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# Design of logistics tracking and monitoring system based on internet of things

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**Abstract.** To improve the information collection and tracking management in existing logistics, we built a logistics tracking system based on Internet of things. The system is implanted with Java language. We designed the system with server layer and application layer. The design adopts the multi-flow method. The implantation of the system shows that the system automatically displays the work order to be processed on the corresponding label card. The system can automatically flow to the corresponding label card of the work order handler of the next task node for the work order that the current node task is processed. The simulation results indicate that the process of the work order is in the closed-loop state, which greatly improves the efficiency of the work order processing. We improved the logistics tracking system with RFID tags, the system can integrate into the intelligence transportation system.

**Key words.** Internet of things, logistics tracking, monitoring system, ITI.

## 1. Introduction

At present, with the rapid development of economic globalization and information technology, the service economy has developed rapidly in the world, and the logistics industry as a new service sector has been rising rapidly in the world [1], too. More and more abundant materials bring convenience to people's lives, but also bring some impact. How to store and transport the large number of goods with various kinds for effective information management has become an important issue. In the process of information management, it needs to track and trace the materials, and can automatically deal with the fault events. The traditional management methods are no longer applicable. The emergence of Internet of things provides the methods and ideas for solving these problems. Internet of things can connect any items to the Internet through RFID, WSN and other information sensing equipment. It can achieve information exchange through the network, and is provided with the fast acquisition speed and high degree of automation. The logistics tracking

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management system based on Internet of things can realize the whole process visual control of purchasing, transportation, storage, distribution and use in the logistics supply chain, and can automatically deal with the fault events and promote the logistics management information [2].

Because of the time-sensitive nature of the perishable food, it is required that the cold chain be able to perform the real-time low-temperature environmental monitoring function and keep the cold chain's low-temperature transportation environment, therefore keeping the low temperature environment is the core requirement of the cold chain system. If the temperature control is not accurate enough, it will lead to a series of low-quality products [3]. Each link of cold chain, from the picking of the product to being sold out, need to participate in control. Every link in the chain can go wrong and break the cold chain, either on the platform of a warehouse, in transit, in storage, or in a retail supermarket, which can affect the final consumer's demand. At present, China's cold chain monitoring system is relatively sound, and sound monitoring measures have been taken in the production, storage and sales. But the cold chain monitoring in the transport is relatively weak. Cold chain system based on Internet of things makes sure that the food is transported in the specified low-temperature environment to keep the original freshness, color and nutrition of the food and ensure the food quality and safety [4].

## 2. Literature review

Internet of Things is a series of independent systems built on the part of infrastructure of existing Internet. It has a unique intelligent infrastructure. Radio Frequency Identification (RFID) is one of the key technologies of Internet of things. The Internet of things can collect information fast and accurately with RFID technology, and make the information interconnect with the traditional Internet [5]. Communication modes of Internet of things includes things and things communication, things and people communication, people and people communication and other different types, which makes the virtual network world extend to real life. The practical application of the Internet of things provides a new opportunity for the development of the logistics industry, gives the goods in the process of transport intelligence, and turns the logistics information management into intelligent. Instrumented, networking, perception, automation and intelligence are the basic characteristics of things [6].

The intelligent, location, tracking, monitoring and management of the Internet of Things is embodied in the field of logistics as a centralized data processing and service center based on the network. It uses radio frequency identification devises (RFID) to collect material information, and transmits information to the data service center through the network. It also integrates the material information on the map displayed by GIS system to achieve the visibility control of material [7-8]. In foreign countries, the intelligent logistics starts some earlier. The development of intelligent logistics of some countries in Europe and the United States is in a leading position. In the United States, the federal logistics company developed a set of logistics system based on Internet of things for real-time monitoring of logistics.

The system calculates the data uploaded through the sensor in the server-side, if the logistics has problems, it can alarm in time. And the user can monitor the dynamic of the goods in time, which is easy to transport some dangerous goods, fragile goods and high value goods. Caterpillar has developed a system which is specifically designed for intelligent logistics. The system can simulate, plan, evaluate and forecast the process of warehousing and freight transportation. In Japan, the intelligent logistics develops rapidly, and the intelligent logistics is applied in the logistics transportation of cold chain, fresh chain and chemical industry, [9].

