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Research Article

Resource Cache Sharing System of Education Information Center Network Based on Internet of Things

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The development of the internet of things has spawned new information concepts such as educational information sharing. Due to the openness of the internet of things, all kinds of mobile terminal devices can rely on the internet of things for data communication, information interaction, and resource sharing. Although the development of the internet of things has brought convenience to people's lives, the internet of things is facing severe challenges in the fields of internal data sharing and cache sharing of educational information. The existing resource sharing systems do not fully consider the problems of privacy, shared data security, and data access control. This paper mainly studies the network integrated resource cache sharing system of the education information center based on internet of things. The data management system of the network education information center is developed on the basis of the school teaching management system and lifelong education public service platform, combined with the actual situation of student information. This paper combines the enrollment and information workflow of the student information management website, analyzes the problems existing in the current workflow, and then uses computer technology to standardize and transform the workflow, realize the information of the built-in resources in the data management, and solve the problems of data cache sharing and data statistics in the management of the education information center. The simulation results show that with the increase in the number of concurrent threads, the average response time of the edge cloud system deployed with two servers is smaller than that of the edge cloud system deployed with a single server, and the cloud system has good scalability.

1. Introduction

The internet of things is an open network. Each terminal device can freely transmit data, exchange information, and share built-in resources between devices. Its emergence promotes the rapid development of data detection, wireless intelligent transmission, intelligent information processing, and other technologies [1]. At the same time, the development of these information technologies makes people's life more convenient and improves people's quality of life [2]. The rapid development of the internet of things and wireless communication technology has driven the rapid development of mobile terminals, giving birth to a series of computing-intensive and delay-sensitive related applications [3]. Nowadays, data information has become an important factor in today's social life. Through the analysis and processing of internet of things data, the quality of applications and services in the network can be improved, so as to promote the rapid development of society and life [4]. At the same time, the demand for massive terminal devices for data resources has high response time and security. Therefore, in the complex internet of things environment, how to effectively and safely exchange data information is a severe challenge. This paper studies the problem of the built-in resource cache sharing system of the education information center network based on the internet of things [5]. With the continuous promotion of the learning society and the continuous improvement of the school's modern distance education brand, more and more students choose to improve their academic qualifications through network education in order to improve their own quality. Therefore, the number of students managed by the off-campus education

information center is increasing, which makes the management of the education center more difficult [6]. At present, the student data management of the education information center is still in the stage of Excel table management, and there is no perfect student data management platform for unified management [7]. At the same time, in order to improve the service quality of students, the "one-stop" service mode has brought problems such as data dispersion and individual war. Through the construction of the student information data management system, we further organize and optimize the workflow of the education information center to solve the problems caused by the "one-stop" service [8]. In the construction of a student information and data management system, it is necessary to combine the quantitative evaluation indicators of employee work performance, dynamic statistical analysis of student sources, and return visit of student problem records, so as to realize the dynamic statistical analysis and return visit records of student sources, data fusion of student status information, automatic statistical calculation, and cache sharing of various pass rates, so as to help the education information center find student source growth sites in time, master students' overall learning process, fully understand students' information, reduce statistical accounting of duplicate data, and realize students' data sharing, dynamic statistical analysis of students' sources, tracking of students' files, and students' management level [9].

2. Related Work

This paper proposes an edge cloud collaboration method based on differentiated tasks, which realizes the collaborative utilization of computing resources [10]. The comprehensive priority of the task is defined according to the importance and response ratio of the request task, and the resources are scheduled according to the global priority of the task. This paper introduces the proposed technologies and methods and puts forward the design and implementation of an edge cloud collaborative internet of things platform for large-scale heterogeneous scenes [11]. The platform has the functions of flag mapping, resource description, node dynamic access, node discovery, permission management, and so on. In the current internet of things environment, there are more and more data resources interaction and sharing between mobile terminals, so it is necessary to store and process data more efficiently and safely. In order to ensure the safe storage and management of data resources, an efficient, secure, and lightweight storage mode is proposed [12]. The sharing and analysis of internet of things data resources is the driving force of the rapid development of information technology. In order to realize the secure sharing and utilization of data resources, secure and flexible access control policies are implemented for data access and exchange [13]. According to the existing student resources of the education information center, we summarize the student unit information, improve the information accumulation of surrounding units, improve the education needs of employees in each unit, implement corresponding incentive policies, improve the education level of each unit, and form a dynamic education demand information database [14]. By recording and summarizing the existing data and new data to provide the basis for enrollment publicity and timely discovery of potential students, the education information center has established a dynamic information database of existing data and new data, urged the head teacher to conduct telemarketing, promoted enrollment publicity, decomposed the indicators according to the enrollment tasks of the education information center, and provided data support for the work assessment and evaluation of head teachers.

3. Research on Resource Cache Sharing and Its Security Based on the Internet of Things

3.1. Design of Side Cloud Collaborative Task Scheduling Model Based on the Internet of Things. The resource types of the platform mainly include computing, network, and storage. Users who call platform services will obtain a corresponding number of resources in the edge cloud or cloud computing center.

The overall architecture of the edge cloud model is shown in Figure 1.

Platform resources mainly include computing resources, network resources, and storage resources. The service uses the resources provided by the platform to process client requests, and the sensing device itself also has certain computing, network, and storage resources. The resource model of the platform will be described in detail below.

The usage scenarios of the edge cloud determine that its storage resources are limited. For a single server deployment, the total storage resources of edge cloud N are as follows:

$$\text{AllStore edge } N = \text{Disk}_{\text{edge}N} - \text{Pro Disk}_{\text{edge } N} - \text{SysDiskedge } N. \tag{1}$$

The task processing request of the edge cloud collaborative architecture IoT platform first arrives at the edge cloud. The edge cloud allocates tasks based on its own resources and the resources needed to process tasks.

The overall architecture of the edge cloud task processing model is shown in Figure 2.

The edge cloud service interface forwards the received task to the task allocation module. The task allocation module uses the corresponding allocation strategy for task allocation. There are three allocation strategies: the first is to deal with it separately in the edge cloud; the second is to transfer the task to the cloud computing center for processing; and the third is task segmentation. Some are processed in the edge cloud and some in the cloud computing center. Finally, the edge cloud integrates the processing results and returns them to the task requestor.

