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Research on a Higher Vocational Education Resource Sharing System Integrating Blockchain and Edge Computing

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Abstract With the rapid development of information technology, in higher vocational colleges and universities, the traditional way of sharing educational resources is difficult to meet the increasing demand and lacks an efficient security mechanism. In this paper, a framework of educational resource sharing system for higher vocational colleges based on blockchain and edge computing technology is proposed. Firstly, a decentralized educational resource sharing platform is constructed through the introduction of blockchain technology, which guarantees the security, transparency and non-tampering of resources. Second, combined with edge computing, it optimizes the efficiency of resource processing and transmission, reduces the delay, and improves the response speed of the system. Test results show that the “edge computing + blockchain” mode excels in upload time and data transmission efficiency, with an upload speed of 11.43 seconds, much better than the traditional data transmission mode (121 seconds). In addition, the system also demonstrates high reliability and flexibility in data storage and security. The design of the system not only meets the needs of educational resource sharing in higher vocational colleges and universities, but also provides technical support for future intelligent development in the field of education.

Index Terms Blockchain, edge computing, educational resources, resource sharing, data transmission, intelligent development

I. Introduction

At present, the development of China's education informatization has entered the 2.0 era supported by “big data, artificial intelligence, blockchain” and other technologies [1]. The core goal of education informatization 2.0 is to comprehensively promote education modernization with education informatization, comprehensively improve the quality of education, and build a new ecosystem of education in the new era [2], [3]. Digital educational resources, as an important part of the educational ecosystem, currently have problems such as few high-quality resources, inconsistent construction standards, poor sharing, and unbalanced resource allocation [4]. Relevant research data show that these problems are also more prominent in higher education as an important main body of digital educational resources construction and application [5].

For the problems existing in the sharing process of traditional college educational resources, the emergence of blockchain technology provides a perfect solution [6]. The design and realization of blockchain-based digital educational resources sharing system in colleges and universities, on the one hand, through the common sharing of educational resources, it can make the students of higher vocational colleges and universities who are relatively scarce in digital educational resources can choose the learning resources they are interested in for learning according to their own needs, and the incentive mechanism can improve the motivation of the users to a large extent [7]-[9]. On the other hand, the traceable and non-tamperable characteristics of blockchain can protect the intellectual property rights of resource creators to a great extent, and the convenience of storing intellectual property rights on the chain saves human resources to a great extent [10]-[12]. Finally, the exploration of applying blockchain technology to the sharing of digital educational resources plays a positive role in popularizing and developing blockchain while promoting the progress of China's higher education field [13], [14].

The idea of this research is to ensure the transparency and security of educational resources by designing an educational resource sharing system based on blockchain and edge computing, utilizing the tamperproof and smart contract functions of blockchain; and to improve the response speed and computational efficiency of the resource sharing platform through the distributed processing capability of edge computing. The system framework first includes the application of blockchain technology to ensure the transparent sharing of educational resources through distributed ledger technology, and utilizes smart contracts to automate the management of resource transactions and usage. Edge computing, on the other hand, reduces the latency during data transmission and

improves the overall performance of the system by moving data processing to the edge of the network close to the user.

The design goal of the system is to realize the sharing, co-construction and common use of educational resources in higher vocational colleges and universities, and at the same time to strengthen school-enterprise cooperation and promote resource sharing and talent cultivation between enterprises and schools. Through intelligent contracts, the system can automatically perform resource uploading, downloading, storage and other operations to ensure that the flow of educational resources is free from human intervention and that the operation is fair and transparent. In addition, by optimizing the computing architecture and resource scheduling mechanism, the system is able to achieve more efficient resource management and utilization, reducing the inefficiency caused by centralized management in the traditional way.

II. Design objectives of the network sharing system of educational resources for higher education institutions

Higher vocational education for higher vocational colleges and universities can enable students to have the necessary theoretical knowledge and scientific and cultural foundation, master the main technology, focusing on practical application; higher vocational education for higher vocational students focusing on the comprehensive application of related knowledge, effectively enhance the hands-on ability of the students; higher vocational education to cultivate the students' ability to express themselves, to communicate with others, and to cooperate and work together as a top priority, so that the students can be with Higher vocational education attaches great importance to the learning of practical knowledge, and strengthens the training of vocational skills in the process of continuous learning, so that students can adapt to the needs of enterprises after completing their studies; higher vocational education also attaches great importance to the learning of practical knowledge, and strengthens the training of vocational skills in the process of continuous learning, so that the knowledge can be effectively transformed into vocational skills.

