Third Party Logistics Information System based on Internet of Things Technology

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Abstract. With the rapid development of computer, communication technology and Internet of Things technology, logistics management system is also rapidly evolving from a simple way to automated management. This paper mainly studies the design method of third-party logistics information system based on Internet of Things technology. This paper first introduces the emergence and current situation of the third-party logistics, combined with the production needs of the third-party logistics. In terms of the overall design idea, it integrates the needs of upstream and downstream logistics enterprises. According to the logistics design criteria, it utilizes technologies such as the Internet of Things, cloud computing and database to complete the integration of the whole logistics system, and realizes information sharing, standard unification and upstream and downstream integration. Thus greatly improved the efficiency of logistics, and completed the supervision of goods.

Keywords: Internet of Things Technology, Third Party Logistics, Logistics Information System, ALOHA Algorithm

1. Introduction

Logistics system refers to a certain time and space, by the need to transport goods and means of transport, storage equipment, personnel and communication and other variable elements of a number of mutually restricted organic whole with specific functions. With the rapid development of computer, communication technology and Internet technology, the logistics management system is also rapidly evolving from a simple way to automated management. The main goal of the logistics system is to pursue time and space benefits [1-2]. Logistics has become an important pillar of China's economic development. With the rapid development of the Internet of Things technology and the continuous optimization of Logistics operation process, Logistics Internet of Things (LIOT) has become an indispensable mode of modern Logistics industry. Different from the traditional logistics industry, LIOT uses RFID, QR code, NFC, D2D and many other network communication technologies, which
can achieve intelligent management and efficient modern logistics system.

LIOT has attracted worldwide attention due to its many advantages. Nowadays, enterprises from all over the world have started the development plan of logistics Internet of Things. For example, FedEx utilizes CRM system to realize real-time logistics tracking information storage and bill delivery, providing on-time delivery service. Zara, a Spanish clothing brand, has used an intelligent supply chain to manage its clothing shipments; Domestic large e-commerce companies such as Jingdong and Alibaba have gradually shifted from commodity market to intelligent logistics market [3-4]. At present, the application of logistics Internet of Things has covered many fields such as intelligent traceability system of products, visual management system of logistics process, intelligent logistics distribution center, intelligent supply chain of enterprises and so on [5].

Logistics is the need to control the flow of things, that is, to control the process. With the help of new and mature communication technology, it is easy to make logistics in the process and control of the rapid development of communication technology economic free ride.

2. Third Party Logistics Information System

2.1. System Architecture

The whole logistics management system adopts a four-layer structure, including the common application layer, system interface layer, data platform layer and perception layer. Integrate the four-tier system by the enterprise specified authority rules and layered security operation environment to ensure the whole logistics management system operation and use security.

The application layer is responsible for all of the UI, including the interaction between administrators and users of the system. Also responsible for the use of all software functions, including user management, inventory management, order processing and distribution management. System database administrator of the background data in the increase, delete and modify operations. Inventory management to achieve the warehousing, warehousing and warehouse inventory and other functions, and according to the order details for sorting, in the process of goods handling, buying and warehousing to adjust the information of the goods and the corresponding location information real-time feedback to the system. Distribution management realizes vehicle source information management and line information management, and conducts distribution and delivery according to the details of orders, and returns the distribution information to the system in real time in the delivery process [6].

The whole system interface layer is the bridge between application layer and data platform layer. The latter provides data support for the former, and the former provides functional presentation for the latter. In addition, the system interface for the platform and other users can be opened according to the need to achieve data sharing, service provision and other functions.

The data platform layer provides data standard formatted storage and data service for the whole logistics management system. According to different data sources, different algorithms and the same data format standard are used to format data. It provides data business processing for the top-level system, and has the ability of message processing and message distribution, information processing and Web support.
This system uses RFID technology as the underlying hardware technology to realize the information collection in the process of goods warehousing, inventory and distribution. The reader adopts anti-conflict technology to realize multi-label identification of goods [7].

2.2. **Software Architecture**

The software system adopts a RESTful style, which is oriented to the separation of the front and rear ends of resources, and mainly consists of two components: the server and the front-end webpage. Communication between modules within the software system also adopts a RESTful style, that is, stateless communication: HTTP protocol is used for requests from the front end to the server and response from the server, and WebSocket protocol is used for push messages from the front end of the server to the web page [8]. The main functions of the software system are as follows: management of the whole business process and user management, authority dynamic management, data statistics and other functional modules. Front-end web page provides the user operation view, accept user input and the user's input data after validation, serialization, through the backend server provides interface transmission to the server, accepting the response returned from the server on the web page displayed visually, accept messages from the server push, with voice reminding and text displays the real-time message to alert users to server push. The background server is responsible for database management, business logic implementation, data upload interface for the hardware system, HTTP interface for the front-end webpage, and push abnormal information and other messages to the front-end and hardware system.

