EOS	C+++	medium	High difficulty
BCOS	Jave	medium	Low difficulty
Neo	Jave,Python, C#	Immature	Medium difficulty
Fabric	Go.Jave. NodeJS	Mature	High difficulty

Table 5 Presentation layer terminal type, technology and application table.

Terminal type	Technology	Function application
Mobile	Androide IOSe	User management, data search, data application
PC side	HTMLS + CSSe + Javascript, Bootstrap	All applications of the system.

Table 6 Symbol definition.

Symbol	Definition
X	User X
Pub_i	Data release i
Sub_i	Data subscription i
M	News
C_{pub_sub}	Release contract
Type	Data type
Key_i	Key words
X.send(Y,M)	User X sends M to Y
Key_i.subList	Keyword i subscription service
$Type_i$.subList	Type i subscription service
KeyIType.dataList	Keyword data list
IPFSHD	IPFS hash code of data object D
DataInfo	Data files
contain(KeyIType)	Judge Key or Type Type

decentralization of the block chain network. The number of units of each subsystem can be operated, and finally we use the least unit as the dispersion index of the whole system. The larger the value, the higher the degree of dispersion.

In the consensus cycle, the storage of shared data about consensus nodes is:

$$\Omega = \begin{bmatrix} x_{1,1} & x_{1,2} & \cdots & x_{1,\lceil F\rceil} \\ x_{2,1} & x_{1,2} & \cdots & x_{1,\lceil F\rceil} \\ \vdots & \vdots & \ddots & \vdots \\ x_{\lceil C\rceil,1} & x_{\lceil C\rceil,2} & \cdots & x_{\lceil C\rceil\lceil F\rceil} \end{bmatrix} \tag{14}$$

Then store the number of data files in the consensus node CI:

$$\Omega_{i,\lceil F\rceil} = x_{i,1} + x_{i,2} + \cdots x_{i,\lceil F\rceil} \tag{15}$$

In order to prevent the loss of the stored data file, the data file FJ can be stored on multiple consensus nodes, and the number of copies stored in the data file FJ is:

$$\Omega_{\lceil C\rceil,j} = x_{1,j} + x_{2,j} + \cdots x_{\lceil C\rceil,j} \tag{16}$$

The difference in the amount of data stored by the consensus node is represented by the variance of the VaR of the number of data files stored by the consensus node. The larger the VaR, the greater the difference in the amount of shared data stored by the consensus node. The formula of VaR is:

$$\text{var} = \frac{\sum\left(\Omega_{i,\lceil F\rceil} - \frac{\sum\sum x_{i,j}}{N_c}\right)}{N_c - 1} \tag{17}$$

The degree of decentralization of blockchain D is:

$$\text{D} = \frac{\beta_3 F_{con} + \beta_{4\,ver}}{var} + \kappa_2 \tag{18}$$

In order to make the dispersion D and the blocking delay equal, it is necessary to normalize the block transfer delay and dispersion from Min max. The delay of block multiplication is normalized as follows:

$$\tau_{\to 1} = \frac{\tau - \tau_{mean}}{\tau_{max} - \tau_{min}} \tag{19}$$

After the maximum normalization, the dispersion D is as follows:

$$\text{D}_{\to 1} = \frac{D - D_{mean}}{D_{max} - D_{min}} \tag{20}$$

3.4.2. Numerical simulation results

In this article, first simulate and compare the difference between the proposed protocol and the original protocol, and then distinguish the relationship between block size and block extension delay. The specific values are shown in Table 7. Table 8Table 9

Fig. 3 illustrates the relationship between the block expansion delay and the block size when the proportion of control nodes raised at the consensus node is different; Fig. 4 shows that the block size S is determined compared to the traditional block propagation scheme, which proposes a traditional the block spreading scheme is much smaller in this article.

Fig. 4 shows the relationship between the block expansion delay and the consensus node capacity threshold under different parameters, where the verification threshold for node calibration and the consensus-based data capacity threshold increase in the same interval. Fig. 4a under certain conditions, the block expansion delay decreases as the consensus threshold of the consensus-based data capacity XC increases. As shown in Fig. 4b, under certain conditions, the block expansion delay will decrease as the consensus value of the storage capacity YC

Table 7 Simulation parameter settings.