The construction of educational resources network sharing system in higher vocational colleges is a comprehensive systematic project, by adopting advanced information technology and multimedia technology at home and abroad, researching and realizing the standards and specifications of the resource platform, and guaranteeing the scientificity and objectivity of the construction of the coming sharing system from the three aspects of the application technology, the application tool and the application method. Secondly, it must be people-oriented, centered on system user needs, the users of this system include higher vocational college administrators, higher vocational college students, higher vocational teachers, enterprise users, social visitors, to higher vocational profession as the basis of the design, to build the school-enterprise sharing, common, shared system resource platform, so as to meet the increasingly personalized learning needs of various types of system users. Again, the author believes that this system should also focus on in-depth school-enterprise cooperation in design, gradually form a long-term mechanism of school-enterprise education, combined with the current development status of higher vocational colleges and universities and talent cultivation goals, through changing the school-enterprise cooperation mechanism to cultivate high-skilled specialists, and delivering high-quality, skilled personnel to the community. Therefore, in the process of system construction, enterprises should be mobilized to participate in the enthusiasm of co-construction, and at the same time effectively integrate the advanced resources and relevant experience of enterprises to ensure that the education resource sharing system is constantly updated to achieve sustainable and long-term development. Finally, it is necessary to deepen the curriculum reform, deeply grasp the core of professional connotation construction, take the vocational competence regulated by national vocational standards as the development direction, use work orientation to reconstruct the higher vocational curriculum system, organically combine the teaching content of vocational competence with the work tasks of modern enterprises, build an open resource system and personalized higher vocational teaching platform, and finally cultivate multi-skilled people to meet the needs of the enterprises and the society.

III. Construction of a network sharing system for educational resources in higher education institutions

III. A. Framework of Higher Vocational Education Resource Sharing System Based on Blockchain Technology

The core technologies such as distributed ledger, asymmetric encryption algorithm and smart contract in the blockchain are introduced into the construction of the educational resource sharing ecosystem of higher vocational colleges, so as to ensure the "vitality and harmony" of the co-creation and sharing ecosystem of educational resources of higher vocational colleges, achieve the dynamic balance of the educational resource sharing ecosystem of higher vocational colleges, and promote the sustainable development of the construction and

application of educational resources in higher vocational colleges. The specific framework is shown in Figure 1. Based on the digital campus infrastructure of higher vocational colleges and universities, supported by the new generation of high-speed network, Internet of Things, cloud storage, automated operation and maintenance and other technologies, blockchain technology is applied to build a blockchain network platform for the co-creation and sharing of higher vocational colleges and universities' educational resources, which provides a sharing infrastructure environment for higher vocational colleges and universities' educational resources and guarantees that the digital educational resources are open and transparent, tamper-proof, traceable, and intelligently transacted when they are shared.

(1) Apply blockchain technology to build a user management center for educational resources in higher vocational colleges and universities to realize the management of users' identity authentication and access privileges, help users to make information query, copyright tracking, and transaction record query of educational resources, etc., and to truly record the dynamic path of users' sharing activities such as checking, uploading, publishing, and downloading digital educational resources.

(2) Apply blockchain technology to build an educational resource sharing center for higher vocational colleges, and promote the ecological flow of digital educational resources through intelligent transactions based on smart contracts (application of virtual digital currency) in the system, including two modules: "resource creation center" and "resource management center". The "Resource Creation Center" realizes the management of the review, certification, release and release of digital educational resources uploaded by users and the certificates obtained by publishing digital educational resources (obtaining corresponding virtual currency); The "Resource Management Center" realizes the distributed storage and management of digital education resources in the blockchain network, as well as the retrieval of resources, download applications (pay for the corresponding virtual currency) and other management.

(3) The interface layer of the educational resources sharing platform for higher vocational colleges and universities mainly provides unified API, SDK, CLI and other technical services to provide blockchain access auditing and management of data calling and access authority authorization for higher vocational colleges and universities, governments, enterprises, public open learning platforms and third-party users accessing the platform within the educational resources sharing platform for higher vocational colleges and universities [15].