2.3. **System Requirements Analysis**

User submit orders, by the related system administrator in accordance with the order type of service, and related requirements of timely treatment, if required inventory will generate transport, transport order and can arrange car transport, inventory information query, accordingly for the related inventory operation, GRN and expense reports related to the content, and be able to deal with the corresponding expense reports by financial management module, generating daily, monthly and yearly financial settlement reports.

Can directly from the logistics company warehouse transfer goods, it is necessary to query the inventory information, see whether the stock can meet the corresponding needs of those customers, if can meet the warehouse can be carried out operation, produce a transport bill, but also can deal with the transport bill, arrange the vehicle for transportation, etc.; If it cannot be met, it can generate purchase orders, transport orders, so as to meet the relevant needs of customers, generate related cost reports, and pay the financial management module to process cost reports, and also produce daily, monthly and annual financial settlement reports.

If the order is only allowed to be shipped from a certain supplier, the corresponding shipping order may be generated to meet the needs of the relevant customers. At the same time, the corresponding expense report will also be generated. The financial management module is responsible for handling the expense report.

From the perspective of function, most customers need the logistics provider to provide the corresponding logistics services, including: freight, inventory, etc., the logistics provider on the one
hand to timely handle the service request submitted by the customer, on the other hand, but also timely management of various internal affairs.

From the aspect of performance, in the server side, the existing various hardware and software conditions, as well as the B/S structure mode adopted by the system, can meet the requirements of customers and service providers. So in terms of information processing, it mainly depends on the quality of the network used by both parties.

2.4. *Improved ALOHA Algorithm*

When RFID readers read and write tags, since the information is received by multiple tags, multiple tags will react at the same time, which may lead to the collision of electronic tags, and thus the tags cannot be read and written normally [9-10]. In recent years, anti-collision of RFID tags has attracted the attention of many experts, because it is the key to improve the reading and writing efficiency. Based on ALOHA algorithm, this paper adopts the dynamic time-slot ALOHA anti-collision algorithm. This algorithm is suitable for tags and has been verified to greatly improve the reading and writing work of RFID readers.

In order to reduce the probability of collision, the proportion of the transmission time of cycle summary data is reduced. So pure ALOHA algorithm is not very efficient. Using mathematical analysis of transmission efficiency, the relationship between channel throughput rate S and frame generation rate G of ALOHA algorithm is:

$$S = Ge^{-2G}$$  \hspace{1cm} (1)

Derivation of the above equation shows that when G=0.5, the maximum throughput is 18.4%.

At this time, the transmission efficiency is still low. In order to further improve the channel efficiency, some scholars have made progress in their research and published a slot ALOHA algorithm. The idea of this algorithm is to divide the time into a separate time period, each time period is called a frame, all transponders must complete the data transmission work within the specified time period. The transmission of its data begins at the beginning of each frame and is completed within that time slot.

In the algorithm, the number of time slots has a great impact on the transmission performance of the channel: if the number of time slots is limited, too many responses will soon cause too many collisions; if the number of time slots is too large, sometimes no responses will occur.

Similarly, the relationship between channel throughput rate S and frame generation rate G of the time slot ALOHA algorithm is:

$$S = Ge^{-G}$$ \hspace{1cm} (2)

When G=1, the maximum throughput rate is 36.8%.

3. **Client Stress Testing and Algorithm Verification**

3.1. **Client Stress Testing**
Before going online, stress test should be conducted on the server to evaluate the normal operation of the server after going online.

There are many tools for the stress test of the server, such as PTS provided by Ali and JMeter provided by Wetest provided by Tencent, which can be customized for deployment. This system uses Wetest server provided by Tencent to conduct stress test.

The server uses the cloud server of Ali Cloud, which is configured with 1 core and 2GB1Mbps bandwidth. As there are at most 16 APIs defined in a single test of Wetest stress test, a total of 16 operations of add, delete, check and change are selected for stress test according to the frequency of each API in practical application.

3.2. Proof of Algorithm

The improved ALOHA algorithm was verified and the effectiveness of the algorithm was proved by monitoring the reading and writing efficiency of tags. Use RFID tags for reading and writing tests.

We show the usefulness of the algorithm directly through several test metrics. The test was to use 20 tags to read the results in half a minute.