Parameter	Value
Block size s /bit	2^{14}
Channel capacity c/(bit • s-1)	200
Average round trip time τRTT /ms	200
Proportion of verification nodes recruited by each consensus nodeα	0.4
Minimum computing power of IoT nodes σc/Hz	2000
Minimum storage capacity of IoT nodes σs/GB	33
The storage capacity threshold of the consensus node Yc/GB	200
The storage capacity threshold of the verification node Yv/GB	70
Total number of nodes N/	20,000
The number of CPU cycles required for each bit of information U	1/65
Parameter function β_1, β_2, β_3, β_4	2,2,20,20

Table 8 Comparison and analysis table of traditional supply chain finance business and Rongyi chain platform financing business.

Comparison item	Traditional business	Platform financing business	Individual summary
System functions	Establish a central database, low security	Establish a block chain system, and the overall function has been optimized	The system is more powerful
effectiveness	Complex online and offline operations	Mainly online business, simple operation	The platform is more efficient
Cost	Set up many positions	Set fewer posts	Low platform operating costs
Risk control ability	Risk control mostly comes from enterprise systems	Risk control involves multiple companies and suppliers	Stronger risk control ability
To sum up	The platform business has greatly improved in terms of system functions, business efficiency, costs and risk control capabilities		

increases. When YC is fixed, the block expansion delay will decrease as YC increases.

3.4.3. System performance analysis

The block chain network consists of four nodes on a single host. These nodes belong to two organizations, two MSPs, classification services with separate consensus, and five clients. The method is to send 5000 transactions to the block chain network, and write and query transaction types separately. Observe the average delay of the system under different transaction sending frequencies, as shown in Fig. 5 and Fig. 6.

Due to the identity verification strategy, the blockchain network only includes four nodes, but it can still ensure that the network is decentralized and anti-interference and the public strategy can be designated as a combination of different organizations and nodes. The user must obtain the same approval from a specific member to complete the transaction. There is no central node that can control transactions. By comparing the books and signatures on different nodes, we can quickly find the place of intervention.

4. Analysis of the technical architecture of the financial service management system

4.1. Overall platform architecture

The financing of the supply chain encounters development difficulties, such as imbalanced information and low business efficiency. The detailed structure of the system is shown in Fig. 7.

4.2. Analysis of platform business model

In fact, Fontaine is the electronic claim of the core company's credit guarantee. The effective performance of Fontaine can be guaranteed through electronic signatures and block chain. The creditor's rights are transferred on the platform as a payment method, which corresponds to the currency in real life. At the same time, the supplier engages in financing transactions on the platform. The platform can benefit from efficient and cheap financing services.Fig. 8

4.3. Risk control management of financial service management system

4.3.1. Comparative analysis of risk control systems

The enterprise risk control data source is mainly based on the data collected by the investors themselves, and the data source is relatively simple. The Rongyi Chain platform can be connected to many core companies, suppliers and fund providers.

4.3.2. Calculation of the weights of financial operation risk evaluation indicators

For each level indicator, it is obtained by comparing the relative importance of the two level indicators.

$$C = (b_{cd})_{pipi} = \begin{bmatrix} b_{11} & b_{12} & \cdots & b_{1p_i} \\ b_{21} & b_{22} & \cdots & b_{2p_i} \\ \vdots & \vdots & \ddots & \vdots \\ b_{p_i1} & b_{p_i2} & \cdots & b_{p_ip_i} \end{bmatrix} \tag{21}$$

In the system used to assess financial operational risks in the supply chain, the relative weights of indicators can be written in vector form

$$V = \left(v_1, v_2, \cdots, v_{p_i}\right)^T \tag{22}$$

The formula for the relative weight vector can be obtained by making the components of the new vector have PI powers and standardizing the vector

Table 9 Credit risk assessment index system of supply chain finance.

Index One	Index two	Three types of indicators
External environment	Big environment	International financial environment
		Domestic financial environment
		Legal and regulatory environment
	Target growth environment	Industry stage
		Industry competition
		Product alternatives
Comprehensive strength of small and medium companies	Basic situation of the company	Leader situation
		Staff situation
		Corporate governance
	Company debt repayment	Assets and liabilities
		Flow ratio
		Company interest protection
	Company operation	The company's accounts receivable turnover
		The company's current asset turnover
		Company inventory turnover
	Company profitability	Company sales gross profit
		Company assets return
	Company innovation	New product sales
		R&D investment
		Technical staff ratio
	Company growth	Net assets
		Sales revenue
		Total wages
	Company reputation	Company transaction performance status
		Company loan performance status
Supply chain operations	Supply chain core companies	Production and demand of core companies
		Core company cost advantage
		Core company product cycle
		Total profit of core enterprises
	Supply chain informationization	Information sharing situation
		Information system completeness
	Enterprise competition	Company product quality competition
		Company customer satisfaction
	Supply chain cooperation	Mutual trust between upstream and downstream companies
		Close cooperation between upstream and downstream companies
		Product dependence of upstream and downstream companies