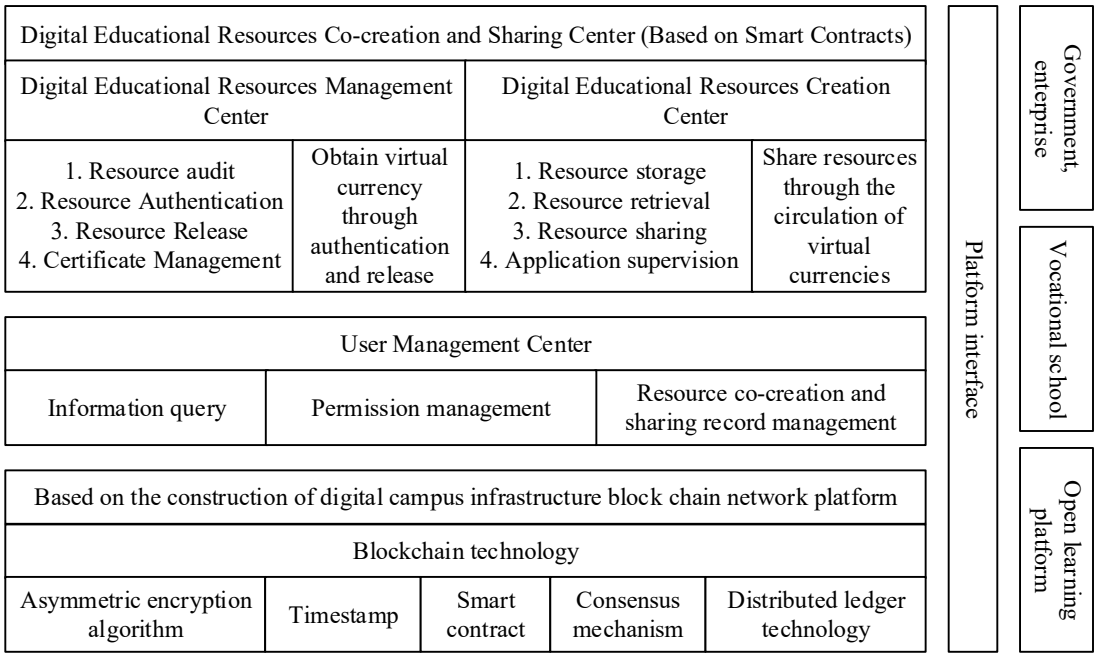


Figure 1: Higher vocational education resource sharing system framework

III. B. Characterization of the educational resource sharing system

Blockchain technology plays a key role in the construction and development of educational resources ecosystem in higher vocational colleges and universities. Through blockchain technology, the safe storage and transaction of educational resources can be realized, the rights and interests of users can be protected, and the circulation efficiency of educational resources can be improved. At the same time, blockchain technology can also realize

automated management and service of educational resources through smart contracts and other functions, so as to further improve the utilization effect of educational resources, promote the co-creation and sharing of educational resources, and realize sustainable development. The operation flow of the educational resources sharing system is shown in Figure 2.

(1) Connotation and characteristics of educational resource ecosystem based on blockchain technology

Educational resource ecosystem is a dynamic system composed of diversified educational resources, users, technical platforms and co-creation and sharing mechanisms. The system is centered on users, supported by the technology platform and powered by the co-creation and sharing mechanism to realize the effective circulation and utilization of educational resources. The decentralization, non-tampering, encryption and openness of blockchain technology can ensure the safety, fairness, transparency and traceability of educational resources, so as to improve the circulation efficiency and utilization of resources. In the ecosystem of digital educational resources, decentralized architecture can ensure that the storage and transaction of resources do not depend on a centralized institution, thus avoiding the risks brought by the mistakes or malicious acts of centralized institutions. Non-tampering ensures that the data of educational resources on the blockchain cannot be changed once it is written, thus ensuring the authenticity and integrity of the resources. The application of encryption technology in the blockchain ensures the security of user data and educational resources. Through the public-private key encryption mechanism, only authorized users can access and process the relevant data, thus protecting user privacy and data confidentiality. The openness and distributed ledger make the data on the blockchain accessible to all participants in real time, thus improving the transparency and fairness of the system.

