# Intelligent Contract Design of Enterprise Annuity Management Based on Blockchain

Jiaxi Liu[1], Xiaohan Huang[2] and Liang Chang[3*]

School of Computer and Information Engineering, Heilongjiang University of Science and Technology ,Harbin, China

[1]leo78bao@qq.com , [2]hhuangxiaohan@163.com , [3]Changliang@usth.edu.cn

**Abstract.** Traditional annuity businesses have some problems, such as multi-agent trust crises, low transaction process efficiency, and difficulty guaranteeing data security. In view of the above problems, this paper introduces blockchain technology into enterprise annuity management, analyzes the annuity process, and designs a general enterprise annuity business intelligent contract to realize intelligent processing of enterprise annuity investment and payment data. According to the specific needs of enterprise annuities, this paper uses the Go language to write intelligent contracts, deploys a network environment based on the Hyperledger Fabric blockchain platform, and collects test data through the Hyperledger Caliper tool for performance testing and analysis. Considering the delay of data transmission in day trading, Caliper simulation performance is used to test the throughput and maximum transaction delay of an intelligent contract. Experimental analysis shows that the general annuity intelligent contract designed in this paper can meet the requirements of enterprise annuity management and perform well in terms of throughput and transaction rate.

**Keywords:** Blockchain; Smart contract; Enterprise annuity management.

## 1 Introduction

China's endowment insurance system consists of enterprise annuities, social endowment insurance, and commercial endowment insurance. As a supplementary endowment insurance system, enterprise annuity lies between the other two[1]. With the development of computer computing speed in the era of big data, enterprise annuity management corresponding to enterprise management institutions has basically realized networking. The networking and data of services have improved the service quality, but there are still many problems in the timeliness and security of annuity data management. (1) The biggest problem faced by enterprise annuity management is that it involves many subjects, and there is a risk of tampering in the transaction process, which is prone to a crisis of trust. (2) Traditional assets and general digital assets still rely on physical vouchers, so the anti-counterfeiting authentication process has certain risks


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and difficulties, and there are certain phenomena of data forgery and distortion. The management of digital assets is relatively closed and has low timeliness.

In recent years, blockchain technology has developed rapidly, and its application research focuses on medical data management, crowdfunding systems, supply chain finance, data asset protection, and other fields. In December 2016, the Chinese government listed blockchain technology in the National Informatization Plan of the 13th Five-Year Plan, aiming at strengthening the basic research and development and frontier layout of new technologies[2] . Blockchain, as an integrated system of distributed books, intelligent contracts, asymmetric encryption, and other technologies, has the characteristics of distributed storage, multi-center credit, data security, and privacy protection. An intelligent contract is carried in blockchain as a digital contract clause, and its essence is an execution agreement or digital agreement reached by both parties stored in blockchain database in the form of computer program code. Once deployed in blockchain, it cannot be changed by anyone or other parties, and it is an intelligent contract without trust and no longer relies on physical contracts. Smart contract technology helps to handle the exchange of money, stocks, and property. At present, many industries use smart contracts to record data such as commercial financial services and patient health histories, but the existence of smart contracts effectively avoids centralization and makes the transaction process transparent.

Based on the above background problems and technical characteristics, this paper proposes the design of a blockchain intelligent contract combined with enterprise annuity management and uses the executable code of an intelligent contract to define the rules of investment and payment in the enterprise annuity business. The consensus mechanism of blockchain ensures the real-time uploading of data operation records to realize innovative management of enterprise annuities, which has the following advantages:(1) Digital assets in "no trust" state can be operated under different management institutions, which is helpful to resolve the trust crisis in enterprise annuity management. (2) All kinds of businesses are automatically processed according to the rules set by the intelligent contract, and the account book data is synchronized in real time so as to realize the real-time reconciliation of investment and payment businesses and solve the problems of slow interaction timeliness and insufficient service capacity caused by frequent reconciliation and verification in fund operations.(3) Due to the characteristics of blockchain-intelligent contracts, asset data cannot be tampered with and can be traced back, so as to prevent repudiation and realize information security.