Edge cloud computing resources are limited, and processing tasks in edge cloud requires waiting time. The time required to complete the task is

$$\text{Time Edge} = \text{Wait}_{\text{edge } N}(\text{Task}) + \text{CPU}_{\text{edge } N(\text{Task})}. \tag{2}$$

The edge cloud transfers the task to the cloud computing center for processing. Because the network bandwidth of the cloud computing center is much larger than that of the edge

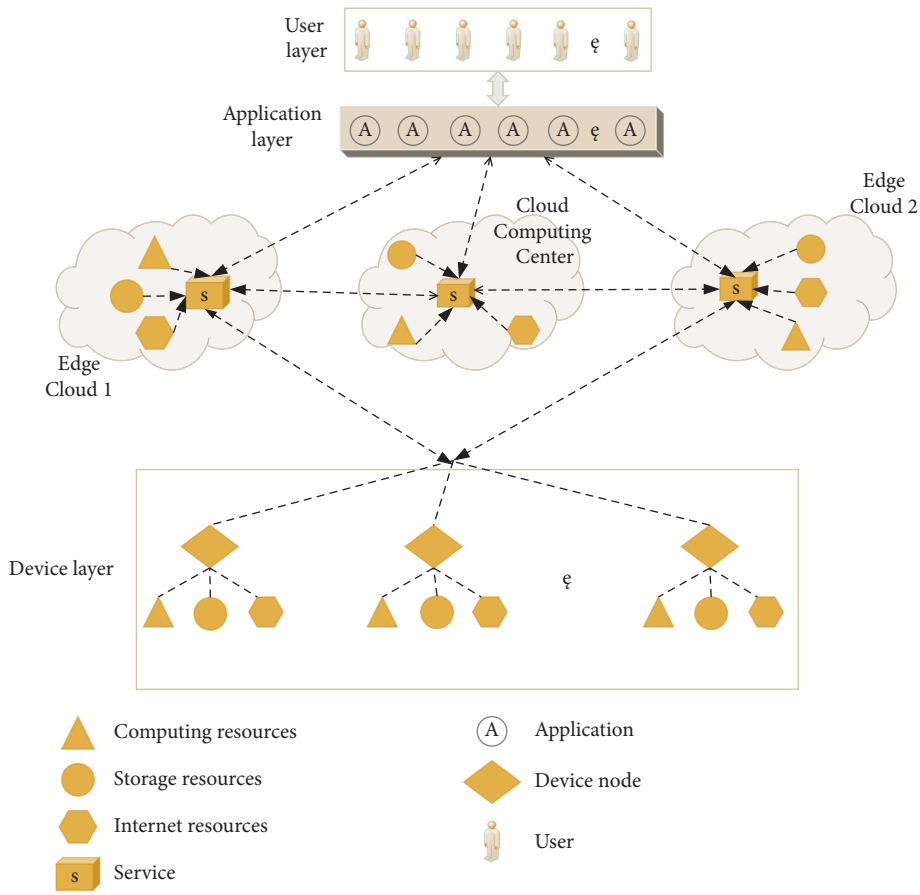

Figure 1: Overall architecture of the edge cloud resource model.

cloud, the network transmission time of the task depends on the available bandwidth of the edge cloud. The cloud computing center has a large number of computing resources, and the task processing of the cloud computing center does not need to wait. The time required to complete the task is

$$\text{Time Cloud} = \text{Net}_{\text{cdge}N}(\text{Task}) + \text{CPU}_{\text{cloud}(\text{Task})}. \quad (3)$$

Edge cloud segmentation task: tasks are processed in the edge cloud and transferred to the cloud computing center for processing. Finally, the edge cloud integrates the results of the two parts and returns them to the requester. The time required to complete the task is

$$\text{Time Mix} = \max\left\{\frac{\text{Wait}_{\text{edge}N}(\text{Task}) + \lambda * \text{CPU}_{\text{edge}N}(\text{Task})}{(1-\lambda) * \text{Net}_{\text{edge}N}(\text{Task}) + (1-\lambda) * \text{CPU}_{\text{cloud}}(\text{Task})}\right\}. \quad (4)$$

According to formulas (2)–(4), the response report of each task allocation strategy is as follows:

Edge cloud individual management response report:

$$\text{Res Ratio Edge} = \frac{\text{Time Edge} + \text{Queue}_{\text{wait}}(\text{Task})}{\text{CPU}_{\text{edge}N}(\text{Task})}. \quad (5)$$

Transfer to cloud computing center processing response ratio:

$$\text{Res Ratio Cloud} = \frac{\text{Time Cloud} + \text{Queue}_{\text{wait}}(\text{Task})}{\text{CPU}_{\text{cloud}}(\text{Task})}. \quad (6)$$