(2) Development mechanism of digital educational resources co-creation and sharing based on blockchain technology

The development mechanism of digital educational resources co-creation and sharing is mainly reflected in three aspects: user participation, technical support and co-creation and sharing mechanism. First of all, users are the main body of digital educational resources co-creation and sharing, and they promote the updating and optimization of educational resources by participating in the creation, evaluation, sharing and other activities of educational resources. The active participation of users not only enriches the diversity of resources, but also improves the quality and practicability of resources. Secondly, blockchain technology provides the infrastructure for the co-creation and sharing of educational resources, such as resource storage, search, recommendation, transaction and other functions, which support users to carry out the co-creation and sharing of educational resources. The decentralization, non-tampering and transparency of blockchain technology ensure the security and credibility of resources. Finally, the co-creation and sharing mechanism mobilizes the enthusiasm of users to participate in co-creation and sharing through incentive mechanism, rule-making, and rights and interests protection, and promotes the effective circulation and utilization of educational resources. Smart contracts and other blockchain technologies can realize automated management and service of resources and ensure fair distribution and use of resources.

IV. Co-optimization of systematic computing tasks and resources

IV. A. Basic Architecture for Mobile Edge Computing Resource Integration for Blockchain

Edge computing is a network architecture that provides services and cloud computing capabilities for accelerating application downloads and allowing users to enjoy a high-quality network experience. It is a distributed computing architecture that communicates, manages, stores, and processes massive amounts of data in an efficient and rational manner. In the mobile edge computing model, edge nodes are data producers and mobile terminals. Compared with traditional cloud computing, mobile edge computing can process and analyze data in real time at the edge of the network, which has the advantages of short transmission distance, low response speed, low energy and bandwidth consumption, and is suitable for computation-intensive and tactile-level response tasks. Edge computing increases terminal devices and edge servers, reduces the dependence of computing applications on cloud computing servers, and at the same time reduces the risk of leakage of sensitive personal information. It is an emerging computing paradigm that places computing, storage and network resources on edge devices closer to end users to improve application performance and user experience. Mobile edge computing has the following characteristics.

(1) Low latency: the delay of task completion consists of three parts: computation, communication and dissemination. Mobile edge computing has lower propagation latency compared to cloud computing, which can reduce the delay error of the task.

(2) Energy saving: mobile edge computing technology supports computation offloading, which can offload computation-intensive tasks to mobile edge computing servers for execution, thus extending the battery life of IoT devices.

(3) Privacy/Security Enhancement: Mobile edge computing uses a distributed architecture to store user data, which is closer to the user, helping to protect user privacy and improve data security [16].