$$v_c = \frac{\sqrt[p_i]{\left(\prod_{d=1}^{p_i} b_{cd}\right)}}{\sum_{k-1}^{p_i} \sqrt[p_i]{\left(\prod_{d=1}^{p_i} b_{cd}\right)}}, c = 1, 2, \cdots, p_i \tag{23}$$

After consistency test, determine the rationality and relative weight coefficient of the above matrix

$$\lambda_{max} = \sum_{c=1}^{p_i} \frac{(CV)_c}{p_i v_c} = \frac{1}{p_i} \sum_{c=1}^{p_i} \frac{\sum_{d=1}^{p_i} b_{cd} v_d}{v_c} \tag{24}$$

The matrix CV is obtained by multiplying the judgment matrix and the relative weight coefficient vector

$$\text{C.I.} = \frac{\lambda_{max} - p_i}{p_i - 1} \tag{25}$$

Find out how big the value of the matrix is and replace it with a formula.

$$\text{C.R.} = \frac{\text{C.I.}}{\text{R.I.}} \tag{26}$$

4.3.3. Supply chain financial operational risk monitoring and management system architecture

For the financial risk management of the online supply chain, the daily monitoring and early warning of operational risk is the most important part of the risk control part, and it plays a major role in the dynamics of operational risk. As shown in Fig. 9, the financial system is used according to the supply chain Monitor and manage financial risks to collect and monitor data from the risk index.Fig. 10

4.4. Evaluation of the supply chain financial service management system based on blockchain technology

4.4.1. Determination of evaluation indicators

Based on existing research projects, the characteristics of China's supply chain business and the external environment, this article selects and adjusts indicators through correlation and discriminant analysis. Through the calculation and analysis

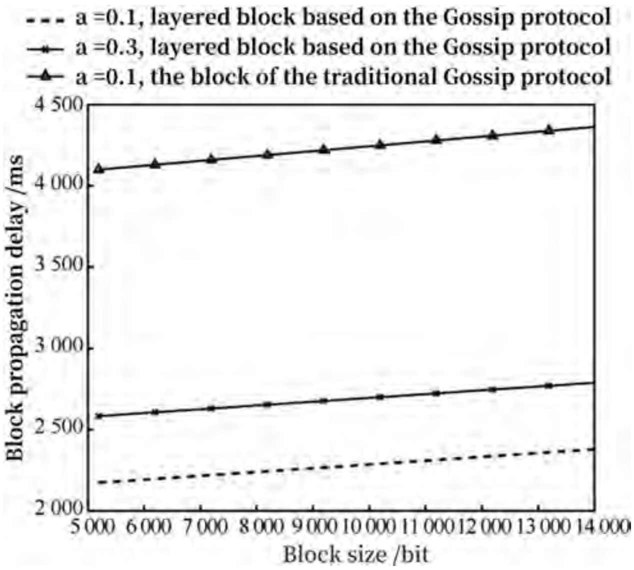

Fig. 3 The relationship between block propagation delay and block size.

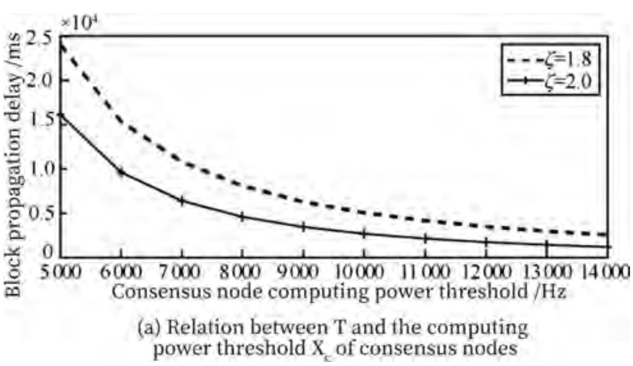

Fig. 4-1 The relationship between block propagation delay and consensus node capabilities (a).