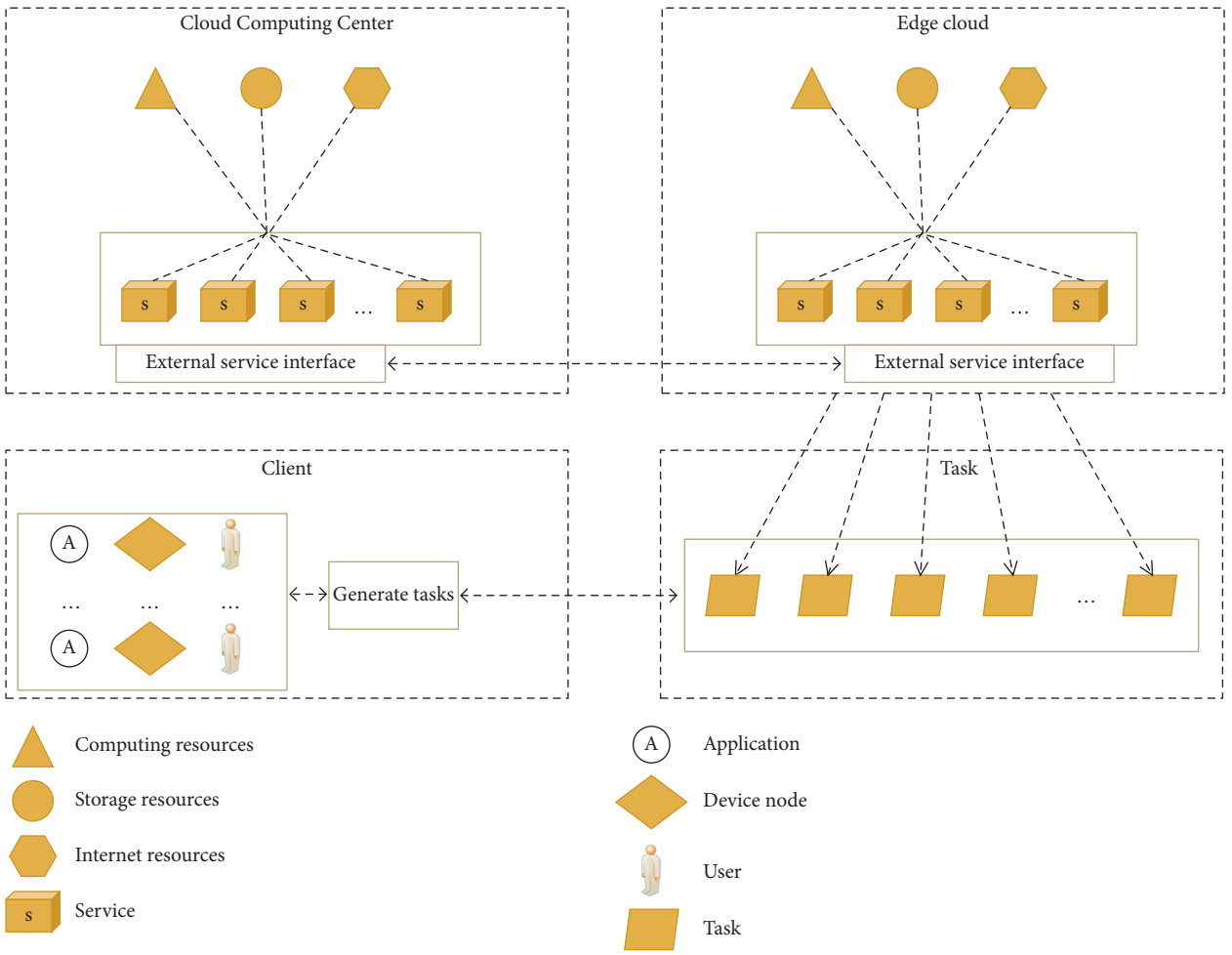

Figure 2: Overall architecture of the edge cloud task processing model.

Mixed processing response ratio:

$$\text{Res Ratio Mix} = \frac{\text{Time Mix} + \text{Queue}_{\text{wait}}(\text{Task})}{\max\left\{\lambda * \text{CPU}_{\text{edge}N}(\text{Task}), (1-\lambda) * \text{CPU}_{\text{cloud}}(\text{Task})\right\}}. \tag{7}$$

The global priority is set by task priority and processing response ratio to ensure that the tasks with high priority are executed first and avoid the hunger for low priority tasks. Task scheduling algorithm can achieve a balance between task priority and response ratio and meet the actual needs of the internet of things application scenarios. Based on the task priority definition method and task processing response ratio proposed above, the comprehensive priority is calculated as follows:

$$\text{Com Priority} = \gamma^* \text{Response Ratio} + (1-\gamma)^{*I\,\text{Priority}}. \tag{8}$$

The certification authority (CA) is equivalent to the system administrator. Set up the system for access control and distribute the key and authority level information to the terminal equipment. The data sharer encrypts the shared data and then uploads the encrypted data resources to the cloud server for other users to access. The data acquirer is interested in the data stored in the cloud server, and then the user can view and download the relevant data on the cloud server according to their access rights. The cloud server is a public storage platform where data sharers can store and share encrypted data. The data requester can freely access and download the data stored on the cloud server according to his own authority.

3.2. Security Resource Sharing Access Control Scheme Design. The certification authority (CA) uses the elements in the ordered network attribute set to construct an R-order polynomial according to the attribute order specified by the network system:

$$\begin{aligned} f(x) &= (x - A_R)(x - A_{R-1}) \cdots (x - A_1) \\ &= b_R x^R + b_{R-1} x^{R-1} + \cdots + b_0. \end{aligned} \tag{9}$$

The certification center (CA) receives the message sent by the user interface of the terminal member. The certification center (CA) calculates and verifies the user interface identifier of the terminal member u_i by verifying (9). If the verification is successful, the certification authority (CA) will calculate the following formula:

$$\begin{cases} b_0\lambda_i g_1 + b_1 a_{i,1}\lambda_i g_1 + \cdots + b_R a_{i,1}^R \lambda_i g_1 = f\left(a_{i,1}\right)\lambda_i g_1, \\ b_0\lambda_i g_1 + b_1 a_{i,2}\lambda_i g_1 + \cdots + b_R a_{i,2}^R \lambda_i g_1 = f\left(a_{i,2}\right)\lambda_i g_1, \\ \cdots, \\ b_0\lambda_i g_1 + b_1 a_{i,r}\lambda_i g_1 + \cdots + b_R a_{i,j}^R \lambda_i g_1 = f\left(a_{i,r}\right)\lambda_i g_1. \end{cases} \tag{10}$$

If the following formula passes verification

$$\begin{cases} f\left(a_{i,1}\right)\lambda_i g_1 = 0, \\ f\left(a_{i,2}\right)\lambda_i g_1 = 0, \\ \cdots, \\ f\left(a_{i,r}\right)\lambda_i g_1 = 0. \end{cases} \tag{11}$$

This means

$$\begin{cases} f\left(a_{i1}\right) = 0, \\ f\left(a_{i,2}\right) = 0, \\ \cdots, \\ f\left(a_{i,r}\right) = 0. \end{cases} \tag{12}$$