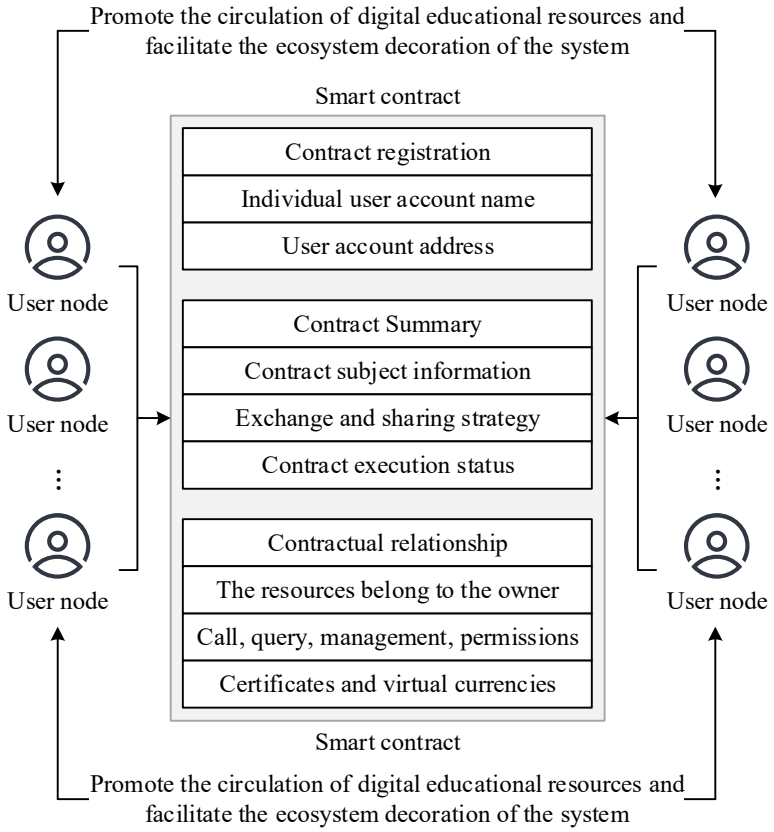


Figure 2: Education resource sharing system running process

The basic architecture of blockchain-based mobile edge computing resource integration is shown in Figure 3. According to different communication systems, processing capabilities and security requirements, the private chain is usually divided into two structures. One is centralized management. The edge server is responsible for adding new devices by creating startup transactions and deleting existing devices by deleting their ledgers, and the edge server can only allow devices to communicate with each other through shared keys. The other type is distributed management. Devices participating in the private chain act as lightweight peers, receiving firmware updates or sending transaction digest files to other peers. The edge servers are mainly responsible for local network control and securely provide a large amount of outsourced data storage and computation for low-performance devices based on the local blockchain [17].

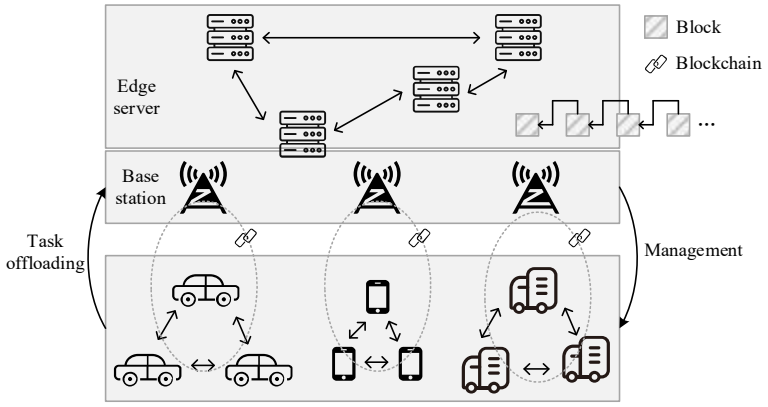


Figure 3: Basic architecture

IV. B. Optimizing Computational Architecture

In the traditional educational resources network sharing system, the allocation of computing resources relies on centralized scheduling strategy, which is susceptible to single point of failure, resource competition and trust issues. The smart contract technology of blockchain can be used to build a decentralized resource management mechanism, which makes the scheduling and allocation of computing tasks more transparent and fair, and reduces the dependence on centralized control nodes. In addition, combined with the ability to dynamically sense computing demand, blockchain-based intelligent resource scheduling can achieve more flexible task distribution and load balancing, and improve the resource utilization of the system. Data in the network usually needs to be transmitted and processed among multiple edge nodes, so data privacy and security become key issues. The distributed ledger technology of blockchain can ensure the secure sharing of data among multiple computing nodes, and at the same time, it can ensure that user data is not accessed by unauthorized entities by using privacy protection mechanisms such as zero-knowledge proof and multi-party computing. In addition, the automatic execution capability of smart contracts can help edge nodes establish a credible data interaction mechanism to prevent malicious nodes from tampering with or falsifying the calculation results and improve the overall security of the system.

In the process of integrating edge computing and blockchain, optimizing the computing architecture to reduce the communication overhead and computational burden is a crucial issue. Since blockchain technology usually adopts consensus mechanisms, while these mechanisms guarantee data security and decentralization, they may also bring high computational overhead and consensus delay, affecting the real-time performance and resource utilization efficiency in edge computing scenarios. In order to solve this problem, researchers have proposed a variety of optimization strategies to achieve efficient edge blockchain architecture. In practical applications, the deep integration of edge computing and blockchain has gradually shown a wide range of potential values. More and more researches are devoted to deploying the convergence technology of edge computing and blockchain into practical applications, which not only optimizes the computing architecture and consensus mechanism, reduces the burden of computation and communication, but also provides a highly efficient, low-latency, safe and reliable distributed computing environment for all kinds of intelligent application scenarios [18].