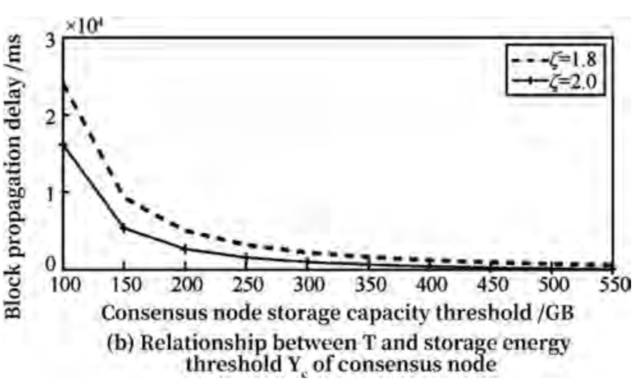

Fig. 4-2 The relationship between block propagation delay and consensus node capabilities (b).

of a series of economic indicators to measure relevance and discrimination, the credit rating system for supply chain financing is finally realized as follows:

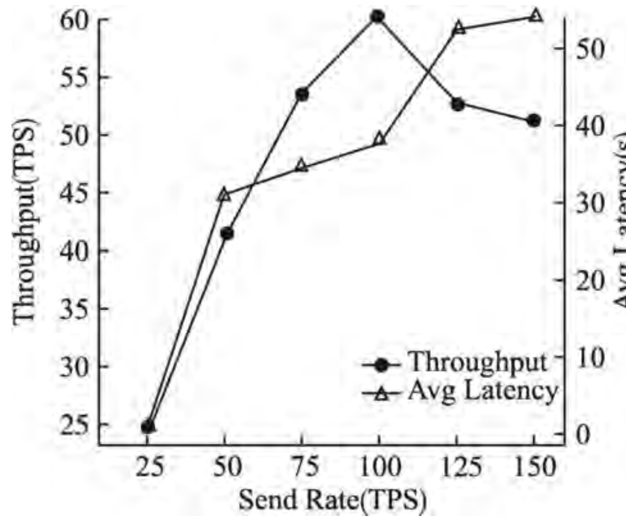

Fig. 5 Write performance.

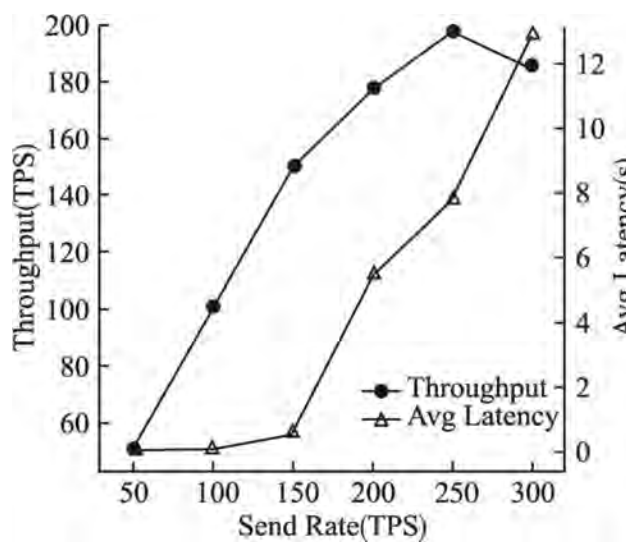

Fig. 6 Query performance.

4.4.2. Review of access conditions for supply chain financial entities

Supply chain financing has helped some small and medium-sized companies overcome financing difficulties. The credit analysis of main supply chain financing is as follows:

4.4.3. Innovation and development ideas of commercial bank supply chain finance

Supply chain financing activities must be carried out with product support to complete the combination of financing and financial management. Mainly manifested in: First, the integration of the Internet to expand the financing chain and promote new changes in enterprises. The second is to provide comprehensive financial services to improve the financial adaptability of the supply chain. Promote financial services with customers as the center. Third, guided by the diversification of the industrial chain, optimize the composition of customers in supply chain financing, adjust the industry