In the country, the national policy attaches importance to Internet of things, and more and more technology companies want to develop on the intelligent logistics. The development of intelligent logistics of some traffic hub cities in China is much higher than other cities. Major electronic business develop rapidly in the field of e-commerce, but also aware the importance of the logistics industry in the supply chain, have increased logistics construction, and Jingdong, Suning and other electricity providers continue to invest in logistics warehousing. With the rapidly development of upstream and downstream industries of supply chain, the logistics industry has also been paid more and more attention [10]. At the same time, the arrival of the era of large data brings opportunities and challenges to the development of intelligent logistics. The storage, processing, query of logistics information uploaded all the time makes the traditional data storage become powerless. Therefore, the new logistics information system of Internet of things should improve the storage way of data.

## 3. System composition and flow design

### *3.1. The overall structure of system*

The overall structure of logistics tracking system based on Internet of things is shown in Fig. 1. It is mainly divided into server layer and application layer. The server layer is the bottom of the application layer. Server layer will deal with the distribution of goods, invoicing and inventory information collected through a variety of sensors. Application layer mainly turns the information processed by server layer into events, and stores the information in the database in accordance with the event format required by logistics enterprises. And then the different information is showed to each user in the system interface according to the different user rights to query and maintain conveniently.

### *3.2. System composition*

Server layer. Server layer is divided into three layers: sensor abstraction layer, application engine layer and communication layer. The sensor abstraction layer provides a common API that integrates with the LLRP sensor adapter, the Alien sensor adapter, the Borcorde sensor adapter, and the DB sensor adapter to collect various data information from the sensor and generate raw events. The application engine layer filters the collected original events according to event handling rules

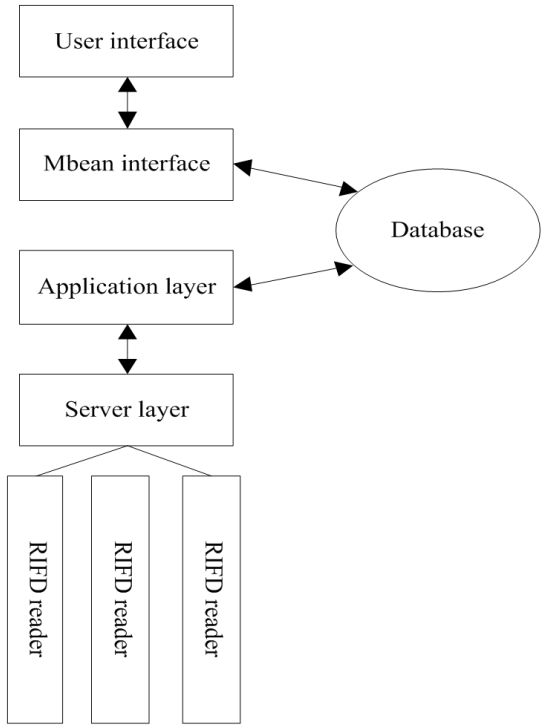



Fig. 1. Overall structure of logistics tracking system based on Internet of things

to get the industrial events needed by logistics enterprises. Through the TCP and SOAP protocol, JMS and RMI technology, communication layer will use the event of the industry in the engine layer to integrate with other systems (such as: database, operation and maintenance systems, etc.). The overall architecture of the server layer is shown in Fig. 2. Sensor abstraction layer: server layer connects to Borcorde reader, RFID reader, terminal mobile devices and wireless sensors and other sensors, from which to collect logistics information for processing. The sensor abstraction layer allows the user to collect all the information needed for the application in a transparent manner. Application Engine Layers: The application engine layer processes a large number of redundant events generated by the sensor abstraction layer and generates meaningful events needed by the logistics industry. The server uses a sophisticated event processing engine Esper that filters and identifies valuable events from a large number of event streams according to rules. Esper allows user to write query statements that are similar to database syntax.

Communication layer: the communication layer will submit the processed data to the application system for integration to realize the information exchange. The design of various application interfaces in this layer achieves effective integration with the existing application system.