V. Status of system testing

V. A. System testing

Higher vocational colleges and universities education resources network sharing system plays a credible role in supporting the upper layer business system, the upper layer business system transaction services based on the smart contract service interface provided by the system to build, the system needs to verify the correctness of the functions provided by the contract, and to ensure that the performance of the underlying Fabric network meets the requirements of low latency, high throughput and zero failure rate.

V. B. Test environment

The educational resources network sharing system for higher vocational colleges and universities uses Intelij IDEA, WebStorm, and Goland as code development tools, version control is managed using git, and multiple sets of physical machines are used for testing in order to prevent testing errors caused by a single test machine. The system test environment includes 5 physical machines: React server, Java backend service, MySQL database server, and 2 Fabric federation chain web servers, which do not affect each other's performance. The hardware environment of the test machine and the software used by the test machine as well as the version are shown in Table 1.

Table 1: Running hardware configuration

Server type	CPU/model	Memory	Hard disk
React server	Core i5-9500 3.00Ghz	16G	512G
Java server	Core i5-9500 3.00Ghz	16G	512G
Mysql database server	Core i5-9500 3.00Ghz	16G	512G
Fabric alliance chain network service (organization 1)	Core i5-9500 3.00Ghz	16G	512G
Fabric alliance chain network service (organization 2)	Core i5-9500 3.00Ghz	16G	512G
Software and version			
Server type	Operating system	Support software	Application software
React server	CentOS 7.5	Node	React

Java server	CentOS 7.5	SpringBoot, Spring Cloud, RocketMQ	Maven, Swagger2, JWT
Mysql database server	Ubuntu 16.04	MySQL 8.0	—
Fabric alliance chain network service (organization 1)	CentOS 7.5	Fabric 1.2.0	—
Fabric alliance chain network service (organization 2)	CentOS 7.5	Fabric 1.2.0	—

V. C. Functional Testing

This system compares "edge computing + blockchain" as a data transmission system with traditional data transmission system. The comparison results are shown in Table 2, from which it can be seen that compared with the traditional data transmission system, the "edge computing + blockchain" model has better performance in data transmission and data protection, which can ensure the safe and efficient transmission, storage and sharing of data.

Table 2: Systematic control

	Marginal calculation+ blockchain data transfer model	Traditional data transmission model
Transmission speed (with 1.6g video upload for example)	Upload time to 11.43 seconds on the local ipfs network	Use qq upload as a comparison time for 2 minutes and 1 second
Whether it is affected by a third party	The data is stored in the ipfsand hash, which is stored in the blockchain and is not controlled by a third party organization, and is decentralized	Data is stored in third-party databases and is affected by third-party institutions in terms of privacy and security
Whether there is a problem of data transmission	Data transmission is not limited, and can be transmitted with arbitrary size data	Data transmission restriction (with qq as an example upload restriction within 2g), is restricted by the central database
Data storage Shared reliability	High, once the data is uploaded, it is stored in ipfsand the corresponding generated hashlock will not be modified once the hash is generated	In general, data storage is affected by a third-party database, and once a third-party database has a problem, the data will be severely affected
System flexibility	High, once the infringement is taken, it can be done directly through the matching of the fragments to complete the rights	In general, after infringement, the third party should be contacted and the time is low
Economic situation	Low bandwidth required and low storage data	High, high price maintenance center database is required for data storage price
other	It's a new technology, and it's a good prospect	To face challenges, change

In order to further verify the performance of edge computing, this paper in the same hardware environment compared to the QQ resource upload test, the test results are shown in Figure 4, it can be seen in the upload less than 2048MB resource edge computing has been to maintain a good upload rate.

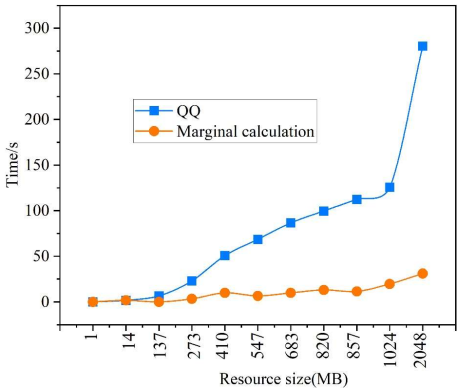


Figure 4: Marginal calculation and QQ upload resource time contrast diagram

Edge computing performance test shown in Figure 5, this paper tests edge computing upload, read test file upload performance, from the figure can be seen edge computing in the upload and read resources 1024MB resources can be kept below 10 seconds, with good upload and read efficiency.