Any terminal member u_i obtains authorization parameters from the information of registered members and calculates the following formula:

$$\begin{aligned} T_{\text{pub},j} &= T_{j,0} = \lambda_j g_1, \\ T_{\text{pri}} &= \sum_{\tau=1}^{r} T_{j,\tau} = \sum_{\tau=1}^{r} t_{j,\tau}\lambda_j g_1 \\ &= \left(t_{j,1} + \ldots + t_{j,r}\right)\lambda_j g_1. \end{aligned} \tag{13}$$

The terminal member u_i selects a random number and calculates and constructs an R–1 order polynomial based on the previously saved attribute authority value:

$$f(x) = m_j K_{j,r-1} x^{r-1} + m_j K_{j,r-2} x^{r-2} + \cdots + m_j K_{j,1} x + M_j. \tag{14}$$

The terminal member u_i accesses the link, downloads the corresponding encrypted resource, and calculates the corresponding attribute authorization value according to the permission setting of the terminal member u_i shared resource and the corresponding threshold value. Then, the terminal member u_i constructs a polynomial according to the information and Lagrangian interpolation theorem:

$$f(x) = \sum_{x=1}^{r} \prod_{1 \le \omega \le r, \omega \ne x} \frac{x - w_{i,w}}{w_{i,x} - w_{i,\omega}} y_{j,x}. \tag{15}$$

And calculate the constant term:

$$\begin{aligned} M_i = f(0) &= \sum_{x=1}^{r} \left(\prod_{1 \le \sigma \le r, \omega \ne x} \frac{-w_{i,w}}{w_{i,x} - w_{i,\omega}} \right) y_{j,x} \\ &= M_j. \end{aligned} \tag{16}$$

3.3. Analysis of the Effect of the Security Sharing Scheme. Any legal terminal member in the system can download encrypted resources with corresponding access rights. CS opens the corresponding shared resource link. According to the characteristics of bilinear mapping, there are

$$\begin{aligned} &e\left(\eta_{i,h}, pk_{u_4}\right) \\ &= e\left(SK_A\left(t_{i,1} + t_{i,2} + \ldots + t_{i,r}\right)g_1, sk_u g_1\right) \\ &= e\left(\left(t_{i,1} + t_{i,2} + \ldots + t_{i,r}\right)g_1, g_1\right)^{SK_i sk_{n_i}}. \end{aligned} \tag{17}$$

The attribute permission setting is signed by the terminal member and the cloud service platform (CS), which means that the cloud service platform (CS) can determine that the terminal member has access rights, and then the cloud service platform (CS) opens the link to the corresponding encrypted resource for the terminal member. Member u_j can download the corresponding encrypted resource according to the link.

Here,

$$\begin{aligned} T_{\text{pub},j} &= T_{j,0} \\ T_{\text{pni}} &= \left(t_{j,1} + \ldots + t_{j,r}\right)\lambda_j g_1, \\ p_{u_j} &= m_j \lambda_j g_1, \\ M_j &= m_j T_{pn}, \\ \eta_{j,h} &= SK_A\left(t_{j,1} + t_{j,2} + \ldots + t_{j,r}\right)g_1. \end{aligned} \tag{18}$$

Then, the terminal member u_i uses the key it solved to do the following calculations:

$$
\begin{aligned}
&V_j \oplus H_3\left(e\left(v_j, M_i\right)\right) \\
&\quad = m \oplus H_3\left(e\left(p_{u_j}, \eta_{j,h}\right)^{\varsigma_j}\right) \oplus H_3\left(e\left(v_j, M_i\right)\right) \\
&\quad = m \oplus H_3\left(e\left(m_j\lambda_j g_1, SK_A\left(t_{j,1} + t_{j,2} + \cdots + t_{j,r}\right)g_1\right)^{\zeta_j}\right) \oplus H_3\left(e\left(\varsigma_j PK_A, m_j T_{pri}\right)\right) \\
&\quad = m \oplus H_3\left(e\left(m_j g_1, \left(t_{j,1} + t_{j,2} + \cdots + t_{j,r}\right)PK_A\right)^{\lambda_j\varsigma_j}\right) \oplus H_3\left(e\left(\varsigma_j PK_A, m_j T_{pri}\right)\right) \\
&\quad = m \oplus H_3\left(e\left(m_j g_1, \left(t_{j,1} + t_{j,2} + \cdots + t_{j,r}\right)PK_A\right)^{\lambda_j\varsigma_j}\right) \oplus H_3\left(e\left(PK_A, m_j T_{pni}\right)^{\varsigma j}\right) \\
&\quad = m \oplus H_3\left(e\left(m_j g_1, \left(t_{j,1} + t_{j,2} + \cdots + t_{j,r}\right)PK_A\right)^{\lambda_j\varsigma}\right) \oplus H_3\left(e\left(PK_A, m_j\left(t_{j,1} + \cdots + t_{j,r}\right)\lambda_j g_1\right)^{\zeta_j}\right) \\
&\quad = m \oplus H_3\left(e\left(m_j g_1, PK_A\right)^{\left(t_{j1}+t_{j,2}+\cdots+t_{j,r}\right)\lambda_j\varsigma_j}\right) \oplus H_3\left(e\left(PK_A, m_j g_1\right)^{\left(t_{j1}+\cdots+t_{j,r}\right)\lambda_j\varsigma_j}\right) = m.
\end{aligned}
\tag{19}
$$

If $w_{j,1}, w_{j,2}, \ldots, w_{j,r}$ are different numbers in the number field F, then $y_{j,1}, y_{j,2}, \ldots, y_{j,r}$ are any set of numbers in the field F. The following is a single polynomial of order not greater than $r-1$:

$$
f(x) = \sum_{x=1}^{r}\left(\prod_{1\le\varpi\le r,\omega\ne x}\frac{x - w_{j,w}}{w_{j,x} - w_{j,\varpi}}\right)y_{j,x}. \tag{20}
$$