Application layer. Application layer mainly turns the event information processed by the server layer into the event information needed by the logistics industry, and

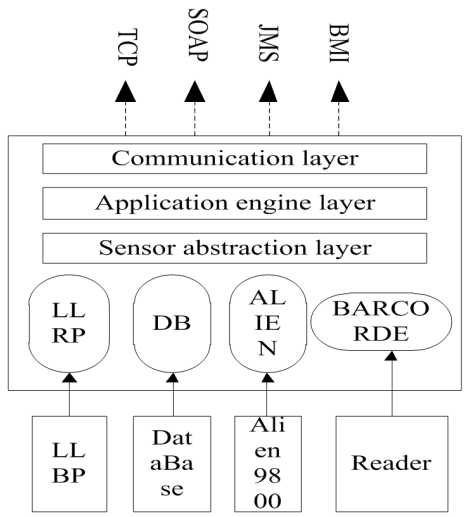



Fig. 2. Overall structure of server layer

then the event information is stored in the database for the display, viewing and dealing with in user interface. In the distribution process, there are two main events: normal events and abnormal events. The normal events include that the designated items reach to the designated location and leave the designated location. Abnormal events indicate that the items are not transported according to the requirements, which includes that items have missed a place, the goods are shipped back, the items don't follow the prescribed route to transport, and there is no corresponding item name and the corresponding location name. The specific process is shown in Fig. 3.

### *3.3. System flow design*

In the logistics business process, the system refers to the best practice and the related standard of the ITIL, and designs the operable, distributed and automatic processing flow according to the event processing in the process of tracking the goods. The design adopts the multi-flow method. The normal events stored in the database by the application layer are handled according to the event work order flow. The abnormal events are processed according to the problem work order flow, and the emergency situation such as line adjustment during the transportation of the goods is processed according to the change work order flow. Event work order can be generated automatically or manually by the failure alarm event during work order processing. Event work order can lead to change work orders and problem work order. Users and customers can query the detail information of the transport process of goods through the system's service desk. Maintenance personnel of logistics operation can deal with the events produced in the transport of goods in accordance with the flow, and manage the assets of logistics enterprises.