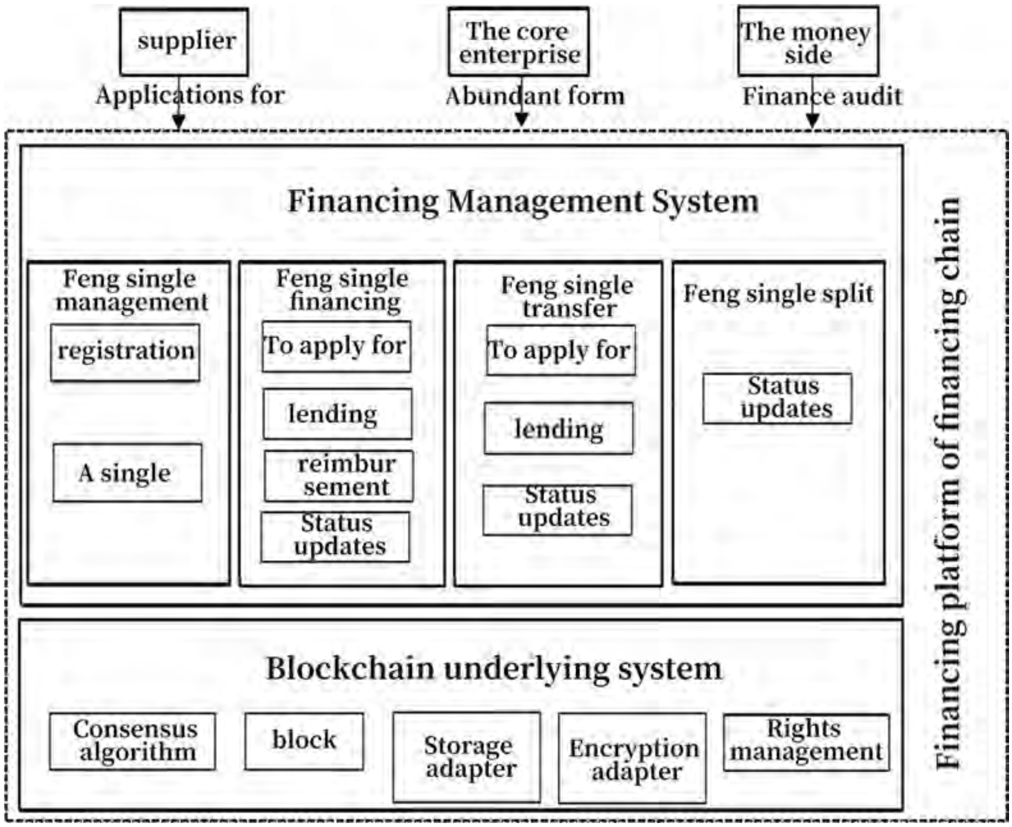

Fig. 7 Financial service management system platform architecture diagram.

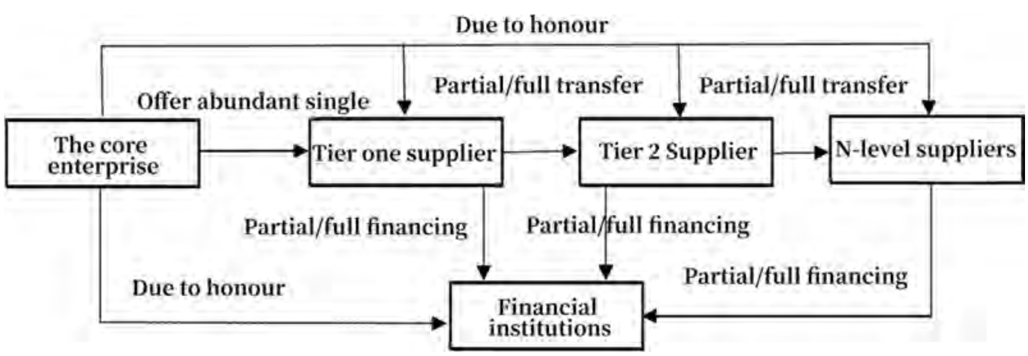

Fig. 8 Platform business model diagram.

structure, and rationalize the traditional industrial structure. Commercial banks adapt to the background of the development of the customer market and help companies strengthen supply chain services. The fourth is to change business methods and management models to improve supply chain financing capabilities. When choosing funds for the development of supply chain financial services, big data technology should be used first to improve the level of refined management of commercial banks: obtain relevant data and information from users to understand the relevant requirements of customers for financial services, so that you can lay the foundation for product innovation.