4. Test Results

4.1. CPU and Memory Usage

As shown in Figure 1, when the outflow bandwidth of the server is at full load, the number of people online continues to increase and the CPU begins to work at full load, but there is no significant impact on the server performance. Due to the gradual saturation of the incoming bandwidth and the increasing memory occupancy, the requests to the server began to decrease, the CPU load primary key decreased, and the receiving and sending packet rate basically remained unchanged.

4.2. Server Broadband Usage
As shown in Figure 2, combined with Figure 1, it can be seen that the performance inflection point of the server occurs when the number of people online reaches 20. The reason for the performance inflection point is the insufficient outflow bandwidth of the public network. Then, as the pressure increased, the server could not process the requests as fast as they came in, and the server gradually ran out of memory until the memory ran out and the server went down, with about 200 people online. Therefore, the performance bottleneck of this single point server lies in the network bandwidth, which eventually leads to the outage due to insufficient memory. When maintaining the best performance, the maximum concurrent volume is 20 people.

4.3. Algorithm Validation Results

|                  | No algorithm | ALOHA algorithm | I-ALOHA algorithm |
|------------------|--------------|-----------------|-------------------|
| First test       | 9            | 14              | 18                |
| Second test      | 12           | 12              | 19                |
| Third test       | 10           | 15              | 17                |

As shown in Table 1, the results show that the read and write efficiency of the improved adaptive dynamic slot ALOHA algorithm has been significantly improved, both in the case of no algorithm and in the case of ALOHA algorithm. This helps to improve the reading and writing efficiency of logistics in the hardware terminal. This helps improve the efficiency of the whole system.

5. Conclusion

By analyzing the structure, characteristics and development trend of the traditional third-party logistics system, it points out that the intelligent logistics will be an important direction of the development of the third-party logistics under the influence of a series of factors such as the need to reduce costs,
improve efficiency and establish brands. This article analyzed the demand of the third party logistics enterprise, according to demand design to achieve a complete set of hardware and software system, to provide from the upstream client order and goods transport, cargo warehousing, cargo inventory, outbound goods, cost settlement in the library business process, and the metal complex environment indoor positioning, a photo storage in road monitoring, data statistics, document and review, and other functions. Through the establishment of a small logistics system, the whole system is tested and verified. The system realizes many tasks such as data acquisition, information transmission, database information storage, client information inquiry, distribution and navigation. However, due to time constraints, the comprehensive intelligent logistics system and concurrent operation tests of multiple terminals have not been completed. In the later stage, the intelligent logistics distribution system will continue to be improved to provide reference for the intelligent logistics industry.

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References

[1] Chang-Soo, Lee. The Impacts of Environmental Uncertainty, Logistics Information System, and Organizational Structure on Logistics Performance[J]. The Journal of Internet Electronic Commerce Resarch, 2016(4):247-271.

[2] Lorenc, Augustyn, Michnej, et al. Information system aiding the logistics processes of loading and securing in railway transport[J]. International journal of shipping and transport logistics: IJSTL, 2016, 8(5):568-589.

[3] Freitag M , Kotzab H , Pannek, Jürgen. [Lecture Notes in Logistics] Dynamics in Logistics || Methodology for Development of Logistics Information and Safety System Using Vehicular Adhoc Networks[J]. 2017, 10.1007/978-3-319-45117-6(Chapter 17):185-195.

[4] Zhao Y , Zhang Y . Safety Protection of E-Commerce Logistics Information Data under the Background of Big Data[J]. International Journal of Network Security, 2019, 21(1):160-165.

[5] Pan X , Dresner M , Xie Y . Logistics IS resources, organizational factors, and operational performance: An investigation into domestic logistics firms in China[J]. The International Journal of Logistics Management, 2019, 30(2):569-594.

[6] Wang J . Application of Association Rule Mining Algorithm in Logistics Information System Design[J]. Journal of Software Engineering, 2017, 11(2):217-223.

[7] Guo L . Design and implementation of logistics information system based on internet of things[J]. Agro Food Industry Hi Tech, 2017, 28(1):2646-2651.

[8] Petra Pleková. PROJECT OF INFORMATION SYSTEM FOR THE NEEDS OF LOGISTIC CONFERENCES ORGANIZED BY DEPARTMENT OF LOGISTICS[J]. Acta Logistica,
[9] Lorenc A, Michnej M, Szkoda M. Information system aiding the logistics processes of loading and securing in railway transport[J]. International Journal of Shipping and Transport Logistics, 2016, 8(5):568-589.

[10] Pereira T, Ferreira F A, Catarina Araújo. A MULTICRITERIA DECISION MODEL FOR THE SELECTION OF AN INFORMATION SYSTEM FOR A LOGISTICS COMPANY USING MMASSI/IT[J]. International Journal for Quality Research, 2019, 13(4):837-848.