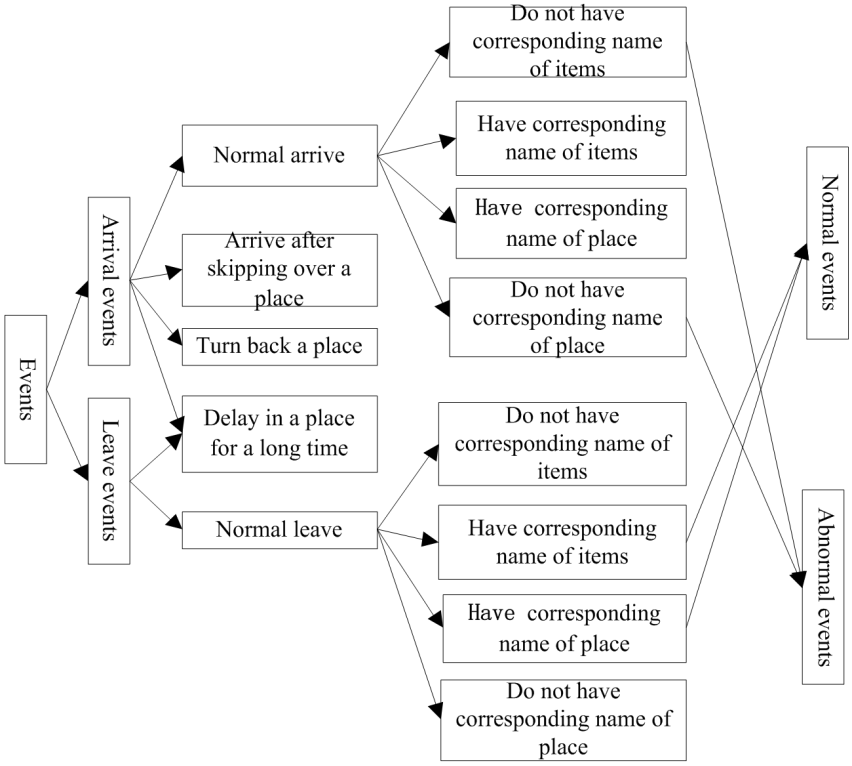



Fig. 3. Application layer events analysis

## 4. System theory and implementation

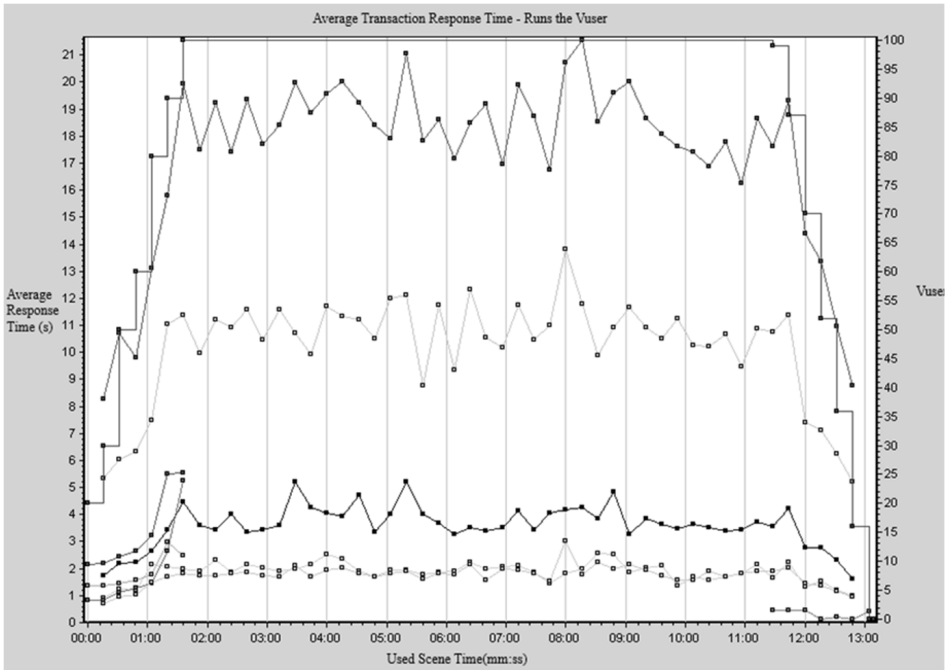
### *4.1. RFID module*

RFID module uses high-frequency RFID devices to collect data, and the goods in transit can be real-time queried. The user can get the information of the arrived items in time through text messages and Email, and can query the historical information.

### *4.2. Geographic information system*

Geographic information system (GIS) is a comprehensive technical system that collects, stores, computes, retrieves, analyzes, displays and describes the geographical information in the whole or part of the Earth's surface space, supported by the computer network system. The geographic information system has the function of displaying the geographical location information of the articles accurately. The system uses this function and the official Chinese map API interface provided by Google to develop to realize the visualization of the geographical information during the transportation of goods, and can improve the accuracy of the display and

maintain the articles line.




| Colour | Figure | Proportion | Measure | The Minimum Value of The Graph | The Average of The Graphs | The maximum value of the graph | The Middle of The Graph | Standard Deviation of Graphs |
|---|---|---|---|---|---|---|---|---|
| | Response Time | 1 | Action_Transaction | 8.279 | 17.335 | 21.55 | 18.396 | 3.119 |
| | Response Time | 1 | vuser_end_Transaction | 0.121 | 0.314 | 0.468 | 0.398 | 0.148 |
| | Response Time | 1 | vuser_init_Transaction | 2.156 | 3.389 | 5.526 | 2.632 | 1.388 |
| | Response Time | 1 | Save | 0.923 | 1.867 | 2.544 | 1.912 | 0.371 |
| | Response Time | 1 | Fill in a form | 1.605 | 3.584 | 5.201 | 3.606 | 0.758 |
| | Response Time | 1 | Create a new page | 5.189 | 10.192 | 13.794 | 10.741 | 1.92 |
| | Response Time | 1 | log in | 0.808 | 1.908 | 5.26 | 1.266 | 1.486 |
| | Response Time | 1 | Enter the work order module | 1.343 | 1.852 | 2.995 | 1.573 | 0.594 |
| | Response Time | 1 | Select the next link | 0.697 | 1.74 | 3.032 | 1.802 | 0.37 |
| | Run The Vuser | 1 | Run | 0 | 52.667 | 100 | 52 | 33.486 |

Fig. 4. Monthly information system response time

### *4.3. Automatic process of event flow based on ITIL*

The event generated by the system is processed through the flow process interface in accordance with pre-designed ITIL process, including the event work order process, the problem work order process and change work order process. The system automatically displays the work order to be processed on the corresponding label card. The system will automatically flow to the corresponding label card of the work order handler of the next task node for the work order that the current node task is processed. In the process of the whole work order, the process of the work order is in the closed-loop state, which greatly improves the efficiency of the work order processing.

## 5. Conclusion

We design and develop the logistics tracking management system based on Internet of things technology. The system realizes the tracking and monitoring of articles in the process of goods transportation, and adopts the ITIL idea to process the events produced in the process of transportation and realize the automatic management. The realization of the system makes the management of logistics and transportation more intelligent and humanized, and promotes the development of logistics industry information construction. The emergence of Internet of things has brought new opportunities for the development of the logistics industry. With the popularity of RFID tags, information technology development of logistics industry will enter a new stage.

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