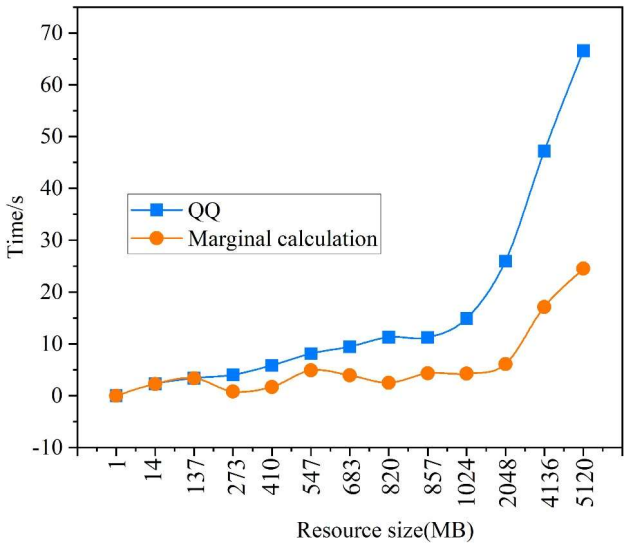


Figure 5: Marginal calculation performance test diagram

To sum up, the use of "edge computing blockchain" as a resource access system is desirable, and it is more prominent in terms of resource access, data security, data constraints, security, system flexibility, and economy. Compared with the traditional data transmission mode and the "edge computing blockchain" data transmission mode, the dual database system retains the traditional database by combining the "edge computing blockchain", that is, retains the advantages of the "edge computing blockchain" data transmission model, and can better realize the maintenance and management of the platform by enterprises, as shown in Table 3, compared with the three different database models, we can intuitively conclude that the "edge computing blockchain" database is in the economy, maintenance management, expansion, security, Storage and rate combined are superior to the other two modes.

Table 3: Database model synopsis

	Marginal calculation + block chain database	Traditional database	Double count system
Cost	The cost is moderate, some of the data is recorded in the blockchain, and the cost of maintaining the local database is lower	High cost, all data is recorded in the local database, and the cost of maintaining the local database is high	The cost is higher, and all the data is recorded in the block chain and it costs a lot of gas
Maintenance and management	The data is convenient to retrieve, the reading is high, the development environment is mature	The data is convenient to retrieve, the reading is high, the development environment is mature	Data retrieval difficulty, low reading efficiency and single development environment
Extensibility	Strong development, the main data processing logic is maintained by traditional database (integrating multiple interfaces and multiple development environments)	Strong expansion. Mature database system (integrated with multiple interfaces and multiple development environments)	Expanded weak, all programs share a main chain, relying on intelligent contracts to complete system development
Property protection	Can be uploaded resources in block chain, resource to decentralize, safe and reliable	Resources are managed by central institutions and low safety	Completely decentralized, safe
Storage and storage efficiency	Storage of large reserves and data resources permanently stored in ipfsand	Storage and storage efficiency are affected by the central database	Large storage and high storage efficiency, no large storage space is required

	hash values are stored in block chains and traditional databases, data access High rates and no need to take up large storage space		
Reading rate	Read the rate of reading, using ipfs to upload and read the data	Low reading rate and central database impact	Read the rate high, and use ipfs to upload and read the data

V. D. Non-functional testing

This section performs non-functional testing of the system's transaction service module.

(1) Blockchain network performance test of education resource sharing system for higher education institutions