Assumptions are as follows:

$$
\begin{cases}
c_0 + c_1 w_{j,1}^1 + c_2 w_{j,1}^2 + \cdots + c_{r-1} w_{j,1}^{r-1} = y_{j,1}, \\
c_0 + c_1 w_{j,2}^1 + c_2 w_{j,2}^2 + \cdots + c_{r-1} w_{j,2}^{r-1} = y_{j,2}, \\
\cdots, \\
c_0 + c_1 w_{j,r}^1 + c_2 w_{j,r}^2 + \cdots + c_{r-1} w_{j,r}^{r-1} = y_{j,r}.
\end{cases} \tag{21}
$$

This is an unknown system of linear equations, and the determinant of its coefficients is as follows:

$$
\begin{aligned}
|A| &= \begin{vmatrix}
1 & w_{j,1}^1 & w_{j,1}^2 & \ldots & w_{j,1}^{r-1} \\
1 & w_{j,2}^1 & w_{j,2}^2 & \ldots & w_{j,2}^{r-2} \\
\ldots & \ldots & \ldots & \ldots & \ldots \\
1 & w_{j,r}^1 & w_{j,r}^2 & \ldots & w_{j,r}^{r-1}
\end{vmatrix} \\
&= \begin{vmatrix}
1 & 1 & \ldots & 1 \\
w_{j,1}^1 & w_{j,2}^1 & \ldots & w_{j,r}^1 \\
w_{j,1}^2 & w_{j,2}^2 & \ldots & w_{j,r}^2 \\
\ldots & \ldots & \ldots & \ldots \\
w_{j,1}^{r-1} & w_{j,2}^{r-1} & \ldots & w_{j,r}^{r-1}
\end{vmatrix} = \prod_{r\ge i>\tau\ge 1}\left(w_{j,i} - w_{j,\tau}\right).
\end{aligned}
\tag{22}
$$

According to the user interface parameters of the corresponding terminal member u_i, the terminal member u_i cannot construct a polynomial but can only construct a system of linear equations with unknown numbers:

$$
\begin{cases}
c_0 + c_1 w_{j,1}^1 + c_2 w_{j,1}^2 + \cdots + c_{r-1} w_{j,1}^{r-1} = y_{j,1}, \\
c_0 + c_1 w_{j,2}^1 + c_2 w_{j,2}^2 + \cdots + c_{r-1} w_{j,2}^{r-1} = y_{j,2}, \\
\cdots, \\
c_0 + c_1 w_{j,r-1}^1 + c_2 w_{j,r-1}^2 + \cdots + c_{r-1} w_{j,r-1}^{r-1} = y_{j,r-1}.
\end{cases} \tag{23}
$$

3.4. Analysis of the Performance Test Results of the Resource Cache Sharing System. The edge-cloud collaborative IoT platform is designed for large-scale heterogeneous scenarios. When invoking highly concurrent services, the platform still needs to ensure that the service is stable and available. Use ApacheJMeter to simulate the throughput and response time of the test platform at different concurrency levels. The platform is mainly divided into two parts: cloud computing center and edge cloud system. The cloud computing center adopts high-performance service cluster deployment, which can dynamically expand system resources to provide services for each edge cloud and application layer; the edge cloud system has limited resources and is an important part of the external services provided by the platform. Therefore, we mainly measure the performance of edge cloud systems.

During the test, we used ApacheJMeter to simulate service requests from edge cloud clients and set up different numbers of threads to simulate concurrent service requests from different clients. Edge cloud systems are divided into single-server deployment and dual-server load balancing deployment. The number of simulated concurrent clients increased from 1 to 50 and then to 100 and then increased by 100 for each test to ensure the authenticity of customer request data and behavior in the simulated environment. Taking the actual requests in the system log as the data source, the test results of cloud edge systems deployed with single- and dual-server load balancing are shown in Tables 1 and 2, respectively. The task queue represents the proportion of the backlog of tasks in the task queue in the cloud edge system.

The test results of a single server are shown in Table 1.

The test results of the two servers are shown in Table 2.

Table 1: Single server test results.

Number of analog clients	Average response time (ms)	Error rate (%)	Task queue (%)	Throughput (TPS)
1	19	0	0	54.7
50	85.3	0	0	228.3
100	117.5	0	0	247.4
200	141.3	0	0	254.4
300	182.5	0	0.7	258.6
400	203.8	0	1.4	256.8
500	224.4	0	2.6	253.5
600	273.3	0	4.3	251.8
700	315.8	0	4.9	247.5
800	420.6	0.23	6.3	242.7
900	607.4	1.38	7.6	215.5

Table 2: Dual server test results.

Number of analog clients	Average response time (ms)	Error rate (%)	Task queue (%)	Throughput (TPS)
1	17.5	0	0	55.4
50	51.4	0	0	235.3
100	86.6	0	0	277.3
200	123	0	0	310.4
300	141.9	0	0	334.9
400	163.8	0	0	347.7
500	170.4	0	0	430.5
600	208.6	0	0	476.8
700	210.5	0	0.9	431.4
800	230.5	0	1.8	397.8
1,000	254.4	0	2.6	384.6
1,200	306.2	0	5.4	388.8
1,400	374.2	0.17	7.3	345.9
1,600	582.8	1.5	8.7	314.7

The relationship between the amount of edge cloud swallowing and the number of concurrent threads of a single server is shown in Figure 3.

With the increase in the number of concurrent threads, the average response time of the edge cloud system deployed by two servers is less than that of the edge cloud system deployed by a single server. When the number of concurrent threads is greater than the maximum number of threads supported by the edge cloud, the average response time will increase significantly. As shown in Figure 3, when the concurrency is 300, the throughput of the edge cloud system deployed by a single service reaches the maximum, which indicates that when the concurrency is less than 300, the number of tasks is not saturated; When the number of concurrent tasks is greater than 300, the number of tasks reaches saturation, but when the number of concurrent tasks is less than 800, the system throughput does not decrease significantly.

The relationship between the throughput of the dual server edge cloud and the number of concurrent threads is shown in Figure 4.