## 2 Research on related technologies

### 2.1 Research on Blockchain Technology

Blockchain technology originated in 2008 and was proposed by a scholar named "Satoshi Nakamoto." As a new technology, it can provide a credible and convenient business environment for enterprise annuities because of its decentralized, traceable, and distributed storage characteristics [3]. Regarding the significance and application of blockchain technology, in 2016, William Mougayar pointed out that blockchain technology has great potential in both financial and other social fields, and blockchain

technology uses new media to build a "truly decentralized" space to achieve the utility of value exchange [4]. Liu Zhuqian (2020) said that blockchain technology can help improve the financing needs of SMEs by reducing the cost of financial risk control in the supply chain [5]. Chen Zhifei (2022) In view of the current fresh food supply chain, there are some difficulties, such as low online trust among users, difficulty handling disputes, and high costs. Blockchain technology is used to solve the problems of data security, private data protection, data traceability, and data reliability in the fresh supply chain and effectively solve the coordinated development of the fresh supply chain[6]. Zhang Xiaoyu (2023) proposed a trusted traceability application scheme based on blockchain to solve the problems of data storage management in traditional traceability applications and designed the traceability data protection method of blockchain, the data model of traceability application operation, the trusted management of traceability data, etc. The experimental test results showed the feasibility and correctness of the research conclusion [7].

### 2.2 Research on Intelligent Contract

Intelligent contract is the program code for executing contract terms, which was proposed by cryptographer Nick Szabo[8] in 1994. Intelligent contracts use protocols and user interfaces to complete all steps of the contract process, allowing users to realize personalized code logic on the blockchain. Intelligent contracts based on blockchain technology have the characteristics of decentralization, verifiability and information sharing[9], which can effectively build programmable finance and programmable society. Similar to the generation and compliance processes of traditional contracts, the life cycle of intelligent contracts has four key processes: creation, deployment, execution, and completion. The entire lifecycle flow is shown in Fig. 1.

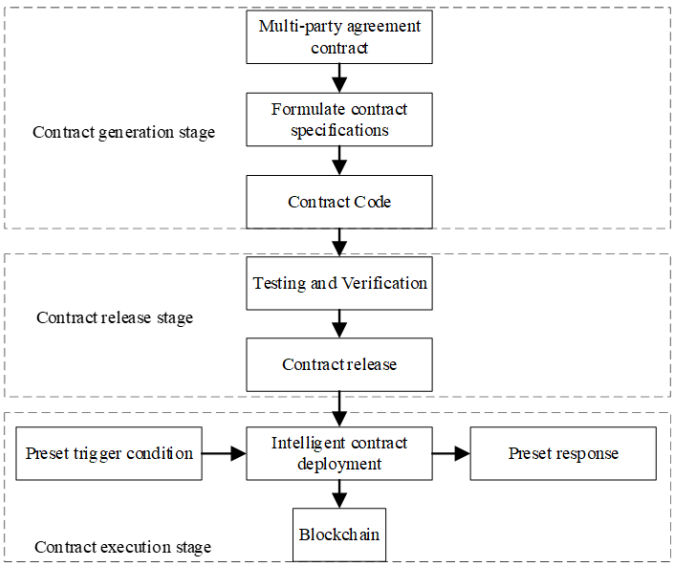


**Fig. 1.** Intelligent contract life cycle process.

# 3 Intelligent Contract Design for General Enterprise Annuity

This chapter analyzes the business process of enterprise annuities and designs a general enterprise annuity business intelligence contract according to business requirements. Smart contracts ensure transparency, security, and efficiency in managing annuity transactions.

## 3.1 Intelligent Contract Design of General Enterprise Annuity Business

Annuity intelligent contract business includes many roles, such as trustee, investment manager, account manager, and asset manager (custodian). Uploading the intelligent contract ensures the authenticity and reliability of data and improves the effectiveness and efficiency of asset transactions by preventing tampering. The functional distribution requirements of each participant in the annuity business are shown in the Fig. 2.