5. Conclusion

In the "Internet +" period, integration into the Internet has become an important trend in the industry. The Internet effectively combines information islands, and the information and integration between industries constitutes new industry ecology. The essence of commercial banks is to serve physical enterprises and must go deep into the industrial chain to find growth points suitable for industrial development. Non-bank financial institutions also actively participate in supply chain financing and have achieved certain achievements. The huge development has provided a new path for commercial banks' supply chain financing. Its main activities are in some original industries. The use of block chain technology is the focus of

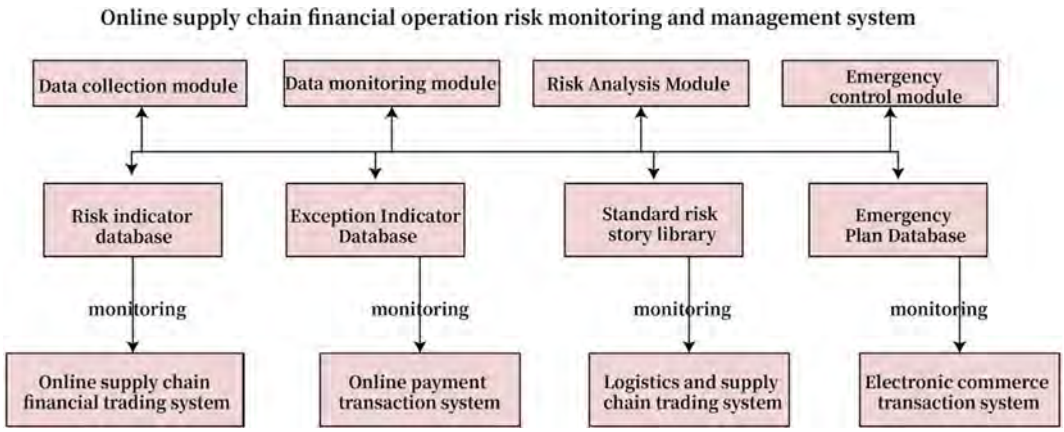

Fig. 9 Supply chain financial operational risk monitoring and management system architecture.

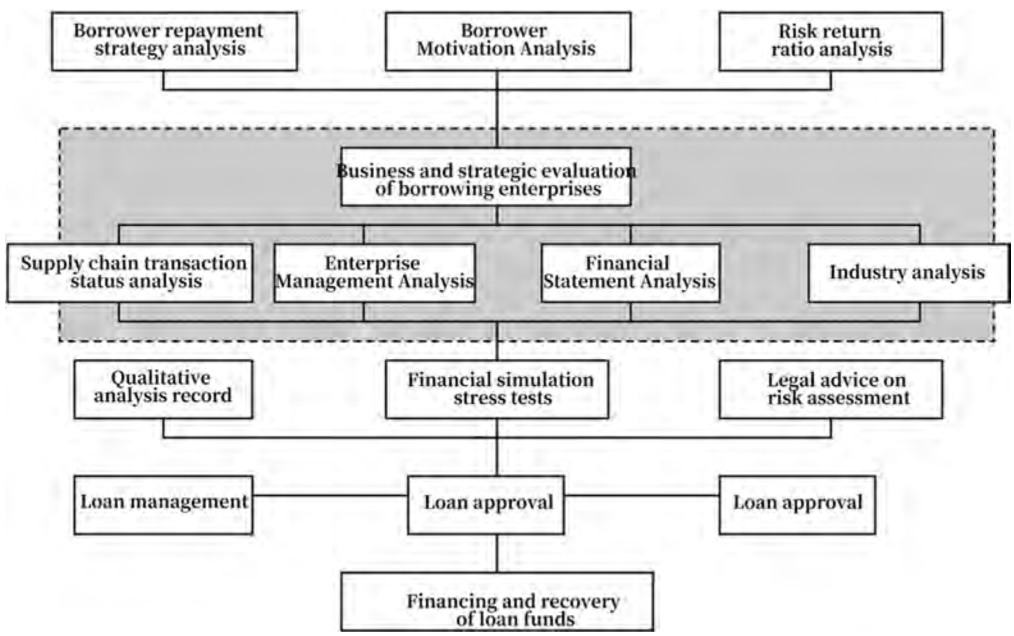

Fig. 10 Credit analysis process of bank supply chain financing entities.

supply chain financing. Based on theoretical research, this article analyzes supply chain financing and block chain technology. Combined with the current specific situation of block chain in supply chain financing, the management system, cash flow of the supply chain, and risk control system are analyzed. All parties to the supply chain financing optimize the supply chain financing risk control system while reducing business costs and improving corporate efficiency, which greatly reduces the risks of all parties in the supply chain financing. The block chain IoT environment based on shared data and advanced data processing has very powerful theoretical and practical significance for promoting the development of commercial banks and enterprises.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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