Similar to a single server, analyze the edge cloud swallowing volume of dual server deployment according to Figure 4. For a single-server deployed edge cloud system, when the number of concurrent tasks reaches 300, the task queue begins to accumulate, but the system can still process tasks in time, and the task processing error rate is 0. When the number of concurrent tasks reaches 800, request processing exceptions begin to occur; when dual server deployment is adopted, the number of concurrent tasks reaches 700, and the task queue begins to accumulate tasks. When the number of concurrent tasks reaches 1,400, request processing exceptions begin to appear. The deployment processing capacity of two servers is about twice that of one server, which proves that the edge cloud system has good horizontal scalability. The increase of servers can improve the concurrency of edge cloud support.

4. Design and Application of the Network Resource Management System in Education Information Center

4.1. Demand Analysis of the Education Information Center Network System. The source of students in the education information center mainly includes the following aspects: due to the influence of the school, students come to sign up, visit and guide enterprises through the education information center, and cooperate with enterprises to establish enterprise classes. The enrollment personnel of the education information center shall go out for publicity and distribute

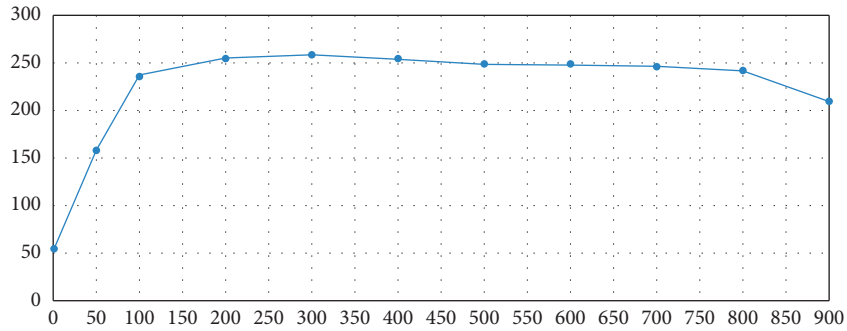

Figure 3: Single server throughput.

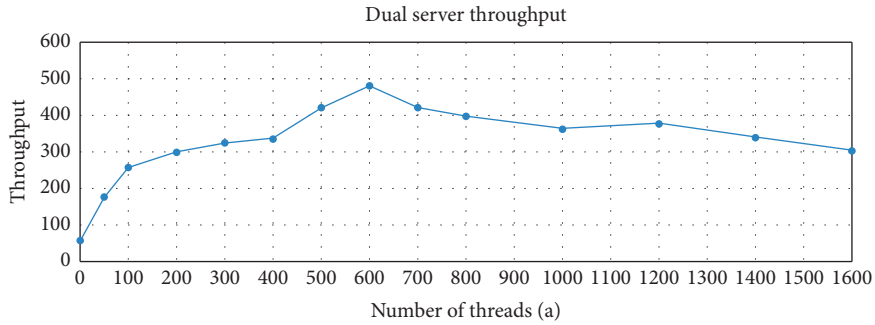

Figure 4: Dual server throughput.

brochures and other publicity materials or recommended by school students. In order to encourage the head teacher of the education information center to publicize the old and bring the new, the college has also formulated the corresponding objectives and tasks of the head teacher of the education information center as the basis for performance appraisal. The number of old and new students is generally recorded by the enrollment personnel and notified regularly in the education information center. Students usually do not know the student number of the recommender and only record the name. Sometimes, there are typos in the name, which may lead to inaccurate records and need to be rechecked in the future. The effect is not very ideal.

In the student support service of the education information center, in addition to solving various problems encountered by students in the learning process, it is also necessary to actively communicate with students at each key node of teaching activities. Understand student information, urge students to select courses, complete various learning activities organized by the school on time, and carry out graduation design and network unified examination according to the division of responsibilities of the education information center. Enrollment management and other business modules are part-time by the corresponding head teacher, so there is cross management. In order to avoid excessive service, it is necessary to share student return visit information with the head teacher.

The graduation certificate management of the education information center is different from that of the school. The education information center does not manage the number and processing time of student certificates, but the school distributes the student graduation file information to the education information center. The education information center arranges the students' graduation certificates, graduation records (transcripts, enrollment information forms), and tuition invoices and notifies the students. Because students receive more people, it is easy to cause confusion. At the same time, adult students are scattered, and the collection cycle is long. The education information center should also archive student cards and other documents at any time to facilitate students receiving them. The system can query whether the certificate storage location, number information, and data of the education information center are complete. It can quickly locate the graduation certificate number and storage location for students to receive.

The network unified examination is the national unified network education undergraduate examination. School students need to participate in College English B and computer culture basic examination. In order to do a good job in the general examination enrollment management, encourage students to practice and participate in guidance and pay a return visit to the students enrolled in this batch to understand the basic situation of students so as to provide guidance. At present, there are some problems in the online examination management of the education information center. First, the list obtained from the online examination office contains not only the data of the education information center but also the data of other education information centers. You must manually sort out and summarize the registration data of this education information center. During the registration period, we have to rearrange the calculation every day, which is very troublesome. Secondly,

after the students' scores are published, there are the same problems between the uploaded score data and the registration data. The corresponding accounting can only be carried out after filtering the data of other education information centers. Finally, after the online examination results are published, each head teacher needs to sort out the students' comprehensive examination results this year and sort out the list of failed students, so as to inform the students to sign up next time.

4.2. System Architecture Design. The data management system of the education information center will cover the record of enrollment publicity information and the maintenance of student enrollment information during the operation of the education information center (mainly maintaining student telephone, business unit, and enrollment change data), the unified examination data management of national network education, score processing and certificate issuing management, daily problem tracking, and record management, and the division of labor of the education information center (i.e., authority management) and enrollment management module mainly focus on the release of rules and regulations. The student basic information management module mainly maintains the management of students' telephone, unit, grade information, and grade head teacher information. The unified examination management module mainly realizes the batch, registration, counseling, and score management of network unified examination. The graduation management module mainly manages graduation information (including file management and distribution management), and the student return visit module mainly manages the return visit records of the education information center through telephone, QQ, WeChat, and so on.

The system functional architecture is shown in Figure 5.