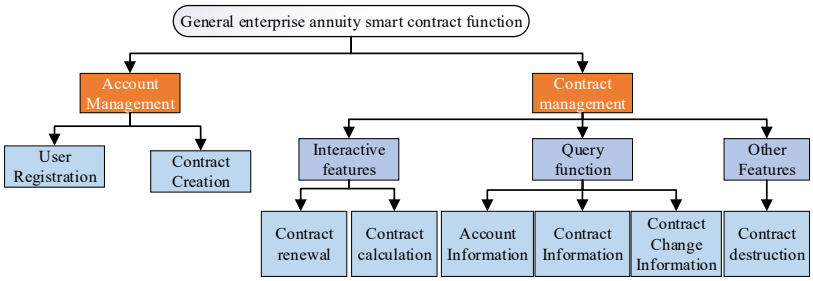


**Fig. 2.** Main Function Design of Annuity Business Intelligent Contract.

Among them, the entrusted supervisor plays the role of administrator as the subject of supervision for the whole business. In order to prevent malicious nodes in the enterprise annuity network from affecting the intelligent contract, the intelligent contract needs to set up interactive authority before writing. The specific interactive settings and functions of the intelligent contract are as follows.

**Account management intelligent contract.**

The account manager uploads the account management intelligent contract. To prevent the presence of malicious nodes in the network, the network connects and grants permission to each node corresponding to the subject. Functional roles determine the five kinds of account permissions that can be set, and Table 1 shows the execution ability of each permission.

**Investment management intelligent contract.**

The investment management intelligent contract is uploaded by the entrusted supervisor to the annuity investment plan, which is jointly executed by the investment manager and the asset manager.

**Payment management intelligent contract.**

The payment management intelligent contract is uploaded by the supervisor to the annuity payment plan, which stipulates the corresponding payment required to participate in the business account. It is jointly implemented by the account manager and the asset manager, and the asset manager pays according to the corresponding business expenses specified in the payment plan and uploads the payment data. The account manager calculates the payment records generated by the uploaded accounts and uploads the accounting data records. The basic interactive functions of smart contracts corresponding to each account are shown in Table 1.

**Table 1.** Basic interactive functions of a general enterprise annuity intelligent contract

| Account | Contract interaction | Functional |
|---|---|---|
| Trustee | Account information entry | Write |
| | Annuity plan contract entry | |
| | Generate contract content | |
| | Query contract information | Read |
| Investment manager | Investment information creation | Write/ Read |
| | Update of investment information | |
| | Annuity contract enquiry | Read |
| | Account information inquiry | |
| | Investment information inquiry | |
| Asset manager | Investment asset information creation | Write/ Read |
| | Update of investment assets information | |
| | Payment information creation | |
| | Payment information update | |
| | Annuity contract enquiry | Read |
| | Account information inquiry | |
| | Investment/payment information inquiry | |
| Account manager | Accounting data generation | Write |
| | Annuity contract enquiry | Read |
| | Account information inquiry | |
| | Payment information inquiry | |
| Other participants | Contract information verification | Read |

## 3.2 Configuration and deployment of a general enterprise annuity intelligent contract network

In this paper, Kali (version kali-linux-2021.4) System is used as the development environment of blockchain intelligent contracts, and Fabric 2.5.3 version is used as the underlying network platform of blockchain in combination with enterprise annuity business scenarios[10]. Fig. 3. illustrates the overall network architecture.

Hyperledger Fabric uses a modular architecture. In this experiment, we use its functional components, including the consensus algorithm and the encryption algorithm, to

build the target network. Fabric uses chain codes to provide an interface for the call of smart contracts, the implementation of which includes Init, Invoke, and Main method nodes.