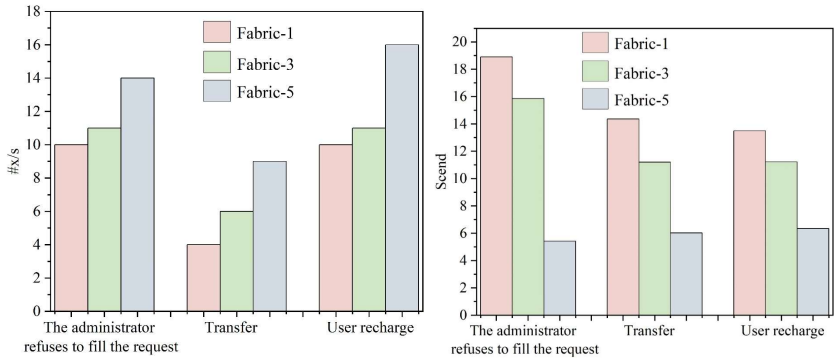
Three typical transaction scenarios in the control layer transaction service are selected for testing, including 1) user submits a top-up transaction; 2) administrator rejects user's top-up request; and 3) user transfers course beans. Different configuration methods are used for the Fabric network to test the Fabric network performance. The transaction performance of the blockchain network is evaluated by three metrics:

A. Throughput: The number of completed transactions per second. The Caliper client can send transactions to the blockchain network and measure the transaction rate throughout the test cycle.

B. Latency: the average time it takes for a transaction to complete and return a response.

C. Transaction Failure Rate: The number of failed transactions as a percentage of the total number of transactions in a test cycle. The underlying blockchain network of the educational resources network sharing system in higher education institutions uses Hyperledger Caliper as a tool for performance testing. Hyperledger Caliper is a testing framework that can evaluate multiple blockchain platforms. The tool can evaluate the performance in terms of metrics such as transaction success rate, transaction throughput, transaction latency, and resource consumption. Three groups of controlled experiments, Fabric-1, Fabric-3 and Fabric-5, were set up to send a total of 300 transactions in the Caliper client and test the blockchain network at different rates to see how each group performed. Where Fabric-1 represents the experimental environment where all docker processes are running on a single physical node; Fabric-3 represents the experimental environment where Organization 1 and Organization 2 processes are running on different physical nodes; and Fabric-5 represents the experimental environment where the CouchDB database is running on different physical nodes.

The experimental results are shown in Figure 6.



(a) The throughput of three courses bean trading (b) Three classes of course bean trading delays

Figure 6: Nonfunctional testing

It can be observed that the performance of Fabric transactions will increase when the physical environment is enhanced. This is because Fabric nodes need to perform a large number of cryptographic computations, which demand higher CPU computational resources. Another conclusion is that the average latency of user recharge and administrator rejection of recharge request is similar at the highest performance. The highest throughput is 14 transactions per second and the lowest latency is 5.42 seconds. And the failure rate of both user recharge and administrator reject recharge request transactions is 0 when the transaction request rate increases. However the transaction failure rate of user transfers increases with the increase of transaction request rate.

From the above conclusion, due to the Fabric nodes need to carry out a large number of encryption and decryption operations and hash operations, the physical resources allocated to the host computer requirements are high, the communication delay between the physical machine is not a bottleneck, out of the considerations of increasing throughput, reducing latency and reducing the transaction failure rate, the best way to deploy the underlying Fabric

network is: each Fabric node docker process should be preferably The best way to deploy the underlying Fabric network is: the docker process of each Fabric node should be deployed on a different physical node, and the CouchDB database for storing data should be deployed on a different physical node. In this deployment mode can get the highest performance, to meet the basic performance requirements of the system, and at the same time can be integrated through the performance monitoring platform to monitor the performance of the fabric real-time operation.

VI. Conclusion

The "edge computing + blockchain" model of educational resource sharing system for higher vocational colleges and universities shows obvious advantages in several aspects. First of all, in terms of data transmission efficiency, the adoption of this model has a significant improvement over the traditional data transmission system, as the upload speed is reduced from 121 seconds to 11.43 seconds, and it is not affected by third-party organizations, which ensures the security and reliability of the data. In addition, the system also shows high advantages in storage efficiency and security, using a combination of IPFS and blockchain technology to ensure long-term storage and non-tampering of resources, improving the security and reliability of data access. In terms of performance testing, edge computing effectively reduces latency, and the upload and read time of 1024MB resources is maintained at less than 10 seconds, demonstrating good system responsiveness. Finally, compared with the traditional database model and dual database system, the database model combining edge computing and blockchain is superior to the other two models in terms of economy, storage efficiency, read rate and system flexibility. Taken together, this system not only has advantages in resource access and data transmission, but also can enhance the sharing effect of educational resources through decentralized design, which provides a more efficient and secure technical support for education in higher education institutions.

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