4.3. Design of the Network Resource Database of Education Information Center. The grade table is designed by a separate table, which is actually relatively simple. In addition to grade ID and grade name, there is also a head teacher field to associate with the username in the user table. Therefore, head teachers and students are linked. The student basic information module adopts two forms, one is the enrollment information table and the other is the grade information table. The student information table contains all registration information because the student number is unique, while other tables are based on the student number, so the student information form takes the student number as the primary key. Use the grade table to associate the head teacher with the user table.

The enrollment module management module includes five forms: unit profile form, old with new form, unit enrollment specialist, enrollment publicity form, and part-time propagandist form. The form is designed as follows: the form of part-time propagandists records the name, identity, account number, telephone number, information recorder, registration time, and whether to continue to work part-time, and contains the basic information of propagandists. The external publicity and promotion form records the types of external publicity (including visits to enterprises, issuance of enrollment brochures, etc.). The company profile shall include name, address, contact number, contact person, company website, company nature, scale and number of people, and education policy information. The old band new record records the student ID number, the name of new student, the number of identity card, the person who records the information, the time of registration, and so on. The enrollment specialist form contains the student number, registrant, registration time, validity period, and other information of the enrollment specialist.

The network unified examination module consists of three tables: unified examination batch table, unified examination information table, and unified examination guidance table. The unified examination batch table contains examination batch information, unified examination information table, examination subjects, and student scores. The unified examination guidance form contains information such as the batch, time, and place of guidance participated by students.

The graduation management module is mainly composed of two tables. One is the graduation certificate information table, which is used to record the graduation certificate and file information organized by the education information center. You also need to represent data when issuing a certificate. The second is the graduation extension application form, which contains the materials for applying for an extension for special reasons, such as the graduation certificate information form, the graduation extension application form, including the issuance batch information, the materials attached to the graduation certificate (documents, invoices), and the certificate receiving status information etc. The application form for delayed graduation records the student number, reasons for applying for delayed graduation, application materials for delayed graduation, recorder of information, recording time, batch of student certificates, and so on.

The student return visit module is used to record telephone return visit data. Considering the uncertainty of the reason for this revisited data, this field is treated as a separate table for addition or modification. The student return visit module has two tables: one is the return visit reason management table, which is used to record the return visit reasons (including urging payment, unified examination registration, course learning, etc.), and the other is the return visit information record table. The system automatically obtains the username of the submitter in the return visit information record table, which can be associated with the head teacher's information for reference during the return visit of the head teacher of the education information center. The return visit type table mainly records the ID and name of the return visit type, and the return visit information table mainly records the student number, return visit method, date, and result information of the return visit student.

4.4. System Operation Test and Result Analysis. The main contents of the system login test include the username and password test when the system logs in and the test of directly entering the system function page when not logging in.

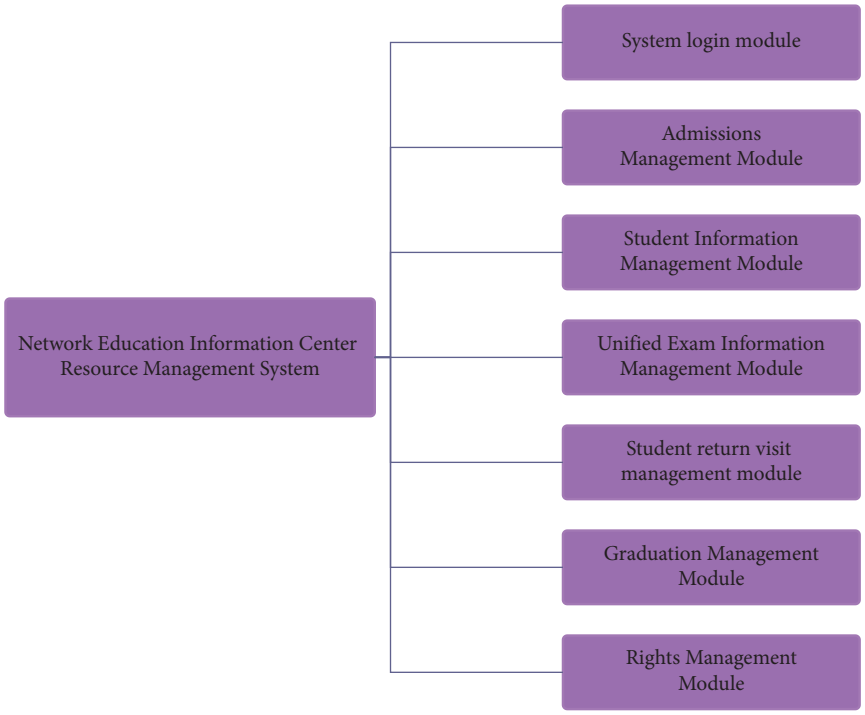

Figure 5: Overall architecture of the student data management system in education information center.

Table 3: User login function test record.

Test content	Step	Expected result	Test results
User login	Enter the correct username and password	Login successful	Passed the test
	Enter the correct username and wrong password	Cannot log in, prompting that the username and password are wrong	Passed the test
	Enter the wrong username and correct password	Cannot log in, prompting that the username or password is empty	Passed the test
	Do not enter username or password	Cannot log in, prompting that the username or password is empty	Passed the test
Login authentication	Direct access to the function menu page without logging in	Jump to the login page	Passed the test

Table 4: System authority module test record.

Test content	Test steps	Expected outcome	Test results
Directory permission test	Do not assign permissions to users	There is no menu directory after login	Passed the test
	Assign all permissions to users	Display all permission directories and form a directory tree	Passed the test
	Assign permissions to users by role	Display the corresponding directory	Passed the test
Button permission test	Click the function button without assigned permissions	Prompt no permission	Passed the test
	Assign permissions to click the function button	Perform corresponding data manipulation functions	Passed the test
Authorization verification	Access the function page without assigning permission	Jump to the prompt page, prompting that there is no permission	Passed the test

The test contents and results are shown in Table 3.

For the test of the system access permission module, the access test is divided into two categories: one is the permission to the test directory; only authorized users can view the menu directory, and the other is the button function permission; only authorized users can click this button to perform this operation.

The test results are shown in Table 4.

Table 5: System function module test record.