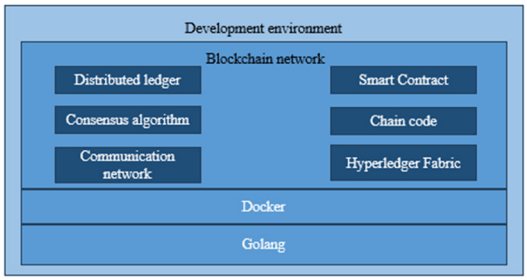


**Fig. 3.** Overall architecture design of intelligent contract network for annuity business.

After the network environment is built, restart Docker for the initialization operation, and start the experimental network with the./network.sh up instruction, which will execute two steps. The first is to start the network generation node through docker-compose-test-net. yaml, and the nodes are independent of each other. The channel is created through the command./network.sh upcreateChannel, and the started node is added to the channel to realize its communication function in the blockchain network. The second is to generate encryption configuration information such as certificates and keys through Fabric-CA, and the node configuration information is as follows Fig. 4.:


**Fig. 4.** Configuration of each organization node.

After each node is connected to the channel, the intelligent contract can be installed and instantiated by the instruction peer chaincode. The successfully deployed intelligent contract runs in the form of chain code, and the annuity intelligent contract is called by peer chaincode invoke. The successful call returns the result status code 200, which is shown in the following Fig. 5.


**Fig. 5.** An enterprise annuity intelligent contract was successfully called.

## 4 Intelligent contract test of general enterprise annuities

Considering that the delay of data transmission in day trading has a certain influence on the experiment, a caliper simulation is used to test the throughput and maximum transaction delay of the intelligent contract. The delay represents the response and processing time for the transaction. The average delay number is selected when the workload, that is, the transaction volume, is in the range of 500–3000 to test the transaction delay. Fig. 6 shows the experimental results.

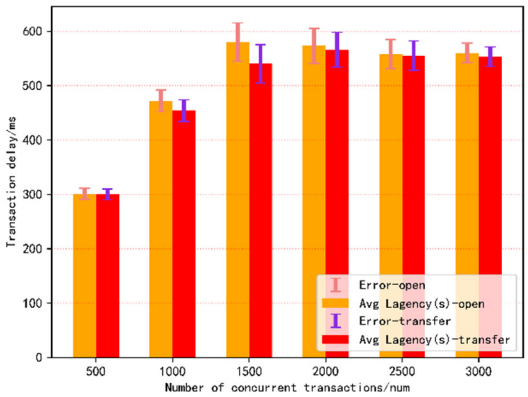


**Fig. 6.** Transaction delay test.

From the experimental results, we can see that when dealing with different transaction volumes, the transaction delay results are different. With the increase in input volume, the maximum delay gradually increases, which shows that the input volume has an impact on the delay of the trading system, but the transaction delay does not increase with the increase in transaction input volume. From the analysis, we know that the trading system has better performance advantages.

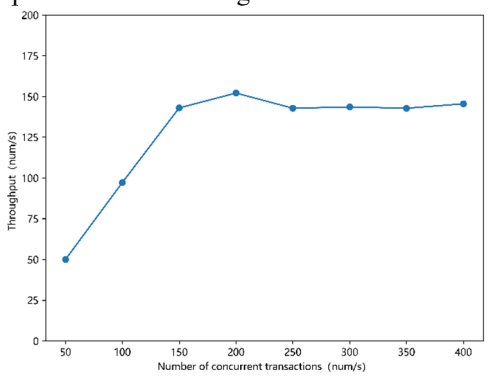


**Fig. 7.** Throughput test.

Transaction throughput represents the number of transactions processed in a fixed time. As shown in Fig. 7., the throughput test mainly shows that when the number of requests sent is between 50 and 200 times/s, the system throughput shows a steady upward trend. When the number of requests sent exceeds 200 times per second, the system throughput fluctuates around 125–150 times per second, which is the maximum throughput of the system. Testing and analyzing the function and performance of the system verifies its effectiveness, and demonstrates that the throughput of 150 transactions/s can be applied to production practice[11] , achieving the expected design goal.

## 5 Conclusion

Aiming at the problem that the data is difficult to share safely and effectively in traditional enterprise annuity management, this paper constructs a general enterprise annuity intelligent contract design, including the functions of annuity investment and annuity payment businesses, and builds a Hyperledger Fabric network to develop, design, and deploy the intelligent contract. At the same time, based on Caliper, transaction throughput and transaction delay are tested for transaction business. On the basis of traditional business, a blockchain technology module is added, which combines the adaptability of their characteristics to effectively guarantee the security and sharing efficiency of data information.

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