Test content	Test module	Test steps	Expected outcome	Test results
New data	Enrollment, unified examination, return visit, graduation, permission module	Fill in the corresponding data according to the system requirements	Data is added normally	Passed the test
		Duplicate data addition	Tips are repeated and cannot be added	Passed the test
		Enter data in the wrong format	Prompt data format error	Passed the test
		Null value of required field	Trigger nonempty verification	Passed the test
Data query	All modules	Do not set query conditions	Show all data	Passed the test
		Enter search criteria	Query the corresponding data	Passed the test
Data modification	All modules	Select data modification to view the modified page situation	Display the data information to be modified	Passed the test
		Modify the data to fill in as required	Prompt data format error	Passed the test
Data deletion	All modules	No data is selected and click Delete	Prompt to select at least one row of data	Passed the test
		After selecting the data, click Delete	Data is no longer displayed	Passed the test
Statistics	Old with new, unified exam module	Show all data statistics	Statistics data is consistent with the list data	Passed the test
		Query statistics by time period	The statistical results are consistent with the data in the same time period in the data list	Passed the test
Data output	All modules	Export data without setting query conditions	Export all valid data in the database	Passed the test
		Set query conditions to export data	Export valid data that meets the conditions	Passed the test
Data import	Unified examination, student information, graduation management	Import eligible data	Import the database normally	Passed the test
		Duplicate data import	The system prompts to repeat, do not import	Passed the test

Business function test includes general process test and special process test. The general process mainly includes data addition, editing, deletion, export, display, and query through the data addition page. The functions of each module are basically similar, and the system test is carried out uniformly. Through the whole process test of the system, the input and output results of the system are consistent with the expected results, indicating that the system logic is no problem and the system runs normally.

The system test results are shown in Table 5.

5. Conclusion

Based on the analysis of the daily business process and existing problems of the education information center, this paper uses the internet of things technology to gradually complete the system requirements analysis, functional structure design, and database design; the data management system uses the B/S structure to achieve coding, mainly to achieve the education information management of enrollment data in the center and real-time query and statistics of old and new data. It played a certain incentive role for the promotion of the original education information center, provided corresponding data for performance appraisal, realized the daily management of the education information center, and provided strong support for the development of the education information center. Providing references for the education information center to comprehensively understand students and provide targeted services will help improve the overall service level of the education information center, realize the automatic integration of student data on multiple platforms, effectively avoid a large number of duplicate data statistics, and improve work efficiency. The student management was changed from excel records to platform management, which improved the information management level of the education information center. The education information center data management system basically meets the work requirements of the education information center data management, but some functions have not yet been realized. With the opening of the education public service platform, the changes in

concepts and processes brought about by the conversion of the semester system to the credit system will also affect the current system functions. Therefore, the system functions need to be updated and improved continuously.

Data Availability

The data used to support the findings of this study are available from the author upon request.

Conflicts of Interest

The author declares that there are no conflicts of interest.

References

[1] Z. Xin-yong, "The realization of wisdom physical logistics based on the internet of things," *Journal of Changzhou Institute of Technology*, vol. 24, no. 5, pp. 46–48, 2011.

[2] L. Zheng, "Jiangsu smart logistics enhances logistics integration capability under "internet+" research on countermeasures," *Logistics Engineering and Management*, vol. 42, no. 8, pp. 21–24, 2020.

[3] X. Wang, J. Zhou, and Y. Gu, "Smart logistics deployment in the context of new retail model study: taking ali hema xiansheng as an example," *Logistics Engineering and Management Li*, vol. 42, no. 1, pp. 22–25, 2020.

[4] A. Oberoi, M. Arora, and V. K. Garg, "A novel approach for dynamic information integration," *International Journal of Reasoning-Based Intelligent Systems*, vol. 13, no. 2, pp. 76-77, 2021.

[5] S. Siekmann, "Which web course management system is right for me? acomparison of webct 3.1 and blackboard 5.0," *CALICO Journal*, vol. 18, no. 3, pp. 590–617, 2013.

[6] V. Fratto, M. G. Sava, and G. J. Krivacek, "The impact of an online homework management system on student performance and course satisfaction in introductory financial accounting," *International Journal of Information and Communication Technology Education*, vol. 12, no. 3, pp. 76–87, 2016.

[7] E. Coatanea, R. Roca, H. Mokhtarian, F. Mokammel, and K. Ikkala, "A conceptual modeling and simulation framework for system design," *Computing in Science & Engineering*, vol. 18, no. 4, pp. 42–52, 2016.

[8] U. Hüseyin, T. Murat, and P. Y. Ezgi, "The effects of the authentic learning approach with a course management system (moodle) on students mathematics success and online authentic learning self-efficacy," *Educational Research and Reviews*, vol. 15, no. 11, pp. 679–689, 2020.

[9] A. N. Alkhaldi and A. M. Abualkishik, "Predictive factors for the intention to adopt a mobile blackboard course management system: the case study of university of hail in Saudi Arabia," *Indian Journal of Science and Technology*, vol. 12, no. 19, pp. 1–12, 2019.

[10] V. S. Tabar, M. A. Jirdehi, and R. Hemmati, "Energy management in microgrid based on the multi objective stochastic programming incorporating portable renewable energy resource as demand response option," *Energy*, vol. 118, pp. 827–839, 2017.

[11] R. Xu, C. Wang, X. Luo, and J. Li, "Based on the background of "internet +" research on deep intelligence of logistics real estate," *Logistics Technology*, vol. 40, no. 3, pp. 7–11, 2017.

[12] W. U. Zhao-Hui, "Research on the application of internet of things technology to digital museum construction," *Acta Geoscientia Sinica*, vol. 38, no. 2, pp. 293–298, 2017.

[13] S. Zhao, S. Li, and Y. Yao, "Blockchain enabled industrial internet of things technology," *IEEE Transactions on Computational Social Systems*, vol. 6, no. 6, pp. 1442–1453, 2019.

[14] L. W. Wardana, "Paper airplane and talking stick learning methods to increase students understanding about management information system courses," *IOSR Journal of Business and Management*, vol. 18, no. 09, pp. 164–169, 2016.